PTO/SB/05 (08-08)
Approved for use through 09/30/2010. OMB 0651-0032
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UTILITY PATENT APPLICATION TRANSMITTAL

(ONLY FOR NEW NONPROVISIONAL APPLICATIONS UNDER 37 CFR 1.53(B))

Attorney Docket No.	612408008US2
First Inventor	Xiaodong Li
Title	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [X] **Fee Transmittal Fonn** (e.g., PTO/SB/17)
2. [ ] **Applicant claims small entity status.** See 37 CFR 1.27.
3. [X] **Specification** [*Total Pages* 17]
   Both the claims and abstract must start on a new page
   (For information on the preferred arrangement, see MPEP 608.01(a))
4. [X] **Drawing(s)** *(35 U.S.C. 113)* [*Total Sheets* 8]
5. **Oath or Declaration** [*Total Sheets* 3]
   a. [ ] Newly executed (original or copy)
   b. [X] A copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [X] **Application Data Sheet**. See 37 CFR 1.76
7. [ ] **CD-ROM or CD-R** in duplicate, large table or Computer Program *(Appendix)*
   [ ] Landscape Table on CD
8. **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

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

ACCOMPANYING APPLICATION PARTS

9. [ ] **Assignment Papers** (cover sheet & document(s))
   Name of Assignee
10. [ ] **37 CFR 3.73(b) Statement** *(when there is an assignee)* [ ] **Power of Attorney**
11. [ ] **English Translation Document** *(if applicable)*
12. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
13. [ ] **Preliminary Amendment**
14. [ ] **Return Receipt Postcard** (MPEP 503) *(Should be specifically itemized)*
15. [ ] **Certified Copy of Priority Document(s)** *(if foreign priority is claimed)*
16. [ ] **Nonpublication Request** under 35 U.S.C.122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
17. [X] Other: General Authorization for Extension of Time and Fees

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:*

[X] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No.: 10/583,158

Prior application information: Examiner Ajibola A. Akinyemi *Art Unit:* 2618

19. CORRESPONDENCE ADDRESS

[X] The address associated with Customer Number: 25096 *OR* [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature		Date	August 8, 2011
Name (Print/Type)	Stephen Bishop	Registration No. (Attorney/Agent)	38,829

PTO/SB/17 (10-08)
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Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2009

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 1,518.00

Complete if Known	
Application Number	Not Yet Assigned
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Attorney Docket No.	612408008US2

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☒ Other (please identify): EFT Account SEA1PIRM

☒ Deposit Account Deposit Account Number: 50-0665 Deposit Account Name: Perkins Coie LLP

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 underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☒ Credit any overpayments

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fees Paid ($)**
Utility	330	165	540	270	220	110	1,090.00
Design	220	110	100	50	140	70	
Plant	220	110	330	165	170	85	
Reissue	330	165	540	270	650	325	
Provisional	220	110	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	52	26
Each independent claim over 3 (including Reissues)	220	110
Multiple dependent claims	390	195

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
24	- 20 or HP	4	x 52.00	=	208.00

HP = highest number of total claims paid for, if greater than 20.

Multiple Dependent Claims	
Fee ($)	**Fee Paid ($)**

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
4	- 3 or HP =	1	x 220.00	=	220.00

HP = highest number of independent claims paid for, if greater than 3.

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 $270 ($135 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).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**	**Fee ($)**		**Fee Paid ($)**
25	- 100 =		/50 =	(round **up** to a whole number) x		=	

4. OTHER FEE(S) **Fees Paid ($)**

Non-English Specification, $130 fee (no small entity discount)

Other (e.g., late filing surcharge):

SUBMITTED BY

Signature		Registration No. (Attorney/Agent)	38,829	Telephone	(206) 359-8000
Name (Print/Type)	Stephen Bishop			Date	August 8, 2011

61240-8008.US02/LEGAL21495009.1

Application Data Sheet

Application Information

Application Type::	Regular
Subject Matter::	Utility
Suggested Group Art Unit::	N/A
CD-ROM or CD-R?::	None
Sequence submission?::	None
Computer Readable Form (CRF)?::	No
Title::	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
Attorney Docket Number::	612408008US2
Request for Early Publication?::	No
Request for Non-Publication?::	No
Total Drawing Sheets::	8
Small Entity?::	No
Petition included?::	No
Secrecy Order in Parent Appl.?::	No

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	US
Status::	Full Capacity

Given Name::	Xiaodong
Family Name::	Li
City of Residence::	Kirkland
State or Province of Residence::	WA
Country of Residence::	US
Street of mailing address::	9919 129th PL NE
City of mailing address::	Kirkland
State or Province of mailing address::	WA
Postal or Zip Code of mailing address::	98033

Applicant Authority Type::	Inventor
Primary Citizenship Country::	Canada
Status::	Full Capacity
Given Name::	Titus
Family Name::	Lo
City of Residence::	Bellevue
State or Province of Residence::	WA
Country of Residence::	US
Street of mailing address::	13312 SE 43rd ST
City of mailing address::	Bellevue
State or Province of mailing address::	WA
Postal or Zip Code of mailing address::	98006

Applicant Authority Type::	Inventor
Primary Citizenship Country::	People's Republic of China
Status::	Full Capacity
Given Name::	Kemin
Family Name::	Li
City of Residence::	Bellevue
State or Province of Residence::	WA
Country of Residence::	US
Street of mailing address::	4228 144th Lane SE
City of mailing address::	Bellevue
State or Province of mailing address::	WA
Postal or Zip Code of mailing address::	98006

Applicant Authority Type::	Inventor
Primary Citizenship Country::	People's Republic of China
Status::	Full Capacity
Given Name::	Haiming
Family Name::	Huang
City of Residence::	Bellevue
State or Province of Residence::	WA
Country of Residence::	US

Street of mailing address:: 605 141st CT SE #D203

City of mailing address:: Bellevue

State or Province of mailing address:: WA

Postal or Zip Code of mailing address:: 98007

Correspondence Information

Correspondence Customer Number:: 25096

Representative Information

Representative Customer Number:: 25096

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	Continuation of	10/583,158	08/27/08
10/583,158	National Stage of	PCT/US05/08169	03/09/05
PCT/US05/08169	An application claiming the benefit under 35 USC 119(e)	60/551,589	03/09/04

Foreign Priority Information

Assignee Information

Docket No.: 612408008US2
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Li et al.

Application No.: Not Yet Assigned

Confirmation No.: N/A

Filed: Concurrently Herewith

Art Unit: Not Yet Assigned

For: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

Examiner: Not Yet Assigned

AUTHORIZATION FOR: EXTENSIONS OF TIME UNDER 37 C.F.R. § 1.136(A)(3) AND FEES UNDER 37 C.F.R. § 1.17

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

Sir:

With respect to the above-identified application, the Commissioner is authorized to treat any concurrent or future reply requiring a petition for an extension of time under 37 C.F.R. § 1.136(a)(3) for its timely submission as incorporating a petition therefor for the appropriate length of time.

The Commissioner is also authorized to charge any extension of time fees or other fees that may be required under 37 C.F.R. § 1.17 for any paper filed concurrently herewith or in the future, or credit any overpayment, to Deposit Account No. 50-0665.

Dated: August 8, 2011

Respectfully submitted,

By _____
Stephen Bishop
Registration No.: 38,829
PERKINS COIE LLP
P.O. Box 1247
Seattle, Washington 98111-1247
(206) 359-8000
(206) 359-7198 (Fax)
Attorney for Applicant

61240-8008.US02/LEGAL21494994.1

Declaration for Patent Application English Language Declaration		
	Attorney Docket No.	612408008US1
	First Named Inventor	Xiaodong Li
	COMPLETE IF KNOWN:	
☐ Submitted with initial filing ☒ Submitted after initial filing (surcharge required 37 CFR 1.16(e))	Application No.	10/583,158-Conf. #8985
	Filing Date	June 16, 2006
	Art Unit	N/A
	Examiner	Not Yet Assigned

As a below named inventor, I hereby declare that:

My residence, mailing address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

the specification of which

☐ is attached hereto

OR

☒ was filed on 06/16/2006

as United States Application No. or PCT International Application No. 10/583,158

and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign applications(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's right certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

(Number)	(Country)	(Filing Date)	Priority Not Claimed	Certified Copy Attached YES	Certified Copy Attached NO
PCT/US05/08169	PCT	03/09/2005	☐	☐	☒
			☐	☐	☐
			☐	☐	☐

☐ Additional prior foreign applications are listed on a supplemental data sheet attached hereto.

IN LIEU OF PTO SB/01 (03-01))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor Xiaodong Li	
Sole or first inventor's signature	Date 1/3/2007
Residence Kirkland, Washington	
Citizenship US	
Mailing Address 9919 129th PL NE Kirkland, Washington 98033	

Full name of second inventor Titus Lo	
Second inventor's signature	Date 01/03/2007
Residence Bellevue, Washington	
Citizenship Canada	
Mailing Address 13312 SE 43rd ST Bellevue, Washington 98006	

Full name of third inventor	
Kemin Li	
Third inventor's signature	Date
	01/03/2007
Residence	
Bellevue, Washington	
Citizenship People's Republic of China	
Mailing Address	
4228 144th Lane SE Bellevue, Washington 98006	

Full name of fourth inventor, if any	
Haiming Huang	
Fourth inventor's signature	Date
	1/3/2007
Residence	
Bellevue, Washington	
Citizenship People's Republic of China	
Mailing Address	
605 141st CT SE #D203 Bellevue, Washington 98007	

PTO/SB/80 (01-06)
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

[X] Practitioners associated with the Customer Number: 25096

OR

[ ] Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned *only* to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

[X] The address associated with Customer Number: 25096

OR

[ ] Firm or Individual Name

Address					
City		State		Zip	
Country		Telephone		Email	

Assignee Name and Address:

Neocific, Inc.
13312 SE 43rd Street
Bellevue, Washington 98006

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	[signature]	Date	1/3/2007
Name	XIAODONG LI	Telephone	425-445-2220
Title	PRESIDENT		

61240-8000/LEGAL12936537.1

PTO/SB/96 (08-08)
Approved for use through 08/31/2008. OMB 0651-0031
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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Xiaodong Li, Titus Lo, Kemin Li, and Haiming Huang

Application No./Patent No.: 10/583,158 Filed/Issue Date: June 16, 2006

Entitled: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

Neocific, Inc. (Name of Assignee) , a corporation (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [X] the assignee of the entire right, title, and interest; or

2. [ ] an assignee of less than the entire right, title and interest.
(The extent (by percentage) of its ownership interest is _____ %)

in the patent application/patent identified above by virtue of either:

A. [X] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 017363 , Frame 0370 .

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____ , Frame _____ , or for which a copy thereof is attached.

2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____ , Frame _____ , or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____ , Frame _____ , or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet.

[X] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature	26 Aug 2008 Date
Stephen Bishop Printed or Typed Name	(206) 359-8000 Telephone Number
Attorney for Assignee Title	

ASSIGNMENT BY INVENTORS

This Assignment is by Xiaodong Li; Titus Lo; Haiming Huang; and Kemin Li (the "Assignors"), residing at 9919 129th PL NE, Kirkland, Washington 98033; 10501 181st Ave. NE, Redmond, Washington 98052; 605 141st CT SE #D203, Bellevue, Washington 98007; and 4228 144th LN SE, Bellevue, 98006, respectively. The Assignors have invented one or more certain inventions (the "Invention(s)") described in a Patent application for Letters Patent of the United States entitled METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS (the "Application"), executed concurrently herewith and naming the Assignors as inventors. The Assignors authorize the Assignee, identified below, or its representatives to insert the application number of the Application 11505/08169 when known.

Waltical Solution, Inc. (formerly Walbell Technologies, Inc.), a corporation of Washington having its principal place of business at Suite D159, 1750 112th Ave. NE, Bellevue, Washington 98004 ("Assignee"), desires to acquire the entire right, title and interest in and to the Invention(s) and the Application, and in and to any patents (collectively, "Patents") that may be granted for the Invention(s) in the United States or in any foreign countries.

For valuable consideration, the receipt and sufficiency of which Assignors acknowledge, Assignors hereby sell, assign, and transfer to Assignee, its successors, legal representatives and assigns, the entire right, title and interest in and to: the Invention(s), the Application, and any Patents; any divisions, continuations, and continuations-in-part of the Application and any other application claiming priority rights from the Application; any reissues, reexaminations, or extensions of any and all Patents; the right to file foreign applications directly in the name of Assignee; and the right to claim priority rights deriving from the Application (collectively, the "Rights"). Assignors warrant that Assignors own the Rights, and that the Rights are unencumbered. Assignors also agree to not sign any writing or do any act conflicting

with this assignment, and, without further compensation, sign all documents and do such additional acts as Assignee deems necessary or desirable to: perfect Assignee's enjoyment of the Rights; conduct proceedings regarding the Rights, including any litigation or interference proceedings; or perfect or defend title to the Rights. Assignors request the Commissioner of Patents to issue any Patent of the United States that may be issued on the Invention(s) to Assignee. This Assignment may be executed in counterparts.

Xiaodong Li

Date: 4/8/05

United States of America)
State of Washington) ss.:
County of King)

On this 8th day of April, 2005, before me personally came Xiaodong Li, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.

Notary Public

Titus Lo

Date: April 8, 2005

United States of America)
State of Washington) ss.:
County of King)

On this 8th day of April, 2005, before me personally came Titus Lo, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.



Notary Public

Kemin Li

Date: Apr 8 2005

United States of America)
State of Washington) ss.:
County of King)

On this 8th day of April, 2005, before me personally came Kemin Li, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.

HONG M TANG
NOTARY
PUBLIC
NOVEMBER 3, 2008
STATE OF WASHINGTON

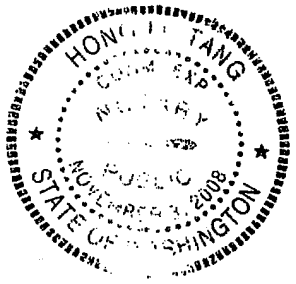
Notary Public

Haiming Huang

Date: April 8, 2005

United States of America)
State of Washington) ss.:
County of King)

On this 8th day of April, 2005, before me personally came Haiming Huang, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.



Notary Public

ASSIGNMENT

Waltical Solutions, Inc., a corporation organized under and pursuant to the laws of Washington, having its principal place of business at 1750 112th Avenue NE, Suite D 159; Bellevue, Washington 98004 (hereinafter referred to as "Assignor"), is the sole and exclusive owner, by assignment, of the Patent Applications listed in Schedule A; and

Neocific, Inc., a corporation organized under and pursuant to the laws of Delaware, having its principal place of business at 13312 SE 43rd Street, Bellevue, Washington 98006 (hereinafter referred to as "Assignee"), desires to acquire the right, title and interest in, to and under said Patent Applications and the inventions covered thereby;

For valuable consideration, the receipt and sufficiency of which Assignor acknowledges, Assignor hereby sells, assigns, and transfers to Assignee, its successors, legal representatives and assigns, the entire right, title and interest in and to said applications for all original, divisional, continuation, continuation-in-part, substitute or reissue applications and patents applied for or granted therefore in the United States of America and all other countries on the attached list of *Schedule A*, and the Commissioner of Patents and Trademarks is hereby authorized and requested to issue all patents on *Schedule A* to said assignee herein, as assignee of the entire interest therein; and the undersigned for itself and its legal representatives, heirs and assigns does hereby agree and covenant without further remuneration, to execute and deliver all divisional, continuation, continuation-in-part, reissue and other applications for Letters Patent and all assignments thereof to said assignee or its assigns, to communicate to said assignee or its representatives all facts known to the undersigned respecting said inventions listed on *Schedule A* whenever requested, to testify in any interferences or other legal proceedings in which any of said applications or patents may become involved, to sign all lawful papers, make all rightful oaths, and do generally everything necessary to aid assignee, its successors, assigns and nominees to obtain patent protection for said inventions listed on *Schedule A* in the United States of America and all other countries, the expenses incident to said applications listed on *Schedule A* to be borne and paid by said assignee.

SCHEDULE A

Application Number (Patent Number)	Filing Date	Inventor	Title	Ctry
US05/01939	Jan. 20, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang	METHODS AND APPARATUS FOR MULTI-CARRIER, MULTI-CELL WIRELESS COMMUNICATION NETWORKS	PCT
US05/04601	Feb. 14, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang	METHODS AND APPARATUS FOR MULTI-CARRIER COMMUNICATIONS SYSTEMS WITH ADAPTIVE TRANSMISSION AND FEEDBACK	PCT
US05/03889	Feb. 7, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang	METHODS AND APPARATUS FOR MULTI-CARRIER COMMUNICATIONS SYSTEMS WITH AUTOMATIC REPEAT REQUEST (ARQ)	PCT
10/456,654	June 5, 2003	Titus Lo	ADAPTIVE COMMUNICATIONS SYSTEM AND METHOD	US
10/360,007	Feb. 7, 2003	Wen-Ping Ying	PROTECTING INFORMATION TRANSMISSIONS VIA ENCRYPTION, SUCH AS WITH KEY HOPPING TECHNIQUES IN AN 802.11 WIRELESS NETWORK	US
US05/03518	Jan. 27, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang	METHODS AND APPARATUS FOR OVERLAYING MULTI-CARRIER AND DIRECT SEQUENCE SPREAD SPECTRUM SIGNALS IN A BROADBAND WIRELESS COMMUNICATION SYSTEM	PCT
US05/08169	March 9, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang	METHOD AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS	PCT
US05/14828	April 29, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang	METHODS AND APPARATUS FOR MULTI-CARRIER COMMUNICATIONS WITH VARIABLE CHANNEL BANDWIDTH	PCT
US05/14835	April 29, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang	METHODS AND APPARATUS FOR COMMUNICATION SYSTEM WITH TIME-DIVISION DUPLEXING	PCT
US05/23399	June 29, 2005	Xiaodong Li, Titus Lo, Kemin Li, Haiming Huang, Jun Meng	METHODS AND APPARATUS FOR POWER CONTROL IN MULTI-CARRIER SYSTEMS	PCT
60/665,184	Mar. 25, 2005	Haiming Huang, Xiaodong Li, Titus Lo, Kemin Li	METHODS AND APPARATUS FOR CELLULAR BROADCASTING AND COMMUNICATION SYSTEM	US

60/665,205	Mar. 25, 2005	Haiming Huang, Xiaodong Li, Titus Lo, Kemin Li	METHODS AND APPARATUS FOR SYNCHRONIZED DISTRIBUTION IN PACKET DATA NETWORKS	US
60/688,937	June 9, 2005	Haiming Huang, Xiaodong Li, Titus Lo, Kemin Li	METHODS AND APPARATUS FOR A POWER EFFICIENT BROADCASTING AND COMMUNICATION SYSTEM	US
60/704,141	July 29, 2005	Titus Lo, Xiaodong Li,Kemin Li, Haiming Huang	METHODS AND APPARATUS FOR MULTI-CARRIER COMMUNICATIONS USING NON-UNIFORM SYMBOL STRUCTURES	US
60/721,451	Sept. 28, 2005	Xiaodong Li, Haiming Huang, Titus Lo, Ruifeng Wang	METHOD AND APPARATUS FOR MULTI-CARRIER PACKET COMMUNICATION WITH REDUCED OVERHEAD	US

Waltical Solutions, Inc.

By: _____

Name: XIAODONG LI

Title: PRESIDENT

Date: December 14, 2005

United States of America)
State of Washington) ss.:
County of King)

On this 14th day of December, 2005, before me personally came Xiaodong Li, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.

ROSALYNN P LE
COMM EXP
NOTARY
PUBLIC
DECEMBER 10, 2008
STATE OF WASHINGTON

_____ /Rosalynn Le
Notary Public

my comm. exp. December 10, 2008

METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application is a continuation of U.S. Patent Application No. 10/583,158, entitled "METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS", filed August 27, 2008, which is a U.S. National Stage application of PCT/US05/08169, entitled "METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS", filed March 9, 2005, which claims the benefit of U.S. Provisional Patent Application No. 60/551,589, entitled "METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS", filed March 9, 2004.

BACKGROUND

[0002] In a wireless communication system, a mobile station first needs to perform a random access for establishing communication with a base station. The random access typically includes two steps: (1) Ranging and (2) Resource Request and Allocation. During Ranging, the mobile station sends a signal to the base station, so that the base station can identify the mobile station and measure the power and time delay of the mobile station, and inform the mobile station for power adjustment and time advance. During Resource Request and Allocation, the uplink and downlink resources for communication are requested and allocated. Ranging is a critical part of multi-carrier wireless communication system, and there are several important issues related to ranging:

1. The bandwidth efficiency of the ranging signals
2. The interference of ranging signal with other uplink signals
3. The detection performance and complexity at the base station receiver

[0003] The ranging process typically involves an exchange of messages between the base station and the mobile station by which the mobile station aligns itself with the start of each time slot after compensating for propagation delay and other factors. One problem in a shared medium communication network involves the ranging of many mobile stations. When many mobile stations attempt to perform the ranging simultaneously, they are forced to contend for access to the shared channel and it becomes difficult for any of the mobile stations to complete the ranging process due to the large number of collisions. As a result, the time needed for all of the mobile stations to complete the ranging process is excessive, and much bandwidth on the shared channel is wasted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figure 1 depicts a basic structure of a multi-carrier signal in the frequency domain, made up of subcarriers.

[0005] Figure 2 shows a radio resource divided into small units in both the frequency domain (subchannels) and the time domain (time slots).

[0006] Figure 3 shows a cellular system with at least one cell and one base station.

[0007] Figure 4 depicts a ranging subchannel composed of at least one block of subcarriers.

[0008] Figure 5 illustrates a case of time misalignment in a ranging signal, with a base station OFDM time frame, due to uncertainty of a mobile station's round trip delay at an initial stage of random access.

[0009] Figure 6 depicts a smeared spectrum of a subcarrier in a ranging subchannel when the ranging signal is received using a regular OFDM time frame.

[0010] Figure 7 illustrates a ranging sequence's corresponding time-domain signal that can be approximated with a binary sequence.

[0011] Figure 8 shows a ranging subchannel arrangement in which spacing between subcarrier blocks in the frequency domain has no, or minimum, repetition.

DETAILED DESCRIPTION

[0012] In the following description, the invention is explained with respect to some of its various embodiments, and provides specific details for a thorough understanding. However, one skilled in the art will understand that the invention may be practiced without such details. In other instances, well-known structures and functions have not been shown or described in detail to avoid obscuring aspects of the embodiments.

[0013] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising," and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to." Words using the singular or plural number also include the plural or singular number respectively. Additionally, the words "herein," "above," "below" and words of similar import, when used in this application, shall refer to this application as a whole and not to any particular portions of this application. When the claims use the word "or" in reference to a list of two or more items, that word covers all of the following interpretations of the word: any of the items in the list, all of the items in the list and any combination of the items in the list.

[0014] The embodiments of this invention disclose methods and apparatus for random access in a multi-carrier system. In particular, ranging signals are designed to improve receiving reliability and to reduce interference with other uplink signals. Furthermore, methods and apparatus are described that improve the detection performance at the base station receiver.

[0015] In a multi-carrier communication system such as multi-carrier code division multiple access (MC-CDMA) and orthogonal frequency division multiple access (OFDMA) systems, information data are multiplexed on subcarriers that are mutually orthogonal in the frequency domain. In effect, a frequency selective channel is partitioned in frequency into a number of parallel, but small, segments that can be treated as flat fading channels and can employ simple one-tap equalizers. The modulation/demodulation can be performed using the fast Fourier transform (FFT).

[0016] In a multi-carrier communication system the physical media resource (e.g., radio or cable) can be divided in both the frequency and time domains. This canonical division provides a high flexibility and fine granularity for resource sharing. A basic structure of a multi-carrier signal in the frequency domain is made up of subcarriers, and within a particular spectral band or channel there are a fixed number of subcarriers. There are three types of subcarriers:

1. Data subcarriers, which carry information data;
2. Pilot subcarriers, whose phases and amplitudes are predetermined and made known to all receivers and which are used for assisting system functions such as estimation of system parameters; and
3. Silent subcarriers, which have no energy and are used for guard-bands and DC carriers.

[0017] The data subcarriers can be arranged into groups called subchannels to support scalability and multiple-access. The carriers forming one subchannel are not necessarily adjacent to each other. Each user may use part or all of the subchannels. The concept is illustrated in Figure 1 for the interleaved subchannels at the base station transmitter. Data subcarriers can be grouped into subchannels in a particular way and the pilot subcarriers are also distributed over the entire channel in a particular way. The basic structure of a multi-carrier signal in the time domain is made up of time slots to support multiple-access. The resource division in both the frequency and time domains is depicted in Figure 2.

[0018] Figure 3 illustrates a typical cellular structure. In this illustration no distinction is made between a cell and a sector. If a cell is divided into sectors, from a system engineering point of view each sector can be considered a cell. In this context, the terms "cell" and "sector" are interchangeable. Both of them are generally called a cell. In the communication system of Figure 3 Base Station 310 is communicating with Mobile Stations 301 and 302 in Sector A of its cell site while Base Station 320 is communicating with Mobile Stations 303, 304, and 305 in Sector B of its cell site.

[0019] Figure 4 illustrates two ranging subchannels, each of which is composed of multiple blocks of subcarriers. The subcarriers in each block are contiguous in

frequency. Figure 4 schematically shows that the signal power of the subcarriers towards the boundary (the lower ends and the higher ends in frequency) of a block is lower than that of the subcarriers towards the center of the block. (In a special case, the power levels of the two subcarriers at both ends of a block are set to zero.) Because different factors may cause possible overlap of two subcarrier blocks from to different transmitters, the attenuated boundary subcarriers will minimize the resulting interference.

[0020] In accordance with aspects of some embodiments, the ranging signal is carried over a ranging subchannel that contains multiple subcarriers. Either binary or non-binary signals can be modulated on the subcarriers of a ranging subchannel.

[0021] The sequence of modulating signals in a ranging subchannel is called a ranging sequence. Multiple ranging sequences are permitted in a cell. A mobile station chooses a ranging sequence for random access and uses the sequence to identify itself in the initial communication with a base station. The period of a ranging signal is called a ranging slot. A ranging slot may last over one or multiple OFDM symbols. Multiple ranging slots can be provided to increase the random access opportunity and reduce the collision probability.

[0022] In one embodiment, different cells may have different subcarrier configurations for their ranging subchannels. Different cells may also have different ranging sequence sets. These differences may be used to identify the association of a mobile station with a cell.

[0023] Figure 5 illustrates the timing of regular uplink data signals and ranging signals (with a Guard Period G.P.). In the beginning of a random access attempt, the mobile station is unaware of its round-trip time to the base station. As a result, the arrival time of ranging signal at the base station may be misaligned with other signals which have been synchronized to the base station clock. As depicted in Figure 5, the random access Ranging Signal does not coincide with the expected arrival time at the base station. As shown in Figure 6, time misalignment of regular signals and ranging signals can cause spectrum of ranging signals to be smeared when it is received using the OFDM time window of regular signals. Therefore, misaligned subcarriers within a

ranging subchannel will interfere with each other and with other data subchannels that are adjacent to them. In the following description, several methods are presented to address such problems.

[0024] In one embodiment, the ranging subchannel is composed of multiple blocks of subcarriers. The subcarriers in each block are contiguous in frequency. The signal power of the subcarriers towards the boundary (the lower ends and the higher ends in frequency) of a block is lower than that of the subcarriers towards the center of the block. In a special case, the power levels of the two subcarriers at both ends of a block are set to zero.

[0025] In yet another embodiment, each segment of a ranging sequence is a Hadamard sequence and a full ranging sequence is composed of multiple Hadamard sequences. Each segment corresponds to a block of contiguous subcarriers. In Table 1, a typical example is shown for two ranging sequences. Each segment is a 4-bit Hadamard sequence and each ranging sequence is composed of 4 segments. The two ranging sequences are segment-wise orthogonal to each other.

Table 1: Example of ranging sequences

Ranging Sequence 1	+1 -1 +1 -1	+1 +1 +1 +1	+1 +1 -1 -1	+1 -1 -1 +1
Ranging Sequence 2	+1 +1 +1 +1	+1 -1 -1 +1	+1 -1 +1 -1	+1 +1 -1 -1

[0026] In addition, other properties in signal processing can be exploited in sequence design. In one embodiment of the implementation, the ranging sequence is designed such that its corresponding time-domain signal exhibits relatively low peak-to-average power ratio. This improves the power efficiency of the mobile station transmission power amplifier. Furthermore, the ranging signal is designed such that the time signal can be approximated with a binary sequence (e.g., Figure 7), thereby reducing the complexity of the receiver correlator. While in theory, and even in practice, each modulating digit of a ranging sequence can represent a range of logic levels, a

binary format is practically the simplest representation and requires the simplest receiver components for its processing. Figure 7 illustrates a ranging sequence's corresponding time-domain signal that can be approximated with a binary sequence.

[0027] In another embodiment, the blocks of a ranging subchannel can be distributed or allocated in such a way that the autocorrelation of a ranging sequence corresponding to the ranging subchannel, in time-domain, exhibits a set of desired properties such as a narrow main peak and low sidelobes. For example, the blocks can be distributed in the frequency band of interest such that there is minimum redundancy in a co-sampling function. In other words, spacing between the blocks of a ranging subchannel in the frequency domain has no or minimum repetition, as illustrated in Figure 8, where the spacing consists of the set {d, 2d, 3d, 4d, 5d, 6d}.

[0028] Figure 8 is merely an example of such possible arrangements, where an autocorrelation process only produces one major peak, regardless of the ranging sequence carried by the ranging subchannel blocks. During an autocorrelation process, two copies of a ranging signal move in parallel with respect to each other, in a step-wise manner, and at each step the sum of the multiplication of their corresponding values is computed and recorded. Note that in an interval of a ranging subchannel where there are no subcarriers, the ranging signal value is zero. Therefore, employing the proposed arrangements, at any step except for the step during which the two copies of the ranging signal are substantially aligned, most of the non-zero values of either copy will correspond to the zero values of the other copy and the multiplication result of the corresponding values will be zero, which results in low sidelobe values.

[0029] With regard to controlling the power settings of a ranging signal, before a random access, a mobile station estimates the path loss from a base station, using the received downlink signal. It uses open-loop power control to set the power level of the ranging signal. In one embodiment, the mobile station adds a negative offset to the open-loop power setting and gradually ramps up the transmission power of the ranging signal as the number of random access failures and retrials increase.

[0030] In one embodiment, the base station receiver detects the presence of each ranging signal, its time delay, and its power level through the use of a matched filter, a correlator, or other means in the time domain, the frequency domain, or both.

[0031] In another embodiment, when the ranging subchannel is composed of blocks of contiguous subcarriers, the base station performs hierarchical detection: first in frequency domain, then in time domain. The detection process is as follows:

1. The FFT is applied to a selected window of the received time-domain signal, s(t).

2. For a particular ranging subchannel, its received version, $\{\vec{r}(k)\}_{k=1}^{K}$, is correlated in the frequency domain with the ranging sequences associated with the cell, in a segment-wise fashion, where K is the total number of blocks in a ranging subchannel. If the m^{th} sequence associated with the cell is denoted by $\{\vec{b}_m(k)\}_{k=1}^{K}$, the correlation value, P_m, is computed by:

$$P_m = \sum_{k=1}^{K} \left| \left\langle \vec{r}(k) \bullet \vec{b}_m(k) \right\rangle \right|^2 ,$$

where the dot-product is computed by:

$$\left\langle \vec{r}(k) \bullet \vec{b}_m(k) \right\rangle = \sum_{n=1}^{N} x(k,n) \cdot [c_m(k,n)]^*$$

and where N denotes the number of subcarriers in a block, $x(k,n)$ denotes the received version of the n^{th} subcarrier of the k^{th} block in the given ranging subchannel, and $c_m(k,n)$ represents the value of the n^{th} subcarrier of the k^{th} block in the given ranging subchannel for the m^{th} sequence. It is noted that that both $\vec{r}(k)$ and $\vec{b}_m(k)$ are vectors of the dimension same as the segment length. If P_m is greater than a given threshold, this indicates that a ranging signal corresponding to the m^{th} sequence has been detected.

3. For the ranging signal identified in Step 2, a time-domain correlation of the full sequence of the ranging signal is performed, in a sliding-window fashion, to find the time delay of that ranging signal, that is:

$$C(\tau)=\left|\sum_{t=0}^{T} s(t+\tau)\cdot z^{*}(t)\right| \qquad \text{for} \quad \tau=0,1,\cdots,D$$

where T denotes the length of the time-domain ranging sequence, D corresponds to the maximum time delay allowed by the system, and $z^{*}(t)$ represents the time-domain signal of the detected ranging sequence. The maximum value of $C(\tau)$ for $\tau=0,1,\cdots,D$ is the estimate of the power of the ranging signal and the corresponding value of τ indicates the time delay associated with the ranging signal.

[0032] In the case of ranging sequences composed of Hadamard sequences, the dot-products of the received signal and the ranging sequence in a particular segment in Step 2 can be evaluated simultaneously using a single Fast Hadamard Transform (FHT), thereby simultaneously detecting multiple ranging sequences.

[0033] The above detailed description of the embodiments of the invention is not intended to be exhaustive or to limit the invention to the precise form disclosed above or to the particular field of usage mentioned in this disclosure. While specific embodiments of, and examples for, the invention are described above for illustrative purposes, various equivalent modifications are possible within the scope of the invention, as those skilled in the relevant art will recognize. Also, the teachings of the invention provided herein can be applied to other systems, not necessarily the system described above. The elements and acts of the various embodiments described above can be combined to provide further embodiments.

[0034] All of the above patents and applications and other references, including any that may be listed in accompanying filing papers, are incorporated herein by reference. Aspects of the invention can be modified, if necessary, to employ the systems, functions, and concepts of the various references described above to provide yet further embodiments of the invention.

[0035] Changes can be made to the invention in light of the above "Detailed Description." While the above description details certain embodiments of the invention and describes the best mode contemplated, no matter how detailed the above appears in text, the invention can be practiced in many ways. Therefore, implementation details may vary considerably while still being encompassed by the invention disclosed herein. As noted above, particular terminology used when describing certain features or aspects of the invention should not be taken to imply that the terminology is being redefined herein to be restricted to any specific characteristics, features, or aspects of the invention with which that terminology is associated.

[0036] In general, the terms used in the following claims should not be construed to limit the invention to the specific embodiments disclosed in the specification, unless the above Detailed Description section explicitly defines such terms. Accordingly, the actual scope of the invention encompasses not only the disclosed embodiments, but also all equivalent ways of practicing or implementing the invention under the claims.

[0037] While certain aspects of the invention are presented below in certain claim forms, the inventors contemplate the various aspects of the invention in any number of claim forms. Accordingly, the inventors reserve the right to add additional claims after filing the application to pursue such additional claim forms for other aspects of the invention.

CLAIMS

We claim:

[c1] 1. In a multi-cell orthogonal frequency division multiple access (OFDMA) wireless communication system comprising a plurality of base stations and mobile stations, a mobile station configured to communicate with a serving base station in a cell via a communication channel, the mobile station comprising:

an apparatus configured to transmit a data signal to the serving base station in the cell over a data subchannel, wherein the data subchannel comprises a plurality of adjacent or non-adjacent subcarriers within the communication channel; and

an apparatus configured to transmit a ranging signal to the serving base station in the cell over a ranging subchannel for random access, wherein:

the ranging signal is formed from a ranging sequence selected from a set of ranging sequences associated with the cell for identifying the mobile station;

the ranging signal lasts over a period of one or multiple orthogonal frequency division multiplexing (OFDM) symbols and the ranging signal exhibits a low peak-to-average power ratio in the time domain; and

the ranging subchannel comprises at least one block of subcarriers within the communication channel and power levels of subcarriers at both ends of a block are set to zero.

[c2] 2. The mobile station of claim 1, wherein the subcarrier configuration of the ranging subchannel for the cell is different from subcarrier configurations of ranging subchannels for other cells.

[c3] 3. The mobile station of claim 1, wherein the set of ranging sequences for the cell is different from sets of ranging sequences for other cells.

[c4] 4. The mobile station of claim 1, wherein subcarriers in a block are contiguous in frequency.

