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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	1426-148.101	7684

106622 7590 05/13/2019

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
CAI, WAYNE HUU	

ART UNIT	PAPER NUMBER
2644	

NOTIFICATION DATE	DELIVERY MODE
05/13/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@bluecapitallaw.com

Office Action Summary	**Application No.** 15/674,483	**Applicant(s)** Lin et al.	
	Examiner WAYNE H CAI	**Art Unit** 2644	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 04/15/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-12 and 16-20 is/are pending in the application.

5a) Of the above claim(s) 13-15 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-12 and 16-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 08/10/2017 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Arguments

2. Applicant's arguments with respect to claims 1-12, and 16-20 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claim(s) 1, 4, 5, 8, 9, 16 and 19 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong et al. (hereinafter "Xiong", US 2018/0020365) in view of Chang et al. (hereinafter "Chang", US 2019/0052331).

Regarding claim 1, Xiong discloses a method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a first numerology (i.e., uplink resource transmitted by the base station to UE as described in paragraph 0146), wherein the information comprises a first frequency location (i.e., frequency location as described in paragraph 0055) and a first bandwidth for the numerology (i.e., uplink resource allocated by the base station as described in paragraphs 0055 and 0146. Also, see Fig. 8 and its descriptions); and

deriving, by the UE, a resource allocation for the numerology based on the first frequency location and the first bandwidth (i.e., UE selects one resource within the resource pool for transmission as described in Abstract, and as described in paragraph 0122).

Xiong, however, does not expressly disclose:

the information comprises information for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

deriving, by the UE a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH.

In a similar endeavor, Chang discloses device and method for synchronous beam switching. Chang also discloses:

the information comprises information for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH) (i.e., PDSCH as described in paragraph 0027);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH (i.e., PDCCH associated with PDSCH as described in paragraph 0027); and

deriving, by the UE a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH (i.e., the UE receives decode the received PDCCH as described in paragraph 0027).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to allocate resources more effectively and optimize the network operations.

With further regarding claim 16, since this claim recites a different statutory class and include similar features to those of recited within claim 1. The Examiner rejects claim 16 at least for the same reasons discussed above. In addition, Xiong also discloses a User Equipment (UE) (i.e., UE 1200 as shown in Fig. 12) capable of determining numerology bandwidth, comprising:

a control circuit (i.e., circuitry as described in paragraph 0094-0096); a processor installed in the control circuit (i.e., processor as described in paragraphs 0094-0096); and a memory installed in the control circuit and coupled to the processor (i.e., memory coupled to circuitry and processor as described in paragraphs 0094-0096), and wherein the processor is configured to execute a program code stored in the memory (paragraphs 0094-0096).

Regarding claim 4, Xiong and Chang disclose all limitations recited within claims as described above. Xiong also discloses wherein the first frequency location is an index of a resource block (paragraph 0055).

Regarding claims 5 and 19, Xiong and Chang disclose all limitations recited within claims as described above. Chang also discloses receiving, by a user equipment (UE), information for a second numerology, wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the second frequency location and the second bandwidth (paragraph 0027).

Regarding claim 8, Xiong and Chang disclose all limitations recited within claims as described above. Xiong also discloses wherein the first bandwidth and the first frequency location is configured by UE-specific RRC message (see claim 17).

Regarding claim 9, Xiong and Chang disclose all limitations recited within claims as described above. Chang also discloses wherein the first bandwidth and the first frequency location is indicated by a physical control channel (paragraph 0027).

5. Claim 2, 3, 6, 7, 17, and 18 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Chang and further in view of Dai et al. (hereinafter "Dai", US 2016/0359593).

Regarding claims 2, and 17, Xiong and Chang disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses configuring, by the UE, a system bandwidth (paragraphs 0238-0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claims 3, and 18, Xiong, Chang and Dai disclose all limitations recited within claims as described above. Dai also discloses wherein the system bandwidth is larger than the first bandwidth (i.e., the system bandwidth is larger than the component carriers as described in Abstract).

Regarding claim 6, Xiong and Chang disclose all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses wherein the first frequency location is an

index of a resource block with a central frequency within the first bandwidth portion (paragraph 0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claim 7, Xiong, Chang and Dai disclose all limitations recited within claims as described above. Dai also discloses the first bandwidth portion is derived from the first frequency location and the first bandwidth (paragraph 0244).

6. Claim 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Chang and further in view of Ma et al. (hereinafter "Ma", US 10,045,345).

Regarding claim 10, Xiong and Chang disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Ma discloses systems and methods self-contained air interface partitions. Ma also discloses wherein the first numerology is indicated by a physical control channel (see claim 1).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to inform the user of the allocated resources.

7. Claim 11, 12, and 20 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Chang, and further in view of Pragada et al. (hereinafter "Pragada", US 2014/0321282).

Regarding claim 11, Xiong and Chang disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a maximum bandwidth for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 12, Xiong and Chang disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a maximum bandwidth that the UE is able to receive for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 20, Xiong and Chang disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a configured bandwidth for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WAYNE H. CAI whose telephone number is (571)272-7798. The examiner can normally be reached on Monday-Friday, 8:00 AM - 5:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KATHY WANG-HURST can be reached on (571)270-5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Wayne H Cai/
Primary Examiner, Art Unit 2644

Notice of References Cited	Application/Control No. 15/674,483	Applicant(s)/Patent Under Reexamination Lin et al.	
	Examiner WAYNE H CAI	Art Unit 2644	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20190052331-A1	02-2019	Chang; Wenting	H04B7/0626	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/18/2018	01/09/2019	05/07/2019						
	1	÷	✓	✓						
	2	÷	✓	✓						
	3	÷	✓	✓						
	4	÷	✓	✓						
	5	÷	✓	✓						
	6	÷	✓	✓						
	7	÷	✓	✓						
	8	÷	✓	✓						
	9	÷	✓	✓						
	10	÷	✓	✓						
	11	÷	✓	✓						
	12	÷	✓	✓						
	13	÷	N	N						
	14	÷	N	N						
	15	÷	N	N						
	16	÷	✓	✓						
	17	÷	✓	✓						
	18	÷	✓	✓						
	19	÷	✓	✓						
	20	÷	✓	✓						

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	Art Unit
	WAYNE H CAI	2644

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventors Search	01/09/2019	WHC
See Search History	01/09/2019	WHC
See Update Search History	05/07/2019	WHC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L6	19	@ad<"20160812" and 5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/08 09:35
L5	90	(((sub-carrier subcarrier) adj3 spac$5) or numerolog$5 or "5G NR" or "5G" or fifth adj generation or "5" adj generation) same (PUSCH or PDSCH or physical adj uplink adj shar$5 adj channel$2 or physical adj downlink adj shar$5 adj channel$2) same (PDCCH or physical adj downlink adj control$5 adj channel$2) same (allocat$5 reserv$9 assign$9)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/08 09:34
L4	19	@ad<"20160812" and 3	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/08 09:25
L3	87	(((sub-carrier subcarrier) adj3 spac$5) or numerolog$5 or new adj radio or "5g nr") same (PUSCH or PDSCH or physical adj uplink adj shar$5 adj channel$2 or physical adj downlink adj shar$5 adj channel$2) same (PDCCH or physical adj downlink adj control$5 adj channel$2) same (allocat$5 reserv$9 assign$9)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/08 09:25
L2	4846	(((sub-carrier subcarrier) adj3 spac$5) or numerolog$5 or new adj radio or "5g nr") and (PUSCH or PDSCH or physical adj uplink adj shar$5 adj channel$2 or physical adj downlink adj shar$5 adj channel$2) same (PDCCH or physical adj downlink adj control$5 adj channel$2)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/08 09:24
L1	5413	(((sub-carrier subcarrier) adj3 spac$5) or numerolog$5 or new adj radio or "5g nr") and (PUSCH or PDSCH or physical adj uplink adj shar$5 adj channel$2 or physical adj downlink adj shar$5 adj channel$2) and (PDCCH or physical adj downlink adj control$5 adj channel$2)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/08 09:23
S58	595	@ad<"20160812" and S57	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 12:03
S57	888	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) near10 (allocat$5 reserv$9	US-PGPUB; USPAT; EPO; JPO;	OR	OFF	2019/05/07 12:01

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		schedul$5 assign$7) same (PDCCH or physical adj downlink adj control$4 adj channel$2) same (DCI or downlink adj control$5 adj (information indicat$5)) same (ue or user adj equipment$2) and (numerolog$5 NR or new adj radio)	DERWENT			
S56	6135	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) near10 (allocat$5 reserv$9 schedul$5 assign$7) same (PDCCH or physical adj downlink adj control$4 adj channel$2) same (DCI or downlink adj control$5 adj (information indicat$5)) same (ue or user adj equipment$2)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:59
S55	6992	@ad<"20160812" and S54	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:58
S54	8763	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) near10 (allocat$5 reserv$9 schedul$5 assign$7) same (PDCCH or physical adj downlink adj control$4 adj channel$2) same (DCI or downlink adj control$5 adj (information indicat$5))	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:50
S53	530	@ad<"20160812" and S52	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:44
S52	1316	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) near10 (allocat$5 reserv$9 schedul$5 assign$7) same (PDCCH or physical adj downlink adj control$4 adj channel$2) and (new adj radio or numerolog$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:44
S51	684	@ad<"20160812" and S50	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:38
S50	1994	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) same (PDCCH or physical adj downlink adj control$4 adj channel$2) same (allocat$5 reserv$9 schedul$5 assign$7) and (new adj radio or numerolog$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:38
S49	17913	@ad<"20160812" and S46	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:33
S48	0	@ad<"20160812" and S47	US-PGPUB;	OR	OFF	2019/05/07 11:33

			USPAT; EPO; JPO; DERWENT			
S47	72	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) same (PDCCH or physical adj downlink adj control$4 adj channel$2) same (allocat$5 reserv$9 schedul$5 assign$7) same numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:32
S46	22596	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) same (PDCCH or physical adj downlink adj control$4 adj channel$2) same (allocat$5 reserv$9 schedul$5 assign$7)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 11:17
S45	30125	(PDSCH or physical adj downlink adj shar$4 adj channel$2 or PUSCH or physical adj uplink adj shar$5 adj channel$2) same (PDCCH or physical adj downlink adj control$4 adj channel$2)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/05/07 10:57
S44	2	("20180020365").PN.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2019/05/07 10:51

5/8/2019 10:07:01 AM
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	15/674,483
Confirmation No.	:	7684
Applicant	:	Ko-Chiang Lin, and Ming-Che Li
Filed	:	August 10, 2017
Title	:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
TC/A.U.	:	2644
Examiner	:	Wayne Huu Cai
Docket No.	:	1426-148.101 (1050198-US)
Customer No.	:	106622

RESPONSE TO OFFICE ACTION

Dear Sir:

In response to the Office Action mailed on January 15, 2018, having a three-month period for responding to **April 15, 2019**, please consider the following amendments and remarks:

Claims begin on page 2.

Remarks begin on page 5.

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IN THE CLAIMS:

1. (Currently Amended) A method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a first numerology, wherein the information comprises a first frequency location and a first bandwidth for the numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH); [[and]]

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

deriving, by the UE, a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth.

2. (Original) The method of claim 1, further comprising:

configuring, by the UE, a system bandwidth.

3. (Currently Amended) The method of claim 2, wherein the system bandwidth is larger than the first bandwidth.

4. (Currently Amended) The method of claim 1, wherein the first frequency location is an index of a resource block.

5. (Currently Amended) The method of claim 1, ~~wherein the resource allocation designates a resource within a bandwidth portion~~ further comprising:

receiving, by a user equipment (UE), information for a second numerology, wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the second frequency location and the second bandwidth.

6. (Currently Amended) The method of claim 1, wherein the first frequency location is an index of a resource block with a central frequency within [[a]]the first bandwidth portion.

7. (Currently Amended) The method of claim 6, the first bandwidth portion is derived from the first frequency location and the first bandwidth.

8. (Currently Amended) The method of claim 1, wherein the first bandwidth and the first frequency location is configured by UE-specific RRC message.

9. (Currently Amended) The method of claim 1, wherein the first bandwidth and the first frequency location is indicated by a physical control channel.

10. (Currently Amended) The method of claim 1, wherein the first numerology is indicated by a physical control channel.

11. (Currently Amended) The method of claim 1, wherein the first bandwidth is a maximum bandwidth for the first numerology.

12. (Currently Amended) The method of claim 1, wherein the first bandwidth is a maximum bandwidth that the UE is able to receive for the first numerology.

13. (Withdrawn) A method for determining numerology bandwidth, the method comprising:

informing a user equipment (UE) information for a numerology, wherein the information comprises a bandwidth portion for the numerology; and

scheduling the UE with a resource allocation for the numerology within the bandwidth portion in a transmission time interval (TTI).

14. (Withdrawn) The method of claim 13, wherein the UE does not assume that a resource block within the bandwidth portion and outside the resource allocation is transmitted with the numerology in the TTI.

15. (Withdrawn) The method of claim 13, wherein the bandwidth portion is derived from a frequency location and a bandwidth.

16. (Currently Amended) A User Equipment (UE) capable of determining numerology bandwidth, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

receive information for a first numerology, wherein the information comprises a first frequency location and a first bandwidth for the physical downlink shared channel or the physical uplink shared channel for the numerology; [[and]]

detect a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

derive a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth.

17. (Original) The UE of claim 16, wherein the UE configures a system bandwidth.

18. (Currently Amended) The UE of claim 17, wherein the system bandwidth is larger than the first bandwidth.

19. (Currently Amended) The UE of claim 16, ~~wherein the resource allocation designates a resource within a bandwidth portion~~ wherein the processor is further configured to execute a program code stored in the memory to:

receive information for a second numerology, wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the second frequency location and the second bandwidth.

20. (Currently Amended) The UE of claim 16, wherein the first bandwidth is a configured bandwidth for the first numerology.

REMARKS

Claims 1-29 are pending in the application. In the Office Action, claims 1, 4, 5, 8, 16 and 19 stand rejected under 35 U.S.C. § 102 as being anticipated by Xiong (U.S. Patent Publication No. 2018/0020365). *See* Office Action, ¶ 6. Claims 2, 3, 6, 7, 17, and 18 also stand rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Dai (U.S. Patent Publication No. 2016/0359593). *See* Office Action, ¶ 8. Furthermore, claim 9 stands rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Lee (U.S. Patent Publication No. 2013/0083753). *See* Office Action, ¶ 9. In addition, claim 10 stands rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Ma (U.S. Patent No. 10,045,345). *See* Office Action, ¶ 10. Also, claims 11, 12, and 20 stand rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Pragada (U.S. Patent Publication No. 2014/0321282). *See* Office Action, ¶ 11.

Claims 1, 3-12, 16, and 19-20 have been amended. No new matter has been added. Applicants respectfully request reconsideration of the claims as amended.

Claims 1 and 16 specify that a first bandwidth portion is derived from the received first frequency location and first bandwidth, and that a resource allocation within the first bandwidth portion is derived (or allocated) within the first bandwidth portion based on the first frequency location and the first bandwidth.

In rejecting the claims, the Office Action cites to Paragraphs [0055] and [0146] of Xiong. Paragraphs [0054], [0055], and [0146] state:

> [0054] FIG. 8 is a diagram of resource pool periodicity 800. Initially, MTC devices would access the network and acquire the necessary information for resource pools 808 for uplink transmission. **The configuration of this resource pool 808 can be predefined or provided by the higher layers via MIB or SIB or UE specific dedicated RRC signaling.**
>
> [0055] **The time and frequency resource configuration for uplink transmission resource pool 808 may comprise at least one of the following information: frequency location (e.g.,in resource block (RB) index region) and/or time location (e.g., OFDM symbol index, slot index, subframe index, radio frame index)**. As a more specific example to signal time related information, the configuration can contain at least periodicity 806 and/or subframe offset 804 for this resource pool 808.

> [0146] Example 33 is circuitry for a wireless mobile network base station. The circuitry can be configured to provide a synchronization signal provided over a mobilebroadband network by a base station. **The circuitry can also be configured to transmit data describing a set of uplink resources within the mobile broadband network of the base station**. The circuitry can be further configured to receive a scheduling request for the selected resource from a user equipment (UE). The circuitry can also be configured to receive data from the UE in the selected resource to the base station without acknowledgement by the base station.

See Xiong, Paragraphs [0054]-[0055] and [0146], emphasis added.

As seen, Xiong discloses that the resource to transmit data is selected by a transmitter from a resource pool. The resource pool in Xiong defines a region that a base station allocates for transmitters to select so that a transmitter would select resource for transmission based on the resource pool without any other instruction from the base station.

In contrast, as recited in the claims, the present invention describes a way for base station to allocate resource via a control channel to the transmitter. The transmitter would need to derive a scheduled resource based on both "PDCCH" and "a bandwidth portion" instead of "a bandwidth portion" only. The motivation to derive the scheduled resource based on both "PDCCH" and "a bandwidth portion" is to solve the issue of multiplexing among resources for different numerologies, which is **not** disclosed by Xiong.

For the reasons discussed above, Applicants respectfully submit that claims 1-13 and 16-20 are patentable over the cited prior art references.

In view of the foregoing it is respectfully submitted that the pending claims are in condition for allowance. Reconsideration of the rejections is requested. Allowance of the claims at an early date is solicited. The Examiner is invited to contact Applicant's undersigned counsel by telephone at (714) 839-3800 to expedite the prosecution of this case should there be any unresolved matters remaining.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Respectfully submitted,
Sang N. Dang
BLUE CAPITAL LAW FIRM, P.C.

Dated: April 15, 2019

/Sang N. Dang/
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Samsung Exhibit 1006, Page 24 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ko-Chiang Lin and Ming-Che Li	
Title:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	15/674,483	Filed: August 10, 2017
Examiner:	Wayne Huu Cai	Group Art Unit: 2644
Attorney Docket No.:	1426-148.101 (1050198-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 2 Page Amendment Transmittal Sheet; and 7 Page Amendment are being transmitted to the United States Patent and Trademark Office via EFS-Web on April 15, 2019.

Date: April 15, 2019 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
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Fax: 714-795-2995

Electronic Acknowledgement Receipt

EFS ID:	35730794
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	15-APR-2019
Filing Date:	10-AUG-2017
Time Stamp:	17:11:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1426-148-101--ROAof01152019asFiled04152019.pdf	182003 78aef6c27c021aaca1f590c4a0029a337ddf3340	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	2
	Amendment/Req. Reconsideration-After Non-Final Reject	3	3
	Claims	4	6
	Applicant Arguments/Remarks Made in an Amendment	7	9
	Miscellaneous Incoming Letter	10	10
Warnings:			
Information:			
	Total Files Size (in bytes):	182003	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Amendment Transmittal Letter

Docket Number
1426-148.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Title of Invention

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

First Named Inventor	Ko-Chiang Lin
Application No.	15/674,483
Filing Date	August 10, 2017
Examiner	Wayne Huu Cai
Art Unit	2644

Transmitted herewith is an amendment in the above-identified application.

The fee has been calculated and is transmitted as shown below.

☐ **Applicant claims Small Entity Status.** See 37 CFR 1.27.

Fee Calculation

Claims as Amended

For	#Filed	#Previously Paid For	#Extra	Rate	Fee
Total Claims	20	- 20 =		x =	
Total Indep. Claims	3	- 3 =		x =	
Multiple Dependent Claims (check if applicable) ☐					
				TOTAL	0

Method of Payment

☐ Deposit Account ☐ Credit Card ☐ Check ☐ Money Order ☐ Other: _____

Deposit Account Number

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge the fee(s) set forth above
☐ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17
☐ Charge fee(s) indicated above, **except for the filing fee**
☐ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on form PTO-2038.

Amount Grand Total 0

Samsung Exhibit 1006, Page 28 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Amendment Transmittal Letter

Docket Number
1426-148.101

Correspondence Address

Customer Number	106622		
-OR-			
Name			
Address			
City		State	
Country		Postal Code	
Phone Number			
E-mail Address			

Certificate of Mailing by Express Mail

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

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(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) authorization are being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission) *(Name of Person Transmitting Correspondence)*

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Amendment from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box Sang N. Dang

Name	Sang N. Dang			Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)		E-mail Address	sdang@bluecapitallaw.com	
eSign	/Sang N. Dang/			Date Signed	04-15-2019

Samsung Exhibit 1006, Page 29 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/674,483	Filing Date 08/10/2017	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 04/15/2019	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $100 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $460 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**0**

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

SLIE
NICOL D. SCOTT

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	1426-148.101	7684

106622 7590 01/15/2019

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
CAI, WAYNE HUU	

ART UNIT	PAPER NUMBER
2644	

NOTIFICATION DATE	DELIVERY MODE
01/15/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@bluecapitallaw.com

Office Action Summary	**Application No.** 15/674,483	**Applicant(s)** Lin et al.	
	Examiner WAYNE H CAI	**Art Unit** 2644	**AIA Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 08/10/2017.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-12 and 16-20 is/are pending in the application.

5a) Of the above claim(s) 13-15 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-12 and 16-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 08/10/2017 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

2. The information disclosure statements (IDSs) submitted on December 29, 2017; May 14, 2018; September 12, 2018; and November 14, 2018 are in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements are being considered by the examiner.

Drawings

3. The drawings were received on August 10, 2017. These drawings are acceptable.

Election/Restrictions

4. Claims 13-15 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on December 03, 2018.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

6. Claim(s) 1, 4, 5, 8, 16 and 19 is/are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Xiong et al. (hereinafter "Xiong", US 2018/0020365).

Regarding claim 1, Xiong discloses a method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a numerology (i.e., uplink resource transmitted by the base station to UE as described in paragraph 0146), wherein the information comprises a frequency location (i.e., frequency location as described in paragraph 0055) and a bandwidth for the numerology (i.e., uplink resource allocated by the base station as described in paragraphs 0055 and 0146. Also, see Fig. 8 and its descriptions); and

deriving, by the UE, a resource allocation for the numerology based on the frequency location and the bandwidth (i.e., UE selects one resource within the resource pool for transmission as described in Abstract, and as described in paragraph 0122).

Regarding claim 16, since this claim recites a different statutory class and include similar features to those of recited within claim 1. The Examiner rejects claim 16 at least for the same reasons discussed above. In addition, Xiong also discloses a

User Equipment (UE) (i.e., UE 1200 as shown in Fig. 12) capable of determining numerology bandwidth, comprising:

a control circuit (i.e., circuitry as described in paragraph 0094-0096); a processor installed in the control circuit (i.e., processor as described in paragraphs 0094-0096); and a memory installed in the control circuit and coupled to the processor (i.e., memory coupled to circuitry and processor as described in paragraphs 0094-0096), and wherein the processor is configured to execute a program code stored in the memory (paragraphs 0094-0096).

Regarding claim 4, Xiong discloses all limitations recited within claims as described above. Xiong also discloses wherein the frequency location is an index of a resource block (paragraph 0055).

Regarding claims 5 and 19, Xiong discloses all limitations recited within claims as described above. Xiong also discloses wherein the resource allocation designates a resource within a bandwidth portion (i.e., allocated frequency as described in 0121).

Regarding claim 8, Xiong discloses all limitations recited within claims as described above. Xiong also discloses wherein the bandwidth and the frequency location is configured by UE-specific RRC message (see claim 17).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claim 2, 3, 6, 7, 17, and 18 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Dai et al. (hereinafter "Dai", US 2016/0359593).

Regarding claims 2, and 17, Xiong discloses all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses configuring, by the UE, a system bandwidth (paragraphs 0238-0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claims 3, and 18, Xiong and Dai disclose all limitations recited within claims as described above. Dai also discloses wherein the system bandwidth is larger than the bandwidth (i.e., the system bandwidth is larger than the component carriers as described in Abstract).

Regarding claim 6, Xiong discloses all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses wherein the frequency location is an index of a resource block with a central frequency within a bandwidth portion (paragraph 0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claim 7, Xiong and Dai disclose all limitations recited within claims as described above. Dai also discloses the bandwidth portion is derived from the frequency location and the bandwidth (paragraph 0244).

9. Claim 9 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Lee et al. (hereinafter “Lee”, US 2013/0083753).

Regarding claim 9, Xiong discloses all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Lee discloses device communication using a reduced channel bandwidth. Lee also discloses wherein the bandwidth and the frequency location is indicated by a physical control channel (paragraph 0227).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to inform the user of the allocated resources.

10. Claim 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Ma et al. (hereinafter "Ma", US 10,045,345).

Regarding claim 10, Xiong discloses all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Ma discloses systems and methods self-contained air interface partitions. Ma also discloses wherein the numerology is indicated by a physical control channel (see claim 1).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to inform the user of the allocated resources.

11. Claim 11, 12, and 20 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Pragada et al. (hereinafter "Pragada", US 2014/0321282).

Regarding claim 11, Xiong discloses all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the bandwidth is a maximum bandwidth for the numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 12, Xiong discloses all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the bandwidth is a maximum bandwidth that the UE is able to receive for the numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 20, Xiong discloses all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the bandwidth is a configured bandwidth for the numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Conclusion

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to WAYNE H. CAI whose telephone number is (571)272-7798. The examiner can normally be reached on Monday-Friday, 8:00 AM - 5:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KATHY WANG-HURST can be reached on (571)270-5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should

you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Wayne H Cai/
Primary Examiner, Art Unit 2644

Notice of References Cited	Application/Control No. 15/674,483	Applicant(s)/Patent Under Reexamination Lin et al.	
	Examiner WAYNE H CAI	Art Unit 2644	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20180020365-A1	01-2018	Xiong; Gang	H04W74/0833	1/1
*	B	US-20160359593-A1	12-2016	DAI; Bo	H04L27/0006	1/1
*	C	US-20130083753-A1	04-2013	Lee; Moon-il	H04W74/0833	370/329
*	D	US-10045345-B2	08-2018	Ma; Jianglei	H04L1/1812	1/1
*	E	US-20140321282-A1	10-2014	Pragada; Ravikumar V.	H04W28/10	370/235
	F					
	G					
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	I					
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	L					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Samsung Exhibit 1006, Page 42 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	Art Unit
	WAYNE H CAI	2644

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventors Search	01/09/2019	WHC
See Search History	01/09/2019	WHC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/18/2018	01/09/2019							
	1	÷	✓							
	2	÷	✓							
	3	÷	✓							
	4	÷	✓							
	5	÷	✓							
	6	÷	✓							
	7	÷	✓							
	8	÷	✓							
	9	÷	✓							
	10	÷	✓							
	11	÷	✓							
	12	÷	✓							
	13	÷	N							
	14	÷	N							
	15	÷	N							
	16	÷	✓							
	17	÷	✓							
	18	÷	✓							
	19	÷	✓							
	20	÷	✓							

Samsung Exhibit 1006, Page 44 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2642
	Examiner Name	Rafael Perez Gutierrez
	Attorney Docket Number	1426-148.101

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2016072766	WO		2016-05-12	LG Electronics Inc.		☒

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

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	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2642
	Examiner Name	Rafael Perez Gutierrez
	Attorney Docket Number	1426-148.101

	1	Office Action from the Korean Intellectual Property Office in the corresponding KR Application No. 10-2017-0102214, dated August 22, 2018.	☒

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Examiner Signature	/Wayne H Cai/	Date Considered	01/09/2019

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Bibliographic Data

Application No: 15/674,483

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /Wayne H Cai/ (Examiner's Signature) | (Initials)

Title: METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
08/10/2017	370	2644	1426-148.101
RULE			

APPLICANTS

ASUSTek Computer Inc., Taipei City 112, TAIWAN

INVENTORS

Ko-Chiang Lin Taipei City, TAIWAN

Ming-Che Li Taipei City 112, OT, TAIWAN

CONTINUING DATA

This application has PRO of 62374354 08/12/2016

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

08/17/2017

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UNITED STATES

FILING FEE RECEIVED

$1,600

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	LIN, KO-CHIANG
	Art Unit	2464
	Examiner Name	Ricky Quoc Ngo
	Attorney Docket Number	1426-148.101

U.S.PATENTS

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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110032850		2011-02-10	Cai	
	2	20110103406		2011-05-05	Cai et al.	
	3	20160150532		2016-05-26	Bhushan et al.	

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	Examiner Name	Ricky Quoc Ngo
	Attorney Docket Number	1426-148.101

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	1	Office Action from Taiwan Intellectual Property Office in the corresponding TW Application No. 106127180, dated May 7, 2018.	☐

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Examiner Signature	/Wayne H Cai/	Date Considered	01/09/2019

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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	Attorney Docket Number	1426-148.101

U.S.PATENTS

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110081913		2011-04-07	Jung A. Lee	

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2010138921	WO		2010-12-02	ZTE USA Inc.		☐
	2	2016072766	WO		2016-05-12	LG Electronics Inc.		☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2464
	Examiner Name	Ricky Quoc Ngo
	Attorney Docket Number	1426-148.101

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	HUAWEI ET AL: "Initial access in NR", 3GPP DRAFT; R2-163923 INITIAL ACCESS IN NR, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE vol. RAN WG2, no. Nanjing, China; 20160523 -20160527 22 May 2016 (2016-05-22), XPO51105295, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN2/Docs/	☐
	2	European search report from corresponding EP Application No. 17185732.9, dated December 22, 2017.	☐

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Examiner Signature	/Wayne H Cai/	Date Considered	01/09/2019

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	283	((index indice) near5 (resourc$5 or block$2)) same (frequenc$5 bandwidth$2) and numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:23
L2	67	@ad<"20160812" and L1	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:23
L3	11	((index indice) near5 (resourc$5 or block$2)) same (frequenc$5 bandwidth$2) same numerolog$5 same (allocat$5 schedul$5 assign$9 reserv$9)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:36
L4	0	@ad<"20160812" and 3	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:39
L5	138	((index indice) near5 (resourc$5 or block$2)) same (frequenc$5 bandwidth$2) same (allocat$5 schedul$5 assign$9 reserv$9) and numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:40
L6	40	@ad<"20160812" and 5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:40
L7	244	numerolog$5 same ((frequenc$5 band$2 bandwidth) near5 (allocat$5 assign$7 schedul$5 reserv$9))	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:45
L8	89	@ad<"20160812" and 7	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:45
L9	48	"5g" same numerolog$5 same (bandwidth band$2 frequenc$5 resourc$5 RB resourc$5 adj block$4) near5 (allocat$5 assign$9 schedul$5 schedul$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:55
L11	3	@ad<"20160812" and 9	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:55
L12	2	wo-2016072766-$.did.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/09 11:14
L13	128	((index indice) near5 (resourc$5 or block$2)) same (frequenc$5 bandwidth$2) and numerolog$5 same (schedul$5 grant$5 allocat$5 assign$9 reserv$9)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 11:22
L14	21	@ad<"20160812" and 13	US-PGPUB; USPAT; EPO;	OR	OFF	2019/01/09 11:23

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IPR2024-01273

			JPO; DERWENT			
L15	161	(frequenc$5 adj3 location$2) same bandwidth same (index indice)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:35
L16	100	@ad<"20160812" and 15	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:40
L17	116	(frequenc$5 adj location$2) same bandwidth same (index indice)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:44
L18	54	(frequenc$5 adj location$2) same bandwidth same (index indice) same resourc$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:45
L19	29	@ad<"20160812" and 18	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:45
L20	51	(frequenc$5 adj location$2) near10 bandwidth near10 indicat$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:47
L21	29	@ad<"20160812" and 20	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:47
L22	1	(index indice) near5 resourc$5 near10 (central adj frequenc$5) same bandwidth	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:51
L23	61	resourc$5 near10 (central adj frequenc$5) same bandwidth	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:54
L24	53	@ad<"20160812" and 23	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 12:54
L25	0	(physical adj control$4 adj channel$2) same numerolog$5 same bandwidth same frequenc$5 adj location$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:06
L26	3	(physical adj control$4 adj channel$2) same bandwidth same frequenc$5 adj location$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:10
L27	10	(physical adj control$4 adj channel$2) same bandwidth same numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:26
L28	0	@ad<"20160812" and 27	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:26
L29	13	(physical adj control$4 adj channel$2) same numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:26
L30	1	@ad<"20160812" and 29	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:27
L31	684	numerolog$5 same bandwidth	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:35
L32	96	numerolog$5 same bandwidth same maximum	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 15:35
L33	61	@ad<"20160812" and 32	US-PGPUB;	OR	OFF	2019/01/09

			USPAT; EPO; JPO; DERWENT			15:36
S1	1	15/674483	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 09:45
S2	100	lin-ko-chiang.in.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 09:45
S3	4	lin-ko-chiang.in. and (numerolog$5).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 09:45
S4	3	lin-ko-chiang.in. and (numerolog$5 and frequenc$5).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 09:45
S5	40	li-ming-che.in.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 09:47
S6	3	li-ming-che.in. and (numerolog$5 and frequenc$5).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 09:47
S7	5	numerolog$5 same indicat$5 near10 frequenc$5 near10 (location$5 position$5) near10 bandwidth	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:17
S9	283	((index indice) near5 (resourc$5 or block$2)) same (frequenc$5 bandwidth$2) and numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:21

1/9/2019 4:00:15 PM
C:\Users\wcai1\Documents\EAST\Workspaces\15674483.wsp

Samsung Exhibit 1006, Page 54 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /WHC/

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2644
	Examiner Name	Wayne Huu Cai
	Attorney Docket Number	1426-148.101

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2018030415	WO		2018-02-15	HARADA HIROKI		☐

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /WHC/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Ko-Chiang Lin
	Art Unit	2644
	Examiner Name	Wayne Huu Cai
	Attorney Docket Number	1426-148.101

	1	Huawei, HiSilicon, Initial access in NR,3GPP TSG-RAN WG2 #94 R2-163923, Internet <URL:http://www.3gpp.org/ftp/tsg_ra, May 14, 2016, 2.1 Multiple numerologies	☐
	2	Nokia Networks, Basic system design for UL NB-IoT[online], 3GPP TSG RAN WG1 adhoc_LTE_NB-IoT_1601 R1-160041, Internet <URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_AH/LTE_NB-IoT_1601/Docs/R1-160041.zip>, January 11. 2016, 2.1 Resource scheduling	☐
	3	Office Action from Japan Patent Office in corresponding JP Application No. 2017-155218, dated October 16, 2018	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/Wayne H Cai/	Date Considered	01/09/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	: 15/674,483
Confirmation No.	: 7684
Applicant	: Ko-Chiang Lin, and Ming-Che Li
Filed	: August 10, 2017
Title	: METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
TC/A.U.	: 2644
Examiner	: Wayne Huu Cai
Docket No.	: 1426-148.101 (1050198-US)
Customer No.	: 106622

RESPONSE TO RESTRICTION REQUIREMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In the Restriction Requirement of October 26, 2018, the Examiner has required election in the present application between:

Group I, claims 1-12 and 16-20, drawn to a method for determining numerology bandwidth, classified in 370/329;

Group II, claims 13-15, drawn to another method for determining numerology bandwidth, classified in 370/329.

For the purpose of examination of the present application, Applicant elects without traverse Group I (claims 1-12 and 16-20).

Samsung Exhibit 1006, Page 57 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Should the Examiner find it necessary to speak with Applicant's attorney, he is invited to contact the undersigned at the telephone number listed below.

Respectfully submitted,

Sang N. Dang

BLUE CAPITAL LAW FIRM, P.C.

Dated: December 3, 2018

/Sang N. Dang/

Reg. No. 51,186
Tel.: (714) 839-3800
Tel.: (714) 839-3800

Samsung Exhibit 1006, Page 58 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ko-Chiang Lin and Ming-Che Li	
Title:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	15/674,483	Filed: August 10, 2017
Examiner:	Wayne Huu Cai	Group Art Unit: 2644
Attorney Docket No.:	1426-148.101 (1050198-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 2 Page Response to Restriction/Election Requirement are being transmitted to the United States Patent and Trademark Office via EFS-Web on December 3, 2018.

Date: December 3, 2018 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

Electronic Acknowledgement Receipt

EFS ID:	34465951
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	03-DEC-2018
Filing Date:	10-AUG-2017
Time Stamp:	14:55:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1426-148-101--ResponsetoRRasFiled12032018v2.pdf	37514 2c3a8fe6e33c0c124d59822cddcaa2dfa5c59699	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response to Election / Restriction Filed	1	2
	Miscellaneous Incoming Letter	3	3
Warnings:			
Information:			
	Total Files Size (in bytes):	37514	

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (03-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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(Not for submission under 37 CFR 1.99)

Application Number	15674483
Filing Date	2017-08-10
First Named Inventor	Ko-Chiang Lin
Art Unit	2644
Examiner Name	Wayne Huu Cai
Attorney Docket Number	1426-148.101

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2018030415	WO		2018-02-15	HARADA HIROKI		☐

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2644
	Examiner Name	Wayne Huu Cai
	Attorney Docket Number	1426-148.101

	1	Huawei, HiSilicon, Initial access in NR,3GPP TSG-RAN WG2 #94 R2-163923, Internet <URL:http://www.3gpp.org/ftp/tsg_ra, May 14, 2016, 2.1 Multiple numerologies	☐
	2	Nokia Networks, Basic system design for UL NB-IoT[online], 3GPP TSG RAN WG1 adhoc_LTE_NB-IoT_1601 R1-160041, Internet <URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_AH/LTE_NB-IoT_1601/Docs/R1-160041.zip>, January 11. 2016, 2.1 Resource scheduling	☐
	3	Office Action from Japan Patent Office in corresponding JP Application No. 2017-155218, dated October 16, 2018	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

Information Disclosure Statement Transmittal

Docket Number
1426-148.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

In Re Application Of:

Ko-Chiang Lin

Application No.	15/674,483
Filing Date	August 10, 2017
Examiner	Wayne Huu Cai
Art Unit	2644

Title of Invention

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

BASIS FOR FILING (Select 1, 2 or 3 below.)

37 CFR 1.97(b)

1) ☐ The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53 (d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.

37 CFR 1.97(c)

2) ☒ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:

a) ☒ the statement specified in 37 CFR 1.97(e);

OR

b) ☐ the fee set forth in 37 CFR 1.17(p).

37 CFR 1.97(d)

3) ☐ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(c), and on or before payment of the issue fee, and is accompanied by the Statement as specified in 37 CFR 1.97(e) and the fee set forth in 37 CFR 1.17(p).

Information Disclosure Statement Transmittal

Docket Number
1426-148.101

STATEMENT UNDER 37 CFR 1.97(e) ACCOMPANYING INFORMATION DISCLOSURE STATEMENT

The Information Disclosure Statement submitted herewith is submitted under one of the following conditions, which satisfies the requirement under 37 CFR 1.97(e). (Select 4 or 5 below if applicable.)

4) [X] That each item of information contained in the Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement; or

5) [ ] That no item of information contained in the Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the Information Disclosure Statement.

Remarks (Enter Remarks Below or Attach Document Containing Remarks)

Fee set forth in 37 CFR 1.17(p):

[X] No additional fee is required.

[ ] A check in the amount of _____ is attached.

[ ] The Director is hereby authorized to charge and credit Deposit Account No. _____ as described below.

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WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Samsung Exhibit 1006, Page 65 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Information Disclosure Statement Transmittal

Docket Number
1426-148.101

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Signatory Drop-Down Box Sang N. Dang

Name	Sang N. Dang	Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)	E-mail Address	sdang@bluecapitallaw.com
eSign	/Sang N. Dang/	Date Signed	11-14-2018

Samsung Exhibit 1006, Page 66 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

(12) 特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2018年2月15日(15.02.2018)

WIPO | PCT

(10) 国際公開番号
WO 2018/030415 A1

(51) 国際特許分類:
H04W 48/10 (2009.01) *H04W 72/04* (2009.01)

(21) 国際出願番号： PCT/JP2017/028799

(22) 国際出願日： 2017年8月8日(08.08.2017)

(25) 国際出願の言語： 日本語

(26) 国際公開の言語： 日本語

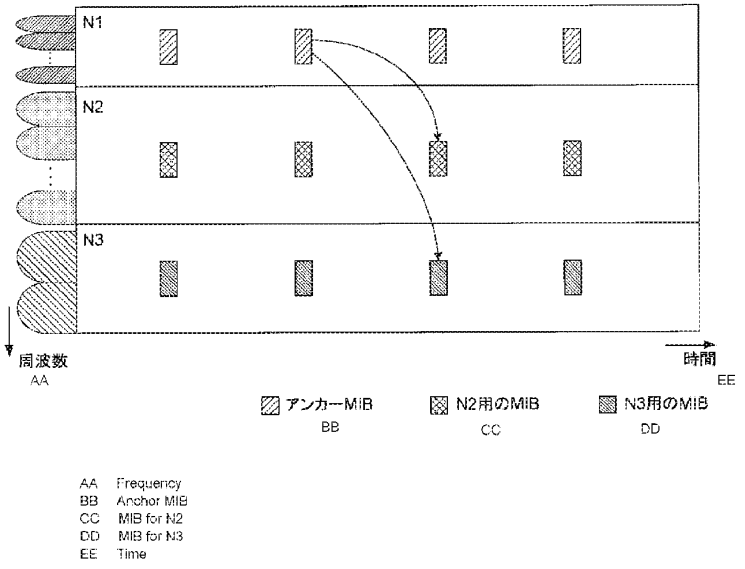
(30) 優先権データ：
特願 2016-157993 2016年8月10日(10.08.2016) JP

(71) 出願人：株式会社ＮＴＴドコモ(NTT DOCOMO, INC.) [JP/JP]; 〒1006150 東京都千代田区永田町二丁目１１番１号 Tokyo (JP).

(72) 発明者： 原 田 浩 樹 (HARADA, Hiroki); 〒1006150 東京都千代田区永田町二丁目１１番１号 山王パークタワー 株式会社ＮＴＴドコモ 知的財産部内 Tokyo (JP). 武田 一樹(TAKEDA, Kazuki); 〒1006150 東京都千代田区永田町二丁目１１番１号 山王パークタワー 株式会社ＮＴＴドコモ 知的財産部内 Tokyo (JP). 永田 聡 (NAGATA, Satoshi); 〒1006150 東京都千代田区永田町二丁目１１番１号 山王パークタワー 株式会社ＮＴＴドコモ 知的財産部内 Tokyo (JP). リュー ジャホイ(LIU, Jiahui); 100190 北京市海澱区科学院南路２号融科資訊中心エイ座７層 都科摩（北京）通信技術研究中心内 Beijing (CN). ムー チン(MU, Qin); 100190 北京市海澱区科学院南路２号融科資訊中心エイ座７層 都科摩（北

(54) **Title:** USER TERMINAL AND WIRELESS COMMUNICATION METHOD

(54) 発明の名称： ユーザ端末及び無線通信方法



(57) **Abstract:** The purpose of the present invention is to properly transmit and/or receive system information in a wireless communication system in which a plurality of numerologies are set. This user terminal, which performs communication in a wireless communication system in which a plurality of numerologies are set, has: a receiving unit which receives system information of each numerology through at least one notification channel; and a control unit which controls the reception of the notification channel, wherein the control unit controls the reception of the notification channel transmitted through

WO 2018/030415 A1

[続葉有]

京）通信技術研究中心内 Beijing (CN). ワン リフェ(**WANG, Lihui**); 100190 北京市海淀区科学院南路２号融科資訊中心エイ座７層 都科摩（北京）通信技術研究中心内 Beijing (CN). リュー リュー(**LIU, Liu**); 100190 北京市海淀区科学院南路２号融科資訊中心エイ座７層 都科摩（北京）通信技術研究中心内 Beijing (CN). ジャン ホイリン(**JIANG, Huiling**); 100190 北京市海淀区科学院南路２号融科資訊中心エイ座７層 都科摩（北京）通信技術研究中心内 Beijing (CN).

(74) 代理人：青木 宏義，外(**AOKI, Hiroyoshi** et al.); 〒1020076 東京都千代田区五番町５番地１ ＪＳ市ヶ谷ビル５Ｆ Tokyo (JP).

(81) 指定国（表示のない限り、全ての種類の国内保護が可能）：AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) 指定国（表示のない限り、全ての種類の広域保護が可能）：ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, RU, TJ, TM), ヨーロッパ (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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each numerology or the notification channel selectively transmitted through a prescribed numerology.

(57) 要約：複数のニューメロロジーが設定される無線通信システムにおいて、システム情報の送信及び／又は受信を適切に行うこと。複数のニューメロロジーが設定される無線通信システムにおいて通信を行うユーザ端末であって、少なくとも１以上の報知チャネルを介して各ニューメロロジーのシステム情報を受信する受信部と、前記報知チャネルの受信を制御する制御部と、を有し、前記制御部は、各ニューメロロジーで送信される報知チャネル又は所定のニューメロロジーで選択的に送信される報知チャネルの受信を制御する。

明　細　書

発明の名称 ： ユーザ端末及び無線通信方法

技術分野

[0001] 本発明は、次世代移動通信システムにおけるユーザ端末及び無線通信方法に関する。

背景技術

[0002] ＵＭＴＳ（Universal Mobile Telecommunications System）ネットワークにおいて、さらなる高速データレート、低遅延などを目的としてロングタームエボリューション（ＬＴＥ：Long Term Evolution）が仕様化された（非特許文献１）。また、ＬＴＥからの更なる広帯域化及び高速化を目的として、ＬＴＥの後継システム（例えば、ＬＴＥ－Ａ（LTE-Advanced）、ＦＲＡ（Future Radio Access）、４Ｇ、５Ｇ、５Ｇ＋（plus）、ＮＲ（New RAT）、ＬＴＥ Ｒｅｌ．１４、１５～、などともいう）も検討されている。

[0003] 既存のＬＴＥシステム（例えば、ＬＴＥ Ｒｅｌ．１０以降）では、広帯域化を図るために、複数のキャリア（コンポーネントキャリア（ＣＣ：Component Carrier）、セル）を統合するキャリアアグリゲーション（ＣＡ：Carrier Aggregation）が導入されている。各キャリアは、ＬＴＥ Ｒｅｌ．８のシステム帯域を一単位として構成される。また、ＣＡでは、同一の無線基地局（eNB：eNodeB）の複数のＣＣがユーザ端末（ＵＥ：User Equipment）に設定される。

[0004] また、既存のＬＴＥシステム（例えば、ＬＴＥ Ｒｅｌ．１２以降）では、異なる無線基地局の複数のセルグループ（ＣＧ：Cell Group）がユーザ端末に設定されるデュアルコネクティビティ（ＤＣ：Dual Connectivity）も導入されている。各セルグループは、少なくとも一つのキャリア（ＣＣ、セル）で構成される。異なる無線基地局の複数のキャリアが統合されるため、ＤＣは、基地局間ＣＡ（Inter-eNB CA）などとも呼ばれる。

[0005] また、既存のＬＴＥシステム（例えば、ＬＴＥ Ｒｅｌ．８－１３）では

、１ｍｓの伝送時間間隔（ＴＴＩ：Transmission Time Interval）（サブフレームともいう）を用いて、下りリンク（ＤＬ：Downlink）及び／又は上りリンク（ＵＬ：Uplink）の通信が行われる。当該１ｍｓのＴＴＩは、チャネル符号化された１データ・パケットの送信時間単位であり、スケジューリング、リンクアダプテーションなどの処理単位となる。

先行技術文献

非特許文献

[0006] 非特許文献1：3GPP TS 36.300 “Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2”

発明の概要

発明が解決しようとする課題

[0007] 将来の無線通信システム（例えば、５Ｇ、ＮＲなど）では、高速で大容量の通信（ｅＭＢＢ：enhanced Mobile Broad Band）、ＩｏＴ（Internet of Things）やＭＴＣ（Machine Type Communication）などの機器間通信（Ｍ２Ｍ：Machine-to-Machine）用のデバイス（ユーザ端末）からの大量接続（ｍＭＴＣ：massive ＭＴＣ）、低遅延で高信頼の通信（ＵＲＬＬＣ：Ultra-reliable and low latency communication）など、多様なサービスを単一のフレームワークで収容することが望まれている。

[0008] このように、将来の無線通信システムでは、遅延削減に対する要求が異なる複数のサービスが混在することが想定される。例えば、ユーザ端末が利用形態に応じて複数のサービス（異なるニューメロロジー）を利用することが考えられる。また、将来の無線通信システムでは、異なるニューメロロジー（numerology）を利用する（又はサポートする）複数のユーザ端末を、同一キャリア（ＣＣ、セル）内に多重することも検討されている。

[0009] ここで、ニューメロロジーとは、周波数方向及び／又は時間方向における通信パラメータ（例えば、サブキャリア間隔、帯域幅、シンボル長、ＣＰの

時間長（ＣＰ長）、サブフレーム長、ＴＴＩの時間長（ＴＴＩ長）、ＴＴＩあたりのシンボル数、無線フレーム構成、フィルタリング処理、ウィンドウイング処理などの少なくとも一つ）である。

[0010] 一方で、ユーザ端末がニューメロロジーの異なるフレーム構成の少なくとも一つを利用して通信を行う場合、通信をどのように制御するかが問題となる。例えば、ユーザ端末が各ニューメロロジーを利用して通信を行う場合、各ニューメロロジーのシステム情報を把握する必要がある。かかる場合、ユーザ端末が当該システム情報等を好適に受信できる方法が望まれる。

[0011] 本発明はかかる点に鑑みてなされたものであり、複数のニューメロロジーが設定される無線通信システムにおいて、システム情報の送信及び／又は受信を適切に行うことができるユーザ端末及び無線通信方法を提供することを目的の一つとする。

課題を解決するための手段

[0012] 本発明の一態様に係るユーザ端末は、複数のニューメロロジーが設定される無線通信システムにおいて通信を行うユーザ端末であって、少なくとも１以上の報知チャネルを介して各ニューメロロジーのシステム情報を受信する受信部と、前記報知チャネルの受信を制御する制御部と、を有し、前記制御部は、各ニューメロロジーで送信される報知チャネル又は所定のニューメロロジーで選択的に送信される報知チャネルの受信を制御することを特徴とする。

発明の効果

[0013] 本発明によれば、複数のニューメロロジーが設定される無線通信システムにおいて、システム情報の送信及び／又は受信を適切に行うことができる。

図面の簡単な説明

[0014] [図1]各ニューメロロジーのＭＩＢの送信方法の課題を説明する図である。

[図2]複数のニューメロロジーにおけるＭＩＢの送信方法の一例を示す図である。

[図3]帯域幅（ＮＲ　ＢＷ）とニューメロロジー間のオフセットを規定したテ

ーブルの一例を示す図である。

[図4]ニューメロロジー間のオフセットを規定したテーブルの一例を示す図である。

[図5]図５Ａは、ニューメロロジー間のオフセットを規定したテーブルの一例を示し、図５Ｂは、複数のニューメロロジーにおけるＭＩＢの送信方法の一例を示す図である。

[図6]複数のニューメロロジーにおけるＭＩＢの送信方法の他の例を示す図である。

[図7]複数のニューメロロジーにおけるＭＩＢの送信方法の他の例を示す図である。

[図8]複数のニューメロロジーにおけるＭＩＢの送信方法の他の例を示す図である。

[図9]複数のニューメロロジーにおけるＭＩＢの送信方法の他の例を示す図である。

[図10]複数のニューメロロジーにおけるＭＩＢの送信方法の他の例を示す図である。

[図11]複数のニューメロロジーにおけるＭＩＢの送信方法の他の例を示す図である。

[図12]本発明の一実施形態に係る無線通信システムの概略構成の一例を示す図である。

[図13]本発明の一実施形態に係る無線基地局の全体構成の一例を示す図である。

[図14]本発明の一実施形態に係る無線基地局の機能構成の一例を示す図である。

[図15]本発明の一実施形態に係るユーザ端末の全体構成の一例を示す図である。

[図16]本発明の一実施形態に係るユーザ端末の機能構成の一例を示す図である。

[図17]本発明の一実施形態に係る無線基地局及びユーザ端末のハードウェア構成の一例を示す図である。

発明を実施するための形態

[0015] 将来の新しい通信システムで用いられるアクセス方式（５Ｇ　ＲＡＴ、Ｎｅｗ　ＲＡＴなどと呼ばれてもよい）としては、既存のＬＴＥ／ＬＴＥ－Ａシステムで用いられるアクセス方式（ＬＴＥ　ＲＡＴ、ＬＴＥ－Ｂａｓｅｄ　ＲＡＴなどと呼ばれてもよい）を拡張したものが検討されている。

[0016] ５Ｇ　ＲＡＴでは、ＬＴＥ　ＲＡＴと異なる無線フレーム及び／又は異なるサブフレーム構成が用いられてもよい。例えば、５Ｇ　ＲＡＴの無線フレーム構成は、既存のＬＴＥ（ＬＴＥ　Ｒｅｌ．８－１２）と比較して、サブフレーム長、シンボル長、サブキャリア間隔、システム帯域幅の少なくとも一つが異なる無線フレーム構成とすることができる。

[0017] なお、サブフレームは、送信時間間隔（ＴＴＩ：Transmission Time Interval）と呼ばれてもよい。例えば、ＬＴＥ　Ｒｅｌ．８－１２におけるＴＴＩ（サブフレーム）長は、１ｍｓであり、２つの時間スロットで構成される。ＴＴＩは、チャネル符号化されたデータパケット（トランスポートブロック）の送信時間単位であり、スケジューリング、リンクアダプテーション（Link Adaptation）などの処理単位となる。

[0018] より具体的には、５Ｇ　ＲＡＴにおいては、新たに無線パラメータを決定するが、例えば、ＬＴＥ　ＲＡＴのニューメロロジー（numerology）に基づいて、ＬＴＥの無線フレームを規定する通信パラメータ（例えば、サブキャリア間隔、帯域幅、シンボル長など）を定数倍（例えば、Ｎ倍や１／Ｎ倍）して用いる方法も検討されている。ここで、ニューメロロジーとは、あるＲＡＴにおける信号のデザインや、ＲＡＴのデザインを特徴付ける通信パラメータのセットのことをいう。なお、１つのＲＡＴで複数のニューメロロジーが規定され、用いられてもよい。

[0019] また、複数のニューメロロジーが異なるとは、例えば、下記（１）－（６）のうち少なくとも１つが異なる場合を表すものとするが、これに限られな

い：（１）サブキャリア間隔、（２）ＣＰ（Cyclic Prefix）長、（３）シンボル長、（４）ＴＴＩあたりのシンボル数、（５）ＴＴＩ長、（６）フィルタリング処理やウィンドウイング処理。

[0020] ５Ｇ ＲＡＴ（ＮＲ）では、キャリア周波数として非常に広い周波数（例えば、１ＧＨｚ－１００ＧＨｚ）をターゲットとしているため、用途ごとの要求条件に応じて、シンボル長やサブキャリア間隔などが異なる複数のニューメロロジーがサポートされ、これらが共存することが考えられる。５ＧＲＡＴに採用されるニューメロロジーの一例としては、ＬＴＥ ＲＡＴを基準としてサブキャリア間隔や帯域幅をＮ（例えば、Ｎ＞１）倍にし、シンボル長を１／Ｎ倍にする構成が考えられる。

[0021] ところで、既存のＬＴＥシステムにおいて、ユーザ端末は、下りリンク通信に必要なシステム情報（報知情報）を報知チャネル（ＰＢＣＨ）で送信されるＭＩＢ（Master Information Block）等で受信する。ＭＩＢは、中心帯域１．４ＭＨｚ（中心６ＲＢｓ）において、１０ｍｓｅｃ周期で各無線フレームにおけるＳｕｂｆｒａｍｅ＃０で送信される。

[0022] ＭＩＢには、下りリンクを受信するための必要な情報（下りリンクの帯域幅、下りリンク制御チャネル構成、システムフレーム番号（ＳＦＮ）等）が含まれている。ユーザ端末は、ＭＩＢに基づいて下り共有データチャネル（ＰＤＳＣＨ）で伝送されるＳＩＢ（System Information Block）の受信を制御する。ＭＩＢの割り当て位置は、時間リソース、周波数リソースで固定となっている。このように、ＭＩＢは、固定的なリソースで無線基地局から送信されるため、ユーザ端末に対して特別な通知をすることなく受信を行うことができる。

[0023] 一方で、５Ｇ ＲＡＴのキャリア（ＮＲキャリア）において複数のニューメロロジーが設定される場合、異なるニューメロロジー間でシステム情報（例えば、システムフレーム番号及び／又はサブフレームインデックス等）が異なることが想定される。また、異なるニューメロロジー間でＰＲＡＣＨ構成に関する情報が異なることも想定される。あるいは、異なるニューメロロ

ジー間で共通する情報も生じることが想定される。かかる場合、各ニューメロロジーに対応するシステム情報等をＭＩＢに含めて報知チャネルで送信することが考えられるが、各ニューメロロジーのシステム情報をどのように送信するかが問題となる。

[0024] 図１は、異なるニューメロロジー（ここでは、Ｎ１とＮ２）において、それぞれＭＩＢを送信する報知チャネルが設定される場合を示している。この場合、システム情報（ＭＩＢ）の送信方法（ユーザ端末における検出方法）や、送信するシステム情報（ＭＩＢ）の内容をどのように制御するかが問題となる。

[0025] そこで、本発明者等は、複数のニューメロロジーのシステム情報の送受信を、ニューメロロジー毎に個別制御する方法、又は複数ニューメロロジーを組み合わせて制御することを着想した。具体的には、各ニューメロロジーに対応するシステム情報（例えば、ＭＩＢの内容）をそれぞれ別々に設定して送受信を制御する。あるいは、各ニューメロロジーに対応するシステム情報（例えば、ＭＩＢの内容）を組み合わせて送受信を制御する。

[0026] 以下に本実施の形態について詳細に説明する。以下の説明では、主に３つの異なるニューメロロジー（Ｎ１、Ｎ２、Ｎ３）を例に挙げて説明するが、適用可能なニューメロロジー数はこれに限られない。また、以下の説明では、システム情報／報知情報（ＭＩＢ）の送受信方法について説明するが、本実施の形態が適用可能な信号はＭＩＢに限られない。ニューメロロジー毎に異なって設定される情報であれば同様に適用することができる。また、ＭＩＢに含まれる情報は、以下に説明する情報に加えて既存のＭＩＢに含まれる内容が含んでいてもよい。また、以下に説明する複数の態様はそれぞれ単独で実施してもよいし、適宜組み合わせて実施することも可能である。

[0027] （第１の態様）

第１の態様では、システム情報又は報知情報（ＭＩＢの内容）をニューメロロジー毎に別々に設定して報知チャネル（ＭＩＢ）の送受信を制御する場合の一例について説明する。また、第１の態様では、ユーザ端末が、所定の

ＭＩＢ（アンカーＭＩＢ、anchor MIB、アンカー報知チャネルとも呼ぶ）に基づいて、別々に設定されたＭＩＢ（ターゲットＭＩＢ、対象ＭＩＢとも呼ぶ）の受信を制御する場合について説明する。

[0028] 図２は、ユーザ端末が所定のニューメロロジー（ここでは、Ｎ１）で送信されるアンカーＭＩＢ（アンカー報知チャネル）に基づいて、他のニューメロロジー（ここでは、Ｎ２、Ｎ３）のＭＩＢを受信する場合の一例を示している。アンカーＭＩＢには、他のニューメロロジーのＭＩＢを検出するための情報（アシスト情報）が含まれている。また、アンカーＭＩＢには、アンカーニューメロロジー（Ｎ１）のシステム情報が含まれていてもよい。アンカーＭＩＢが送信されるニューメロロジーは、アンカーニューメロロジーと呼んでも良い。

[0029] 例えば、ユーザ端末は、無線基地局から送信される同期信号を受信して同期をとった後、アンカーニューメロロジーで送信されるアンカーＭＩＢの受信を行う。ユーザ端末がアンカーニューメロロジーを認識する方法として、あらかじめアンカーニューメロロジーを定義しておく方法、又は所定信号（例えば、同期信号）に基づいて判断する方法を適用することができる。

[0030] 例えば、複数のニューメロロジーで同期信号が共通に設定される場合（shared SS design）、ユーザ端末は、共通に設定される同期信号（共通同期信号）が送信されるニューメロロジーをアンカーニューメロロジーとして判断する。つまり、ユーザ端末は、同期信号に対して受信処理（例えば、ブラインド検出）を行うことにより、アンカーニューメロロジーを把握することができる。

[0031] 複数のニューメロロジー毎に同期信号がそれぞれ設定される場合（separate SS design）、所定のニューメロロジーをアンカーニューメロロジーとしてあらかじめ定義しておけばよい。この場合、ユーザ端末は同期信号を検出したニューメロロジーに関わらず、アンカーニューメロロジーを特定することができる。アンカーニューメロロジーとしては、あるサブキャリア間隔（例えば、１５ｋＨｚ）を適用するニューメロロジーとすることができる。

[0032] アンカーニューメロロジーで送信されるアンカーＭＩＢの位置（周波数及び／又は時間リソース）は、あらかじめ定義してもよい。あるいは、所定信号に基づいてアンカーＭＩＢの位置を判断してもよい。一例として、同期信号（例えば、アンカーニューメロロジーの同期信号）の位置から所定のオフセット（例えば、周波数及び／又は時間リソースオフセット）だけ離れた位置にアンカーＭＩＢが配置される構成とすることができる。ユーザ端末は、受信した同期信号に基づいてアンカーＭＩＢを受信することが可能となる。

[0033] ユーザ端末は、自端末がサポートするニューメロロジーの少なくとも一つを選択して通信を制御する。例えば、複数のニューメロロジーのうちアンカーニューメロロジーのみサポートするユーザ端末は、アンカーニューメロロジーでＭＩＢ（アンカーＭＩＢ）を検出して当該アンカーニューメロロジーに対応するシステム情報を取得する。

[0034] 複数のニューメロロジーをサポートするユーザ端末は、所定数Ｍ（例えば、Ｍ（≧１））のニューメロロジーを通信対象のニューメロロジー（target numerologies）として選択することができる。所定数Ｍと当該Ｍ個のターゲットニューメロロジーは、ユーザ端末の能力等に基づいてユーザ端末が自律的に決定してもよいし、無線基地局からの指示により決定してもよい。あるいは、ユーザ端末は、あらかじめ定義された規則（又は選択テーブル）に基づいてＭ個のターゲットニューメロロジーを選択してもよい。

[0035] 無線基地局がユーザ端末の利用するニューメロロジー（ターゲットニューメロロジー）を指定する場合、当該無線基地局は、ニューメロロジーの優先度に関する情報をユーザ端末に通知する。ニューメロロジーの優先度に関する情報は、アンカーＭＩＢ及び／又はアンカーニューメロロジーで送信されるＳＩＢ等に含めてユーザ端末に通知することができる。ユーザ端末は、ニューメロロジーの優先度に関する情報に基づいて、自端末がサポートするニューメロロジーのうち優先度が高いＭ個（例えば、最も優先度が高い１つ）のターゲットニューメロロジーを選択する。

[0036] ユーザ端末は、選択したターゲットニューメロロジーに対応するＭＩＢ（

ターゲットＭＩＢ）の受信を行う。ターゲットＭＩＢ（ターゲット報知チャネル）はアンカーＭＩＢに基づいて受信を行うことができる。例えば、ユーザ端末は、アンカーＭＩＢとの間に予め設定されたオフセットに基づいて、ターゲットＭＩＢの受信を制御する。アンカーＭＩＢとターゲットＭＩＢ間のオフセットは、予め規定しておいてもよい。

[0037] 以下にユーザ端末が通信に利用するターゲットニューメロロジーに対応するターゲットＭＩＢを受信する方法について説明する。

[0038] （方法１）

まず、ユーザ端末は、アンカーニューメロロジーで送信されるアンカーＭＩＢを受信する。無線基地局は、アンカーＭＩＢに所定のニューメロロジー（ターゲットニューメロロジー）を指定する情報を含めてユーザ端末に通知する。例えば、無線基地局は、ターゲットニューメロロジーを指定する情報を所定ビット（例えば、２ビット）でユーザ端末に通知する。

[0039] ２ビットの一例として、サブキャリア間隔が１５ＫＨｚに対応するニューメロロジー（例えば、Ｎ１）と３０ＫＨｚに対応するニューメロロジー（Ｎ２）を“００”、１５ＫＨｚに対応するニューメロロジー（例えば、Ｎ１）と６０ＫＨｚに対応するニューメロロジー（Ｎ３）を“０１”、１５ＫＨｚに対応するニューメロロジー（例えば、Ｎ１）と３０ＫＨに対応するニューメロロジー（例えば、Ｎ２）と６０ＫＨｚに対応するニューメロロジー（Ｎ３）を“１０”に設定する（“１１”はリザーブ）。ユーザ端末は、アンカーＭＩＢに含まれるビット値に基づいて、ターゲットＭＩＢの受信を行うニューメロロジーを判断することができる。

[0040] あるいは、ビットマップ（例えば、Ｎ１－Ｎ３に対応する３ビットのビットマップ）を用いてターゲットニューメロロジーに関する情報をユーザ端末に通知してもよい。

[0041] ユーザ端末は、ターゲットニューメロロジーを決定した後、アンカーニューメロロジー（アンカーＭＩＢ）との間に設定されるオフセットに基づいてターゲットＭＩＢを受信する。アンカーニューメロロジー（ここでは、Ｎ１

）のアンカーＭＩＢとターゲットＭＩＢとの間に設定されるオフセットは、予め定義されたテーブルに基づいて判断することができる。

[0042] アンカーＭＩＢとターゲットＭＩＢ間のオフセットは、複数のニューメロロジーを含む帯域幅（例えば、複数のニューメロロジーが設定される帯域幅の合計）毎にそれぞれ定義することができる。図３は、複数のニューメロロジーが設定される帯域幅（ＮＲ　ＢＷ）の長さに応じて、アンカーＭＩＢとターゲットＭＩＢ間に設定されるオフセットを示すテーブルの一例を示している。例えば、ＮＲ　ＢＲが１．４ＭＨｚである場合、Ｎ１（アンカーＭＩＢ）とＮ２（Ｎ２用のＭＩＢ）間のオフセットはＭとなる。一方で、Ｎ１（アンカーＭＩＢ）とＮ３（Ｎ３用のＭＩＢ）間のオフセットがＭ’となる。なお、図３におけるオフセットは、周波数方向のオフセット（周波数リソースオフセット）とすることができ、ＰＲＢ、ＲＥ単位で設定することができる。なお、時間方向のオフセットについても同様にテーブルに定義してもよいし、時間方向のオフセットはゼロに設定してもよい。

[0043] 複数のニューメロロジーが設定される帯域幅（ＮＲ　ＢＷ）に関する情報は、アンカーＭＩＢ等に含めて無線基地局からユーザ端末に通知することができる。例えば、３ビットを利用して、所定の帯域幅（例えば、１．４ＭＨｚ、３ＭＨｚ、５ＭＨｚ、１０ＭＨｚ、１５ＭＨｚ、２０ＭＨｚのいずれか）をユーザ端末に通知する。もちろん、帯域幅や適用するビット数はこれに限られず適宜変更することができる。あるいは、ニューメロロジー毎の帯域幅に関する情報をアンカーＭＩＢに含めて通知してもよい。

[0044] ユーザ端末は、アンカーＭＩＢに含まれる情報、図３のテーブル等に基づいて、ターゲットＭＩＢを受信することができる。

[0045] （方法２）

方法２では、方法１のテーブル（図３）と異なるテーブルを利用する場合を示す。なお、テーブルの利用以外の構成は方法１の構成を適用することができる。

[0046] 図４は、各ニューメロロジー間に設定されるオフセットを示すテーブルで

ある。ここでは、各ターゲットニューメロロジーについて、１ビットを利用して、アンカーＭＩＢとターゲットＭＩＢ間のオフセットをそれぞれ規定する場合を示している。

[0047] 具体的には、ビット値が“０”の場合、Ｎ２（ターゲットＭＩＢ）とＮ１（アンカーＭＩＢ）間のオフセットがMであり、ビット値が“１”の場合、Ｎ２とＮ１間のオフセットがｍとなる。同様に、ビット値が“０”の場合、Ｎ３とＮ１間のオフセットがM’であり、ビット値が“１”の場合、Ｎ３とＮ１間のオフセットがｍ’となる。つまり、図４では、１ビットを利用して、２つの条件（例えば、２種類の帯域幅等）におけるアンカーＭＩＢとターゲットＭＩＢのオフセットをユーザ端末に通知することができる。

[0048] 無線基地局は、ユーザ端末に設定されるターゲットニューメロロジー等に基づいて、所定のビット値をユーザ端末に通知する。なお、図４に示すように１ビットで通知を行う場合には、ターゲットニューメロロジー毎に２つのオフセットが設定できるが、２つより多いオフセットを設定する場合にはビット数を増やせばよい。

[0049] （方法３）

ユーザ端末は、アンカーニューメロロジーで送信されるアンカーＭＩＢを受信する。無線基地局は、アンカーＭＩＢにターゲットニューメロロジーを指定する情報と、複数のニューメロロジーが設定される帯域幅（ＮＲ　ＢＷ）に関する情報を含めてユーザ端末に通知する。

[0050] 例えば、無線基地局は、複数のニューメロロジーが設定される合計の帯域幅（ＮＲ　ＢＷ）に関する情報を所定ビット（例えば、３ビット）でユーザ端末に通知する。また、無線基地局は、ターゲットニューメロロジーを指定する情報を所定ビット（例えば、２ビット）でユーザ端末に通知する。ユーザ端末への通知方法は上記方法１、２と同様に行うことができる。

[0051] また、無線基地局は、各ニューメロロジーの構成に関する情報（例えば、ニューメロロジー毎の帯域幅比率に関する情報）をユーザ端末に通知する。各ニューメロロジーに設定される報知チャネルの構成（例えば、配置位置）

が予め定義されている場合、ユーザ端末は、複数のニューメロロジーが設定される合計の帯域幅と、ニューメロロジー毎の帯域幅比率に関する情報に基づいてターゲットＭＩＢを検出することができる。

[0052] ニューメロロジー毎の帯域幅比率は、予めテーブルに規定しておき、所定のビット値をユーザ端末に通知することができる（図５Ａ参照）。図５Ａでは、２つのニューメロロジーが設定される場合と、３つのニューメロロジーが設定される場合の各ニューメロロジーの帯域幅の比率が規定されている。例えば、ビット値が“００”の場合、２つのニューメロロジー（例えば、Ｎ１とＮ２）の帯域幅比率が１：３である、又は３つのニューメロロジー（例えば、Ｎ１とＮ２とＮ３）の帯域幅比率が１：２：２である場合に対応する。

[0053] ２つのニューメロロジー（例えば、Ｎ１とＮ２）において、それぞれのニューメロロジーを構成するＰＲＢのうち中央のＰＲＢでＭＩＢが送信されることが予め定義されている場合を想定する。かかる場合、無線基地局がＮＲＢＲが３ＭＨｚ、ターゲットニューメロロジーがＮ１とＮ２、ニューメロロジー構成が１：２（ビット値“０１”）である旨をユーザ端末に通知した場合、ユーザ端末はＮ１の帯域幅が１ＭＨｚ、Ｎ２の帯域幅が２ＭＨｚであり、アンカーＭＩＢと対象ＭＩＢのオフセットが１．５Ｍｈｚであると判断することができる（図５Ｂ参照）。このように、ユーザ端末はアンカーＭＩＢに基づいてターゲットニューメロロジーのＭＩＢを受信することができる。

[0054] 続いて、アンカーＭＩＢとその他のＭＩＢ（ターゲットＭＩＢ）に含めるシステム情報（ＭＩＢの内容）の一例について説明する。

[0055] ＜ＳＦＮ／サブフレームインデックス＞

異なるニューメロロジー間で共通のシステムフレーム番号（ＳＦＮ）及び／又はサブフレームインデックスを利用する場合、アンカーＭＩＢに共通のＳＦＮ及び／又はサブフレームインデックスの情報を含めることができる。ユーザ端末は、アンカーＭＩＢに含まれる共通情報から各ニューメロロジー

に共通に適用されるＳＦＮ及び／又はサブフレームインデックスを把握することができる。

[0056] ニューメロロジー毎（少なくとも一つのニューメロロジー）に固有のＳＦＮ及び／又はサブフレームインデックスを利用する場合、各ニューメロロジーに対応するＭＩＢ（ターゲットＭＩＢ）にＳＦＮ及び／又はサブフレームインデックスの情報を含めることができる。この場合、無線基地局は、ＳＦＮ及び／又はサブフレーム番号に関連するパラメータを各ＭＩＢ（ターゲットＭＩＢ）の固有の領域で送信し、アンカーＭＩＢの共通情報には含めないことができる。

[0057] ターゲットニューメロロジーのＳＦＮ及び／又はサブフレームインデックスが、アンカーニューメロロジーのＳＦＮ及び／又はサブフレームインデックスから所定の時間インターバル（例えば、Ｘ）だけ離れている場合、アンカーＭＩＢの共通情報にＳＦＮ及び／又はサブフレーム番号に関連するパラメータを含めることができる。所定の時間インターバルは予め規定された値であってもよいし、アンカーＭＩＢに含めてユーザ端末に通知されてもよい。これにより、ユーザ端末は、アンカーＭＩＢを受信することにより、各ニューメロロジーのＳＦＮ及び／又はサブフレームインデックスを把握することができる。

[0058] ＜他の情報＞

アンカーＭＩＢの固有情報は当該アンカーＭＩＢに含めてユーザ端末に通知する。アンカーＭＩＢの固有情報としては、アンカーニューメロロジー（例えば、当該アンカーＭＩＢ）の受信に利用する参照信号に関するパラメータ（例えば、ポート番号、時間及び／又は周波数リソース等）、ＰＲＡＣＨに関するパラメータ（例えば、ランダムアクセス用のプリアンブルインデックス、時間及び／又は周波数リソース等）が挙げられる。

[0059] ターゲットＭＩＢに関する情報は当該ターゲットＭＩＢに含めてユーザ端末に通知する。ターゲットＭＩＢに関する情報としては、ターゲットニューメロロジー（例えば、当該ターゲットＭＩＢ）の受信に利用する参照信号に

関するパラメータ（例えば、ポート番号、時間及び／又は周波数リソース等）、ＰＲＡＣＨに関するパラメータ（例えば、ランダムアクセス用のプリアンブルインデックス、時間及び／又は周波数リソース等）が挙げられる。

[0060] ターゲットＭＩＢの検出時間（ユーザ端末がターゲットＭＩＢを検出するタイミング）は、アンカーＭＩＢから所定の時間オフセットを設定してもよいし、同期信号（例えば、アンカーニューメロロジーの同期信号、又はターゲットニューメロロジーの同期信号）から所定の時間オフセットを設定してもよい。あるいは、ターゲットニューメロロジーにおいて固定的に設定されたＳＦＮ及び／又はサブフレームとしてもよい。

[0061] ＜ユーザ端末動作＞

ユーザ端末は、同期信号（shared SS又はseparate SS）を受信した後、アンカーニューメロロジーでアンカーＭＩＢの検出を行う。アンカーニューメロロジーの認識方法は上述した方法を適用することができる。次に、ユーザ端末は、ターゲットニューメロロジーを選択する。ユーザ端末が１つのニューメロロジー（アンカーニューメロロジー）のみサポートしている場合、当該アンカーニューメロロジーでアンカーＭＩＢを受信し、その後の手順（ＳＩＢ受信等）を行う。

[0062] ユーザ端末が複数のニューメロロジーをサポートしている場合、アンカーＭＩＢに基づいて選択したターゲットニューメロロジーのＭＩＢを受信する。ターゲットＭＩＢを受信した後、ＳＩＢの受信処理等を行う。

[0063] このように、複数のニューメロロジーのＭＩＢをアンカーＭＩＢに基づいて受信する場合、必ず受信するアンカーＭＩＢに共通情報を含めることにより、ターゲットＭＩＢに共通情報を含める必要がなくなる。これにより、ターゲットＭＩＢのオーバーヘッドの増加を抑制することができる。

[0064] （第２の態様）

第２の態様では、システム情報（ＭＩＢの内容）をニューメロロジー毎に別々に設定して報知チャネル（ＭＩＢ）の送受信を制御する場合の一例について説明する。また、第２の態様では、ユーザ端末が、各ニューメロロジー

にそれぞれ対応するＭＩＢを直接受信する場合について説明する。

[0065] 図６は、ユーザ端末が各ニューメロロジー（ここでは、Ｎ１－Ｎ３）でそれぞれ送信されるＭＩＢを直接（アンカーＭＩＢを介さずに）受信する場合の一例を示している。なお、図６では、各ニューメロロジーで送信されるＭＩＢが同じ時間領域（時間リソース）に配置される場合を示しているが、これに限られない。

[0066] ユーザ端末が、１つのニューメロロジーのみサポートする場合、ユーザ端末はサポートするニューメロロジーにおいてＭＩＢの受信処理（例えば、ブラインド検出）を行う。これにより、ユーザ端末は、自端末がサポートするニューメロロジーのシステム情報を選択的に取得することができる。

[0067] 複数のニューメロロジーをサポートするユーザ端末は、所定数Ｍ（例えば、Ｍ（≧１））のニューメロロジーを通信対象ニューメロロジー（ターゲットニューメロロジー）として選択することができる。例えば、ユーザ端末は、サポートするニューメロロジーにおいて全てのＭＩＢを受信し、受信後に所定数Ｍ個のニューメロロジーを選択する。所定数Ｍと当該Ｍ個のターゲットニューメロロジーは、ユーザ端末の能力等に基づいてユーザ端末が自律的に決定してもよいし、無線基地局からの指示により決定してもよい。あるいは、ユーザ端末は、あらかじめ定義された規則（又は選択テーブル）に基づいてターゲットニューメロロジーを選択してもよい。

[0068] 無線基地局がユーザ端末にターゲットニューメロロジーを指定する場合、当該無線基地局は、例えば、ニューメロロジーの優先度に関する情報をユーザ端末に通知する。ニューメロロジーの優先度に関する情報は、各ニューメロロジーに対応するＭＩＢに含めてユーザ端末に通知することができる。ユーザ端末は、ニューメロロジーの優先度に関する情報に基づいて、自端末がサポートするニューメロロジーのうち優先度が高いＭ個（例えば、最も優先度が高い１個）のニューメロロジーを選択することができる。

[0069] あるいは、ユーザ端末は、ＭＩＢの受信を行う前にＭ個のニューメロロジーを選択してもよい。この場合、ユーザ端末は、選択したターゲットニュー

メロロジーに対応するＭＩＢのみ選択的に受信するように制御することができる。これにより、ターゲットニューメロロジー以外のＭＩＢの受信動作を省略することができる。

[0070] ユーザ端末は、選択したニューメロロジーに対応するＭＩＢ（ターゲットＭＩＢ）の受信を行う。例えば、ユーザ端末は、所定信号とターゲットＭＩＢとの間に予め設定されたオフセットに基づいて、ターゲットＭＩＢの受信を制御する。所定信号としては、同じニューメロロジーで検出した同期信号及び／又は異なるニューメロロジーで検出した同期信号を利用することができる。

[0071] 例えば、複数のニューメロロジーにおいて共通の同期信号が設定される場合（shared SS）、ユーザ端末は、共通同期信号とターゲットＭＩＢ間に設定されるオフセットに基づいて、ターゲットＭＩＢの受信を制御する。共通同期信号とターゲットＭＩＢ間に設定されるオフセットに関する情報は、予め定義してもよいし、無線基地局からユーザ端末に通知してもよい。

[0072] 図７は、所定のニューメロロジー（ここでは、Ｎ１）で共通同期信号が送信され、当該共通同期信号に基づいて各ニューメロロジー（Ｎ１－Ｎ３）でそれぞれ送信されるＭＩＢを受信する場合の一例を示している。ユーザ端末が、ターゲットニューメロロジーとして、Ｎ１－Ｎ３を選択した場合、共通同期信号（例えば、共通同期信号との間に設定されるオフセット）に基づいて各ニューメロロジーのＭＩＢの受信を制御する。共通同期信号と各ＭＩＢとの間に設定されるオフセットは予め定義されてもよいし、無線基地局からユーザ端末に通知してもよい。

[0073] 例えば、ユーザ端末は、共通同期信号が送信されるニューメロロジー（ここでは、Ｎ１）において当該共通同期信号とＮ１用のＭＩＢ間に設定されたオフセット（周波数及び／又は時間リソースのオフセット）に基づいてＮ１用のＭＩＢを受信する。同様に、ユーザ端末は、共通同期信号とＮ２用のＭＩＢ間に設定されたオフセットと、Ｎ３用のＭＩＢ間に設定されたオフセットに基づいて各ニューメロロジーのＭＩＢを受信する。なお、Ｎ２及び／又

はＮ３用のＭＩＢと共通同期信号間のオフセットに関する情報をＮ１用のＭＩＢに含めてユーザ端末に通知してもよい。

[0074] 複数のニューメロロジー毎にそれぞれ同期信号が設定される場合（separate SS）、ユーザ端末は、各ニューメロロジーにおいて、同期信号との間に設定されるオフセットに基づいてターゲットニューメロロジーのＭＩＢを受信することができる。

[0075] 図８は、各ニューメロロジー（ここでは、Ｎ１－Ｎ３）でそれぞれ送信される同期信号に基づいて、各ニューメロロジーのＭＩＢをそれぞれ受信する場合の一例を示している。ユーザ端末が、ターゲットニューメロロジーとして、Ｎ１－Ｎ３を選択した場合、各ニューメロロジーの同期信号に基づいて各ニューメロロジーのＭＩＢをそれぞれ受信する。各ニューメロロジーにおいて、同期信号とＭＩＢ間に設定されるオフセットは予め定義することができる。なお、各ニューメロロジーにおいて同期信号とＭＩＢ間に設定されるオフセットは、共通としてもよいし個別に設定してもよい。

[0076] なお、同期信号とＭＩＢ間に設定されるオフセット（周波数及び／又は時間リソースオフセット）は、所定単位（例えば、ＰＲＢ）で設定することができる。ＭＩＢ検出時間（ユーザ端末がＭＩＢを検出するタイミング）は、同期信号を基準として設定された固定的なオフセット（時間リソースオフセット）に基づいて決定することができる。あるいは、所定のシステムフレーム番号及び／又はサブフレームインデックスにＭＩＢを設定してもよい。

[0077] 各ニューメロロジーのＭＩＢには、各ニューメロロジーに固有の情報を含めることができる。また、複数のニューメロロジーに共通のシステム情報（ＭＩＢ）は、異なるニューメロロジーのＭＩＢにそれぞれ含めてもよい。なお、ニューメロロジーに固有な情報及び複数ニューメロロジーに共通の情報としては、上記第１の態様で示した情報を適用することができる。

[0078] ＜ユーザ端末動作＞

ユーザ端末は、同期信号（shared SS又はseparate SS）を受信した後、ターゲットニューメロロジーを選択する。ユーザ端末が１つのニューメロロ

ジーのみサポートしている場合、当該ニューメロロジーでＭＩＢを受信し、その後の手順（ＳＩＢ受信等）を行う。

[0079] ユーザ端末が複数のニューメロロジーをサポートしている場合、当該複数のニューメロロジーにおいてＭＩＢをそれぞれ受信した後に、ターゲットニューメロロジーを選択する。あるいは、複数のニューメロロジーの中からターゲットニューメロロジーを選択した後、ターゲットニューメロロジーにおいてＭＩＢの受信を行う。ターゲットＭＩＢを受信した後、ＳＩＢの受信処理等を行う。

[0080] このように、複数のニューメロロジーのＭＩＢを受信する場合、ターゲットニューメロロジー（又は、サポートするニューメロロジー）のＭＩＢを直接受信することにより、ユーザ端末動作を簡略化することができる。

[0081] （第３の態様）

第３の態様では、システム情報（ＭＩＢの内容）を複数のニューメロロジーで組み合わせて報知チャネル（ＭＩＢ）の送受信を制御する場合の一例について説明する。

[0082] 図９は、ユーザ端末が所定のニューメロロジー（ここでは、Ｎ１）で送信されるＭＩＢ（Combined MIB）を受信する場合の一例を示している。Ｎ１で送信されるＭＩＢには、Ｎ１に加えて他のニューメロロジーＮ２、Ｎ３に対応するシステム情報も含まれている。つまり、ユーザ端末は、一つのＭＩＢの受信により複数のニューメロロジーのシステム情報を取得することができる。

[0083] 例えば、ユーザ端末は、無線基地局から送信される同期信号を受信して同期をとった後、所定のニューメロロジーで送信されるコンバインドＭＩＢの受信を行う。ユーザ端末がコンバインドＭＩＢが送信されるニューメロロジーを認識する方法として、あらかじめ当該ニューメロロジーを定義しておく方法、又は所定信号（例えば、同期信号）に基づいて判断する方法を適用することができる。コンバインドＭＩＢが送信されるニューメロロジーをアンカーニューメロロジーと呼んでもよい。

[0084] 例えば、複数のニューメロロジーで同期信号が共通に設定される場合（shared SS design）、ユーザ端末は、共通同期信号が送信されるニューメロロジーをコンバインドＭＩＢが送信されるニューメロロジーと判断する。この場合、ユーザ端末は、同期信号に対して受信処理（例えば、ブラインド検出）を行うことにより、コンバインドＭＩＢが送信されるニューメロロジーを把握することができる。

[0085] 複数のニューメロロジー毎に同期信号がそれぞれ設定される場合（separate SS design）、所定のニューメロロジーをコンバインドＭＩＢが送信されるニューメロロジーとしてあらかじめ定義しておけばよい。所定のニューメロロジーとしては、あるサブキャリア間隔（例えば、１５ｋＨｚ）を適用するニューメロロジーとすることができる。

[0086] 所定のニューメロロジーで送信されるコンバインドＭＩＢの位置（周波数及び／又は時間リソース）は、あらかじめ定義してもよい。あるいは、同期信号（例えば、所定のニューメロロジーの同期信号）の位置から所定オフセット（例えば、周波数及び／又は時間リソースオフセット）だけ離れた位置にコンバインドＭＩＢを配置する構成としてもよい。

[0087] ユーザ端末は、自端末がサポートするニューメロロジーの少なくとも一つを選択して通信を制御する。例えば、複数のニューメロロジーのうちコンバインドＭＩＢが送信される所定のニューメロロジーのみサポートするユーザ端末は、当該所定のニューメロロジーでコンバインドＭＩＢを検出してシステム情報を取得する。

[0088] 複数のニューメロロジーをサポートするユーザ端末は、所定数Ｍ（例えば、Ｍ（≧１））のニューメロロジーをターゲットニューメロロジーとして選択することができる。所定数Ｍと当該Ｍ個のニューメロロジーは、ユーザ端末の能力等に基づいてユーザ端末が自律的に決定してもよいし、無線基地局からの指示により決定してもよい。あるいは、ユーザ端末は、あらかじめ定義された規則（又は選択テーブル）に基づいてニューメロロジーを選択する。

[0089] 無線基地局がユーザ端末にターゲットニューメロロジーを指定する場合、当該無線基地局は、例えば、ニューメロロジーの優先度に関する情報をユーザ端末に通知する。ニューメロロジーの優先度に関する情報は、コンバインドＭＩＢ及び／又はアンカーニューメロロジーで送信されるＳＩＢに含めてユーザ端末に通知することができる。ユーザ端末は、ニューメロロジーの優先度に関する情報に基づいて、自端末がサポートするニューメロロジーのうちＭ個（例えば、最も優先度が高い１つ）のニューメロロジーを選択する。

[0090] ユーザ端末は、選択したターゲットニューメロロジーに対応するシステム情報をコンバインドＭＩＢから取得する。コンバインドＭＩＢには、複数のニューメロロジーに共通の情報や各ニューメロロジーに固有の情報を含めることができる。無線基地局はコンバインドＭＩＢにターゲットニューメロロジーを指定する情報を含めてユーザ端末に通知することができる。例えば、無線基地局は、ターゲットニューメロロジーを指定する情報を所定ビット（例えば、２ビット）でユーザ端末に通知する。

[0091] ２ビットの一例として、サブキャリア間隔が１５ＫＨｚに対応するニューメロロジー（例えば、Ｎ１）と３０ＫＨｚに対応するニューメロロジー（Ｎ２）を“００”、１５ＫＨｚに対応するニューメロロジー（例えば、Ｎ１）と６０ＫＨｚに対応するニューメロロジー（Ｎ３）を“０１”、１５ＫＨｚに対応するニューメロロジー（例えば、Ｎ１）と３０ＫＨに対応するニューメロロジー（例えば、Ｎ２）と６０ＫＨｚに対応するニューメロロジー（Ｎ３）を“１０”に設定する（“１１”はリザーブ）。ユーザ端末は、コンバインドＭＩＢに含まれるビット値に基づいて、ターゲットニューメロロジーを判断することができる。

[0092] あるいは、ターゲットニューメロロジーの指定をビットマップ（例えば、Ｎ１－Ｎ３に対応する３ビットのビットマップ）を用いてユーザ端末に通知してもよい。

[0093] また、異なるニューメロロジー間で共通のＳＦＮ及び／又はサブフレーム番号を適用する場合、当該ＳＦＮ及び／又はサブフレーム番号に関する情報

をコンバインドＭＩＢに含めてユーザ端末に通知する。あるいは、あるニューメロロジーに固有のＳＦＮ及び／又はサブフレーム番号を適用する場合にも、当該ニューメロロジー固有のＳＦＮ及び／又はサブフレーム番号に関する情報をコンバインドＭＩＢに含めてユーザ端末に通知する。

[0094] また、各ニューメロロジーの構成に関する情報をコンバインドＭＩＢに含めてもよい。ターゲットニューメロロジーの中心領域（中央のＰＲＢ番号）に関する情報をコンバインドＭＩＢに含めてユーザ端末に通知してもよい。ターゲットニューメロロジーの中心領域（中央のＰＲＢ番号）に関する情報としては、例えば、所定ニューメロロジー（コンバインドＭＩＢが送信されるニューメロロジー）と、ターゲットニューメロロジー間に設定されるオフセットとすることができる。ユーザ端末は、ターゲットニューメロロジーの構成に関する情報に基づいて、その後の処理（例えば、ランダムアクセス手順）を適切に行うことができる。

[0095] また、ターゲットニューメロロジーの受信に利用する参照信号に関するパラメータ（例えば、ポート番号、時間及び／又は周波数リソース等）、ＰＲＡＣＨに関するパラメータ（例えば、ランダムアクセス用のプリアンブルインデックス、時間及び／又は周波数リソース等）をコンバインドＭＩＢに含めてもよい。

[0096] ＜ユーザ端末動作＞

ユーザ端末は、同期信号（shared SS又はseparate SS）を受信した後、所定のニューメロロジーでコンバインドＭＩＢの検出を行う。コンバインドＭＩＢが送信されるニューメロロジーの認識方法は上述した方法を適用することができる。次に、ユーザ端末は、ターゲットニューメロロジーを選択する。ターゲットニューメロロジーは、コンバインドＭＩＢに含まれる情報に基づいて選択してもよい。ユーザ端末が１つのニューメロロジーのみサポートしている場合、当該ニューメロロジーでコンバインドＭＩＢを受信し、その後の手順（ＳＩＢ受信等）を行う。

[0097] ユーザ端末が複数のニューメロロジーをサポートしている場合、ターゲッ

トニューメロロジーを選択して、コンバインドＭＩＢからターゲットニューメロロジーに対応するシステム情報を取得する。ターゲットニューメロロジーのシステム情報を取得した後、ＳＩＢの受信処理等を行う。

[0098] このように、複数のニューメロロジーのＭＩＢを組み合わせたコンバインドＭＩＢを設定することにより、一つのＭＩＢの受信に基づいて各ニューメロロジーのシステム情報を取得することができる。これにより、複数のＭＩＢの受信処理を抑制することができる。

[0099] （変形例１）

上記図９では、複数のニューメロロジー（Ｎ１－Ｎ３全て）のシステム情報（ＭＩＢ）を組み合わせてコンバインドＭＩＢとして送信する形態を示したが、一部のニューメロロジーのシステム情報を選択的に組み合わせてコンバインドＭＩＢとしてもよい。

[0100] 図１０は、３つのニューメロロジー（Ｎ１－Ｎ３）のうち２つのニューメロロジー（例えば、Ｎ１とＮ２）に対応するシステム情報を組み合わせてコンバインドＭＩＢとして送信する場合を示している。この場合、残りの１つのニューメロロジー（Ｎ３）のシステム情報は、コンバインドＭＩＢとは別に送信する。２つのニューメロロジーのＭＩＢが組み合わされたコンバインドＭＩＢはハイブリッドＭＩＢ（hybrid MIB）と呼んでもよい。

[0101] Ｎ１とＮ２のシステム情報が組み合わされたコンバインドＭＩＢと、Ｎ３のシステム情報を含むＭＩＢは同一のニューメロロジーで送信してもよいし、異なるニューメロロジーで送信してもよい。他のニューメロロジーのＭＩＢが送信されるニューメロロジー（ここでは、Ｎ１）は、アンカーニューメロロジーと呼んでもよい。ユーザ端末がアンカーニューメロロジーを認識する方法は、上記第１の態様又は第３の態様で示した方法を利用することができる。

[0102] システム情報を組み合わせるニューメロロジーは適宜選択することができる。例えば、報知チャネル（ＰＢＣＨ）の送信周期が同じニューメロロジーのＭＩＢをそれぞれ組み合わせてコンバインドＭＩＢとすることができる。

あるいは、ニューメロロジーの構成（例えば、サブキャリア間隔）が近いニューメロロジー同士のＭＩＢをそれぞれ組み合わせてコンバインドＭＩＢとしてもよい。例えば、サブキャリア間隔が１５ＫＨｚ、３０ＫＨｚ、６０ＫＨｚの３つのニューメロロジーが設定される場合、１５ＫＨｚのニューメロロジーと３０ＫＨｚのニューメロロジーを組み合わせることが好ましい。

[0103] コンバインドＭＩＢ及び／又は他のニューメロロジーのＭＩＢを配置する位置（周波数及び／又は時間リソース）は、所定信号（例えば、同期信号）から所定のオフセット（周波数及び／又は時間リソースオフセット）だけ離れた位置とすることができる。

[0104] 複数のニューメロロジー（例えば、Ｎ１とＮ２）のシステム情報が組み合わされたコンバインドＭＩＢには、Ｎ１とＮ２に対応するシステム情報を含めてユーザ端末に通知する。コンバインドＭＩＢとは別に送信されるＭＩＢには、Ｎ３に対応するシステム情報を含めてユーザ端末に通知する。Ｎ３に対応するシステム情報としては、当該Ｎ３の構成（例えば、Ｎ３における中心周波数（中心ＰＲＢ））に関する情報、Ｎ３で利用されるＳＦＮ及び／又はサブフレーム番号に関する情報、Ｎ３で利用される参照信号に関する情報、Ｎ３で利用されるＰＲＡＣＨに関する情報等が挙げられる。

[0105] ＜ユーザ端末動作＞

まず、ユーザ端末は、同期信号（shared SS又はseparate SS）を受信する。その後、自端末がサポートする複数のニューメロロジーに対するＭＩＢの検出を行った後、ターゲットニューメロロジーの選択を行う。あるいは、ユーザ端末は、ターゲットニューメロロジーの選択を行った後、選択したターゲットニューメロロジーに対するＭＩＢを選択的に検出してもよい。

[0106] このように、全てのニューメロロジーのシステム情報を組み合わせるのでなく、一部のニューメロロジーのシステム情報をコンバインドＭＩＢとは別に送信することにより、各ニューメロロジーのシステム情報の送受信を柔軟に制御することができる。

[0107] （変形例２）

上記図２では、アンカーＭＩＢと当該アンカーＭＩＢに基づいて受信する他のＭＩＢ（ターゲットＭＩＢ）を異なるニューメロロジー（周波数帯域）に配置する場合を示したが、ターゲットＭＩＢをアンカーニューメロロジーで送信してもよい。

[0108] 図１１は、アンカーＭＩＢと、当該アンカーＭＩＢに基づいて受信を行うターゲットＭＩＢをアンカーニューメロロジー（ここでは、Ｎ１）で送信する場合を示している。アンカーＭＩＢが送信されるアンカーニューメロロジーの認識方法、アンカーＭＩＢの配置位置は上記第１の態様と同様に設定することができる。

[0109] ターゲットＭＩＢの配置位置（例えば、時間リソース）は、アンカーＭＩＢとの間に設定されたオフセットに基づいて設定してもよいし、予め定義された固定ＳＦＮ及び／又はサブフレームインデックスに基づいて設定してもよい。各ターゲットＭＩＢとアンカーＭＩＢ間にオフセットを設定する場合、当該オフセットに関する情報はアンカーＭＩＢに含めてユーザ端末に通知してもよい。

[0110] アンカーＭＩＢに含めるシステム情報及び／又はターゲットＭＩＢに含めるシステム情報は、上記第１の態様と同様に設定することができる。

[0111] ＜ユーザ端末動作＞

ユーザ端末は、同期信号（shared SS又はseparate SS）を受信した後、アンカーニューメロロジーでアンカーＭＩＢの検出を行う。アンカーニューメロロジーの認識方法は第１の態様で示した方法を適用することができる。次に、ユーザ端末は、ターゲットニューメロロジーを選択する。

[0112] ユーザ端末が複数のニューメロロジーをサポートしている場合、アンカーＭＩＢに基づいて選択したターゲットニューメロロジーのＭＩＢを受信する。ターゲットＭＩＢを受信した後、ＳＩＢの受信処理等を行う。

[0113] このように、ターゲットＭＩＢをアンカーＭＩＢと同じアンカーニューメロロジーで送信することにより、ユーザ端末は同じニューメロロジーで各ニューメロロジーのシステム情報を受信することができる。また、アンカーＭ

ＩＢとターゲットＭＩＢを同じ周波数位置に設定する場合、ユーザ端末は所定信号（例えば、アンカーＭＩＢ）からの時間オフセットだけ考慮してターゲットＭＩＢを受信することができる。この場合、周波数オフセットに関する情報が不要となるため、オーバーヘッドの増加を抑制することができる。

[0114] （無線通信システム）

以下、本実施の形態に係る無線通信システムの構成について説明する。この無線通信システムでは、上記各態様に係る無線通信方法が適用される。なお、上記各態様に係る無線通信方法は、それぞれ単独で適用されてもよいし、組み合わせて適用されてもよい。

[0115] 図１２は、本実施の形態に係る無線通信システムの概略構成の一例を示す図である。無線通信システム１では、ＬＴＥシステムのシステム帯域幅（例えば、２０ＭＨｚ）を１単位とする複数の基本周波数ブロック（コンポーネントキャリア）を一体としたキャリアアグリゲーション（ＣＡ）及び／又はデュアルコネクティビティ（ＤＣ）を適用することができる。なお、無線通信システム１は、ＳＵＰＥＲ　３Ｇ、ＬＴＥ－Ａ（ＬＴＥ－Ａｄｖａｎｃｅｄ）、ＩＭＴ－Ａｄｖａｎｃｅｄ、４Ｇ、５Ｇ、ＦＲＡ（Future Radio Access）、ＮＲ（New Rat）等と呼ばれても良い。

[0116] 図１２に示す無線通信システム１は、マクロセルＣ１を形成する無線基地局１１と、マクロセルＣ１内に配置され、マクロセルＣ１よりも狭いスモールセルＣ２を形成する無線基地局１２ａ～１２ｃとを備えている。また、マクロセルＣ１及び各スモールセルＣ２には、ユーザ端末２０が配置されている。セル間で異なるニューメロロジーが適用される構成としてもよい。なお、ニューメロロジーとは、あるＲＡＴにおける信号のデザインや、ＲＡＴのデザインを特徴付ける通信パラメータのセットのことをいう。

[0117] ユーザ端末２０は、無線基地局１１及び無線基地局１２の双方に接続することができる。ユーザ端末２０は、異なる周波数を用いるマクロセルＣ１とスモールセルＣ２を、ＣＡ又はＤＣにより同時に使用することが想定される。また、ユーザ端末２０は、複数のセル（ＣＣ）（例えば、２個以上のＣＣ

）を用いてＣＡ又はＤＣを適用することができる。また、ユーザ端末は、複数のセルとしてライセンスバンドＣＣとアンライセンスバンドＣＣを利用することができる。なお、複数のセルのいずれかに短縮ＴＴＩを適用するＴＤＤキャリアが含まれる構成とすることができる。

[0118] ユーザ端末２０と無線基地局１１との間は、相対的に低い周波数帯域（例えば、２ＧＨｚ）で帯域幅が狭いキャリア（既存キャリア、Legacy carrier等と呼ばれる）を用いて通信を行うことができる。一方、ユーザ端末２０と無線基地局１２との間は、相対的に高い周波数帯域（例えば、３．５ＧＨｚ、５ＧＨｚ、３０～７０ＧＨｚ等）で帯域幅が広いキャリアが用いられてもよいし、無線基地局１１との間と同じキャリアが用いられてもよい。なお、各無線基地局が利用する周波数帯域の構成はこれに限られない。

[0119] 無線基地局１１と無線基地局１２との間（又は、２つの無線基地局１２間）は、有線接続（例えば、ＣＰＲＩ（Common Public Radio Interface）に準拠した光ファイバ、Ｘ２インターフェース等）又は無線接続する構成とすることができる。

[0120] 無線基地局１１及び各無線基地局１２は、それぞれ上位局装置３０に接続され、上位局装置３０を介してコアネットワーク４０に接続される。なお、上位局装置３０には、例えば、アクセスゲートウェイ装置、無線ネットワークコントローラ（ＲＮＣ）、モビリティマネジメントエンティティ（ＭＭＥ）等が含まれるが、これに限定されるものではない。また、各無線基地局１２は、無線基地局１１を介して上位局装置３０に接続されてもよい。

[0121] なお、無線基地局１１は、相対的に広いカバレッジを有する無線基地局であり、マクロ基地局、集約ノード、ｅＮＢ（eNodeB）、送受信ポイント、等と呼ばれてもよい。また、無線基地局１２は、局所的なカバレッジを有する無線基地局であり、スモール基地局、マイクロ基地局、ピコ基地局、フェムト基地局、ＨｅＮＢ（Home eNodeB）、ＲＲＨ（Remote Radio Head）、送受信ポイント等と呼ばれてもよい。以下、無線基地局１１及び１２を区別しない場合は、無線基地局１０と総称する。

[0122] 各ユーザ端末２０は、ＬＴＥ、ＬＴＥ－Ａ等の各種通信方式に対応した端末であり、移動通信端末だけでなく固定通信端末を含んでもよい。

[0123] 無線通信システム１においては、無線アクセス方式として、下りリンク（ＤＬ）にＯＦＤＭＡ（直交周波数分割多元接続）が適用でき、上りリンク（ＵＬ）にＳＣ－ＦＤＭＡ（シングルキャリアー周波数分割多元接続）が適用できる。ＯＦＤＭＡは、周波数帯域を複数の狭い周波数帯域（サブキャリア）に分割し、各サブキャリアにデータをマッピングして通信を行うマルチキャリア伝送方式である。ＳＣ－ＦＤＭＡは、システム帯域幅を端末毎に１つ又は連続したリソースブロックからなる帯域に分割し、複数の端末が互いに異なる帯域を用いることで、端末間の干渉を低減するシングルキャリア伝送方式である。なお、上り及び下りの無線アクセス方式は、これらの組み合わせに限られず、ＵＬでＯＦＤＭＡが用いられてもよい。

[0124] 無線通信システム１では、ＤＬチャネルとして、各ユーザ端末２０で共有されるＤＬデータチャネル（ＰＤＳＣＨ：Physical Downlink Shared Channel、ＤＬ共有チャネル等ともいう）、ブロードキャストチャネル（ＰＢＣＨ：Physical Broadcast Channel）、Ｌ１／Ｌ２制御チャネル等が用いられる。ＰＤＳＣＨにより、ユーザデータや上位レイヤ制御情報、ＳＩＢ（System Information Block）等が伝送される。また、ＰＢＣＨにより、ＭＩＢ（Master Information Block）が伝送される。

[0125] Ｌ１／Ｌ２制御チャネルは、ＤＬ制御チャネル（ＰＤＣＣＨ（Physical Downlink Control Channel）、ＥＰＤＣＣＨ（Enhanced Physical Downlink Control Channel））、ＰＣＦＩＣＨ（Physical Control Format Indicator Channel）、ＰＨＩＣＨ（Physical Hybrid-ARQ Indicator Channel）等を含む。ＰＤＣＣＨにより、ＰＤＳＣＨ及びＰＵＳＣＨのスケジューリング情報を含む下り制御情報（ＤＣＩ：Downlink Control Information）等が伝送される。ＰＣＦＩＣＨにより、ＰＤＣＣＨに用いるＯＦＤＭシンボル数が伝送される。ＰＨＩＣＨにより、ＰＵＳＣＨに対するＨＡＲＱの送達確認情報（ＡＣＫ／ＮＡＣＫ）が伝送される。ＥＰＤＣＣＨは、ＰＤＳＣ

Ｈ（下り共有データチャネル）と周波数分割多重され、ＰＤＣＣＨと同様にＤＣＩ等の伝送に用いられる。

[0126] 無線通信システム１では、ＵＬチャネルとして、各ユーザ端末２０で共有されるＵＬデータチャネル（ＰＵＳＣＨ：Physical Uplink Shared Channel、ＵＬ共有チャネル等ともいう）、ＵＬ制御チャネル（ＰＵＣＣＨ：Physical Uplink Control Channel）、ランダムアクセスチャネル（ＰＲＡＣＨ：Physical Random Access Channel）等が用いられる。ＰＵＳＣＨにより、ユーザデータ、上位レイヤ制御情報が伝送される。送達確認情報（ＡＣＫ／ＮＡＣＫ）や無線品質情報（ＣＱＩ）等の少なくとも一つを含む上り制御情報（ＵＣＩ：Uplink Control Information）は、ＰＵＳＣＨ又はＰＵＣＣＨにより、伝送される。ＰＲＡＣＨにより、セルとの接続確立のためのランダムアクセスプリアンブルが伝送される。

[0127] ＜無線基地局＞

図１３は、本実施の形態に係る無線基地局の全体構成の一例を示す図である。無線基地局１０は、複数の送受信アンテナ１０１と、アンプ部１０２と、送受信部１０３と、ベースバンド信号処理部１０４と、呼処理部１０５と、伝送路インターフェース１０６と、を備えている。なお、送受信アンテナ１０１、アンプ部１０２、送受信部１０３は、それぞれ１つ以上を含むように構成されればよい。

[0128] 無線基地局１０からユーザ端末２０に送信されるＤＬデータは、上位局装置３０から伝送路インターフェース１０６を介してベースバンド信号処理部１０４に入力される。

[0129] ベースバンド信号処理部１０４では、ＤＬデータに関して、ＰＤＣＰ（Packet Data Convergence Protocol）レイヤの処理、ユーザデータの分割・結合、ＲＬＣ（Radio Link Control）再送制御等のＲＬＣレイヤの送信処理、ＭＡＣ（Medium Access Control）再送制御（例えば、ＨＡＲＱの送信処理）、スケジューリング、伝送フォーマット選択、チャネル符号化、逆高速フーリエ変換（ＩＦＦＴ：Inverse Fast Fourier Transform）処理、プ

リコーディング処理等の送信処理が行われて送受信部１０３に転送される。また、ＤＬ制御信号に関しても、チャネル符号化や逆高速フーリエ変換等の送信処理が行われて、送受信部１０３に転送される。

[0130] 送受信部１０３は、ベースバンド信号処理部１０４からアンテナ毎にプリコーディングして出力されたベースバンド信号を無線周波数帯に変換して送信する。送受信部１０３で周波数変換された無線周波数信号は、アンプ部１０２により増幅され、送受信アンテナ１０１から送信される。送受信部１０３は、本発明に係る技術分野での共通認識に基づいて説明されるトランスミッター／レシーバー、送受信回路又は送受信装置から構成することができる。なお、送受信部１０３は、一体の送受信部として構成されてもよいし、送信部及び受信部から構成されてもよい。

[0131] 一方、ＵＬ信号については、送受信アンテナ１０１で受信された無線周波数信号がアンプ部１０２で増幅される。送受信部１０３はアンプ部１０２で増幅されたＵＬ信号を受信する。送受信部１０３は、受信信号をベースバンド信号に周波数変換して、ベースバンド信号処理部１０４に出力する。

[0132] ベースバンド信号処理部１０４では、入力されたＵＬ信号に含まれるユーザデータに対して、高速フーリエ変換（ＦＦＴ：Fast Fourier Transform）処理、逆離散フーリエ変換（ＩＤＦＴ：Inverse Discrete Fourier Transform）処理、誤り訂正復号、ＭＡＣ再送制御の受信処理、ＲＬＣレイヤ及びＰＤＣＰレイヤの受信処理がなされ、伝送路インターフェース１０６を介して上位局装置３０に転送される。呼処理部１０５は、通信チャネルの設定や解放等の呼処理や、無線基地局１０の状態管理や、無線リソースの管理を行う。

[0133] 伝送路インターフェース１０６は、所定のインターフェースを介して、上位局装置３０と信号を送受信する。また、伝送路インターフェース１０６は、基地局間インターフェース（例えば、ＣＰＲＩ（Common Public Radio Interface）に準拠した光ファイバ、Ｘ２インターフェース）を介して他の無線基地局１０と信号を送受信（バックホールシグナリング）してもよい。

[0134] なお、送受信部１０３は、ＤＬ信号（例えば、ＤＬ制御信号（ＤＬ制御チャネル）、ＤＬデータ信号（ＤＬデータチャネル、ＤＬ共有チャネル）、ＤＬ参照信号（ＤＭ－ＲＳ、ＣＳＩ－ＲＳ等）、ディスカバリ信号、同期信号、ブロードキャスト信号等）を送信し、ＵＬ信号（例えば、ＵＬ制御信号（ＵＬ制御チャネル）、ＵＬデータ信号（ＵＬデータチャネル、ＵＬ共有チャネル）、ＵＬ参照信号等）を受信する。

[0135] 具体的には、送受信部１０３は、各ニューメロロジーのシステム情報（ＭＩＢ）をユーザ端末に送信する。例えば、送受信部１０３は、アンカーＭＩＢ（アンカー報知チャネル）をアンカーニューメロロジーで送信し、ターゲットＭＩＢ（ターゲット報知チャネル）をアンカーニューメロロジー及び／又はターゲットニューメロロジーで送信する（図２、図１１参照）。アンカーＭＩＢには、複数のニューメロロジーが設定される帯域幅に関する情報、ターゲットＭＩＢの配置領域に関する情報、ＳＦＮ及び／又はサブフレームインデックスに関する情報、参照信号の構成やＰＲＡＣＨの構成に関する情報等が含まれる。ターゲットＭＩＢには、ターゲットニューメロロジーに固有の情報が含まれる。

[0136] また、送受信部１０３は、各ニューメロロジーにおいて当該ニューメロロジーに対応するＭＩＢをそれぞれ送信する（図６参照）。あるいは、送受信部１０３は、所定のニューメロロジーにおいて、複数のニューメロロジーの一部又は全部が組み合わされたコンバインドＭＩＢを送信する（図９、図１０参照）。

[0137] 本発明の送信部及び受信部は、送受信部１０３及び／又は伝送路インターフェース１０６により構成される。

[0138] 図１４は、本実施の形態に係る無線基地局の機能構成の一例を示す図である。なお、図１４では、本実施形態における特徴部分の機能ブロックを主に示しており、無線基地局１０は、無線通信に必要な他の機能ブロックも有しているものとする。図１４に示すように、ベースバンド信号処理部１０４は、制御部３０１と、送信信号生成部３０２と、マッピング部３０３と、受信

信号処理部３０４と、測定部３０５と、を少なくとも備えている。

[0139] 制御部３０１は、無線基地局１０全体の制御を実施する。制御部３０１は、本発明に係る技術分野での共通認識に基づいて説明されるコントローラ、制御回路又は制御装置から構成することができる。

[0140] 制御部３０１は、例えば、送信信号生成部３０２による信号（システム情報、ＭＩＢ等）の生成や、マッピング部３０３による信号の割り当てを制御する。また、制御部３０１は、受信信号処理部３０４による信号の受信処理や、測定部３０５による信号の測定を制御する。

[0141] 制御部３０１は、ＤＬ信号及び／又はＵＬ信号のスケジューリング（例えば、リソース割り当て）を制御する。具体的には、制御部３０１は、システム情報（ＭＩＢ、ＳＩＢ等）、ＤＬデータチャネルのスケジューリング情報を含むＤＣＩ（ＤＬアサインメント）、ＤＬ参照信号、ＵＬデータチャネルのスケジューリング情報を含むＤＣＩ（ＵＬグラント）、ＵＬ参照信号等を生成及び送信するように、送信信号生成部３０２、マッピング部３０３、送受信部１０３を制御する。

[0142] 制御部３０１は、異なるニューメロロジーに対応するＭＩＢ（アンカーＭＩＢ、ターゲットＭＩＢ等）を周波数及び／又は時間分割多重するように割当てを制御することができる。

[0143] 送信信号生成部３０２は、制御部３０１からの指示に基づいて、ＤＬ信号（ＤＬ制御チャネル、ＤＬデータチャネル、ＤＬ参照信号等）を生成して、マッピング部３０３に出力する。送信信号生成部３０２は、本発明に係る技術分野での共通認識に基づいて説明される信号生成器、信号生成回路又は信号生成装置から構成することができる。

[0144] マッピング部３０３は、制御部３０１からの指示に基づいて、送信信号生成部３０２で生成されたＤＬ参照信号等のＤＬ信号を、所定の無線リソースにマッピングして、送受信部１０３に出力する。マッピング部３０３は、本発明に係る技術分野での共通認識に基づいて説明されるマッパー、マッピング回路又はマッピング装置から構成することができる。

[0145] 受信信号処理部３０４は、送受信部１０３から入力された受信信号に対して、受信処理（例えば、デマッピング、復調、復号等）を行う。ここで、受信信号は、例えば、ユーザ端末２０から送信されるＵＬ信号（ＵＬ制御チャネル、ＵＬデータチャネル、ＵＬ参照信号等）である。受信信号処理部３０４は、本発明に係る技術分野での共通認識に基づいて説明される信号処理器、信号処理回路又は信号処理装置から構成することができる。

[0146] 受信信号処理部３０４は、受信処理により復号された情報を制御部３０１に出力する。例えば、受信処理部３０４は、プリアンブル、制御情報、ＵＬデータの少なくとも一つを制御部３０１に出力する。また、受信信号処理部３０４は、受信信号や、受信処理後の信号を、測定部３０５に出力する。

[0147] 測定部３０５は、受信した信号に関する測定を実施する。測定部３０５は、本発明に係る技術分野での共通認識に基づいて説明される測定器、測定回路又は測定装置から構成することができる。

[0148] 測定部３０５は、例えば、受信した信号の受信電力（例えば、ＲＳＲＰ（Reference Signal Received Power））、受信品質（例えば、ＲＳＲＱ（Reference Signal Received Quality））やチャネル状態等について測定してもよい。測定結果は、制御部３０１に出力されてもよい。

[0149] ＜ユーザ端末＞

図１５は、本実施の形態に係るユーザ端末の全体構成の一例を示す図である。ユーザ端末２０は、複数の送受信アンテナ２０１と、アンプ部２０２と、送受信部２０３と、ベースバンド信号処理部２０４と、アプリケーション部２０５と、を備えている。なお、送受信アンテナ２０１、アンプ部２０２、送受信部２０３は、それぞれ１つ以上を含むように構成されればよい。

[0150] 送受信アンテナ２０１で受信された無線周波数信号は、アンプ部２０２で増幅される。送受信部２０３は、アンプ部２０２で増幅されたＤＬ信号を受信する。送受信部２０３は、受信信号をベースバンド信号に周波数変換して、ベースバンド信号処理部２０４に出力する。送受信部２０３は、本発明に係る技術分野での共通認識に基づいて説明されるトランスミッター／レシー

バー、送受信回路又は送受信装置から構成することができる。なお、送受信部２０３は、一体の送受信部として構成されてもよいし、送信部及び受信部から構成されてもよい。

[0151] ベースバンド信号処理部２０４は、入力されたベースバンド信号に対して、ＦＦＴ処理や、誤り訂正復号、再送制御の受信処理等を行う。ＤＬデータは、アプリケーション部２０５に転送される。アプリケーション部２０５は、物理レイヤやＭＡＣレイヤより上位のレイヤに関する処理等を行う。また、ＤＬデータのうち、システム情報や上位レイヤ制御情報もアプリケーション部２０５に転送される。

[0152] 一方、ＵＬデータについては、アプリケーション部２０５からベースバンド信号処理部２０４に入力される。ベースバンド信号処理部２０４では、再送制御の送信処理（例えば、ＨＡＲＱの送信処理）や、チャネル符号化、プリコーディング、離散フーリエ変換（ＤＦＴ：Discrete Fourier Transform）処理、ＩＦＦＴ処理等が行われて送受信部２０３に転送される。送受信部２０３は、ベースバンド信号処理部２０４から出力されたベースバンド信号を無線周波数帯に変換して送信する。送受信部２０３で周波数変換された無線周波数信号は、アンプ部２０２により増幅され、送受信アンテナ２０１から送信される。

[0153] なお、送受信部２０３は、ＤＬ信号（例えば、ＤＬ制御信号（ＤＬ制御チャネル）、ＤＬデータ信号（ＤＬデータチャネル、ＤＬ共有チャネル）、ＤＬ参照信号（ＤＭ－ＲＳ、ＣＳＩ－ＲＳ等）、ディスカバリ信号、同期信号、報知信号等）を受信し、ＵＬ信号（例えば、ＵＬ制御信号（ＵＬ制御チャネル）、ＵＬデータ信号（ＵＬデータチャネル、ＵＬ共有チャネル）、ＵＬ参照信号等）を送信する。

[0154] 具体的には、送受信部２０３は、各ニューメロロジーに対応するシステム情報（ＭＩＢ）を無線基地局から受信する。例えば、送受信部２０３は、アンカーＭＩＢ（アンカー報知チャネル）をアンカーニューメロロジーで受信し、ターゲットＭＩＢ（ターゲット報知チャネル）をアンカーニューメロロ

ジー及び／又はターゲットニューメロロジーで受信する（図２、図１１参照）。アンカーＭＩＢには、複数のニューメロロジーが設定される帯域幅に関する情報、ターゲットＭＩＢの配置領域に関する情報、ＳＦＮ及び／又はサブフレームインデックスに関する情報、参照信号の構成やＰＲＡＣＨの構成に関する情報等が含まれる。ターゲットＭＩＢには、ターゲットニューメロロジーに固有の情報が含まれる。

[0155] また、送受信部２０３は、各ニューメロロジーにおいて当該ニューメロロジーに対応するＭＩＢをそれぞれ受信する（図６参照）。あるいは、送受信部２０３は、所定のニューメロロジーにおいて、複数のニューメロロジーの一部又は全部が組み合わされたコンバインドＭＩＢを受信する（図９、図１０参照）。

[0156] 図１６は、本実施の形態に係るユーザ端末の機能構成の一例を示す図である。なお、図１６においては、本実施の形態における特徴部分の機能ブロックを主に示しており、ユーザ端末２０は、無線通信に必要な他の機能ブロックも有しているものとする。図１６に示すように、ユーザ端末２０が有するベースバンド信号処理部２０４は、制御部４０１と、送信信号生成部４０２と、マッピング部４０３と、受信信号処理部４０４と、測定部４０５と、を少なくとも備えている。

[0157] 制御部４０１は、ユーザ端末２０全体の制御を実施する。制御部４０１は、本発明に係る技術分野での共通認識に基づいて説明されるコントローラ、制御回路又は制御装置から構成することができる。

[0158] 制御部４０１は、例えば、送信信号生成部４０２による信号の生成や、マッピング部４０３による信号の割り当てを制御する。また、制御部４０１は、受信信号処理部４０４による信号（ＭＩＢ等）の受信処理や、測定部４０５による信号の測定を制御する。

[0159] 制御部４０１は、各ニューメロロジーで送信される報知チャネル（ＭＩＢ）又は所定のニューメロロジーで選択的に送信される報知チャネル（ＭＩＢ）の受信を制御する。例えば、制御部４０１は、所定のニューメロロジーで

送信されるアンカー報知チャネルに基づいて、他のニューメロロジーで送信される報知チャネルの受信を制御する（図２参照）。また、制御部４０１は、ニューメロロジー毎にそれぞれ送信される報知チャネルを、所定信号との間に設定されるオフセットに基づいて受信するように制御する（図７、図８参照）。

[0160] あるいは、制御部４０１は、複数のニューメロロジーのシステム情報が組み合わされた情報（コンバインドＭＩＢ）を所定のニューメロロジーで受信するように制御する（図９、図１０参照）。あるいは、制御部４０１は、所定のニューメロロジーでアンカー報知チャネルを受信すると共に、アンカー報知チャネルに基づいて他のニューメロロジーのシステム情報を含む報知チャネルを当該所定のニューメロロジーで受信するように制御する（図１１参照）。

[0161] 送信信号生成部４０２は、制御部４０１からの指示に基づいて、ＵＬ信号（ＵＬ制御チャネル、ＵＬデータチャネル、ＵＬ参照信号等）を生成して、マッピング部４０３に出力する。送信信号生成部４０２は、本発明に係る技術分野での共通認識に基づいて説明される信号生成器、信号生成回路又は信号生成装置から構成することができる。

[0162] 送信信号生成部４０２は、制御部４０１からの指示に基づいてＵＬデータチャネルを生成する。例えば、送信信号生成部４０２は、無線基地局１０から通知されるＤＬ制御チャネルにＵＬグラントが含まれている場合に、制御部４０１からＵＬデータチャネルの生成を指示される。

[0163] マッピング部４０３は、制御部４０１からの指示に基づいて、送信信号生成部４０２で生成されたＵＬ信号を無線リソースにマッピングして、送受信部２０３へ出力する。マッピング部４０３は、本発明に係る技術分野での共通認識に基づいて説明されるマッパー、マッピング回路又はマッピング装置から構成することができる。

[0164] 受信信号処理部４０４は、送受信部２０３から入力された受信信号に対して、受信処理（例えば、デマッピング、復調、復号等）を行う。ここで、受

信信号は、例えば、無線基地局１０から送信されるＤＬ信号（ＤＬ制御チャネル、ＤＬデータチャネル、ＤＬ参照信号等）である。受信信号処理部４０４は、本発明に係る技術分野での共通認識に基づいて説明される信号処理器、信号処理回路又は信号処理装置から構成することができる。また、受信信号処理部４０４は、本発明に係る受信部を構成することができる。

[0165] 受信信号処理部４０４は、制御部４０１の指示に基づいて、同期信号やＭＩＢをブラインド検出して受信処理を行う。また、受信信号処理部４０４は、ＤＭ－ＲＳ又はＣＲＳ等の参照信号に基づいてチャネル利得を推定し、推定されたチャネル利得に基づいて、ＤＬ信号を復調する。

[0166] 受信信号処理部４０４は、受信処理により復号された情報を制御部４０１に出力する。受信信号処理部４０４は、例えば、報知情報、システム情報、ＲＲＣシグナリング、ＤＣＩ等を、制御部４０１に出力する。受信信号処理部４０４は、データの復号結果を制御部４０１に出力してもよい。また、受信信号処理部４０４は、受信信号や、受信処理後の信号を、測定部４０５に出力する。

[0167] 測定部４０５は、受信した信号に関する測定を実施する。測定部４０５は、本発明に係る技術分野での共通認識に基づいて説明される測定器、測定回路又は測定装置から構成することができる。

[0168] 測定部４０５は、例えば、受信した信号の受信電力（例えば、ＲＳＲＰ）、ＤＬ受信品質（例えば、ＲＳＲＱ）やチャネル状態等について測定してもよい。測定結果は、制御部４０１に出力されてもよい。

[0169] ＜ハードウェア構成＞

なお、上記実施形態の説明に用いたブロック図は、機能単位のブロックを示している。これらの機能ブロック（構成部）は、ハードウェア及び／又はソフトウェアの任意の組み合わせによって実現される。また、各機能ブロックの実現手段は特に限定されない。すなわち、各機能ブロックは、物理的及び／又は論理的に結合した１つの装置により実現されてもよいし、物理的及び／又は論理的に分離した２つ以上の装置を直接的及び／又は間接的に（例

えば、有線及び／又は無線で）接続し、これら複数の装置により実現されてもよい。

[0170] 例えば、本発明の一実施形態における無線基地局、ユーザ端末等は、本発明の無線通信方法の処理を行うコンピュータとして機能してもよい。図１７は、本発明の一実施形態に係る無線基地局及びユーザ端末のハードウェア構成の一例を示す図である。上述の無線基地局１０及びユーザ端末２０は、物理的には、プロセッサ１００１、メモリ１００２、ストレージ１００３、通信装置１００４、入力装置１００５、出力装置１００６、バス１００７等を含むコンピュータ装置として構成されてもよい。

[0171] なお、以下の説明では、「装置」という文言は、回路、デバイス、ユニット等に読み替えることができる。無線基地局１０及びユーザ端末２０のハードウェア構成は、図に示した各装置を１つ又は複数含むように構成されてもよいし、一部の装置を含まずに構成されてもよい。

[0172] 例えば、プロセッサ１００１は１つだけ図示されているが、複数のプロセッサがあってもよい。また、処理は、１のプロセッサで実行されてもよいし、処理が同時に、逐次に、又はその他の手法で、１以上のプロセッサで実行されてもよい。なお、プロセッサ１００１は、１以上のチップで実装されてもよい。

[0173] 無線基地局１０及びユーザ端末２０における各機能は、例えば、プロセッサ１００１、メモリ１００２等のハードウェア上に所定のソフトウェア（プログラム）を読み込ませることで、プロセッサ１００１が演算を行い、通信装置１００４による通信や、メモリ１００２及びストレージ１００３におけるデータの読み出し及び／又は書き込みを制御することで実現される。

[0174] プロセッサ１００１は、例えば、オペレーティングシステムを動作させてコンピュータ全体を制御する。プロセッサ１００１は、周辺装置とのインターフェース、制御装置、演算装置、レジスタ等を含む中央処理装置（ＣＰＵ：Central Processing Unit）で構成されてもよい。例えば、上述のベースバンド信号処理部１０４（２０４）、呼処理部１０５等は、プロセッサ１０

０１で実現されてもよい。

[0175] また、プロセッサ１００１は、プログラム（プログラムコード）、ソフトウェアモジュール、データ等を、ストレージ１００３及び／又は通信装置１００４からメモリ１００２に読み出し、これらに従って各種の処理を実行する。プログラムとしては、上述の実施形態で説明した動作の少なくとも一部をコンピュータに実行させるプログラムが用いられる。例えば、ユーザ端末２０の制御部４０１は、メモリ１００２に格納され、プロセッサ１００１で動作する制御プログラムによって実現されてもよく、他の機能ブロックについても同様に実現されてもよい。

