



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
62/088,257	12/05/2014		260	MP6128PR		

CONFIRMATION NO. 3846

23624
MARVELL SEMICONDUCTOR, INC.
INTELLECTUAL PROPERTY DEPARTMENT
5488 Marvell Lane
Santa Clara, CA 95054

FILING RECEIPT



OC000000072453097

Date Mailed: 12/19/2014

Receipt is acknowledged of this provisional patent application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Liwen Chu, San Ramon, CA;
Yakum Sun, Sunnyvale, CA;
Lei Wang, San Diego, CA;
Hongyuan Zhang, Fremont, CA;
Jinjing Jiang, San Jose, CA;
Hui-Ling Lou, Sunnyvale, CA;

Applicant(s)

Liwen Chu, San Ramon, CA;
Yakum Sun, Sunnyvale, CA;
Lei Wang, San Diego, CA;
Hongyuan Zhang, Fremont, CA;
Jinjing Jiang, San Jose, CA;
Hui-Ling Lou, Sunnyvale, CA;

Power of Attorney:

Horace Ng--39315

If Required, Foreign Filing License Granted: 12/17/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/088,257**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

Title

SYNC DESIGN

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No**PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES**

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER**Title 35, United States Code, Section 184****Title 37, Code of Federal Regulations, 5.11 & 5.15****GRANTED**

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier

license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

**TRANSMITTAL
FORM**

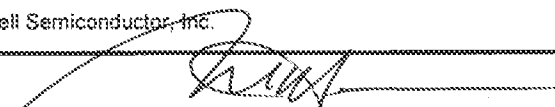
(to be used for all correspondence after initial filing)

TRANSMITTAL FORM (to be used for all correspondence after initial filing)	Application Number	Unassigned	
	Filing Date	December 5, 2014	
	First Named Inventor	Liwen Chu	
	Art Unit	Unassigned	
	Examiner Name	Unassigned	
Total Number of Pages in This Submission		Attorney Docket Number	MP6128PR

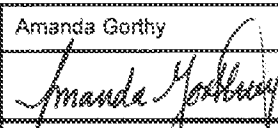
ENCLOSURES (check all that apply)

☐ Fee Transmittal Form ☐ Fee Attached ☐ Amendment / Reply ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☐ Response to Missing Parts/Incomplete Application ☐ Response to Missing Parts under 37 CFR 1.52 or 1.53	☐ Drawing(s) ☐ Licensing-related Papers ☐ Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation Change of Correspondence Address ☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ After Allowance Communication to Technology Center (TC) ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☒ Other Enclosure(s) (please identify below): Provisional Application (36 pgs) Application Data Sheet (4 pgs)
Remarks		

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Marvell Semiconductor, Inc.		
Signature			
Printed name	Horace Ng		
Date	December 5, 2014	Reg. No.	39,315

CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being transmitted electronically to the USPTO on the date shown below.			
Typed or printed name	Amanda Gorthy	Telephone No.	408-222-9006
Signature		Date	December 5, 2014

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

INVENTOR INFORMATION

Inventor Authority Type:: INV
Primary Citizenship Country:: CN
Status:: Full Capacity
Given Name:: Liwen
Family Name:: Chu
Name Suffix::
City of Residence:: San Ramon
State or Prov. Of Residence:: California
Country of Residence:: United States
Street:: 5639 Lysander Way
Street::
City:: San Ramon
State or Province:: California
Country:: United States
Postal or Zip Code:: 94582

Inventor Authority Type:: INV
Primary Citizenship Country:: CN
Status:: Full Capacity
Given Name:: Yakun
Family Name:: Sun
Name Suffix::
City of Residence:: Sunnyvale
State or Prov. Of Residence:: California
Country of Residence:: United States
Street:: 825 Inverness Way
Street::
City:: Sunnyvale
State or Province:: California
Country:: United States
Postal or Zip Code:: 94087

Inventor Authority Type:: INV
Primary Citizenship Country:: CA
Status:: Full Capacity
Given Name:: Lei
Family Name:: Wang
Name Suffix::
City of Residence:: San Diego
State or Prov. Of Residence:: California
Country of Residence:: United States
Street:: 13519 Ginger Glen Road
Street::
City:: San Diego
State or Province:: California
Country:: United States
Postal or Zip Code:: 92130

Inventor Authority Type:: INV
Primary Citizenship Country:: CN
Status:: Full Capacity
Given Name:: Hongyuan
Family Name:: Zhang
Name Suffix::
City of Residence:: Fremont
State or Prov. Of Residence:: California
Country of Residence:: United States
Street:: 4707 Paseo Padre Parkway
Street::
City:: Fremont
State or Province:: California
Country:: United States
Postal or Zip Code:: 94555

Inventor Authority Type:: INV
Primary Citizenship Country:: CN
Status:: Full Capacity
Given Name:: Jinjing
Family Name:: Jiang
Name Suffix::
City of Residence:: San Jose
State or Prov. Of Residence:: California
Country of Residence:: United States
Street:: 1920 Messina Dr.
Street::
City:: San Jose
State or Province:: California
Country:: United States
Postal or Zip Code:: 95132

Inventor Authority Type:: INV
Primary Citizenship Country:: US
Status:: Full Capacity
Given Name:: Hui-Ling
Family Name:: Lou
Name Suffix::
City of Residence:: Sunnyvale
State or Prov. Of Residence:: California
Country of Residence:: United States
Street:: 1485 Firebird Way
Street::
City:: Sunnyvale
State or Province:: California
Country:: United States
Postal or Zip Code:: 94087

CORRESPONDENCE INFORMATION

Correspondence Customer Number:: 23624
 Phone Number:: (408) 222-2500

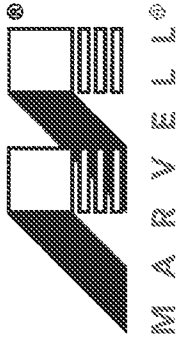
APPLICATION INFORMATION

Subject Matter:: PROVISIONAL
 Title:: SYNC DESIGN
 Docket Number:: MP6128PR
 Request for Early Publication::
 Request for Non-Publication::
 Total Drawing Sheets:: 0
 Small Entity?: No
 Secrecy Order in Parent Appl.?: No
 Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::