[c5] 5. The mobile station of claim 1, further comprising an apparatus configured to control a transmission power of the ranging signal using an open-loop power control method by:

estimating a path loss between the serving base station and the mobile station based on a received downlink signal;

setting the transmission power of the ranging signal based on the path loss; and

increasing the transmission power of the ranging signal for retransmission .

[c6] 6. The mobile station of claim 1, wherein a power level of subcarriers towards the high-end and low-end frequency boundaries of a block of subcarriers is lower than a power level of subcarriers towards the center of the block.

[c7] 7. The mobile station of claim 1, wherein boundary subcarriers of a block of subcarriers in the ranging subchannel are attenuated to reduce interference with other uplink signals when signal time misalignment occurs at the base station .

[c8] 8. The mobile station of claim 1, wherein the ranging sequence is a binary or non- binary sequence.

[c9] 9. In a multi-cell orthogonal frequency division multiple access (OFDMA) wireless communication system, a base station configured to communicate with mobile stations in a cell via a communication channel, the base station comprising:

an apparatus configured to receive a data signal from a first mobile station in the cell over a data subchannel, wherein the data subchannel

comprises a plurality of adjacent or non-adjacent subcarriers within the communication channel; and

an apparatus configured to receive a ranging signal from a second mobile station in the cell over a ranging subchannel for random access, wherein:

the ranging signal is formed from a ranging sequence selected from a set of ranging sequences associated with the cell for identifying a mobile station;

the ranging signal lasts over a period of one or multiple orthogonal frequency division multiplexing (OFDM) symbols and the ranging signal exhibits a low peak-to-average power ratio in the time domain; and

the ranging subchannel comprises at least one block of subcarriers within the communication channel and power levels of subcarriers at both ends of a block are set to zero.

[c10] 10. The base station of claim 9, wherein the subcarrier configuration of the ranging subchannel for the cell is different from subcarrier configurations of ranging subchannels for other cells.

[c11] 11. The base station of claim 9, wherein the set of ranging sequences for the cell is different from sets of ranging sequences for other cells.

[c12] 12. The base station of claim 9, further comprising an apparatus configured to detect the ranging sequence in the received ranging signal in the time domain, frequency domain, or both time and frequency domain.

[c13] 13. The base station of claim 12, wherein the apparatus applies matched filtering to the received ranging signal to detect the ranging sequence.

[c13] 13. The base station of claim 12, wherein the apparatus applies matched filtering to the received ranging signal to detect the ranging sequence.

[c14] 14. The base station of claim 12, wherein the apparatus correlates the received ranging signal with a ranging sequence stored at the base station to detect the ranging sequence.

[c15] 15. The base station of claim 9, further comprising an apparatus configured to detect a time delay of the received ranging signal and to inform the second mobile station to adjust transmission time based on the detected time delay.

[c16] 16. The base station of claim 9, further comprising an apparatus configured to detect a power level of the received ranging signal and to inform the second mobile station to adjust a transmission power based on the detected power level.

[c17] 17. In an orthogonal frequency division multiple access (OFDMA) wireless communication system, a method for signal transmission by a mobile station to a serving base station via a communication channel, the method comprising:

transmitting a data signal over a data subchannel to the serving base station, wherein the data subchannel comprises a plurality of adjacent or non-adjacent subcarriers within the communication channel; and

transmitting a ranging signal over a ranging subchannel to the serving base station for random access, wherein:

the ranging signal is formed from a ranging sequence selected from a set of ranging sequences for identifying the mobile station;

the ranging signal lasts over a period of one or multiple orthogonal frequency division multiplexing (OFDM) symbols and the

ranging signal exhibits a low peak-to-average power ratio in the time domain; and

the ranging subchannel comprises at least one block of subcarriers within the communication channel and power levels of subcarriers at both ends of a block are set to zero.

[c18] 18. The method of claim 17, wherein a power level of subcarriers towards the high-end and low-end frequency boundaries of a block of subcarriers is lower than a power level of subcarriers towards the center of the block.

[c19] 19. The method of claim 17, wherein boundary subcarriers of a block of subcarriers in the ranging subchannel are attenuated to reduce interference with other uplink signals when signal time misalignment occurs at the base station.

[c20] 20. The method of claim 17, wherein subcarriers in a block are contiguous in frequency.

[c21] 21. The method of claim 17, further comprising controlling a transmission power of the ranging signal using an open-loop power control methodby:

estimating a path loss between the serving base station and the mobile station based on a received downlink signal;

setting the transmission power of the ranging signal based on the path loss; and

increasing the transmission power of the ranging signal for retransmission.

[c22] 22. In an orthogonal frequency division multiple access (OFDMA) wireless communication system, a method for receiving signals by a base station from a plurality of mobile stations via a communication channel, the method comprising:

receiving a data signal over a data subchannel from a first mobile station, wherein the data subchannel comprises a plurality of adjacent or non-adjacent subcarriers within the communication channel; and

receiving a ranging signal over a ranging subchannel for random access by a second mobile station, wherein:

the ranging signal is formed from a ranging sequence selected from a set of ranging sequences for identifying the mobile station;

the ranging signal lasts over a period of one or multiple orthogonal frequency division multiplexing (OFDM) symbols and the ranging signal exhibits a low peak-to-average power ratio in the time domain; and

the ranging subchannel comprises at least one block of subcarriers within the communication channel and power levels of subcarriers at both ends of a block are set to zero.

[c23] 23. The method of claim 22, further comprising detecting a time delay of the received ranging signal and informing the second mobile station to adjust transmission time based on the detected time delay.

[c24] 24. The method of claim 22, further comprising detecting a power level of the received ranging signal and informing the second mobile station to adjust a transmission power based on the detected power level.

METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

ABSTRACT OF THE DISCLOSURE

Methods and apparatus in a multi-carrier cellular wireless network with random access improve receiving reliability and reduce interference of uplink signals of a random access, while improving the detection performance of a base station receiver by employing specifically configured ranging signals.

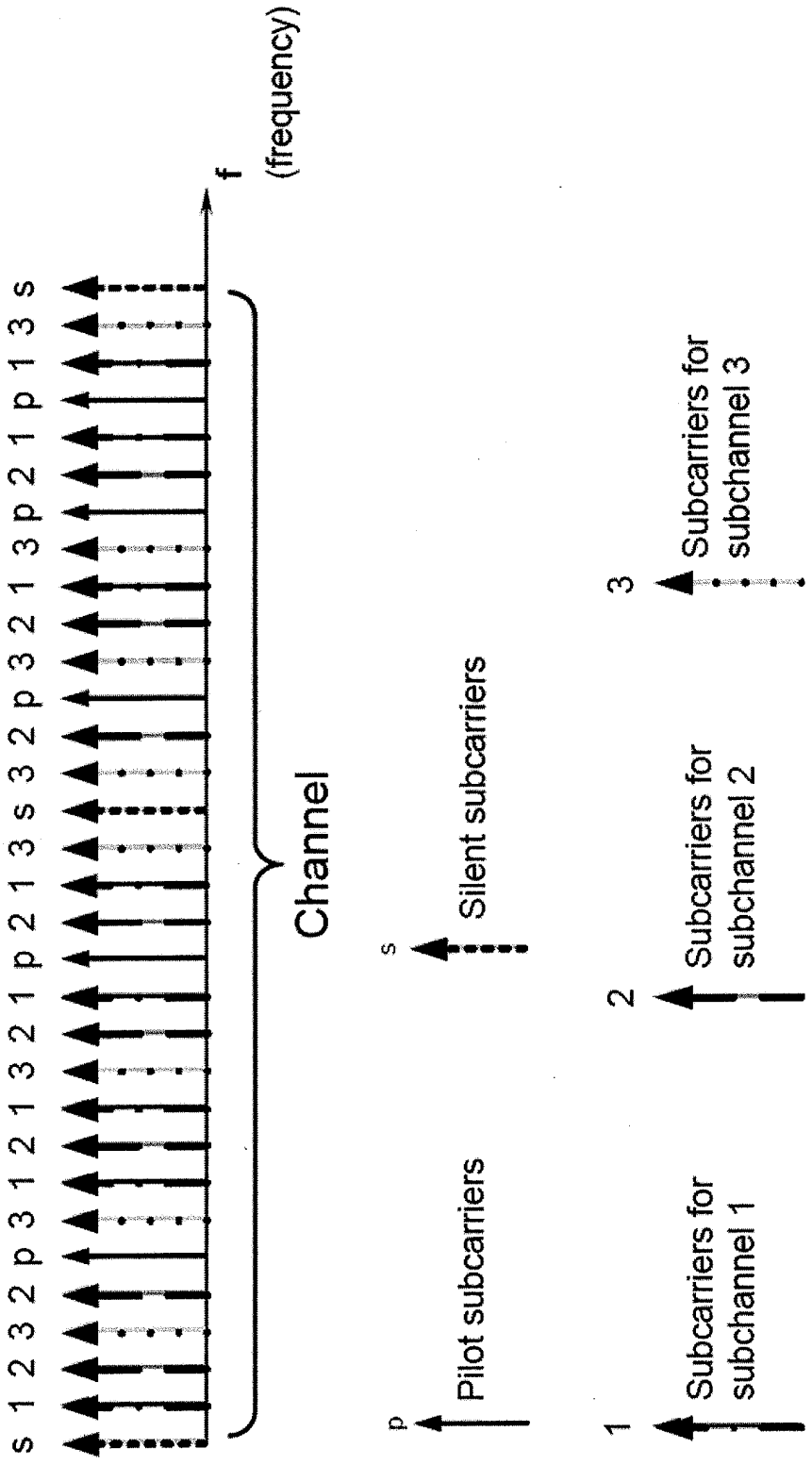

f (frequency)
s 1 2 3 2 p 3 1 2 1 3 2 1 p 2 1 3 s 3 2 p 3 2 1 3 p 2 1 p 1 3 s
Channel
p
Pilot subcarriers
s
Silent subcarriers
1
Subcarriers for subchannel 1
2
Subcarriers for subchannel 2
3
Subcarriers for subchannel 3

FIG. 1

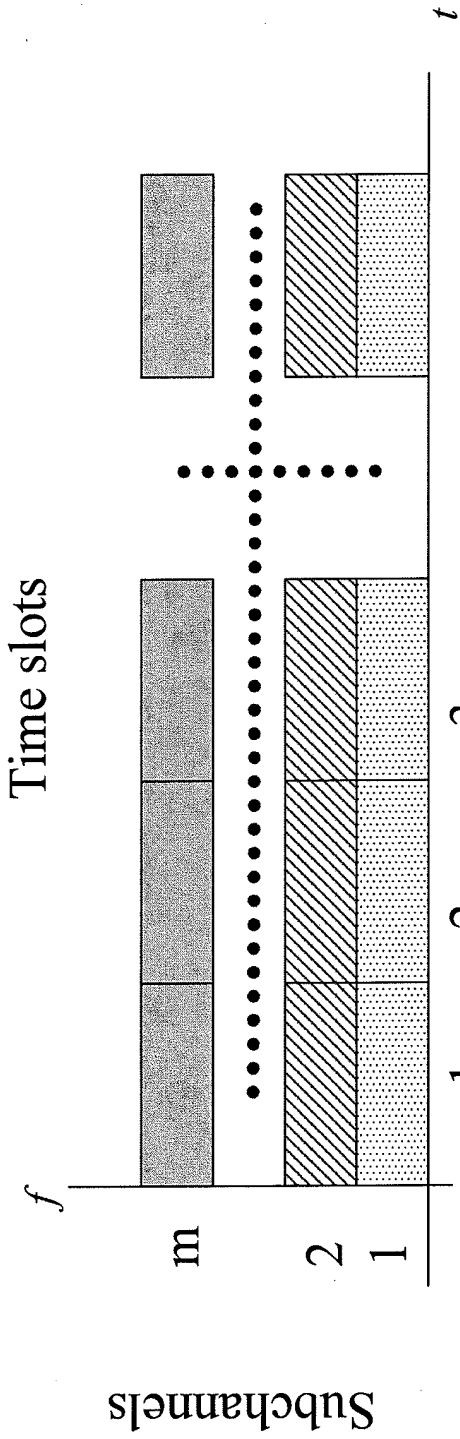


FIG. 2

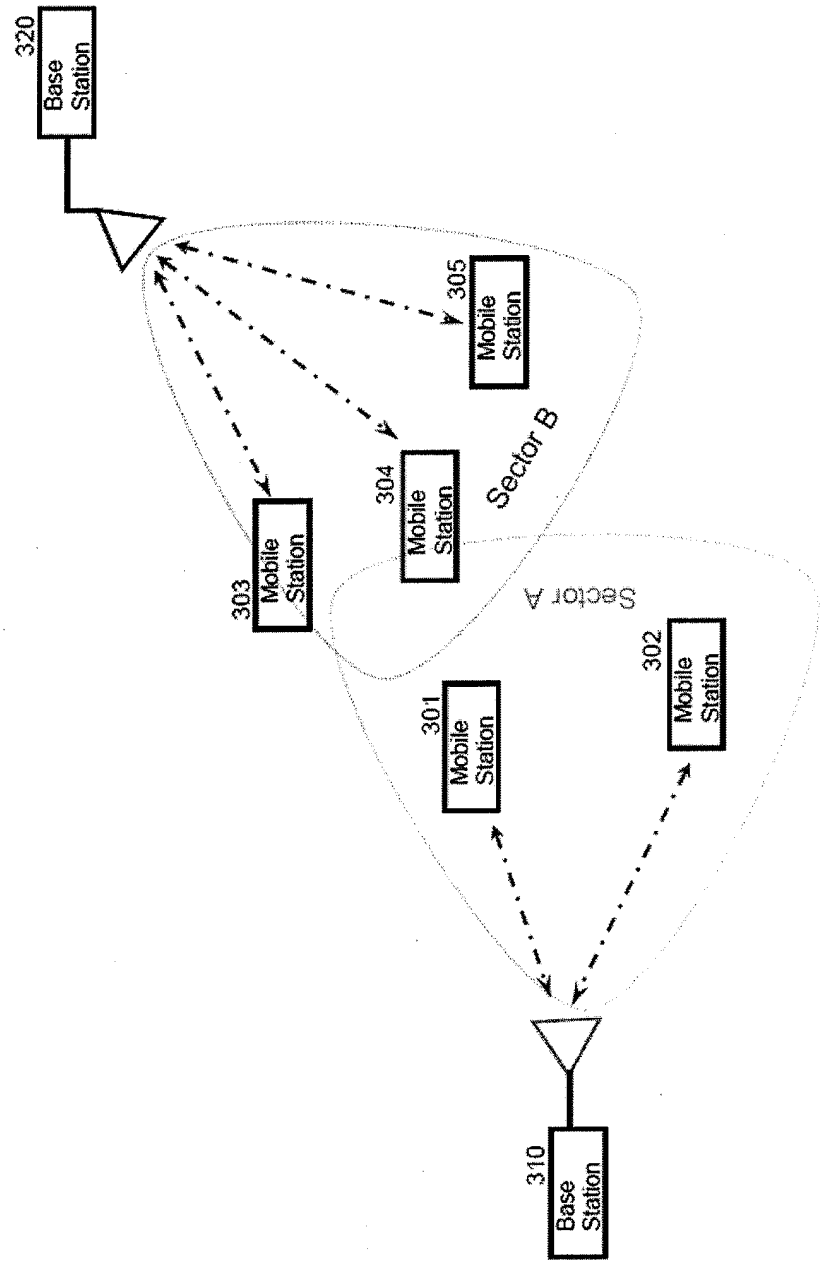

320
Base Station
305
Mobile Station
304
Mobile Station
303
Mobile Station
Sector B
Sector A
302
Mobile Station
301
Mobile Station
310
Base Station

FIG. 3

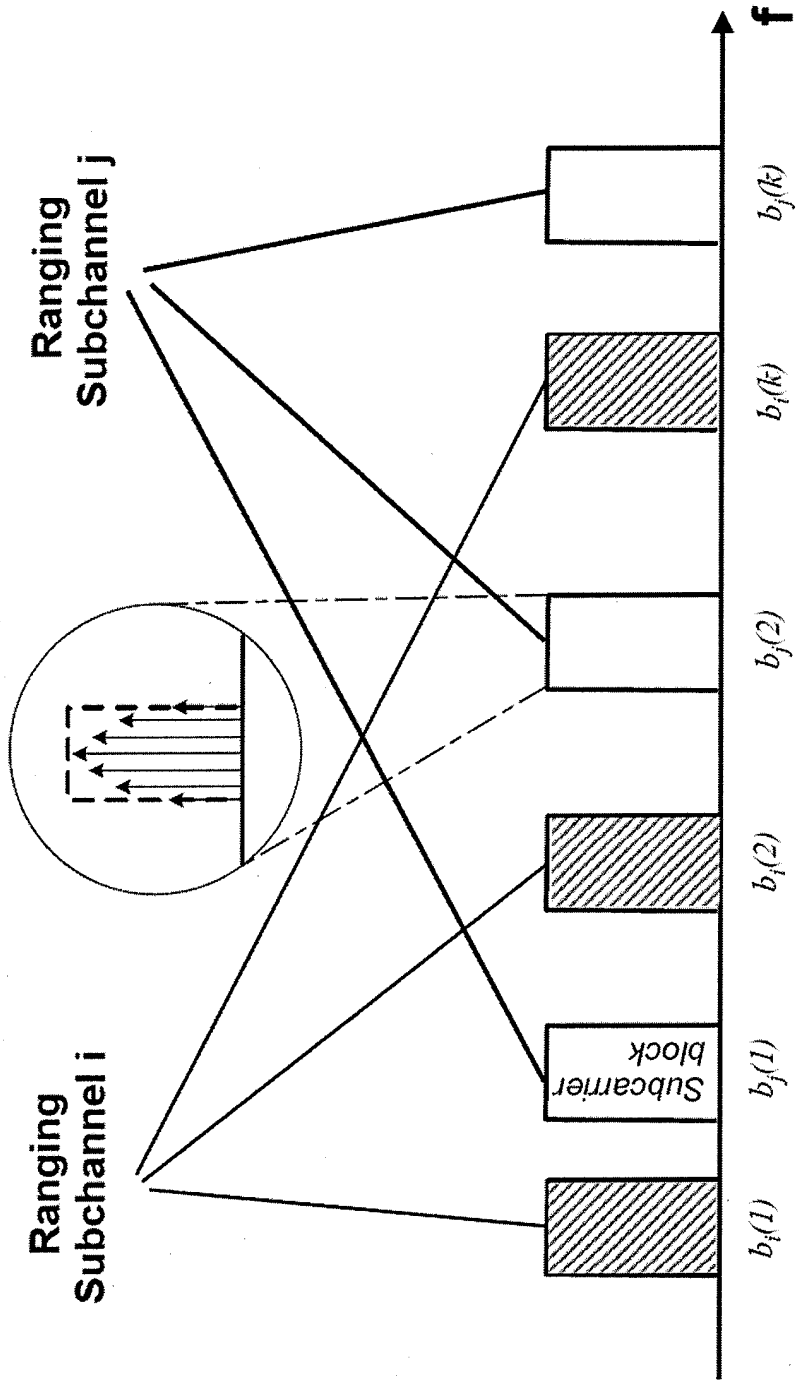

f
Ranging Subchannel j
Ranging Subchannel i
Subcarrier block
$b_j(k)$
$b_i(k)$
$b_j(2)$
$b_i(2)$
$b_j(1)$
$b_i(1)$

FIG. 4

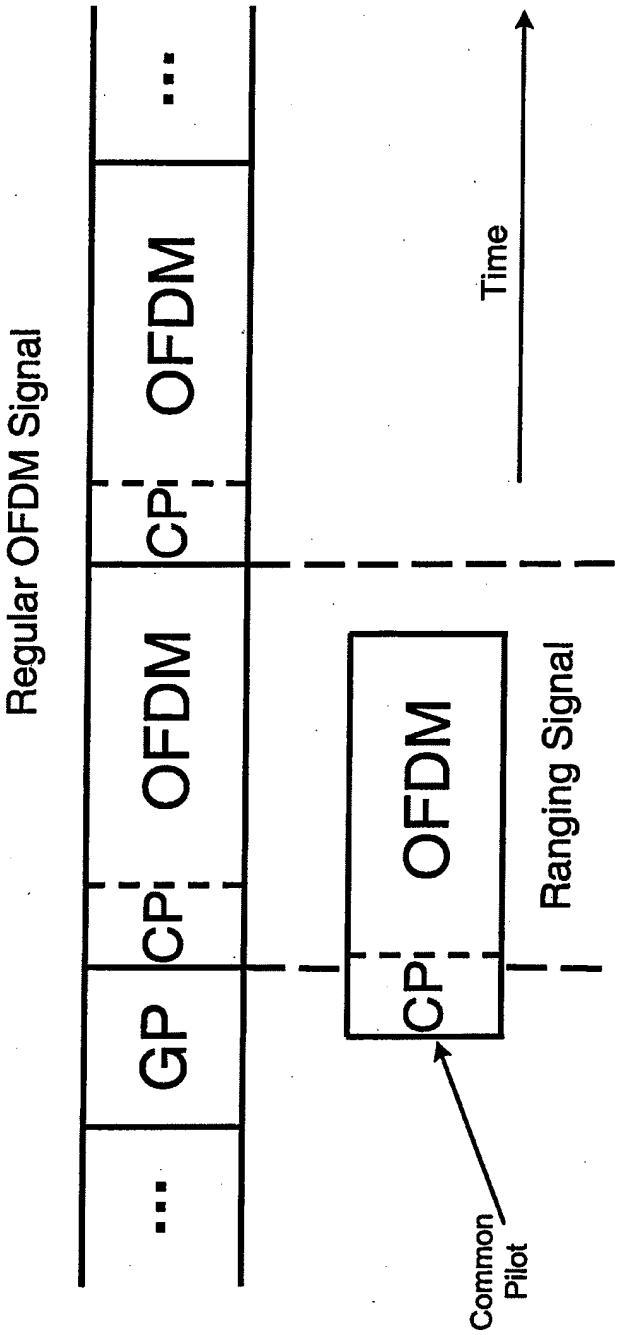

Regular OFDM Signal
...
GP
OFDM
CP
OFDM
CP
OFDM
...
Ranging Signal
Common Pilot
Time

FIG. 5

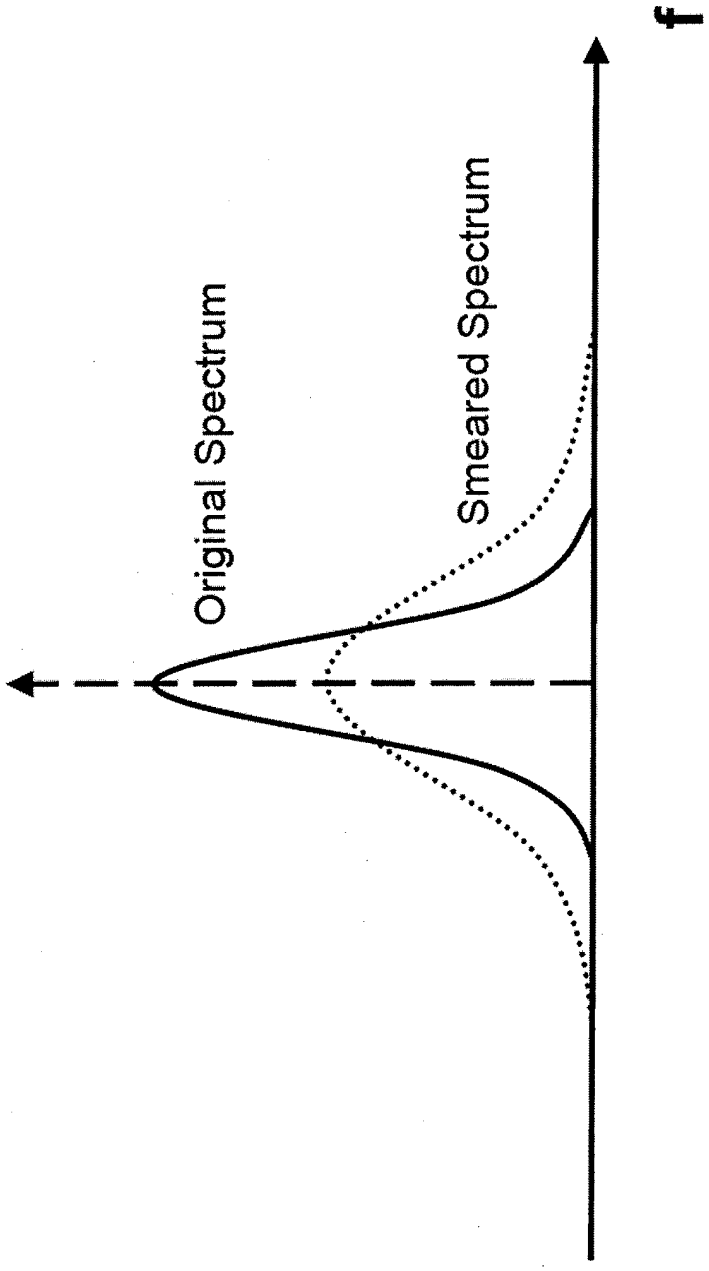


FIG. 6

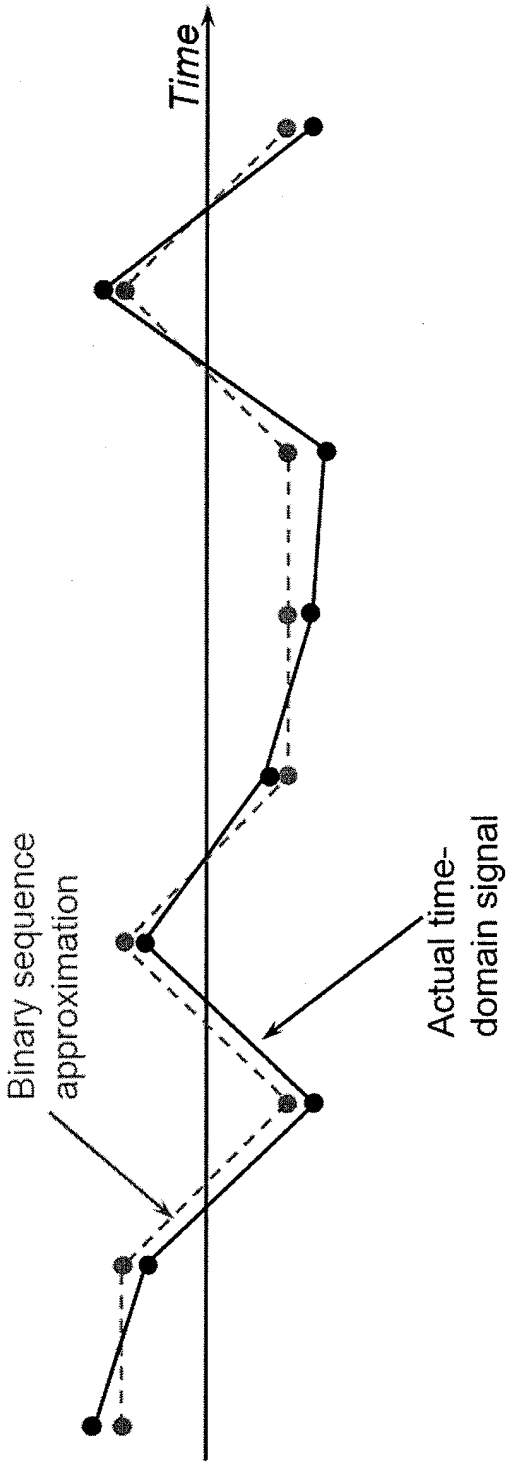

Time
Binary sequence approximation
Actual time-domain signal

FIG. 7

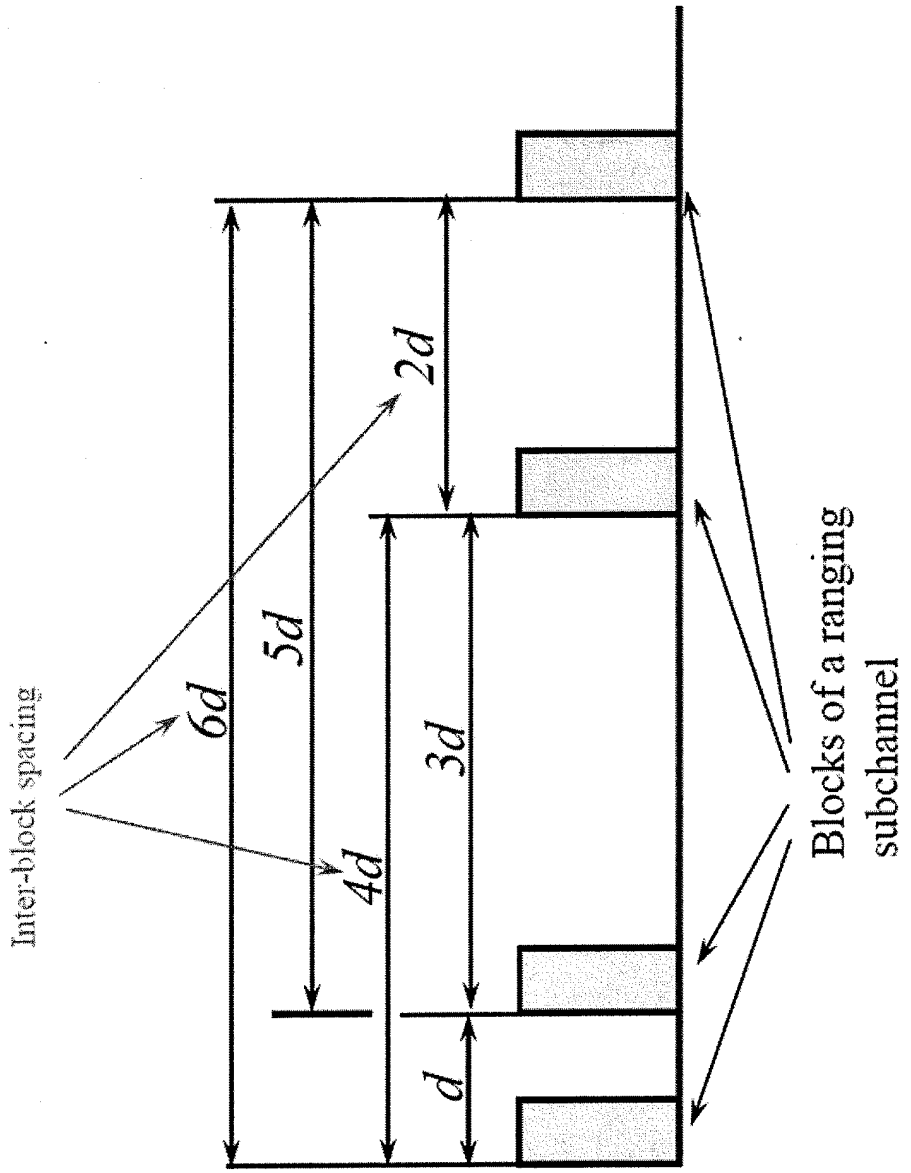

Inter-block spacing
6d
5d
4d
3d
2d
d
Blocks of a ranging subchannel

FIG. 8

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Filer:	Christopher J. Daley-Watson/Erica Tollefson
Attorney Docket Number:	61240-8008.US02

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Claims in excess of 20	1202	4	52	208
Independent claims in excess of 3	1201	1	220	220
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1518**

Electronic Acknowledgement Receipt

EFS ID:	10692046
Application Number:	13205579
International Application Number:	
Confirmation Number:	2138
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Customer Number:	25096
Filer:	Christopher J. Daley-Watson/Erica Tollefson
Filer Authorized By:	Christopher J. Daley-Watson
Attorney Docket Number:	61240-8008.US02
Receipt Date:	08-AUG-2011
Filing Date:	
Time Stamp:	21:34:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Electronic Funds Transfer
Payment was successfully received in RAM	$1518
RAM confirmation Number	6590
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		App_8008US02.PDF	1869929 c013dd60fa392c2fe041c3dd0c6f2d33b33191ff	yes	47

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Transmittal of New Application	1	1
Fee Worksheet (SB06)	2	2
Application Data Sheet	3	6
Authorization for Extension of Time all replies	7	7
Oath or Declaration filed	8	10
Power of Attorney	11	22
Specification	23	32
Claims	33	38
Abstract	39	39
Drawings-only black and white line drawings	40	47

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	37835 153b726e9115fc29f13fdc8251e7af9f61ad1aee	no	2

Warnings:

Information:

Total Files Size (in bytes):	1907764

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.

Docket No.: 612408008US2
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Li et al.

Application No.: 13/205,579 | Confirmation No.: 2138

Filed: August 8, 2011 | Art Unit: Not Yet Assigned

For: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS | Examiner: Not Yet Assigned

FIRST PRELIMINARY AMENDMENT UNDER 37 C.F.R. 1.115

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

Sir:

INTRODUCTORY COMMENTS

Prior to examination on the merits, please amend the above-identified U.S. patent application as follows:

Amendments to the Drawings begin on page 2 of this paper and include an attached replacement sheet.

Remarks/Arguments begin on page 3 of this paper.

AMENDMENTS TO THE DRAWINGS

Please amend Figure 5 to remove the phrase "common pilot," as depicted in the attached clean replacement of Figure 5.

Attachment: Replacement sheet

REMARKS

In this amendment, applicants have removed the phrase "common pilot" from Figure 5. Such a change is made to conform Figure 5 with the Figure 5 that was contained in the provisional application, which was incorporated by reference into the present application by virtue of paragraph [0034]. No new matter has been added.

Applicant believes no fee is due with this amendment. However, if a fee is due, please charge our Deposit Account No. 50-0665, under Order No. 612408008US2 from which the undersigned is authorized to draw.

Dated: 12 Aug 2011

Respectfully submitted,

By _____

Stephen Bishop
Registration No.: 38,829
PERKINS COIE LLP
P.O. Box 1247
Seattle, Washington 98111-1247
(206) 359-8000
(206) 359-7198 (Fax)
Attorney for Applicant

Attachment

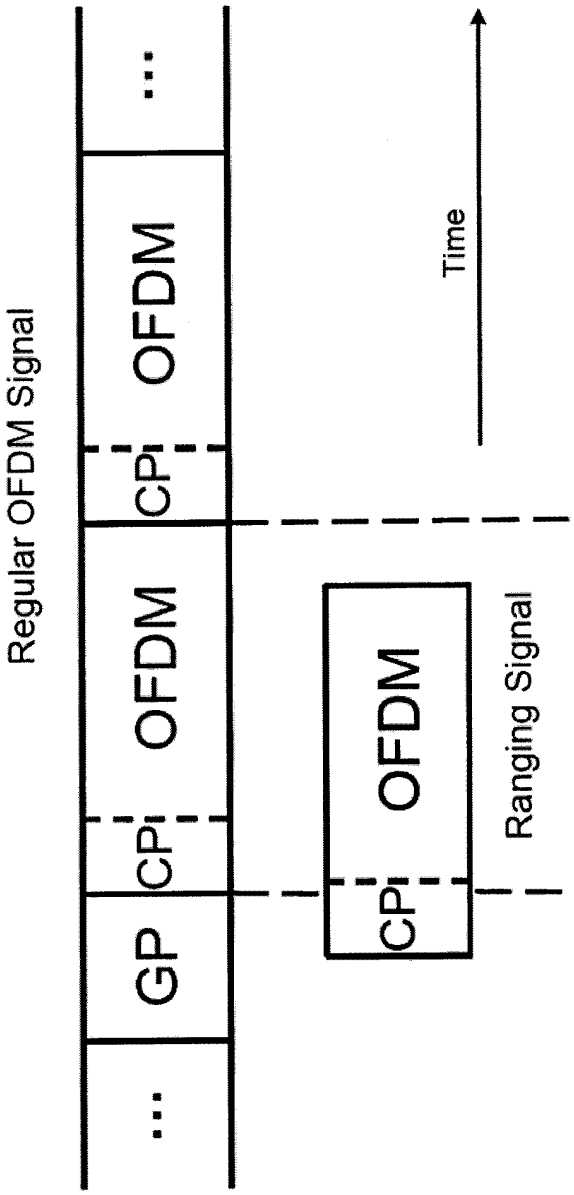

Regular OFDM Signal
...
GP
CP
OFDM
CP
OFDM
CP
OFDM
...
Time
Ranging Signal

FIG. 5

Electronic Acknowledgement Receipt

EFS ID:	10727182
Application Number:	13205579
International Application Number:	
Confirmation Number:	2138
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Customer Number:	25096
Filer:	Christopher J. Daley-Watson/Erica Tollefson
Filer Authorized By:	Christopher J. Daley-Watson
Attorney Docket Number:	61240-8008.US02
Receipt Date:	12-AUG-2011
Filing Date:	
Time Stamp:	15:18:14
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		Prelim_Am_8008US2.PDF	83132 4c62eb03ea74df24f0f97ee12a57a1e7c0f64072	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	2
	Applicant Arguments/Remarks Made in an Amendment	3	3
	Drawings-only black and white line drawings	4	4
Warnings:			
Information:			
	Total Files Size (in bytes):	83132	

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
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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.