[0176] メモリ１００２は、コンピュータ読み取り可能な記録媒体であり、例えば、ＲＯＭ（Read Only Memory）、ＥＰＲＯＭ（Erasable Programmable ROM）、ＥＥＰＲＯＭ（Electrically EPROM）、ＲＡＭ（Random Access Memory）、その他の適切な記憶媒体の少なくとも１つで構成されてもよい。メモリ１００２は、レジスタ、キャッシュ、メインメモリ（主記憶装置）等と呼ばれてもよい。メモリ１００２は、本発明の一実施形態に係る無線通信方法を実施するために実行可能なプログラム（プログラムコード）、ソフトウェアモジュール等を保存することができる。

[0177] ストレージ１００３は、コンピュータ読み取り可能な記録媒体であり、例えば、フレキシブルディスク、フロッピー（登録商標）ディスク、光磁気ディスク（例えば、コンパクトディスク（ＣＤ－ＲＯＭ（Compact Disc ROM）等）、デジタル多用途ディスク、Ｂｌｕ－ｒａｙ（登録商標）ディスク）、リムーバブルディスク、ハードディスクドライブ、スマートカード、フラッシュメモリデバイス（例えば、カード、スティック、キードライブ）、磁気ストライプ、データベース、サーバ、その他の適切な記憶媒体の少なくとも１つで構成されてもよい。ストレージ１００３は、補助記憶装置と呼ばれてもよい。

[0178] 通信装置１００４は、有線及び／又は無線ネットワークを介してコンピュータ間の通信を行うためのハードウェア（送受信デバイス）であり、例えば

ネットワークデバイス、ネットワークコントローラ、ネットワークカード、通信モジュール等ともいう。通信装置１００４は、例えば周波数分割複信（ＦＤＤ：Frequency Division Duplex）及び／又は時分割複信（ＴＤＤ：Time Division Duplex）を実現するために、高周波スイッチ、デュプレクサ、フィルタ、周波数シンセサイザ等を含んで構成されてもよい。例えば、上述の送受信アンテナ１０１（２０１）、アンプ部１０２（２０２）、送受信部１０３（２０３）、伝送路インターフェース１０６等は、通信装置１００４で実現されてもよい。

[0179] 入力装置１００５は、外部からの入力を受け付ける入力デバイス（例えば、キーボード、マウス、マイクロフォン、スイッチ、ボタン、センサ等）である。出力装置１００６は、外部への出力を実施する出力デバイス（例えば、ディスプレイ、スピーカー、ＬＥＤ（Light Emitting Diode）ランプ等）である。なお、入力装置１００５及び出力装置１００６は、一体となった構成（例えば、タッチパネル）であってもよい。

[0180] また、プロセッサ１００１やメモリ１００２等の各装置は、情報を通信するためのバス１００７で接続される。バス１００７は、単一のバスで構成されてもよいし、装置間で異なるバスで構成されてもよい。

[0181] また、無線基地局１０及びユーザ端末２０は、マイクロプロセッサ、デジタル信号プロセッサ（ＤＳＰ：Digital Signal Processor）、ＡＳＩＣ（Application Specific Integrated Circuit）、ＰＬＤ（Programmable Logic Device）、ＦＰＧＡ（Field Programmable Gate Array）等のハードウェアを含んで構成されてもよく、当該ハードウェアにより、各機能ブロックの一部又は全てが実現されてもよい。例えば、プロセッサ１００１は、これらのハードウェアの少なくとも１つで実装されてもよい。

[0182] （変形例）

なお、本明細書で説明した用語及び／又は本明細書の理解に必要な用語については、同一の又は類似する意味を有する用語と置き換えてもよい。例えば、チャネル及び／又はシンボルは信号（シグナリング）であってもよい。

また、信号はメッセージであってもよい。参照信号は、ＲＳ（Reference Signal）と略称することもでき、適用される標準によってパイロット（Pilot）、パイロット信号等と呼ばれてもよい。また、コンポーネントキャリア（ＣＣ：Component Carrier）は、セル、周波数キャリア、キャリア周波数等と呼ばれてもよい。

[0183] また、無線フレームは、時間領域において１つ又は複数の期間（フレーム）で構成されてもよい。無線フレームを構成する当該１つ又は複数の各期間（フレーム）は、サブフレームと呼ばれてもよい。さらに、サブフレームは、時間領域において１つ又は複数のスロットで構成されてもよい。さらに、スロットは、時間領域において１つ又は複数のシンボル（ＯＦＤＭ（Orthogonal Frequency Division Multiplexing）シンボル、ＳＣ－ＦＤＭＡ（Single Carrier Frequency Division Multiple Access）シンボル等）で構成されてもよい。

[0184] 無線フレーム、サブフレーム、スロット及びシンボルは、いずれも信号を伝送する際の時間単位を表す。無線フレーム、サブフレーム、スロット及びシンボルは、それぞれに対応する別の呼称が用いられてもよい。例えば、１サブフレームは送信時間間隔（ＴＴＩ：Transmission Time Interval）と呼ばれてもよいし、複数の連続したサブフレームがＴＴＩと呼ばれてよいし、１スロットがＴＴＩと呼ばれてもよい。つまり、サブフレームやＴＴＩは、既存のＬＴＥにおけるサブフレーム（１ｍｓ）であってもよいし、１ｍｓより短い期間（例えば、１－１３シンボル）であってもよいし、１ｍｓより長い期間であってもよい。

[0185] ここで、ＴＴＩは、例えば、無線通信におけるスケジューリングの最小時間単位のことをいう。例えば、ＬＴＥシステムでは、無線基地局が各ユーザ端末に対して、無線リソース（各ユーザ端末において使用することが可能な周波数帯域幅や送信電力等）を、ＴＴＩ単位で割り当てるスケジューリングを行う。なお、ＴＴＩの定義はこれに限られない。ＴＴＩは、チャネル符号化されたデータパケット（トランスポートブロック）の送信時間単位であっ

てもよいし、スケジューリングやリンクアダプテーション等の処理単位となってもよい。

[0186] １ｍｓの時間長を有するＴＴＩは、通常ＴＴＩ（ＬＴＥ　Ｒｅｌ．８－１２におけるＴＴＩ）、ノーマルＴＴＩ、ロングＴＴＩ、通常サブフレーム、ノーマルサブフレーム、又はロングサブフレーム等と呼ばれてもよい。通常ＴＴＩより短いＴＴＩは、短縮ＴＴＩ、ショートＴＴＩ、短縮サブフレーム、又はショートサブフレーム等と呼ばれてもよい。

[0187] リソースブロック（ＲＢ：Resource　Block）は、時間領域及び周波数領域のリソース割当単位であり、周波数領域において、１つ又は複数個の連続した副搬送波（サブキャリア（subcarrier））を含んでもよい。また、ＲＢは、時間領域において、１つ又は複数個のシンボルを含んでもよく、１スロット、１サブフレーム又は１ＴＴＩの長さであってもよい。１ＴＴＩ、１サブフレームは、それぞれ１つ又は複数のリソースブロックで構成されてもよい。なお、ＲＢは、物理リソースブロック（ＰＲＢ：Physical　RB）、ＰＲＢペア、ＲＢペア等と呼ばれてもよい。

[0188] また、リソースブロックは、１つ又は複数のリソースエレメント（ＲＥ：Resource　Element）で構成されてもよい。例えば、１ＲＥは、１サブキャリア及び１シンボルの無線リソース領域であってもよい。

[0189] なお、上述した無線フレーム、サブフレーム、スロット及びシンボル等の構造は例示に過ぎない。例えば、無線フレームに含まれるサブフレームの数、サブフレームに含まれるスロットの数、スロットに含まれるシンボル及びＲＢの数、ＲＢに含まれるサブキャリアの数、並びにＴＴＩ内のシンボル数、シンボル長、サイクリックプレフィックス（ＣＰ：Cyclic　Prefix）長等の構成は、様々に変更することができる。

[0190] また、本明細書で説明した情報、パラメータ等は、絶対値で表されてもよいし、所定の値からの相対値で表されてもよいし、対応する別の情報で表されてもよい。例えば、無線リソースは、所定のインデックスで指示されるものであってもよい。さらに、これらのパラメータを使用する数式等は、本明

細書で明示的に開示したものと異なってもよい。

[0191] 本明細書においてパラメータ等に使用する名称は、いかなる点においても限定的なものではない。例えば、様々なチャネル（ＰＵＣＣＨ（Physical Uplink Control Channel）、ＰＤＣＣＨ（Physical Downlink Control Channel）等）及び情報要素は、あらゆる好適な名称によって識別できるので、これらの様々なチャネル及び情報要素に割り当てている様々な名称は、いかなる点においても限定的なものではない。

[0192] 本明細書で説明した情報、信号等は、様々な異なる技術のいずれかを使用して表されてもよい。例えば、上記の説明全体に渡って言及され得るデータ、命令、コマンド、情報、信号、ビット、シンボル、チップ等は、電圧、電流、電磁波、磁界若しくは磁性粒子、光場若しくは光子、又はこれらの任意の組み合わせによって表されてもよい。

[0193] また、情報、信号等は、上位レイヤから下位レイヤ、及び／又は下位レイヤから上位レイヤへ出力され得る。情報、信号等は、複数のネットワークノードを介して入出力されてもよい。

[0194] 入出力された情報、信号等は、特定の場所（例えば、メモリ）に保存されてもよいし、管理テーブルで管理してもよい。入出力される情報、信号等は、上書き、更新又は追記をされ得る。出力された情報、信号等は、削除されてもよい。入力された情報、信号等は、他の装置へ送信されてもよい。

[0195] 情報の通知は、本明細書で説明した態様／実施形態に限られず、他の方法で行われてもよい。例えば、情報の通知は、物理レイヤシグナリング（例えば、下り制御情報（ＤＣＩ：Downlink Control Information）、上り制御情報（ＵＣＩ：Uplink Control Information））、上位レイヤシグナリング（例えば、ＲＲＣ（Radio Resource Control）シグナリング、ブロードキャスト情報（マスタ情報ブロック（ＭＩＢ：Master Information Block）、システム情報ブロック（ＳＩＢ：System Information Block）等）、ＭＡＣ（Medium Access Control）シグナリング）、その他の信号又はこれらの組み合わせによって実施されてもよい。

[0196] なお、物理レイヤシグナリングは、Ｌ１／Ｌ２（Layer 1／Layer 2）制御情報（Ｌ１／Ｌ２制御信号）、Ｌ１制御情報（Ｌ１制御信号）等と呼ばれてもよい。また、ＲＲＣシグナリングは、ＲＲＣメッセージと呼ばれてもよく、例えば、ＲＲＣ接続セットアップ（RRCConnectionSetup）メッセージ、ＲＲＣ接続再構成（RRCConnectionReconfiguration）メッセージ等であってもよい。また、ＭＡＣシグナリングは、例えば、ＭＡＣ制御要素（ＭＡＣＣＥ（Control Element））で通知されてもよい。

[0197] また、所定の情報の通知（例えば、「Ｘであること」の通知）は、明示的に行うものに限られず、暗示的に（例えば、当該所定の情報の通知を行わないことによって又は別の情報の通知によって）行われてもよい。

[0198] 判定は、１ビットで表される値（０か１か）によって行われてもよいし、真（true）又は偽（false）で表される真偽値（boolean）によって行われてもよいし、数値の比較（例えば、所定の値との比較）によって行われてもよい。

[0199] ソフトウェアは、ソフトウェア、ファームウェア、ミドルウェア、マイクロコード、ハードウェア記述言語と呼ばれるか、他の名称で呼ばれるかを問わず、命令、命令セット、コード、コードセグメント、プログラムコード、プログラム、サブプログラム、ソフトウェアモジュール、アプリケーション、ソフトウェアアプリケーション、ソフトウェアパッケージ、ルーチン、サブルーチン、オブジェクト、実行可能ファイル、実行スレッド、手順、機能等を意味するよう広く解釈されるべきである。

[0200] また、ソフトウェア、命令、情報等は、伝送媒体を介して送受信されてもよい。例えば、ソフトウェアが、有線技術（同軸ケーブル、光ファイバケーブル、ツイストペア、デジタル加入者回線（ＤＳＬ：Digital Subscriber Line）等）及び／又は無線技術（赤外線、マイクロ波等）を使用してウェブサイト、サーバ、又は他のリモートソースから送信される場合、これらの有線技術及び／又は無線技術は、伝送媒体の定義内に含まれる。

[0201] 本明細書で使用する「システム」及び「ネットワーク」という用語は、互

換的に使用される。

[0202] 本明細書では、「基地局（ＢＳ：Base Station）」、「無線基地局」、「ｅＮＢ」、「セル」、「セクタ」、「セルグループ」、「キャリア」及び「コンポーネントキャリア」という用語は、互換的に使用され得る。基地局は、固定局（fixed station）、ＮｏｄｅＢ、ｅＮｏｄｅＢ（ｅＮＢ）、アクセスポイント（access point）、送信ポイント、受信ポイント、フェムトセル、スモールセル等の用語で呼ばれる場合もある。

[0203] 基地局は、１つ又は複数（例えば、３つ）のセル（セクタとも呼ばれる）を収容することができる。基地局が複数のセルを収容する場合、基地局のカバレッジエリア全体は複数のより小さいエリアに区分でき、各々のより小さいエリアは、基地局サブシステム（例えば、屋内用の小型基地局（ＲＲＨ：Remote Radio Head）によって通信サービスを提供することもできる。「セル」又は「セクタ」という用語は、このカバレッジにおいて通信サービスを行う基地局及び／又は基地局サブシステムのカバレッジエリアの一部又は全体を指す。

[0204] 本明細書では、「移動局（ＭＳ：Mobile Station）」、「ユーザ端末（user terminal）」、「ユーザ装置（ＵＥ：User Equipment）」及び「端末」という用語は、互換的に使用され得る。基地局は、固定局（fixed station）、ＮｏｄｅＢ、ｅＮｏｄｅＢ（ｅＮＢ）、アクセスポイント（access point）、送信ポイント、受信ポイント、フェムトセル、スモールセル等の用語で呼ばれる場合もある。

[0205] 移動局は、当業者によって、加入者局、モバイルユニット、加入者ユニット、ワイヤレスユニット、リモートユニット、モバイルデバイス、ワイヤレスデバイス、ワイヤレス通信デバイス、リモートデバイス、モバイル加入者局、アクセス端末、モバイル端末、ワイヤレス端末、リモート端末、ハンドセット、ユーザエージェント、モバイルクライアント、クライアント又はいくつかの他の適切な用語で呼ばれる場合もある。

[0206] また、本明細書における無線基地局は、ユーザ端末で読み替えてもよい。

例えば、無線基地局及びユーザ端末間の通信を、複数のユーザ端末間（Ｄ２Ｄ：Device-to-Device）の通信に置き換えた構成について、本発明の各態様／実施形態を適用してもよい。この場合、上述の無線基地局１０が有する機能をユーザ端末２０が有する構成としてもよい。また、「上り」や「下り」等の文言は、「サイド」と読み替えられてもよい。例えば、上りチャネルは、サイドチャネルと読み替えられてもよい。

[0207] 同様に、本明細書におけるユーザ端末は、無線基地局で読み替えてもよい。この場合、上述のユーザ端末２０が有する機能を無線基地局１０が有する構成としてもよい。

[0208] 本明細書において、基地局によって行われるとした特定動作は、場合によってはその上位ノード（upper node）によって行われることもある。基地局を有する１つ又は複数のネットワークノード（network nodes）から成るネットワークにおいて、端末との通信のために行われる様々な動作は、基地局、基地局以外の１つ以上のネットワークノード（例えば、ＭＭＥ（Mobility Management Entity）、Ｓ－ＧＷ（Serving-Gateway）等が考えられるが、これらに限られない）又はこれらの組み合わせによって行われ得ることは明らかである。

[0209] 本明細書で説明した各態様／実施形態は単独で用いてもよいし、組み合わせて用いてもよいし、実行に伴って切り替えて用いてもよい。また、本明細書で説明した各態様／実施形態の処理手順、シーケンス、フローチャート等は、矛盾の無い限り、順序を入れ替えてもよい。例えば、本明細書で説明した方法については、例示的な順序で様々なステップの要素を提示しており、提示した特定の順序に限定されない。

[0210] 本明細書で説明した各態様／実施形態は、ＬＴＥ（Long Term Evolution）、ＬＴＥ－Ａ（LTE-Advanced）、ＬＴＥ－Ｂ（LTE-Beyond）、ＳＵＰＥＲ３Ｇ、ＩＭＴ－Ａｄｖａｎｃｅｄ、４Ｇ（4th generation mobile communication system）、５Ｇ（5th generation mobile communication system）、ＦＲＡ（Future Radio Access）、Ｎｅｗ－ＲＡＴ（Radio Acces

s Technology)、ＮＲ (New Radio)、ＮＸ (New radio access)、ＦＸ (Future generation radio access)、ＧＳＭ (登録商標) (Global System for Mobile communications)、ＣＤＭＡ２０００、ＵＭＢ (Ultra Mobile Broadband)、ＩＥＥＥ ８０２．１１ (Ｗｉ－Ｆｉ (登録商標))、ＩＥＥＥ ８０２．１６ (ＷｉＭＡＸ (登録商標))、ＩＥＥＥ ８０２．２０、UWB (Ultra-WideBand)、Ｂｌｕｅｔｏｏｔｈ (登録商標)、その他の適切な無線通信方法を利用するシステム及び／又はこれらに基づいて拡張された次世代システムに適用されてもよい。

[0211] 本明細書で使用する「に基づいて」という記載は、別段に明記されていない限り、「のみに基づいて」を意味しない。言い換えれば、「に基づいて」という記載は、「のみに基づいて」と「に少なくとも基づいて」の両方を意味する。

[0212] 本明細書で使用する「第１の」、「第２の」等の呼称を使用した要素へのいかなる参照も、それらの要素の量又は順序を全般的に限定するものではない。これらの呼称は、２つ以上の要素間を区別する便利な方法として本明細書で使用され得る。したがって、第１及び第２の要素の参照は、２つの要素のみが採用され得ること又は何らかの形で第１の要素が第２の要素に先行しなければならないことを意味しない。

[0213] 本明細書で使用する「判断（決定）（determining）」という用語は、多種多様な動作を包含する場合がある。例えば、「判断（決定）」は、計算（calculating）、算出（computing）、処理（processing）、導出（deriving）、調査（investigating）、探索（looking up）（例えば、テーブル、データベースまたは別のデータ構造での探索）、確認（ascertaining）等を「判断（決定）」することであるとみなされてもよい。また、「判断（決定）」は、受信（receiving）（例えば、情報を受信すること）、送信（transmitting）（例えば、情報を送信すること）、入力（input）、出力（output）、アクセス（accessing）（例えば、メモリ中のデータにアクセスすること）等を「判断（決定）」することであるとみなされてもよい。また、「判断（決定）

」は、解決（resolving）、選択（selecting）、選定（choosing）、確立（establishing）、比較（comparing）等を「判断（決定）」することであるとみなされてもよい。つまり、「判断（決定）」は、何らかの動作を「判断（決定）」することであるとみなされてもよい。

[0214] 本明細書で使用する「接続された（connected）」、「結合された（coupled）」という用語、又はこれらのあらゆる変形は、２又はそれ以上の要素間の直接的又は間接的なあらゆる接続又は結合を意味し、互いに「接続」又は「結合」された２つの要素間に１又はそれ以上の中間要素が存在することを含むことができる。要素間の結合又は接続は、物理的なものであっても、論理的なものであっても、或いはこれらの組み合わせであってもよい。例えば、「接続」は「アクセス」と読み替えられてもよい。本明細書で使用する場合、２つの要素は、１又はそれ以上の電線、ケーブル及び／又はプリント電気接続を使用することにより、並びにいくつかの非限定的かつ非包括的な例として、無線周波数領域、マイクロ波領域及び／又は光（可視及び不可視の両方）領域の波長を有する電磁エネルギー等を使用することにより、互いに「接続」又は「結合」されると考えることができる。

[0215] 本明細書又は特許請求の範囲で「含む（including）」、「含んでいる（comprising）」、及びそれらの変形が使用されている場合、これらの用語は、用語「備える」と同様に、包括的であることが意図される。さらに、本明細書あるいは特許請求の範囲において使用されている用語「又は（or）」は、排他的論理和ではないことが意図される。

[0216] 以上、本発明について詳細に説明したが、当業者にとっては、本発明が本明細書中に説明した実施形態に限定されるものではないということは明らかである。本発明は、特許請求の範囲の記載により定まる本発明の趣旨及び範囲を逸脱することなく修正及び変更態様として実施することができる。したがって、本明細書の記載は、例示説明を目的とするものであり、本発明に対して何ら制限的な意味を有するものではない。

[0217] 本出願は、２０１６年８月１０日出願の特願２０１６－１５７９９３に基

づく。この内容は、全てここに含めておく。

請求の範囲

[請求項1] 複数のニューメロロジーが設定される無線通信システムにおいて通信を行うユーザ端末であって、

少なくとも１以上の報知チャネルを介して各ニューメロロジーのシステム情報を受信する受信部と、

前記報知チャネルの受信を制御する制御部と、を有し、

前記制御部は、各ニューメロロジーで送信される報知チャネル又は所定のニューメロロジーで選択的に送信される報知チャネルの受信を制御することを特徴とするユーザ端末。

[請求項2] 前記制御部は、所定のニューメロロジーで送信されるアンカー報知チャネルに基づいて、他のニューメロロジーで送信される報知チャネルの受信を制御することを特徴とする請求項１に記載のユーザ端末。

[請求項3] 前記制御部は、ニューメロロジー毎にそれぞれ送信される報知チャネルを、所定信号と当該報知チャネルとの間に設定されるオフセットに基づいて受信するように制御することを特徴とする請求項１に記載のユーザ端末。

[請求項4] 前記制御部は、複数のニューメロロジーのシステム情報が組み合わされた情報を所定のニューメロロジーで受信するように制御することを特徴とする請求項１に記載のユーザ端末。

[請求項5] 前記制御部は、所定のニューメロロジーで前記アンカー報知チャネルを受信すると共に、前記アンカー報知チャネルに基づいて他のニューメロロジーのシステム情報を含む報知チャネルを当該所定のニューメロロジーで受信するように制御することを特徴とする請求項１に記載のユーザ端末。

[請求項6] 複数のニューメロロジーが設定される無線通信システムにおいて通信を行うユーザ端末の無線通信方法であって、

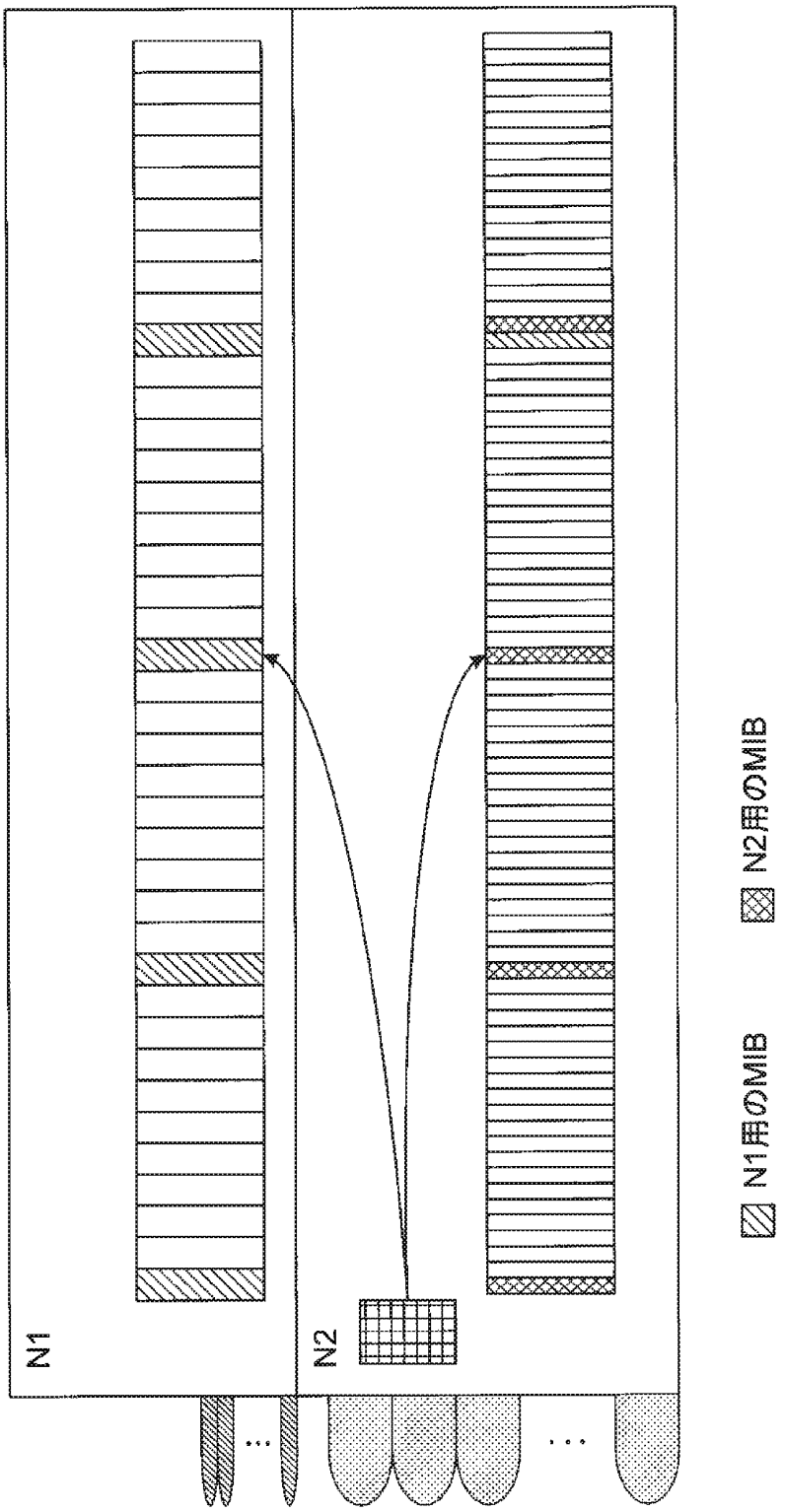
少なくとも１以上の報知チャネルを受信する工程と、

受信した報知チャネルから各ニューメロロジーのシステム情報を取

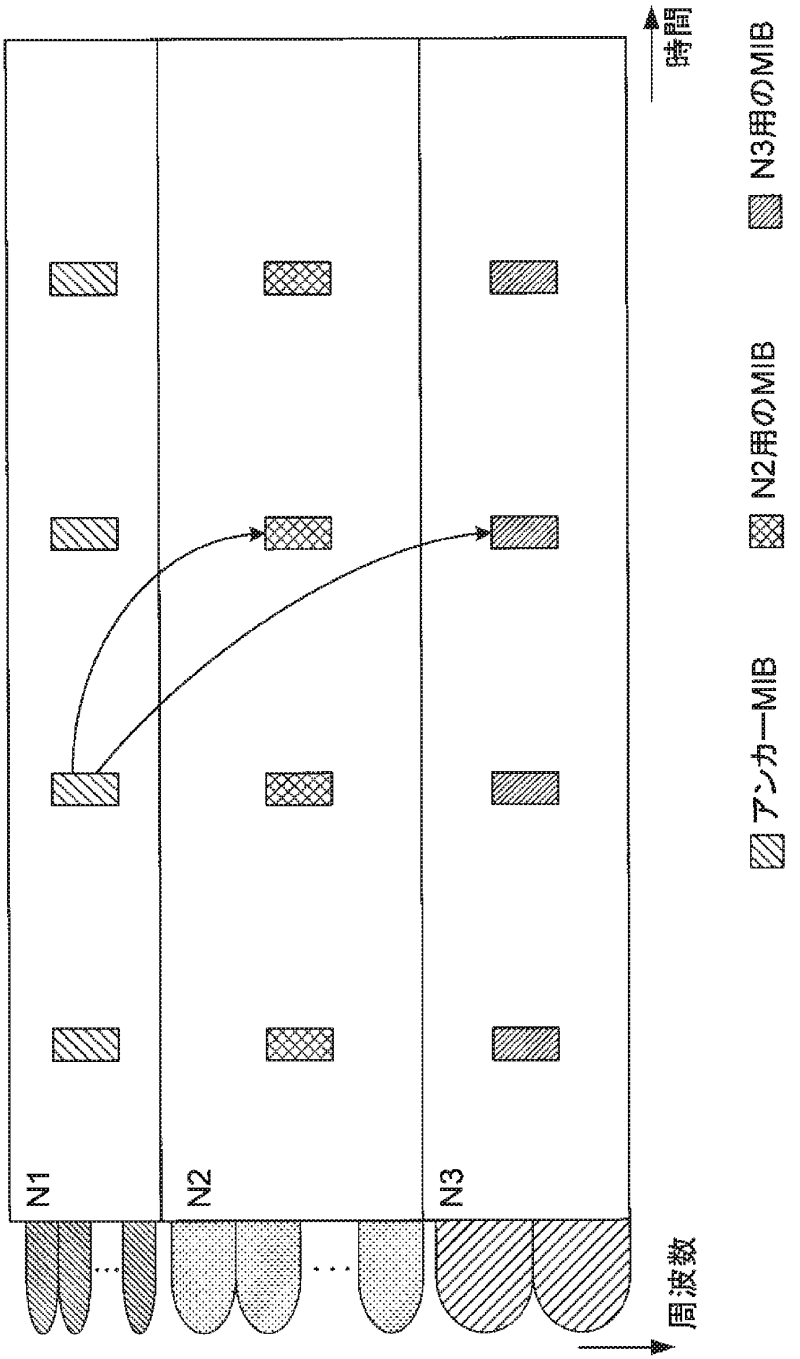
得する工程と、を有し、

各ニューメロロジーで送信される報知チャネル又は所定のニューメロロジーで選択的に送信される報知チャネルの受信を制御することを特徴とする無線通信方法。

[図1]



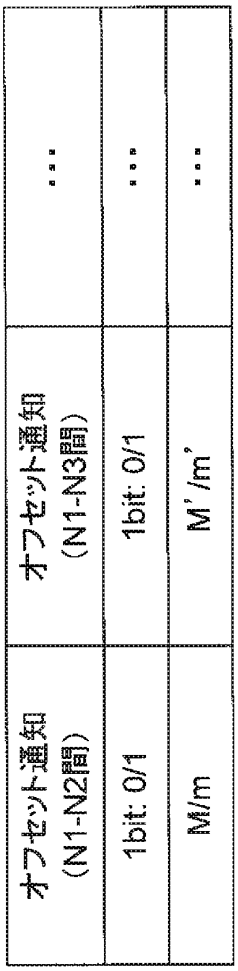
[図2]



[図3]

NR BW	N1-N2間オフセット	N1-N3間オフセット
1.4MHz	M	M'
3MHz	N	N'
5MHz	L	L'
10MHz	X	X'
15MHz	Y	Y'
20MHz	Z	Z'

[図4]



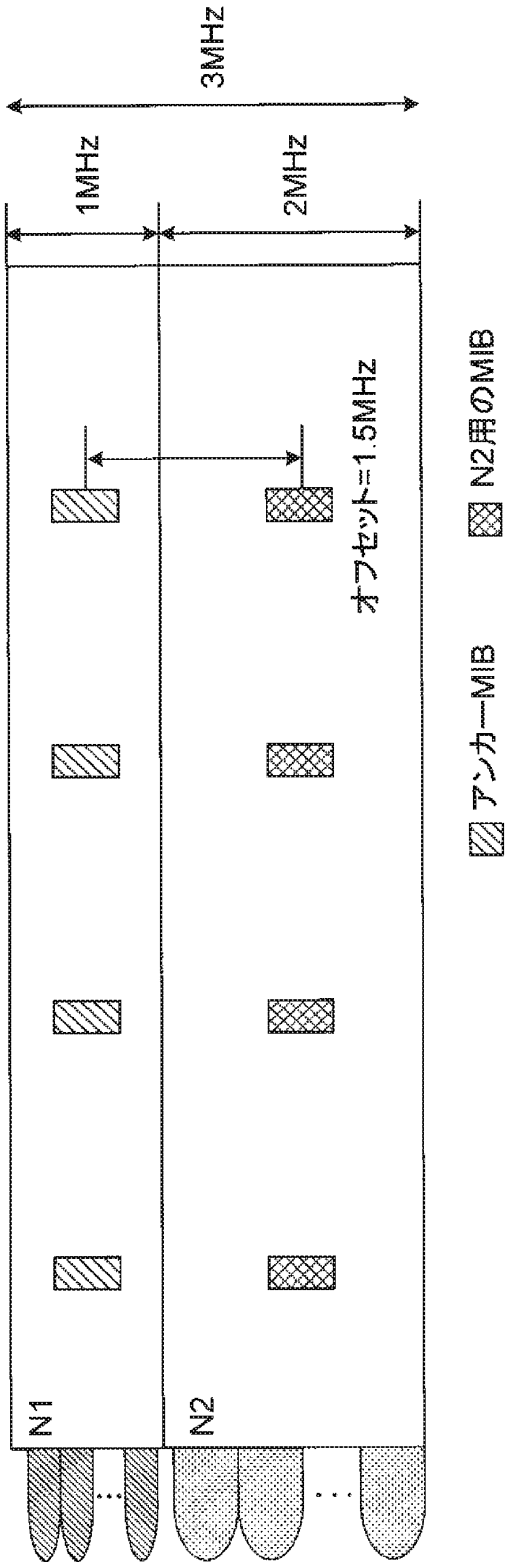
オフセット通知（N1-N2間）	オフセット通知（N1-N3間）	...
1bit: 0/1	1bit: 0/1	...
M/m	M'/m'	...

[図5]

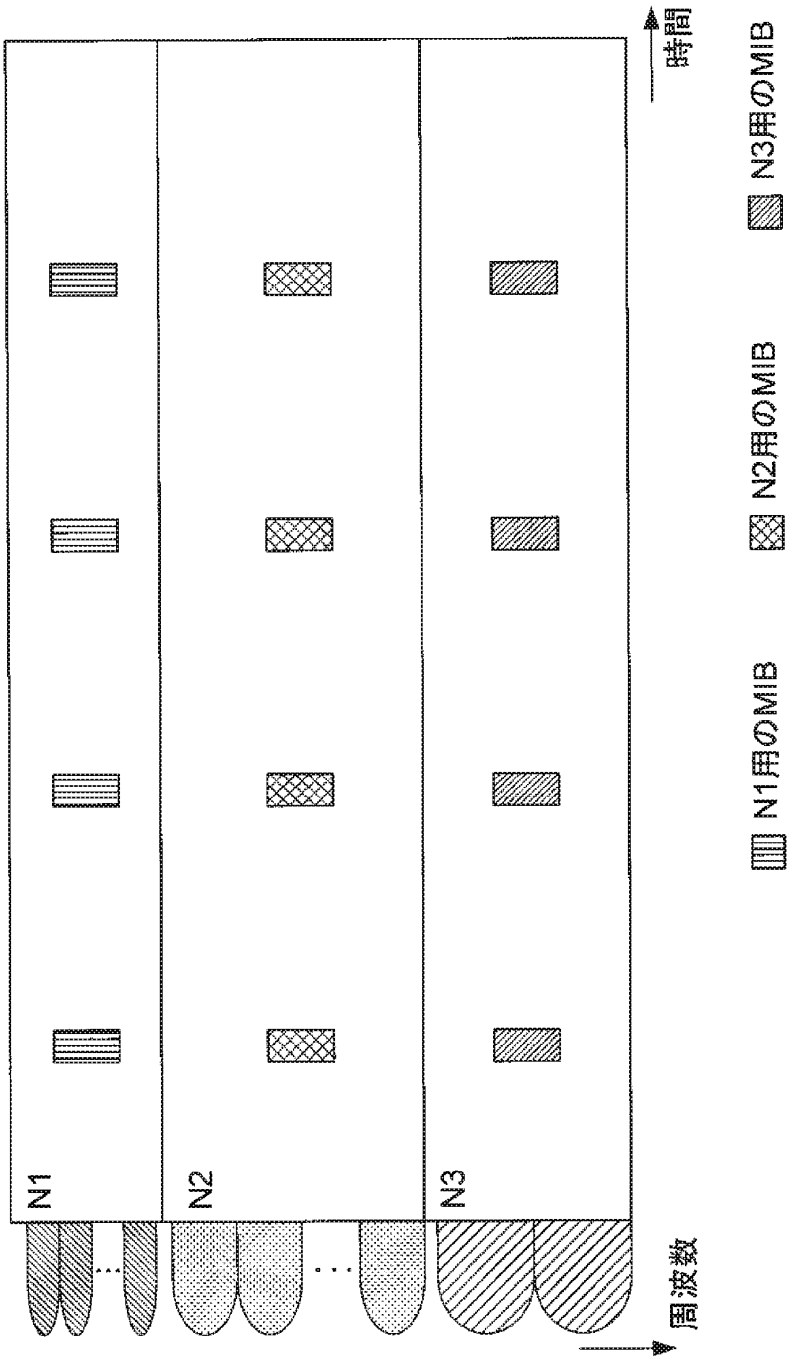
図5A

Conf.	2つのニューメロロジー	3つのニューメロロジー
00	1:3	1:2:2
01	1:2	1:2:4
10	1:1	1:1:1

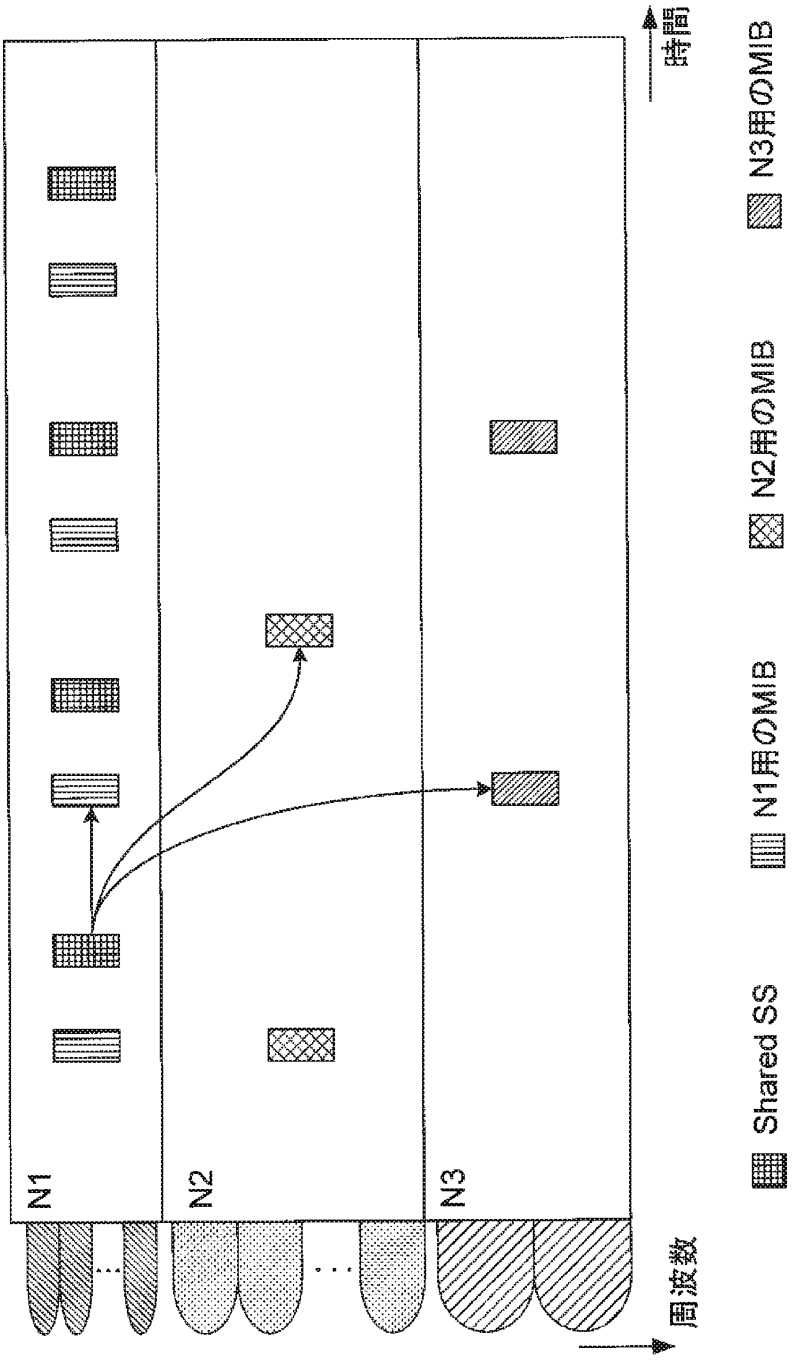
図5B



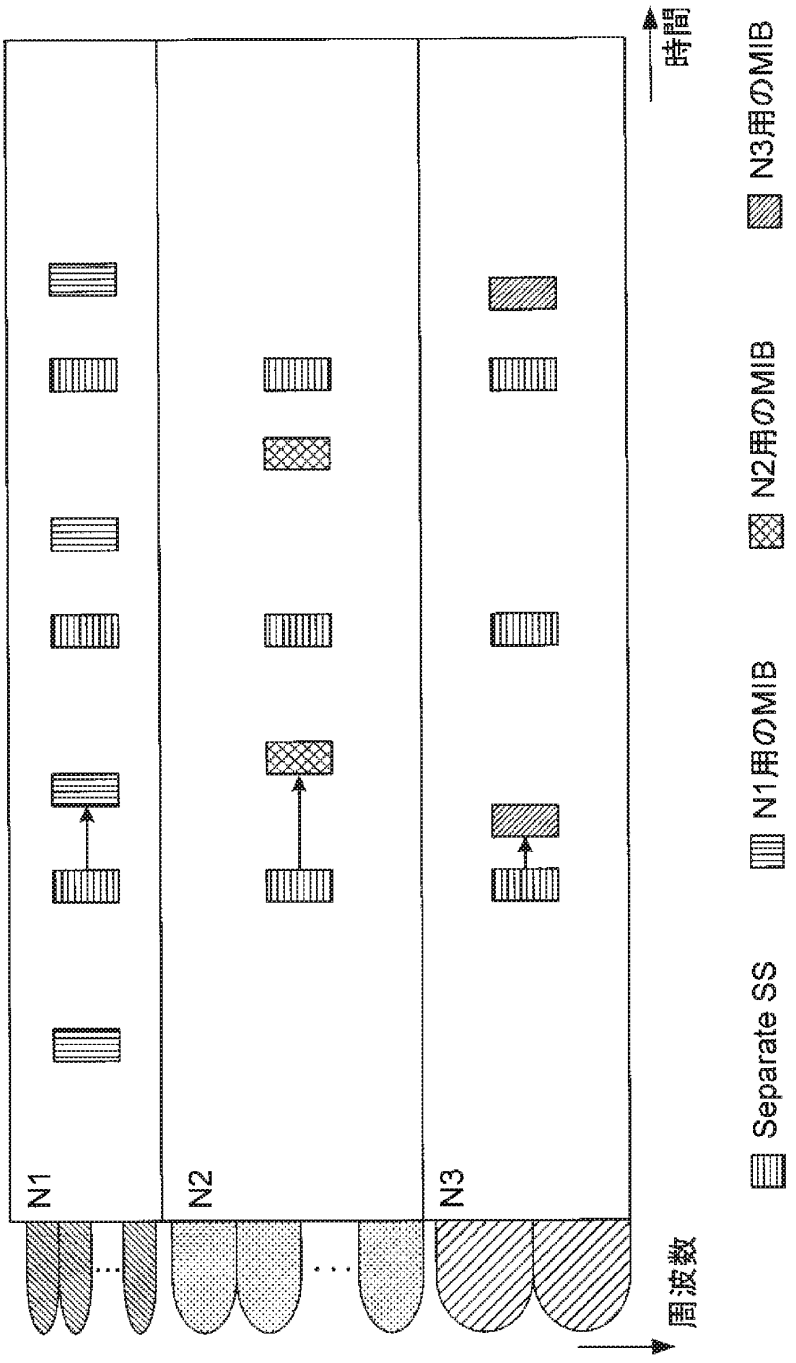
[図6]



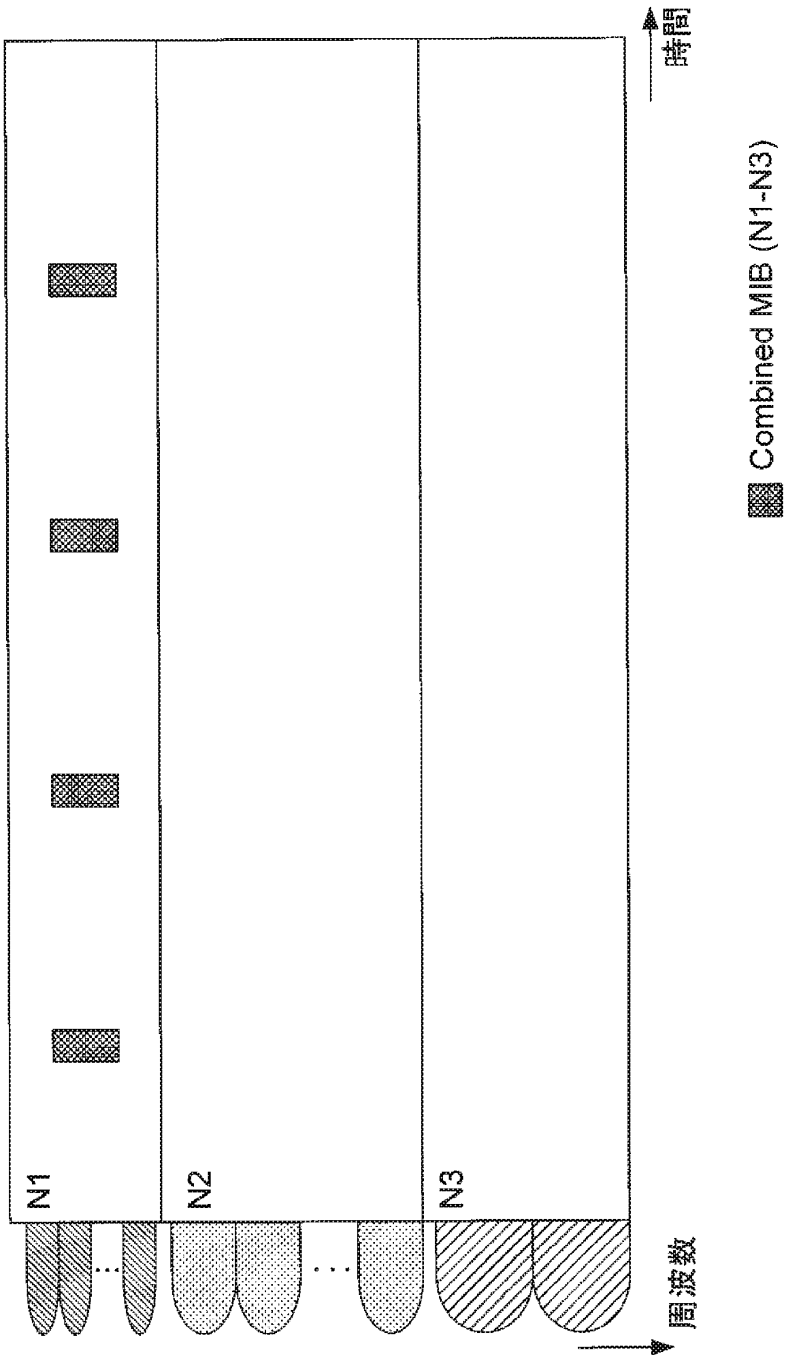
[図7]



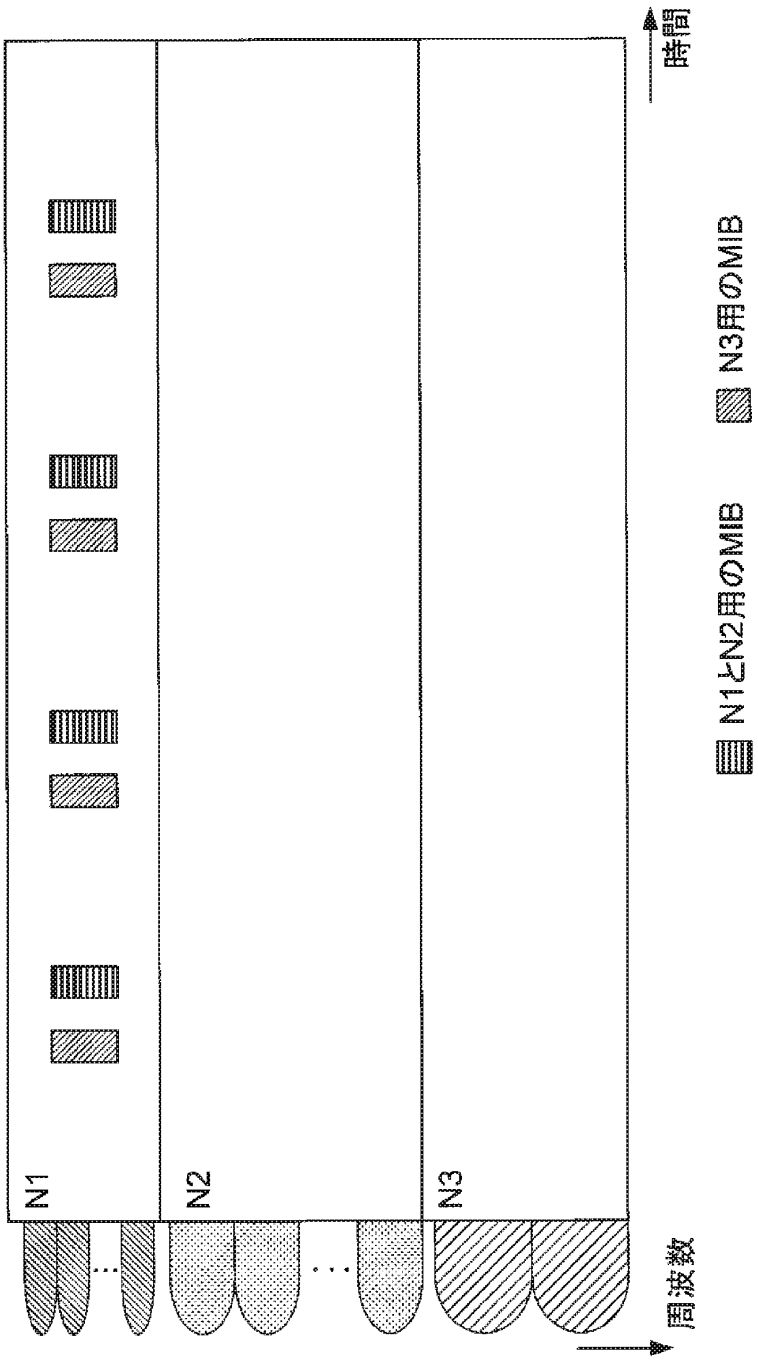
[図8]



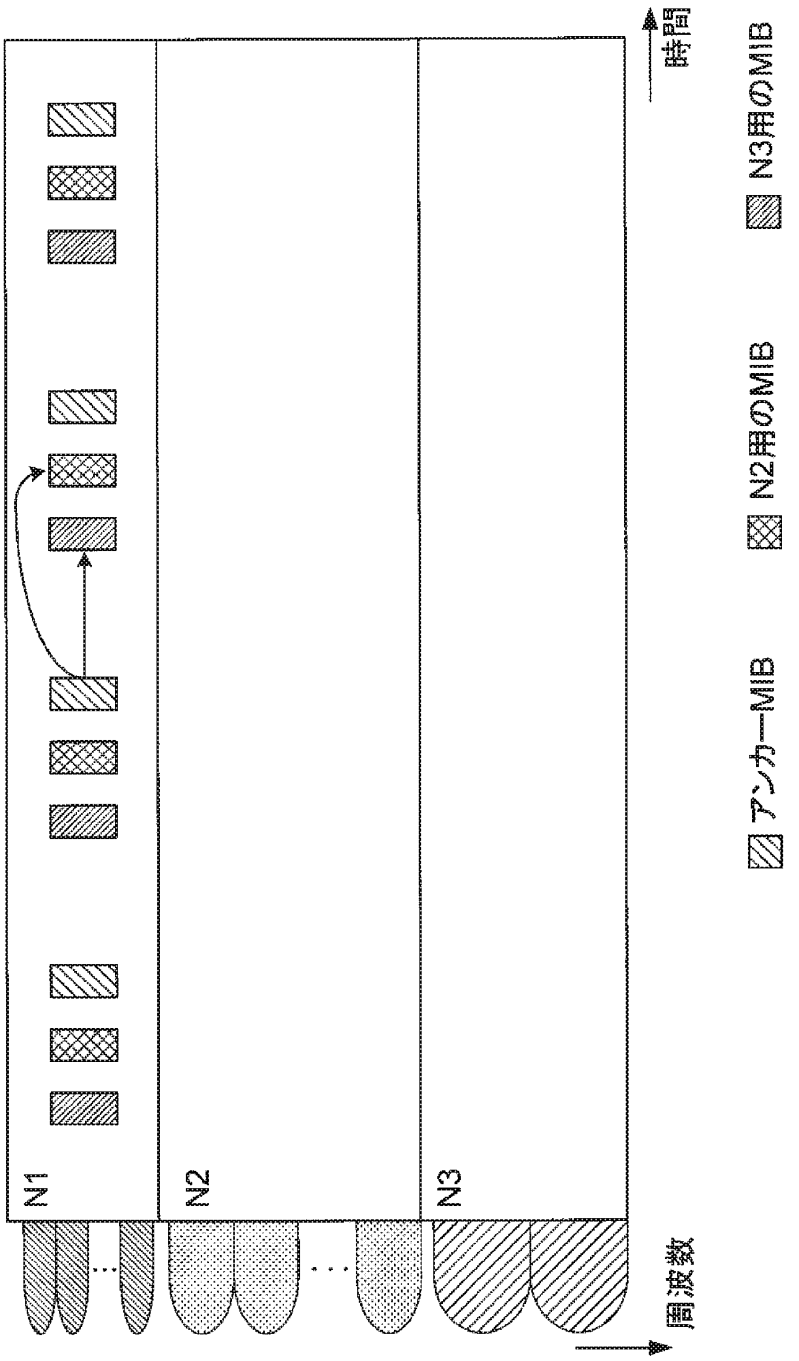
[図9]



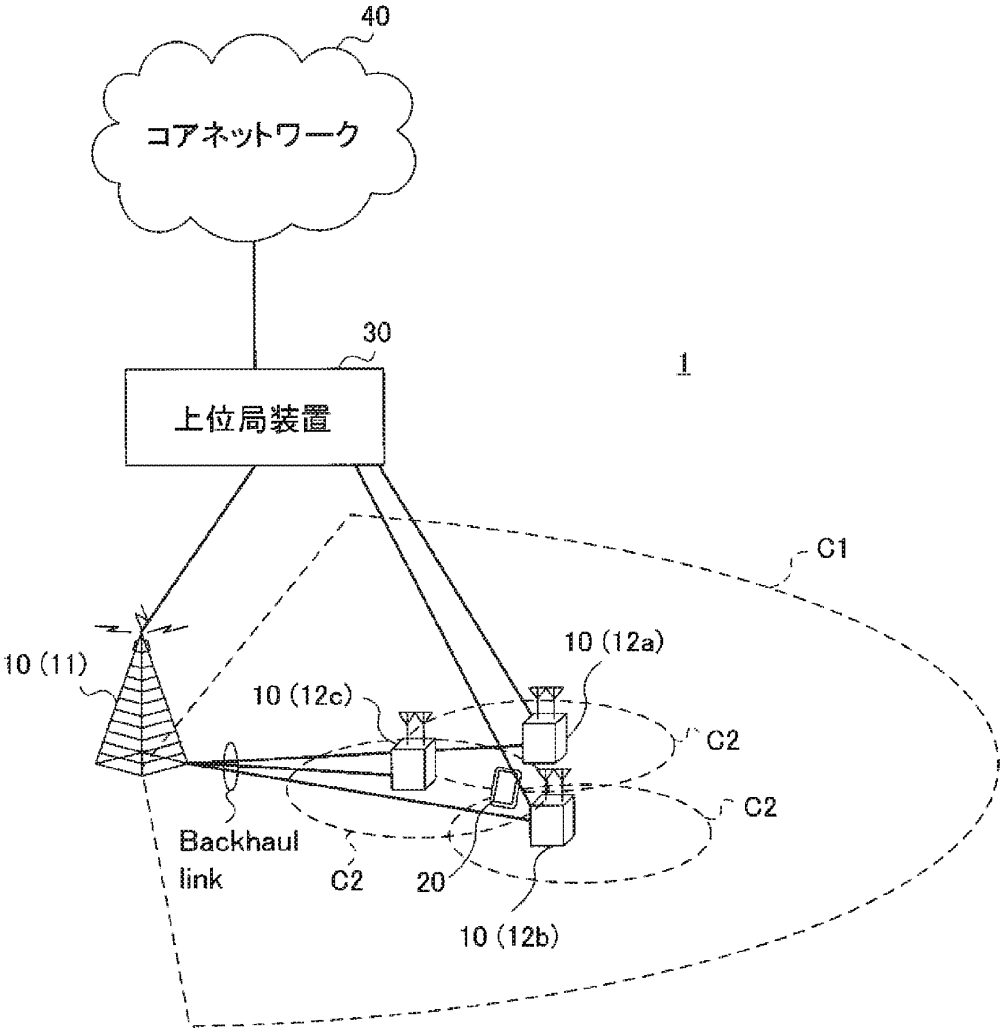
[図10]



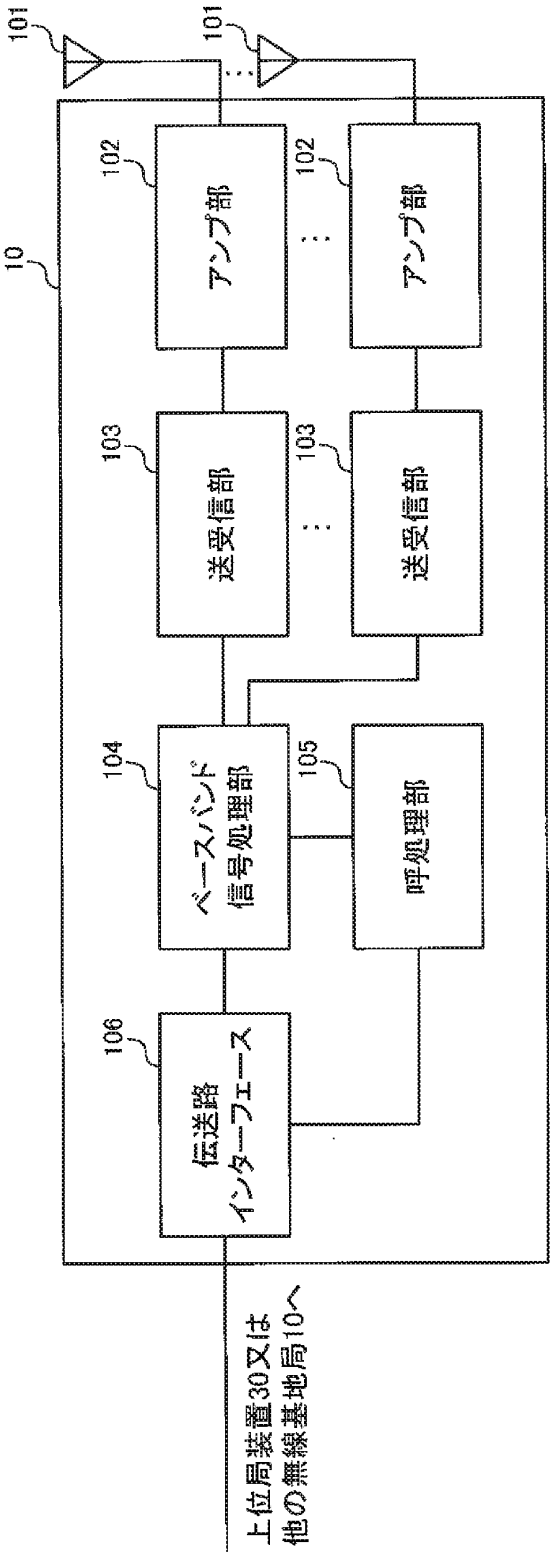
[図11]



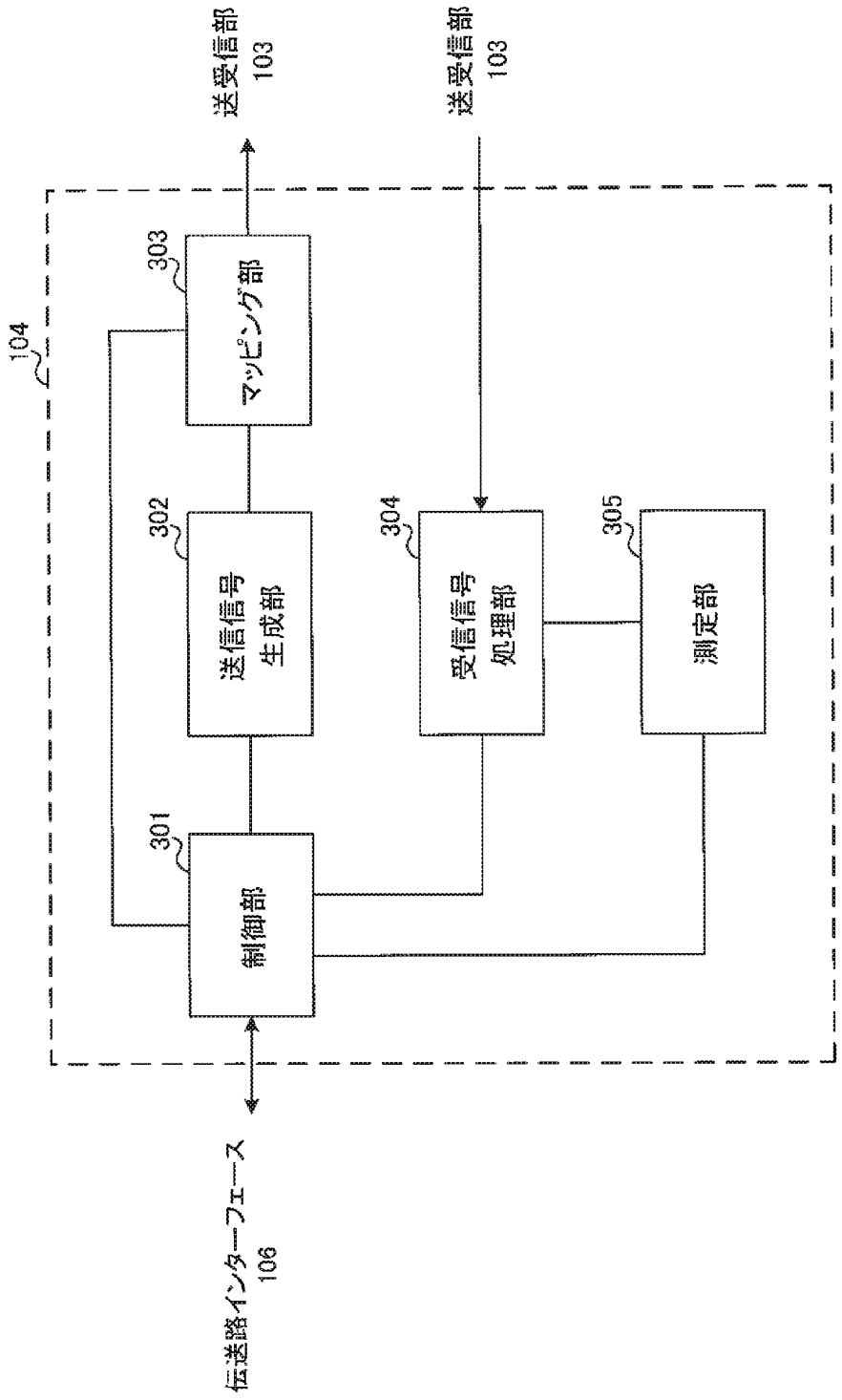
[図12]


40
コアネットワーク
30
上位局装置
1
C1
10 (11)
10 (12a)
10 (12c)
C2
C2
Backhaul
link
C2
20
10 (12b)

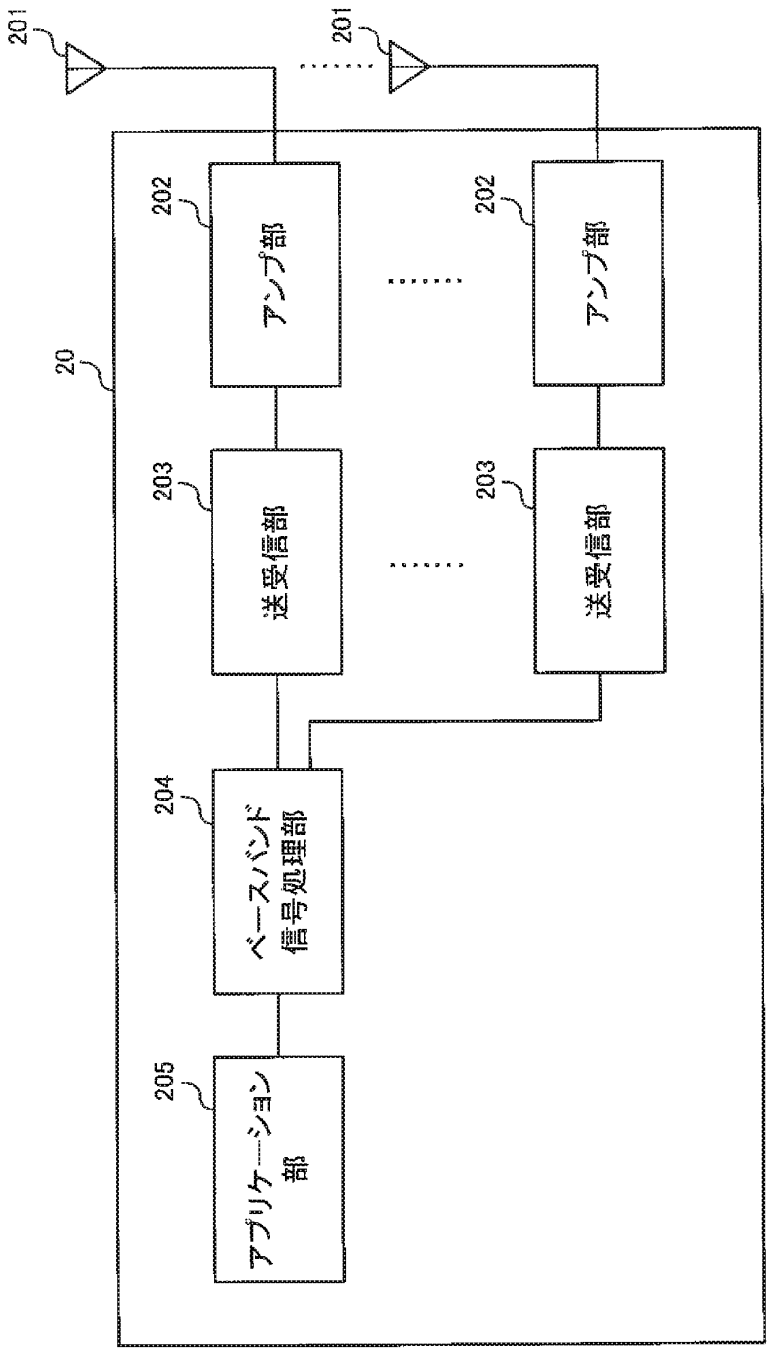
[図13]


101
101
10
102
アンプ部
102
アンプ部
103
送受信部
103
送受信部
104
ベースバンド信号処理部
105
呼処理部
106
伝送路インターフェース
上位局装置30又は他の無線基地局10へ

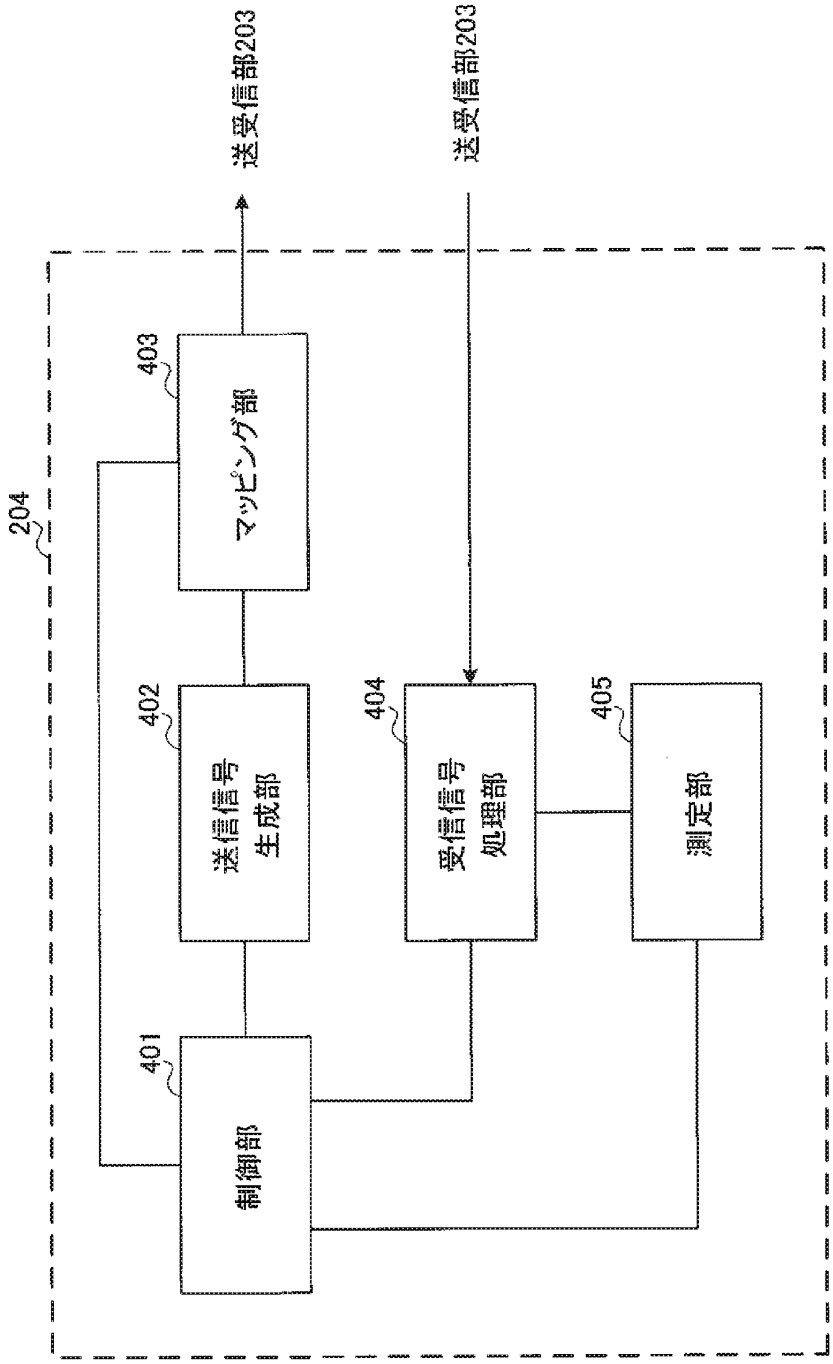
[図14]


送受信部
103
送受信部
103
104
303
マッピング部
302
送信信号
生成部
304
受信信号
処理部
305
測定部
301
制御部
伝送路インターフェース
106

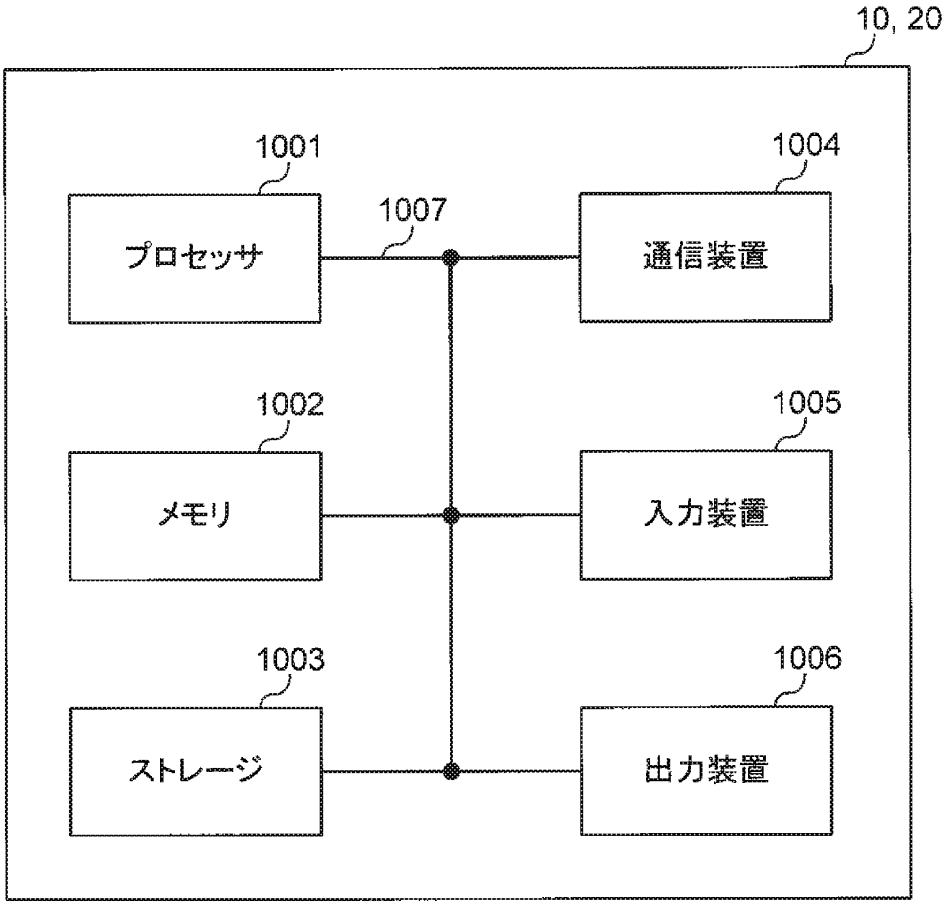
[図15]


201
201
202
アンプ部
202
アンプ部
20
203
送受信部
203
送受信部
204
ベースバンド信号処理部
205
アプリケーション部

[図16]


送受信部203
送受信部203
204
403
マッピング部
402
送信信号
生成部
404
受信信号
処理部
405
測定部
401
制御部

[図17]


10, 20
1001
プロセッサ
1007
1004
通信装置
1002
メモリ
1005
入力装置
1003
ストレージ
1006
出力装置

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/028799

A. CLASSIFICATION OF SUBJECT MATTER
H04W48/10(2009.01)i, *H04W72/04*(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B7/24-7/26, H04W4/00-99/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Huawei, HiSilicon, Initial access in NR, 3GPP TSG-RAN WG2 #94 R2-163923, 2016.05.14	1,4,6
A		2-3,5
A	Qualcomm Incorporated, NB-PBCH design, 3GPP TSG-RAN WG1 #84 R1-160875, 2016.02.06	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 October 2017 (18.10.17)	31 October 2017 (31.10.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１７／０２８７９９

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　H04W48/10(2009.01)i, H04W72/04(2009.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　H04B7/24-7/26, H04W4/00-99/00

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１７年
日本国実用新案登録公報	１９９６－２０１７年
日本国登録実用新案公報	１９９４－２０１７年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
X	Huawei, HiSilicon, Initial access in NR, 3GPP TSG-RAN WG2 #94	1,4,6
A	R2-163923, 2016.05.14	2-3,5
A	Qualcomm Incorporated, NB-PBCH design, 3GPP TSG-RAN WG1 #84 R1-160875, 2016.02.06	1-6

☐　Ｃ欄の続きにも文献が列挙されている。

☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの
「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「＆」同一パテントファミリー文献

国際調査を完了した日 １８．１０．２０１７	国際調査報告の発送日 ３１．１０．２０１７
国際調査機関の名称及びあて先 日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　５Ｊ　３８６３ 横田　有光 電話番号　０３－３５８１－１１０１　内線　３５３４

様式ＰＣＴ／ＩＳＡ／２１０（第２ページ）（２０１５年１月）

Electronic Acknowledgement Receipt	
EFS ID:	34307986
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	14-NOV-2018
Filing Date:	10-AUG-2017
Time Stamp:	14:11:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1426-148-101--IDSasFiled11142018.pdf	147254 9cbd4b759a8c05f7a81e514042c0ef705239 8ef5	yes	6

	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Miscellaneous Incoming Letter		6	6	
	Information Disclosure Statement (IDS) Form (SB08)		4	5	
	Transmittal Letter		1	3	
Warnings:					
Information:					
2	Foreign Reference	WO2018030415.pdf	7845694 f62c465a998a8892f54cd0f33cc63dca933de7b5	no	72
Warnings:					
Information:					
3	Non Patent Literature	NPL-R2-163923.pdf	509631 1e79565109c4902861f8a94752274ea7a2326bb6	no	6
Warnings:					
Information:					
4	Non Patent Literature	NPL-R1-160041.pdf	288177 bbc05d9711ae974644a1ab573f518558d951aed8	no	3
Warnings:					
Information:					
5	Non Patent Literature	NPL-JPOfficeAction.pdf	100483 05a50b3020e6a10ad8e3d8db29d036fcba7e5153	no	3
Warnings:					
Information:					
6	Non Patent Literature	NPL--JPOfficeActionEnglish.pdf	28796 b95b8b61d6996cc9b5a9980d33bad76cb86e7dc8	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	8920035		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ko-Chiang Lin and Ming-Che Li	
Title:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	15/674,483	Filed: August 10, 2017
Examiner:	Wayne Huu Cai	Group Art Unit: 2644
Attorney Docket No.:	1426-148.101 (1050198-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 3 Page Information Disclosure Statement Transmittal; 2 Page Information Disclosure Statement with 5 references are being transmitted to the United States Patent and Trademark Office via EFS-Web on November 14, 2018.

Date: November 14, 2018 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	1426-148.101	7684

106622 7590 10/26/2018

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
CAI, WAYNE HUU	

ART UNIT	PAPER NUMBER
2644	

NOTIFICATION DATE	DELIVERY MODE
10/26/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@bluecapitallaw.com

Office Action Summary	**Application No.** 15/674,483	**Applicant(s)** Lin et al.	
	Examiner WAYNE H CAI	**Art Unit** 2644	**AIA Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 8/10/2017.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☐ Claim(s) _____ is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☑ Claim(s) 1-20 are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Election/Restriction

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-12, and 16-20, drawn to a method for determining numerology bandwidth, classified in 370/329.

II. Claims 13-15, drawn to another method for determining numerology bandwidth, classified in 370/329.

The inventions are independent or distinct, each from the other because:

2. Inventions I and II are directed to related apparatus. The related inventions are distinct if: (1) the inventions as claimed are either not capable of use together or can have a materially different design, mode of operation, function, or effect; (2) the inventions do not overlap in scope, i.e., are mutually exclusive; and (3) the inventions as claimed are not obvious variants. See MPEP § 806.05(j). Furthermore, the inventions as claimed do not encompass overlapping subject matter and there is nothing of record to show them to be obvious variants.

3. Restriction for examination purposes as indicated is proper because all the inventions listed in this action are independent or distinct for the reasons given above and there would be a serious search and/or examination burden if restriction were not required because one or more of the following reasons apply:

A method as claimed in claims 1-12, and 16-20 as shown in Figure 48 is different from a method as claimed in claims 13-15 as shown in Figure 49.

Applicant is advised that the reply to this requirement to be complete must include (i) an election of a invention to be examined even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected invention**.

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103 or pre-AIA 35 U.S.C. 103(a) of the other invention.

4. A telephone call was made to Sang Dang on October 18, 2018 to request an oral election to the above restriction requirement, but did not result in an election being made.

5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be corrected in compliance with 37 CFR 1.48(a) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. A request to correct inventorship under 37 CFR 1.48(a) must be accompanied by an application data sheet in accordance with 37 CFR 1.76 that identifies each inventor by his or her legal name and by the processing fee required under 37 CFR 1.17(i).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WAYNE H. CAI whose telephone number is (571)272-7798. The examiner can normally be reached on Monday-Friday, 8:00 AM - 5:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KATHY WANG-HURST can be reached on (571)270-5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR.

Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Wayne H Cai/
Primary Examiner, Art Unit 2644

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant						☐ CPA		☐ T.D.		☐ R.1.47
CLAIM		**DATE**								
Final	Original	10/18/2018								
	1	÷								
	2	÷								
	3	÷								
	4	÷								
	5	÷								
	6	÷								
	7	÷								
	8	÷								
	9	÷								
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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15674483
Filing Date	2017-08-10
First Named Inventor	Ko-Chiang Lin
Art Unit	2642
Examiner Name	Rafael Perez Gutierrez
Attorney Docket Number	1426-148.101

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2016072766	WO		2016-05-12	LG Electronics Inc.		☒

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2642
	Examiner Name	Rafael Perez Gutierrez
	Attorney Docket Number	1426-148.101

	1	Office Action from the Korean Intellectual Property Office in the corresponding KR Application No. 10-2017-0102214, dated August 22, 2018.	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

(43) 국제공개일
2016 년 5 월 12 일 (12.05.2016)

WIPO | PCT

(10) 국제공개번호
WO 2016/072766 A1

(51) 국제특허분류:
H04L 5/00 (2006.01) *H04W 72/04* (2009.01)

(21) 국제출원번호: PCT/KR2015/011855

(22) 국제출원일: 2015 년 11 월 5 일 (05.11.2015)

(25) 출원언어: 한국어

(26) 공개언어: 한국어

(30) 우선권정보:
62/075,272 2014 년 11 월 5 일 (05.11.2014) US
62/088,688 2014 년 12 월 8 일 (08.12.2014) US

(71) 출원인: **엘지전자 주식회사 (LG ELECTRONICS INC.)** [KR/KR]; 07336 서울시 영등포구 여의대로 128, Seoul (KR).

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(74) 대리인: **해스앤아이피 특허법인 (S&IP PATENT & LAW FIRM)**; 06235 서울시 강남구 테헤란로 14 길 5 (역삼동 삼흥역삼빌딩 2 층), Seoul (KR).

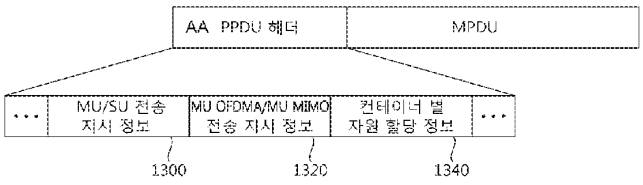
(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

공개:
---- 국제조사보고서와 함께 (조약 제 21 조(3))

(54) Title: METHOD AND DEVICE FOR ALLOCATING RESOURCE UNIT ON BASIS OF CONTAINER IN WIRELESS LAN

(54) 발명의 명칭 : 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치



1300 ... MU/SU transmission indication information
1320 ... MU OFDMA/MU MIMO transmission indication information
1340 ... Resource allocation information for each container
AA ... PPDU header

(57) **Abstract**: Disclosed are a method and a device for allocating a resource unit on the basis of a container in a wireless LAN. The method for allocating a resource unit in a wireless LAN comprises the steps of: generating, by an AP, a PPDU to be transmitted to a plurality of STAs; and transmitting, by the AP, the PPDU to the plurality of STAs through at least one container allocated on the entire frequency band, wherein the PPDU includes MU/SU transmission indication information and resource allocation information for each container, the MU/SU transmission indication information includes information on whether an SU-based transmission or an MU-based transmission is carried out on the entire bandwidth, and the resource allocation information for each container can include information on the number of STAs allocated to each of the at least one container.

(57) **요약서**: 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치가 개시되어 있다. 무선랜에서 자원 단위를 할당하는 방법은 AP 가 복수의 STA 으로 전송할 PPDU 를 생성하는 단계와 AP 가 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 복수의 STA 으로 PPDU 를 전송하는 단계를 포함하되, PPDU 는 MU/SU 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고, MU/SU 전송 지시 정보는 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고, 컨테이너 별 자원 할당 정보는 적어도 하나의 컨테이너 각각에 할당된 STA 의 개수에 대한 정보를 포함할 수 있다.

WO 2016/072766 A1

Samsung Exhibit 1006, Page 152 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

명세서

발명의 명칭: 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치

기술분야

[1] 본 발명은 무선 통신에 관한 것으로 보다 상세하게는 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치에 관한 것이다.

배경기술

[2] 차세대 WLAN(wireless local area network)를 위한 논의가 진행되고 있다. 차세대 WLAN에서는 1) 2.4GHz 및 5GHz 대역에서 IEEE(institute of electronic and electronics engineers) 802.11 PHY(physical) 계층과 MAC(medium access control) 계층의 향상, 2) 스펙트럼 효율성(spectrum efficiency)과 영역 쓰루풋(area through put)을 높이는 것, 3) 간섭 소스가 존재하는 환경, 밀집한 이종 네트워크(heterogeneous network) 환경 및 높은 사용자 부하가 존재하는 환경과 같은 실제 실내 환경 및 실외 환경에서 성능을 향상 시키는 것 을 목표로 한다.

[3] 차세대 WLAN에서 주로 고려되는 환경은 AP(access point)와 STA(station)이 많은 밀집 환경이며, 이러한 밀집 환경에서 스펙트럼 효율(spectrum efficiency)과 공간 전송률(area throughput)에 대한 개선이 논의된다. 또한, 차세대 WLAN에서는 실내 환경뿐만 아니라, 기존 WLAN에서 많이 고려되지 않던 실외 환경에서의 실질적 성능 개선에 관심을 가진다.

[4] 구체적으로 차세대 WLAN에서는 무선 오피스(wireless office), 스마트 홈(smart home), 스타디움(Stadium), 핫스팟(Hotspot), 빌딩/아파트(building/apartment)와 같은 시나리오에 관심이 크며, 해당 시나리오 기반으로 AP와 STA이 많은 밀집 환경에서의 시스템 성능 향상에 대한 논의가 진행되고 있다.

[5] 또한, 차세대 WLAN에서는 하나의 BSS(basic service set)에서의 단일 링크 성능 향상보다는, OBSS(overlapping basic service set) 환경에서의 시스템 성능 향상 및 실외 환경 성능 개선, 그리고 셀룰러 오프로딩 등에 대한 논의가 활발할 것으로 예상된다. 이러한 차세대 WLAN의 방향성은 차세대 WLAN이 점점 이동 통신과 유사한 기술 범위를 갖게 됨을 의미한다. 최근 스몰셀 및 D2D(Direct-to-Direct) 통신 영역에서 이동 통신과 WLAN 기술이 함께 논의되고 있는 상황을 고려해 볼 때, 차세대 WLAN과 이동 통신의 기술적 및 사업적 융합은 더욱 활발해질 것으로 예측된다.

발명의 상세한 설명

기술적 과제

[6] 본 발명의 목적은 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법을 제공하는 것이다.

[7] 본 발명의 또 다른 목적은 무선랜에서 컨테이너를 기반으로 자원 단위를

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할당하는 장치를 제공하는 것이다.

과제 해결 수단

[8] 상술한 본 발명의 목적을 달성하기 위한 본 발명의 일 측면에 따른 무선랜에서 자원 단위를 할당하는 방법은 AP(access point)가 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하는 단계와 상기 AP가 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하는 단계를 포함할 수 있되, 상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고, 상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고, 상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고, 상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고, 상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 클 수 있다.

[9] 상술한 본 발명의 목적을 달성하기 위한 본 발명의 다른 측면에 따른 무선랜에서 자원 단위를 할당하는 AP(access point)는 무선 신호를 송신 및 수신하는 RF(radio frequency) 부와 상기 RF 부와 동작 가능하게(operatively) 결합된 프로세서를 포함하되, 상기 프로세서는 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하고, 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하도록 구현될 수 있되, 상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고, 상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고, 상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고, 상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고, 상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 클 수 있다.

발명의 효과

[10] OFDMA(orthogonalfrequency division multiple access)를 기반으로 복수의 STA 각각을 위한 무선 자원을 할당시 서로 다른 크기로 정의된 무선 자원 단위를 사용하여 복수의 STA 각각으로의 자원 할당이 수행될 수 있다. 따라서, 스케줄링 유연도(scheduling flexibility)가 높아지고 무선랜의 처리량(throughput)이 증가될 수 있다. 컨테이너를 기반으로 자원 단위를 스케줄링함으로써 자원 단위 할당의 스케줄링을 위한 복잡도가 감소될 수 있다.

도면의 간단한 설명

[11] 도 1은 무선랜(wireless local area network, WLAN)의 구조를 나타낸 개념도이다.

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[12] 도 2는 본 발명의 실시예에 따른 20MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[13] 도 3은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[14] 도 4는 본 발명의 실시예에 따른 자원 단위의 할당을 위한 시그널링 방법을 나타낸 개념도이다.

[15] 도 5는 본 발명의 실시예에 따른 40MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[16] 도 6은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[17] 도 7은 본 발명의 실시예에 따른 80MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[18] 도 8은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[19] 도 9는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[20] 도 10은 본 발명의 실시예에 따른 컨테이너 별 자원 할당 정보를 나타낸 개념도이다.

[21] 도 11은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[22] 도 12는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[23] 도 13은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[24] 도 14는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[25] 도 15는 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[26] 도 16은 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[27] 도 17은 본 발명의 실시예에 따른 DL MU PPDU 포맷을 나타낸 개념도이다.

[28] 도 18은 본 발명의 실시예에 따른 UL MU PPDU의 전송을 나타낸 개념도이다.

[29] 도 19는 본 발명의 실시예가 적용될 수 있는 무선 장치를 나타내는 블록도이다.

발명의 실시를 위한 형태

[30] 도 1은 무선랜(wireless local area network, WLAN)의 구조를 나타낸 개념도이다.

[31] 도 1의 상단은 IEEE(institute of electrical and electronic engineers) 802.11의 인프라스트럭처 BSS(basic service set)의 구조를 나타낸다.

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[32] 도 1의 상단을 참조하면, 무선랜 시스템은 하나 또는 그 이상의 인프라스트럭처 BSS(100, 105)(이하, BSS)를 포함할 수 있다. BSS(100, 105)는 성공적으로 동기화를 이루어서 서로 통신할 수 있는 AP(access point, 125) 및 STA1(Station, 100-1)과 같은 AP와 STA의 집합으로서, 특정 영역을 가리키는 개념은 아니다. BSS(105)는 하나의 AP(130)에 하나 이상의 결합 가능한 STA(105-1, 105-2)을 포함할 수도 있다.

[33] BSS는 적어도 하나의 STA, 분산 서비스(distribution Service)를 제공하는 AP(125, 130) 및 다수의 AP를 연결시키는 분산 시스템(distribution System, DS, 110)을 포함할 수 있다.

[34] 분산 시스템(110)는 여러 BSS(100, 105)를 연결하여 확장된 서비스 셋인 ESS(extended service set, 140)를 구현할 수 있다. ESS(140)는 하나 또는 여러 개의 AP(125, 230)가 분산 시스템(110)을 통해 연결되어 이루어진 하나의 네트워크를 지시하는 용어로 사용될 수 있다. 하나의 ESS(140)에 포함되는 AP는 동일한 SSID(service set identification)를 가질 수 있다.

[35] 포털(portal, 120)은 무선랜 네트워크(IEEE 802.11)와 다른 네트워크(예를 들어, 802.X)와의 연결을 수행하는 브리지 역할을 수행할 수 있다.

[36] 도 1의 상단과 같은 BSS에서는 AP(125, 130) 사이의 네트워크 및 AP(125, 130)와 STA(100-1, 105-1, 105-2) 사이의 네트워크가 구현될 수 있다. 하지만, AP(125, 130)가 없이 STA 사이에서도 네트워크를 설정하여 통신을 수행하는 것도 가능할 수 있다. AP(125, 130)가 없이 STA 사이에서도 네트워크를 설정하여 통신을 수행하는 네트워크를 애드-혹 네트워크(Ad-Hoc network) 또는 독립 BSS(independent basic service set, IBSS)라고 정의한다.

[37] 도 1의 하단은 IBSS를 나타낸 개념도이다.

[38] 도 1의 하단을 참조하면, IBSS는 애드-혹 모드로 동작하는 BSS이다. IBSS는 AP를 포함하지 않기 때문에 중앙에서 관리 기능을 수행하는 개체(centralized management entity)가 없다. 즉, IBSS에서 STA(150-1, 150-2, 150-3, 155-4, 155-5)들은 분산된 방식(distributed manner)으로 관리된다. IBSS에서는 모든 STA(150-1, 150-2, 150-3, 155-4, 155-5)이 이동 STA으로 이루어질 수 있으며, 분산 시스템으로의 접속이 허용되지 않아서 자기 완비적 네트워크(self-contained network)를 이룬다.

[39] STA은 IEEE(Institute of Electrical and Electronics Engineers) 802.11 표준의 규정을 따르는 매체 접속 제어(medium access control, MAC)와 무선 매체에 대한 물리 계층(Physical Layer) 인터페이스를 포함하는 임의의 기능 매체로서, 광의로는 AP와 비-AP STA(Non-AP Station)을 모두 포함하는 의미로 사용될 수 있다.

[40] STA은 이동 단말(mobile terminal), 무선 기기(wireless device), 무선 송수신 유닛(Wireless Transmit/Receive Unit; WTRU), 사용자 장비(User Equipment; UE), 이동국(Mobile Station; MS), 이동 가입자 유닛(Mobile Subscriber Unit) 또는

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단순히 유저(user) 등의 다양한 명칭으로도 불릴 수 있다.

[41] 이하, 본 발명의 실시예에서는 AP에서 STA으로 전송되는 데이터(또는 프레임)는 하향링크 데이터(또는 하향링크 프레임), STA에서 AP로 전송되는 데이터(또는 프레임)는 상향링크 데이터(또는 상향링크 프레임)라는 용어로 표현될 수 있다. 또한, AP에서 STA으로의 전송은 하향링크 전송, STA에서 AP로의 전송은 상향링크 전송이라는 용어로 표현할 수 있다.

[42] 또한, 하향링크 전송을 통해 전송되는 PPDU(PHY protocol data unit), 프레임 및 데이터 각각은 하향링크 PPDU, 하향링크 프레임 및 하향링크 데이터라는 용어로 표현될 수 있다. PPDU는 PPDU 헤더와 PSDU(physical layer service data unit)(또는 MPDU(MAC protocol data unit))를 포함하는 데이터 단위일 수 있다. PPDU 헤더는 PHY 헤더와 PHY 프리앰블을 포함할 수 있고, PSDU(또는 MPDU)는 프레임(또는 MAC 계층의 정보 단위)을 포함하거나 프레임을 지시하는 데이터 단위일 수 있다. PHY 헤더는 다른 용어로 PLCP(physical layer convergence protocol) 헤더, PHY 프리앰블은 다른 용어로 PLCP 프리앰블로 표현될 수도 있다.

[43] 또한, 상향링크 전송을 통해 전송되는 PPDU, 프레임 및 데이터 각각은 상향링크 PPDU, 상향링크 프레임 및 상향링크 데이터라는 용어로 표현될 수 있다.

[44] 기존의 무선랜 시스템에서는 SU(single)-OFDM(orthogonal frequency division multiplexing) 전송을 기반으로 전체 대역폭이 하나의 STA으로의 하향링크 전송 및 하나의 STA의 상향링크 전송을 위해 사용되었다. 또한, 기존의 무선랜 시스템에서 AP는 MU MIMO(multiple input multiple output)를 기반으로 DL(downlink) MU(multi-user) 전송을 수행할 수 있었고, 이러한 전송은 DL MU MIMO 전송이라는 용어로 표현될 수 있다.

[45] 본 발명의 실시예에 따른 무선랜 시스템에서는 OFDMA(orthogonal frequency division multiple access) 기반의 전송 방법이 상향링크 전송 및 하향링크 전송을 위해 지원될 수 있다. 구체적으로 본 발명의 실시예에 따른 무선랜 시스템에서 AP가 OFDMA를 기반으로 DL MU 전송을 수행할 수 있고, 이러한 전송은 DL MU OFDMA 전송이라는 용어로 표현될 수 있다. DL MU OFDMA 전송이 수행되는 경우, AP는 중첩된 시간 자원 상에서 복수의 주파수 자원 각각을 통해 복수의 STA 각각으로 하향링크 데이터(또는 하향링크 프레임, 하향링크 PPDU)를 전송할 수 있다. 복수의 주파수 자원은 복수의 서브밴드(또는 서브채널) 또는 복수의 RU(resource unit)(예를 들어, 서로 다른 크기로 정의된 기본 자원 단위(basic resource unit, BRU))일 수 있다. DL MU OFDMA 전송은 DL MU MIMO 전송과 함께 사용될 수 있다. 예를 들어, DL MU OFDMA 전송을 위해 할당된 특정 서브 밴드(또는 서브 채널) 상에서 복수의 시공간 스트림(space-time stream)(또는 공간적 스트림(spatial stream))을 기반으로 한 DL MU MIMO 전송이 수행될 수 있다.

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[46] 또한, 본 발명의 실시예에 따른 무선랜 시스템에서는 복수의 STA이 동일한 시간 자원 상에서 AP로 데이터를 전송하는 것을 UL MU 전송(uplink multi-user transmission)이 지원될 수 있다. 복수의 STA 각각에 의한 중첩된 시간 자원 상에서의 상향링크 전송은 주파수 도메인 또는 공간 도메인(spatial domain) 상에서 수행될 수 있다.

[47] 복수의 STA 각각에 의한 상향링크 전송이 주파수 도메인 상에서 수행되는 경우, OFDMA를 기반으로 복수의 STA 각각에 대해 서로 다른 주파수 자원이 상향링크 전송 자원으로 할당될 수 있다. 서로 다른 주파수 자원은 서로 다른 서브밴드(또는 서브채널) 또는 서로 다른 RU(resource unit)일 수 있다. 복수의 STA 각각은 할당된 서로 다른 주파수 자원을 통해 AP로 상향링크 데이터를 전송할 수 있다. 이러한 서로 다른 주파수 자원을 통한 전송 방법은 UL MU OFDMA 전송 방법이라는 용어로 표현될 수도 있다.

[48] 복수의 STA 각각에 의한 상향링크 전송이 공간 도메인 상에서 수행되는 경우, 복수의 STA 각각에 대해 서로 다른 시공간 스트림(또는 공간적 스트림)이 할당되고 복수의 STA 각각이 서로 다른 시공간 스트림을 통해 상향링크 데이터를 AP로 전송할 수 있다. 이러한 서로 다른 공간적 스트림을 통한 전송 방법은 UL MU MIMO 전송 방법이라는 용어로 표현될 수도 있다.

[49] UL MU OFDMA 전송과 UL MU MIMO 전송은 함께 수행될 수 있다. 예를 들어, UL MU OFDMA 전송을 위해 할당된 특정 서브 밴드(또는 서브 채널) 상에서 복수의 시공간 스트림(또는 공간적 스트림)을 기반으로 한 UL MU MIMO 전송이 수행될 수 있다.

[50] MU OFDMA 전송을 지원하지 않았던 종래의 무선랜 시스템에서 하나의 단말에게 넓은 대역폭(wider bandwidth)(예를 들어, 20MHz 초과 대역폭)을 할당하기 위해 멀티 채널 할당 방법이 사용되었다. 멀티 채널은 하나의 채널 단위를 20MHz라고 할 경우, 복수개의 20MHz 채널을 포함할 수 있다. 멀티 채널 할당 방법에서는 단말에게 넓은 대역폭을 할당하기 위해 프라이머리 채널 규칙(primary channel rule)이 사용되었다. 프라이머리 채널 규칙이 사용되는 경우, 단말로 넓은 대역폭을 할당하기 위한 제약이 존재한다. 구체적으로, 프라이머리 채널 룰에 따르면, 프라이머리 채널에 인접한 세컨더리 채널(secondary channel)이 OBSS(overlapped BSS)에서 사용되어 '비지(busy)' 한 경우, STA은 프라이머리 채널을 제외한 나머지 채널을 사용할 수 없다. 따라서, STA은 프라이머리 채널로만 프레임을 전송할 수 있어 멀티 채널을 통한 프레임의 전송에 대한 제약을 받는다. 즉, 기존의 무선랜 시스템에서 멀티 채널 할당을 위해 사용되던 프라이머리 채널 룰은 OBSS가 적지 않은 현재 무선랜 환경에서 넓은 대역폭을 운용하여 높은 처리량을 얻고자 함에 있어 큰 제약이 될 수 있다.

[51] 이러한 문제점을 해결하고자 본 발명에 실시예에서는 OFDMA(orthogonalfrequency division multiple access) 기술을 지원하는 무선랜

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시스템이 개시된다. OFDMA 기술이 사용되는 경우, 프라이머리 채널 룰에 의한 제한 없이 멀티 채널을 하나의 단말이 아닌 다수의 단말이 동시에 사용할 수 있다. 따라서, 넓은 대역폭 운용이 가능하여 무선 자원의 운용의 효율성이 향상될 수 있다.

[52] 본 발명에서 실시예에 따른 무선랜 시스템에서 가정되는 시간-주파수 구조(time-frequency structure)는 예시적으로 아래와 같을 수 있다.

[53] FFT(fast fourier transform) 사이즈/IFFT(inverse fast fourier transform) 사이즈는 기존의 무선랜 시스템에서 사용되던 FFT/IFFT 사이즈의 N배(N은 자연수, 예를 들어, N=4)로 정의될 수 있다. 예를 들어, 20MHz의 대역폭에 대하여 256FFT/IFFT가 적용되고, 40MHz의 대역폭에 대하여 512FFT/IFFT가 적용되고, 80MHz의 대역폭에 대하여 1024FFT/IFFT가 적용되고, 연속 160MHz 또는 불연속 160MHz의 대역폭에 대하여 2048FFT/IFFT가 적용될 수 있다.

[54] 서브캐리어 공간(subcarrier spacing)은 기존의 무선랜 시스템에서 사용되던 서브캐리어 공간의 1/N배(N은 자연수, 예를 들어, N=4일 경우, 78.125kHz)의 크기일 수 있다.

[55] IDFT(inverse discrete fourier transform)/DFT(discrete fourier transform)(또는 FFT/IFFT)를 기반으로 한 IDFT/DFT 길이(또는 유효 심볼 길이)는 기존의 무선랜 시스템에서 IDFT/DFT 길이의 N배일 수 있다. 예를 들어, 기존의 무선랜 시스템에서 IDFT/DFT 길이가 3.2μs이고, N=4인 경우, 본 발명의 실시예에 따른 무선랜 시스템에서 IDFT/DFT 길이는 3.2μs *4(= 12.8μs)일 수 있다.

[56] OFDM 심볼의 길이는 IDFT/DFT 길이에 GI(guard interval)의 길이를 더한 값일 수 있다. GI의 길이는 0.4μs, 0.8μs, 1.6μs, 2.4μs, 3.2μs와 같은 다양한 값일 수 있다.

[57] 본 발명의 실시예에 따른 OFDMA 기반의 자원 할당 방법이 사용될 경우, 서로 다른 크기로 정의된 자원 할당 단위가 사용될 수 있다. 구체적으로 OFDMA 기반의 자원 할당을 위한 기본 자원 단위(basic resource unit)는 26톤의 자원 단위 및 242톤의 자원 단위로 정의될 수 있다. 예를 들어, 26톤의 자원 단위는 24톤의 데이터 톤과 2톤의 파일롯 톤을 포함할 수 있다. 242톤의 자원 단위는 234톤의 데이터 톤과 8톤의 파일롯 톤을 포함할 수 있다. 242톤의 자원 단위에 대하여 234 크기의 인터리버가 적용되고, 26톤의 자원 단위에 대하여 24 크기의 인터리버가 적용되어 데이터 톤에 대한 인터리빙이 수행될 수 있다. 톤(tone)은 서브캐리어(subcarrier)와 동일한 의미로 해석될 수 있다.

[58] 242톤의 기본 자원 단위에 대하여 기존의 IEEE 802.11ac의 242톤의 뉴머롤로지(numerology)를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치가 적용될 수 있다. 기존의 IEEE 802.11ac의 242톤의 뉴머롤로지를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치는 IEEE Standard for Information technology telecommunications and information exchange between systems local and metropolitan area networks specific requirements 'Part 11: Wireless LAN Medium Access Control(MAC) and Physical Layer (PHY) Specifications Amendment 4:

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Enhancements for Very High Throughput for Operation in Bands below 6 GHz의 22.3.10.10 Pilot subcarriers에 개시되어 있다.

[59] 242톤의 자원 단위는 가상 할당 자원 단위(virtual allocation resource unit)일 수 있다. 가상 할당 자원 단위는 가상 할당 자원 단위보다 작은 자원 단위의 조합을 기반으로 생성될 수 있다. 예를 들어, 242톤의 자원 단위는 복수의 26톤의 자원 단위 및 추가의 레프트오버 톤(leftover tone)의 조합, 121톤의 자원 단위의 조합일 수 있다. 가상 할당 자원 단위는 기존의 무선랜 시스템의 인터리버 사이즈 및 OFDM 뉴머롤로지(numerology)(또는 톤(tone) 뉴머롤로지)를 재활용하기 위한 자원 단위일 수 있다.

[60] 26톤의 기본 자원 단위에 대하여 기존의 IEEE 802.11ah의 26톤의 뉴머롤로지를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치가 적용될 수 있다. 기존의 IEEE 802.11ah의 26톤의 뉴머롤로지를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치는 IEEE P802.11ah™/D5.0 Draft Standard for Information technology tele-communications and information exchange between systems Local and metropolitan area network specific requirements 'Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) SpecificationsAmendment 2: Sub 1 GHz License ExemptOperation'의 24.3.9.10 Pilot subcarriers에 개시되어 있다.

[61] AP는 위와 같은 서로 다른 크기의 자원 단위를 기반으로 적어도 하나의 STA을 위한 하향링크 전송 자원 및/또는 상향링크 전송 자원을 결정할 수 있다. AP는 스케줄링된 하향링크 전송 자원을 통해 적어도 하나의 PPDU를 적어도 하나의 STA으로 전송할 수 있다. 또한 AP는 스케줄링된 상향링크 전송 자원을 통해 적어도 하나의 STA에 의해 전송되는 적어도 하나의 PPDU를 수신할 수 있다.

[62] 기본 자원 단위는 전체 대역폭(또는 가용한 대역폭) 상에서 전체 대역폭의 양 끝단에 위치한 간섭 완화를 위한 좌측 가드 톤(left guard tone), 우측 가드 톤(right guard tone) 및 전체 대역폭의 중앙에 위치한 DC(direct current) 톤을 제외한 가용한 톤 상에서 할당될 수 있다. 이뿐만 아니라 기본 자원 단위는 사용자 할당 분리(user allocation separation)(또는 STA 별 자원 할당), 일반 파일롯(common pilot), AGC(automatic gain control), 위상 트래킹(phase tracking) 등의 용도로 사용될 수 있는 레프트오버(leftover) 톤(또는 나머지 톤(remaining tone))을 고려하여 할당될 수 있다.

[63] 전체 대역폭 상에서 기본 자원 단위의 할당 방법(할당 개수, 할당 위치 등)은 자원 활용 효율, 전체 대역폭에 따른 스케일러빌러티(scalability)(또는 확장성)을 고려하여 설정될 수 있다. 기본 자원 단위의 할당 방법은 미리 정의되거나 다양한 방법(예를 들어, PPDU의 PPDU 헤더에 포함되는 시그널 필드(signal field)를 기반으로 한 시그널링)을 기반으로 시그널링될 수 있다.

[64] 이하, 구체적인 기본 자원 단위를 기반으로 한 자원 할당 방법이 개시된다.

[65] 본 발명의 실시예에 따르면, 20MHz, 40MHz, 80MHz의 대역폭 각각에 대한 톤 뉴머롤로지(tone numerology)는 아래와 같을 수 있다. 아래의 각 대역폭의 자원

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할당 방법은 하나의 예시로서 이외에도 다양한 방법으로 각 대역폭 상에서의 자원 할당이 수행될 수 있다.

[66] 20MHz 대역폭에 대하여 좌측 가드 톤(left guard tone)은 6톤, DC(direct current) 톤은 3톤, 우측 가드 톤(right guard tone)은 5톤으로 정의될 수 있다. 20MHz 대역폭에 대하여 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[67] 40MHz 대역폭에 대하여 좌측 가드 톤은 6톤, DC 톤은 9톤, 우측 가드 톤은 5톤으로 정의될 수 있다. 40MHz 대역폭에 대하여 492톤이 가용할 수 있고, 492톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[68] 40MHz 대역폭에 대하여 좌측 가드 톤은 6톤, DC 톤은 5톤, 우측 가드 톤은 5톤으로 정의될 수 있다. 40MHz 대역폭에 대하여 496톤이 가용할 수 있고, 496톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[69] 80MHz 대역폭에 대하여 좌측 가드 톤은 11톤, DC 톤은 3톤, 우측 가드 톤은 10톤으로 정의될 수 있다. 80MHz 대역폭에 대하여 1000톤이 가용할 수 있고, 1000톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[70] 80MHz 대역폭에 대하여 좌측 가드 톤은 6톤, DC 톤은 5톤, 우측 가드 톤은 5톤으로 정의될 수 있다. 80MHz 대역폭에 대하여 1008톤이 가용할 수 있고, 1008톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[71] 본 발명의 실시예에서 래프트오버 톤은 설명의 편의상 도면에 표시하지 않으나 26톤의 자원 단위 및 242톤의 자원 단위 사이 또는 26톤의 자원 단위 및/또는 242톤의 자원 단위 각각에 인접하여 위치할 수 있다.

[72] 도 2는 본 발명의 실시예에 따른 20MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[73] 도 2에서는 242톤의 자원 단위/26톤의 자원 단위의 20MHz 대역폭 상에서의 자원 할당 및 자원 할당에 대한 시그널 방법이 개시된다.

[74] 도 2의 좌측을 참조하면, 하나의 242톤의 자원 단위가 20MHz 대역폭 상의 가용한 톤 상에서 할당될 수 있다. 가용한 톤은 좌측 가드 톤, 우측 가드 톤 및 DC 톤을 제외한 나머지 톤일 수 있다. 242톤의 자원 단위는 DC 톤을 기준으로 2개의 121톤의 분할 자원 단위의 조합일 수 있다.

[75] 20MHz 대역폭 상에서 하나의 STA에게 하나의 242톤의 자원 단위가 할당될 수 있다. SU(single user) 기반의 전송을 위해 20MHz 대역폭 상에서 하나의 242톤의 자원 단위가 하나의 STA으로 할당될 수 있다. 20MHz 대역폭 상에서 하나의 242톤의 자원 단위가 하나의 STA으로 할당되는 경우, 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 만약 MU OFDMA기반의 전송이

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수행되지 않고, 복수의 STA에 대한 자원이 MU-MIMO 기반의 전송을 위해 하나의 242톤의 자원 단위에 멀티플렉싱되어 할당되는 경우에도 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 이러한 경우, MU-MIMO로 할당되는 STA의 수 정보가 PPDU의 헤더에 포함될 수 있다. STA은 전체 대역폭 크기의 정보(예를 들어, 20MHz) 및 전체 대역폭 상에 할당된 STA에 대한 정보(STA만이 전체 대역폭 상에서 할당되었다는 정보)만을 기반으로 20MHz 대역폭 상에서 하나의 242톤의 자원 단위가 하나의 STA으로 할당되었음을 알 수 있다.

[76] 도 2의 우측을 참조하면, 20MHz 대역폭 상에서 242톤의 자원 단위의 할당 없이 26톤의 자원 단위만이 복수의 STA 각각에 대한 자원 할당을 위해 사용될 수 있다. 예를 들어, 20MHz 대역폭 상에서 하나의 STA은 적어도 하나의 26톤의 자원 단위를 할당받을 수 있다.

[77] 20MHz 대역폭 상에서는 최대 9개의 26톤의 자원 단위가 할당될 수 있다. 9개의 26톤의 자원 단위 각각이 복수의 STA 각각에게 할당되는 경우, 하나의 STA은 하나의 26톤의 자원 단위를 할당받을 수 있다. 즉, 26톤의 자원 단위가 할당되는 경우, 20MHz 대역폭 상에서 동시에 최대 9개의 STA으로 자원이 할당될 수 있다. 하나의 26톤의 자원 단위는 DC 톤을 기준으로 2개의 13톤의 분할 자원 단위로 분할될 수 있다.

[78] 20MHz 대역폭 상에서 복수개(예를 들어, 9개)의 26톤의 자원 단위 각각의 할당 위치는 고정되어 있을 수 있고, 자원 단위 할당 시그널링(resource unit allocation signaling)(또는 시그널링 지시(signaling indication))을 기반으로 주파수 축상에서 순차적으로 위치한 복수개의 26톤의 자원 단위 각각이 순차적으로 개별 STA으로 할당될 수 있다.

[79] 도 3은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[80] 도 3을 참조하면, 20MHz 대역폭 상에서 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 전체 할당 정보(300))로 n 비트(예를 들어, 1비트)가 할당될 수 있다. n비트의 242톤 자원 단위 전체 할당 정보(300)는 20MHz 대역폭 상에서 242톤의 자원 단위의 할당 여부에 대한 정보를 포함할 수 있다. STA은 242톤 자원 단위 전체 할당 정보(300)를 기반으로 20MHz 대역폭 상에서 242톤의 자원 단위의 할당 여부를 결정할 수 있다. 예를 들어, 1비트의 242톤 자원 단위 전체 할당 정보(300)의 값이 1인 경우, 20MHz 대역폭 상에서 242톤의 자원 단위의 할당이 지시되고, 1비트의 242톤 자원 단위 전체 할당 정보(300)의 값이 0인 경우, 20MHz 대역폭 상에서 242톤의 자원 단위의 비할당(non allocation)이 지시될 수 있다.

[81] 20MHz 대역폭 상에서 242톤의 자원 단위가 할당되는 경우, SU 기반 전송이 수행되고, 242톤의 자원 단위가 할당되지 않는 경우, MU 기반 전송이 수행된다. 따라서, 다른 표현으로 242톤 자원 단위 전체 할당 정보(300)는 20MHz 대역폭

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상에서 SU 기반 전송이 수행되는지 MU 기반 전송이 수행되는지 여부를 지시하는 의미로도 해석될 수 있다.

[82] 또한, 20MHz 대역폭 상에서 개별 STA으로의 26톤의 자원 단위의 할당에 대한 정보(이하, 26톤 자원 단위 개별 할당 정보(350))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 26톤 자원 단위 개별 할당 정보(350)는 개별 STA으로의 26톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(200)가 20MHz 대역폭 상에서 242톤의 자원 단위의 할당을 지시하는 경우, STA에 대해 26톤의 자원 단위가 할당되지 않을 수 있다. 이러한 경우, 26톤 자원 단위 개별 할당 정보(350)는 다른 정보로 활용될 수도 있다. 또는 242톤 자원 단위 전체 할당 정보(300)가 20MHz 대역폭 상에서 1개의 242톤의 자원 단위의 할당을 지시하는 경우, STA은 26톤 자원 단위 개별 할당 정보(350)에 대한 디코딩을 수행하지 않을 수도 있다.

[83] 예를 들어, '00'인 2비트의 26톤 자원 단위 개별 할당 정보(350)는 STA으로의 1개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[84] '01'인 2비트의 26톤 자원 단위 개별 할당 정보(350)는 STA으로의 2개의 26톤의 자원 단위의 할당을 지시할 수 있다. STA으로 2개의 26톤의 자원 단위가 할당 경우, 4개의 레프트오버 톤(leftover tone)도 함께 할당될 수 있다. 2개의 26톤 자원 단위와 4개의 레프트오버 톤은 조합되어 하나의 56톤의 자원 단위로서 사용될 수 있다. 2개의 26톤 자원 단위와 4개의 레프트오버 톤의 조합을 기반으로 생성된 56톤의 자원 단위에 포함되는 파일롯 톤의 위치는 기존의 IEEE802.11ah spec 상에서 2개의 26톤의 자원 단위 각각에 기존에 정의되어 있던 파일롯 톤의 위치와 동일하거나, 기존의 IEEE802.11ac spec 상에서 기존의 56톤의 자원 단위에 정의된 파일롯 톤의 위치와 동일할 수 있다. 기존의 56톤의 자원 단위에 정의된 파일롯 톤의 위치는 전술한 IEEE 802.11ac spec의 22.3.10.10 Pilot subcarriers에 개시되어 있다.

[85] '10'인 2비트의 26톤의 자원 단위 개별 할당 정보(350)는 STA으로 3개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[86] '11'인 2비트의 26톤의 자원 단위 개별 할당 정보(350)는 STA으로 4개의 26톤의 자원 단위의 할당을 지시할 수 있다. 4개의 26톤의 자원 단위와 함께 8개의 레프트오버 톤이 할당되는 경우, STA은 전체 112(26*4+8)톤을 할당받을 수 있다. 이러한 경우, 기존에 IEEE802.11ac spec에 정의된 114톤의 자원 단위(108톤의 데이터 톤과 6톤의 파일롯 톤)에 적용되던 프로세싱 절차(예를 들어, 108 사이즈의 인터리버)를 재활용하기 위해 112톤의 자원 단위 내에 파일롯 톤을 4개만을 할당하고 나머지 108톤을 데이터 톤으로 할당할 수 있다.

[87] 즉, 4개의 26톤의 자원 단위에 대응되는 112톤의 자원 단위는 108톤의 데이터 톤, 4톤의 파일롯 톤으로 구성될 수 있다. 112톤의 자원 단위에 포함되는 4개의 파일롯 톤 각각의 위치는 112톤의 자원 단위에 포함되는 4개의 26톤의 자원 단위 각각에서 동일할 수 있다. 또는 112톤의 자원 단위에 포함되는 4개의 파일롯 톤

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각각은 112톤의 자원 단위에 포함되는 4개의 26톤의 자원 단위 각각의 위치를 고려하지 않고, 112톤의 자원 단위에 대응되는 주파수 축 상에서 동등하게 할당될 수도 있다. 또는 기존의 114톤의 자원 단위에 할당된 6개의 파일롯 톤 중 4개의 파일롯 톤을 선택하여 112톤의 자원 단위의 파일롯 톤으로 정의할 수도 있다.

[88] 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 20MHz 대역폭 상에서 최소 1개의 STA, 최대 9개의 STA이 지원될 수 있다.

[89] 전술한 바와 같이 STA은 20MHz 대역폭 상에서 1개의 242톤의 자원 단위 또는 1, 2, 3 또는 4개의 26톤의 자원 단위를 할당받아 동작할 수 있다.

[90] 아래의 표 1은 지원되는 STA의 개수에 따른 자원 단위의 할당을 예시적으로 나타낸다.

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[91] [표1]

STA의 개수	자원 할당	STA의 개수	자원 할당
1	STA1:242톤(1개)	6	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(2개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)
2	STA1:26톤(4개)STA2:26톤(4개)	7	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(1개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)STA7:26톤(1개)
3	STA1:26톤(3개)STA2:26톤(3개)STA3:26톤(3개)	8	STA1:26톤(2개)STA2:26톤(1개)STA3:26톤(1개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)STA7:26톤(1개)STA8:26톤(1개)
4	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(2개)STA4:26톤(3개)	9	STA1:26톤(1개)STA2:26톤(1개)STA3:26톤(1개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)STA7:26톤(1개)STA8:26톤(1개)STA9:26톤(1개)
5	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(2개)STA4:26톤(2개)STA5:26톤(1개)		

[92] 도 4는 본 발명의 실시예에 따른 자원 단위의 할당을 위한 시그널링 방법을 나타낸 개념도이다.

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[93] 도 4에서는 PPDU를 수신하는 STA에 대한 식별 정보 및 STA에게 할당되는 자원 단위의 개수에 대한 정보를 기반으로 STA으로 자원 단위를 할당하는 방법이 개시된다.

[94] 도 4를 참조하면, PPDU 헤더는 PPDU를 수신할 복수의 STA에 대한 정보(수신 STA 식별 정보(400)) 및 PPDU의 수신을 위해 복수의 STA 각각에 할당된 자원 단위에 대한 정보(자원 할당 정보(450))를 포함할 수 있다. 수신 STA 식별 정보(400)는 복수의 STA 각각의 식별자 정보(예를 들어, AID(association identifier))를 순차적으로 포함할 수 있다. 자원 할당 정보(450)는 복수의 STA 각각에 대해 할당된 자원 단위의 개수에 대한 정보를 순차적으로 포함할 수 있다. 예를 들어, 자원 할당 정보는 26톤 자원 단위 개별 할당 정보, 후술할 242톤 자원 단위 개별 할당 정보일 수 있다. 242톤 자원 단위 개별 할당 정보는 개별 STA으로 할당되는 242톤의 자원 단위의 개수에 대한 정보일 수 있다.

[95] 수신 STA 식별 정보(400)에 의해 순차적으로 지시되는 복수의 STA 각각은 자원 할당 정보(450)에 순차적으로 포함되는 복수의 STA 각각에 대해 할당되는 자원 단위의 개수에 대한 정보와 대응될 수 있다. 수신 STA 식별 정보(400)에 의해 순차적으로 지시되는 복수의 STA 각각은 복수의 STA 각각에 대해 할당되는 자원 단위의 개수에 대한 정보를 고려하여 주파수 축 상에서 순차적으로 나열된 자원 단위를 할당받을 수 있다.

[96] 예를 들어, 9개의 자원 단위(자원 단위1 내지 자원 단위 9)가 주파수 축 상에 순차적으로 할당되고, 수신 STA 식별 정보가 STA1, STA2, STA3을 순차적으로 지시하고, 자원 할당 정보가 3개, 2개, 4개를 순차적으로 지시하는 경우가 가정될 수 있다. 이러한 경우, STA1은 3개의 자원 단위, STA2는 2개의 자원 단위, STA3은 4개의 자원 단위를 할당받을 수 있다. 이때 자원 단위1 내지 자원 단위9가 STA1, STA2, STA3 각각에 할당된 자원 단위의 개수를 고려하여 STA1, STA2, STA3 각각으로 순차적으로 할당될 수 있다. 구체적으로 STA1은 자원 단위 1, 자원 단위 2, 자원 단위 3를 할당받고, STA2는 자원 단위 4, 자원 단위 5를 할당받고, STA3은 자원 단위 6, 자원 단위 7, 자원 단위 8 및 자원 단위 9를 할당받을 수 있다.

[97] 즉, 순차적으로 PPDU를 수신할 복수의 STA을 포함하는 수신 STA 식별 정보 및 순차적으로 복수의 STA 각각으로 할당된 자원 단위의 개수에 대한 정보를 포함하는 자원 할당 정보를 기반으로 주파수 축 상에서 순차적으로 위치한 복수의 자원 단위 각각이 복수의 STA 각각으로 연속적으로 할당될 수 있다.

[98] 이하, 본 발명의 실시예에서는 자원 할당 방법을 자원 단위 할당 시그널링/시그널링 지시를 기반으로 한 자원 할당 방법이라고 표현될 수도 있다. 자원 단위 할당 시그널링/시그널링 지시를 기반으로 한 자원 할당 방법은 복수의 STA 각각으로 할당된 자원 단위에 대한 직접적인 지시없이 복수의 STA 각각으로 할당된 자원 단위를 간접적으로 지시할 수 있다.

[99] 위와 같은 자원 단위 할당 시그널링/시그널링 지시를 기반으로 한 자원 할당

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방법은 서로 다른 크기의 자원 단위 각각에 별도로 적용될 수 있다. 예를 들어, 242톤 자원 단위 개별 할당 정보를 기반으로 한 242톤의 자원 단위를 위한 자원 단위 할당 시그널링 및 26톤 자원 단위 개별 할당 정보를 기반으로 한 26톤의 자원 단위를 위한 자원 단위 할당 시그널링이 별도로 수행될 수 있다.

[100] 도 5는 본 발명의 실시예에 따른 40MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[101] 도 5에서는 242톤의 자원 단위/26톤의 자원 단위의 40MHz 대역폭 상에서의 할당이 개시된다.

[102] 도 5의 좌측에서 첫번째 그림을 참조하면, 두 개의 242톤의 자원 단위가 40MHz 대역폭 상의 가용한 톤 상에서 할당될 수 있다.

[103] 40MHz 대역폭 상에서 하나의 STA에게 두 개의 242톤의 자원 단위가 할당될 수 있다. 즉, SU 기반의 전송을 위해 40MHz 대역폭 상에서 두 개의 242톤의 자원 단위가 하나의 STA으로 할당될 수 있다. 40MHz 대역폭 상에서 두 개의 242톤의 자원 단위가 하나의 STA으로 할당되는 경우, 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 만약 MU OFDMA기반의 전송이 수행되지 않고, 복수의 STA에 대한 자원이 MU-MIMO 기반의 전송을 위해 두개의 242톤의 자원 단위에 멀티플렉싱되어 할당되는 경우에도 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 이러한 경우, MU-MIMO로 할당되는 STA의 수 정보가 PPDU의 헤더에 포함될 수 있다. STA은 전체 대역폭 크기의 정보(예를 들어, 40MHz) 및 전체 대역폭 상에 할당된 STA에 대한 정보(STA만이 전체 대역폭 상에서 할당되었다는 정보)만을 기반으로 40MHz 대역폭 상에서 두 개의 242톤의 자원 단위가 모두 할당되었음을 알 수 있다.

[104] 40MHz 대역폭 상에서 두 개의 STA 각각으로 두 개의 242톤의 자원 단위 각각이 할당될 수 있다. 26톤의 자원 단위는 자원 단위의 할당을 위해 사용되지 않을 수 있다. 전술한 바와 같이 2개의 STA은 PPDU 헤더 상에서 순차적인 자원 단위 할당 시그널링을 기반으로 두 개의 242톤의 자원 단위 각각을 할당받을 수 있다.

[105] 도 5의 좌측에서 두번째 그림을 참조하면, 40MHz 대역폭의 가용한 톤 상에서 하나의 242톤 자원 단위가 할당되고 나머지 가용한 톤 상에서 복수개의 26톤의 자원 단위가 할당될 수 있다. 하나의 242톤의 자원 단위는 하나의 STA으로 할당되고, 나머지 복수 개의 26톤의 자원 단위는 적어도 하나의 STA으로 할당될 수 있다. 예를 들어, 나머지 가용한 톤 상에서 9개의 26톤의 자원 단위가 할당될 수 있다. 9개의 26톤의 자원 단위 각각은 최대 9개의 STA 각각으로 할당 가능하다.

[106] 40MHz 대역폭 상에서 위와 같은 자원 할당이 수행되는 경우, 242톤의 자원 단위의 할당 위치 및 복수의 26톤의 자원 단위 각각의 할당 위치는 고정될 수 있다.

[107] 242톤의 자원 단위와 복수의 26톤의 자원 단위 각각은 개별적으로 할당될 수

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있고, 복수의 26톤의 자원 단위는 자원 단위 할당 시그널링을 기반으로 복수의 STA으로 할당될 수 있다.