REPRESENTATIVE INFORMATION

Representative Customer Number::		
23624		



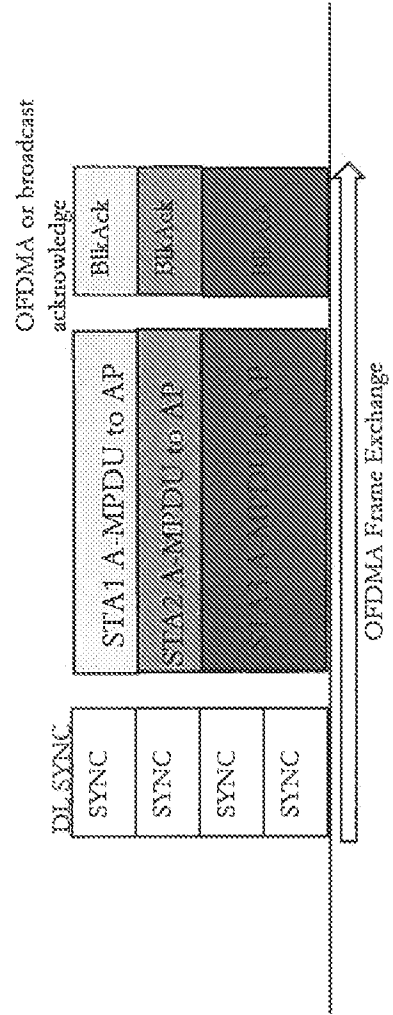
SYNC Design

Liwen Chu, Yakun Sun, Lei Wang, Hongyuan Zhang,
Jinjing Jiang, Hui-Ling Lou

Broadcast SYNC Frame

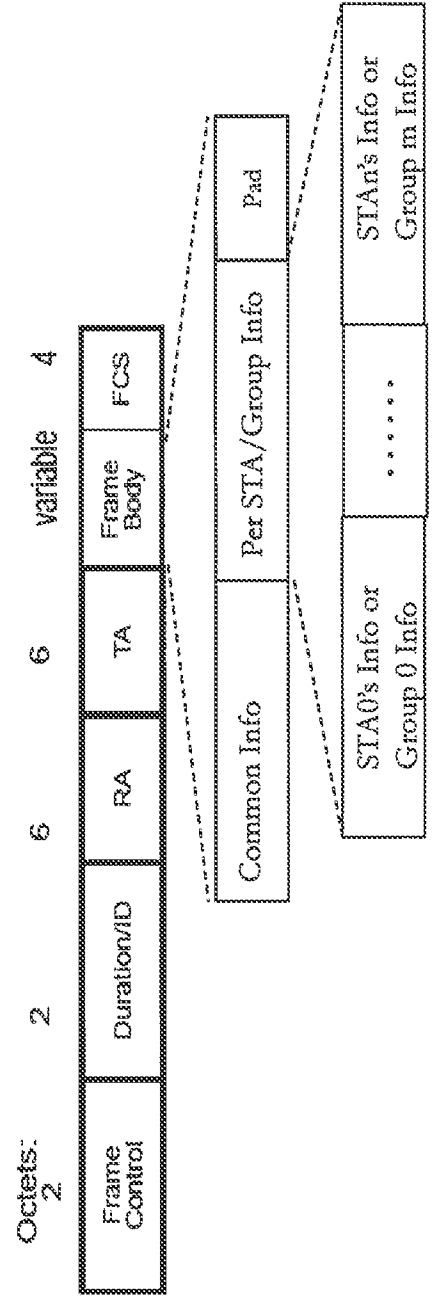
Recap of UL OFDMA Frame Exchange

- A (duplicate) legacy SYNC frame/HE SYNC/NDP SYNC frame is transmitted in legacy PPDU is used to trigger a UL OFDMA/MU-MIMO frame exchange.
 - From SYNC design point of view, legacy SYNC and HE SYNC have same frame format. The difference is that SYNC frame is encapsulated in different PPDU format.
- SIFS after the end of PPDU which carries SYNC, STAs transmit UL OFDMA/MU-MIMO frames.
- After receiving UL MU PPDU, the AP acknowledges the received frames by using broadcast acknowledge or OFDMA acknowledge.



SYNC Frame Format

- SYNC frame is a control frame.
- RA is a broadcast MAC address.
- TA is the MAC address of the AP that transmits SYNC frame.
- Duration/ID indicates the time until the end of the TXOP.
- Pad field is used to pad the frame body to multiple octets if needed.
- SYNC frame needs to indicate the SYNC bandwidth and the UL OFDMA bandwidth (same as SYNC bandwidth)
 - Scrambling sequence and signaling TA can indicate SYNC bandwidth.
 - Bits in HE SIG can be allocated to carry SYNC and UL OFDMA bandwidth.



Resource Allocation Discussion

- In a UL MU transmission, the following resource needs to be defined by the AP:
 - Total bandwidth of the UL MU transmission
 - UL PPDU length
 - GI type
 - HE-LTF type
 - Subchannel allocation for each STA
 - NSTS allocation for each MU MIMO STA
- In a UL MU transmission, the following per STA resource may be defined by either the AP or the STAs:
 - Beamforming indication
 - Transmission power of the UL transmission
 - NSTS allocation for each SU STA
 - MCS of the UL transmission
 - STBC indication
 - LDPC indication.

SYNC Common Info

- Common Info field includes the following subfields:
 - BW indicating total bandwidth of the UL MU transmission (2 bits to indicate: 20MHz, 40MHz, 80MHz, 160/80+80MHz)
 - When the method of Scrambling sequence and signaling TA is selected, BW field is not needed.
 - UL PPDU length indicating PPDU length in OFDM Symbols (10 bits or 8 bits for maximal 4096ms PPDU)
 - GI Mode (1 bit or 2 bits)
 - HE-LTF Type (1 bit)
 - Subchannel allocation for all STAs (defined by BW subfield)
 - It is easy to get same length of Per STA Info fields when Subchannel Allocation for STAs are in common part.
 - Pad subfield being used to pad to multiple octets if needed

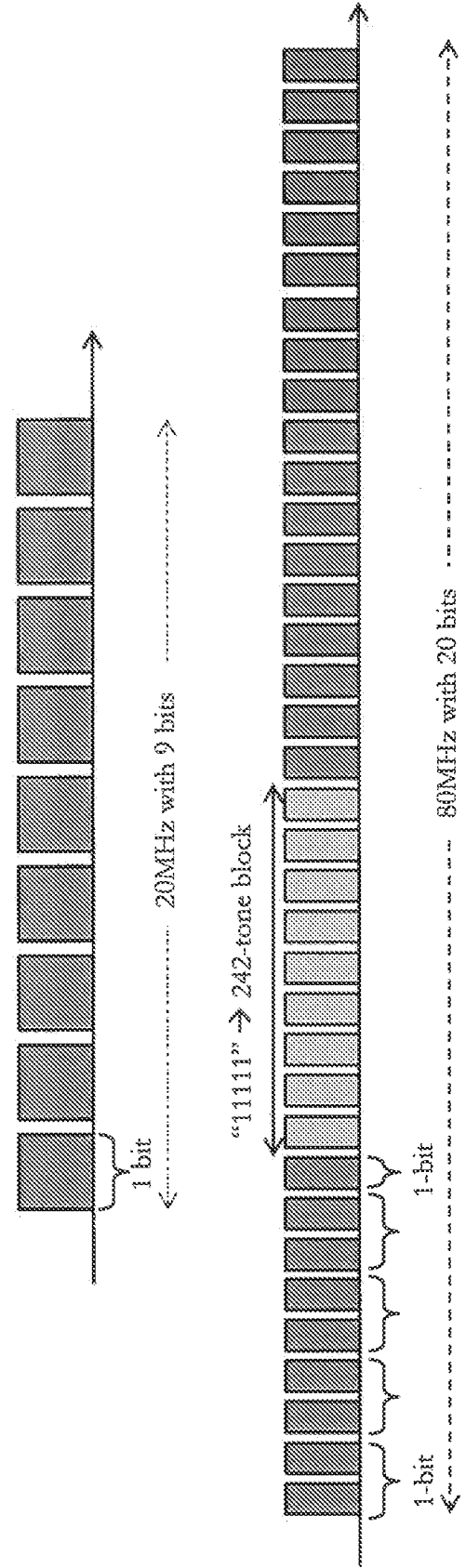
Bits:	2	10	1 or 2	1	Variable per BW	
	BW	UL PPDU Length	GI Mode	HE-LTF Type	Subchannel Allocation	Pad

Subchannel Allocation

- A basic resource unit of 26 tones are agreed for OFDMA transmission.
- The subchannel allocation bitmap consists of one or multiple subchannel allocation codes, each code corresponds to an OFDMA subchannel that is allocated to a single STA if not using MU MIMO or to multiple STAs if using MU MIMO.
 - the continuous “1” or “0” sub bitmap indicates the subchannel allocation for a STA.
- There is a deterministic mapping between the subchannel allocation codes and the allowed subchannel allocation sizes.