PTO/SB/17 (10-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no person are required to respond to a collection of information unless it displays a valid OMB control number

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2009

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($) 1,518.00

Complete if Known	
Application Number	Not Yet Assigned
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Attorney Docket No.	612408008US2

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☒ Other (please identify): EFT Account SEA!PIRM

☒ Deposit Account Deposit Account Number: 50-0665 Deposit Account Name: Perkins Coie LLP

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 underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☒ Credit any overpayments

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	Fee ($)	Small Entity Fee ($)	Fee ($)	Small Entity Fee ($)	Fee ($)	Small Entity Fee ($)	Fees Paid ($)
Utility	330	165	540	270	220	110	1,090.00
Design	220	110	100	50	140	70	
Plant	220	110	330	165	170	85	
Reissue	330	165	540	270	650	325	
Provisional	220	110	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	52	26
Each independent claim over 3 (including Reissues)	220	110
Multiple dependent claims	390	195

Total Claims	- 20 or HP	Extra Claims	Fee ($)		Fee Paid ($)
24		4	x 52.00	=	208.00

HP = highest number of total claims paid for, if greater than 20.

Multiple Dependent Claims	
Fee ($)	Fee Paid ($)

Indep. Claims	- 3 or HP =	Extra Claims	Fee ($)		Fee Paid ($)
4		1	x 220.00	=	220.00

HP = highest number of independent claims paid for, if greater than 3.

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 $270 ($135 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).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)		Fee Paid ($)
25	- 100 =		/50 =		(round up to a whole number) x		=	

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge):	

SUBMITTED BY

Signature		Registration No. (Attorney/Agent) 38,829	Telephone (206) 359-8000
Name (Print/Type)	Stephen Bishop		Date August 8, 2011

08/17/2011 CCETIN 00000005 500665 13205579

01 FC:1202 52.00 DA

61240-8008.US02/LEGAL21495009.1

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/205,579

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	330
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	220
TOTAL CLAIMS (37 CFR 1.16(i))	25 minus 20=	* 5			OR	x 52 =	260
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1				x 220 =	220
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 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	1570

APPLICATION AS AMENDED - PART II

		(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($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	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	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	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.

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
13/205,579	08/08/2011		1570	612408008US2	25	4

CONFIRMATION NO. 2138

25096
PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

FILING RECEIPT

OC000000049377321

Date Mailed: 08/22/2011

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**

Applicant(s)

Xiaodong Li, Kirkland, WA;
Titus Lo, Bellevue, WA;
Kemin Li, Bellevue, WA;
Haiming Huang, Bellevue, WA;

Power of Attorney: The patent practitioners associated with Customer Number 25096

Domestic Priority data as claimed by applicant

This application is a CON of 10/583,158 08/27/2008 PAT 7,995,967
which is a 371 of PCT/US2005/008169 03/09/2005
which claims benefit of 60/551,589 03/09/2004

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 08/17/2011

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/205,579**

Projected Publication Date: 12/01/2011

Non-Publication Request: No

Early Publication Request: No

Title

METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

Preliminary Class

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 (1-866-999-4158).

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

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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	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/205,579	08/08/2011	Xiaodong Li	612408008US2

CONFIRMATION NO. 2138

POA ACCEPTANCE LETTER

25096
PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

OC000000049377402

Date Mailed: 08/22/2011

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/08/2011.

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.

/yli/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	2618
Examiner Name	A. A. Akinyemi
Attorney Docket Number	612408008US2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-20100111017-A1	05-06-2010	Um et al.	
		US-4,977,593	12-11-1990	Ballance et al.	
		US-5,991,308	11-23-1999	Fuhrmann et al.	
		US-6,519,449	02-11-2003	Zhang et al.	
		US-7,995,967-A1	08-09-2011	Li et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	2618
Examiner Name	A. A. Akinyemi
Attorney Docket Number	612408008US2

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	**	International Search Report and Written Opinion; International Patent Application No. PCT/US05/08169; Filed Mar. 9, 2005; Applicant: Waltical Solutions, Inc.; Mailed Jun. 9, 2005; 9 pages.	

Examiner Signature		Date Considered	

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Electronic Acknowledgement Receipt

EFS ID:	11392734
Application Number:	13205579
International Application Number:	
Confirmation Number:	2138
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Customer Number:	25096
Filer:	Christopher J. Daley-Watson/Erica Tollefson
Filer Authorized By:	Christopher J. Daley-Watson
Attorney Docket Number:	61240-8008.US02
Receipt Date:	11-NOV-2011
Filing Date:	08-AUG-2011
Time Stamp:	19:33:02
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		IDS_8008US2.PDF	181322 8e372d08be448bb256256b0ecc2d7d07a6d5fa52	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	2
	Information Disclosure Statement (IDS) Form (SB08)	3	4
Warnings:			
Information:			
	Total Files Size (in bytes):	181322	

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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.: 612408008US2
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Li et al.

Application No.: 13/205,579 | Confirmation No.: 2138

Filed: August 8, 2011 | Art Unit: 2618

For: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS | Examiner: A. A. Akinyemi

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

In accordance with 37 CFR 1.98(a)(2)(ii), Applicant has not submitted copies of U.S. patents and U.S. patent applications.

Those documents which are marked with a double asterisk (**) next to the Cite No. in the attached form PTO/SB/08 are not supplied because they were previously cited by or submitted to the Office in prior application number 10/583,158 filed August 27, 2008 and relied upon in this application for an earlier filing date under 35 U.S.C. 120.

This Information Disclosure Statement is not to be construed as a representation that: (i) a search has been made; (ii) additional information that may be material to the examination of this application does not exist; (iii) the information, protocols, results and the like reported by third parties are accurate or enabling; or (iv) the cited information is, or is considered to be, material to patentability. In addition, applicant does not admit that any enclosed item of information constitutes prior art to the subject invention and specifically reserves the right to demonstrate that any such reference is not prior art.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 50-0665, under Order No. 612408008US2.

Dated: 11 Nov 2011

Respectfully submitted,

By _____

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Attorney for Applicant

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UNITED STATES DEPARTMENT OF COMMERCE
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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/205,579	08/08/2011	Xiaodong Li	61240-8008.US02

CONFIRMATION NO. 2138

25096
PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

PUBLICATION NOTICE

OC000000051239345

Title:METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

Publication No.US-2011-0292881-A1
Publication Date:12/01/2011

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 Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, 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 http://pair.uspto.gov/. 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/26 (08-11)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) 612408008US2

In re Application of: Li et al.

Application No.: 13/205,579-Conf. #2138

Filed: August 8, 2011

For: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

The owner*, Neocific, Inc., of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of **prior patent** No. 7,995,967

as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

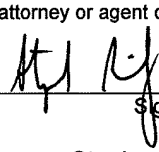
expires for failure to pay a maintenance fee;
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has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☒ The undersigned is an attorney or agent of record. Reg. No. 38,829



Signature — January 10, 2012 (Date)

Stephen Bishop
Typed or printed name

(206) 359-8000
Telephone Number

☒ Terminal disclaimer fee under 37 CFR 1.20(d) is included.

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Electronic Patent Application Fee Transmittal

Application Number:	13205579
Filing Date:	08-Aug-2011
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Filer:	Christopher J. Daley-Watson/Erica Tollefson
Attorney Docket Number:	61240-8008.US02

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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($)
Miscellaneous:				
Statutory or terminal disclaimer	1814	1	160	160
		Total in USD ($)		**160**

Electronic Acknowledgement Receipt

EFS ID:	11800842
Application Number:	13205579
International Application Number:	
Confirmation Number:	2138
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Customer Number:	25096
Filer:	Christopher J. Daley-Watson/Erica Tollefson
Filer Authorized By:	Christopher J. Daley-Watson
Attorney Docket Number:	61240-8008.US02
Receipt Date:	10-JAN-2012
Filing Date:	08-AUG-2011
Time Stamp:	14:43:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$160
RAM confirmation Number	1102
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Terminal Disclaimer Filed	TD_8008US2.PDF	64369 304cd3b3f5c62d3ce73792e2594ed3870bb5c346	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30484 04fc64d3a02d20d94f948bf4eb71583ae0fd8922	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	94853		

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New Applications Under 35 U.S.C. 111
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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
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Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	13/205,579	LI ET AL.	

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : 1/10/12	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:
jean proctor

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	2473
Examiner Name	K. B. Yao
Attorney Docket Number	612408008US2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
		KR-20050015119-A	02-21-2005	Samsung Electronics Co Ltd		
		KR-20060055636-A	05-24-2006	Korea Electronics Telecomm et al.		
		KR-100585233-B1	05-24-2006	Korea Electronics Telecomm		

Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	2473
Examiner Name	K. B. Yao
Attorney Docket Number	612408008US2

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]

Examiner Signature		Date Considered	

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Bibliographic data: KR100585233 (B1) — 2006-05-24

A METHOD FOR DETECTING MC-CDMA(MULTI CARRIER CODE DIVISION MULTIPLE ACCESS) RANGING SIGNAL, AND AN APPARATUS THEREFOR

Inventor(s):	KIM IL GYU [KR]; SHIN EUN JEONG [KR]; KIM YOUNG HOON [KR] ±
Applicant(s):	KOREA ELECTRONICS TELECOMM [KR] ±
Classification:	**- international:** ***H04L27/26***
	- European:
Application number:	KR20040099144 20041130
Priority number (s):	KR20040099144 20041130

Abstract not available for KR100585233 (B1)

Last updated: 26.04.2011 Worldwide Database 5.7.36; 93p

Title of Invention

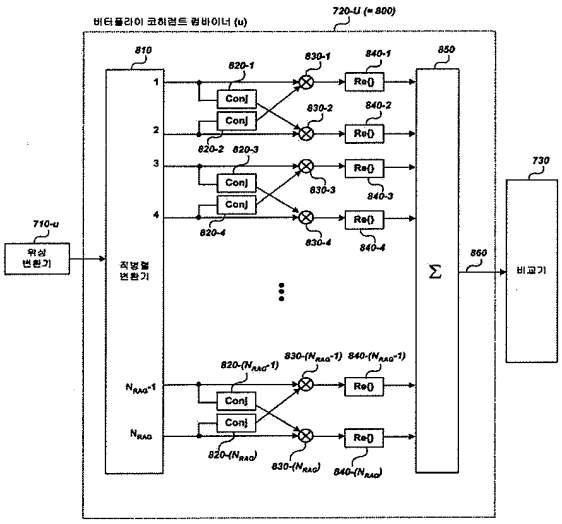
다중반송파 부호 분할 다중접속(MC-CDMA) 방식의레인징 신호 검출 방법 및 장치 (A method for detecting MC-CDMA(Multi Carrier CodeDivision Multiple Access) ranging signal, and anapparatus therefor)

-

Int. Cl	*H04L 27/26* (2006.01)
Application No.(Date)	10-2004-0099144 (20041130)
Unex. Pub. No.(Date)	
Publication No.(Date)	(20060601)
Registration No.(Date)	1005852330000 (20060524)
Kind/Right of Org. Application	/
Right of Org. Application No.(Date)	
Family No.	
Final administrative status	Decision to grant (General)
Trial Info	
Registration Status	Registered
Int'l Application No.(Date)	
Int'l Unex. Pub. No.(Date)	
Request for an examination(Date)	Y(2004.11.30)
Number of claims	15

-

Drawing



Abstract

본 발명은 OFDM 기반의 무선통신 시스템에 있어서, 이동국이 송신한 OFDM 기반의 MC-CDMA 레인징 신호를 기지국이 검출하는 방법 및 장치에 관한 것이다.

본 발명에 따른 기지국의 레인징 신호 검출 장치는, OFDM 기반의 무선통신 시스템에서 이동국이 송신한 MC-CDMA 레인징 신호를 기지국이 검출하는 장치에 있어서, 기지국 기준 시간 심볼 경계에서 시작해서 소정 샘플(W)의 탐색 구간만큼의 주기적 전치 부호 부분을 제거하는 CP 제거기; 상기 제거된 소정 샘플(W) 이후에 상기 NFFT개의 시간영역 샘플링 신호를 주파수 영역의 신호로 변환하는 퓨리에 변환기 블록; 및 상기 NFFT개의 시간영역 신호의 샘플을 퓨리에 변환하여 얻은 NFFT개의 주파수 영역의 신호 중에서 현재 심볼 구간의 레인징 부반송파에 해당하는 NRAG개 의 주파수 영역 신호를 선택하는 레인징 복조 블록을 포함한다. 본 발명에 따르면, 기지국의 레인징 신호 검출기가 파일롯 또는 프리앰블이 없이도 이동국으로부터 수신된 레인징 신호를 코히런트하게 복조함으로써, 종래의 방식에 비해 시스템 용량을 증대시킬 수 있고, 또한, 고속 이동 환경에서도 레인징 신호 검출 성능을 향상시킬 수 있다.

OFDM, 레인징, 코히런트 복조, MC-CDMA, 코히런트 컴바이너

Abstract (Machine Translation):

The present invention in OFDM-based wireless communication systems, OFDM-based mobile station transmits a ranging signal of the MC-CDMA base station is about a method and apparatus for detection. According to the invention of the base station a ranging signal detection device, OFDM-based wireless communication systems ranging from the MC-CDMA mobile station transmits a signal to a device that detects the base station, base stations, starting from a predetermined reference time symbol boundary samples (W) in the navigation section periodically displaced as many CP remover to remove part of the sign; above a predetermined sample removed (W) after the above two time-domain sampling NFFT signal in the frequency domain signal converter that converts the Fourier block; and the NFFT two time-domain signal obtained by Fourier transform of the sample NFFT of two frequency-domain signal of the current symbol interval ranging subcarrier signal corresponding NRAG to choose from ranging in frequency domain demodulation includes a block. According to the present invention, the base station a ranging signal detector without a pilot or preamble kohireonteuhage demodulated ranging signal received from the mobile station, by the way compared to conventional systems to increase capacity, and also, even in fast-moving environment ranging signal detection performance can be improved.

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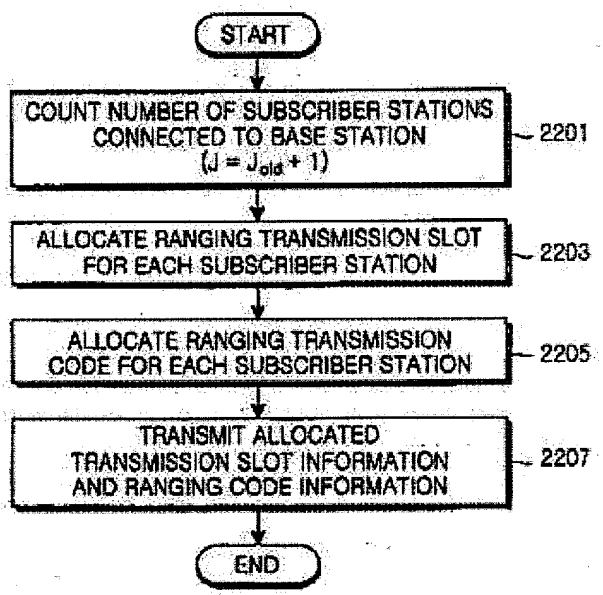
Bibliographic data: KR20050015119 (A) — 2005-02-21

APPARATUS AND METHOD OF MODULATING RANGING SIGNALS IN BROADBAND WIRELESS ACCESS COMMUNICATION SYSTEM FOR PREVENTING GENERATION OF SIGNAL INTERFERENCE WITHIN SAME CELL OR BETWEEN ADJACENT CELLS

Inventor(s):	CHO JAE HEE; EOM KWANG SEOP; HUH HOON; HWANG IN SEOK; ROH KWAN HEE; SONG BONG GEE; SUNG SANG HOON; YOON SOON YOUNG ±
Applicant(s):	SAMSUNG ELECTRONICS CO LTD ±
Classification:	- international: ***H04J3/06; H04L27/26; H04J11/00; H04J13/00;*** (IPC1-7): H04L27/26 - European: H04J3/06C4
Application number:	KR20030053799 20030804
Priority number (s):	KR20030053799 20030804
Also published as:	US2005030931 (A1)

Abstract of KR20050015119 (A)

PURPOSE: An apparatus and a method of modulating ranging signals in a broadband wireless access communication system are provided to reduce an initial wireless access time and a hand-over delay time by detecting the ranging signals correctly and rapidly. CONSTITUTION: A subscriber terminal is synchronized with a base station through ranging in order to receive base station information from the base station (2301). The subscriber terminal generates a first code assigned to the corresponding base station by using the base station information(2303). The base station generates a second code for distinguishing subscriber terminals from each other within corresponding cells of the base station (2305). A new ranging code is generated by combining the first code with the second code(2307). The ranging code is mapped onto an assigned sub-carrier and is transmitted to the base station(2309,2311).



Last updated: 28.02.2012 Worldwide Database 5.7.36; 93p

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(54) 광대역 무선 접속 통신 시스템에서 레인징 신호 변조 장치및 방법

요약

본 발명은 광대역 무선 접속 통신 시스템에 관한 것으로서, 직교 주파수 분할 다중 방식(OFDM)/직교 주파수 분할 다중 접속 방식(OFDMA)을 사용하고, 기지국과 가입자 단말기간의 시간 동기 또는 기지국 동기를 맞추기 위하여 상기 기지국으로부터 상기 가입자 단말기로 레인징 정보를 전송하는 광대역 무선 접속 통신 시스템에서, 상기 가입자 단말기가 상기 기지국으로 상기 레인징 또는 대역 요구를 위한 레인징 코드를 전송하는 방법에 있어서, 상기 기지국과 동기를 획득하고, 상기 동기를 획득한 기지국으로부터 기지국 정보를 수신하는 과정과, 상기 수신된 기지국 정보로부터 기지국 고유의 제1 코드를 생성하고, 상기 기지국의 해당 셀 내에서 상기 가입자 단말기를 구별하기 위한 제2 코드를 생성하는 과정과, 상기 생성된 제1 코드 및 제2 코드를 조합하여 새로운 레인징 코드를 생성하는 과정과, 상기 생성된 레인징 코드를 상기 레인징 코드를 전송하기 위해 할당된 서브 캐리어에 매핑하여 전송하는 과정을 포함함을 특징으로 한다.

대표도

도 18

색인어

광대역 무선 통신, 전송 시점, 레인징 코드, 초기 레인징, 주기적 레인징, 대역 요구

명세서

도면의 간단한 설명

도 1은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템을 개략적으로 도시한 도면.

도 2는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 프레임 구조를 시간-주파수 영역 상에서 도시한 도면.

도 3은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 하향 링크 프레임 구조를 개략적으로 도시한 도면.

도 4는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 상향 링크 프레임 구조를 개략적으로 도시한 도면.

도 5는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 레인징 코드 생성 장치를 나타낸 도면.

도 6은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 통신 절차를 개략적으로 도시한 도면.

도 7은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 통신 절차를 개략적으로 도시한 도면.

도 8은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 초기 레인징 절차를 나타낸 흐름도.

도 9는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 주기적인 레인징 절차를 나타낸 흐름도.

도 10은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 대역 요청 절차를 나타낸 흐름도.

도 11은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 역방향 접속시 충돌 상황을 나타낸 도면.

도 12는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템에서 다중 셀에서의 레인징 신호 전송을 나타낸 도면.

도 13은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템에서 레인징 신호를 검출하는 기지국 장치를 나타낸 블록도.

도 14는 본 발명에 따른 다중 셀에서 레인징을 위한 PN 코드를 할당하는 방법을 나타낸 도면.

도 15는 본 발명에 따른 동일 셀 내의 각 단말기에 레인징을 위한 왈쉬 코드를 할당하는 방법을 나타낸 도면.

도 16은 본 발명에 따른 각 단말기별로 고유의 새로운 레인징 코드를 할당하는 방법을 나타낸 도면.

도 17은 본 발명의 실시예에 따른 레인징 신호를 변조하는 단말기 송신 장치를 나타낸 도면.

도 18은 본 발명의 실시예에 따른 레인징 신호를 검출하는 기지국 수신 장치를 나타낸 도면.

도 19는 본 발명의 실시예에 따른 PN 코드 상관기를 나타낸 도면.

도 20은 본 발명의 실시예에 따른 왈시 코드 상관기를 나타낸 도면.

도 21은 본 발명의 실시예에 따른 레인징 코드 및 전송시간을 스케줄링하는 프레임 구조를 나타낸 도면.

도 22는 본 발명의 실시예에 따른 기지국의 레인징 전송 시간 및 레인징 코드 할당 절차를 나타낸 흐름도.

도 23은 본 발명의 실시예에 따른 단말기의 레인징 정보 수신 및 레인징 신호 전송 절차를 나타낸 흐름도.

발명의 상세한 설명

발명의 목적

발명이 속하는 기술 및 그 분야의 종래기술

본 발명은 광대역 무선 접속 통신 시스템에 관한 것으로서, 특히 직교 주파수 분할 다중 방식을 사용하는 광대역 무선 접속 통신 시스템의 레인징 신호 변조 장치 및 방법에 관한 것이다.

차세대 통신 시스템인 4세대(4th Generation; 이하 '4G'라 칭하기로 한다) 통신 시스템에서는 약 100Mbps의 전송 속도를 가지는 다양한 서비스 품질(Quality of Service; 이하 'QoS' 칭하기로 한다)을 가지는 서비스들을 사용자들에게 제공하기 위한 활발한 연구가 진행되고 있다. 현재 3세대(3rd Generation; 이하 '3G'라 칭하기로 한다) 통신 시스템은 일반적으로 비교적 열악한 채널 환경을 가지는 실외 채널 환경에서는 약 384Kbps의 전송 속도를 지원하며, 비교적 양호한 채널 환경을 가지는 실내 채널 환경에서도 최대 2Mbps 정도의 전송 속도를 지원한다.

한편, 무선 근거리 통신 네트워크(Local Area Network; 이하 'LAN'이라 칭하기로 한다) 시스템 및 무선 도시 지역 네트워크(Metropolitan Area Network; 이하 'MAN'이라 칭하기로 한다) 시스템은 일반적으로 20Mbps ~ 50Mbps의 전송 속도를 지원한다. 따라서, 현재 4G 통신 시스템에서는 비교적 높은 전송 속도를 보장하는 무선 LAN 시스템 및 무선 MAN 시스템에 이동성(mobility)과 QoS를 보장하는 형태로 새로운 통신 시스템을 개발하여 상기 4G 통신 시스템에서 제공하고자 하는 고속 서비스를 지원하도록 하는 연구가 활발하게 진행되고 있다.

IEEE(Institute of Electrical and Electronics Engineers) 802.16a에서 고려하고 있는 통신 시스템은 가입자 단말기와 기지국(BS; Base Station) 사이에 레인징(ranging) 동작을 수행하여 통신을 수행하는 시스템이다. 그러면 여기서 도 1을 참조하여 종래 기술에 따른 상기 IEEE 802.16a에서 고려하고 있는 통신 시스템 구조를 설명하기로 한다.

상기 도 1은 직교 주파수 분할 다중 방식(OFDM)/직교 주파수 분할 다중 접속 방식(OFDMA)을 사용하는 광대역 무선 접속 통신 시스템의 구조를 개략적으로 도시한 도면으로서, 특히 IEEE 802.16a/IEEE 802.16e 통신 시스템의 구조를 개략적으로 도시한 도면이다.

상기 도 1을 설명하기에 앞서, 상기 무선 MAN 시스템은 광대역 무선 접속(BWA; Broadband Wireless Access) 통신 시스템으로서, 상기 무선 LAN 시스템에 비해서 그 서비스 영역이 넓고 보다 고속의 전송 속도를 지원한다. 상기 무선 MAN 시스템의 물리 채널(physical channel)에 광대역(broadband) 전송 네트워크를 지원하기 위해 직교 주파수 분할 다중(Orthogonal Frequency Division Multiplexing; 이하 'OFDM'이라 칭하기로 한다) 방식 및 직교 주파수 분할 다중 접속(Orthogonal Frequency Division Multiplexing Access; 이하 'OFDMA'라 칭하기로 한다) 방식을 적용한 시스템이 상기 IEEE 802.16a 통신 시스템이다. 즉, IEEE 802.16a 통신 시스템은 상기 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템이다.

상기 IEEE 802.16a 통신 시스템은 상기 무선 MAN 시스템에 OFDM/OFDMA 방식을 적용하기 때문에 다수의 서브 캐리어(sub-carrier)들을 사용하여 물리 채널 신호를 송신함으로써 고속 데이터 송신이 가능하다. 또한 IEEE 802.16e 통신 시스템은 상기 IEEE 802.16a 통신 시스템에 가입자 단말기의 이동성을 고려하는 시스템으로서, 현재 상기 IEEE 802.16e 통신 시스템에 대해서는 구체적으로 규정된 바가 없다. 결과적으로 IEEE 802.16a 통신 시스템 및 IEEE 802.16e 통신 시스템 모두는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템이며, 설명의 편의상 상기 IEEE 802.16a 통신 시스템 및 IEEE 802.16e 통신 시스템을 일 예로 하여 설명하기로 한다.

상기 도 1을 참조하면, 상기 IEEE 802.16a/IEEE 802.16e 통신 시스템은 단일 셀(single cell) 구조를 가지며, 기지국(100)과 상기 기지국(100)이 관리하는 다수의 가입자 단말기들(110, 120 및 130)로 구성된다. 상기 기지국(100)과 상기 가입자 단말기들(110, 120 및 130)간의 신호 송수신은 상기 OFDM/OFDMA 방식을 사용하여 이루어진다.

한편, 상기 OFDMA 방식은 시간 분할 접속(Time Division Access; 이하 'TDA'이라 칭하기로 한다)과 주파수 분할 접속(Frequency Division Access; 이하 'FDA'이라 칭하기로 한다) 기술을 결합하는 2차원 접속 방법으로 정의할 수 있다. 따라서, 상기 OFDMA 방식을 사용하여 데이터를 전송함에 있어 각각의 OFDMA 심볼은 서브 캐리어(sub-carrier)들에 나뉘어 실려 소정의 서브 채널(sub-channel)들을 통해 전송된다. 상기 서브 채널이라 함은 다수의 서브 캐리어들로 구성되는 채널을 의미하며, 상기 OFDMA 방식을 사용하는 통신 시스템(이하 'OFDMA 통신 시스템'이라 칭하기로 한다)에서 시스템 상황에 따라 미리 설정된 개수의 서브 캐리어들이 1개의 서브 채널을 구성하는 것이다.

그러면, 여기서 도 2를 참조하여 상기 OFDMA 통신 시스템의 프레임(frame) 구조를 설명하기로 한다. 한편, 상기 OFDM 통신 시스템의 프레임 구조는 상기 OFDMA 통신 시스템의 프레임 구조와 유사하며, 소정 심볼에서 전체 서브 캐리어 구간을 하나의 가입자 단말기가 사용한다는 점에서 차이가 있다.

상기 도 2는 OFDMA 통신 시스템의 프레임 구조를 개략적으로 도시한 도면이다.

상기 도 2를 참조하면, 가로축은 OFDMA 심벌 번호(OFDMA symbol number)를 나타내며, 세로축은 서브 채널 번호(sub-channel number)를 나타낸다. 상기 도 2에 도시되어 있는 바와 같이 1개의 OFDMA 프레임은 다수개(예컨대, 8개)의 OFDMA 심벌들로 구성된다. 또한, 상기 1개의 OFDMA 심벌은 다수개(예컨대, N개)의 서브 채널들로 구성된다.

한편, 상기 1개의 OFDMA 프레임마다 레인징 채널(ranging channel)을 가지며, 상기 하나의 레인징 채널은 다수개(예컨대, 도 2에서는 4개)의 레인징 슬롯(ranging slot)들로 구성된다. 참조부호 201은 제M 프레임 내에 존재하는 레인징 영역(ranging region), 즉 레인징 슬롯들을 나타내며, 참조부호 202은 제M+1 프레임 내에 존재하는 레인징 슬롯들을 나타낸다. 상기 레인징 채널은 1개 이상의 서브 채널들로 구성되며, 상기 레인징 채널을 구성하는 서브 채널들의 번호는 UL(UpLink)-MAP 메시지에 포함된다.

상기 UL-MAP 메시지는 업링크(uplink) 프레임 정보를 나타내는 메시지로서, 사용되는 상향 링크 채널 식별자(Uplink Channel ID)를 나타내는 Uplink Channel ID, 상향 링크 버스트 프로파일을 포함하고 있는 상향링크 채널 디스크립트(Uplink Channel Descript; 이하 'UCD'라 칭하기로 한다) 메시지의 구성 변화에 상응하는 카운트를 나타내는 UCD count 및 상기 UCD count 이후에 존재하는 엘리먼트들의 개수를 나타내는 Number of UL_MAP Elements n을 포함한다. 여기서, 상기 상향 링크 채널 식별자는 매체 접속 제어(Media Access Control; 이하 'MAC'이라 칭하기로 한다)-서브 계층(sublayer)에서 유일하게 할당된다.

결과적으로, 상기 OFDMA 통신 시스템은 시스템에서 사용하는 전체 서브 캐리어들, 특히 데이터 서브 캐리어들을 전체 주파수 대역에 분산시켜 주파수 다이버시티 이득(frequency diversity gain)을 획득하는 것을 목적으로 하는 통신 시스템이다. 또한, 상기와 같은 OFDMA 통신시스템에서는 송신측(즉, 기지국)과 수신측(즉, 가입자 단말기)간에 정확한 시간 오프셋(offset)을 맞추고, 전력을 조정하는 레인징과정이 요구된다. 상기 레인징 과정에 대해서는 후술하기로 한다.

이하, 도 3 및 도 4를 참조하여 상기 OFDMA 통신 시스템에서의 상향링크 및 하향링크의 프레임 구조를 구체적으로 설명한다.

먼저, 하향 링크(downlink) 프레임(frame) 구조를 도 3을 참조하여 설명하기로 한다.

상기 도 3은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 하향 링크 프레임 구조를 개략적으로 도시한 도면으로서, 특히 IEEE 802.16a/IEEE 802.16e OFDM 통신 시스템의 하향 링크 프레임 구조를 개략적으로 도시한 도면이다.

상기 도 3을 참조하면, 상기 하향 링크 프레임(300)은 프리앰블(preamble) 영역(310), 프레임 제어 헤더(Frame Control Header; 이하 'FCH'라 한다) 영역(320), 다수의 하향 링크 버스트(DL burst #1 내지 #m) 영역들(330, 340)로 구성된다. 상기 프리앰블 영역(310)을 통해서는 기지국과 가입자 단말기간 상호 동기를 획득하기 위한 동기 신호, 즉 프리앰블 시퀀스(preamble sequence)가 송신된다.

상기 FCH 영역(320)은 DL 프레임 프레픽스(DL Frame Prefix) 영역(321)과 DCD, UCD 및 MAPs 영역으로 구성된 영역(323) 및 패딩(padding) 영역(325)으로 구성된다. 한편, 상기 MAPs 영역은 하향 링크 프레임에 대한 정보를 포함하는 DL_MAP 영역 및 상향 링크 프레임에 대한 정보를 포함하는 UL_MAP 영역으로 구성된다.

상기 DL_MAP 영역은 DL_MAP 메시지가 송신되는 영역으로서 상기 DL_MAP 메시지에 포함되는 정보 엘리먼트(Information Element; 이하 'IE'라 칭하기로 한다)들을 하기 <표 1>에 나타내었다.

표 1.

Syntax	Size	Notes
DL-MAP_Message_Format() {		
Management Message Type = 2	8 bits	
PHY Synchronization Field	Variable	See appropriate PHY specification.
DCD Count	8 bits	
Base Station ID	48 bits	
Number of DL-MAP Elements *n*	16 bits	
Begin PHY Specific Section {		See applicable PHY section.
for (*i* = 1; *i* <= *n*; *i*++) {		For each DL-MAP element 1 to *n*.
DL_MAP_Information_Element()	Variable	See corresponding PHY specification.
if !(byte boundary) {		
Padding Nibble	4 bits	Padding to reach byte boundary.
}		
}		
}		
}		

상기 <표 1>에 나타낸 바와 같이, DL_MAP 메시지는 다수의 IE들, 즉 송신되는 메시지의 타입을 나타내는 Management Message Type, 동기를 획득하기 위해 물리 채널에 적용되는 변조 방식 및 복조 방식에 상응하게 설정되는 PHY(PHYsical) Synchronization, 하향 링크 버스트 프로파일(burst profile)을 포함하고 있는 하향링크 채널 디스크립트(Downlink Channel Descript; 이하 'DCD'라 칭하기로 한다) 메시지의 구성(configuration) 변화에 상응하는 카운트(count)를 나타내는 DCD count, 기지국 식별자(Base Station Identifier)를 나타내는 Base Station ID 및 상기 Base Station ID 이후에 존재하는 엘리먼트들의 개수를 나타내는 Number of DL_MAP Elements n을 포함한다. 특히, 상기 <표 1>에 도시하지는 않았으나 상기 UL_MAP 메시지는 하기에서 설명할 레인징들 각각에 할당되는 레인징 코드들에 대한 정보를 포함한다.

또한, 상기 UL_MAP 영역(313)은 UL_MAP 메시지가 송신되는 영역으로서 상기 UL_MAP 메시지에 포함되는 IE들을 하기 <표 2>에 나타내었다.

표 2.

Syntax	Size
UL_MAP_Message_Format() {	
Management Message Type=3	8 bits
Uplink channel ID	8 bits
UCD Count	8 bits
Number of UL_MAP Elements n	16 bits
Allocation Start Time	32 bits
Begin PHY Specific Section {	
for(i=1; i<n; i+n)	
UL_MAP_Information_Element {	Variable
Connection ID	
UIUC	
Offset	
}	
}	
}	
}	

상기 <표 2>에 나타낸 바와 같이, UL_MAP 메시지는 다수의 IE들, 즉 송신되는 메시지의 타입을 나타내는 Management Message Type, 사용되는 상향 링크 채널 식별자(Uplink Channel ID)를 나타내는 Uplink Channel ID, 상향 링크 버스트 프로파일을 포함하고 있는 상향 링크 채널 디스크립트(Uplink Channel Descript; 이하 'UCD'라 칭하기로 한다) 메시지의 구성 변화에 상응하는 카운트를 나타내는 UCD count 및 상기 UCD count 이후에 존재하는 엘리먼트들의 개수를 나타내는 Number of UL_MAP Elements n을 포함한다. 여기서, 상기 상향 링크 채널 식별자는 매체 접속 제어(Media Access Control; 이하 'MAC'이라 칭하기로 한다)-서브 계층(sublayer)에서 유일하게 할당된다.

한편, 상기 UIUC(Uplink Interval Usage Code; 이하 'UIUC'라 한다.) 영역은 상기 오프셋 영역에 기록되는 오프셋의 용도를 지정하는 정보가 기록된다. 예컨대, 상기 UIUC 영역에 2가 기록되면, 초기 레인징에 사용되는 시작 오프셋(Starting offset)이 상기 오프셋 영역에 기록됨을 의미한다. 또한, 상기 UIUC 영역에 3이 기록되면, 대역 요청 레인징 또는 유지 관리 레인징에 사용되는 시작 오프셋(Starting offset)이 상기 오프셋 영역에 기록됨을 의미한다.

상기 오프셋 영역은 상술한 바와 같이 상기 UIUC 영역에 기록된 정보에 대응하여 초기 레인징, 대역 요청 레인징 또는 유지 관리 레인징에 사용되는 시작 오프셋 값이 기록된다. 또한, 상기 UIUC 영역에서 전송되어질 물리채널의 특징에 대해서는 UCD에 정보가 수록되어 있다.