[108] 도 5의 좌측에서 세번째 그림을 참조하면, 40MHz 대역폭의 가용한 톤 상에서 242톤의 자원 단위에 대한 할당없이 26톤의 자원 단위만을 기반으로 한 자원 할당이 수행될 수 있다.

[109] 예를 들어, 492톤이 가용한 톤의 개수인 경우(492 톤 플랜(tone plan)), DC 톤을 기준으로 9개의 26톤의 자원 단위가 DC 톤과 좌측 가드 톤 사이에 할당되고, 9개의 26톤의 자원 단위가 DC 톤과 우측 가드 톤 사이에 할당될 수 있다. 즉, 전체 18개의 26톤의 자원 단위가 주파수 축 상에 할당될 수 있다.

[110] 또 다른 예를 들어, 496톤이 가용한 톤의 개수인 경우(496 톤 플랜), 전체 19개의 26톤의 자원 단위가 주파수 축 상에서 할당될 수 있다. 26톤의 자원 단위는 2개의 13톤의 분할 자원 단위로 분할될 수 있다. DC 톤을 기준으로 9개의 26톤의 자원 단위+13톤의 분할 자원 단위가 DC 톤과 좌측 가드 톤 사이에 할당되고, 9개의 26톤의 자원 단위+13톤의 분할 자원 단위가 DC 톤과 우측 가드 톤 사이에 할당될 수 있다. 즉, 전체 19개의 26톤의 자원 단위가 주파수 축 상에 할당될 수 있다. 복수의 26톤의 자원 단위는 자원 단위 할당 시그널링을 기반으로 복수의 STA으로 할당될 수 있다.

[111] 도 6은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[112] 도 6을 참조하면, 40MHz 대역폭 상에서 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 전체 할당 정보(600))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 242톤 자원 단위 전체 할당 정보(600)는 40MHz 대역폭 상에서 할당된 242톤의 자원 단위에 대한 정보를 STA으로 알려줄 수 있다.

[113] 예를 들어, 242톤 자원 단위 전체 할당 정보(600)에 포함되는 2비트 중 1개의 비트는 좌측 가드 톤에 인접한 하나의 242톤 자원 단위(제1 242톤 자원 단위)를 지시하고, 나머지 1개의 비트는 우측 가드 톤에 인접한 다른 242톤 자원 단위(제2 242톤 자원 단위)를 지시할 수 있다.

[114] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '00'인 경우, 40MHz 대역폭 상에서 242톤의 자원 단위가 할당되지 않음이 지시될 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '00'인 경우, 40MHz 대역폭 상에서 MU 기반 전송이 수행됨이 지시될 수 있다.

[115] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '01'인 경우, 40MHz 대역폭 상에서 제1 242톤의 자원 단위가 할당됨을 지시할 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보가 '01'인 경우, 40MHz 대역폭 상에서 MU 기반 전송이 수행됨이 지시될 수 있다.

[116] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '10'인 경우, 40MHz 대역폭 상에서 제2 242톤의 자원 단위가 할당됨을 지시할 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '10'인 경우, 40MHz

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대역폭 상에서 MU 기반 전송이 수행됨이 지시될 수 있다.

[117] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '11'인 경우, 40MHz 대역폭 상에서 제1 242톤의 자원 단위/제2 242톤의 자원 단위가 할당됨을 지시할 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '11'인 경우, 40MHz 대역폭 상에서 SU 기반 전송이 수행 가능함이 지시될 수 있다.

[118] 또한, 40MHz 대역폭 상에서 개별 STA으로의 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 개별 할당 정보(620))로 n비트(예를 들어, 1비트)가 할당될 수 있다. 242톤 자원 단위 개별 할당 정보(620)는 개별 STA으로 242톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(620)가 40MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, 242톤의 자원 단위의 개별 STA으로의 할당이 수행되지 않을 수 있다. 이러한 경우, 242톤 자원 단위 개별 할당 정보(620)는 다른 정보로 활용될 수도 있다. 또는 242톤 자원 단위 전체 할당 정보(600)의 값이 40MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, STA은 242톤 자원 단위 개별 할당 정보(620)에 대한 디코딩을 수행하지 않을 수도 있다.

[119] 예를 들어, '0'인 1비트의 242톤 자원 단위 개별 할당 정보(620)는 STA으로의 1개의 242톤의 자원 단위의 할당을 지시할 수 있다.

[120] 예를 들어, '1'인 1비트의 242톤 자원 단위 개별 할당 정보(620)는 STA으로의 2개의 242톤의 자원 단위의 할당을 지시할 수 있다. 하나의 STA으로의 2개의 242톤의 자원 단위의 할당은 40MHz 대역폭 상에서 SU 기반 전송을 지시할 수 있다. 만약, 40MHz 대역폭 상에서 할당 가능한 26톤의 자원 단위의 개수가 19개이고 242톤 자원 단위 개별 할당 정보(620)가 STA으로의 2개의 242톤의 자원 단위의 할당을 지시하는 경우, STA을 추가로 하나의 26톤의 자원 단위를 더 할당받을 수도 있다.

[121] STA은 2개의 242톤의 자원 단위를 할당받은 경우, 242톤의 자원 단위를 위한 인터리버(234크기의 인터리버)가 사용되어 242톤에 포함되는 234개의 데이터 톤에 대한 인터리빙이 수행될 수 있다. STA은 2개의 242톤의 자원 단위과 1개의 26톤의 자원 단위를 할당받은 경우, 242톤을 위한 인터리버(234크기의 인터리버) 및 26톤의 자원 단위를 위한 인터리버(24크기의 인터리버)를 기반으로 한 인터리빙이 수행될 수 있다.

[122] 또한, 40MHz 대역폭 상에서 개별 STA으로의 26톤의 자원 단위의 할당에 대한 정보(이하, 26톤 자원 단위 개별 할당 정보(640))로 n 비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 26톤 자원 단위 개별 할당 정보(640)는 개별 STA으로의 26톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(600)가 40MHz 대역폭 상에서 2개의 242톤의 자원 단위의 할당을 지시하는 경우, 26톤의 자원 단위에 대한 할당이 수행되지 않을 수 있다. 이러한 경우, 26톤 자원 단위 개별 할당 정보(640)는 다른 정보로 활용될 수도 있다. 또는 40MHz 대역폭 상에서 2개의 242톤의 자원 단위의 할당이 지시되는 경우, STA은 26톤

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자원 단위 개별 할당 정보(640)에 대한 디코딩을 수행하지 않을 수 있다.

[123] 예를 들어, '00'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 1개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[124] 예를 들어, '01'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 2개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[125] 예를 들어, '10'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 3개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[126] 예를 들어, '11'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 4개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[127] 이러한 26톤의 자원 단위 및 242톤의 자원 단위에 대한 할당은 26톤 자원 단위 개별 할당 정보(640) 및 242톤 자원 단위 개별 할당 정보(620)를 기반으로 자원 단위 할당 시그널링/시그널링 지시를 통해 수행될 수 있다.

[128] 본 발명의 실시예에 따르면, 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 40MHz 대역폭 상에서 최소 1개의 STA, 최대 19개의 STA이 지원될 수 있다. STA은 40MHz 대역폭 상에서 1개 또는 2개의 242톤의 자원 단위 또는 1,2, 3 또는 4개의 26톤의 자원 단위를 할당받아 동작할 수 있다.

[129] 예를 들어, 40MHz 대역폭 상에서 2개의 242톤의 자원 단위의 1개의 STA으로의 할당(또는 SU 기반의 전송)을 기반으로 최소 1개의 STA의 통신이 지원될 수 있다. 또는 40MHz 대역폭 상에서 2개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수도 있다. 또는 40MHz 대역폭 상에서 1개의 242톤의 자원 단위가 1개의 STA에 할당되고, 나머지 주파수 대역 상에 할당된 9개 또는 10개의 26톤의 자원 단위가 2개의 STA에 할당될 수 있다. 40MHz 대역폭 상에서 19개의 26톤의 자원 단위 각각에 19개의 STA 각각의 할당을 기반으로 최대 19개의 STA의 통신이 지원될 수 있다.

[130] 도 7은 본 발명의 실시예에 따른 80MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[131] 도 7에서는 242톤의 자원 단위/26톤의 자원 단위의 80MHz 대역폭 상에서의 할당이 개시된다.

[132] 도 7의 최측에서 첫번째 그림을 참조하면, 네 개의 242톤의 자원 단위가 80MHz 대역폭 상의 가용한 톤 상에서 할당될 수 있다. 80MHz 대역폭 상에서 하나의 STA에게 네 개의 242톤의 자원 단위가 할당될 수 있다. SU 기반의 전송을 위해 80MHz 대역폭 상에서 네 개의 242톤의 자원 단위가 하나의 STA으로 할당될 수 있다. 만약 MU OFDMA기반의 전송이 수행되지 않고, 복수의 STA에 대한 자원이 MU-MIMO 기반의 전송을 위해 네개의 242톤의 자원 단위에 멀티플렉싱되어 할당되는 경우에도 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 이러한 경우, MU-MIMO로 할당되는 STA의 수 정보가 PPDU의 헤더에 포함될 수 있다. 80MHz 대역폭 상에서 네 개의 242톤의 자원 단위가 하나의 STA으로 할당되는 경우, 별도의 자원 할당 정보가 PPDU의

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헤더에 포함되지 않을 수 있다. STA은 전체 대역폭 크기의 정보(예를 들어, 80MHz) 및 전체 대역폭 상에 할당된 STA에 대한 정보(STA만이 전체 대역폭 상에서 할당되었다는 정보)만을 기반으로 80MHz 대역폭 상에서 네 개의 242톤의 자원 단위가 STA으로 할당되었음을 알 수 있다.

[133] 또는 80MHz 대역폭 상에서 두 개의 STA 각각으로 두 개의 242톤의 자원 단위를 포함하는 자원 단위가 개별적으로 할당될 수 있다. 즉, STA1로 두 개의 242톤의 자원 단위가 할당되고, STA2로 두 개의 242톤의 자원 단위가 할당될 수 있다. 26톤의 자원 단위는 자원 단위 할당을 위해 사용되지 않을 수 있다. 전술한 바와 같이 2개의 STA 각각은 PPDU 헤더 상에서 순차적인 자원 단위 할당 시그널링을 기반으로 두 개의 242톤의 자원 단위를 포함하는 자원 단위 각각을 할당받을 수 있다.

[134] 도 7의 좌측에서 두번째 그림을 참조하면, 80MHz 대역폭 상에서 두 개의 STA 각각으로 두 개의 242톤의 자원 단위 각각이 할당되고, 다른 복수의 STA으로 나머지 가용한 톤 상에 할당된 복수개의 26톤의 자원 단위 각각이 할당될 수 있다.

[135] 80MHz 대역폭 상에서 가용한 톤의 개수가 1000톤인 경우(1000 톤 플랜), 19개의 26톤의 자원 단위가 나머지 가용한 톤 상에 할당될 수 있다. 이러한 경우, 최대 19개의 STA이 19개의 26톤의 자원 단위 상에 할당되어 서비스를 받을 수 있다.

[136] 80MHz 대역폭 상에서 가용한 톤의 개수가 1008톤인 경우(1008 톤 플랜), 20개의 26톤의 자원 단위가 나머지 가용한 톤 상에 할당될 수 있다. 이러한 경우, 최대 20개의 STA이 20개의 26톤의 자원 단위 상에 할당되어 서비스를 받을 수 있다.

[137] 도 7의 좌측에서 세번째 그림을 참조하면, 80MHz 대역폭 상에서 하나의 STA으로 하나의 242톤의 자원 단위가 할당되고, 다른 복수의 STA으로 나머지 가용한 톤 상에 할당된 복수개의 26톤의 자원 단위 각각이 할당될 수 있다. 하나의 242톤의 자원 단위를 제외한 나머지 가용한 톤 상에서 29개의 26톤의 자원 단위가 할당될 수 있고, 29개의 26톤의 자원 단위 각각은 최대 29개의 STA 각각에게 할당될 수 있다.

[138] 도 7의 좌측에서 네번째 그림을 참조하면, 80MHz 대역폭 상에서 242톤의 자원 단위없이 26톤의 자원 단위만을 기반으로 한 자원 할당이 수행될 수 있다. 이러한 경우, 80MHz 대역폭 상에서 38개의 26톤의 자원 단위가 할당될 수 있고, 38개의 26톤의 자원 단위 각각은 최대 38개의 STA 각각에게 할당될 수 있다.

[139] 도 8은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[140] 도 8을 참조하면, 80MHz 대역폭 상에서 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 전체 할당 정보(800))로 n비트(예를 들어, 4비트)가 할당될 수 있다. 242톤 자원 단위 전체 할당 정보(800)는 80MHz 대역폭 상에서

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할당된 242톤의 자원 단위에 대한 정보를 STA으로 알려줄 수 있다.

[141] 242톤 자원 단위 전체 할당 정보(800)에 대응되는 4비트 각각은 80MHz 대역폭 상에 할당 가능한 4개의 242톤의 자원 단위 각각을 지시할 수 있다. 예를 들어, 좌측 래프트오버 톤에서 우측 래프트오버 톤까지 4개의 242톤의 자원 단위는 순차적으로 제1 242톤의 자원 단위, 제2 242톤의 자원 단위, 제3 242톤의 자원 단위, 제4 242톤의 자원 단위로 표현될 수 있다. 즉, 242톤 자원 단위 전체 할당 정보에 대응되는 4비트 각각은 제1 242톤의 자원 단위, 제2 242톤의 자원 단위, 제3 242톤의 자원 단위 및 제4 242톤의 자원 단위 각각을 지시할 수 있다.

[142] 즉, '0000' 내지 '1111'의 4비트의 시그널링(또는 4비트의 비트맵)을 기반으로 제1 242톤의 자원 단위 내지 제4 242톤의 자원 단위 각각의 80MHz 대역폭 상에서의 할당 여부가 지시될 수 있다.

[143] 4비트의 242톤 자원 단위 전체 할당 정보(800)가 '1111'인 경우, 80MHz 대역폭 상에서 SU 기반 전송이 수행 가능함이 지시되고, 4비트의 242톤 자원 단위 전체 할당 정보(800)가 나머지인 경우, 80MHz 대역폭 상에서 MU 기반 전송이 지시될 수 있다.

[144] 또한, 80MHz 대역폭 상에서 개별 STA으로의 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 개별 할당 정보(820))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 242톤 자원 단위 개별 할당 정보(820)는 개별 STA으로 할당된 242톤 자원 단위의 개수에 대한 정보를 포함할 수 있다. 242톤 자원 단위 전체 할당 정보(800)가 80MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, 242톤의 자원 단위의 개별 STA으로의 할당이 수행되지 않을 수 있다. 이러한 경우, 242톤 자원 단위 개별 할당 정보(820)는 다른 정보로 활용될 수도 있다. 또는 242톤 자원 단위 전체 할당 정보(800)의 값이 80MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, STA은 242톤 자원 단위 개별 할당 정보(820)에 대한 디코딩을 수행하지 않을 수도 있다.

[145] 예를 들어, '00'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 1개의 242톤의 자원 단위의 할당을 지시할 수 있다.

[146] 예를 들어, '01'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 2개의 242톤의 자원 단위의 할당을 지시할 수 있다. 만약, 80MHz 대역폭 상에서 할당되는 26톤의 자원 단위의 개수가 38개인 경우, '01'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 2개의 242톤의 자원 단위와 1개의 26톤의 자원 단위의 할당을 지시할 수도 있다. 이러한 경우, 전술한 바와 같이 242톤의 자원 단위을 위한 인터리버와 26톤의 자원 단위을 위한 인터리버가 개별적으로 242톤의 자원 단위 및 26톤의 자원 단위 각각에 적용될 수 있다.

[147] 예를 들어, '10'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 3개의 242톤의 자원 단위의 할당을 지시할 수 있다.

[148] 예를 들어, '11'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 4개의 242톤의 자원 단위의 할당을 지시할 수 있다. 만약, 80MHz 대역폭 상에서

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할당되는 26톤의 자원 단위의 개수가 38개인 경우, '11'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 4개의 242톤의 자원 단위와 2개의 26톤의 자원 단위의 할당을 지시할 수도 있다. 이러한 경우, 전술한 바와 같이 242톤의 자원 단위을 위한 인터리버와 26톤의 자원 단위을 위한 인터리버가 개별적으로 242톤의 자원 단위 및 26톤의 자원 단위에 적용될 수 있다.

[149] 또한, 80MHz 대역폭 상에서 개별 STA으로의 26톤의 자원 단위의 할당에 대한 정보(이하, 26톤 자원 단위 개별 할당 정보(840))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 26톤 자원 단위 개별 할당 정보(840)는 개별 STA으로의 26톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(800)가 80MHz 대역폭 상에서 4개의 242톤의 자원 단위의 할당을 지시하는 경우, 26톤의 자원 단위에 대한 할당이 수행되지 않을 수 있다. 이러한 경우, 26톤 자원 단위 개별 할당 정보(840)는 다른 정보로 활용될 수도 있다. 또는 80MHz 대역폭 상에서 4개의 242톤의 자원 단위의 할당이 지시되는 경우, STA은 26톤 자원 단위 개별 할당 정보에 대한 디코딩을 수행하지 않을 수 있다.

[150] 예를 들어, '00'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 1개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[151] 예를 들어, '01'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 2개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[152] 예를 들어, '10'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 3개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[153] 예를 들어, '11'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 4개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[154] 이러한 26톤의 자원 단위 및 242톤의 자원 단위에 대한 할당은 26톤 자원 단위 개별 할당 정보(840) 및 242톤 자원 단위 개별 할당 정보(820)를 기반으로 자원 단위 할당 시그널링/시그널링 지시를 통해 수행될 수 있다.

[155] 본 발명의 실시예에 따르면, 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 80MHz 대역폭 상에서 최소 1개의 STA, 최대 38개의 STA이 지원될 수 있다. STA은 80MHz 대역폭 상에서 1개 또는 2개의 242톤의 자원 단위 또는 1, 2, 3 또는 4개의 26톤의 자원 단위를 할당받아 동작할 수 있다.

[156] 예를 들어, 80MHz 대역폭 상에서 4개의 242톤의 자원 단위가 1개의 STA으로의 할당(또는 SU 기반 전송)을 기반으로 최소 1개의 STA의 통신이 지원될 수 있다. 80MHz 대역폭 상에서 2개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수도 있다. 80MHz 대역폭 상에서 2개의 242톤의 자원 단위가 1개의 STA에 할당되고, 나머지 2개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수 있다. 80MHz 대역폭 상에서 38개의 26톤의 자원 단위 각각에 38개의 STA 각각의 할당을 기반으로 최대 38개의 STA의 통신이 지원될 수 있다.

[157] 도 9는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

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[158] STA의 개수가 증가하는 경우, 자원 할당을 위한 시그널링을 위한 오버헤드가 많을 수 있다. 따라서, 본 발명의 실시예에 따르면, STA으로의 자원 할당을 위해 컨테이너(container)를 정의하고, 컨테이너를 기반으로 한 자원 할당이 수행될 수 있다.

[159] 도 9에서는 STA으로의 자원 할당을 위한 컨테이너가 개시된다.

[160] 도 9를 참조하면, 하나의 컨테이너는 242톤의 자원 단위 1개에 대응되거나, 복수개의 26톤의 자원 단위에 대응될 수 있다. 컨테이너는 추가의 레프트오버 톤을 더 포함할 수도 있고, 26톤의 자원 단위를 분할한 13톤의 분할 자원 단위를 포함할 수도 있다. 예를 들어, 컨테이너는 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위를 포함하는 26*9+13=247톤의 자원 단위에 대응될 수 있다.

[161] 즉, 컨테이너는 자원 할당에 대한 정보를 시그널링하기 위해 정의된 자원 단위일 수 있다. 컨테이너 별로 할당 가능한 자원 단위가 설정되고, 컨테이너 별로 할당 가능한 STA의 개수가 제한될 수 있다. 대역폭 별로 할당 가능한 컨테이너의 개수는 아래와 같을 수 있다.

[162] 20MHz 대역폭에 대하여 1개의 컨테이너가 할당되고, 40MHz 대역폭에 대하여 2개의 컨테이너가 할당되고, 80MHz 대역폭에 대하여 4개의 컨테이너가 할당될 수 있다.

[163] 컨테이너에 대해 할당 가능한 STA의 개수는 대역폭 별로 한정될 수 있다. 예를 들어, 20MHz 대역폭에 대하여 컨테이너 별로 8개의 STA(또는 9개의 STA)이 할당될 수 있다. 40MHz 대역폭에 대하여 컨테이너 별로 8개의 STA(또는 9개의 STA)이 할당될 수 있고, 2개의 컨테이너에 대하여 전체 16개의 STA(또는 18개의 STA)이 할당될 수 있다. 80MHz 대역폭에 대하여 컨테이너 별로 4개의 STA(또는 5개의 STA)이 할당될 수 있고, 4개의 컨테이너에 대하여 전체 16개의 STA(또는 20개의 STA)이 할당될 수 있다.

[164] 도 10은 본 발명의 실시예에 따른 컨테이너 별 자원 할당 정보를 나타낸 개념도이다.

[165] 도 10을 참조하면, n 비트(예를 들어, 2비트 또는 3비트)가 컨테이너 별 자원 할당 정보(컨테이너 별 자원 할당 비트)(1000)로 정의되어 컨테이너 별로 할당되는 사용자의 수(또는 FDM(frequency division multiplexing)으로 구분되는 할당을 위한 톤 유닛의 개수)를 알려줄 수 있다. 2비트의 컨테이너 별 자원 할당 정보(600)는 최대 4개의 STA에 대한 자원 할당을 지시하고, 3비트의 컨테이너 별 자원 할당 정보(600)는 최대 8개의 STA에 대한 자원 할당을 지시할 수 있다.

[166] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '000'인 경우, 컨테이너에 대한 1개의 STA의 할당이 지시될 수 있다. 예를 들어, 1개의 STA은 컨테이너에 대응되는 242톤의 자원 단위를 할당받을 수 있다.

[167] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '001'인 경우, 컨테이너에 대한 2개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원

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단위에 대응되고, 2개의 STA 각각에 4개의 26톤의 자원 단위가 할당될 수 있다.

[168] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '010'인 경우, 컨테이너에 대한 3개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 3개의 STA 각각에 3개의 26톤의 자원 단위가 할당될 수 있다.

[169] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '011'인 경우, 컨테이너에 대한 4개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원 단위에 대응되고, 4개의 STA 각각에 2개의 26톤의 자원 단위가 할당될 수 있다. 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 3개의 STA 각각에 2개의 26톤의 자원 단위가 할당되고, 1개의 STA에 3개의 26톤의 자원 단위가 할당될 수 있다.

[170] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '111'인 경우, 컨테이너에 대한 8개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원 단위에 대응되고, 8개의 STA 각각에 1개의 26톤의 자원 단위가 할당될 수 있다. 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 7개의 STA 각각에 1개의 26톤의 자원 단위가 할당되고, 1개의 STA에 2개의 26톤의 자원 단위가 할당될 수 있다.

[171] 도 11은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[172] 도 11에서는 복수의 컨테이너 각각에 포함되는 분할 자원 단위의 논리적인 결합을 기반으로 한 자원 할당 방법이 개시된다.

[173] 만약, 특정 컨테이너 내부에 26톤의 자원 단위를 분할할 13톤의 분할 자원 단위가 포함되는 경우, 다른 컨테이너 내부에 포함되는 다른 13톤의 분할 자원 단위와 논리적으로 결합되어 하나의 26톤의 자원 단위로 활용될 수 있다.

[174] 예를 들어, 제1 컨테이너(1110)에 13톤의 제1 분할 자원 단위(1115)가 할당되고, 제2 컨테이너(1120)에 13톤의 제2 분할 자원 단위(1125)가 할당되는 경우, 제1 분할 자원 단위(1115)와 제2 분할 자원 단위(1125)를 결합한 자원 단위의 할당을 위한 시그널링이 수행될 수 있다.

[175] 제1 컨테이너(1110)에 포함되는 제1 분할 자원 단위(715) 및 제2 컨테이너(1120)에 포함되는 제2 분할 자원 단위(1125)는 물리적으로 이어지도록 주파수 축 상에서 할당될 수 있다.

[176] 하나의 컨테이너 안에 13톤의 분할 자원 단위가 포함되는 경우, 13톤의 분할 자원 단위는 26톤의 자원 단위와 동일한 방법으로 시그널링될 수 있다. 예를 들어, 하나의 컨테이너 안에 9개의 26톤의 자원 단위가 포함되고, 1개의 13톤의 분할 자원 단위가 포함되는 경우, 13톤의 분할 자원 단위에 대한 시그널링을 위해 10개의 26톤의 자원 단위에 대한 시그널링과 동일한 방식의 시그널링이 수행될 수 있다. 다른 표현으로 13톤의 분할 자원 단위가 하나의 26톤의 자원 단위로 가정되어 자원 할당에 대한 시그널링이 수행될 수 있다.

[177] 제1 컨테이너에 포함된 13톤의 제1 분할 자원 단위가 할당되는 경우, 제1

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컨테이너에 포함된 13톤의 제1 분할 자원 단위는 논리적으로 매핑되어 있는 제2 컨테이너에 포함된 13톤의 제2 분할 자원 단위와 함께 할당될 수 있다. 제1 분할 자원 단위와 제2 분할 자원 단위는 논리적으로 결합되어 하나의 26톤의 자원 단위로 STA으로 할당될 수 있다. 제2 컨테이너는 제1 컨테이너에 인접한 컨테이너일 수 있다. 제2 분할 자원 단위는 제1 분할 자원 단위에 인접한 분할 자원 단위일 수 있다.

[178] 만약, 13톤의 분할 자원 단위와 논리적으로 매핑되어 있는 다른 분할 자원 단위가 이미 사용된 경우, 13톤의 분할 자원 단위를 제외한 9개의 26톤의 자원 단위에 대한 할당만이 수행될 수 있다. 또 다른 표현으로 만약, 13톤의 분할 자원 단위와 논리적으로 매핑되어 있는 다른 분할 자원 단위가 이미 사용된 경우, 컨테이너 내에 9개의 26톤의 자원 단위만이 존재하는 것으로 가정하고 자원 할당이 수행될 수도 있다.

[179] 본 발명의 실시예에 따르면, 컨테이너에 포함되는 13톤의 분할 자원 단위의 사용 여부에 따라 컨테이너 별 자원 할당 정보가 서로 다르게 해석될 수 있다.

[180] 예를 들어, 컨테이너 별 자원 할당 정보가 '000'인 경우, 컨테이너에 대한 1개의 STA의 할당이 지시될 수 있다. 예를 들어, 1개의 STA은 컨테이너에 대응되는 242톤의 자원 단위를 할당받을 수 있다.

[181] 예를 들어, 컨테이너 별 자원 할당 정보가 '001'인 경우, 컨테이너에 대한 2개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원 단위에 대응되고, 2개의 STA 각각에 4개의 26톤의 자원 단위가 할당될 수 있다.

[182] 예를 들어, 컨테이너 별 자원 할당 정보가 '010'이고, 컨테이너에 대한 3개의 STA의 할당이 지시될 수 있다.

[183] 13톤의 분할 자원 단위가 사용되지 않는 경우, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 3개의 STA 각각에 3개의 26톤의 자원 단위가 할당될 수 있다.

[184] 13톤의 분할 자원 단위가 사용되는 경우, 컨테이터가 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위에 대응되고, 2개의 STA 각각에 대해 3개의 26톤의 자원 단위가 할당되고, 나머지 1개의 STA에 대해 4개의 26톤의 자원 단위가 할당될 수 있다. 이때, 4개의 26톤의 자원 단위 중 1개의 26톤의 자원 단위는 컨테이너에 포함된 13톤의 분할 자원 단위와 다른 컨테이너에 포함된 다른 13톤의 분할 자원 단위의 결합을 기반으로 할당될 수 있다.

[185] 예를 들어, 컨테이너 별 자원 할당 정보가 '011'이고, 컨테이너에 대한 4개의 STA의 할당이 지시될 수 있다.

[186] 구체적으로 13톤의 분할 자원 단위가 사용되지 않는 경우, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 4개의 STA 각각은 2개의 26톤의 자원 단위, 2개의 26톤의 자원 단위, 3개의 26톤의 자원 단위, 2개의 26톤의 자원 단위 각각을 할당받을 수 있다.

[187] 13톤의 분할 자원 단위가 사용되는 경우, 컨테이터가 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위에 대응되고, 4개의 STA 각각은 2개의 26톤의 자원

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단위, 2개의 26톤의 자원 단위, 3개의 26톤의 자원 단위, 3개의 26톤의 자원 단위 각각을 할당받을 수 있다. 이때 3개의 26톤의 자원 단위 중 하나의 26톤의 자원 단위는 컨테이너에 포함된 13톤의 분할 자원 단위와 다른 컨테이너에 포함된 다른 13톤의 분할 자원 단위의 결합을 기반으로 할당될 수 있다.

[188] 예를 들어, 컨테이너 별 자원 할당 정보가 '111'이고, 컨테이너에 대한 8개의 STA의 할당이 지시될 수 있다.

[189] 구체적으로 13톤의 분할 자원 단위가 사용되지 않는 경우, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 7개의 STA 각각은 1개의 26톤의 자원 단위를 할당받고, 1개의 STA은 2개의 26톤의 자원 단위를 할당받을 수 있다.

[190] 13톤의 분할 자원 단위가 사용되는 경우, 컨테이터가 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위에 대응되고, 6개의 STA 각각은 1개의 26톤의 자원 단위를 할당받고, 2개의 STA 각각은 2개의 26톤의 자원 단위를 할당받을 수 있다. 이때 2개의 26톤의 자원 단위 중 하나의 26톤의 자원 단위는 컨테이너에 포함된 13톤의 분할 자원 단위와 다른 컨테이너에 포함된 다른 13톤의 분할 자원 단위의 결합을 기반으로 할당될 수 있다.

[191] 위와 같은 컨테이너 별 자원 할당 정보를 기반으로 한 자원 할당을 위해서 각 컨테이너 별로 논리적으로 묶여질 13톤의 분할 자원 단위의 사용 여부가 지시될 수 있다. 또는 13톤의 분할 자원 단위 간의 결합을 기반으로 한 자원 할당을 위한 정보가 추가적으로 PPDU에 포함되어 전송될 수 있다.

[192] 컨테이너가 정의되는 경우, 컨테이너 별 자원 할당 정보를 기반으로 컨테이너에 할당될 STA의 개수 및 STA 별로 할당되는 자원 단위의 개수가 결정될 수 있다. 컨테이너에 할당될 STA의 개수 및 STA 별로 할당되는 자원 단위의 개수가 결정되는 경우, 자원 단위 할당 시그널링을 기반으로 한 자원 할당 방법과 같이 각 STA이 순차적으로 주파수 축 상에서 자원 단위를 할당받을 수 있다.

[193] 또는 컨테이너가 정의되는 경우, 컨테이너 별 자원 할당 정보를 기반으로 컨테이너에 할당될 STA의 개수가 정해질 수 있다. 컨테이너에 할당될 STA의 개수에 따라 컨테이너 내에서 STA 별로 할당되는 자원 단위의 개수가 결정될 수 있다. 컨테이너에 할당될 STA의 개수 및 STA 별로 할당되는 자원 단위의 개수가 결정되는 경우, 자원 단위 할당 시그널링을 기반으로 한 자원 할당 방법과 같이 각 STA이 순차적으로 주파수 축 상에서 자원 단위를 할당받을 수 있다.

[194] 도 12는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타내는 개념도이다.

[195] 도 12에서는 STA으로의 자원 할당을 위한 컨테이너가 개시된다. 컨테이너를 기반으로 한 MU OFDMA 전송/MU MIMO 전송이 개시된다.

[196] MU OFDMA 전송과 MU MIMO 전송이 함께 사용되는 경우, 주파수 도메인뿐만 아니라 공간 도메인(spatial domain) 상으로도 멀티플렉싱되어 복수의 STA의 전송이 가능할 수 있다. 즉, 동일한 주파수 자원이 공간 도메인

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상에서 분할되어 분할된 공간 도메인 상에서 복수의 STA의 전송이 가능할 수 있다.

[197] 도 12를 참조하면, 컨테이너 별로 컨테이너에 MU OFDMA 전송(1200), MU MIMO 전송(1250)의 수행 여부가 지시될 수 있다.

[198] 예를 들어, n 비트를 기반으로 컨테이너 별로 컨테이너에 대응되는 자원이 MU OFDMA 전송(1200)을 위한 자원인지 MU MIMO를 위한 자원인지 여부가 지시될 수 있다. 예를 들어, 1비트를 기반으로 특정 컨테이너에 대응되는 자원을 통해 MU OFDMA 전송(1200)이 수행되는지 MU MIMO 전송(1250)이 수행되는지 여부가 지시될 수 있다.

[199] 또 다른 예를 들어, 특정 컨테이너 상에서 MU OFDMA 전송(1200)이 수행되는지 여부를 지시하는 비트, 특정 컨테이너 상에서 MU MIMO 전송(1250)이 수행되는지 여부를 지시하는 비트가 개별적으로 정의될 수도 있다.

[200] MU OFDMA 전송(1200)이 수행되든, MU MIMO 전송(1250)이 수행되든, 컨테이너 상에서 할당될 수 있는 최대의 STA의 개수는 동일할 수 있다. 예를 들어, 컨테이너 상에서 MU OFDMA 전송(1200)과 MU MIMO 전송(1250)이 함께 수행되는 경우의 최대 STA의 개수는 MU OFDMA 전송(1200)과 MU MIMO 전송(1250) 각각이 개별적으로 수행되는 경우와 동일할 수 있다.

[201] 예를 들어, 20MH 대역폭에 대하여 컨테이너 별로 8개의 STA이 최대 STA의 개수로 정의될 수 있다. 40MH 대역폭에 대하여 컨테이너 별로 8개의 STA이 최대 STA의 개수로 정의되고, 40MHz 대역폭에 정의된 2개의 컨테이너 상에서 총 16개의 STA이 할당될 수 있다. 80MH 대역폭에 대하여 컨테이너 별로 4개의 STA이 최대 STA의 개수로 정의되고, 80MHz 대역폭에 정의된 4개의 컨테이너 상에서 총 16개의 STA이 할당될 수 있다.

[202] 도 13은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[203] 도 13에서는 컨테이너 상에서 MU MIMO 전송을 지원하기 위한 방법이 개시된다. MU MIMO 전송은 컨테이너에 포함되는 다양한 자원 단위에 대해서 적용될 수 있다. 도 9에서는 특히, MU MIMO 전송이 컨테이너에 포함될 수 있는 가장 큰 자원 단위인 242톤의 자원 단위에 대해서 적용되는 경우가 개시된다.

[204] 예를 들어, MU MIMO 전송은 컨테이너에 포함될 수 있는 가장 큰 자원 단위(예를 들어, 242톤의 자원 단위)에 대해서 적용될 수 있다. SU 기반 전송인 경우, SU 기반 전송을 위한 뉴머롤로지를 기반으로 MU MIMO 전송이 수행될 수 있다. 이하, 242톤의 자원 단위가 컨테이너에 포함될 수 있는 가장 큰 자원 단위로 가정하나, 242톤의 자원 단위가 아닌 다른 크기의 자원 단위가 컨테이너에 포함될 수 있는 가장 큰 자원 단위로 정의될 수 있다.

[205] 우선 전체 주파수 대역 상에서 SU 기반 전송이 수행되는지 MU 기반 전송이 수행되는지 여부가 n비트의 MU/SU 전송 지시 정보(MU/SU 전송 지시 비트)(1300)를 통해 지시될 수 있다.

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[206] 예를 들어, 전체 주파수 대역 상에서 SU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1300)의 값은 1이고, 전체 주파수 대역 상에서 MU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1300)의 값은 0일 수 있다. 전체 주파수 대역이 20MHz 대역폭인 경우, MU/SU 전송 지시 정보(1300)가 사용되지 않을 수 있다.

[207] 만약, MU/SU 전송 지시 정보(1300)가 MU 기반 전송을 지시하는 경우, 각 컨테이너에 대하여 n 비트의 MU OFDMA/MU MIMO 전송 지시 정보(MU OFDMA/MU MIMO 전송 지시 비트)(1320)를 통해 컨테이너 별로 MU OFDMA 전송/MU MIMO 전송 여부가 지시될 수 있다. 예를 들어, 1 비트의 MU OFDMA/MU MIMO 전송 지시 정보(1320)를 통해 컨테이너 별로 MU OFDMA 전송이 수행되는지 MU MIMO 전송이 수행되는지 여부가 지시될 수 있다.

[208] 만약, MU/SU 전송 지시 정보(1300)가 MU 기반 전송을 지시하는 경우, 각 컨테이너에 대하여 전술한 n 비트의 컨테이너 별 자원 할당 정보(1340)를 통해 컨테이너 별로 할당되는 STA의 개수가 정의될 수 있다. 예를 들어, 2~3 비트의 컨테이너 별 자원 할당 정보(1340)를 통해 컨테이너 별로 할당되는 STA의 개수가 정의될 수 있다. MU OFDMA/MU MIMO 전송 지시 정보(1320)가 컨테이너 상에서 MU MIMO 전송을 지시하는 경우, MU MIMO 전송은 컨테이너에 포함될 수 있는 가장 큰 자원 단위(예를 들어, 242톤의 자원 단위)에 대해서 적용되므로 n 비트의 컨테이너 별 자원 할당 정보(1340)는 242톤의 자원 단위에 할당되는 MU MIMO 기반 전송을 통해 통신을 수행할 STA의 개수를 지시할 수 있다.

[209] 만약, MU/SU 전송 지시 정보(1300)가 SU 기반 전송을 지시하는 경우, SU 기반 전송의 뉴머롤로지를 기반으로 MU MIMO 전송을 위한 STA의 개수가 시그널링될 수 있다.

[210] 도 14는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[211] 도 14에서는 컨테이너 상에서 MU MIMO 전송을 지원하기 위한 방법이 개시된다. 도 14에서는 특히, 톤 유닛(tone unit)을 기준으로 MU MIMO 전송을 지원하기 위한 방법이 개시된다.

[212] 도 14를 참조하면, MU MIMO 전송은 컨테이너에 포함되는 다양한 자원 단위에 대해서 적용될 수 있다. MU MIMO 전송은 컨테이너에 포함될 수 있는 다양한 자원 단위의 크기를 기반으로 수행될 수 있다. 예를 들어, MU MIMO 전송은 1개의 26톤의 자원 단위, 2개의 26톤의 자원 단위, 3개의 26톤의 자원 단위, 4개의 26톤의 자원 단위 또는 242톤의 자원 단위 상에서 수행될 수 있다.

[213] 컨테이너 상에서 MU MIMO 전송을 지원하기 위해 컨테이너 별로 할당 가능한 톤 유닛의 개수가 정의될 수 있다. 예를 들어, 하나의 컨테이너가 9개의 26톤의 자원 단위를 포함하고, 하나의 컨테이너 상에서 3개의 26톤의 자원 단위가 3개 할당될 수 있다. 3개의 26톤의 자원 단위가 하나의 26톤의 자원 단위 그룹을

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형성하고 컨테이너 상에서 3개의 26톤의 자원 단위 그룹이 할당될 수 있다. 이러한 경우, 컨테이너에 할당되는 톤 유닛의 개수는 3개일 수 있다. 톤 유닛은 하나의 컨테이너 상에서 MU MIMO 전송을 위한 분할된 자원 단위일 수 있다.

[214] 이하, 톤 유닛을 기반으로 한 MU MIMO 전송을 위한 자원 할당 방법이 개시된다.

[215] 우선 전체 주파수 대역 상에서 SU 기반 전송이 수행되는지 MU 기반 전송이 수행되는지 여부가 n비트의 MU/SU 전송 지시 정보(1400)를 통해 지시될 수 있다.

[216] 예를 들어, 전체 주파수 대역 상에서 SU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1400)의 값은 1이고, 전체 주파수 대역 상에서 MU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1400)의 값은 0일 수 있다. 전체 주파수 대역이 20MHz 대역폭인 경우, MU/SU 전송 지시 정보(1400)가 사용되지 않을 수 있다.

[217] 만약, MU/SU 전송 지시 정보(1400)가 MU 기반 전송을 지시하는 경우, n 비트를 기반으로 각 컨테이너에 대한 톤 유닛의 개수가 지시될 수 있다. 각 컨테이너에 대하여 톤 유닛의 개수를 지시하는 정보(또는 비트)는 톤 유닛 개수 정보(또는 톤 유닛 개수 정보 비트)(1420)라는 용어로 표현될 수 있다. 다른 표현으로, 톤 유닛 개수 정보(1420)는 FDM(frequency division multiplexing)으로 구분되는 MU MIMO 전송에 대한 자원 할당을 위한 톤 유닛의 개수에 대한 정보를 포함할 수 있다. 예를 들어, 2 또는 3비트의 톤 유닛 개수 정보(1420)가 하나의 컨테이너에 포함되는 톤 유닛의 개수를 지시할 수 있다.

[218] 또한, MU/SU 전송 지시 정보(1400)가 MU 기반 전송을 지시하는 경우, n 비트의 톤 유닛 별 자원 할당 정보(1440)를 기반으로 톤 유닛 각각에 할당되는 MU MIMO 전송을 기반으로 통신을 수행할 STA의 개수가 지시될 수 있다.

[219] 예를 들어, 하나의 컨테이너에는 복수개의 톤 유닛이 포함될 수 있고, n 비트의 톤 유닛 별 자원 할당 정보(1440) 각각은 복수개의 톤 유닛 각각에 할당된 MU MIMO 전송을 기반으로 통신을 수행할 STA의 개수를 지시할 수 있다.

[220] 만약, MU/SU 전송 지시 정보(1400)가 SU 기반 전송을 지시하는 경우, SU 기반 전송의 뉴머롤로지를 기반으로 MU MIMO 전송을 위한 STA의 개수가 시그널링될 수 있다.

[221] 본 발명의 실시예에 따르면, 컨테이너 별로 할당 가능한 톤 유닛의 개수가 n 개이고, 컨테이너 별로 할당 가능한 최대 STA의 개수가 x 개인 경우가 가정될 수 있다. 이러한 경우, 각 톤 유닛 별로 Flooring(x/n) 비트 (또는 min (Flooring(x/n), m) 비트) 또는 Ceiling (x/n) 비트 (또는 min(Ceiling (x/n), m) 비트)가 톤 유닛 별 자원 할당 비트로 정의되고, 톤 유닛 별 자원 할당 비트는 개별 톤 유닛에서 MU MIMO 전송을 기반으로 통신을 수행할 STA의 개수를 지시할 수 있다.

[222] 본 발명의 실시예에 따르면, 톤 유닛의 크기 별로 각 톤 유닛에서 최대로 할당 가능한 MU MIMO 전송을 수행하는 STA의 개수(이하, 최대 MU MIMO 전송

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STA 개수)가 정의될 수 있다.

[223] 예를 들어, 톤 유닛의 크기가 242톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 컨테이너 별로 할당 가능한 최대 STA의 개수와 동일하게 설정될 수 있다. 예를 들어, 톤 유닛의 크기가 242톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 20MHz 대역폭/40MHz 대역폭에서는 4개, 80MHz 대역폭에서는 2개일 수 있다.

[224] 톤 유닛의 크기가 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 최대 4개(20MHz 대역폭/40MHz 대역폭)이거나, 2개(80MHz 대역폭)일 수 있다.

[225] 톤 유닛의 크기가 2개의 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 최대 4개(20MHz 대역폭/40MHz 대역폭)이거나, 2개(80MHz 대역폭)일 수 있다.

[226] 톤 유닛의 크기가 3개의 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 4개일 수 있다.

[227] 톤 유닛의 크기가 4개의 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 4개일 수 있다.

[228] 또는 본 발명의 실시예에 따르면, 톤 유닛의 크기에 상관없이 각 톤 유닛에서 최대로 할당 가능한 MU MIMO 기반 전송을 수행하는 STA의 개수(이하, 최대 MU MIMO 전송 STA 개수)가 동일하게 설정될 수도 있다. 또는 톤 유닛의 크기가 242톤의 자원 단위인 경우, 톤 유닛에서 최대 MU MIMO 전송 STA 개수가 8개이고, 톤 유닛의 크기가 242톤의 자원 단위보다 작은 경우(n개의 26톤의 자원 단위), 톤 유닛에서 최대 MU MIMO 전송 STA 개수는 4개일 수 있다.

[229] 어떠한 경우이든 컨테이너 별로 할당 가능한 최대 STA의 개수는 만족하도록 톤 유닛에 할당되는 최대 MU MIMO 전송 STA의 개수가 설정될 수 있다.

[230] 전술한 본 발명의 실시예에서는 26톤의 자원 단위를 기준으로 설명하였으나, 26톤의 자원 단위가 아닌 다른 자원 단위(예를 들어, 30톤의 자원 단위)에 대해서도 전술한 자원 할당 방법이 적용될 수 있다.

[231] 예를 들어, 컨테이너가 242톤의 자원 단위 1개 또는 8개의 30톤의 자원 단위로 정의될 수 있다.

[232] 이러한 경우, 대역폭 별 컨테이너의 개수는 20MHz 대역폭에 대하여 1개, 40MHz 대역폭에 대하여 2개, 80MHz 대역폭에 대하여 4개가 정의될 수 있다.

[233] 또한 컨테이너 별로 할당 가능한 최대 STA의 개수는 20MHz 대역폭에 대하여 8개의 STA이 할당될 수 있다.

[234] 40MHz 대역폭 상에서 2개의 컨테이너가 정의될 수 있고, 2개의 컨테이너 각각에 대하여 4개의 STA이 할당 가능하다. 따라서, 40MHz 대역폭 상에서 최대 8개의 STA이 할당될 수 있다.

[235] 80MHz 대역폭 상에서 4개의 컨테이너가 정의될 수 있고, 4개의 컨테이너 각각에 대하여 4개의 STA이 할당 가능하다. 따라서, 80MHz 대역폭 상에서 최대 16개의 STA이 할당될 수 있다.

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[236] 컨테이너 별로 2비트 또는 3비트가 컨테이너 별 자원 할당 정보로 정의되어 컨테이너 별로 할당되는 STA의 개수를 알려줄 수 있다. 2비트의 컨테이너 별 자원 할당 비트는 최대 4개의 STA에 대한 자원 할당을 지시하고, 3비트의 컨테이너 별 자원 할당 비트는 최대 8개의 STA에 대한 자원 할당을 지시할 수 있다.

[237] 예를 들어, 컨테이너 별 자원 할당 비트가 '000'인 경우, 컨테이너에 대한 1개의 STA의 할당이 지시될 수 있다. 예를 들어, 1개의 STA은 컨테이너에 대응되는 242톤의 자원 단위를 할당받을 수 있다.

[238] 예를 들어, 컨테이너 별 자원 할당 비트가 '001'인 경우, 컨테이너에 대한 2개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 2개의 STA 각각에 4개의 30톤의 자원 단위가 할당될 수 있다.

[239] 예를 들어, 컨테이너 별 자원 할당 비트가 '010'인 경우, 컨테이너에 대한 3개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 2개의 STA 각각에 3개의 30톤의 자원 단위, 1개의 STA에 2개의 30톤의 자원 단위가 할당될 수 있다.

[240] 예를 들어, 컨테이너 별 자원 할당 비트가 '011'인 경우, 컨테이너에 대한 4개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 4개의 STA 각각에 2개의 30톤의 자원 단위가 할당될 수 있다.

[241] 예를 들어, 컨테이너 별 자원 할당 비트가 '111'인 경우, 컨테이너에 대한 8개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 8개의 STA 각각에 1개의 30톤의 자원 단위가 할당될 수 있다.

[242] 전체 대역폭이 80MHz 대역폭인 경우, 17개의 30톤의 자원 단위의 할당이 가능할 수 있다. 따라서, 4개의 컨테이너 각각에 4개의 30톤의 자원 단위를 할당하고, 추가의 1개의 30톤의 자원 단위가 활용될 수 있다. 추가의 1개의 30톤의 자원 단위는 다른 컨테이너(또는 다른 자원)과 조합되어 자동으로 할당될 수도 있다.

[243] 본 발명의 실시예에 따르면, 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 한 자원 할당을 위한 시그널링은 할당된 적어도 하나의 242톤의 자원 단위(또는 제1 자원 단위)를 그룹핑한 제1 자원 단위 그룹과 적어도 하나의 26톤의 자원 단위(또는 제2 자원 단위)를 그룹핑한 제2 자원 단위 그룹 각각에 대해 수행될 수 있다. 전술한 자원 단위 할당 시그널링/시그널링 지시가 제1 자원 단위 그룹과 제2 자원 단위 그룹 각각에 대해 수행될 수 있다.

[244] 논리 도메인 상에 주파수 축 상에서 할당된 제1 자원 단위 그룹이 우선적으로 나열되고, 제1 자원 단위 그룹 이후에 제2 자원 단위 그룹이 나열될 수 있다. 주파수 축 상에서 제2 자원 단위 그룹에 대한 할당은 주파수 축 상에서 제1 자원 단위 그룹에 대한 할당에 영향을 받을 수 있다. 예를 들어, 제2 자원 단위 그룹에 포함되는 제2 자원 단위는 제1 자원 단위 그룹에 포함되는 제1 자원 단위에 대한 할당된 주파수 대역의 나머지 대역에 할당될 수 있고, 제2 자원 단위 그룹에

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포함되는 제2 자원 단위의 개수 및 위치는 제1 자원 단위 그룹에 포함되는 제1 자원 단위의 개수 및 위치를 기반으로 결정될 수 있다.

[245] 도 15는 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[246] 도 15에서는 MU OFDMA 전송/MU MIMO 전송을 수행하는 STA에 대한 개수 제한이 개시된다.

[247] 도 15를 참조하면, MU MIMO 전송이 242톤의 자원 단위를 기반으로 수행되고, 242톤의 자원 단위 상에서 MU MIMO 전송이 가능한 STA은 최대 4개로 제한될 수 있다.

[248] OFDMA 구조에 따라 변할수 있으나, 20MHz 대역폭은 9개의 26톤의 자원 단위, 40MHz 대역폭은 18개의 26톤의 자원 단위, 80MHz 대역폭은 37개의 26톤의 자원 단위를 포함할 수 있다. 이때 각 대역폭 상에서 MU OFDMA 전송이 수행되는 경우, 20MHz 대역폭에 대해서는 최대 9개의 STA의 MU OFDMA 기반 통신이 가능하고, 40MHz 대역폭에 대해서는 최대 18개의 STA의 MU OFDMA 기반 통신이 가능하고, 80MHz 대역폭에 대해서는 최대 18개의 STA의 MU OFDMA 기반 통신이 가능할 수 있다.

[249] 본 발명의 실시예에 따르면, 주파수 대역폭의 크기에 상관없이 중첩된 시간 자원 상에서 MU OFDMA 기반 전송을 사용하여 통신하는 최대 STA의 개수만 18개로 제한될 수 있다.

[250] 또는 주파수 대역폭의 크기에 상관없이 중첩된 시간 자원 상에서 MU OFDMA 전송을 사용하여 통신하는 최대 STA의 개수 및 MU MIMO 전송을 사용하여 통신하는 최대 STA의 개수는 18개로 제한될 수 있다.

[251] 아래의 표 2는 대역폭 및 MU OFDMA 기반 전송/MU MIMO 기반 전송에 따른 최대 STA의 개수를 나타낸다.

[252] [표2]

대역폭(BW)	할당(Allocation)	최대 STA의 개수
20MHz	9x26 for OFDMA1x242 for MU MIMO	94
40MHz	18x26 for OFDMA1x242 for MU MIMO, 9x26 for OFDMA2x242 for MU MIMO	18138
80MHz	37x26 for OFDMA1x242 for MU MIMO, 28x26 for OFDMA2x242 for MU MIMO, 19x26 for OFDMA3x242 for MU MIMO, 10x26 for OFDMA4x242 for MU MIMO, 1x26 for OFDMA	1822 or 1826 or 1822 or 1817

[253] 표 2를 참조하면, 20MHz 대역폭에 대하여 MU OFDMA 전송이 수행될 경우, 9개의 26톤의 자원 단위 각각이 9개의 STA 각각에 할당되므로 최대 9개의

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STA에 대한 통신이 지원될 수 있다. 20MHz 대역폭에 대하여 MU MIMO 전송이 수행될 경우, 242톤의 자원 단위를 기준으로 최대 4개의 STA이 지원 가능하므로 하나의 242톤의 자원 단위 상에서 최대 4개의 STA에 대한 통신이 지원될 수 있다.

[254] 40MHz 대역폭에 대하여 MU OFDMA 전송이 수행될 경우, 18개의 26톤의 자원 단위 각각이 18개의 STA 각각에 할당되므로 최대 18개의 STA에 대한 통신이 지원될 수 있다.

[255] 40MHz 대역폭에 대하여 MU MIMO 전송/MU OFDMA 전송이 수행될 경우, 하나의 242톤의 자원 단위 상에서 최대 4개의 STA에 대한 MU MIMO 기반 통신이 지원되고, 나머지 9개의 26톤의 자원 단위 상에서 최대 9개의 STA에 대한 MU OFDMA 기반 통신이 지원될 수 있다.

[256] 40MHz 대역폭에 대하여 MU MIMO 전송이 수행될 경우, 두 개의 242톤의 자원 단위 각각 상에서 최대 4개의 STA에 대한 MU MIMO 기반 통신이 지원될 수 있다. 따라서, 최대 8개의 STA에 대한 MU MIMO 기반 통신이 지원될 수 있다.

[257] 80MHz 대역폭에 대하여 MU OFDMA 전송이 수행될 경우, 37개의 26톤의 자원 단위가 18개의 STA 각각에 할당될 수 있다. 전술한 바와 같이 MU OFDMA 전송은 최대 18개의 STA을 지원할 수 있다. 또는 MU OFDMA 전송/MU MIMO 전송은 최대 18개의 STA을 지원할 수 있다. 따라서, 37개의 26톤의 자원 단위가 가용한 경우에도 최대 18개의 STA의 통신이 지원될 수 있다.

[258] 80MHz 대역폭에 대하여 MU MIMO 전송/ MU OFDMA 전송이 수행될 수 있다. 하나의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 28개의 26톤의 자원 단위가 MU OFDMA 전송을 위해 사용되는 경우, 최대 22개의 STA의 통신이 지원되거나, 최대 18개의 STA의 통신이 지원될 수 있다.

[259] 구체적으로 전술한 바와 같이 MU OFDMA 전송의 최대 지원 가능한 STA의 개수만 18개로 제한되는 경우, MU OFDMA 전송이 수행 가능한 최대 18개의 STA과 MU MIMO 전송이 수행 가능한 최대 4개의 STA의 합인 22개의 STA이 최대 지원 가능한 STA의 개수일 수 있다. MU OFDMA 전송 및 MU MIMO 전송의 최대 지원 가능한 STA의 개수가 18개로 제한되는 경우, MU OFDMA 전송을 수행하는 STA의 개수와 MU MIMO 전송을 수행하는 STA의 개수의 합이 최대 18개가 되도록 설정될 수 있다.

[260] 80MHz 대역폭에 대하여 MU MIMO 전송/MU OFDMA 전송이 수행될 수 있다. 두 개의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 19개의 26톤의 자원 단위가 MU OFDMA 전송을 위해 사용되는 경우, 최대 26개의 STA의 통신이 지원되거나, 최대 18개의 STA의 통신이 지원될 수 있다.

[261] 구체적으로 전술한 바와 같이 MU OFDMA 전송의 최대 지원 가능한 STA의 개수만 18개로 제한되는 경우, MU OFDMA 전송이 수행 가능한 최대 18개의 STA과 2개의 242톤의 자원 단위 상에서 MU MIMO 전송이 수행 가능한 최대 8개의 STA의 합인 26개의 STA이 최대 지원 가능한 STA의 개수일 수 있다. MU

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OFDMA 전송 및 MU MIMO 전송의 최대 지원 가능한 STA의 개수가 18개로 제한되는 경우, MU OFDMA 전송을 수행하는 STA의 개수와 MU MIMO 전송을 수행하는 STA의 개수의 합이 최대 18개가 되도록 설정될 수 있다.

[262] 80MHz 대역폭에 대하여 MU MIMO 전송/ MU OFDMA 전송이 수행될 수 있다. 세 개의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 10개의 26톤의 자원 단위가 MU OFDMA 전송을 위해 사용되는 경우, 마찬가지 방식으로 최대 22개의 STA의 통신이 지원되거나, 최대 18개의 STA의 통신이 지원될 수 있다.

[263] 80MHz 대역폭에 대하여 MU MIMO 전송/MU OFDMA 전송이 수행될 수 있다. 네 개의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 1개의 26톤의 자원 단위가 MU OFDMA 기반 전송을 위해 사용되는 경우, 최대 17개의 STA의 통신이 지원될 수 있다.

[264] 도 16은 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[265] 도 16에서는 242톤의 자원 단위 및 26톤의 자원 단위에 대한 자원 할당 방법이 개시된다.

[266] 도 16을 참조하면, PPDU 헤더의 시그널 필드(예를 들어, HE(high efficiency)-SIG(signal) A/HE-SIG B)(1600)를 기반으로 OFDMA 패킷의 수신 STA에 대한 정보(또는 PPDU를 수신하는 STA의 개수에 대한 정보)가 할당 STA 정보(1610)로서 전송될 수 있다.

[267] 또한, 전체 대역폭 상에서 할당되는 242톤의 자원 단위에 대한 정보가 PPDU 헤더를 통해 전송될 수 있다. 242톤의 자원 단위의 전체 대역폭 상의 할당에 대한 정보를 지시하기 위해 242톤의 자원 단위에 대한 비트맵(이하, 242톤 자원 단위 비트맵(또는 242 청크 비트맵(chunk bitmap)))(1620)이 정의될 수 있다. 242톤 자원 단위 비트맵(1620)은 전체 대역폭 상에서 할당된 242톤의 자원 단위의 위치 및 개수에 대한 정보를 포함할 수 있다.

[268] 또한, STA에 할당되는 26톤의 자원 단위의 할당에 대한 정보(1630)가 PPDU 헤더를 통해 전송될 수 있다. 예를 들어, n비트(예를 들어, 3비트)를 기반으로 STA에 할당되는 26톤의 자원 단위의 개수에 대한 정보가 지시될 수 있다. 26톤의 자원 단위의 할당에 대한 정보(1630)인 n비트는 특정 크기의 자원 단위(예를 들어, 9개의 26톤의 자원 단위) 상에서 STA으로 할당되는 26톤의 자원 단위의 개수에 대한 정보을 포함할 수 있다.

[269] STA에 할당되는 242톤의 자원 단위에 대한 정보는 OFDMA 패킷의 사용자의 개수에 대한 정보 및 26톤의 자원 단위를 할당받는 사용자의 개수에 대한 정보를 기반으로 결정될 수 있다.

[270] 예를 들어, 두 개의 242톤의 자원 단위 및 2개의 26톤의 자원 단위가 4개의 STA으로 할당된 경우, 두 개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당되고, 2개의 26톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수 있다.

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[271] 또 다른 예를 들어, 두 개의 242톤의 자원 단위 및 3개의 26톤의 자원 단위가 4개의 STA으로 할당된 경우, 두 개의 242톤의 자원 단위가 1개의 STA에 할당되고, 3개의 26톤의 자원 단위 각각이 3개의 STA 각각에 할당될 수 있다.

[272] N은 242톤의 자원 단위가 주파수 축 상에서 할당된 이후, 나머지 할당되지 않은 242톤의 자원 단위의 개수로 가정할 수 있다. 이러한 경우, 주파수 축 상에 할당되는 242톤의 자원 단위 및 26톤의 자원 단위는 242톤 자원 단위 비트맵 및 3비트의 26톤의 자원 단위에 대한 할당 정보를 기반으로 할당될 수 있다.

[273] 242톤의 자원 단위는 20MHz 대역폭에 대해서 1개 할당 가능하고, 40MHz 대역폭에 대해서 2개 할당 가능하고, 80MHz 대역폭에 대해서 4개 할당 가능할 수 있다. 따라서, 242톤 자원 단위 비트맵은 20MHz 대역폭에 대해서 1비트, 40MHz 대역폭에 대해서 2비트, 80MHz 대역폭에 대해서 4비트로 정의될 수 있다.

[274] 26톤의 자원 단위에 대한 할당 정보(1630)는 242톤의 자원 단위로 사용되지 않는 N개의 나머지 242톤의 자원 단위 각각 상에서 STA으로 할당되는 26톤의 자원 단위의 개수를 지시할 수 있다. 따라서, 26톤의 자원 단위에 대한 할당 정보는 3비트*N의 크기를 가질 수 있다.

[275] 따라서, 20MHz 대역폭에 대해 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 1(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다. 40MHz 대역폭에 대해 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 2(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다. 80MHz 대역폭에 대해 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 4(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다.

[276] 위와 같은 시그널링은 대역폭의 크기에 따라 최적화된 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)에 대한 시그널링 방법(또는 BW-최적화 시그널링(BW-optimized signaling) 방법)이다.

[277] 본 발명의 실시예에 따르면, 대역폭의 크기에 상관없이 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)에 대한 시그널링하는 방법(BW 공통 시그널링 방법(BW common signaling))이 개시된다.

[278] 242톤 자원 단위 비트맵(1620)은 대역폭의 크기와 상관없이 4비트로 정의될 수 있고, 26톤의 자원 단위에 대한 할당 정보(1630)는 3비트*N의 크기로 정의될 수 있다. 따라서, 대역폭의 크기에 상관없이 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 4(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다.

[279] 위와 같은 BW 최적화 시그널링 및 BW 공통 시그널링 방법에서 N은 N'로 정의될 수 있고, N'는 각 대역폭에 할당 가능한 최대 242톤의 자원 단위의 개수일 수 있다. 즉, 20MHz 대역폭에 대하여, N'는 1이고, 40MHz 대역폭에 대하여, N'는

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2이고, 80MHz 대역폭에 대하여, N'는 4일 수 있다. N'는 현재 242톤의 자원 단위의 할당 상태에 따라 변하는 값이 아닌 고정된 값일 수 있다. 따라서, 자원 할당 정보를 전송하는 시그널 필드(예를 들어, HE-SIG B)에 대한 고정된 디자인이 가능할 수 있다.

[280] N'가 정의되는 경우, 26톤의 자원 단위에 대한 할당 정보는 20MHz 대역폭에 대하여 3비트, 40MHz 대역폭에 대하여 6비트, 80MHz 대역폭에 대하여 12비트로 고정될 수 있다.

[281] 242톤 자원 단위 비트맵(1620)의 크기가 20MHz 대역폭에 대해 1비트, 40MHz 대역폭에 대해 2비트, 80MHz 대역폭에 대해 4비트인 경우, 26톤의 자원 단위에 대한 할당 정보(1630)와 242톤 자원 단위 비트맵(1620)의 합은 20MHz 대역폭에 대해 4비트, 40MHz 대역폭에 대해 8비트, 80MHz 대역폭에 대해 16비트일 수 있다.

[282] 본 발명의 실시예에 따르면 특정 크기의 자원 단위에 대해 MU MIMO 전송이 수행되는지 여부가 지시될 수 있다. 예를 들어, MU MIMO 전송이 242톤의 자원 단위 상에서 수행되는 경우, 242톤의 자원 단위에 MU MIMO 전송이 수행되는지 여부를 지시하는 1비트가 추가되어 시그널링될 수 있다.

[283] 이러한 경우, 전체 주파수 대역에 포함되는 242톤의 자원 단위 각각에 대해 MU MIMO 기반 전송이 수행되는지 여부를 지시하는 1비트가 추가될 수 있다. 20MHz 대역폭 상에서는 242톤의 자원 단위의 개수가 1개이므로 1비트가 추가되고, 40MHz 대역폭 상에서는 242톤의 자원 단위의 개수가 2개이므로 2비트가 추가되고, 80MHz 대역폭 상에서는 242톤의 자원 단위의 개수가 4개이므로 4비트가 추가될 수 있다.

[284] 따라서, 26톤의 자원 단위에 대한 할당 정보와 242톤 자원 단위 비트맵 및 MU MIMO 기반 전송이 수행되는지 여부를 지시하는 비트의 합은 20MHz 대역폭에 대해 5비트, 40MHz 대역폭에 대해 10비트, 80MHz 대역폭에 대해 16비트일 수 있다.

[285] 도 17은 본 발명의 실시예에 따른 DL MU PPDU 포맷을 나타낸 개념도이다.

[286] 도 17에서는 본 발명의 실시예에 따른 AP에 의해 OFDMA를 기반으로 전송되는 DL MU PPDU 포맷이 개시된다.

[287] 도 17을 참조하면, DL MU PPDU의 PPDU 헤더는 L-STF(legacy-short training field), L-LTF(legacy-long training field), L-SIG(legacy-signal), HE-SIG A(high efficiency-signal A), HE-SIG B(high efficiency-signal-B), HE-STF(high efficiency-short training field), HE-LTF(high efficiency-long training field), 데이터 필드(또는 MAC 페이로드)를 포함할 수 있다. PHY 헤더에서 L-SIG까지는 레가시 부분(legacy part), L-SIG 이후의 HE(high efficiency) 부분(HE part)으로 구분될 수 있다.

[288] L-STF(1700)는 짧은 트레이닝 OFDM 심볼(short training orthogonal frequency division multiplexing symbol)을 포함할 수 있다. L-STF(1700)는 프레임 탐지(frame

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detection), AGC(automatic gain control), 다이버시티 탐지(diversity detection), 대략적인 주파수/시간 동기화(coarse frequency/time synchronization)을 위해 사용될 수 있다.

[289] L-LTF(1710)는 긴 트레이닝 OFDM 심볼(long training orthogonal frequency division multiplexing symbol)을 포함할 수 있다. L-LTF(1710)는 정밀한 주파수/시간 동기화(fine frequency/time synchronization) 및 채널 예측을 위해 사용될 수 있다.

[290] L-SIG(1720)는 제어 정보를 전송하기 위해 사용될 수 있다. L-SIG(1720)는 데이터 전송률(rate), 데이터 길이(length)에 대한 정보를 포함할 수 있다.

[291] HE-SIG A(1730)는 DL MU PPDU를 수신할 STA을 지시하기 위한 정보를 포함할 수도 있다. 예를 들어, HE-SIG A(1730)는 PPDU를 수신할 특정 STA(또는 AP)의 식별자, 특정 STA의 그룹을 지시하기 위한 정보를 포함할 수 있다. 또한, HE-SIG A(1730)는 DL MU PPDU가 OFDMA 또는 MIMO를 기반으로 전송되는 경우, STA의 DL MU PPDU의 수신을 위한 자원 할당 정보도 포함할 수 있다.

[292] 또한, HE-SIG A(1730)는 BSS 식별 정보를 위한 칼라 비트(color bits) 정보, 대역폭(bandwidth) 정보, 테일 비트(tail bit), CRC 비트, HE-SIG B(1740)에 대한 MCS(modulation and coding scheme) 정보, HE-SIG B(1740)를 위한 심볼 개수 정보, CP(cyclic prefix)(또는 GI(guard interval)) 길이 정보를 포함할 수도 있다.

[293] HE-SIG B(1740)는 각 STA에 대한 PSDU(Physical layer service data unit)의 길이 MCS에 대한 정보 및 테일 비트 등을 포함할 수 있다. 또한 HE-SIG B(1740)는 PPDU를 수신할 STA에 대한 정보, OFDMA 기반의 자원 할당(resource allocation) 정보(또는 MU-MIMO 정보)를 포함할 수도 있다. HE-SIG B(1740)에 OFDMA 기반의 자원 할당 정보(또는 MU-MIMO 관련 정보)가 포함되는 경우, HE-SIG A(1730)에는 자원 할당 정보가 포함되지 않을 수도 있다.

[294] 전술한 바와 같이 HE-SIG A(1750) 또는 HE-SIG B(1760)는 수신 STA 식별 정보 및 자원 할당 정보를 포함할 수 있다. 수신 STA 식별 정보는 순차적으로 PPDU를 수신할 복수의 STA을 포함할 수 있고, 자원 할당 정보는 순차적으로 복수의 STA 각각으로 할당된 자원 단위의 개수에 대한 정보를 포함할 수 있다. HE-SIG A(1350) 또는 HE-SIG B(1760)는 제1 자원 단위 그룹(또는 제1 자원 단위)를 위한 수신 STA 식별 정보 및 자원 할당 정보 및 제2 자원 단위 그룹(또는 제2 자원 단위)를 위한 수신 STA 식별 정보 및 자원 할당 정보를 별도로 포함할 수 있다.

[295] 또한, HE-SIG A(1750) 또는 HE-SIG B(1760)는 비트맵 정보를 기반으로 복수의 STA 각각으로 할당되는 제1 자원 단위 및 제2 자원 단위 각각을 직접적으로 지시할 수도 있다.

[296] 또한, HE-SIG A(1750) 또는 HE-SIG B(1760)는 전술한 242톤 자원 단위 전체 할당 정보, 242톤 자원 단위 개별 할당 정보, 26톤 자원 단위 개별 할당 정보, 톤 유닛 개수 정보, 컨테이너 별 자원 할당 정보 MU/SU 전송 지시 정보 MU OFDMA/MU MIMO 전송 지시 정보 등을 포함할 수 있다.

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[297] DL MU PPDU 상에서 HE-SIG B(1740)의 이전 필드는 서로 다른 전송 자원 각각에서 듀플리케이트된 형태로 전송될 수 있다. HE-SIG B(1740)의 경우, 일부의 자원 단위(예를 들어, 자원 단위1, 자원 단위2)에서 전송되는 HE-SIG B(1740)은 개별적인 정보를 포함하는 독립적인 필드이고, 나머지 자원 단위(예를 들어, 자원 단위3, 자원 단위4)에서 전송되는 HE-SIG B(1740)은 다른 자원 단위(예를 들어, 자원 단위1, 자원 단위2)에서 전송되는 HE-SIG B(1740)을 듀플리케이트한 포맷일 수 있다. 또는 HE-SIG B(1740)는 전체 전송 자원 상에서 인코딩된 형태로 전송될 수 있다. HE-SIG B(1740) 이후의 필드는 PPDU를 수신하는 복수의 STA 각각을 위한 개별 정보를 포함할 수 있다.

[298] HE-STF(1750)는 MIMO(multiple input multiple output) 환경 또는 OFDMA 환경에서 자동 이득 제어 추정(automatic gain control estimation)을 향상시키기 위하여 사용될 수 있다.

[299] 구체적으로 STA1은 AP로부터 자원 단위1을 통해 전송되는 HE-STF1을 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드1(또는 프레임1)을 디코딩할 수 있다. 마찬가지로 STA2는 AP로부터 자원 단위2를 통해 전송되는 HE-STF2를 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드2(또는 프레임2)를 디코딩할 수 있다. STA3은 AP로부터 자원 단위3을 통해 전송되는 HE-STF3을 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드3(또는 프레임3)을 디코딩할 수 있다. STA4는 AP로부터 자원 단위4을 통해 전송되는 HE-STF4를 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드4(또는 프레임4)를 디코딩할 수 있다.

[300] HE-LTF(1760)는 MIMO 환경 또는 OFDMA 환경에서 채널을 추정하기 위하여 사용될 수 있다.

[301] HE-STF(1750) 및 HE-STF(1750) 이후의 필드에 적용되는 IFFT의 크기와 HE-STF(1750) 이전의 필드에 적용되는 IFFT의 크기는 서로 다를 수 있다. 예를 들어, HE-STF(1750) 및 HE-STF(1750) 이후의 필드에 적용되는 IFFT의 크기는 HE-STF(1750) 이전의 필드에 적용되는 IFFT의 크기보다 4배 클 수 있다. STA은 HE-SIG A(1730)를 수신하고, HE-SIG A(1730)를 기반으로 하향링크 PPDU의 수신을 지시받을 수 있다. 이러한 경우, STA은 HE-STF(1750) 및 HE-STF(1750) 이후 필드부터 변경된 FFT 사이즈를 기반으로 디코딩을 수행할 수 있다. 반대로 STA이 HE-SIG A(1730)를 기반으로 하향링크 PPDU의 수신을 지시받지 못한 경우, STA은 디코딩을 중단하고 NAV(network allocation vector) 설정을 할 수 있다. HE-STF(1750)의 CP(cyclic prefix)는 다른 필드의 CP보다 큰 크기를 가질 수 있고, 이러한 CP 구간 동안 STA은 FFT 사이즈를 변화시켜 하향링크 PPDU에 대한 디코딩을 수행할 수 있다.

[302] AP(access point)가 전체 대역폭 상에서 복수의 STA(station) 각각을 위한 복수의 자원 단위 각각을 할당하고 복수의 STA 각각으로 복수의 자원 단위 각각을 통해 복수의 STA 각각에 대한 개별적인 데이터 필드(또는 프레임)을 전송할 수 있다.

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복수의 STA 각각에 대한 복수의 자원 단위 각각의 할당에 대한 정보는 전술한 바와 같이 HE-SIG A(1750) 또는 HE-SIG B(1760)에 포함될 수 있다.

[303] 도 18은 본 발명의 실시예에 따른 UL MU PPDU의 전송을 나타낸 개념도이다.

[304] 도 18을 참조하면, 복수의 STA은 AP로 UL MU OFDMA를 기반으로 UL MU PPDU를 전송할 수 있다.

[305] L-STF(1800), L-LTF(1810), L-SIG(1820), HE-SIG A(1830), HE-SIG B(1840)는 도 13에서 개시된 역할을 수행할 수 있다. 시그널 필드(L-SIG(1820), HE-SIG A(1830), HE-SIG B(1840))에 포함되는 정보는 수신한 DL MU PPDU의 시그널 필드에 포함되는 정보를 기반으로 생성될 수 있다.

[306] STA1은 HE-SIG B(1840)까지는 전체 대역폭을 통해 상향링크 전송을 수행하고, HE-STF(1850) 이후부터는 할당된 대역폭을 통해 상향링크 전송을 수행할 수 있다. STA1은 할당된 대역폭(예를 들어, 자원 단위1)을 통해 상향링크 프레임을 UL MU PPDU를 기반으로 전달할 수 있다. AP는 DL MU PPDU(예를 들어, HE-SIG A/B)를 기반으로 복수의 STA 각각의 상향링크 자원을 할당할 수 있고, 복수의 STA 각각은 상향링크 자원을 할당받고 UL MU PPDU를 전송할 수 있다.

[307] 도 19는 본 발명의 실시예가 적용될 수 있는 무선 장치를 나타내는 블록도이다.

[308] 도 19를 참조하면, 무선 장치(1900)는 상술한 실시예를 구현할 수 있는 STA로서, AP(1900) 또는 비AP STA(non-AP station)(또는 STA)(1950)일 수 있다.

[309] AP(1900)는 프로세서(1910), 메모리(1920) 및 RF부(radio frequency unit, 1930)를 포함한다.

[310] RF부(1930)는 프로세서(1910)와 연결하여 무선신호를 송신/수신할 수 있다.

[311] 프로세서(1910)는 본 발명에서 제안된기능, 과정 및/또는 방법을 구현할 수 있다. 예를 들어, 프로세서(1910)는 전술한 본 발명의 실시예에 따른 AP의 동작을 수행하도록 구현될 수 있다. 프로세서는 도 1 내지 18의 실시예에서 개시한 AP의 동작을 수행할 수 있다.

[312] 예를 들어, 프로세서(1910)는 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하고, 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 복수의 STA으로 상기 PPDU를 전송하도록 구현될 수 있다.

[313] 이때, PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함할 수 있다. MU/SU 전송 지시 정보는 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함할 수 있다. 컨테이너 별 자원 할당 정보는 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고, 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위(예를 들어, 242톤의 자원 단위) 또는 복수의 제2 자원 단위(예를 들어, 26톤의 자원 단위)를 포함할 수 있다. 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 클 수 있다.

[314] PPDU는 상기 적어도 하나의 컨테이너 각각에 대한 MU OFDMA(orthogonal frequency division multiplexing)/MU MIMO(multiple input multiple output) 전송

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지시 정보를 더 포함할 수 있다. MU OFDMA/MU MIMO 전송 지시 정보는 적어도 하나의 컨테이너 각각 상에서 MU OFDMA 전송이 수행되는지 여부에 대한 정보 및 MU MIMO 전송이 수행되는지 여부에 대한 정보를 포함할 수 있다.

[315] MU OFDMA/MU MIMO 전송 지시 정보가 적어도 하나의 컨테이너 중 특정 컨테이너 상에서의 MU MIMO 전송을 지시하는 경우, MU MIMO 전송은 특정 컨테이너에 포함되는 적어도 하나의 톤 유닛 상에서 수행되고, 톤 유닛은 특정 컨테이너에 포함되는 제1 자원 단위 또는 상기 복수의 제2 자원 단위를 복수개의 그룹으로 분할한 단위일 수 있다.

[316] PPDU의 전송을 위한 적어도 하나의 컨테이너 각각은 하나의 제2 자원 단위를 분할한 적어도 하나의 분할 제2 자원 단위 각각을 더 포함하고, 적어도 하나의 분할 제2 자원 단위 각각은 하나의 제2 자원 단위로 결합되어 STA으로 할당될 수 있다.

[317] STA(1950)는 프로세서(1960), 메모리(1970) 및 RF부(radio frequency unit, 1980)를 포함한다.

[318] RF부(1980)는 프로세서(1960)와 연결하여 무선신호를 송신/수신할 수 있다.

[319] 프로세서(1960)는 본 발명에서 제안된 기능, 과정 및/또는 방법을 구현할 수 있다. 예를 들어, 프로세서(1960)는 전술한 본 발명의 실시예에 따른 STA의 동작을 수행하도록 구현될 수 있다. 프로세서는 도 1 내지 18의 실시예에서 STA의 동작을 수행할 수 있다.

[320] 예를 들어, 프로세서(1960)는 AP로부터 수신한 PPDU에 포함되는 MU/SU 전송 지시 정보, 컨테이너 별 자원 할당 정보, MU OFDMA/MU MIMO 전송 지시 정보를 기반으로 자원 할당을 받고, 할당받은 자원 상에서 하향링크 데이터를 수신하거나 상향링크 데이터를 전송할 수 있다.

[321] 프로세서(1910, 1960)는 ASIC(application-specific integrated circuit), 다른 칩셋, 논리 회로, 데이터 처리 장치 및/또는 베이스밴드 신호 및 무선 신호를 상호 변환하는 변환기를 포함할 수 있다.메모리(1920, 1970)는 ROM(read-only memory), RAM(random access memory), 플래쉬 메모리, 메모리 카드, 저장 매체 및/또는 다른 저장 장치를 포함할 수 있다. RF부(1930, 1980)는 무선 신호를 전송 및/또는 수신하는 하나 이상의 안테나를 포함할 수 있다.

[322] 실시예가 소프트웨어로 구현될 때, 상술한 기법은 상술한 기능을 수행하는 모듈(과정, 기능 등)로 구현될 수 있다. 모듈은 메모리(1920, 1970)에 저장되고, 프로세서(1910, 1960)에 의해 실행될 수 있다. 메모리(1920, 1970)는 프로세서(1910, 1960) 내부 또는 외부에 있을 수 있고, 잘 알려진 다양한 수단으로 프로세서(1910, 1960)와 연결될 수 있다.

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청구범위

[청구항 1] 무선랜에서 자원 단위를 할당하는 방법은,
AP(access point)가 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하는 단계; 및
상기 AP가 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하는 단계를 포함하되,
상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고,
상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고,
상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고,
상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고,
상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 큰 것을 특징으로 하는 방법.

[청구항 2] 제1항에 있어서,
상기 PPDU는 상기 적어도 하나의 컨테이너 각각에 대한 MU OFDMA(orthogonal frequency division multiplexing)/MU MIMO(multiple input multiple output) 전송 지시 정보를 더 포함하고,
상기 MU OFDMA/MU MIMO 전송 지시 정보는 상기 적어도 하나의 컨테이너 각각 상에서 MU OFDMA 전송이 수행되는지 여부에 대한 정보 및 MU MIMO 전송이 수행되는지 여부에 대한 정보를 포함하는 것을 특징으로 하는 방법.

[청구항 3] 제2항에 있어서,
상기 MU OFDMA/MU MIMO 전송 지시 정보가 상기 적어도 하나의 컨테이너 중 특정 컨테이너 상에서의 상기 MU MIMO 전송을 지시하는 경우,
상기 MU MIMO 전송은 상기 특정 컨테이너에 포함되는 적어도 하나의 톤 유닛 상에서 수행되고,
상기 톤 유닛은 상기 특정 컨테이너에 포함되는 상기 제1 자원 단위 또는 상기 복수의 제2 자원 단위를 복수개의 그룹으로 분할한 단위인 것을 특징으로 하는 방법.

[청구항 4] 제1항에 있어서,

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상기 적어도 하나의 컨테이너의 개수는 상기 전체 대역폭의 크기가 증가함에 따라 증가하고,
상기 적어도 하나의 컨테이너 각각에 할당 가능한 STA의 개수는 상기 전체 대역폭의 크기에 따라 제한되는 것을 특징으로 하는 방법.

[청구항 5] 제1항에 있어서,
상기 적어도 하나의 컨테이너 각각은 하나의 제2 자원 단위를 분할한 적어도 하나의 분할 제2 자원 단위 각각을 더 포함하고,
상기 적어도 하나의 분할 제2 자원 단위 각각은 하나의 제2 자원 단위로 결합되어 상기 복수의 STA으로 할당되는 것을 특징으로 하는 방법.

[청구항 6] 무선랜에서 자원 단위를 할당하는 AP(access point)에 있어서, 상기 AP는,
무선 신호를 송신 및 수신하는 RF(radio frequency) 부; 및
상기 RF 부와 동작 가능하게(operatively) 결합된 프로세서를 포함하되,
상기 프로세서는 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하고,
전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하도록 구현되되,
상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고,
상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고,
상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고,
상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고,
상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 큰 것을 특징으로 하는 AP.

[청구항 7] 제6항에 있어서,
상기 PPDU는 상기 적어도 하나의 컨테이너 각각에 대한 MU OFDMA(orthogonal frequency division multiplexing)/MU MIMO(multiple input multiple output) 전송 지시 정보를 더 포함하고,
상기 MU OFDMA/MU MIMO 전송 지시 정보는 상기 적어도 하나의 컨테이너 각각 상에서 MU OFDMA 전송이 수행되는지

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여부에 대한 정보 및 MU MIMO 전송이 수행되는지 여부에 대한 정보를 포함하는 것을 특징으로 하는 AP.

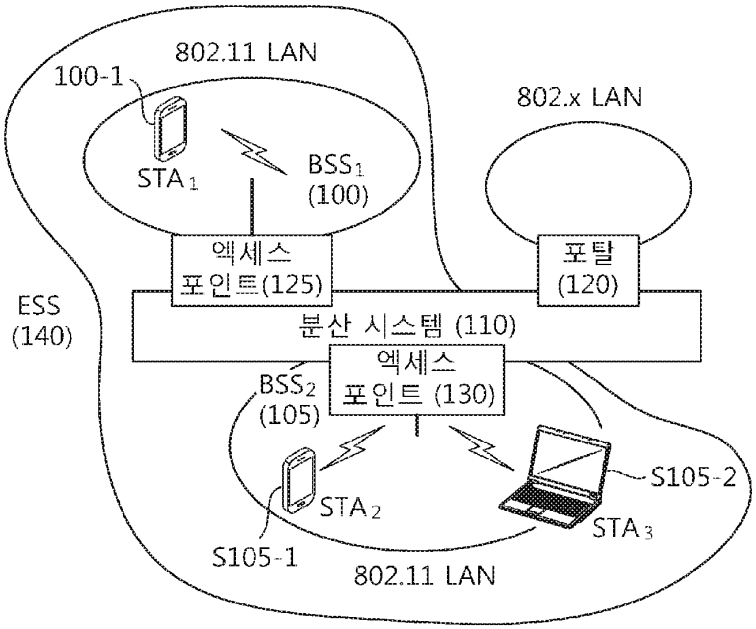
[청구항 8] 제7항에 있어서,
상기 MU OFDMA/MU MIMO 전송 지시 정보가 상기 적어도 하나의 컨테이너 중 특정 컨테이너 상에서의 상기 MU MIMO 전송을 지시하는 경우,
상기 MU MIMO 전송은 상기 특정 컨테이너에 포함되는 적어도 하나의 톤 유닛 상에서 수행되고,
상기 톤 유닛은 상기 특정 컨테이너에 포함되는 상기 제1 자원 단위 또는 상기 복수의 제2 자원 단위를 복수개의 그룹으로 분할한 단위인 것을 특징으로 하는 AP.

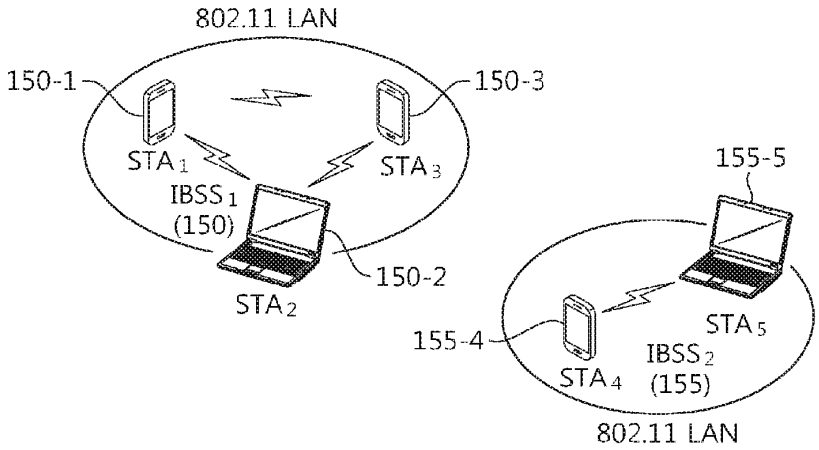
[청구항 9] 제6항에 있어서,
상기 적어도 하나의 컨테이너의 개수는 상기 전체 대역폭의 크기가 증가함에 따라 증가하고,
상기 적어도 하나의 컨테이너 각각에 할당 가능한 STA의 개수는 상기 전체 대역폭의 크기에 따라 제한되는 것을 특징으로 하는 AP.

[청구항 10] 제6항에 있어서,
상기 적어도 하나의 컨테이너 각각은 하나의 제2 자원 단위를 분할한 적어도 하나의 분할 제2 자원 단위 각각을 더 포함하고,
상기 적어도 하나의 분할 제2 자원 단위 각각은 하나의 제2 자원 단위로 결합되어 상기 복수의 STA으로 할당되는 것을 특징으로 하는 AP.

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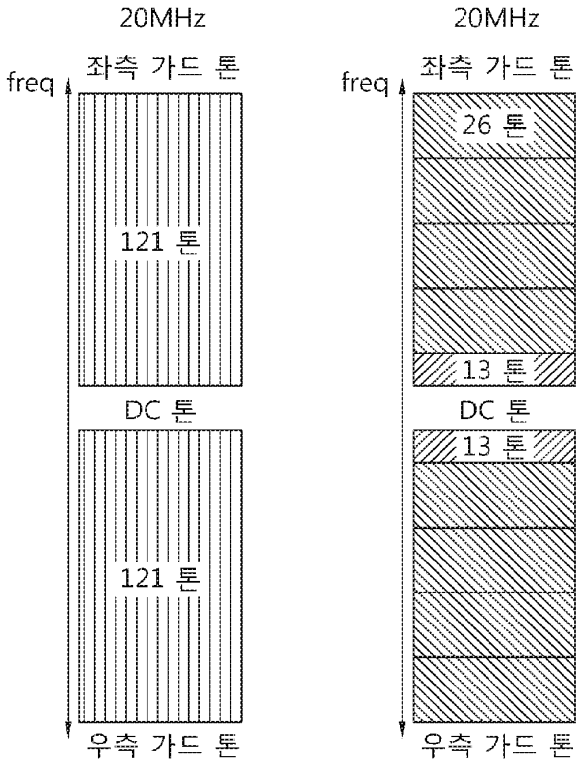
[도1]





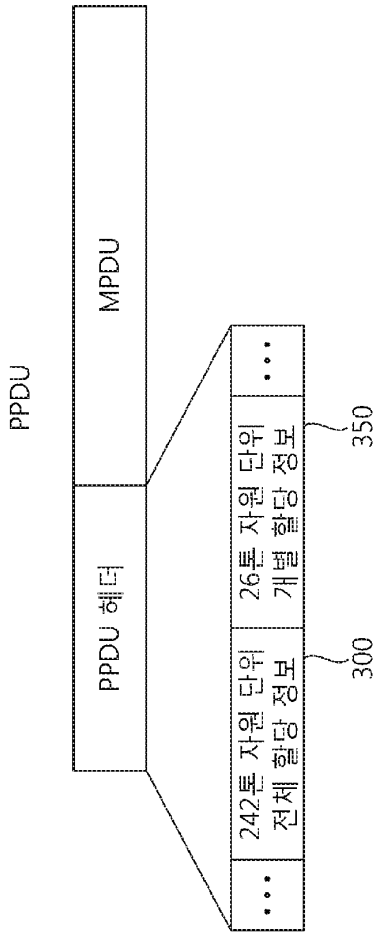
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[도2]



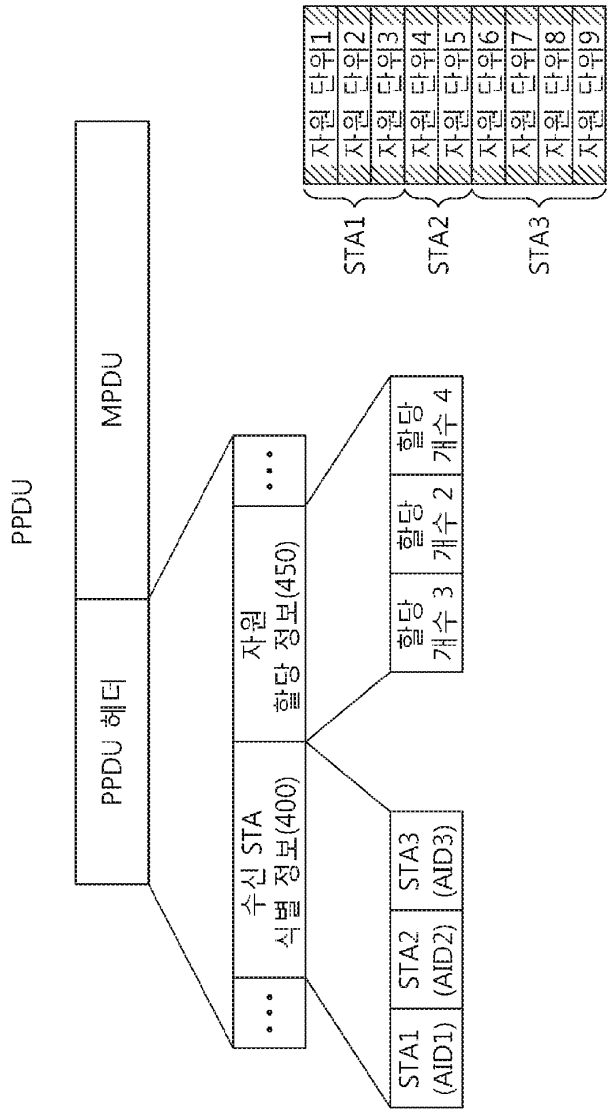
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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
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[도3]



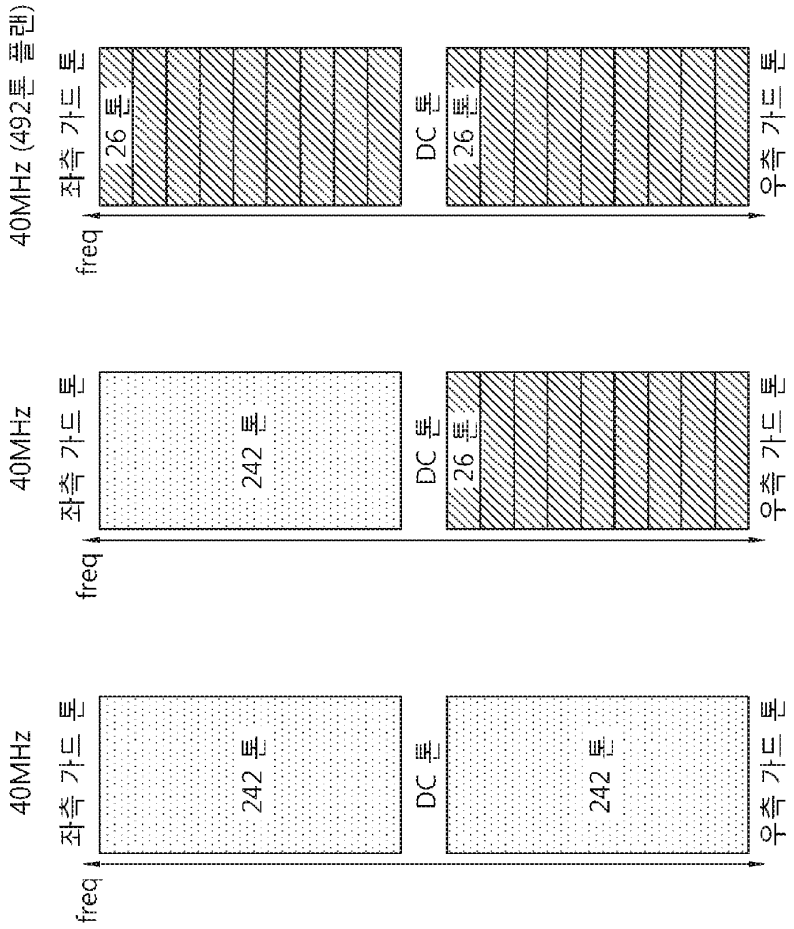
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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
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[도4]



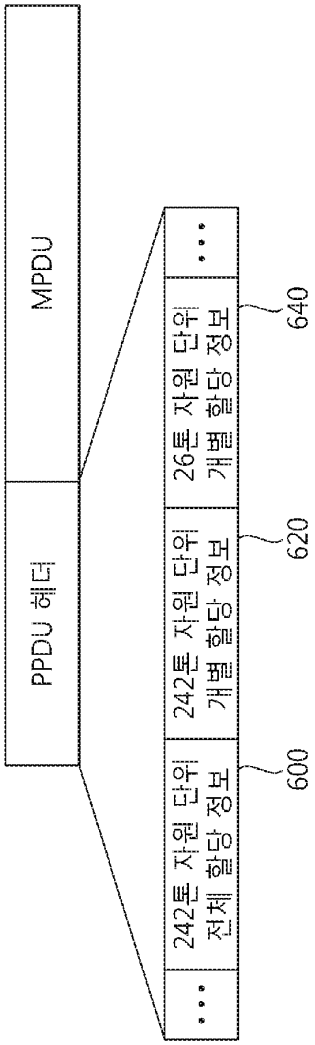
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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
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[도5]



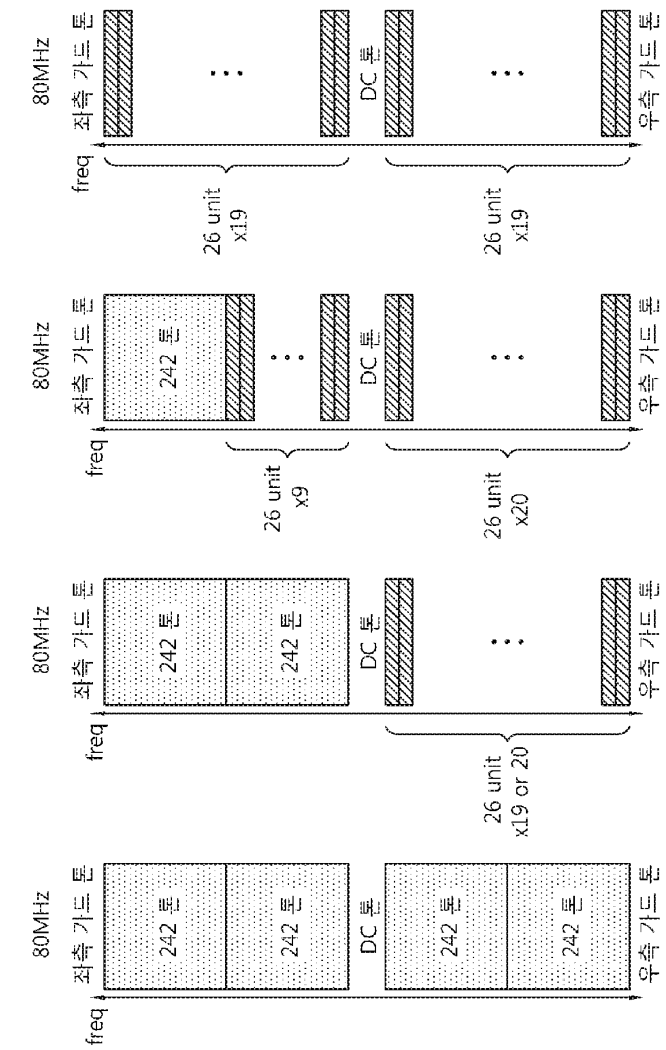
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[도6]



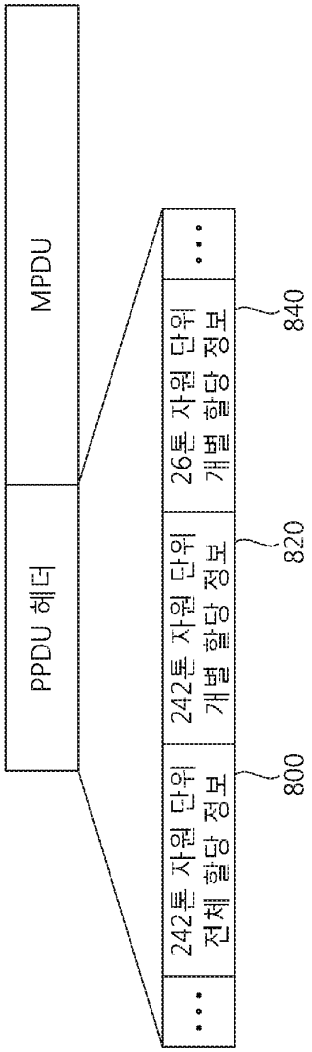
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[도7]



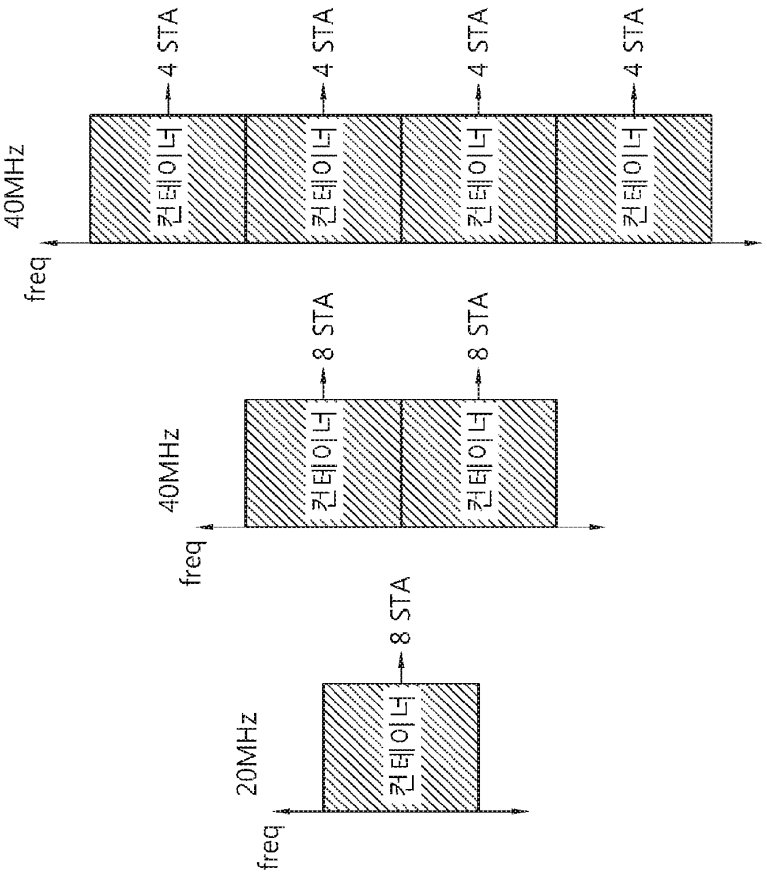
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[도8]



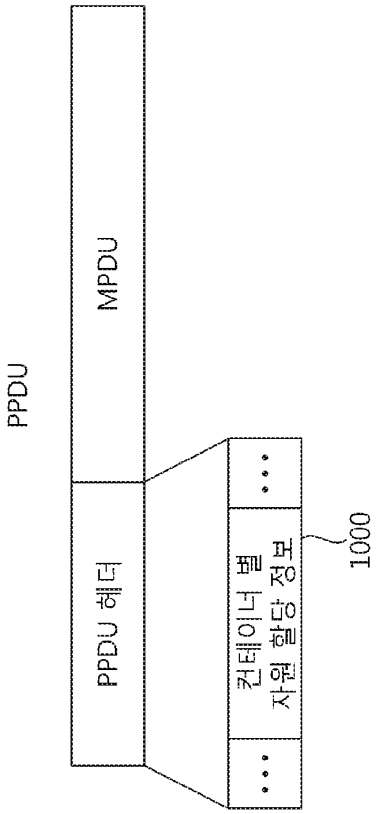
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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
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[도9]



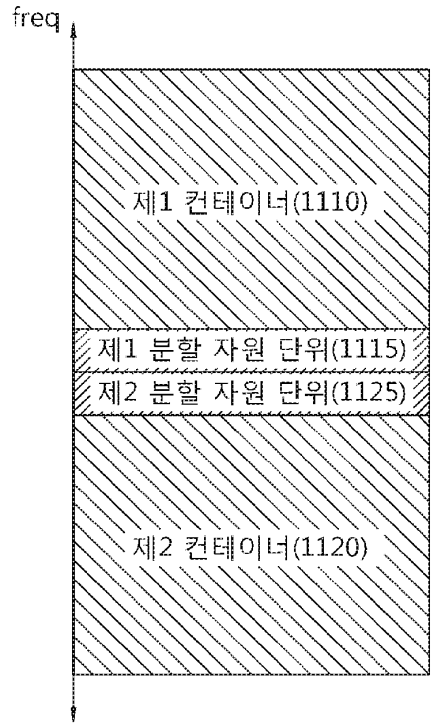
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[도10]



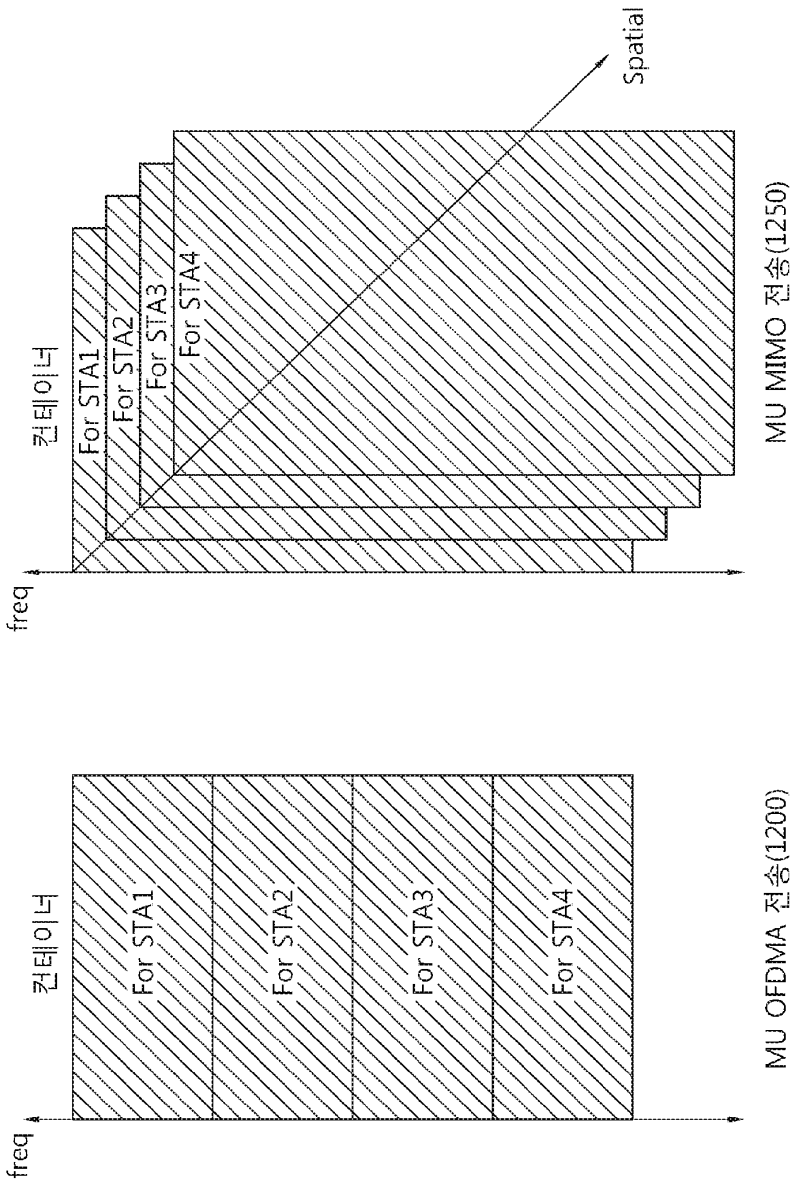
Samsung Exhibit 1006, Page 204 of 647
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[도11]



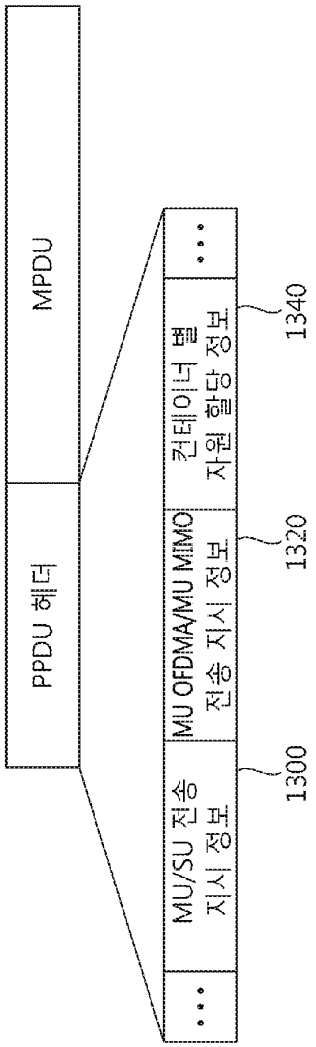
Samsung Exhibit 1006, Page 205 of 647
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[도12]



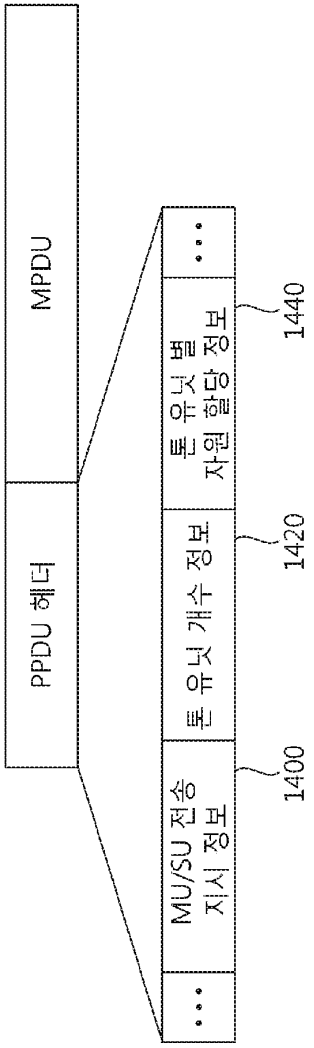
Samsung Exhibit 1006, Page 206 of 647
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[도13]



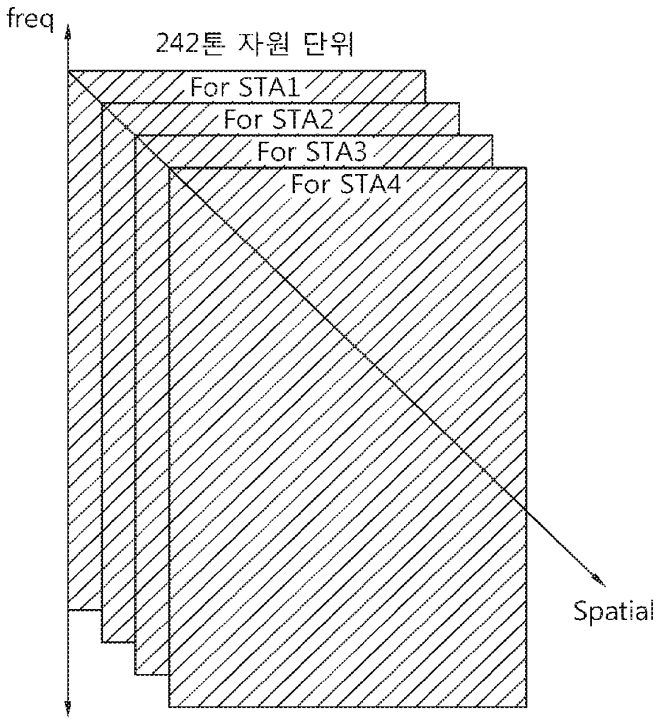
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[도14]



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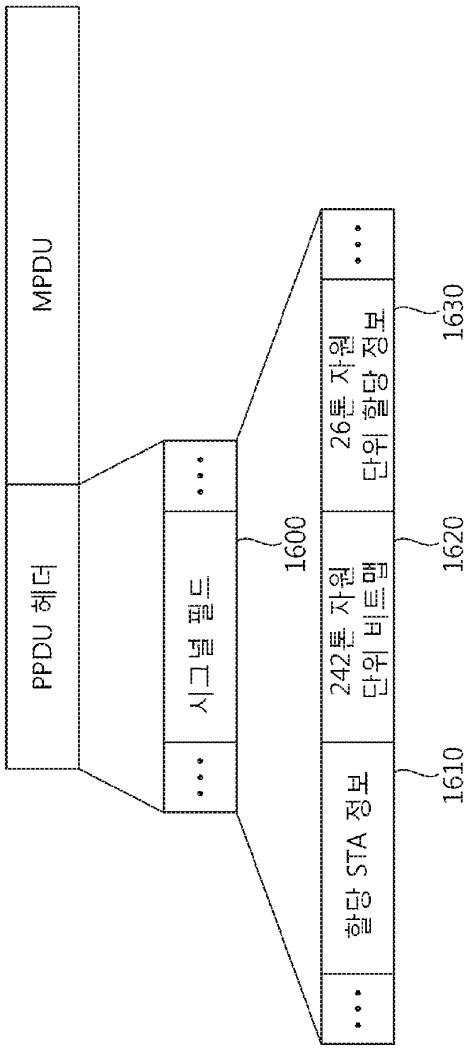
[도15]



MU MIMO 전송
최대 4개의 STA 지원

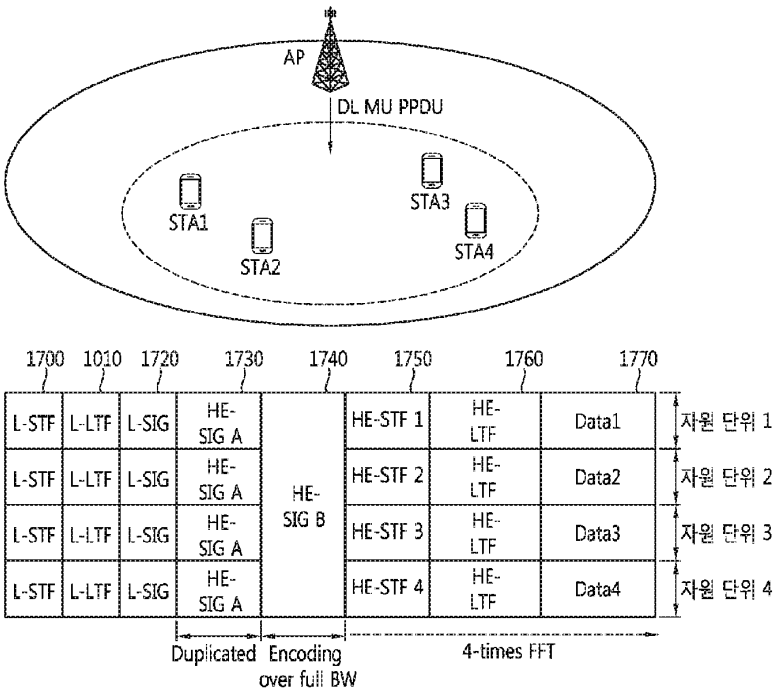
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[도16]



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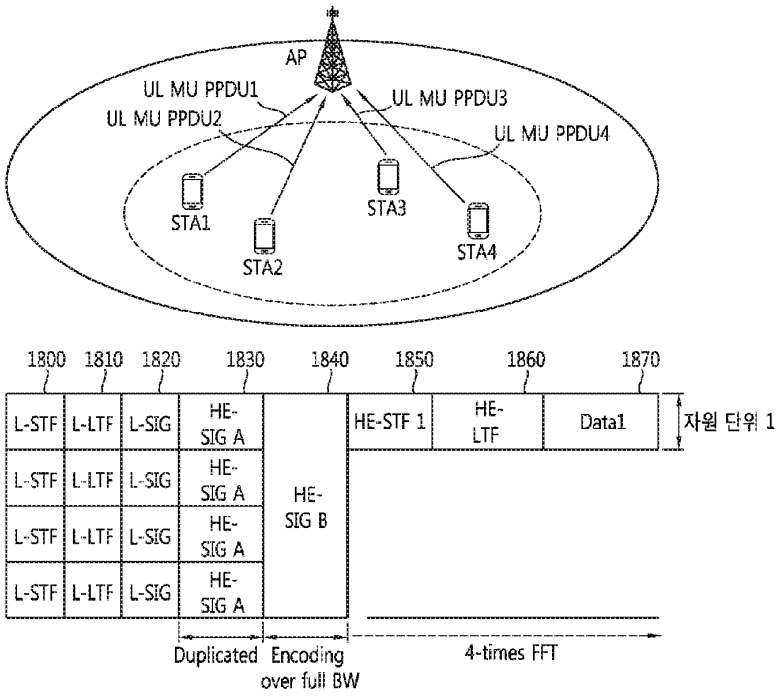
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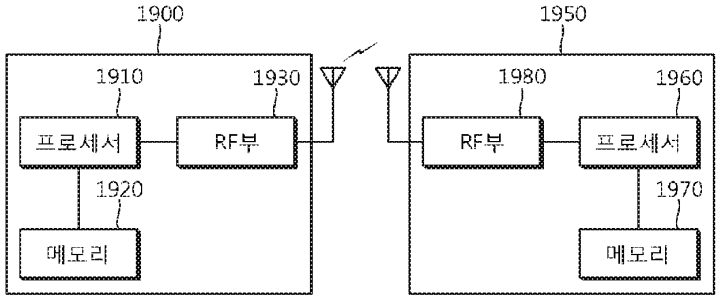
DL MU PPDU

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[도18]



[도19]



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/011855

A. CLASSIFICATION OF SUBJECT MATTER

H04L 5/00(2006.01)i, H04W 72/04(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L 5/00; H04L 1/06; H04W 72/04; H04W 84/02; H04B 7/04; H04W 84/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: WLAN, resource unit, allocation, PPDU, container, resource allocation information, MU/SU transmission indication information, the number of STAs, the number of tones

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012-0327871 A1 (GHOSH, Monisha et al.) 27 December 2012 See paragraphs [0068]-[0080]; and figures 3A-4C.	1-10
A	KR 10-2012-0095434 A (LG ELECTRONICS INC.) 28 August 2012 See paragraphs [0063]-[0076]; and figure 3.	1-10
A	US 2013-0148644 A1 (FUTUREWEI TECHNOLOGIES, INC.) 13 June 2013 See paragraphs [0028]-[0035]; and figures 2a-3b.	1-10
A	US 2011-0002319 A1 (HUSEN, Sri Andari et al.) 06 January 2011 See paragraphs [0029]-[0043]; and figures 2-4.	1-10
A	NEWRACOM, "IIEW PPDU Format for Supporting MIMO-OFDMA", IEEE 802.11-14/1210rt, 16 September 2014 See pages 2-15.	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 FEBRUARY 2016 (18.02.2016)	**18 FEBRUARY 2016 (18.02.2016)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent document cited in search report	Publication date	Patent family member	Publication date
US 2012-0327871 A1	27/12/2012	EP 2724488 A1	30/04/2014
		KR 10-2014-0053128 A	07/05/2014
		TW 201308960 A	16/02/2013
		WO 2012-177993 A1	27/12/2012
KR 10-2012-0095434 A	28/08/2012	AU 2010-293217 B2	07/08/2014
		CA 2771605 A1	17/03/2011
		CA 2786622 A1	18/08/2011
		CA 2786622 C	28/04/2015
		CN 102484522 A	30/05/2012
		CN 102484522 B	17/12/2014
		CN 104378149 A	25/02/2015
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		KR 10-2010-0127248 A	03/12/2010
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국 제 조 사 보 고 서

국제출원번호
PCT/KR2015/011855

A. 발명이 속하는 기술분류(국제특허분류(IPC))

H04L 5/00(2006.01)i, H04W 72/04(2009.01)i

B. 조사된 분야

조사된 최소문헌(국제특허분류를 기재)
H04L 5/00; H04L 1/06; H04W 72/04; H04W 84/02; H04B 7/04; H04W 84/12

조사된 기술분야에 속하는 최소문헌 이외의 문헌
한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC
일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))
eKOMPASS(특허청 내부 검색시스템) & 키워드: WLAN, 자원 단위, 할당, PPDU, 컨테이너, 자원 할당 정보, MU/SU 전송 지시 정보, STA 개수, 톤의 개수

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
A	US 2012-0327871 A1 (MONISHA GHOSH 등) 2012.12.27 단락 [0068]-[0080]; 및 도면 3A-4C 참조.	1-10
A	KR 10-2012-0095434 A (엘지전자 주식회사) 2012.08.28 단락 [0063]-[0070]; 및 도면 3 참조.	1-10
A	US 2013-0148644 A1 (FUTUREWEI TECHNOLOGIES, INC.) 2013.06.13 단락 [0028]-[0035]; 및 도면 2a-3b 참조.	1-10
A	US 2011-0002319 A1 (SRI ANDARI HUSEN 등) 2011.01.06 단락 [0029]-[0043]; 및 도면 2-4 참조.	1-10
A	NEWRACOM, `HEW PPDU Format for Supporting MIMO-OFDMA`, IEEE 802.11-14/1210r1, 2014.09.16 페이지 2-15 참조.	1-10

☐ 추가 문헌이 C(계속)에 기재되어 있습니다.

☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌; 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌; 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2016년 02월 18일 (18.02.2016)	2016년 02월 18일 (18.02.2016)

ISA/KR의 명칭 및 우편주소
대한민국 특허청
(35208) 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사)
팩스 번호 :82-42-472-7140

심사관
장희곡
전화번호 +82-42-481-8264

서식 PCT/ISA/210 (두 번째 용지) (2015년 1월)

Samsung Exhibit 1006, Page 215 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

국제조사보고서
대응특허에 관한 정보

국제출원번호
PCT/KR2015/011855

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
US 2012-0327871 A1	2012/12/27	EP 2724488 A1	2014/04/30
		KR 10-2014-0053128 A	2014/05/07
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		EP 2263407 A1	2010/12/22
		JP 2011-515051 A	2011/05/12
		JP 5503561 B2	2014/05/28
		KR 10-2010-0127248 A	2010/12/03
		TW 201006284 A	2010/02/01
		WO 2009-109894 A1	2009/09/11

Electronic Acknowledgement Receipt

EFS ID:	33698724
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	12-SEP-2018
Filing Date:	10-AUG-2017
Time Stamp:	14:14:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	1426-148-101--IDSasFiled09122018.pdf	53526 49272a93eae0b3673f19fa6f97bd87028a402a23	no	2
Warnings:					

Information:					
This is not an USPTO supplied IDS fillable form					
2	Foreign Reference	WO2016072766.pdf	6725386 b4d388051f901e81ed0a39ac6f71edf49a8056bb	no	65
Warnings:					
Information:					
3	Non Patent Literature	NPL--1050198-KR-1OA.pdf	1553360 7719d80b06a05fd79fbb65adefdbfdab352b038a	no	4
Warnings:					
Information:					
4	Non Patent Literature	NPL--1050198-KR-1OAEng.pdf	42427 0b05b9573eaea2f01da77294b70d2108d196e676	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	8374699		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15674483
Filing Date	2017-08-10
First Named Inventor	LIN, KO-CHIANG
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	1426-148.101

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110032850		2011-02-10	Cai	
	2	20110103406		2011-05-05	Cai et al.	
	3	20160150532		2016-05-26	Bhushan et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	LIN, KO-CHIANG
	Art Unit	2464
	Examiner Name	Ricky Quoc Ngo
	Attorney Docket Number	1426-148.101

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Office Action from Taiwan Intellectual Property Office in the corresponding TW Application No. 106127180, dated May 7, 2018.	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

Electronic Acknowledgement Receipt

EFS ID:	32614876
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	14-MAY-2018
Filing Date:	10-AUG-2017
Time Stamp:	14:48:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	1426-148-101--IDsasFiled05142018.pdf	54378 d07a32b00cb1bf6e4f270b0897b1a43654eb2aa0	no	2

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Information:					
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2	Non Patent Literature	NPL-TIPO106127180.pdf	617272 a56ab4d6b29d43cecadfe616f4efb75cd474d9fe	no	14
Warnings:					
Information:					
		Total Files Size (in bytes):	671650		

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New Applications Under 35 U.S.C. 111

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/674,483	08/10/2017	Ko-Chiang Lin	1426-148.101

CONFIRMATION NO. 7684

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

PUBLICATION NOTICE

OC00000097451527

Title:METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

Publication No.US-2018-0049169-A1
Publication Date:02/15/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15674483
Filing Date	2017-08-10
First Named Inventor	Ko-Chiang Lin
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	1426-148.101

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110081913		2011-04-07	Jung A. Lee	

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2010138921	WO		2010-12-02	ZTE USA Inc.		☐
	2	2016072766	WO		2016-05-12	LG Electronics Inc.		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2464
	Examiner Name	Ricky Quoc Ngo
	Attorney Docket Number	1426-148.101

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	HUAWEI ET AL: "Initial access in NR", 3GPP DRAFT; R2-163923 INITIAL ACCESS IN NR, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE vol. RAN WG2, no. Nanjing, China; 20160523 -20160527 22 May 2016 (2016-05-22), XPO51105295, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN2/Docs/	☐
	2	European search report from corresponding EP Application No. 17185732.9, dated December 22, 2017.	☐

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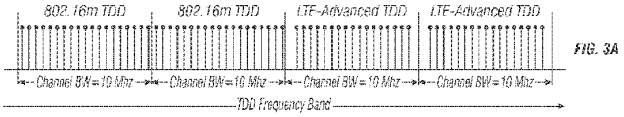


FIG. 3A

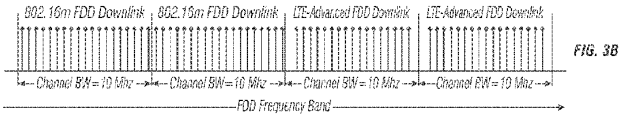


FIG. 3B

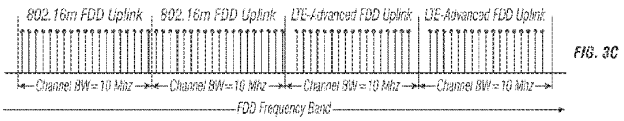


FIG. 3C

(57) Abstract: A station is disclosed that is configured for signal transmission in an Orthogonal Frequency Division Multiple Access (OFDMA) system. The station includes a processor configured to fix a subcarrier spacing to a predetermined value for one or more subframes in all available bandwidths. The station further includes a transmitter configured to transmit a signal having the fixed subcarrier spacing, regardless of a frame structure of the one or more subframes. According to certain embodiments, the predetermined value may be divided evenly by at least one channel raster. The predetermined value may be 12.5 KHz, according to certain embodiments. Alternatively, the predetermined value is 6.25 KHz for one or more low mobility mobile stations, and/or the predetermined value is 25 KHz for one or more high mobility mobile stations. The station may be a mobile station or a base station configured for uplink and downlink transmission.

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SIGNAL TRANSMISSION WITH FIXED SUBCARRIER SPACING WITHIN OFDMA COMMUNICATION SYSTEMS

Cross-Reference to Related Applications

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/182,658 filed on May 29, 2009, entitled "Further Considerations on OFDMA Numerology", and U.S. Provisional Patent Application No. 61/185,170 filed on June 8, 2009, entitled "Further Considerations on OFDMA Numerology," the contents of which are incorporated by reference herein in their entirety.

Field of the Invention

[0002] The present invention relates generally to numerology in wireless communication systems, and more particularly to signal transmission with fixed subcarrier spacing in Orthogonal Frequency Division Multiple Access (OFDMA) communication systems.

Background

[0003] Two competing IMT-Advanced technologies are based on Long Term Evolution (LTE)-Advanced and IEEE 802.16m. 3GPP is developing an IMT-Advanced specification based on a newly completed LTE standard, which is to be adopted as the 4G standard. The air interface specification of Wireless Interoperability for Microwave Access (WiMAX) has been provided by the IEEE 802.16 standard, and the IEEE 802.16 Task Group m (TGm) is actively developing evolutionary specifications based on existing IEEE 802.16 and WiMAX profiles for IMT-Advanced submissions.

[0004] However, LTE and IEEE 802.16 have adopted different values of subcarrier spacing. LTE has fixed its subcarrier spacing to 15 KHz, but IEEE 802.16 has made its subcarrier spacing a variable for different sets of system bandwidths, namely 10.9375 KHz, 7.8125 KHz, 9.765625 KHz, etc. It is desired that the design of IEEE 802.16m enable it to be a cost-effective, global and competitive technology well into the future. Meeting these needs

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will require some balance between how IEEE 802.16m will be constrained by the requirement to support legacy mobile stations while continuing to meet the needs of a global IMT-Advanced technology.

[0005] IEEE 802.16m SRD requires that IEEE 802.16m shall meet the IMT-Advanced requirements. And all enhancements included as part of IEEE 802.16m should promote the concept of continued evolution, allowing IEEE 802.16 to maintain competitive performance as technology advances beyond 802.16m. On the other hand, the IEEE 802.16m standard requires that IEEE 802.16m shall provide continuing support and interoperability for a Wireless MAN-OFDMA Reference System which is defined as being system compliant with the capabilities set specified by the WiMAX Forum Mobile System Profile Release 1.0. For example, based on the backward compatibility requirements, 802.16m base stations shall support 802.16m and legacy mobile stations when both are operating on the same RF carrier.