Subchannel Allocation

- Option 1: Each bit in the bitmap indicate an allocation unit ([1])
 - Using 26xn is agreed ("n" is for discussion). A 9-bit bitmap is sufficient for resource allocation for 20MHz
 - Example1: 110010100 → 6 RAs of (2, 2, 1, 1, 1, 2) 26-tone units.
 - Example2: 111111111 → 1 RA of 242-tone block.
 - 26 tone per unit for 80/160MHz requires pretty long subchannel bitmap, e.g. 78 bits for 160/80+80MHz.
 - For 80/160MHz, grouping *certain* 2 consecutive basic units as a *schedulable* allocation unit
 - The following is what is required for subchannel indication (option 1).
 - 9 bits for 20MHz,
 - 19 bits for 40MHz,
 - 20 bits for 80MHz.
 - 40 bits for 160MHz.

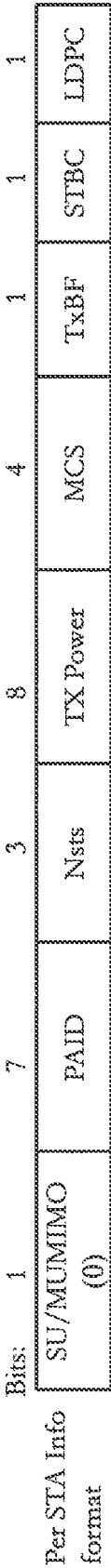


Subchannel Allocation (Cont'd)

- Option 2: If the allowed subchannel allocation sizes are [26, 2*26, 4*26, 242], then mapping between subchannel allocation codes and subchannel sizes could be defined as follows:
 - 1(or 0) → 26tones,
 - 11 (or 00) → 2*26tones,
 - 111 (or 000) → 4*26tones.
 - 1111 (or 0000) → 242tones (~9*26tones).

Per STA Information for SU

- SU/MUMIMO indicates whether the per STA info is for SU STA or MU MIMO STA.
 - If OFDMA and MU MIMO are never transmitted in a UL MU PPDU, this bit is not needed.
- When SU/MUMIMO indicates SU,
 - 7-bit PAID field is the lowest 7 bits of STA's AID.
 - 8-bit TX Power in unit of 0.25dbm indicates the UL transmit power
 - If any of TX power, Nsts, MCS, TxBF, STBC, LDPC is decided by STA, the reserved subfield is not part of the per STA info field. Other possibilities include 1), the TX power, MCS, TxBF, STBC, LDPC for STAs and STAs follow the decision, gives advice about TX power, MCS, TxBF, STBC, LDPC to STAs, and STAs make decision.
 - Buffer Polling Indication may also be part of Per STA Info to poll a buffer report.



Per STA Information for SU (Cont'd)

- One optimization is an AP can indicate the PAID length through Beacon or common field of SYNC frame.

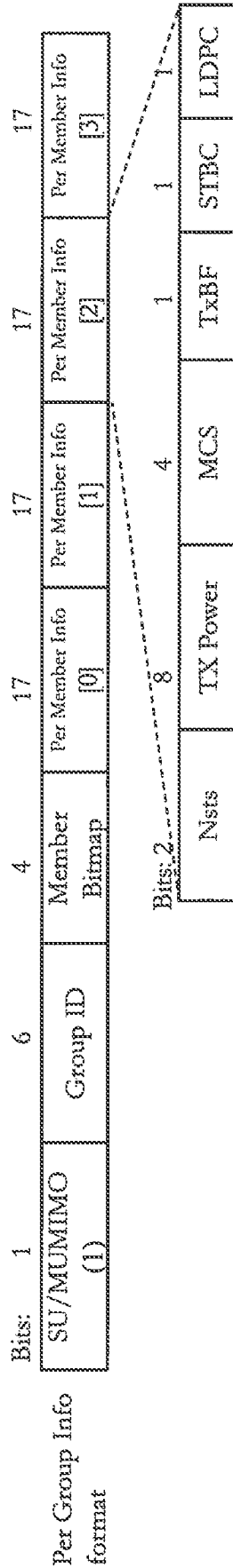
Common Info with PAID length per Common Information		Bits: 2		10	1 or 2	1	Variable per BW		
		BW	UL PPDU Length	GI Mode	HE-LTF Type	Subchannel Allocation	PAID Length	Pad	

Common Info with PAID length per Beacon		Bits: 2		10	1 or 2	1	Variable per BW		
		BW	UL PPDU Length	GI Mode	HE-LTF Type	Subchannel Allocation	Pad		

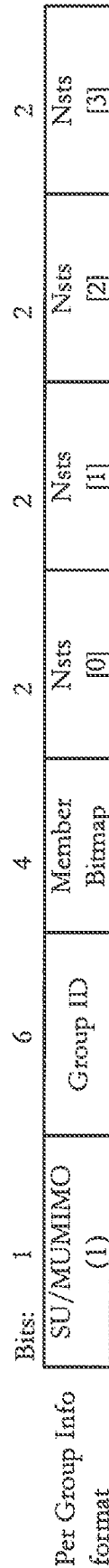
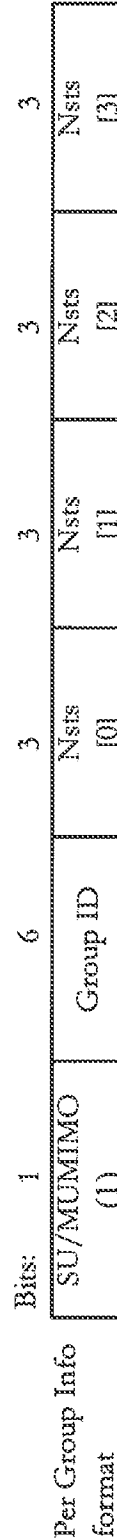
Per STA Info format		Bits: 1		3 to 7	3	8	4	1	1	1
		SU/MUMIMO (0)	PAID	Nsts	TX Power	MCS	TxBF	STBC	LDPC	

Per Group Information for MU

- When SU/MUMIMO indicates MU,
 - Member Bitmap indicates whether a member can transmit UL MU MIMO frames to the AP where bit i is the indication of member i.
 - When a bit in Member Bitmap is 0, the related Member Info field is not included in SYNC frame and the related member is not allowed to transmit frames to AP.
 - If any of TX power, MCS, TxBF, STBC, LDPC is decided by STA, the related subfield is not part of the Per Member Info field. Other possibilities include 1), the AP decides TX power, MCS, TxBF, STBC, LDPC for STAs and STAs follow the decision, 2), the AP gives advice about TX power, MCS, TxBF, STBC, LDPC to STAs, and STAs make final decision.