만일, 단말기가 레인징을 성공적으로 수행하지 못하였다면, 다음 시도에서의 성공 확률을 높이기 위해서 임의의 백오프 값을 정하며, 상기 백오프 시간 만큼 지연한 후에 레인징 시도를 다시 수행하게 된다. 이때, 상기 백오프 값을 정하기 위해서 필요한 정보도 상기 UCD 메시지에 포함되어 있다. 상기 UCD 메시지의 구조는 하기 <표 3>을 참고하여 보다 구체적으로 설명한다.

표 3.

Syntax	Size	Notes
UCD-Message_Format() {		
Management Message Type=0	8 bits	
Uplink channel ID	8 bits	
Configuration Change Count	8 bits	
Mini-slot size	8 bits	
Ranging Backoff Start	8 bits	
Ranging Backoff End	8 bits	
Request Backoff Start	8 bits	
Request Backoff End	8 bits	
TLV Encoded Information for the overall channel	Variable	
Begin PHY Specific Section {		
for(i=1; i<n; i+n)		
Uplink_Burst_Descriptor	Variable	
}		
}		
}		

상기 <표 3>에 나타낸 바와 같이, UCD 메시지는 다수의 IE들, 즉 송신되는 메시지의 타입을 나타내는 Management Message Type, 사용되는 상향 링크 채널 식별자를 나타내는 Uplink Channel ID, 기지국에서 카운트되는 Configuration Change Count, 상향 링크 물리 채널의 미니 슬럿(mini-slot)의 크기를 나타내는 Mini-slot Size, 초기 레인징을 위한 백오프의 시작점(즉, 초기 레인징을 위한 최초 백오프 윈도우(Initial backoff window) 크기)을 나타내는 Ranging Backoff Start, 상기 초기 레인징을 위한 백오프의 종료점(즉, 최종 백오프 윈도우(Final backoff window) 크기)를 나타내는 Ranging Backoff End, contention data and requests을 위한 백오프의 시작점(즉, 최초 백오프 윈도우의 크기)을 나타내는 Request Backoff Start 및 contention data and requests을 위한 백오프의 종료점(즉, 최종 백오프 윈도우 크기)을 나타내는 Request Backoff End를 포함한다.

여기서, 상기 백오프 값은 하기에서 설명할 레인징들이 실패할 경우 다음번 레인징을 위해 대기해야하는 일종의 대기 시간 값을 나타내며, 기지국은 가입자 단말기가 레인징에 실패할 경우 다음번 레인징을 위해 대기해야하는 시간 정보인 상기 백오프값을 상기 가입자 단말기로 송신해야만 하는 것이다.

또한, 상기 DL 버스트 영역들(330, 340)은 가입자 단말기들별로 TDM/시간 분할 다중 접속(Time Division Multiple Access; 이하 'TDMA'라 칭하기로 한다) 방식으로 할당된 타임 슬럿(time slot)들에 해당하는 영역들이다. 상기 기지국은 미리 설정되어 있는 센터 캐리어(center carrier)를 이용하여 상기 기지국이 관리하고 있는 가입자 단말기들에 방송해야 할 방송 정보들을 상기 하향 링크 프레임의 DL_MAP 영역을 통해 송신한다.

상기 가입자 단말기들은 파워 온(power on)함에 따라 상기 가입자 단말기들 각각에 미리 설정되어 있는 모든 주파수 대역들을 모니터링하여 가장 센 크기, 즉 가장 센 파일럿(pilot) 캐리어 대 간섭 잡음비(Carrier to Interference and Noise Ratio; 이하 'CINR'이라 칭하기로 한다)를 가지는 파일럿 채널 신호를 검출한다. 그리고, 상기 가장 센 파일럿 CINR을 가지는 파일럿 채널 신호를 송신한 기지국을 가입자 단말기 자신이 현재 속해있는 기지국으로 판단하고, 상기 기지국에서 송신하는 하향 링크 프레임의 DL_MAP 영역과 UL_MAP 영역을 확인하여 자신의 상향 링크 및 하향 링크를 제어하는 제어 정보 및 실제 데이터 송수신 위치를 나타내는 정보를 알게 된다.

상기 도 3에서는 IEEE 802.16a/IEEE 802.16e OFDM 통신 시스템의 하향 링크 프레임 구조를 설명하였으며, 다음으로 도 4를 참조하여 IEEE 802.16a/IEEE 802.16e OFDM 통신 시스템의 상향 링크 프레임 구조를 설명하기로 한다.

도 4는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 상향 링크 프레임 구조를 개략적으로 도시한 도면으로서, 특히 IEEE 802.16a/IEEE 802.16e OFDM 통신 시스템의 상향 링크 프레임 구조를 개략적으로 도시한 도면이다.

상기 도 4를 설명하기에 앞서 상기 IEEE 802.16a/IEEE 802.16e 통신 시스템에서 사용되는 레인징(ranging)들, 즉 초기 레인징(Initial Ranging) 및 유지 관리 레인징(Maintenance Ranging)(즉, 주기적 레인징(Periodic Ranging) 및 대역 요청(Bandwidth Request))에 대해서 설명하기로 한다.

첫 번째로 초기 레인징에 대해서 설명하기로 한다.

상기 초기 레인징은 기지국과 가입자 단말기와의 동기 획득을 위해 기지국에 요청할 경우에 수행되는 레인징으로서, 상기 초기 레인징은 상기 가입자 단말기와 기지국간에 정확한 시간 오프셋(offset)을 맞추고, 송신 전력(transmit power)을 조정하기 위해 수행되는 레인징이다. 즉, 상기 가입자 단말기는 파워 온한 후 DL_MAP 메시지, UL_MAP메시지 및 UCD 메시지를 수신하여 기지국과 동기를 획득한 후, 상기 기지국과 상기 시간 오프셋과 송신 전력을 조정하기 위해서 상기 초기 레인징을 수행한다.

여기서, 상기 IEEE 802.16a/IEEE 802.16e 통신 시스템은 OFDM/OFDMA 방식을 사용하기 때문에 상기 레인징 절차에는 레인징 서브 채널(sub-channel)들과 레인징 코드(ranging code)들이 필요하고, 기지국은 레인징들의 목적, 즉 종류에 따라서 각각 사용 가능한 레인징 코드들을 할당한다. 이를 구체적으로 설명하면 다음과 같다.

상기 레인징 코드는 먼저 소정 길이, 일 예로 2^{15}-1비트(bits) 길이를 가지는 의사 랜덤 잡음(Psuedorandom Noise; 이하 'PN'이라 칭하기로 한다) 시퀀스를 소정 단위로 세그멘테이션(segmentation)하여 생성된다. 일반적으로 53비트 길이를 갖는 레인징 서브 채널 2개가 한 개의 레인징 채널을 구성하고, 106비트 길이의 레인징 채널을 통해서 PN 코드를 세그먼테이션하여 레인징 코드를 구성한다. 이렇게 구성된 레인징 코드는 최대 48개(RC #1 ~ RC #48)까지 가입자 단말기에게 할당될 수 있으며, 디폴트(default)값으로 가입자 단말기당 최소 2개의 레인징 코드들이 상기 3가지 목적의 레인징, 즉 초기 레인징과, 주기적 레인징 및 대역 요청에 적용된다.

이렇게, 상기 3가지 목적의 레인징들 각각에 상이한 레인징 코드들이 할당되는데, 일 예로 N개의 레인징 코드들이 초기 레인징을 위해 할당되고(N RC(Ranging Code)s for initial ranging), M개의 레인징 코드들이 주기적 레인징을 위해 할당되고(M RCs for maintenance ranging), L개의 레인징 코드들이 대역 요청 레인징에 할당된다(L RCs for BW-request ranging). 이렇게 할당된 레인징 코드들은 상기에서 설명한 바와 같이 UCD 메시지를 통해 가입자 단말기들로 송신되고, 상기 가입자 단말기들은 상기 UCD 메시지에 포함되어 있는 레인징 코드들을 그 목적에 맞게 사용하여 레인징 절차를 수행한다.

그러면 여기서 도 5를 참조하여 OFDMA 통신 시스템의 레인징 코드를 생성하는 레인징 코드 생성기 구조를 설명하기로 한다.

상기 도 5는 일반적인 OFDMA 통신 시스템의 레인징 코드 생성기 구조를 도시한 도면이다.

상기 도 5를 참조하면, 상술한 바와 같이 상기 레인징 코드는 소정 길이 길이를 가지는 PN 시퀀스를 소정 단위로 세그멘테이션하여 생성된다. 상기 도 5에는 생성 다항식(generation polynomial)이 $1 + x^1 + x^4 + x^7 + x^{15}$를 가지는 PN 시퀀스, 즉 레인징 코드 생성기가 도시되어 있다.

상기 레인징 코드 생성기는 상기 각 생성 다항식의 각 항들과 매칭되는 다수의 메모리들(510)과 상기 생성 다항식의 각 탭들에 해당하는 메모리로부터 출력된 값들을 배타적 논리합(XOR) 연산하는 배타적 논리합 연산기(520)로 구성된다.

상기 OFDMA 통신 시스템에서는 상기에서 설명한 바와 같이 1개의 레인징 채널이 2개의 서브 채널들로 구성되고, 1개의 서브 채널이 53개의 서브 캐리어들로 구성되면 106 비트(bits)의 레인징 코드가 사용된다. 가입자 단말기들은 상기 레인징 코드들중 어느 한 레인징 코드를 랜덤하게 선택하고, 상기 랜덤하게 선택한 레인징 코드를 사용하여 레인징 절차를 수행한다.

또한, 상기 레인징 코드는 상기 레인징 채널 상의 서브 캐리어들 각각에 1비트씩 이진 위상 쉬프트 키잉(Binary Phase Shift Keying; 이하 'BPSK'라 칭하기로 한다) 변조되어 송신된다. 따라서, 상기 레인징 코드들 각각은 서로 다른 레인징 코드들 각각에 대해서 상관(correlation) 관계가 거의 없는 특성을 가지기 때문에 동일 시점에 전송된 경우라 할지라도 수신측에서는 상기 각기 다른 코드들을 통해 구별이 가능하게 된다.

두 번째로 주기적 레인징에 대해서 설명하기로 한다.

상기 주기적 레인징은 상기 초기 레인징을 통해 기지국과 시간 오프셋 및 송신 전력을 조정한 가입자 단말기가 상기 기지국과 채널 상태 등을 조정하기 위해서 주기적으로 수행하는 레인징을 나타낸다. 상기 가입자 단말기는 상기 주기적 레인징을 위해 할당된 레인징 코드들을 이용하여 상기 주기적 레인징을 수행한다.

세 번째로 대역 요청 레인징에 대해서 설명하기로 한다.

상기 대역 요청 레인징은 상기 초기 레인징을 통해 기지국과 시간 오프셋 및 송신 전력을 조정한 가입자 단말기가 상기 기지국과 실제 통신을 수행하기 위해서 대역폭(bandwidth) 할당을 요청하는 레인징이다.

한편, 상기 도 4를 참조하면, 상기 상향 링크 프레임(400)은 초기 레인징을 위해 할당된 초기 레인징 경쟁 슬랏 영역(410)과, 대역 요청 레인징을 위해 할당된 대역 요청 경쟁 슬랏 영역(420)과, 가입자 단말기들의 상향 링크 데이터들을 포함하는 다수의 상향 링크 버스트 영역들(430, 440)으로 구성된다.

상기 초기 레인징 경쟁 슬랏 영역(410)은 실제 초기 레인징 정보들을 포함하는 다수의 접속 버스트(access burst) 구간들과, 상기 다수의 접속 버스트 구간들간 충돌이 발생할 경우 충돌(collision) 구간이 존재한다.

상기 대역 요청 경쟁 슬랏 영역(420)은 실제 대역 요구 레인징을 포함하는 다수의 대역 요구(bandwidth request) 구간들과, 상기 다수의 대역 요구 구간들간의 충돌이 발생할 경우 충돌 구간이 존재한다.

또한, 상기 상향 링크 버스트 영역들(430, 440)은 각 가입자 단말기별로 상향 링크 데이터를 전송할 수 있도록 다수의 버스트 영역(SS #1 scheduled data 영역 내지 SS #n scheduled data 영역)들로 구성되며, 상기 다수의 버스트 영역들 각각에는 프리앰블(431) 및 상향링크 버스트(433)들로 구성된다.

도 6은 상기 도 3 및 도 4에서 상술한 메시지들을 통한 광대역 무선 접속 통신 시스템의 통신 절차를 개략적으로 도시한 도면이다.

상기 도 6을 참조하면, 먼저 가입자 단말기(620)는 파워 온(power on)됨에 따라 상기 가입자 단말기(620)에 미리 설정되어 있는 모든 주파수 대역들을 모니터링하여 가장 센 크기, 즉 가장 센 파일럿(pilot) 캐리어 대 간섭 잡음비(CNIR)를 가지는 파일럿 채널(pilot channel) 신호를 검출한다. 그리고, 상기 가입자 단말기(620)는 가장 센 파일럿 CINR을 가지는 파일럿 채널 신호를 송신한 기지국(600)을 상기 가입자 단말기(620) 자신이 현재 속해있는 기지국(600)으로 판단하고, 상기 기지국(600)에서 송신하는 하향 링크(downlink) 프레임(frame)의 프리앰블(preamble)을 수신하여 상기 기지국(600)과의 시스템 동기를 획득한다.

상기에서 설명한 바와 같이 상기 가입자 단말기(620)와 기지국(600)간에 시스템 동기가 획득되면, 상기 기지국은 상기 가입자 단말기로 DL_MAP 메시지와 UL_MAP 메시지를 송신한다.(601 단계, 603 단계). 여기서, 상기 DL_MAP 메시지는 상기 <표 1>에서 상술한 바와 같이, 순방향 링크에서 상기 가입자 단말기가 상기 기지국에 대해서 동기를 획득하기 위해서 필요한 정보들과 이를 통해서 상기 순방향 링크에서 가입자 단말기들에게 전송되는 메시지들을 수신할 수 있는 물리채널의 구조 등의 정보를 상기 가입자 단말기에게 알려주는 기능을 수행한다. 또한, 상기 UL_MAP 메시지는 상기 <표 2>에서 상술한 바와 같이, 역방향 링크에서 단말의 스케줄링(scheduling) 주기 및 물리채널의 구조 등의 정보를 단말에게 알려주는 기능을 수행한다.

한편, 상기 DL_MAP 메시지는 기지국에서 모든 가입자 단말기들에게 주기적으로 방송되는데, 상기 가입자 단말기가 이를 계속 수신할 수 있는 경우를 기지국과 동기가 일치했다고 지칭한다. 즉, 상기 DL_MAP 메시지를 수신한 단말기들은 순방향 링크로 전송되는 모든 메시지들을 수신할 수 있다.

상기 <표 3>에서 상술한 바와 같이, 기지국은 가입자 단말기가 액세스에 실패할 경우, 사용할 수 있는 백오프 값을 알려주는 정보를 포함하고 있는 상기 UCD 메시지를 상기 가입자 단말기로 전송한다.

한편, 상기 레인징을 수행할 경우, 상기 가입자 단말기는 상기 기지국으로 RNG_REQ 메시지를 전송(605 단계)하게 되고, 상기 RNG_REQ 메시지를 수신한 상기 기지국은 상기 가입자 단말기에게 상기에서 언급된 주파수, 시간 및 전송 파워를 보정하기 위한 정보들을 포함한 RNG_RSP 메시지를 전송(607 단계)하게 된다.

상기 RNG_REQ 메시지의 구조는 하기 <표 4>에 나타낸 바와 같다.

표 4.

Syntax	Size	Notes
RNG-REQ_Message_Format() {		
Management Message Type = 4	8 bits	
Downlink Channel ID	8 bits	
Pending Until Complete	8 bits	
TLV Encoded Information	Variable	TLV specific
}		

상기 <표 4>에서 Downlink Channel ID는 상기 가입자 단말기가 상기 UCD를 통해 수신한 레인징 요구 메시지에 포함된 순방향 채널 아이디를 의미하며, 상기 Pending Until Complete는 전송되는 레인징 응답의 우선순위를 나타낸다. 즉, 상기 Pending Until Complete가 '0'이라면, 이전의 레인징 응답이 우선시 되는 것이며, 상기 Pending Until Complete가 '0'이 아니라면 현재 전송되어진 응답이 우선시 되어진다.

또한, 상기 <표 4>에서 나타낸 RNG_REQ 메시지에 대응한 상기 RNG_RSP 메시지의 구조는 하기 <표 5>와 같다.

표 5.

Syntax	Size	Notes
RNG-RSP_Message_Format() {		
Management Message Type = 5	8 bits	
Uplink Channel ID	8 bits	
TLV Encoded Information	Variable	TLV specific
}		

상기 <표 5>에서 Uplink Channel ID는 기지국이 RNG_REQ 메시지에 있던 상향링크 채널의 아이디를 의미한다.

한편, 802.16a에서 OFDMA를 사용하는 시스템에서는 상기와 같은 레인징을 더 효율적으로 수행할 수 있도록 레인징을 위한 전용 구간을 두고 여기에서 레인징 코드를 전송하는 방식을 사용하여 상기 RNG_REQ를 대신하기도 한다. 상기와 같은 OFDMA 방식에서의 광대역 무선 접속 통신 시스템의 통신 절차는 도 7과 같이 나타낼 수 있다.

상기 도 7을 참조하면, 기지국에서는 가입자 단말기로 DL_MAP 메시지 및 UL_MAP 메시지를 전송(701 단계, 703 단계)하며, 구체적인 사항은 상기 도 6에서와 동일하다. 한편, 상기 OFDMA를 사용하는 시스템에서는 상술한 바와 같이 상기 도 6에서 사용한 RNG_REQ 메시지 대신에 레인징 코드를 전송(705 단계)하며, 상기 레인징 코드를 수신한 기지국은 RNG_RSP 메시지를 상기 가입자 단말기로 전송(707 단계)한다.

한편, 상기 기지국으로 전송되는 레인징 코드에 대응한 정보를 RNG_RSP 메시지에 수록할 수 있도록 새로운 정보들이 추가되어야 한다. 상기 RNG_RSP 메시지에 추가되어야 하는 새로운 정보들은 다음과 같다.

1. Ranging Code : 수신된 레인징 CDMA 코드.

2. Ranging Symbol : 상기 수신된 레인징 CDMA 코드에서의 OFDM 심볼.

3. Ranging subchannel : 상기 수신된 레인징 CDMA 코드에서의 레인징 서브채널.

4. Ranging frame number : 상기 수신된 레인징 CDMA 코드에서의 프레임 번호.

그러면, 상기 도 6 및 도 7에서 상술한 광대역 무선 접속 통신 시스템에 따라 상술한 각 레인징들이 수행되는 절차를 도 8 내지 도 10을 참조하여 보다 구체적으로 설명한다.

한편, IEEE 802.16a OFDMA에서는 106 비트 길이의 레인징 코드 48개가 세 그룹으로 나뉘어 각각 초기 레인징, 주기적 레인징 및 대역폭 요구에 사용된다. 하나의 레인징 코드가 전송되는 시간 구간을 레인징 슬롯이라고 하면, 초기 레인징 과정에서는 한 레인징 슬롯이 두 개의 심볼로 구성되며, 주기적인 레인징과 대역폭 요구 과정에서는 한 레인징 슬롯이 한 개의 심볼로 구성된다. 이하, 초기 레인징 전송은 도 8에, 주기적인 레인징 전송 과정은 도 9에, 대역폭 요구 전송 과정은 도 10에 도시되어 있다.

먼저, 도 8을 참조하여 초기 레인징이 수행되는 절차를 설명한다.

도 8은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 초기 레인징 절차를 나타낸 흐름도이다.

상기 도 8에서는 코드 분할 다중 접속(Code Division Multiple Access; 이하 'CDMA'라 칭하기로 한다) 방식을 기반으로 하는 OFDMA 통신 시스템의 초기 레인징 과정을 설명하기로 한다. 상기 도 8를 참조하면, 먼저 가입자 단말기(820)는 파워 온(power on)됨에 따라 상기 가입자 단말기(820)에 미리 설정되어 있는 모든 주파수 대역들을 모니터링하여 가장 셀 크기, 예컨대, 최대 CINR을 가지는 파일럿 채널(pilot channel) 신호를 검출한다. 그리고, 상기 가입자 단말기(820)는 가장 셀 파일럿 CINR을 가지는 파일럿 채널 신호를 송신한 기지국(800)을 상기 가입자 단말기(820) 자신이 현재 속해 있는 기지국(800)으로 판단하고, 상기 기지국(800)에서 송신하는 다운 링크(downlink) 프레임의 프리앰블(preamble)을 수신하여 상기 기지국(800)과의 시스템 동기를 획득한다.

상기에서 설명한 바와 같이 상기 가입자 단말기(820)와 기지국(800)간에 시스템 동기가 획득되면, 상기 기지국(800)은 상기 가입자 단말기(820)로 DL-MAP 메시지를 송신한다(미도시). 여기서, 상기 DL-MAP 메시지는 동기를 획득하기 위해 물리 채널에 적용되는 변조 방식 및 복조 방식에 상응하게 설정되는 PHY(PHYsical) Synchronization과, 다운 링크 버스트 프로파일(burst profile)을 포함하고 있는 다운 링크 채널 디스크립트(DCD) 메시지의 구성(configuration) 변화에 상응하는 카운트(count)를 나타내는 DCD count와, 기지국 식별자(Base Station IDentifier)를 나타내는 Base Station ID와, 상기 Base Station ID 이후에 존재하는 엘리먼트들의 개수를 나타내는 Number of DL-MAP Elements n와, 레인징들 각각에 할당되는 레인징 코드들에 대한 정보를 포함한다.

상기 기지국(800)은 상기 DL-MAP 메시지를 송신한 후 상기 가입자 단말기(820)로 UCD 메시지를 송신한다(미도시). 여기서, 상기 UCD 메시지는 사용되는 업 링크 채널 식별자를 나타내는 Uplink Channel ID와, 기지국에서 카운트되는 Configuration Change Count과, 상향 링크 물리 채널의 미니 슬롯(mini-slot)의 크기를 나타내는 Mini-slot Size와, 초기 레인징을 이용한 백오프의 시작점을 나타내는, 즉 초기 레인징을 이용한 초기 백오프 윈도우(Initial backoff window) 크기를 나타내는 Ranging Backoff Start와, 상기 초기 레인징을 이용한 백오프의 종료점을 나타내는, 즉 최종 백오프 윈도우(Final backoff window) 크기를 나타내는 Ranging Backoff End와, contention data and requests을 위한 백오프의 시작점을 나타내는, 즉 초기 백오프 윈도우의 크기를 나타내는 Request Backoff Start와, contention data and requests을 위한 백오프의 종료점을 나타내는, 즉 최종 백오프 윈도우 크기를 나타내는 Request Backoff End를 포함한다. 여기서, 상기 백오프 값은 하기에서 설명할 레인징들이 실패할 경우 다음번 레인징을 위해 대기해야하는 일종의 대기 시간 값을 나타내며, 기지국은 가입자 단말기가 레인징에 실패할 경우 다음번 레인징을 위해 대기해야하는 시간 정보인 상기 백오프값을 상기 가입자 단말기로 송신해야만 한다.

그런다음, 상기 기지국(800)은 상기 UCD 메시지를 송신한 후 상기 가입자 단말기(820)로 UL-MAP 메시지를 송신한다(801단계). 상기 기지국(800)으로부터 UL-MAP 메시지까지 수신한 후 상기 가입자 단말기(820)는 상기 초기 레인징에 사용되는 레인징 코드들과, 변조 방식 및 코딩 방식 정보와, 레인징 채널과 레인징 슬롯을 인식할 수 있다. 상기 가입자 단말기(820)는 상기 초기 레인징에 사용되는 레인징 코드들중 랜덤하게 한 레인징 코드를 선택하고, 상기 초기 레인징에 사용되는 레인징 슬럿들 중 랜덤하게 한 레인징 슬럿을 선택한 후, 상기 선택한 레인징 슬럿을 통해 상기 선택한 레인징 코드를 상기 기지국(800)으로 송신한다(803 단계). 상기 803단계에서 상기 레인징 코드를 송신하는 송신 전력(transmit power)은 최소 송신 전력 레벨을 가진다.

상기 가입자 단말기(850)는 상기 레인징 코드를 송신하였음에도 불구하고 상기 기지국(800)으로부터 별도의 응답을 수신하지 못했을 경우 다시 한번 상기 초기 레인징에 사용되는 레인징 코드들중 랜덤하게 한 레인징 코드를 선택하고, 상기 초기 레인징에 사용되는 레인징 슬럿들 중 랜덤하게 한 레인징 슬럿을 선택한 후, 상기 선택한 레인징 슬럿을 통해 상기 선택한 레인징 코드를 송신한다(805 단계). 상기 805단계에서 상기 레인징 코드를 송신하는 송신 전력은 상기 803단계에서 레인징 코드를 송신하는 송신 전력보다 증가된 송신 전력 레벨을 가진다. 물론, 상기 803단계에서 송신한 레인징 코드에서 대해서 상기 가입자 단말기(820)가 상기 기지국(800)으로부터 응답을 수신하였을 경우에는 상기 805단계는 거치지 않게 된다.

상기 기지국(800)은 상기 가입자 단말기(820)로부터 임의의 레인징 슬럿을 통해서 임의의 레인징 코드를 수신하면, 레인징 코드 수신에 성공하였음을 나타내는 성공 정보, 일 예로 OFDMA 심벌 번호와, 서브 채널 등과 같은 레인징 응답(RNG-RSP) 메시지를 상기 가입자 단말기(820)로 송신한다(807단계). 여기서, 도시하지는 않았지만 상기 가입자 단말기(820)는 상기 RNG-RSP를 수신함에 따라, 상기 RNG-RSP 메시지에 포함되어 있는 성공 정보를 사용하여 시간 및 주파수 오프셋을 조정하고, 송신 전력을 조정하게 되는 것이다. 또한, 상기 기지국(800)은 상기 가입자 단말기(820)로 상기 가입자 단말기(820)를 위한 CDMA 할당 정보 엘리먼트(CDMA_Allocation_IE(Information Element))를 포함하는 UL-MAP 메시지를 송신한다(809 단계). 여기서, 상기 CDMA 할당 정보 엘리먼트에는 상기 가입자 단말기(820)가 레인징 요구(RNG-REQ) 메시지를 송신할 업링크 대역폭(up link bandwidth)이 포함되어 있다.

상기 기지국(800)으로부터 UL-MAP 메시지를 수신한 상기 가입자 단말기(820)는 상기 UL-MAP 메시지에 포함되어 있는 CDMA 할당 정보 엘리먼트를 검출하고, 상기 CDMA 할당 정보 엘리먼트에 포함되어 있는 업링크 자원, 즉 업링크 대역폭을 사용하여 MAC 어드레스를 포함하는 RNG-REQ 메시지를 상기 기지국(800)으로 송신한다(811단계). 상기 가입자 단말기(820)로부터 RNG-REQ 메시지를 수신한 상기 기지국(800)은 상기 가입자 단말기(820)의 MAC 어드레스에 상응하게 연결 식별자(CID)들, 즉 basic CID와 primary management CID를 포함하는 RNG-RSP 메시지를 상기 가입자 단말기(820)로 송신한다.

상기 도 8에서 설명한 바와 같이 상기 초기 레인징 과정을 수행하고 나면, 가입자 단말기는 가입자 단말기 자신에게 고유하게 할당되는 basic CID와 primary management CID를 알 수 있게 된다. 또한, 상기 초기 레인징 과정에서 가입자 단말기는 랜덤하게 레인징 슬럿 및 레인징 코드를 선택하고, 상기 랜덤하게 선택한 레인징에서 상기 랜덤하게 선택한 레인징 코드를 송신하기 때문에 한 레인징 슬럿에 서로 다른 가입자 단말기들에 의해 송신된 동일한 레인징 코드가 충돌하는 경우가 발생한다. 이렇게 레인징 코드끼리 충돌할 경우 기지국은 상기 충돌한 레인징 코드를 식별하지 못하고, 따라서 RNG-RSP 메시지 역시 송신하지 못하게 된다. 그리고, 상기 기지국으로부터 RNG-RSP 메

시지를 수신하지 못하므로 상기 가입자 단말기는 상기 exponential random backoff 알고리즘에 상응하는 백오프 값을 대기한 후 상기 초기 레인징을 위한 레인징 코드 송신을 반복하게 된다.

그러면 여기서 상기 exponential random backoff 알고리즘에 대해서 설명하기로 한다.

상기 exponential random backoff 알고리즘에 사용되는 최소 윈도우 크기를 MIN_WIN, 최대 윈도우 크기를 MAX_WIN이라 정의하면, 상기 가입자 단말기는 첫 번째 레인징 코드를 송신시 2^{MIN_WIN}개의 레인징 슬롯들중 1개의 레인징 슬롯을 랜덤하게 선택하여 레인징 코드를 송신한다. 상기 첫 번째 레인징 코드 송신시 레인징 코드 충돌이 발생하였을 경우, 두 번째 레인징 코드 송신시에는 다시 그 레인징 슬롯에서부터 2^{MIN_WIN+1}개 이후의 레인징 슬롯들 중에서 1개의 레인징 슬롯을 랜덤하게 선택하여 레인징 코드를 송신한다.

상기 두 번째 레인징 코드 송신시 레인징 코드 충돌이 발생하였을 경우, 세 번째 레인징 코드 송신시에는 다시 그 레인징 슬롯에서부터 2^{MIN_WIN+2}개 이후의 레인징 슬롯들 중에서 1개의 레인징 슬롯을 랜덤하게 선택하여 레인징 코드를 송신한다. 이와 같이 가입자 단말기가 2^k개의 레인징 슬롯들 중에서 1개의 레인징 슬롯을 랜덤하게 선택할 때, 상기 k를 윈도우 사이즈(window size)라고 정의한다. 상기 레인징 코드 재송신 과정에서 사용되는 윈도우 사이즈 k는 상기 최소 윈도우 크기 MIN_WIN부터 상기 레인징 코드 송신이 성공할 때까지, 즉 RNG-RSP 메시지를 수신할 때까지 1씩 증가하여 최대 상기 최대 윈도우 크기 MAX_WIN이 될 때까지 증가한다.

이하, 도 9를 참조하여 주기적 레인징이 수행되는 절차를 설명한다.

도 9는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템의 주기적 레인징 절차를 나타낸 흐름도이다.

상기 도 9를 참조하면, 단말기는 기지국으로부터 UCD(Uplink Channel Descriptor) 메시지를 수신하고, 상기 UCD 메시지로부터 주기적인 레인징에 사용되는 레인징 코드와 변조(modulation) 및 코딩(coding) 정보를 알아낸다. 또한, 상기 단말기는 상기 기지국으로부터 UL-MAP을 수신(901)하고, 상기 UL-MAP으로부터 주기적인 레인징에 사용되는 레인징 채널과 레인징 슬롯을 알아낸다.

상기 단말기는 주기적인 레인징 코드 집합 중 임의의 한 코드를 선택해 임의의 한 레인징 슬롯에 전송(903)한다. 상기 기지국이 상기 단말기가 전송한 레인징 코드를 식별하면, 수신한 레인징 코드 및 해당 레인징 슬롯, 그리고 timing/frequency/power 조정 파라미터를 RNG_RSP 메시지를 통해 브로드캐스팅(905)한다.

상기 단말기는 자신이 송신한 레인징 코드와 레인징 슬롯과 일치하는 RNG_RSP 메시지를 통해 timing/frequency/power offset을 조정한다. 초기 레인징 과정에서는 한 레인징 슬롯이 두 개의 심볼로 구성되나, 주기적인 레인징 과정에서는 한 레인징 슬롯이 한 개의 심볼로 구성된다. 또한 초기 레인징 과정에서 Basic CID와 Primary Management CID를 할당받았으므로, 주기적인 레인징 과정에서는 CID를 할당받는 과정이 없다.

한편, 상기 기지국이 전송하는 RNG_RSP 메시지의 상태값이 계속(Continue)를 나타내면, 상기 가입자 단말기는 상태값을 계속(Continue)으로 저장한다. 이때, 상기 기지국은 다음 UL_MAP의 전송시 상기 단말기에 대한 주기적 레인징 절차를 반복하게 된다. 따라서, 상기 기지국은 상기 단말기로 UL_MAP을 전송(907)하며, 상기 단말기는 상기 UL-MAP으로부터 주기적인 레인징에 사용되는 레인징 채널과 레인징 슬롯을 알아낸다.

상술한 바와 마찬가지로, 상기 단말기는 주기적인 레인징 코드 집합 중 임의의 한 코드를 선택해 임의의 한 레인징 슬롯에 전송(909)한다. 상기 기지국이 상기 단말기가 전송한 레인징 코드를 식별하면, 수신한 레인징 코드 및 해당 레인징 슬롯, 그리고 timing/frequency/power 조정 파라미터를 RNG_RSP 메시지를 통해 브로드캐스팅(911)한다. 그런다음 상기 단말기는 자신이 송신한 레인징 코드와 레인징 슬롯과 일치하는 RNG_RSP 메시지를 통해 timing/frequency/power offset을 조정한다.

이때, 상기 기지국이 전송하는 RNG_RSP 메시지의 상태값이 성공(Success)을 나타내면, 상기 가입자 단말기는 상태값을 성공(Success)으로 저장한다. 이때, 상기 기지국은 상기 단말기에 대한 주기적 레인징 절차를 종료하게 된다. 한편, 상기 주기적 레인징은 상기 가입자 단말기가 데이터 전송시 주기적으로 실시하게 되므로, 상기 기지국과 상기 가입자 단말기는 기 정해진 소정 시간 간격마다 상기 주기적 레인징 절차를 반복한다.

마지막으로, 도 10을 참조하여 대역폭 요구 레인징에 대해서 설명하기로 한다.

상기 대역 요구 레인징은 상기 초기 레인징을 통해 기지국과 시간 오프셋 및 송신 전력을 조정한 가입자 단말기가 상기 기지국과 실제 통신을 수행하기 위해서 대역폭(bandwidth) 할당을 요구하는 레인징이다.

상기 도 10을 참조하면, 가입자 단말기(1020)는 상기 대역폭 요구 레인징에 사용되는 레인징 코드들중 랜덤하게 한 레인징 코드(CDMA 코드)를 선택하고, 상기 대역폭 레인징에 사용되는 레인징 슬롯들 중 랜덤하게 한 레인징 슬롯을 선택한 후, 상기 선택한 레인징 슬롯을 통해 상기 선택한 레인징 코드를 기지국(1000)으로 송신한다(1001단계). 상기 가입자 단말기(1020)는 상기 레인징 코드를 송신하였음에도 불구하고 상기 기지국(1000)으로부터 별도의 응답을 수신하지 못했을 경우 다시 한번 상기 대역폭 요구 레인징에 사용되는 레인징 코드들중 랜덤하게 한 레인징 코드를 선택하고, 상기 대역폭 요구 레인징에 사용되는 레인징 슬롯들 중 랜덤하게 한 레인징 슬롯을 선택한 후, 상기 선택한 레인징 슬롯을 통해 상기 선택한 레인징 코드를 송신한다(1003단계, 1005단계). 물론, 상기 1001단계에서 송신한 레인징 코드에서 대해서 상기 가입자 단말기(1020)가 상기 기지국(1000)으로부터 응답을 수신하였을 경우에는 상기 1013단계와 1015단계는 거치지 않게 된다.

상기 기지국(1000)은 상기 가입자 단말기(1020)로부터 임의의 레인징 슬럿을 통해서 임의의 레인징 코드를 수신하면, CDMA 할당 정보 엘리먼트를 포함하는 UL-MAP 메시지를 송신한다(1007단계). 여기서, 상기 CDMA 할당 정보 엘리먼트에는 상기 가입자 단말기(1020)가 대역폭 요구(Bandwidth-Request; 이하 'BW-REQ'라 칭하기로 한다) 메시지를 송신할 업링크 대역폭이 포함되어 있다. 상기 기지국(1000)으로부터 UL-MAP 메시지를 수신한 상기 가입자 단말기(1020)는 상기 UL-MAP 메시지에 포함되어 있는 CDMA 할당 정보 엘리먼트를 검출하고, 상기 CDMA 할당 정보 엘리먼트에 포함되어 있는 업링크 자원, 즉 업링크 대역폭을 사용하여 BW-REQ 메시지를 송신한다(1009단계). 상기 가입자 단말기(1020)로부터 BW-REQ 메시지를 수신한 상기 기지국(1000)은 상기 가입자 단말기(1020)의 데이터 송신을 위한 업링크 대역폭을 할당한다. 그리고, 상기 기지국(1000)은 상기 가입자 단말기(1020)의 데이터 송신을 위해 할당한 업링크 대역폭 정보를 포함하는 UL-MAP 메시지를 상기 가입자 단말기(1020)로 송신한다(1011단계). 상기 기지국(1000)으로부터 UL-MAP 메시지를 수신한 상기 가입자 단말기(1020)는 상기 데이터 송신을 위해 할당된 업링크 대역폭을 인식하고, 상기 업링크 대역폭을 통해 데이터를 상기 기지국(1000)으로 송신한다(1013단계).