[0006] However, there are problems existing in current legacy system designs. Some of them have an unfavorable impact of system implementation, network deployment and equipment cost. Thus, it is desirable to prevent the inheritance of the legacy systems' drawbacks as the 802.16m system is designed.

Summary of the Invention

[0007] The presently disclosed embodiments are directed to solving one or more of the problems presented in the prior art, described above, as well as providing additional features that will become readily apparent by reference to the following detailed description when taken in conjunction with the accompanying drawings.

[0008] In the following description, embodiments of the invention are disclosed that provide that in order for 802.16m (referred to herein as "16m") to be a cost-effective, competitive, global technology, it should adopt a different approach to OFDMA configuration in which the subcarrier spacing is fixed to a value that properly serves the radio environments in which 16m is intended to operate and which is highly compatible with available and potential future carrier bandwidths. To this end, according to various embodiments, the physical layer of IEEE 802.16m is proposed to be based on a fixed subcarrier spacing of 12.5 kHz, for example; the rationale for this approach and the selection of this particular spacing and the issues with retaining the current OFDMA parameters are

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described in detail in the remainder of this document. It is also suggested that TDD LTE-Advanced can adopt the same subcarrier spacing, so that the two systems can work side-by-side in adjacent channels without cross-channel interference. With the same subcarrier spacing of 12.5 KHz, for example, both LTE-Advanced and IEEE 802.16m can share the same sampling frequency, and the same piece of hardware can support both LTE-Advanced and IEEE 802.16m in all available bandwidths in all frequency bands in the world.

[0009] One embodiment of the present invention is directed to a method for signal transmission in an Orthogonal Frequency Division Multiple Access (OFDMA) system. According to certain embodiments, the method may include fixing a subcarrier spacing to a predetermined value for one or more subframes in all available bandwidths; and transmitting a signal having the fixed subcarrier spacing, regardless of a frame structure of the one or more subframes.

[0010] Another embodiment is directed to a station is disclosed that is configured for signal transmission in an OFDMA system. The station includes a processor configured to fix a subcarrier spacing to a predetermined value for one or more subframes in all available bandwidths. The station further includes a transmitter configured to transmit a signal having the fixed subcarrier spacing, regardless of a frame structure of the one or more subframes. The station may be a mobile station or a base station configured for uplink and downlink transmission.

[0011] Yet another embodiment is directed to a computer-readable medium storing executable instructions thereon for performing method for signal transmission in an OFDMA system. The method may include fixing a subcarrier spacing to a predetermined value for one or more subframes in all available bandwidths; and transmitting a signal having the fixed subcarrier spacing, regardless of a frame structure of the one or more subframes.

[0012] According to certain embodiments, the predetermined value may be divided evenly by at least one channel raster. The common value for the channel raster can include 100kHz, 200kHz and/or 250kHz, for example.

[0013] The predetermined value may be 12.5 KHz, according to certain embodiments. Alternatively, the predetermined value is 6.25 KHz for one or more low mobility mobile stations, and/or the predetermined value is 25 KHz for one or more high mobility mobile stations. By adopting the proposed solutions described herein, the IEEE 8016m design become much cleaner and simpler with noticeably improved performance. The

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problems and challenges described above, among others that will become apparent, can be resolved by the proposed solutions described herein.

[0014] Further features and advantages of the present disclosure, as well as the structure and operation of various embodiments of the present disclosure, are described in detail below with reference to the accompanying drawings.

Brief Description of the Drawings

[0015] The present disclosure, in accordance with one or more various embodiments, is described in detail with reference to the following Figures. The drawings are provided for purposes of illustration only and merely depict exemplary embodiments of the disclosure. These drawings are provided to facilitate the reader's understanding of the disclosure and should not be considered limiting of the breadth, scope, or applicability of the disclosure. It should be noted that for clarity and ease of illustration these drawings are not necessarily made to scale.

[0016] Fig. 1 is an illustration of an exemplary OFDM/OFDMA mobile radio channel operating environment, according to an embodiment.

[0017] Fig. 2 is an illustration of an exemplary OFDM/OFDMA exemplary communication system according to an embodiment.

[0018] Figs. 3(a)-3(c) show examples of common subcarrier spacing of 12.5 kHz in TDD and FDD bands, according to an embodiment.

[0019] Fig. 4 is a diagram of carriers in a wireless communication system operated as adjacent carriers, according to an embodiment.

[0020] Fig. 5 is a diagram of carriers in a wireless communication system operated as adjacent carriers, according to an embodiment.

[0021] Fig. 6 shows an illustration of mixed bandwidths multi-carrier deployment without guard bands, according to an embodiment.

[0022] Figs. 7(a) and 7(b) provide exemplary frame structures for Type 1 and Type 2 frame structures, respectively, according to an embodiment.

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[0023] Figs. 8(a) and 8(b) provide exemplary frame structures for Type 3 frame structures for FDD mode and TDD mode, respectively, according to an embodiment.

[0024] Fig. 9 illustrates superframe and frame configurations with trie data structures, according to an embodiment.

[0025] Figs. 10(a) and 10(b) provide exemplary frame structures for Type 4 frame structures for FDD mode and TDD mode, respectively, according to an embodiment.

[0026] Figs. 11(a) and 11(b) show exemplary pilot patterns for 1 and 2 data streams, respectively, according to an embodiment.

[0027] Fig. 12 shows exemplary pilot patterns for 4 data streams, according to an embodiment.

[0028] Fig. 13 shows exemplary pilot patterns for 8 data streams, according to an embodiment of the present disclosure.

[0029] Figs. 14(a) and 14(b) show pilot patterns for uplink only distributed resource blocks, according to an embodiment.

[0030] Fig. 15 shows an example of legacy support by frame structure Type 3 in TDD mode, according to an embodiment.

[0031] Fig. 16 shows an example of legacy support by frame structure Type 4 in TDD mode, according to an embodiment.

[0032] Fig. 17 shows an exemplary illustration of deployment with mixed base stations and mobile stations, according to an embodiment.

[0033] Fig. 18 shows an example of a legacy IEEE 802.16 system deployment with 10MHz channel bandwidth, according to an embodiment.

[0034] Fig. 19 shows an example of a multi-carrier deployment with 10, 20 and 30 MHz channel bandwidth, without guard bands, according to an embodiment.

[0035] Fig. 20 illustrates a multi-CP network deployment for frame structures Type 1 and Type 2, according to an embodiment.

[0036] Fig. 21 illustrates a multi-CP network deployment for frame structure Type 3, according to an embodiment.

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Detailed Description of Exemplary Embodiments

[0037] The following description is presented to enable a person of ordinary skill in the art to make and use the invention. Descriptions of specific devices, techniques, and applications are provided only as examples. Various modifications to the examples described herein will be readily apparent to those of ordinary skill in the art, and the general principles defined herein may be applied to other examples and applications without departing from the spirit and scope of the invention. Thus, the present invention is not intended to be limited to the examples described herein and shown, but is to be accorded the scope consistent with the claims.

[0038] The word "exemplary" is used herein to mean "serving as an example or illustration." Any aspect or design described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects or designs.

[0039] Reference will now be made in detail to aspects of the subject technology, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0040] It should be understood that the specific order or hierarchy of steps in the processes disclosed herein is an example of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[0041] Embodiments disclosed herein describe a wireless cellular communication system where the transmission direction from a base station to mobile station is called downlink, while the opposite direction is called uplink. On both downlink and uplink, the radio signal transmissions over the time are divided into periodic frames (or subframes, slots, etc). Each radio frame contains multiple time symbols that include data symbols (DS) and reference symbols (RS). Data symbols carry the data information, while the reference symbols are known at both transmitter and receiver, and are used for channel estimation purposes. Note that the functions described in the present disclosure may be performed by either a base station or a mobile station. A mobile station may be any user device such as a mobile phone, and a mobile station may also be referred to as user equipment (UE).

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[0042] Aspects of the present disclosure are directed toward systems and methods for OFDM/OFDMA frame structure technology for communication systems. Embodiments of the invention are described herein in the context of one practical application, namely, communication between a base station and a plurality of mobile devices. In this context, the exemplary system is applicable to provide data communications between a base station and a plurality of mobile devices. Embodiments of the disclosure, however, are not limited to such base station and mobile device communication applications, and the methods described herein may also be utilized in other applications such as mobile-to-mobile communications, or wireless local loop communications. As would be apparent to one of ordinary skill in the art after reading this description, these are merely examples and the invention is not limited to operating in accordance with these examples. Assignment of resources within a frame to the data being carried can be applied to any digital communications system with data transmissions organized within a frame structure and where the full set of such resources within a frame can be flexibly divided according to portions of different sizes to the data being carried. Thus, the present disclosure is not limited to any particular type of communication system; however, embodiments of the present invention are described herein with respect to exemplary OFDM/OFDMA systems.

[0043] As explained in additional detail below, the OFDM/OFDMA frame structure comprises a variable length sub-frame structure with an efficiently sized cyclic prefix operable to effectively utilize OFDM/OFDMA bandwidth. The frame structure provides compatibility with multiple wireless communication systems.

[0044] Fig. 1 illustrates a mobile radio channel operating environment 100, according to one embodiment of the present invention. The mobile radio channel operating environment 100 may include a base station (BS) 102, a mobile station (MS) 104, various obstacles 106/108/110, and a cluster of notional hexagonal cells 126/130/132/134/136/138/140 overlaying a geographical area 101. Each cell 126/130/132/134/136/138/140 may include a base station operating at its allocated bandwidth to provide adequate radio coverage to its intended users. For example, the base station 102 may operate at an allocated channel transmission bandwidth to provide adequate coverage to the mobile station 104. The exemplary mobile station 104 in Fig. 1 is an automobile; however mobile station 104 may be any user device such as a mobile phone. Alternately, mobile station 104 may be a personal digital assistant (PDA) such as a Blackberry device,

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MP3 player or other similar portable device. According to some embodiments, mobile station 104 may be a personal wireless computer such as a wireless notebook computer, a wireless palmtop computer, or other mobile computer devices.

[0045] The base station 102 and the mobile station 104 may communicate via a downlink radio frame 118, and an uplink radio frame 124 respectively. Each radio frame 118/124 may be further divided into sub-frames 120/126 which may include data symbols 122/124. In this mobile radio channel operating environment 100, a signal transmitted from a base station 102 may suffer from the operating conditions mentioned above. For example, multipath signal components 112 may occur as a consequence of reflections, scattering, and diffraction of the transmitted signal by natural and/or man-made objects 106/108/110. At the receiver antenna 114, a multitude of signals may arrive from many different directions with different delays, attenuations, and phases. Generally, the time difference between the arrival moment of the first received multipath component 116 (typically the line of sight component), and the last received multipath component (possibly any of the multipath signal components 112) is called delay spread. The combination of signals with various delays, attenuations, and phases may create distortions such as ISI and ICI in the received signal. The distortion may complicate reception and conversion of the received signal into useful information. For example, delay spread may cause ISI in the useful information (data symbols) contained in the radio frame 124.

[0046] OFDM can mitigate delay spread and many other difficult operating conditions. OFDM divides an allocated radio communication channel into a number of orthogonal subchannels of equal bandwidth. Each subchannel is modulated by a unique group of subcarrier signals, whose frequencies are equally and minimally spaced for optimal bandwidth efficiency. The group of subcarrier signals are chosen to be orthogonal, meaning the inner product of any two of the subcarriers equals zero. In this manner, the entire bandwidth allocated to the system is divided into orthogonal subcarriers. OFDMA is a multi-user version of OFDM. For a communication device such as the base station 102, multiple access is accomplished by assigning subsets of orthogonal sub-carriers to individual subscriber devices. A subscriber device may be a mobile station 104 with which the base station 102 is communicating.

[0047] Fig. 2 shows an exemplary wireless communication system 200 for transmitting and receiving OFDM/OFDMA transmissions, in accordance with one

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embodiment of the present invention. The system 200 may include components and elements configured to support known or conventional operating features that need not be described in detail herein. In the exemplary embodiment, system 200 can be used to transmit and receive OFDM/OFDMA data symbols in a wireless communication environment such as the wireless communication environment 100 (Fig. 1). System 200 generally comprises a base station 102 with a base station transceiver module 202, a base station antenna 206, a base station processor module 216 and a base station memory module 218. System 200 generally comprises a mobile station 104 with a mobile station transceiver module 208, a mobile station antenna 212, a mobile station memory module 220, a mobile station processor module 222, and a network communication module 226. Of course both BS 102 and MS 104 may include additional or alternative modules without departing from the scope of the present invention.

[0048] Furthermore, these and other elements of system 200 may be interconnected together using a data communication bus (*e.g.*, 228, 230), or any suitable interconnection arrangement. Such interconnection facilitates communication between the various elements of wireless system 200. Those skilled in the art will understand that the various illustrative blocks, modules, circuits, and processing logic described in connection with the embodiments disclosed herein may be implemented in hardware, computer-readable software, firmware, or any practical combination thereof. To clearly illustrate this interchangeability and compatibility of hardware, firmware, and software, various illustrative components, blocks, modules, circuits, and steps are described generally in terms of their functionality. Whether such functionality is implemented as hardware, firmware, or software depends upon the particular application and design constraints imposed on the overall system. Those familiar with the concepts described herein may implement such functionality in a suitable manner for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

[0049] In the exemplary OFDM/OFDMA system 200, the base station transceiver 202 and the mobile station transceiver 208 each comprise a transmitter module and a receiver module (not shown). Additionally, although not shown in this figure, those skilled in the art will recognize that a transmitter may transmit to more than one receiver, and that multiple transmitters may transmit to the same receiver. In a TDD system, transmit and receive timing

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gaps exist as guard bands to protect against transitions from transmit to receive and vice versa.

[0050] In the particular example of the OFDM/OFDMA system depicted in Figure 2, an "uplink" transceiver 208 includes an OFDM/OFDMA transmitter that shares an antenna with an uplink receiver. A duplex switch may alternatively couple the uplink transmitter or receiver to the uplink antenna in time duplex fashion. Similarly, a "downlink" transceiver 202 includes an OFDM/OFDMA receiver which shares a downlink antenna with a downlink transmitter. A downlink duplex switch may alternatively couple the downlink transmitter or receiver to the downlink antenna in time duplex fashion.

[0051] Although many OFDM/OFDMA systems will use OFDM/OFDMA technology in both directions, those skilled in the art will recognize that the present embodiments of the invention are applicable to systems using OFDM/OFDMA technology in only one direction, with an alternative transmission technology (or even radio silence) in the opposite direction. Furthermore, it should be understood by a person of ordinary skill in the art that the OFDM/OFDMA transceiver modules 202/208 may utilize other communication techniques such as, without limitation, a frequency division duplex (FDD) communication technique.

[0052] The mobile station transceiver 208 and the base station transceiver 202 are configured to communicate via a wireless data communication link 214. The mobile station transceiver 208 and the base station transceiver 202 cooperate with a suitably configured RF antenna arrangement 206/212 that can support a particular wireless communication protocol and modulation scheme. In the exemplary embodiment, the mobile station transceiver 208 and the base station transceiver 202 are configured to support industry standards such as the Third Generation Partnership Project Long Term Evolution (3GPP LTE), Third Generation Partnership Project 2 Ultra Mobile Broadband (3Gpp2 UMB), Time Division-Synchronous Code Division Multiple Access (TD-SCDMA), and Wireless Interoperability for Microwave Access (WiMAX), and the like. The mobile station transceiver 208 and the base station transceiver 202 may be configured to support alternate, or additional, wireless data communication protocols, including future variations of IEEE 802.16, such as 802.16e, 802.16m, and so on.

[0053] According to certain embodiments, the base station 102 controls the radio resource allocations and assignments, and the mobile station 104 is configured to decode and

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interpret the allocation protocol. For example, such embodiments may be employed in systems where multiple mobile stations 104 share the same radio channel which is controlled by one base station 102. However, in alternative embodiments, the mobile station 104 controls allocation of radio resources for a particular link, and could implement the role of radio resource controller or allocator, as described herein.

[0054] Processor modules 216/222 may be implemented, or realized, with a general purpose processor, a content addressable memory, a digital signal processor, an application specific integrated circuit, a field programmable gate array, any suitable programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof, designed to perform the functions described herein. In this manner, a processor may be realized as a microprocessor, a controller, a microcontroller, a state machine, or the like. A processor may also be implemented as a combination of computing devices, e.g., a combination of a digital signal processor and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a digital signal processor core, or any other such configuration. Processor modules 216/222 comprise processing logic that is configured to carry out the functions, techniques, and processing tasks associated with the operation of OFDM/OFDMA system 200. In particular, the processing logic is configured to support the OFDM/OFDMA frame structure parameters described herein. In practical embodiments the processing logic may be resident in the base station and/or may be part of a network architecture that communicates with the base station transceiver 202.

[0055] The steps of a method or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in firmware, in a software module executed by processor modules 216/222, or in any practical combination thereof. A software module may reside in memory modules 218/220, which may be realized as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. In this regard, memory modules 218/220 may be coupled to the processor modules 218/222 respectively such that the processors modules 216/220 can read information from, and write information to, memory modules 618/620. As an example, processor module 216, and memory modules 218, processor module 222, and memory module 220 may reside in their respective ASICs. The memory modules 218/220 may also be integrated into the processor modules 216/220. In an embodiment, the memory module 218/220 may include a

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cache memory for storing temporary variables or other intermediate information during execution of instructions to be executed by processor modules 216/222. Memory modules 218/220 may also include non-volatile memory for storing instructions to be executed by the processor modules 216/220.

[0056] Memory modules 218/220 may include a frame structure database (not shown) in accordance with an exemplary embodiment of the invention. Frame structure parameter databases may be configured to store, maintain, and provide data as needed to support the functionality of system 200 in the manner described below. Moreover, a frame structure database may be a local database coupled to the processors 216/222, or may be a remote database, for example, a central network database, and the like. A frame structure database may be configured to maintain, without limitation, frame structure parameters as explained below. In this manner, a frame structure database may include a lookup table for purposes of storing frame structure parameters.

[0057] The network communication module 226 generally represents the hardware, software, firmware, processing logic, and/or other components of system 200 that enable bi-directional communication between base station transceiver 202, and network components to which the base station transceiver 202 is connected. For example, network communication module 226 may be configured to support internet or WiMAX traffic. In a typical deployment, without limitation, network communication module 226 provides an 802.3 Ethernet interface such that base station transceiver 202 can communicate with a conventional Ethernet based computer network. In this manner, the network communication module 226 may include a physical interface for connection to the computer network (e.g., Mobile Switching Center (MSC)).

[0058] In accordance with embodiments described herein, time-frequency allocation units are referred to as Resource Blocks (RBs). A Resource Block (RB) is defined as a fixed-size rectangular area within a subframe comprised of a specified number of subcarriers (frequencies) and a specified number of OFDMA symbols (time slots). An RB is the smallest fundamental time-frequency unit that may be allocated to an 802.16m user.

[0059] Figs. 3(a)-3(c) show examples of common subcarrier spacing of 12.5 kHz in TDD and FDD bands, according to an embodiment. Table 1 below provides a summary comparing how the new 12.5-kHz subcarrier spacing compares with the various options of retaining the current subcarrier spacing(s) in meeting key design considerations for 802.16m.

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Key Design Considerations	Design Approach for 16m & LTE-Advanced Subcarrier Spacing		
	New 12.5 kHz	Retain Current 16e & LTE Subcarrier Spacings	
		Multiple Spacings 'As Is' (16e)	15 kHz (LTE)
Greenfield (Legacy-free) Considerations			
Lower Hardware Cost	√	X	√
Simplified Global Roaming	√	X	√
Maximize usable bandwidth within carrier adjacent multi-carrier scenarios	√ (1)	X	X (2)
Enable efficient adjacent multicarrier operation with different bandwidths	√	X	X (2)
Enable multicarrier overlay scenarios of different bandwidths	√	X	X
Simplified adaptation to new carrier bandwidths (e.g. 6/12 MHz)	√	X	√-- (3)
Legacy Support Considerations			
Legacy support via TDM multiplexing between 16e and 16m, or between LTE and LTE-Advanced	√	√	√
Legacy support via FDM multiplexing between 16e and 16m	√-- (4)	√- (5)	N/A
16e and 16m or LTE and LTE-Advanced sharing of same freq/time area	√-- (6)	√- (7)	√ (8)
Less hardware re-design	√- (9)	√- (10)	√- (10)
Inter-RAT Co-existence Considerations			
Ease of co-existence with other IMT-Advanced Technologies (e.g. LTE) with Frame Slot Time Alignment	√	x (11)	x (11)

NOTES

√ indicates is able to satisfy

√- indicates is able to satisfy but with some undesirable constraints

√-- indicates is able to satisfy but not preferred due to significant drawbacks

X indicates is not feasible or not practical

(1) Alignment of subcarrier spacing between adjacent subcarriers allows full carrier bandwidth to be utilized if adjacent carriers are 16m … resulting in >8%

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improvement in available used bandwidth.

(2)	This also results in additional loss due to guard bands required between edges of adjacent carriers since carrier bandwidths are not divisible evenly by the raster.
(3)	There may be some efficiency loss since 15 kHz subcarrier spacing does not divide most of available carrier bandwidths within spectrum band/block. Channel RF filter may be used to reduce out-of-band emission. On the other hand, the proposed 12.5 kHz subcarrier can divide any carrier bandwidths in any spectrum band/ block in the world, and no channel RF filter is required.
(4)	This can be done with additional hardware for parallel FFTs for different subcarrier spacings, coordinated subcarrier assignment for 16m & 16e, and sufficient guard subcarriers between 16e and 16m used subcarriers. Also, same constraints as (5).
(5)	This can be done but can constrain subcarrier arrangement options on 16m subcarriers for 16e distributed subcarrier permutations (e.g. PUSC). The resource blocks are differently defined in 16m and 16e, and FDM is practically unworkable.
(6)	16e and 16m support via TDM multiplexing between 16e and 16m in the same RF channel.
(7)	Maximizes resource sharing between 16e and 16m but 16m MSs need to operate in a combined 16e/16m mode (tight coupling to 16e). BS has to support both 16e and 16m at the same time. With new releases of 16e and 16m in the future, it makes it very challenging to design and support such BS.
(8)	No such requirements, but it can be done via TDM multiplexing.
(9)	Complexity of change depends heavily on current design.
(10)	One skilled in the art would realize that there may be PHY and/or MAC design changes for 16m. The similar reason goes to LTE-Advanced. However LTE-Advanced may expect smaller changes in PHY/MAC.
(11)	Zone and subframe boundaries based on current numerology do not line up well with LTE frame element timings. Major problem expected for TDD mode. Even in FDD, a tight RF channel filter is needed to reduce out-of-band emission. Adopting the same 12.5 kHz subcarrier spacing, No RF channel filters are needed for any two systems in different bandwidths for adjacent channel co-existence.

Table 1

[0060] OFDMA numerology is the base of OFDM technology and directly affects the frame structure design, which is one of the basic elements of the Physical Layer. Various problems are caused by OFDMA numerology used by legacy system and their effect on current legacy system. The following table describes the basic OFDMA numerology defined by current legacy system:

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Nominal Channel Bandwidth (MHz)		5	7	8.75	10	20
Over-sampling Factor		28/25	8/7	8/7	28/25	28/25
Sampling Frequency (MHz)		5.6	8	10	11.2	22.4
FFT Size		512	1024	1024	1024	2048
Sub-Carrier Spacing (kHz)		10.9375	7.8125	9.765625	10.9375	10.9375
Tu (us)		91.4	128	102.4	91.4	91.4
Cyclic Prefix (CP)	Ts (us)	Number of OFDM Symbols per Frame				Idle Time (us)
Tg=1/8 Tu	91.4 + 11.42=102.82 (for 5, 10, 20 MHz)	48 (for 5, 10, 20 MHz)				64.64
	128+16=144 (for 7 MHz)	34 (for 7 MHz)				104
	102.4+12.8=115.2 (for 8.75 MHz)	43 (for 8.75 MHz)				46.40

Table 2

[0061] The legacy systems with 5/10/20MHz, 3.5/7MHz and 8.75MHz have different subcarrier spacing values which are derived based on different series bandwidths, and therefore different sets of sampling frequencies. Such incompatible sampling frequency sets impose unnecessary complexity for equipment to support the various bandwidths. Based on the legacy support requirements, 802.16m BS 102 can support 802.16m and legacy MSs 104 when both are operating on the same RF carrier. However, there are three sets of legacy numerology in the 802.16 (or Mobile WiMAX) deployment, namely 5/10, 7/14, and 8.75. It is extremely crucial to support them all, to ensure global roaming compatibility with common

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equipment and devices. However, these legacy systems not only have different numerology parameters such as subcarrier spacing, they are often located in different frequency bands. These are significant challenges in the 16m design to support legacy systems.

[0062] The numerology based on a typical legacy 16e design can be found in Table 310a of IEEE 802.15e 2005, which is incorporated herein by reference. Out of 914 subcarriers that fall into the 10MHz bandwidth, there are only 840 subcarriers that can be used to transmit information. Thus, 8.8% of the bandwidth is wasted. Furthermore, the bandwidth occupied by the 914 subcarriers does not fully fill the 10-Mhz carrier bandwidth. The following is the formula on how to calculate the maximum frequency efficiency:

$$n_{Efficiency} = \frac{R_{Modulation} \times n_{UsedSubcarriers}}{T_{symobol} \times BW_{System}} \quad (1)$$

where $R_{Modulation}$ is modulation rate (e.g. 4 for 16QAM), $n_{UsedSubcarriers}$ is number of used subcarriers within the nominal system bandwidth, $T_{symobol}$ is symbol period, and BW_{System} is the nominal system bandwidth.

[0063] According to an example, set CP=0 to calculate the maximum $n_{Efficiency}$ of the system:

$$T_{symobol} = \frac{1}{f_{\Delta}} \quad (2)$$

where f_{Δ} is subcarrier spacing.

$$BW_{System} \geq n_{MaximumSubcarriers} \times f_{\Delta} \quad (3)$$

where $n_{MaximumSubcarriers}$ is the maximum number of subcarriers that a nominal system bandwidth can have.

[0064] Substituting Eq. 2 and Eq. 3 into Eq. 1, results in the following:

$$n_{Efficiency} \leq \frac{R_{Modulation} \times n_{UsedSubcarriers}}{n_{MaximumSubcarriers}} \quad (4)$$

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[0065] The frequency efficiency is proportional to the number of used subcarriers within the system bandwidth. For example, the 73 Guard Subcarriers ($n_{MaximumSubcarriers}$ - $n_{UsedSubcarriers}$=914-841=73) and 1 DC subcarrier can be used to transmit data, and divided by the maximum number of subcarriers of 914, the new 16m system can be immediately 8.8% more efficient. The proposed 16m numerology described herein allows all subcarriers to be used for data transmission without Guard Subcarriers since the subcarrier spacings between adjacent abutting carriers are aligned. This makes operation with the proposed 16m numerology to be 8.8%, according to this example, more efficient by design when compared to PUSC operation with the existing 16e numerology. When the operator bandwidth has sufficient guard band around a carrier, then the 8.8% need not be wasted.

[0066] Service providers, for example often prefer a solution such as scalable deployment plan, launching more carriers as the business grows. The incompatible subcarrier spacing makes it unnecessarily restrict the efficiency and flexibility for 1.25MHz series (5, 8.75, 10, 20MHz) and 3.5MHz series (3.5, 7, 14MHz) to work in multi-carrier mode with the carriers being of the same or a mixture of different system bandwidths. If the carriers are operated as adjacent carriers as illustrated in Figs. 4 and 5, inter-carrier interference due to the incompatible subcarrier spacings necessitates the presence of guard subcarriers. In addition, the multiple carriers cannot be operated as an overlay of several multiple bandwidths onto a common aggregate bandwidth (common FFT) in order to support devices of different bandwidth capabilities at the same time. This feature is important to be able to support devices with very different cost, complexity and throughput requirements on a common air interface (e.g. from low-rate, low-cost remote data collection/monitoring devices to high-end multimedia devices).

[0067] This multi-carrier mode is illustrated in Fig. 6. Using 12.5 kHz as the subcarrier spacing, 16m will line up with different rasters in different frequency bands and the subcarrier spacings between adjacent carriers will be aligned. Therefore, this subcarrier spacing will allow multi-carrier deployment with the same or mixed system bandwidths to be readily supported. This capability provides 16m a competitive advantage over UMB and LTE which cannot support multi-carrier deployment without guard subcarriers between neighboring carriers, as shown in Fig. 6. It demonstrates great advantages in multi-carrier deployment and an effective way to achieve global roaming for different 16m devices.

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[0068] According to various embodiments, the downlink transmission scheme is based on conventional OFDM using a cyclic prefix, where the OFDM sub-carrier spacing is Δf = 12.5 kHz. In addition there may be also a reduced subcarrier spacing Δf_{low} = 6.25 kHz, for low mobility and Multicast Broadcast Services (MBS) dedicated cell(s), and an increased subcarrier spacing Δf_{hi} = 25 kHz, for higher mobility coverage such, to cover a bullet train, for example. Table 3 below provides proposed basic OFDM numerology, according to certain embodiments.

Parameter	Unit	Parameter Values
Sub-carrier Spacing (Δf)	KHz	12.5
Optional sub-carrier Spacing (Δf_{low}, Δf_{hi})	KHz	6.25, 25
Sampling Frequency (Fs)	MHz	25.6
Sampling Period (Ts)	µs	0.0390625
Number of Ts for 10ms	Ts	256000
FFT size		2048

Table 3

[0069] According to certain embodiments, radio frames, according to the LTE standard, include a 10 ms duration. Two radio fame structures remain supported by LTE-Advanced:

- Type 1 – applicable to FDD; and
- Type 2 – applicable to TDD and H-FDD.

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Figs. 7(a) and (b) provide a frame structure of Type 1 and a frame structure of Type 2, respectively. There may be 10 subframes within a 10-ms radio frame, where each subframe is 1 ms long. The common subframe parameters are provided in Table 4 below.

Sub-carrier Spacing (Δf)		**KHz**	**12.5**	**6.25**	**25**
Sub-frame duration		ms	**1**	**1**	**1**
Number of Ts		T_s	25600	25600	25600
CP Length (T_{CP})	**Normal CP1**	T_s	85	170	195
	Extended CP2	T_s	512		682
Number of OFDM Symbols Per Sub-frame		N_{CP1}	12	6	21
		N_{CP2}	10		15
Extra Samples for Symbol#0	n_{CP1}	T_s	4	4	1
	n_{CP2}		0		10

Table 4

[0070] In the case of 12.5 kHz sub-carrier spacing, for example there may be 2 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 12 and 10 OFDM symbols per subframe respectively, according to the present embodiment.

- Normal cyclic prefix 1: T_{CP1} = 89×Ts (OFDM symbol #0)=3.4765625μs , T_{CP1} = 85×Ts (OFDM symbol #1 to #11) = 3.3203125 μs

- Extended cyclic prefix 2: T_{CP2} = 512×Ts (OFDM symbol #0 to #9) = 20 μs, where $T_s = 1/(2048 \times \Delta f)$

In case of 6.25 KHz sub-carrier spacing there may be only a single CP length.

- Low Δf cyclic prefix 1: $T_{CP\text{-}low}$ = 174×Ts (OFDM symbol #0)=6.796875μs , $T_{CP\text{-}low}$ = 170×Ts (OFDM symbol #1 to #5) = 6.640625μs

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In the case of 25 kHz sub-carrier spacing there may be 2 CP lengths. These are CP choices for a 1-ms subframe, corresponding to 21 and 15 OFDM symbols per subframe respectively.

- High Δf cyclic prefix 1: $T_{CP\text{-}hi1}$ = 196×Ts (OFDM symbol #0)=7.65625μs , $T_{CP\text{-}hi1}$ = 195×Ts (OFDM symbol #1 to #20) = 7.6171875μs

- High Δf cyclic prefix 2: $T_{CP\text{-}hi2}$ = 692×Ts (OFDM symbol #0 to #4) = 27.03125 μs, $T_{CP\text{-}hi2}$ = 682×Ts (OFDM symbol #1 to #14) = 26.640625 μs

[0071] In both Type 1 and Type 2 frame structures, the concept of lots is only used to describe the dimensions of various resource blocks. For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Each subframe duration is 1 ms. Uplink and downlink transmissions are separated in the frequency domain.

[0072] For LTE-Advanced TDD mode, for example, frame structure Type 2 can be used (see Fig. 7(b). Each radio frame of length of 10 ms consists of two half-frames of length 5 ms each. Each half-frame consists of five subframes of length 1 ms. For each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS.

[0073] Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity may be supported. In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames. In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe may exist in the first half-frame.

[0074] According to an embodiment, subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission. However, one of ordinary skill in the art would realize that various modifications could be made without departing from the scope of the present disclosure. In case of FDD, operation with half duplex from the UE point of view can be supported.

[0075] Table 5 below provides exemplary uplink-downlink configurations:

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Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

Table 5

[0076] Table 6 below provides exemplary configurations of a special subframe S:

Special subframe configuration	Normal cyclic prefix in downlink		Extended cyclic prefix in downlink	
	DwPTS (N_{symbol})	UpPTS (N_{symbol})	DwPTS (N_{symbol})	UpPTS (N_{symbol})
0	3	1	3	1
1	7	1	6	1
2	8	1	7	1
3	9	1	8	1
4	10	1	3	2
5	3	2	6	2
6	7	2	7	2
7	8	2		
8	9	2		

Table 6

[0077] In IEEE 802.16m frame structures, the concept of a radio superframe is introduced. A superframe last for 20 ms. There can be 4 frames within a superframe, where each frame length is 5 ms. A frame has the same duration of a half-frame of Type 2 described above.

[0078] According to certain embodiments, two radio fame structures can be supported by IEEE 802.16m:

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- Type 3 – applicable to IEEE 802.16m FDD and TDD modes; and
- Type 4 – Optional frame structure for IEEE 802.16m FDD and TDD modes.

[0079] Figs. 8(a) and 8(b) provide exemplary frame structures for Type 3 frame structures for FDD mode and TDD mode, respectively, according to an embodiment. Frame Structure Type 3 is similar to Frame Structure Type 1 described above, with an improved cyclic prefixes selection. Type 3 can be used to support both FDD and TDD modes. There are 10 subframe within a 5 ms radio frame, each subframe is 1 ms long. The common subframe parameters are provided in Table 7.

Sub-carrier Spacing (Δf, Δf_{low},Δf_{hi})		**KHz**	**12.5**	**6.25**	**25**
Subframe Duration		**ms**	**1**	**1**	**1**
Number of Ts		**ms**	25600	25600	25600
CP Length (T_{CP})	**Normal CP1**	**T_s**	85	170	195
	Extended CP2	**T_s**	512	1024	682
	CP3	**T_s**	279		89
	CP4	**T_s**	796		398
Number of OFDM Symbols Per Subframe		**N_{CP1}**	12	6	21
		N_{CP2}	10	5	15
		N_{CP3}	11		23
		N_{CP4}	9		18
Extra Samples for Subframe Idle Time	**n_{CP1}**	**T_S**	4	4	1
	n_{CP2}		0	0	10
	n_{CP3}		3		1
	n_{CP4}		4		4

Table 7

[0080] In the case of 12.5 kHz sub-carrier spacing there are 4 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 12, 10, 11, and 9 OFDM symbols per subframe, respectively.

- Normal cyclic prefix 1: T_{CP1} = 85×Ts (OFDM symbol #0 to #11) = 3.3203125 μs, cyclic postfix = 4×Ts = 0.15625 μs

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- Extended cyclic prefix 2: $T_{CP2} = 512 \times Ts$ (OFDM symbol #0 to #9) = 20 μs
- Cyclic prefix 3: $T_{CP3} = 279 \times Ts$ (OFDM symbol #0 to #10) = 10.8984375 μs, cyclic postfix = $3 \times Ts$ = 0.1171875 μs
- Cyclic prefix 4: $T_{CP4} = 796 \times Ts$ (OFDM symbol #0 to #8) = 31.09375 μs, cyclic postfix = $4 \times Ts$ = 0.15625 μs, where $T_s = 1/(2048 \times \Delta f)$

[0081] In the case of 6.25 kHz sub-carrier spacing there are 2 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 6, and 5 OFDM symbols per subframe respectively.

- Low Δf cyclic prefix 1: $T_{CP\text{-}low1} = 170 \times Ts$ (OFDM symbol #0 to #5) = 6.640625μs, cyclic postfix = $4 \times Ts$ = 0.15625 μs
- Low Δf cyclic prefix 2: $T_{CP\text{-}low1} = 1024 \times Ts$ (OFDM symbol #0 to #4) = 40μs

[0082] In the case of 25 kHz sub-carrier spacing there are 2 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 21, and 15 OFDM symbols per subframe respectively.

- High Δf cyclic prefix 1: $T_{CP\text{-}hi1} = 195 \times Ts$ (OFDM symbol #0 to #20) = 7.6171875μs, cyclic postfix = $1 \times Ts$ = 0.0390625 μs
- High Δf cyclic prefix 2: $T_{CP\text{-}hi2} = 682 \times Ts$ (OFDM symbol #0 to #14) = 26.640625 μs, cyclic postfix = $10 \times Ts$ = 0.390625 μs
- High Δf cyclic prefix 3: $T_{CP\text{-}hi3} = 89 \times Ts$ (OFDM symbol #0 to #22) = 3.4765625μs, cyclic postfix = $1 \times Ts$ = 0.0390625 μs
- High Δf cyclic prefix 4: $T_{CP\text{-}hi4} = 398 \times Ts$ (OFDM symbol #0 to #17) = 15.546875μs, cyclic postfix = $4 \times Ts$ = 0.15625 μs.

[0083] For Type 3 TDD mode (see Fig. 8(b)), a subframe is also the smallest unit to be configurable for downlink and uplink transmission. As shown in Fig. 8(b), Subframe# 0 is always reserved for downlink transmission. Starting from Subframe# 1, each subframe can be configurable for downlink or uplink transmission. For each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmission, "U" denotes the subframe is reserved for uplink transmission. The concept of slots is only used to describe the dimensions of resource blocks, according to this example.

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[0084] Downlink-uplink configurations with 5 ms, 10 ms, and 20 ms downlink-to-uplink switch-point periodicity are supported. In case of 5 ms downlink-to-uplink switch-point periodicity, the switch-point exists in each frame. In case of 10 ms downlink-to-uplink switch-point periodicity, the switch-point exists in only one of the two frames. In case of 20 ms downlink-to-uplink switch-point periodicity, the switch-point only exists in one of the four frames. Multiple switch-points are also supported within a 5-ms frame as optional features to support such as extremely high mobility performance where very fast feedbacks are required.

[0085] In the superframe configuration, "D" denotes the frame is reserved for downlink transmission, "U" denotes the frame is reserved for uplink transmission. "X" denotes the frame can be configured as indicated by the Frame Configuration Index in Table 8 below.

Superframe Configuration Index (SCI)	Downlink-to-Uplink Switch-point Periodicity	Frame number			
		0	1	2	3
0	5 ms	X	X	X	X
1	10 ms	X	D	X	D
2	20 ms	D	D	D	X
3	10 ms	X	U	X	U

Table 8

[0086] The TDD adjacent channel coexistence with Frame Structure Type 2 can also be resolved by Frame Structure Type 3 in TDD mode with Frame Configuration Index 9 to 15, as shown in Table 9 below. These configurations can be used to inline the downlink-to-uplink switch-points with that of TDD system operating in Frame Structure Type 2, and what will be potentially deployed TDD-LTE. The smallest switch-point periodicity is 2 ms to allow channel fast feedback mechanism.

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Frame Configuration Index (FCI)	Switch-point Periodicity	Slot number of "X" frame									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	D	D	U	U	D	D	U	U	U
1	5 ms	D	D	D	U	U	D	D	D	U	U
2	5 ms	D	D	D	D	U	D	D	D	D	U
3	5 ms	D	D	U	U	U	D	D	U	U	U
4	>5 ms	D	D	D	D	D	D	D	D	D	D
5	≤3 ms	D	D	U	D	U	D	D	U	D	U
6	≤3 ms	D	D	U	D	U	D	U	U	D	U
7	2 ms	D	U	D	U	D	U	D	U	D	U
8	≤3 ms	D	U	U	D	U	D	U	U	D	U
9	5 ms	D	S	U	U	U	D	S	U	U	U
10	5 ms	D	S	U	U	D	D	S	U	U	D
11	5 ms	D	S	U	D	D	D	S	U	D	D
12	10 ms	D	S	U	U	U	D	D	D	D	D
13	10 ms	D	S	U	U	D	D	D	D	D	D
14	10 ms	D	S	U	D	D	D	D	D	D	D
15	5 ms	D	S	U	U	U	D	S	U	U	D

Table 9

[0087] When a network is deployed, a superframe is often configured to a default system profile. However, a superframe can change its frame structure via superframe control signaling. There are many different superframe and frame configurations available for different networks deployment. However, it is believed that only limited set of configurations are practically used within a particular network. In order to minimize the number of bits for superframe and frame configurations to be transmitted in the air by superframe header the trie data structure is used to broadcast configurations information. If the network is operating in default configuration, only one bit is transmitted in the air to indicate that the superframe and frames are configured in default mode. An example is provided with reference to Table 10 below and Fig. 9, where the values of Superframe Configuration Index (SCI) and Frame Configuration Index (FCI) in Fig. 9 are selected for illustration purpose, and are not intended to limit the embodiment in any way.

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Bit#0 = 0	System Default Configuration#0: SCI=x0, FCI=y0		
Bit#0 = 1	**Bit#1 = 0, Bit#2 = 0**	Configuration#1: SCI=x1, FCI=y1	
	Bit#1 = 0, Bit#2 = 1	Configuration#2: SCI=x2, FCI=y2	
	Bit#1 = 1, Bit#2 = 0	Configuration#3: SCI=x3, FCI=y3	
	Bit#1 = 1, Bit#2 = 1	**Bit#3 = 0, Bit#4 = 0, Bit#5 = 0**	Configuration#4: SCI=x4, FCI=y4
		Bit#3 = 0, Bit#4 = 0, Bit#5 = 1	Configuration#5: SCI=x5, FCI=y5
		Bit#3 = 0, Bit#4 = 1, Bit#5 = 0	Configuration#6: SCI=x6, FCI=y6
		Bit#3 = 0, Bit#4 = 1, Bit#5 = 1	Configuration#7: SCI=x7, FCI=y7
		Bit#3 = 1, Bit#4 = 0, Bit#5 = 0	Configuration#8: SCI=x8, FCI=y8
		Bit#3 = 1, Bit#4 = 0, Bit#5 = 1	Configuration#9: SCI=x9, FCI=y9
		Bit#3 = 1, Bit#4 = 1, Bit#5 = 0	Configuration#10: SCI=x10, FCI=y10
		Bit#3 = 1, Bit#4 = 1, Bit#5 = 1	Configuration#11: SCI=x11, FCI=y11

Note: Notations of x0 to x11 in the above table are representation of Superframe Configuration Index values, and y0 to y11 are representation of Frame Configuration Index values, according to this embodiment.

Table 10

[0088] In the Type 4 frame structure, the concept of subframe is removed. A 5-ms frame is made of multiple slots. A regular frame contains up to 10 slots. The concept of slots is used to describe the dimensions of resource blocks. Each slot contains 6 OFDM symbols. For FDD, all frames are available for downlink transmission and all frames are available for uplink transmissions in each 20 ms superframe interval. Uplink and downlink transmissions are separated in the frequency domain.

[0089] Figs. 10(a) and 10(b) provide exemplary frame structures for Type 4 frame structures for FDD mode and TDD mode, respectively, according to an embodiment. The frame parameters are provided in Table 11.

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Sub-carrier Spacing (Δf, Δf_{low},Δf_{hi})		KHz	12.5	6.25	25
Frame Duration		ms	5	5	5
Number of Ts		ms	128000	128000	128000
CP Length (T_{CP})	CP1	T_s	85	170	161
	CP2	T_s	322	644	230
	CP3	T_s	618		309
	CP4	T_s			617
Number of OFDM Symbols Per Frame		N_{CP1}	60	30	108
		N_{CP2}	54	27	102
		N_{CP3}	48		96
		N_{CP4}			78
Extra Samples for Frame Idle Time	n_{CP1}	T_S	20	20	20
	n_{CP2}		20	20	92
	n_{CP3}		32		32
	n_{CP4}				2

Table 11

[0090] In the case of 12.5 kHz sub-carrier spacing there are 3 cyclic-prefix (CP) lengths. These are CP choices for a 5-ms frame, corresponding to 60, 54, and 48 OFDM symbols per frame respectively.

- Cyclic prefix 1: T_{CP1} = 85×Ts (OFDM symbol #0 to #59) = 3.3203125 μs, frame idle time = 20×Ts = 0.78125 μs
- Cyclic prefix 2: T_{CP2} = 322×Ts (OFDM symbol #0 to #53) = 12.578125 μs, frame idle time = 20×Ts = 0.78125 μs
- Cyclic prefix 3: T_{CP3} = 618×Ts (OFDM symbol #0 to #47) = 24.140625 μs, frame idle time = 32×Ts = 1.25 μs, where $T_s = 1/\{2048 \times \Delta f\}$

[0091] In the case of 6.25 kHz sub-carrier spacing there are 2 cyclic-prefix (CP) lengths. These are CP choices for a 5-ms frame, corresponding to 30, and 27 OFDM symbols per frame respectively.

- Low Δf cyclic prefix 1: T_{CPL1} = 170×Ts (OFDM symbol #0 to #29) = 6.640625μs, frame idle time = 20×Ts = 0.78125 μs

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- Low Δf cyclic prefix 2: T_{CPL2} = 644×Ts (OFDM symbol #0 to #26) = 25.15625 μs, frame idle time = 20×Ts = 0.78125 μs

[0092] In the case of 25 kHz sub-carrier spacing there are 4 cyclic-prefix (CP) lengths. These are CP choices for a 5-ms frame, corresponding to 108, 102, 96, and 78 OFDM symbols per frame respectively.

- High Δf cyclic prefix 1: T_{CPH1} = 161×Ts (OFDM symbol #0 to #107)= 6.2890625 μs , frame idle time = 20×Ts = 0.78125 μs

- High Δf cyclic prefix 2: T_{CPH2} = 230×Ts (OFDM symbol #0 to #101) = 8.984375 μs, frame idle time = 92×Ts = 3.59375 μs

- High Δf cyclic prefix 3: T_{CPH3} = 309×Ts (OFDM symbol #0 to #95) = 12.0703125 μs, frame idle time = 32×Ts = 1.25 μs

- High Δf cyclic prefix 4: T_{CPH4} = 617×Ts (OFDM symbol #0 to #77) = 24.1015625 μs, frame idle time = 2×Ts = 0.078125 μs

[0093] For Type TDD mode, as shown in Fig. 10(b), a superframe consists of 4 frames, each frame is made of multiple slots. A regular frame contains up to 10 slots. The concept of slots is not only used to describe the dimensions of resource blocks, it is also the smallest unit to be configurable for downlink and uplink transmission. Each slot contains 6 OFDM symbols as shown in Fig. 10(b). Slot 0 is always reserved for downlink transmission. Starting from Slot 1, each slot can be configurable for downlink or uplink transmission. Slot durations in different frames may vary depending on the selected CP sizes. For each slot in a radio frame, "D" denotes the slot is reserved for downlink transmission, "U" denotes the slot is reserved for uplink transmission.

[0094] Downlink-uplink configurations with 5 ms, 10 ms, and 20 ms downlink-to-uplink switch-point periodicity are supported. In case of 5 ms downlink-to-uplink switch-point periodicity, the switch-point exists in each frame. In case of 10 ms downlink-to-uplink switch-point periodicity, the switch-point may exist in only one of the two frames. In case of 20 ms downlink-to-uplink switch-point periodicity, the switch-point only exists in one of the four frames. Multiple switch-points are also supported within a 5-ms frame as optional features to support such as extremely high mobility performance where faster feedbacks are required.

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[0095] In the superframe configuration, as shown in Table 12 below, "D" denotes the frame is reserved for downlink transmission, "U" denotes the frame is reserved for uplink transmission. "X" denotes the frame can be configured as indicated by the Frame Configuration Index in Table 13 below.

Superframe Configuration Index (SCI)	Downlink-to-Uplink Switch-point Periodicity	Frame number			
		0	1	2	3
0	5 ms	X	X	X	X
1	10 ms	X	D	X	D
2	20 ms	D	D	D	X
3	10 ms	X	U	X	U

Table 12

[0096] The TDD adjacent channel coexistence with Frame Structure Type 2 can also be resolved by Frame Structure Type 4 in TDD mode with Frame Configuration Index 3 to 7 (see Table 13 below). These configurations can be used to inline the downlink-to-uplink switch-points with that of TDD system operating in Frame Structure Type 2.

Frame Configuration Index (FCI)	Switch-point Periodicity	Slot number of "X" frame									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	D	D	D	D	U	U	U	U	U
1	5 ms	D	D	D	D	D	D	U	U	U	U
2	>5 ms	D	D	D	D	D	D	D	D	D	D
3	5 ms	D	D	D	U	U	U	U	U	U	U
4	5 ms	D	D	D	D	U	U	U	U	U	U
5	5 ms	D	D	D	U	U	U	U	D	D	D
6	5 ms	D	D	D	D	U	U	U	U	D	D
7	5 ms	D	D	D	U	U	D	D	D	D	D
8	5 ms	D	D	D	D	D	D	D	U	U	U
9	5 ms	D	D	D	D	D	D	D	D	U	U
10	≤5 ms	D	D	D	U	U	D	D	D	U	U
11	≤5 ms	D	D	D	D	U	D	D	D	D	U
12	≤5 ms	D	D	U	U	U	D	D	U	U	U
13	≤5 ms	D	U	U	U	U	D	U	U	U	U
14	≤5 ms	D	D	U	D	D	U	D	D	U	D
15	≤5 ms	D	D	U	U	D	D	U	U	D	D

Table 13

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[0097] A physical resource block is defined as N_{symb} consecutive OFDM symbols in the time domain and N_{sc}^{RB} consecutive subcarriers in the frequency domain, where N_{symb} and N_{sc}^{RB} are updated in Table 14. A physical resource block in the uplink thus consists of a number of resource elements corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Frame Structure Configuration	Sub-carrier Spacing	Cyclic Prefix	N_{symb}	N_{sc}^{RB}
Type 1, Type 2	$\Delta f = 12.5$ kHz	Normal CP1	6	12
		Extended CP2	5	
	$\Delta f = 6.25$ kHz	CP-Low	3	24
Type 3	$\Delta f = 12.5$ kHz	CP1	6	16
		CP2	5	
		CP3	6, 5	
		CP4	6, 3	
	$\Delta f = 6.25$ kHz	CP1	6	16
		CP2	5	
	$\Delta f = 25$ kHz	CP1	6, 3	
		CP2		
		CP3	6, 5	
		CP4	6	
Type 4	$\Delta f = 12.5$ kHz	CP1, CP2, CP3	6	16
	$\Delta f = 6.25$ kHz	CPL1, CPL2		
	$\Delta f = 25$ kHz	CPH1, CPH2, CPH3, CPH4		

Table 14

[0098] Table 15 below provides examples of supported system bandwidths. Of course, the supported system bandwidths are merely for exemplary purposes and are not intended to limit the scope of the disclosure in any way.

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Parameter		Unit	Parameter Values							
Channel Bandwidth (BW)		MHz	1.4	2.5	3	3.5	5	6	7	8
Number of Used sub-carriers (Nused)	N_{sc}^{RB} 12	Sub-carrier	108	192	240	276	396	480	552	636
	N_{sc}^{RB} 16		112	192	240	272	400	480	560	640

Parameter		Unit	Parameter Values (Continue)							
Channel Bandwidth (BW)		MHz	8.75	10	11	12	14	15	20	40
Number of Used sub-carriers (Nused)	N_{sc}^{RB} 12	Sub-carrier	696	792	876	960	1116	1200	1596	3192
	N_{sc}^{RB} 16		688	800	880	960	1120	1200	1600	3200

Table 15

[0099] According to certain embodiments, pilot patterns may be specified within a resource block for Type 3 and Type 4 resource blocks. Figs. 11(a) and 11(b) show exemplary pilot patterns for 1 and 2 data streams, respectively.

[00100] Fig. 12 shows exemplary pilot patterns for 4 data streams, according to an embodiment of the present disclosure.

[00101] Fig. 13 shows exemplary pilot patterns for 8 data streams, according to an embodiment of the present disclosure.

[00102] For N_{symb}=5, the last symbol of the pilot patterns as shown in Figs. 11(a)-119b) or Fig. 12 is deleted. Similarly for N_{symb}=3, the last three symbols of the pilot patterns are deleted, according to an exemplary embodiment.

[00103] Figs. 14(a) and 14(b) show pilot patterns for uplink only distributed resource blocks (also known as LRU). For N_{symb}=5, the last symbol of the pilot patterns as shown in Fig. 13 or Figs. 14(a)-14(b) is deleted. Similarly for N_{symb}=3, the last three symbols of the pilot patterns are deleted.

[00104] In a mixed deployment of legacy WiMAX (IEEE 802.16) and IEEE 802.16m systems, the allocation of time zones in the TDD mode is as shown in Figs. 15 and 16 for Type 3 and 4 frame structures, respectively. The duration of the zones may vary. In this

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embodiment, every frame starts with a legacy preamble and the MAP followed by IEEE 802.16e DL zone since the legacy mobiles expect legacy zone in this region, then IEEE 802.16m DL zone for advanced mobiles. Similarly, in a mixed deployment, the UL portion starts with IEEE 802.16e UL zone since IEEE 802.16e UL control information is expected to be sent in this region, then followed by IEEE 802.16m UL zone for advanced mobiles. Here the coexistence is defined as a deployment where co-exist on the same frequency band and in the same or neighboring geographical areas. In a green-field deployment where no legacy mobile exists, the legacy zone can be removed. Switching points can be synchronized across network to reduce inter-cell interference.

[00105] Fig. 17 shows an exemplary illustration of deployment with mixed base stations 102 and mobile stations 104, according to an embodiment. Of course, the present disclosure is not limited to any particular number or type of base stations 102 or mobile station 104.

[00106] Almost all the WiMAX (IEEE 802.16) deployments in the world are in multi-carrier deployment. A sector may be supporting a radio frequency carrier, or even multiple carriers. Each carrier has out-of-band interference to the neighboring carriers, which needs to be resolved by over 8% guard bands and RF filters. Proposed herein is a 12.5-kHz subcarrier spacing which is applied for all the channel bandwidth, e.g. 5/10/20MHz, 3.5/7/14MHz and also 8.75MHz. A 12.5-kHz subcarrier spacing has a property of good trade-off of mobility and frequency efficiency with CP overhead, and divides evenly into the 250-kHz channel raster. The sampling frequency of different channel bandwidths will be based on this subcarrier spacing and appropriate FFT size. It means that all the channel bandwidths will have the same base sampling frequency. The mobile station 104 can roam to different carrier bandwidths in different frequency bands while utilizing the same OFDMA parameter set. This feature is important for a simplified coherent 4G standard and developing a healthy ecosystem, and beyond. Moreover, the Frame Structure Type 1, 2 and 3 can support backward compatibility to future LTE deployment.

[00107] Fig. 18 shows an example of a legacy IEEE 802.16 system deployment with 10MHz channel bandwidth, according to an embodiment.

[00108] Fig. 19 shows an example of a multi-carrier deployment with 10, 20 and 30 MHz channel bandwidth, without guard bands, according to an embodiment.

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[00109] According to certain embodiments, there may be up to four CP lengths based on 12.5-kHz subcarrier spacing, which are used for different radio scenarios. These CP lengths are needed to adequately balance the required length of CP with the loss of capacity due to the CP in order to serve the breadth of radio environments envisaged for 802.16m. Among the different CP lengths, CP1 are the shortest CPs which are typically used for normal small cell deployments such as for urban and indoor, CP2 is typically used for extended cell coverage such as suburban environments, and long CP with 15us duration is needed for the large delay spreads that may be encountered with large rural cells.

[00110] The number of used subcarriers is independent of permutation mode, according to an embodiment. For all the types of permutation modes, with the same bandwidth, the number of used subcarriers can be the same. With consideration of legacy system support, TDM mode can be used for DL and UL.

[00111] Based on the Frame Structure Type 1, 2 and 3, the system can be configurable to support multiple CP lengths in the same BS 102 and in the same frame. This feature is particular useful for deployment of mixed Macro, Micro, Pico, and Femto cells and mixed mobile and fixed applications.

[00112] As illustrated in Fig. 20 and Fig. 21, multiple cyclic prefix lengths can be configured within the same network deployment, different base stations 102 can be configured to different cyclic prefix lengths for Frame Structure Type 1, 2, 3, and 4. Furthermore for Frame Structure Type 1, 2, and 3, different cyclic prefix lengths can be chosen within the same base station 102 cell for different subframes. The proposed implementation can also be adopted for LTE.

[00113] By adopting the proposed solutions described herein, the IEEE 8016m design become much cleaner and simpler with noticeable improved performance. All the following problems or challenges can be resolved nicely by the proposed solutions, which only require minimum changes in the current baseline design today.

[00114] While various embodiments of the invention have been described above, it should be understood that they have been presented by way of example only, and not by way of limitation. Likewise, the various diagrams may depict an example architectural or other configuration for the disclosure, which is done to aid in understanding the features and functionality that can be included in the disclosure. The disclosure is not restricted to the

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illustrated example architectures or configurations, but can be implemented using a variety of alternative architectures and configurations. Additionally, although the disclosure is described above in terms of various exemplary embodiments and implementations, it should be understood that the various features and functionality described in one or more of the individual embodiments are not limited in their applicability to the particular embodiment with which they are described. They instead can be applied alone or in some combination, to one or more of the other embodiments of the disclosure, whether or not such embodiments are described, and whether or not such features are presented as being a part of a described embodiment. Thus the breadth and scope of the present disclosure should not be limited by any of the above-described exemplary embodiments.

[00115] In this document, the term "module" as used herein, refers to software, firmware, hardware, and any combination of these elements for performing the associated functions described herein. Additionally, for purpose of discussion, the various modules are described as discrete modules; however, as would be apparent to one of ordinary skill in the art, two or more modules may be combined to form a single module that performs the associated functions according embodiments of the invention.

[00116] In this document, the terms "computer program product", "computer-readable medium", and the like, may be used generally to refer to media such as, memory storage devices, or storage unit. These, and other forms of computer-readable media, may be involved in storing one or more instructions for use by processor to cause the processor to perform specified operations. Such instructions, generally referred to as "computer program code" (which may be grouped in the form of computer programs or other groupings), when executed, enable the computing system.

[00117] It will be appreciated that, for clarity purposes, the above description has described embodiments of the invention with reference to different functional units and processors. However, it will be apparent that any suitable distribution of functionality between different functional units, processors or domains may be used without detracting from the invention. For example, functionality illustrated to be performed by separate processors or controllers may be performed by the same processor or controller. Hence, references to specific functional units are only to be seen as references to suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organization.

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[00118] Terms and phrases used in this document, and variations thereof, unless otherwise expressly stated, should be construed as open ended as opposed to limiting. As examples of the foregoing: the term "including" should be read as meaning "including, without limitation" or the like; the term "example" is used to provide exemplary instances of the item in discussion, not an exhaustive or limiting list thereof; and adjectives such as "conventional," "traditional," "normal," "standard," "known", and terms of similar meaning, should not be construed as limiting the item described to a given time period, or to an item available as of a given time. But instead these terms should be read to encompass conventional, traditional, normal, or standard technologies that may be available, known now, or at any time in the future. Likewise, a group of items linked with the conjunction "and" should not be read as requiring that each and every one of those items be present in the grouping, but rather should be read as "and/or" unless expressly stated otherwise. Similarly, a group of items linked with the conjunction "or" should not be read as requiring mutual exclusivity among that group, but rather should also be read as "and/or" unless expressly stated otherwise. Furthermore, although items, elements or components of the disclosure may be described or claimed in the singular, the plural is contemplated to be within the scope thereof unless limitation to the singular is explicitly stated. The presence of broadening words and phrases such as "one or more," "at least," "but not limited to", or other like phrases in some instances shall not be read to mean that the narrower case is intended or required in instances where such broadening phrases may be absent.

[00119] Additionally, memory or other storage, as well as communication components, may be employed in embodiments of the invention. It will be appreciated that, for clarity purposes, the above description has described embodiments of the invention with reference to different functional units and processors. However, it will be apparent that any suitable distribution of functionality between different functional units, processing logic elements or domains may be used without detracting from the invention. For example, functionality illustrated to be performed by separate processing logic elements, or controllers, may be performed by the same processing logic element, or controller. Hence, references to specific functional units are only to be seen as references to suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organization.

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[00120] Furthermore, although individually listed, a plurality of means, elements or method steps may be implemented by, for example, a single unit or processing logic element. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined. The inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. Also, the inclusion of a feature in one category of claims does not imply a limitation to this category, but rather the feature may be equally applicable to other claim categories, as appropriate.

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WHAT IS CLAIMED IS:

1. A method for signal transmission in an Orthogonal Frequency Division Multiple Access (OFDMA) system, comprising:

fixing a subcarrier spacing to a predetermined value for one or more subframes in all available bandwidths; and

transmitting a signal having the fixed subcarrier spacing, regardless of a frame structure of the one or more subframes.

2. The method of claim 1, wherein the predetermined value is divided evenly by at least one channel raster.

3. The method of claim 2, wherein a common value for the channel raster includes at least one of 100kHz, 200kHz, 250kHz and 300kHz.

4. The method of claim 2, wherein the predetermined value is 12.5 KHz.

5. The method of claim 2, wherein the predetermined value is 6.25 KHz for one or more low mobility mobile stations.

6. The method of claim 2, wherein the predetermined value is 25 KHz for one or more high mobility mobile stations.

7. The method of claim 1, wherein the frame structure is a Long Term Evolution (LTE)-Advanced frame structure.

8. The method of claim 7, wherein the frame structure is a frequency division duplex (FDD) frame structure.

9. The method of claim 7, wherein the frame structure is a time division duplex (TDD) frame structure.

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10. The method of claim 1, wherein the frame structure is an IEEE 802.16m frame structure.

11. The method of claim 10, wherein the frame structure is an FDD frame structure.

12. The method of claim 10, wherein the frame structure is a TDD frame structure.

13. The method of claim 1, wherein the signal transmission is an uplink transmission.

14. The method of claim 1, wherein the signal transmission is a downlink transmission.

15. A station configured for signal transmission in an Orthogonal Frequency Division Multiple Access (OFDMA) system, comprising:

a processor configured to fix a subcarrier spacing to a predetermined value for one or more subframes in all available bandwidths; and

a transmitter configured to transmit a signal having the fixed subcarrier spacing, regardless of a frame structure of the one or more subframes.

16. The station of claim 15, wherein the predetermined value is divided evenly by at least one channel raster.

17. The station of claim 16, wherein a common value for the channel raster includes at least one of 100kHz, 200kHz, 250kHz and 300kHz.

18. The station of claim 16, wherein the predetermined value is 12.5 KHz.

19. The station of claim 16, wherein the predetermined value is 6.25 KHz for one or more low mobility mobile stations.

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20. The station of claim 16, wherein the predetermined value is 25 KHz for one or more high mobility mobile stations.

21. The station of claim 15, wherein the frame structure is a Long Term Evolution (LTE)-Advanced frame structure.

22. The station of claim 15, wherein the frame structure is a frequency division duplex (FDD) frame structure.

23. The station of claim 21, wherein the frame structure is a time division duplex (TDD) frame structure.

24. The station of claim 15, wherein the frame structure is an IEEE 802.16m frame structure.

25. The station of claim 24, wherein the frame structure is an FDD frame structure.

26. The station of claim 24, wherein the frame structure is a TDD frame structure.

27. The station of claim 15, wherein the signal transmission is an uplink transmission.

28. The station of claim 15, wherein the signal transmission is a downlink transmission.

29. A computer-readable medium storing executable instructions thereon for performing method for signal transmission in an Orthogonal Frequency Division Multiple Access (OFDMA) system, the method comprising:

fixing a subcarrier spacing to a predetermined value for one or more subframes in all available bandwidths; and

transmitting a signal having the fixed subcarrier spacing, regardless of a frame structure of the one or more subframes.

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30. The computer-readable medium of claim 29, wherein the predetermined value is divided evenly by at least one channel raster.

31. The computer-readable medium of claim 30, wherein a common value for the channel raster includes at least one of 100kHz, 200kHz, 250kHz and 300kHz.

32. The computer-readable medium of claim 30, wherein the predetermined value is 12.5 KHz.

33. The computer-readable medium of claim 30, wherein the predetermined value is 6.25 KHz for one or more low mobility mobile stations.

34. The computer-readable medium of claim 30, wherein the predetermined value is 25 KHz for one or more high mobility mobile stations.

35. The computer-readable medium of claim 29, wherein the frame structure is a Long Term Evolution (LTE)-Advanced frame structure.

36. The computer-readable medium of claim 35, wherein the frame structure is a frequency division duplex (FDD) frame structure.

37. The computer-readable medium of claim 35, wherein the frame structure is a time division duplex (TDD) frame structure.

38. The computer-readable medium of claim 29, wherein the frame structure is an IEEE 802.16m frame structure.

39. The computer-readable medium of claim 38, wherein the frame structure is an FDD frame structure.

40. The computer-readable medium of claim 38, wherein the frame structure is a TDD frame structure.

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41. The computer-readable medium of claim 29, wherein the signal transmission is an uplink transmission.

42. The computer-readable medium of claim 29, wherein the signal transmission is a downlink transmission.

43. A method for signal transmission in an Orthogonal Frequency Division Multiple Access (OFDMA) system, comprising:

transmitting OFDM symbols using more than one cyclic prefix values within at least one of a frame, or a subframe and a superframe.

44. The method of claim 43, further comprising:

transmitting at least one downlink subframe and one uplink subframe in a frame, wherein

the last OFDM symbol in the downlink subframe is punctured to make room for transmit/receive transition gap (TTG) time.

45. The method of claim 43, further comprising:

transmitting frame configuration information in a beginning portion of at least one of the superframe and the frame, wherein

the frame configuration information is designed with a trie data structure.

46. A method for signal transmission in an Orthogonal Frequency Division Multiple Access (OFDMA) communication system, comprising:

transmitting a plurality of radio frequency channels, wherein

there is no guard band required between adjacent radio frequency channels.

47. A method for signal transmission in a plurality of Orthogonal Frequency Division Multiple Access (OFDMA) communication systems, comprising:

transmitting alternative radio frames of the plurality of OFDMA communications systems; and

synchronizing a beginning of each radio frame of each OFDMA communication system with a 1ms time period.

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48. The method of claim 47, wherein subcarrier spacing of one or more of the plurality of OFDMA communication systems is different.

49. The method of claim 47, wherein frequency bandwidths of one or more of the plurality of OFDMA communication systems is different.

50. The method of claim 1, further comprising:

transmitting a subframe with a predetermined unit resource block size.

51. The method of claim 50, wherein the predetermined unit resource block size is 16 subcarriers by 6 symbols.

52. The method of claim 50, wherein the predetermined unit resource block size is 4 subcarriers by 6 symbols.

53. The method of claim 50, wherein the predetermined unit resource supports multiple antenna transmission technologies.

54. The station of claim 15, wherein:

the transmitter is configured to transmit a subframe with a predetermined unit resource block size.

55. The station of claim 54, wherein the predetermined unit resource block size is 16 subcarriers by 6 symbols.

56. The station of claim 54, wherein the predetermined unit resource block size is 4 subcarriers by 6 symbols.

57. The station of claim 54, wherein the predetermined unit resource supports multiple antenna transmission technologies.

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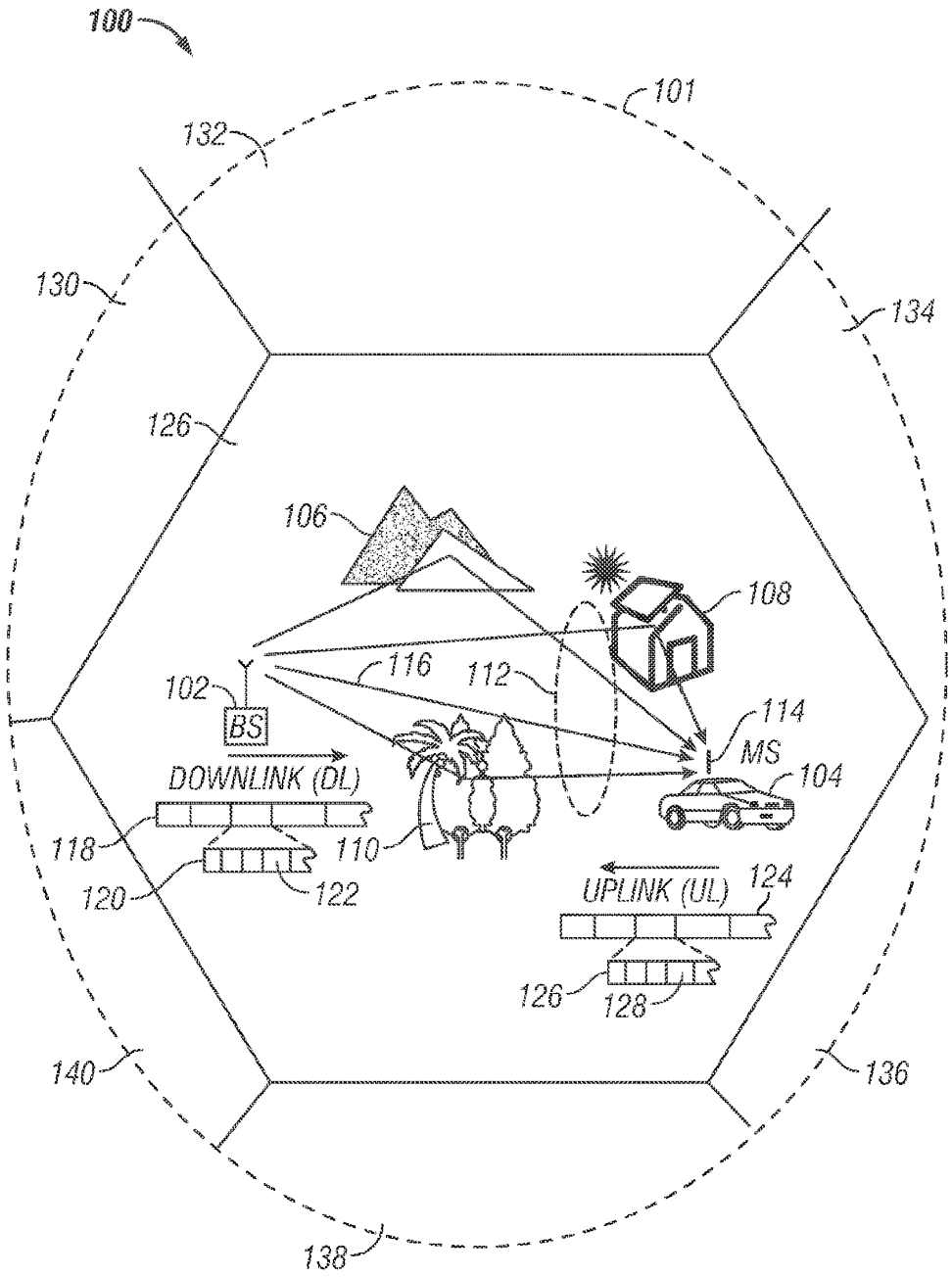


FIG. 1

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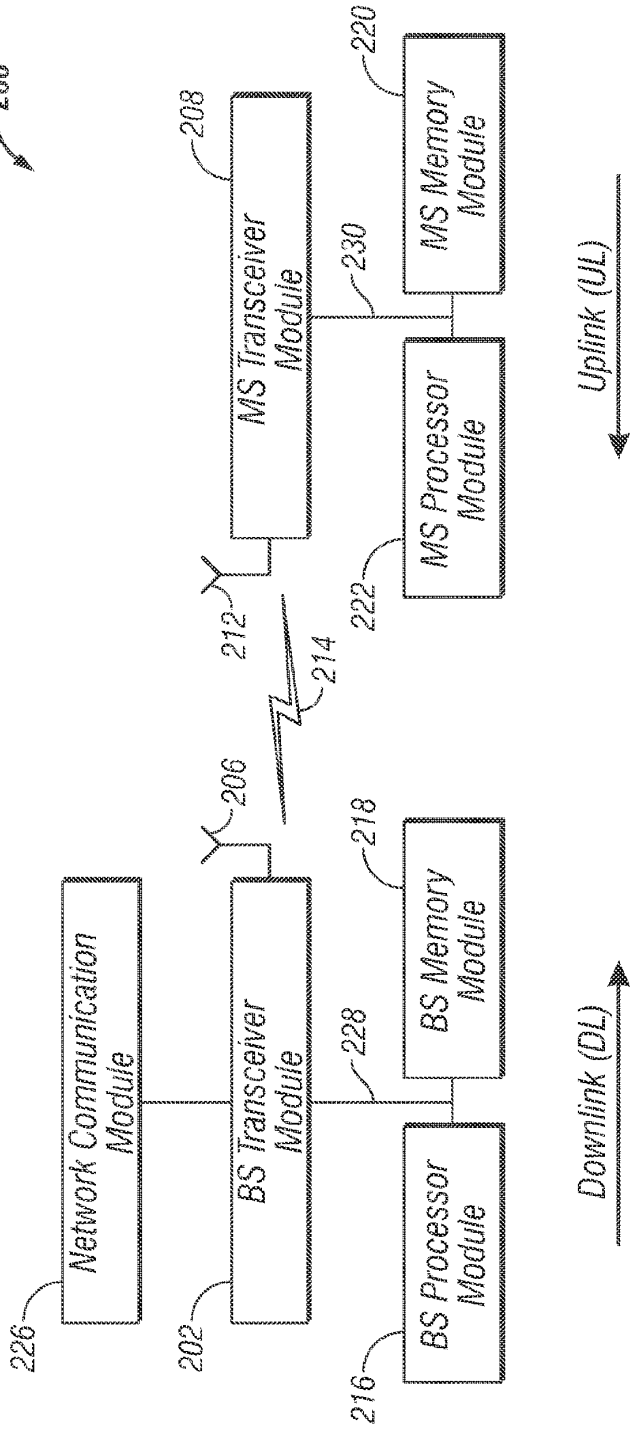


FIG. 2

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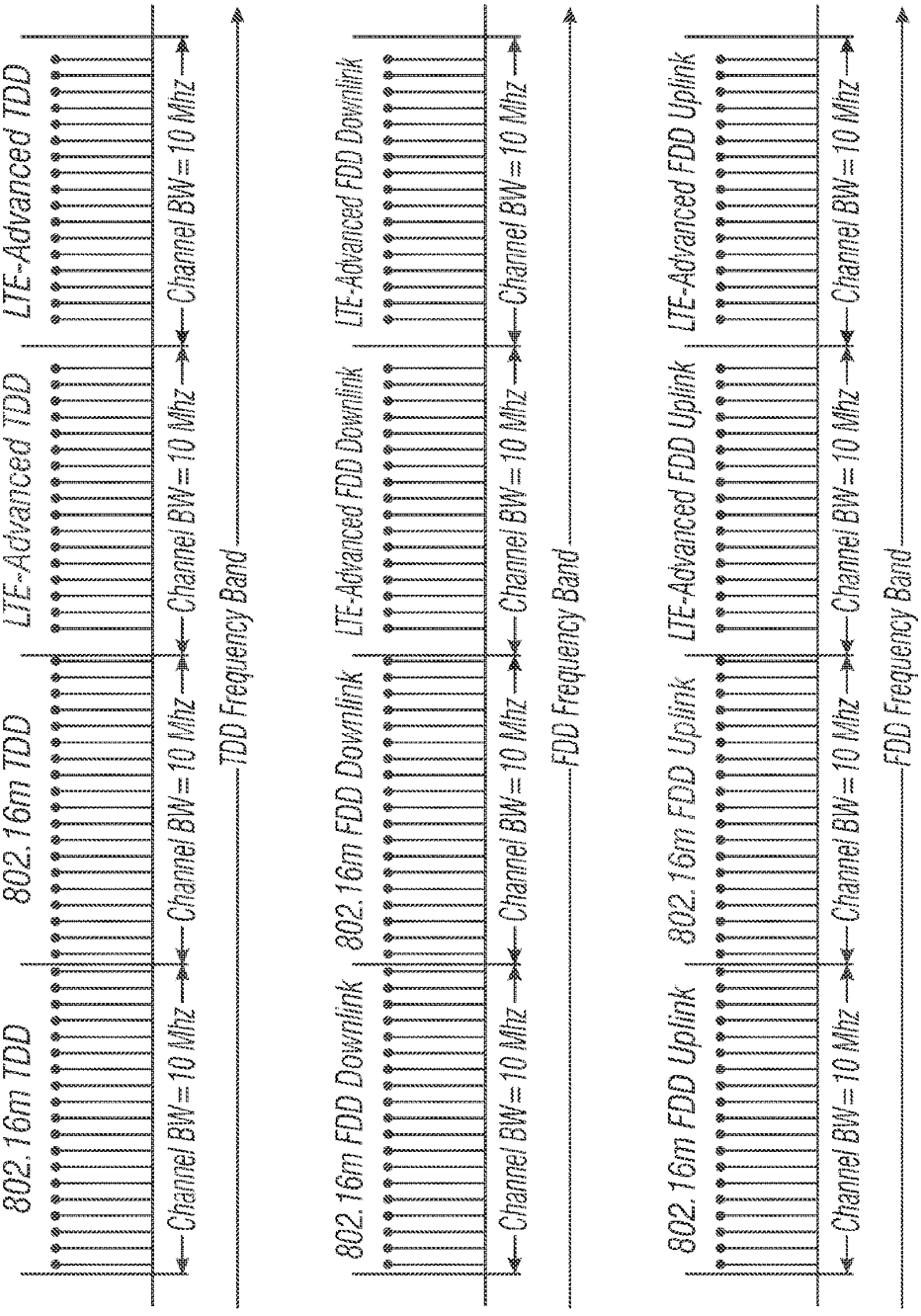


FIG. 3A

FIG. 3B

FIG. 3C

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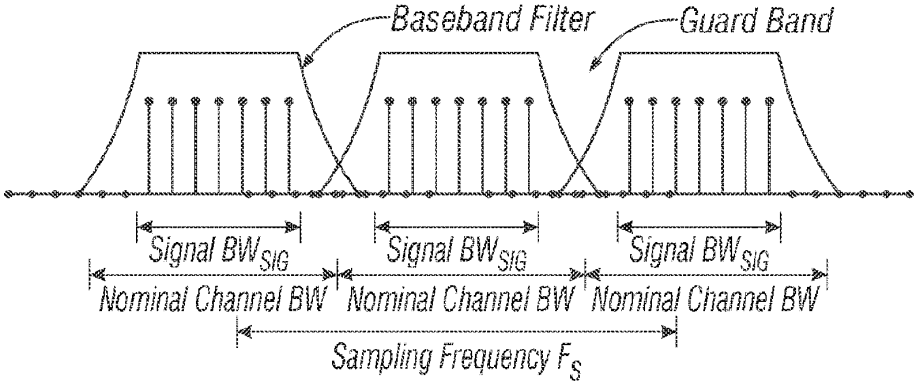


FIG. 4

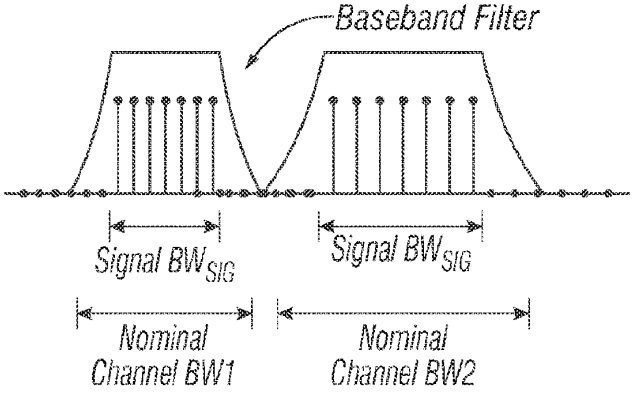


FIG. 5

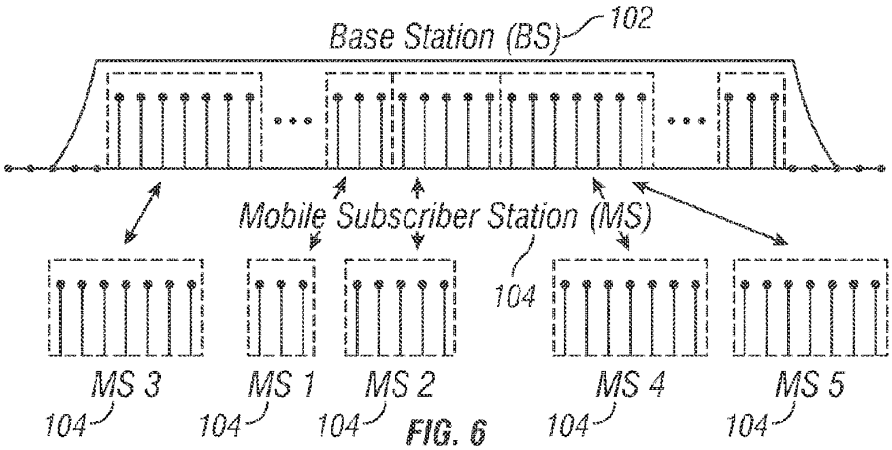


FIG. 6

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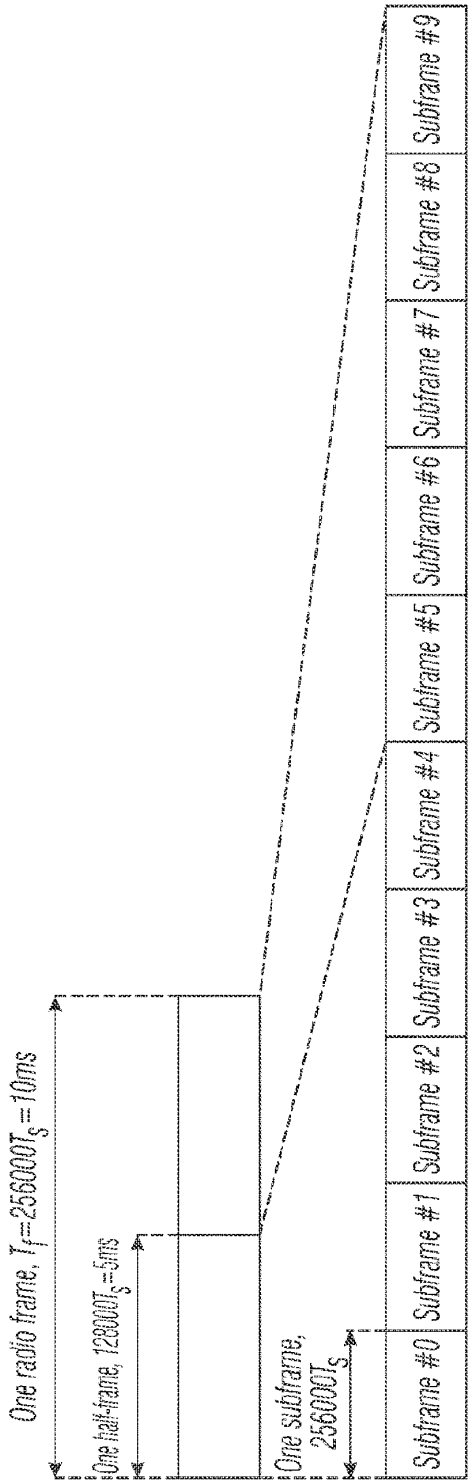


FIG. 7A

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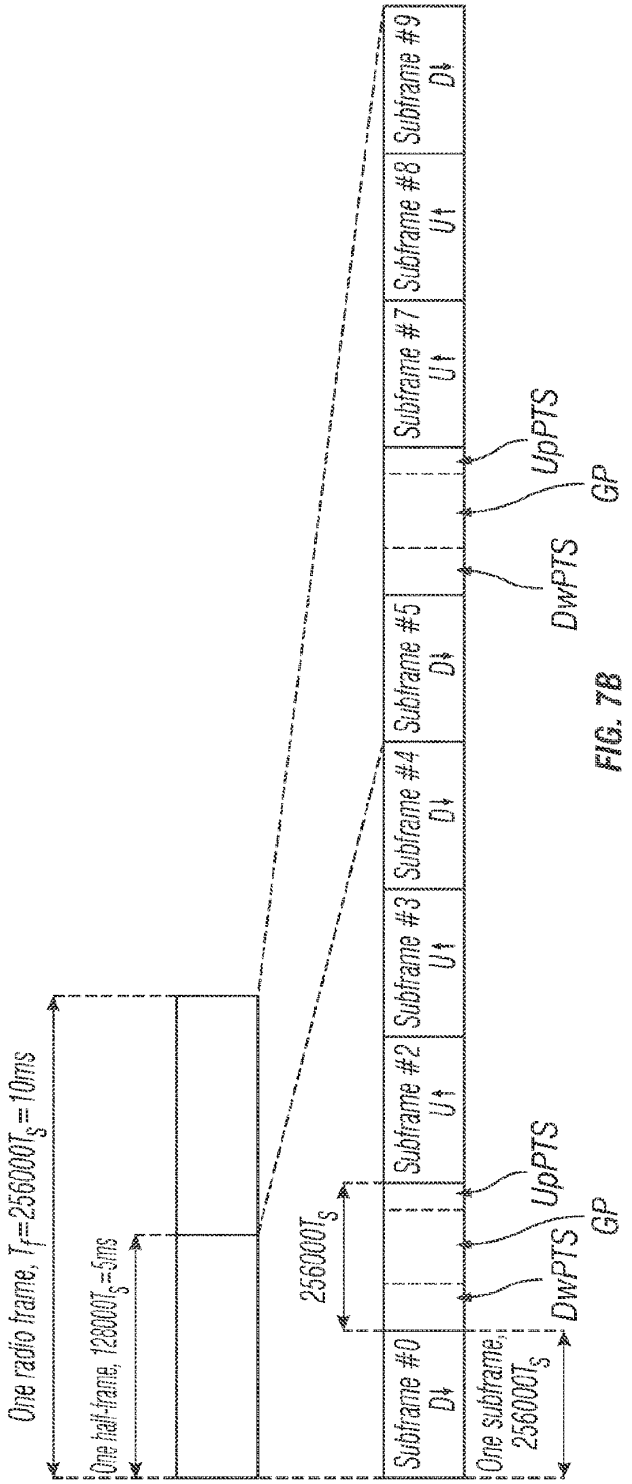


FIG. 7B

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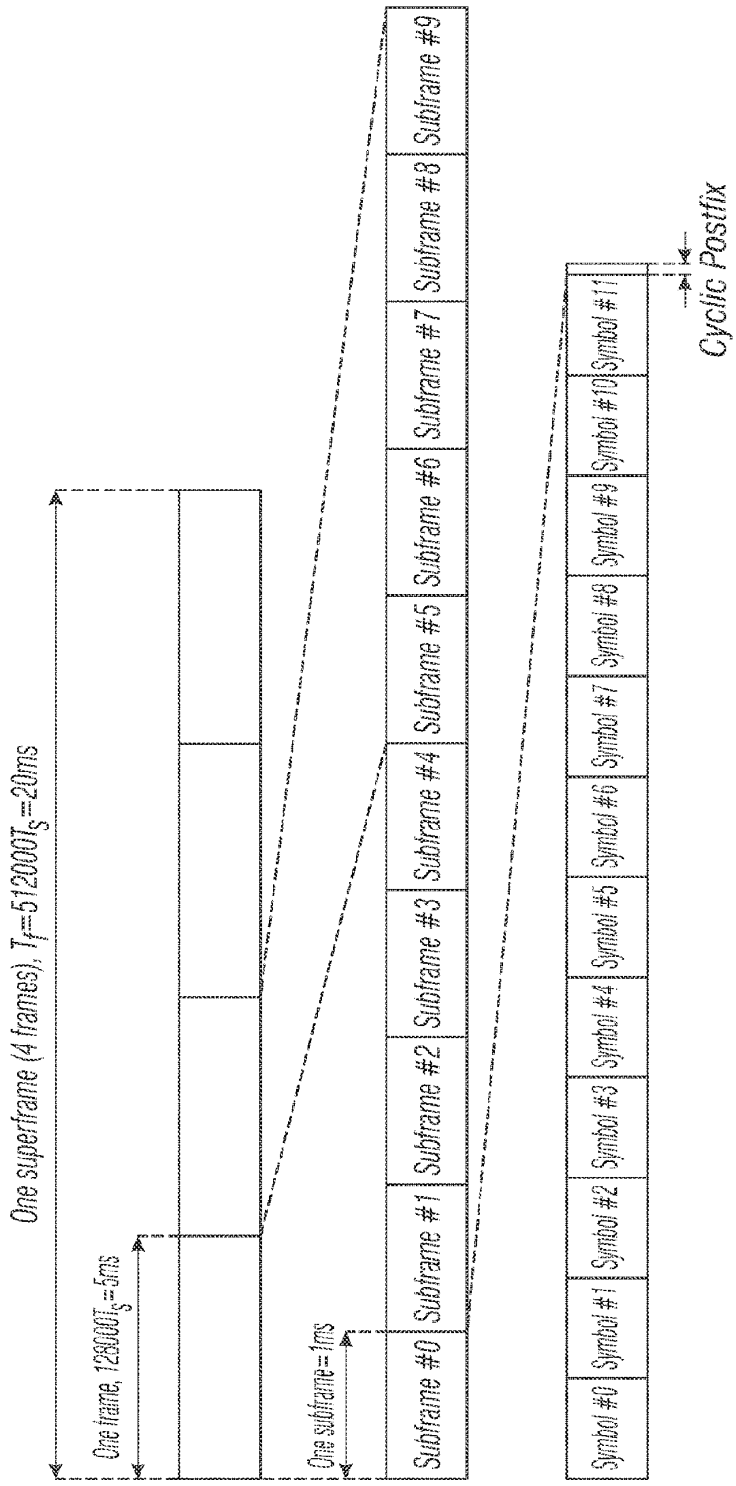


FIG. 8A

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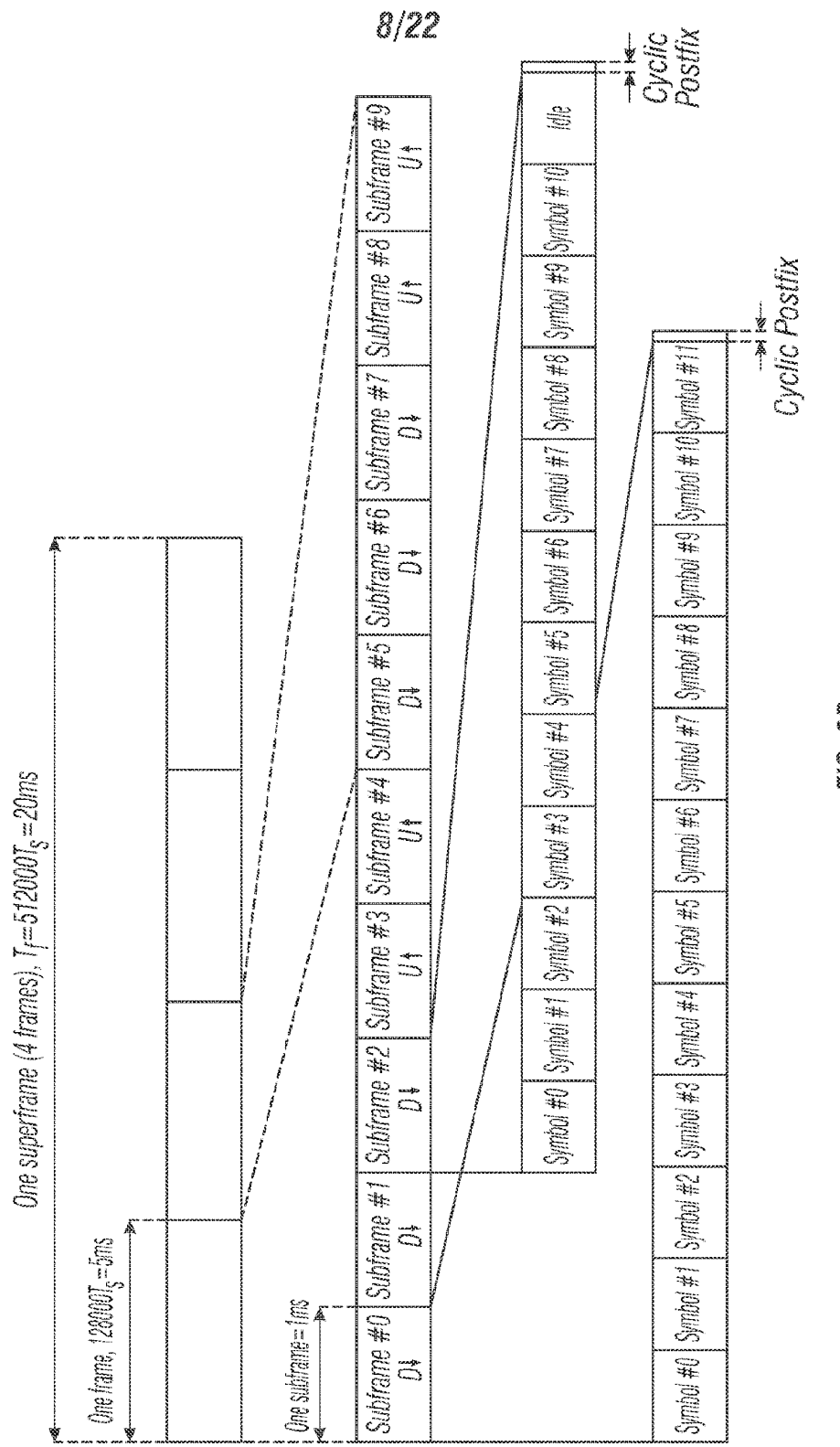


FIG. 8B

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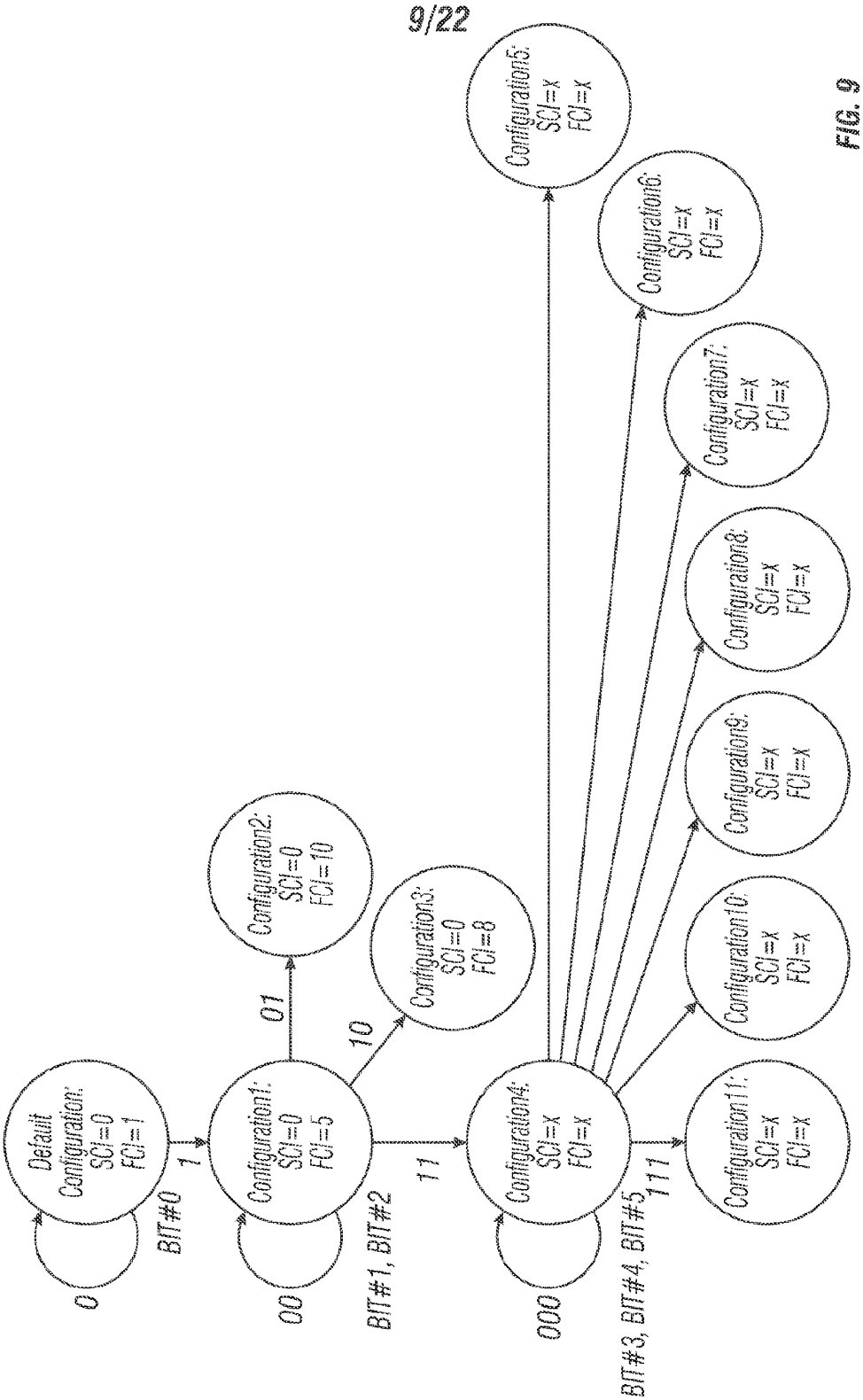


FIG. 9

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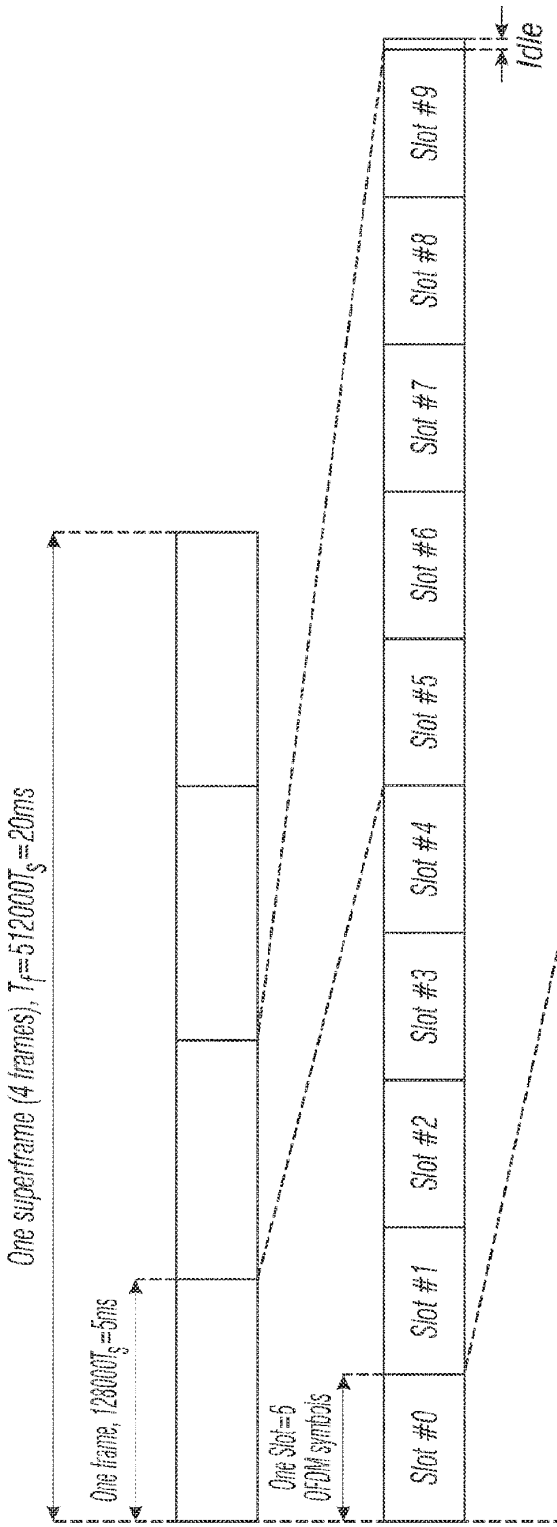


FIG. 10A

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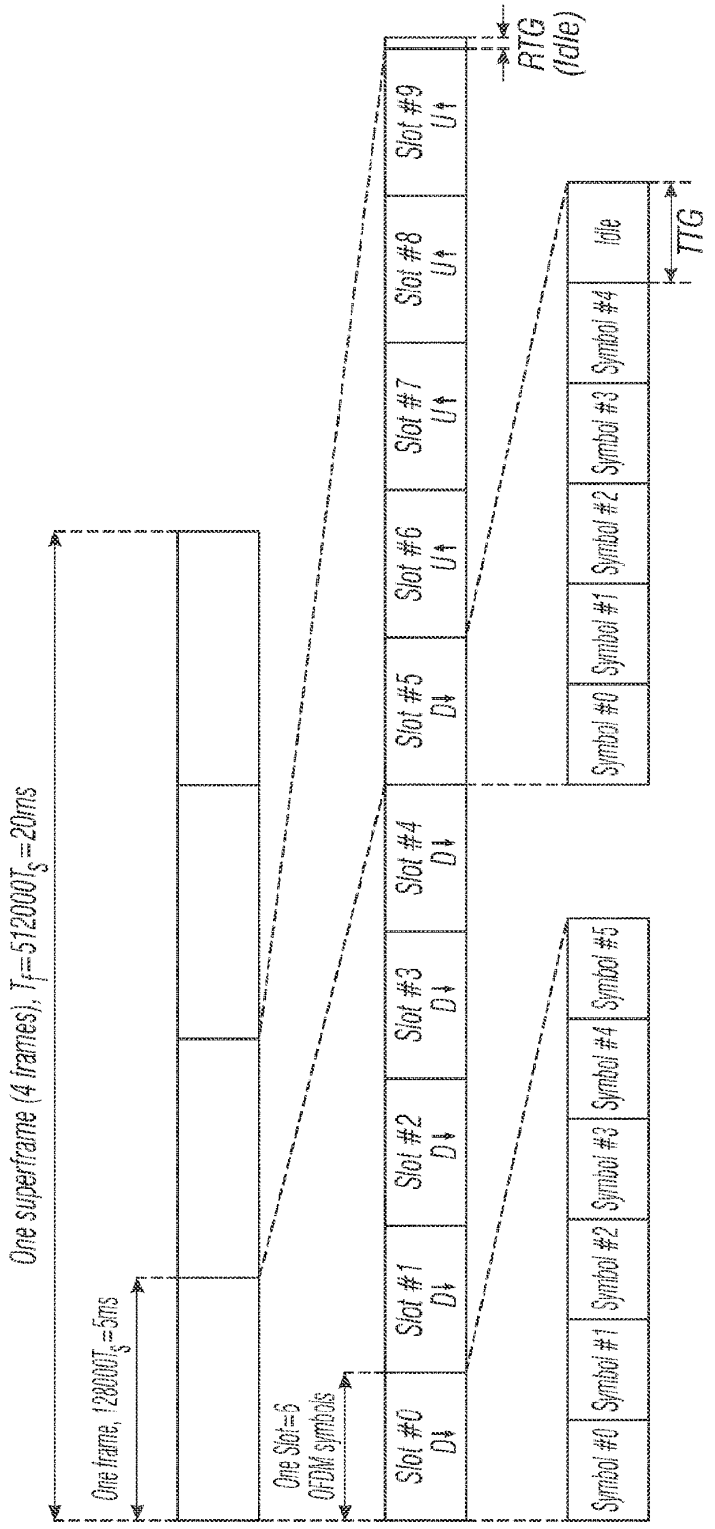


FIG. 10B

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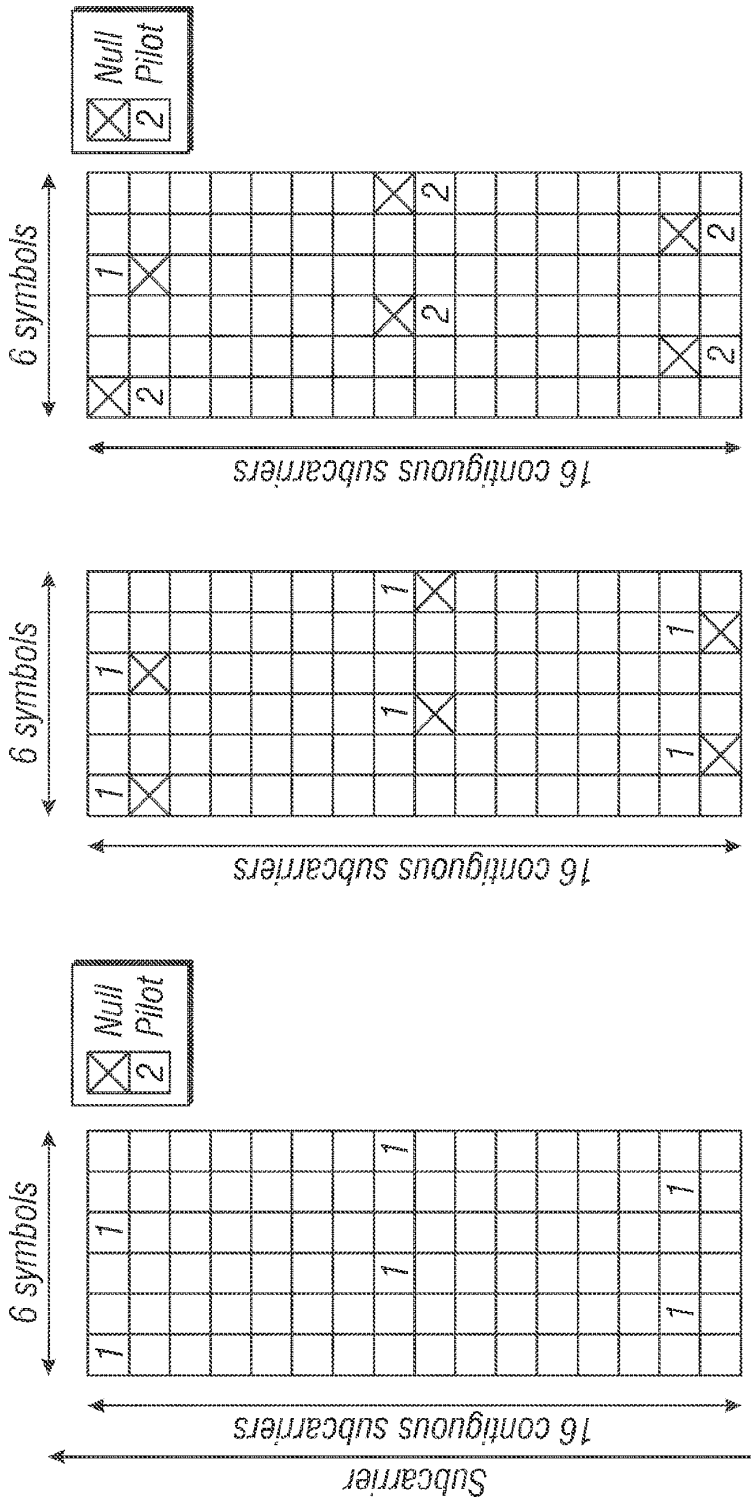


FIG. 11B

FIG. 11A

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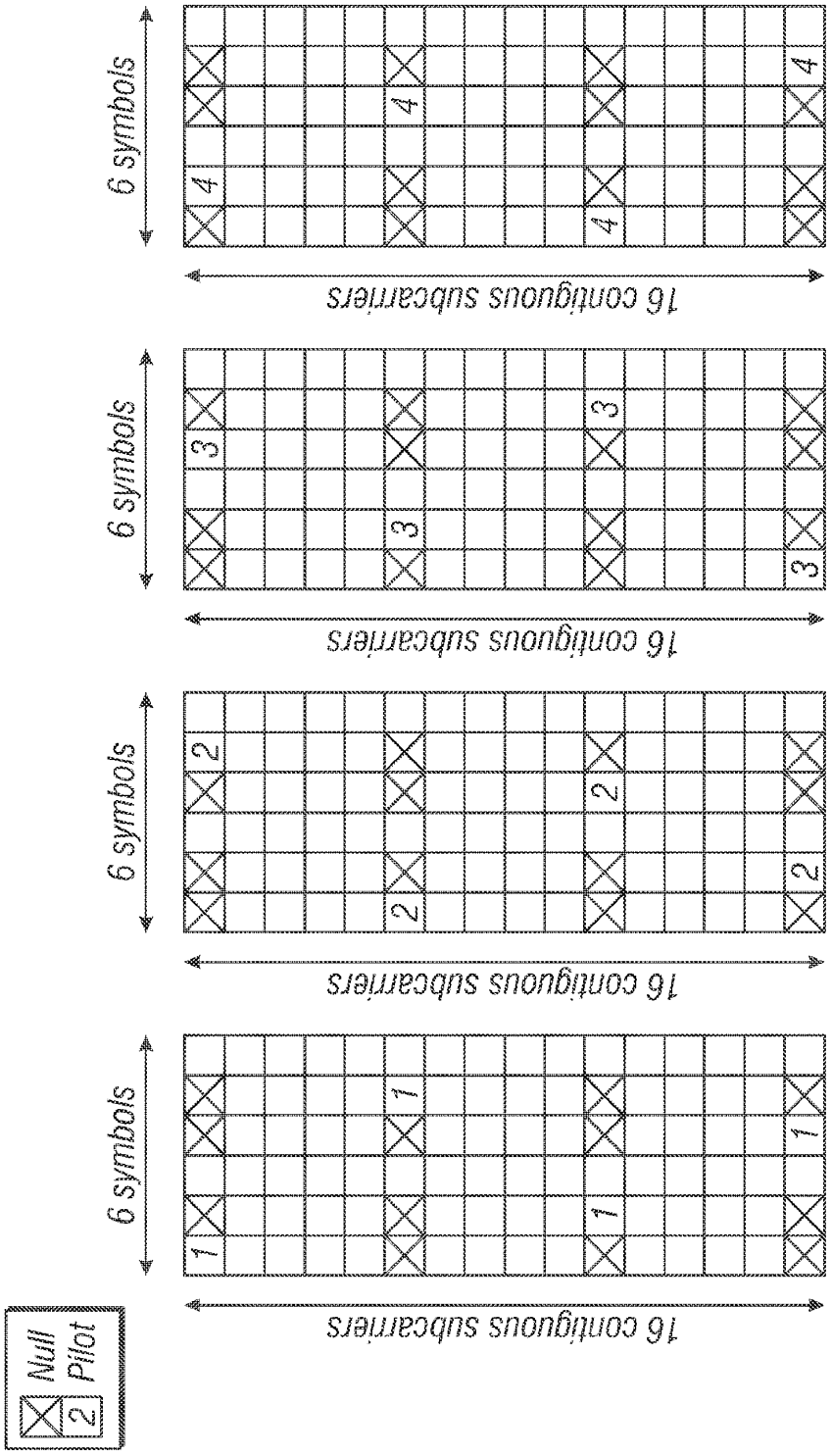


FIG. 12

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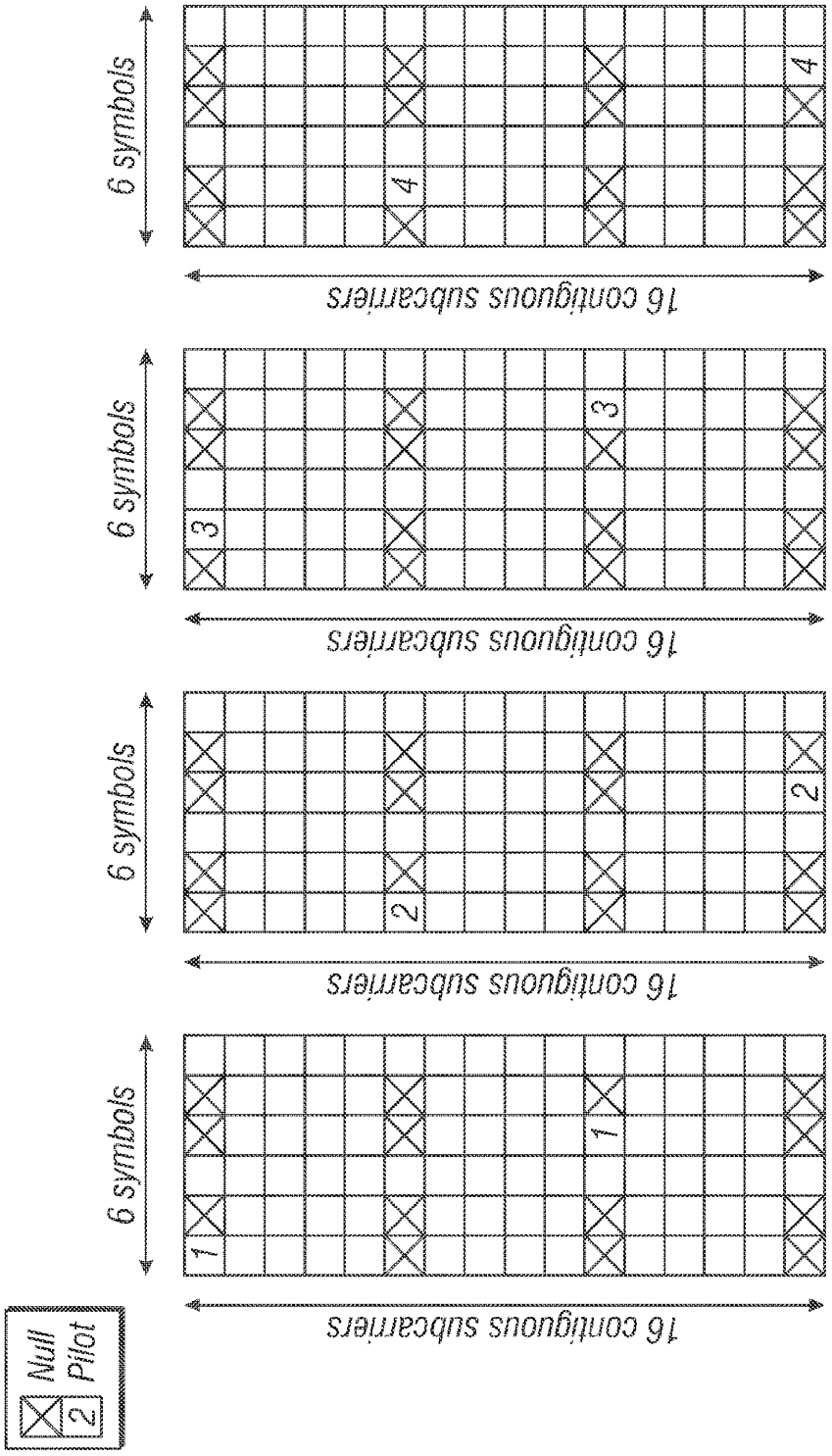


Fig. 13

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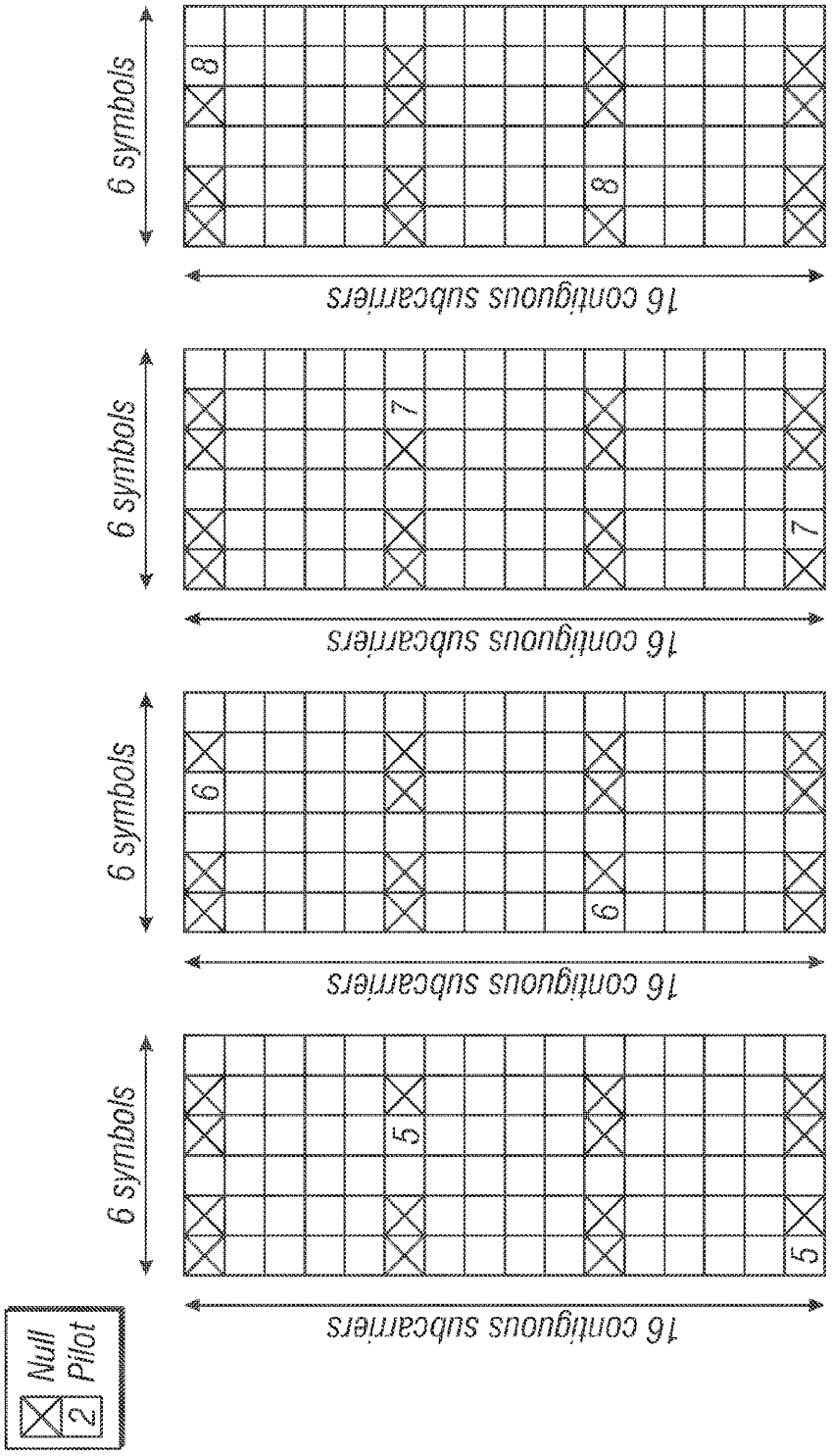


Fig. 13
(Continued)

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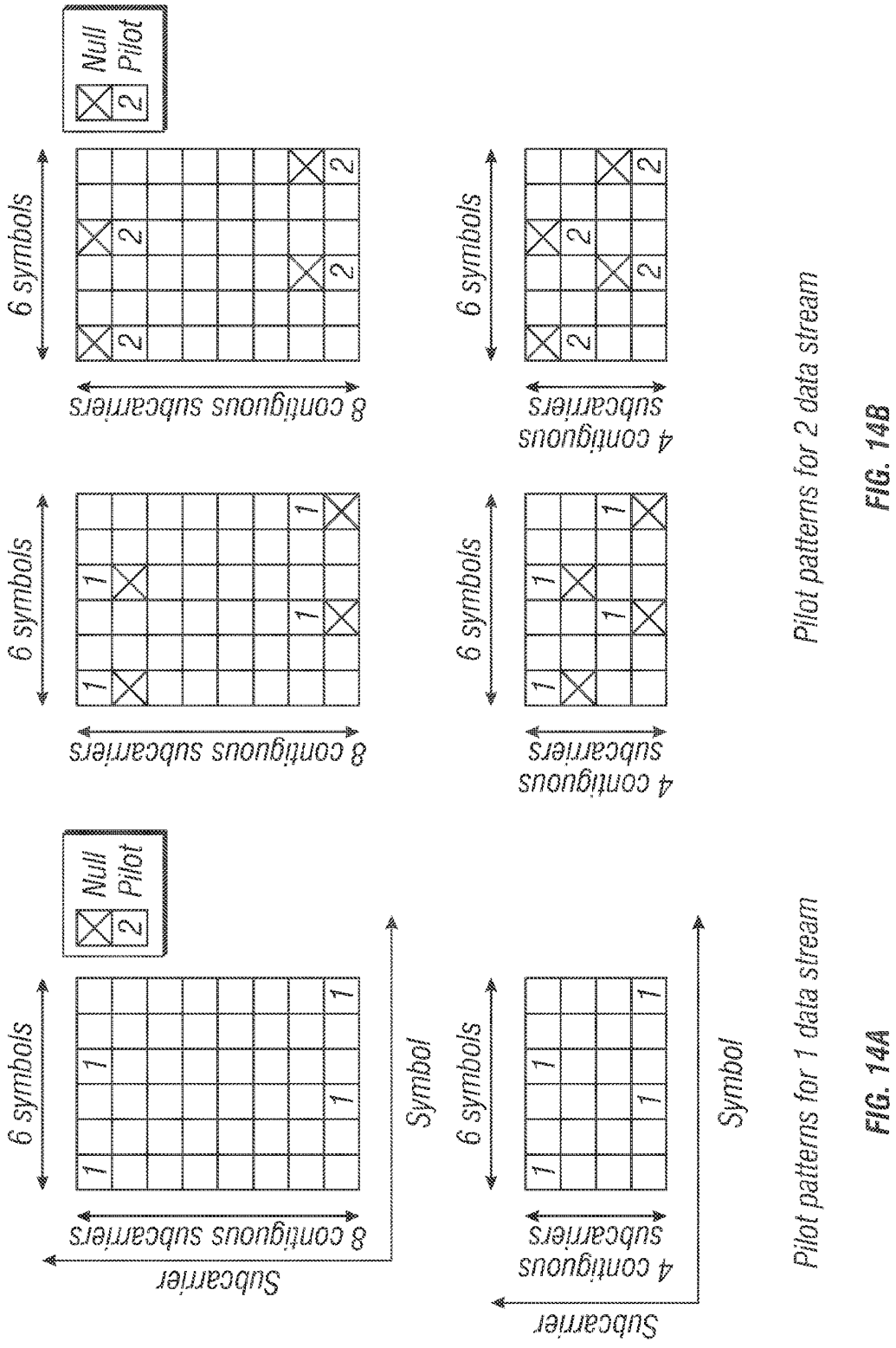


FIG. 14A

FIG. 14B

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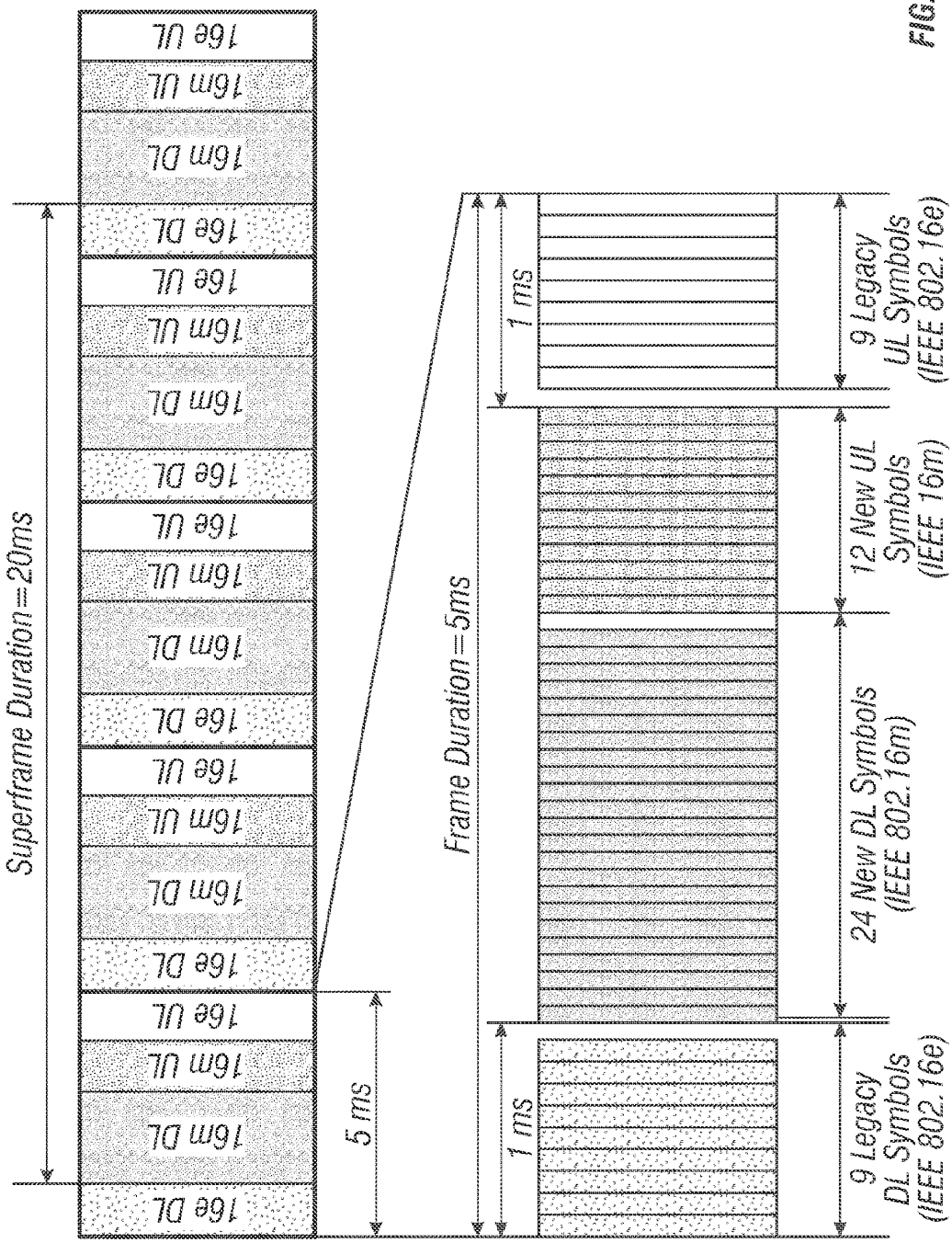