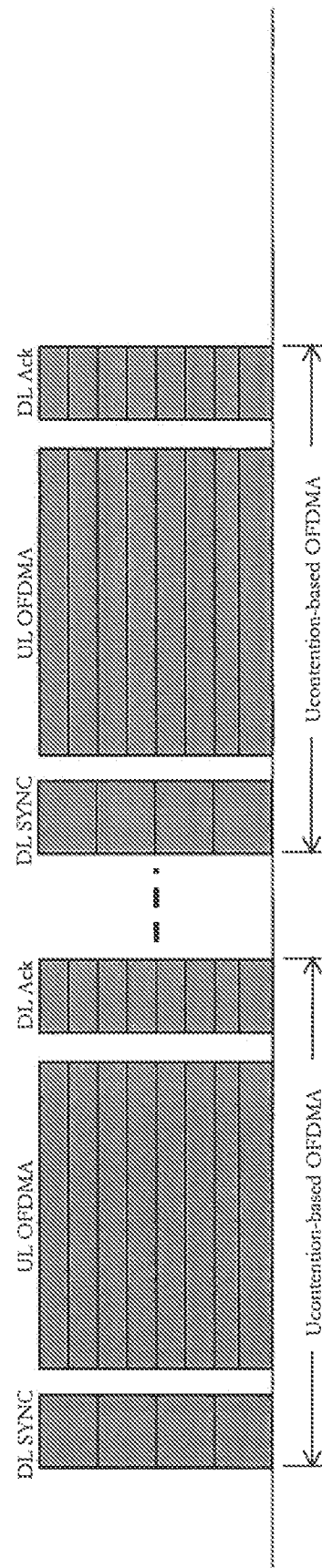
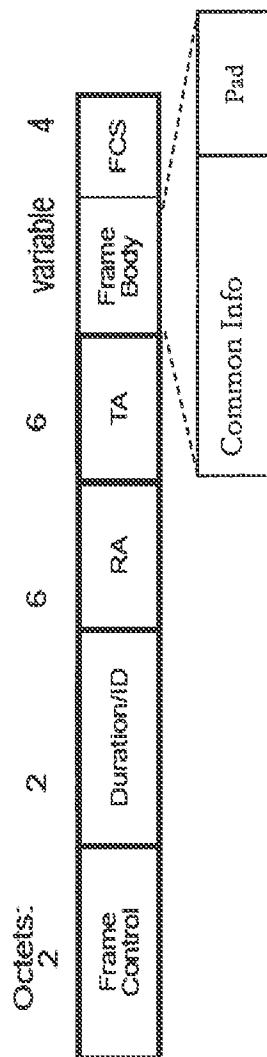


- If Nsts is the only subfield for Per Member Info, Per Group Info can be one of the following:



SYNC with Contention-based OFDMA Access

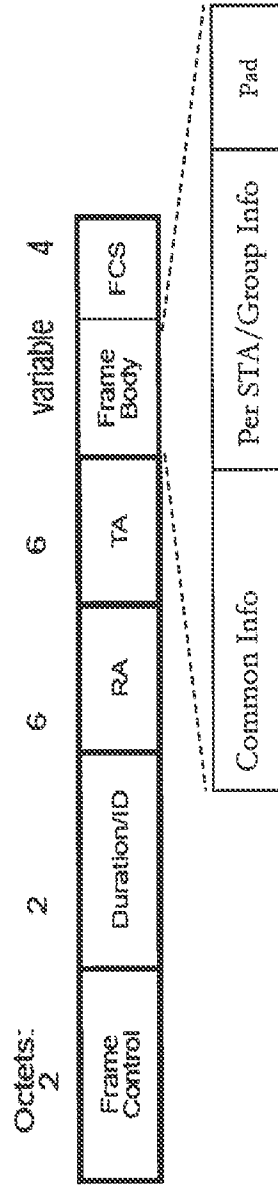
- Option 1:
 - In Common Info field, Contention Indication subfield is added, and when Contention Indication is set to 1, all subchannels are allocated for contention based OFDMA access.
 - Per STA Info are not part of SYNC with Contention Indication being 1.



SYNC with Contention-based OFDMA Access (Cont'd)

- Option 3:

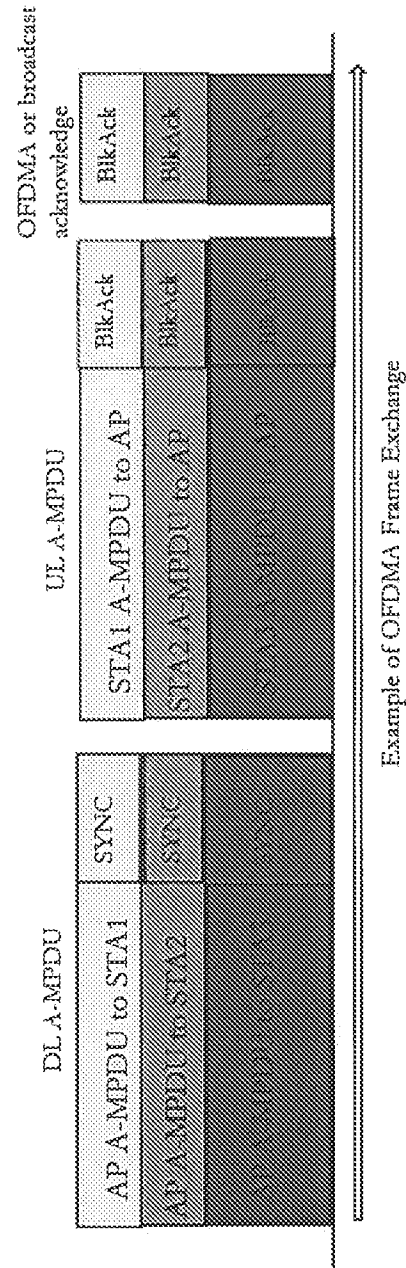
- In Per STA Info field, Contention Indication subfield is added, and when Contention Indication is set to 1, the related subchannel is allocated for contention based OFDMA access.
 - PAID is set to all 0 which indicates that all STAs can contend the subchannel. .



Unicast SYNC Frame

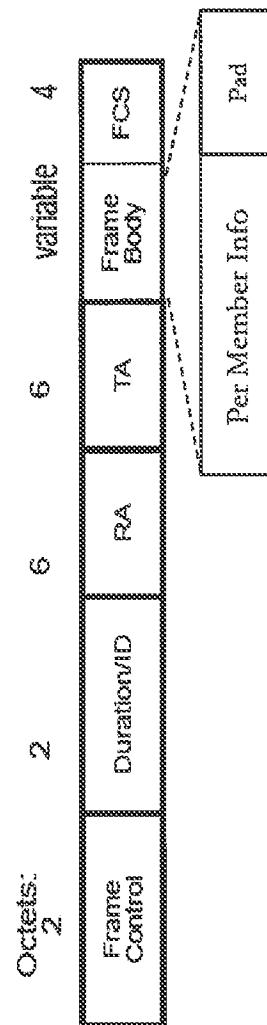
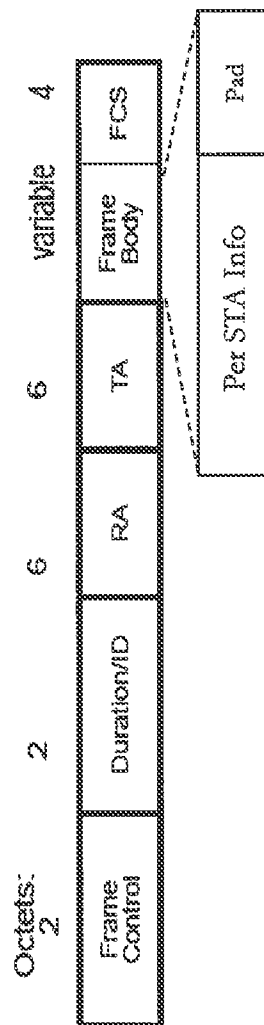
Recap of DL/UL OFDMA Frame Exchange

- A SYNC frame in A-MPDU which is transmitted to a single receiver can be used to trigger UL OFDMA/MU-MIMO frame exchange (UL data OFDMA PPDU + DL acknowledge) or UL OFDMA acknowledge from a STA.
- We assume UL HE-LTF is same as DL HE-LTF.
- SIFS after the end of PPDU which carries SYNC, STAs transmit UL OFDMA/MU-MIMO frames.
- After receiving UL MU PPDU, the AP acknowledges the received frames by using broadcast acknowledge or OFDMA acknowledge.