상기 도 10에서 설명한 바와 같이 상기 대역폭 요구 레인징 과정을 수행하고 나면, 가입자 단말기는 기지국으로 데이터를 송신하는 것이 가능하게 된다. 또한, 상기 초기 레인징 과정과 마찬가지로 상기 대역폭 요구 레인징 과정에서 가입자 단말기는 랜덤하게 레인징 슬럿 및 레인징 코드를 선택하고, 상기 랜덤하게 선택한 레인징 슬럿에서 상기 랜덤하게 선택한 레인징 코드를 송신하기 때문에 한 레인징 슬럿에 서로 다른 가입자 단말기들에 의해 송신된 동일한 레인징 코드가 충돌하는 경우가 발생한다. 이렇게 레인징 코드끼리 충돌할 경우 기지국은 상기 충돌한 레인징 코드를 식별하지 못하고, 따라서 업링크 대역폭을 할당받지 못하게 된다. 그리고, 상기 기지국으로부터 업링크 대역폭을 할당받지 못하므로 상기 가입자 단말기는 상기 exponential random backoff 알고리즘에 상응하는 백오프값을 대기한 후 상기 대역폭 요구를 위한 레인징 코드 송신을 반복하게 된다.

그러면 여기서 도 11을 참조하여 상기 OFDMA 통신 시스템에서 가입자 단말기의 초기 레인징 및 대역폭 요구 레인징시 백오프 과정을 설명하기로 한다.

상기 도 11은 일반적인 OFDMA 통신 시스템에서 초기 레인징, 주기적 레인징 및 대역폭 요구 레인징시 백오프 과정을 개략적으로 도시한 도면이다.

상기 도 11을 설명하기에 앞서, 상기 도 6에서 설명하는 백오프 과정은 상기 초기 레인징 과정, 주기적 레인징 과정 및 대역폭 요구 레인징 과정 모두에 적용되나, 여기서는 설명의 편의상 상기 초기 레인징 과정을 일 예로 하여 설명하기로 한다.

상기 도 11을 참조하면, 1개의 프레임은 L개의 초기 레인징을 위한 레인징 슬럿들로 구성된다. 첫 번째로, 제1 프레임(frame 1)을 살펴보기로 한다. 상기 L개의 레인징 슬럿들중 제3 레인징 슬럿에서 3개의 가입자 단말기들이 레인징 코드들을 송신하며, 제L 레인징 슬럿에서 3개의 가입자 단말기들이 레인징 코드들을 송신한다. 여기서, 상기 제3 레인징 슬럿에서 레인징 코드를 송신하는 가입자 단말기들을 제1 가입자 단말기(1101), 제2 가입자 단말기(1103) 및 제3 가입자 단말기(1105)라고 가정하기로 한다. 또한, 상기 제L 레인징 슬럿에서 레인징 코드를 송신하는 가입자 단말기들을 제4 가입자 단말기(1107)와, 제5 가입자 단말기(1109)와 제6 가입자 단말기(1111)라고 가정하기로 한다.

상기 제3 레인징 슬럿에서 상기 제1 가입자 단말기(1101)는 ①번 레인징 코드를 송신하고, 상기 제2 가입자 단말기(1103) 및 제3 가입자 단말기(1105)는 ②번 레인징 코드를 송신한다. 이렇게 동일한 레인징 슬럿에서 동일한 레인징 코드, 즉 ②번 레인징 코드를 사용하여 레인징 코드를 송신할 경우 상기 ②번 레인징 코드는 충돌하게 되고, 상기 기지국은 상기 ②번 레인징 코드를 인식하지 못하게 된다(1120). 상기와 같이 되는 이유는 상술한 바와 같이, 동일한 슬럿(즉, 동일한 시간)에서 다수의 가입자 단말기들을 통해 전송되는 각 데이터들은 상술한 레인징 코드(예컨대, PN 코드)로서 구별이 가능하다. 그러나, 상기 다른 가입자 단말기들이 동일한 코드를 사용하여 동일한 시점에서 데이터를 전송한다면, 상기 기지국은 상기 각 단말기별로 전송된 상기 데이터들을 구별할 수가 없게 된다.

따라서, 상기 제2 가입자 단말기(1103) 및 제3 가입자 단말기(1105)는 상기 기지국으로부터 별도의 응답을 수신하지 못하게 되고, 상기 exponential random backoff 알고리즘에 상응하게 백오프를 수행하게 된다. 즉, 상기 제2 가입자 단말기는 제2 프레임(frame 2)의 제4 레인징 슬럿에서 ③번 레인징 코드를 사용하여 레인징 코드를 송신(1115)하고, 상기 제3 가입자 단말기는 상기 제2 프레임의 제2 레인징 슬럿에서 다시 ②번 레인징 코드를 사용하여 레인징 코드를 송신(1113)한다.

한편, 상기 제L 레인징 슬럿에서 상기 제4 가입자 단말기(1107)와 제5 가입자 단말기(1109)는 ①번 레인징 코드를 송신하고, 상기 제6 가입자 단말기(1111)는 ③번 레인징 코드를 송신한다. 이렇게 동일한 레인징 슬럿에서 동일한 레인징 코드, 즉 ①번 레인징 코드를 사용하여 레인징 코드를 송신할 경우 상기 ①번 레인징 코드는 충돌하게 되고, 상기 기지국은 상기 ①번 레인징 코드를 인식하지 못하게 된다. 따라서, 상기 제4 가입자 단말기(1107) 및 제5 가입자 단말기(1109)는 상기 기지국으로부터 별도의 응답을 수신하지 못하게 되고, 상기 exponential random backoff 알고리즘에 상응하게 백오프를 수행하게 된다. 상기 도 11에서는 상기 제4 가입자 단말기(1107) 및 제5 가입자 단말기(1109)의 백오프를 별도로 도시하지는 않았으나 상기 제2 가입자 단말기(1103) 및 제3 가입자 단말기(1105)의 백오프와 동일한 방식으로 동작하게 된다.

결국, 상기 OFDMA 통신 시스템에서 가입자 단말기는 초기 레인징, 주기적 레인징 및 대역폭 요구 레인징시 상기 초기 레인징, 주기적 레인징 및 대역폭 요구 레인징을 위한 레인징 슬럿 및 레인징 코드를 랜덤하게 선택하므로 레인징 코드 충돌이 빈번하게 발생하게 된다. 이렇게 레인징 코드 충돌이 발생하게 되면 기지국은 가입자 단말기의 레인징 코드를 인식할 수 없어 더 이상의 동작을 수행하지 못하게 된다. 물론, 상기 레인징 코드 충돌로 인해 가입자 단말기는 exponential random backoff 알고리즘에 상응하게 백오프를 수행하지만, 상기 백오프에 따른 레인징 코드 송신 역시 충돌이 발생할 수 있으므로 가입자 단말기의 기지국 접속에 접속 지연이 발생한다. 상기 접속 지연은 결국 상기 OFDMA 통신 시스템의 성능 열화를 발생시킨다는 문제점을 가진다.

한편, 주기적 레인징에서는 단말기의 첫 레인징 코드 전송부터 첫 RNG_RSP까지의 시간을 '접속지연시간'이라 정의할 수 있고, 또한, 대역폭 요구 과정에서는 첫 레인징 코드 전송부터 UL-MAP의 CDMA_Allocation_IE 정보로부터 레인징 성공 정보를 받을 때까지 걸리는 시간을 '접속지연시간'이라 정의할 수 있다. IEEE 802.16a OFDMA 방식에서는 상술한 바와 같이 주기적인 레인징과 대역폭 요구 전송에 있어서 임의의 레인징 슬롯에 임의의 레인징 코드를 전송하는 임의 접속(Random Access) 방식이므로, 레인징 코드 충돌이 발생하면 exponential random backoff 후 재접속 과정을 통해 접속지연시간이 길어지게 된다. 따라서 최대접속지연시간을 보장할 수 없으며, 특히 코드 충돌 확률이 클수록 접속지연시간이 길어져 시스템의 성능 열화를 야기하게 된다.

한편, 상술한 바와 같이 상기 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템에 가입자 단말기 이동성 및 다중 셀을 고려하여야 하므로, 상기 다중 셀에서 다수의 가입자 단말기들이 상기와 같은 레인징을 수행하는 상황이 발생할 수 있다.

그러면, 여기서 도 12를 참조하여 다중 셀에서 상술한 종래의 레인징 코드를 사용하여 레인징(즉, 초기 레인징, 주기적 레인징 및 대역 요구)을 시도할 때 발생할 수 있는 상황을 설명한다.

도 12는 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템에서 다중 셀에서의 레인징 신호 전송을 나타낸 도면이다.

상기 도 12를 참조하면, 상기 OFDM/OFDMA 통신 시스템은 다수개의 셀들로 구성된다. 상기 도 12에서는 설명의 편의상 cell A(1200), cell B(1210) 및 cell C(1220)의 3개의 셀로 이루어진 구조를 설명한다. 한편, 기지국 A(1201)는 상기 cell A(1200) 영역 내에 있는 다수의 가입자 단말기들(1203, 1205)과 상기 OFDM/OFDMA 통신을 수행하며, 기지국 B(1211)는 상기 cell B(1210) 영역 내에 있는 다수의 가입자 단말기들(1213, 1215)과 상기 OFDM/OFDMA 통신을 수행하고, 기지국 C(1221)는 상기 cell C(1220) 영역 내에 있는 다수의 가입자 단말기들(1223, 1225, 1227)과 상기 OFDM/OFDMA 통신을 수행한다.

상술한 바와 같이, 상기 다수의 가입자 단말기들은 각각 해당 기지국들과 레인징을 위하여 소정의 프레임 내의 레인징 슬롯들에서 초기 레인징, 주기적 레인징 및 대역 요청을 수행한다. 이때, 상기 레인징들을 위하여 상기 각 가입자 단말기들은 레인징 코드를 사용하며, 상기 레인징 코드는 상술한 바와 같이 N 칩 길이의 PN(Pseudo Noise) 코드를 IFFT를 통해 전송한다. 이때, 각 PN 칩은 특정 부반송파에 의해 변조된다. 각 가입자 단말기는 상술한 레인징 신호의 용도에 따라 미리 정해진 PN 코드 그룹 내의 특정 코드를 무작위 선택(random selection)한 후, 신호를 발생시켜 전송한다.

예컨대, 상기 도 12에서는, 상기 cell A(1200) 내의 1203번 가입자 단말기는 PN #1 코드로 레인징 코드를 전송하고, 1205번 가입자 단말기는 PN #2 코드로 레인징 코드를 전송할 수 있다. 또한, 상기 cell B(1210) 내의 1213번 가입자 단말기는 PN #4 코드로 레인징 코드를 전송하고, 1215번 가입자 단말기는 PN #4 코드로 레인징 코드를 전송할 수 있다. 만약, 이때 상기 1213번 가입자 단말기와 상기 1215번 가입자 단말기가 동일한 시점에서 상기 레인징 코드를 전송한다면, 상기 두개의 레인징 코드는 같은 코드를 사용함으로 인해 충돌이 발생한다. 종래 기술에 의하면, 상술한 바와 같이 상기 충돌한 두개의 레인징 코드는 exponential random backoff를 수행하여 재전송한다.

마찬가지로, 상기 cell C(1220)내의 각 가입자 단말기들(1223, 1225, 1227)은 임의로 선택된 PN 코드들에 의해 레인징을 수행하므로, 다른 코드를 선택하는 경우가 발생할 수도 있으며, 같은 코드를 선택하는 경우가 발생할 수도 있다. 만약, 상기 cell B(1210)에서와 같이 다수의 가입자 단말기들이 동일한 슬롯에서 동일한 레인징 코드를 사용할 경우, 충돌이 발생한다.

한편, 상기 cell A(1200)의 기지국 A(1201)와 레인징을 시도하는 1205번 가입자 단말기가 PN #5를 사용한 레인징 코드를 전송하고, 동일한 슬롯 시점에서 상기 cell C(1220)의 기지국 C(1221)와 레이징을 시도하는 1223번 가입자 단말기가 PN #5를 사용한 레인징 코드를 전송한다면, 상호간의 간섭이 발생한다. 즉, 인접 셀간에 동일 PN 코드를 사용하여 가입자 단말기들이 레인징 신호를 전송하는 경우, 인접 셀간 신호 간섭이 발생한다.

따라서, 상기와 같은 셀간 신호 간섭을 없애기 위해서는 각 단말기별로 고유한 PN 코드를 할당해 주어야 하는데, 이러한 경우 수신기의 구조가 복잡해지는 단점이 있다.

이하, 도 13을 참조하여, 다수의 단말기들로부터 레인징 신호를 수신한 기지국이 상기 레인징 코드를 검출하는 방법을 설명한다.

도 13은 OFDM/OFDMA 방식을 사용하는 광대역 무선 접속 통신 시스템에서 레인징 신호를 검출하는 기지국 장치를 나타낸 블록도이다.

상기 도 13을 참조하면, 다수의 단말기들로부터 레인징 신호를 수신하여 레인징 코드를 검출하는 상기 기지국 장치는 N-포인트 FFT(1311), 다중화기(1313), 다수의 PN 상관기(PN correlator; 1315 내지 1319) 및 시간 옵셋/신호 전력 트래킹기(1321)로 구성된다.

다수의 단말기들로부터 수신된 레인징 신호는 상기 N-포인트 FFT(1311)를 통해 주파수 영역에서의 L개의 PN 코드들로 변환되며, 상기 PN 코드는 다중화기(1313)를 거쳐 다수의 PN 상관기(1315 내지 1319)로 입력된다. 상기 PN 상관기는 추적하고자 하는 다수의 레인징 코드들을 각각 검출할 수 있도록 상기 레인징 코드들의 개수만큼 구비되어야 한다. 즉, 상기 도 13에서와 같이 K개의 레인징 코드를 검출하고자 할 경우, 상기와 같이 K개의 PN 상관기가 필요하다. 상기 다수의 PN 상관기를 통해 검출된 레인징 코드로부터 상기 시간 옵셋/신호 전력 트래킹기(1321)에서 시간 옵셋 및 신호 전력을 추적한다.

상기 도 13에서와 같이 소정의 기지국이 인접 기지국과는 다른 PN 레인징 코드를 사용할 경우, 전체 시스템 관점에서 볼 때 요구되는 레인징 코드들의 총 수는 매우 많아지게 되며, 또한 이렇게 많은 코드를 네트워크에서 관리하는 것도 어렵게 된다. 아울러, 핸드오버 시 각 기지국은 인접 기지국들에 할당된 레인징 코드를 검출할 능력을 가지고 있어야 하기 때문에 기지국 레인징 구현 알고리즘이 매우 복잡하게 된다. 상술한 바와 같이 상기 도 13에서는 K개의 PN 코드 상관기와 그에 해당하는 시간 옵셋 추적 알고리즘이 요구된다.

정리하면, 상술한 바와 같은 종래의 IEEE 802.16a 방식에 따라 다수의 가입자 단말기들이 기지국에 레인징을 시도할 경우, 다음과 같은 문제점이 발생한다.

첫째, 현재 각 셀마다 레인징 용도에 따른 PN 코드 집합을 공동으로 사용하도록 하고 있으나, 상기 도 12에서 상술한 바와 같이 인접 셀에 있는 가입자 단말기들이 동일 PN 코드를 사용하여 레인징 신호를 전송할 경우, 상기 인접 셀 간에 신호 간섭이 발생한다. 예컨대, 기지국 A의 단말기 A와 기지국 B의 단말기 B가 동일 레인징 코드를 동일 전송시간과 동일 전송 주파수에 사용한다면, 상기 각 기지국은 상기 2개의 동일 레인징 코드를 수신하게 되어 두 개의 코드는 구분할 수 없게 된다. 상기 두 개의 코드를 구분할 수 없다는 것의 의미는 상기 기지국이 레인징 시간 오차 추정시 상기 기지국은 수신된 상기 레인징 코드가 상기 다른 두 단말기에 의해 송출된 신호로 인식하는 것이 아니라 상기 하나의 단말기가 송출한 신호가 두개의 채널 패스를 경유해서 수신된 신호로 인식한다는 의미이다.

결국, 현재의 방식으로는 이러한 신호 간섭을 없애기 위해서는 레인징 신호의 발생을 위한 공용 서브캐리어의 사용(주파수 재사용)은 불가능하다.

한편, 상기 도 13에서 상술한 바와 같이 각 셀의 모든 가입자 단말기들이 고유의 PN 코드를 사용한다고 할 경우, 상기와 같은 인접 셀간의 신호 간섭은 피할 수 있으나, 이러한 경우 필요한 PN 코드의 총 수는 전체 기지국의 수 및 가입자 단말기의 수의 곱에 비례해서 증가하게 된다. 또한, 상기와 같이 많은 코드를 상위 네트워크(예컨대, 기지국 관리기 또는 교환기 등)에서 관리하기도 용이하지 않다. 아울러, 핸드오버시 각 기지국은 최소 몇개의 인접 기지국에 속한 단말기들에 할당된 PN 코드들에 대하여 레이징 신호의 검색 능력을 가지고 있어야 하는 문제가 발생할 뿐만 아니라, 기존 셀에서 새로운 셀을 추가하게 될 경우 인접 기지국에도 동일한 문제점을 야기시키게 된다.

둘째, 현재 상기 IEEE 802.16a 방식에서와 같이 각 단말기가 초기 기지국 접속 이후 시간 옵셋 추적 및 채널 상태 보완을 위한 주기적 레인징 코드를 임의로 선택하여 사용하는 경우, 상기 기지국은 수신된 주기적 레인징 코드의 인식은 가능하나, 상기 검출된 주기적 레인징 코드와 상기 레인징 코드를 전송한 단말기를 매핑시키지 못하기 때문에, 어떤 단말기가 주기적 레인징 코드를 사용했는지 여부에 대한 단말기 인식(terminal identification)이 불가능하다. 상기와 같이 단말기 인식이 안될 경우, 기지국이 동기 수정, 신호 세기 및 레인징 상태를 포함한 레인징 응답(RNG-RSP)을 해당 단말기에만 전송하는 것이 불가능하며, 방송 채널(broadcasting channel)을 통해서 모든 단말기에게 전송해야 하는 단점이 발생한다.

셋째, 부가적 백색 잡음(AWGN; Additive White Gaussian Noise)이 추가되는 무선 환경에서는 상기 PN 코드들간의 직교성 부족으로 인해 수신 성능의 열화가 발생한다. 또한, 상기 PN 코드는 코드들간의 상관(correlation) 특성이 직교성(Orthogonality)을 보장하지 않는다. 따라서, 상기 PN 코드들이 전송 시간 슬롯 및 전송 주파수를 공유하는 경우, 레인징 코드들간의 직교성 부족으로 인해 코드간 간섭이 발생하며, 결국에는 레인징 성능의 열화로 이어진다.

네째, 현재 IEEE 802.16a 방식에 의하면 단말기의 주기적 레인징 시간 슬롯을 할당하지 않을 경우, 기지국에서는 한꺼번에 많은 레인징 신호들을 수신하는 경우가 발생할 수 있다. 이러한 경우, 상기 레인징 신호들은 서로 전송 슬롯 및 전송 주파수를 공유하기 때문에 코드간 간섭이 발생한다. 특히, 무선 접속 채널이 다중 경로(multipath)일 경우 채널 응답이 주파수에 따라 변하는 주파수 선택성(frequency selectivity)을 나타내기 때문에 이로 인한 코드 간섭이 더욱 심화된다. 결국, 심화된 코드 간섭은 레인징을 시도한 모든 단말기들의 레인징 실패로 이어지게 되는 문제가 발생한다.

발명이 이루고자 하는 기술적 과제

따라서, 본 발명의 목적은 직교 주파수 분할 다중 접속 방식을 사용하는 광대역 이동통신 시스템에서 동일 셀 내에서 및 인접 셀 간에 신호 간섭이 일어나지 않게 하는 레인징 신호 변조 장치 및 방법을 제공함에 있다.

또한, 본 발명의 목적은 직교 주파수 분할 다중 접속 방식을 사용하는 광대역 이동통신 시스템에서 각 기지국에 속한 단말기들에 할당된 레인징 코드를 용이하게 검색하는 방법을 제공함에 있다.

또한, 본 발명의 목적은 직교 주파수 분할 다중 접속 방식을 사용하는 광대역 이동통신 시스템에서 기지국이 각 단말기의 레인징 신호를 용이하게 인식하는 방법을 제공함에 있다.

또한, 본 발명의 목적은 직교 주파수 분할 다중 접속 방식을 사용하는 광대역 이동통신 시스템에서 초기 접속, 핸드오버 및 대역 요청 시간을 빠르게 하는 방법을 제공함에 있다.

또한, 본 발명의 목적은 직교 주파수 분할 다중 접속 방식을 사용하는 광대역 이동통신 시스템에서 백오프로 인한 시간 지연 없이 레인징 코드를 전송하는 방법을 제공함에 있다.

또한, 본 발명의 목적은 직교 주파수 분할 다중 접속 방식을 사용하는 광대역 이동통신 시스템에서 가입자 단말기별로 레인징 코드의 전송 시점을 스케줄링하여 레인징 코드를 효과적으로 전송하는 방법을 제공함에 있다.

상기한 목적을 달성하기 위한 본 발명의 방법은; 직교 주파수 분할 다중 방식(OFDM)/직교 주파수 분할 다중 접속 방식(OFDMA)을 사용하고, 기지국과 가입자 단말기간의 시간 동기 또는 기지국 동기를 맞추기 위하여 상기 기지국으로부터 상기 가입자 단말기로 레인징 정보를 전송하는 광대역 무선 접속 통신 시스템에서, 상기 가입자 단말기가 상기 기지국으로 상기 레인징 또는 대역 요구를 위한 레인징 코드를 전송하는 방법에 있어서, 상기 기지국과 동기를 획득하고, 상기 동기를 획득한 기지국으로부터 기지국 정보를 수신하는 과정과, 상기 수신된 기지국 정보로부터 기지국 고유의 제1 코드를 생성하고, 상기 기지국의 해당 셀 내에서 상기 가입자 단말기를 구별하기 위한 제2 코드를 생성하는 과정과, 상기 생성된 제1 코드 및 제2 코드를 조합하여 새로운 레인징 코드를 생성하는 과정과, 상기 생성된 레인징 코드를 상기 레인징 코드를 전송하기 위해 할당된 서브 캐리어에 매핑하여 전송하는 과정을 포함함을 특징으로 한다.

상기한 목적을 달성하기 위한 본 발명의 장치는; 직교 주파수 분할 다중 방식(OFDM)/직교 주파수 분할 다중 접속 방식(OFDMA)을 사용하고, 기지국과 가입자 단말기간의 시간 동기 또는 기지국 동기를 맞추기 위하여 상기 기지국으로부터 상기 가입자 단말기로 레인징 정보를 전송하는 광대역 무선 접속 통신 시스템에서, 상기 가입자 단말기가 상기 기지국으로 상기 레인징 또는 대역 요구를 위한 레인징 신호를 생성하는 장치에 있어서, 상기 가입자 단말기가 접속하고 있는 기지국의 정보와 매핑된 제1 코드를 생성하는 제1 코드 생성기와, 상기 기지국의 해당 셀 내에서 상기 가입자 단말기를 구별하기 위한 제2 코드를 생성하는 제2 코드 생성기와, 상기 생성된 제1 코드 및 제2 코드를 조합하여 새로운 레인징 코드를 생성하는 레인징 코드 생성기와, 상기 생성된 레인징 코드를 상기 레인징 코드를 전송하기 위해 할당된 서브 캐리어에 매핑하는 서브 캐리어 매핑기를 포함함을 특징으로 한다.

발명의 구성 및 작용

이하, 본 발명에 따른 바람직한 실시예를 첨부한 도면을 참조하여 상세히 설명한다. 하기의 설명에서는 본 발명에 따른 동작을 이해하는데 필요한 부분만이 설명되며 그 이외 부분의 설명은 본 발명의 요지를 흐트리지 않는 범위에서 생략될 것이라는 것을 유의하여야 한다.

본 발명은 직교 주파수 분할 다중 접속(Orthogonal Frequency Division Multiple Access; 이하 'OFDMA'이라 칭하기로 한다) 방식을 사용하는 통신 시스템(이하 'OFDMA 통신 시스템'이라 칭하기로 한다)에서 다중 셀에서 레인징 코드간의 간섭을 방지하고, 각 기지국별 가입자 단말기의 레인징 코드 식별을 용이하게 하며, 접속 지연 시간을 최소화하면서, 레인징 코드(ranging code) 충돌이 발생하지 않는 레인징 코드 할당 및 전송 방법을 제안한다.

이하, 본 발명을 설명함에 있어, 상기 OFDMA 통신 시스템의 구조는 상기 종래 기술 부분에서 설명한 도 1의 IEEE(Institute of Electrical and Electronics Engineers) 802.16a 통신 시스템과 동일한 구조를 가진다고 가정하기로 하며, 또한 OFDMA 프레임 구조 역시 상기 종래 기술 부분에서 설명한 도 2의 OFDMA 프레임 구조와 동일한 구조를 가진다고 가정하기로 한다. 물론, 상기 IEEE 802.16a 통신 시스템에 가입자 단말기의 이동성(mobility)을 고려한 IEEE 802.16e 통신 시스템에도 본 발명이 적용될 수 있음은 물론이다.

본 발명에서는 상술한 바와 같은 문제점을 해결하기 위하여, 레인징 코드를 구성함에 있어 각 기지국 별로 구별 가능한 코드를 사용하며, 동일셀 내의 다수의 기지국들에게 구별된 코드들을 할당하여 준다.

또한, 상기 각 가입자 단말기별로 할당된 고유한 레인징 코드를 특정 전송 슬롯을 통해 전송되도록 스케줄링함으로써 각 레인징 코들간의 충돌을 방지하여 초기 레인징, 핸드 오버 및 대역 요청을 빠르게 수행 가능하도록 한다.

즉, 본 발명에서는 상술한 바와 같이 레인징 절차를 진행함에 있어 역방향으로 레인징 코드를 랜덤하게 전송할 때 발생할 수 있는 각 단말기들의 레인징 코드들간의 충돌을 방지하기 위하여, 각 기지국의 각 단말기별로 직교성을 가지는 레인징 코드를 미리 할당하여 준다. 상기와 같은 할당을 통해, 해당 기지국에 초기 무선 접속을 시도하는 단말기들과 이미 접속된 후 주기적 레인징을 시도하는 단말기들이 송신하는 레인징 코드는 상호 코드 직교성을 가진다. 아울러 다수의 인접 기지국들에 접속된 단말기들과 다수의 인접 기지국들에 접속을 시도하는 단말기들이 송신하는 레인징 코드들과도 기지국간 상호 코드 직교성을 가진다.

또한, 기지국의 특정 시간 슬롯에 너무 많은 레인징 신호가 수신되어 해당 기지국의 레인징 검출 성능이 열화(degradation) 되는 것을 방지하기 위하여 각 단말기별로 레인징 코드 전송 시점을 다르게 하여 전송한다.

특히, 본 발명은 무선 셀룰라 시스템에서 상기와 같이 한 기지국에 다수의 단말기가 접속하고자 하는 상황에서 주기적인 레인징을 위한 효율적인 역방향 접속 방법을 제안한다.

한편, 본 발명의 실시예에 따르면, 상기 레인징 코드를 구성함에 있어 각 기지국별 구별을 위한 코드로는 PN 코드를 사용하며, 상기 각 셀에 속한 가입자 단말기들을 구별하기 위해서는 왈시 코드를 사용한다. 즉, 상기 가입자 단말기는 상기 각 기지국 별로 할당된 PN 코드와 각 가입자 단말기별로 할당된 왈시코드를 조합함으로써 고유의 레인징 코드를 할당받아 레인징 신호를 전송한다.

먼저, 도 14 및 도 15를 참조하여 레인징 코드 구성 방법을 설명한다.

도 14는 본 발명에 따른 다중 셀에서 레인징을 위한 PN 코드를 할당하는 방법을 나타낸 도면이다.

상기 도 14를 참조하면, 상기 OFDM/OFDMA 통신 시스템은 다수개의 셀(예컨대, 101번 셀 내지 106번 셀)로 구성될 수 있다. 즉, 상기 각 셀 영역에 속한 다수의 가입자 단말기는 소정의 기지국과 통신하게 되며, 상기 가입자 단말기의 이동에 따라 인접 셀로 핸드오버(handover)하여 통신하게 된다.

본 발명에 따르면, 각 단말기가 속한 셀 및 셀간의 신호 간섭을 제거하여 주파수 재사용률을 높이기 위하여 각 셀마다 하나 또는 다수의 정해진 PN 코드를 할당한다. 예컨대, 상기 셀 #100에는 PN #100을 할당하고, 셀 #101에는 PN #101A 및 PN #101B, 셀 #102에는 PN #102, 셀 #103에는 PN #103A, PN #103B 및 PN #103C, 셀 #104에는 PN #104, 셀 #105에는 PN #105, 셀 #106에는 PN #106A 및 PN #106B와 같이 할당할 수 있다.

상기 예에서 셀 #101의 경우는 상기 셀에 접속한 가입자 단말기들의 수가 많음으로써 요구되는 코드가 많기 때문에 두 개의 PN 코드를 할당하였다. 상기 셀 #103 및 셀 #106의 경우도 마찬가지이다. 즉, 하나의 PN 코드에 대해 N개의 왈시코드를 조합할 수 있다고 가정할 경우, 상기 소정 셀에 접속한 가입자 단말기들의 수가 N개를 초과할 경우, 상기 PN 코드가 추가로 요구된다. 예컨대, 할당 가능한 왈시코드가 10개라고 가정할 경우, 특정 셀에 접속한 가입자 단말기가 54개이면 상기 해당 셀에 할당되는 PN 코드는 6개(즉, PN #101A ~ PN #101F)가 되어야 한다.

한편, 상기 기지국들은 각 기지국별로 할당된 상기 PN 코드의 정보를 순방향 DL-MAP 메시지에 포함하여 상기 해당 기지국과 접속하는 각 가입자 단말기들로 전송하게 되며, 상기 DL-MAP 메시지를 수신한 상기 가입자 단말기들은 상기 DL-MAP 메시지로부터 사용할 기지국 코드 정보를 알아낸 후, 후술할 기지국 레인징 신호 변조 과정에 사용한다.

또한, 상기 기지국은 수신된 레인징 신호의 검출시에 인접 기지국들의 PN 코드들의 정보를 미리 알고 있는 상태에서 상기 정보를 이용하여 인접 기지국들에 접속된 단말기들이 상기 기지국으로 핸드오버할 경우 송신하게 되는 레인징 신호들의 검출에 이용한다. 즉, 상기와 같은 과정을 통해, 상기 기지국은 인접 기지국들로부터 상기 기지국으로 핸드오버를 원하는 가입자 단말기들의 현재 접속된 기지국을 자동으로 인식하게 된다.

아울러, 상기와 같이 기지국 별로 할당된 PN 코드를 사용함으로써 상기 셀에 초기 무선 접속 및 주기적 동기 시간 오차 보상을 위한 주기적 레인징 신호를 송신하는 단말기들과 인접 기지국에 접속된 단말기가 송신하는 레인징 신호들간의 상호 신호 간섭을 제거할 수 있게 된다.

이하, 도 15를 참조하여 상기 PN 코드가 할당된 특정 셀 내에서 각 가입자 단말기별로 구분하기 위한 코드의 할당을 설명한다.

도 15는 본 발명에 따른 동일 셀 내의 각 단말기에 레인징을 위한 왈쉬 코드를 할당하는 방법을 나타낸 도면이다.

상기 도 15를 참조하면, 셀 ID가 #200이고, 기지국 ID가 #300이라고 가정하며, 상기 셀 내에 3개의 가입자 단말기(#400, #401, #402)가 접속하고 있다고 가정한다. 이때, 하나의 PN 코드당 할당할 수 있는 왈시(Walsh) 코드가 N개라고 할 때, 상기 가입자 단말기 #400에는 왈시 #1 코드가 할당되고, 가입자 단말기 #401에는 왈시 #2가 할당되고, 가입자 단말기 #402에는 왈시 #3이 할당될 수 있다.

한편, 상기 왈시 코드의 길이는 후술할 레인징 코드의 코딩을 위해 상기 PN 코드와 같은 길이를 가지도록 설정함이 바람직하다. 또한, 상기 왈시 코드들 중 일부는 특정 가입자 단말기에게 할당하지 않고 남겨두어, 초기 무선 접속시에 불특정 가입자 단말기들이 사용할 수 있도록 하게 할 수 있다. 예컨대, 상기 길이 N의 왈시코드가 N개 할당할 수 있다고 할 경우, 왈시 #1 내지 왈시 #J(J<N)는 상기 가입자 단말기들의 레인징 코드 구성을 위해 할당하며, 왈시 #J+1 내지 왈시 #N은 초기 레인징 신호를 위한 불특정 가입자 단말기들의 레인징 코드 구성을 위해 할당한다.

보다 구체적으로 설명하면, 상술한 바와 같이 OFDMA 역방향 시스템에서 셀(기지국)마다 공동으로 같은 코드 길이의 왈시 코드를 레인징 코드로 사용하게 되고, 상기 왈시 코드의 길이가 N이라 하면, 상기 도 14에서 상술한 PN 코드의 길이도 N으로서 동일하게 할당한다. 상기 왈시 코드는 코드들간에 직교성을 가지기 때문에 동일 셀내에서 사용되는 레인징 코드들간에는 신호 간섭이 발생하지 않는다.

또한, 상술한 바와 같이 셀마다 동일한 일정 수의 왈시 코드들을 레인징 코드의 용도에 따라 구분하여 사용할 수 있다. 예컨대, 추기 무선 접속을 원하는 단말기가 임의 선택하여 초기 레인징 코드로 사용 가능하도록 미리 정해진 (N-J)개의 왈시 코드들을 구분하여 사용할 수 있다. 여기서, 초기 레인징 코드는 가입자 단말기의 기지국 역방향 초기 무선 접속시 및 상기 단말기가 다른 기지국으로의 핸드오버시를 지칭한다. 또한, N 개의 왈시 코드들 중에서 남은 J 개의 왈시 코드를 상기 가입자 단말기의 무선 접속 후 주기적 레인징 코드용 및 대역 요청 코드로 구분하여 사용할 수 있다. 상기 J 개의 주기적 레인징 코드 및 대역 요청 코드는 단말기 인식 및 임의 선택시 발생되는 단말기들의 동일 코드 사용으로 인한 코드 간섭을 방지하기 위하여 기지국이 각 단말기에게 할당한다. 상기 할당 방법은 후술하기로 한다.

이하, 도 16을 참조하여, 상기 특정 가입자 단말기에게 할당된 PN 코드 및 왈시 코드를 이용하여 레인징 코드를 구성 및 전송하는 방법을 설명한다.

도 16은 본 발명에 따른 각 단말기별로 고유의 새로운 레인징 코드를 할당하는 방법을 나타낸 도면이다.

상기 도 16을 참조하면, 실제적으로 상기 가입자 단말기별로 할당되는 레인징을 위한 코드는 상기 도 14에서 상술한 PN 코드와 상기 도 15에서 상술한 왈시 코드를 칩 단위로 곱셈 연산함으로써 얻어진다. 즉, 상기 PN 코드 및 왈시 코드의 곱셈 연산을 통해 새로운 레인징 코드가 생성된다.

이때, 상기 PN 코드의 수가 K개이고, 왈시 코드의 수가 M개라고 가정할 경우, 발생 가능한 상기 레인징 코드의 수는 K×M 개가 된다. 결과적으로 상기 레인징 코드는 코드간의 비트 연산을 통해 생성되므로, 새로이 생성되는 상기 레인징 코드의 길이는 상기 PN 코드 또는 왈시 코드의 길이와 동일하게 된다.