FIG. 15

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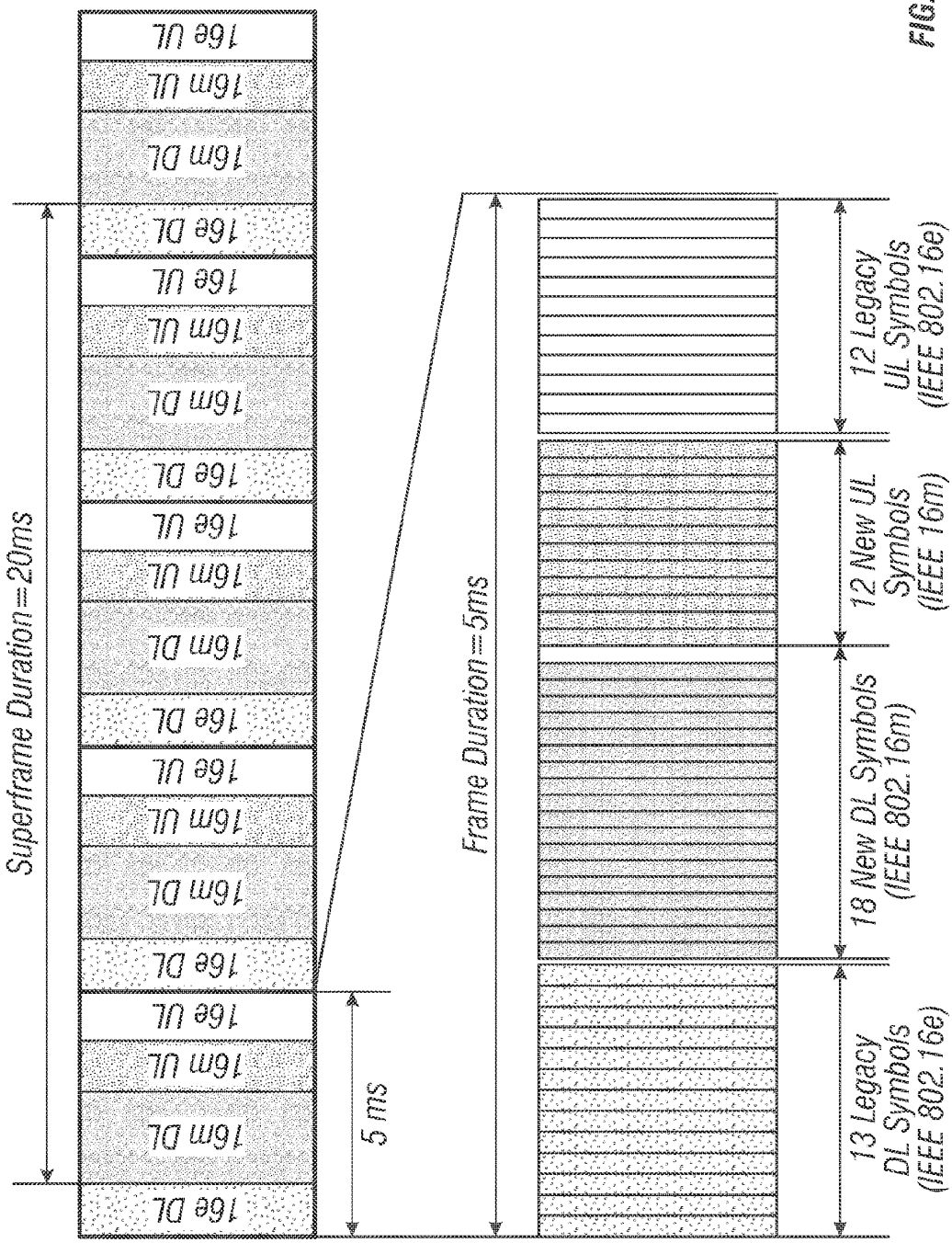


FIG. 16

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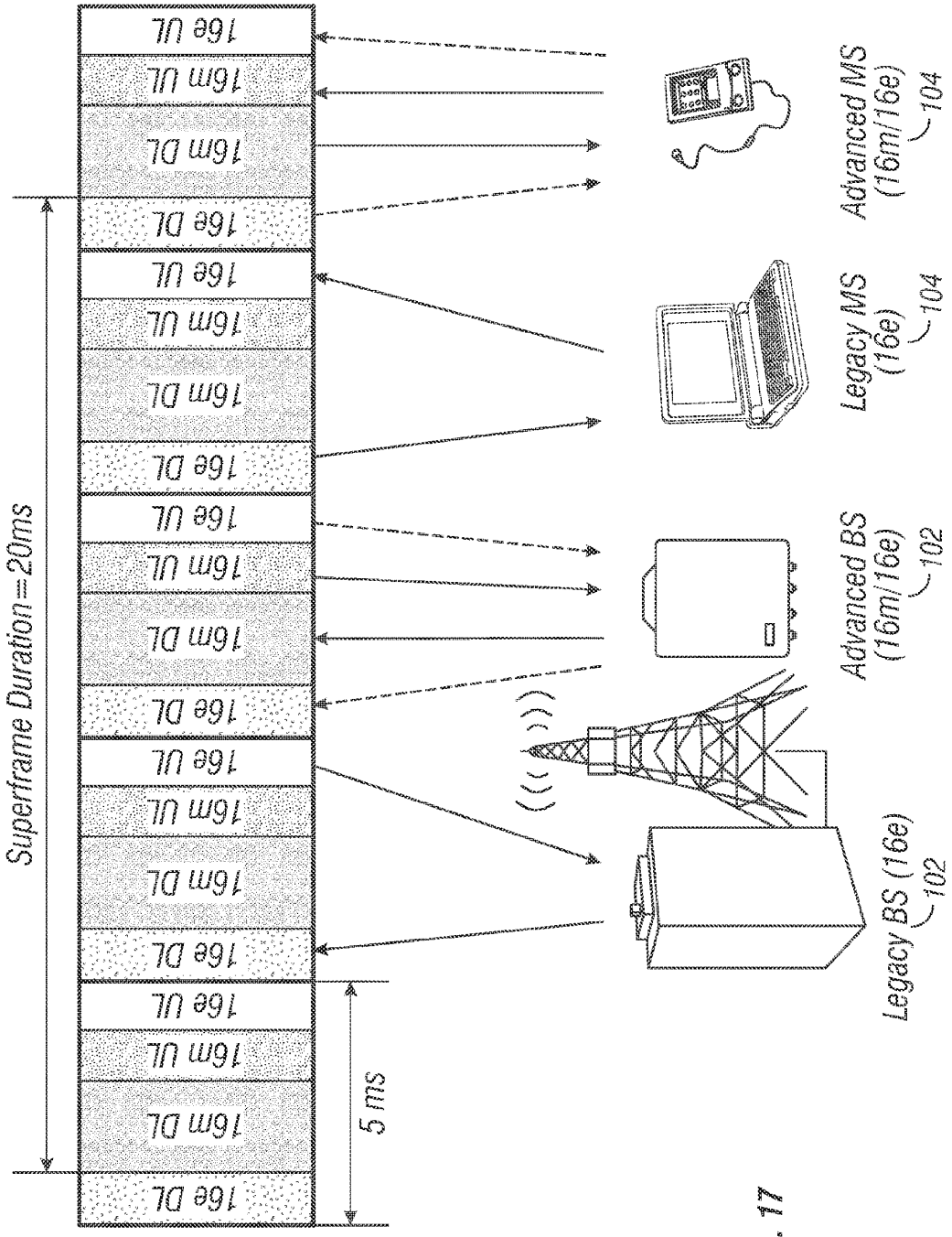


FIG. 17

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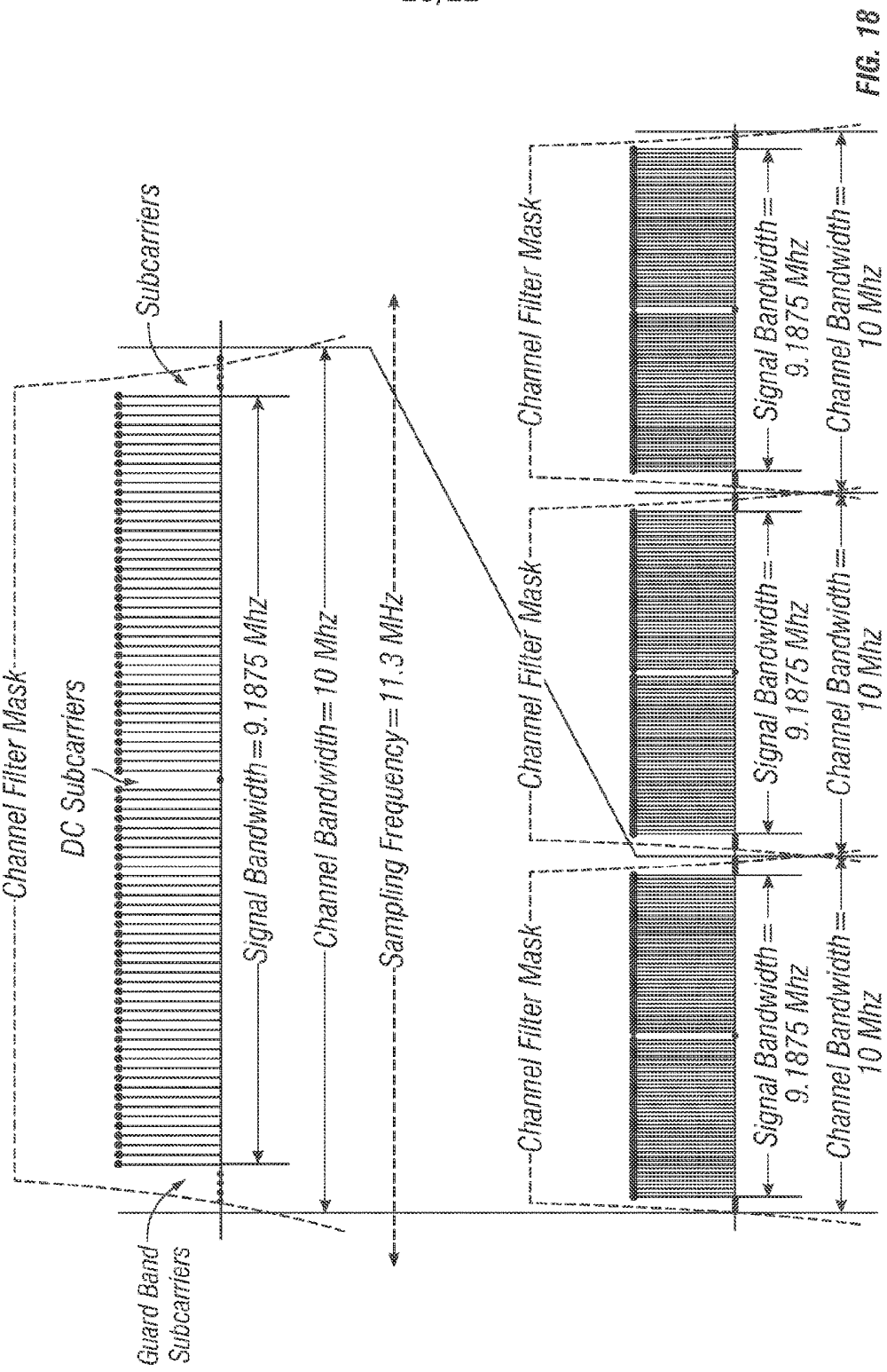


FIG. 18

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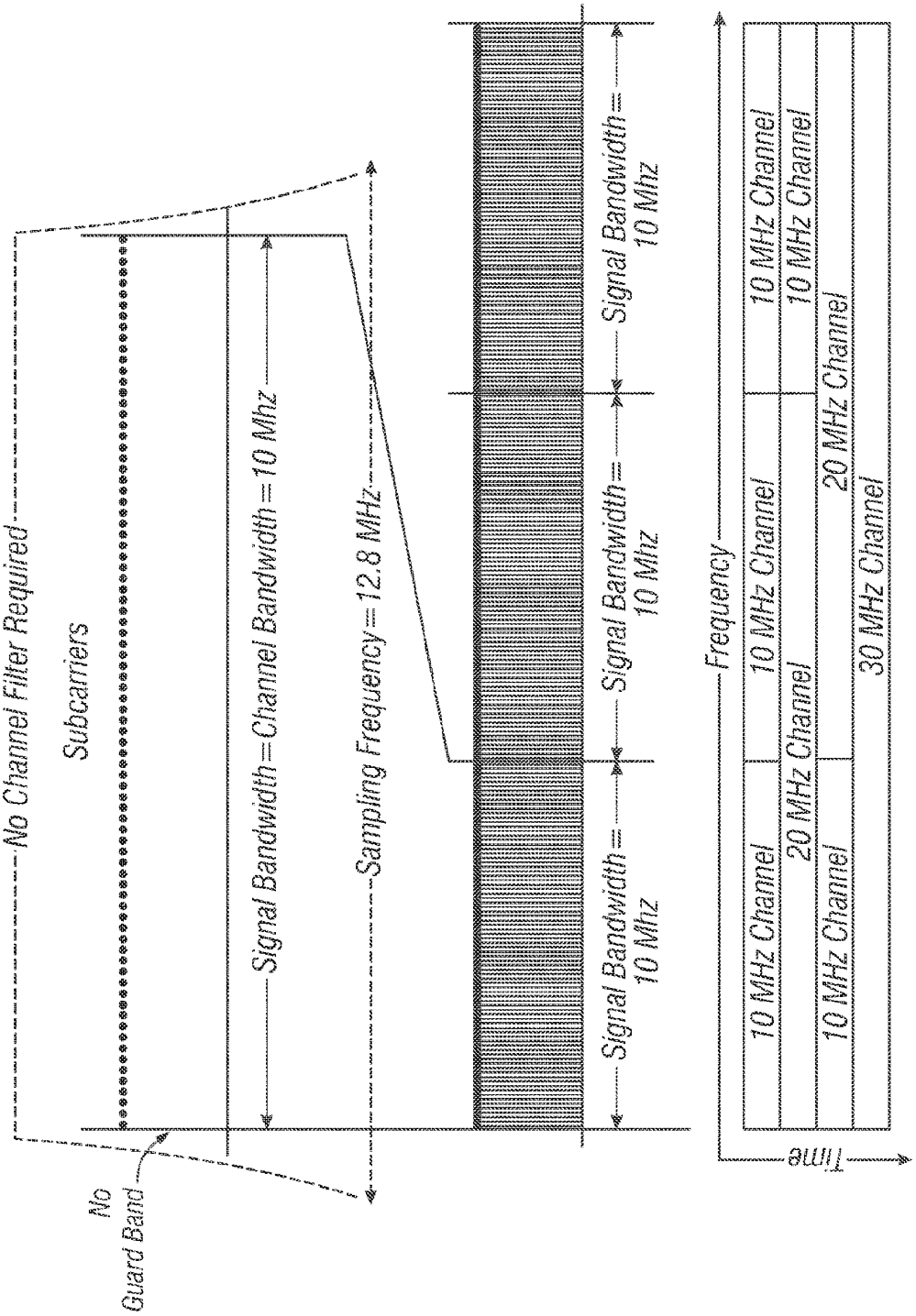


FIG. 19

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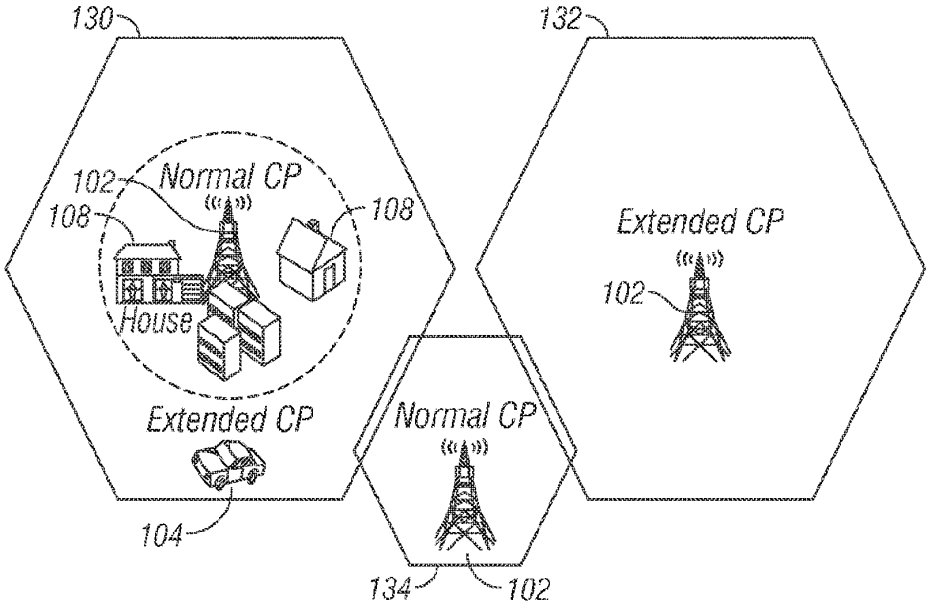


FIG. 20

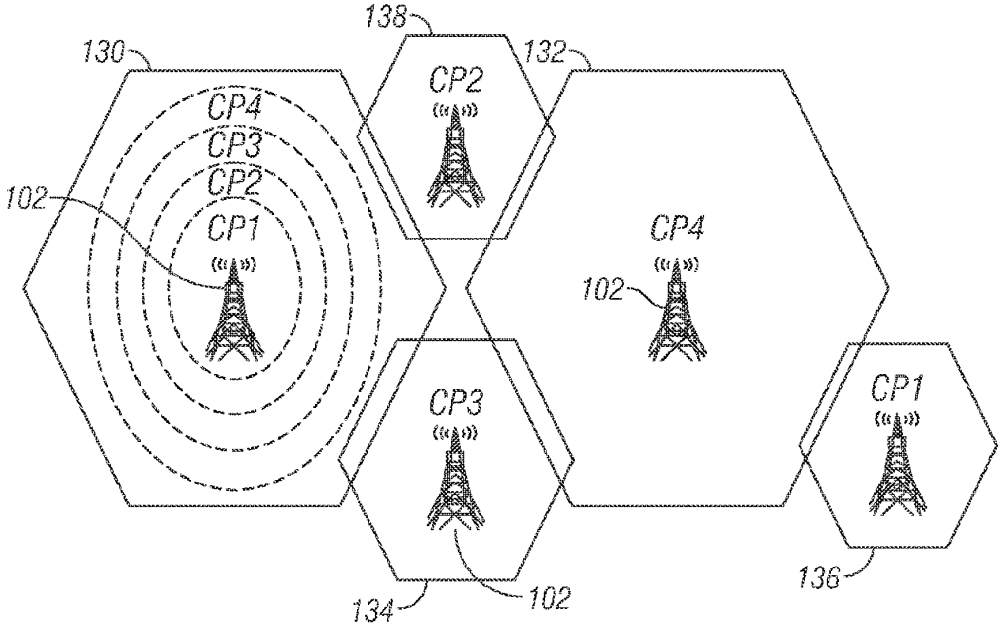


FIG. 21

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(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

(43) 국제공개일
2016 년 5 월 12 일 (12.05.2016)

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(25) 출원언어: 한국어

(26) 공개언어: 한국어

(30) 우선권정보:
62/075,272 2014 년 11 월 5 일 (05.11.2014) US
62/088,688 2014 년 12 월 8 일 (08.12.2014) US

(71) 출원인: **엘지전자 주식회사 (LG ELECTRONICS INC.)** [KR/KR]; 07336 서울시 영등포구 여의대로 128, Seoul (KR).

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(74) 대리인: **에스엔아이피 특허법인 (S&IP PATENT & LAW FIRM)**; 06235 서울시 강남구 테헤란로 14 길 5 (역삼동 삼흥역삼빌딩 2 층), Seoul (KR).

(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

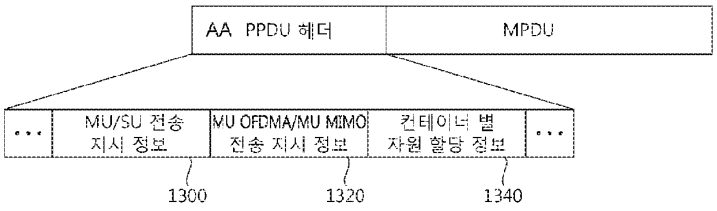
(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

공개:

— 국제조사보고서와 함께 (조약 제 21 조(3))

(54) Title: METHOD AND DEVICE FOR ALLOCATING RESOURCE UNIT ON BASIS OF CONTAINER IN WIRELESS LAN

(54) 발명의 명칭 : 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치



1300 ... MU/SU transmission indication information
1320 ... MU OFDMA/MU MIMO transmission indication information
1340 ... Resource allocation information for each container
AA ... PPDU header

(57) Abstract: Disclosed are a method and a device for allocating a resource unit on the basis of a container in a wireless LAN. The method for allocating a resource unit in a wireless LAN comprises the steps of: generating, by an AP, a PPDU to be transmitted to a plurality of STAs; and transmitting, by the AP, the PPDU to the plurality of STAs through at least one container allocated on the entire frequency band, wherein the PPDU includes MU/SU transmission indication information and resource allocation information for each container, the MU/SU transmission indication information includes information on whether an SU-based transmission or an MU-based transmission is carried out on the entire bandwidth, and the resource allocation information for each container can include information on the number of STAs allocated to each of the at least one container.

(57) 요약서: 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치가 개시되어 있다. 무선랜에서 자원 단위를 할당하는 방법은 AP 가 복수의 STA 으로 전송할 PPDU 를 생성하는 단계와 AP 가 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 복수의 STA 으로 PPDU 를 전송하는 단계를 포함하되, PPDU 는 MU/SU 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고, MU/SU 전송 지시 정보는 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고, 컨테이너 별 자원 할당 정보는 적어도 하나의 컨테이너 각각에 할당된 STA 의 개수에 대한 정보를 포함할 수 있다.

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명세서

발명의 명칭: 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치

기술분야

[1] 본 발명은 무선 통신에 관한 것으로 보다 상세하게는 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법 및 장치에 관한 것이다.

배경기술

[2] 차세대 WLAN(wireless local area network)를 위한 논의가 진행되고 있다. 차세대 WLAN에서는 1) 2.4GHz 및 5GHz 대역에서 IEEE(institute of electronic and electronics engineers) 802.11 PHY(physical) 계층과 MAC(medium access control) 계층의 향상, 2) 스펙트럼 효율성(spectrum efficiency)과 영역 쓰루풋(area through put)을 높이는 것, 3) 간섭 소스가 존재하는 환경, 밀집한 이종 네트워크(heterogeneous network) 환경 및 높은 사용자 부하가 존재하는 환경과 같은 실제 실내 환경 및 실외 환경에서 성능을 향상 시키는 것 을 목표로 한다.

[3] 차세대 WLAN에서 주로 고려되는 환경은 AP(access point)와 STA(station)이 많은 밀집 환경이며, 이러한 밀집 환경에서 스펙트럼 효율(spectrum efficiency)과 공간 전송률(area throughput)에 대한 개선이 논의된다. 또한, 차세대 WLAN에서는 실내 환경뿐만 아니라, 기존 WLAN에서 많이 고려되지 않던 실외 환경에서의 실질적 성능 개선에 관심을 가진다.

[4] 구체적으로 차세대 WLAN에서는 무선 오피스(wireless office), 스마트 홈(smart home), 스타디움(Stadium), 핫스팟(Hotspot), 빌딩/아파트(building/apartment)와 같은 시나리오에 관심이 크며, 해당 시나리오 기반으로 AP와 STA이 많은 밀집 환경에서의 시스템 성능 향상에 대한 논의가 진행되고 있다.

[5] 또한, 차세대 WLAN에서는 하나의 BSS(basic service set)에서의 단일 링크 성능 향상보다는, OBSS(overlapping basic service set) 환경에서의 시스템 성능 향상 및 실외 환경 성능 개선, 그리고 셀룰러 오프로딩 등에 대한 논의가 활발할 것으로 예상된다. 이러한 차세대 WLAN의 방향성은 차세대 WLAN이 점점 이동 통신과 유사한 기술 범위를 갖게 됨을 의미한다. 최근 스몰셀 및 D2D(Direct-to-Direct) 통신 영역에서 이동 통신과 WLAN 기술이 함께 논의되고 있는 상황을 고려해 볼 때, 차세대 WLAN과 이동 통신의 기술적 및 사업적 융합은 더욱 활발해질 것으로 예측된다.

발명의 상세한 설명

기술적 과제

[6] 본 발명의 목적은 무선랜에서 컨테이너를 기반으로 자원 단위를 할당하는 방법을 제공하는 것이다.

[7] 본 발명의 또 다른 목적은 무선랜에서 컨테이너를 기반으로 자원 단위를

할당하는 장치를 제공하는 것이다.

과제 해결 수단

[8] 상술한 본 발명의 목적을 달성하기 위한 본 발명의 일 측면에 따른 무선랜에서 자원 단위를 할당하는 방법은 AP(access point)가 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하는 단계와 상기 AP가 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하는 단계를 포함할 수 있되, 상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고, 상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고, 상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고, 상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고, 상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 클 수 있다.

[9] 상술한 본 발명의 목적을 달성하기 위한 본 발명의 다른 측면에 따른 무선랜에서 자원 단위를 할당하는 AP(access point)는 무선 신호를 송신 및 수신하는 RF(radio frequency) 부와 상기 RF 부와 동작 가능하게(operatively) 결합된 프로세서를 포함하되, 상기 프로세서는 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하고, 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하도록 구현될 수 있되, 상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고, 상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고, 상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고, 상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고, 상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 클 수 있다.

발명의 효과

[10] OFDMA(orthogonalfrequency division multiple access)를 기반으로 복수의 STA 각각을 위한 무선 자원을 할당시 서로 다른 크기로 정의된 무선 자원 단위를 사용하여 복수의 STA 각각으로의 자원 할당이 수행될 수 있다. 따라서, 스케줄링 유연도(scheduling flexibility)가 높아지고 무선랜의 처리량(throughput)이 증가될 수 있다. 컨테이너를 기반으로 자원 단위를 스케줄링함으로써 자원 단위 할당의 스케줄링을 위한 복잡도가 감소될 수 있다.

도면의 간단한 설명

[11] 도 1은 무선랜(wireless local area network, WLAN)의 구조를 나타내 개념도이다.

[12] 도 2는 본 발명의 실시예에 따른 20MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[13] 도 3은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[14] 도 4는 본 발명의 실시예에 따른 자원 단위의 할당을 위한 시그널링 방법을 나타낸 개념도이다.

[15] 도 5는 본 발명의 실시예에 따른 40MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[16] 도 6은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[17] 도 7은 본 발명의 실시예에 따른 80MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[18] 도 8은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[19] 도 9는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[20] 도 10은 본 발명의 실시예에 따른 컨테이너 별 자원 할당 정보를 나타낸 개념도이다.

[21] 도 11은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[22] 도 12는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[23] 도 13은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[24] 도 14는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[25] 도 15는 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[26] 도 16은 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[27] 도 17은 본 발명의 실시예에 따른 DL MU PPDU 포맷을 나타낸 개념도이다.

[28] 도 18은 본 발명의 실시예에 따른 UL MU PPDU의 전송을 나타낸 개념도이다.

[29] 도 19는 본 발명의 실시예가 적용될 수 있는 무선 장치를 나타내는 블록도이다.

발명의 실시를 위한 형태

[30] 도 1은 무선랜(wireless local area network, WLAN)의 구조를 나타낸 개념도이다.

[31] 도 1의 상단은 IEEE(institute of electrical and electronic engineers) 802.11의 인프라스트럭처 BSS(basic service set)의 구조를 나타낸다.

[32] 도 1의 상단을 참조하면, 무선랜 시스템은 하나 또는 그 이상의 인프라스트럭처 BSS(100, 105)(이하, BSS)를 포함할 수 있다. BSS(100, 105)는 성공적으로 동기화를 이루어서 서로 통신할 수 있는 AP(access point, 125) 및 STA1(Station, 100-1)과 같은 AP와 STA의 집합으로서, 특정 영역을 가리키는 개념은 아니다. BSS(105)는 하나의 AP(130)에 하나 이상의 결합 가능한 STA(105-1, 105-2)을 포함할 수도 있다.

[33] BSS는 적어도 하나의 STA, 분산 서비스(distribution Service)를 제공하는 AP(125, 130) 및 다수의 AP를 연결시키는 분산 시스템(distribution System, DS, 110)을 포함할 수 있다.

[34] 분산 시스템(110)는 여러 BSS(100, 105)를 연결하여 확장된 서비스 셋인 ESS(extended service set, 140)를 구현할 수 있다. ESS(140)는 하나 또는 여러 개의 AP(125, 230)가 분산 시스템(110)을 통해 연결되어 이루어진 하나의 네트워크를 지시하는 용어로 사용될 수 있다. 하나의 ESS(140)에 포함되는 AP는 동일한 SSID(service set identification)를 가질 수 있다.

[35] 포털(portal, 120)은 무선랜 네트워크(IEEE 802.11)와 다른 네트워크(예를 들어, 802.X)와의 연결을 수행하는 브리지 역할을 수행할 수 있다.

[36] 도 1의 상단과 같은 BSS에서는 AP(125, 130) 사이의 네트워크 및 AP(125, 130)와 STA(100-1, 105-1, 105-2) 사이의 네트워크가 구현될 수 있다. 하지만, AP(125, 130)가 없이 STA 사이에서도 네트워크를 설정하여 통신을 수행하는 것도 가능할 수 있다. AP(125, 130)가 없이 STA 사이에서도 네트워크를 설정하여 통신을 수행하는 네트워크를 애드-혹 네트워크(Ad-Hoc network) 또는 독립 BSS(independent basic service set, IBSS)라고 정의한다.

[37] 도 1의 하단은 IBSS를 나타낸 개념도이다.

[38] 도 1의 하단을 참조하면, IBSS는 애드-혹 모드로 동작하는 BSS이다. IBSS는 AP를 포함하지 않기 때문에 중앙에서 관리 기능을 수행하는 개체(centralized management entity)가 없다. 즉, IBSS에서 STA(150-1, 150-2, 150-3, 155-4, 155-5)들은 분산된 방식(distributed manner)으로 관리된다. IBSS에서는 모든 STA(150-1, 150-2, 150-3, 155-4, 155-5)이 이동 STA으로 이루어질 수 있으며, 분산 시스템으로의 접속이 허용되지 않아서 자기 완비적 네트워크(self-contained network)를 이룬다.

[39] STA은 IEEE(Institute of Electrical and Electronics Engineers) 802.11 표준의 규정을 따르는 매체 접속 제어(medium access control, MAC)와 무선 매체에 대한 물리 계층(Physical Layer) 인터페이스를 포함하는 임의의 기능 매체로서, 광의로는 AP와 비-AP STA(Non-AP Station)을 모두 포함하는 의미로 사용될 수 있다.

[40] STA은 이동 단말(mobile terminal), 무선 기기(wireless device), 무선 송수신 유닛(Wireless Transmit/Receive Unit; WTRU), 사용자 장비(User Equipment; UE), 이동국(Mobile Station; MS), 이동 가입자 유닛(Mobile Subscriber Unit) 또는

단순히 유저(user) 등의 다양한 명칭으로도 불릴 수 있다.

[41] 이하, 본 발명의 실시예에서는 AP에서 STA으로 전송되는 데이터(또는 프레임)는 하향링크 데이터(또는 하향링크 프레임), STA에서 AP로 전송되는 데이터(또는 프레임)는 상향링크 데이터(또는 상향링크 프레임)라는 용어로 표현될 수 있다. 또한, AP에서 STA으로의 전송은 하향링크 전송, STA에서 AP로의 전송은 상향링크 전송이라는 용어로 표현할 수 있다.

[42] 또한, 하향링크 전송을 통해 전송되는 PPDU(PHY protocol data unit), 프레임 및 데이터 각각은 하향링크 PPDU, 하향링크 프레임 및 하향링크 데이터라는 용어로 표현될 수 있다. PPDU는 PPDU 헤더와 PSDU(physical layer service data unit)(또는 MPDU(MAC protocol data unit))를 포함하는 데이터 단위일 수 있다. PPDU 헤더는 PHY 헤더와 PHY 프리앰블을 포함할 수 있고, PSDU(또는 MPDU)는 프레임(또는 MAC 계층의 정보 단위)을 포함하거나 프레임을 지시하는 데이터 단위일 수 있다. PHY 헤더는 다른 용어로 PLCP(physical layer convergence protocol) 헤더, PHY 프리앰블은 다른 용어로 PLCP 프리앰블로 표현될 수도 있다.

[43] 또한, 상향링크 전송을 통해 전송되는 PPDU, 프레임 및 데이터 각각은 상향링크 PPDU, 상향링크 프레임 및 상향링크 데이터라는 용어로 표현될 수 있다.

[44] 기존의 무선랜 시스템에서는 SU(single)-OFDM(orthogonal frequency division multiplexing) 전송을 기반으로 전체 대역폭이 하나의 STA으로의 하향링크 전송 및 하나의 STA의 상향링크 전송을 위해 사용되었다. 또한, 기존의 무선랜 시스템에서 AP는 MU MIMO(multiple input multiple output)를 기반으로 DL(downlink) MU(multi-user) 전송을 수행할 수 있었고, 이러한 전송은 DL MU MIMO 전송이라는 용어로 표현될 수 있다.

[45] 본 발명의 실시예에 따른 무선랜 시스템에서는 OFDMA(orthogonal frequency division multiple access) 기반의 전송 방법이 상향링크 전송 및 하향링크 전송을 위해 지원될 수 있다. 구체적으로 본 발명의 실시예에 따른 무선랜 시스템에서 AP가 OFDMA를 기반으로 DL MU 전송을 수행할 수 있고, 이러한 전송은 DL MU OFDMA 전송이라는 용어로 표현될 수 있다. DL MU OFDMA 전송이 수행되는 경우, AP는 중첩된 시간 자원 상에서 복수의 주파수 자원 각각을 통해 복수의 STA 각각으로 하향링크 데이터(또는 하향링크 프레임, 하향링크 PPDU)를 전송할 수 있다. 복수의 주파수 자원은 복수의 서브밴드(또는 서브채널) 또는 복수의 RU(resource unit)(예를 들어, 서로 다른 크기로 정의된 기본 자원 단위(basic resource unit, BRU))일 수 있다. DL MU OFDMA 전송은 DL MU MIMO 전송과 함께 사용될 수 있다. 예를 들어, DL MU OFDMA 전송을 위해 할당된 특정 서브 밴드(또는 서브 채널) 상에서 복수의 시공간 스트림(space-time stream)(또는 공간적 스트림(spatial stream))을 기반으로 한 DL MU MIMO 전송이 수행될 수 있다.

[46] 또한, 본 발명의 실시예에 따른 무선랜 시스템에서는 복수의 STA이 동일한 시간 자원 상에서 AP로 데이터를 전송하는 것을 UL MU 전송(uplink multi-user transmission)이 지원될 수 있다. 복수의 STA 각각에 의한 중첩된 시간 자원 상에서의 상향링크 전송은 주파수 도메인 또는 공간 도메인(spatial domain) 상에서 수행될 수 있다.

[47] 복수의 STA 각각에 의한 상향링크 전송이 주파수 도메인 상에서 수행되는 경우, OFDMA를 기반으로 복수의 STA 각각에 대해 서로 다른 주파수 자원이 상향링크 전송 자원으로 할당될 수 있다. 서로 다른 주파수 자원은 서로 다른 서브밴드(또는 서브채널) 또는 서로 다른 RU(resource unit)일 수 있다. 복수의 STA 각각은 할당된 서로 다른 주파수 자원을 통해 AP로 상향링크 데이터를 전송할 수 있다. 이러한 서로 다른 주파수 자원을 통한 전송 방법은 UL MU OFDMA 전송 방법이라는 용어로 표현될 수도 있다.

[48] 복수의 STA 각각에 의한 상향링크 전송이 공간 도메인 상에서 수행되는 경우, 복수의 STA 각각에 대해 서로 다른 시공간 스트림(또는 공간적 스트림)이 할당되고 복수의 STA 각각이 서로 다른 시공간 스트림을 통해 상향링크 데이터를 AP로 전송할 수 있다. 이러한 서로 다른 공간적 스트림을 통한 전송 방법은 UL MU MIMO 전송 방법이라는 용어로 표현될 수도 있다.

[49] UL MU OFDMA 전송과 UL MU MIMO 전송은 함께 수행될 수 있다. 예를 들어, UL MU OFDMA 전송을 위해 할당된 특정 서브 밴드(또는 서브 채널) 상에서 복수의 시공간 스트림(또는 공간적 스트림)을 기반으로 한 UL MU MIMO 전송이 수행될 수 있다.

[50] MU OFDMA 전송을 지원하지 않았던 종래의 무선랜 시스템에서 하나의 단말에게 넓은 대역폭(wider bandwidth)(예를 들어, 20MHz 초과 대역폭)을 할당하기 위해 멀티 채널 할당 방법이 사용되었다. 멀티 채널은 하나의 채널 단위를 20MHz라고 할 경우, 복수개의 20MHz 채널을 포함할 수 있다. 멀티 채널 할당 방법에서는 단말에게 넓은 대역폭을 할당하기 위해 프라이머리 채널 규칙(primary channel rule)이 사용되었다. 프라이머리 채널 규칙이 사용되는 경우, 단말로 넓은 대역폭을 할당하기 위한 제약이 존재한다. 구체적으로, 프라이머리 채널 룰에 따르면, 프라이머리 채널에 인접한 세컨더리 채널(secondary channel)이 OBSS(overlapped BSS)에서 사용되어 '비지(busy)' 한 경우, STA은 프라이머리 채널을 제외한 나머지 채널을 사용할 수 없다. 따라서, STA은 프라이머리 채널로만 프레임을 전송할 수 있어 멀티 채널을 통한 프레임의 전송에 대한 제약을 받는다. 즉, 기존의 무선랜 시스템에서 멀티 채널 할당을 위해 사용되던 프라이머리 채널 룰은 OBSS가 적지 않은 현재 무선랜 환경에서 넓은 대역폭을 운용하여 높은 처리량을 얻고자 함에 있어 큰 제약이 될 수 있다.

[51] 이러한 문제점을 해결하고자 본 발명에 실시예에서는 OFDMA(orthogonalfrequency division multiple access) 기술을 지원하는 무선랜

시스템이 개시된다. OFDMA 기술이 사용되는 경우, 프라이머리 채널 룰에 의한 제한 없이 멀티 채널을 하나의 단말이 아닌 다수의 단말이 동시에 사용할 수 있다. 따라서, 넓은 대역폭 운용이 가능하여 무선 자원의 운용의 효율성이 향상될 수 있다.

[52] 본 발명에서 실시예에 따른 무선랜 시스템에서 가정되는 시간-주파수 구조(time-frequency structure)는 예시적으로 아래와 같을 수 있다.

[53] FFT(fast fourier transform) 사이즈/IFFT(inverse fast fourier transform) 사이즈는 기존의 무선랜 시스템에서 사용되던 FFT/IFFT 사이즈의 N배(N은 자연수, 예를 들어, N=4)로 정의될 수 있다. 예를 들어, 20MHz의 대역폭에 대하여 256FFT/IFFT가 적용되고, 40MHz의 대역폭에 대하여 512FFT/IFFT가 적용되고, 80MHz의 대역폭에 대하여 1024FFT/IFFT가 적용되고, 연속 160MHz 또는 불연속 160MHz의 대역폭에 대하여 2048FFT/IFFT가 적용될 수 있다.

[54] 서브캐리어 공간(subcarrier spacing)은 기존의 무선랜 시스템에서 사용되던 서브캐리어 공간의 1/N배(N은 자연수, 예를 들어, N=4일 경우, 78.125kHz)의 크기일 수 있다.

[55] IDFT(inverse discrete fourier transform)/DFT(discrete fourier transform)(또는 FFT/IFFT)를 기반으로 한 IDFT/DFT 길이(또는 유효 심볼 길이)는 기존의 무선랜 시스템에서 IDFT/DFT 길이의 N배일 수 있다. 예를 들어, 기존의 무선랜 시스템에서 IDFT/DFT 길이가 3.2μs이고, N=4인 경우, 본 발명의 실시예에 따른 무선랜 시스템에서 IDFT/DFT 길이는 3.2μs *4(= 12.8μs)일 수 있다.

[56] OFDM 심볼의 길이는 IDFT/DFT 길이에 GI(guard interval)의 길이를 더한 값일 수 있다. GI의 길이는 0.4μs, 0.8μs, 1.6μs, 2.4μs, 3.2μs와 같은 다양한 값일 수 있다.

[57] 본 발명의 실시예에 따른 OFDMA 기반의 자원 할당 방법이 사용될 경우, 서로 다른 크기로 정의된 자원 할당 단위가 사용될 수 있다. 구체적으로 OFDMA 기반의 자원 할당을 위한 기본 자원 단위(basic resource unit)는 26톤의 자원 단위 및 242톤의 자원 단위로 정의될 수 있다. 예를 들어, 26톤의 자원 단위는 24톤의 데이터 톤과 2톤의 파일롯 톤을 포함할 수 있다. 242톤의 자원 단위는 234톤의 데이터 톤과 8톤의 파일롯 톤을 포함할 수 있다. 242톤의 자원 단위에 대하여 234 크기의 인터리버가 적용되고, 26톤의 자원 단위에 대하여 24 크기의 인터리버가 적용되어 데이터 톤에 대한 인터리빙이 수행될 수 있다. 톤(tone)은 서브캐리어(subcarrier)와 동일한 의미로 해석될 수 있다.

[58] 242톤의 기본 자원 단위에 대하여 기존의 IEEE 802.11ac의 242톤의 뉴머롤로지(numerology)를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치가 적용될 수 있다. 기존의 IEEE 802.11ac의 242톤의 뉴머롤로지를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치는 IEEE Standard for Information technology telecommunications and information exchange between systems local and metropolitan area networks specific requirements 'Part 11: Wireless LAN Medium Access Control(MAC) and Physical Layer (PHY) Specifications Amendment 4:

Enhancements for Very High Throughput for Operation in Bands below 6 GHz의 22.3.10.10 Pilot subcarriers에 개시되어 있다.

[59] 242톤의 자원 단위는 가상 할당 자원 단위(virtual allocation resource unit)일 수 있다. 가상 할당 자원 단위는 가상 할당 자원 단위보다 작은 자원 단위의 조합을 기반으로 생성될 수 있다. 예를 들어, 242톤의 자원 단위는 복수의 26톤의 자원 단위 및 추가의 레프트오버 톤(leftover tone)의 조합, 121톤의 자원 단위의 조합일 수 있다. 가상 할당 자원 단위는 기존의 무선랜 시스템의 인터리버 사이즈 및 OFDM 뉴머롤로지(numerology)(또는 톤(tone) 뉴머롤로지)를 재활용하기 위한 자원 단위일 수 있다.

[60] 26톤의 기본 자원 단위에 대하여 기존의 IEEE 802.11ah의 26톤의 뉴머롤로지를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치가 적용될 수 있다. 기존의 IEEE 802.11ah의 26톤의 뉴머롤로지를 기반으로 한 파일롯 톤/데이터 톤의 개수 및 할당 위치는 IEEE P802.11ah™/D5.0 Draft Standard for Information technology tele-communications and information exchange between systems Local and metropolitan area network specific requirements 'Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) SpecificationsAmendment 2: Sub 1 GHz License ExemptOperation'의 24.3.9.10 Pilot subcarriers에 개시되어 있다.

[61] AP는 위와 같은 서로 다른 크기의 자원 단위를 기반으로 적어도 하나의 STA을 위한 하향링크 전송 자원 및/또는 상향링크 전송 자원을 결정할 수 있다. AP는 스케줄링된 하향링크 전송 자원을 통해 적어도 하나의 PPDU를 적어도 하나의 STA으로 전송할 수 있다. 또한 AP는 스케줄링된 상향링크 전송 자원을 통해 적어도 하나의 STA에 의해 전송되는 적어도 하나의 PPDU를 수신할 수 있다.

[62] 기본 자원 단위는 전체 대역폭(또는 가용한 대역폭) 상에서 전체 대역폭의 양 끝단에 위치한 간섭 완화를 위한 좌측 가드 톤(left guard tone), 우측 가드 톤(right guard tone) 및 전체 대역폭의 중앙에 위치한 DC(direct current) 톤을 제외한 가용한 톤 상에서 할당될 수 있다. 이뿐만 아니라 기본 자원 단위는 사용자 할당 분리(user allocation separation)(또는 STA 별 자원 할당), 일반 파일롯(common pilot), AGC(automatic gain control), 위상 트래킹(phase tracking) 등의 용도로 사용될 수 있는 레프트오버(leftover) 톤(또는 나머지 톤(remaining tone))을 고려하여 할당될 수 있다.

[63] 전체 대역폭 상에서 기본 자원 단위의 할당 방법(할당 개수, 할당 위치 등)은 자원 활용 효율, 전체 대역폭에 따른 스케일러빌러티(scalability)(또는 확장성)을 고려하여 설정될 수 있다. 기본 자원 단위의 할당 방법은 미리 정의되거나 다양한 방법(예를 들어, PPDU의 PPDU 헤더에 포함되는 시그널 필드(signal field)를 기반으로 한 시그널링)을 기반으로 시그널링될 수 있다.

[64] 이하, 구체적인 기본 자원 단위를 기반으로 한 자원 할당 방법이 개시된다.

[65] 본 발명의 실시예에 따르면, 20MHz, 40MHz, 80MHz의 대역폭 각각에 대한 톤 뉴머롤로지(tone numerology)는 아래와 같을 수 있다. 아래의 각 대역폭의 자원

할당 방법은 하나의 예시로서 이외에도 다양한 방법으로 각 대역폭 상에서의 자원 할당이 수행될 수 있다.

[66] 20MHz 대역폭에 대하여 좌측 가드 톤(left guard tone)은 6톤, DC(direct current) 톤은 3톤, 우측 가드 톤(right guard tone)은 5톤으로 정의될 수 있다. 20MHz 대역폭에 대하여 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[67] 40MHz 대역폭에 대하여 좌측 가드 톤은 6톤, DC 톤은 9톤, 우측 가드 톤은 5톤으로 정의될 수 있다. 40MHz 대역폭에 대하여 492톤이 가용할 수 있고, 492톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[68] 40MHz 대역폭에 대하여 좌측 가드 톤은 6톤, DC 톤은 5톤, 우측 가드 톤은 5톤으로 정의될 수 있다. 40MHz 대역폭에 대하여 496톤이 가용할 수 있고, 496톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[69] 80MHz 대역폭에 대하여 좌측 가드 톤은 11톤, DC 톤은 3톤, 우측 가드 톤은 10톤으로 정의될 수 있다. 80MHz 대역폭에 대하여 1000톤이 가용할 수 있고, 1000톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[70] 80MHz 대역폭에 대하여 좌측 가드 톤은 6톤, DC 톤은 5톤, 우측 가드 톤은 5톤으로 정의될 수 있다. 80MHz 대역폭에 대하여 1008톤이 가용할 수 있고, 1008톤 상에서 26톤의 자원 단위 및/또는 242톤의 자원 단위를 기반으로 대역폭 상의 자원 할당이 수행될 수 있다.

[71] 본 발명의 실시예에서 레프트오버 톤은 설명의 편의상 도면에 표시하지 않으나 26톤의 자원 단위 및 242톤의 자원 단위 사이 또는 26톤의 자원 단위 및/또는 242톤의 자원 단위 각각에 인접하여 위치할 수 있다.

[72] 도 2는 본 발명의 실시예에 따른 20MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[73] 도 2에서는 242톤의 자원 단위/26톤의 자원 단위의 20MHz 대역폭 상에서의 자원 할당 및 자원 할당에 대한 시그널 방법이 개시된다.

[74] 도 2의 좌측을 참조하면, 하나의 242톤의 자원 단위가 20MHz 대역폭 상의 가용한 톤 상에서 할당될 수 있다. 가용한 톤은 좌측 가드 톤, 우측 가드 톤 및 DC 톤을 제외한 나머지 톤일 수 있다. 242톤의 자원 단위는 DC 톤을 기준으로 2개의 121톤의 분할 자원 단위의 조합일 수 있다.

[75] 20MHz 대역폭 상에서 하나의 STA에게 하나의 242톤의 자원 단위가 할당될 수 있다. SU(single user) 기반의 전송을 위해 20MHz 대역폭 상에서 하나의 242톤의 자원 단위가 하나의 STA으로 할당될 수 있다. 20MHz 대역폭 상에서 하나의 242톤의 자원 단위가 하나의 STA으로 할당되는 경우, 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 만약 MU OFDMA기반의 전송이

수행되지 않고, 복수의 STA에 대한 자원이 MU-MIMO 기반의 전송을 위해 하나의 242톤의 자원 단위에 멀티플렉싱되어 할당되는 경우에도 별도의 자원 할당 정보가 PPDU의 헤디에 포함되지 않을 수 있다. 이러한 경우, MU-MIMO로 할당되는 STA의 수 정보가 PPDU의 헤더에 포함될 수 있다. STA은 전체 대역폭 크기의 정보(예를 들어, 20MHz) 및 전체 대역폭 상에 할당된 STA에 대한 정보(STA만이 전체 대역폭 상에서 할당되었다는 정보)만을 기반으로 20MHz 대역폭 상에서 하나의 242톤의 자원 단위가 하나의 STA으로 할당되었음을 알 수 있다.

[76] 도 2의 우측을 참조하면, 20MHz 대역폭 상에서 242톤의 자원 단위의 할당 없이 26톤의 자원 단위만이 복수의 STA 각각에 대한 자원 할당을 위해 사용될 수 있다. 예를 들어, 20MHz 대역폭 상에서 하나의 STA은 적어도 하나의 26톤의 자원 단위를 할당받을 수 있다.

[77] 20MHz 대역폭 상에서는 최대 9개의 26톤의 자원 단위가 할당될 수 있다. 9개의 26톤의 자원 단위 각각이 복수의 STA 각각에게 할당되는 경우, 하나의 STA은 하나의 26톤의 자원 단위를 할당받을 수 있다. 즉, 26톤의 자원 단위가 할당되는 경우, 20MHz 대역폭 상에서 동시에 최대 9개의 STA으로 자원이 할당될 수 있다. 하나의 26톤의 자원 단위는 DC 톤을 기준으로 2개의 13톤의 분할 자원 단위로 분할될 수 있다.

[78] 20MHz 대역폭 상에서 복수개(예를 들어, 9개)의 26톤의 자원 단위 각각의 할당 위치는 고정되어 있을 수 있고, 자원 단위 할당 시그널링(resource unit allocation signaling)(또는 시그널링 지시(signaling indication))을 기반으로 주파수 축상에서 순차적으로 위치한 복수개의 26톤의 자원 단위 각각이 순차적으로 개별 STA으로 할당될 수 있다.

[79] 도 3은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[80] 도 3을 참조하면, 20MHz 대역폭 상에서 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 전체 할당 정보(300))로 n 비트(예를 들어, 1비트)가 할당될 수 있다. n비트의 242톤 자원 단위 전체 할당 정보(300)는 20MHz 대역폭 상에서 242톤의 자원 단위의 할당 여부에 대한 정보를 포함할 수 있다. STA은 242톤 자원 단위 전체 할당 정보(300)를 기반으로 20MHz 대역폭 상에서 242톤의 자원 단위의 할당 여부를 결정할 수 있다. 예를 들어, 1비트의 242톤 자원 단위 전체 할당 정보(300)의 값이 1인 경우, 20MHz 대역폭 상에서 242톤의 자원 단위의 할당이 지시되고, 1비트의 242톤 자원 단위 전체 할당 정보(300)의 값이 0인 경우, 20MHz 대역폭 상에서 242톤의 자원 단위의 비할당(non allocation)이 지시될 수 있다.

[81] 20MHz 대역폭 상에서 242톤의 자원 단위가 할당되는 경우, SU 기반 전송이 수행되고, 242톤의 자원 단위가 할당되지 않는 경우, MU 기반 전송이 수행된다. 따라서, 다른 표현으로 242톤 자원 단위 전체 할당 정보(300)는 20MHz 대역폭

상에서 SU 기반 전송이 수행되는지 MU 기반 전송이 수행되는지 여부를 지시하는 의미로도 해석될 수 있다.

[82] 또한, 20MHz 대역폭 상에서 개별 STA으로의 26톤의 자원 단위의 할당에 대한 정보(이하, 26톤 자원 단위 개별 할당 정보(350))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 26톤 자원 단위 개별 할당 정보(350)는 개별 STA으로의 26톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(200)가 20MHz 대역폭 상에서 242톤의 자원 단위의 할당을 지시하는 경우, STA에 대해 26톤의 자원 단위가 할당되지 않을 수 있다. 이러한 경우, 26톤 자원 단위 개별 할당 정보(350)는 다른 정보로 활용될 수도 있다. 또는 242톤 자원 단위 전체 할당 정보(300)가 20MHz 대역폭 상에서 1개의 242톤의 자원 단위의 할당을 지시하는 경우, STA은 26톤 자원 단위 개별 할당 정보(350)에 대한 디코딩을 수행하지 않을 수도 있다.

[83] 예를 들어, '00'인 2비트의 26톤 자원 단위 개별 할당 정보(350)는 STA으로의 1개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[84] '01'인 2비트의 26톤 자원 단위 개별 할당 정보(350)는 STA으로의 2개의 26톤의 자원 단위의 할당을 지시할 수 있다. STA으로 2개의 26톤의 자원 단위가 할당 경우, 4개의 레프트오버 톤(leftover tone)도 함께 할당될 수 있다. 2개의 26톤 자원 단위와 4개의 레프트오버 톤은 조합되어 하나의 56톤의 자원 단위로서 사용될 수 있다. 2개의 26톤 자원 단위와 4개의 레프트오버 톤의 조합을 기반으로 생성된 56톤의 자원 단위에 포함되는 파일롯 톤의 위치는 기존의 IEEE802.11ah spec 상에서 2개의 26톤의 자원 단위 각각에 기존에 정의되어 있던 파일롯 톤의 위치와 동일하거나, 기존의 IEEE802.11ac spec 상에서 기존의 56톤의 자원 단위에 정의된 파일롯 톤의 위치와 동일할 수 있다. 기존의 56톤의 자원 단위에 정의된 파일롯 톤의 위치는 전술한 IEEE 802.11ac spec의 22.3.10.10 Pilot subcarriers에 개시되어 있다.

[85] '10'인 2비트의 26톤의 자원 단위 개별 할당 정보(350)는 STA으로 3개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[86] '11'인 2비트의 26톤의 자원 단위 개별 할당 정보(350)는 STA으로 4개의 26톤의 자원 단위의 할당을 지시할 수 있다. 4개의 26톤의 자원 단위와 함께 8개의 레프트오버 톤이 할당되는 경우, STA은 전체 112(26*4+8)톤을 할당받을 수 있다. 이러한 경우, 기존에 IEEE802.11ac spec에 정의된 114톤의 자원 단위(108톤의 데이터 톤과 6톤의 파일롯 톤)에 적용되던 프로세싱 절차(예를 들어, 108 사이즈의 인터리버)를 재활용하기 위해 112톤의 자원 단위 내에 파일롯 톤을 4개만을 할당하고 나머지 108톤을 데이터 톤으로 할당할 수 있다.

[87] 즉, 4개의 26톤의 자원 단위에 대응되는 112톤의 자원 단위는 108톤의 데이터 톤, 4톤의 파일롯 톤으로 구성될 수 있다. 112톤의 자원 단위에 포함되는 4개의 파일롯 톤 각각의 위치는 112톤의 자원 단위에 포함되는 4개의 26톤의 자원 단위 각각에서 동일할 수 있다. 또는 112톤의 자원 단위에 포함되는 4개의 파일롯 톤

각각은 112톤의 자원 단위에 포함되는 4개의 26톤의 자원 단위 각각의 위치를 고려하지 않고, 112톤의 자원 단위에 대응되는 주파수 축 상에서 동등하게 할당될 수도 있다. 또는 기존의 114톤의 자원 단위에 할당된 6개의 파일롯 톤 중 4개의 파일롯 톤을 선택하여 112톤의 자원 단위의 파일롯 톤으로 정의할 수도 있다.

[88] 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 20MHz 대역폭 상에서 최소 1개의 STA, 최대 9개의 STA이 지원될 수 있다.

[89] 전술한 바와 같이 STA은 20MHz 대역폭 상에서 1개의 242톤의 자원 단위 또는 1, 2, 3 또는 4개의 26톤의 자원 단위를 할당받아 동작할 수 있다.

[90] 아래의 표 1은 지원되는 STA의 개수에 따른 자원 단위의 할당을 예시적으로 나타낸다.

[91] [표1]

STA의 개수	자원 할당	STA의 개수	자원 할당
1	STA1:242톤(1개)	6	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(2개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)
2	STA1:26톤(4개)STA2:26톤(4개)	7	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(1개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)STA7:26톤(1개)
3	STA1:26톤(3개)STA2:26톤(3개)STA3:26톤(3개)	8	STA1:26톤(2개)STA2:26톤(1개)STA3:26톤(1개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)STA7:26톤(1개)STA8:26톤(1개)
4	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(2개)STA4:26톤(3개)	9	STA1:26톤(1개)STA2:26톤(1개)STA3:26톤(1개)STA4:26톤(1개)STA5:26톤(1개)STA6:26톤(1개)STA7:26톤(1개)STA8:26톤(1개)STA9:26톤(1개)
5	STA1:26톤(2개)STA2:26톤(2개)STA3:26톤(2개)STA4:26톤(2개)STA5:26톤(1개)		

[92] 도 4는 본 발명의 실시예에 따른 자원 단위의 할당을 위한 시그널링 방법을 나타낸 개념도이다.

[93] 도 4에서는 PPDU를 수신하는 STA에 대한 식별 정보 및 STA에게 할당되는 자원 단위의 개수에 대한 정보를 기반으로 STA으로 자원 단위를 할당하는 방법이 개시된다.

[94] 도 4를 참조하면, PPDU 헤더는 PPDU를 수신할 복수의 STA에 대한 정보(수신 STA 식별 정보(400)) 및 PPDU의 수신을 위해 복수의 STA 각각에 할당된 자원 단위에 대한 정보(자원 할당 정보(450))를 포함할 수 있다. 수신 STA 식별 정보(400)는 복수의 STA 각각의 식별자 정보(예를 들어, AID(association identifier))를 순차적으로 포함할 수 있다. 자원 할당 정보(450)는 복수의 STA 각각에 대해 할당된 자원 단위의 개수에 대한 정보를 순차적으로 포함할 수 있다. 예를 들어, 자원 할당 정보는 26톤 자원 단위 개별 할당 정보, 후술할 242톤 자원 단위 개별 할당 정보일 수 있다. 242톤 자원 단위 개별 할당 정보는 개별 STA으로 할당되는 242톤의 자원 단위의 개수에 대한 정보일 수 있다.

[95] 수신 STA 식별 정보(400)에 의해 순차적으로 지시되는 복수의 STA 각각은 자원 할당 정보(450)에 순차적으로 포함되는 복수의 STA 각각에 대해 할당되는 자원 단위의 개수에 대한 정보와 대응될 수 있다. 수신 STA 식별 정보(400)에 의해 순차적으로 지시되는 복수의 STA 각각은 복수의 STA 각각에 대해 할당되는 자원 단위의 개수에 대한 정보를 고려하여 주파수 축 상에서 순차적으로 나열된 자원 단위를 할당받을 수 있다.

[96] 예를 들어, 9개의 자원 단위(자원 단위1 내지 자원 단위 9)가 주파수 축 상에 순차적으로 할당되고, 수신 STA 식별 정보가 STA1, STA2, STA3을 순차적으로 지시하고, 자원 할당 정보가 3개, 2개, 4개를 순차적으로 지시하는 경우가 가정될 수 있다. 이러한 경우, STA1은 3개의 자원 단위, STA2는 2개의 자원 단위, STA3은 4개의 자원 단위를 할당받을 수 있다. 이때 자원 단위1 내지 자원 단위9가 STA1, STA2, STA3 각각에 할당된 자원 단위의 개수를 고려하여 STA1, STA2, STA3 각각으로 순차적으로 할당될 수 있다. 구체적으로 STA1은 자원 단위 1, 자원 단위 2, 자원 단위 3를 할당받고, STA2는 자원 단위 4, 자원 단위 5를 할당받고, STA3은 자원 단위 6, 자원 단위 7, 자원 단위 8 및 자원 단위 9를 할당받을 수 있다.

[97] 즉, 순차적으로 PPDU를 수신할 복수의 STA을 포함하는 수신 STA 식별 정보 및 순차적으로 복수의 STA 각각으로 할당된 자원 단위의 개수에 대한 정보를 포함하는 자원 할당 정보를 기반으로 주파수 축 상에서 순차적으로 위치한 복수의 자원 단위 각각이 복수의 STA 각각으로 연속적으로 할당될 수 있다.

[98] 이하, 본 발명의 실시예에서는 자원 할당 방법을 자원 단위 할당 시그널링/시그널링 지시를 기반으로 한 자원 할당 방법이라고 표현될 수도 있다. 자원 단위 할당 시그널링/시그널링 지시를 기반으로 한 자원 할당 방법은 복수의 STA 각각으로 할당된 자원 단위에 대한 직접적인 지시없이 복수의 STA 각각으로 할당된 자원 단위를 간접적으로 지시할 수 있다.

[99] 위와 같은 자원 단위 할당 시그널링/시그널링 지시를 기반으로 한 자원 할당

방법은 서로 다른 크기의 자원 단위 각각에 별도로 적용될 수 있다. 예를 들어, 242톤 자원 단위 개별 할당 정보를 기반으로 한 242톤의 자원 단위를 위한 자원 단위 할당 시그널링 및 26톤 자원 단위 개별 할당 정보를 기반으로 한 26톤의 자원 단위를 위한 자원 단위 할당 시그널링이 별도로 수행될 수 있다.

[100] 도 5는 본 발명의 실시예에 따른 40MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[101] 도 5에서는 242톤의 자원 단위/26톤의 자원 단위의 40MHz 대역폭 상에서의 할당이 개시된다.

[102] 도 5의 좌측에서 첫번째 그림을 참조하면, 두 개의 242톤의 자원 단위가 40MHz 대역폭 상의 가용한 톤 상에서 할당될 수 있다.

[103] 40MHz 대역폭 상에서 하나의 STA에게 두 개의 242톤의 자원 단위가 할당될 수 있다. 즉, SU 기반의 전송을 위해 40MHz 대역폭 상에서 두 개의 242톤의 자원 단위가 하나의 STA으로 할당될 수 있다. 40MHz 대역폭 상에서 두 개의 242톤의 자원 단위가 하나의 STA으로 할당되는 경우, 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 만약 MU OFDMA기반의 전송이 수행되지 않고, 복수의 STA에 대한 자원이 MU-MIMO 기반의 전송을 위해 두개의 242톤의 자원 단위에 멀티플렉싱되어 할당되는 경우에도 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 이러한 경우, MU-MIMO로 할당되는 STA의 수 정보가 PPDU의 헤더에 포함될 수 있다. STA은 전체 대역폭 크기의 정보(예를 들어, 40MHz) 및 전체 대역폭 상에 할당된 STA에 대한 정보(STA만이 전체 대역폭 상에서 할당되었다는 정보)만을 기반으로 40MHz 대역폭 상에서 두 개의 242톤의 자원 단위가 모두 할당되었음을 알 수 있다.

[104] 40MHz 대역폭 상에서 두 개의 STA 각각으로 두 개의 242톤의 자원 단위 각각이 할당될 수 있다. 26톤의 자원 단위는 자원 단위의 할당을 위해 사용되지 않을 수 있다. 전술한 바와 같이 2개의 STA은 PPDU 헤더 상에서 순차적인 자원 단위 할당 시그널링을 기반으로 두 개의 242톤의 자원 단위 각각을 할당받을 수 있다.

[105] 도 5의 좌측에서 두번째 그림을 참조하면, 40MHz 대역폭의 가용한 톤 상에서 하나의 242톤 자원 단위가 할당되고 나머지 가용한 톤 상에서 복수개의 26톤의 자원 단위가 할당될 수 있다. 하나의 242톤의 자원 단위는 하나의 STA으로 할당되고, 나머니 복수 개의 26톤의 자원 단위는 적어도 하나의 STA으로 할당될 수 있다. 예를 들어, 나머지 가용한 톤 상에서 9개의 26톤의 자원 단위가 할당될 수 있다. 9개의 26톤의 자원 단위 각각은 최대 9개의 STA 각각으로 할당 가능하다.

[106] 40MHz 대역폭 상에서 위와 같은 자원 할당이 수행되는 경우, 242톤의 자원 단위의 할당 위치 및 복수의 26톤의 자원 단위 각각의 할당 위치는 고정될 수 있다.

[107] 242톤의 자원 단위와 복수의 26톤의 자원 단위 각각은 개별적으로 할당될 수

있고, 복수의 26톤의 자원 단위는 자원 단위 할당 시그널링을 기반으로 복수의 STA으로 할당될 수 있다.

[108] 도 5의 좌측에서 세번째 그림을 참조하면, 40MHz 대역폭의 가용한 톤 상에서 242톤의 자원 단위에 대한 할당없이 26톤의 자원 단위만을 기반으로 한 자원 할당이 수행될 수 있다.

[109] 예를 들어, 492톤이 가용한 톤의 개수인 경우(492 톤 플랜(tone plan)), DC 톤을 기준으로 9개의 26톤의 자원 단위가 DC 톤과 좌측 가드 톤 사이에 할당되고, 9개의 26톤의 자원 단위가 DC 톤과 우측 가드 톤 사이에 할당될 수 있다. 즉, 전체 18개의 26톤의 자원 단위가 주파수 축 상에 할당될 수 있다.

[110] 또 다른 예를 들어, 496톤이 가용한 톤의 개수인 경우(496 톤 플랜), 전체 19개의 26톤의 자원 단위가 주파수 축 상에서 할당될 수 있다. 26톤의 자원 단위는 2개의 13톤의 분할 자원 단위로 분할될 수 있다. DC 톤을 기준으로 9개의 26톤의 자원 단위+13톤의 분할 자원 단위가 DC 톤과 좌측 가드 톤 사이에 할당되고, 9개의 26톤의 자원 단위+13톤의 분할 자원 단위가 DC 톤과 우측 가드 톤 사이에 할당될 수 있다. 즉, 전체 19개의 26톤의 자원 단위가 주파수 축 상에 할당될 수 있다. 복수의 26톤의 자원 단위는 자원 단위 할당 시그널링을 기반으로 복수의 STA으로 할당될 수 있다.

[111] 도 6은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[112] 도 6을 참조하면, 40MHz 대역폭 상에서 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 전체 할당 정보(600))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 242톤 자원 단위 전체 할당 정보(600)는 40MHz 대역폭 상에서 할당된 242톤의 자원 단위에 대한 정보를 STA으로 알려줄 수 있다.

[113] 예를 들어, 242톤 자원 단위 전체 할당 정보(600)에 포함되는 2비트 중 1개의 비트는 좌측 가드 톤에 인접한 하나의 242톤 자원 단위(제1 242톤 자원 단위)를 지시하고, 나머지 1개의 비트는 우측 가드 톤에 인접한 다른 242톤 자원 단위(제2 242톤 자원 단위)를 지시할 수 있다.

[114] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '00'인 경우, 40MHz 대역폭 상에서 242톤의 자원 단위가 할당되지 않음이 지시될 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '00'인 경우, 40MHz 대역폭 상에서 MU 기반 전송이 수행됨이 지시될 수 있다.

[115] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '01'인 경우, 40MHz 대역폭 상에서 제1 242톤의 자원 단위가 할당됨을 지시할 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보가 '01'인 경우, 40MHz 대역폭 상에서 MU 기반 전송이 수행됨이 지시될 수 있다.

[116] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '10'인 경우, 40MHz 대역폭 상에서 제2 242톤의 자원 단위가 할당됨을 지시할 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '10'인 경우, 40MHz

대역폭 상에서 MU 기반 전송이 수행됨이 지시될 수 있다.

[117] 예를 들어, 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '11'인 경우, 40MHz 대역폭 상에서 제1 242톤의 자원 단위/제2 242톤의 자원 단위가 할당됨을 지시할 수 있다. 또 다른 의미로 2비트의 242톤 자원 단위 전체 할당 정보(600)가 '11'인 경우, 40MHz 대역폭 상에서 SU 기반 전송이 수행 가능함이 지시될 수 있다.

[118] 또한, 40MHz 대역폭 상에서 개별 STA으로의 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 개별 할당 정보(620))로 n비트(예를 들어, 1비트)가 할당될 수 있다. 242톤 자원 단위 개별 할당 정보(620)는 개별 STA으로 242톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(620)가 40MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, 242톤의 자원 단위의 개별 STA으로의 할당이 수행되지 않을 수 있다. 이러한 경우, 242톤 자원 단위 개별 할당 정보(620)는 다른 정보로 활용될 수도 있다. 또는 242톤 자원 단위 전체 할당 정보(600)의 값이 40MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, STA은 242톤 자원 단위 개별 할당 정보(620)에 대한 디코딩을 수행하지 않을 수도 있다.

[119] 예를 들어, '0'인 1비트의 242톤 자원 단위 개별 할당 정보(620)는 STA으로의 1개의 242톤의 자원 단위의 할당을 지시할 수 있다.

[120] 예를 들어, '1'인 1비트의 242톤 자원 단위 개별 할당 정보(620)는 STA으로의 2개의 242톤의 자원 단위의 할당을 지시할 수 있다. 하나의 STA으로의 2개의 242톤의 자원 단위의 할당은 40MHz 대역폭 상에서 SU 기반 전송을 지시할 수 있다. 만약, 40MHz 대역폭 상에서 할당 가능한 26톤의 자원 단위의 개수가 19개이고 242톤 자원 단위 개별 할당 정보(620)가 STA으로의 2개의 242톤의 자원 단위의 할당을 지시하는 경우, STA을 추가로 하나의 26톤의 자원 단위를 더 할당받을 수도 있다.

[121] STA은 2개의 242톤의 자원 단위를 할당받은 경우, 242톤의 자원 단위를 위한 인터리버(234크기의 인터리버)가 사용되어 242톤에 포함되는 234개의 데이터 톤에 대한 인터리빙이 수행될 수 있다. STA은 2개의 242톤의 자원 단위과 1개의 26톤의 자원 단위를 할당받은 경우, 242톤을 위한 인터리버(234크기의 인터리버) 및 26톤의 자원 단위를 위한 인터리버(24크기의 인터리버)를 기반으로 한 인터리빙이 수행될 수 있다.

[122] 또한, 40MHz 대역폭 상에서 개별 STA으로의 26톤의 자원 단위의 할당에 대한 정보(이하, 26톤 자원 단위 개별 할당 정보(640))로 n 비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 26톤 자원 단위 개별 할당 정보(640)는 개별 STA으로의 26톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(600)가 40MHz 대역폭 상에서 2개의 242톤의 자원 단위의 할당을 지시하는 경우, 26톤의 자원 단위에 대한 할당이 수행되지 않을 수 있다. 이러한 경우, 26톤 자원 단위 개별 할당 정보(640)는 다른 정보로 활용될 수도 있다. 또는 40MHz 대역폭 상에서 2개의 242톤의 자원 단위의 할당이 지시되는 경우, STA은 26톤

자원 단위 개별 할당 정보(640)에 대한 디코딩을 수행하지 않을 수 있다.

[123] 예를 들어, '00'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 1개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[124] 예를 들어, '01'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 2개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[125] 예를 들어, '10'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 3개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[126] 예를 들어, '11'인 2비트의 26톤 자원 단위 개별 할당 정보(640)는 STA으로의 4개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[127] 이러한 26톤의 자원 단위 및 242톤의 자원 단위에 대한 할당은 26톤 자원 단위 개별 할당 정보(640) 및 242톤 자원 단위 개별 할당 정보(620)를 기반으로 자원 단위 할당 시그널링/시그널링 지시를 통해 수행될 수 있다.

[128] 본 발명의 실시예에 따르면, 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 40MHz 대역폭 상에서 최소 1개의 STA, 최대 19개의 STA이 지원될 수 있다. STA은 40MHz 대역폭 상에서 1개 또는 2개의 242톤의 자원 단위 또는 1,2, 3 또는 4개의 26톤의 자원 단위를 할당받아 동작할 수 있다.

[129] 예를 들어, 40MHz 대역폭 상에서 2개의 242톤의 자원 단위의 1개의 STA으로의 할당(또는 SU 기반의 전송)을 기반으로 최소 1개의 STA의 통신이 지원될 수 있다. 또는 40MHz 대역폭 상에서 2개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수도 있다. 또는 40MHz 대역폭 상에서 1개의 242톤의 자원 단위가 1개의 STA에 할당되고, 나머지 주파수 대역 상에 할당된 9개 또는 10개의 26톤의 자원 단위가 2개의 STA에 할당될 수 있다. 40MHz 대역폭 상에서 19개의 26톤의 자원 단위 각각에 19개의 STA 각각의 할당을 기반으로 최대 19개의 STA의 통신이 지원될 수 있다.

[130] 도 7은 본 발명의 실시예에 따른 80MHz 대역폭 상에서 자원 단위의 할당을 나타낸 개념도이다.

[131] 도 7에서는 242톤의 자원 단위/26톤의 자원 단위의 80MHz 대역폭 상에서의 할당이 개시된다.

[132] 도 7의 좌측에서 첫번째 그림을 참조하면, 네 개의 242톤의 자원 단위가 80MHz 대역폭 상의 가용한 톤 상에서 할당될 수 있다. 80MHz 대역폭 상에서 하나의 STA에게 네 개의 242톤의 자원 단위가 할당될 수 있다. SU 기반의 전송을 위해 80MHz 대역폭 상에서 네 개의 242톤의 자원 단위가 하나의 STA으로 할당될 수 있다. 만약 MU OFDMA기반의 전송이 수행되지 않고, 복수의 STA에 대한 자원이 MU-MIMO 기반의 전송을 위해 네개의 242톤의 자원 단위에 멀티플렉싱되어 할당되는 경우에도 별도의 자원 할당 정보가 PPDU의 헤더에 포함되지 않을 수 있다. 이러한 경우, MU-MIMO로 할당되는 STA의 수 정보가 PPDU의 헤더에 포함될 수 있다. 80MHz 대역폭 상에서 네 개의 242톤의 자원 단위가 하나의 STA으로 할당되는 경우, 별도의 자원 할당 정보가 PPDU의

헤더에 포함되지 않을 수 있다. STA은 전체 대역폭 크기의 정보(예를 들어, 80MHz) 및 전체 대역폭 상에 할당된 STA에 대한 정보(STA만이 전체 대역폭 상에서 할당되었다는 정보)만을 기반으로 80MHz 대역폭 상에서 네 개의 242톤의 자원 단위가 STA으로 할당되었음을 알 수 있다.

[133] 또는 80MHz 대역폭 상에서 두 개의 STA 각각으로 두 개의 242톤의 자원 단위를 포함하는 자원 단위가 개별적으로 할당될 수 있다. 즉, STA1로 두 개의 242톤의 자원 단위가 할당되고, STA2로 두 개의 242톤의 자원 단위가 할당될 수 있다. 26톤의 자원 단위는 자원 단위 할당을 위해 사용되지 않을 수 있다. 전술한 바와 같이 2개의 STA 각각은 PPDU 헤더 상에서 순차적인 자원 단위 할당 시그널링을 기반으로 두 개의 242톤의 자원 단위를 포함하는 자원 단위 각각을 할당받을 수 있다.

[134] 도 7의 좌측에서 두번째 그림을 참조하면, 80MHz 대역폭 상에서 두 개의 STA 각각으로 두 개의 242톤의 자원 단위 각각이 할당되고, 다른 복수의 STA으로 나머지 가용한 톤 상에 할당된 복수개의 26톤의 자원 단위 각각이 할당될 수 있다.

[135] 80MHz 대역폭 상에서 가용한 톤의 개수가 1000톤인 경우(1000 톤 플랜), 19개의 26톤의 자원 단위가 나머지 가용한 톤 상에 할당될 수 있다. 이러한 경우, 최대 19개의 STA이 19개의 26톤의 자원 단위 상에 할당되어 서비스를 받을 수 있다.

[136] 80MHz 대역폭 상에서 가용한 톤의 개수가 1008톤인 경우(1008 톤 플랜), 20개의 26톤의 자원 단위가 나머지 가용한 톤 상에 할당될 수 있다. 이러한 경우, 최대 20개의 STA이 20개의 26톤의 자원 단위 상에 할당되어 서비스를 받을 수 있다.

[137] 도 7의 좌측에서 세번째 그림을 참조하면, 80MHz 대역폭 상에서 하나의 STA으로 하나의 242톤의 자원 단위가 할당되고, 다른 복수의 STA으로 나머지 가용한 톤 상에 할당된 복수개의 26톤의 자원 단위 각각이 할당될 수 있다. 하나의 242톤의 자원 단위를 제외한 나머지 가용한 톤 상에서 29개의 26톤의 자원 단위가 할당될 수 있고, 29개의 26톤의 자원 단위 각각은 최대 29개의 STA 각각에게 할당될 수 있다.

[138] 도 7의 좌측에서 네번째 그림을 참조하면, 80MHz 대역폭 상에서 242톤의 자원 단위없이 26톤의 자원 단위만을 기반으로 한 자원 할당이 수행될 수 있다. 이러한 경우, 80MHz 대역폭 상에서 38개의 26톤의 자원 단위가 할당될 수 있고, 38개의 26톤의 자원 단위 각각은 최대 38개의 STA 각각에게 할당될 수 있다.

[139] 도 8은 본 발명의 실시예에 따른 자원 단위 할당 정보를 시그널링하는 방법을 나타낸 개념도이다.

[140] 도 8을 참조하면, 80MHz 대역폭 상에서 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 전체 할당 정보(800))로 n비트(예를 들어, 4비트)가 할당될 수 있다. 242톤 자원 단위 전체 할당 정보(800)는 80MHz 대역폭 상에서

할당된 242톤의 자원 단위에 대한 정보를 STA으로 알려줄 수 있다.

[141] 242톤 자원 단위 전체 할당 정보(800)에 대응되는 4비트 각각은 80MHz 대역폭 상에 할당 가능한 4개의 242톤의 자원 단위 각각을 지시할 수 있다. 예를 들어, 좌측 래프트오버 톤에서 우측 래프트오버 톤까지 4개의 242톤의 자원 단위는 순차적으로 제1 242톤의 자원 단위, 제2 242톤의 자원 단위, 제3 242톤의 자원 단위, 제4 242톤의 자원 단위로 표현될 수 있다. 즉, 242톤 자원 단위 전체 할당 정보에 대응되는 4비트 각각은 제1 242톤의 자원 단위, 제2 242톤의 자원 단위, 제3 242톤의 자원 단위 및 제4 242톤의 자원 단위 각각을 지시할 수 있다.

[142] 즉, '0000' 내지 '1111'의 4비트의 시그널링(또는 4비트의 비트맵)을 기반으로 제1 242톤의 자원 단위 내지 제4 242톤의 자원 단위 각각의 80MHz 대역폭 상에서의 할당 여부가 지시될 수 있다.

[143] 4비트의 242톤 자원 단위 전체 할당 정보(800)가 '1111'인 경우, 80MHz 대역폭 상에서 SU 기반 전송이 수행 가능함이 지시되고, 4비트의 242톤 자원 단위 전체 할당 정보(800)가 나머지인 경우, 80MHz 대역폭 상에서 MU 기반 전송이 지시될 수 있다.

[144] 또한, 80MHz 대역폭 상에서 개별 STA으로의 242톤의 자원 단위의 할당에 대한 정보(이하, 242톤 자원 단위 개별 할당 정보(820))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 242톤 자원 단위 개별 할당 정보(820)는 개별 STA으로 할당된 242톤 자원 단위의 개수에 대한 정보를 포함할 수 있다. 242톤 자원 단위 전체 할당 정보(800)가 80MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, 242톤의 자원 단위의 개별 STA으로의 할당이 수행되지 않을 수 있다. 이러한 경우, 242톤 자원 단위 개별 할당 정보(820)는 다른 정보로 활용될 수도 있다. 또는 242톤 자원 단위 전체 할당 정보(800)의 값이 80MHz 대역폭 상에서 0개의 242톤의 자원 단위의 할당을 지시하는 경우, STA은 242톤 자원 단위 개별 할당 정보(820)에 대한 디코딩을 수행하지 않을 수도 있다.

[145] 예를 들어, '00'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 1개의 242톤의 자원 단위의 할당을 지시할 수 있다.

[146] 예를 들어, '01'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 2개의 242톤의 자원 단위의 할당을 지시할 수 있다. 만약, 80MHz 대역폭 상에서 할당되는 26톤의 자원 단위의 개수가 38개인 경우, '01'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 2개의 242톤의 자원 단위와 1개의 26톤의 자원 단위의 할당을 지시할 수도 있다. 이러한 경우, 전술한 바와 같이 242톤의 자원 단위을 위한 인터리버와 26톤의 자원 단위을 위한 인터리버가 개별적으로 242톤의 자원 단위 및 26톤의 자원 단위 각각에 적용될 수 있다.

[147] 예를 들어, '10'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 3개의 242톤의 자원 단위의 할당을 지시할 수 있다.

[148] 예를 들어, '11'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 STA으로의 4개의 242톤의 자원 단위의 할당을 지시할 수 있다. 만약, 80MHz 대역폭 상에서

할당되는 26톤의 자원 단위의 개수가 38개인 경우, '11'인 2비트의 242톤 자원 단위 개별 할당 정보(820)는 4개의 242톤의 자원 단위와 2개의 26톤의 자원 단위의 할당을 지시할 수도 있다. 이러한 경우, 전술한 바와 같이 242톤의 자원 단위을 위한 인터리버와 26톤의 자원 단위을 위한 인터리버가 개별적으로 242톤의 자원 단위 및 26톤의 자원 단위에 적용될 수 있다.

[149] 또한, 80MHz 대역폭 상에서 개별 STA으로의 26톤의 자원 단위의 할당에 대한 정보(이하, 26톤 자원 단위 개별 할당 정보(840))로 n비트(예를 들어, 2비트)가 할당될 수 있다. 2비트의 26톤 자원 단위 개별 할당 정보(840)는 개별 STA으로의 26톤 자원 단위의 할당에 대해 알려줄 수 있다. 242톤 자원 단위 전체 할당 정보(800)가 80MHz 대역폭 상에서 4개의 242톤의 자원 단위의 할당을 지시하는 경우, 26톤의 자원 단위에 대한 할당이 수행되지 않을 수 있다. 이러한 경우, 26톤 자원 단위 개별 할당 정보(840)는 다른 정보로 활용될 수도 있다. 또는 80MHz 대역폭 상에서 4개의 242톤의 자원 단위의 할당이 지시되는 경우, STA은 26톤 자원 단위 개별 할당 정보에 대한 디코딩을 수행하지 않을 수 있다.

[150] 예를 들어, '00'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 1개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[151] 예를 들어, '01'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 2개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[152] 예를 들어, '10'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 3개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[153] 예를 들어, '11'인 2비트의 26톤 자원 단위 개별 할당 정보(840)는 STA으로의 4개의 26톤의 자원 단위의 할당을 지시할 수 있다.

[154] 이러한 26톤의 자원 단위 및 242톤의 자원 단위에 대한 할당은 26톤 자원 단위 개별 할당 정보(840) 및 242톤 자원 단위 개별 할당 정보(820)를 기반으로 자원 단위 할당 시그널링/시그널링 지시를 통해 수행될 수 있다.

[155] 본 발명의 실시예에 따르면, 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 80MHz 대역폭 상에서 최소 1개의 STA, 최대 38개의 STA이 지원될 수 있다. STA은 80MHz 대역폭 상에서 1개 또는 2개의 242톤의 자원 단위 또는 1, 2, 3 또는 4개의 26톤의 자원 단위를 할당받아 동작할 수 있다.

[156] 예를 들어, 80MHz 대역폭 상에서 4개의 242톤의 자원 단위가 1개의 STA으로의 할당(또는 SU 기반 전송)을 기반으로 최소 1개의 STA의 통신이 지원될 수 있다. 80MHz 대역폭 상에서 2개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수도 있다. 80MHz 대역폭 상에서 2개의 242톤의 자원 단위가 1개의 STA에 할당되고, 나머지 2개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수 있다. 80MHz 대역폭 상에서 38개의 26톤의 자원 단위 각각에 38개의 STA 각각의 할당을 기반으로 최대 38개의 STA의 통신이 지원될 수 있다.

[157] 도 9는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[158] STA의 개수가 증가하는 경우, 자원 할당을 위한 시그널링을 위한 오버헤드가 많을 수 있다. 따라서, 본 발명의 실시예에 따르면, STA으로의 자원 할당을 위해 컨테이너(container)를 정의하고, 컨텐이너를 기반으로 한 자원 할당이 수행될 수 있다.

[159] 도 9에서는 STA으로의 자원 할당을 위한 컨테이너가 개시된다.

[160] 도 9를 참조하면, 하나의 컨테이너는 242톤의 자원 단위 1개에 대응되거나, 복수개의 26톤의 자원 단위에 대응될 수 있다. 컨테이너는 추가의 레프트오버 톤을 더 포함할 수도 있고, 26톤의 자원 단위를 분할한 13톤의 분할 자원 단위를 포함할 수도 있다. 예를 들어, 컨테이너는 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위를 포함하는 26*9+13=247톤의 자원 단위에 대응될 수 있다.

[161] 즉, 컨테이너는 자원 할당에 대한 정보를 시그널링하기 위해 정의된 자원 단위일 수 있다. 컨테이너 별로 할당 가능한 자원 단위가 설정되고, 컨테이너 별로 할당 가능한 STA의 개수가 제한될 수 있다. 대역폭 별로 할당 가능한 컨테이너의 개수는 아래와 같을 수 있다.

[162] 20MHz 대역폭에 대하여 1개의 컨테이너가 할당되고, 40MHz 대역폭에 대하여 2개의 컨데이너가 할당되고, 80MHz 대역폭에 대하여 4개의 컨데이너가 할당될 수 있다.

[163] 컨테이너에 대해 할당 가능한 STA의 개수는 대역폭 별로 한정될 수 있다. 예를 들어, 20MHz 대역폭에 대하여 컨테이너 별로 8개의 STA(또는 9개의 STA)이 할당될 수 있다. 40MHz 대역폭에 대하여 컨테이너 별로 8개의 STA(또는 9개의 STA)이 할당될 수 있고, 2개의 컨테이너에 대하여 전체 16개의 STA(또는 18개의 STA)이 할당될 수 있다. 80MHz 대역폭에 대하여 컨테이너 별로 4개의 STA(또는 5개의 STA)이 할당될 수 있고, 4개의 컨테이너에 대하여 전체 16개의 STA(또는 20개의 STA)이 할당될 수 있다.

[164] 도 10은 본 발명의 실시예에 따른 컨테이너 별 자원 할당 정보를 나타낸 개념도이다.

[165] 도 10을 참조하면, n 비트(예를 들어, 2비트 또는 3비트)가 컨테이너 별 자원 할당 정보(컨테이너 별 자원 할당 비트)(1000)로 정의되어 컨테이너 별로 할당되는 사용자의 수(또는 FDM(frequency division multiplexing)으로 구분되는 할당을 위한 톤 유닛의 개수)를 알려줄 수 있다. 2비트의 컨테이너 별 자원 할당 정보(600)는 최대 4개의 STA에 대한 자원 할당을 지시하고, 3비트의 컨테이너 별 자원 할당 정보(600)는 최대 8개의 STA에 대한 자원 할당을 지시할 수 있다.

[166] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '000'인 경우, 컨테이너에 대한 1개의 STA의 할당이 지시될 수 있다. 예를 들어, 1개의 STA은 컨테이너에 대응되는 242톤의 자원 단위를 할당받을 수 있다.

[167] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '001'인 경우, 컨테이너에 대한 2개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원

단위에 대응되고, 2개의 STA 각각에 4개의 26톤의 자원 단위가 할당될 수 있다.

[168] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '010'인 경우, 컨테이너에 대한 3개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 3개의 STA 각각에 3개의 26톤의 자원 단위가 할당될 수 있다.

[169] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '011'인 경우, 컨테이너에 대한 4개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원 단위에 대응되고, 4개의 STA 각각에 2개의 26톤의 자원 단위가 할당될 수 있다. 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 3개의 STA 각각에 2개의 26톤의 자원 단위가 할당되고, 1개의 STA에 3개의 26톤의 자원 단위가 할당될 수 있다.

[170] 예를 들어, 컨테이너 별 자원 할당 정보(1000)가 '111'인 경우, 컨테이너에 대한 8개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원 단위에 대응되고, 8개의 STA 각각에 1개의 26톤의 자원 단위가 할당될 수 있다. 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 7개의 STA 각각에 1개의 26톤의 자원 단위가 할당되고, 1개의 STA에 2개의 26톤의 자원 단위가 할당될 수 있다.

[171] 도 11은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[172] 도 11에서는 복수의 컨테이너 각각에 포함되는 분할 자원 단위의 논리적인 결합을 기반으로 한 자원 할당 방법이 개시된다.

[173] 만약, 특정 컨테이너 내부에 26톤의 자원 단위를 분할한 13톤의 분할 자원 단위가 포함되는 경우, 다른 컨테이너 내부에 포함되는 다른 13톤의 분할 자원 단위와 논리적으로 결합되어 하나의 26톤의 자원 단위로 활용될 수 있다.

[174] 예를 들어, 제1 컨테이너(1110)에 13톤의 제1 분할 자원 단위(1115)가 할당되고, 제2 컨테이너(1120)에 13톤의 제2 분할 자원 단위(1125)가 할당되는 경우, 제1 분할 자원 단위(1115)와 제2 분할 자원 단위(1125)를 결합한 자원 단위의 할당을 위한 시그널링이 수행될 수 있다.

[175] 제1 컨테이너(1110)에 포함되는 제1 분할 자원 단위(715) 및 제2 컨테이너(1120)에 포함되는 제2 분할 자원 단위(1125)는 물리적으로 이어지도록 주파수 축 상에서 할당될 수 있다.

[176] 하나의 컨테이너 안에 13톤의 분할 자원 단위가 포함되는 경우, 13톤의 분할 자원 단위는 26톤의 자원 단위와 동일한 방법으로 시그널링될 수 있다. 예를 들어, 하나의 컨테이너 안에 9개의 26톤의 자원 단위가 포함되고, 1개의 13톤의 분할 자원 단위가 포함되는 경우, 13톤의 분할 자원 단위에 대한 시그널링을 위해 10개의 26톤의 자원 단위에 대한 시그널링과 동일한 방식의 시그널링이 수행될 수 있다. 다른 표현으로 13톤의 분할 자원 단위가 하나의 26톤의 자원 단위로 가정되어 자원 할당에 대한 시그널링이 수행될 수 있다.

[177] 제1 컨테이너에 포함된 13톤의 제1 분할 자원 단위가 할당되는 경우, 제1

컨테이너에 포함된 13톤의 제1 분할 자원 단위는 논리적으로 매핑되어 있는 제2 컨테이너에 포함된 13톤의 제2 분할 자원 단위와 함께 할당될 수 있다. 제1 분할 자원 단위와 제2 분할 자원 단위는 논리적으로 결합되어 하나의 26톤의 자원 단위로 STA으로 할당될 수 있다. 제2 컨테이너는 제1 컨테이너에 인접한 컨테이너일 수 있다. 제2 분할 자원 단위는 제1 분할 자원 단위에 인접한 분할 자원 단위일 수 있다.

[178] 만약, 13톤의 분할 자원 단위와 논리적으로 매핑되어 있는 다른 분할 자원 단위가 이미 사용된 경우, 13톤의 분할 자원 단위를 제외한 9개의 26톤의 자원 단위에 대한 할당만이 수행될 수 있다. 또 다른 표현으로 만약, 13톤의 분할 자원 단위와 논리적으로 매핑되어 있는 다른 분할 자원 단위가 이미 사용된 경우, 컨테이너 내에 9개의 26톤의 자원 단위만이 존재하는 것으로 가정하고 자원 할당이 수행될 수도 있다.

[179] 본 발명의 실시예에 따르면, 컨테이너에 포함되는 13톤의 분할 자원 단위의 사용 여부에 따라 컨테이너 별 자원 할당 정보가 서로 다르게 해석될 수 있다.

[180] 예를 들어, 컨테이너 별 자원 할당 정보가 '000'인 경우, 컨테이너에 대한 1개의 STA의 할당이 지시될 수 있다. 예를 들어, 1개의 STA은 컨테이너에 대응되는 242톤의 자원 단위를 할당받을 수 있다.

[181] 예를 들어, 컨테이너 별 자원 할당 정보가 '001'인 경우, 컨테이너에 대한 2개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 26톤의 자원 단위에 대응되고, 2개의 STA 각각에 4개의 26톤의 자원 단위가 할당될 수 있다.

[182] 예를 들어, 컨테이너 별 자원 할당 정보가 '010'이고, 컨테이너에 대한 3개의 STA의 할당이 지시될 수 있다.

[183] 13톤의 분할 자원 단위가 사용되지 않는 경우, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 3개의 STA 각각에 3개의 26톤의 자원 단위가 할당될 수 있다.

[184] 13톤의 분할 자원 단위가 사용되는 경우, 컨테이터가 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위에 대응되고, 2개의 STA 각각에 대해 3개의 26톤의 자원 단위가 할당되고, 나머지 1개의 STA에 대해 4개의 26톤의 자원 단위가 할당될 수 있다. 이때, 4개의 26톤의 자원 단위 중 1개의 26톤의 자원 단위는 컨테이너에 포함된 13톤의 분할 자원 단위와 다른 컨테이너에 포함된 다른 13톤의 분할 자원 단위의 결합을 기반으로 할당될 수 있다.

[185] 예를 들어, 컨테이너 별 자원 할당 정보가 '011'이고, 컨테이너에 대한 4개의 STA의 할당이 지시될 수 있다.

[186] 구체적으로 13톤의 분할 자원 단위가 사용되지 않는 경우, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 4개의 STA 각각은 2개의 26톤의 자원 단위, 2개의 26톤의 자원 단위, 3개의 26톤의 자원 단위, 2개의 26톤의 자원 단위 각각을 할당받을 수 있다.

[187] 13톤의 분할 자원 단위가 사용되는 경우, 컨테이터가 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위에 대응되고, 4개의 STA 각각은 2개의 26톤의 자원

단위, 2개의 26톤의 자원 단위, 3개의 26톤의 자원 단위, 3개의 26톤의 자원 단위 각각을 할당받을 수 있다. 이때 3개의 26톤의 자원 단위 중 하나의 26톤의 자원 단위는 컨테이너에 포함된 13톤의 분할 자원 단위와 다른 컨테이너에 포함된 다른 13톤의 분할 자원 단위의 결합을 기반으로 할당될 수 있다.

[188] 예를 들어, 컨테이너 별 자원 할당 정보가 '111'이고, 컨테이너에 대한 8개의 STA의 할당이 지시될 수 있다.

[189] 구체적으로 13톤의 분할 자원 단위가 사용되지 않는 경우, 컨테이터가 9개의 26톤의 자원 단위에 대응되고, 7개의 STA 각각은 1개의 26톤의 자원 단위를 할당받고, 1개의 STA은 2개의 26톤의 자원 단위를 할당받을 수 있다.

[190] 13톤의 분할 자원 단위가 사용되는 경우, 컨테이터가 9개의 26톤의 자원 단위와 1개의 13톤의 분할 자원 단위에 대응되고, 6개의 STA 각각은 1개의 26톤의 자원 단위를 할당받고, 2개의 STA 각각은 2개의 26톤의 자원 단위를 할당받을 수 있다. 이때 2개의 26톤의 자원 단위 중 하나의 26톤의 자원 단위는 컨테이너에 포함된 13톤의 분할 자원 단위와 다른 컨테이너에 포함된 다른 13톤의 분할 자원 단위의 결합을 기반으로 할당될 수 있다.

[191] 위와 같은 컨테이너 별 자원 할당 정보를 기반으로 한 자원 할당을 위해서 각 컨테이너 별로 논리적으로 묶여질 13톤의 분할 자원 단위의 사용 여부가 지시될 수 있다. 또는 13톤의 분할 자원 단위 간의 결합을 기반으로 한 자원 할당을 위한 정보가 추가적으로 PPDU에 포함되어 전송될 수 있다.

[192] 컨테이너가 정의되는 경우, 컨테이너 별 자원 할당 정보를 기반으로 컨테이너에 할당될 STA의 개수 및 STA 별로 할당되는 자원 단위의 개수가 결정될 수 있다. 컨테이너에 할당될 STA의 개수 및 STA 별로 할당되는 자원 단위의 개수가 결정되는 경우, 자원 단위 할당 시그널링을 기반으로 한 자원 할당 방법과 같이 각 STA이 순차적으로 주파수 축 상에서 자원 단위를 할당받을 수 있다.

[193] 또는 컨테이너가 정의되는 경우, 컨테이너 별 자원 할당 정보를 기반으로 컨테이너에 할당될 STA의 개수가 정해질 수 있다. 컨테이너에 할당될 STA의 개수에 따라 컨테이너 내에서 STA 별로 할당되는 자원 단위의 개수가 결정될 수 있다. 컨테이너에 할당될 STA의 개수 및 STA 별로 할당되는 자원 단위의 개수가 결정되는 경우, 자원 단위 할당 시그널링을 기반으로 한 자원 할당 방법과 같이 각 STA이 순차적으로 주파수 축 상에서 자원 단위를 할당받을 수 있다.

[194] 도 12는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[195] 도 12에서는 STA으로의 자원 할당을 위한 컨테이너가 개시된다. 컨테이너를 기반으로 한 MU OFDMA 전송/MU MIMO 전송이 개시된다.

[196] MU OFDMA 전송과 MU MIMO 전송이 함께 사용되는 경우, 주파수 도메인뿐만 아니라 공간 도메인(spatial domain) 상으로도 멀티플렉싱되어 복수의 STA의 전송이 가능할 수 있다. 즉, 동일한 주파수 자원이 공간 도메인

상에서 분할되어 분할된 공간 도메인 상에서 복수의 STA의 전송이 가능할 수 있다.

[197] 도 12를 참조하면, 컨테이너 별로 컨테이너에 MU OFDMA 전송(1200), MU MIMO 전송(1250)의 수행 여부가 지시될 수 있다.

[198] 예를 들어, n 비트를 기반으로 컨테이너 별로 컨테이너에 대응되는 자원이 MU OFDMA 전송(1200)을 위한 자원인지 MU MIMO를 위한 자원인지 여부가 지시될 수 있다. 예를 들어, 1비트를 기반으로 특정 컨테이너에 대응되는 자원을 통해 MU OFDMA 전송(1200)이 수행되는지 MU MIMO 전송(1250)이 수행되는지 여부가 지시될 수 있다.

[199] 또 다른 예를 들어, 특정 컨테이너 상에서 MU OFDMA 전송(1200)이 수행되는지 여부를 지시하는 비트, 특정 컨테이너 상에서 MU MIMO 전송(1250)이 수행되는지 여부를 지시하는 비트가 개별적으로 정의될 수도 있다.

[200] MU OFDMA 전송(1200)이 수행되든, MU MIMO 전송(1250)이 수행되든, 컨테이너 상에서 할당될 수 있는 최대의 STA의 개수는 동일할 수 있다. 예를 들어, 컨테이너 상에서 MU OFDMA 전송(1200)과 MU MIMO 전송(1250)이 함께 수행되는 경우의 최대 STA의 개수는 MU OFDMA 전송(1200)과 MU MIMO 전송(1250) 각각이 개별적으로 수행되는 경우와 동일할 수 있다.

[201] 예를 들어, 20MH 대역폭에 대하여 컨테이너 별로 8개의 STA이 최대 STA의 개수로 정의될 수 있다. 40MH 대역폭에 대하여 컨테이너 별로 8개의 STA이 최대 STA의 개수로 정의되고, 40MHz 대역폭에 정의된 2개의 컨테이너 상에서 총 16개의 STA이 할당될 수 있다. 80MH 대역폭에 대하여 컨테이너 별로 4개의 STA이 최대 STA의 개수로 정의되고, 80MHz 대역폭에 정의된 4개의 컨테이너 상에서 총 16개의 STA이 할당될 수 있다.

[202] 도 13은 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[203] 도 13에서는 컨테이너 상에서 MU MIMO 전송을 지원하기 위한 방법이 개시된다. MU MIMO 전송은 컨테이너에 포함되는 다양한 자원 단위에 대해서 적용될 수 있다. 도 9에서는 특히, MU MIMO 전송이 컨테이너에 포함될 수 있는 가장 큰 자원 단위인 242톤의 자원 단위에 대해서 적용되는 경우가 개시된다.

[204] 예를 들어, MU MIMO 전송은 컨테이너에 포함될 수 있는 가장 큰 자원 단위(예를 들어, 242톤의 자원 단위)에 대해서 적용될 수 있다. SU 기반 전송인 경우, SU 기반 전송을 위한 뉴머롤로지를 기반으로 MU MIMO 전송이 수행될 수 있다. 이하, 242톤의 자원 단위가 컨테이너에 포함될 수 있는 가장 큰 자원 단위로 가정하나, 242톤의 자원 단위가 아닌 다른 크기의 자원 단위가 컨테이너에 포함될 수 있는 가장 큰 자원 단위로 정의될 수 있다.

[205] 우선 전체 주파수 대역 상에서 SU 기반 전송이 수행되는지 MU 기반 전송이 수행되는지 여부가 n비트의 MU/SU 전송 지시 정보(MU/SU 전송 지시 비트)(1300)를 통해 지시될 수 있다.

[206] 예를 들어, 전체 주파수 대역 상에서 SU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1300)의 값은 1이고, 전체 주파수 대역 상에서 MU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1300)의 값은 0일 수 있다. 전체 주파수 대역이 20MHz 대역폭인 경우, MU/SU 전송 지시 정보(1300)가 사용되지 않을 수 있다.

[207] 만약, MU/SU 전송 지시 정보(1300)가 MU 기반 전송을 지시하는 경우, 각 컨테이너에 대하여 n 비트의 MU OFDMA/MU MIMO 전송 지시 정보(MU OFDMA/MU MIMO 전송 지시 비트)(1320)를 통해 컨테이너 별로 MU OFDMA 전송/MU MIMO 전송 여부가 지시될 수 있다. 예를 들어, 1 비트의 MU OFDMA/MU MIMO 전송 지시 정보(1320)를 통해 컨테이너 별로 MU OFDMA 전송이 수행되는지 MU MIMO 전송이 수행되는지 여부가 지시될 수 있다.

[208] 만약, MU/SU 전송 지시 정보(1300)가 MU 기반 전송을 지시하는 경우, 각 컨테이너에 대하여 전술한 n 비트의 컨테이너 별 자원 할당 정보(1340)를 통해 컨테이너 별로 할당되는 STA의 개수가 정의될 수 있다. 예를 들어, 2~3 비트의 컨테이너 별 자원 할당 정보(1340)를 통해 컨테이너 별로 할당되는 STA의 개수가 정의될 수 있다. MU OFDMA/MU MIMO 전송 지시 정보(1320)가 컨테이너 상에서 MU MIMO 전송을 지시하는 경우, MU MIMO 전송은 컨테이너에 포함될 수 있는 가장 큰 자원 단위(예를 들어, 242톤의 자원 단위)에 대해서 적용되므로 n 비트의 컨테이너 별 자원 할당 정보(1340)는 242톤의 자원 단위에 할당되는 MU MIMO 기반 전송을 통해 통신을 수행할 STA의 개수를 지시할 수 있다.

[209] 만약, MU/SU 전송 지시 정보(1300)가 SU 기반 전송을 지시하는 경우, SU 기반 전송의 뉴머롤로지를 기반으로 MU MIMO 전송을 위한 STA의 개수가 시그널링될 수 있다.

[210] 도 14는 본 발명의 실시예에 따른 컨테이너를 기반으로 한 자원 할당을 나타낸 개념도이다.

[211] 도 14에서는 컨테이너 상에서 MU MIMO 전송을 지원하기 위한 방법이 개시된다. 도 14에서는 특히, 톤 유닛(tone unit)을 기준으로 MU MIMO 전송을 지원하기 위한 방법이 개시된다.

[212] 도 14를 참조하면, MU MIMO 전송은 컨테이너에 포함되는 다양한 자원 단위에 대해서 적용될 수 있다. MU MIMO 전송은 컨테이너에 포함될 수 있는 다양한 자원 단위의 크기를 기반으로 수행될 수 있다. 예를 들어, MU MIMO 전송은 1개의 26톤의 자원 단위, 2개의 26톤의 자원 단위, 3개의 26톤의 자원 단위, 4개의 26톤의 자원 단위 또는 242톤의 자원 단위 상에서 수행될 수 있다.

[213] 컨테이너 상에서 MU MIMO 전송을 지원하기 위해 컨테이너 별로 할당 가능한 톤 유닛의 개수가 정의될 수 있다. 예를 들어, 하나의 컨테이너가 9개의 26톤의 자원 단위를 포함하고, 하나의 컨테이너 상에서 3개의 26톤의 자원 단위가 3개 할당될 수 있다. 3개의 26톤의 자원 단위가 하나의 26톤의 자원 단위 그룹을

형성하고 컨테이너 상에서 3개의 26톤의 자원 단위 그룹이 할당될 수 있다. 이러한 경우, 컨테이너에 할당되는 톤 유닛의 개수는 3개일 수 있다. 톤 유닛은 하나의 컨테이너 상에서 MU MIMO 전송을 위한 분할된 자원 단위일 수 있다.

[214] 이하, 톤 유닛을 기반으로 한 MU MIMO 전송을 위한 자원 할당 방법이 개시된다.

[215] 우선 전체 주파수 대역 상에서 SU 기반 전송이 수행되는지 MU 기반 전송이 수행되는지 여부가 n비트의 MU/SU 전송 지시 정보(1400)를 통해 지시될 수 있다.

[216] 예를 들어, 전체 주파수 대역 상에서 SU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1400)의 값은 1이고, 전체 주파수 대역 상에서 MU 기반 전송이 수행되는 경우, 1비트의 MU/SU 전송 지시 정보(1400)의 값은 0일 수 있다. 전체 주파수 대역이 20MHz 대역폭인 경우, MU/SU 전송 지시 정보(1400)가 사용되지 않을 수 있다.

[217] 만약, MU/SU 전송 지시 정보(1400)가 MU 기반 전송을 지시하는 경우, n 비트를 기반으로 각 컨테이너에 대한 톤 유닛의 개수가 지시될 수 있다. 각 컨테이너에 대하여 톤 유닛의 개수를 지시하는 정보(또는 비트)는 톤 유닛 개수 정보(또는 톤 유닛 개수 정보 비트)(1420)라는 용어로 표현될 수 있다. 다른 표현으로, 톤 유닛 개수 정보(1420)는 FDM(frequency division multiplexing)으로 구분되는 MU MIMO 전송에 대한 자원 할당을 위한 톤 유닛의 개수에 대한 정보를 포함할 수 있다. 예를 들어, 2 또는 3비트의 톤 유닛 개수 정보(1420)가 하나의 컨테이너에 포함되는 톤 유닛의 개수를 지시할 수 있다.

[218] 또한, MU/SU 전송 지시 정보(1400)가 MU 기반 전송을 지시하는 경우, n 비트의 톤 유닛 별 자원 할당 정보(1440)를 기반으로 톤 유닛 각각에 할당되는 MU MIMO 전송을 기반으로 통신을 수행할 STA의 개수가 지시될 수 있다.

[219] 예를 들어, 하나의 컨테이너에는 복수개의 톤 유닛이 포함될 수 있고, n 비트의 톤 유닛 별 자원 할당 정보(1440) 각각은 복수개의 톤 유닛 각각에 할당된 MU MIMO 전송을 기반으로 통신을 수행할 STA의 개수를 지시할 수 있다.

[220] 만약, MU/SU 전송 지시 정보(1400)가 SU 기반 전송을 지시하는 경우, SU 기반 전송의 뉴머롤로지를 기반으로 MU MIMO 전송을 위한 STA의 개수가 시그널링될 수 있다.

[221] 본 발명의 실시예에 따르면, 컨테이너 별로 할당 가능한 톤 유닛의 개수가 n 개이고, 컨테이너 별로 할당 가능한 최대 STA의 개수가 x 개인 경우가 가정될 수 있다. 이러한 경우, 각 톤 유닛 별로 Flooring(x/n) 비트 (또는 min (Flooring(x/n), m) 비트) 또는 Ceiling (x/n) 비트 (또는 min(Ceiling (x/n), m) 비트)가 톤 유닛 별 자원 할당 비트로 정의되고, 톤 유닛 별 자원 할당 비트는 개별 톤 유닛에서 MU MIMO 전송을 기반으로 통신을 수행할 STA의 개수를 지시할 수 있다.

[222] 본 발명의 실시예에 따르면, 톤 유닛의 크기 별로 각 톤 유닛에서 최대로 할당 가능한 MU MIMO 전송을 수행하는 STA의 개수(이하, 최대 MU MIMO 전송

STA 개수)가 정의될 수 있다.

[223] 예를 들어, 톤 유닛의 크기가 242톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 컨테이너 별로 할당 가능한 최대 STA의 개수와 동일하게 설정될 수 있다. 예를 들어, 톤 유닛의 크기가 242톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 20MHz 대역폭/40MHz 대역폭에서는 4개, 80MHz 대역폭에서는 2개일 수 있다.

[224] 톤 유닛의 크기가 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 최대 4개(20MHz 대역폭/40MHz 대역폭)이거나, 2개(80MHz 대역폭)일 수 있다.

[225] 톤 유닛의 크기가 2개의 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 최대 4개(20MHz 대역폭/40MHz 대역폭)이거나, 2개(80MHz 대역폭)일 수 있다.

[226] 톤 유닛의 크기가 3개의 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 4개일 수 있다.

[227] 톤 유닛의 크기가 4개의 26톤의 자원 단위인 경우, 최대 MU MIMO 전송 STA 개수는 4개일 수 있다.

[228] 또는 본 발명의 실시예에 따르면, 톤 유닛의 크기에 상관없이 각 톤 유닛에서 최대로 할당 가능한 MU MIMO 기반 전송을 수행하는 STA의 개수(이하, 최대 MU MIMO 전송 STA 개수)가 동일하게 설정될 수도 있다. 또는 톤 유닛의 크기가 242톤의 자원 단위인 경우, 톤 유닛에서 최대 MU MIMO 전송 STA 개수가 8개이고, 톤 유닛의 크기가 242톤의 자원 단위보다 작은 경우(n개의 26톤의 자원 단위), 톤 유닛에서 최대 MU MIMO 전송 STA 개수는 4개일 수 있다.

[229] 어떠한 경우이든 컨테이너 별로 할당 가능한 최대 STA의 개수는 만족하도록 톤 유닛에 할당되는 최대 MU MIMO 전송 STA의 개수가 설정될 수 있다.

[230] 전술한 본 발명의 실시예에서는 26톤의 자원 단위를 기준으로 설명하였으나, 26톤의 자원 단위가 아닌 다른 자원 단위(예를 들어, 30톤의 자원 단위)에 대해서도 전술한 자원 할당 방법이 적용될 수 있다.

[231] 예를 들어, 컨테이너가 242톤의 자원 단위 1개 또는 8개의 30톤의 자원 단위로 정의될 수 있다.

[232] 이러한 경우, 대역폭 별 컨테이너의 개수는 20MHz 대역폭에 대하여 1개, 40MHz 대역폭에 대하여 2개, 80MHz 대역폭에 대하여 4개가 정의될 수 있다.

[233] 또한 컨테이너 별로 할당 가능한 최대 STA의 개수는 20MHz 대역폭에 대하여 8개의 STA이 할당될 수 있다.

[234] 40MHz 대역폭 상에서 2개의 컨테이너가 정의될 수 있고, 2개의 컨테이너 각각에 대하여 4개의 STA이 할당 가능하다. 따라서, 40MHz 대역폭 상에서 최대 8개의 STA이 할당될 수 있다.

[235] 80MHz 대역폭 상에서 4개의 컨테이너가 정의될 수 있고, 4개의 컨테이너 각각에 대하여 4개의 STA이 할당 가능하다. 따라서, 80MHz 대역폭 상에서 최대 16개의 STA이 할당될 수 있다.

[236] 컨테이너 별로 2비트 또는 3비트가 컨테이너 별 자원 할당 정보로 정의되어 컨테이너 별로 할당되는 STA의 개수를 알려줄 수 있다. 2비트의 컨테이너 별 자원 할당 비트는 최대 4개의 STA에 대한 자원 할당을 지시하고, 3비트의 컨테이너 별 자원 할당 비트는 최대 8개의 STA에 대한 자원 할당을 지시할 수 있다.

[237] 예를 들어, 컨테이너 별 자원 할당 비트가 '000'인 경우, 컨테이너에 대한 1개의 STA의 할당이 지시될 수 있다. 예를 들어, 1개의 STA은 컨테이너에 대응되는 242톤의 자원 단위를 할당받을 수 있다.

[238] 예를 들어, 컨테이너 별 자원 할당 비트가 '001'인 경우, 컨테이너에 대한 2개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 2개의 STA 각각에 4개의 30톤의 자원 단위가 할당될 수 있다.

[239] 예를 들어, 컨테이너 별 자원 할당 비트가 '010'인 경우, 컨테이너에 대한 3개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 2개의 STA 각각에 3개의 30톤의 자원 단위, 1개의 STA에 2개의 30톤의 자원 단위가 할당될 수 있다.

[240] 예를 들어, 컨테이너 별 자원 할당 비트가 '011'인 경우, 컨테이너에 대한 4개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 4개의 STA 각각에 2개의 30톤의 자원 단위가 할당될 수 있다.

[241] 예를 들어, 컨테이너 별 자원 할당 비트가 '111'인 경우, 컨테이너에 대한 8개의 STA의 할당이 지시될 수 있다. 예를 들어, 컨테이터가 8개의 30톤의 자원 단위에 대응되고, 8개의 STA 각각에 1개의 30톤의 자원 단위가 할당될 수 있다.

[242] 전체 대역폭이 80MHz 대역폭인 경우, 17개의 30톤의 자원 단위의 할당이 가능할 수 있다. 따라서, 4개의 컨테이너 각각에 4개의 30톤의 자원 단위를 할당하고, 추가의 1개의 30톤의 자원 단위가 활용될 수 있다. 추가의 1개의 30톤의 자원 단위는 다른 컨테이너(또는 다른 자원)과 조합되어 자동으로 할당될 수도 있다.

[243] 본 발명의 실시예에 따르면, 242톤의 자원 단위와 26톤의 자원 단위를 기반으로 한 자원 할당을 위한 시그널링은 할당된 적어도 하나의 242톤의 자원 단위(또는 제1 자원 단위)를 그룹핑한 제1 자원 단위 그룹과 적어도 하나의 26톤의 자원 단위(또는 제2 자원 단위)를 그룹핑한 제2 자원 단위 그룹 각각에 대해 수행될 수 있다. 전술한 자원 단위 할당 시그널링/시그널링 지시가 제1 자원 단위 그룹과 제2 자원 단위 그룹 각각에 대해 수행될 수 있다.

[244] 논리 도메인 상에 주파수 축 상에서 할당된 제1 자원 단위 그룹이 우선적으로 나열되고, 제1 자원 단위 그룹 이후에 제2 자원 단위 그룹이 나열될 수 있다. 주파수 축 상에서 제2 자원 단위 그룹에 대한 할당은 주파수 축 상에서 제1 자원 단위 그룹에 대한 할당에 영향을 받을 수 있다. 예를 들어, 제2 자원 단위 그룹에 포함되는 제2 자원 단위는 제1 자원 단위 그룹에 포함되는 제1 자원 단위에 대한 할당된 주파수 대역의 나머지 대역에 할당될 수 있고, 제2 자원 단위 그룹에

포함되는 제2 자원 단위의 개수 및 위치는 제1 자원 단위 그룹에 포함되는 제1 자원 단위의 개수 및 위치를 기반으로 결정될 수 있다.

[245] 도 15는 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[246] 도 15에서는 MU OFDMA 전송/MU MIMO 전송을 수행하는 STA에 대한 개수 제한이 개시된다.

[247] 도 15를 참조하면, MU MIMO 전송이 242톤의 자원 단위를 기반으로 수행되고, 242톤의 자원 단위 상에서 MU MIMO 전송이 가능한 STA은 최대 4개로 제한될 수 있다.

[248] OFDMA 구조에 따라 변할수 있으나, 20MHz 대역폭은 9개의 26톤의 자원 단위, 40MHz 대역폭은 18개의 26톤의 자원 단위, 80MHz 대역폭은 37개의 26톤의 자원 단위를 포함할 수 있다. 이때 각 대역폭 상에서 MU OFDMA 전송이 수행되는 경우, 20MHz 대역폭에 대해서는 최대 9개의 STA의 MU OFDMA 기반 통신이 가능하고, 40MHz 대역폭에 대해서는 최대 18개의 STA의 MU OFDMA 기반 통신이 가능하고, 80MHz 대역폭에 대해서는 최대 18개의 STA의 MU OFDMA 기반 통신이 가능할 수 있다.

[249] 본 발명의 실시예에 따르면, 주파수 대역폭의 크기에 상관없이 중첩된 시간 자원 상에서 MU OFDMA 기반 전송을 사용하여 통신하는 최대 STA의 개수만 18개로 제한될 수 있다.

[250] 또는 주파수 대역폭의 크기에 상관없이 중첩된 시간 자원 상에서 MU OFDMA 전송을 사용하여 통신하는 최대 STA의 개수 및 MU MIMO 전송을 사용하여 통신하는 최대 STA의 개수는 18개로 제한될 수 있다.

[251] 아래의 표 2는 대역폭 및 MU OFDMA 기반 전송/MU MIMO 기반 전송에 따른 최대 STA의 개수를 나타낸다.

[252] [표2]

대역폭(BW)	할당(Allocation)	최대 STA의 개수
20MHz	9x26 for OFDMA1x242 for MU MIMO	94
40MHz	18x26 for OFDMA1x242 for MU MIMO, 9x26 for OFDMA2x242 for MU MIMO	18138
80MHz	37x26 for OFDMA1x242 for MU MIMO, 28x26 for OFDMA2x242 for MU MIMO, 19x26 for OFDMA3x242 for MU MIMO, 10x26 for OFDMA4x242 for MU MIMO, 1x26 for OFDMA	1822 or 1826 or 1822 or 1817

[253] 표 2를 참조하면, 20MHz 대역폭에 대하여 MU OFDMA 전송이 수행될 경우, 9개의 26톤의 자원 단위 각각이 9개의 STA 각각에 할당되므로 최대 9개의

STA에 대한 통신이 지원될 수 있다. 20MHz 대역폭에 대하여 MU MIMO 전송이 수행될 경우, 242톤의 자원 단위를 기준으로 최대 4개의 STA이 지원 가능하므로 하나의 242톤의 자원 단위 상에서 최대 4개의 STA에 대한 통신이 지원될 수 있다.

[254] 40MHz 대역폭에 대하여 MU OFDMA 전송이 수행될 경우, 18개의 26톤의 자원 단위 각각이 18개의 STA 각각에 할당되므로 최대 18개의 STA에 대한 통신이 지원될 수 있다.

[255] 40MHz 대역폭에 대하여 MU MIMO 전송/MU OFDMA 전송이 수행될 경우, 하나의 242톤의 자원 단위 상에서 최대 4개의 STA에 대한 MU MIMO 기반 통신이 지원되고, 나머지 9개의 26톤의 자원 단위 상에서 최대 9개의 STA에 대한 MU OFDMA 기반 통신이 지원될 수 있다.

[256] 40MHz 대역폭에 대하여 MU MIMO 전송이 수행될 경우, 두 개의 242톤의 자원 단위 각각 상에서 최대 4개의 STA에 대한 MU MIMO 기반 통신이 지원될 수 있다. 따라서, 최대 8개의 STA에 대한 MU MIMO 기반 통신이 지원될 수 있다.

[257] 80MHz 대역폭에 대하여 MU OFDMA 전송이 수행될 경우, 37개의 26톤의 자원 단위가 18개의 STA 각각에 할당될 수 있다. 전술한 바와 같이 MU OFDMA 전송은 최대 18개의 STA을 지원할 수 있다. 또는 MU OFDMA 전송/MU MIMO 전송은 최대 18개의 STA을 지원할 수 있다. 따라서, 37개의 26톤의 자원 단위가 가용한 경우에도 최대 18개의 STA의 통신이 지원될 수 있다.

[258] 80MHz 대역폭에 대하여 MU MIMO 전송/ MU OFDMA 전송이 수행될 수 있다. 하나의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 28개의 26톤의 자원 단위가 MU OFDMA 전송을 위해 사용되는 경우, 최대 22개의 STA의 통신이 지원되거나, 최대 18개의 STA의 통신이 지원될 수 있다.

[259] 구체적으로 전술한 바와 같이 MU OFDMA 전송의 최대 지원 가능한 STA의 개수만 18개로 제한되는 경우, MU OFDMA 전송이 수행 가능한 최대 18개의 STA과 MU MIMO 전송이 수행 가능한 최대 4개의 STA의 합인 22개의 STA이 최대 지원 가능한 STA의 개수일 수 있다. MU OFDMA 전송 및 MU MIMO 전송의 최대 지원 가능한 STA의 개수가 18개로 제한되는 경우, MU OFDMA 전송을 수행하는 STA의 개수와 MU MIMO 전송을 수행하는 STA의 개수의 합이 최대 18개가 되도록 설정될 수 있다.

[260] 80MHz 대역폭에 대하여 MU MIMO 전송/MU OFDMA 전송이 수행될 수 있다. 두 개의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 19개의 26톤의 자원 단위가 MU OFDMA 전송을 위해 사용되는 경우, 최대 26개의 STA의 통신이 지원되거나, 최대 18개의 STA의 통신이 지원될 수 있다.

[261] 구체적으로 전술한 바와 같이 MU OFDMA 전송의 최대 지원 가능한 STA의 개수만 18개로 제한되는 경우, MU OFDMA 전송이 수행 가능한 최대 18개의 STA과 2개의 242톤의 자원 단위 상에서 MU MIMO 전송이 수행 가능한 최대 8개의 STA의 합인 26개의 STA이 최대 지원 가능한 STA의 개수일 수 있다. MU

OFDMA 전송 및 MU MIMO 전송의 최대 지원 가능한 STA의 개수가 18개로 제한되는 경우, MU OFDMA 전송을 수행하는 STA의 개수와 MU MIMO 전송을 수행하는 STA의 개수의 합이 최대 18개가 되도록 설정될 수 있다.

[262] 80MHz 대역폭에 대하여 MU MIMO 전송/ MU OFDMA 전송이 수행될 수 있다. 세 개의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 10개의 26톤의 자원 단위가 MU OFDMA 전송을 위해 사용되는 경우, 마찬가지 방식으로 최대 22개의 STA의 통신이 지원되거나, 최대 18개의 STA의 통신이 지원될 수 있다.

[263] 80MHz 대역폭에 대하여 MU MIMO 전송/MU OFDMA 전송이 수행될 수 있다. 네 개의 242톤의 자원 단위가 MU MIMO 전송을 위해 사용되고 나머지 1개의 26톤의 자원 단위가 MU OFDMA 기반 전송을 위해 사용되는 경우, 최대 17개의 STA의 통신이 지원될 수 있다.

[264] 도 16은 본 발명의 실시예에 따른 주파수 대역 상에서 STA의 개수 제한을 나타낸 개념도이다.

[265] 도 16에서는 242톤의 자원 단위 및 26톤의 자원 단위에 대한 자원 할당 방법이 개시된다.

[266] 도 16을 참조하면, PPDU 헤더의 시그널 필드(예를 들어, HE(high efficiency)-SIG(signal) A/HE-SIG B)(1600)를 기반으로 OFDMA 패킷의 수신 STA에 대한 정보(또는 PPDU를 수신하는 STA의 개수에 대한 정보)가 할당 STA 정보(1610)로서 전송될 수 있다.

[267] 또한, 전체 대역폭 상에서 할당되는 242톤의 자원 단위에 대한 정보가 PPDU 헤더를 통해 전송될 수 있다. 242톤의 자원 단위의 전체 대역폭 상의 할당에 대한 정보를 지시하기 위해 242톤의 자원 단위에 대한 비트맵(이하, 242톤 자원 단위 비트맵(또는 242 청크 비트맵(chunk bitmap)))(1620)이 정의될 수 있다. 242톤 자원 단위 비트맵(1620)은 전체 대역폭 상에서 할당된 242톤의 자원 단위의 위치 및 개수에 대한 정보를 포함할 수 있다.

[268] 또한, STA에 할당되는 26톤의 자원 단위의 할당에 대한 정보(1630)가 PPDU 헤더를 통해 전송될 수 있다. 예를 들어, n비트(예를 들어, 3비트)를 기반으로 STA에 할당되는 26톤의 자원 단위의 개수에 대한 정보가 지시될 수 있다. 26톤의 자원 단위의 할당에 대한 정보(1630)인 n비트는 특정 크기의 자원 단위(예를 들어, 9개의 26톤의 자원 단위) 상에서 STA으로 할당되는 26톤의 자원 단위의 개수에 대한 정보을 포함할 수 있다.

[269] STA에 할당되는 242톤의 자원 단위에 대한 정보는 OFDMA 패킷의 사용자의 개수에 대한 정보 및 26톤의 자원 단위를 할당받는 사용자의 개수에 대한 정보를 기반으로 결정될 수 있다.

[270] 예를 들어, 두 개의 242톤의 자원 단위 및 2개의 26톤의 자원 단위가 4개의 STA으로 할당된 경우, 두 개의 242톤의 자원 단위 각각이 2개의 STA 각각에 할당되고, 2개의 26톤의 자원 단위 각각이 2개의 STA 각각에 할당될 수 있다.

[271] 또 다른 예를 들어, 두 개의 242톤의 자원 단위 및 3개의 26톤의 자원 단위가 4개의 STA으로 할당된 경우, 두 개의 242톤의 자원 단위가 1개의 STA에 할당되고, 3개의 26톤의 자원 단위 각각이 3개의 STA 각각에 할당될 수 있다.

[272] N은 242톤의 자원 단위가 주파수 축 상에서 할당된 이후, 나머지 할당되지 않은 242톤의 자원 단위의 개수로 가정할 수 있다. 이러한 경우, 주파수 축 상에 할당되는 242톤의 자원 단위 및 26톤의 자원 단위는 242톤 자원 단위 비트맵 및 3비트의 26톤의 자원 단위에 대한 할당 정보를 기반으로 할당될 수 있다.

[273] 242톤의 자원 단위는 20MHz 대역폭에 대해서 1개 할당 가능하고, 40MHz 대역폭에 대해서 2개 할당 가능하고, 80MHz 대역폭에 대해서 4개 할당 가능할 수 있다. 따라서, 242톤 자원 단위 비트맵은 20MHz 대역폭에 대해서 1비트, 40MHz 대역폭에 대해서 2비트, 80MHz 대역폭에 대해서 4비트로 정의될 수 있다.