SYNC Frame Format

- SYNC frame is a control frame.
- RA is a unicast MAC address.
- TA is the MAC address of the AP that transmits SYNC frame.
- Duration/ID indicates the time until the end of the TXOP.
- Pad field is used to pad the frame body to multiple octets if needed.



Per STA Info for OFDMA

- In a ULOFDMA transmission, the following resource needs to be defined by the AP:
 - SU/MUMIMO indicates whether the UL is SU transmission or MU MIMO transmission
 - Same Bandwidth when being set to 1 indicates that the UL subchannel is same as the DL subchannel for the STA and Subchannel allocation is removed.
 - UL PPDU length indicating PPDU length in OFDM Symbols (10 bits)
 - If any of TX power, Nsts, MCS, TxBF, STBC, LDPC is decided by STA, the related subfield is not part of the per STA info field.
 - Subchannel Allocation indicates Start Allocation Unit and Number Allocation Unit.
 - 20MHz: Start Allocation Unit has 4 bits, Number Allocation Unit has 4 bits.
 - 40MHz : Start Allocation Unit has 5 bits, Number Allocation Unit has 5 bits.
 - 80MHz : Start Allocation Unit has 5 bits, Number Allocation Unit has 5 bits.
 - 160/80+80 MHz : Start Allocation Unit has 6 bits, Number Allocation Unit has 6 bits.
 - If UL GI mode is always same as DL GI mode, GI Mode field is not needed.
 - Note: The total UL bandwidth is same as the total DL bandwidth. So BW field is not needed.
 - Short frame may be used to decrease the SYNC overhead.

Bits:	1	10	1 or 2	3	8	4	1	1	1	Variable per BW
SU/ MUMIMO (0)	Same Bandwidth	UL PPDU Length	GI Mode	Nsts	TX Power	MCS	TxBF	STBC	LDPC	Subchannel Allocation

Frame Control	Per STA Info	Pad	FCS
------------------	--------------	-----	-----

Frame Control	Per Member Info	Pad	FCS
------------------	-----------------	-----	-----

Per Member Info for UL MU MIMO

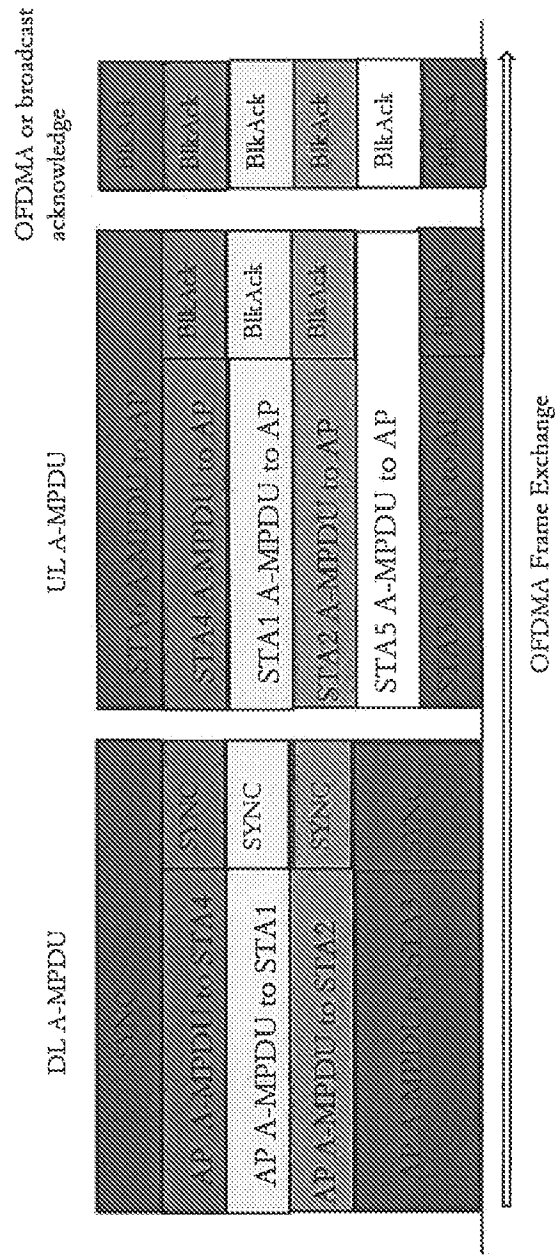
- In a UL MU MIMO transmission, the following resource needs to be defined by the AP:
 - SU/MUMIMO indicates whether the UL is SU transmission or MU MIMO transmission
 - Same Nsts when being set to 1 indicates that the UL space-time streams are same as the DL space-time streams for the member and Nsts Allocation is removed.
 - UL PPDU length indicating PPDU length in OFDM Symbols (10 bits)
 - If any of TX power, Nsts, MCS, TxBF, STBC, LDPC is decided by STA, the related subfield is not part of the per STA info field.
 - Note: The total UL bandwidth is same as the total DL bandwidth. So BW field is not needed.

Bits:	1	1	10	1 or 2	8	4	1	1	1	3	Variable per BW	
SU/ MUMIMO (1)	Same Nsts	UL PPDU Length	GI Mode	TX Power	MCS	TxBF	STBC	LDPC	Nsts Allocation	Subchannel Allocation		