예컨대, 상기 기지국에 할당된 PN 코드를 PN #1코드라 하고, 상기 PN 칩을 $[C_{11}\ C_{12}\ C_{13}\ C_{14}\ \ldots\ C_{1N}]$의 1 by N 의 벡터로 표시하며, 선택된 특정 왈시 코드를 왈시 #1이라 하고, 상기 왈시 칩을 $[W_{11}\ W_{12}\ W_{13}\ W_{14}\ \ldots\ W_{1N}]$의 1 by N 의 벡터로 표시할 경우, 상기 칩들간의 곱셈 연산을 통해 얻어지는 레인징 코드는 $[C_{11}W_{11}\ C_{12}W_{12}\ C_{13}W_{13}\ \ldots\ C_{1N}W_{1N}]$의 1 by N 벡터로 얻어진다.

상기 각 칩들별로 연산된 값들은 레인징 코드 전송용으로 할당된 다수의 서브 캐리어들에 각각 할당된다. 예컨대, $C_{11}*W_{11}$의 결과는 f_1, $C_{12}*W_{12}$의 결과는 f_2, $C_{13}*W_{13}$의 결과는 f_3, $C_{14}*W_{14}$의 결과는 f_4,.....및 $C_{1N}*W_{1N}$의 결과는 f_N의 서브캐리어에 할당하여 IFFT 변환한다. 상기에서 발생된 레인징 코드의 코드 길이가 N인 경우 레인징 서버 채널에 속한 부반송파의 개수도 N이며 상기 부반송파마다 상기 레이징 코드의 코드칩을 변조하게 된다.

이하, 상기와 같이 생성된 레인징 코드를 IFFT를 사용하여 변조하여 전송하는 단말기 장치를 도 17을 참조하여 설명한다.

도 17은 본 발명의 실시예에 따른 레인징 신호를 변조하는 단말기 송신 장치를 나타낸 도면이다.

상기 도 17을 참조하면, 상기 도 14 내지 16의 방법에 의해 결정된 레이징 코드를 전송하는 단말기의 송신 장치는 N 포인트 IFFT(1711), 병렬/직렬 변환기(1713), 저역 통과 필터(1715) 등으로 구성된다.

상기 도 16에서 각각의 서브 캐리어에 매핑된 길이 N의 레인징 코드는 각각 상기 N 포인트 IFFT(1711)에 입력된다. 한편, 상기 IFFT의 입력 포인트가 N개라고 가정하며, 상기 레인징 코드의 길이를 L이라고 가정하였을 때, 상기 길이 L의 레인징 코드는 상기 N 포인트 IFFT(1711)의 N 개의 입력 포인트들 중에서 L개의 포인트를 선택하여 입력한다. 상기 N 포인트 IFFT(1711)를 통해 IFFT 변환된 상기 레인징 코드는 병렬/직렬 변환기(1713)를 통해 병렬/직렬 변환된후, 저역 통과 필터(1715)를 통해 필터링된 후, RF 처리기(미도시) 및 안테나(미도시)에 의해 기지국으로 전송된다.

이하, 상기 도 17의 송신 장치를 통해 송신된 레인징 코드를 수신하여 복조하는 기지국 수신 장치를 도 18 내지 도 20을 참조하여 설명한다.

도 18은 본 발명의 실시예에 따른 레인징 신호를 검출하는 기지국 수신 장치를 나타낸 도면이다.

상기 도 18을 참조하면, 가입자 단말기로부터 전송된 상기 레인징 코드를 수신하여 복조하는 기지국 수신 장치는 N 포인트 FFT(1811), 레인징 서브채널 선택기(1823), 제1 및 제2 PN 상관기(PN correlator; 1815, 1821), 제1 및 제2 왈시 상관기(Walsh correlator; 1817, 1823) 및 시간 옵셋/신호 전력 트래킹기(1819)로 구성된다.

상기 도 17에서의 가입자 단말기로부터 전송된 레인징 신호를 수신한 기지국은 Cyclic prefix가 제거된 후 N 개의 샘플로서 상기 N 포인트 FFT(1811)를 통해 FFT 변환된다. 상기 변환된 FFT의 출력 샘플은 개념상 주파수 영역의 신호이며, 상기 출력된 N 개의 서브 캐리어들은 상기 레인징 서브 채널 선택기(1813)에서 레인징 서버 채널을 구성하는 서브 캐리어들의 주파수 위치에 해당되는 샘플만을 선택하게 된다. 상기 선택된 레인징용 서브 캐리어들은 용도에 따라 제1 PN 상관기(1815) 또는 제2 PN 상관기(1821)로 입력된다. 예컨대, 상기 제1 PN 상관기(1815)에서는 해당 기지국에 할당된 PN 코드를 사용하며, 상기 제2 PN 상관기(1821)에서는 인접 기지국에 할당된 PN 코드를 사용하도록 구현할 수 있다. 따라서, 해당 기지국과 접속하는 가입자 단말기들로부터 전송된 레인징 신호들은 상기 제1 PN 상관기(1815)에서 처리하며, 인접 기지국들에 속한 가입자 단말기들이 핸드오버 등을 위해 상기 해당 기지국으로 전송하는 레인징 신호들은 상기 제2 PN 상관기(1821)에서 처리하도록 할 수 있다. 상기 제1 및 제2 PN 상관기(1815, 1821)에 대한 구체적인 구조는 도 19에서 후술하기로 한다.

상기 제1 PN 상관기(1815) 및 제2 PN 상관기(1817)에서는 해당 기지국별로 할당된 PN 코드에 의해 상기 해당 기지국과 접속하는 가입자 단말기들이 상기 PN 코드를 통해 전송한 레인징 신호만을 검출한다. 즉, 인접 기지국들의 다수의 가입자 단말기들로부터 전송되는 레인징 코드들은 상기 PN 상관기들에 의해 여과된다.

한편, 상기 제1 PN 상관기(1815) 및 제2 PN 상관기(1817)로부터 출력된 신호는 제1 및 제2 왈시 상관기(1817, 1823)로 입력되며, 최종적으로 상기 제1 및 제2 왈시 상관기(1817, 1823)에 의해 각 가입자 단말기들을 구별하게 된다. 즉, 상기 기지국이 해당 기지국에 속한 가입자 단말기별로 부여한 왈시 코드를 검출함으로써 상기 레인징 신호를 전송한 가입자 단말기를 식별하게 된다. 상기 가입자 단말기를 식별한 기지국은 상기 시간 옵셋 및 신호 전력 트래킹기(1819)에 의해 시간 옵셋 및 신호 전력을 트래킹함으로써 레인징을 수행한다.

한편, 상기 PN 상관기들(1815, 1821)은 도 19와 같이 구현될 수 있다.

도 19는 본 발명의 실시예에 따른 PN 코드 상관기를 나타낸 도면이다.

상기 도 19를 참조하면, 상기 PN 상관기는 길이 K의 PN코드를 저장하는 PN 코드 레지스터(1913)와 상기 PN 코드의 각각의 값들과 입력 신호를 곱셈 연산하는 K개의 곱셈기들(1917 내지 1921)로 구성될 수 있다. 예컨대, K개의 서브 캐리어에 할당된 레인징 코드(1911)는 각각 상기 PN 코드 레지스터(1913)에 저장된 각각의 PN 코드값들과 곱셈 연산 처리된다. 한편, 상기 PN 코드 레지스터(1913)에 저장된 PN 코드값들은 상술한 바와 같이 해당 기지국별로 기 설정된 PN 코드 값이다. 따라서, 상기 저장된 PN 코드 값들과 수신된 레인징 코드(1911)를 상관 검출함으로써 동일한 PN 코드로서 전송된 레인징 코드만을 검출해낼 수 있게 된다.

이하, 상기 도 18의 왈시 상관기들(1917, 1823)을 도 20을 참조하여 설명한다.

도 20은 본 발명의 실시예에 따른 왈시 코드 상관기를 나타낸 도면이다.

상기 도 20을 참조하면, 상기 기지국 수신 장치를 구성하는 왈시 코드 상관기는 K 개의 왈시 가중값들을 저장하는 왈시 가중 처리기(2013), 다수의 곱셈기들(2015 내지 2021) 및 다수의 덧셈 연산기들(2023 내지 2027)로 구성된다. 상기 왈시 코드 상관기는 상기 도 19의 출력값들을 입력값들(2011)로 취하여 왈시 코드 상관 검출을 수행한다.

즉, 상기 왈시 코드 상관기로 입력된 PN 코드 상관 검출된 K 개의 값들(2011)은 상기 왈시 가중 처리기(2013)의 가중 상수들과 각각 곱셈 연산되고, 상기 도 20에 도시된 바와 같이 상기 각 곱셈 연산된 값들을 덧셈 연산 함으로써 최종 결과값(2029)을 출력한다.

여기서, 상기 왈시 가중 처리기(2013)의 K 개의 가중 값들은 상기 왈시 코드 상관기가 상기 도 18에서의 제1 왈시 상관기(1817)일 경우, 모든 왈시 코드들 중에서 임의로 선택된 코드이며, 상기 왈시 코드 상관기가 상기 도 18에서의 제2 왈시 상관기(1823)일 경우 상기 왈시 코드들 중에서 주기적 레인징, 대역 요청 및 핸드오버 용으로 구분된 코드들 중의 하나이다. 또한, 상기 왈시 가중 처리기(2013)의 각 상수들은 예컨대 채널 주파수 응답을 고려하여 상술한 해당 왈시 코드 칩과 특정 상수의 곱셈으로 얻어지는 가중된 왈시 코드들로 구현될 수 있다.

한편, 본 발명에서 제안하는 레인징 코드의 단말기별 할당 및 전송시간 할당은 기지국에서 처리하도록 하는 것이 바람직하다. 본 발명에 따르면 상기 레인징 전송시간의 할당 방법은 상기 레인징 신호의 전송 시간을 다르게 함으로써 상기 기지국에서 레인징 신호를 수신시 다중 패스 채널 환경으로 인해 발생되는 레인징 신호들간의 간섭을 줄일 수 있게 된다. 이에 따라, 상기 레인징 신호의 검출 성능을 높일 수가 있다.

이하, 상기 각 가입자 단말기별로 새로이 생성된 레인징 코드를 전송하는 방법을 도 20을 참조하여 설명한다.

도 21은 본 발명의 실시예에 따른 기지국이 각 단말기의 레인징 신호 전송을 스케줄링 하는 방법을 나타낸 도면이다.

상기 도 18에서 상술한 바와 같이 IFFT 변환된 레인징 코드는 하나의 슬롯 구간을 통해 전송된다. 종래 기술에서는 상술한 바와 같이 상기 각 가입자 단말기들이 레인징 코드를 전송하고자 할 경우, 레인징 코드 전송 구간 중에서 무작위로 선택된 슬롯 구간을 통해 전송하였다. 그러나, 본 발명에 따르면, 각 가입자 단말들에게 고유의 레인징 코드를 할당하였으므로, 기지국이 각 가입자 단말기를 식별하여 상기 레인징 코드의 전송 시점을 스케줄링하는 것이 가능하다.

즉, 본 발명에 따르면 다중 패스 채널 환경에서 같은 셀 내의 레인징 신호 전송 시간을 그룹 지어 신호간 충돌을 줄임으로써 기지국에서 레인징 신호의 수신 성능을 높이게 된다.

상기 도 21을 참조하면, 상기 레인징 신호 전송은 가입자 단말기가 L개의 업링크 프레임들로 구성된 1개의 업링크 수퍼 프레임(UL super-frame)마다 한번씩 실시할 수 있도록 구현한다. 상기 업링크 수퍼 프레임의 크기를 결정하는 파라미터인 L값은 각 기지국마다 다른 정수 값을 가지도록 설정할 수 있다.

또한, 상기 업링크 수퍼 프레임을 구성하는 L 개의 프레임 각각마다 M 개의 레인징 슬롯이 존재한다. 이러한 경우에, 파라미터 M은 각 기지국마다 동일한 정수 값으로 설정하는 것이 바람직하다. 예컨대, 하나의 업링크 수퍼 프레임 구간동안 레인징 신호 전송이 가능한 슬롯은 M×L 개가 존재하면, 각 단말기는 상기 기지국으로부터 단 하나의 슬롯을 할당받아 주기적 레인징을 한다.

상기와 같이 다수의 가입자 단말기들이 레인징 신호를 전송하는 구간을 분산시킴으로써 주파수 선택적 무선 채널 환경에서 다른 레인징 신호들과의 신호 간섭이 발생하더라도 전체 간섭의 정도를 감소시킬 수 있게 된다.

이하, 도 22 및 도 23을 참조하여, 상술한 바와 같은 본 발명에 따른 레인징 신호 송수신 장치에 의한 상기 레인징 신호 송수신 방법을 설명한다.

도 22는 본 발명의 실시예에 따른 기지국 송신 절차를 나타낸 흐름도이다.

상기 도 22를 참조하면, 각 기지국은 상기 기지국에 접속된 단말기들의 수를 항상 소정의 레지스터(Register)에 저장한다. 먼저, 2201 단계에서 상기 기지국에 새로이 접속하는 단말기가 있을 경우, 상기 새로이 접속된 단말기의 개수를 업데이트($J=J_{old}+1$, J는 해당 기지국과 접속하는 모든 단말기의 수)한다.

한편, 상기와 같이 단말기의 개수가 업데이트 된 후, 2203단계에서 상기 각 가입자 단말기에 대한 레인징 슬롯을 할당한다. 이때, 상기 각 가입자 단말기별로 할당되는 레인징 슬롯은 하기 <수학식 1>과 같이 나타낼 수 있다.

수학식 1

$$\#\ of\ slot = J \bmod ML$$

이때, 상기 M 및 L은 각각 상기 도 22에서 상술한 하나의 수퍼 프레임당 프레임 개수 및 하나의 프레임당 슬롯 수이다.

상기와 같이 단말기별 레인징 전송 슬롯을 할당한 후, 2205 단계에서 상기 단말기별 레인징 코드의 구별을 위하여 왈시 코드를 각각 할당한다. 상기 왈시 코드의 할당 방법은 하기 <수학식 2>와 같이 구현할 수 있다.

수학식 2

$$\#\ of\ Walsh = Fix(\frac{J}{ML})$$

상기 <수학식 2>에서 Fix(x)는 x 값을 0의 방향으로 가장 가까운 정수 값으로 투영한다. 즉, 상기 Fix 함수는 x값의 소수점 이하 값을 버리고, 정수값을 취하게 되는 함수이다.

그런다음, 2207 단계에서 상기 기지국은 상술한 UL-MAP 등과 같은 하향링크 방송 메시지를 통해 상기 할당된 왈시 코드 및 전송 슬롯 정보를 해당 가입자 단말기로 전송한다.

이하, 상기 도 22에 의해 기지국으로부터 전송된 레인진 코드 정보 및 레인징 전송 슬롯 정보를 수신하여 해당 가입자 단말기가 레인징을 수행하는 절차를 도 23을 참조하여 설명한다.

도 23은 본 발명의 실시예에 따른 가입자 단말기가 레인징 코드를 생성하여 전송하는 절차를 나타낸 도면이다.

상기 도 23을 참조하면, 먼저 가입자 단말기는 초기 레인징을 통해 기지국과의 동기를 획득하고, 상기 접속하고 있는 기지국의 정보를 수신(2301 단계)한다. 상기 가입자 단말기는 상기 기지국의 정보로부터 해당 기지국에 대해 기설정된 PN 코드를 할당(2303 단계)한다. 또한, 상기 기지국으로부터 가입자 단말기 고유의 왈시 코드를 할당(2305 단계)받는다.

상기 PN 코드 및 왈시 코드를 할당받은 상기 가입자 단말기는 상기 코드들로부터 상술한 방법에 의해 새로운 레인징 코드를 생성(2307 단계)한다. 상기 생성된 레인징 코드는 레인징 코드 전송을 위해 할당된 서브 캐리어에 매핑(2319 단계)된다.

상기 각 서브 캐리어에 매핑된 레인징 코드들은 IFFT 변환된 후, 기 설정된 시간에 기지국으로 전송(2311 단계)된다.

상기와 같은 방법에 의해 각 가입자 단말기별로 레인징 코드를 전송할 시점을 결정해 주며, 각 기지국 및 가입자 단말기별로 구별할 수 있는 고유의 코드를 각각 할당하여 줌으로써 상술한 바와 같이 레인징 신호의 전송 및 레인징 신호의 복호를 효율적으로 수행할 수 있다.

한편, 본 발명의 상세한 설명에서는 구체적인 실시예에 관해 설명하였으나, 본 발명의 범위에서 벗어나지 않는 한도 내에서 여러가지 변형이 가능함은 물론이다. 그러므로 본 발명의 범위는 설명된 실시예에 국한되어 정해져서는 안되며 후술하는 특허청구의 범위뿐만 아니라 이 특허청구의 범위와 균등한 것들에 의해 정해져야 한다.

발명의 효과

상술한 바와 같은 본 발명은, 기지국에서 레인징 수신 검출 성능을 향상시킨에 따라 초기 무선 접속 시간 및 핸드오버 지연시간을 줄일 수 있게 되는 장점이 있다. 또한, 기지국 구별을 위한 코드와 단말기 구별을 위한 코드를 별도 할당하여, 기지국의 레인징 신호 검출 계산량을 줄일 수 있다. 뿐만아니라, 기존 셀에 속한 단말기의 급격한 증가로 인해 새로운 셀을 추가해야 하는 경우에는 단순히 새로운 셀에 하나 이상의 PN 코드를 할당함으로써 용이하게 셀 계획을 수립하게 되는 장점이 있다. 아울러, PN 코드와 왈시 코드의 조합을 레인징 신호로 사용하는 경우 PN 코드만을 사용하는 경우보다 훨씬 많은 할당 가능 코드를 발생시킬 수 있다.

(57) 청구의 범위

청구항 1.

직교 주파수 분할 다중 방식(OFDM)/직교 주파수 분할 다중 접속 방식(OFDMA)을 사용하고, 기지국과 가입자 단말기간의 시간 동기 또는 기지국 동기를 맞추기 위하여 상기 기지국으로부터 상기 가입자 단말기로 레인징 정보를 전송하는 광대역 무선 접속 통신 시스템에서, 상기 가입자 단말기가 상기 기지국으로 상기 레인징 또는 대역 요구를 위한 레인징 코드를 전송하는 방법에 있어서,

상기 기지국과 동기를 획득하고, 상기 동기를 획득한 기지국으로부터 기지국 정보를 수신하는 과정과,

상기 수신된 기지국 정보로부터 기지국 고유의 제1 코드를 생성하고, 상기 기지국의 해당 셀 내에서 상기 가입자 단말기를 구별하기 위한 제2 코드를 생성하는 과정과,

상기 생성된 제1 코드 및 제2 코드를 조합하여 새로운 레인징 코드를 생성하는 과정과,

상기 생성된 레인징 코드를 상기 레인징 코드를 전송하기 위해 할당된 서브 캐리어에 매핑하여 전송하는 과정을 포함함을 특징으로 하는 상기 방법.

청구항 2.

제1항에 있어서,

상기 전송되는 레인징 코드는 주기적 레인징을 위하여 전송되는 레인징 코드임을 특징으로 하는 상기 방법.

청구항 3.

제1항에 있어서,

상기 전송되는 레인징 코드는 대역 요청을 위하여 전송되는 레인징 코드임을 특징으로 하는 상기 방법.

청구항 4.

제1항에 있어서,

상기 기지국 고유의 제1 코드는 PN(Pseudo Noise) 시퀀스로서 구성함을 특징으로 하는 상기 방법.

청구항 5.

제1항에 있어서,

상기 특정 셀 내에서 가입자 단말기를 구별하기 위한 제2 코드는 왈시 코드임을 특징으로 하는 상기 방법.

청구항 6.

제1항에 있어서,

상기 제1 코드 및 제2 코드를 조합하는 방법은 상기 제1 코드와 제2 코드를 곱셈 연산함을 특징으로 하는 상기 방법.

청구항 7.

제1항에 있어서,

상기 가입자 단말기의 레인징 코드 전송은,

해당 셀 내에서 상기 레인징 코드를 전송하기 위해 할당된 상향링크 전송 슬롯 구간들을 다수개의 전송 그룹들로 분할하고, 상기 레인징 코드를 전송하는 다수의 가입자 단말기들이 상기 전송 그룹들에 고르게 분포되도록 상기 전송 그룹을 할당하여, 상기 할당된 전송 그룹에서 상기 레인징 코드를 전송함을 특징으로 하는 상기 방법.

청구항 8.

제1항에 있어서,

상기 가입자 단말기로 전송되는 기지국 정보는 상기 기지국이 전송하는 하향링크 맵(DL-MAP) 메시지를 통해 전송됨을 특징으로 하는 상기 방법.

청구항 9.

제1항에 있어서,

상기 레인징 코드의 전송 시점에 대한 정보는 상기 기지국이 전송하는 상향링크 맵(UL-MAP) 메시지를 통해 전송됨을 특징으로 하는 상기 방법.

청구항 10.

제1항에 있어서,

상기 레인징 코드에 관한 변조 방법 및 코딩 정보는 상기 기지국이 전송하는 상향링크 채널 디스크립트(UCD) 메시지를 통해 전송됨을 특징으로 하는 상기 방법.

청구항 11.

직교 주파수 분할 다중 방식(OFDM)/직교 주파수 분할 다중 접속 방식(OFDMA)을 사용하고, 기지국과 가입자 단말기간의 시간 동기 또는 기지국 동기를 맞추기 위하여 상기 기지국으로부터 상기 가입자 단말기로 레인징 정보를 전송하는 광대역 무선 접속 통신 시스템에서, 상기 가입자 단말기가 상기 기지국으로 상기 레인징 또는 대역 요구를 위한 레인징 신호를 생성하는 장치에 있어서,

상기 가입자 단말기가 접속하고 있는 기지국의 정보와 매핑된 제1 코드를 생성하는 제1 코드 생성기와,

상기 기지국의 해당 셀 내에서 상기 가입자 단말기를 구별하기 위한 제2 코드를 생성하는 제2 코드 생성기와,

상기 생성된 제1 코드 및 제2 코드를 조합하여 새로운 레인징 코드를 생성하는 레인징 코드 생성기와,

상기 생성된 레인징 코드를 상기 레인징 코드를 전송하기 위해 할당된 서브 캐리어에 매핑하는 서브 캐리어 매핑기를 포함함을 특징으로 하는 상기 장치.

청구항 12.

제11항에 있어서,

상기 전송되는 레인징 코드는 주기적 레인징을 위하여 전송되는 레인징 코드임을 특징으로 하는 상기 장치.

청구항 13.

제11항에 있어서,

상기 전송되는 레인징 코드는 대역 요청을 위하여 전송되는 레인징 코드임을 특징으로 하는 상기 장치.

청구항 14.

제11항에 있어서,

상기 제1 코드 생성기에서 생성되는 제1 코드는 PN(Pseudo Noise) 시퀀스임을 특징으로 하는 상기 장치.

청구항 15.

제11항에 있어서,

상기 제2 코드 생성기에서 생성되는 제2 코드는 왈시 코드임을 특징으로 하는 상기 장치.

청구항 16.

제11항에 있어서,

상기 레인징 코드 생성기는 상기 제1 코드 및 제2 코드를 곱셈 연산하는 곱셈기를 더 포함함을 특징으로 하는 상기 장치.

청구항 17.

제11항에 있어서,

상기 가입자 단말기의 레인징 코드 전송은,

해당 셀 내에서 상기 레인징 코드를 전송하기 위해 할당된 상향링크 전송 슬롯 구간들을 다수개의 전송 그룹들로 분할하고, 상기 레인징 코드를 전송하는 다수의 가입자 단말기들이 상기 전송 그룹들에 고르게 분포되도록 상기 전송 그룹을 할당하여, 상기 할당된 전송 그룹에서 상기 레인징 코드를 전송함을 특징으로 하는 상기 장치.

청구항 18.

제11항에 있어서,

상기 가입자 단말기로 전송되는 기지국 정보는 상기 기지국이 전송하는 하향링크 맵(DL-MAP) 메시지를 통해 전송됨을 특징으로 하는 상기 장치.

청구항 19.

제11항에 있어서,

상기 레인징 코드의 전송 시점에 대한 정보는 상기 기지국이 전송하는 상향링크 맵(UL-MAP) 메시지를 통해 전송됨을 특징으로 하는 상기 장치.

청구항 20.

제11항에 있어서,

상기 레인징 코드에 관한 변조 방법 및 코딩 정보는 상기 기지국이 전송하는 상향링크 채널 디스크립트(UCD) 메시지를 통해 전송됨을 특징으로 하는 상기 장치.

청구항 21.

제11항에 있어서,

상기 제1 코드 생성기는,

상기 생성된 다수의 제1 코드군들 중에서 상기 기지국과 매핑된 하나의 제1 코드를 할당하는 제1 코드 할당기를 더 포함함을 특징으로 하는 상기 장치.

청구항 22.

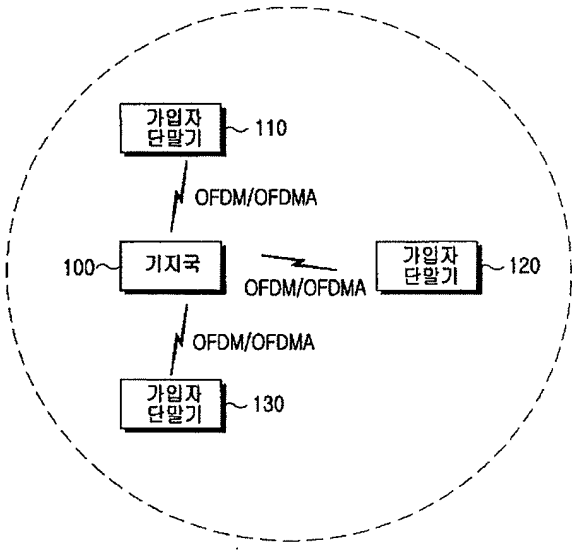
제11항에 있어서,

상기 제2 코드 생성기는,

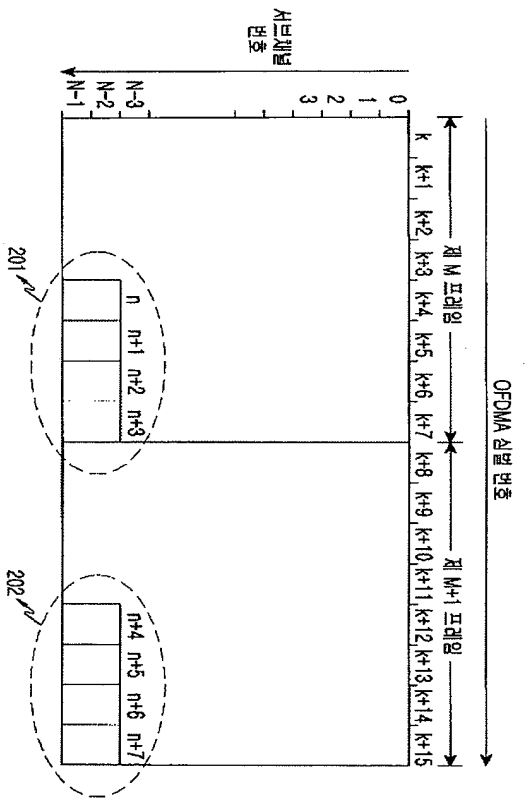
상기 생성된 다수의 제2 코드군들 중에서 특정 셀 내에서 상기 가입자 단말기에게 고유한 하나의 제2 코드를 할당하는 제2 코드 할당기를 더 포함함을 특징으로 하는 상기 장치.

도면

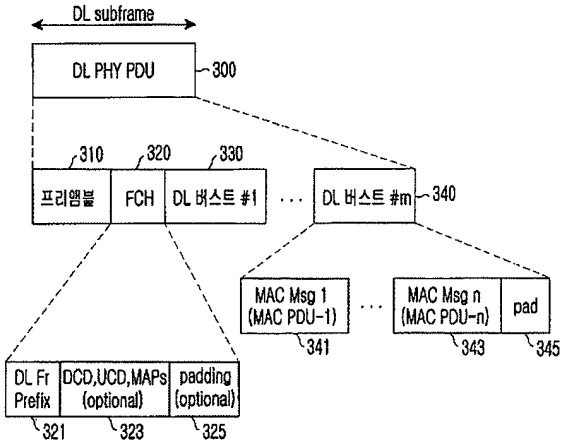
도면1



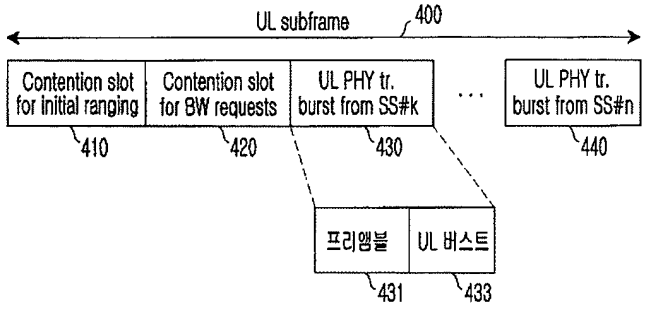
도면2


서브채널 번호
N-1
N-2
N-3
3
2
1
0
k
k+1
k+2
k+3
k+4
k+5
k+6
k+7
k+8
k+9
k+10
k+11
k+12
k+13
k+14
k+15
제 M 프레임
제 M+1 프레임
OFDMA 심볼 번호
201
n
n+1
n+2
n+3
202
n+4
n+5
n+6
n+7

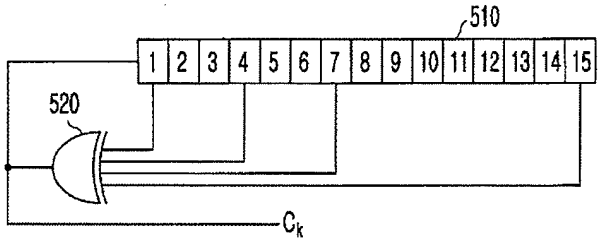
도면3


DL subframe
DL PHY PDU
300
310
320
330
프리앰블
FCH
DL 버스트 #1
DL 버스트 #m
340
MAC Msg 1
(MAC PDU-1)
MAC Msg n
(MAC PDU-n)
pad
341
343
345
DL Fr
Prefix
DCD,UCD,MAPs
(optional)
padding
(optional)
321
323
325

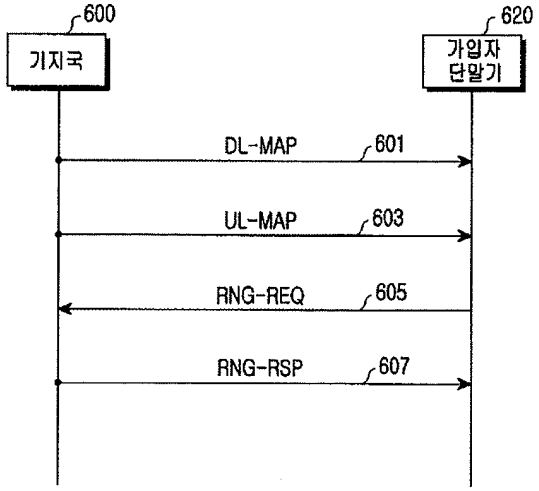
도면4


UL subframe
400
Contention slot
for initial ranging
Contention slot
for BW requests
UL PHY tr.
burst from SS#k
UL PHY tr.
burst from SS#n
410
420
430
440
프리앰블
UL 버스트
431
433

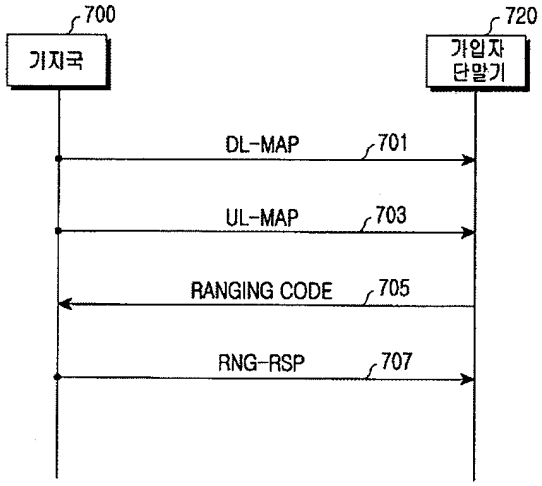
도면5


510
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
520
C_k

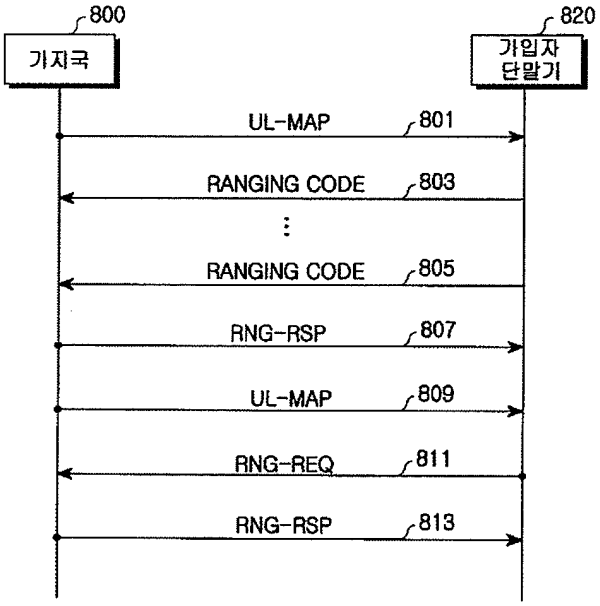
도면6


600
기지국
620
가입자 단말기
DL-MAP
601
UL-MAP
603
RNG-REQ
605
RNG-RSP
607

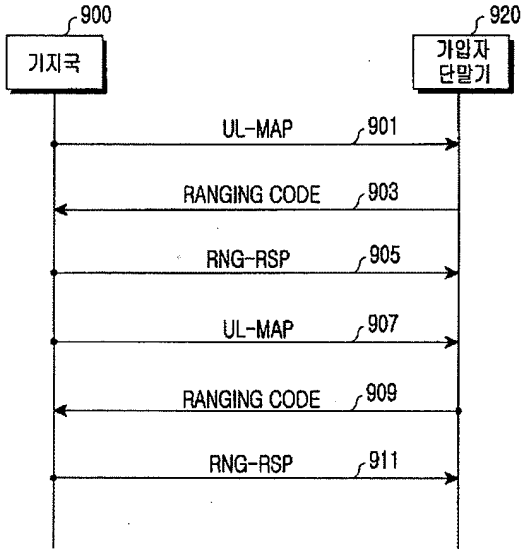
도면7


700
기지국
720
가입자 단말기
DL-MAP
701
UL-MAP
703
RANGING CODE
705
RNG-RSP
707

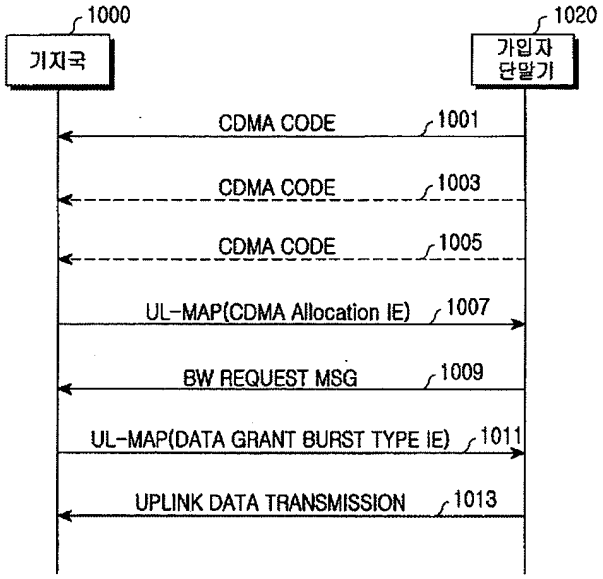
도면8


800
기지국
820
가입자 단말기
UL-MAP
801
RANGING CODE
803
RANGING CODE
805
RNG-RSP
807
UL-MAP
809
RNG-REQ
811
RNG-RSP
813

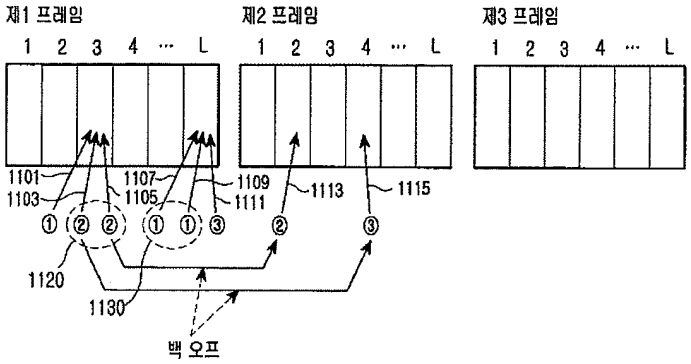
도면9


900
기지국
920
가입자 단말기
UL-MAP
901
RANGING CODE
903
RNG-RSP
905
UL-MAP
907
RANGING CODE
909
RNG-RSP
911

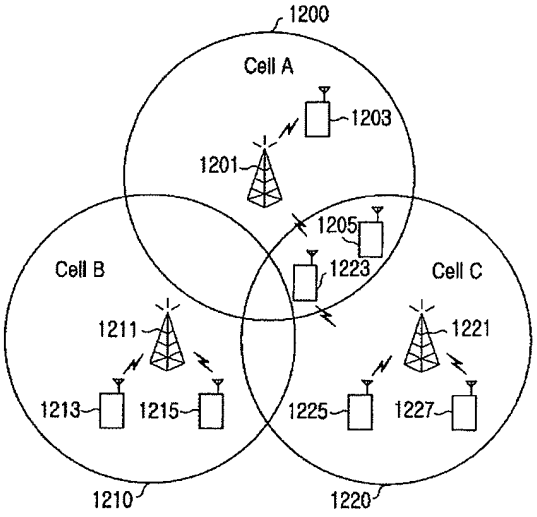
도면10



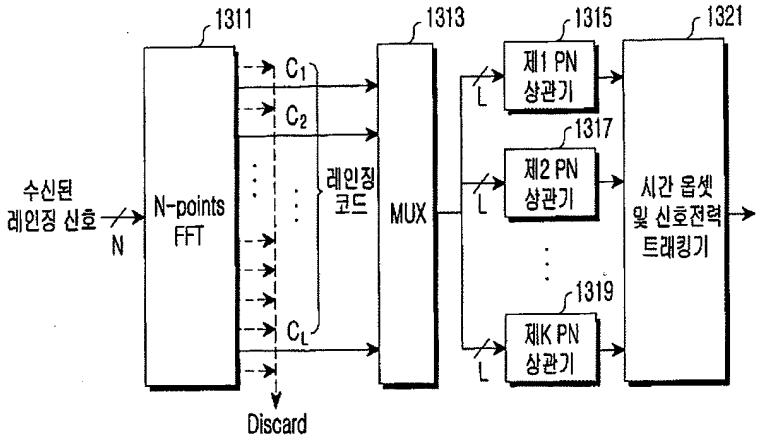
도면11



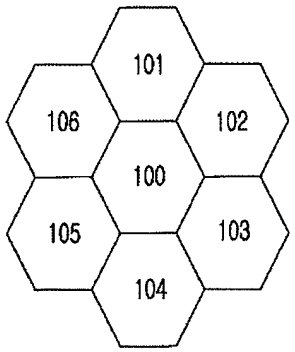
도면12



도면13

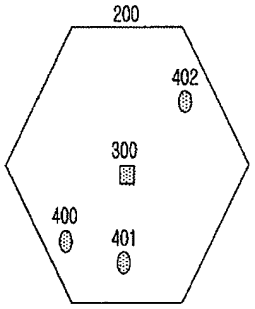


도면14



셀 ID :
100, 101, 102, 103, 104, 105, 106
PN 코드 할당 :
셀 #100 → PN #100
셀 #101 → PN #101A, PN #101B
셀 #102 → PN #102
셀 #103 → PN #103A, PN #103B, PN #103C
셀 #104 → PN #104
셀 #105 → PN #105
셀 #106 → PN #106A, PN #106B