[274] 26톤의 자원 단위에 대한 할당 정보(1630)는 242톤의 자원 단위로 사용되지 않는 N개의 나머지 242톤의 자원 단위 각각 상에서 STA으로 할당되는 26톤의 자원 단위의 개수를 지시할 수 있다. 따라서, 26톤의 자원 단위에 대한 할당 정보는 3비트*N의 크기를 가질 수 있다.

[275] 따라서, 20MHz 대역폭에 대해 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 1(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다. 40MHz 대역폭에 대해 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 2(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다. 80MHz 대역폭에 대해 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 4(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다.

[276] 위와 같은 시그널링은 대역폭의 크기에 따라 최적화된 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)에 대한 시그널링 방법(또는 BW-최적화 시그널링(BW-optimized signaling) 방법)이다.

[277] 본 발명의 실시예에 따르면, 대역폭의 크기에 상관없이 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)에 대한 시그널링하는 방법(BW 공통 시그널링 방법(BW common signaling))이 개시된다.

[278] 242톤 자원 단위 비트맵(1620)은 대역폭의 크기와 상관없이 4비트로 정의될 수 있고, 26톤의 자원 단위에 대한 할당 정보(1630)는 3비트*N의 크기로 정의될 수 있다. 따라서, 대역폭의 크기에 상관없이 242톤 자원 단위 비트맵(1620) 및 3비트의 26톤의 자원 단위에 대한 할당 정보(1630)는 4(242톤 자원 단위 비트맵)+N*3(26톤의 자원 단위 할당 정보)일 수 있다.

[279] 위와 같은 BW 최적화 시그널링 및 BW 공통 시그널링 방법에서 N은 N'로 정의될 수 있고, N'는 각 대역폭에 할당 가능한 최대 242톤의 자원 단위의 개수일 수 있다. 즉, 20MHz 대역폭에 대하여, N'는 1이고, 40MHz 대역폭에 대하여, N'는

2이고, 80MHz 대역폭에 대하여, N'는 4일 수 있다. N'는 현재 242톤의 자원 단위의 할당 상태에 따라 변하는 값이 아닌 고정된 값일 수 있다. 따라서, 자원 할당 정보를 전송하는 시그널 필드(예를 들어, HE-SIG B)에 대한 고정된 디자인이 가능할 수 있다.

[280] N'가 정의되는 경우, 26톤의 자원 단위에 대한 할당 정보는 20MHz 대역폭에 대하여 3비트, 40MHz 대역폭에 대하여 6비트, 80MHz 대역폭에 대하여 12비트로 고정될 수 있다.

[281] 242톤 자원 단위 비트맵(1620)의 크기가 20MHz 대역폭에 대해 1비트, 40MHz 대역폭에 대해 2비트, 80MHz 대역폭에 대해 4비트인 경우, 26톤의 자원 단위에 대한 할당 정보(1630)와 242톤 자원 단위 비트맵(1620)의 합은 20MHz 대역폭에 대해 4비트, 40MHz 대역폭에 대해 8비트, 80MHz 대역폭에 대해 16비트일 수 있다.

[282] 본 발명의 실시예에 따르면 특정 크기의 자원 단위에 대해 MU MIMO 전송이 수행되는지 여부가 지시될 수 있다. 예를 들어, MU MIMO 전송이 242톤의 자원 단위 상에서 수행되는 경우, 242톤의 자원 단위에 MU MIMO 전송이 수행되는지 여부를 지시하는 1비트가 추가되어 시그널링될 수 있다.

[283] 이러한 경우, 전체 주파수 대역에 포함되는 242톤의 자원 단위 각각에 대해 MU MIMO 기반 전송이 수행되는지 여부를 지시하는 1비트가 추가될 수 있다. 20MHz 대역폭 상에서는 242톤의 자원 단위의 개수가 1개이므로 1비트가 추가되고, 40MHz 대역폭 상에서는 242톤의 자원 단위의 개수가 2개이므로 2비트가 추가되고, 80MHz 대역폭 상에서는 242톤의 자원 단위의 개수가 4개이므로 4비트가 추가될 수 있다.

[284] 따라서, 26톤의 자원 단위에 대한 할당 정보와 242톤 자원 단위 비트맵 및 MU MIMO 기반 전송이 수행되는지 여부를 지시하는 비트의 합은 20MHz 대역폭에 대해 5비트, 40MHz 대역폭에 대해 10비트, 80MHz 대역폭에 대해 16비트일 수 있다.

[285] 도 17은 본 발명의 실시예에 따른 DL MU PPDU 포맷을 나타낸 개념도이다.

[286] 도 17에서는 본 발명의 실시예에 따른 AP에 의해 OFDMA를 기반으로 전송되는 DL MU PPDU 포맷이 개시된다.

[287] 도 17을 참조하면, DL MU PPDU의 PPDU 헤더는 L-STF(legacy-short training field), L-LTF(legacy-long training field), L-SIG(legacy-signal), HE-SIG A(high efficiency-signal A), HE-SIG B(high efficiency-signal-B), HE-STF(high efficiency-short training field), HE-LTF(high efficiency-long training field), 데이터 필드(또는 MAC 페이로드)를 포함할 수 있다. PHY 헤더에서 L-SIG까지는 레가시 부분(legacy part), L-SIG 이후의 HE(high efficiency) 부분(HE part)으로 구분될 수 있다.

[288] L-STF(1700)는 짧은 트레이닝 OFDM 심볼(short training orthogonal frequency division multiplexing symbol)을 포함할 수 있다. L-STF(1700)는 프레임 탐지(frame

detection), AGC(automatic gain control), 다이버시티 탐지(diversity detection), 대략적인 주파수/시간 동기화(coarse frequency/time synchronization)을 위해 사용될 수 있다.

[289] L-LTF(1710)는 긴 트레이닝 OFDM 심볼(long training orthogonal frequency division multiplexing symbol)을 포함할 수 있다. L-LTF(1710)는 정밀한 주파수/시간 동기화(fine frequency/time synchronization) 및 채널 예측을 위해 사용될 수 있다.

[290] L-SIG(1720)는 제어 정보를 전송하기 위해 사용될 수 있다. L-SIG(1720)는 데이터 전송률(rate), 데이터 길이(length)에 대한 정보를 포함할 수 있다.

[291] HE-SIG A(1730)는 DL MU PPDU를 수신할 STA을 지시하기 위한 정보를 포함할 수도 있다. 예를 들어, HE-SIG A(1730)는 PPDU를 수신할 특정 STA(또는 AP)의 식별자, 특정 STA의 그룹을 지시하기 위한 정보를 포함할 수 있다. 또한, HE-SIG A(1730)는 DL MU PPDU가 OFDMA 또는 MIMO를 기반으로 전송되는 경우, STA의 DL MU PPDU의 수신을 위한 자원 할당 정보도 포함할 수 있다.

[292] 또한, HE-SIG A(1730)는 BSS 식별 정보를 위한 칼라 비트(color bits) 정보, 대역폭(bandwidth) 정보, 테일 비트(tail bit), CRC 비트, HE-SIG B(1740)에 대한 MCS(modulation and coding scheme) 정보, HE-SIG B(1740)를 위한 심볼 개수 정보, CP(cyclic prefix)(또는 GI(guard interval)) 길이 정보를 포함할 수도 있다.

[293] HE-SIG B(1740)는 각 STA에 대한 PSDU(Physical layer service data unit)의 길이 MCS에 대한 정보 및 테일 비트 등을 포함할 수 있다. 또한 HE-SIG B(1740)는 PPDU를 수신할 STA에 대한 정보, OFDMA 기반의 자원 할당(resource allocation) 정보(또는 MU-MIMO 정보)를 포함할 수도 있다. HE-SIG B(1740)에 OFDMA 기반의 자원 할당 정보(또는 MU-MIMO 관련 정보)가 포함되는 경우, HE-SIG A(1730)에는 자원 할당 정보가 포함되지 않을 수도 있다.

[294] 전술한 바와 같이 HE-SIG A(1750) 또는 HE-SIG B(1760)는 수신 STA 식별 정보 및 자원 할당 정보를 포함할 수 있다. 수신 STA 식별 정보는 순차적으로 PPDU를 수신할 복수의 STA을 포함할 수 있고, 자원 할당 정보는 순차적으로 복수의 STA 각각으로 할당된 자원 단위의 개수에 대한 정보를 포함할 수 있다. HE-SIG A(1350) 또는 HE-SIG B(1760)는 제1 자원 단위 그룹(또는 제1 자원 단위)를 위한 수신 STA 식별 정보 및 자원 할당 정보 및 제2 자원 단위 그룹(또는 제2 자원 단위)를 위한 수신 STA 식별 정보 및 자원 할당 정보를 별도로 포함할 수 있다.

[295] 또한, HE-SIG A(1750) 또는 HE-SIG B(1760)는 비트맵 정보를 기반으로 복수의 STA 각각으로 할당되는 제1 자원 단위 및 제2 자원 단위 각각을 직접적으로 지시할 수도 있다.

[296] 또한, HE-SIG A(1750) 또는 HE-SIG B(1760)는 전술한 242톤 자원 단위 전체 할당 정보, 242톤 자원 단위 개별 할당 정보, 26톤 자원 단위 개별 할당 정보, 톤 유닛 개수 정보, 컨테이너 별 자원 할당 정보 MU/SU 전송 지시 정보 MU OFDMA/MU MIMO 전송 지시 정보 등을 포함할 수 있다.

[297] DL MU PPDU 상에서 HE-SIG B(1740)의 이전 필드는 서로 다른 전송 자원 각각에서 듀플리케이트된 형태로 전송될 수 있다. HE-SIG B(1740)의 경우, 일부의 자원 단위(예를 들어, 자원 단위1, 자원 단위2)에서 전송되는 HE-SIG B(1740)은 개별적인 정보를 포함하는 독립적인 필드이고, 나머지 자원 단위(예를 들어, 자원 단위3, 자원 단위4)에서 전송되는 HE-SIG B(1740)은 다른 자원 단위(예를 들어, 자원 단위1, 자원 단위2)에서 전송되는 HE-SIG B(1740)을 듀플리케이트한 포맷일 수 있다. 또는 HE-SIG B(1740)는 전체 전송 자원 상에서 인코딩된 형태로 전송될 수 있다. HE-SIG B(1740) 이후의 필드는 PPDU를 수신하는 복수의 STA 각각을 위한 개별 정보를 포함할 수 있다.

[298] HE-STF(1750)는 MIMO(multiple input multiple output) 환경 또는 OFDMA 환경에서 자동 이득 제어 추정(automatic gain control estimation)을 향상시키기 위하여 사용될 수 있다.

[299] 구체적으로 STA1은 AP로부터 자원 단위1을 통해 전송되는 HE-STF1을 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드1(또는 프레임1)을 디코딩할 수 있다. 마찬가지로 STA2는 AP로부터 자원 단위2를 통해 전송되는 HE-STF2를 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드2(또는 프레임2)를 디코딩할 수 있다. STA3은 AP로부터 자원 단위3을 통해 전송되는 HE-STF3을 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드3(또는 프레임3)을 디코딩할 수 있다. STA4는 AP로부터 자원 단위4을 통해 전송되는 HE-STF4를 수신하고, 동기화, 채널 트래킹/예측, AGC을 수행하여 데이터 필드4(또는 프레임4)를 디코딩할 수 있다.

[300] HE-LTF(1760)는 MIMO 환경 또는 OFDMA 환경에서 채널을 추정하기 위하여 사용될 수 있다.

[301] HE-STF(1750) 및 HE-STF(1750) 이후의 필드에 적용되는 IFFT의 크기와 HE-STF(1750) 이전의 필드에 적용되는 IFFT의 크기는 서로 다를 수 있다. 예를 들어, HE-STF(1750) 및 HE-STF(1750) 이후의 필드에 적용되는 IFFT의 크기는 HE-STF(1750) 이전의 필드에 적용되는 IFFT의 크기보다 4배 클 수 있다. STA은 HE-SIG A(1730)를 수신하고, HE-SIG A(1730)를 기반으로 하향링크 PPDU의 수신을 지시받을 수 있다. 이러한 경우, STA은 HE-STF(1750) 및 HE-STF(1750) 이후 필드부터 변경된 FFT 사이즈를 기반으로 디코딩을 수행할 수 있다. 반대로 STA이 HE-SIG A(1730)를 기반으로 하향링크 PPDU의 수신을 지시받지 못한 경우, STA은 디코딩을 중단하고 NAV(network allocation vector) 설정을 할 수 있다. HE-STF(1750)의 CP(cyclic prefix)는 다른 필드의 CP보다 큰 크기를 가질 수 있고, 이러한 CP 구간 동안 STA은 FFT 사이즈를 변화시켜 하향링크 PPDU에 대한 디코딩을 수행할 수 있다.

[302] AP(access point)가 전체 대역폭 상에서 복수의 STA(station) 각각을 위한 복수의 자원 단위 각각을 할당하고 복수의 STA 각각으로 복수의 자원 단위 각각을 통해 복수의 STA 각각에 대한 개별적인 데이터 필드(또는 프레임)을 전송할 수 있다.

복수의 STA 각각에 대한 복수의 자원 단위 각각의 할당에 대한 정보는 전술한 바와 같이 HE-SIG A(1750) 또는 HE-SIG B(1760)에 포함될 수 있다.

[303] 도 18은 본 발명의 실시예에 따른 UL MU PPDU의 전송을 나타낸 개념도이다.

[304] 도 18을 참조하면, 복수의 STA은 AP로 UL MU OFDMA를 기반으로 UL MU PPDU를 전송할 수 있다.

[305] L-STF(1800), L-LTF(1810), L-SIG(1820), HE-SIG A(1830), HE-SIG B(1840)는 도 13에서 개시된 역할을 수행할 수 있다. 시그널 필드(L-SIG(1820), HE-SIG A(1830), HE-SIG B(1840))에 포함되는 정보는 수신한 DL MU PPDU의 시그널 필드에 포함되는 정보를 기반으로 생성될 수 있다.

[306] STA1은 HE-SIG B(1840)까지는 전체 대역폭을 통해 상향링크 전송을 수행하고, HE-STF(1850) 이후부터는 할당된 대역폭을 통해 상향링크 전송을 수행할 수 있다. STA1은 할당된 대역폭(예를 들어, 자원 단위1)을 통해 상향링크 프레임을 UL MU PPDU를 기반으로 전달할 수 있다. AP는 DL MU PPDU(예를 들어, HE-SIG A/B)를 기반으로 복수의 STA 각각의 상향링크 자원을 할당할 수 있고, 복수의 STA 각각은 상향링크 자원을 할당받고 UL MU PPDU를 전송할 수 있다.

[307] 도 19는 본 발명의 실시예가 적용될 수 있는 무선 장치를 나타내는 블록도이다.

[308] 도 19를 참조하면, 무선 장치(1900)는 상술한 실시예를 구현할 수 있는 STA로서, AP(1900) 또는 비AP STA(non-AP station)(또는 STA)(1950)일 수 있다.

[309] AP(1900)는 프로세서(1910), 메모리(1920) 및 RF부(radio frequency unit, 1930)를 포함한다.

[310] RF부(1930)는 프로세서(1910)와 연결하여 무선신호를 송신/수신할 수 있다.

[311] 프로세서(1910)는 본 발명에서 제안된기능, 과정 및/또는 방법을 구현할 수 있다. 예를 들어, 프로세서(1910)는 전술한 본 발명의 실시예에 따른 AP의 동작을 수행하도록 구현될 수 있다. 프로세서는 도 1 내지 18의 실시예에서 개시한 AP의 동작을 수행할 수 있다.

[312] 예를 들어, 프로세서(1910)는 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하고, 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 복수의 STA으로 상기 PPDU를 전송하도록 구현될 수 있다.

[313] 이때, PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함할 수 있다. MU/SU 전송 지시 정보는 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함할 수 있다. 컨테이너 별 자원 할당 정보는 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고, 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위(예를 들어, 242톤의 자원 단위) 또는 복수의 제2 자원 단위(예를 들어, 26톤의 자원 단위)를 포함할 수 있다. 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 클 수 있다.

[314] PPDU는 상기 적어도 하나의 컨테이너 각각에 대한 MU OFDMA(orthogonal frequency division multiplexing)/MU MIMO(multiple input multiple output) 전송

지시 정보를 더 포함할 수 있다. MU OFDMA/MU MIMO 전송 지시 정보는 적어도 하나의 컨테이너 각각 상에서 MU OFDMA 전송이 수행되는지 여부에 대한 정보 및 MU MIMO 전송이 수행되는지 여부에 대한 정보를 포함할 수 있다.

[315] MU OFDMA/MU MIMO 전송 지시 정보가 적어도 하나의 컨테이너 중 특정 컨테이너 상에서의 MU MIMO 전송을 지시하는 경우, MU MIMO 전송은 특정 컨테이너에 포함되는 적어도 하나의 톤 유닛 상에서 수행되고, 톤 유닛은 특정 컨테이너에 포함되는 제1 자원 단위 또는 상기 복수의 제2 자원 단위를 복수개의 그룹으로 분할한 단위일 수 있다.

[316] PPDU의 전송을 위한 적어도 하나의 컨테이너 각각은 하나의 제2 자원 단위를 분할한 적어도 하나의 분할 제2 자원 단위 각각을 더 포함하고, 적어도 하나의 분할 제2 자원 단위 각각은 하나의 제2 자원 단위로 결합되어 STA으로 할당될 수 있다.

[317] STA(1950)는 프로세서(1960), 메모리(1970) 및 RF부(radio frequency unit, 1980)를 포함한다.

[318] RF부(1980)는 프로세서(1960)와 연결하여 무선신호를 송신/수신할 수 있다.

[319] 프로세서(1960)는 본 발명에서 제안된 기능, 과정 및/또는 방법을 구현할 수 있다. 예를 들어, 프로세서(1960)는 전술한 본 발명의 실시예에 따른 STA의 동작을 수행하도록 구현될 수 있다. 프로세서는 도 1 내지 18의 실시예에서 STA의 동작을 수행할 수 있다.

[320] 예를 들어, 프로세서(1960)는 AP로부터 수신한 PPDU에 포함되는 MU/SU 전송 지시 정보, 컨테이너 별 자원 할당 정보, MU OFDMA/MU MIMO 전송 지시 정보를 기반으로 자원 할당을 받고, 할당받은 자원 상에서 하향링크 데이터를 수신하거나 상향링크 데이터를 전송할 수 있다.

[321] 프로세서(1910, 1960)는 ASIC(application-specific integrated circuit), 다른 칩셋, 논리 회로, 데이터 처리 장치 및/또는 베이스밴드 신호 및 무선 신호를 상호 변환하는 변환기를 포함할 수 있다.메모리(1920, 1970)는 ROM(read-only memory), RAM(random access memory), 플래쉬 메모리, 메모리 카드, 저장 매체 및/또는 다른 저장 장치를 포함할 수 있다. RF부(1930, 1980)는 무선 신호를 전송 및/또는 수신하는 하나 이상의 안테나를 포함할 수 있다.

[322] 실시예가 소프트웨어로 구현될 때, 상술한 기법은 상술한 기능을 수행하는 모듈(과정, 기능 등)로 구현될 수 있다. 모듈은 메모리(1920, 1970)에 저장되고, 프로세서(1910, 1960)에 의해 실행될 수 있다. 메모리(1920, 1970)는 프로세서(1910, 1960) 내부 또는 외부에 있을 수 있고, 잘 알려진 다양한 수단으로 프로세서(1910, 1960)와 연결될 수 있다.

청구범위

[청구항 1] 무선랜에서 자원 단위를 할당하는 방법은,
AP(access point)가 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하는 단계; 및
상기 AP가 전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하는 단계를 포함하되,
상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고,
상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고,
상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고,
상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고,
상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 큰 것을 특징으로 하는 방법.

[청구항 2] 제1항에 있어서,
상기 PPDU는 상기 적어도 하나의 컨테이너 각각에 대한 MU OFDMA(orthogonal frequency division multiplexing)/MU MIMO(multiple input multiple output) 전송 지시 정보를 더 포함하고,
상기 MU OFDMA/MU MIMO 전송 지시 정보는 상기 적어도 하나의 컨테이너 각각 상에서 MU OFDMA 전송이 수행되는지 여부에 대한 정보 및 MU MIMO 전송이 수행되는지 여부에 대한 정보를 포함하는 것을 특징으로 하는 방법.

[청구항 3] 제2항에 있어서,
상기 MU OFDMA/MU MIMO 전송 지시 정보가 상기 적어도 하나의 컨테이너 중 특정 컨테이너 상에서의 상기 MU MIMO 전송을 지시하는 경우,
상기 MU MIMO 전송은 상기 특정 컨테이너에 포함되는 적어도 하나의 톤 유닛 상에서 수행되고,
상기 톤 유닛은 상기 특정 컨테이너에 포함되는 상기 제1 자원 단위 또는 상기 복수의 제2 자원 단위를 복수개의 그룹으로 분할한 단위인 것을 특징으로 하는 방법.

[청구항 4] 제1항에 있어서,

상기 적어도 하나의 컨테이너의 개수는 상기 전체 대역폭의 크기가 증가함에 따라 증가하고,
상기 적어도 하나의 컨테이너 각각에 할당 가능한 STA의 개수는 상기 전체 대역폭의 크기에 따라 제한되는 것을 특징으로 하는 방법.

[청구항 5] 제1항에 있어서,
상기 적어도 하나의 컨테이너 각각은 하나의 제2 자원 단위를 분할한 적어도 하나의 분할 제2 자원 단위 각각을 더 포함하고,
상기 적어도 하나의 분할 제2 자원 단위 각각은 하나의 제2 자원 단위로 결합되어 상기 복수의 STA으로 할당되는 것을 특징으로 하는 방법.

[청구항 6] 무선랜에서 자원 단위를 할당하는 AP(access point)에 있어서, 상기 AP는,
무선 신호를 송신 및 수신하는 RF(radio frequency) 부; 및
상기 RF 부와 동작 가능하게(operatively) 결합된 프로세서를 포함하되,
상기 프로세서는 복수의 STA(station)으로 전송할 PPDU(PHY layer protocol data unit)를 생성하고,
전체 주파수 대역 상에 할당된 적어도 하나의 컨테이너를 통해 상기 복수의 STA으로 상기 PPDU를 전송하도록 구현되되,
상기 PPDU는 MU(multiple user)/SU(single user) 전송 지시 정보, 컨테이너 별 자원 할당 정보를 포함하고,
상기 MU/SU 전송 지시 정보는 상기 전체 대역폭 상에서 SU 기반 전송 또는 MU 기반 전송이 수행되는지 여부에 대한 정보를 포함하고,
상기 컨테이너 별 자원 할당 정보는 상기 적어도 하나의 컨테이너 각각에 할당된 STA의 개수에 대한 정보를 포함하고,
상기 적어도 하나의 컨테이너 각각은 하나의 제1 자원 단위 또는 복수의 제2 자원 단위를 포함하고,
상기 제1 자원 단위에 대응되는 톤의 개수는 상기 제2 자원 단위에 대응되는 톤의 개수보다 큰 것을 특징으로 하는 AP.

[청구항 7] 제6항에 있어서,
상기 PPDU는 상기 적어도 하나의 컨테이너 각각에 대한 MU OFDMA(orthogonal frequency division multiplexing)/MU MIMO(multiple input multiple output) 전송 지시 정보를 더 포함하고,
상기 MU OFDMA/MU MIMO 전송 지시 정보는 상기 적어도 하나의 컨테이너 각각 상에서 MU OFDMA 전송이 수행되는지

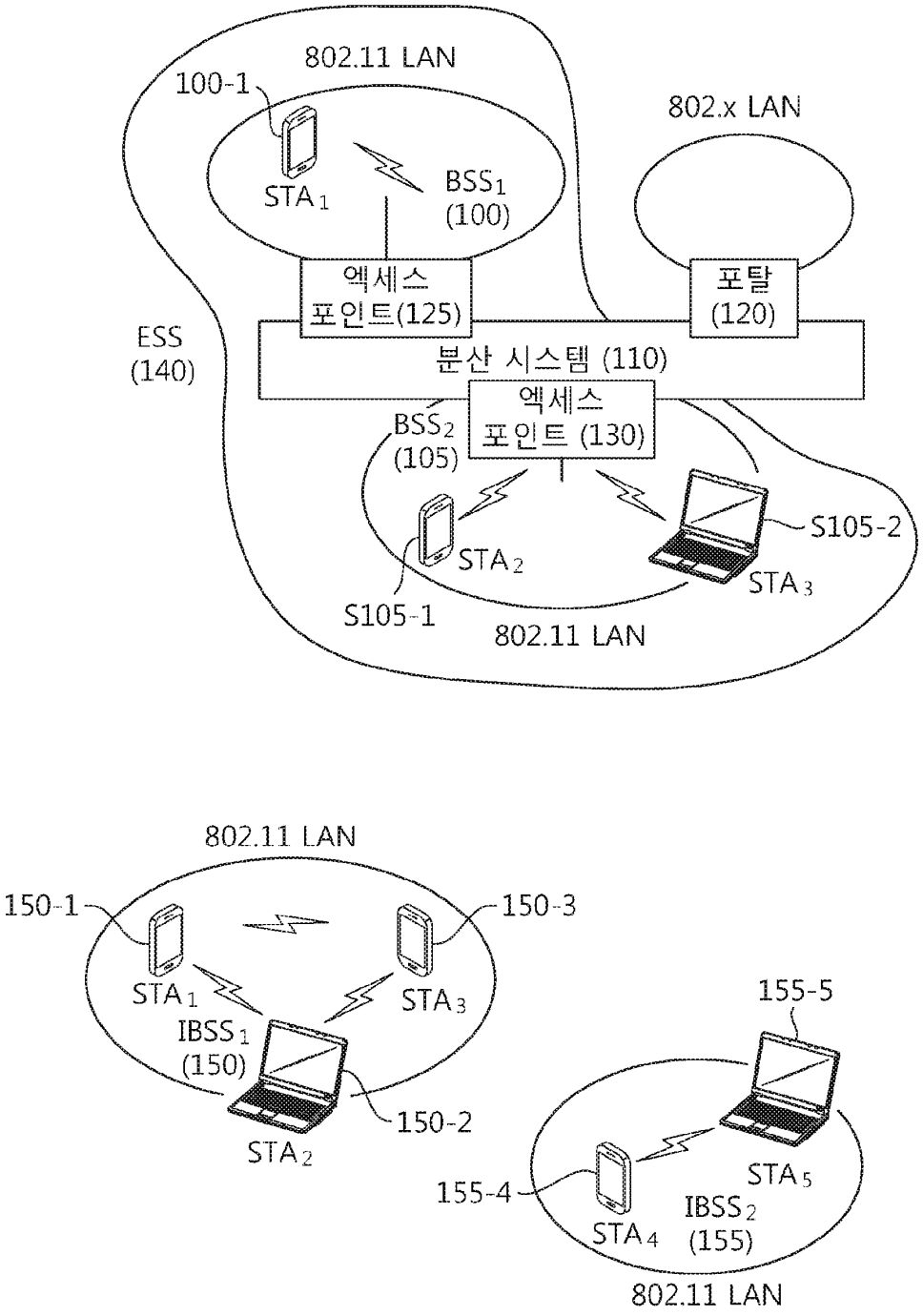
여부에 대한 정보 및 MU MIMO 전송이 수행되는지 여부에 대한 정보를 포함하는 것을 특징으로 하는 AP.

[청구항 8] 제7항에 있어서,
상기 MU OFDMA/MU MIMO 전송 지시 정보가 상기 적어도 하나의 컨테이너 중 특정 컨테이너 상에서의 상기 MU MIMO 전송을 지시하는 경우,
상기 MU MIMO 전송은 상기 특정 컨테이너에 포함되는 적어도 하나의 톤 유닛 상에서 수행되고,
상기 톤 유닛은 상기 특정 컨테이너에 포함되는 상기 제1 자원 단위 또는 상기 복수의 제2 자원 단위를 복수개의 그룹으로 분할한 단위인 것을 특징으로 하는 AP.

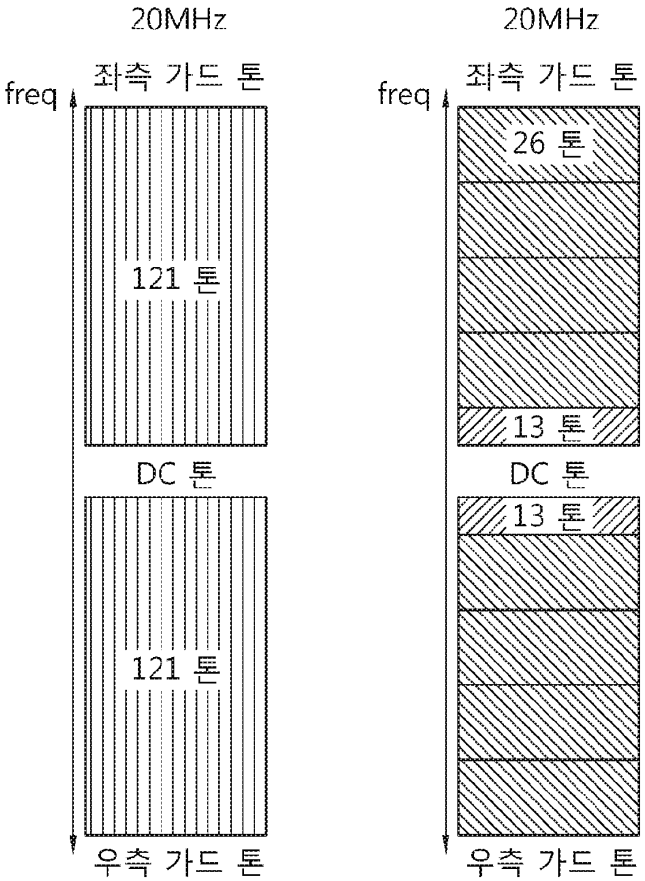
[청구항 9] 제6항에 있어서,
상기 적어도 하나의 컨테이너의 개수는 상기 전체 대역폭의 크기가 증가함에 따라 증가하고,
상기 적어도 하나의 컨테이너 각각에 할당 가능한 STA의 개수는 상기 전체 대역폭의 크기에 따라 제한되는 것을 특징으로 하는 AP.

[청구항 10] 제6항에 있어서,
상기 적어도 하나의 컨테이너 각각은 하나의 제2 자원 단위를 분할한 적어도 하나의 분할 제2 자원 단위 각각을 더 포함하고,
상기 적어도 하나의 분할 제2 자원 단위 각각은 하나의 제2 자원 단위로 결합되어 상기 복수의 STA으로 할당되는 것을 특징으로 하는 AP.

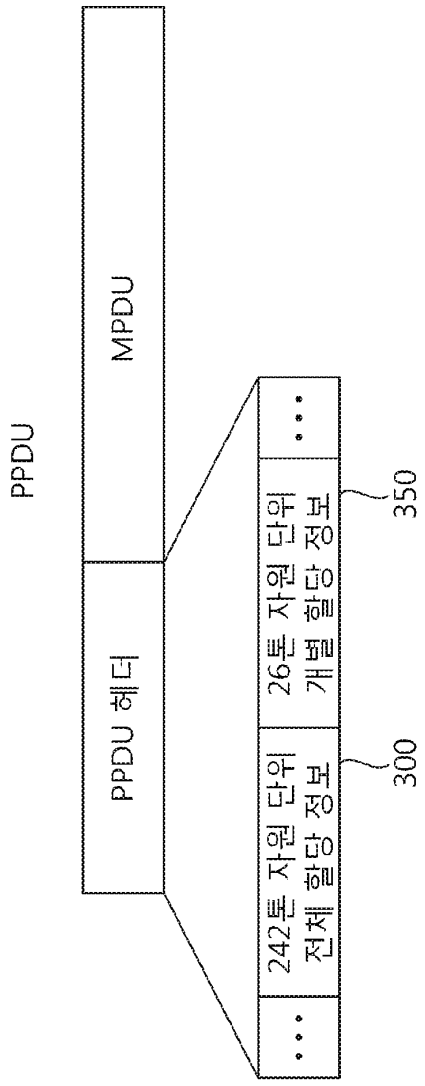
[도1]


802.11 LAN
100-1
802.x LAN
STA1
BSS1
(100)
엑세스
포인트(125)
포탈
(120)
ESS
(140)
분산 시스템 (110)
엑세스
포인트 (130)
BSS2
(105)
S105-2
STA2
STA3
S105-1
802.11 LAN
802.11 LAN
150-1
150-3
STA1
STA3
IBSS1
(150)
150-2
STA2
155-5
155-4
STA5
IBSS2
(155)
STA4
802.11 LAN

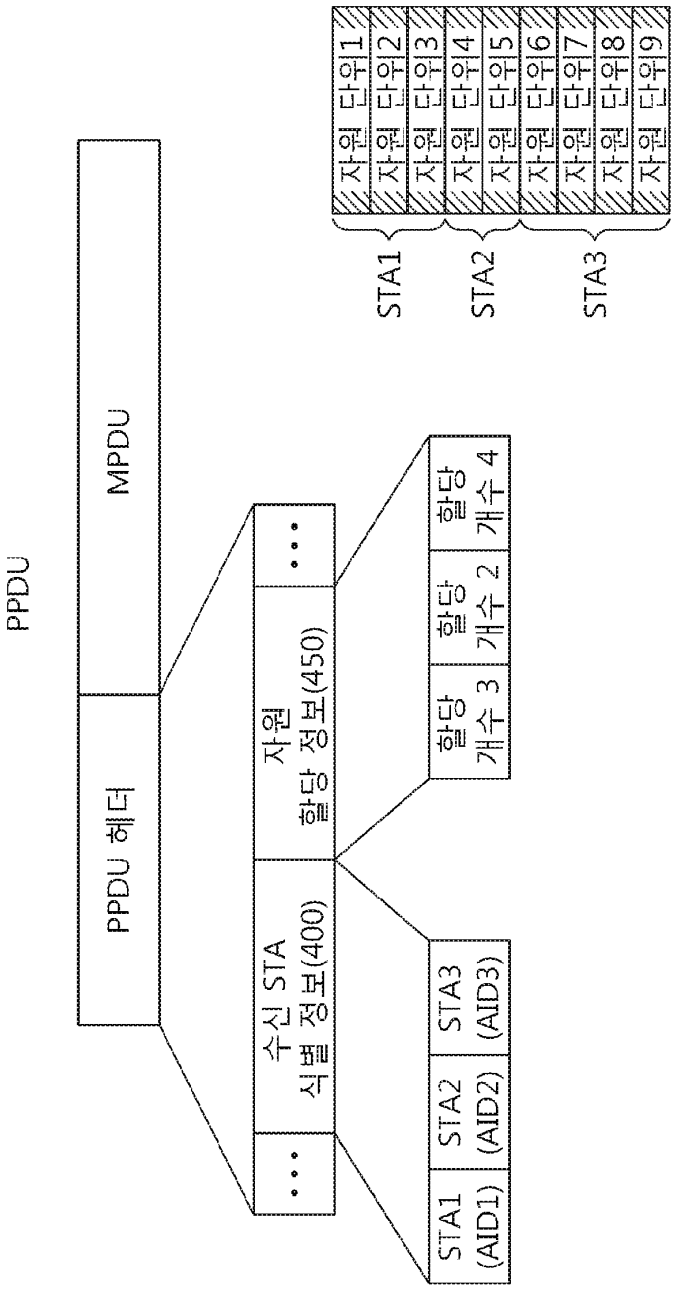
[도2]


20MHz
좌측 가드 톤
freq
121 톤
DC 톤
121 톤
우측 가드 톤
20MHz
좌측 가드 톤
freq
26 톤
13 톤
DC 톤
13 톤
우측 가드 톤

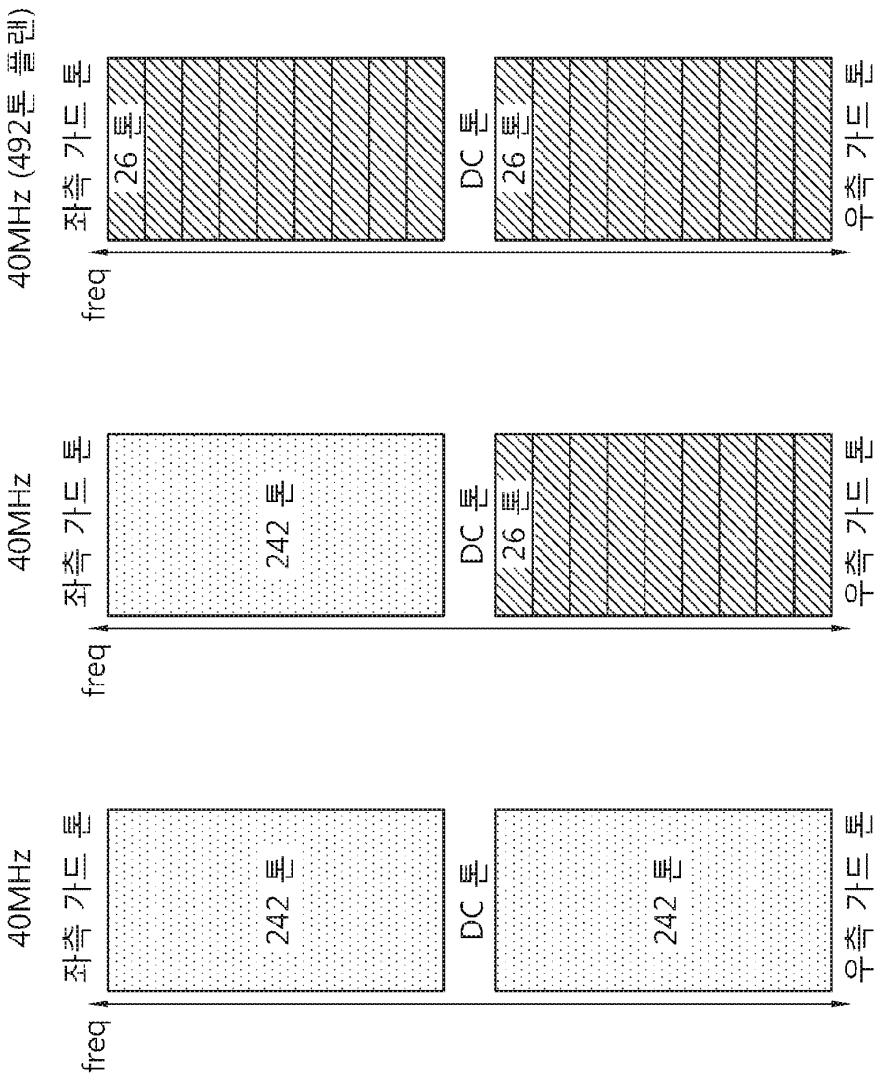
[도3]



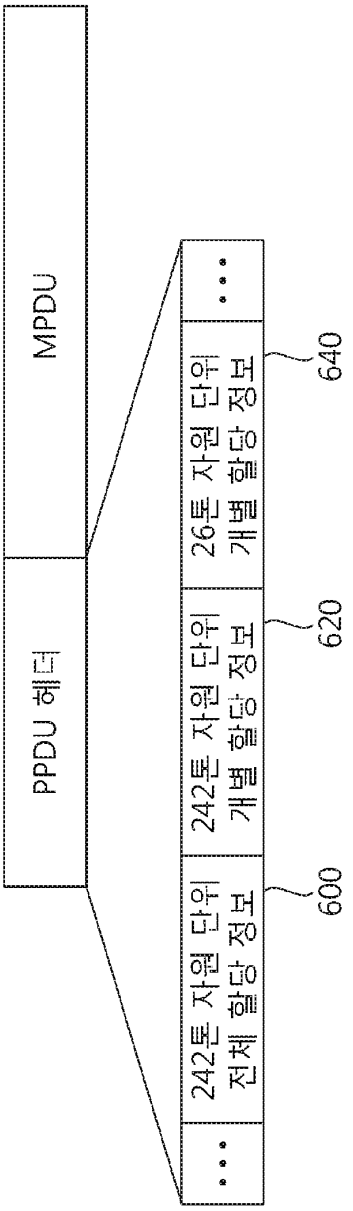
[도4]


PPDU
PPDU 헤더
MPDU
수신 STA 식별 정보(400)
자원 할당 정보(450)
...
...
STA1 (AID1)
STA2 (AID2)
STA3 (AID3)
할당 개수 3
할당 개수 2
할당 개수 4
자원 단위1
자원 단위2
자원 단위3
자원 단위4
자원 단위5
자원 단위6
자원 단위7
자원 단위8
자원 단위9
STA1
STA2
STA3

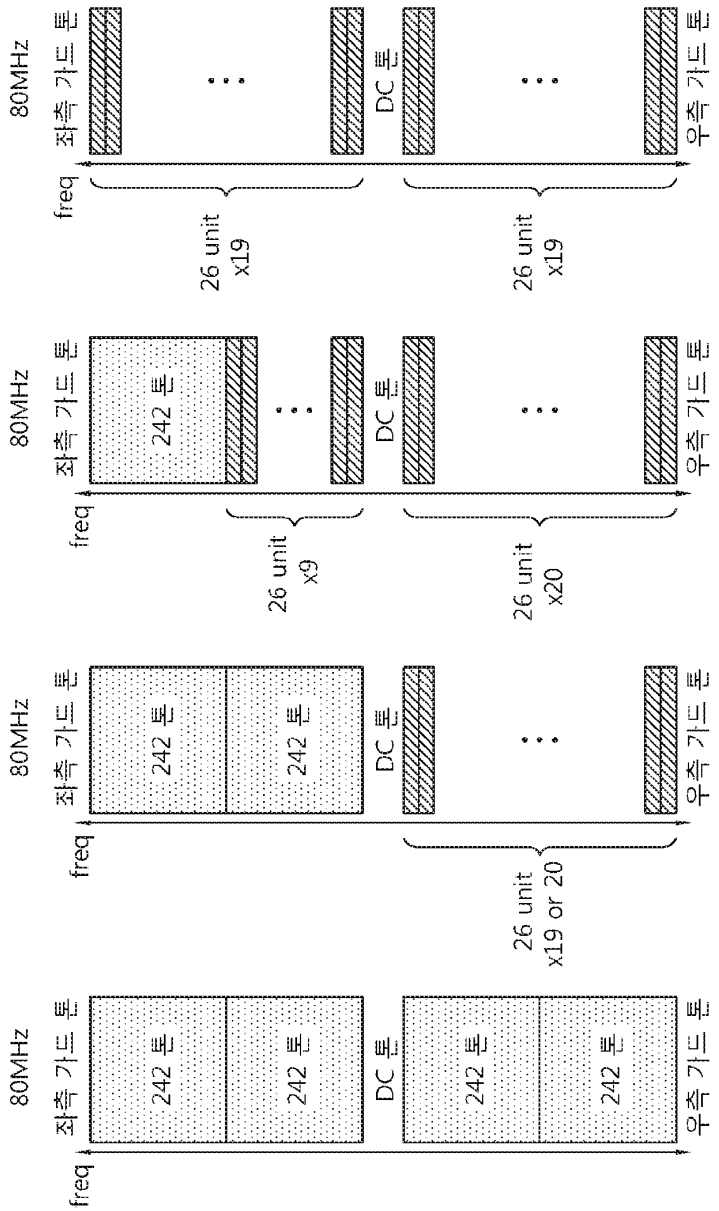
[도5]


40MHz (492톤 플랜)
좌측 가드 톤
26 톤
DC 톤
26 톤
우측 가드 톤
freq
40MHz
좌측 가드 톤
242 톤
DC 톤
26 톤
우측 가드 톤
freq
40MHz
좌측 가드 톤
242 톤
DC 톤
242 톤
우측 가드 톤
freq

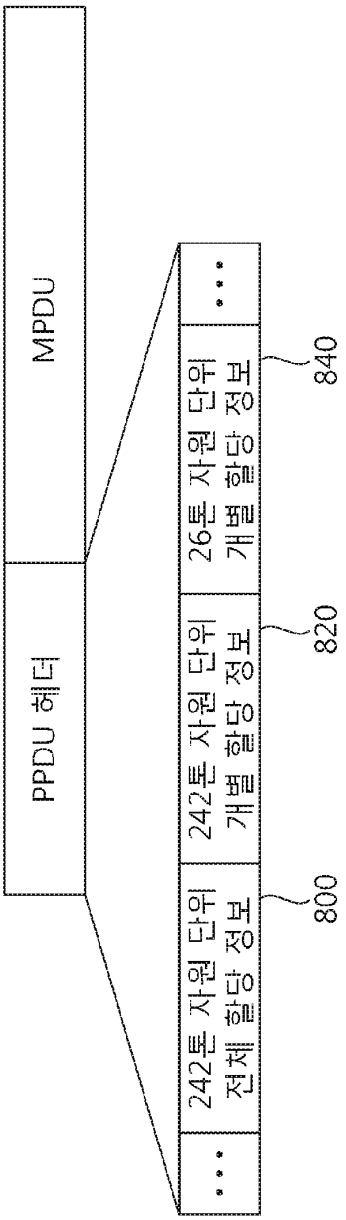
[도6]


PPDU 헤더
MPDU
242톤 자원 단위 전체 할당 정보
242톤 자원 단위 개별 할당 정보
26톤 자원 단위 개별 할당 정보
...
...
600
620
640

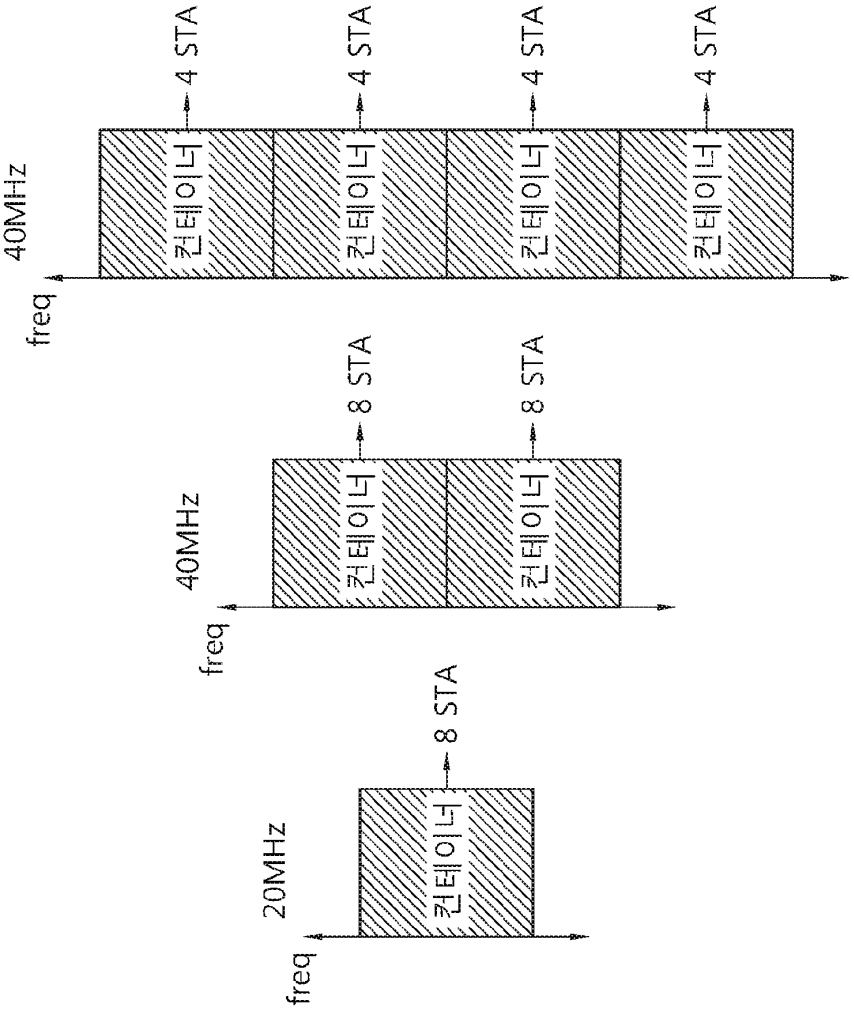
[도7]


80MHz
좌측 가드 톤
242 톤
242 톤
DC 톤
242 톤
242 톤
우측 가드 톤
freq
26 unit
x19
26 unit
x19
80MHz
좌측 가드 톤
242 톤
DC 톤
우측 가드 톤
freq
26 unit
x9
26 unit
x20
80MHz
좌측 가드 톤
242 톤
242 톤
DC 톤
우측 가드 톤
freq
26 unit
x19 or 20
80MHz
좌측 가드 톤
242 톤
242 톤
DC 톤
242 톤
242 톤
우측 가드 톤
freq

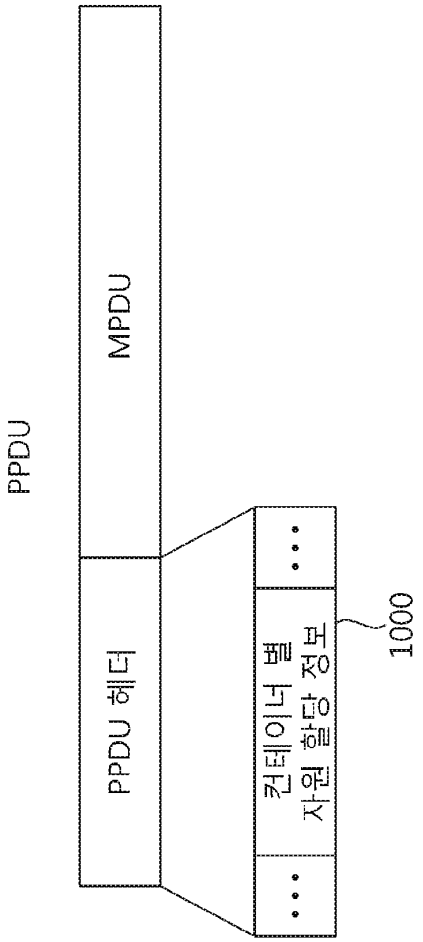
[도8]


PPDU 헤더
MPDU
242톤 자원 단위 전체 할당 정보
242톤 자원 단위 개별 할당 정보
26톤 자원 단위 개별 할당 정보
...
...
800
820
840

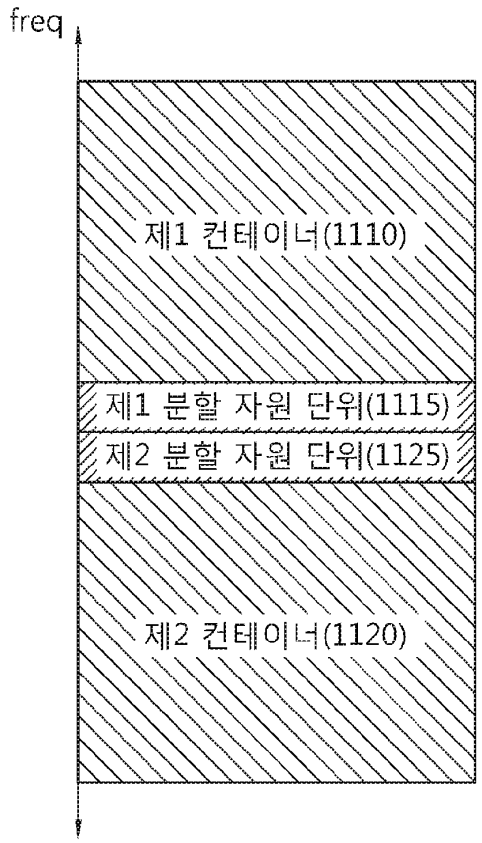
[도9]


4 STA
4 STA
4 STA
4 STA
컨테이너
컨테이너
컨테이너
컨테이너
40MHz
freq
8 STA
8 STA
컨테이너
컨테이너
40MHz
freq
8 STA
컨테이너
20MHz
freq

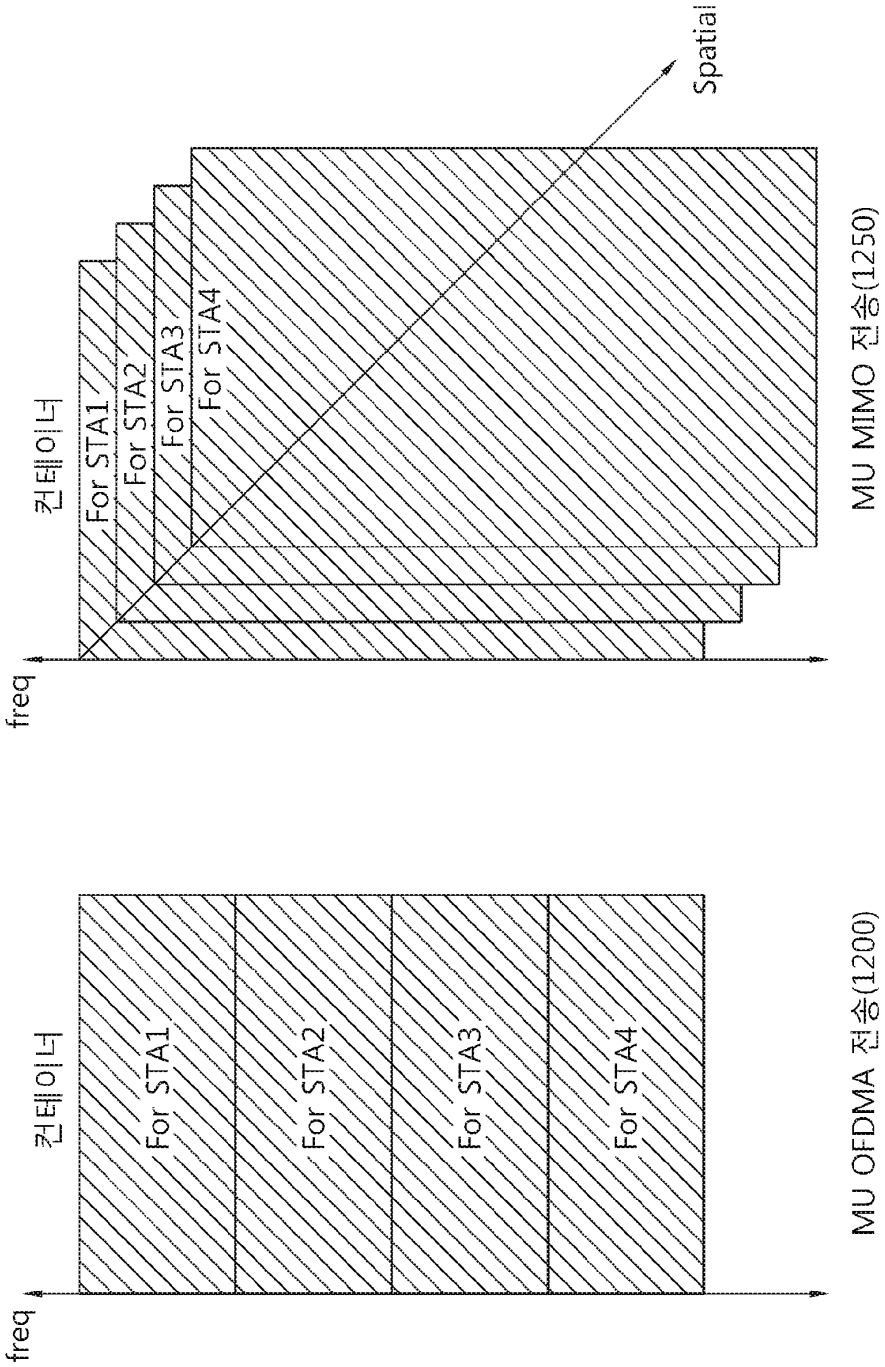
[도10]



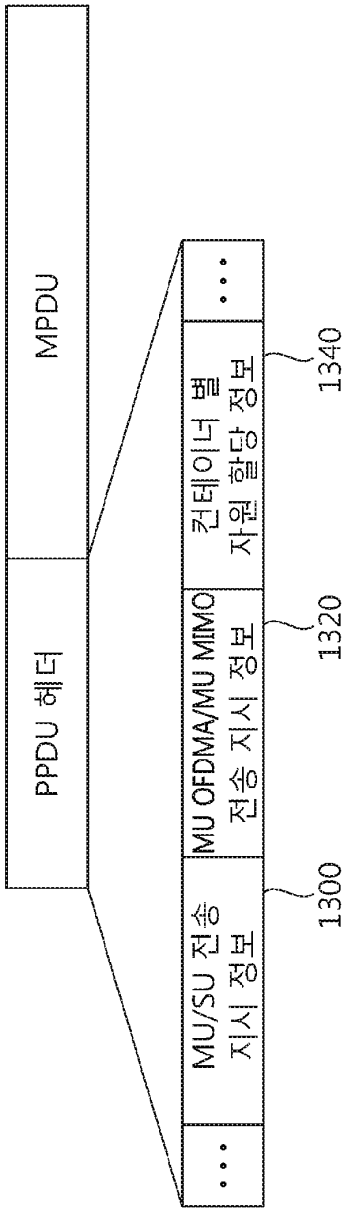
[도11]



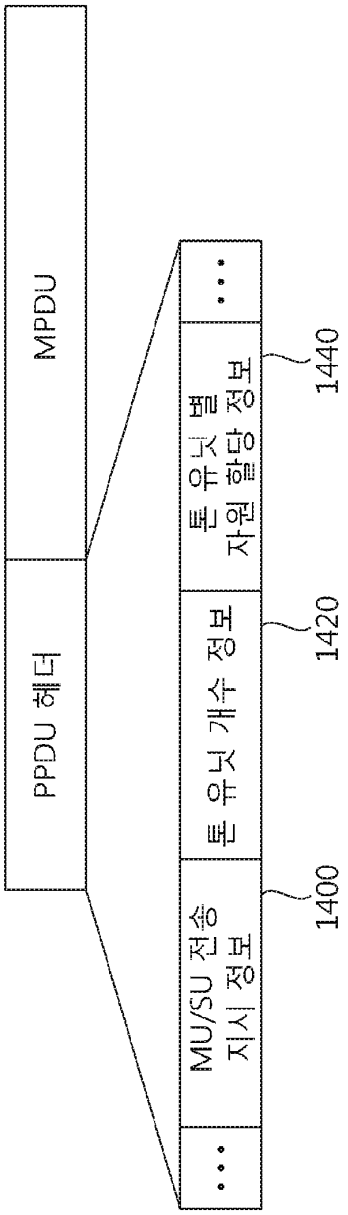
[도12]


Spatial
컨테이너
For STA1
For STA2
For STA3
For STA4
freq
MU MIMO 전송(1250)
컨테이너
For STA1
For STA2
For STA3
For STA4
freq
MU OFDMA 전송(1200)

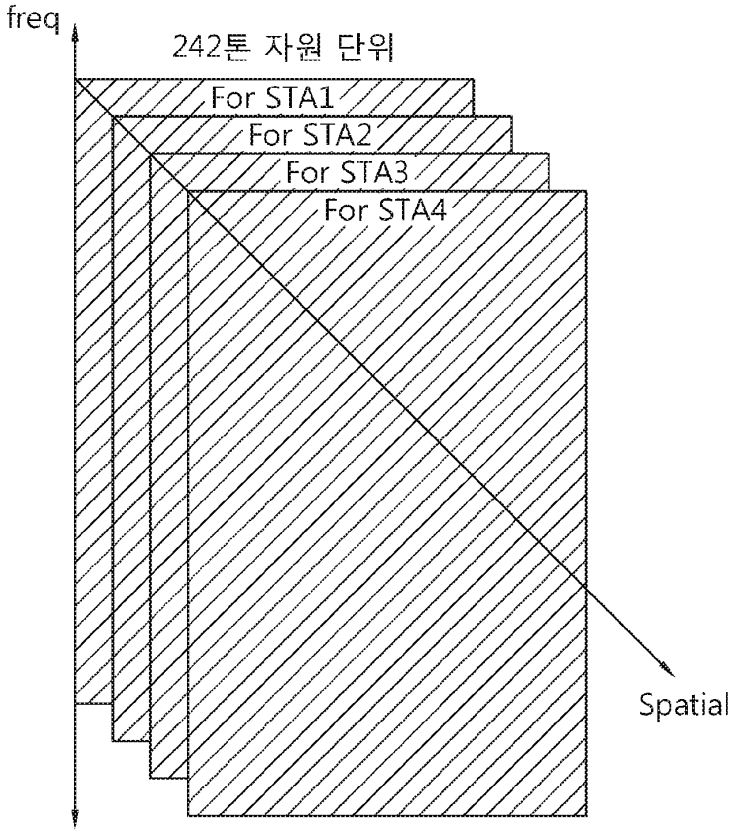
[도13]


PPDU 헤더
MPDU
MU/SU 전송 지시 정보
MU OFDMA/MU MIMO 전송 지시 정보
컨테이너 별 자원 할당 정보
...
1300
1320
1340

[도14]

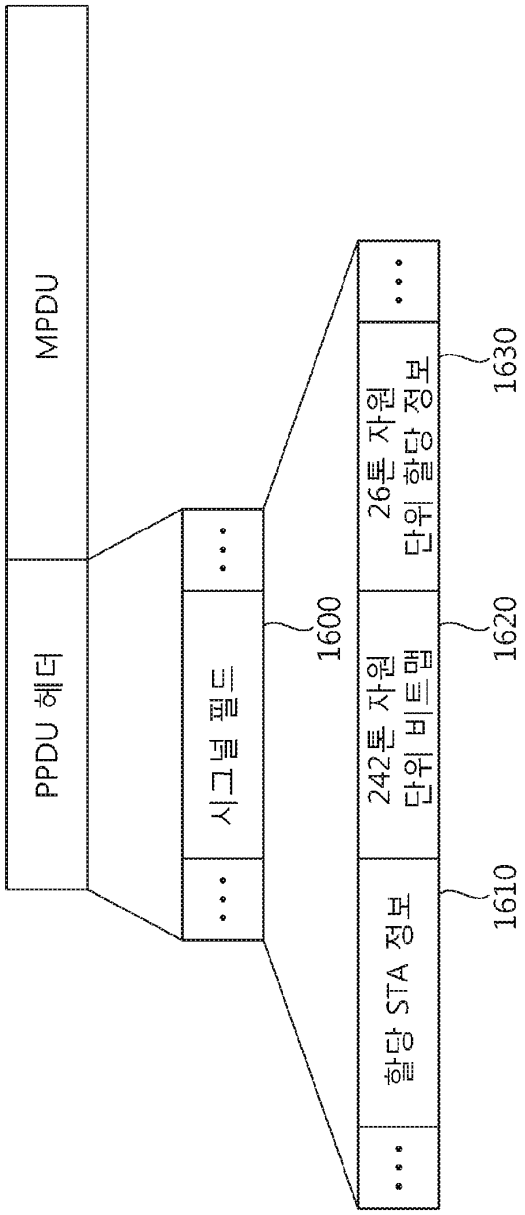


[도15]

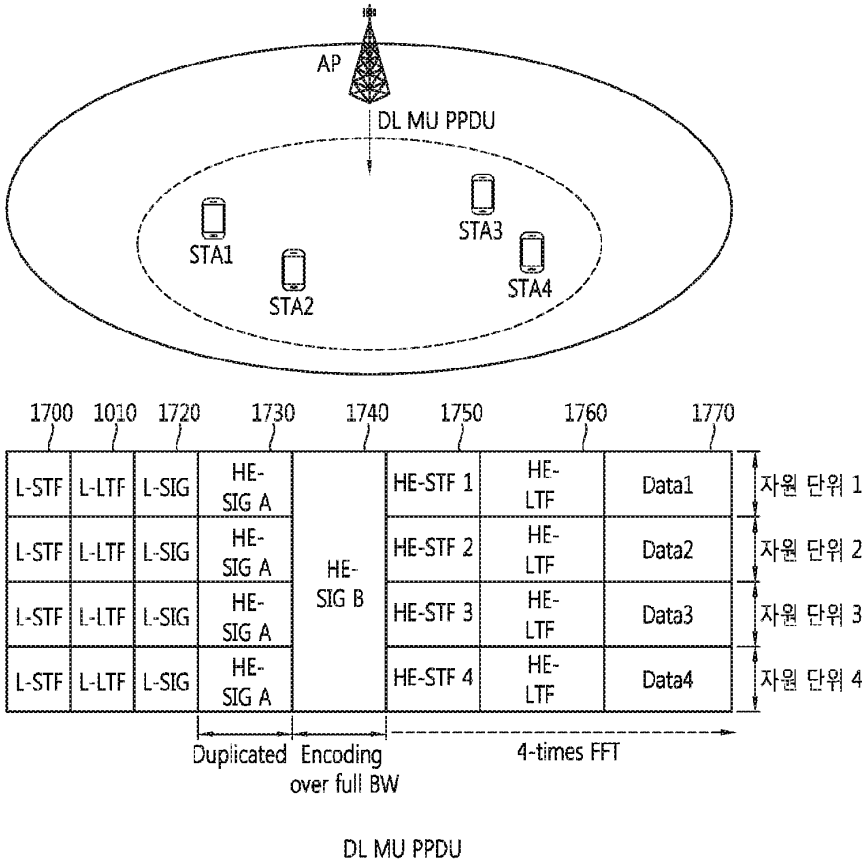


MU MIMO 전송
최대 4개의 STA 지원

[도16]

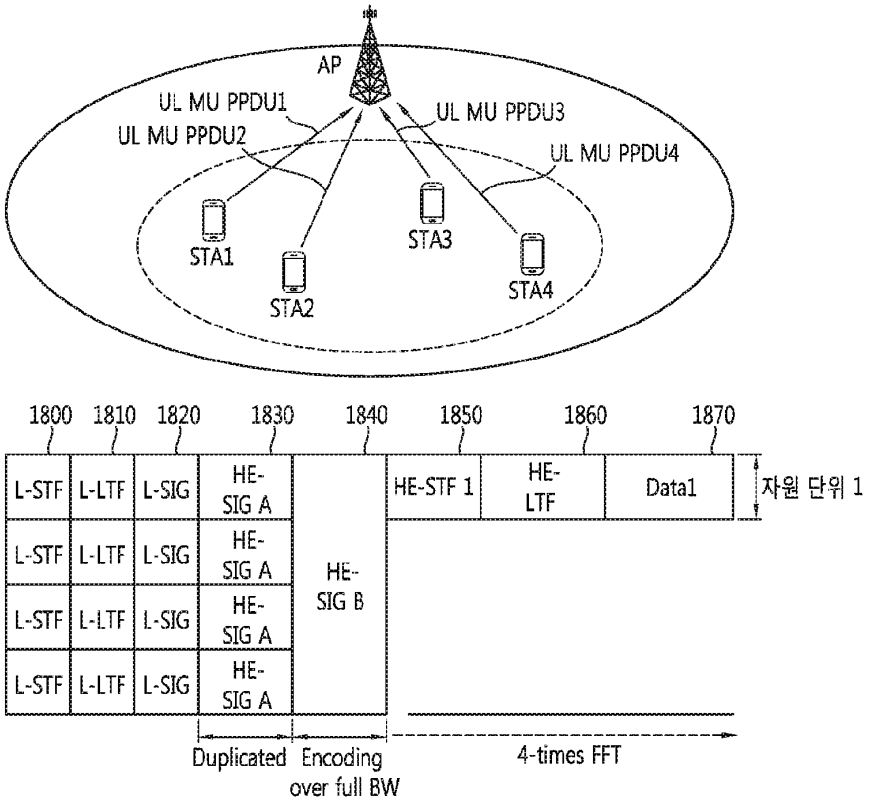

MPDU
PPDU 헤더
시그널 필드
...
...
1600
할당 STA 정보
242톤 자원 단위 비트맵
26톤 자원 단위 할당 정보
...
1610
1620
1630

[도17]

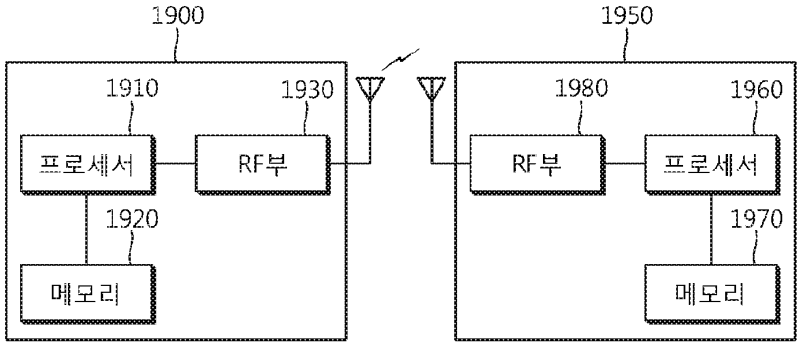


DL MU PPDU

[도18]


AP
UL MU PPDU1
UL MU PPDU2
UL MU PPDU3
UL MU PPDU4
STA1
STA2
STA3
STA4
1800
1810
1820
1830
1840
1850
1860
1870
L-STF
L-LTF
L-SIG
HE-SIG A
HE-SIG B
HE-STF 1
HE-LTF
Data1
자원 단위 1
Duplicated
Encoding over full BW
4-times FFT
UL MU PPDU1

[도19]


1900
1910
1930
프로세서
RF부
1920
메모리
1950
1980
1960
RF부
프로세서
1970
메모리

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/011855

A. CLASSIFICATION OF SUBJECT MATTER

H04L 5/00(2006.01)i, H04W 72/04(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L 5/00; H04L 1/06; H04W 72/04; H04W 84/02; H04B 7/04; H04W 84/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: WLAN, resource unit, allocation, PPDU, container, resource allocation information, MU/SU transmission indication information, the number of STAs, the number of tones

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012-0327871 A1 (GHOSH, Monisha et al.) 27 December 2012 See paragraphs [0068]-[0080]; and figures 3A-4C.	1-10
A	KR 10-2012-0095434 A (LG ELECTRONICS INC.) 28 August 2012 See paragraphs [0063]-[0076]; and figure 3.	1-10
A	US 2013-0148644 A1 (FUTUREWEI TECHNOLOGIES, INC.) 13 June 2013 See paragraphs [0028]-[0035]; and figures 2a-3b.	1-10
A	US 2011-0002319 A1 (HUSEN, Sri Andari et al.) 06 January 2011 See paragraphs [0029]-[0043]; and figures 2-4.	1-10
A	NEWRACOM, "HEW PPDU Format for Supporting MIMO-OFDMA", IEEE 802.11-14/1210r1, 16 September 2014 See pages 2-15.	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 FEBRUARY 2016 (18.02.2016)	**18 FEBRUARY 2016 (18.02.2016)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

Patent document cited in search report	Publication date	Patent family member	Publication date
US 2012-0327871 A1	27/12/2012	EP 2724488 A1	30/04/2014
		KR 10-2014-0053128 A	07/05/2014
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		WO 2011-031058 A2	17/03/2011
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		EP 2777236 A1	17/09/2014
		EP 2777236 A4	24/12/2014
		US 2015-271704 A1	24/09/2015
		US 9071489 B2	30/06/2015
		WO 2013-083083 A1	13/06/2013
US 2011-0002319 A1	06/01/2011	CN 101960899 A	26/01/2011
		EP 2263407 A1	22/12/2010
		JP 2011-515051 A	12/05/2011
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		KR 10-2010-0127248 A	03/12/2010
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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

국제조사보고서

국제출원번호
PCT/KR2015/011855

A. 발명이 속하는 기술분류(국제특허분류(IPC))

H04L 5/00(2006.01)i, H04W 72/04(2009.01)i

B. 조사된 분야

조사된 최소문헌(국제특허분류를 기재)

H04L 5/00; H04L 1/06; H04W 72/04; H04W 84/02; H04B 7/04; H04W 84/12

조사된 기술분야에 속하는 최소문헌 이외의 문헌

한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))

eKOMPASS(특허청 내부 검색시스템) & 키워드: WLAN, 자원 단위, 할당, PPDU, 컨테이너, 자원 할당 정보, MU/SU 전송 지시 정보, STA 개수, 톤의 개수

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
A	US 2012-0327871 A1 (MONISHA GHOSH 등) 2012.12.27 단락 [0068]-[0080]; 및 도면 3A-4C 참조.	1-10
A	KR 10-2012-0095434 A (엘지전자 주식회사) 2012.08.28 단락 [0063]-[0076]; 및 도면 3 참조.	1-10
A	US 2013-0148644 A1 (FUTUREWEI TECHNOLOGIES, INC.) 2013.06.13 단락 [0028]-[0035]; 및 도면 2a-3b 참조.	1-10
A	US 2011-0002319 A1 (SRI ANDARI HUSEN 등) 2011.01.06 단락 [0029]-[0043]; 및 도면 2-4 참조.	1-10
A	NEWRACOM, `HEW PPDU Format for Supporting MIMO-OFDMA`, IEEE 802.11-14/1210r1, 2014.09.16 페이지 2 15 참조.	1-10

☐ 추가 문헌이 C(계속)에 기재되어 있습니다.

☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2016년 02월 18일 (18.02.2016)	2016년 02월 18일 (18.02.2016)

ISA/KR의 명칭 및 우편주소
대한민국 특허청
(35208) 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사)
팩스 번호 +82-42-472-7140

심사관
강희곡
전화번호 +82-42-481-8264

서식 PCT/ISA/210 (두 번째 용지) (2015년 1월)

국제조사보고서
대응특허에 관한 정보

국제출원번호
PCT/KR2015/011855

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
US 2012-0327871 A1	2012/12/27	EP 2724488 A1	2014/04/30
		KR 10-2014-0053128 A	2014/05/07
		TW 201308960 A	2013/02/16
		WO 2012-177993 A1	2012/12/27
KR 10-2012-0095434 A	2012/08/28	AU 2010-293217 B2	2014/08/07
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		CN 102484522 A	2012/05/30
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		EP 2476212 A2	2012/07/18
		JP 2013-504248 A	2013/02/04
		JP 2014-195256A	2014/10/09
		JP 5529969 B2	2014/06/25
		JP 5834105 B2	2015/12/16
		KR 10-1317570 B1	2013/10/11
		KR 10-2011-0027533 A	2011/03/16
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		US 2014-0140311 A1	2014/05/22
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		US 9065502 B2	2015/06/23
		WO 2011-031058 A2	2011/03/17
		WO 2011-031058 A3	2011/07/14
		WO 2011-099765 A2	2011/08/18
		WO 2011-099765 A3	2011/12/29
US 2013-0148644 A1	2013/06/13	CN 103931153 A	2014/07/16
		EP 2777236 A1	2014/09/17
		EP 2777236 A4	2014/12/24
		US 2015-271704 A1	2015/09/24
		US 9071489 B2	2015/06/30
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US 2011-0002319 A1	2011/01/06	CN 101960899 A	2011/01/26
		EP 2263407 A1	2010/12/22
		JP 2011-515051 A	2011/05/12
		JP 5503561 B2	2014/05/28
		KR 10-2010-0127248 A	2010/12/03
		TW 201006284 A	2010/02/01
		WO 2009-109894 A1	2009/09/11

Samsung Exhibit 1006, Page 355 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Electronic Acknowledgement Receipt

EFS ID:	31366597
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	29-DEC-2017
Filing Date:	10-AUG-2017
Time Stamp:	13:34:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	1426-148-101--IDSasFiled12292017.pdf	57328 a5303e1f2c60fb418a780b71c3489d8bf181fa03	no	2

Warnings:

Information:					
This is not an USPTO supplied IDS fillable form					
2	Foreign Reference	FOR-WO2010138921.pdf	7296225 40d7eea76837dbc6b3ef0230790606b2952e9321	no	65
Warnings:					
Information:					
3	Foreign Reference	FOR-WO2016072766.pdf	8423359 4e4af751c5661c1af1a535df3de6b570efb91b25	no	65
Warnings:					
Information:					
4	Non Patent Literature	NPL-R2-163923.pdf	806931 b83187738f647dcb28c976578295825d46dfa3e9	no	4
Warnings:					
Information:					
5	Non Patent Literature	NPL-EPsearchreport.pdf	1575795 244b4d5a4e3223bc048dd73132f0f338c664a081	no	8
Warnings:					
Information:					
		Total Files Size (in bytes):	18159638		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/674,483	08/10/2017		1600	1426-148.101	20	3

CONFIRMATION NO. 7684

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

FILING RECEIPT

OC000000093540393

Date Mailed: 08/21/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Ko-Chiang Lin, Taipei City, TAIWAN;
Ming-Che Li, Taipei City, TAIWAN;

Applicant(s)

ASUSTek Computer Inc., Taipei City 112, TAIWAN;

Power of Attorney: The patent practitioners associated with Customer Number 106622

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/374,354 08/12/2016

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 08/17/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/674,483**

Projected Publication Date: 02/15/2018

Non-Publication Request: No

Early Publication Request: No

Title

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/674,483

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	1426-148.101
First Named Inventor	Ko-Chiang Lin
Title	Method and Apparatus for Determining Numerology Bandwidth...
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

1. [✓] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [ ] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✓] **Specification** [*Total Pages* 91] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✓] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 39]
6. **Inventor's Oath or Declaration** [*Total Pages* 2] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [✓] Newly executed (original or copy)
   b. [ ] A copy from a prior application (37 CFR 1.63(d))
7. [✓] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
   b. [ ] Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee _____
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [✓] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [ ] **Other:** _____

***Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[✓] The address associated with Customer Number: 106622 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Sang N. Dang/	Date	August 10, 2017
Name (Print/Type)	Sang N. Dang	Registration No. (Attorney/Agent)	51,186

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Filer:	Sang N. Dang/Sandy Kim
Attorney Docket Number:	1426-148.101

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1600**

Electronic Acknowledgement Receipt	
EFS ID:	30044410
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	10-AUG-2017
Filing Date:	
Time Stamp:	21:22:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1600
RAM confirmation Number	081117INTEFSW21225900
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	WebADS.pdf	126214 21aaf1c812066b3dae166b84e4bfb67841bf0a5a	no	8
Warnings:					
Information:					
2		1426-148-101--PackageAsFiled.pdf	2262308 a46d5509a871c28874cef1086ad2479d7b83fba3	yes	137

Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	137	137
Power of Attorney	135	136
Oath or Declaration filed	133	134
Drawings-only black and white line drawings	94	132
Abstract	93	93
Claims	90	92
Specification	3	89
Fee Worksheet (SB06)	2	2
Transmittal of New Application	1	1

Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	34986 41e0fd694afa330d65048e976767c94f477463f1	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	2423508

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ko-Chiang		Lin	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Taipei City	Country of Residence i	TW

Mailing Address of Inventor:

Address 1	No. 15, Lite Rd. Peitou District		
Address 2			
City	Taipei City 112	State/Province	OT
Postal Code		Country i	TW

Inventor 2

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ming-Che		Li	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Taipei City	Country of Residence i	TW

Mailing Address of Inventor:

Address 1	No. 15, Lite Rd., Peitou District		
Address 2			
City	Taipei City 112	State/Province	OT
Postal Code		Country i	TW

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	106622		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM		
Attorney Docket Number	1426-148.101	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	39	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

Please Select One:	(•) Customer Number	( ) US Patent Practitioner	( ) Limited Recognition (37 CFR 11.9)
Customer Number	106622		

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					
Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Claims benefit of provisional	62/374354	2016-08-12

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Approved for use through 04/30/2017. OMB 0651-0032
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (08-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	

If the Applicant is an Organization check here. ☒

Organization Name	ASUSTek Computer Inc.		
Mailing Address Information For Applicant:			
Address 1	No. 15, Lite Rd., Peitou District		
Address 2			
City	Taipei City 112	**State/Province**	OT
Country[i]	TW	Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (08-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-148.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e. g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Sang N. Dang/			Date (YYYY-MM-DD)	
First Name	Sang N.	Last Name	Dang	Registration Number	51186

Additional Signature may be generated within this form by selecting the Add button.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ko-Chiang Lin and Ming-Che Li	
Title:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	TBD	Filed: Herewith
Examiner:	TBD	Group Art Unit: TBD
Attorney Docket No.:	1426-148.101 (1050198-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 1 Page Utility Transmittal Sheet; 1 Page Fee Transmittal; 8 Page Application Data Sheet Web-ADS; 91 Page Specification; 39 Page Drawings; 2 Page executed Declaration; and 2 Page Power of Attorney are being transmitted to the United States Patent and Trademark Office via EFS-Web on August 10, 2017.

Date: August 10, 2017 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Not Yet Assigned
Filing Date	Herewith
First Named Inventor	Ko-Chiang Lin
Title	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	1426-148.101

SIGNATURE of Applicant or Patent Practitioner

Signature	/Sang N. Dang/	Date (Optional)	August 10, 2017
Name	Sang N. Dang	Registration Number	51,186
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of _____ forms are submitted.

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 106622

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	MING-HSIU	Date (Optional)	Aug. 28, 2015
Name	MING-HSIU HSU		
Title	Director of ASUSTek Computer Inc.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Lin, Ko-Chiang Date (Optional): 2014.9.21.

Signature: Lin, Ko-Chiang

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Li, Ming-Che Date (Optional): 2017.1.24

Signature: Li, Ming-Che

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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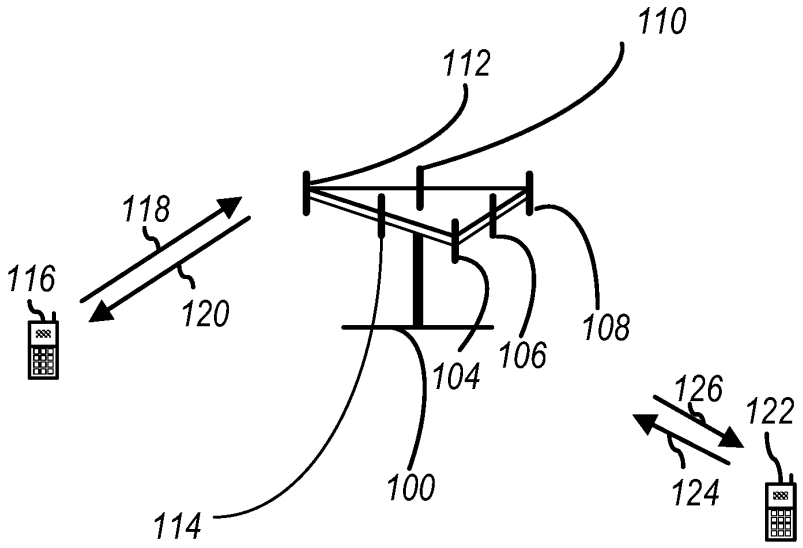


FIG. 1

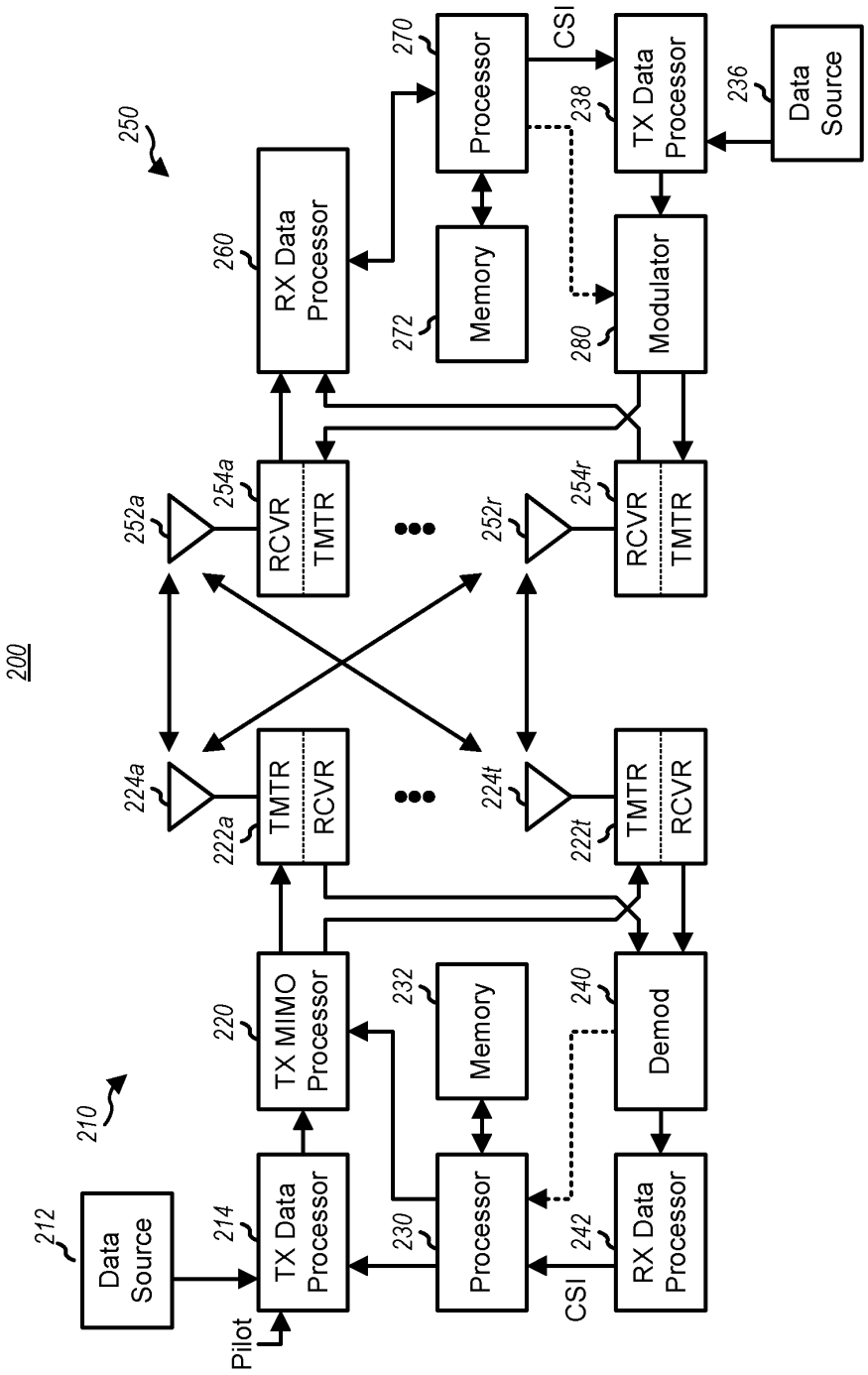

200
210
212
Data Source
214
TX Data Processor
Pilot
220
TX MIMO Processor
222a
TMTR
RCVR
224a
224t
222t
230
Processor
232
Memory
240
Demod
242
RX Data Processor
CSI
250
252a
252r
254a
254r
RCVR
TMTR
260
RX Data Processor
270
Processor
272
Memory
280
Modulator
238
CSI
TX Data Processor
236
Data Source

FIG. 2

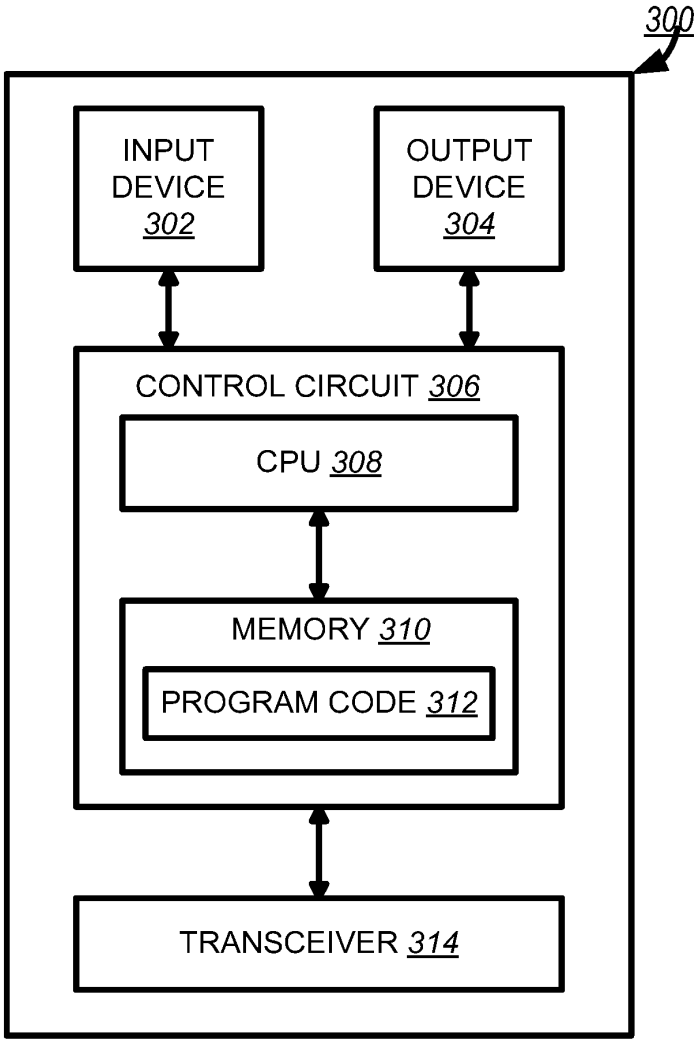

300
INPUT DEVICE 302
OUTPUT DEVICE 304
CONTROL CIRCUIT 306
CPU 308
MEMORY 310
PROGRAM CODE 312
TRANSCEIVER 314

FIG. 3

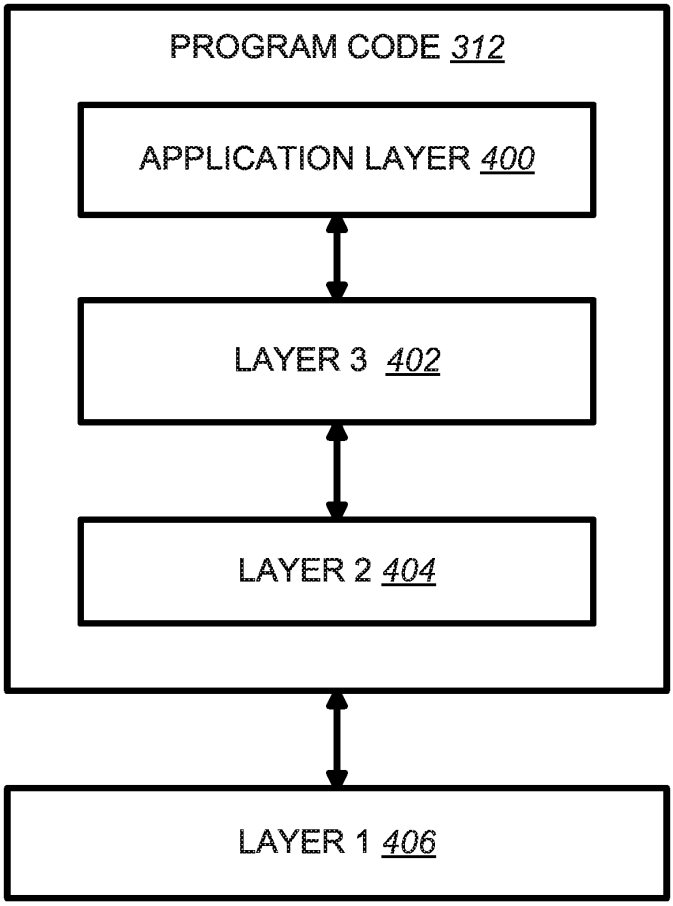

PROGRAM CODE 312
APPLICATION LAYER 400
LAYER 3 402
LAYER 2 404
LAYER 1 406

FIG. 4

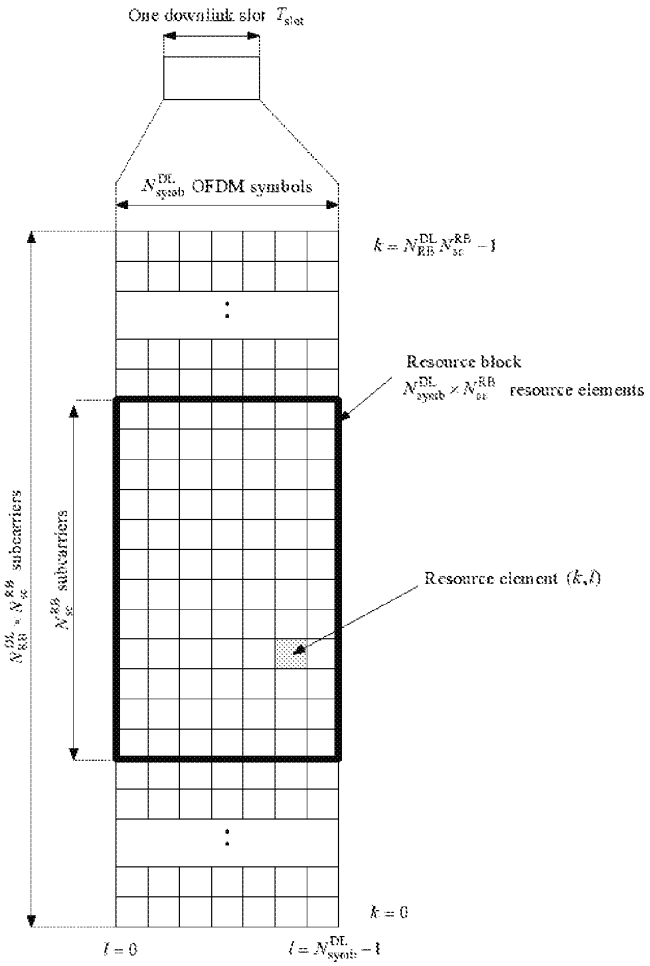


FIG. 5 (PRIOR ART)

Configuration		N_{sc}^{RB}	N_{symb}^{DL}
Normal cyclic prefix	$\Delta f = 15$ kHz	12	7
Extended cyclic prefix	$\Delta f = 15$ kHz		6
	$\Delta f = 7.5$ kHz	24	3

FIG. 6 (PRIOR ART)

Configuration		Cyclic prefix length $N_{CP,l}$
Normal cyclic prefix	$\Delta f = 15$ kHz	160 for $l = 0$ 144 for $l = 1,2,...,6$
Extended cyclic prefix	$\Delta f = 15$ kHz	512 for $l = 0,1,...,5$
	$\Delta f = 7.5$ kHz	1024 for $l = 0,1,2$

FIG. 7 (PRIOR ART)

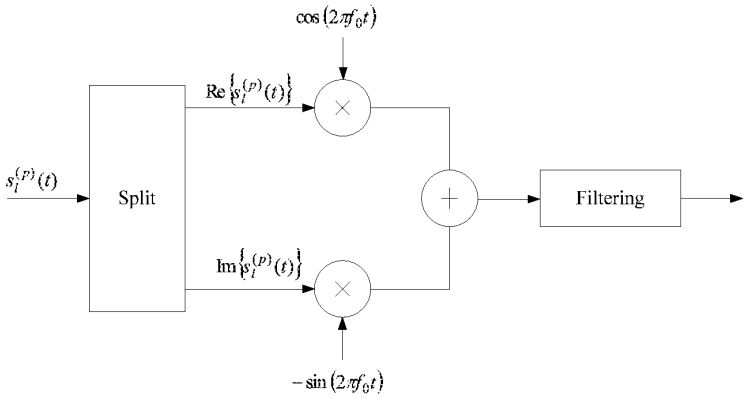


FIG. 8 (PRIOR ART)

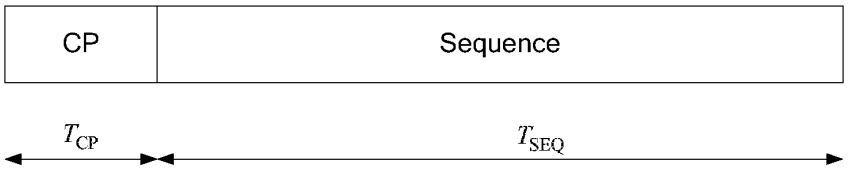


FIG. 9 (PRIOR ART)

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4 (see Note)	$448 \cdot T_s$	$4096 \cdot T_s$
NOTE: Frame structure type 2 and special subframe configurations with UpPTS lengths $4384 \cdot T_s$ and $5120 \cdot T_s$ only.		

FIG. 10 (PRIOR ART)

PRACH Configuration Index	Preamble Format	System frame number	Subframe number	PRACH Configuration Index	Preamble Format	System frame number	Subframe number
0	0	Even	1	32	2	Even	1
1	0	Even	4	33	2	Even	4
2	0	Even	7	34	2	Even	7
3	0	Any	1	35	2	Any	1
4	0	Any	4	36	2	Any	4
5	0	Any	7	37	2	Any	7
6	0	Any	1, 6	38	2	Any	1, 6
7	0	Any	2 ,7	39	2	Any	2 ,7
8	0	Any	3, 8	40	2	Any	3, 8
9	0	Any	1, 4, 7	41	2	Any	1, 4, 7
10	0	Any	2, 5, 8	42	2	Any	2, 5, 8
11	0	Any	3, 6, 9	43	2	Any	3, 6, 9
12	0	Any	0, 2, 4, 6, 8	44	2	Any	0, 2, 4, 6, 8
13	0	Any	1, 3, 5, 7, 9	45	2	Any	1, 3, 5, 7, 9
14	0	Any	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	46	N/A	N/A	N/A
15	0	Even	9	47	2	Even	9
16	1	Even	1	48	3	Even	1
17	1	Even	4	49	3	Even	4
18	1	Even	7	50	3	Even	7
19	1	Any	1	51	3	Any	1
20	1	Any	4	52	3	Any	4
21	1	Any	7	53	3	Any	7
22	1	Any	1, 6	54	3	Any	1, 6
23	1	Any	2 ,7	55	3	Any	2 ,7
24	1	Any	3, 8	56	3	Any	3, 8
25	1	Any	1, 4, 7	57	3	Any	1, 4, 7
26	1	Any	2, 5, 8	58	3	Any	2, 5, 8
27	1	Any	3, 6, 9	59	3	Any	3, 6, 9
28	1	Any	0, 2, 4, 6, 8	60	N/A	N/A	N/A
29	1	Any	1, 3, 5, 7, 9	61	N/A	N/A	N/A
30	N/A	N/A	N/A	62	N/A	N/A	N/A
31	1	Even	9	63	3	Even	9

FIG. 11 (PRIOR ART)

PRACH configuration Index	Preamble Format	Density Per 10 ms D_{RA}	Version r_{RA}	PRACH configuration Index	Preamble Format	Density Per 10 ms D_{RA}	Version r_{RA}
0	0	0.5	0	32	2	0.5	2
1	0	0.5	1	33	2	1	0
2	0	0.5	2	34	2	1	1
3	0	1	0	35	2	2	0
4	0	1	1	36	2	3	0
5	0	1	2	37	2	4	0
6	0	2	0	38	2	5	0
7	0	2	1	39	2	6	0
8	0	2	2	40	3	0.5	0
9	0	3	0	41	3	0.5	1
10	0	3	1	42	3	0.5	2
11	0	3	2	43	3	1	0
12	0	4	0	44	3	1	1
13	0	4	1	45	3	2	0
14	0	4	2	46	3	3	0
15	0	5	0	47	3	4	0
16	0	5	1	48	4	0.5	0
17	0	5	2	49	4	0.5	1
18	0	6	0	50	4	0.5	2
19	0	6	1	51	4	1	0
20	1	0.5	0	52	4	1	1
21	1	0.5	1	53	4	2	0
22	1	0.5	2	54	4	3	0
23	1	1	0	55	4	4	0
24	1	1	1	56	4	5	0
25	1	2	0	57	4	6	0
26	1	3	0	58	N/A	N/A	N/A
27	1	4	0	59	N/A	N/A	N/A
28	1	5	0	60	N/A	N/A	N/A
29	1	6	0	61	N/A	N/A	N/A
30	2	0.5	0	62	N/A	N/A	N/A
31	2	0.5	1	63	N/A	N/A	N/A

FIG. 12 (PRIOR ART)

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)
6	(0,0,0,2) (0,0,1,2)	(0,0,0,1) (0,0,1,1)	(0,0,0,0) (0,0,1,0)	(0,0,0,1) (0,0,0,2)	(0,0,0,0) (0,0,0,1)	(0,0,0,0) (1,0,0,0)	(0,0,0,2) (0,0,1,1)
7	(0,0,0,1) (0,0,1,1)	(0,0,0,0) (0,0,1,0)	N/A	(0,0,0,0) (0,0,0,2)	N/A	N/A	(0,0,0,1) (0,0,1,0)
8	(0,0,0,0) (0,0,1,0)	N/A	N/A	(0,0,0,0) (0,0,0,1)	N/A	N/A	(0,0,0,0) (0,0,1,1)
9	(0,0,0,1) (0,0,0,2) (0,0,1,2)	(0,0,0,0) (0,0,0,1) (0,0,1,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0)	(0,0,0,0) (0,0,0,1) (0,0,0,2)	(0,0,0,0) (0,0,0,1) (1,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0)	(0,0,0,1) (0,0,0,2) (0,0,1,1)
10	(0,0,0,0) (0,0,1,0) (0,0,1,1)	(0,0,0,1) (0,0,1,0) (0,0,1,1)	(0,0,0,0) (0,0,1,0) (1,0,1,0)	N/A	(0,0,0,0) (0,0,0,1) (1,0,0,0)	N/A	(0,0,0,0) (0,0,0,2) (0,0,1,0)
11	N/A	(0,0,0,0) (0,0,0,1) (0,0,1,0)	N/A	N/A	N/A	N/A	(0,0,0,1) (0,0,1,0) (0,0,1,1)
12	(0,0,0,1) (0,0,0,2) (0,0,1,1) (0,0,1,2)	(0,0,0,0) (0,0,0,1) (0,0,1,0) (0,0,1,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0)	(0,0,0,0) (0,0,0,1) (0,0,0,2) (1,0,0,2)	(0,0,0,0) (0,0,0,1) (1,0,0,0) (1,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0)	(0,0,0,1) (0,0,0,2) (0,0,1,0) (0,0,1,1)
13	(0,0,0,0) (0,0,0,2) (0,0,1,0) (0,0,1,2)	N/A	N/A	(0,0,0,0) (0,0,0,1) (0,0,0,2) (1,0,0,1)	N/A	N/A	(0,0,0,0) (0,0,0,1) (0,0,0,2) (0,0,1,1)
14	(0,0,0,0) (0,0,0,1) (0,0,1,0) (0,0,1,1)	N/A	N/A	(0,0,0,0) (0,0,0,1) (0,0,0,2) (1,0,0,0)	N/A	N/A	(0,0,0,0) (0,0,0,2) (0,0,1,0) (0,0,1,1)
15	(0,0,0,0) (0,0,0,1) (0,0,0,2) (0,0,1,1) (0,0,1,2)	(0,0,0,0) (0,0,0,1) (0,0,1,0) (0,0,1,1) (1,0,0,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0) (2,0,0,0)	(0,0,0,0) (0,0,0,1) (0,0,0,2) (1,0,0,1) (1,0,0,2)	(0,0,0,0) (0,0,0,1) (1,0,0,0) (1,0,0,1) (2,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0) (4,0,0,0)	(0,0,0,0) (0,0,0,1) (0,0,0,2) (0,0,1,0) (0,0,1,1)

FIG. 13 (PRIOR ART)

16	(0,0,0,1) (0,0,0,2) (0,0,1,0) (0,0,1,1) (0,0,1,2)	(0,0,0,0) (0,0,0,1) (0,0,1,0) (0,0,1,1) (1,0,1,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0) (2,0,1,0)	(0,0,0,0) (0,0,0,1) (0,0,0,2) (1,0,0,0) (1,0,0,2)	(0,0,0,0) (0,0,0,1) (1,0,0,0) (1,0,0,1) (2,0,0,0)	N/A	N/A
17	(0,0,0,0) (0,0,0,1) (0,0,0,2) (0,0,1,0) (0,0,1,2)	(0,0,0,0) (0,0,0,1) (0,0,1,0) (0,0,1,1) (1,0,0,0)	N/A	(0,0,0,0) (0,0,0,1) (0,0,0,2) (1,0,0,0) (1,0,0,1)	N/A	N/A	N/A
18	(0,0,0,0) (0,0,0,1) (0,0,0,2) (0,0,1,0) (0,0,1,1) (0,0,1,2)	(0,0,0,0) (0,0,0,1) (0,0,1,0) (0,0,1,1) (1,0,0,1) (1,0,1,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0) (2,0,0,0) (2,0,1,0)	(0,0,0,0) (0,0,0,1) (0,0,0,2) (1,0,0,0) (1,0,0,1) (1,0,0,2)	(0,0,0,0) (0,0,0,1) (1,0,0,0) (1,0,0,1) (2,0,0,0) (2,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0) (4,0,0,0) (5,0,0,0)	(0,0,0,0) (0,0,0,1) (0,0,0,2) (0,0,1,0) (0,0,1,1) (1,0,0,2)
19	N/A	(0,0,0,0) (0,0,0,1) (0,0,1,0) (0,0,1,1) (1,0,0,0) (1,0,1,0)	N/A	N/A	N/A	N/A	(0,0,0,0) (0,0,0,1) (0,0,0,2) (0,0,1,0) (0,0,1,1) (1,0,1,1)
20 / 30	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,0,1)
21 / 31	(0,2,0,1)	(0,2,0,0)	N/A	(0,2,0,1)	(0,2,0,0)	N/A	(0,2,0,1)
22 / 32	(0,1,1,1)	(0,1,1,0)	N/A	N/A	N/A	N/A	(0,1,1,0)
23 / 33	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,1)
24 / 34	(0,0,1,1)	(0,0,1,0)	N/A	N/A	N/A	N/A	(0,0,1,0)
25 / 35	(0,0,0,1) (0,0,1,1)	(0,0,0,0) (0,0,1,0)	N/A	(0,0,0,1) (1,0,0,1)	(0,0,0,0) (1,0,0,0)	N/A	(0,0,0,1) (0,0,1,0)
26 / 36	(0,0,0,1) (0,0,1,1) (1,0,0,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0)	N/A	(0,0,0,1) (1,0,0,1) (2,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0)	N/A	(0,0,0,1) (0,0,1,0) (1,0,0,1)
27 / 37	(0,0,0,1) (0,0,1,1) (1,0,0,1) (1,0,1,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0)	N/A	(0,0,0,1) (1,0,0,1) (2,0,0,1) (3,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0)	N/A	(0,0,0,1) (0,0,1,0) (1,0,0,1) (1,0,1,0)
28 / 38	(0,0,0,1) (0,0,1,1) (1,0,0,1) (1,0,1,1) (2,0,0,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0) (2,0,0,0)	N/A	(0,0,0,1) (1,0,0,1) (2,0,0,1) (3,0,0,1) (4,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0) (4,0,0,0)	N/A	(0,0,0,1) (0,0,1,0) (1,0,0,1) (1,0,1,0) (2,0,0,1)

FIG. 13 CONT'D. (PRIOR ART)

29 /39	(0,0,0,1) (0,0,1,1) (1,0,0,1) (1,0,1,1) (2,0,0,1) (2,0,1,1)	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0) (2,0,0,0) (2,0,1,0)	N/A	(0,0,0,1) (1,0,0,1) (2,0,0,1) (3,0,0,1) (4,0,0,1) (5,0,0,1)	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0) (4,0,0,0) (5,0,0,0)	N/A	(0,0,0,1) (0,0,1,0) (1,0,0,1) (1,0,1,0) (2,0,0,1) (2,0,1,0)
40	(0,1,0,0)	N/A	N/A	(0,1,0,0)	N/A	N/A	(0,1,0,0)
41	(0,2,0,0)	N/A	N/A	(0,2,0,0)	N/A	N/A	(0,2,0,0)
42	(0,1,1,0)	N/A	N/A	N/A	N/A	N/A	N/A
43	(0,0,0,0)	N/A	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,0)
44	(0,0,1,0)	N/A	N/A	N/A	N/A	N/A	N/A
45	(0,0,0,0) (0,0,1,0)	N/A	N/A	(0,0,0,0) (1,0,0,0)	N/A	N/A	(0,0,0,0) (1,0,0,0)
46	(0,0,0,0) (0,0,1,0) (1,0,0,0)	N/A	N/A	(0,0,0,0) (1,0,0,0) (2,0,0,0)	N/A	N/A	(0,0,0,0) (1,0,0,0) (2,0,0,0)
47	(0,0,0,0) (0,0,1,0) (1,0,0,0) (1,0,1,0)	N/A	N/A	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0)	N/A	N/A	(0,0,0,0) (1,0,0,0) (2,0,0,0) (3,0,0,0)
48	(0,1,0,*)	(0,1,0,*)	(0,1,0,*)	(0,1,0,*)	(0,1,0,*)	(0,1,0,*)	(0,1,0,*)
49	(0,2,0,*)	(0,2,0,*)	(0,2,0,*)	(0,2,0,*)	(0,2,0,*)	(0,2,0,*)	(0,2,0,*)
50	(0,1,1,*)	(0,1,1,*)	(0,1,1,*)	N/A	N/A	N/A	(0,1,1,*)
51	(0,0,0,*)	(0,0,0,*)	(0,0,0,*)	(0,0,0,*)	(0,0,0,*)	(0,0,0,*)	(0,0,0,*)
52	(0,0,1,*)	(0,0,1,*)	(0,0,1,*)	N/A	N/A	N/A	(0,0,1,*)
53	(0,0,0,*) (0,0,1,*)	(0,0,0,*) (0,0,1,*)	(0,0,0,*) (0,0,1,*)	(0,0,0,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*)
54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)

FIG. 13 CONT'D. (PRIOR ART)

57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NOTE: * UpPTS							

FIG. 13 CONT'D. (PRIOR ART)

Preamble format	N_{ZC}
0 – 3	839
4	139

FIG. 14 (PRIOR ART)

zeroCorrelationZoneConfig	N_{CS} value	
	Unrestricted set	Restricted set
0	0	15
1	13	18
2	15	22
3	18	26
4	22	32
5	26	38
6	32	46
7	38	55
8	46	68
9	59	82
10	76	100
11	93	128
12	119	158
13	167	202
14	279	237
15	419	-

FIG. 15 (PRIOR ART)

zeroCorrelationZoneConfig	N_{CS} value
0	2
1	4
2	6
3	8
4	10
5	12
6	15
7	N/A
8	N/A
9	N/A
10	N/A
11	N/A
12	N/A
13	N/A
14	N/A
15	N/A

FIG. 16 (PRIOR ART)

Logical root sequence number	Physical root sequence number u (in increasing order of the corresponding logical sequence number)
0–23	129, 710, 140, 699, 120, 719, 210, 629, 168, 671, 84, 755, 105, 734, 93, 746, 70, 769, 60, 779 2, 837, 1, 838
24–29	56, 783, 112, 727, 148, 691
30–35	80, 759, 42, 797, 40, 799
36–41	35, 804, 73, 766, 146, 693
42–51	31, 808, 28, 811, 30, 809, 27, 812, 29, 810
52–63	24, 815, 48, 791, 68, 771, 74, 765, 178, 661, 136, 703
64–75	86, 753, 78, 761, 43, 796, 39, 800, 20, 819, 21, 818
76–89	95, 744, 202, 637, 190, 649, 181, 658, 137, 702, 125, 714, 151, 688
90–115	217, 622, 128, 711, 142, 697, 122, 717, 203, 636, 118, 721, 110, 729, 89, 750, 103, 736, 61, 778, 55, 784, 15, 824, 14, 825
116–135	12, 827, 23, 816, 34, 805, 37, 802, 46, 793, 207, 632, 179, 660, 145, 694, 130, 709, 223, 616
136–167	228, 611, 227, 612, 132, 707, 133, 706, 143, 696, 135, 704, 161, 678, 201, 638, 173, 666, 106, 733, 83, 756, 91, 748, 66, 773, 53, 786, 10, 829, 9, 830
168–203	7, 832, 8, 831, 16, 823, 47, 792, 64, 775, 57, 782, 104, 735, 101, 738, 108, 731, 208, 631, 184, 655, 197, 642, 191, 648, 121, 718, 141, 698, 149, 690, 216, 623, 218, 621
204–263	152, 687, 144, 695, 134, 705, 138, 701, 199, 640, 162, 677, 176, 663, 119, 720, 158, 681, 164, 675, 174, 665, 171, 668, 170, 669, 87, 752, 169, 670, 88, 751, 107, 732, 81, 758, 82, 757, 100, 739, 98, 741, 71, 768, 59, 780, 65, 774, 50, 789, 49, 790, 26, 813, 17, 822, 13, 826, 6, 833
264–327	5, 834, 33, 806, 51, 788, 75, 764, 99, 740, 96, 743, 97, 742, 166, 673, 172, 667, 175, 664, 187, 652, 163, 676, 185, 654, 200, 639, 114, 725, 189, 650, 115, 724, 194, 645, 195, 644, 192, 647, 182, 657, 157, 682, 156, 683, 211, 628, 154, 685, 123, 716, 139, 700, 212, 627, 153, 686, 213, 626, 215, 624, 150, 689
328–383	225, 614, 224, 615, 221, 618, 220, 619, 127, 712, 147, 692, 124, 715, 193, 646, 205, 634, 206, 633, 116, 723, 160, 679, 186, 653, 167, 672, 79, 760, 85, 754, 77, 762, 92, 747, 58, 781, 62, 777, 69, 770, 54, 785, 36, 803, 32, 807, 25, 814, 18, 821, 11, 828, 4, 835
384–455	3, 836, 19, 820, 22, 817, 41, 798, 38, 801, 44, 795, 52, 787, 45, 794, 63, 776, 67, 772, 72 767, 76, 763, 94, 745, 102, 737, 90, 749, 109, 730, 165, 674, 111, 728, 209, 630, 204, 635, 117, 722, 188, 651, 159, 680, 198, 641, 113, 726, 183, 656, 180, 659, 177, 662, 196, 643, 155, 684, 214, 625, 126, 713, 131, 708, 219, 620, 222, 617, 226, 613
456–513	230, 609, 232, 607, 262, 577, 252, 587, 418, 421, 416, 423, 413, 426, 411, 428, 376, 463, 395, 444, 283, 556, 285, 554, 379, 460, 390, 449, 363, 476, 384, 455, 388, 451, 386, 453, 361, 478, 387, 452, 360, 479, 310, 529, 354, 485, 328, 511, 315, 524, 337, 502, 349, 490, 335, 504, 324, 515
514–561	323, 516, 320, 519, 334, 505, 359, 480, 295, 544, 385, 454, 292, 547, 291, 548, 381, 458, 399, 440, 380, 459, 397, 442, 369, 470, 377, 462, 410, 429, 407, 432, 281, 558, 414, 425, 247, 592, 277, 562, 271, 568, 272, 567, 264, 575, 259, 580

FIG. 17 (PRIOR ART)

562–629	237, 602, 239, 600, 244, 595, 243, 596, 275, 564, 278, 561, 250, 589, 246, 593, 417, 422, 248, 591, 394, 445, 393, 446, 370, 469, 365, 474, 300, 539, 299, 540, 364, 475, 362, 477, 298, 541, 312, 527, 313, 526, 314, 525, 353, 486, 352, 487, 343, 496, 327, 512, 350, 489, 326, 513, 319, 520, 332, 507, 333, 506, 348, 491, 347, 492, 322, 517
630–659	330, 509, 338, 501, 341, 498, 340, 499, 342, 497, 301, 538, 366, 473, 401, 438, 371, 468, 408, 431, 375, 464, 249, 590, 269, 570, 238, 601, 234, 605
660–707	257, 582, 273, 566, 255, 584, 254, 585, 245, 594, 251, 588, 412, 427, 372, 467, 282, 557, 403, 436, 396, 443, 392, 447, 391, 448, 382, 457, 389, 450, 294, 545, 297, 542, 311, 528, 344, 495, 345, 494, 318, 521, 331, 508, 325, 514, 321, 518
708–729	346, 493, 339, 500, 351, 488, 306, 533, 289, 550, 400, 439, 378, 461, 374, 465, 415, 424, 270, 569, 241, 598
730–751	231, 608, 260, 579, 268, 571, 276, 563, 409, 430, 398, 441, 290, 549, 304, 535, 308, 531, 358, 481, 316, 523
752–765	293, 546, 288, 551, 284, 555, 368, 471, 253, 586, 256, 583, 263, 576
766–777	242, 597, 274, 565, 402, 437, 383, 456, 357, 482, 329, 510
778–789	317, 522, 307, 532, 286, 553, 287, 552, 266, 573, 261, 578
790–795	236, 603, 303, 536, 356, 483
796–803	355, 484, 405, 434, 404, 435, 406, 433
804–809	235, 604, 267, 572, 302, 537
810–815	309, 530, 265, 574, 233, 606
816–819	367, 472, 296, 543
820–837	336, 503, 305, 534, 373, 466, 280, 559, 279, 560, 419, 420, 240, 599, 258, 581, 229, 610

FIG. 17 CONT'D. (PRIOR ART)

Logical root sequence number	Physical root sequence number u (in increasing order of the corresponding logical sequence number)																			
0 – 19	1	138	2	137	3	136	4	135	5	134	6	133	7	132	8	131	9	130	10	129
20 – 39	11	128	12	127	13	126	14	125	15	124	16	123	17	122	18	121	19	120	20	119
40 – 59	21	118	22	117	23	116	24	115	25	114	26	113	27	112	28	111	29	110	30	109
60 – 79	31	108	32	107	33	106	34	105	35	104	36	103	37	102	38	101	39	100	40	99
80 – 99	41	98	42	97	43	96	44	95	45	94	46	93	47	92	48	91	49	90	50	89
100 – 119	51	88	52	87	53	86	54	85	55	84	56	83	57	82	58	81	59	80	60	79
120 – 137	61	78	62	77	63	76	64	75	65	74	66	73	67	72	68	71	69	70	-	-
138 – 837	N/A																			

FIG. 18 (PRIOR ART)

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

FIG. 19 (PRIOR ART)

Physical channel	Modulation schemes
PBCH	QPSK

FIG. 20 (PRIOR ART)

l	Frame offset, slot and symbol number triplets (i,n_s',l')	
	Normal cyclic prefix	Extended cyclic prefix
0	(1,18,3), (1,19,0), (1,19,4), (0,0,4)	(1,18,3), (1,19,0), (1,19,5)
1	(1,18,4), (1,19,1). (1,19,5), (0,1,4)	(1,18,4), (1,19,1). (0,0,3)
2	(1,18,5), (1,19,2), (1,19,6), (0,1,5)	(1,18,5), (1,19,2), (0,1,4)
3	(1,18,6), (1,19,3), (0,0,3), (0,1,6)	(1,19,3), (1,19,4), (0,1,5)

FIG. 21 (PRIOR ART)

l	Slot and symbol number pairs (n_s',l')	
	Normal cyclic prefix	Extended cyclic prefix
0	(0,3), (1,4), (10,3), (11,0), (11,4)	(0,3), (10,3), (11,0)
1	(0,4), (1,5), (10,4), (11,1), (11,5)	(0,4), (10,4), (11,1)
2	(0,5), (10,5), (11.2)	(0,5), (10,5), (11.2)
3	(0,6), (10,6), (11.3)	(1,4), (11,3), (11.4)

FIG. 22 (PRIOR ART)

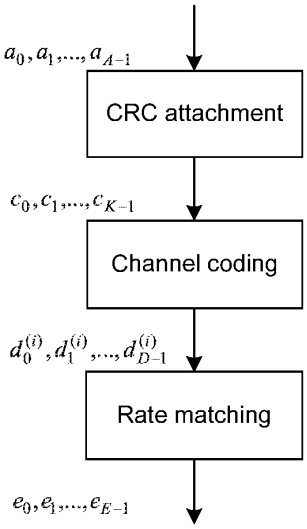


FIG. 23 (PRIOR ART)

{12, 14, 16 ,20, 24, 26, 32, 40, 44, 56}

FIG. 24 (PRIOR ART)

Number of bits	
4	For UEs configured by higher layers with *codebooksizeDetermination-r13 = 0*, the 4-bit DAI further consists of a 2-bit counter DAI and a 2-bit total DAI. - Counter DAI – 2 bits as defined in section 7.3 of [3] - Total DAI – 2 bits as defined in section 7.3 of [3]
2	For UEs configured with no more than five DL cells, or for UEs configured by higher layers with *codebooksizeDetermination-r13 = 1*, this field is present for FDD or TDD operation, for cases with TDD primary cell. If the UL/DL configuration of all TDD serving cells is same and the UE is not configured to decode PDCCH with CRC scrambled by *eimta-RNTI*, then this field only applies to serving cell with UL/DL configuration 1-6 If at least two TDD serving cells have different UL/DL configurations or the UE is configured to decode PDCCH with CRC scrambled by *eimta-RNTI*, then this field applies to a serving cell with DL-reference UL/DL configuration 1-6 as defined in section 10.2 of [3]
0	For UEs configured with no more than five DL cells, or for UEs configured by higher layers with *codebooksizeDetermination-r13 = 1*, this field is not present for FDD or TDD operation, for cases with FDD primary cell.

FIG. 25 (PRIOR ART)

TDD UL/DL configuration	Maximum number of HARQ processes
0	4
1	7
2	10
3	9
4	12
5	15
6	6

FIG. 26 (PRIOR ART)

DCI format	Search Space	Transmission scheme of PDSCH corresponding to PDCCH
DCI format 1C	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2).
DCI format 1A	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2).

FIG. 27 (PRIOR ART)

DCI format	Search Space	Transmission scheme of PDSCH corresponding to PDCCH
DCI format 1C	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)
DCI format 1A	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)

FIG. 28 (PRIOR ART)

DCI format	Search Space	Transmission scheme of PDSCH corresponding to PDCCH
DCI format 1C	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)
DCI format 1A	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)

FIG. 29 (PRIOR ART)

DCI format	Search Space	Transmission scheme of PDSCH corresponding to PDCCH
DCI format 1C	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2).
DCI format 1A	Common	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2).