Broadcast SYNC Frame Optimization

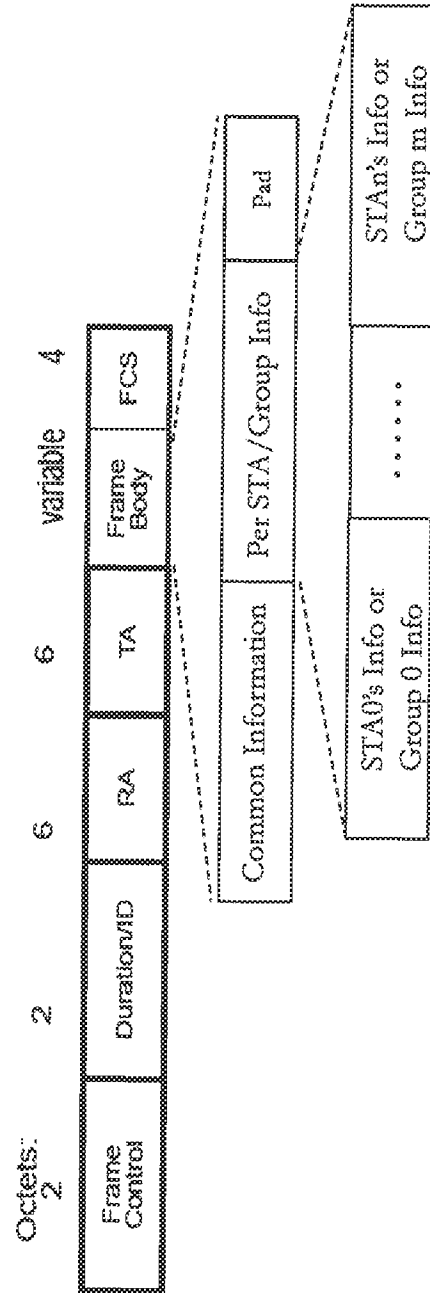
Recap of UL OFDMA Frame Exchange

- When a subchannel in DL OFDMA PPDU is used to broadcast SYNC to multiple STAs, UL OFDMA PPDU and DL OFDMA PPDU can have different STAs as the transmitters/receivers.
- SYNC in A-MPDU with data frames has the same receiver as the data frames.
- SYNC only in a PPDU can be received by multiple STAs.
 - Partial AID in HE SIG for SYNC that is received by multiple STAs is a special partial AID, e.g. all 0 partial AID.
- SIFS after the end of PPDU which carries SYNC, STAs transmit UL OFDMA/MU-MIMO frames.
- After receiving UL MU PPDU, the AP acknowledges the received frames by using broadcast acknowledge or OFDMA acknowledge.



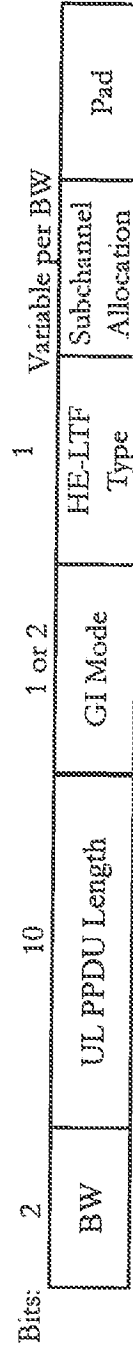
Frame Format of Broadcast SYNC

- SYNC frame is a control frame.
- RA is a broadcast MAC address.
- TA is the MAC address of the AP that transmits SYNC frame.
- Duration/ID indicates the time until the end of the TXOP.
- Pad field is used to pad the frame body to multiple octets if needed.



Common Info for Broadcast SYNC

- In a UL MU transmission, the following resource needs to be defined by the AP:
 - BW indicating total bandwidth of the UL MU transmission (2 bits to indicate: 20MHz, 40MHz, 80MHz, 160/80+80MHz)
 - UL PPDU length indicating PPDU length in OFDM Symbols (10 bits)
 - Subchannel allocation for all STAs (defined by BW subfield)
 - It is easy to get same length of Per STA Info fields when Subchannel Allocation for STAs are in common part.
 - HE LTF Type (1 bit)
 - GI Mode (1 bit or 2 bits)
 - Pad subfield being used to pad to multiple octets if needed
 - Beamforming Indication may be moved to common part if beamforming is needed by all STAs.



Per STA Information for SU

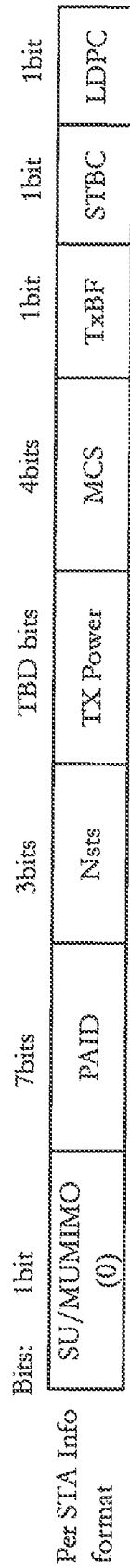
- One-bit SU/MUMIMO indicates whether the per STA info is for SU STA or MU MIMO STA.
- When a subchannel is allocated by a unicast SYNC in DL A-MPDU, the PAID is set to 0 and the per STA info is

Bits:

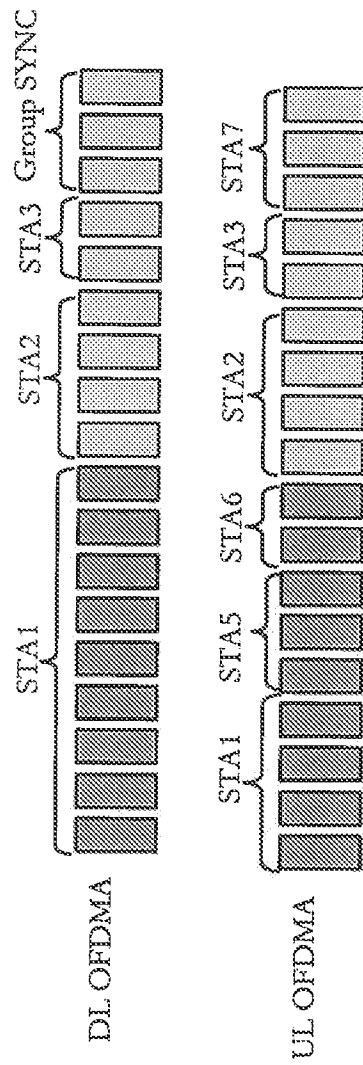
1bit

7bits

Per STA Info format	SU/MUMIMO (0)	PAID
------------------------	------------------	------
- When a subchannel is not allocated by a unicast SYNC in DL A-MPDU,
 - 7-bit PAID field is the lowest 7 bits of STA's AID.
 - 8-bit TX Power in unit of 0.25dbm indicates the UL transmit power
 - If any of TX power, Nsts, MCS, TxBF, STBC, LDPC is decided by STA, the related subfield is not part of the per STA info field.