도면15

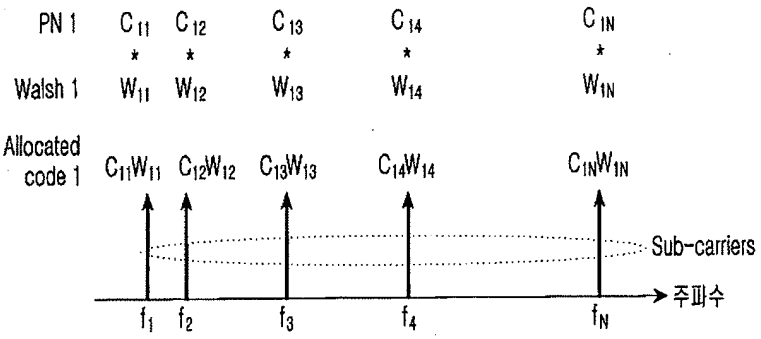


셀 ID : 200
기지국 ID : 300

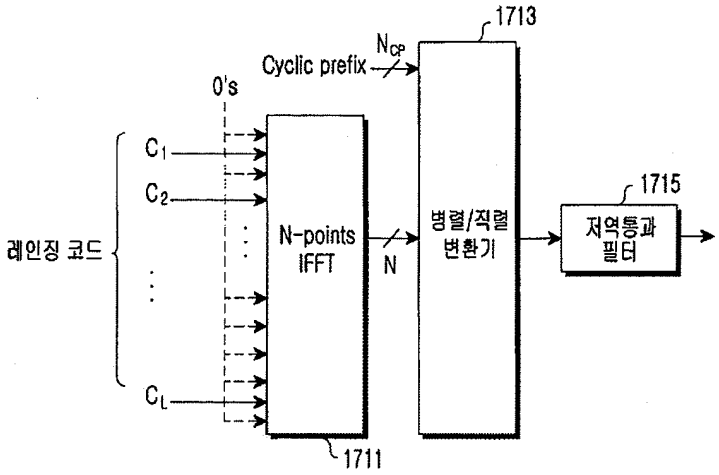
Walsh 코드 할당 :
단말기 400 → Walsh 1
단말기 401 → Walsh 2
단말기 402 → Walsh 3

Walsh size = N
Walsh 1
Walsh 2
Walsh 3
Walsh 4
Walsh J
Walsh J+1
Walsh N
초기 레인징 신호를 위한
(N-J) WALSH 코드

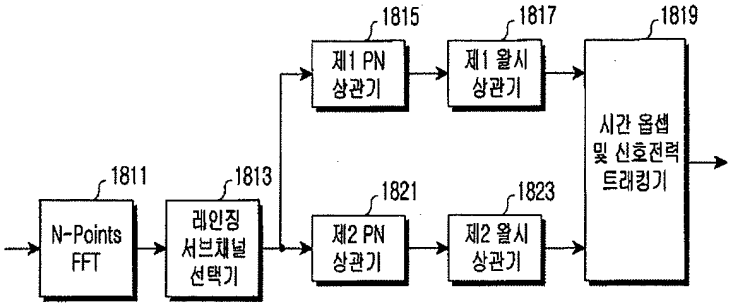
도면16



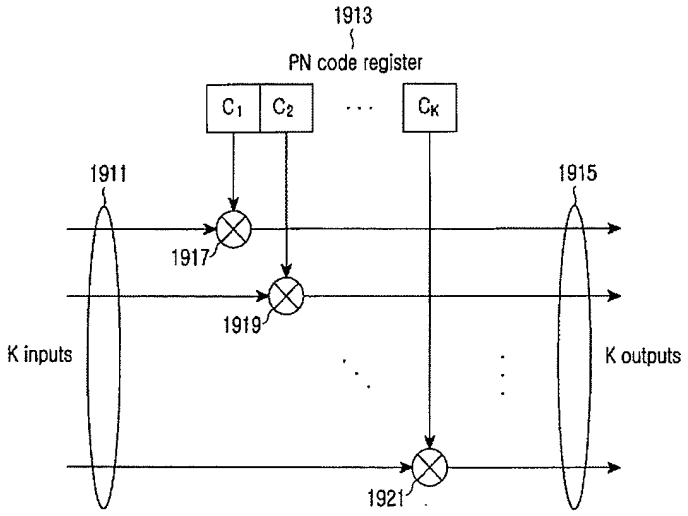
도면17



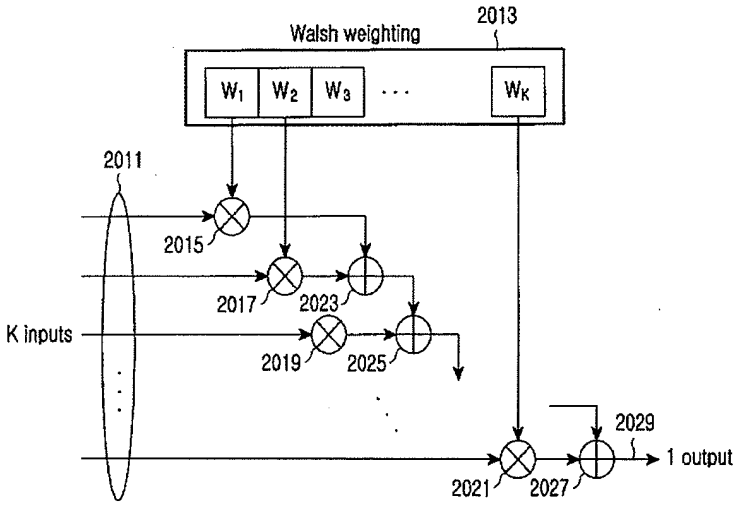
도면18



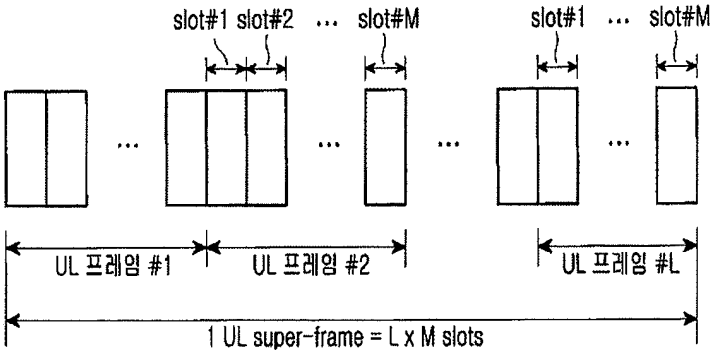
도면19



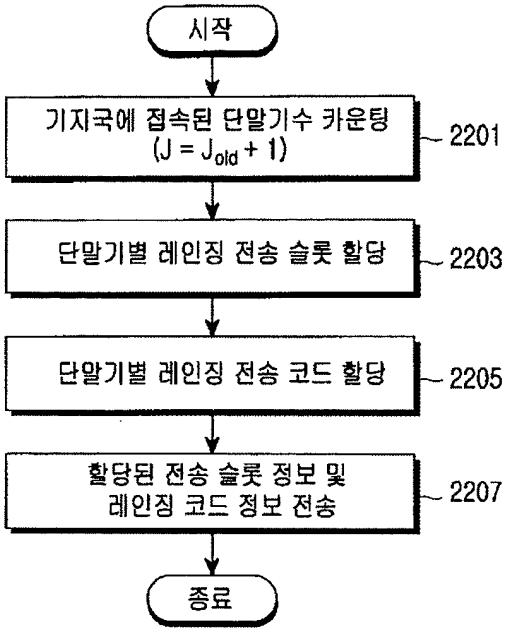
도면20



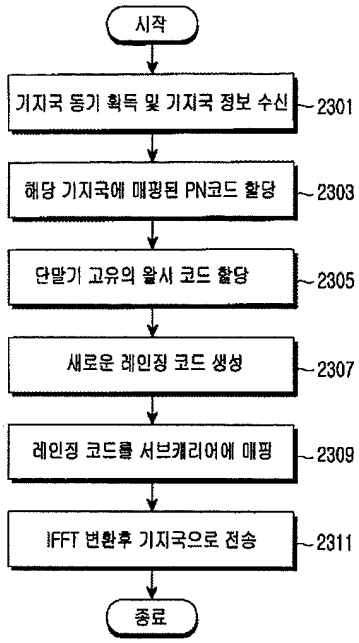
도면21



도면22



도면23


시작
기지국 동기 획득 및 기지국 정보 수신
2301
해당 기지국에 매핑된 PN코드 할당
2303
단말기 고유의 왈시 코드 할당
2305
새로운 레인징 코드 생성
2307
레인징 코드를 서브캐리어에 매핑
2309
IFFT 변환후 기지국으로 전송
2311
종료

Europäisches Patentamt
European Patent Office
Office européen des brevets

Espacenet

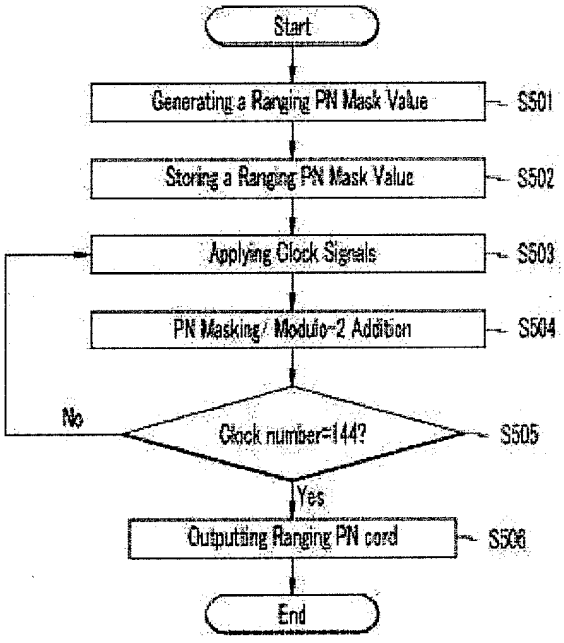
Bibliographic data: KR20060055636 (A) — 2006-05-24

APPARATUS AND METHOD FOR GENERATING RANGING PSEUDO NOISE CODE

Inventor(s):	SOHN KYUNG YEOL [KR]; YU CHANG WAHN [KR]; PARK YOUN OK [KR] ±
Applicant(s):	KOREA ELECTRONICS TELECOMM [KR]; SAMSUNG ELECTRONICS CO LTD [KR]; KT CORP [KR]; KT FREETEL CO LTD [KR]; SK TELECOM CO LTD [KR]; HANAROTELECOM INC [KR] ±
Classification:	**- international:** ***H04B7/26; H04J13/00; H04J13/10; H04L27/26***
	- European: H04J13/00B5; H04J13/10
Application number:	KR20040094536 20041118
Priority number(s):	KR20040094536 20041118
Also published as:	KR100625248 (B1) WO2006054848 (A2) WO2006054848 (A3) US2008170632 (A1) US7817707 (B2)

Abstract not available for KR20060055636 (A)
Abstract of corresponding document: WO2006054848 (A2)

Disclosed is an apparatus for generating a ranging pseudo noise (PN) code used in a base station of a portable internet system of an orthogonal frequency division multiplexing access scheme, wherein a ranging pseudo noise mask value is generated using a cell ID number, and then the generated ranging pseudo noise mask value is stored in a memory. A final ranging PN code is generated using the stored ranging PN mask value and a status of a pseudo random binary sequence for generating a ranging PN code. With such a structure, the maximal 256-numbered ranging PN code values can be obtained simultaneously with each 144 bit-length.



Last updated: 28.02.2012 Worldwide Database 5.7.36; 93p

Electronic Acknowledgement Receipt

EFS ID:	12985868
Application Number:	13205579
International Application Number:	
Confirmation Number:	2138
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Customer Number:	25096
Filer:	Christopher J. Daley-Watson/Erica Tollefson
Filer Authorized By:	Christopher J. Daley-Watson
Attorney Docket Number:	61240-8008.US02
Receipt Date:	11-JUN-2012
Filing Date:	08-AUG-2011
Time Stamp:	18:21:58
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		Suppl_IDS_8008US2.PDF	184134 44f8a3631d9350037de02455c5c8800ae07c520e	yes	4

	Multipart Description/PDF files in .zip description				
	Document Description	**Start**	**End**		
	Transmittal Letter	1	2		
	Information Disclosure Statement (IDS) Form (SB08)	3	4		
Warnings:					
Information:					
2	Foreign Reference	KR100585233.PDF	138705 9210f868f6b847e0b8fbdd3036fd6096fcd43a46	no	3
Warnings:					
Information:					
3	Foreign Reference	KR20050015119.PDF	2623893 cb9f862c6850dd98b8269c3432eaf38ec703172f	no	31
Warnings:					
Information:					
4	Foreign Reference	KR20060055636.PDF	80673 0c7bfeb6c9e8bec52db1bd6f73318b130bf7926b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3027405		

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<u>New Applications Under 35 U.S.C. 111</u>
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.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.: 612408008US2
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Li et al.

Application No.: 13/205,579 Confirmation No.: 2138

Filed: August 8, 2011 Art Unit: 2473

For: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS Examiner: K. B. Yao

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT (IDS)

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

Madam:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant submits herewith copies of foreign patents in accordance with 37 CFR 1.98(a)(2).

This Information Disclosure Statement is not to be construed as a representation that: (i) a search has been made; (ii) additional information material to the examination of this application does not exist; (iii) the information, protocols, results and the like reported by third parties are accurate or enabling; or (iv) the cited information is, or is considered to be, material to patentability. In addition, applicant does not admit that any enclosed item of information constitutes prior art to the subject invention and specifically reserves the right to demonstrate that any such reference is not prior art.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 50-0665, under Order No. 612408008US2.

Dated: 6 June 2012

Respectfully submitted,

By _____

Stephen Bishop
Registration No.: 38,829
PERKINS COIE LLP
P.O. Box 1247
Seattle, Washington 98111-1247
(206) 359-8000
(206) 359-7198 (Fax)
Attorney for Applicant

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NOTICE OF ALLOWANCE AND FEE(S) DUE

25096 7590 03/06/2013

PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

EXAMINER
AKINYEMI, AJIBOLA A

ART UNIT	PAPER NUMBER
2649	

DATE MAILED: 03/06/2013

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/205,579	08/08/2011	Xiaodong Li	61240-8008.US02	2138

TITLE OF INVENTION: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1770	$300	$0	$2070	06/06/2013

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 SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

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: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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)

25096 7590 03/06/2013

PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/205,579	08/08/2011	Xiaodong Li	61240-8008.US02	2138

TITLE OF INVENTION: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1770	$300	$0	$2070	06/06/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
AKINYEMI, AJIBOLA A	2649	370-342000

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 03-02 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 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.

(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. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

❑ A check is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information 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 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, 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.

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.
13/205,579	08/08/2011	Xiaodong Li	61240-8008.US02	2138

25096 7590 03/06/2013

PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

EXAMINER	
AKINYEMI, AJIBOLA A	
ART UNIT	PAPER NUMBER
2649	

DATE MAILED: 03/06/2013

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 149 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 149 day(s).

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 Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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.	Applicant(s)	
	13/205,579	LI ET AL.	
	Examiner	Art Unit	
	AJIBOLA AKINYEMI	2649	

-- 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 *08/08/2011*.

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 *1,9,17 and 22*. 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).
   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 _____.

/Ajibola Akinyemi/
Examiner, Art Unit 2649

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	13/205,579	LI ET AL.	
	Examiner	Art Unit	
	AJIBOLA AKINYEMI	2649	

All participants (applicant, applicant's representative, PTO personnel):

(1) *AJIBOLA AKINYEMI*. (3)_____.

(2) *STEPHEN BISHOP*. (4)_____.

Date of Interview: *06 February 2013*.

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*.

Identification of prior art discussed: *N/A*.

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...)

Examiner called Mr. Stephen Bishop about duplicated claim 13 and Mr. Bishop authorized cancellation of one of the duplicated claim 13 by 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

/Ajibola Akinyemi/ Examiner, Art Unit 2649	

DETAILED ACTION

EXAMINER'S AMENDMENT

1. 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 a telephone interview with Mr. Stephen Bishop on Feb. 6th 2013.

Please amend the claim as below:

Delete one of duplicated **claim 13.**

REASON FOR ALLOWANCE

2. Claims 1-24 are allowable over cited prior art.

3. The following is an examiner's statement of reasons for allowance: Regarding claims 1, 9, 17 and 22, The prior art of record Um does not disclose the ranging signal lasts over a period of one or multiple orthogonal frequency division multiplexing (OFDM) symbols and the ranging signal exhibits a low peak-to-average power ratio in the time domain; and the ranging subchannel comprises at least one block of subcarriers within the communication channel and power levels of subcarriers at both ends of a block are set to zero **as applied to independent claims 1, 9, 17 and 22. These limitations in**

combination with other limitations of claims 1, 9, 17 and 22 are not disclosed by the prior art of record.

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AJIBOLA AKINYEMI whose telephone number is (571)270-1846. The examiner can normally be reached on monday- friday (8.30-5pm) Est.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, YUWEN PAN can be reached on (571) 272-7855. 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.

/Ajibola Akinyemi/
Examiner, Art Unit 2649

Notice of References Cited	Application/Control No. 13/205,579	Applicant(s)/Patent Under Reexamination LI ET AL.	
	Examiner AJIBOLA AKINYEMI	Art Unit 2649	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2010/0111017	05-2010	Um et al.	370/329
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	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.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13205579	LI ET AL.
	Examiner	Art Unit
	AJIBOLA AKINYEMI	2649

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	342	2/6/2013	AA

SEARCH NOTES		
Search Notes	Date	Examiner
370/329	2/6/2013	AA
Consulted with Duc Nguyen (SPE)	2/6/2013	AA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
See PgPub. Text Search		2/6/2013	AA

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13205579	LI ET AL.
	Examiner	Art Unit
	AJIBOLA AKINYEMI	2649

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

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

CLAIM		DATE								
Final	Original	02/06/2013								
1	1	=								
2	2	=								
3	3	=								
4	4	=								
5	5	=								
6	6	=								
7	7	=								
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United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 2138

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/205,579	08/08/2011	370	2649	61240-8008.US02

APPLICANTS
Xiaodong Li, Kirkland, WA;
Titus Lo, Bellevue, WA;
Kemin Li, Bellevue, WA;
Haiming Huang, Bellevue, WA;

**** CONTINUING DATA ***************************
This application is a CON of 10/583,158 08/27/2008 PAT 7,995,967
which is a 371 of PCT/US2005/008169 03/09/2005
which claims benefit of 60/551,589 03/09/2004

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
08/17/2011

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged		STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ Yes ☑ No	☐ Yes ☑ No	/AJIBOLA A AKINYEMI/ Examiner's Signature	☑ Met after Allowance AA Initials	WA	8	25	4

ADDRESS

PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247
UNITED STATES

TITLE

METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

FILING FEE RECEIVED		
1570	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	~~2478~~ 2649
Examiner Name	~~K.B. Yao~~ /Ajibola Akinyemi/
Attorney Docket Number	612408008US2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
		KR-20050015119-A	02-21-2005	Samsung Electronics Co Ltd		
		KR-20060055636-A	05-24-2006	Korea Electronics Telecomm et al.		
		KR-100585233-B1	05-24-2006	Korea Electronics Telecomm		

Examiner Signature	/Ajibola Akinyemi/	Date Considered	02/06/2013

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.A./

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. 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.

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	~~2473~~ 2649
Examiner Name	~~K. B. Yao~~ /Ajibola Akinyemi/
Attorney Docket Number	612408008US2

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]

Examiner Signature	/Ajibola Akinyemi/	Date Considered	02/06/2013

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

61240-8008.US02/LEGAL22925739.1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.A./

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	~~2618~~ 2649
Examiner Name	A. A. Akinyemi
Attorney Docket Number	612408008US2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-20100111017-A1	05-06-2010	Um et al.	
		US-4,977,593	12-11-1990	Ballance et al.	
		US-5,991,308	11-23-1999	Fuhrmann et al.	
		US-6,519,449	02-11-2003	Zhang et al.	
		US-7,995,967-A1	08-09-2011	Li et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]

Examiner Signature	/Ajibola Akinyemi/	Date Considered	02/06/2013

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

61240-8008.US02/LEGAL22081120.1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.A./

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 2

Complete if Known	
Application Number	13/205,579-Conf. #2138
Filing Date	August 8, 2011
First Named Inventor	Xiaodong Li
Art Unit	~~2618~~ 2649
Examiner Name	A. A. Akinyemi
Attorney Docket Number	612408008US2

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	**	International Search Report and Written Opinion; International Patent Application No. PCT/US05/08169; Filed Mar. 9, 2005; Applicant: Waltical Solutions, Inc.; Mailed Jun. 9, 2005; 9 pages.	

Examiner Signature	/Ajibola Akinyemi/	Date Considered	02/06/2013

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

61240-8008.US02/LEGAL22081120.1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.A./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L4	5927	370/342.ccls.	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:20
L5	56876	mobile with rang$3	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:20
L6	2334	455/127.1.ccls.	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:21
L7	1734418	@rlad<"20040911"	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:21
L8	1635366	@rlad<"20040309"	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:23
L9	9732	5 and 8	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:23
L10	27	4 and 6	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:24
L11	92	4 and 9	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:24
L12	31	6 and 9	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:24
L13	7752	power same rang$3 same base adj station	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:25
L14	1813	8 and 13	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:25
L15	110	4 and 14	US-PGPUB; USPAT	OR	OFF	2013/02/06 10:25
L16	1	(OFDMA and communication adj channel and subchannel and ranging and random adj access and mobile adj station and peak).clm.	US-PGPUB	OR	OFF	2013/02/06 10:27

2/ 6/ 2013 10:28:52 AM
C:\ Users\ aakinyemi\ Documents\ EAST\ Workspaces\ 11306295.wsp

Issue Classification

Application/Control No.	Applicant(s)/Patent Under Reexamination
13205579	LI ET AL.
Examiner	**Art Unit**
AJIBOLA AKINYEMI	2649

CPC

Symbol	Type	Version
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CPC Combination Sets

Symbol	Type	Set	Ranking	Version
/				
/				

US ORIGINAL CLASSIFICATION

CLASS	SUBCLASS
370	342

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
370	329				

INTERNATIONAL CLASSIFICATION

CLAIMED					NON-CLAIMED				
H	0	4	Q	7 / 216 ()					

		Total Claims Allowed:	
(Assistant Examiner)	(Date)	24	
/AJIBOLA AKINYEMI/ Examiner.Art Unit 2649 (Primary Examiner)	02/06/2013 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 3

U.S. Patent and Trademark Office — Part of Paper No. 20130206

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13205579	LI ET AL.
	Examiner	**Art Unit**
	AJIBOLA AKINYEMI	2649

(Assistant Examiner)	(Date)	**Total Claims Allowed:** 24	
/AJIBOLA AKINYEMI/ Examiner.Art Unit 2649	02/06/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13205579	LI ET AL.
	Examiner	**Art Unit**
	AJIBOLA AKINYEMI	2649

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

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17												
2	2	18	18												
3	3	19	19												
4	4	20	20												
5	6	21	21												
6	6	22	22												
7	7	23	23												
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12	12														
13	13														
14	14														
15	15														
16	16														

(Assistant Examiner)	(Date)	**Total Claims Allowed:** 24	
/AJIBOLA AKINYEMI/ Examiner.Art Unit 2649	02/06/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

U.S. Patent and Trademark Office

Part of Paper No. 20130206

PART B -FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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)

25096
PERKINS COIE LLP
PATENT-SEA
P.O. Box 1247
Seattle, Washington 98111-1247

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 electronically filed on the date indicated below.

LEILA JAVANSHIR	(Depositor's name)
	(Signature)
3/21/13	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/205,579	08/08/2011	Xiaodong Li	612408008US2	2138

TITLE OF INVENTION: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	Yes	$885.00	$300.00		$1,191.00	06/06/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
A. A. Akinyemi	2649	370-342000

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 03-02 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 Perkins Coie LLP
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 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.

(A) NAME OF ASSIGNEE: Neocific, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Bellevue, Washington

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☒ Publication Fee (No small entity discount permitted)
- ☒ Advance Order - # of Copies 2

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☒ Payment by credit card.
- ☒ The Director is hereby authorized to charge any deficiencies or credit any overpayment to Deposit Account Number 50-0665

5. **Change in Entity Status** (from status indicated above)
- ☒ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date 21 March 2013

Typed or printed name Stephen Bishop Registration No. 38,829

PTOL-85 (Rev. 02/11) Approved for use through 08/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

61240-8008.US02/LEGAL26037645.1

Docket No.: 612408008US2
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Li et al.

Application No.: 13/205,579 | Confirmation No.: 2138

Filed: August 8, 2011 | Art Unit: 2649

For: METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS | Examiner: A. A. Akinyemi

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

MS Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Madam:

In the Notice of Allowability mailed March 6, 2013, the Examiner allowed claims 1-24. Although applicant agrees with the Examiner's conclusion that these claims are allowable, applicant notes that the claims may be allowable for reasons other than those identified by the Examiner and does not concede that the Examiner's characterizations of the terms of the claims and the prior art are correct.

Dated: 21 March 2013

Respectfully submitted,

By _____
Stephen Bishop
Registration No.: 38,829
PERKINS COIE LLP
P.O. Box 1247
Seattle, Washington 98111-1247
(206) 359-8000
(206) 359-7198 (Fax)
Attorney for Applicant

61240-8008.US02/LEGAL26037650.1

Electronic Patent Application Fee Transmittal

Application Number:	13205579
Filing Date:	08-Aug-2011
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Filer:	Christopher J. Daley-Watson/Leila Javanshir
Attorney Docket Number:	61240-8008.US02

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

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:				
Utility Appl Issue Fee	2501	1	890	890
Publ. Fee- Early, Voluntary, or Normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
Printed Copy of Patent - No Color	8001	2	3	6
		Total in USD ($)		**1196**

Electronic Acknowledgement Receipt

EFS ID:	15326193
Application Number:	13205579
International Application Number:	
Confirmation Number:	2138
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Customer Number:	25096
Filer:	Christopher J. Daley-Watson/Leila Javanshir
Filer Authorized By:	Christopher J. Daley-Watson
Attorney Docket Number:	61240-8008.US02
Receipt Date:	21-MAR-2013
Filing Date:	08-AUG-2011
Time Stamp:	18:35:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1196
RAM confirmation Number	5380
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		13-3-21_Fee_Trans_Comments_on_Reasons_For_Allowance.PDF	119882 9ecc4934d58040ccec852f78ec65dcdb26fafe16	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Issue Fee Payment (PTO-85B)	1	1
	Post Allowance Communication - Incoming	2	2

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	33780 3ba303d3f58600aea38143e2c8fb53f40f7105ec	no	2

Warnings:

Information:

Total Files Size (in bytes):	153662

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 NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/205,579	06/18/2013	8467366	61240-8008.US02	2138

25096 7590 05/29/2013

PERKINS COIE LLP - SEA General
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

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 149 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):

Xiaodong Li, Kirkland, WA;
Titus Lo, Bellevue, WA;
Kemin Li, Bellevue, WA;
Haiming Huang, Bellevue, WA;

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.

PTO/SB/80 (11-08)
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 03624

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 03624

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Neo Wireless LLC
123 West Wayne Avenue, Floor 1
Wayne, PA 19087

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	David Loo	Date	02/20/2020
Name	David Loo	Telephone	603.674.2754
Title	C.E.O., Neo Wireless LLC		

This collection of information is required by 37 CFR 1.31, 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:	38777883
Application Number:	13205579
International Application Number:	
Confirmation Number:	2138
Title of Invention:	METHODS AND APPARATUS FOR RANDOM ACCESS IN MULTI-CARRIER COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Xiaodong Li
Customer Number:	25096
Filer:	Christina R. Walsh/Justin Slater
Filer Authorized By:	Christina R. Walsh
Attorney Docket Number:	61240-8008.US02
Receipt Date:	05-MAR-2020
Filing Date:	08-AUG-2011
Time Stamp:	14:08:37
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	Assignee showing of ownership per 37 CFR 3.73	NEO-PT014_2-373b_ExtraEntries_EFS-20200305.PDF	34600 05f1a44e15ef08aea05da1590f94af4495f534c4	no	1

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	NEO-PT014_2-PreAIA_373b_sb0096_EFS-20200305.PDF	204475 864028231aa6b485b2bfb6598ad0d420f6c28109	no	2
Warnings:					
Information:					
3	Power of Attorney	NEO-PT014_2-Executed_POA_sb0080_EFS-20200305.PDF	902039 a65a4b6133de7ca3e9a084eabfbd4d70ba23b784	no	1
Warnings:					
Information:					
		Total Files Size (in bytes):	1141114		

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.

<u>New Applications Under 35 U.S.C. 111</u>
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.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

4. From: CFIP NCF LLC To: NEO WIRELESS LLC

The document was recorded in the United States Patent and Trademark Office at

Reel 051971 , Frame 0226 , or a copy* is attached.

PTO/SB/96 (11-18)
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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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Neo Wireless LLC

Application No./Patent No.: 8,467,366 Filed/Issue Date: June 18, 2013

Titled:

Neo Wireless LLC, a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. ■ the assignee of the entire right, title, and interest in;

2. ☐ an assignee of less than the entire right, title, and interest in (The extent (by percentage) of its ownership interest is _____ %); or

3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel_____, Frame_____, or a copy* is attached.

OR

B. ■ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: INVENTORS To: WALTICAL SOLUTIONS, INC.

The document was recorded in the United States Patent and Trademark Office at Reel 051258, Frame 0162, or a copy* is attached.

2. From: WALTICAL SOLUTIONS, INC. To: NEOCIFIC, INC.

The document was recorded in the United States Patent and Trademark Office at Reel 051258, Frame 0850, or a copy* is attached.

3. From: NEOCIFIC, INC. To: CFIP NCF LLC

The document was recorded in the United States Patent and Trademark Office at Reel 051116, Frame 0396, or a copy* is attached.

☒ Additional documents in the chain of title are listed on a supplemental sheet(s).

■ *As required by 37 CFR 3.73(b)(1)(i), if a copy/copies is/are attached, the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Christina R. Walsh/ March 5, 2020

Signature Date

Christina R. Walsh 61553

Printed or Typed Name Title or Registration Number

This collection of information is required by 37 CFR 3.73(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.

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.
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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.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/205,579	08/08/2011	Xiaodong Li	61240-8008.US02

CONFIRMATION NO. 2138

POWER OF ATTORNEY NOTICE

25096
PERKINS COIE LLP - SEA General
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247

OC000000115316058

Date Mailed: 03/11/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/05/2020.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. 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**.

/kpowell/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/205,579	08/08/2011	Xiaodong Li	61240-8008.US02

CONFIRMATION NO. 2138

3624
VOLPE AND KOENIG, P.C.
30 SOUTH 17TH STREET, 18th Floor
PHILADELPHIA, PA 19103

POA ACCEPTANCE LETTER

OC000000115316165

Date Mailed: 03/11/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/05/2020.

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**.

/kpowell/

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 Western District of Texas Waco Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
6:21-cv-00025	4/28/2021	Western District of Texas Waco Division

PLAINTIFF	DEFENDANT
Neo Wireless LLC	LG Electronics Inc., LG Electronics U.S.A., Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,044,517	8/7/2018	Neo Wireless LLC
3	10,833,908	4/17/2018	Neo Wireless LLC
4	10,075,941	9/11/2018	Neo Wireless LLC
5	10,447,450	10/15/2019	Neo Wireless LLC

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 Western District of Texas Waco Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
6:21-cv-00026	4/28/2021	Western District of Texas Waco Division

PLAINTIFF	DEFENDANT
Neo Wireless LLC	Apple Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,044,517	8/7/2018	Neo Wireless LLC
3	10,833,908	4/17/2018	Neo Wireless LLC
4	10,075,941	9/11/2018	Neo Wireless LLC
5	10,447,450	10/15/2019	Neo Wireless LLC

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

Trials@uspto.gov
571-272-7822

Paper 11
Date: March 16, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DELL INC. and DELL TECHNOLOGIES INC.,
Petitioner,

v.

NEO WIRELESS LLC,
Patent Owner.

IPR2021-01480
Patent 8,467,366 B2

Before CHARLES J. BOUDREAU, MICHELLE N. ANKENBRAND, and MATTHEW S. MEYERS, *Administrative Patent Judges.*

ANKENBRAND, *Administrative Patent Judge.*

DECISION
Denying Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Dell Inc. and Dell Technologies Inc. (collectively, "Petitioner") filed a Petition requesting an *inter partes* review of claims 1–24 of U.S. Patent No. 8,467,366 B2 (Ex. 1001, "the '366 patent"). Paper 3 ("Pet."). Neo Wireless LLC ("Patent Owner") filed a Preliminary Response. Paper 7 ("Prelim. Resp.").