FIG. 30 (PRIOR ART)

Transmission mode	DCI format	Search Space	Transmission scheme of PDSCH corresponding to PDCCH
Mode 1	DCI format 1A	Common and UE specific by C-RNTI	Single-antenna port, port 0 (see subclause 7.1.1)
	DCI format 1	UE specific by C-RNTI	Single-antenna port, port 0 (see subclause 7.1.1)
Mode 2	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see subclause 7.1.2)
	DCI format 1	UE specific by C-RNTI	Transmit diversity (see subclause 7.1.2)
Mode 3	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see subclause 7.1.2)
	DCI format 2A	UE specific by C-RNTI	Large delay CDD (see subclause 7.1.3) or Transmit diversity (see subclause 7.1.2)
Mode 4	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see subclause 7.1.2)
	DCI format 2	UE specific by C-RNTI	Closed-loop spatial multiplexing (see subclause 7.1.4)or Transmit diversity (see subclause 7.1.2)
Mode 5	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see subclause 7.1.2)
	DCI format 1D	UE specific by C-RNTI	Multi-user MIMO (see subclause 7.1.5)

FIG. 31 (PRIOR ART)

Mode 6	DCI format 1A	Common and UE specific by C-RNTI	Transmit diversity (see subclause 7.1.2)
	DCI format 1B	UE specific by C-RNTI	Closed-loop spatial multiplexing (see subclause 7.1.4) using a single transmission layer
Mode 7	DCI format 1A	Common and UE specific by C-RNTI	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)
	DCI format 1	UE specific by C-RNTI	Single-antenna port, port 5 (see subclause 7.1.1)
Mode 8	DCI format 1A	Common and UE specific by C-RNTI	If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)
	DCI format 2B	UE specific by C-RNTI	Dual layer transmission, port 7 and 8 (see subclause 7.1.5A) or single-antenna port, port 7 or 8 (see subclause 7.1.1)

FIG. 31 CONT'D. (PRIOR ART)

Mode 9	DCI format 1A	Common and UE specific by C-RNTI	• Non-MBSFN subframe: If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2) • MBSFN subframe: Single-antenna port, port 7 (see subclause 7.1.1)
	DCI format 2C	UE specific by C-RNTI	Up to 8 layer transmission, ports 7-14 (see subclause 7.1.5B) or single-antenna port, port 7, 8, 11, or 13 (see subclause 7.1.1) if UE is configured with higher layer parameter *dmrs-tableAlt,* single-antenna port, port 7 or 8 (see subclause 7.1.1) otherwise
Mode 10	DCI format 1A	Common and UE specific by C-RNTI	• Non-MBSFN subframe: If the number of PBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2) • MBSFN subframe: Single-antenna port, port 7 (see subclause 7.1.1)
	DCI format 2D	UE specific by C-RNTI	Up to 8 layer transmission, ports 7-14 (see subclause 7.1.5B) or single-antenna port, port 7, 8, 11, or 13 (see subclause 7.1.1) if UE is configured with higher layer parameter *dmrs-tableAlt*, single-antenna port, port 7 or 8 (see subclause 7.1.1) otherwise

FIG. 31 CONT'D. (PRIOR ART)

DCI format	Search Space	Transmission scheme of PDSCH corresponding to PDCCH
DCI format 1A	Common and UE specific by Temporary C-RNTI	If the number of PBCH antenna port is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)
DCI format 1	UE specific by Temporary C-RNTI	If the number of PBCH antenna port is one, Single-antenna port, port 0 is used (see subclause 7.1.1), otherwise Transmit diversity (see subclause 7.1.2)

FIG. 32 (PRIOR ART)

Value of *schedulingInfoSIB1-BR-r13*	Number of PDSCH repetitions
0	N/A
1	4
2	8
3	16
4	4
5	8
6	16
7	4
8	8
9	16
10	4
11	8
12	16
13	4
14	8
15	16
16	4
17	8
18	16
19-31	Reserved

FIG. 33 (PRIOR ART)

System Bandwidth N_{RB}^{DL}	RBG Size (P)
≤10	1
11 – 26	2
27 – 63	3
64 – 110	4

FIG. 34 (PRIOR ART)

System BW (N_{RB}^{DL})	N_{RB}^{step}
	DCI format 1C
6-49	2
50-110	4

FIG. 35 (PRIOR ART)

TDD UL/DL configuration	Number of HARQ processes for normal HARQ operation	Number of HARQ processes for subframe bundling operation
0	7	3
1	4	2
2	2	N/A
3	3	N/A
4	2	N/A
5	1	N/A
6	6	3

FIG. 36 (PRIOR ART)

Transmission mode	DCI format	Search Space	Transmission scheme of PUSCH corresponding to PDCCH
Mode 1	DCI format 0	Common and UE specific by C-RNTI	Single-antenna port, port 10 (see subclause 8.0.1)
Mode 2	DCI format 0	Common and UE specific by C-RNTI	Single-antenna port, port 10 (see subclause 8.0.1)
	DCI format 4	UE specific by C-RNTI	Closed-loop spatial multiplexing (see subclause 8.0.2)

FIG. 37 (PRIOR ART)

DCI format	Search Space
DCI format 1A	Common and UE specific by C-RNTI

FIG. 38 (PRIOR ART)

DCI format	Search Space
DCI format 0	Common

FIG. 39 (PRIOR ART)

DCI format	Search Space
DCI format 3/3A	Common

FIG. 40 (PRIOR ART)

DCI format	Search Space
DCI format 3/3A	Common

FIG. 41 (PRIOR ART)

Value of resource allocation field	Allocated resource blocks
'000'	0
'001'	1
'010'	2
'011'	3
'100'	4
'101'	5
'110'	0 and 1
'111'	2 and 3

FIG. 42 (PRIOR ART)

Search space $S_k^{(L)}$			Number of PDCCH candidates $M^{(L)}$
Type	Aggregation level L	Size [in CCEs]	
UE-specific	1	6	6
	2	12	6
	4	8	2
	8	16	2
Common	4	16	4
	8	16	2

FIG. 43 (PRIOR ART)

Search space $S_k^{(L)}$			Number of PDCCH candidates $M^{(L)}$ in first slot	Number of PDCCH candidates $M^{(L)}$ in second slot
Type	Aggregation level L	Size [in CCEs]		
UE-specific	1	6	6	6
	2	12	6	6
	4	8	2	2
	8	16	2	2

FIG. 44 (PRIOR ART)

pdcch-candidateReductions	Value of α
0	0
1	0.33
2	0.66
3	1

FIG. 45 (PRIOR ART)

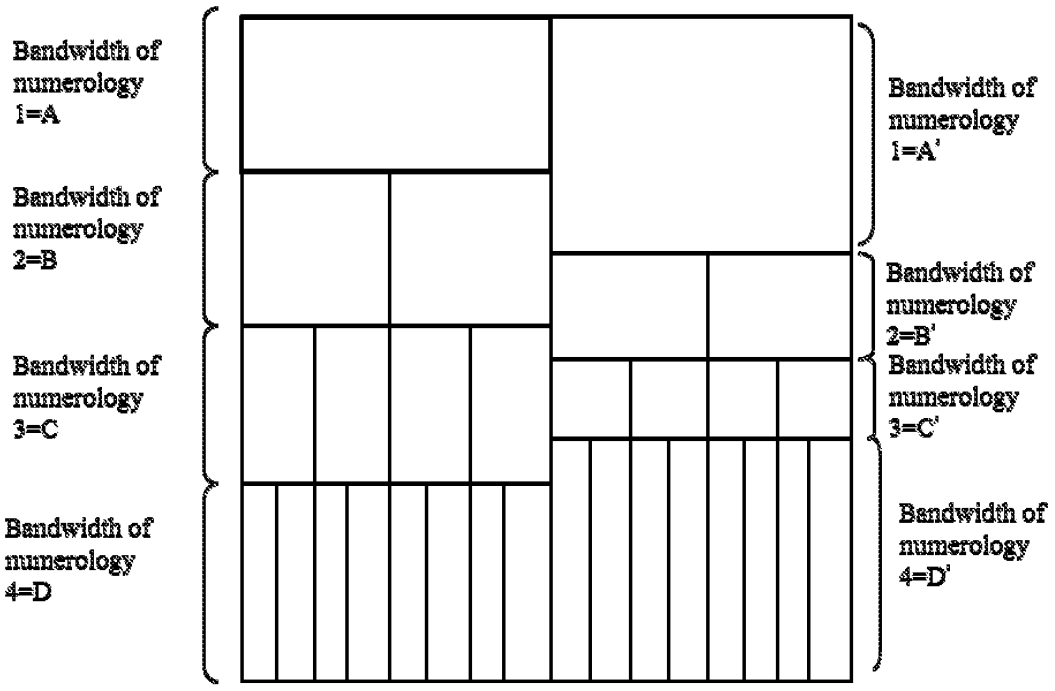

Bandwidth of numerology 1=A
Bandwidth of numerology 2=B
Bandwidth of numerology 3=C
Bandwidth of numerology 4=D
Bandwidth of numerology 1=A'
Bandwidth of numerology 2=B'
Bandwidth of numerology 3=C'
Bandwidth of numerology 4=D'

FIG. 46

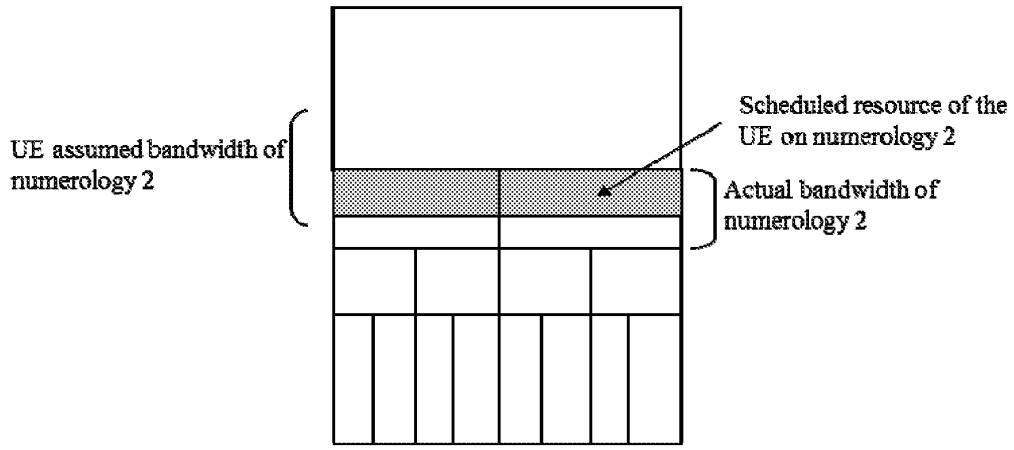

UE assumed bandwidth of numerology 2
Scheduled resource of the UE on numerology 2
Actual bandwidth of numerology 2

FIG. 47

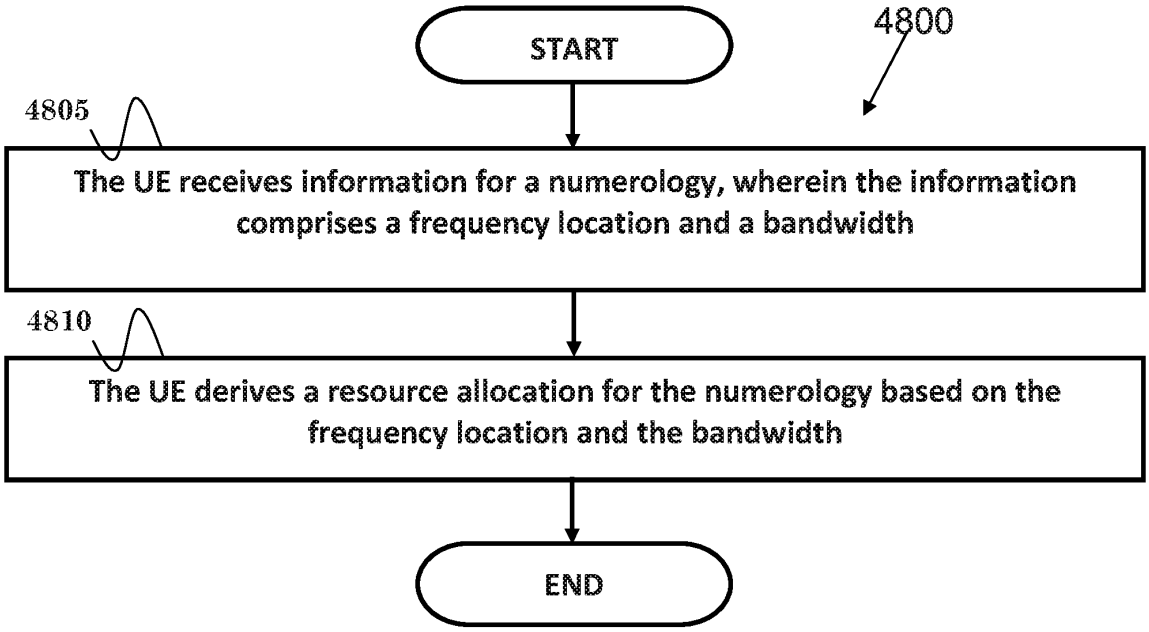

START
4800
4805
The UE receives information for a numerology, wherein the information comprises a frequency location and a bandwidth
4810
The UE derives a resource allocation for the numerology based on the frequency location and the bandwidth
END

FIG. 48

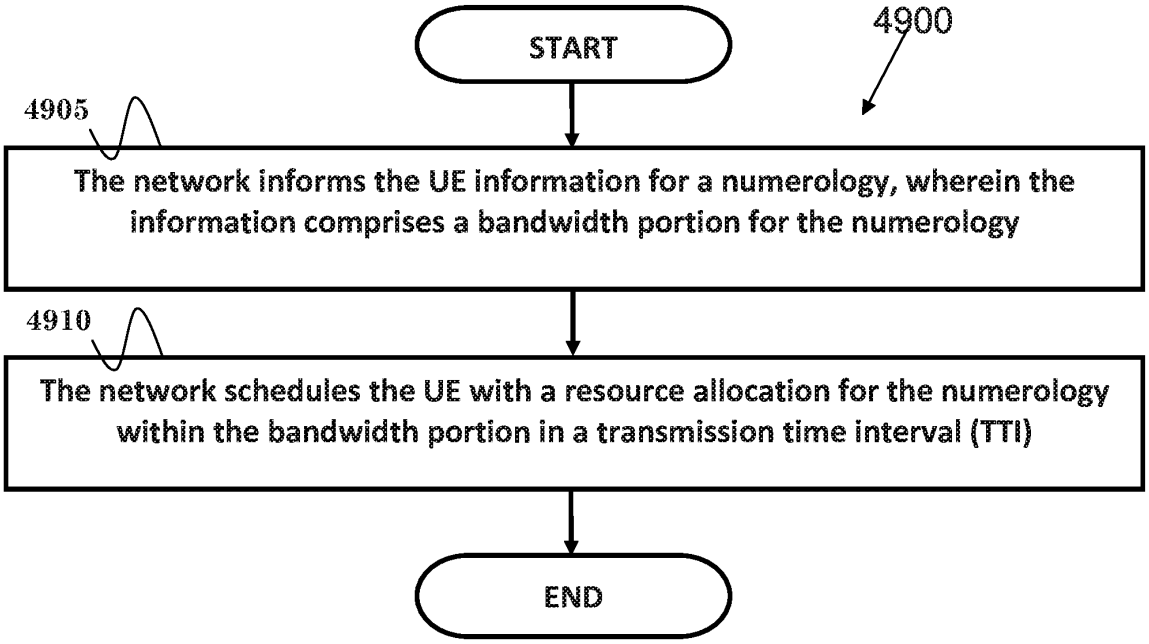

START
4900
4905
The network informs the UE information for a numerology, wherein the information comprises a bandwidth portion for the numerology
4910
The network schedules the UE with a resource allocation for the numerology within the bandwidth portion in a transmission time interval (TTI)
END

FIG. 49

ABSTRACT

Methods and apparatuses for determining numerology bandwidth in a wireless communication system are disclosed herein. In one method, a user equipment receives information for a numerology. The information comprises a frequency location and a bandwidth. The UE derives a resource allocation for the numerology based on the frequency location and the bandwidth.

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CLAIMS

1. A method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a numerology, wherein the information comprises a frequency location and a bandwidth for the numerology; and

deriving, by the UE, a resource allocation for the numerology based on the frequency location and the bandwidth.

2. The method of claim 1, further comprising:

configuring, by the UE, a system bandwidth.

3. The method of claim 2, wherein the system bandwidth is larger than the bandwidth.

4. The method of claim 1, wherein the frequency location is an index of a resource block.

5. The method of claim 1, wherein the resource allocation designates a resource within a bandwidth portion.

6. The method of claim 1, wherein the frequency location is an index of a resource block with a central frequency within a bandwidth portion.

7. The method of claim 6, the bandwidth portion is derived from the frequency location and the bandwidth.

8. The method of claim 1, wherein the bandwidth and the frequency location is configured by UE-specific RRC message.

9. The method of claim 1, wherein the bandwidth and the frequency location is indicated by a physical control channel.

10. The method of claim 1, wherein the numerology is indicated by a physical control channel.

11. The method of claim 1, wherein the bandwidth is a maximum bandwidth for the numerology.

12. The method of claim 1, wherein the bandwidth is a maximum bandwidth that the UE is able to receive for the numerology.

13. A method for determining numerology bandwidth, the method comprising:

informing a user equipment (UE) information for a numerology, wherein the information comprises a bandwidth portion for the numerology; and

scheduling the UE with a resource allocation for the numerology within the bandwidth portion in a transmission time interval (TTI).

14. The method of claim 13, wherein the UE does not assume that a resource block within the bandwidth portion and outside the resource allocation is transmitted with the numerology in the TTI.

15. The method of claim 13, wherein the bandwidth portion is derived from a frequency location and a bandwidth.

16. A User Equipment (UE) capable of determining numerology bandwidth, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

receive information for a numerology, wherein the information comprises a frequency location and a bandwidth for the numerology; and

derive a resource allocation for the numerology based on the frequency location and the bandwidth.

17. The UE of claim 16, wherein the UE configures a system bandwidth.

18. The UE of claim 17, wherein the system bandwidth is larger than the bandwidth.

19. The UE of claim 16, wherein the resource allocation designates a resource within a bandwidth portion.

20. The UE of claim 16, wherein the bandwidth is a configured bandwidth for the numerology.

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Client Docket No.: 1050198-US
Filed Via EFS

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present Application claims the benefit of U.S. Provisional Patent Application Serial No. 62/374,354 filed on August 12, 2016, the entire disclosure of which is incorporated herein in its entirety by reference.

FIELD

[0002] This disclosure generally relates to wireless communication networks, and more particularly, to a method and apparatus for determining numerology bandwidth in a wireless communication system.

BACKGROUND

[0003] With the rapid rise in demand for communication of large amounts of data to and from mobile communication devices, traditional mobile voice communication networks are evolving into networks that communicate with Internet Protocol (IP) data packets. Such IP data packet communication can provide users of mobile communication devices with voice over IP, multimedia, multicast and on-demand communication services.

[0004] An exemplary network structure is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). The E-UTRAN system can provide high data throughput in order to realize the above-noted voice over IP and multimedia services. A new radio technology for the next generation (e.g., 5G) is currently being discussed by the 3GPP standards organization. Accordingly, changes to the current body of 3GPP standard are currently being submitted and considered to evolve and finalize the 3GPP standard.

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IPR2024-01273

SUMMARY

[0005] Methods and apparatuses for determining numerology bandwidth in a wireless communication system are disclosed herein. In one method, a user equipment receives information for a numerology. The information comprises a frequency location and a bandwidth. The UE derives a resource allocation for the numerology based on the frequency location and the bandwidth.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 shows a diagram of a wireless communication system according to one exemplary embodiment.

[0007] FIG. 2 is a block diagram of a transmitter system (also known as access network) and a receiver system (also known as user equipment or UE) according to one exemplary embodiment.

[0008] FIG. 3 is a functional block diagram of a communication system according to one exemplary embodiment.

[0009] FIG. 4 is a functional block diagram of the program code of FIG. 3 according to one exemplary embodiment.

[0010] FIG. 5 is a reproduction of FIG. 6.2.2-1from 3GPP TR 36.211 V13.1.0 illustrating a downlink resource grid.

[0011] FIG. 6 is a reproduction of Table 6.2.3-1 from 3GPP TR 36.211 V13.1.0 providing physical resource block parameters.

[0012] FIG. 7 is a reproduction of Table 6.12-1 from 3GPP TR 36.211 V13.1.0 providing Orthogonal Frequency Division Multiplexing (OFDM) parameters.

[0013] FIG. 8 is a reproduction of FIG. 6.13-1from 3GPP TR 36.211 V13.1.0 illustrating downlink modulation.

[0014] FIG. 9 is a reproduction of FIG. 5.7.1-1from 3GPP TR 36.211 V13.1.0 illustrating a random access preamble format.

[0015] FIG. 10 is a reproduction of Table 5.7.1-1 from 3GPP TR 36.211 V13.1.0 providing random access preamble parameters.

[0016] FIG. 11 is a reproduction of Table 5.7.1-2 from 3GPP TR 36.211 V13.1.0 providing random access configurations for preamble formats 0-3.

[0017] FIG. 12 is a reproduction of Table 5.7.1-3 from 3GPP TR 36.211 V13.1.0 providing frame structure type 2 random access configurations for preamble formats 0-4.

[0018] FIG. 13 is a reproduction of Table 5.7.1-4 from 3GPP TR 36.211 V13.1.0 providing frame structure type 2 random access configurations for preamble formats 0-4.

[0019] FIG. 14 is a reproduction of Table 5.7.2-1 from 3GPP TR 36.211 V13.1.0 providing a random access sequence length.

[0020] FIG. 15 is a reproduction of Table 5.7.2-2 from 3GPP TR 36.211 V13.1.0 providing N_{CS} for preamble generation (preamble formats 0-3).

[0021] FIG. 16 is a reproduction of Table 5.7.2-3 from 3GPP TR 36.211 V13.1.0 providing N_{CS} for preamble generation (preamble format 4).

[0022] FIG. 17 is a reproduction of Table 5.7.2-4 from 3GPP TR 36.211 V13.1.0 providing Root Zadoff-Chu sequence order for preamble formats 0-3.

[0023] FIG. 18 is a reproduction of Table 5.7.2-5 from 3GPP TR 36.211 V13.1.0 providing Root Zadoff-Chu sequence order for preamble format 4.

[0024] FIG. 19 is a reproduction of Table 5.7.3-1 from 3GPP TR 36.211 V13.1.0 providing random access baseband parameters.

[0025] FIG. 20 is a reproduction of Table 6.6.2-1 from 3GPP TR 36.211 V13.1.0 providing PBCH modulation schemes.

[0026] FIG. 21 is a reproduction of Table 6.6.4-1 from 3GPP TR 36.211 V13.1.0 providing frame offset, slot and symbol number triplets for repetition of PBCH for frame structure type 1.

[0027] FIG. 22 is a reproduction of Table 6.6.4-2 from 3GPP TR 36.211 V13.1.0 providing slot and symbol number pairs for repetition of PBCH for frame structure type 2.

[0028] FIG. 23 is a reproduction of Figure 5.3.3-1 from 3GPP TS 36.212 V13.1.0 illustrating the processing structure for one DCI.

[0029] FIG. 24 is a reproduction of Table 5.3.3.1.2-1 from 3GPP TS 36.212 V13.1.0 providing ambiguous sizes of information bits.

[0030] FIG. 25 is a reproduction of Table 5.3.3.1.2-2 from 3GPP TS 36.212 V13.1.0 providing a number of bits for downlink assignment index.

[0031] FIG. 26 is a reproduction of Table 7-1 from 3GPP TS 36.213 V13.1.1 providing a maximum number of DL HARQ processes for TDD.

[0032] FIG. 27 is a reproduction of Table 7.1-1 from 3GPP TS 36.213 V13.1.1 providing PDCCH and PDSCH configured by SI-RNTI.

[0033] FIG. 28 is a reproduction of Table 7.1-2 from 3GPP TS 36.213 V13.1.1 providing PDCCH and PDSCH configured by P-RNTI.

[0034] FIG. 29 is a reproduction of Table 7.1-3 from 3GPP TS 36.213 V13.1.1 providing PDCCH and PDSCH configured by RA-RNTI.

[0035] FIG. 30 is a reproduction of Table 7.1-4 from 3GPP TS 36.213 V13.1.1 providing PDCCH and PDSCH configured by G-RNTI or SC-RNTI.

[0036] FIG. 31 is a reproduction of Table 7.1-5 from 3GPP TS 36.213 V13.1.1 providing PDCCH and PDSCH configured by C-RNTI.

[0037] FIG. 32 is a reproduction of Table 7.1-7 from 3GPP TS 36.213 V13.1.1 providing PDCCH and PDSCH configured by Temporary C-RNTI.

[0038] FIG. 33 is a reproduction of Table 7.1.6-1 from 3GPP TS 36.213 V13.1.1 providing number repetitions for PDSCH carrying *SystemInformationBlockType1-BR* for BL/CE UE.

[0039] FIG. 34 is a reproduction of Table 7.1.6.1-1 from 3GPP TS 36.213 V13.1.1 providing Type 0 resource allocation RBG size vs. Downlink System Bandwidth.

[0040] FIG. 35 is a reproduction of Table 7.1.6.3-1 from 3GPP TS 36.213 V13.1.1 providing $N_{\mathrm{RB}}^{\mathrm{step}}$ values vs. Downlink System Bandwidth.

[0041] FIG. 36 is a reproduction of Table 8-1 from 3GPP TS 36.213 V13.1.1 providing a number of synchronous UL HARQ processes for TDD.

[0042] FIG. 37 is a reproduction of Table 8-3 from 3GPP TS 36.213 V13.1.1 providing PDCCH and PUSCH configured by Temporary C-RNTI.

[0043] FIG. 38 is a reproduction of Table 8-4 from 3GPP TS 36.213 V13.1.1 providing PDCCH configured as a "PDCCH order" to initiate random access procedure.

[0044] FIG. 39 is a reproduction of Table 8-6 from 3GPP TS 36.213 V13.1.1 providing PDCCH configured by Temporary C-RNTI.

[0045] FIG. 40 is a reproduction of Table 8-7 from 3GPP TS 36.213 V13.1.1 providing PDCCH configured by TPC-PUCCH-RNTI.

[0046] FIG. 41 is a reproduction of Table 8-8 from 3GPP TS 36.213 V13.1.1 providing PDCCH configured by TPC-PUSCH-RNTI.

[0047] FIG. 42 is a reproduction of Table 8.1.3-1 from 3GPP TS 36.213 V13.1.1 providing resource block(s) allocation for BL/CE UE configured with CEModeB.

[0048] FIG. 43 is a reproduction of Table 9.1.1-1 from 3GPP TS 36.213 V13.1.1 providing PDCCH candidates monitored by a UE.

[0049] FIG. 44 is a reproduction of Table 9.1.1-1A from 3GPP TS 36.213 V13.1.1 providing PDCCH UE-specific search space candidates monitored by a UE on LAA Scell.

[0050] FIG. 45 is a reproduction of Table 9.1.1-2 from 3GPP TS 36.213 V13.1.1 providing scaling factor for PDCCH candidates reduction.

[0051] FIG. 46 illustrates one exemplary embodiment of adjusting bandwidth and frequency location for each numerology.

[0052] FIG. 47 illustrates on exemplary embodiment of the assumed bandwidth of a numerology and scheduling resources of the UE on the numerology.

[0053] FIG. 48 is a flow diagram for one exemplary embodiment from the perspective of a UE.

[0054] FIG. 49 is a flow diagram for one exemplary embodiment from the perspective of a network.

DETAILED DESCRIPTION

[0055] The exemplary wireless communication systems and devices described below employ a wireless communication system, supporting a broadcast service. Wireless communication systems are widely deployed to provide various types of communication such as voice, data, and so on. These systems may be based on code division multiple access (CDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), 3GPP LTE (Long Term Evolution) wireless access, 3GPP LTE-A or LTE-Advanced (Long Term Evolution Advanced), 3GPP2 UMB (Ultra Mobile Broadband), WiMax, or some other modulation techniques.

[0056] In particular, the exemplary wireless communication systems devices described below may be designed to support one or more standards such as the standard offered by a consortium named "3rd Generation Partnership Project" referred to herein as 3GPP, including: RP-150465, "New SI proposal: Study on Latency reduction techniques for LTE"; TR 36.211 V13.1.0, "E-UTRA Study on latency reduction techniques for LTE (Release 13)"; TS 36.331, V13.2.0, "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 13)"; TS 36.212 v13.1.0, "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding (Release 13)"; and TS 36.213 v13.1.1, "E-UTRA Physical layer procedures (Release 13)". The standards and documents listed above are hereby expressly incorporated by reference in their entirety.

[0057] FIG. 1 shows a multiple access wireless communication system according to one embodiment of the invention. An access network 100 (AN) includes multiple antenna groups, one including 104 and 106, another including 108 and 110, and an additional including 112 and 114. In FIG. 1, only two antennas are shown for each antenna group, however, more or fewer antennas may be utilized for each antenna group. Access terminal 116 (AT) is in communication with antennas 112 and 114, where antennas 112 and 114 transmit information to access terminal 116 over forward link 120 and receive information from access terminal 116 over reverse link 118. Access terminal (AT) 122 is in communication with antennas 106 and 108, where antennas

106 and 108 transmit information to access terminal (AT) 122 over forward link 126 and receive information from access terminal (AT) 122 over reverse link 124. In a FDD system, communication links 118, 120, 124 and 126 may use different frequency for communication. For example, forward link 120 may use a different frequency then that used by reverse link 118.

[0058] Each group of antennas and/or the area in which they are designed to communicate is often referred to as a sector of the access network. In the embodiment, antenna groups each are designed to communicate to access terminals in a sector of the areas covered by access network 100.

[0059] In communication over forward links 120 and 126, the transmitting antennas of access network 100 may utilize beamforming in order to improve the signal-to-noise ratio of forward links for the different access terminals 116 and 122. Also, an access network using beamforming to transmit to access terminals scattered randomly through its coverage causes less interference to access terminals in neighboring cells than an access network transmitting through a single antenna to all its access terminals.

[0060] An access network (AN) may be a fixed station or base station used for communicating with the terminals and may also be referred to as an access point, a Node B, a base station, an enhanced base station, an evolved Node B (eNB), or some other terminology. An access terminal (AT) may also be called user equipment (UE), a wireless communication device, terminal, access terminal or some other terminology.

[0061] FIG. 2 is a simplified block diagram of an embodiment of a transmitter system 210 (also known as the access network) and a receiver system 250 (also known as access terminal (AT) or user equipment (UE) in a MIMO system 200. At the transmitter system 210, traffic data for a number of data streams is provided from a data source 212 to a transmit (TX) data processor 214.

[0062] In one embodiment, each data stream is transmitted over a respective transmit antenna. TX data processor 214 formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0063] The coded data for each data stream may be multiplexed with pilot data using OFDM techniques. The pilot data is typically a known data pattern that is processed in a known manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on a particular modulation scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions performed by processor 230.

[0064] The modulation symbols for all data streams are then provided to a TX MIMO processor 220, which may further process the modulation symbols (e.g., for OFDM). TX MIMO processor 220 then provides N_T modulation symbol streams to N_T transmitters (TMTR) 222a through 222t. In certain embodiments, TX MIMO processor 220 applies beamforming weights to the symbols of the data streams and to the antenna from which the symbol is being transmitted.

[0065] Each transmitter 222 receives and processes a respective symbol stream to provide one or more analog signals, and further conditions (e.g., amplifies, filters, and upconverts) the analog signals to provide a modulated signal suitable for transmission over the MIMO channel. N_T modulated signals from transmitters 222a through 222t are then transmitted from N_T antennas 224a through 224t, respectively.

[0066] At receiver system 250, the transmitted modulated signals are received by N_R antennas 252a through 252r and the received signal from each antenna 252 is provided to a respective receiver (RCVR) 254a through 254r. Each receiver 254 conditions (e.g., filters, amplifies, and downconverts) a respective received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding "received" symbol stream.

[0067] An RX data processor 260 then receives and processes the N_R received symbol streams from N_R receivers 254 based on a particular receiver processing technique to provide N_T "detected" symbol streams. The RX data processor 260 then demodulates, deinterleaves, and decodes each detected symbol stream to recover the traffic data for the data stream. The

processing by RX data processor 260 is complementary to that performed by TX MIMO processor 220 and TX data processor 214 at transmitter system 210.

[0068] A processor 270 periodically determines which pre-coding matrix to use (discussed below). Processor 270 formulates a reverse link message comprising a matrix index portion and a rank value portion.

[0069] The reverse link message may comprise various types of information regarding the communication link and/or the received data stream. The reverse link message is then processed by a TX data processor 238, which also receives traffic data for a number of data streams from a data source 236, modulated by a modulator 280, conditioned by transmitters 254a through 254r, and transmitted back to transmitter system 210.

[0070] At transmitter system 210, the modulated signals from receiver system 250 are received by antennas 224, conditioned by receivers 222, demodulated by a demodulator 240, and processed by a RX data processor 242 to extract the reserve link message transmitted by the receiver system 250. Processor 230 then determines which pre-coding matrix to use for determining the beamforming weights then processes the extracted message.

[0071] Turning to FIG. 3, this figure shows an alternative simplified functional block diagram of a communication device according to one embodiment of the invention. As shown in FIG. 3, the communication device 300 in a wireless communication system can be utilized for realizing the UEs (or ATs) 116 and 122 in FIG. 1 or the base station (or AN) 100 in FIG. 1, and the wireless communications system is preferably the LTE system. The communication device 300 may include an input device 302, an output device 304, a control circuit 306, a central processing unit (CPU) 308, a memory 310, a program code 312, and a transceiver 314. The control circuit 306 executes the program code 312 in the memory 310 through the CPU 308, thereby controlling an operation of the communications device 300. The communications device 300 can receive signals input by a user through the input device 302, such as a keyboard or keypad, and can output images and sounds through the output device 304, such as a monitor or speakers. The transceiver 314 is used to receive and transmit wireless signals, delivering received signals to the control circuit 306, and outputting signals generated by the control circuit

306 wirelessly. The communication device 300 in a wireless communication system can also be utilized for realizing the AN 100 in FIG. 1.

[0072] FIG. 4 is a simplified block diagram of the program code 312 shown in FIG. 3 in accordance with one embodiment of the invention. In this embodiment, the program code 312 includes an application layer 400, a Layer 3 portion 402, and a Layer 2 portion 404, and is coupled to a Layer 1 portion 406. The Layer 3 portion 402 generally performs radio resource control. The Layer 2 portion 404 generally performs link control. The Layer 1 portion 406 generally performs physical connections.

[0073] Packet data latency is one of the important metrics for performance evaluation. Reducing packet data latency improves the system performance. In 3GPP RP-150465, the study item aims to investigate and standardize some techniques of latency reduction.

[0074] According to 3GPP RP-150465, the objective is to study enhancements to the E-UTRAN radio system in order to significantly reduce the packet data latency over the LTE Uu air interface for an active UE and significantly reduce the packet data transport round trip latency for UEs that have been inactive for a longer period (in connected state). The study area includes resource efficiency, including air interface capacity, battery lifetime, control channel resources, specification impact and technical feasibility. Both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes are considered.

[0075] According to 3GPP RP-150465, the two areas studied and documented are as follows:

- Fast uplink access solutions

  For active UEs and UEs that have been inactive a long time, but are kept in Radio Resource Control (RRC) Connected, the focus should be on reducing user plane latency for the scheduled Uplink (UL) transmission and getting a more resource efficient solution with protocol and signaling enhancements, compared to the pre-scheduling solutions allowed by the standard today, both with and without preserving the current Transmission Time Interval (TTI) length and processing times

- TTI shortening and reduced processing times

Assess specification impact and study feasibility and performance of TTI lengths between 0.5ms and one Orthogonal Frequency Division Multiplexing (OFDM) symbol, taking into account impact on reference signals and physical layer control signaling

[0076] TTI shortening and processing time reduction can be considered as an effective solution for reducing latency as the time unit for transmission can be reduced, for example, from 1 ms (14 OFDM) symbol to 1~7 OFDM symbols and the delay caused by decoding can be reduced as well. Another benefit of shortening TTI length is to support a finer granularity of transport block (TB) size so that unnecessary padding can be reduced. On the other hand, reducing the length of TTI may also have significant impact to current system design as the physical channels are developed based on a 1ms structure. A shortened TTI is also called an sTTI.

[0077] 3GPP RP-150465 discloses a frame structure used in New RAT (NR) for 5G that accommodates various types of requirements for time and frequency resource such as, for example, ultra-low latency (~0.5 ms) to delay-tolerant traffic for machine-type communication (MTC), high peak rate for enhanced mobile broadband (eMBB) to very low data rate for MTC. An important focus of this study is low latency aspect, e.g. short TTI, while another aspect of mixing/adapting different TTIs is also considered in the study. In addition to diverse services and requirements, forward compatibility is an important consideration in initial NR frame structure design as not all features of NR would be included in the beginning phase/release.

[0078] Reducing latency of a protocol is an important improvement between the different generations/releases. This can improve efficiency and meet new application requirements such as real-time service. One method adopted to reduce latency is to reduce the length of TTIs, from 10 ms in 3G to 1 ms in LTE. In the context of LTE-A Pro in REl-14, SI/WI was proposed to reduce the TTI to sub-ms level (e.g., 0.1~0.5 ms) by reducing the number of OFDM symbols within a TTI without changing any existing LTE numerology (i.e., there is only one numerology in LTE). This improvement can be used to solve the TCP slow start issue, extremely low but frequent traffic, or to meet foreseen ultra-low latency in NR to some extent. Processing time reduction is another consideration to reduce the latency. The study has not yet concluded that whether short TTI and short processing time always come together. The study suffers from some

limitation, as the method adopted should preserve backward compatibility, e.g. the existence of legacy control region. As disclosed in 3GPP TR 36.211 V13.1.0, a brief description of LTE numerology is quoted as follows:

6 Downlink

6.1 Overview

The smallest time-frequency unit for downlink transmission is denoted a resource element and is defined in clause 6.2.2.

A subset of the downlink subframes in a radio frame on a carrier supporting PDSCH transmission can be configured as MBSFN subframes by higher layers. Each MBSFN subframe is divided into a non-MBSFN region and an MBSFN region.

- The non-MBSFN region spans the first one or two OFDM symbols in an MBSFN subframe where the length of the non-MBSFN region is given according to Subclause 6.7.
- The MBSFN region in an MBSFN subframe is defined as the OFDM symbols not used for the non-MBSFN region.

For frame structure type 3, MBSFN configuration shall not be applied to downlink subframes in which at least one OFDM symbol is not occupied or discovery signal is transmitted.
Unless otherwise specified, transmission in each downlink subframe shall use the same cyclic prefix length as used for downlink subframe #0.

6.1.1 Physical channels

A downlink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 3GPP TS 36.212 and the present document 3GPP TS 36.211.
The following downlink physical channels are defined:

- Physical Downlink Shared Channel, PDSCH
- Physical Broadcast Channel, PBCH
- Physical Multicast Channel, PMCH

- Physical Control Format Indicator Channel, PCFICH
- Physical Downlink Control Channel, PDCCH
- Physical Hybrid ARQ Indicator Channel, PHICH
- Enhanced Physical Downlink Control Channel, EPDCCH
- MTC Physical Downlink Control Channel, MPDCCH

6.1.2 Physical signals

A downlink physical signal corresponds to a set of resource elements used by the physical layer but does not carry information originating from higher layers. The following downlink physical signals are defined:

- Reference signal
- Synchronization signal
- Discovery signal

6.2 Slot structure and physical resource elements

6.2.1 Resource grid

The transmitted signal in each slot is described by one or several resource grids of $N_{RB}^{DL} N_{sc}^{RB}$ subcarriers and N_{symb}^{DL} OFDM symbols. The resource grid structure is illustrated in Figure 6.2.2-1. The quantity N_{RB}^{DL} depends on the downlink transmission bandwidth configured in the cell and shall fulfil

$$N_{RB}^{min,DL} \le N_{RB}^{DL} \le N_{RB}^{max,DL}$$

where $N_{RB}^{min,DL} = 6$ and $N_{RB}^{max,DL} = 110$ are the smallest and largest downlink bandwidths, respectively, supported by the current version of this specification.

The set of allowed values for N_{RB}^{DL} is given by 3GPP TS 36.104. The number of OFDM symbols in a slot depends on the cyclic prefix length and subcarrier spacing configured and is given in FIG. 6 (a reproduction of Table 6.2.3-1 from 3GPP TR 36.211 V13.1.0).

An antenna port is defined such that the channel over which a symbol on the antenna port is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed. For MBSFN reference signals, positioning reference signals, UE-specific reference signals associated with PDSCH and demodulation reference signals associated with EPDCCH, there are limits given below within which the channel can be inferred from one symbol to another symbol on the same antenna port. There is one resource grid per antenna port. The set of antenna ports supported depends on the reference signal configuration in the cell:

- Cell-specific reference signals support a configuration of one, two, or four antenna ports and are transmitted on antenna ports $p=0$, $p\in\{0,1\}$, and $p\in\{0,1,2,3\}$, respectively.

- MBSFN reference signals are transmitted on antenna port $p=4$. The channel over which a symbol on antenna port $p=4$ is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to subframes of the same MBSFN area.

- UE-specific reference signals associated with PDSCH are transmitted on antenna port(s) $p=5$, $p=7$, $p=8$, or one or several of $p\in\{7,8,9,10,11,12,13,14\}$. The channel over which a symbol on one of these antenna ports is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols are within the same subframe and in the same PRG when PRB bundling is used or in the same PRB pair when PRB bundling is not used.

- Demodulation reference signals associated with EPDCCH are transmitted on one or several of $p\in\{107,108,109,110\}$. The channel over which a symbol on one of these antenna ports is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols are in the same PRB pair.

- Positioning reference signals are transmitted on antenna port $p=6$. The channel over which a symbol on antenna port $p=6$ is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only within one positioning

reference signal occasion consisting of N_{PRS} consecutive downlink subframes, where N_{PRS} is configured by higher layers.

- CSI reference signals support a configuration of one, two, four, eight, twelve, or sixteen antenna ports and are transmitted on antenna ports $p=15$, $p=15,16$, $p=15,...,18$, $p=15,...,22$, $p=15,...,26$ and $p=15,...,30$, respectively.

Two antenna ports are said to be quasi co-located if the large-scale properties of the channel over which a symbol on one antenna port is conveyed can be inferred from the channel over which a symbol on the other antenna port is conveyed. The large-scale properties include one or more of delay spread, Doppler spread, Doppler shift, average gain, and average delay.

6.2.2 Resource elements

Each element in the resource grid for antenna port p is called a resource element and is uniquely identified by the index pair (k,l) in a slot where $k=0,...,N_{\text{RB}}^{\text{DL}}N_{\text{sc}}^{\text{RB}}-1$ and $l=0,...,N_{\text{symb}}^{\text{DL}}-1$ are the indices in the frequency and time domains, respectively. Resource element (k,l) on antenna port p corresponds to the complex value $a_{k,l}^{(p)}$.

When there is no risk for confusion, or no particular antenna port is specified, the index p may be dropped.

6.2.3 Resource blocks

Resource blocks are used to describe the mapping of certain physical channels to resource elements. Physical and virtual resource blocks are defined.

A physical resource block is defined as $N_{\text{symb}}^{\text{DL}}$ consecutive OFDM symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{DL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by FIG. 6(a reproduction of Table 6.2.3-1 from 3GPP TR 36.211 V13.1.0). A physical resource block thus consists of $N_{\text{symb}}^{\text{DL}}\times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Physical resource blocks are numbered from 0 to $N_{\mathrm{RB}}^{\mathrm{DL}}-1$ in the frequency domain. The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\mathrm{PRB}}=\left\lfloor \frac{k}{N_{\mathrm{sc}}^{\mathrm{RB}}} \right\rfloor$$

A physical resource-block pair is defined as the two physical resource blocks in one subframe having the same physical resource-block number n_{PRB}.

A virtual resource block is of the same size as a physical resource block. Two types of virtual resource blocks are defined:

- Virtual resource blocks of localized type
- Virtual resource blocks of distributed type

For each type of virtual resource blocks, a pair of virtual resource blocks over two slots in a subframe is assigned together by a single virtual resource block number, n_{VRB}.

<….>

6.12 OFDM baseband signal generation

The time-continuous signal $s_l^{(p)}(t)$ on antenna port p in OFDM symbol l in a downlink slot is defined by

$$s_l^{(p)}(t)=\sum_{k=-\left\lfloor N_{\mathrm{RB}}^{\mathrm{DL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2\right\rfloor}^{-1} a_{k^{(-)},l}^{(p)}\cdot e^{j2\pi k\Delta f\left(t-N_{\mathrm{CP},l}T_{\mathrm{s}}\right)}+\sum_{k=1}^{\left\lceil N_{\mathrm{RB}}^{\mathrm{DL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2\right\rceil} a_{k^{(+)},l}^{(p)}\cdot e^{j2\pi k\Delta f\left(t-N_{\mathrm{CP},l}T_{\mathrm{s}}\right)}$$

for $0\le t<(N_{\mathrm{CP},l}+N)\times T_{\mathrm{s}}$ where $k^{(-)}=k+\left\lfloor N_{\mathrm{RB}}^{\mathrm{DL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2\right\rfloor$ and $k^{(+)}=k+\left\lfloor N_{\mathrm{RB}}^{\mathrm{DL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2\right\rfloor-1$. The variable N equals 2048 for $\Delta f=15\,\mathrm{kHz}$ subcarrier spacing and 4096 for $\Delta f=7.5\,\mathrm{kHz}$ subcarrier spacing.

The OFDM symbols in a slot shall be transmitted in increasing order of l, starting with $l=0$, where OFDM symbol $l>0$ starts at time $\sum_{l'=0}^{l-1}(N_{\mathrm{CP},l'}+N)T_{\mathrm{s}}$ within the slot. In case the first OFDM symbol(s) in a slot use normal cyclic prefix and the remaining OFDM symbols use extended cyclic prefix, the starting position the OFDM symbols with extended cyclic prefix shall be identical to those in a slot where all OFDM symbols use extended cyclic prefix. Thus there

will be a part of the time slot between the two cyclic prefix regions where the transmitted signal is not specified.

FIG. 7(a reproduction of Table 6.12-1 from 3GPP TR 36.211 V13.1.0) lists the value of $N_{\mathrm{CP},l}$ that shall be used. Note that different OFDM symbols within a slot in some cases have different cyclic prefix lengths.

6.13 Modulation and upconversion

Modulation and upconversion to the carrier frequency of the complex-valued OFDM baseband signal for each antenna port is shown in Figure 6.13-1. The filtering required prior to transmission is defined by the requirements in 3GPP TS 36.104.

[0079] In LTE, there is only one downlink (DL) numerology defined for initial access, which is 15 KHz subcarrier spacing and the signal and channel to be acquired during initial access is based on 15 KHz numerology. To access a cell, the UE may need to acquire some fundamental information. For example, the UE first acquires time/frequency synchronization of cell, which is done during cell search or cell selection/reselection. The time/frequency synchronization can be obtained by receiving a synchronization signal, such as a primary synchronization signal (PSS) or a secondary synchronization signal (SSS). During synchronization, the center frequency of a cell is known, and the subframe/frame boundary is obtained. When PSS or SSS are acquired, the Cyclic prefix (CP) of the cell (e.g., normal CP or extended CP) and the duplex mode of the cell (e.g. FDD or TDD) can be obtained. When the master information block (MIB) carried on physical broadcast channel (PBCH) is received, some fundamental system information such as the system frame number (SFN), system bandwidth, physical control channel related information can be obtained. UE would receive the DL control channel (e.g. PDCCH) on proper resource elements and with proper payload size according to the system bandwidth and can acquire some more system information required to access the cell in system information block (SIB), such as whether the cell can be access, UL bandwidth and

frequency, random access parameter, and so on. UE then can perform random access and request the connection to the cell. After the connection set up is complete, UE would enter connected mode and be able to perform data transmission to the cell or perform data reception from the cell. The resource allocation for data reception and transmission is done according to system bandwidth (e.g. N_{RB}^{DL} **or** N_{RB}^{UL} in the following quotation) signaled in MIB or SIB. The following are quotations from 3GPP TR 36.211 V13.1.0, 3GPP TS 36.331, V13.2.0, 3GPP TS 36.212 v13.1.0, and 3GPP TS 36.213 v13.1.1 as follows:

Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in FIG. 10 (a reproduction of Table 5.7.1-1 from 3GPP TR 36.211 V13.1.0) and depend on the frame structure and the random access configuration. Higher layers control the preamble format.
The transmission of a random access preamble, if triggered by the MAC layer, is restricted to certain time and frequency resources. These resources are enumerated in increasing order of the subframe number within the radio frame and the physical resource blocks in the frequency domain such that index 0 correspond to the lowest numbered physical resource block and subframe within the radio frame. PRACH resources within the radio frame are indicated by a PRACH configuration index, where the indexing is in the order of appearance in FIG. 11 (a reproduction of Table 5.7.1-2 from 3GPP TR 36.211 V13.1.0) and FIG. 13 (a reproduction of Table 5.7.1-4 from 3GPP TR 36.211 V13.1.0).
For non-BL/CE UEs there is a single PRACH configuration with $n_{PRB\,offset}^{RA}$ given by the higher-layer parameter *prach-FrequencyOffset.*
For BL/CE UEs, for each PRACH coverage enhancement level, there is a PRACH configuration configured by higher layers with a PRACH configuration index (*prach-ConfigurationIndex*), a PRACH frequency offset $\bar{n}_{PRBoffset}^{RA}$ (*prach-FrequencyOffset*), a number of PRACH repetitions per attempt N_{rep}^{PRACH} (*numRepetitionPerPreambleAttempt*) and optionally a PRACH starting subframe

periodicity $N_{\text{start}}^{\text{PRACH}}$ (*prach-StartingSubframe*). PRACH of preamble format 0-3 is transmitted $N_{\text{rep}}^{\text{PRACH}} \geq 1$ times, whereas PRACH of preamble format 4 is transmitted one time only.

For BL/CE UEs and for each PRACH coverage enhancement level, if frequency hopping is enabled for a PRACH configuration by the higher-layer parameter *prach-HoppingConfig*, the value of the parameter $n_{\text{PRB offset}}^{\text{RA}}$ depends on the SFN and the PRACH configuration index and is given by

- In case the PRACH configuration index is such that a PRACH resource occurs in every radio frame when calculated as below from FIG. 11 (a reproduction of Table 5.7.1-2 from 3GPP TR 36.211 V13.1.0) or FIG. 13 (a reproduction of Table 5.7.1-4 from 3GPP TR 36.211 V13.1.0),

$$n_{\text{PRB offset}}^{\text{RA}} = \begin{cases} \overline{n}_{\text{PRB offset}}^{\text{RA}} & \text{if } n_f \bmod 2 = 0 \\ \left(\overline{n}_{\text{PRB offset}}^{\text{RA}} + f_{\text{PRB,hop}}^{\text{PRACH}}\right) \bmod N_{\text{RB}}^{\text{UL}} & \text{if } n_f \bmod 2 = 1 \end{cases}$$

- otherwise

$$n_{\text{PRB offset}}^{\text{RA}} = \begin{cases} \overline{n}_{\text{PRB offset}}^{\text{RA}} & \text{if } \left\lfloor \frac{n_f \bmod 4}{2} \right\rfloor = 0 \\ \left(\overline{n}_{\text{PRB offset}}^{\text{RA}} + f_{\text{PRB,hop}}^{\text{PRACH}}\right) \bmod N_{\text{RB}}^{\text{UL}} & \text{if } \left\lfloor \frac{n_f \bmod 4}{2} \right\rfloor = 1 \end{cases}$$

where n_f is the system frame number, $f_{\text{PRB,hop}}^{\text{PRACH}}$ corresponds to a cell-specific higher-layer parameter *prach-HoppingOffset*. If frequency hopping is not enabled for the PRACH configuration then $n_{\text{PRB offset}}^{\text{RA}} = \overline{n}_{\text{PRB offset}}^{\text{RA}}$.

For frame structure type 1 with preamble format 0-3, for each of the PRACH configurations there is at most one random access resource per subframe.

FIG. 11 (a reproduction of Table 5.7.1-2 from 3GPP TR 36.211 V13.1.0) lists the preamble formats according to FIG. 10 (a reproduction of Table 5.7.1-1 from 3GPP TR 36.211 V13.1.0) and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\text{TA}} = 0$, where N_{TA} is defined in clause 8.1. For PRACH configurations 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48,

49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble formats 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\,offset}^{RA}$.

For frame structure type 2 with preamble formats 0-4, for each of the PRACH configurations there might be multiple random access resources in an UL subframe (or UpPTS for preamble format 4) depending on the UL/DL configuration [see table 4.2-2]. FIG. 12 (a reproduction of Table 5.7.1-3 from 3GPP TR 36.211 V13.1.0) lists PRACH configurations allowed for frame structure type 2 where the configuration index corresponds to a certain combination of preamble format, PRACH density value, D_{RA} and version index, r_{RA}.

For frame structure type 2 with PRACH configuration indices 0, 1, 2, 20, 21, 22, 30, 31, 32, 40, 41, 42, 48, 49, 50, or with PRACH configuration indices 51, 53, 54, 55, 56, 57 in UL/DL configuration 3, 4, 5, the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell is less than $153600 \cdot T_s$. FIG. 13 (a reproduction of Table 5.7.1-4 from 3GPP TR 36.211 V13.1.0) lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{(0)}, t_{RA}^{(1)}, t_{RA}^{(2)})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{(0)} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{(1)} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where $t_{RA}^{(2)}$ is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where $t_{RA}^{(2)}$ is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_s$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE's uplink frame timing assuming $N_{TA} = 0$.

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{\mathrm{PRB}}^{\mathrm{RA}} = \begin{cases} n_{\mathrm{PRB\,offset}}^{\mathrm{RA}} + 6\left\lfloor \frac{f_{\mathrm{RA}}}{2} \right\rfloor, & \text{if } f_{\mathrm{RA}} \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 6 - n_{\mathrm{PRB\,offset}}^{\mathrm{RA}} - 6\left\lfloor \frac{f_{\mathrm{RA}}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where $N_{\mathrm{RB}}^{\mathrm{UL}}$ is the number of uplink resource blocks, $n_{\mathrm{PRB}}^{\mathrm{RA}}$ is the first physical resource block allocated to the PRACH opportunity considered and where $n_{\mathrm{PRB\,offset}}^{\mathrm{RA}}$ is the first physical resource block available for PRACH.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{\mathrm{PRB}}^{\mathrm{RA}} = \begin{cases} 6 f_{\mathrm{RA}}, & \text{if } \left((n_{\mathrm{f}} \bmod 2) \times (2 - N_{\mathrm{SP}}) + t_{\mathrm{RA}}^{(1)}\right) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 6(f_{\mathrm{RA}} + 1), & \text{otherwise} \end{cases}$$

where n_{f} is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

For BL/CE UEs, only a subset of the subframes allowed for preamble transmission are allowed as starting subframes for the $N_{\mathrm{rep}}^{\mathrm{PRACH}}$ repetitions. The allowed starting subframes for a PRACH configuration are determined as follows:

- Enumerate the subframes that are allowed for preamble transmission for the PRACH configuration as $n_{\mathrm{sf}}^{\mathrm{RA}} = 0,\ldots N_{\mathrm{sf}}^{\mathrm{RA}} - 1$ where $n_{\mathrm{sf}}^{\mathrm{RA}} = 0$ and $n_{\mathrm{sf}}^{\mathrm{RA}} = N_{\mathrm{sf}}^{\mathrm{RA}} - 1$ correspond to the two subframes allowed for preamble transmission with the smallest and the largest absolute subframe number $n_{\mathrm{sf}}^{\mathrm{abs}}$, respectively.

- If a PRACH starting subframe periodicity $N_{\mathrm{start}}^{\mathrm{PRACH}}$ is not provided by higher layers, the periodicity of the allowed starting subframes in terms of subframes allowed for preamble transmission is $N_{\mathrm{rep}}^{\mathrm{PRACH}}$. The allowed starting subframes defined over $n_{\mathrm{sf}}^{\mathrm{RA}} = 0,\ldots N_{\mathrm{sf}}^{\mathrm{RA}} - 1$ are given by $jN_{\mathrm{rep}}^{\mathrm{PRACH}}$ where $j = 0, 1, 2, \ldots$

- If a PRACH starting subframe periodicity $N_{\text{start}}^{\text{PRACH}}$ is provided by higher layers, it indicates the periodicity of the allowed starting subframes in terms of subframes allowed for preamble transmission. The allowed starting subframes defined over $jN_{\text{start}}^{\text{PRACH}} + N_{\text{rep}}^{\text{PRACH}}$ where $j = 0, 1, 2, \ldots$
- No starting subframe with absolute subframe number $n_{\text{sf}}^{\text{abs}} > 10240 - N_{\text{rep}}^{\text{PRACH}}$ is allowed.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found.

The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The uth root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{\text{ZC}}}}, \quad 0 \le n \le N_{\text{ZC}} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the uth root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{\text{CS}} - 1$ are defined by cyclic shifts according to

$$x_{u,v}(n) = x_u((n + C_v) \bmod N_{\text{ZC}})$$

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where the cyclic shift is given by

$$C_v = \begin{cases} vN_{\mathrm{CS}} & v = 0,1,\ldots,\lfloor N_{\mathrm{ZC}}/N_{\mathrm{CS}} \rfloor - 1, N_{\mathrm{CS}} \neq 0 \quad \text{for unrestricted sets} \\ 0 & N_{\mathrm{CS}} = 0 \quad \text{for unrestricted sets} \\ d_{\mathrm{start}} \lfloor v/n_{\mathrm{shift}}^{\mathrm{RA}} \rfloor + (v \bmod n_{\mathrm{shift}}^{\mathrm{RA}}) N_{\mathrm{CS}} & v = 0,1,\ldots,n_{\mathrm{shift}}^{\mathrm{RA}} n_{\mathrm{group}}^{\mathrm{RA}} + \overline{n}_{\mathrm{shift}}^{\mathrm{RA}} - 1 \quad \text{for restricted sets} \end{cases}$$

and N_{CS} is given by Tables 5.7.2-2 and 5.7.2-3 for preamble formats 0-3 and 4, respectively, where the parameter *zeroCorrelationZoneConfig* is provided by higher layers. The parameter *High-speed-flag* provided by higher layers determines if unrestricted set or restricted set shall be used.

The variable d_u is the cyclic shift corresponding to a Doppler shift of magnitude $1/T_{\mathrm{SEQ}}$ and is given by

$$d_u = \begin{cases} p & 0 \leq p < N_{\mathrm{ZC}}/2 \\ N_{\mathrm{ZC}} - p & \text{otherwise} \end{cases}$$

where p is the smallest non-negative integer that fulfils $(pu) \bmod N_{\mathrm{ZC}} = 1$. The parameters for restricted sets of cyclic shifts depend on d_u. For $N_{\mathrm{CS}} \leq d_u < N_{\mathrm{ZC}}/3$, the parameters are given by

$$\begin{aligned} n_{\mathrm{shift}}^{\mathrm{RA}} &= \lfloor d_u / N_{\mathrm{CS}} \rfloor \\ d_{\mathrm{start}} &= 2d_u + n_{\mathrm{shift}}^{\mathrm{RA}} N_{\mathrm{CS}} \\ n_{\mathrm{group}}^{\mathrm{RA}} &= \lfloor N_{\mathrm{ZC}} / d_{\mathrm{start}} \rfloor \\ \overline{n}_{\mathrm{shift}}^{\mathrm{RA}} &= \max\left(\left\lfloor (N_{\mathrm{ZC}} - 2d_u - n_{\mathrm{group}}^{\mathrm{RA}} d_{\mathrm{start}}) / N_{\mathrm{CS}} \right\rfloor, 0\right) \end{aligned}$$

For $N_{\mathrm{ZC}}/3 \leq d_u \leq (N_{\mathrm{ZC}} - N_{\mathrm{CS}})/2$, the parameters are given by

$$\begin{aligned} n_{\mathrm{shift}}^{\mathrm{RA}} &= \lfloor (N_{\mathrm{ZC}} - 2d_u) / N_{\mathrm{CS}} \rfloor \\ d_{\mathrm{start}} &= N_{\mathrm{ZC}} - 2d_u + n_{\mathrm{shift}}^{\mathrm{RA}} N_{\mathrm{CS}} \\ n_{\mathrm{group}}^{\mathrm{RA}} &= \lfloor d_u / d_{\mathrm{start}} \rfloor \\ \overline{n}_{\mathrm{shift}}^{\mathrm{RA}} &= \min\left(\max\left(\left\lfloor (d_u - n_{\mathrm{group}}^{\mathrm{RA}} d_{\mathrm{start}}) / N_{\mathrm{CS}} \right\rfloor, 0\right), n_{\mathrm{shift}}^{\mathrm{RA}}\right) \end{aligned}$$

For all other values of d_u, there are no cyclic shifts in the restricted set.

5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t) = \beta_{\text{PRACH}} \sum_{k=0}^{N_{ZC}-1} \sum_{n=0}^{N_{ZC}-1} x_{u,v}(n) \cdot e^{-j\frac{2\pi nk}{N_{ZC}}} \cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{RA}(t-T_{CP})}$$

where $0 \le t < T_{SEQ} + T_{CP}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in clause 6.1 in 3GPP TS 36.213 [4], and $k_0 = n_{\text{PRB}}^{\text{RA}} N_{\text{sc}}^{\text{RB}} - N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter $n_{\text{PRB}}^{\text{RA}}$ is derived from clause 5.7.1. The factor $K = \Delta f / \Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by FIG. 19 (a reproduction of Table 5.7.3-1 from 3GPP TR 36.211 V13.1.0).

<…>

Physical broadcast channel

The PBCH is not transmitted for frame structure type 3.

6.6.1 Scrambling

The block of bits $b(0),\ldots,b(M_{\text{bit}}-1)$, where M_{bit}, the number of bits transmitted on the physical broadcast channel, equals 1920 for normal cyclic prefix and 1728 for extended cyclic prefix, shall be scrambled with a cell-specific sequence prior to modulation, resulting in a block of scrambled bits $\tilde{b}(0),\ldots,\tilde{b}(M_{\text{bit}}-1)$ according to

$$\tilde{b}(i) = (b(i) + c(i)) \bmod 2$$

where the scrambling sequence $c(i)$ is given by clause 7.2. The scrambling sequence shall be initialised with $c_{\text{init}} = N_{\text{ID}}^{\text{cell}}$ in each radio frame fulfilling $n_{\text{f}} \bmod 4 = 0$.

6.6.2 Modulation

The block of scrambled bits $\tilde{b}(0),\ldots,\tilde{b}(M_{\text{bit}}-1)$ shall be modulated as described in clause 7.1, resulting in a block of complex-valued modulation symbols $d(0),\ldots,d(M_{\text{symb}}-1)$. FIG. 20 (a

reproduction of Table 6.6.2-1 from 3GPP TR 36.211 V13.1.0)specifies the modulation mappings applicable for the physical broadcast channel.

6.6.3 Layer mapping and precoding

The block of modulation symbols $d(0),...,d(M_{\text{symb}}-1)$ shall be mapped to layers according to one of clauses 6.3.3.1 or 6.3.3.3 with $M_{\text{symb}}^{(0)} = M_{\text{symb}}$ and precoded according to one of clauses 6.3.4.1 or 6.3.4.3, resulting in a block of vectors $y(i) = \left[y^{(0)}(i) \quad ... \quad y^{(P-1)}(i)\right]^T$, $i = 0,...,M_{\text{symb}}-1$, where $y^{(p)}(i)$ represents the signal for antenna port p and where $p = 0,...,P-1$ and the number of antenna ports for cell-specific reference signals $P \in \{1,2,4\}$.

6.6.4 Mapping to resource elements

The block of complex-valued symbols $y^{(p)}(0),...,y^{(p)}(M_{\text{symb}}-1)$ for each antenna port is transmitted during 4 consecutive radio frames starting in each radio frame fulfilling $n_{\text{f}} \bmod 4 = 0$ and shall be mapped in sequence starting with $y(0)$ to resource elements (k,l) constituting the core set of PBCH resource elements. The mapping to resource elements (k,l) not reserved for transmission of reference signals shall be in increasing order of first the index k, then the index l in slot 1 in subframe 0 and finally the radio frame number. The resource-element indices are given by

$$k = \frac{N_{\text{RB}}^{\text{DL}} N_{\text{sc}}^{\text{RB}}}{2} - 36 + k', \qquad k' = 0,1,...,71$$
$$l = 0,1,...,3$$

where resource elements reserved for reference signals shall be excluded. The mapping operation shall assume cell-specific reference signals for antenna ports 0-3 being present irrespective of the actual configuration. The UE shall assume that the resource elements assumed to be reserved for reference signals in the mapping operation above but not used for transmission of reference signal are not available for PDSCH transmission. The UE shall not make any other assumptions about these resource elements.

If a cell is configured with repetition of the physical broadcast channel

- symbols mapped to core resource element (k,l) in slot 1 in subframe 0 within a radio frame n_f according to the mapping operation above, and

- cell-specific reference signals in OFDM symbols l in slot 1 in subframe 0 within a radio frame n_f with l according to the mapping operation above

shall additionally be mapped to resource elements (k,l') in slot number n_s' within radio frame $n_f - i$ unless resource element (k,l') is used by CSI reference signals.

For frame structure type 1, l', n_s', and i are given by FIG. 21 (a reproduction of Table 6.6.4-1 from 3GPP TR 36.211 V13.1.0).

For frame structure type 2,

- if $N_{RB}^{DL} > 15$, l' and n_s' are given by FIG. 22 (a reproduction of Table 6.6.4-2 from 3GPP TR 36.211 V13.1.0) and $i = 0$;

- if $7 \le N_{RB}^{DL} \le 15$, l' and n_s' are given by FIG. 22 (a reproduction of Table 6.6.4-2 from 3GPP TR 36.211 V13.1.0) and $i = 0$, except that repetitions with $n_s' = 10$ and $n_s' = 11$ are not applied.

For both frame structure type 1 and frame structure type 2, repetition of the physical broadcast channel is not applicable if $N_{RB}^{DL} = 6$.

Resource elements already used for transmission of cell-specific reference signals in absence of repetition shall not be used for additional mapping of cell-specific reference signals.

<...>

– *MasterInformationBlock*

The *MasterInformationBlock* includes the system information transmitted on BCH.

Signalling radio bearer: N/A

RLC-SAP: TM

Logical channel: BCCH

Direction: E-UTRAN to UE

MasterInformationBlock

```
-- ASN1START

MasterInformationBlock ::=              SEQUENCE {
    dl-Bandwidth                        ENUMERATED {
                                            n6, n15, n25, n50, n75, n100},
    phich-Config                        PHICH-Config,
    systemFrameNumber                       BIT STRING (SIZE (8)),
    schedulingInfoSIB1-BR-r13               INTEGER (0..31),
    spare                               BIT STRING (SIZE (5))
}


-- ASN1STOP
```

***MasterInformationBlock* field descriptions**
dl-Bandwidth Parameter: transmission bandwidth configuration, N_{RB} in downlink, see TS 36.101 [42, table 5.6-1]. n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on.
phich-Config Specifies the PHICH configuration. If the UE is a BL UE or UE in CE, it shall ignore this field.
schedulingInfoSIB1-BR This field contains an index to a table that defines *SystemInformationBlockType1-BR* scheduling information. The table is specified in TS 36.213 [23, FIG. 33 (a reproduction of Table 7.1.6-1 from 3GPP TS 36.213 V13.1.1) and Table 7.1.7.2.7-1]. Value 0 means that *SystemInformationBlockType1-BR* is not scheduled.
systemFrameNumber Defines the 8 most significant bits of the SFN. As indicated in TS 36.211 [21, 6.6.1], the 2 least significant bits of the SFN are acquired implicitly in the P-BCH decoding, i.e. timing of 40ms P-BCH TTI indicates 2 least significant bits (within 40ms P-BCH TTI, the first radio frame: 00, the second radio frame: 01, the third radio frame: 10, the last radio frame: 11). One value applies for all serving cells of a Cell Group (i.e. MCG or SCG). The associated functionality is common (i.e. not performed independently for each cell).

[0080] The following is quoted from 3GPP TS 36.212 V13.1.0:

5.3.3 Downlink control information

A DCI transports downlink, uplink or sidelink scheduling information, requests for aperiodic CQI reports, LAA common information, notifications of MCCH change [6] or uplink power control commands for one cell and one RNTI. The RNTI is implicitly encoded in the CRC.

FIG. 23 (a reproduction of Figure 5.3.3-1 from 3GPP TS 36.212 V13.1.0) shows the processing structure for one DCI. The following coding steps can be identified:

- Information element multiplexing
- CRC attachment

- Channel coding
- Rate matching

The coding steps for DCI are shown in [FIG. 23].

5.3.3.1 DCI formats

The fields defined in the DCI formats below are mapped to the information bits a_0 to a_{A-1} as follows.

Each field is mapped in the order in which it appears in the description, including the zero-padding bit(s), if any, with the first field mapped to the lowest order information bit a_0 and each successive field mapped to higher order information bits. The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to a_0.

5.3.3.1.1 Format 0

DCI format 0 is used for the scheduling of PUSCH in one UL cell.

The following information is transmitted by means of the DCI format 0:

- Carrier indicator – 0 or 3 bits. This field is present according to the definitions in 3GPP TS 36.331, V13.2.0.
- Flag for format0/format1A differentiation – 1 bit, where value 0 indicates format 0 and value 1 indicates format 1A
- Frequency hopping flag – 1 bit as defined in section 8.4 of 3GPP TS 36.331, V13.2.0. This field is used as the MSB of the corresponding resource allocation field for resource allocation type 1.
- Resource block assignment and hopping resource allocation – $\left\lceil \log_2(N_{RB}^{UL}(N_{RB}^{UL}+1)/2) \right\rceil$ bits
  - For PUSCH hopping (resource allocation type 0 only):

- N_{UL_hop} MSB bits are used to obtain the value of $\tilde{n}_{PRB}(i)$ as indicated in section 8.4 of 3GPP TS 36.331, V13.2.0

- $\left(\left\lceil \log_2(N_{\mathrm{RB}}^{\mathrm{UL}}(N_{\mathrm{RB}}^{\mathrm{UL}}+1)/2)\right\rceil - N_{\mathrm{UL\_hop}}\right)$ bits provide the resource allocation of the first slot in the UL subframe

- For non-hopping PUSCH with resource allocation type 0:

- $\left(\left\lceil \log_2(N_{\mathrm{RB}}^{\mathrm{UL}}(N_{\mathrm{RB}}^{\mathrm{UL}}+1)/2)\right\rceil\right)$ bits provide the resource allocation in the UL subframe as defined in section 8.1.1 of 3GPP TS 36.331, V13.2.0

- For non-hopping PUSCH with resource allocation type 1:

- The concatenation of the frequency hopping flag field and the resource block assignment and hopping resource allocation field provides the resource allocation field in the UL subframe as defined in section 8.1.2 of 3GPP TS 36.331, V13.2.0

- Modulation and coding scheme and redundancy version – 5 bits as defined in section 8.6 of 3GPP TS 36.331, V13.2.0

- New data indicator – 1 bit

- TPC command for scheduled PUSCH – 2 bits as defined in section 5.1.1.1 of 3GPP TS 36.331, V13.2.0

- Cyclic shift for DM RS and OCC index – 3 bits as defined in section 5.5.2.1.1 of 3GPP TR 36.211 V13.1.0

- UL index – 2 bits as defined in sections 5.1.1.1, 7.2.1, 8 and 8.4 of 3GPP TS 36.331, V13.2.0 (this field is present only for TDD operation with uplink-downlink configuration 0)

- Downlink Assignment Index (DAI) – 2 bits as defined in section 7.3 of 3GPP TS 36.331, V13.2.0 (this field is present only for cases with TDD primary cell and either TDD operation with uplink-downlink configurations 1-6 or FDD operation)

- CSI request – 1, 2 or 3 bits as defined in section 7.2.1 of 3GPP TS 36.331, V13.2.0. The 2-bit field applies to UEs configured with no more than five DL cells and to

  - UEs that are configured with more than one DL cell and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in 3GPP TS 36.331, V13.2.0;

  - UEs that are configured by higher layers with more than one CSI process and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in 3GPP TS 36.331, V13.2.0;

  - UEs that are configured with two CSI measurement sets by higher layers with the parameter *csi-MeasSubframeSet,* and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in 3GPP TS 36.331, V13.2.0;

  the 3-bit field applies to UEs that are configured with more than five DL cells and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in 3GPP TS 36.331, V13.2.0;

  otherwise the 1-bit field applies

- SRS request – 0 or 1 bit. This field can only be present in DCI formats scheduling PUSCH which are mapped onto the UE specific search space given by the C-RNTI as defined in [3]. The interpretation of this field is provided in section 8.2 of 3GPP TS 36.331, V13.2.0

- Resource allocation type – 1 bit. This field is only present if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq N_{\mathrm{RB}}^{\mathrm{DL}}$. The interpretation of this field is provided in section 8.1 of 3GPP TS 36.331, V13.2.0

If the number of information bits in format 0 mapped onto a given search space is less than the payload size of format 1A for scheduling the same serving cell and mapped onto the same search space (including any padding bits appended to format 1A), zeros shall be appended to format 0 until the payload size equals that of format 1A.

5.3.3.1.2 Format 1

DCI format 1 is used for the scheduling of one PDSCH codeword in one cell.

The following information is transmitted by means of the DCI format 1:

- Carrier indicator – 0 or 3 bits. This field is present according to the definitions in 3GPP TS 36.331, V13.2.0.

- Resource allocation header (resource allocation type 0 / type 1) – 1 bit as defined in section 7.1.6 of 3GPP TS 36.331, V13.2.0

  If downlink bandwidth is less than or equal to 10 PRBs, there is no resource allocation header and resource allocation type 0 is assumed.

- Resource block assignment:

  - For resource allocation type 0 as defined in section 7.1.6.1 of 3GPP TS 36.331, V13.2.0:

    - $\lceil N_{RB}^{DL} / P \rceil$ bits provide the resource allocation

  - For resource allocation type 1 as defined in section 7.1.6.2 of 3GPP TS 36.331, V13.2.0:

    - $\lceil \log_2(P) \rceil$ bits of this field are used as a header specific to this resource allocation type to indicate the selected resource blocks subset

    - 1 bit indicates a shift of the resource allocation span

    - $\left(\lceil N_{RB}^{DL} / P \rceil - \lceil \log_2(P) \rceil - 1 \right)$ bits provide the resource allocation

    where the value of P depends on the number of DL resource blocks as indicated in section 7.1.6.1 of 3GPP TS 36.331, V13.2.0

- Modulation and coding scheme – 5 bits as defined in section 7.1.7 of 3GPP TS 36.331, V13.2.0

- HARQ process number – 3 bits (for cases with FDD primary cell), 4 bits (for cases with TDD primary cell)

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- New data indicator – 1 bit

- Redundancy version – 2 bits

- TPC command for PUCCH – 2 bits as defined in section 5.1.2.1 of 3GPP TS 36.331, V13.2.0

- Downlink Assignment Index – number of bits as specified in FIG. 25 (a reproduction of Table 5.3.3.1.2-2 from 3GPP TS 36.212 V13.1.0).

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in section 10.1 of 3GPP TS 36.331, V13.2.0. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

If the UE is not configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1 is equal to that for format 0/1A, one bit of value zero shall be appended to format 1.

If the UE is configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1 is equal to that for format 0/1A for scheduling the same serving cell and mapped onto the UE specific search space given by the C-RNTI as defined in 3GPP TS 36.331, V13.2.0, one bit of value zero shall be appended to format 1.

If the number of information bits in format 1 carried by PDCCH belongs to one of the sizes in FIG. 24 (a reproduction of Table 5.3.3.1.2-1 from 3GPP TS 36.212 V13.1.0), one or more zero bit(s) shall be appended to format 1 until the payload size of format 1 does not belong to one of the sizes in FIG. 24 (a reproduction of Table 5.3.3.1.2-1 from 3GPP TS 36.212 V13.1.0) and is not equal to that of format 0/1A mapped onto the same search space.

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5.3.3.1.3 Format 1A

DCI format 1A is used for the compact scheduling of one PDSCH codeword in one cell and random access procedure initiated by a PDCCH order. The DCI corresponding to a PDCCH order can be carried by PDCCH or EPDCCH.

The following information is transmitted by means of the DCI format 1A:

- Carrier indicator – 0 or 3 bits. This field is present according to the definitions in [3].

- Flag for format0/format1A differentiation – 1 bit, where value 0 indicates format 0 and value 1 indicates format 1A

Format 1A is used for random access procedure initiated by a PDCCH order only if format 1A CRC is scrambled with C-RNTI and all the remaining fields are set as follows:

- Localized/Distributed VRB assignment flag – 1 bit is set to '0'

- Resource block assignment – $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits, where all bits shall be set to 1

- Preamble Index – 6 bits

- PRACH Mask Index – 4 bits, [5]

- All the remaining bits in format 1A for compact scheduling assignment of one PDSCH codeword are set to zero

Otherwise,

- Localized/Distributed VRB assignment flag – 1 bit as defined in 7.1.6.3 of [3]

- Resource block assignment – $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits as defined in section 7.1.6.3 of [3]:

  - For localized VRB:

    $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation

  - For distributed VRB:

- If $N_{RB}^{DL} < 50$ or if the format 1A CRC is scrambled by RA-RNTI, P-RNTI, SI-RNTI, SC-RNTI or G-RNTI:

  - $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation

- Else

  - 1 bit, the MSB indicates the gap value, where value 0 indicates $N_{gap} = N_{gap,1}$ and value 1 indicates $N_{gap} = N_{gap,2}$

  - $(\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil - 1)$ bits provide the resource allocation,

  where N_{gap} is defined in [2].

- Modulation and coding scheme – 5bits as defined in section 7.1.7 of [3]

- HARQ process number – 3 bits (for cases with FDD primary cell) , 4 bits (for cases with TDD primary cell)

- New data indicator – 1 bit

  - If the format 1A CRC is scrambled by RA-RNTI, P-RNTI, SI-RNTI, SC-RNTI or G-RNTI:

    - If $N_{RB}^{DL} \geq 50$ and Localized/Distributed VRB assignment flag is set to 1

      - the new data indicator bit indicates the gap value, where value 0 indicates $N_{gap} = N_{gap,1}$ and value 1 indicates $N_{gap} = N_{gap,2}$.

    - Else the new data indicator bit is reserved.

  - Else

    - The new data indicator bit as defined in [5]

- Redundancy version – 2 bits

- TPC command for PUCCH – 2 bits as defined in section 5.1.2.1 of [3]

  - If the format 1A CRC is scrambled by RA-RNTI, P-RNTI, or SI-RNTI:

    - The most significant bit of the TPC command is reserved.

    - The least significant bit of the TPC command indicates column N_{PRB}^{1A} of the TBS table defined of [3].

    - If least significant bit is 0 then $N_{PRB}^{1A} = 2$ else $N_{PRB}^{1A} = 3$.

  - Else

    - The two bits including the most significant bit indicates the TPC command

- Downlink Assignment Index – number of bits as specified in FIG. 25 (a reproduction of Table 5.3.3.1.2-2 from 3GPP TS 36.212 V13.1.0).

- SRS request – 0 or 1 bit. This field can only be present in DCI formats scheduling PDSCH which are mapped onto the UE specific search space given by the C-RNTI as defined in [3]. The interpretation of this field is provided in section 8.2 of [3]

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in section 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

If the UE is not configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI, and the number of information bits in format 1A is less than that of format 0, zeros shall be appended to format 1A until the payload size equals that of format 0.

If the UE is configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1A mapped onto a given search space is less than that of format 0 for scheduling the same serving cell and mapped onto the same search space, zeros

shall be appended to format 1A until the payload size equals that of format 0, except when format 1A assigns downlink resource on a secondary cell without an uplink configuration associated with the secondary cell.

If the number of information bits in format 1A carried by PDCCH belongs to one of the sizes in FIG. 24 (a reproduction of Table 5.3.3.1.2-1 from 3GPP TS 36.212 V13.1.0), one zero bit shall be appended to format 1A.

When the format 1A CRC is scrambled with a RA-RNTI, P-RNTI, SI-RNTI, SC-RNTI or G-RNTI then the following fields among the fields above are reserved:

- HARQ process number
- Downlink Assignment Index (used for cases with TDD primary cell and either FDD operation or TDD operation, and is not present for cases with FDD primary cell and either FDD operation or TDD operation)

[0081] The following is quoted from 3GPP TS 36.213 V13.1.1:

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7 Physical downlink shared channel related procedures

If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG unless stated otherwise

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells', 'serving cell', and 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell or serving cells belonging to the MCG respectively unless stated otherwise. The terms 'subframe' and 'subframes' refer to subframe or subframes belonging to MCG.
- When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell' and 'serving cells' in this clause refer to secondary cell, secondary cells (not including the PSCell), serving cell, serving cells belonging to the SCG respectively unless stated otherwise. The term 'primary cell' in this clause refers to the PSCell of the SCG. The terms 'subframe' and 'subframes' refer to subframe or subframes belonging to SCG

If a UE is configured with a LAA Scell, the UE shall apply the procedures described in this clause assuming frame structure type 1 for the LAA Scell unless stated otherwise.

For FDD, there shall be a maximum of 8 downlink HARQ processes per serving cell.

<…>

The dedicated broadcast HARQ process defined in [8] is not counted as part of the maximum number of HARQ processes for FDD, TDD and FDD-TDD.

7.1 UE procedure for receiving the physical downlink shared channel

Except the subframes indicated by the higher layer parameter *mbsfn-SubframeConfigList* or by *mbsfn-SubframeConfigList-v12x0* or by *laa-SCellSubframeConfig* of serving cell c, a UE shall

- upon detection of a PDCCH of the serving cell with DCI format 1, 1A, 1B, 1C, 1D, 2, 2A, 2B, 2C, or 2D intended for the UE in a subframe, or
- upon detection of an EPDCCH of the serving cell with DCI format 1, 1A, 1B, 1D, 2, 2A, 2B, 2C, or 2D intended for the UE in a subframe

decode the corresponding PDSCH in the same subframe with the restriction of the number of transport blocks defined in the higher layers.

For BL/CE UEs configured with higher layer parameter *fddDownlinkOrTddSubframeBitmapLC,* the higher layer parameter indicates the set of BL/CE DL subframes.

For BL/CE UEs not configured with higher layer parameter *fddDownlinkOrTddSubframeBitmapLC,* subframes other than those indicated by the higher layer parameter *mbsfn-SubframeConfigList* are considered as BL/CE DL subframes.

A BL/CE UE shall upon detection of a MPDCCH with DCI format 6-1A, 6-1B, 6-2 intended for the UE, decode the corresponding PDSCH in one more BL/CE DL subframes as described in subclause 7.1.11, with the restriction of the number of transport blocks defined in the higher layers

If a UE is configured with more than one serving cell and if the frame structure type of any two configured serving cells is different, then the UE is considered to be configured for FDD-TDD carrier aggregation.

Except for MBMS reception, the UE is not required to monitor PDCCH with CRC scrambled by the SI-RNTI on the PSCell.

A UE may assume that positioning reference signals are not present in resource blocks in which it shall decode PDSCH according to a detected PDCCH with CRC scrambled by the SI-RNTI or P-RNTI with DCI format 1A or 1C intended for the UE.

A UE configured with the carrier indicator field for a given serving cell shall assume that the carrier indicator field is not present in any PDCCH of the serving cell in the common search space that is described in subclause 9.1. Otherwise, the configured UE shall assume that for the given serving cell the carrier indicator field is present in PDCCH/EPDCCH located in the UE specific search space described in subclause 9.1 when the PDCCH/EPDCCH CRC is scrambled by C-RNTI or SPS C-RNTI.

If a UE is configured by higher layers to decode PDCCH with CRC scrambled by the SI-RNTI, the UE shall decode the PDCCH and the corresponding PDSCH according to any of the combinations defined in FIG. 27 (a reproduction of Table 7.1-1 from 3GPP TS 36.213 V13.1.1). The scrambling initialization of PDSCH corresponding to these PDCCHs is by SI-RNTI.

If a UE is configured by higher layers to decode PDCCH with CRC scrambled by the P-RNTI, the UE shall decode the PDCCH and the corresponding PDSCH according to any of the combinations defined in FIG. 28 (a reproduction of Table 7.1-2 from 3GPP TS 36.213 V13.1.1). The scrambling initialization of PDSCH corresponding to these PDCCHs is by P-RNTI.

If a UE is configured by higher layers to decode MPDCCH with CRC scrambled by the P-RNTI, the UE shall decode the MPDCCH and any corresponding PDSCH according to any of the combinations defined in Table 7.1-2A.
The scrambling initialization of PDSCH corresponding to these MPDCCHs is by P-RNTI.

The UE is not required to monitor PDCCH with CRC scrambled by the P-RNTI on the PSCell.

<...>

If a UE is configured by higher layers to decode PDCCH with CRC scrambled by the RA-RNTI, the UE shall decode the PDCCH and the corresponding PDSCH according to any of the combinations defined in FIG. 29 (a reproduction of Table 7.1-3 from 3GPP TS 36.213 V13.1.1). The scrambling initialization of PDSCH corresponding to these PDCCHs is by RA-RNTI.

If a UE is configured by higher layers to decode MPDCCH with CRC scrambled by the RA-RNTI, the UE shall decode the MPDCCH and the corresponding PDSCH according to any of the combinations defined in Table 7.1-3A. The scrambling initialization of PDSCH corresponding to these MPDCCHs is by RA-RNTI.

When RA-RNTI and either C-RNTI or SPS C-RNTI are assigned in the same subframe, the UE is not required to decode a PDSCH on the primary cell indicated by a PDCCH/EPDCCH with a CRC scrambled by C-RNTI or SPS C-RNTI.

If a UE is configured by higher layers to decode PDCCH with CRC scrambled by the G-RNTI or SC-RNTI, the UE shall decode the PDCCH and the corresponding PDSCH according to any of the combinations defined in FIG. 30 (a reproduction of Table 7.1-4 from 3GPP TS 36.213 V13.1.1). The scrambling initialization of PDSCH corresponding to these PDCCHs is by G-RNTI or SC-RNTI.

The UE is semi-statically configured via higher layer signalling to receive PDSCH data transmissions signalled via PDCCH/EPDCCH according to one of the transmission modes, denoted mode 1 to mode 10.

For a BL/CE UE, the UE is semi-statically configured via higher layer signalling to receive PDSCH data transmissions signalled via MPDCCH according to one of the transmission modes: mode 1, mode 2, mode 6, and mode 9.

For LAA Scells, the UE is not expected to receive PDSCH data transmissions signalled via PDCCH/EPDCCH according to transmission modes 5,6,7.

For frame structure type 1,

- the UE is not expected to receive PDSCH resource blocks transmitted on antenna port 5 in any subframe in which the number of OFDM symbols for PDCCH with normal CP is equal to four;

- the UE is not expected to receive PDSCH resource blocks transmitted on antenna port 5, 7, 8, 9, 10, 11, 12, 13 or 14 in the two PRBs to which a pair of VRBs is mapped if either one of the two PRBs overlaps in frequency with a transmission of either PBCH or primary or secondary synchronization signals in the same subframe;

- the UE is not expected to receive PDSCH resource blocks transmitted on antenna port 7 for which distributed VRB resource allocation is assigned.

- The UE may skip decoding the transport block(s) if it does not receive all assigned PDSCH resource blocks except if it is capable of receiving the non-colliding PDSCH resource blocks in an assignment which partly collides in frequency with a transmission of PBCH or primary synchronization signal or secondary synchronization signal in the same subframes and that capability is indicated by *pdsch-CollisionHandling* [12]. If the UE skips decoding, the physical layer indicates to higher layer that the transport block(s) are not successfully decoded.

For frame structure type 2,

- the UE is not expected to receive PDSCH resource blocks transmitted on antenna port 5 in any subframe in which the number of OFDM symbols for PDCCH with normal CP is equal to four;

- the UE is not expected to receive PDSCH resource blocks transmitted on antenna port 5 in the two PRBs to which a pair of VRBs is mapped if either one of the two PRBs overlaps in frequency with a transmission of PBCH in the same subframe;

- the UE is not expected to receive PDSCH resource blocks transmitted on antenna port 7, 8, 9, 10, 11, 12, 13 or 14 in the two PRBs to which a pair of VRBs is mapped if either one of the two PRBs overlaps in frequency with a transmission of primary or secondary synchronization signals in the same subframe;

- with normal CP configuration, the UE is not expected to receive PDSCH on antenna port 5 for which distributed VRB resource allocation is assigned in the special subframe with configuration #1 or #6;

- the UE is not expected to receive PDSCH on antenna port 7 for which distributed VRB resource allocation is assigned;

- with normal cyclic prefix, the UE is not expected to receive PDSCH resource blocks transmitted on antenna port 5 in DwPTS when the UE is configured with special subframe configuration 9.

- The UE may skip decoding the transport block(s) if it does not receive all assigned PDSCH resource blocks except if it is capable of receiving the non-colliding PDSCH resource blocks in an assignment which partly collides in frequency with a transmission of PBCH or primary synchronization signal or secondary synchronization signal in the same subframe and that capability is indicated by *pdsch-CollisionHandling* [12]. If the UE skips decoding, the physical layer indicates to higher layer that the transport block(s) are not successfully decoded.

If a UE is configured by higher layers to decode PDCCH with CRC scrambled by the C-RNTI, the UE shall decode the PDCCH and any corresponding PDSCH according to the respective combinations defined in FIG. 31 (a reproduction of Table 7.1-5 from 3GPP TS 36.213 V13.1.1). The scrambling initialization of PDSCH corresponding to these PDCCHs is by C-RNTI.

If a UE is configured by higher layers to decode EPDCCH with CRC scrambled by the C-RNTI, the UE shall decode the EPDCCH and any corresponding PDSCH according to the respective combinations defined in Table 7.1-5A. The scrambling initialization of PDSCH corresponding to these EPDCCHs is by C-RNTI.

If a BL/CE UE is configured by higher layers to decode MPDCCH with CRC scrambled by the C-RNTI, the UE shall decode the MPDCCH and any corresponding PDSCH according to the respective combinations defined in Table 7.1-5B. The scrambling initialization of PDSCH corresponding to these MPDCCHs is by C-RNTI.

If a UE is configured with CEModeA, the UE shall decode MPDCCH DCI Format 6-1A. If the UE is configured with CEModeB, the UE shall decode MPDCCH DCI Format 6-1B.

If the UE is configured with the carrier indicator field for a given serving cell and, if the UE is configured by higher layers to decode PDCCH/EPDCCH with CRC scrambled by the C-RNTI, then the UE shall decode PDSCH of the serving cell indicated by the carrier indicator field value in the decoded PDCCH/EPDCCH.

When a UE configured in transmission mode 3, 4, 8, 9 or 10 receives a DCI Format 1A assignment, it shall assume that the PDSCH transmission is associated with transport block 1 and that transport block 2 is disabled.

When a UE is configured in transmission mode 7, scrambling initialization of UE-specific reference signals corresponding to these PDCCHs/EPDCCHs is by C-RNTI.

The UE does not support transmission mode 8 if extended cyclic prefix is used in the downlink.

When a UE is configured in transmission mode 9 or 10, in the downlink subframes indicated by the higher layer parameter *mbsfn-SubframeConfigList* or by *mbsfn-SubframeConfigList-v12x0* or by *laa-SCellSubframeConfig* of serving cell c except in subframes for the serving cell

- indicated by higher layers to decode PMCH or,
- configured by higher layers to be part of a positioning reference signal occasion and the positioning reference signal occasion is only configured within MBSFN subframes and the cyclic prefix length used in subframe #0 is normal cyclic prefix,

the UE shall upon detection of a PDCCH with CRC scrambled by the C-RNTI with DCI format 1A/2C/2D intended for the UE or, upon detection of an EPDCCH with CRC scrambled by the C-RNTI with DCI format 1A/2C/2D intended for the UE, decode the corresponding PDSCH in the same subframe.

A UE configured in transmission mode 10 can be configured with scrambling identities, $n_{\mathrm{ID}}^{\mathrm{DMRS},i}$, $i=0,1$ by higher layers for UE-specific reference signal generation as defined in subclause

6.10.3.1 of [3] to decode PDSCH according to a detected PDCCH/EPDCCH with CRC scrambled by the C-RNTI with DCI format 2D intended for the UE.

<...>

If a UE is configured by higher layers to decode PDCCH with CRC scrambled by the SPS C-RNTI, the UE shall decode the PDCCH on the primary cell and any corresponding PDSCH on the primary cell according to the respective combinations defined in Table 7.1-6. The same PDSCH related configuration applies in the case that a PDSCH is transmitted without a corresponding PDCCH. The scrambling initialization of PDSCH corresponding to these PDCCHs and PDSCH without a corresponding PDCCH is by SPS C-RNTI.

If a UE is configured by higher layers to decode EPDCCH with CRC scrambled by the SPS C-RNTI, the UE shall decode the EPDCCH on the primary cell and any corresponding PDSCH on the primary cell according to the respective combinations defined in Table 7.1-6A. The same PDSCH related configuration applies in the case that a PDSCH is transmitted without a corresponding EPDCCH. The scrambling initialization of PDSCH corresponding to these EPDCCHs and PDSCH without a corresponding EPDCCH is by SPS C-RNTI.

If a UE configured with CEModeA is configured by higher layers to decode MPDCCH with CRC scrambled by the SPS C-RNTI, the UE shall decode the MPDCCH on the primary cell and any corresponding PDSCH on the primary cell according to the respective combinations defined in Table 7.1-6B. The same PDSCH related configuration applies in the case that a PDSCH is transmitted without a corresponding MPDCCH. The scrambling initialization of PDSCH corresponding to these MPDCCHs and PDSCH without a corresponding MPDCCH is by SPS C-RNTI.

When a UE is configured in transmission mode 7, scrambling initialization of UE-specific reference signals for PDSCH corresponding to these PDCCHs/EPDCCHs and for PDSCH without a corresponding PDCCH/EPDCCH is by SPS C-RNTI.

When a UE is configured in transmission mode 9 or 10, in the downlink subframes indicated by the higher layer parameter *mbsfn-SubframeConfigList* or by *mbsfn-SubframeConfigList-v12x0* of serving cell c except in subframes for the serving cell

- indicated by higher layers to decode PMCH or,
- configured by higher layers to be part of a positioning reference signal occasion and the positioning reference signal occasion is only configured within MBSFN subframes and the cyclic prefix length used in subframe #0 is normal cyclic prefix,

the UE shall upon detection of a PDCCH with CRC scrambled by the SPS C-RNTI with DCI format 1A/2C/2D, or upon detection of a EPDCCH with CRC scrambled by the SPS C-RNTI with DCI format 1A/2C/2D, or for a configured PDSCH without PDCCH intended for the UE, decode the corresponding PDSCH in the same subframe.

A UE configured in transmission mode 10 can be configured with scrambling identities, $n_{\mathrm{ID}}^{\mathrm{DMRS},i}$, $i=0,1$ by higher layers for UE-specific reference signal generation as defined in subclause 6.10.3.1 of [3] to decode PDSCH according to a detected PDCCH/EPDCCH with CRC scrambled by the SPS C-RNTI with DCI format 2D intended for the UE.

For PDSCH without a corresponding PDCCH/EPDCCH, the UE shall use the value of n_{SCID} and the scrambling identity of $n_{\mathrm{ID}}^{(n_{\mathrm{SCID}})}$ (as defined in subclause 6.10.3.1 of [3]) derived from the DCI format 2D corresponding to the associated SPS activation for UE-specific reference signal generation.

<…>

If a UE is configured by higher layers to decode PDCCH with CRC scrambled by the Temporary C-RNTI and is not configured to decode PDCCH with CRC scrambled by the C-RNTI, the UE shall decode the PDCCH and the corresponding PDSCH according to the combination defined in Table 7.1-7. The scrambling initialization of PDSCH corresponding to these PDCCHs is by Temporary C-RNTI.

<….>

7.1.6 Resource allocation

The UE shall interpret the resource allocation field depending on the PDCCH/EPDCCH DCI format detected. A resource allocation field in each PDCCH/EPDCCH includes two parts, a resource allocation header field and information consisting of the actual resource block assignment.

PDCCH DCI formats 1, 2, 2A, 2B, 2C and 2D with type 0 and PDCCH DCI formats 1, 2, 2A, 2B, 2C and 2D with type 1 resource allocation have the same format and are distinguished from each other via the single bit resource allocation header field which exists depending on the downlink system bandwidth (subclause 5.3.3.1 of [4]), where type 0 is indicated by 0 value and type 1 is indicated otherwise. PDCCH with DCI format 1A, 1B, 1C and 1D have a type 2 resource allocation while PDCCH with DCI format 1, 2, 2A, 2B, 2C and 2D have type 0 or type 1 resource allocation. PDCCH DCI formats with a type 2 resource allocation do not have a resource allocation header field.

EPDCCH DCI formats 1, 2, 2A, 2B, 2C and 2D with type 0 and EPDCCH DCI formats 1, 2, 2A, 2B, 2C and 2D with type 1 resource allocation have the same format and are distinguished from each other via the single bit resource allocation header field which exists depending on the downlink system bandwidth (subclause 5.3.3.1 of [4]), where type 0 is indicated by 0 value and type 1 is indicated otherwise. EPDCCH with DCI format 1A, 1B, and 1D have a type 2 resource allocation while EPDCCH with DCI format 1, 2, 2A, 2B, 2C and 2D have type 0 or type 1 resource allocation. EPDCCH DCI formats with a type 2 resource allocation do not have a resource allocation header field.

MPDCCH with DCI format 6-1A a type 2 resource allocation. Resource allocation for PDCCH with DCI format 6-1B is given by the Resource block assignment field as described in [4]. MPDCCH with DCI format 6-2 assigns a set of six contiguously allocated localized virtual resource blocks within a narrowband. Localized virtual resource blocks are always used in case of MPDCCH with DCI format 6-1A, 6-1B, or 6-2.

A UE may assume, for any PDSCH transmission scheduled by a cell with physical cell identity given in *NAICS-AssistanceInfo-r12* and the PDSCH transmission mode belonging to

transmissionModeList-r12 associated with the cell except spatial multiplexing using up to 8 transmission layers in transmission mode 10, that the resource allocation granularity and precoding granularity in terms of PRB pairs in the frequency domain are both given by *N*, where *N* is given by the higher layer parameter *resAllocGranularity-r12* associated with the cell. The first set of *N* consecutive PRB pairs of the resource allocation starts from the lowest frequency of the system bandwidth and the UE may assume the same precoding applies to all PRB pairs within a set.

For a BL/CE UE, the resource allocation for PDSCH carrying *SystemInformationBlockType1-BR* and SI messages is a set of six contiguously allocated localized virtual resource blocks within a narrowband. The number of repetitions for the PDSCH carrying *SystemInformationBlockType1-BR* is determined based on the parameter *schedulingInfoSIB1-BR-r13* configured by higher-layers and according to FIG. 33 (a reproduction of Table 7.1.6-1 from 3GPP TS 36.213 V13.1.1). If the value of the parameter *schedulingInfoSIB1-BR-r13* configured by higher-layers is set to 0, UE assumes that *SystemInformationBlockType1-BR* is not transmitted.

7.1.6.1 Resource allocation type 0

In resource allocations of type 0, resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks (VRBs) of localized type as defined in subclause 6.2.3.1 of [3]. Resource block group size (*P*) is a function of the system bandwidth as shown in FIG. 34 (a reproduction of Table 7.1.6.1-1 from 3GPP TS 36.213 V13.1.1). The total number of RBGs (N_{RBG}) for downlink system bandwidth of $N_{\mathrm{RB}}^{\mathrm{DL}}$ is given by $N_{RBG} = \lceil N_{\mathrm{RB}}^{\mathrm{DL}} / P \rceil$ where $\lfloor N_{\mathrm{RB}}^{\mathrm{DL}} / P \rfloor$ of the RBGs are of size P and if $N_{\mathrm{RB}}^{\mathrm{DL}} \bmod P > 0$ then one of the RBGs is of size $N_{\mathrm{RB}}^{\mathrm{DL}} - P \cdot \lfloor N_{\mathrm{RB}}^{\mathrm{DL}} / P \rfloor$. The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency and non-increasing RBG sizes starting at the lowest frequency. The order of RBG to bitmap bit mapping is in such way that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped to MSB to LSB of the bitmap. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

7.1.6.2 Resource allocation type 1

In resource allocations of type 1, a resource block assignment information of size N_{RBG} indicates to a scheduled UE the VRBs from the set of VRBs from one of P RBG subsets. The virtual resource blocks used are of localized type as defined in subclause 6.2.3.1 of [3]. Also P is the RBG size associated with the system bandwidth as shown in FIG. 34 (a reproduction of Table 7.1.6.1-1 from 3GPP TS 36.213 V13.1.1). A RBG subset p, where $0 \le p < P$, consists of every P th RBG starting from RBG p. The resource block assignment information consists of three fields [4].

The first field with $\lceil \log_2(P) \rceil$ bits is used to indicate the selected RBG subset among P RBG subsets.

The second field with one bit is used to indicate a shift of the resource allocation span within a subset. A bit value of 1 indicates shift is triggered. Shift is not triggered otherwise.

The third field includes a bitmap, where each bit of the bitmap addresses a single VRB in the selected RBG subset in such a way that MSB to LSB of the bitmap are mapped to the VRBs in the increasing frequency order. The VRB is allocated to the UE if the corresponding bit value in the bit field is 1, the VRB is not allocated to the UE otherwise. The portion of the bitmap used to address VRBs in a selected RBG subset has size $N_{\mathrm{RB}}^{\mathrm{TYPE1}}$ and is defined as

$$N_{\mathrm{RB}}^{\mathrm{TYPE1}} = \left\lceil N_{\mathrm{RB}}^{\mathrm{DL}} / P \right\rceil - \lceil \log_2(P) \rceil - 1$$

The addressable VRB numbers of a selected RBG subset start from an offset, $\Delta_{\mathrm{shift}}(p)$ to the smallest VRB number within the selected RBG subset, which is mapped to the MSB of the bitmap. The offset is in terms of the number of VRBs and is done within the selected RBG subset. If the value of the bit in the second field for shift of the resource allocation span is set to 0, the offset for RBG subset p is given by $\Delta_{\mathrm{shift}}(p) = 0$. Otherwise, the offset for RBG subset p is given by $\Delta_{\mathrm{shift}}(p) = N_{\mathrm{RB}}^{\mathrm{RBG\,subset}}(p) - N_{\mathrm{RB}}^{\mathrm{TYPE1}}$, where the LSB of the bitmap is justified with the

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highest VRB number within the selected RBG subset. $N_{\mathrm{RB}}^{\mathrm{RBG\,subset}}(p)$ is the number of VRBs in RBG subset p and can be calculated by the following equation,

$$N_{\mathrm{RB}}^{\mathrm{RBG\,subset}}(p)=\begin{cases}\left\lfloor \frac{N_{\mathrm{RB}}^{\mathrm{DL}}-1}{P^2}\right\rfloor \cdot P+P & ,p<\left\lfloor \frac{N_{\mathrm{RB}}^{\mathrm{DL}}-1}{P}\right\rfloor \bmod P \\ \left\lfloor \frac{N_{\mathrm{RB}}^{\mathrm{DL}}-1}{P^2}\right\rfloor \cdot P+(N_{\mathrm{RB}}^{\mathrm{DL}}-1)\bmod P+1 & ,p=\left\lfloor \frac{N_{\mathrm{RB}}^{\mathrm{DL}}-1}{P}\right\rfloor \bmod P \\ \left\lfloor \frac{N_{\mathrm{RB}}^{\mathrm{DL}}-1}{P^2}\right\rfloor \cdot P & ,p>\left\lfloor \frac{N_{\mathrm{RB}}^{\mathrm{DL}}-1}{P}\right\rfloor \bmod P \end{cases}$$

Consequently, when RBG subset p is indicated, bit i for $i=0,1,\cdots,N_{\mathrm{RB}}^{\mathrm{TYPE1}}-1$ in the bitmap field indicates VRB number,

$$n_{\mathrm{VRB}}^{\mathrm{RBG\,subset}}(p)=\left\lfloor \frac{i+\Delta_{\mathrm{shift}}(p)}{P}\right\rfloor P^2+p\cdot P+\left(i+\Delta_{\mathrm{shift}}(p)\right)\bmod P\,.$$

7.1.6.3 Resource allocation type 2

For BL/CE UEs with resource allocation type 2 resource assignment, $N_{\mathrm{RB}}^{\mathrm{DL}}=6$ and $N_{\mathrm{VRB}}^{\mathrm{DL}}=6$ is used in the rest of this subclause.

In resource allocations of type 2, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated localized virtual resource blocks or distributed virtual resource blocks. In case of resource allocation signalled with PDCCH DCI format 1A, 1B or 1D, or for resource allocation signalled with EPDCCH DCI format 1A, 1B, or 1D, one bit flag indicates whether localized virtual resource blocks or distributed virtual resource blocks are assigned (value 0 indicates Localized and value 1 indicates Distributed VRB assignment) while distributed virtual resource blocks are always assigned in case of resource allocation signalled with PDCCH DCI format 1C. Localized VRB allocations for a UE vary from a single VRB up to a maximum number of VRBs spanning the system bandwidth. For DCI format 1A the distributed VRB allocations for a UE vary from a single VRB up to $N_{\mathrm{VRB}}^{\mathrm{DL}}$ VRBs, where $N_{\mathrm{VRB}}^{\mathrm{DL}}$ is defined in [3], if the DCI CRC is scrambled by P-RNTI, RA-RNTI, or SI-RNTI. With PDCCH DCI format

1B, 1D with a CRC scrambled by C-RNTI, or with DCI format 1A with a CRC scrambled with C-RNTI, SPS C-RNTI or Temporary C-RNTI distributed VRB allocations for a UE vary from a single VRB up to $N_{\mathrm{VRB}}^{\mathrm{DL}}$ VRBs if $N_{\mathrm{RB}}^{\mathrm{DL}}$ is 6-49 and vary from a single VRB up to 16 if $N_{\mathrm{RB}}^{\mathrm{DL}}$ is 50-110. With EPDCCH DCI format 1B, 1D with a CRC scrambled by C-RNTI, or with DCI format 1A with a CRC scrambled with C-RNTI, SPS C-RNTI distributed VRB allocations for a UE vary from a single VRB up to $N_{\mathrm{VRB}}^{\mathrm{DL}}$ VRBs if $N_{\mathrm{RB}}^{\mathrm{DL}}$ is 6-49 and vary from a single VRB up to 16 if $N_{\mathrm{RB}}^{\mathrm{DL}}$ is 50-110. With PDCCH DCI format 1C, distributed VRB allocations for a UE vary from $N_{\mathrm{RB}}^{\mathrm{step}}$ VRB(s) up to $\lfloor N_{\mathrm{VRB}}^{\mathrm{DL}} / N_{\mathrm{RB}}^{\mathrm{step}} \rfloor \cdot N_{\mathrm{RB}}^{\mathrm{step}}$ VRBs with an increment step of $N_{\mathrm{RB}}^{\mathrm{step}}$, where $N_{\mathrm{RB}}^{\mathrm{step}}$ value is determined depending on the downlink system bandwidth as shown in FIG. 35 (a reproduction of Table 7.1.6.3-1 from 3GPP TS 36.213 V13.1.1).

For PDCCH DCI format 1A, 1B or 1D, or for EPDCCH DCI format 1A, 1B, or 1D, or for MPDCCH DCI format 6-1A, a type 2 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting resource block (RB_{start}) and a length in terms of virtually contiguously allocated resource blocks L_{CRBs}. The resource indication value is defined by

if $(L_{CRBs} - 1) \leq \lfloor N_{RB}^{DL} / 2 \rfloor$ then

$$RIV = N_{RB}^{DL}(L_{CRBs} - 1) + RB_{start}$$

else

$$RIV = N_{RB}^{DL}(N_{RB}^{DL} - L_{CRBs} + 1) + (N_{RB}^{DL} - 1 - RB_{start})$$

where $L_{CRBs} \geq 1$ and shall not exceed $N_{VRB}^{DL} - RB_{start}$.

For PDCCH DCI format 1C, a type 2 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block ($RB_{start} = 0, N_{\mathrm{RB}}^{\mathrm{step}}, 2N_{\mathrm{RB}}^{\mathrm{step}}, \ldots, (\lfloor N_{\mathrm{VRB}}^{\mathrm{DL}} / N_{\mathrm{RB}}^{\mathrm{step}} \rfloor - 1) N_{\mathrm{RB}}^{\mathrm{step}}$) and a length in terms of virtually contiguously allocated resource blocks ($L_{CRBs} = N_{\mathrm{RB}}^{\mathrm{step}}, 2N_{\mathrm{RB}}^{\mathrm{step}}, \ldots, \lfloor N_{\mathrm{VRB}}^{\mathrm{DL}} / N_{\mathrm{RB}}^{\mathrm{step}} \rfloor \cdot N_{\mathrm{RB}}^{\mathrm{step}}$).

The resource indication value is defined by:

if $(L'_{CRBs} - 1) \leq \lfloor N'^{DL}_{VRB} / 2 \rfloor$ then

$$RIV = N'^{DL}_{VRB}(L'_{CRBs} - 1) + RB'_{start}$$

else

$$RIV = N'^{DL}_{VRB}(N'^{DL}_{VRB} - L'_{CRBs} + 1) + (N'^{DL}_{VRB} - 1 - RB'_{start})$$

where $L'_{CRBs} = L_{CRBs} / N^{step}_{RB}$, $RB'_{start} = RB_{start} / N^{step}_{RB}$ and $N'^{DL}_{VRB} = \lfloor N^{DL}_{VRB} / N^{step}_{RB} \rfloor$. Here,

$L'_{CRBs} \geq 1$ and shall not exceed $N'^{DL}_{VRB} - RB'_{start}$.

7.1.6.4 PDSCH starting position

This subclause describes PDSCH starting position for UEs that are not BL/CE UEs.

PDSCH starting position for BL/CE UEs is described in subclause 7.1.6.4A.

The starting OFDM symbol for the PDSCH of each activated serving cell is given by index $l_{\text{DataStart}}$.

For a UE configured in transmission mode 1-9, for a given activated serving cell

- if the PDSCH is assigned by EPDCCH received in the same serving cell, or if the UE is configured to monitor EPDCCH in the subframe and the PDSCH is not assigned by a PDCCH/EPDCCH, and if the UE is configured with the higher layer parameter *epdcch-StartSymbol-r11*
  - $l_{\text{DataStart}}$ is given by the higher-layer parameter *epdcch-StartSymbol-r11*.
- else if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells
  - $l_{\text{DataStart}}$ is given by the higher-layer parameter *pdsch-Start-r10* for the serving cell on which PDSCH is received,
- Otherwise

- $l_{\text{DataStart}}$ is given by the CFI value in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} > 10$, and $l_{\text{DataStart}}$ is given by the CFI value + 1 in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} \leq 10$.

For a UE configured in transmission mode 10, for a given activated serving cell

- if the PDSCH is assigned by a PDCCH with DCI format 1C or by a PDCCH with DCI format 1A and with CRC scrambled with P-RNTI/RA-RNTI/SI-RNTI/Temporary C-RNTI
  - $l_{\text{DataStart}}$ is given by the span of the DCI given by the CFI value in the subframe of the given serving cell according to subclause 5.3.4 of [4].
- if the PDSCH is assigned by a PDCCH/EPDCCH with DCI format 1A and with CRC scrambled with C-RNTI and if the PDSCH transmission is on antenna ports 0 - 3
  - if the PDSCH is assigned by EPDCCH received in the same serving cell
    - $l_{\text{DataStart}}$ is given by $l_{\text{EPDCCHStart}}$ for the EPDCCH-PRB-set where EPDCCH with the DCI format 1A was received ($l_{\text{EPDCCHStart}}$ as defined in subclause 9.1.4.1),
  - else if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells
    - $l_{\text{DataStart}}$ is given by the higher-layer parameter *pdsch-Start-r10* for the serving cell on which PDSCH is received.
  - otherwise
    - $l_{\text{DataStart}}$ is given by the CFI value in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} > 10$, and $l_{\text{DataStart}}$ is given by the CFI value+1 in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} \leq 10$.
- if the PDSCH is assigned by or semi-statically scheduled by a PDCCH/EPDCCH with DCI format 1A and if the PDSCH transmission is on antenna port 7

- if the value of the higher layer parameter *pdsch-Start-r11* determined from parameter set 1 in table 7.1.9-1 for the serving cell on which PDSCH is received belongs to {1,2,3,4},
  - $l'_{\text{DataStart}}$ is given by the higher layer parameter *pdsch-Start-r11* determined from parameter set 1 in table 7.1.9-1 for the serving cell on which PDSCH is received.
- else,
  - if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells,
    - $l'_{\text{DataStart}}$ is given by the higher-layer parameter *pdsch-Start-r10* for the serving cell on which PDSCH is received
  - otherwise
    - $l'_{\text{DataStart}}$ is given by the CFI value in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} > 10$, and $l'_{\text{DataStart}}$ is given by the CFI value + 1 in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} \leq 10$.
- if the subframe on which PDSCH is received is indicated by the higher layer parameter *mbsfn-SubframeConfigList-r11* determined from parameter set 1 in table 7.1.9-1 for the serving cell on which PDSCH is received, or if the PDSCH is received on subframe 1 or 6 for the frame structure type 2,
  - $l_{\text{DataStart}} = \min(2, l'_{\text{DataStart}})$,
- otherwise
  - $l_{\text{DataStart}} = l'_{\text{DataStart}}$.
- if the PDSCH is assigned by or semi-persistently scheduled by a PDCCH/EPDCCH with DCI format 2D,

- if the value of the higher layer parameter *pdsch-Start-r11* determined from the DCI (according to subclause 7.1.9) for the serving cell on which PDSCH is received belongs to {1,2,3,4},
  - $l'_{\text{DataStart}}$ is given by parameter *pdsch-Start-r11* determined from the DCI (according to subclause 7.1.9) for the serving cell on which PDSCH is received
- else,
  - if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells,
    - $l'_{\text{DataStart}}$ is given by the higher-layer parameter *pdsch-Start-r10* for the serving cell on which PDSCH is received
  - Otherwise
    - $l'_{\text{DataStart}}$ is given by the CFI value in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} > 10$, and $l_{\text{DataStart}}$ is given by the CFI value+1 in the subframe of the given serving cell when $N_{\text{RB}}^{\text{DL}} \le 10$.
- if the subframe on which PDSCH is received is indicated by the higher layer parameter *mbsfn-SubframeConfigList-r11* determined from the DCI (according to subclause 7.1.9) for the serving cell on which PDSCH is received, or if the PDSCH is received on subframe 1 or 6 for frame structure type 2,
  - $l_{\text{DataStart}} = \min(2, l'_{\text{DataStart}})$,
- otherwise
  - $l_{\text{DataStart}} = l'_{\text{DataStart}}$.

<...>

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8 Physical uplink shared channel related procedures

If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the MCG respectively.
- When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including PSCell), serving cell, serving cells belonging to the SCG respectively. The term 'primary cell' in this clause refers to the PSCell of the SCG.

For a non-BL/CE UE, and for FDD and transmission mode 1, there shall be 8 uplink HARQ processes per serving cell for non-subframe bundling operation, i.e. normal HARQ operation, and 3 uplink HARQ processes for subframe bundling operation when parameter *e-HARQ-Pattern-r12* is set to *TRUE* and 4 uplink HARQ processes for subframe bundling operation otherwise. For a non-BL/CE UE, and for FDD and transmission mode 2, there shall be 16 uplink HARQ processes per serving cell for non-subframe bundling operation and there are two HARQ processes associated with a given subframe as described in [8]. The subframe bundling operation is configured by the parameter *ttiBundling* provided by higher layers.

For FDD and a BL/CE UE configured with CEModeA, there shall be at most 8 uplink HARQ processes per serving cell.

For FDD and a BL/CE UE configured with CEModeB, there shall be at most 2 uplink HARQ processes per serving cell.

In case higher layers configure the use of subframe bundling for FDD and TDD, the subframe bundling operation is only applied to UL-SCH, such that four consecutive uplink subframes are used.

A BL/CE UE is not expected to be configured with simultaneous PUSCH and PUCCH transmission.

8.0 UE procedure for transmitting the physical uplink shared channel

The term "UL/DL configuration" in this subclause refers to the higher layer parameter *subframeAssignment* unless specified otherwise.

For FDD and normal HARQ operation, the UE shall upon detection on a given serving cell of a PDCCH/EPDCCH with DCI format 0/4 and/or a PHICH transmission in subframe *n* intended for the UE, adjust the corresponding PUSCH transmission in subframe *n+4* according to the PDCCH/EPDCCH and PHICH information.

For FDD-TDD and normal HARQ operation and a PUSCH for serving cell c with frame structure type 1, the UE shall upon detection of a PDCCH/EPDCCH with DCI format 0/4 and/or a PHICH transmission in subframe *n* intended for the UE, adjust the corresponding PUSCH transmission for serving cell *c* in subframe *n+4* according to the PDCCH/EPDCCH and PHICH information.

For normal HARQ operation, if the UE detects a PHICH transmission and if the most recent PUSCH transmission for the same transport block was using spatial multiplexing according to subclause 8.0.2 and the UE does not detect a PDCCH/EPDCCH with DCI format 4 in subframe *n* intended for the UE, the UE shall adjust the corresponding PUSCH retransmission in the associated subframe according to the PHICH information, and using the number of transmission layers and precoding matrix according to the most recent PDCCH/EPDCCH, if the number of negatively acknowledged transport blocks is equal to the number of transport blocks indicated in the most recent PDCCH/EPDCCH associated with the corresponding PUSCH.

For normal HARQ operation, if the UE detects a PHICH transmission and if the most recent PUSCH transmission for the same transport block was using spatial multiplexing according to subclause 8.0.2 and the UE does not detect a PDCCH/EPDCCH with DCI format 4 in subframe *n* intended for the UE, and if the number of negatively acknowledged transport blocks is not equal to the number of transport blocks indicated in the most recent PDCCH/EPDCCH associated with the corresponding PUSCH then the UE shall adjust the corresponding PUSCH retransmission in the associated subframe according to the PHICH information, using the precoding matrix with codebook index 0 and the number of transmission layers equal to number

of layers corresponding to the negatively acknowledged transport block from the most recent PDCCH/EPDCCH. In this case, the UL DMRS resources are calculated according to the cyclic shift field for DMRS [3] in the most recent PDCCH/EPDCCH with DCI format 4 associated with the corresponding PUSCH transmission and number of layers corresponding to the negatively acknowledged transport block.

If a UE is configured with the carrier indicator field for a given serving cell, the UE shall use the carrier indicator field value from the detected PDCCH/EPDCCH with uplink DCI format to determine the serving cell for the corresponding PUSCH transmission.

For FDD and normal HARQ operation, if a PDCCH/EPDCCH with CSI request field set to trigger an aperiodic CSI report, as described in subclause 7.2.1, is detected by a UE on subframe *n,* then on subframe *n+4* UCI is mapped on the corresponding PUSCH transmission, when simultaneous PUSCH and PUCCH transmission is not configured for the UE.

<...>

When a UE is configured with higher layer parameter *ttiBundling* and configured with higher layer parameter *e-HARQ-Pattern-r12* set to *FALSE* or not configured, for FDD and subframe bundling operation, the UE shall upon detection of a PDCCH/EPDCCH with DCI format 0 in subframe *n* intended for the UE, and/or a PHICH transmission in subframe *n-5* intended for the UE, adjust the corresponding first PUSCH transmission in the bundle in subframe *n+4* according to the PDCCH/EPDCCH and PHICH information.

When a UE is configured with higher layer parameter *ttiBundling* and configured with higher layer parameter *e-HARQ-Pattern-r12* set to *TRUE*, for FDD and subframe bundling operation, the UE shall upon detection of a PDCCH/EPDCCH with DCI format 0 in subframe *n* intended for the UE, and/or a PHICH transmission in subframe *n-1* intended for the UE, adjust the corresponding first PUSCH transmission in the bundle in subframe *n+4* according to the PDCCH/EPDCCH and PHICH information.

For both FDD and TDD serving cells, the NDI as signalled on PDCCH/EPDCCH, the RV as determined in subclause 8.6.1, and the TBS as determined in subclause 8.6.2, shall be delivered to higher layers.

For a non-BL/CE UE, for TDD and transmission mode 1, the number of HARQ processes per serving cell shall be determined by the UL/DL configuration (Table 4.2-2 of [3]), as indicated in Table 8-1. For TDD and transmission mode 2, the number of HARQ processes per serving cell for non-subframe bundling operation shall be twice the number determined by the UL/DL configuration (Table 4.2-2 of [3]) as indicated in FIG. 36 (a reproduction of Table 8-1 from 3GPP TS 36.213 V13.1.1) and there are two HARQ processes associated with a given subframe as described in [8]. For TDD and both transmission mode 1 and transmission mode 2, the "TDD UL/DL configuration" in FIG. 36 (a reproduction of Table 8-1 from 3GPP TS 36.213 V13.1.1)refers to the UL-reference UL/DL configuration for the serving cell if UL-reference UL/DL configuration is defined for the serving cell and refers to the serving cell UL/DL configuration otherwise.

For a BL/CE UE configured with CEModeA and for TDD, the maximum number of HARQ processes per serving cell shall be determined by the UL/DL configuration (Table 4.2-2 of [3]) according to the normal HARQ operation in Table 8-1. For TDD a BL/CE UE configured with CEModeB is not expected to support more than 2 uplink HARQ processes per serving cell.

<...>

A UE is semi-statically configured via higher layer signalling to transmit PUSCH transmissions signalled via PDCCH/EPDCCH according to one of two uplink transmission modes, denoted mode 1 - 2.

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the C-RNTI, the UE shall decode the PDCCH according to the combination defined in FIG. 37 (a reproduction of Table 8-3 from 3GPP TS 36.213 V13.1.1)and transmit the corresponding PUSCH. The scrambling initialization of this PUSCH corresponding to these PDCCHs and the PUSCH retransmission for the same transport block is by C-RNTI.

If a UE is configured by higher layers to decode EPDCCHs with the CRC scrambled by the C-RNTI, the UE shall decode the EPDCCH according to the combination defined in Table 8-3A and transmit the corresponding PUSCH. The scrambling initialization of this PUSCH corresponding to these EPDCCHs and the PUSCH retransmission for the same transport block is by C-RNTI.

If a UE is configured by higher layers to decode MPDCCHs with the CRC scrambled by the C-RNTI, the UE shall decode the MPDCCH according to the combination defined in Table 8-3B and transmit the corresponding PUSCH. The scrambling initialization of this PUSCH corresponding to these MPDCCHs and the PUSCH retransmission for the same transport block is by C-RNTI.

Transmission mode 1 is the default uplink transmission mode for a UE until the UE is assigned an uplink transmission mode by higher layer signalling.

When a UE configured in transmission mode 2 receives a DCI Format 0 uplink scheduling grant, it shall assume that the PUSCH transmission is associated with transport block 1 and that transport block 2 is disabled.

<...>

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the C-RNTI and is also configured to receive random access procedures initiated by "PDCCH orders", the UE shall decode the PDCCH according to the combination defined in FIG. 38 (a reproduction of Table 8-4 from 3GPP TS 36.213 V13.1.1).

If a UE is configured by higher layers to decode EPDCCHs with the CRC scrambled by the C-RNTI and is also configured to receive random access procedures initiated by "PDCCH orders", the UE shall decode the EPDCCH according to the combination defined in Table 8-4A.

If a UE is configured by higher layers to decode MPDCCHs with the CRC scrambled by the C-RNTI and is also configured to receive random access procedures initiated by "PDCCH orders", the UE shall decode the MPDCCH according to the combination defined in Table 8-4B.

<...>

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the SPS C-RNTI, the UE shall decode the PDCCH according to the combination defined in Table 8-5 and transmit the corresponding PUSCH.
The scrambling initialization of this PUSCH corresponding to these PDCCHs and PUSCH retransmission for the same transport block is by SPS C-RNTI. The scrambling initialization of initial transmission of this PUSCH without a corresponding PDCCH and the PUSCH retransmission for the same transport block is by SPS C-RNTI.

If a UE is configured by higher layers to decode EPDCCHs with the CRC scrambled by the SPS C-RNTI, the UE shall decode the EPDCCH according to the combination defined in Table 8-5A and transmit the corresponding PUSCH.
The scrambling initialization of this PUSCH corresponding to these EPDCCHs and PUSCH retransmission for the same transport block is by SPS C-RNTI. The scrambling initialization of initial transmission of this PUSCH without a corresponding EPDCCH and the PUSCH retransmission for the same transport block is by SPS C-RNTI.

If a UE is configured by higher layers to decode MPDCCHs with the CRC scrambled by the SPS C-RNTI, the UE shall decode the MPDCCH according to the combination defined in Table 8-5B and transmit the corresponding PUSCH.
The scrambling initialization of this PUSCH corresponding to these MPDCCHs and PUSCH retransmission for the same transport block is by SPS C-RNTI. The scrambling initialization of initial transmission of this PUSCH without a corresponding MPDCCH and the PUSCH retransmission for the same transport block is by SPS C-RNTI.

<...>

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the Temporary C-RNTI regardless of whether UE is configured or not configured to decode PDCCHs with the CRC scrambled by the C-RNTI, the UE shall decode the PDCCH according to the combination defined in FIG. 39 (a reproduction of Table 8-6 from 3GPP TS 36.213 V13.1.1) and transmit the corresponding PUSCH. The scrambling initialization of PUSCH corresponding to these PDCCH is by Temporary C-RNTI.

<...>

If a Temporary C-RNTI is set by higher layers, the scrambling of PUSCH corresponding to the Random Access Response Grant in subclause 6.2 and the PUSCH retransmission for the same transport block is by Temporary C-RNTI. Else, the scrambling of PUSCH corresponding to the Random Access Response Grant in subclause 6.2 and the PUSCH retransmission for the same transport block is by C-RNTI.

<...>

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the TPC-PUCCH-RNTI, the UE shall decode the PDCCH according to the combination defined in FIG. 40 (a reproduction of Table 8-7 from 3GPP TS 36.213 V13.1.1). The notation 3/3A implies that the UE shall receive either DCI format 3 or DCI format 3A depending on the configuration.

<...>

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the TPC-PUSCH-RNTI, the UE shall decode the PDCCH according to the combination defined in table 8.8. The notation 3/3A implies that the UE shall receive either DCI format 3 or DCI format 3A depending on the configuration.

<...>

8.1 Resource allocation for PDCCH/EPDCCH with uplink DCI format

Two resource allocation schemes Type 0 and Type 1 are supported for PDCCH/EPDCCH with uplink DCI format.

Resource allocation scheme Type 0 or Type 2 are supported for MPDCCH with uplink DCI format.

If the resource allocation type bit is not present in the uplink DCI format, only resource allocation type 0 is supported.

If the resource allocation type bit is present in the uplink DCI format, the selected resource allocation type for a decoded PDCCH/EPDCCH is indicated by a resource allocation type bit where type 0 is indicated by 0 value and type 1 is indicated otherwise. The UE shall interpret the resource allocation field depending on the resource allocation type bit in the PDCCH/EPDCCH with uplink DCI format detected.

8.1.1 Uplink resource allocation type 0

The resource allocation information for uplink resource allocation type 0 indicates to a scheduled UE a set of contiguously allocated virtual resource block indices denoted by n_{VRB}. A resource allocation field in the scheduling grant consists of a resource indication value (*RIV*) corresponding to a starting resource block (RB_{START}) and a length in terms of contiguously allocated resource blocks ($L_{\mathrm{CRBs}} \geq 1$). For a BL/CE UE, uplink resource allocation type 0 is only applicable for UE configured with CEModeA and $N_{\mathrm{RB}}^{\mathrm{UL}} = 6$ in this subclause. The resource indication value is defined by

if $(L_{\mathrm{CRBs}} - 1) \leq \lfloor N_{\mathrm{RB}}^{\mathrm{UL}} / 2 \rfloor$ then

$$RIV = N_{\mathrm{RB}}^{\mathrm{UL}} (L_{\mathrm{CRBs}} - 1) + RB_{\mathrm{START}}$$

else

$$RIV = N_{\mathrm{RB}}^{\mathrm{UL}} (N_{\mathrm{RB}}^{\mathrm{UL}} - L_{\mathrm{CRBs}} + 1) + (N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - RB_{\mathrm{START}})$$

8.1.2 Uplink resource allocation type 1

The resource allocation information for uplink resource allocation type 1 indicates to a scheduled UE two sets of resource blocks with each set including one or more consecutive resource block groups of size *P* as given in FIG. 34 (a reproduction of Table 7.1.6.1-1 from 3GPP TS 36.213 V13.1.1) assuming $N_{\mathrm{RB}}^{\mathrm{UL}}$ as the system bandwidth. A combinatorial index *r* consists of $\left\lceil \log_2 \left(\binom{\lceil N_{RB}^{UL} / P + 1 \rceil}{4} \right) \right\rceil$ bits. The bits from the resource allocation field in the scheduling grant represent *r* unless the number of bits in the resource allocation field in the scheduling grant is

- smaller than required to fully represent *r*, in which case the bits in the resource allocation field in the scheduling grant occupy the LSBs of *r* and the value of the remaining bits of *r* shall be assumed to be 0; or

- larger than required to fully represent *r*, in which case *r* occupies the LSBs of the resource allocation field in the scheduling grant.

The combinatorial index *r* corresponds to a starting and ending RBG index of resource block set 1, s_0 and $s_1 - 1$, and resource block set 2, s_2 and $s_3 - 1$ respectively, where *r* is given by equation $r = \sum_{i=0}^{M-1} \left\langle \begin{matrix} N - s_i \\ M - i \end{matrix} \right\rangle$ defined in subclause 7.2.1 with *M*=4 and $N = \left\lceil N_{\mathrm{RB}}^{\mathrm{UL}} / P \right\rceil + 1$. subclause 7.2.1 also defines ordering properties and range of values that s_i (RBG indices) map to. Only a single RBG is allocated for a set at the starting RBG index if the corresponding ending RBG index equals the starting RBG index.

8.1.3 Uplink resource allocation type 2

Uplink resource allocation type 2 is only applicable for BL/CE UE configured with CEModeB. The resource allocation information for uplink resource allocation type 2 indicates to a scheduled UE a set of contiguously allocated resource blocks within a narrowband as given in FIG. 42 (a reproduction of Table 8.1.3-1 from 3GPP TS 36.213 V13.1.1)

<...>

9.1 UE procedure for determining physical downlink control channel assignment

9.1.1 PDCCH assignment procedure

The control region of each serving cell consists of a set of CCEs, numbered from 0 to $N_{\mathrm{CCE},k} - 1$ according to subclause 6.8.1 in [3], where $N_{\mathrm{CCE},k}$ is the total number of CCEs in the control region of subframe k.

The UE shall monitor a set of PDCCH candidates on one or more activated serving cells as configured by higher layer signalling for control information, where monitoring implies attempting to decode each of the PDCCHs in the set according to all the monitored DCI formats. A BL/CE UE is not required to monitor PDCCH.

The set of PDCCH candidates to monitor are defined in terms of search spaces, where a search space $S_k^{(L)}$ at aggregation level $L \in \{1,2,4,8\}$ is defined by a set of PDCCH candidates. For each serving cell on which PDCCH is monitored, the CCEs corresponding to PDCCH candidate *m* of the search space $S_k^{(L)}$ are given by

$$L\left\{(Y_k + m') \bmod \left\lfloor N_{\mathrm{CCE},k} / L \right\rfloor\right\} + i$$

where Y_k is defined below, $i = 0, \cdots, L-1$. For the common search space $m' = m$. For the PDCCH UE specific search space, for the serving cell on which PDCCH is monitored, if the monitoring UE is configured with carrier indicator field then $m' = m + M^{(L)} \cdot n_{CI}$ where n_{CI} is the carrier indicator field value, else if the monitoring UE is not configured with carrier indicator field then $m' = m$, where $m = 0, \cdots, M^{(L)} - 1$. $M^{(L)}$ is the number of PDCCH candidates to monitor in the given search space.