Example of Per STA Information for SU



Group SYNC's Subchannel Allocation field

1111000100001000

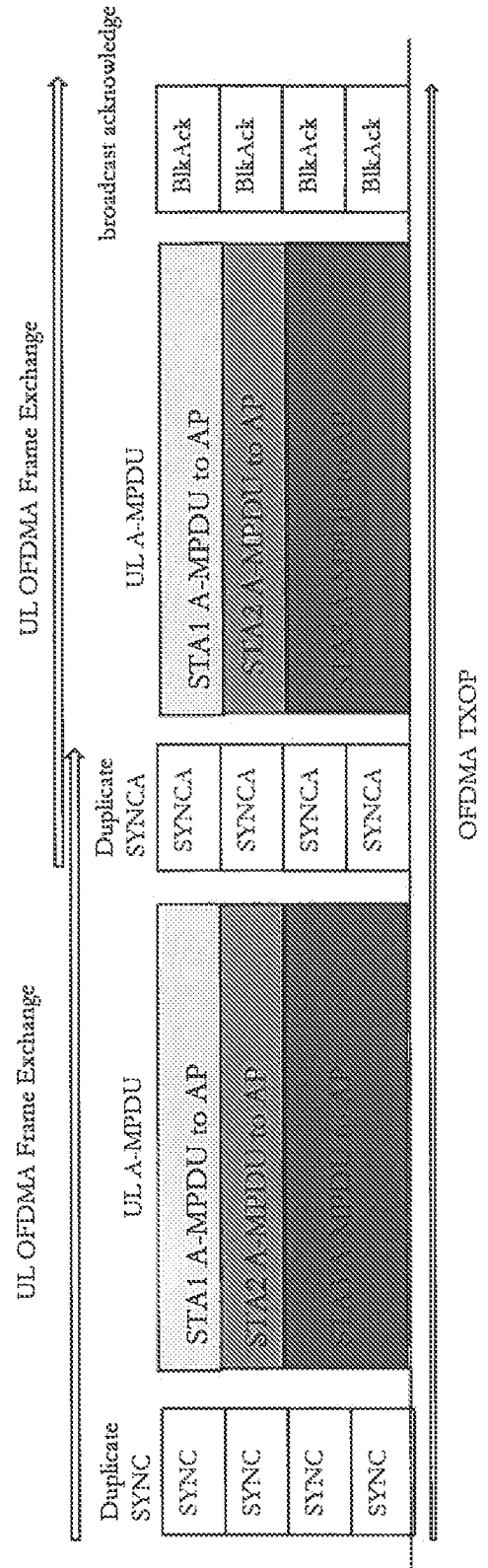
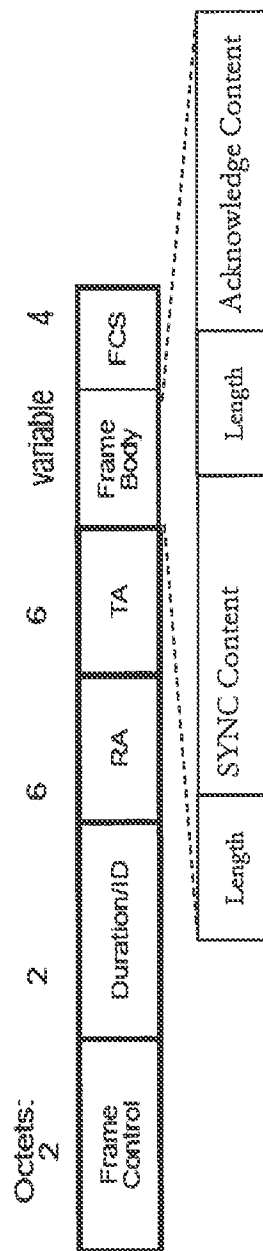
Group SYNC's Per STA Info field (assume PAID is the only per STA information):

0000000001010001100000000011

Aggregation of SYNC and Acknowledge

SYNC Optimization: SYNC frame with Acknowledge

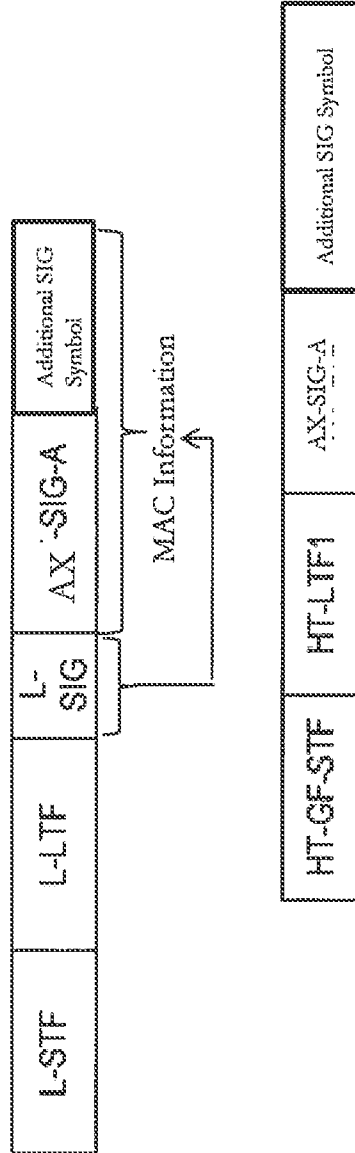
- SYNC frame can optionally carry acknowledge information in its frame body after SYNC content.
- SYNC with acknowledge (SYNCA) is used only when SYNC is not aggregated with other frames.
 - Legacy devices can decode the Duration field in (duplicate)SYNC frame with acknowledge.



NDP SYNC Frame

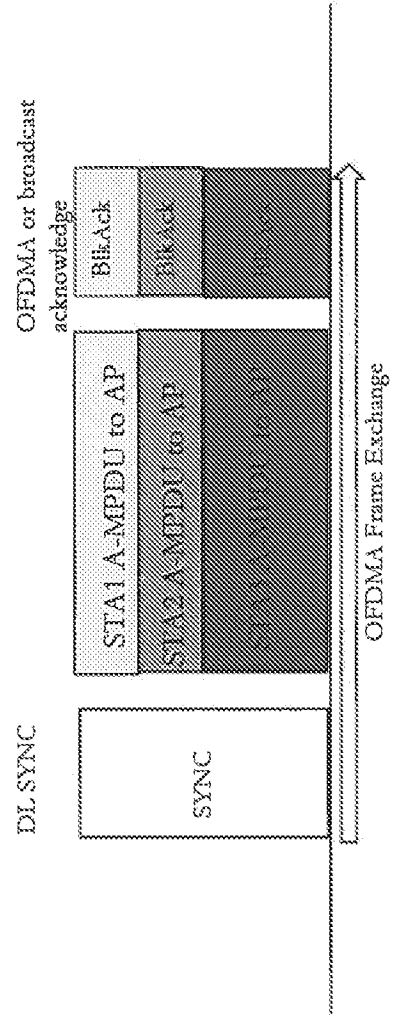
HE NDP Frame Design Options in [2]

- One bit in AX-SIG/AX-SIG-A is used to indicate whether NDP frame or normal frame is in the PPDU.
- AX greenfield NDP frame can only use AX SIG part to carry MAC layer information.
- AX mixed mode NDP frame includes L-SIG and AX-SIG.
 - AX Mixed-mode Option 1 is to use both L-SIG and AX-SIG part to carry MAC layer information. The redefined L-SIG must not confuse legacy STAs (11a/g/n/ac STAs).
 - AX Mixed-mode Option 2 is to only use AX-SIG part to carry MAC layer information. L-SIG is define as what is in AX PPDU.
- AX NDP frame may include additional OFDM symbols after AX-SIG-A.



Recap of UL OFDMA Frame Exchange

- A NDP SYNC frame is transmitted to trigger a UL OFDMA/MU-MIMO frame exchange.
- SIFS after NDP SYNC, STAs transmit UL OFDMA/MU-MIMO frames.
- After receiving UL MU PPDU, the AP acknowledges the received frames by using broadcast acknowledge or OFDMA acknowledge.