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314 (2018); 37 C.F.R. § 42.4(a) (2020). The standard for instituting an *inter partes* review is set forth in 35 U.S.C. § 314(a), which provides that an *inter partes* review may not be instituted "unless the Director determines . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least [one] of the claims challenged in the petition."

For the reasons set forth below, upon considering the Petition, Preliminary Response, and evidence of record, we determine the information presented in the Petition does not establish a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. Accordingly, we deny the Petition, and do not institute an *inter partes* review.

II. BACKGROUND

A. Related Matters

The parties identify *Neo Wireless LLC v. Dell Technologies Inc.*, 6-21-cv-00024 (W.D. Tex.) as a district court proceeding involving the '366 patent. Pet. 80; Paper 5, 1. Patent Owner also identifies two former district court proceedings and two proceedings before the Board: IPR2021-01468 and IPR2021-01486. Paper 5, 1.

B. The '366 Patent

The '366 patent, titled "Methods and Apparatus for Random Access in Multi-Carrier Communication Systems," issued on June 18, 2013. Ex. 1001, at [45], [54]. The '366 patent describes a random access process that includes ranging:

> In a wireless communication system, a mobile station first needs to perform a random access for establishing communication with a base station. The random access typically includes two steps: (1) Ranging and (2) Resource Request and Allocation. During Ranging, the mobile station sends a signal to the base station, so that the base station can identify the mobile station and measure the power and time delay of the mobile station, and inform the mobile station for power adjustment and time advance. During Resource Request and Allocation, the uplink and downlink resources for communication are requested and allocated. Ranging is a critical part of multi-carrier wireless communication system, and there are several important issues related to ranging:
>
> 1. The bandwidth efficiency of the ranging signals
> 2. The interference of ranging signal with other uplink signals
> 3. The detection performance and complexity at the base station receiver
>
> The ranging process typically involves an exchange of messages between the base station and the mobile station by which the mobile station aligns itself with the start of each time slot after compensating for propagation delay and other factors.

Id. at 1:24–47. The '366 patent further explains that the ranging of many mobile stations may cause a problem because the mobile stations contend for access to the shared channel and it is difficult to complete ranging for any of the mobile stations. *Id.* at 1:47–53. This leads to excessive time to complete the ranging process and the waste of much bandwidth on the shared channel. *Id.* at 1:53–55.

The '366 patent describes methods and apparatus that use ranging signals that are designed to improve receiving reliability, reduce interference with other uplink signals, and improve the detection performance at a base station receiver. *Id.* at 2:40–44. The '366 patent explains that a multi-carrier signal is made up of subcarriers in the frequency domain and data subcarriers can be arranged into groups called subchannels. *Id.* at 2:61–64, 3:5–6.

We reproduce Figure 4 of the '366 patent below.

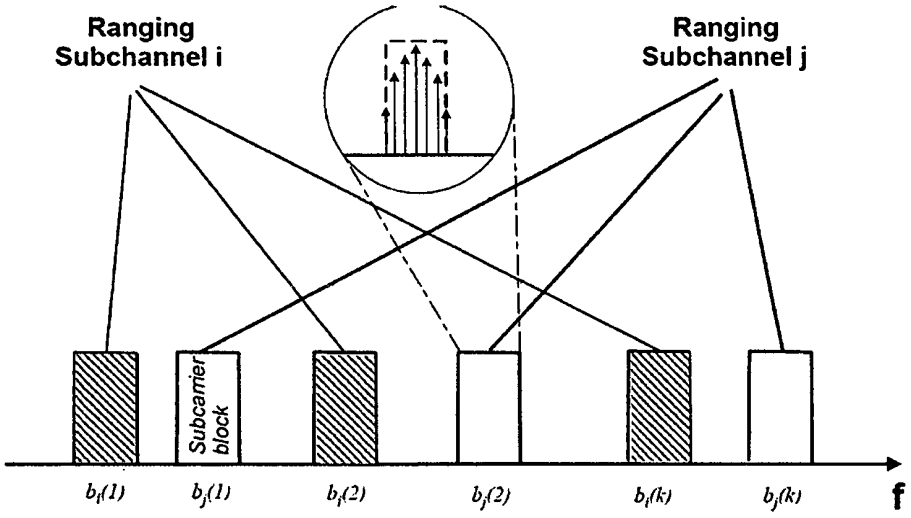


FIG. 4

Figure 4 shows two ranging subchannels composed of subcarrier blocks. *Id.* at 1:66–67, 3:27–28. The '366 patent states:

> FIG. 4 schematically shows that the signal power of the subcarriers towards the boundary (the lower ends and the higher ends in frequency) of a block is lower than that of the subcarriers towards the center of the block. (In a special case, the power levels of the two subcarriers at both ends of a block are set to zero.) Because different factors may cause possible overlap of two subcarrier blocks from to different transmitters, the attenuated boundary subcarriers will minimize the resulting interference.

Id. at 3:29–38.

The '366 patent further describes an embodiment in which "the ranging sequence is designed such that its corresponding time-domain signal exhibits relatively low peak-to-average power ratio." *Id.* at 4:34–37. According to the '366 patent, "[t]his improves the power efficiency of the mobile station transmission power amplifier." *Id.* at 4:37–38.

C. Illustrative Claim

Petitioner challenges claims 1–24 of the '366 patent (collectively, "the challenged claims"). Claims 1, 9, 17, and 22 are the independent challenged claims. Claim 1 is illustrative of the claimed subject matter, and recites:

> 1. In a multi-cell orthogonal frequency division multiple access (OFDMA) wireless communication system comprising a plurality of base stations and mobile stations, a mobile station configured to communicate with a serving base station in a cell via a communication channel, the mobile station comprising:
>
> an apparatus configured to transmit a data signal to the serving base station in the cell over a data subchannel, wherein the data subchannel comprises a plurality of adjacent or non-adjacent subcarriers within the communication channel; and
>
> an apparatus configured to transmit a ranging signal to the serving base station in the cell over a ranging subchannel for random access, wherein:
>
> the ranging signal is formed from a ranging sequence selected from a set of ranging sequences associated with the cell for identifying the mobile station;
>
> the ranging signal lasts over a period of one or multiple orthogonal frequency division multiplexing (OFDM) symbols

and the ranging signal exhibits a low peak-to-average power ratio in the time domain; and

the ranging subchannel comprises at least one block of subcarriers within the communication channel and power levels of subcarriers at both ends of a block are set to zero.

Ex. 1001, 7:2–26.

D. Asserted Grounds of Unpatentability

Petitioner asserts that the challenged claims are unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §	References/Basis
1–4, 6–12, 14–20, 22–24	103(a)[1]	Ma,[2] TR[3]
5, 21	103(a)	Ma, TR, Soliman[4]
13	103(a)	Ma, TR, Li[5]
1–4, 6–12, 14–20, 22–24	103(a)	Ma, Jung[6]
5, 21	103(a)	Ma, Jung, Soliman
13	103(a)	Ma, Jung, Li

Pet. 1–2. Petitioner relies on the Declaration of Dr. Matthew Valenti (Ex. 1003) to support its asserted grounds of unpatentability. Patent Owner disputes that Petitioner's asserted grounds render any of the challenged

[1] The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA"), amended 35 U.S.C. § 103. Because the '366 patent has an effective filing date before the effective date of the applicable AIA amendments, we refer to the pre-AIA version of 35 U.S.C. § 103.
[2] U.S. Pub. No. 2004/0001429 A1, published Jan. 1, 2004 (Ex. 1005).
[3] *Universal Mobile Telecommunications System (UMTS); UMTS Terrestrial Radio Access (UTRA); Concept evaluation (UMTS 30.06 version 3.0.0)*, TR 101 146 V3.0.0, European Telecommunications Standards Institute (December 1997) (Ex. 1006).
[4] U.S. Patent No. 6,101,179, issued Aug. 8, 2000 (Ex. 1007).
[5] U.S. Pub. No. 2002/0159422 A1, published Oct. 31, 2002 (Ex. 1009).
[6] U.S. Pub. No. 2004/0114504 A1, published June 17, 2004 (Ex. 1010).

claims unpatentable. *See generally* Prelim. Resp. Patent Owner relies on the Declaration of William P. Alberth, Jr. (Ex. 2001).

III. ANALYSIS

A. Level of Ordinary Skill in the Art

Petitioner asserts that a person of ordinary skill in the art "would have had at least a Bachelor's degree in an academic area emphasizing electrical engineering or a similar discipline, and at least two years of experience in the field working with, teaching, or researching wireless communication networks" and "[s]uperior education could compensate for a deficiency in work experience, and *vice-versa*." Pet. 4–5 (citing Ex. 1003 ¶¶ 23–24). Patent Owner does not provide its own description regarding the level of ordinary skill in the art, or otherwise dispute Petitioner's assertion. *See generally* Prelim. Resp.; *see also* Ex. 2001 ¶ 23 (Mr. Alberth "accept[ing] Dr. Valenti's proposed qualifications of a" person of ordinary skill in the art).

Petitioner's description is consistent with the level of ordinary skill reflected in the prior art references of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (recognizing that the prior art itself may reflect an appropriate level of skill in the art). Accordingly, for purposes of this decision, we apply Petitioner's description of the person of ordinary skill in the art.

B. Claim Construction

It is not necessary for us to construe any claim terms to resolve the parties' disputes at institution. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (per curiam) (claim terms need to be construed "only to the extent necessary to resolve the

controversy" (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

C. Petitioner's Challenges to the '366 Patent

All of Petitioner's challenges to the '366 patent are based on the combination of Ma and TR, or the combination of Ma and Jung, even though some of the challenges include additional references. *See* Pet. 1–2 (summary of asserted grounds). The parties dispute at this stage of the proceeding whether a person of ordinary skill in the art would have had reason to incorporate TR's guard carrier/guard band feature or Jung's null data into both ends of the block of subcarriers of Ma's Random Access Channel ("RACH"). Accordingly, we focus our discussion on this issue, which is dispositive. First, however, we provide a brief summary of Ma, TR, and Jung.

1. Ma (Ex. 1005)

Ma describes "a new uplink OFDM protocol" for a wireless terminal and a network terminal. Ex. 1005, at [57]. The protocol includes "a low rate mode OFDM transmission in a first frequency band of the OFDM band; and a second transmit chain for generating and transmitting a burst-mode transmission in a second frequency band of the OFDM band." *Id.* We reproduce Figure 2 of Ma below.

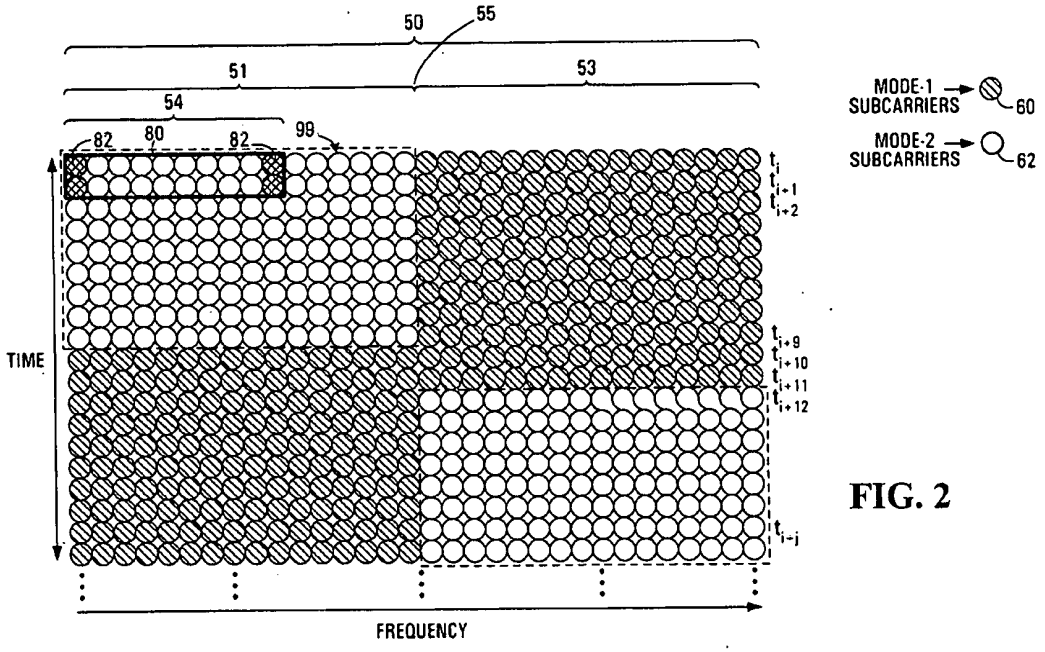


FIG. 2

Figure 2 illustrates an example time-frequency resource allocation within a common wireless channel according to an orthogonal frequency division multiple-access ("OFDMA") scheme. Ex. 1005 ¶ 94. Ma states that "OFDM is a method of digital modulation in which a set of data is mapped onto the set of OFDM sub-carriers." *Id.* ¶ 122. Ma explains that each circle in Figure 2 "represents the transmission of a single sub-carrier during a single OFDM symbol transmission period," with Figure 2's horizontal axis representing frequency and the vertical axis representing time. *Id.*

Ma describes the exemplary OFDMA scheme as including common wireless channel 50, which is implemented via an OFDM transmission scheme within an overall OFDM band that is divided into two frequency bands 51, 53. *Id.* ¶ 124. Ma explains that frequency bands 51, 53 can be used interchangeably to provide two different OFDMA modes, Mode-1 and Mode-2. *Id.* Sub-carriers 60 are used for Mode-1 and sub-carriers 62 are used for Mode-2 in Figure 2. *Id.* Ma describes first frequency band 51 has

the first sixteen sub-carriers of OFDM band 50 and second frequency band 53 has the second sixteen sub-carriers of OFDM band 50. Ex. 1005 ¶ 124. According to Ma, "Mode-1 is used to provide low rate circuit oriented connectivity for multiple users simultaneously preferably using orthogonal code separation, while Mode-2 is used to provide higher rate bursty packet connectivity." *Id.* Ma further describes Mode-1 as supporting "the provision of user dedicated channels with fixed data rate to support real-time service, uplink signaling and simple messaging," whereas "Mode-2 supports the transmission of high speed data bursts." *Id.* ¶ 143.

Ma also describes a RACH that User Equipment ("UE") new to a wireless network use to access a system. *Id.* ¶ 205. Ma describes an embodiment in which a RACH is overlaid atop common wireless channel 50 or over one of bands 51, 53. *Id.* ¶ 206. Ma explains that the RACH is therefore "transmitted simultaneously both in time and frequency with the transmission of the other Mode-1 signals by other users" and thus "[t]he RACH is thus a form of interference to the other users." *Id.* ¶ 206.

In addition, Ma describes a procedure for a UE to initiate a connection with a network. *Id.* ¶ 234. The procedure includes synchronizing the UE to a base station for timing and frequency and the UE listening to a downlink ("DL") signaling channel for information identifying RACH PN codes. *Id.* ¶¶ 235–236. The UE then "measures the DL long term C/I," sends a RACH code chosen randomly from the base station's code set, and "[t]he transmit power is determined inversely proportional to the DL long term C/I measurement." *Id.* ¶¶ 237–238. Ma explains that "[i]f the base station detects the RACH code successfully it measures the time offset of that UE and then sends the initial dedicated uplink access channel grant, together with the RACH code index as well as the time offset information." *Id.*

¶ 239. According to Ma, the "UE adjusts its timing and sends back its ID, its CQI report information, and uplink traffic load request if it wants to start uplink data transmission." *Id.* ¶ 240.

2. TR (Ex. 1006)

TR is a technical report that "describes the detailed evaluation work towards the definition of the Universal Mobile Telecommunications System UMTS Terrestrial Radio Access (UTRA) within SMG2." Ex. 1006, 5. TR describes time and frequency synchronization for an OFDMA system, which includes both downlink and uplink synchronization. *Id.* at 196–197, 204–206. TR explains that "[a]fter the mobile [station] has detected the basestations timing it sends an RACH to the basestation" and the basestation "measures the time offset for the received RACH and sends back the necessary timing advance to the MS (very similar to GSM)." *Id.* at 206.

We reproduce TR's Figure 6 below.

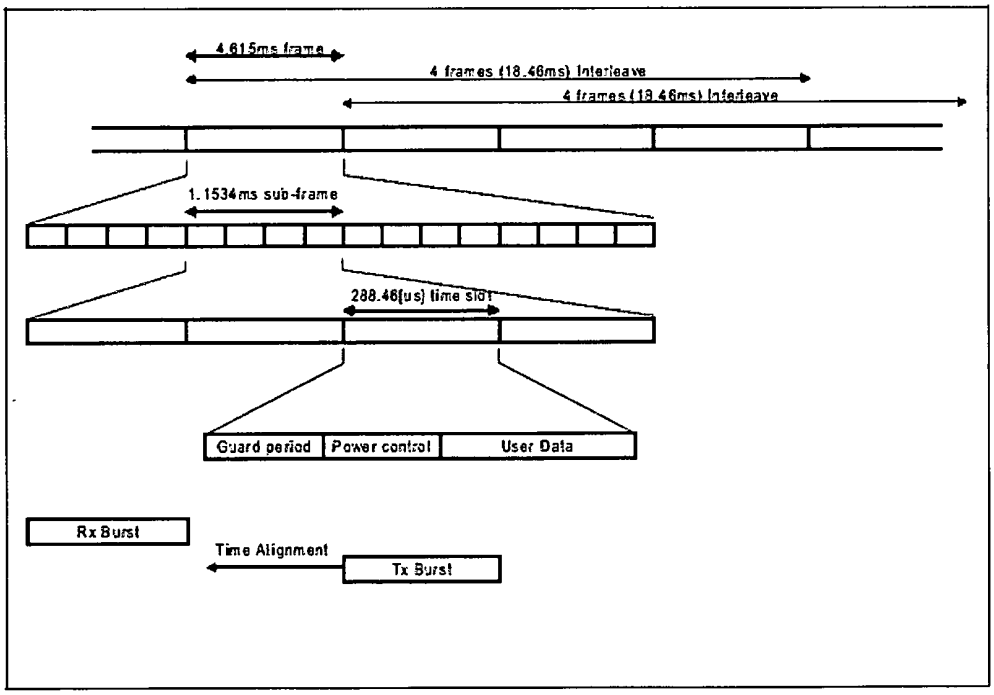


Figure 6: Frame (TDMA) Structure

Figure 6 depicts a TDMA frame structure. Ex. 1006, 198. TR describes the TDMA frame structure as including frames having a length of 4.615 ms that are divided into 4 sub-frames having a 1.1534 ms length. *Id.* A sub-frame in turn includes four time slots that are 288.46 μs in length. *Id.* TR describes a time slot as including a guard period, power control information, and data. *Id.*

TR's Figure 7, which we reproduce below, shows the shape of the modulation unit. *Id.* at 199.

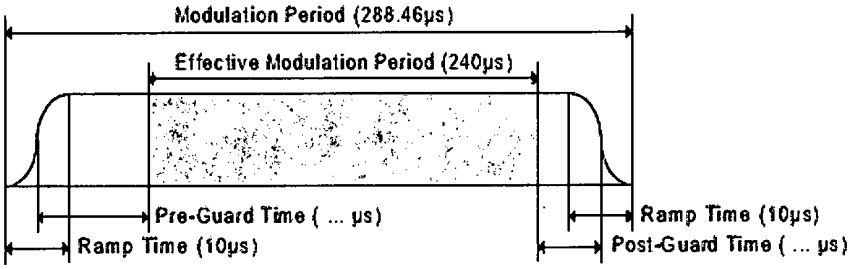


Figure 7: OFDM Modulation Burst

Figure 7 depicts an OFDM modulation burst. TR explains that "[t]he whole system frequency band is divided into small blocks (bandslots) with a fixed number of subcarriers." *Id.* TR shows several bandslots in Figure 8, which we reproduce below.

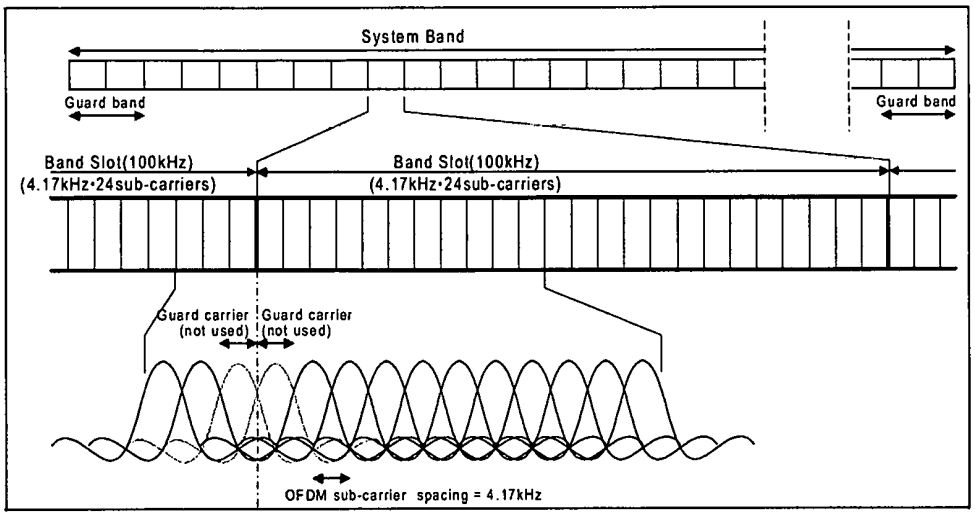


Figure 8: BDMA Frequency Structure

TR's Figure 8 shows individual bandslots having guard carriers at each end of the bandslot. Ex. 1006, 199. TR explains that "[i]n each bandslot the two subcarriers at the edge of the bandslot are left unmodulated to relax receiver blocking requirements." *Id.*

3. Jung (Ex. 1010)

Jung "relates generally to an orthogonal frequency division multiplexing (OFDM) communication system, and in particular, to an apparatus and method for generating a preamble sequence having a minimum peak-to-average power ratio (PAPR)." Ex. 1010 ¶ 3. Jung describes synchronization for the transmission and reception of transmission frames between a node and user equipment (UE). *Id.* ¶ 5. Jung explains that a node transmits a synchronization signal to enable the UE to detect the start of a frame that was transmitted by the node. *Id.* Jung states that "[g]enerally, a particular preamble sequence previously appointed by the Node B and the UE is used for the synchronization signal." *Id.* Jung further explains:

> In addition, a preamble sequence having a low peak-to-average power ratio (PAPR) is used for the preamble sequence used in an OFDM communication system, and a preamble created by concatenating a long preamble necessary for performing coarse synchronization to a short preamble necessary for performing fine frequency synchronization is used for the preamble transmitted from a Node B to a UE.

Id. ¶ 6.

Jung describes a long preamble sequence in which "a length-64 sequence is repeated 4 times and a length-128 sequence is repeated 2 times." *Id.* ¶ 13. Jung describes using the length-64 sequence that is repeated 4 times for time offset estimation and coarse frequency offset estimation, whereas the length-128 sequence that is repeated 2 times is used for fine frequency offset estimation. *Id.* ¶¶ 25–26. Jung further describes using the long preamble sequence for initial ranging and bandwidth request ranging. *Id.* ¶¶ 29–30.

Jung also describes an OFDM communication system that uses 256 subcarriers and that only 200 subcarriers of those are used. *Id.* ¶ 42. Specifically, Jung explains:

> Here, of the 256 subcarriers, only 200 subcarriers are used. That is, only 200 subcarriers excluding a 0^{th} subcarrier, the -128^{th} to -101^{st} subcarriers, and the 101^{st} to 127^{th} subcarriers from the 256 subcarriers are used. Null data, or 0-data, is inserted in each of the 0^{th} subcarrier, -128^{th} to -101^{st} subcarriers and 101^{st} to 127^{th} subcarriers, before being transmitted, and the reasons are as follows.

Id. As a first reason, Jung describes inserting null data into the 0^{th} subcarrier so it represents a reference point of a preamble sequence in a time domain. *Id.* ¶ 43. Jung further states:

> In addition, the reason for inserting null data into 28 subcarriers of the -128^{th} to -101^{st} subcarriers and 27 subcarriers of the 101^{st}

> to 127th subcarriers is to provide a guard interval in a frequency domain because the 28 subcarriers of the -128th to -101st subcarriers and the 27 subcarriers of the 101st to 127th subcarriers correspond to a high frequency band in the frequency domain.

Id.

4. Analysis

Petitioner contends the subject matter of claims 1–24 of the '366 patent would have been obvious over Ma and TR (alone or with additional references), and Ma and Jung (alone or with additional references). Pet. 1–2, 11–74. Patent Owner disagrees, focusing, *inter alia*, on Petitioner's argument that an ordinarily skilled artisan would have had reason to combine Ma and TR, or Ma and Jung, which we address below. *See, e.g.*, Prelim. Resp. 4, 32–35, 38, 50.

As is relevant to our analysis, Petitioner relies on Ma combined with TR or Jung as disclosing the limitation that recites "the ranging subchannel comprises at least one block of subcarriers within the communication channel and power levels of subcarriers at both ends of a block are set to zero." Pet. 31–34, 63–65. In the Ma and TR combination, Petitioner asserts that Ma's RACH "comprises at least one block of subcarriers within the communication channel" (*id.* at 31–33 (emphasis omitted)), and TR discloses two "Unmodulated Guard Carriers" at the edge of each bandslot "to relax receiver blocking requirements" (*id.* at 34 ((quoting Ex. 1006, 199 and citing Ex. 1003 ¶ 67; Ex. 1006, 202)). According to Petitioner, the guard carriers at both ends of the bandslot (i.e., block) "are 'not used' and thus the *power levels of guard carriers are set to zero*." *Id.* (citing Ex. 1006, 199, 202, Fig. 8; Ex. 1003 ¶¶ 67, 121).

In the Ma and Jung combination, Petitioner argues that the "limitation is rendered obvious based on Ma's disclosure of this limitation as discussed" in the ground involving Ma and TR "and Jung's disclosure of 'a guard interval in a frequency domain.'" Pet. 63 (quoting Ex. 1010 ¶¶ 43, 76, 105; Ex. 1003 ¶ 160). For the portion of the limitation that recites "power levels of subcarriers at both ends of a block are set to zero," Petitioner points to Jung's disclosure that subcarriers on both ends of a block of subcarriers are "left as" guard intervals "with power level set to zero, i.e., '**null data**' 'or **0-data.**'" *Id.* at 64 (citing Ex. 1010 ¶¶ 42–43, 67, 69, 76, Fig. 5; Ex. 1003 ¶ 161).

Petitioner argues that a person of ordinary skill in the art would have had reason to incorporate TR's guard carrier feature or Jung's null data on both ends of the block of subcarriers of Ma's RACH for similar reasons, including to reduce interference. *Id.* at 11–12 (also identifying reducing adjacent channel emissions, facilitating easy bandslot separation, and relaxing receive blocking requirements as advantages of using a guard carrier and citing Ex. 1003 ¶ 68; Ex. 1006, 199), 60 (citing Ex. 1003 ¶ 84). Petitioner further asserts that implementing TR's guard carrier or Jung's null data "would have been merely the application of a known technique" "to a known system (Ma's OFDMA communication system) ready for improvement to yield predictable results." *Id.* at 12 (citing Ex. 1006, 199; Ex. 1003 ¶ 69), 60. According to Petitioner, an ordinarily skilled artisan "would have had a reasonable expectation of success in this implementation at least because Ma and TR [or Ma and Jung] are related to similar methods and systems." *Id.* at 12 (citing *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007); Ex. 1003 ¶ 69), 35 (citing Ex. 1003 ¶ 122), 60 (citing Ex. 1003 ¶ 84).

"[A] patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *KSR*, 550 U.S. at 418. "[I]t can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." *Id.* An articulated reason to combine helps to avoid "the distortion caused by hindsight bias." *Id.* at 421.

Petitioner does not show sufficiently, on this record, that the above-discussed disclosures of Ma and TR, or Ma and Jung, would have led an ordinarily skilled artisan to incorporate guard carriers or null data on both ends of the block of subcarriers of Ma's RACH. Specifically, Petitioner's analysis, and Dr. Valenti's testimony in this regard, are both conclusory and fail to explain adequately how or why the ordinarily skilled artisan would have implemented TR's guard carrier or Jung's null data into Ma's RACH structure.[7] *See TriVascular, Inc. v. Samuels*, 812 F.3d 1056, 1066 (Fed. Cir. 2016) ("Although the *KSR* test is flexible, the Board 'must still be careful not to allow hindsight reconstruction of references . . . without any explanation as to *how* or *why* the references would be combined to produce the claimed invention.'" (citation omitted)).

As Patent Owner argues, and Mr. Alberth testifies, Ma does not use "a ranging subchannel that is transmitted on separate frequencies from the data," but rather, "spreads the RACH widely and transmits the RACH at a very low power at the same frequencies and at the same time as the traffic data so that it intentionally, but minimally, interferes with the traffic data

[7] Dr. Valenti's testimony merely mirrors the Petition, and Dr. Valenti does not provide additional explanation to support Petitioner's arguments.

transmitted via the subcarriers on the same frequencies." Prelim. Resp. 32 (citing Ex. 1005 ¶¶ 206, 208, 215, 217, 219); Ex. 2001 ¶¶ 30, 32; *see* Prelim. Resp. 50 (advancing the same arguments against Petitioner's combination of Ma and Jung). Mr. Alberth testifies that adding guard carriers to the end of Ma's RACH "has the effect of reducing the number of carriers transmitting RACH and thus narrowing the available bandwidth available for the RACH signal." Ex. 2001 ¶ 33. Mr. Alberth further explains that incorporating TR's guard carriers or Jung's null data on both ends of the block of subcarriers of Ma's RACH would result in "a 6.25% reduction in bandwidth" such that the modified RACH would have to be transmitted at 6.25% higher power "to achieve the same RACH performance." *Id.* Mr. Alberth testifies that "this increase of power expressly contradicts Ma's instruction that, '[t]he RACH should be transmitted with the power as low as possible to reduce its impact to slow traffic channel'" and "increases the power requirements of the system as a whole, which a [person of ordinary skill in the art] would know is generally undesirable." *Id.* ¶¶ 34–35 (quoting Ex. 1005 ¶ 217) (first alteration in original).

Absent more analysis in the Petition or Dr. Valenti's declaration, we cannot say that Petitioner sufficiently shows that Ma's OFDMA communication system was ready for improvement, or that implementing TR's guard carriers or Jung's null data in Ma's system would have yielded predictable results given the structure of Ma's RACH. *See In re NuVasive, Inc.*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (stating that "conclusory statements" amount to an "insufficient articulation[] of motivation to combine"; "instead, the finding must be supported by a 'reasoned explanation'" (citation omitted)). Thus, Petitioner fails to demonstrate a reasonable likelihood of prevailing in its assertion that the subject matter of

claims 1–4, 6–12, 14–20, and 22–24 would have been obvious over the combination of Ma and TR, or Ma and Jung. Further, because Petitioner relies on Soliman and Li only for the additional limitations in claims 5 and 21 or 13, respectively, Petitioner also fails to demonstrate a reasonable likelihood of prevailing in its assertion that the subject matter of those claims would have been obvious.

IV. CONCLUSION

Taking account of the information presented in the Petition and the Preliminary Response, and the evidence of record, we determine that Petitioner fails to demonstrate a reasonable likelihood of prevailing at trial as to any challenged claim. Accordingly, we deny the Petition, and do not institute trial.

V. ORDER

It is hereby

ORDERED that the Petition is *denied*, and no trial is instituted.

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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

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00093	3/29/2022	Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
Neo Wireless LLC	Toyota Motor North America, Inc., Toyota Motor Sales, U.S.A., Inc., & Toyota Motor Engineering & Manufacturing North America, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,075,941	9/11/2018	Neo Wireless LLC
3	10,447,450	10/15/2019	Neo Wireless LLC
4	10,771,302	9/8/2020	Neo Wireless LLC
5	10,833,908	4/17/2018	Neo Wireless LLC

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
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DECISION/JUDGEMENT

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PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
6 10,965,512	3/30/2021	Neo Wireless LLC

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00094	3/29/2022	Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
Neo Wireless LLC	General Motors Company and General Motors LLC

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,075,941	9/11/2018	Neo Wireless LLC
3	10,447,450	10/15/2019	Neo Wireless LLC
4	10,771,302	9/8/2020	Neo Wireless LLC
5	10,833,908	4/17/2018	Neo Wireless LLC

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6 10,965,512	3/30/2021	Neo Wireless LLC

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00095	3/29/2022	Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
Neo Wireless LLC	Tesla Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,075,941	9/11/2018	Neo Wireless LLC
3	10,447,450	10/15/2019	Neo Wireless LLC
4	10,771,302	9/8/2020	Neo Wireless LLC
5	10,833,908	4/17/2018	Neo Wireless LLC

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6 10,965,512	3/30/2021	Neo Wireless LLC

To Be Filed in CM/ECF

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	3/29/2022	Eastern District of Tennessee

PLAINTIFF	DEFENDANT
Neo Wireless LLC	Volkswagen Group of America, Inc. & Volkswagen Group of America Chattanooga Operations, LLC

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,075,941	9/11/2018	Neo Wireless LLC
3	10,447,450	10/15/2019	Neo Wireless LLC
4	10,771,302	9/8/2020	Neo Wireless LLC
5	10,833,908	4/17/2018	Neo Wireless LLC

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PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
6 10,965,512	3/30/2021	Neo Wireless LLC

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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 for the Middle District of Tennessee on the following

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
3:22-cv-00220	3/29/2022	for the Middle District of Tennessee

PLAINTIFF	DEFENDANT
NEO Wireless, LLC	Nissan North America Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8467366		See attached complaint
2	10833908		
3	10075941		
4	10447450		
5	10965512		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

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PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10771302		
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE
LYNDA M. HILL	VANESSA HAINES	4/4/2022

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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 Northern District of Ohio on the following

☑ Trademarks or ☐ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
3:22-cv-01252	7/15/2022	Northern District of Ohio

PLAINTIFF	DEFENDANT
Neo Wireless LLC	FCA US, LLC

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,075,941	9/11/2018	Neo Wireless LLC
3	10,447,450	10/15/2019	Neo Wireless LLC
4	10,771,302	9/8/2020	Neo Wireless LLC
5	10,833,908	4/17/2018	Neo Wireless LLC

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PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
6 10,965,512	3/30/2021	Neo Wireless LLC

AO 120 (Rev. 08/10)

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☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
3:22-cv-780-J-MMHJBT	July 15, 2022	Middle District of Florida

PLAINTIFF	DEFENDANT
NEO WIRELESS, LLC	MERCEDES-BENZ USA, LLC

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	January 23, 2020	Neo Wireless LLC
2	10,833,908	June 16, 2020	Neo Wireless LLC
3	10,075,941	January 23, 2020	Neo Wireless LLC
4	10,447,450	January 23, 2020	Neo Wireless LLC
5	10,965,512	September 4, 2020	Neo Wireless
6	10,771,302	January 23, 2020	Neo Wireless LLC

CLERK	(BY) DEPUTY CLERK	DATE
ELIZABETH M. WARREN	Amy Thomas	July 20, 2022

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AO 120 (Rev. 08/10)

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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 Northern District of Ohio on the following

☑ Trademarks or ☐ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
3:22-cv-01252	7/15/2022	Northern District of Ohio

PLAINTIFF	DEFENDANT
Neo Wireless LLC	FCA US, LLC

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	8,467,366	6/18/2013	Neo Wireless LLC
2	10,075,941	9/11/2018	Neo Wireless LLC
3	10,447,450	10/15/2019	Neo Wireless LLC
4	10,771,302	9/8/2020	Neo Wireless LLC
5	10,833,908	4/17/2018	Neo Wireless LLC

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

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PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT
Conditional Transfer Order (CTO 1) by the Judicial Panel on Multidistrict Litigation. In re: MDL 3034 Neo Wireless, LLC, Patent Litigation. Case Transferred to Eastern District of Michigan and assigned to the Honorable Terrence G. Berg.

CLERK	(BY) DEPUTY CLERK	DATE
Sandy Opacich	/s/Natalie Wlotzko	8/15/2022

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PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
6 10,965,512	3/30/2021	Neo Wireless LLC