If a UE is configured with higher layer parameter *cif-InSchedulingCell-r13*, the carrier indicator field value corresponds to *cif-InSchedulingCell-r13,* otherwise, the carrier indicator field value is the same as *ServCellIndex* given in [11].

The UE shall monitor one common search space in every non-DRX subframe at each of the aggregation levels 4 and 8 on the primary cell.

A UE shall monitor common search space on a cell to decode the PDCCHs necessary to receive MBMS on that cell when configured by higher layers.

If a UE is not configured for EPDCCH monitoring, and if the UE is not configured with a carrier indicator field, then the UE shall monitor one PDCCH UE-specific search space at each of the aggregation levels 1, 2, 4, 8 on each activated serving cell in every non-DRX subframe.

If a UE is not configured for EPDCCH monitoring, and if the UE is configured with a carrier indicator field, then the UE shall monitor one or more UE-specific search spaces at each of the aggregation levels 1, 2, 4, 8 on one or more activated serving cells as configured by higher layer signalling in every non-DRX subframe.

If a UE is configured for EPDCCH monitoring on a serving cell, and if that serving cell is activated, and if the UE is not configured with a carrier indicator field, then the UE shall monitor

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one PDCCH UE-specific search space at each of the aggregation levels 1, 2, 4, 8 on that serving cell in all non-DRX subframes where EPDCCH is not monitored on that serving cell.
If a UE is configured for EPDCCH monitoring on a serving cell, and if that serving cell is activated, and if the UE is configured with a carrier indicator field, then the UE shall monitor one or more PDCCH UE-specific search spaces at each of the aggregation levels 1, 2, 4, 8 on that serving cell as configured by higher layer signalling in all non-DRX subframes where EPDCCH is not monitored on that serving cell.
The common and PDCCH UE-specific search spaces on the primary cell may overlap.
A UE configured with the carrier indicator field associated with monitoring PDCCH on serving cell *c* shall monitor PDCCH configured with carrier indicator field and with CRC scrambled by C-RNTI in the PDCCH UE specific search space of serving cell *c*.
A UE configured with the carrier indicator field associated with monitoring PDCCH on the primary cell shall monitor PDCCH configured with carrier indicator field and with CRC scrambled by SPS C-RNTI in the PDCCH UE specific search space of the primary cell.
The UE shall monitor the common search space for PDCCH without carrier indicator field.
For the serving cell on which PDCCH is monitored, if the UE is not configured with a carrier indicator field, it shall monitor the PDCCH UE specific search space for PDCCH without carrier indicator field, if the UE is configured with a carrier indicator field it shall monitor the PDCCH UE specific search space for PDCCH with carrier indicator field.
If the UE is not configured with a LAA Scell, the UE is not expected to monitor the PDCCH of a secondary cell if it is configured to monitor PDCCH with carrier indicator field corresponding to that secondary cell in another serving cell.
If the UE is configured with a LAA Scell, the UE is not expected to monitor the PDCCH UE specific space of the LAA SCell if it is configured to monitor PDCCH with carrier indicator field corresponding to that LAA Scell in another serving cell,

- where the UE is not expected to be configured to monitor PDCCH with carrier indicator field in an LAA Scell;

- where the UE is not expected to be scheduled with PDSCH starting in the second slot in a subframe in an LAA Scell if the UE is configured to monitor PDCCH with carrier indicator field corresponding to that LAA Scell in another serving cell.

For the serving cell on which PDCCH is monitored, the UE shall monitor PDCCH candidates at least for the same serving cell.

A UE configured to monitor PDCCH candidates with CRC scrambled by C-RNTI or SPS C-RNTI with a common payload size and with the same first CCE index n_{CCE} (as described in subclause 10.1) but with different sets of DCI information fields as defined in [4] in the

common search space

PDCCH UE specific search space

on the primary cell shall assume that for the PDCCH candidates with CRC scrambled by C-RNTI or SPS C-RNTI,

if the UE is configured with the carrier indicator field associated with monitoring the PDCCH on the primary cell, only the PDCCH in the common search space is transmitted by the primary cell;

otherwise, only the PDCCH in the UE specific search space is transmitted by the primary cell.

A UE configured to monitor PDCCH candidates in a given serving cell with a given DCI format size with CIF, and CRC scrambled by C- RNTI, where the PDCCH candidates may have one or more possible values of CIF for the given DCI format size, shall assume that a PDCCH candidate with the given DCI format size may be transmitted in the given serving cell in any PDCCH UE specific search space corresponding to any of the possible values of CIF for the given DCI format size.

If a serving cell is a LAA Scell, and if the higher layer parameter *subframeStartPosition* for the Scell indicates 's07',

- The UE monitors PDCCH UE-specific search space candidates on the Scell in both the first and second slots of a subframe, and the aggregation levels defining the search spaces are listed in FIG. 44 (a reproduction of Table 9.1.1-1A from 3GPP TS 36.213 V13.1.1);

otherwise,

- The aggregation levels defining the search spaces are listed in Table 9.1.1-1.

If a serving cell is a LAA Scell, the UE may receive PDCCH with DCI CRC scrambled by CC-RNTI as described in subclause 13A on the LAA Scell.

The DCI formats that the UE shall monitor depend on the configured transmission mode per each serving cell as defined in subclause 7.1.

If a UE is configured with higher layer parameter *skipMonitoringDCI-format0-1A* for a serving cell, the UE is not required to monitor the PDCCH with DCI Format 0/1A in the UE specific search space for that serving cell.

If a UE is configured with higher layer parameter *pdcch-candidateReductions* for a UE specific search space at aggregation level *L* for a serving cell, the corresponding number of PDCCH candidates is given by $M^{(L)} = \text{round}\left(a \times M_{full}^{(L)}\right)$, where the value of a is determined according to FIG. 45 (a reproduction of Table 9.1.1-2 from 3GPP TS 36.213 V13.1.1) and $M_{full}^{(L)}$ is determined according to FIG. 43 (a reproduction of Table 9.1.1-1 from 3GPP TS 36.213 V13.1.1) by replacing $M^{(L)}$ with $M_{full}^{(L)}$.

For the common search spaces, Y_k is set to 0 for the two aggregation levels $L = 4$ and $L = 8$.

For the UE-specific search space $S_k^{(L)}$ at aggregation level L, the variable Y_k is defined by

$$Y_k = (A \cdot Y_{k-1}) \bmod D$$

where $Y_{-1} = n_{\text{RNTI}} \neq 0$, $A = 39827$, $D = 65537$ and $k = \lfloor n_s/2 \rfloor$, n_s is the slot number within a radio frame.

The RNTI value used for n_{RNTI} is defined in subclause 7.1 in downlink and subclause 8 in uplink.

[0082] When it comes to NR, backward compatibility is not necessarily required. Numerology can be adjusted so that a reducing symbol number of a TTI would not be the only tool to change TTI length. Using LTE numerology, as an example, it comprises 14 OFDM symbol in 1 ms and a subcarrier spacing of 15 KHz. When the subcarrier spacing goes to 30KHz, under the assumption of the same FFT (Fast Fourier Transform) size and the same Cyclic Prefix (CP) structure, there would be 28 OFDM symbols in 1 ms. Equivalently, the TTI become 0.5 ms if the number of OFDM symbol in a TTI is kept the same. This implies the

design between different TTI lengths can be kept common with good scalability performed on the subcarrier spacing. Of course, there would always be a trade-off for the subcarrier spacing selection, e.g., FFT size, definition/number of Physical Resource Block (PRB), the design of CP, or supportable system bandwidth. While NR considers a larger system bandwidth and a larger coherence bandwidth, the inclusion of a larger sub carrier spacing is contemplated.

[0083] As disclosed above, it is very difficult to fulfill all the diverse requirements with a single numerology. Therefore, in early 3GPP RAN1 meetings, it was acknowledged that more than one numerology would be adopted. Considering the standardization and implementation efforts as well as the multiplexing capability among different numerologies, it would be beneficial to have some relationship between the different numerologies such as an integral multiple relationship. Several numerology families were raised during the 3GPP meetings with one numerology family being based on LTE 15KHz, and other numerologies (see Alt. 2~4 disclosed below) which allows power N of 2 symbols in 1 ms:

- For NR, it is necessary to support more than one values of subcarrier-spacing
  - Values of subcarrier-spacing are derived from a particular value of subcarrier-spacing multiplied by N where N is an integer
    - Alt.1: Subcarrier-spacing values include 15 kHz subcarrier-spacing (i.e., LTE based numerology)
    - Alt.2: Subcarrier-spacing values include 17.5 kHz subcarrier-spacing with uniform symbol duration including CP length
    - Alt.3: Subcarrier-spacing values include 17.06 kHz subcarrier-spacing with uniform symbol duration including CP length
    - Alt.4: Subcarrier-spacing values 21.33 kHz
    - Note: other alternatives are not precluded
    - FFS (For Further Study): the exact value of a particular value and possible values of N

- The values of possible subcarrier-spacing will be further narrowed-down in RAN1#85.

[0084] Also, whether there would be restriction on the multiplier of a given numerology family was also discussed during 3GPP RAN1 meetings. The power of 2 (Alt.1 disclosed below) drew some interest because it can multiplex different numerologies easier without introducing much overhead when different numerologies are multiplexed in time domain:

• RAN1 will continue further study and conclude between following alternatives in the next meeting

- Alt. 1:

› The subcarrier spacing for the NR scalable numerology should scale as

› $f_{sc} = f_0 * 2^m$

› where

- f_0 is FFS
- m is an integer chosen from a set of possible values

- Alt. 2:

› The subcarrier spacing for the NR scalable numerology should scale as

› $f_{sc} = f_0 * M$

› where

- f_0 is FFS
- M is an integer chosen from a set of possible positive values.

[0085] Usually, RAN1 works in a band agnostic manner so that a scheme/feature would be assumed to be applicable for all frequency bands. In the following RAN4, a group would derive relevant test case considering whether some combinations are unrealistic or whether deployment can be done reasonably. This rule would still be assumed in NR, but some companies do see that there would be restrictions as the frequency range of NR is quite high:

- For the study of NR, RAN1 assumes that multiple (but not necessarily all) OFDM numerologies can apply to the same frequency range
  - Note: RAN1 does not assume to apply very low value of subcarrier spacing to very high carrier frequency.

[0086] The above-discussed use cases for NR have diverse requirements in terms of data rates, latency, and coverage. Enhanced mobile broadband (eMBB) is expected to support peak data rate (20Gbps for downlink and 10Gbps for uplink) and user experienced data rates in the order of three times IMT (International Mobile Telecommunications)-Advanced. On the other hand, in case of URLLC (Ultra Reliable Low Latency Communication), the tighter requirements are put on ultra-low latency (0.5ms for UL and DL each for user plane latency) and high reliability (1-10-5 within 1ms). Finally, mMTC (massive Machine Type Communications) requires high connection density (1,000,000 devices/km2 in urban environment), large coverage in harsh environments ([164 dB] MCL (Maximum Coupling Loss)), and extremely long-life battery (15 years) for low cost devices.

[0087] One option provides FDM/TDM of different types for subframes and/or subbands with different subcarrier numerologies (i.e., different subcarrier-spacing values and correspondingly different OFDM symbol lengths) in a single system bandwidth of a cell where the different subcarrier values are chosen according to the use-case specific requirements. In this case, a UE may be configured with a single subcarrier numerology or multiple subcarrier numerologies, possibly depending upon UE capability, UE category, and UE-supported use cases.

[0088] The network may provide a given numerology with certain bandwidth and in a certain frequency location within the whole system bandwidth of a cell, e.g. 100MHz or 200MHz. The bandwidth and frequency location may be adjusted according to certain conditions such as the amount of traffic required for each numerology, as shown in FIG. 46. It is noted that FIG. 46 is an example for illustration purposes and the bandwidth for a given numerology may be non-contiguous in frequency domain as well. Therefore, when a UE is configured with a numerology, there still requires additional consideration to determine whether or how the UE knows the bandwidth partition including the bandwidth and/or frequency location

for a given numerology, and the UE can correctly derives resource allocation for data transmission or reception.

[0089] Accordingly, the following messages or channels can be used to carry the information regarding bandwidth partition to a UE. In one embodiment, information regarding bandwidth partition is signaled by the Physical Broadcast Channel (PBCH) and/or System Information Block (SIB). The information regarding bandwidth partition for all numerologies is signaled on a specific numerology. More specifically, the specific numerology is the numerology with which the UE detects the corresponding synchronization signal. Alternatively, the information is signaled on a per numerology basis. That is, a numerology would provide its own bandwidth partition in PBCH and/or SIB on the numerology.

[0090] Before receiving the bandwidth partition information for a numerology, the UE assumes a default bandwidth partition on the numerology. An example of the default bandwidth partition includes a fixed bandwidth and a frequency location derived from the synchronization signal. More specifically, the frequency location would be derived from a system bandwidth of a cell(e.g. the total bandwidth for all numerologies), in addition to synchronization. In one embodiment, synchronization would determine a first frequency location. The first frequency location and an offset value would determine a second frequency location. The default bandwidth locates in the second frequency location (center frequency or starting frequency). More specifically, the offset value is determined from the total system bandwidth. Alternatively, the offset value is determined from information carried on the MIB or SIB.

[0091] In another embodiment, MIB would indicate a first bandwidth partition of a numerology. The first bandwidth partition allows a UE to receive some common signaling, such as the SIB, on the numerology. The common signal would further indicate a second bandwidth partition of the numerology. A subsequent UE reception would follow the second bandwidth partition.

[0092] In yet another alternative, information regarding a bandwidth is signalled by Radio Resource Control (RRC) message. The MIB or SIB would indicate a first bandwidth partition of a first numerology. The first bandwidth partition allows the UE to receive at least some common signaling, such as SIB, on the first numerology. The first bandwidth partition

would be utilized and after entering the connected mode, a UE-specific RRC would further indicate a second bandwidth partition of the first numerology. A subsequent UE reception would utilize the second bandwidth partition. If the second bandwidth partition of the first numerology is absent, the UE would continue to use the first bandwidth partition.

[0093] In another embodiment, the MIB or SIB would indicate a first bandwidth partition of a first numerology. The first bandwidth partition allows the UE to receive at least some common signaling, such as the SIB, on the first numerology. The first bandwidth partition would be utilized and after entering the connected mode, a UE-specific RRC message would further configure a second numerology and a second bandwidth partition of the second numerology. A subsequent UE reception would be on the second numerology following the second bandwidth partition.

[0094] In an alternate embodiment, the physical control channel can be used to carry the information of the bandwidth partition. In one embodiment, the information can be used for a single TTI. Alternatively, the information can be used for multiple TTIs. More specifically, the multiple TTIs are within a fixed duration. Alternatively, the multiple TTIs start at predefined timing. Alternatively, the multiple TTIs start a predetermined number X TTIs after receiving the physical control channel. Alternatively, the information can be used until new information is received. In one embodiment, the information is transmitted together with scheduling information. The scheduling information is for DL data. Alternatively, the information is transmitted on a specific physical control channel which does not comprise scheduling information. Preferably, the information includes bandwidth partition for all available numerologies. Alternatively, the information includes bandwidth partition for a single numerology. More specifically, the single numerology is the numerology UE is configured with. Alternatively, the single numerology is the numerology UE decodes a corresponding physical control channel with. Alternatively, the single numerology is indicated in the same physical control channel.

[0095] In another embodiment, a UE-specific RRC message would configure a first bandwidth partition of a first numerology. A subsequent UE reception would be on the first numerology following the first bandwidth partition. A physical control channel can further

indicate a second numerology and a second bandwidth partition of the second numerology. A subsequent UE reception would be on the second numerology following the second bandwidth partition.

[0096] In another alternative embodiment, a whole system bandwidth of a cell can be considered as potential candidates for a numerology. In one embodiment, the maximum bandwidth that a UE can receive with the numerology is less than the system bandwidth of a cell. The network indicates to the UE which resource blocks would be utilized for the data transmission based on the numerology that the UE is configured with. The UE can ignore a scheduling if the total resource allocated for the UE is larger than what UE is able to receive or if the bandwidth indicated is larger than what UE is able to receive. Alternatively, the UE can receive data according to a scheduling if total resources allocated for the UE is larger than what UE is able to receive or if a bandwidth indicated is larger than what UE is able to receive. More specifically, the UE would receive the data within a maximum bandwidth that can be received by the UE and it does not receive the data outside the maximum bandwidth. The UE may need a way to decide which part of the received data is a valid resource to be counted in the maximum bandwidth. In one example, the UE counts the maximum bandwidth starting from the resource block with lowest frequency within the resource allocation. In another example, the UE counts the maximum bandwidth starting from the resource block with highest frequency within the resource allocation.

[0097] In some or all of the above-disclosed embodiments, messages or channels can be combined to carry the information regarding bandwidth partition to a UE. That is, the information regarding bandwidth partition can be carried on one or more of the messages or channels in parallel and/or a part of the information can be carried in one message or channel while the remaining part can be carried in one or more messages or channels. Furthermore, the embodiments or any combination thereof can all be enhanced on basis of the following features.

[0098] In one embodiment, the indication comprises a bandwidth portion index associated with a resource allocation within the bandwidth portion. In one embodiment, a number of the bandwidth portion is fixed. Alternatively, the number of bandwidth portion is configured by a network. In another alternative, the number of bandwidth portion is derived

from a system bandwidth. More specifically, the number of bandwidth portion is equal to the system bandwidth divided by the maximum bandwidth that can be received by a UE with the numerology. For example, if the system bandwidth is 100 MHz and the maximum bandwidth for a numerology is 20 MHz, there would be 5 bandwidth portions for the numerology. The value may be rounded up if the system bandwidth cannot be equally divided by the maximum bandwidth. Using the previous example, if the system bandwidth is 100 MHz and a second numerology whose maximum bandwidth is 40 MHz, the resulting value (2.5) would be rounded up to 3 bandwidth portions for the second numerology. Different numerologies may have different maximum bandwidths, which results in different values for the bandwidth portion.

[0099] Alternatively, the bandwidth of bandwidth portion is configured by RRC. In another alternative, the bandwidth of bandwidth portion is fixed. In another alternative, the bandwidth portion may be indexed from the lower frequency, higher frequency, or the center frequency.

[00100] In some embodiments, the resource allocation within the bandwidth portion is done via a bit map. Alternatively, the resource allocation within the bandwidth portion is done by a value indicating starting position and a bandwidth of the resource allocation. Alternatively, the resource allocation within the bandwidth portion is done by a value indicating the starting position(s) and the ending position(s) of the resource allocation.

[00101] In another embodiment, the resource allocation granularity differs depending upon the numerology. More specifically, a numerology with larger subcarrier spacing would have a finer granularity of resource allocation than a numerology with a smaller subcarrier spacing. In one embodiment, the number of PRBs within a resource scheduling unit would be different for different numerologies. By way of example but not of limitation, the number of PRBs within a resource scheduling unit for a numerology with a larger subcarrier spacing would be less than a numerology with a smaller subcarrier spacing.

[00102] In another embodiment, the number of subcarriers within a resource scheduling unit would be different for different numerologies. More specifically, the number of subcarriers within a resource scheduling unit for a numerology with a larger subcarrier spacing would be less than a numerology with a smaller subcarrier spacing. In one non-limiting example, a

numerology with 30 KHz subcarrier spacing would have 48 subcarriers as a scheduling unit and a numerology with 60 KHz subcarrier spacing would have 24 subcarriers as a scheduling unit. There may be inverse-proportional relationship between the numbers of subcarrier/PRB in resource units for different numerologies. For example, a numerology with X KHz subcarrier spacing would have Y subcarriers as a scheduling unit, and a numerology with 2X KHz subcarrier spacing would have Y/2 subcarriers as a scheduling unit. In one embodiment, a bitmap can be transmitted with a numerology configured for a UE, and the bitmap also can be used for indicating which resource unit is allocated for the UE.

[00103] In one exemplary embodiment, a value can be used for indicating which resource unit is allocated for a UE and transmitted with the numerology configured for the UE, e.g., the starting position of the resource unit is allocated for the UE and/or length of the allocation.

[00104] In another exemplary embodiment, the number of a subcarrier within a resource unit is a function of a system bandwidth. More specifically, the number of subcarrier within a resource unit is a function of a numerology.

[00105] As discussed in the above-disclosed embodiments, the UE may choose to receive part of the resource allocation if the allocated resource exceeds what the UE is able to receive. In one example, the UE counts the maximum bandwidth starting from the resource block with lowest frequency within the resource allocation. In another example, the UE counts the maximum bandwidth starting from the resource block with highest frequency within the resource allocation.

[00106] In another embodiment, the UE determines the bandwidth partition according to the resource when a corresponding control channel is decoded. There would be an association between a bandwidth portion and a resource for a control channel. When the UE decodes the control channel in a certain resource, the UE realizes a corresponding data scheduled by the control channel would be transmitted within a bandwidth portion associated with the resource. More specifically, the control channel would carry resource allocation within the associated bandwidth portion to let UE know which resource block is allocated to the UE and the allocated resource block(s) is transmitted with the numerology UE configured with. In one embodiment,

the association is configured by the RRC. Alternatively, the association is the bandwidth portion associated with a control channel resource.

[00107] In one exemplary embodiment, the control channel resource would spread across the system bandwidth. Alternatively, the control channel resource would spread across a configured bandwidth. In another exemplary embodiment, the UE would attempt to decode the control channel on multiple control channel resources that are associated with the same bandwidth portion. Alternatively, the UE would attempt to decode the control channel on multiple control channel resources that are associated with different bandwidth portions. In these embodiments, the different bandwidth portions do not overlap each other. Alternatively, the different bandwidth portions overlap each other. In one exemplary embodiment, the number of bandwidth portion is fixed. In other embodiments, the number of bandwidth portions is configured by the network. Alternatively, the number of bandwidth portion is derived from the system bandwidth. More specifically, the number of bandwidth portions is equal to the system bandwidth divided by the maximum bandwidth that can be received by a UE with the numerology with the possible number of bandwidth portions rounded up if the system bandwidth cannot be equally divided by the maximum bandwidth. For example, if the system bandwidth is 100 MHz and the maximum bandwidth for a numerology is 20 MHz, there would be 5 bandwidth portions for the numerology. Using the previous example, if the system bandwidth is 100 MHz and a second numerology whose maximum bandwidth is 40 MHz, the resulting value (2.5) would be rounded up to 3 bandwidth portions for the second numerology.

[00108] Different numerology may have different maximum bandwidths, which results in different numbers of bandwidth portions. Alternatively, the bandwidth of the bandwidth portion is configured by the RRC. Alternatively, the bandwidth of bandwidth portion is fixed. In one embodiment, the resource allocation within the bandwidth portion is done via a bitmap. Alternatively, the resource allocation within the bandwidth portion is done by a value indicating a starting position and a bandwidth of the resource allocation. Alternatively, the resource allocation within the bandwidth portion is done by a value indicating a starting position(s) and an ending position(s) of the resource allocation. In one exemplary embodiment, the control channel resource is all the resources carrying the control channel. Alternatively, the control channel resource is a part of the resources carrying the control channel. In other words, the part of the

resources carrying the control channel is defined as the resource with the lowest frequency. Alternatively, the part of the resources carrying the control channel is defined as the resource with the lowest index.

[00109] As those skilled in the art will appreciate, any combinations of the above-disclosed embodiments can be used to form a new method to signal the information regarding the bandwidth partition.

[00110] The content of bandwidth partition information of a numerology may be a frequency location and a bandwidth for the numerology.

[00111] In one embodiment, a frequency location is defined as the frequency location of a center resource block of the bandwidth partition for the numerology. Alternatively, the frequency location is defined as the frequency location of a resource block with the lowest frequency of the bandwidth partition for the numerology. Alternatively, the frequency location is defined as a frequency location of a resource block with highest frequency of the bandwidth partition for the numerology.

[00112] In one embodiment, the different numerologies may use different types of frequency locations. By way of example but not of limitation, a first frequency location of a first numerology is given by a frequency location of a center resource block of the bandwidth partition for the first numerology, and a second frequency location of a second numerology is given by a frequency location of a resource block with the lowest frequency of the bandwidth partition for the second numerology.

[00113] The bandwidth may be expressed in the unit of a resource block. In one exemplary embodiment, the resource block is a physical resource block. In one exemplary embodiment, the resource blocks using the numerology is contiguous in the frequency domain.

[00114] The content of bandwidth partition information of a numerology may be a frequency location for the numerology. In one embodiment, the frequency location is a frequency location of a center resource block of the bandwidth partition for the numerology. Alternatively, the frequency location is a frequency location of a resource block with lowest frequency of the bandwidth partition for the numerology. In another alternative, the frequency

location is a frequency location of a resource block with highest frequency of the bandwidth partition for the numerology.

[00115] Different numerologies may use different type of frequency location. In one embodiment, a first frequency location of a first numerology is given by a frequency location of a center resource block of the bandwidth partition for the first numerology. The second frequency location of a second numerology is given by a frequency location of a resource block with lowest frequency of the bandwidth partition for the second numerology.

[00116] In one embodiment, the bandwidth of the numerology is a predefined value. The predefined value is a maximum bandwidth UE supports, for example, due to FFT size. Alternatively, the predefined value is a maximum bandwidth of the numerology. In another alternative, the predefined value is a bandwidth indicated in system information. In yet another alternative, the predefined value is derived from a total system bandwidth. More specifically, the predefined value is a bandwidth of the total system bandwidth equally divided by a number of available numerology. The available numerology means the network supports the numerology. Alternatively, the available numerology means the network is transmitting with the numerology.

[00117] The content of the bandwidth partition information of a numerology may be a bandwidth for the numerology. The bandwidth may be expressed in the unit of a resource block.

[00118] In an exemplary embodiment, the resource block is a physical resource block.

[00119] In an exemplary embodiment, the resource blocks of the bandwidth part for the numerology is contiguous in the frequency domain.

[00120] In one embodiment, a frequency location is the frequency location of a center resource block of the bandwidth partition for the numerology. Alternatively, the frequency location is a frequency location of a resource block with lowest frequency of the bandwidth partition for the numerology. In yet another alternative, the frequency location is a frequency location of a resource block with highest frequency of the bandwidth partition for the numerology.

[00121] The frequency location of the numerology is predefined. In one embodiment, the frequency location is indicated by the system information. In another embodiment, the

frequency location is derived from synchronization and an offset value, which is indicated by the system information. Alternatively, the offset value is determined according to a total system bandwidth.

[00122] In still another embodiment, the frequency location is fixed. In one exemplary embodiment, the frequency location is a resource block with the lowest frequency among all the resource blocks within the system bandwidth. The resource block may be a resource block with the lowest frequency of the bandwidth partition for the numerology. In another exemplary embodiment, the frequency location is a resource block with the highest frequency among all the resource blocks within the system bandwidth. The resource block is a resource block with the highest frequency of the bandwidth partition for the numerology.

[00123] Different numerologies may use different types of frequency locations. In one exemplary embodiment, a first frequency location of a first numerology is given by a frequency location of a center resource block of the bandwidth partition for the first numerology. The second frequency location of a second numerology is given by a frequency location of a resource block with the lowest frequency of the bandwidth partition for the second numerology.

[00124] Each consecutive frequency resource (cluster) of a numerology can be identified by one starting position, one ending position, and the resource block between the starting and ending positions. If the resource blocks using the numerology are contiguous in the frequency domain, one starting position and one ending position can be used to identify which resource block(s) uses the numerology. Alternatively, if resource blocks using the numerology are contiguous in the frequency domain, multiple starting positions and multiple ending positions can be used to identify which resource block(s) uses the numerology.

[00125] In one exemplary embodiment, the starting position and ending position can be indicated by a sum of the binomial coefficients. The sum of the binomial coefficients can be used to indicate starting position and ending position of multiple numerologies.

[00126] In one embodiment, the number of the starting position and/or ending position can be configured by RRC. In another embodiment, the number of the starting position and/or ending position can be broadcasted in the system information. In yet another embodiment, the number of the starting position and/or ending position can be a fixed value. In another

embodiment, the number of the starting position and/or ending position is determined according to the number of the available numerology. In another embodiment, the number of the starting position and/or ending position is signaled together with the sum of the binomial coefficients.

[00127] Each resource block or a group of resource blocks is represented by a bit in a bitmap. There is one bit map associated with a numerology. If a bit in a bitmap is set to one, a resource block or a group of resource blocks corresponding to the bit would use the numerology associated with the bitmap.

[00128] It is contemplated that the above alternatives can be combined to form new methods to express bandwidth partition information. Also, any of the methods expressing bandwidth partition information can be associated with any combination of the above-disclosed methods to signal the information regarding the bandwidth partition.

[00129] In one exemplary embodiment, the bandwidth partitions information may be for all numerologies the cell is transmitting. Alternatively, the bandwidth partitions information may be for a specific numerology. In another embodiment, the specific numerology is the numerology being used by the UE. In yet another embodiment, the specific numerology is the numerology that the UE is interested in.

[00130] As disclosed above, the network may want to update the bandwidth partitions of the numerologies according to some criteria, e.g., the traffic amount on each numerology. If the information is updated frequently, the network needs to transmit the new bandwidth partition information frequently. Also, the transition of adjusting the bandwidth would be much more frequent. Accordingly, a virtual bandwidth partition can be utilized to solve the frequent update issue.

[00131] If an evolved Node B (eNB) does not intend to schedule a UE outside the bandwidth partition of a numerology configured for the UE, the eNB does not have to update the bandwidth partition configuration of the numerology of the UE. The UE may have a different understanding of the real numerology bandwidth; thus, the UE should not make any assumption on what numerology is used for a resource block outside the scheduled resource even if the resource block is within the configured bandwidth partition of the numerology. For example, if a

UE is configured with a resource block 20~80 for a numerology with a 30 KHz subcarrier spacing and is scheduled with resource block 31~60 in a TTI, the UE can receive the data in resource block 31~60 with numerology 1 in the TTI. The UE should not assume that resource block 20~30 and resource block 61~80 are transmitted with numerology 1 in the TTI. For example, the UE should not assume there is reference signal for measurement in resource block 20~30 and resource block 61~80 with numerology 1. In another example, the UE should not assume that there is a reference signal in resource block 20~30 and resource block 61~80 with numerology 1 for demodulation. If in the TTI and the CSI-RS (Channel State Information-Reference Signal) is configured, the UE does not perform a CSI (Channel State Information) measurement on resource block 20~30 and resource block 61~80, but rather the UE performs a measurement within resource block 31~60. An illustration of this example is shown in FIG. 47.

[00132] As disclosed in the specification, the bandwidth portion may be defined as a set of resources in the frequency domain.

[00133] FIG. 48 is a flow chart 4800 according to one exemplary embodiment from the perspective of a UE. In step 4805, the UE receives information for a numerology, wherein the information comprises a frequency location and a bandwidth. In step 4810, the UE derives a resource allocation for the numerology based on the frequency location and the bandwidth.

[00134] In another embodiment, the UE is configured with a system bandwidth. In one another embodiment, the system bandwidth may be larger than the bandwidth. In the various methods, the frequency location may be an index of a resource block. In another method, the resource allocation allocates the resource within a bandwidth portion. In one embodiment, the bandwidth portion is derived from the frequency location and the bandwidth.

[00135] In the various embodiments, the frequency location is an index of the resource block with the lowest frequency within the bandwidth portion. Alternatively, the frequency location is an index of the resource block with the highest frequency within the bandwidth portion. In another alternative, the frequency location is an index of the resource block with central frequency within the bandwidth portion.

[00136] In the various embodiments, the bandwidth is a fixed bandwidth. Alternatively, the bandwidth is a configured bandwidth. Alternatively, the bandwidth is the maximum

bandwidth for the numerology. In yet another alternative, the bandwidth is the maximum bandwidth the UE is able to receive for the numerology.

[00137] In the various embodiments, the resource allocation is done by a bitmap. Alternatively, the resource allocation is done by a value indicating the starting position and a length of the resource allocation.

[00138] In the various embodiments, the bandwidth is consecutive in frequency domain.

[00139] In the various embodiments, the bandwidth portion is indicated by a broadcast channel. In another embodiment, the bandwidth portion is indicated by a UE-specific RRC message. In another embodiment, the bandwidth portion is indicated by a physical control channel. In still another embodiment, the bandwidth portion is indicated by a broadcast channel and may be updated by a UE-specific RRC message. In still another embodiment, the bandwidth portion is indicated by a UE-specific RRC message and may be updated by a physical control channel.

[00140] In the various embodiments, the bandwidth is indicated by a broadcast channel. In another embodiment, the bandwidth is indicated by a UE-specific RRC message. In another embodiment, the bandwidth is indicated by a physical control channel. In still another embodiment, the bandwidth is indicated by a broadcast channel and may be updated by a UE-specific RRC message. In still another embodiment, the bandwidth is indicated by a UE-specific RRC message and may be updated by a physical control channel.

[00141] In the various embodiments, the frequency location is indicated by a broadcast channel. In another embodiment, the frequency location is indicated by a UE-specific RRC message. In another embodiment, the frequency location is indicated by a physical control channel. In still another embodiment, the frequency location is indicated by a broadcast channel and may be updated by a UE-specific RRC message. In still another embodiment, the frequency location is indicated by a UE-specific RRC message and may be updated by a physical control channel.

[00142] In the various embodiments, in particular that described in connection with Fig. 48, further alternatively or additionally preferably the numerology is configured by a UE-specific

RRC message. Further alternatively or additionally preferably, the numerology is indicated by a physical control channel. Further alternatively or additionally preferably, the numerology is indicated by a UE-specific RRC message and may be updated by a physical control channel.

[00143] FIG. 49 is a flow chart 4900 according to another exemplary embodiment from the perspective of a network. In step 4905, the network informs the UE information for a numerology, wherein the information comprises a bandwidth portion for the numerology. In step 4910, the network schedules the UE with a resource allocation for the numerology within the bandwidth portion in a transmission time interval (TTI).

[00144] In the various embodiments, the bandwidth portion comprises a frequency location and a bandwidth. In another embodiment, the bandwidth portion comprises a frequency location. In still another embodiment, the bandwidth portion comprises a bandwidth.

[00145] In the various embodiments, the bandwidth portion is indicated by a broadcast channel. In another embodiment, the bandwidth portion is indicated by a UE-specific RRC message. In another embodiment, the bandwidth portion is indicated by a physical control channel. In still another embodiment, the bandwidth portion is indicated by a broadcast channel and may be updated by a UE-specific RRC message. In still another embodiment, the bandwidth portion is indicated by a UE-specific RRC message and may be updated by a physical control channel.

[00146] In the various embodiments, in particular that described in connection with Fig. 49, further alternatively or additionally preferably the numerology is configured by a UE-specific RRC message. Further alternatively or additionally preferably, the numerology is indicated by a physical control channel. Further alternatively or additionally preferably, the numerology is indicated by a UE-specific RRC message and may be updated by a physical control channel.

[00147] In one method, the UE does not assume that a resource block within the bandwidth portion and outside the resource allocation is transmitted with the numerology in the TTI.

[00148] In another method, the UE does not perform measurement on resource block(s) within the bandwidth portion and outside the resource allocation.

[00149] In yet another method, the UE does not perform demodulation with the reference signal on the resource block(s) within the bandwidth portion and outside the resource allocation.

[00150] In another method, the measurement is a channel state information (CSI) measurement. In some methods, if the UE is configured with CSI-RS in the TTI, the UE measures CSI-RS within the bandwidth portion and outside the resource allocation. In some methods, if the UE is configured with CSI-RS in the TTI, the UE measures CSI-RS within the resource allocation. In yet another method, the network would transmit a second numerology different from the numerology within the bandwidth portion.

[00151] Referring back to FIGS. 3 and 4, in one embodiment, the device 300 includes a program code 312 stored in memory 310. The CPU 308 could execute program code 312 to enable the UE (i) to receive information for a numerology, wherein the information comprises a frequency location and a bandwidth; (ii) to derive a resource allocation for the numerology based on the frequency location and the bandwidth.

[00152] In another embodiment, the CPU 308 could execute program code 312 to enable the network (i) to configure the UE with a numerology; (ii) to configure the UE with a bandwidth portion for the numerology schedule a transmission or a reception for the UE based on the information; and (iii) to schedule the UE with a resource allocation with the bandwidth in a transmission time interval (TTI), wherein the UE does not assume that a resource block within the bandwidth portion and outside the resource allocation is transmitted with the numerology in the TTI.

[00153] In another embodiment, the CPU 308 could execute program code 312 to enable the network (i) to inform the UE information for a numerology, wherein the information comprises a bandwidth portion for the numerology; and (ii) to schedule the UE with a resource allocation for the numerology with the bandwidth in a TTI.

[00154] Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others methods described herein.

[00155] Various aspects of the disclosure have been described above. It should be apparent that the teachings herein may be embodied in a wide variety of forms and that any

specific structure, function, or both being disclosed herein is merely representative. Based on the teachings herein one skilled in the art should appreciate that an aspect disclosed herein may be implemented independently of any other aspects and that two or more of these aspects may be combined in various ways. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, such an apparatus may be implemented or such a method may be practiced using other structure, functionality, or structure and functionality in addition to or other than one or more of the aspects set forth herein. As an example of some of the above concepts, in some aspects concurrent channels may be established based on pulse repetition frequencies. In some aspects concurrent channels may be established based on pulse position or offsets. In some aspects concurrent channels may be established based on time hopping sequences.

[00156] Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[00157] Those of skill would further appreciate that the various illustrative logical blocks, modules, processors, means, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware (e.g., a digital implementation, an analog implementation, or a combination of the two, which may be designed using source coding or some other technique), various forms of program or design code incorporating instructions (which may be referred to herein, for convenience, as "software" or a "software module"), or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[00158] In addition, the various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented within or performed by an integrated circuit ("IC"), an access terminal, or an access point. The IC may comprise a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, electrical components, optical components, mechanical components, or any combination thereof designed to perform the functions described herein, and may execute codes or instructions that reside within the IC, outside of the IC, or both. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00159] It is understood that any specific order or hierarchy of steps in any disclosed process is an example of a sample approach. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[00160] The steps of a method or algorithm described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module (e.g., including executable instructions and related data) and other data may reside in a data memory such as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of computer-readable storage medium known in the art. A sample storage medium may be coupled to a machine such as, for example, a computer/processor (which may be referred to herein, for convenience, as a "processor") such the processor can read information (e.g., code) from and write information to the storage medium. A sample storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in user equipment. In the

alternative, the processor and the storage medium may reside as discrete components in user equipment. Moreover, in some aspects any suitable computer-program product may comprise a computer-readable medium comprising codes relating to one or more of the aspects of the disclosure. In some aspects a computer program product may comprise packaging materials.

[00161] While the invention has been described in connection with various aspects, it will be understood that the invention is capable of further modifications. This application is intended to cover any variations, uses or adaptation of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within the known and customary practice within the art to which the invention pertains.

Samsung Exhibit 1006, Page 510 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

PTO/SB/17 (03-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

FEE TRANSMITTAL

Complete if known	
Application Number	Not Yet Assigned
Filing Date	Herewith
First Named Inventor	Ko-Chiang Lin
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Practitioner Docket No.	1426-148.101

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

TOTAL AMOUNT OF PAYMENT ($) 1600.00

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☐ Deposit Account Deposit Account Number: _____ Deposit Account Name: _____

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☐ Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17 ☐ Credit any overpayment of fee(s)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

	FILING FEES			SEARCH FEES			EXAMINATION FEES			
Application Type	U ($)	S ($)	M ($)	U ($)	S ($)	M ($)	U ($)	S ($)	M ($)	Fees Paid ($)
Utility	280	140*	70	600	300	150	720	360	180	1600
Design	180	90	45	120	60	30	460	230	115	
Plant	180	90	45	380	190	95	580	290	145	
Reissue	280	140	70	600	300	150	2,160	1,080	540	
Provisional	260	130	65	0	0	0	0	0	0	

* The $140 small entity status filing fee for a utility application is further reduced to $70 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	Undiscounted Fee ($)	Small Entity Fee ($)	Micro Entity Fee ($)
Each claim over 20 (including Reissues)	80	40	20
Each independent claim over 3 (including Reissues)	420	210	105
Multiple dependent claims	780	390	195

Total Claims		Extra Claims	Fee ($)		Fee Paid ($)
20	-20 or HP =	_____ x	_____	=	_____

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims	Fee ($)		Fee Paid ($)
3	-3 or HP =	_____ x	_____	=	_____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	Fee Paid ($)
_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $400 ($200 for small entity) ($100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)		Fee Paid ($)
130	- 100 =	_____	/ 50 =	_____ (round **up** to a whole number)	x	_____	=	_____

4. OTHER FEE(S) — Fees Paid ($)

Non-English specification, $130 fee (no small or micro entity discount) _____

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, $400 fee ($200 small or micro entity) _____

Other (e.g., late filing surcharge): _____ _____

SUBMITTED BY

Signature	/Sang N. Dang/	Registration No. (Attorney/Agent) 51,186	Telephone (714) 839-3800
Name (Print/Type)	Sang N. Dang		Date August 10, 2017

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

if you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

SCORE Placeholder Sheet for IFW Content

Application Number: 15674483 Document Date: 08/10/2017

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

To access the documents in the SCORE database, refer to instructions below.

At the time of document entry (noted above):

- Examiners may access SCORE content via the eDAN interface.
- Other USPTO employees can bookmark the current SCORE URL (http://Score.uspto.gov/ScoreAccessWeb/).
- External customers may access SCORE content via the Public and Private PAIR interfaces.

Form Revision Date: September 30, 2013

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas - Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:23-cv-409	3/11/2024	Eastern District of Texas - Marshall Division

PLAINTIFF	DEFENDANT
ASUS TECHNOLOGY LICENSING INC. AND CELERITY IP, LLC	SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS AMERICA, INC., AND SAMSUNG RESEARCH AMERICA

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,187,878 B2	1/22/2019	ASUS TECHNOLOGY LICENSING INC.
2	11,291,052 B2	3/29/2022	ASUS TECHNOLOGY LICENSING INC.
3	10,104,658 B2	10/16/2018	ASUS TECHNOLOGY LICENSING INC.
4	10,785,759 B2	9/22/2010	ASUS TECHNOLOGY LICENSING INC.
5	10,986,585 B2	4/20/2021	ASUS TECHNOLOGY LICENSING INC.

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas - Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

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2:23-cv-409	3/11/2024	Eastern District of Texas - Marshall Division

PLAINTIFF	DEFENDANT
ASUS TECHNOLOGY LICENSING INC. AND CELERITY IP, LLC	SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS AMERICA, INC., AND SAMSUNG RESEARCH AMERICA

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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3	10,104,658 B2	10/16/2018	ASUS TECHNOLOGY LICENSING INC.
4	10,785,759 B2	9/22/2010	ASUS TECHNOLOGY LICENSING INC.
5	10,986,585 B2	4/20/2021	ASUS TECHNOLOGY LICENSING INC.

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

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UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	09/22/2020	10785759	ASUP139US	7684

92096 7590 09/02/2020

Cooper Legal Group LLC
6505 Rockside Road
Suite 330
Independence, OH 44131

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 16 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Ko-Chiang Lin, Taipei City, TAIWAN;
ASUSTek Computer Inc., Taipei City 112, TAIWAN;
Ming-Che Li, Taipei City, TAIWAN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

Document Description: Issue Fee Payment (PTO-85B)

Issue Fee Transmittal Form

Application Number	Filing Date	First Named Inventor	Atty. Docket No.	Confirmation No.
15674483	10-Aug-2017	Ko-Chiang Lin	ASUP139US	7684

TITLE OF INVENTION :

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

Entity Status	Application Type	Art Unit	Class - Subclass	EXAMINER
Regular Undiscounted	Utility under 35 USC 111(a)	2644	329000	WAYNE CAI

Issue Fee Due	Publication Due	Total Fee(s) Due	Date Due	Prev. Paid Fee
$1000	$0	$1000	20-Aug-2020	$0

1.Change of Correspondence Address and/or Indication Of Fee Address (37 CFR 1.33 & 1.363)

Current Correspondence Address:	Current Indicated Fee Address :
92096 Cooper Legal Group LLC 6505 Rockside Road Suite 330 Independence OH 44131 UNITED STATES 216-654-0090 docketing@cooperlegalgroup.com	
☐ Change of correspondence address requested, system generated AIA/122-EFS form attached	☐ Fee Address indication requested, system generated SB/47-EFS form attached

2.Entity Status

Change in Entity Status

○ Applicant certifying micro entity status; system generated Micro Entity certification form attached. See 37 CFR 1.29.
Note: Absent a valid certification of micro entity status, issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment. If this box is checked, you will be prompted to choose a micro entity status on the gross income basis (37 CFR 1.29(a)) or the institution of higher education basis (37 CFR 1.29(d)), and make the applicable certification online.

○ Applicant asserting small entity status. See 37 CFR 1.27.
Note: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

◉ Applicant changing to regular undiscounted fee status.
Note: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

Doc Code: IFEE PTOL/85B-EFS

Document Description: Issue Fee Payment (PTO-85B)

3.The Following Fee(s) Are Submitted:

☒ Issue Fee	☐ I authorize USPTO to apply my previously paid issue fee to the current fees due
☐ Publication Fee	☐ The Director is hereby authorized to apply my previously paid issue fee to the current fee due and to charge deficient fees to Deposit Account Number _____
☐ Advance Order - # of copies _____	☐ If **in addition to** the payment of the issue fee amount submitted with this form, there are any discrepancies in any amount(s) due, the Director is authorized to charge any deficiency, or credit any overpayment, to Deposit Account Number _____ . The **issue fee must be submitted** with this form. **If payment of the issue fee does not accompany this form, checking this box and providing a deposit account number will NOT be effective to satisfy full payment of the fee(s) due.**

4.Firm and/or Attorney Names To Be Printed

NOTE: If no name is listed, no name will be printed
For printing on the patent front page, list to be displayed as entered

1. COOPER LEGAL GROUP, LLC
2.
3.

5.Assignee Name(s) and Residence Data To Be Printed

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

Name	City	State	Country	Category
ASUSTek Computer Inc.	Taipei City		taiwan	corporation

6.Signature

I certify, in accordance with 37 CFR 1.4(d)(4) that I am an attorney or agent registered to practice before the Patent and Trademark Office who has filed and has been granted power of attorney in this application. I also certify that this Fee(s) Transmittal form is being transmitted to the USPTO via EFS-WEB on the date indicated below.

Signature	/William Joseph Cooper/	**Date**	08-19-2020
Name	William Joseph Cooper	**Registration Number**	44629

WEB IFEE 1.0

Electronic Patent Application Fee Transmittal

Application Number:	15674483
Filing Date:	10-Aug-2017
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Filer:	William Joseph Cooper/Jennifer Meinyk
Attorney Docket Number:	ASUP139US

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1000**

Electronic Acknowledgement Receipt	
EFS ID:	40326248
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	92096
Filer:	William Joseph Cooper/Jennifer Meinyk
Filer Authorized By:	William Joseph Cooper
Attorney Docket Number:	ASUP139US
Receipt Date:	19-AUG-2020
Filing Date:	10-AUG-2017
Time Stamp:	13:22:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1000
RAM confirmation Number	E20208ID22278924
Deposit Account	505088
Authorized User	Jennifer Meinyk
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.20 (Post Issuance fees) 37 CFR 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Web85b.pdf	45840 dd6e188add1ca3ef1f9efe96c4f40592d2363768	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32377 6bf4d566024d7708f90aa119040bb57292f13b6d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	78217		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

92096 7590 05/20/2020

Cooper Legal Group LLC
6505 Rockside Road
Suite 330
Independence, OH 44131

EXAMINER	
CAI, WAYNE HUU	
ART UNIT	PAPER NUMBER
2644	

DATE MAILED: 05/20/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	ASUP139US	7684

TITLE OF INVENTION: METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	08/20/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PTOL-85 (Rev. 02/11)

Samsung Exhibit 1006, Page 522 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

92096 7590 05/20/2020

Cooper Legal Group LLC
6505 Rockside Road
Suite 330
Independence, OH 44131

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	ASUP139US	7684

TITLE OF INVENTION: METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	08/20/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
CAI, WAYNE HUU	2644	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1_____
2_____
3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Samsung Exhibit 1006, Page 523 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	ASUP139US	7684

92096 7590 05/20/2020

Cooper Legal Group LLC
6505 Rockside Road
Suite 330
Independence, OH 44131

EXAMINER	
CAI, WAYNE HUU	
ART UNIT	**PAPER NUMBER**
2644	

DATE MAILED: 05/20/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 02/11)

Samsung Exhibit 1006, Page 524 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/674,483	Applicant(s) Lin et al.	
	Examiner WAYNE H CAI	Art Unit 2644	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 03/10/2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-12 and 16-20 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☑ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/Wayne H Cai/
Primary Examiner, Art Unit 2644

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on March 10, 2020 has been entered.

EXAMINER'S AMENDMENT

3. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Ali Assar on May 14, 2020.

The application has been amended as follows:

Claims 13-15 (Cancelled)

(END OF AMENDMENT)

Allowable Subject Matter

4. Claims 1-12, and 16-20 are allowed, and they have been renumbered as 1-17, respectively.

5. The following is an examiner's statement of reasons for allowance: The Examiner performed an update search; however, none of the prior arts found, taken either alone or in combination, expressly teaches or suggests claimed invention. Therefore, the Examiner allows these claims at least for this reason, and also for the same reasons discussed in Remarks dated March 10, 2020.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to WAYNE H. CAI whose telephone number is (571)272-7798. The examiner can normally be reached on Monday-Friday, 8:00 AM - 5:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an

interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KATHY WANG-HURST can be reached on (571)270-5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Wayne H Cai/
Primary Examiner, Art Unit 2644

Examiner-Initiated Interview Summary	**Application No.** 15/674,483	**Applicant(s)** Lin et al.	
	Examiner WAYNE H CAI	**Art Unit** 2644	**AIA (FITF) Status** Yes

All participants (applicant, applicant's representative, PTO personnel):

(1) WAYNE H.. CAI. (3) _____.

(2) ALI ASSAR (REG. NO. 65,848). (4) _____.

Date of Interview: 14 May 2020.

Type: ☑ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐ 101 ☐ 112 ☐ 102 ☐ 103 ☑ Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 13-15.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The Examiner suggested the Applicant's Representative to cancel claims 13-15 to place this application in condition for allowance. The Applicant's Representative agreed and authorized the Examiner to make these changes by way of Examiner's Amendment..

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/Wayne H Cai/ Primary Examiner, Art Unit 2644	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/18/2018	01/09/2019	05/07/2019	08/21/2019	12/05/2019	05/14/2020			
1	1	÷	✓	✓	✓	✓	=			
2	2	÷	✓	✓	✓	✓	=			
3	3	÷	✓	✓	✓	✓	=			
4	4	÷	✓	✓	✓	✓	=			
5	5	÷	✓	✓	✓	✓	=			
6	6	÷	✓	✓	✓	✓	=			
7	7	÷	✓	✓	✓	✓	=			
8	8	÷	✓	✓	✓	✓	=			
9	9	÷	✓	✓	✓	✓	=			
10	10	÷	✓	✓	✓	✓	=			
11	11	÷	✓	✓	✓	✓	=			
12	12	÷	✓	✓	✓	✓	=			
-	13	÷	N	N	N	N	-			
-	14	÷	N	N	N	N	-			
-	15	÷	N	N	N	N	-			
13	16	÷	✓	✓	✓	✓	=			
14	17	÷	✓	✓	✓	✓	=			
15	18	÷	✓	✓	✓	✓	=			
16	19	÷	✓	✓	✓	✓	=			
17	20	÷	✓	✓	✓	✓	=			

Samsung Exhibit 1006, Page 531 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	Art Unit
	WAYNE H CAI	2644

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04W 72/042	05/14/2020	WHC
H04L 27/2602	05/14/2020	WHC
H04L 5/0007,0051,0094,003	05/14/2020	WHC

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Inventors Search	01/09/2019	WHC
See Search History	01/09/2019	WHC
See Update Search History	05/07/2019	WHC
See Update Search History	08/21/2019	WHC
See Update Search History	12/05/2019	WHC
Update Inventors Search	05/14/2020	WHC
Update Search History	05/14/2020	WHC

Samsung Exhibit 1006, Page 532 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	Art Unit
	WAYNE H CAI	2644

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	Same As Above	05/14/2020	WHC

Samsung Exhibit 1006, Page 533 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

CPC						
Symbol					**Type**	**Version**
H04W	/	72	/	042	F	2013-01-01
H04L	/	27	/	2602	I	2013-01-01
H04L	/	5	/	0007	I	2013-01-01
H04L	/	5	/	0051	I	2013-01-01
H04L	/	5	/	0094	I	2013-01-01
H04L	/	5	/	003	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/Wayne H Cai/ Primary Examiner, Art Unit 2644	14 May 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	48

U.S. Patent and Trademark Office — Part of Paper No.: 20200514

Samsung Exhibit 1006, Page 534 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04W72/04	/	72	/	04

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/Wayne H Cai/ Primary Examiner, Art Unit 2644	14 May 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	48

U.S. Patent and Trademark Office — Part of Paper No.: 20200514

Samsung Exhibit 1006, Page 535 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	Art Unit
	WAYNE H CAI	2644

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	10	16	19										
2	2	11	11	17	20										
3	3	12	12												
4	4	-	13												
5	5	-	14												
6	6	-	15												
7	7	13	16												
8	8	14	17												
9	9	15	18												

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/Wayne H Cai/ Primary Examiner, Art Unit 2644	14 May 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	48

U.S. Patent and Trademark Office Part of Paper No.: 20200514

Samsung Exhibit 1006, Page 536 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S123	12	S116 and S118	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:54
S121	2	S120 not S119	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:47
S120	2	S115 and S118	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:47
S119	6	S114 and S118	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:46
S118	29	@ad<"20160812" and S117	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:32
S117	110	(frequenc$5 adj location$2) near10 bandwidth near10 indicat$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:32
S116	33979	H04L5/0007,0051,0094,003.cpc. and (@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812")	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:27
S115	8131	H04L27/2602.cpc. and (@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812")	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:27

S114	27236	H04W72/042.cpc. and (@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812")	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 17:26
S113	29	@ad<"20160812" and S112	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 15:12
S112	110	(frequenc$5 adj location$2) near10 bandwidth near10 indicat$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 15:12
S111	156	@ad<"20160812" and S110	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 15:10
S110	1510	(("PDSCH" or physical adj downlink adj shared adj channel) or ("PUSCH" or physical adj uplink adj shared adj channel$2)) near15 ("PDCCH" or physical adj downlink adj control$5 adj channel) near15 (allocat$5 assign$9 schedul$5) and numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 15:10
S109	0	S108 and S100	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 15:07
S108	49	(@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812") and S107	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 15:07
S107	115	numerolog$4 same ("UE" or user adj equipment) near15 (bandwidth near5 (partition$2 portion$2) or sub-band$2 or subband$2)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 15:07
S106	4	((generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5 (sub-band$2 subband$2 bandwidth) near5 (part partial partition portion) and (generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 13:20

		(sub-band$2 subband$2 bandwidth) near5 (part partial partition portion) same (location$4 position$5)).clm.				
S105	2	(generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5 (sub-band$2 subband$2 bandwidth) near5 (part partial partition portion) same (location$4 position$5) and (bit adj map)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 13:03
S104	106	S101 and S102	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 13:01
S103	26	(generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5 (sub-band$2 subband$2 bandwidth) near5 (part partial partition portion) same (location$4 position$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 13:01
S102	203	(generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5 (sub-band$2 subband$2 bandwidth) near5 (part partial partition portion)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 13:00
S101	62640	("PUSCH" or physical adj uplink adj shared adj channel) or ("PDSCH" or physical adj downlink adj shared adj channel)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 13:00
S100	6104	(("PUSCH" or physical adj uplink adj shared adj channel) or ("PDSCH" or physical adj downlink adj shared adj channel) and (subcarrier$2 sub-carrier$2) adj4 spac$4 and (resource adj (allocat$5 assign$5)) and (generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5 (sub-band$2 subband$2 bandwidth) near5 (part partial partition portion)).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:58
S99	6104	(("PUSCH" or physical adj uplink adj shared adj channel) or ("PDSCH" or physical adj downlink adj shared adj channel) and (subcarrier$2 sub-carrier$2) adj4 spac$4 and (resource adj (allocat$5 assign$5)) and (generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:57

		(sub-band$2 subband$2 bandwidth) near5 (part partial portion)).clm.				
S98	6104	(("PUSCH" or physical adj uplink adj shared adj channel) or ("PDSCH" or physical adj downlink adj shared adj channel) and (subcarrier$2 sub-carrier$2) and spac$4 and (resource adj (allocat$5 assign$5)) and (generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment) near5 (sub-band$2 subband$2 bandwidth) near5 (part partial portion)).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:57
S97	6104	(("PUSCH" or physical adj uplink adj shared adj channel) or ("PDSCH" or physical adj downlink adj shared adj channel) and (subcarrier$2 sub-carrier$2) and spac$4 and (resource adj (allocat$5 assign$5)) and (generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment)).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:57
S96	9	S95 not S93	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:56
S95	10	li-ming-che.in. and (("PUSCH" or physical adj uplink adj shared adj channel) or ("PDSCH" or physical adj downlink adj shared adj channel) and (subcarrier$2 sub-carrier$2) and spac$4 and (resource adj (allocat$5 assign$5)) and (generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment)).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:50
S94	69	li-ming-che.in.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:50
S93	7	lin-ko-chiang.in. and (("PUSCH" or physical adj uplink adj shared adj channel) or ("PDSCH" or physical adj downlink adj shared adj channel) and (subcarrier$2 sub-carrier$2) and spac$4 and (resource adj (allocat$5 assign$5)) and (generat$5 deriv$5 calculat$5 determin$) near5 (UE or user adj equipment)).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:45

S92	132	lin-ko-chiang.in.	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:43
S91	1	15/674483	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/14 12:43
S90	49	(@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812") and S89	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/12 09:51
S89	115	numerolog$4 same ("UE" or user adj equipment) near15 (bandwidth near5 (partition$2 portion$2) or sub-band$2 or subband$2)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/12 09:51
S87	192	numerolog$4 same ("UE" or user adj equipment) same (bandwidth near5 (partition$2 portion$2) or sub-band$2 or subband$2)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/12 09:50
S86	13	(@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812") and S85	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/12 09:48
S85	44	numerolog$4 same ("UE" or user adj equipment) same (bandwidth near5 (partition$2 portion$2))	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2020/05/12 09:47

EAST Search History (Interference)

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5/14/2020 8:46:52 PM
C:\Users\wcai1\Documents\EAST\Workspaces\15674483.wsp

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/674,483	Filing Date 08/10/2017	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $420 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	03/10/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/JULIET MCMILLAN/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	15/674,483	Filing Date	2017-08-10	Docket Number (if applicable)	ASUP139US	Art Unit	2644
First Named Inventor	Ko-Chiang Lin			Examiner Name	Wayne Huu Cai		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 505088

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Ali Assar/	Date (YYYY-MM-DD)	2020-03-10
Name	Ali Assar	Registration Number	65848

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	15674483
Filing Date:	10-Aug-2017
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Filer:	William Joseph Cooper/Amy Ansbro
Attorney Docket Number:	ASUP139US

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 2ND AND SUBSEQUENT REQUEST	1820	1	1900	1900
		Total in USD ($)		**1900**

Electronic Acknowledgement Receipt	
EFS ID:	38820084
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	92096
Filer:	William Joseph Cooper/Amy Ansbro
Filer Authorized By:	William Joseph Cooper
Attorney Docket Number:	ASUP139US
Receipt Date:	10-MAR-2020
Filing Date:	10-AUG-2017
Time Stamp:	13:36:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1900
RAM confirmation Number	E202030D36584385
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		ASUP139US_R01.pdf	65053 772b357a2d66a90667057d13ace640bb4dfe5864	yes	13
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Amendment Submitted/Entered with Filing of CPA/RCE		1	1	
	Claims		2	6	
	Applicant Arguments/Remarks Made in an Amendment		7	13	
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	RCE.pdf	74334 9d0c86ca581e839cfffdfd1a48464a18069c4638	no	3
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30954 95b607f76a1bc4ebef0d95ac58d80159959b0bb4	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	170341		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No. **1050198-US** **ASUP139US**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re **PATENT** application of:

Applicant: Ko-Chiang Lin

Serial No.: 15/674,483

For: METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

Filing Date: August 10, 2017

Examiner: WAYNE HUU CAI

Art Unit: 2644

RCE SUBMISSION/REPLY TO THE FINAL OFFICE ACTION DATED DECEMBER 10, 2019

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner,

Favorable reconsideration of the above-identified application is respectfully requested in view of the following remarks and amendments.

AMENDMENTS

IN THE CLAIMS:

Please amend claims 1, 3, 5 and 16 and 19 as follows:

1. (Currently Amended) A method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a first numerology associated with a first subcarrier spacing, wherein the information comprises a first frequency location and a first bandwidth for the first numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH;

deriving, by the UE, a first bandwidth portion based on the first frequency location and the first bandwidth for the first numerology; and

deriving, by the UE, a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within [[a]] the first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth, wherein ~~the first bandwidth portion is derived from the first frequency location and the first bandwidth for the first numerology, and~~ the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE.

2. (Original) The method of claim 1, further comprising:

configuring, by the UE, a system bandwidth.

3. (Currently Amended) The method of claim [[2]] 1, comprising:

receiving, by the UE, second information for a second numerology associated with a second subcarrier spacing, wherein the second information comprises a second

frequency location and a second bandwidth for the second numerology for a second PDSCH or a second PUSCH;

detecting a second PDCCH, wherein the second PDCCH is associated with the second PDSCH or the second PUSCH;

deriving, by the UE, a second bandwidth portion based on the second frequency location and the second bandwidth for the second numerology; and

deriving, by the UE, a second resource allocation scheduled by a second network and carried by the second PDCCH for the second PDSCH or the second PUSCH for the second numerology within the second bandwidth portion based on the second PDCCH, the second frequency location and the second bandwidth ~~wherein the system bandwidth is larger than the first bandwidth~~.

4. (Previously Presented) The method of claim 1, wherein the first frequency location is an index of a resource block.

5. (Currently Amended) The method of claim 1, further comprising:

receiving, by [[a]] the UE ~~user equipment (UE)~~, second information for a second numerology associated with a second subcarrier spacing, wherein the second information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a second resource allocation for a second PDSCH or a second PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth.

6. (Previously Presented) The method of claim 1, wherein the first frequency location is an index of a resource block with a central frequency within the first bandwidth portion.

7. (Previously Presented) The method of claim 6, the first bandwidth portion is

derived from the first frequency location and the first bandwidth.

8. (Previously Presented) The method of claim 1, wherein the first bandwidth and the first frequency location is configured by UE-specific RRC message.

9. (Previously Presented) The method of claim 1, wherein the first bandwidth and the first frequency location is indicated by a physical control channel.

10. (Previously Presented) The method of claim 1, wherein the first numerology is indicated by a physical control channel.

11. (Previously Presented) The method of claim 1, wherein the first bandwidth is a maximum bandwidth for the first numerology.

12. (Previously Presented) The method of claim 1, wherein the first bandwidth is a maximum bandwidth that the UE is able to receive for the first numerology.

13. (Withdrawn) A method for determining numerology bandwidth, the method comprising:

informing a user equipment (UE) information for a numerology, wherein the information comprises a bandwidth portion for the numerology; and

scheduling the UE with a resource allocation for the numerology within the bandwidth portion in a transmission time interval (TTI).

14. (Withdrawn) The method of claim 13, wherein the UE does not assume that a resource block within the bandwidth portion and outside the resource allocation is transmitted with the numerology in the TTI.

15. (Withdrawn) The method of claim 13, wherein the bandwidth portion is derived

from a frequency location and a bandwidth.

16. (Currently Amended) A User Equipment (UE) capable of determining numerology bandwidth, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

receive information for a first numerology associated with a first subcarrier spacing, wherein the information comprises a first frequency location and a first bandwidth for the first numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detect[[ing]] a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH;

derive a first bandwidth portion based on the first frequency location and the first bandwidth for the first numerology; and

derive a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within [[a]] the first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth, wherein ~~the first bandwidth portion is derived from the first frequency location and the first bandwidth for the first numerology, and~~ the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE.

17. (Original) The UE of claim 16, wherein the UE configures a system bandwidth.

18. (Previously Presented) The UE of claim 17, wherein the system bandwidth is larger than the first bandwidth.

19. (Currently Amended) The UE of claim 16, wherein the processor is further configured to execute a second program code stored in the memory to:

receive second information for a second numerology associated with a second subcarrier spacing, wherein the second information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a second resource allocation for a second PDSCH or a second PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth.

20. (Previously Presented) The UE of claim 16, wherein the first bandwidth is a configured bandwidth for the first numerology.

REMARKS

Claims 1-12 and 16-20 are pending in the application, and are all rejected. Claims 13-15 were withdrawn from consideration. Claims 1, 3, 5 and 16 and 19 are amended herein by way of RCE. Reconsideration of the application in light of the following remarks is respectfully requested.

I. REJECTION OF CLAIMS 1, 4, 5, 8, 9, 16 AND 19 UNDER 35 U.S.C. § 103(a)

Claims 1, 4, 5, 8, 9, 16 and 19 are rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Xiong, U.S. Publication No. 2018/0020365 (*hereinafter* "Xiong") in view of Fwu, U.S. Publication No. 2018/0007673 (*hereinafter* "Fwu") and further in view of Yi, U.S. Publication No. 2019/0229879 (*hereinafter* "Yi"). Withdrawal of this rejection is respectfully requested for at least the following reasons.

Independent claim 1 provides for, among other things, **deriving, by the UE, a first bandwidth portion based on the first frequency location and the first bandwidth for the first numerology; and deriving, by the UE, a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within the first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth, wherein the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE**, and **independent claim 16** is believed to provide for at least some similar features. At least some support may be provided in [0088] and/or [0098] of the instant application, for example.

It is respectfully submitted that the references cited fail to teach and/or suggest at least these features.

The Office Action seems to acknowledge that Xiong and/or Fwu are silent as to at least some of these features (e.g., pages 3-4 of the Office Action).

Yi is believed to fail to make up for the deficiencies of Xiong and/or Fwu.

For example, Yi provides that "a PRB region constituting the GPDCCH search

space may be limited to a partial contiguous or non-contiguous PRB region in the entire system bandwidth for the purpose of multiplexing between the GPDCCH and a PDSCH, which is transmitted to a legacy UE. Such a PRB region may be pre-defined or notified to a UE by an eNB through the legacy PDCCH, SIB, or RRC" (e.g., [0312] of Yi).

Yi further provides that "the eNB may inform the UE of the location of the data transmission sTTI in the form of a bitmap through the GPDCCH" (e.g., [0321] of Yi).

That is, Yi seems to mention that a physical resource block may be predefined or notified to a UE, and that an eNB may send a bitmap indicative of a data transmission shortened transmission time interval to a UE.

Notably, Yi seems to be silent as to a UE deriving a first bandwidth portion based on a first frequency location and a first bandwidth for a first numerology, wherein resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE.

It is respectfully submitted that **a physical resource block being predefined or notified to a UE, and an eNB sending a bitmap indicative of a data transmission shortened transmission time interval to a UE**, as provided for by Yi, does not teach **deriving, by the UE, a first bandwidth portion based on the first frequency location and the first bandwidth for the first numerology; and deriving, by the UE, a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within the first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth, wherein the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE** as provided for by independent claim 1, and as similarly provided for by independent claim 16, at least in part. It is thus respectfully submitted that independent claims 1 and 16 and the remaining claims that depend therefrom are not taught by the suggested combination, and allowance of the same is therefore respectfully requested.

Therefore, withdrawal of the rejection and allowance of the pending claims is respectfully requested.

II. REJECTION OF CLAIMS 2, 3, 6, 7, 17 AND 18 UNDER 35 U.S.C. § 103

Claims 2, 3, 6, 7, 17 and 18 are rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Xiong in view of Fwu in view of Yi and further in view of Dai, U.S. Publication No.: 2016/0359593 (*hereinafter* "Dai"). Withdrawal of this rejection is respectfully requested for at least the following reasons.

Claims 2, 3, 6, 7, 17 and 18 depend from independent claims 1 or 16, which are believed to be allowable over Xiong, Fwu and Yi for at least the foregoing reasons. It is believed that Dai does not make up for at least the aforementioned deficiencies of Xiong, Fwu and Yi with regard to independent claims 1 and 16. Independent claims 1 and 16 are therefore believed to be allowable over the suggested combination, and claims 2, 3, 6, 7, 17 and 18 are believed to be allowable as well at least because they depend from independent claims 1 or 16.

Alternatively and/or additionally, **claim 3** provides for, among other things, **receiving, by the UE, second information for a second numerology associated with a second subcarrier spacing, wherein the second information comprises a second frequency location and a second bandwidth for the second numerology for a second PDSCH or a second PUSCH; detecting a second PDCCH, wherein the second PDCCH is associated with the second PDSCH or the second PUSCH; deriving, by the UE, a second bandwidth portion based on the second frequency location and the second bandwidth for the second numerology; and deriving, by the UE, a second resource allocation scheduled by a second network and carried by the second PDCCH for the second PDSCH or the second PUSCH for the second numerology within the second bandwidth portion based on the second PDCCH, the second frequency location and the second bandwidth**. At least some support may be provided in [0088] and/or [0098] of the instant application, for example.

It is respectfully submitted that the references cited fail to teach and/or suggest at least these features.

The Office Action seems to acknowledge that Xiong and/or Fwu are silent as to

at least some of these features (e.g., pages 3-4 of the Office Action).

Yi is believed to fail to make up for the deficiencies of Xiong and/or Fwu.

For example, Yi provides that "a PRB region constituting the GPDCCH search space may be limited to a partial contiguous or non-contiguous PRB region in the entire system bandwidth for the purpose of multiplexing between the GPDCCH and a PDSCH, which is transmitted to a legacy UE. Such a PRB region may be pre-defined or notified to a UE by an eNB through the legacy PDCCH, SIB, or RRC" (e.g., [0312] of Yi).

Yi further provides that "the eNB may inform the UE of the location of the data transmission sTTI in the form of a bitmap through the GPDCCH" (e.g., [0321] of Yi).

That is, Yi seems to mention that a physical resource block may be predefined or notified to a UE, and that an eNB may send a bitmap indicative of a data transmission shortened transmission time interval to a UE.

Dai seems to provide that "maximum number of CCs, which are available to a system, on the multisystem shared spectrum is determined according to the predefined information" (e.g., Abstract of Dai).

Notably, Yi and/or Dai seem to be silent as to a UE deriving a first bandwidth portion based on a first frequency location and a first bandwidth for a first numerology, wherein resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE, as provided for in claim 1, and/or the UE deriving a second bandwidth portion based on the second frequency location and the second bandwidth for the second numerology, as provided for in claim 3.

That is, the references cited are not believed to provide for the same UE deriving multiple (e.g., different) bandwidth portions.

It is respectfully submitted that **a physical resource block being predefined or notified to a UE, and an eNB sending a bitmap indicative of a data transmission shortened transmission time interval to a UE**, as provided for by Yi, and/or **determining a maximum number of CCs, which are available to a system, on the multisystem shared spectrum according to predefined information**, as provided for

by Dai, do not teach **receiving, by the UE, second information for a second numerology associated with a second subcarrier spacing, wherein the second information comprises a second frequency location and a second bandwidth for the second numerology for a second PDSCH or a second PUSCH; detecting a second PDCCH, wherein the second PDCCH is associated with the second PDSCH or the second PUSCH; deriving, by the UE, a second bandwidth portion based on the second frequency location and the second bandwidth for the second numerology; and deriving, by the UE, a second resource allocation scheduled by a second network and carried by the second PDCCH for the second PDSCH or the second PUSCH for the second numerology within the second bandwidth portion based on the second PDCCH, the second frequency location and the second bandwidth** as provided for by claim 3. It is thus respectfully submitted that claim 3 is not taught by the suggested combination, and allowance of the same is therefore respectfully requested.

Therefore, withdrawal of the rejection and allowance of the pending claims is respectfully requested.

III. REJECTION OF CLAIM 10 UNDER 35 U.S.C. § 103(a)

Claim 10 is rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Xiong in view of Fwu in view of Yi and in further view of Ma, U.S. Patent No. 10,045,345 (*hereinafter* "Ma"). Withdrawal of this rejection is respectfully requested for at least the following reasons.

Dependent claim 10 depends from independent claim 1, which is believed to be allowable over Xiong, Fwu and Yi for at least the foregoing reasons. It is believed that Ma fails to make up for the deficiencies of Xiong, Fwu and Yi with regard to independent claim 1. Independent claim 1 is thus believed to be allowable over the suggested combination, and claim 10 is thus likewise believed to be allowable over the suggested combination at least because it depends from independent claim 1.

Therefore, withdrawal of the rejection and allowance of the pending claim is respectfully requested.

IV. REJECTION OF CLAIMS 11, 12 AND 20 UNDER 35 U.S.C. § 103

Claims 11, 12 and 20 are rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Xiong in view of Fwu in view of Yi and further in view of Pragada, U.S. Publication No.: 2014/0321282 (*hereinafter* "Pragada"). Withdrawal of this rejection is respectfully requested for at least the following reasons.

Claims 11, 12 and 20 depend from independent claims 1 or 16, which are believed to be allowable over Xiong, Fwu and Yi for at least the foregoing reasons. It is believed that Pragada does not make up for at least the aforementioned deficiencies of Xiong, Fwu and Yi with regard to independent claims 1 and 16. Independent claims 1 and 16 are therefore believed to be allowable over the suggested combination, and claims 11, 12 and 20 are believed to be allowable as well at least because they depend from independent claims 1 or 16.

Therefore, withdrawal of the rejection and allowance of the pending claims is respectfully requested.

V. CONCLUSION

For at least the above reasons, the claims currently under consideration are believed to be in condition for allowance. It is to be appreciated that while reference may be made back to certain parts of the application in this Reply (e.g., page numbers, line numbers, Figs., etc.), that such referencing is not to be interpreted in a limiting manner (e.g., to limit the scope of the claims and/or features therein to the particular portion(s) referenced), but is instead merely done for purposes of explanation, illustration and/or ease of understanding, for example. Additionally, at least one of A and B and/or the like generally comprises A or B and/or both A and B. Also, first, second, third, etc. are generally merely used as names, designators, etc. and are not

necessarily meant to imply an ordering, temporal relation, etc. Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, the Applicant is not conceding that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that the Applicants have made any disclaimers or disavowals of any subject matter supported by the present application.

Should the Examiner feel that a telephone interview would be helpful to facilitate favorable prosecution of the above-identified application, the Examiner is invited to contact the undersigned at the telephone number provided below.

Should any fees be due as a result of the filing of this response, the Commissioner is hereby authorized to charge the Deposit Account Number 50-5088, **ASUP139US**.

Respectfully submitted,

COOPER LEGAL GROUP, LLC

By: /Ali Assar/

Ali Assar
Reg. No. 65,848

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/674,483	08/10/2017	Ko-Chiang Lin	1426-148.101

CONFIRMATION NO. 7684

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

POWER OF ATTORNEY NOTICE

OC000000113723644

Date Mailed: 01/06/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/26/2019.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/vnguyen/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/674,483	08/10/2017	Ko-Chiang Lin	ASUP139US

CONFIRMATION NO. 7684

92096
Cooper Legal Group LLC
6505 Rockside Road
Suite 330
Independence, OH 44131

POA ACCEPTANCE LETTER

OC000000113723693

Date Mailed: 01/06/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/26/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/vnguyen/

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	15/674,483
Filing Date	August 10, 2017
First Named Inventor	Ko-Chiang Lin
Title	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
Art Unit	2644
Examiner Name	Wayne Huu Cai
Attorney Docket Number	ASUP139US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Ali Assar/	Date (Optional)	December 26, 2019
Name	Ali Assar	Registration Number	65848
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 92096

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name	Cooper Legal Group, LLC				
Address	6505 Rockside Road, Suite 330				
City	Independence	State	Ohio	Zip	44131
Country	US				
Telephone	216-654-0090	Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

ASUSTek Computer Inc.

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	MING-HSIU HSU	Date (Optional)	
Name	MING-HSIU HSU		
Title	Director of ASUSTek Computer Inc.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	38141715
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	William Joseph Cooper/Amy Ansbro
Filer Authorized By:	William Joseph Cooper
Attorney Docket Number:	1426-148.101
Receipt Date:	26-DEC-2019
Filing Date:	10-AUG-2017
Time Stamp:	15:10:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	POA.pdf	489145 110717bc5fa91f1bfc3c7e009d72da4a8bc12a8c	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	489145

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	1426-148.101	7684

106622 7590 12/10/2019

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
CAI, WAYNE HUU	

ART UNIT	PAPER NUMBER
2644	

NOTIFICATION DATE	DELIVERY MODE
12/10/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@bluecapitallaw.com

Office Action Summary	**Application No.** 15/674,483	**Applicant(s)** Lin et al.	
	Examiner WAYNE H CAI	**Art Unit** 2644	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 11/13/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-12 and 16-20 is/are pending in the application.

5a) Of the above claim(s) 13-15 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-12 and 16-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 08/10/2017 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Arguments

2. Applicant's arguments with respect to claims 1-12, and 16-20 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Information Disclosure Statement

3. The information disclosure statement (IDS) submitted on September 05, 2019 was filed after the mailing date of the Non-Final Office Action on August 26, 2019. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claim(s) 1, 4, 5, 8, 9, 16 and 19 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong et al. (hereinafter "Xiong", US 2018/0020365) in view of Fwu et al. (hereinafter "Fwu", US 2018/0007673), and further in view of Yi et al. (hereinafter "Yi", US 2019/0229879).

Regarding claim 1, Xiong discloses a method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a first numerology associated with a first subcarrier spacing (i.e., uplink resource transmitted by the base station to UE as described in paragraph 0146), wherein the information comprises a first frequency location (i.e., frequency location as described in paragraph 0055) and a first bandwidth for the first numerology (i.e., uplink resource allocated by the base station as described in paragraphs 0055 and 0146. Also, see Fig. 8 and its descriptions); and

deriving, by the UE, a resource allocation for the numerology based on the first frequency location and the first bandwidth (i.e., UE selects one resource within the resource pool for transmission as described in Abstract, and as described in paragraph 0122).

Xiong, however, does not expressly disclose:

the information comprises information for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH;

deriving, by the UE a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH; and

wherein the first bandwidth portion is derived from the first frequency location and the first bandwidth for the first numerology, and the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE.

In a similar endeavor, Fwu discloses a device, system, and method employing unified flexible 5G air interface. Fwu also discloses:

the information comprises information for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH) (i.e., PDSCH as described in paragraph 0022);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH (i.e., PDCCH associated with PDSCH as described in paragraph 0022); and

deriving, by the UE a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH (i.e., downlink resource assignment is sent to a scheduled UE on PDCCH used for PDSCH reception of the UE as described in paragraph 0022).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to allocate resources more effectively and optimize the network operations.

Furthermore, Yi discloses a method and user equipment for receiving downlink channel, and method and base station for transmitting downlink channel. Yi also discloses:

wherein the first bandwidth portion is derived from the first frequency location and the first bandwidth for the first numerology, and the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE (i.e., the UE obtains system information such as operating bandwidth in a form of bit map as described in paragraphs 0312-0321).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to allocate resources more effectively and optimize the network operations.

With further regarding claim 16, since this claim recites a different statutory class and include similar features to those of recited within claim 1. The Examiner rejects claim 16 at least for the same reasons discussed above. In addition, Xiong also discloses a User Equipment (UE) (i.e., UE 1200 as shown in Fig. 12) capable of determining numerology bandwidth, comprising:

a control circuit (i.e., circuitry as described in paragraph 0094-0096); a processor installed in the control circuit (i.e., processor as described in paragraphs 0094-0096); and a memory installed in the control circuit and coupled to the processor (i.e., memory coupled to circuitry and processor as described in paragraphs 0094-0096), and wherein the processor is configured to execute a program code stored in the memory (paragraphs 0094-0096).

Regarding claim 4, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above. Xiong also discloses wherein the first frequency location is an index of a resource block (paragraph 0055).

Regarding claims 5 and 19, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above. Fwu also discloses receiving, by a user equipment (UE), information for a second numerology associated with a second subscarrier spacing (see Table 2), wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth (paragraph 0022).

Regarding claim 8, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above. Xiong also discloses wherein the first bandwidth and the first frequency location is configured by UE-specific RRC message (see claim 17).

Regarding claim 9, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above. Fwu also discloses wherein the first bandwidth and the first frequency location is indicated by a physical control channel (i.e., assignment as indicated in PDCCH as described in paragraph 0022).

6. Claim 2, 3, 6, 7, 17, and 18 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Fwu in view of Yi and further in view of Dai et al. (hereinafter "Dai", US 2016/0359593).

Regarding claims 2, and 17, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses configuring, by the UE, a system bandwidth (paragraphs 0238-0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claims 3, and 18, Xiong, Fwu, Yi and Dai disclose all limitations recited within claims as described above. Dai also discloses wherein the system bandwidth is larger than the first bandwidth (i.e., the system bandwidth is larger than the component carriers as described in Abstract).

Regarding claim 6, Xiong, Fwu, and Yi disclose all limitations recited within claims asdescribed above, but does not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses wherein the first frequency location is an

index of a resource block with a central frequency within the first bandwidth portion (paragraph 0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claim 7, Xiong, Fwu, Yi, and Dai disclose all limitations recited within claims as described above. Dai also discloses the first bandwidth portion is derived from the first frequency location and the first bandwidth (paragraph 0244).

7. Claim 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Fwu in view of Yi and further in view of Ma et al. (hereinafter "Ma", US 10,045,345).

Regarding claim 10, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Ma discloses systems and methods self-contained air interface partitions. Ma also discloses wherein the first numerology is indicated by a physical control channel (see claim 1).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to inform the user of the allocated resources.

8. Claim 11, 12, and 20 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Fwu in view of Yi, and further in view of Pragada et al. (hereinafter "Pragada", US 2014/0321282).

Regarding claim 11, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a maximum bandwidth for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 12, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a maximum bandwidth that the UE is able to receive for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 20, Xiong, Fwu, and Yi disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a configured bandwidth for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WAYNE H. CAI whose telephone number is (571)272-7798. The examiner can normally be reached on Monday-Friday, 8:00 AM - 5:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KATHY WANG-HURST can be reached on (571)270-5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a

USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Wayne H Cai/
Primary Examiner, Art Unit 2644

Notice of References Cited	Application/Control No. 15/674,483	Applicant(s)/Patent Under Reexamination Lin et al.	
	Examiner WAYNE H CAI	Art Unit 2644	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20190229879-A1	07-2019	Yl; Yunjung	H04L1/0038	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
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	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	Art Unit
	WAYNE H CAI	2644

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventors Search	01/09/2019	WHC
See Search History	01/09/2019	WHC
See Update Search History	05/07/2019	WHC
See Update Search History	08/21/2019	WHC
See Update Search History	12/05/2019	WHC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/18/2018	01/09/2019	05/07/2019	08/21/2019	12/05/2019				
	1	÷	✓	✓	✓	✓				
	2	÷	✓	✓	✓	✓				
	3	÷	✓	✓	✓	✓				
	4	÷	✓	✓	✓	✓				
	5	÷	✓	✓	✓	✓				
	6	÷	✓	✓	✓	✓				
	7	÷	✓	✓	✓	✓				
	8	÷	✓	✓	✓	✓				
	9	÷	✓	✓	✓	✓				
	10	÷	✓	✓	✓	✓				
	11	÷	✓	✓	✓	✓				
	12	÷	✓	✓	✓	✓				
	13	÷	N	N	N	N				
	14	÷	N	N	N	N				
	15	÷	N	N	N	N				
	16	÷	✓	✓	✓	✓				
	17	÷	✓	✓	✓	✓				
	18	÷	✓	✓	✓	✓				
	19	÷	✓	✓	✓	✓				
	20	÷	✓	✓	✓	✓				

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2644
	Examiner Name	Wayne Huu Cai
	Attorney Docket Number	1426-148.101

U.S.PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					
If you wish to add additional U.S. Patent citation information please click the Add button.						

U.S.PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					
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FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐
If you wish to add additional Foreign Patent Document citation information please click the Add button								

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /WHC/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2644
	Examiner Name	Wayne Huu Cai
	Attorney Docket Number	1426-148.101

	1	"Initial access in NR", Huawei, HiSilicon, 3GPP TSG-RAN WG2 Meeting #94, R2-163923, 20160514	☐
	2	"Basic system design for UL NB-IoT", 3GPP TSG-RAN WG1 NB-IoT Adhoc, RI-160041, 20160111	☐
	3	Office Action from SIPO in corresponding CN Application No. 201710682076.0, dated September 3, 2019	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/Wayne H Cai/	Date Considered	12/05/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /WHC/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S84	17	(@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812") and S83	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/12/05 08:29
S83	126	(PDCCH or physical adj downlink adj control adj channel or PDSCH or PUSCH or physical adj downlink adj shared adj channel or physical adj uplink adj shared adj channel) and (bitmap$5 bit adj2 map$5) and (frequenc$5 adj location$4) and resource$2 and bandwidth and ("5G" new adj radio or "NR") and numerolog$5 and (subcarrier sub-carrier) and spac$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/12/05 08:29
S82	128	(PDCCH or physical adj downlink adj control adj channel or PDSCH or PUSCH or physical adj downlink adj shared adj channel or physical adj uplink adj shared adj channel) and (bitmap$5 bit adj2 map$5) and (frequenc$5 adj location$4) and resource$2 and bandwidth and ("5G" new adj radio or "NR") and numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/12/05 08:28
S81	334	(PDCCH or physical adj downlink adj control adj channel or PDSCH or PUSCH or physical adj downlink adj shared adj channel or physical adj uplink adj shared adj channel) and (bitmap$5 bit adj2 map$5) and (frequenc$5 adj location$4) and resource$2 and bandwidth and ("5G" new adj radio or "NR")	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/12/05 08:27
S80	6	(@ad<="20160812" or @rlad<="20160812" or @ptad<="20160812" or @pt1d<="20160812" or @pt3d<="20160812") and S78	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/12/05 08:17
S79	6	@ad<"20160812" and S78	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/12/05 08:16
S78	7	(bit adj2 map$5) same bandwidth same (frequenc$5 adj3 location$4)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2019/12/05 08:10

EAST Search History (Interference)

< This search history is empty>

12/5/2019 5:12:46 PM

Samsung Exhibit 1006, Page 588 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

C:\ Users\ wcai1\ Documents\ EAST\ Workspaces\ 15674483.wsp

Samsung Exhibit 1006, Page 589 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	15/674,483
Confirmation No.	:	7684
Applicant	:	Ko-Chiang Lin, and Ming-Che Li
Filed	:	August 10, 2017
Title	:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
TC/A.U.	:	2644
Examiner	:	Wayne Huu Cai
Docket No.	:	1426-148.101 (1050198-US)
Customer No.	:	106622

RESPONSE TO OFFICE ACTION

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action mailed on August 26, 2019, having a three-month period for responding to **November 26, 2019**, Applicants respectfully submit the following amendments and remarks.

Claims begin on page 2.

Remarks begin on page 6.

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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

IN THE CLAIMS:

1. (Currently Amended) A method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a first numerology associated with a first subcarrier spacing, wherein the information comprises a first frequency location and a first bandwidth for the first numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

deriving, by the UE, a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth, wherein the first bandwidth portion is derived from the first frequency location and the first bandwidth for the first numerology, and the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE.

2. (Original) The method of claim 1, further comprising:

configuring, by the UE, a system bandwidth.

3. (Previously Presented) The method of claim 2, wherein the system bandwidth is larger than the first bandwidth.

4. (Previously Presented) The method of claim 1, wherein the first frequency location is an index of a resource block.

5. (Previously Presented) The method of claim 1, further comprising:

receiving, by a user equipment (UE), information for a second numerology associated with a second subcarrier spacing, wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth.

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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

6. (Previously Presented) The method of claim 1, wherein the first frequency location is an index of a resource block with a central frequency within the first bandwidth portion.

7. (Previously Presented) The method of claim 6, the first bandwidth portion is derived from the first frequency location and the first bandwidth.

8. (Previously Presented) The method of claim 1, wherein the first bandwidth and the first frequency location is configured by UE-specific RRC message.

9. (Previously Presented) The method of claim 1, wherein the first bandwidth and the first frequency location is indicated by a physical control channel.

10. (Previously Presented) The method of claim 1, wherein the first numerology is indicated by a physical control channel.

11. (Previously Presented) The method of claim 1, wherein the first bandwidth is a maximum bandwidth for the first numerology.

12. (Previously Presented) The method of claim 1, wherein the first bandwidth is a maximum bandwidth that the UE is able to receive for the first numerology.

13. (Withdrawn) A method for determining numerology bandwidth, the method comprising:

informing a user equipment (UE) information for a numerology, wherein the information comprises a bandwidth portion for the numerology; and

scheduling the UE with a resource allocation for the numerology within the bandwidth portion in a transmission time interval (TTI).

14. (Withdrawn) The method of claim 13, wherein the UE does not assume that a resource block within the bandwidth portion and outside the resource allocation is transmitted with the numerology in the TTI.

15. (Withdrawn) The method of claim 13, wherein the bandwidth portion is derived from a frequency location and a bandwidth.

16. (Currently Amended) A User Equipment (UE) capable of determining numerology bandwidth, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

receive information for a first numerology associated with a first subcarrier spacing, wherein the information comprises a first frequency location and a first bandwidth for the first numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

derive a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth, wherein the first bandwidth portion is derived from the first frequency location and the first bandwidth for the first numerology, and the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE.

17. (Original) The UE of claim 16, wherein the UE configures a system bandwidth.

18. (Previously Presented) The UE of claim 17, wherein the system bandwidth is larger than the first bandwidth.

19. (Previously Presented) The UE of claim 16, wherein the processor is further configured to execute a program code stored in the memory to:

receive information for a second numerology associated with a second subcarrier spacing, wherein the information comprises a second frequency location and a second bandwidth for the

second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth.

20. (Previously Presented) The UE of claim 16, wherein the first bandwidth is a configured bandwidth for the first numerology.

REMARKS

Claims 1-12 and 16-20 are pending in the application. In the Office Action, claims 1, 4, 5, 8, 9, 16, and 19 stand rejected under 35 U.S.C. § 103 as being unpatentable by Xiong (U.S. Patent Publication No. 2018/0020365) in view of Fwu (U.S. Patent Publication No. 2018/0007673). *See* Office Action, ¶ 5. Furthermore, claims 2, 3, 6, 7, 17, and 18 also stand rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Fwu and further in view of Dai (U.S. Patent Publication No. 2016/0359593). *See* Office Action, ¶ 6. In addition, claim 10 stands rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Fwu and further in view of Ma (U.S. Patent No. 10,045,345). *See* Office Action, ¶ 7. Also, claims 11, 12 and 20 stand rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Fwu and further in view of Pragada et al. (U.S. Patent Publication No. 2014/0321282). *See* Office Action, ¶ 8.

Claims 1 and 16 have been amended. The claim amendments are supported by at least Paragraphs [0100] – [0102] of the present application. Applicants respectfully request reconsideration of the claims as amended.

Claims 1 and 16 recite "deriving [or derive] … a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth, wherein the first bandwidth portion is derived from the first frequency location and the first bandwidth for the first numerology, and the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE." Applicants respectfully submit that the cited prior art references fail to disclose the noted limitations.

The Office Action admits that Xiong does not disclose deriving a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH. *See* Office Action, Pages 3-4. Nevertheless, the Office Action cites to Paragraph [0022] of Fwu in rejecting the claims. *See* Office Action, Page 4.

Applicants respectfully disagree. In particular, it appears that the Examiner considers "the first bandwidth portion" as the resource allocation to the UE. However, the limitation "derives a resource allocation…within a first bandwidth portion" in the claims actually means a subset of

resource within the bandwidth portion is allocated to the UE (how the resource is derived from by PDCCH.

Nevertheless, to further distinguish the claimed invention from the cited prior art references, Applicants amended the claims to add "wherein the first bandwidth portion is derived from the frequency location and a bandwidth for the first numerology, and the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE."

For the reasons discussed above, Applicants respectfully submit that claims 1-13 and 16-20 are patentable over the cited prior art references.

In view of the foregoing it is respectfully submitted that the pending claims are in condition for allowance. Reconsideration of the rejections is requested. Allowance of the claims at an early date is solicited. The Examiner is invited to contact Applicant's undersigned counsel by telephone at (714) 839-3800 to expedite the prosecution of this case should there be any unresolved matters remaining.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Respectfully submitted,
Sang N. Dang
BLUE CAPITAL LAW FIRM, P.C.

Dated: November 13, 2019

/Sang N. Dang/

Reg. No. 51,186
Tel.: (714) 839-3800
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Samsung Exhibit 1006, Page 596 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ko-Chiang Lin and Ming-Che Li	
Title:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	15/674,483	Filed: August 10, 2017
Examiner:	Wayne Huu Cai	Group Art Unit: 2644
Attorney Docket No.:	1426-148.101 (1050198-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 2 Page Amendment Transmittal Sheet; and 7 Page Amendment are being transmitted to the United States Patent and Trademark Office via EFS-Web on November 13, 2019.

Date: November 13, 2019 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

Electronic Acknowledgement Receipt

EFS ID:	37741296
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	13-NOV-2019
Filing Date:	10-AUG-2017
Time Stamp:	15:21:14
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1426-148-101--ROAof08262019asFiled11132019.pdf	147612 011f6a29ade7f55dba74786e488ccd7d0f75e690	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	2
	Amendment/Req. Reconsideration-After Non-Final Reject	3	3
	Claims	4	7
	Applicant Arguments/Remarks Made in an Amendment	8	9
	Miscellaneous Incoming Letter	10	10
Warnings:			
Information:			
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Amendment Transmittal Letter

Docket Number
1426-148.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Title of Invention

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

First Named Inventor	Ko-Chiang Lin
Application No.	15/674,483
Filing Date	August 10, 2017
Examiner	Wayne Huu Cai
Art Unit	2644

Transmitted herewith is an amendment in the above-identified application.

The fee has been calculated and is transmitted as shown below.

☐ **Applicant claims Small Entity Status.** See 37 CFR 1.27.

Fee Calculation

Claims as Amended

For	#Filed	#Previously Paid For	#Extra	Rate	Fee
Total Claims	20	- 20 =		x ☐ =	
Total Indep. Claims	3	- 3 =		x =	
Multiple Dependent Claims (check if applicable) ☐					
				TOTAL	0

Method of Payment

☐ Deposit Account ☐ Credit Card ☐ Check ☐ Money Order ☐ Other: _____

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For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

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Amount Grand Total 0

Samsung Exhibit 1006, Page 600 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Amendment Transmittal Letter

Docket Number
1426-148.101

Correspondence Address

Customer Number	106622		
-OR-			
Name			
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Certificate of Mailing by Express Mail

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(Signature of Person Mailing Correspondence)

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Select the name of the person who will electronically sign the Amendment from the drop-down box below.

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Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box Sang N. Dang

Name	Sang N. Dang	Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)	E-mail Address	sdang@bluecapitallaw.com
eSign	/Sang N. Dang/	Date Signed	11-13-2019

Samsung Exhibit 1006, Page 601 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2644
	Examiner Name	Wayne Huu Cai
	Attorney Docket Number	1426-148.101

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15674483
	Filing Date	2017-08-10
	First Named Inventor	Ko-Chiang Lin
	Art Unit	2644
	Examiner Name	Wayne Huu Cai
	Attorney Docket Number	1426-148.101

	1	"Initial access in NR", Huawei, HiSilicon, 3GPP TSG-RAN WG2 Meeting #94, R2-163923, 20160514	☐
	2	"Basic system design for UL NB-IoT", 3GPP TSG-RAN WG1 NB-IoT Adhoc, RI-160041, 20160111	☐
	3	Office Action from SIPO in corresponding CN Application No. 201710682076.0, dated September 3, 2019	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ko-Chiang Lin and Ming-Che Li	
Title:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	15/674,483	Filed: August 10, 2017
Examiner:	Wayne Huu Cai	Group Art Unit: 2644
Attorney Docket No.:	1426-148.101 (1050198-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 3 Page Information Disclosure Statement Transmittal; 2 Page Information Disclosure Statement with 3 references are being transmitted to the United States Patent and Trademark Office via EFS-Web on September 5, 2019.

Date: September 5, 2019 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

Electronic Acknowledgement Receipt

EFS ID:	37077895
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	05-SEP-2019
Filing Date:	10-AUG-2017
Time Stamp:	16:32:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1426-148-101--IDSasFiled09052019.pdf	155686 3dcf5434fbb37458729be6ce9f5bc76e1e8c9714	yes	6

	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	3	
	Information Disclosure Statement (IDS) Form (SB08)		4	5	
	Miscellaneous Incoming Letter		6	6	
Warnings:					
Information:					
2	Non Patent Literature	R2-163923.pdf	366239 93d5284054ef3e3a258674f55a5764a5c9568f2d	no	5
Warnings:					
Information:					
3	Non Patent Literature	R1-160041.pdf	250852 09d7a624af99b58ac405107070c6bd64d2a45ba7	no	3
Warnings:					
Information:					
4	Non Patent Literature	NPL-CNOfficeAction.pdf	923128 4c3c92544de81d3410ba6650e27b2b2450bb2a94	no	8
Warnings:					
Information:					
		Total Files Size (in bytes):	1695905		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Information Disclosure Statement Transmittal

Docket Number
1426-148.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

In Re Application Of:

Ko-Chiang Lin

Application No.	15/674,483
Filing Date	August 10, 2017
Examiner	Wayne Huu Cai
Art Unit	2644

Title of Invention

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

BASIS FOR FILING (Select 1, 2 or 3 below.)

37 CFR 1.97(b)

1) ☐ The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53 (d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.

37 CFR 1.97(c)

2) ☒ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:

a) ☒ the statement specified in 37 CFR 1.97(e);

OR

b) ☐ the fee set forth in 37 CFR 1.17(p).

37 CFR 1.97(d)

3) ☐ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(c), and on or before payment of the issue fee, and is accompanied by the Statement as specified in 37 CFR 1.97(e) and the fee set forth in 37 CFR 1.17(p).

Samsung Exhibit 1006, Page 608 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Information Disclosure Statement Transmittal

Docket Number
1426-148.101

STATEMENT UNDER 37 CFR 1.97(e) ACCOMPANYING INFORMATION DISCLOSURE STATEMENT

The Information Disclosure Statement submitted herewith is submitted under one of the following conditions, which satisfies the requirement under 37 CFR 1.97(e). (Select 4 or 5 below if applicable.)

4) [X] That each item of information contained in the Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement; or

5) [ ] That no item of information contained in the Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the Information Disclosure Statement.

Remarks (Enter Remarks Below or Attach Document Containing Remarks)

Fee set forth in 37 CFR 1.17(p):

[X] No additional fee is required.

[ ] A check in the amount of _____ is attached.

[ ] The Director is hereby authorized to charge and credit Deposit Account No. _____ as described below.

- [ ] Charge the amount of _____
- [ ] Credit any overpayment.
- [ ] Charge any additional fee required.

[ ] Payment by credit card. Form PTO-2038 is attached.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Samsung Exhibit 1006, Page 609 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Information Disclosure Statement Transmittal

Docket Number
1426-148.101

Correspondence Address

Customer Number	106622		
-OR-			
Name			
Address			
City		State	
Country		Postal Code	
Phone Number			
E-mail Address			

Certificate of Mailing by Express Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing) *(Name of Person Mailing Correspondence)*

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Certificate of Transmission

I hereby certify that this Transmittal Letter, accompanying documents and fee authorization (if appropriate) is being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission) *(Name of Person Transmitting Correspondence)*

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Trasmittal Letter from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box Sang N. Dang

Name	Sang N. Dang			Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)		E-mail Address	sdang@bluecapitallaw.com	
eSign	/Sang N. Dang/			Date Signed	09-05-2019

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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/674,483	08/10/2017	Ko-Chiang Lin	1426-148.101	7684

106622 7590 08/26/2019

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
CAI, WAYNE HUU	

ART UNIT	PAPER NUMBER
2644	

NOTIFICATION DATE	DELIVERY MODE
08/26/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@bluecapitallaw.com

Office Action Summary	**Application No.** 15/674,483	**Applicant(s)** Lin et al.	
	Examiner WAYNE H CAI	**Art Unit** 2644	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 08/13/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-12 and 16-20 is/are pending in the application.

5a) Of the above claim(s) 13-15 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-12 and 16-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 08/10/2017 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on August 13, 2019 has been entered.

Response to Arguments

3. Applicant's arguments with respect to claims 1-12, and 16-20 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the

> claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claim(s) 1, 4, 5, 8, 9, 16 and 19 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong et al. (hereinafter "Xiong", US 2018/0020365) in view of Fwu et al. (hereinafter "Fwu", US 2018/0007673).

Regarding claim 1, Xiong discloses a method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a first numerology associated with a first subcarrier spacing (i.e., uplink resource transmitted by the base station to UE as described in paragraph 0146), wherein the information comprises a first frequency location (i.e., frequency location as described in paragraph 0055) and a first bandwidth for the first numerology (i.e., uplink resource allocated by the base station as described in paragraphs 0055 and 0146. Also, see Fig. 8 and its descriptions); and

deriving, by the UE, a resource allocation for the numerology based on the first frequency location and the first bandwidth (i.e., UE selects one resource within the resource pool for transmission as described in Abstract, and as described in paragraph 0122).

Xiong, however, does not expressly disclose:

the information comprises information for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

deriving, by the UE a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH.

In a similar endeavor, Fwu discloses a device, system, and method employing unified flexible 5G air interface. Fwu also discloses:

the information comprises information for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH) (i.e., PDSCH as described in paragraph 0022);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH (i.e., PDCCH associated with PDSCH as described in paragraph 0022); and

deriving, by the UE a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH (i.e., downlink resource assignment is sent to a scheduled UE on PDCCH used for PDSCH reception of the UE as described in paragraph 0022).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to allocate resources more effectively and optimize the network operations.

With further regarding claim 16, since this claim recites a different statutory class and include similar features to those of recited within claim 1. The Examiner rejects claim 16 at least for the same reasons discussed above. In addition, Xiong also

discloses a User Equipment (UE) (i.e., UE 1200 as shown in Fig. 12) capable of determining numerology bandwidth, comprising:

a control circuit (i.e., circuitry as described in paragraph 0094-0096); a processor installed in the control circuit (i.e., processor as described in paragraphs 0094-0096); and a memory installed in the control circuit and coupled to the processor (i.e., memory coupled to circuitry and processor as described in paragraphs 0094-0096), and wherein the processor is configured to execute a program code stored in the memory (paragraphs 0094-0096).

Regarding claim 4, Xiong and Fwu disclose all limitations recited within claims as described above. Xiong also discloses wherein the first frequency location is an index of a resource block (paragraph 0055).

Regarding claims 5 and 19, Xiong and Fwu disclose all limitations recited within claims as described above. Fwu also discloses receiving, by a user equipment (UE), information for a second numerology associated with a second subscarrier spacing (see Table 2), wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth (paragraph 0022).

Regarding claim 8, Xiong and Fwu disclose all limitations recited within claims as described above. Xiong also discloses wherein the first bandwidth and the first frequency location is configured by UE-specific RRC message (see claim 17).

Regarding claim 9, Xiong and Fwu disclose all limitations recited within claims as described above. Fwu also discloses wherein the first bandwidth and the first frequency location is indicated by a physical control channel (i.e., assignment as indicated in PDCCH as described in paragraph 0022).

6. Claim 2, 3, 6, 7, 17, and 18 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Fwu and further in view of Dai et al. (hereinafter "Dai", US 2016/0359593).

Regarding claims 2, and 17, Xiong and Fwu disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses configuring, by the UE, a system bandwidth (paragraphs 0238-0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claims 3, and 18, Xiong, Fwu and Dai disclose all limitations recited within claims as described above. Dai also discloses wherein the system bandwidth is larger than the first bandwidth (i.e., the system bandwidth is larger than the component carriers as described in Abstract).

Regarding claim 6, Xiong and Fwu disclose all limitations recited within claims as described above, but does not expressly disclose features of this claim.

In a similar endeavor, Dai discloses methods and devices for determining or acquiring radio resources. Dai also discloses wherein the first frequency location is an index of a resource block with a central frequency within the first bandwidth portion (paragraph 0244).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize resources of the network.

Regarding claim 7, Xiong, Fwu and Dai disclose all limitations recited within claims as described above. Dai also discloses the first bandwidth portion is derived from the first frequency location and the first bandwidth (paragraph 0244).

7. Claim 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Fwu and further in view of Ma et al. (hereinafter "Ma", US 10,045,345).

Regarding claim 10, Xiong and Fwu disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Ma discloses systems and methods self-contained air interface partitions. Ma also discloses wherein the first numerology is indicated by a physical control channel (see claim 1).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to inform the user of the allocated resources.

8. Claim 11, 12, and 20 is/are rejected under 35 U.S.C. 103 as being unpatentable over Xiong in view of Fwu, and further in view of Pragada et al. (hereinafter "Pragada", US 2014/0321282).

Regarding claim 11, Xiong and Fwu disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a maximum bandwidth for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 12, Xiong and Fwu disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a maximum bandwidth that the UE is able to receive for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Regarding claim 20, Xiong and Fwu disclose all limitations recited within claims as described above, but do not expressly disclose features of this claim.

In a similar endeavor, Pragada discloses a high-rate dual-band cellular communications. Pragada also discloses wherein the first bandwidth is a configured bandwidth for the first numerology (paragraph 0072).

Therefore, it would have been obvious to one of ordinary skilled in the art to modify the teachings of the cited references, and arrive at the present invention.

The motivation/suggestion for doing so would have been to optimize the network resources.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WAYNE H. CAI whose telephone number is (571)272-7798. The examiner can normally be reached on Monday-Friday, 8:00 AM - 5:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KATHY WANG-HURST can be reached on (571)270-5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Wayne H Cai/
Primary Examiner, Art Unit 2644

Notice of References Cited	Application/Control No. 15/674,483	Applicant(s)/Patent Under Reexamination Lin et al.	
	Examiner WAYNE H CAI	Art Unit 2644	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20180007673-A1	01-2018	Fwu; Jong-Kae	H04W4/70	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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IPR2024-01273

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	Art Unit
	WAYNE H CAI	2644

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventors Search	01/09/2019	WHC
See Search History	01/09/2019	WHC
See Update Search History	05/07/2019	WHC
See Update Search History	08/21/2019	WHC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/674,483	Lin et al.
	Examiner	**Art Unit**
	WAYNE H CAI	2644

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/18/2018	01/09/2019	05/07/2019	08/21/2019					
	1	÷	✓	✓	✓					
	2	÷	✓	✓	✓					
	3	÷	✓	✓	✓					
	4	÷	✓	✓	✓					
	5	÷	✓	✓	✓					
	6	÷	✓	✓	✓					
	7	÷	✓	✓	✓					
	8	÷	✓	✓	✓					
	9	÷	✓	✓	✓					
	10	÷	✓	✓	✓					
	11	÷	✓	✓	✓					
	12	÷	✓	✓	✓					
	13	÷	N	N	N					
	14	÷	N	N	N					
	15	÷	N	N	N					
	16	÷	✓	✓	✓					
	17	÷	✓	✓	✓					
	18	÷	✓	✓	✓					
	19	÷	✓	✓	✓					
	20	÷	✓	✓	✓					

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L12	47	10 and 11	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 14:25
L13	1	@ad<"20160812" and 12	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 14:25
L11	15113	(("PDSCH" or physical adj downlink adj shared adj channel) or ("PUSCH" or physical adj uplink adj shared adj channel$2)) near15 ("PDCCH" or physical adj downlink adj control$5 adj channel) near15 (allocat$5 assign$9 schedul$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 14:24
L10	305	(first adj3 numerolog$5) and (second$9 adj3 numerolog$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 14:22
L9	22	@ad<"20160812" and 8	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 12:57
L8	368	(("PDSCH" or physical adj downlink adj shared adj channel) or ("PUSCH" or physical adj uplink adj shared adj channel$2)) near15 ("PDCCH" or physical adj downlink adj control$5 adj channel) near15 (allocat$5 assign$9 schedul$5) and numerolog$5 same ((subcarrier$2 or sub-carrier) near5 spac$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 12:56
L7	593	(("PDSCH" or physical adj downlink adj shared adj channel) or ("PUSCH" or physical adj uplink adj shared adj channel$2)) near15 ("PDCCH" or physical adj downlink adj control$5 adj channel) near15 (allocat$5 assign$9 schedul$5) and numerolog$5 and ((subcarrier$2 or sub-carrier) near5 spac$5)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 12:55
L6	147	@ad<"20160812" and 5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 12:53
L5	741	(("PDSCH" or physical adj downlink adj shared adj channel) or ("PUSCH" or physical adj uplink adj shared adj	US-PGPUB; USPAT;	OR	OFF	2019/08/21 12:52

		channel$2)) near15 ("PDCCH" or physical adj downlink adj control$5 adj channel) near15 (allocat$5 assign$9 schedul$5) and numerolog$5	EPO; JPO; DERWENT			
L4	220	@ad<"20160812" and 3	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 12:36
L2	1521	(("PDSCH" or physical adj downlink adj shared adj channel) or ("PUSCH" or physical adj uplink adj shared adj channel$2)) same ("PDCCH" or physical adj downlink adj control$5 adj channel) and numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 11:54
L3	1153	(("PDSCH" or physical adj downlink adj shared adj channel) or ("PUSCH" or physical adj uplink adj shared adj channel$2)) same ("PDCCH" or physical adj downlink adj control$5 adj channel) same (allocat$5 assign$9 schedul$5) and numerolog$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 11:54
L1	1	15/674483	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/08/21 11:23
S17	89	@ad<"20160812" and S16	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2019/01/09 10:45

8/21/2019 3:32:11 PM
C:\Users\wcai1\Documents\EAST\Workspaces\15674483.wsp

Samsung Exhibit 1006, Page 627 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	15/674,483	Filing Date	2017-08-10	Docket Number (if applicable)	1426-148.101	Art Unit	2644
First Named Inventor	Ko-Chiang Lin			Examiner Name	Wayne Huu Cai		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☐ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No _____

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Sang N. Dang/	Date (YYYY-MM-DD)	2019-08-13
Name	Sang N. Dang	Registration Number	51186

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Amendment Transmittal Letter

Docket Number
1426-148.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Title of Invention

METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM

First Named Inventor	Ko-Chiang Lin
Application No.	15/674,483
Filing Date	August 10, 2017
Examiner	Wayne Huu Cai
Art Unit	2644

Transmitted herewith is an amendment in the above-identified application.

The fee has been calculated and is transmitted as shown below.

☐ **Applicant claims Small Entity Status.** See 37 CFR 1.27.

Fee Calculation

Claims as Amended

For	#Filed	#Previously Paid For	#Extra	Rate	Fee
Total Claims	20	- 20 =		x ☐ =	
Total Indep. Claims	3	- 3 =		x =	
Multiple Dependent Claims (check if applicable) ☐					
				TOTAL	0

Method of Payment

☐ Deposit Account ☐ Credit Card ☐ Check ☐ Money Order ☐ Other: _____

Deposit Account Number

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge the fee(s) set forth above
☐ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17
☐ Charge fee(s) indicated above, **except for the filing fee**
☐ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on form PTO-2038.

Amount Grand Total 0

Samsung Exhibit 1006, Page 630 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

Amendment Transmittal Letter

Docket Number
1426-148.101

Correspondence Address

Customer Number	106622		
-OR-			
Name			
Address			
City		State	
Country		Postal Code	
Phone Number			
E-mail Address			

Certificate of Mailing by Express Mail

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing) *(Name of Person Mailing Correspondence)*

(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) authorization are being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission) *(Name of Person Transmitting Correspondence)*

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Amendment from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box Sang N. Dang

Name	Sang N. Dang	Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)	E-mail Address	sdang@bluecapitallaw.com
eSign	/Sang N. Dang/	Date Signed	08-13-2019

Samsung Exhibit 1006, Page 631 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	15/674,483
Confirmation No.	:	7684
Applicant	:	Ko-Chiang Lin, and Ming-Che Li
Filed	:	August 10, 2017
Title	:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
TC/A.U.	:	2644
Examiner	:	Wayne Huu Cai
Docket No.	:	1426-148.101 (1050198-US)
Customer No.	:	106622

RESPONSE TO FINAL OFFICE ACTION

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the final Office Action mailed on May 13, 2019, having a three-month period for responding to **August 13, 2019**, Applicants respectfully submit the following amendments and remarks along with a RCE.

Claims begin on page 2.

Remarks begin on page 5.

Samsung Exhibit 1006, Page 632 of 647
Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

IN THE CLAIMS:

1. (Currently Amended) A method for determining numerology bandwidth, the method comprising:

receiving, by a user equipment (UE), information for a first numerology associated with a first subcarrier spacing, wherein the information comprises a first frequency location and a first bandwidth for the first numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

deriving, by the UE, a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth.

2. (Original) The method of claim 1, further comprising:

configuring, by the UE, a system bandwidth.

3. (Previously Presented) The method of claim 2, wherein the system bandwidth is larger than the first bandwidth.

4. (Previously Presented) The method of claim 1, wherein the first frequency location is an index of a resource block.

5. (Currently Amended) The method of claim 1, further comprising:

receiving, by a user equipment (UE), information for a second numerology associated with a second subcarrier spacing, wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth.

6. (Previously Presented) The method of claim 1, wherein the first frequency location is an index of a resource block with a central frequency within the first bandwidth portion.

7. (Previously Presented) The method of claim 6, the first bandwidth portion is derived from the first frequency location and the first bandwidth.

8. (Previously Presented) The method of claim 1, wherein the first bandwidth and the first frequency location is configured by UE-specific RRC message.

9. (Previously Presented) The method of claim 1, wherein the first bandwidth and the first frequency location is indicated by a physical control channel.

10. (Previously Presented) The method of claim 1, wherein the first numerology is indicated by a physical control channel.

11. (Previously Presented) The method of claim 1, wherein the first bandwidth is a maximum bandwidth for the first numerology.

12. (Previously Presented) The method of claim 1, wherein the first bandwidth is a maximum bandwidth that the UE is able to receive for the first numerology.

13. (Withdrawn) A method for determining numerology bandwidth, the method comprising:

informing a user equipment (UE) information for a numerology, wherein the information comprises a bandwidth portion for the numerology; and

scheduling the UE with a resource allocation for the numerology within the bandwidth portion in a transmission time interval (TTI).

14. (Withdrawn) The method of claim 13, wherein the UE does not assume that a resource block within the bandwidth portion and outside the resource allocation is transmitted with the numerology in the TTI.

15. (Withdrawn) The method of claim 13, wherein the bandwidth portion is derived from a frequency location and a bandwidth.

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Samsung Electronics Co., Ltd. v. Asus Technology Licensing Inc.
IPR2024-01273

16. (Previously Presented) A User Equipment (UE) capable of determining numerology bandwidth, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

receive information for a first numerology associated with a first subcarrier spacing, wherein the information comprises a first frequency location and a first bandwidth for the first numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH);

detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH; and

derive a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth.

17. (Original) The UE of claim 16, wherein the UE configures a system bandwidth.

18. (Previously Presented) The UE of claim 17, wherein the system bandwidth is larger than the first bandwidth.

19. (Currently Amended) The UE of claim 16, wherein the processor is further configured to execute a program code stored in the memory to:

receive information for a second numerology associated with a second subcarrier spacing, wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth.

20. (Previously Presented) The UE of claim 16, wherein the first bandwidth is a configured bandwidth for the first numerology.

REMARKS

Claims 1-12 and 16-20 are pending in the application. In the Office Action, claims 1, 4, 5, 8, 16, and 19 stand rejected under 35 U.S.C. § 103 as being unpatentable by Xiong (U.S. Patent Publication No. 2018/0020365) in view of Chang (U.S. Patent Publication No. 2019/0052331). *See* Office Action, ¶ 4. Claims 2, 3, 6, 7, 17, and 18 also stand rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Chang and further in view of Dai (U.S. Patent Publication No. 2016/0359593). *See* Office Action, ¶ 5. Furthermore, claim 10 stands rejected under 35 U.S.C. § 103 as being unpatentable over Xiong in view of Chang and further in view of Ma (U.S. Patent No. 10,045345). *See* Office Action, ¶ 6.

Claims 1, 5, 16, and 19 have been amended. The amendments of claims 1 and 16 are supported at least by Paragraphs [0087], [0101], [0102], [0106], [0131], and [0143] of the present application. The amendments of claims 5 and 19 are supported at least by Paragraphs [0081], [0087], [0101], [0102], and [0131] of the present application. No new matter has been added. Applicants respectfully request reconsideration of the claims as amended.

In general, the present application teaches a method for determining numerology bandwidth. For example, as illustrated in FIG. 46 and discussed in Paragraph [0088] of the present application, when a UE is configured with a numerology, there are still additional consideration required to determine whether or how the UE knows the bandwidth partition including the bandwidth and/or frequency location for a given numerology, and the UE can correctly derives resource allocation for data transmission or reception.

FIG. 46 (reproduced below) of the present application illustrates an exemplary embodiment of adjusting bandwidth and frequency location for each numerology.

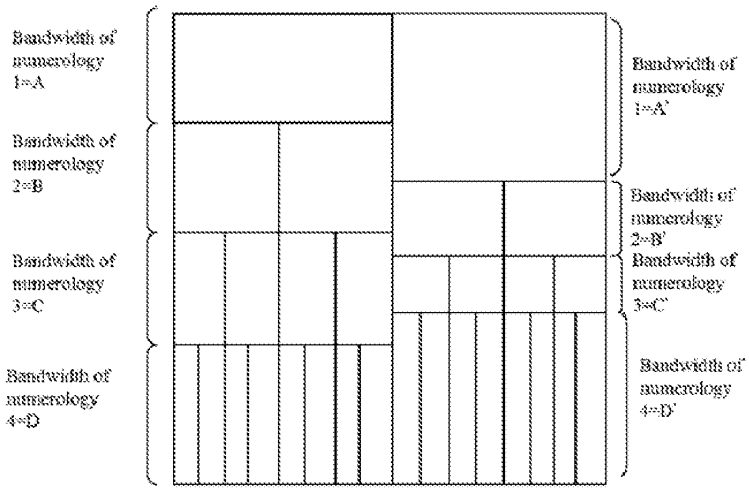


FIG. 46

Consistent with the specification, claims 1 and 16 recite "deriving [or derive] … a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth." Applicants respectfully submit that the cited prior art references fail to disclose the noted limitation.

In rejecting the claims, the Office Action cites to Paragraphs [0055] and [0146] of Xiong. Paragraphs [0054], [0055], and [0146] of Xiong state:

> [0054] FIG. 8 is a diagram of resource pool periodicity 800. Initially, MTC devices would access the network and acquire the necessary information for resource pools 808 for uplink transmission. **The configuration of this resource pool 808 can be predefined or provided by the higher layers via MIB or SIB or UE specific dedicated RRC signaling.**
>
> [0055] **The time and frequency resource configuration for uplink transmission resource pool 808 may comprise at least one of the following information: frequency location (e.g.,in resource block (RB) index region) and/or time location (e.g., OFDM symbol index, slot index, subframe index, radio frame index)**. As a more specific example to signal time related information, the configuration can contain at least periodicity 806 and/or subframe offset 804 for this resource pool 808.

> [0146] Example 33 is circuitry for a wireless mobile network base station. The circuitry can be configured to provide a synchronization signal provided over a mobilebroadband network by a base station. **The circuitry can also be configured to transmit data describing a set of uplink resources within the mobile broadband network of the base station**. The circuitry can be further configured to receive a scheduling request for the selected resource from a user equipment (UE). The circuitry can also be configured to receive data from the UE in the selected resource to the base station without acknowledgement by the base station.

See Xiong, Paragraphs [0054], [0055], and [0146], emphasis added.

As seen, Xiong discloses that the resource pool is informed the UE by system information data from the BS. The UE would select resource based on the resource pool. Also, Xiong teaches three Type transmission schemes (including Type-1, Type-2, and Type-3 transmission schemes); and in those transmission schemes, the UE could select resource by itself. *See e.g.*, Xiong, Abstract. In contrast, as recited in the claims, the network (and **not** the UE) allocates resource via a control channel to the UE.

In addition, as recited in the claims, the UE would derive a scheduled resource allocation "for the first numerology within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth."

In contrast, as discussed in Paragraphs [0037] – [0038] of Xiong, in Type-1 transmission scheme, an UE randomly selects one resource within the resource pool and transmits the data in the uplink on the selected resource. In Type-2 transmission scheme, a UE selects a resource within the SR region in the resource pool, transmits the SR information on the selected resource which contains the resource allocation for data transmission and transmits the uplink data on the resource which is indicated in the SR information. In Type-3 transmission scheme, the UE selects a resource within the SR region, transmits the SR on the selected resource with information on the resource selected for subsequent data transmission and transmits on the indicated resource if it receives an ACK. Therefore, Xiong fails to disclose that the UE derives a resource allocation for the first numerology "within a first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth" as recited in the claims.

Furthermore, the Office Action cites to Paragraph [0027] of Chang in rejecting the claims. *See* Office Action, Pages 3 and 4. Applicants respectfully disagree.

Paragraph [0027] of Chang states:

> [0027] There may be several different 5G physical downlink channels that are conveyed using such resource blocks, including the 5G physical downlink control channel (xPDCCH) and the 5G physical downlink shared channel (xPDSCH). Each downlink subframe may be partitioned into the xPDCCH and the xPDSCH, and perhaps additional signals, as discussed below. The xPDCCH may occupy the first two symbols of each subframe and carry, among other information, information about the transport format and resource allocations related to the xPDSCH channel, as well as allocation and hybrid automatic repeat request (H-ARQ) information related to the 5G uplink shared channel (xPUSCH). The xPDSCH may carry user data and higher-layer signaling to a UE and, in some embodiments, occupy the remainder of the subframe. Typically, downlink scheduling (assigning control and shared channel resource blocks to UEs within a cell) may be performed at the eNB based on channel quality information provided from the UEs to the eNB, and then the downlink resource assignment information may be sent to each UE on the xPDCCH used for (assigned to) the UE. The xPDCCH may contain DCI in one of a number of formats that indicate to the UE how to find and decode data, transmitted on the xPDSCH in the same subframe, from the resource grid. The DCI format may provide details such as a number of resource blocks, resource allocation type, modulation scheme, transport block, redundancy version, coding rate, etc. Each DCI format may have a cyclic redundancy code (CRC) and be scrambled with a Radio Network Temporary Identifier (RNTI) that identifies the target UE for which the xPDSCH is intended. Use of the UE-specific RNTI may limit decoding of the DCI format (and hence the corresponding xPDSCH) to only the intended UE.

As seen, Paragraph [0027] of Chang teaches the xPDCCH may contain DCI in one of a number of formats that indicates to the UE how to find and decode data, which are transmitted on the xPDSCH in the same subframe, from the resource grid. However, Chang fails to teach the UE derives a resource allocation for the PDSCH or the PUSCH for the first numerology within a first bandwidth portion **based on the PDCCH, the first frequency location and the first bandwidth** as recited in the claims.

In addition, claims 5 and 19 recite "receiving [or receive] … information for a second numerology associated with a second subcarrier spacing, wherein the information comprises a second frequency location and a second bandwidth for the second numerology and deriving, by the UE, a resource allocation for a PDSCH or a PUSCH for the second numerology within a second bandwidth portion based on the PDCCH, the second frequency location and the second bandwidth." Applicants respectfully submit that the cited prior art references fail to disclose a

plurality of numerologies, including "a first numerology associated with a first subcarrier spacing" and "a second numerology associated with a second subcarrier spacing" as recited in the claims.

For the reasons discussed above, Applicants respectfully submit that claims 1-13 and 16-20 are patentable over the cited prior art references.

In view of the foregoing it is respectfully submitted that the pending claims are in condition for allowance. Reconsideration of the rejections is requested. Allowance of the claims at an early date is solicited. The Examiner is invited to contact Applicant's undersigned counsel by telephone at (714) 839-3800 to expedite the prosecution of this case should there be any unresolved matters remaining.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Respectfully submitted,
Sang N. Dang
BLUE CAPITAL LAW FIRM, P.C.

Dated: August 13, 2019

/Sang N. Dang/
Reg. No. 51,186
Tel.: (714) 839-3800
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Ko-Chiang Lin and Ming-Che Li	
Title:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	15/674,483	Filed: August 10, 2017
Examiner:	Wayne Huu Cai	Group Art Unit: 2644
Attorney Docket No.:	1426-148.101 (1050198-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 2 Page Request for Continued Examination; 2 Page Amendment Transmittal Sheet; and 9 Page Amendment are being transmitted to the United States Patent and Trademark Office via EFS-Web on August 13, 2019.

Date: August 13, 2019 /Sandy Kim/
Sandy Kim

Mailing Address:

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Electronic Patent Application Fee Transmittal

Application Number:	15674483
Filing Date:	10-Aug-2017
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Filer:	Sang N. Dang/Sandy Kim
Attorney Docket Number:	1426-148.101

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1300	1300
		Total in USD ($)		**1300**

Electronic Acknowledgement Receipt	
EFS ID:	36859381
Application Number:	15674483
International Application Number:	
Confirmation Number:	7684
Title of Invention:	METHOD AND APPARATUS FOR DETERMINING NUMEROLOGY BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-148.101
Receipt Date:	13-AUG-2019
Filing Date:	10-AUG-2017
Time Stamp:	14:14:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1300
RAM confirmation Number	E20198CE14179219
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1426-148-101--RFOAwRCEasFiled08132019.pdf	337804 9d64e60a36ac76c1b3060e4a60a322a4d07f1b18	yes	14

Multipart Description/PDF files in .zip description

Document Description	Start	End
Request for Continued Examination (RCE)	1	2
Transmittal Letter	3	4
Amendment Submitted/Entered with Filing of CPA/RCE	5	5
Claims	6	8
Applicant Arguments/Remarks Made in an Amendment	9	13
Miscellaneous Incoming Letter	14	14

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30475 80a73f8f86fdb5a35757c70b141c40c921beeaaa	no	2

Warnings:

Information:

Total Files Size (in bytes):	368279

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/674,483	Filing Date 08/10/2017	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $420 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	08/13/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/TRINA RIDDICK/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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