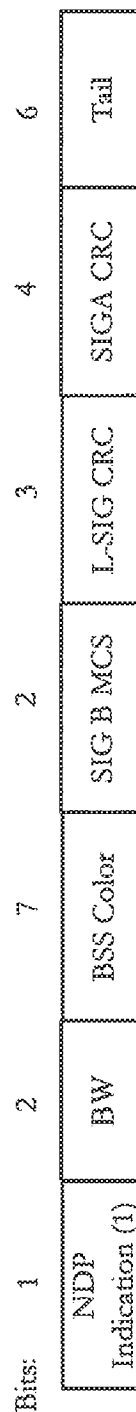


SIG Structure

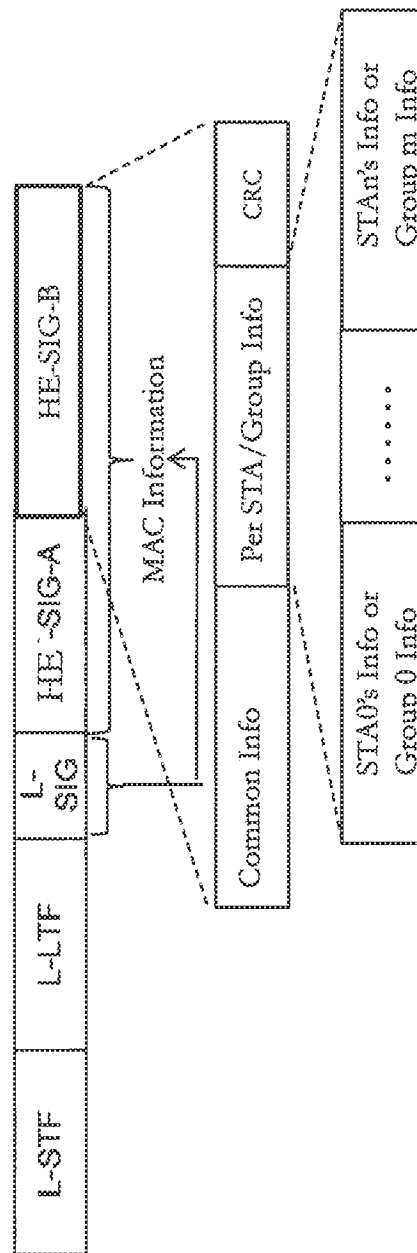
- SIG consists of two individually encoded segments before HE-STF/HE-LTF.
 - SIG-A
 - SIG-B
- SIG-A contains information for SIG-B decoding, and other immediately needed information.
- SIG-B contains information of UL signaling.

HE SIG-A

- NDP Indication being set to 1 indicates that the HE SIG carry NDP SYNC frame.
- BW field indicates both NDP SYNC bandwidth and uplink OFDMA/MU-MIMO bandwidth.
- Additional CRC for L-SIG are included in SIG-A to reduce L-SIG false positive and improve robustness.
- SIG-B-GI type can be signaled by polarity of L-SIG and/or SIG-A repetition.

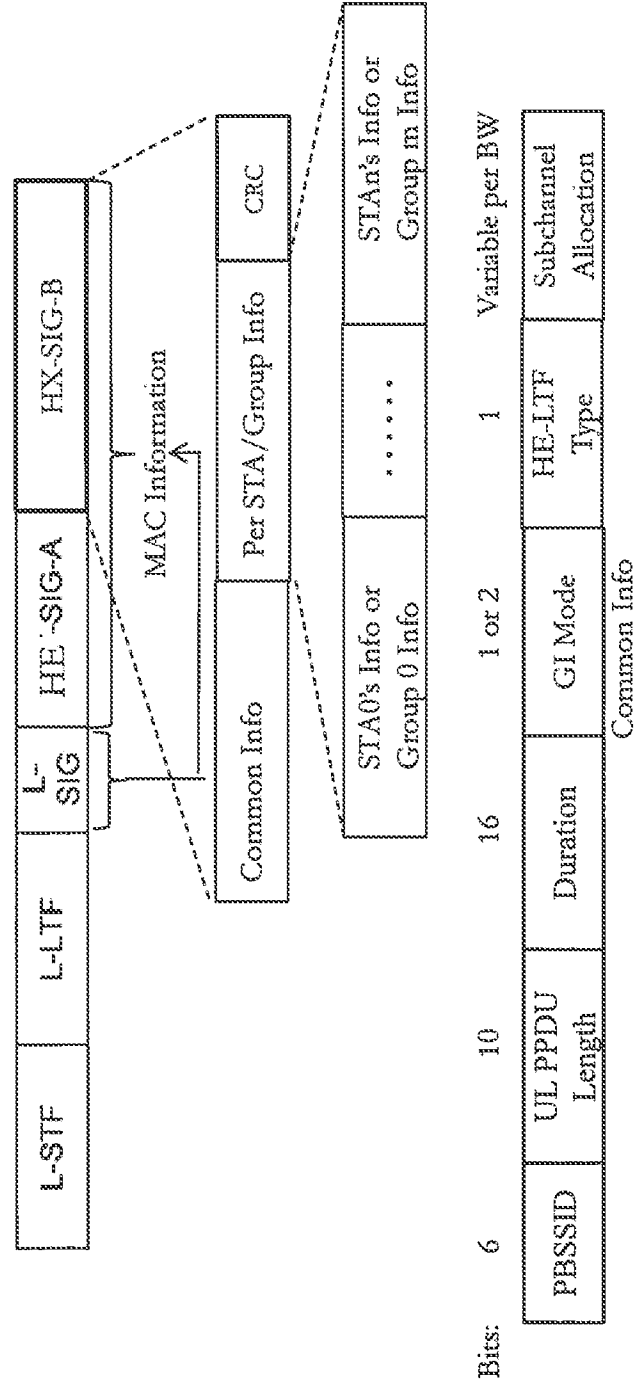


HE SIG-A



SIG-B Common Info

- PBSSID is the 6-bit LSB BSSID.
 - BSSID and BSS Color are used to identify the AP that broadcasts NDP SYNC frame.
- The combination of Length and Rate in L-SIG indicates the length of SIG-A and SIG-B
- SIG-B-GI type can be signaled by polarity of L-SIG and/or SIG-A repetition.
- If UL GI mode and UL HE-LTF type are always same as DL GI mode and DL HE-LTF type respectively, UL GI Mode and UL HE-LTF can be removed from Common Info field.
- Per STA Info/Group Info in NDP SYNC frame are same as Per STA Info/Group Info in normal SYNC frame.



Reference

- [1] 201411xxr0 Marvell SIG structure.ppt
- [2] U.S. Provisional Application No. 61/986,650, filed April 30, 2014, entitled: HEW NDP Frame Design” by Liwen Chu, Lei Wang, Hongyuan Zhang, Hui-Ling Lou, and Yakun Sun.

Electronic Patent Application Fee Transmittal

Application Number:

Filing Date:

Title of Invention:

SYNC DESIGN

First Named Inventor/Applicant Name:

Liwen Chu

Filer:

Horace H. Ng/Amanda Gorthy

Attorney Docket Number:

MP6128PR

Filed as Large Entity

Provisional Filing Fees

Description

Fee Code

Quantity

Amount

**Sub-Total in
USD(\$)**

Basic Filing:

Provisional Application Filing

1005

1

260

260

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:				
Total in USD (\$)				260

Electronic Acknowledgement Receipt

EFS ID:	20883163
Application Number:	62088257
International Application Number:	
Confirmation Number:	3846
Title of Invention:	SYNC DESIGN
First Named Inventor/Applicant Name:	Liwen Chu
Customer Number:	23624
Filer:	Horace H. Ng/Amanda Gorthy
Filer Authorized By:	Horace H. Ng
Attorney Docket Number:	MP6128PR
Receipt Date:	05-DEC-2014
Filing Date:	
Time Stamp:	17:08:45
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$260
RAM confirmation Number	3958
Deposit Account	
Authorized User	

File Listing:

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

1		MP6128PR-Provisional.pdf	1644537 7107f1dc38f54def3f9efac63bb2e8c3a80285ee	yes	41				
	Multipart Description/PDF files in .zip description								
	Document Description		Start	End					
	Transmittal of New Application		1	1					
	Application Data Sheet		2	5					
	Specification		6	41					
Warnings:									
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing									
Information:									
2	Fee Worksheet (SB06)	fee-info.pdf	29448 e9aa629673c41b43a25100d5e2bc73e98d71c976	no	2				
Warnings:									
Information:									
Total Files Size (in bytes):			1673985						
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.									