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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
62/043,061	08/28/2014		260	QTELE.158PR / 146852P1		

CONFIRMATION NO. 4740

14870
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street
Fourteenth Floor
Irvine, CA 92614

FILING RECEIPT



OC000000070754135

Date Mailed: 09/16/2014

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)

Santosh Paul Abraham, San Diego, CA;
Simone Merlin, Solana Beach, CA;
George Cherian, San Diego, CA;
Gwendolyn Denise Barriac, Encinitas, CA;
Sameer Vermani, San Diego, CA;

Applicant(s)

QUALCOMM Incorporated, San Diego, CA

Power of Attorney:

Eric Nelson--43829

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 09/15/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/043,061**

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

Non-Publication Request: No

Early Publication Request: No

Title

SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER
MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK

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

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	QTELE.158PR / 146852P1
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--

Inventor Information:

Inventor 1					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Santosh	Paul	Abraham			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	San Diego	State/Province	CA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1		5775 Morehouse Drive				
Address 2						
City	San Diego	State/Province	CA			
Postal Code	92121-1714	Country	US			
Inventor 2					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Simone		Merlin			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	Solana Beach	State/Province	CA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1		5775 Morehouse Drive				
Address 2						
City	San Diego	State/Province	CA			
Postal Code	92121-1714	Country	US			
Inventor 3					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	George		Cherian			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						

Application Data Sheet 37 CFR 1.76		Attorney Docket Number		QTELE.158PR / 146852P1	
		Application Number			
Title of Invention		SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK			
City	San Diego	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1		5775 Morehouse Drive			
Address 2					
City	San Diego	State/Province	CA		
Postal Code	92121-1714	Country	US		
Inventor 4					Remove
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Gwendolyn	Denise	Barriac		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	Encinitas	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1		5775 Morehouse Drive			
Address 2					
City	San Diego	State/Province	CA		
Postal Code	92121-1714	Country	US		
Inventor 5					Remove
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Sameer		Vermani		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	San Diego	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1		5775 Morehouse Drive			
Address 2					
City	San Diego	State/Province	CA		
Postal Code	92121-1714	Country	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add					

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ An Address is being provided for the correspondence information of this application.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	QTELE.158PR / 146852P1	
		Application Number		
Title of Invention	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK			
Customer Number	14870			
Email Address	efiling@knobbe.com		Add Email	Remove Email

Application Information:

Title of the Invention	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK			
Attorney Docket Number	QTELE.158PR / 146852P1	Small Entity Status Claimed ☐		
Application Type	Provisional			
Subject Matter	Utility			
Total Number of Drawing Sheets (if any)	11	Suggested Figure for Publication (if any)		

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	14870		

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	QTELE.158PR / 146852P1
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the application number blank.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)¹ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove			
Application Number	Country ¹	Filing Date (YYYY-MM-DD)	Access Code ¹ (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. ☐ NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.
--

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	QTELE.158PR / 146852P1
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK		

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices
If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application. In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application. In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.		
Applicant 1		
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. Clear		
☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor
☐ Person to whom the inventor is obligated to assign.	☐ Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:		
Name of the Deceased or Legally Incapacitated Inventor :		
If the Applicant is an Organization check here. ☒		
Organization Name	QUALCOMM Incorporated	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	QTELE.158PR / 146852P1
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK		

Mailing Address Information For Applicant:			
Address 1		5775 Morehouse Drive	
Address 2			
City	San Diego	State/Province	CA
Country	US	Postal Code	92121-1714
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			

Assignee Information including Non-Applicant Assignee Information:

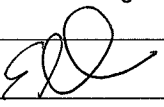
Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1				
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1				
Address 2				
City		State/Province		
Country		Postal Code		
Phone Number		Fax Number		
Email Address				
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.				

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	QTELE.158PR / 146852P1
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK		

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.					
Signature				Date (YYYY-MM-DD)	2014-08-28
First Name	Eric M.	Last Name	Nelson	Registration Number	43829
Additional Signature may be generated within this form by selecting the Add button.					

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

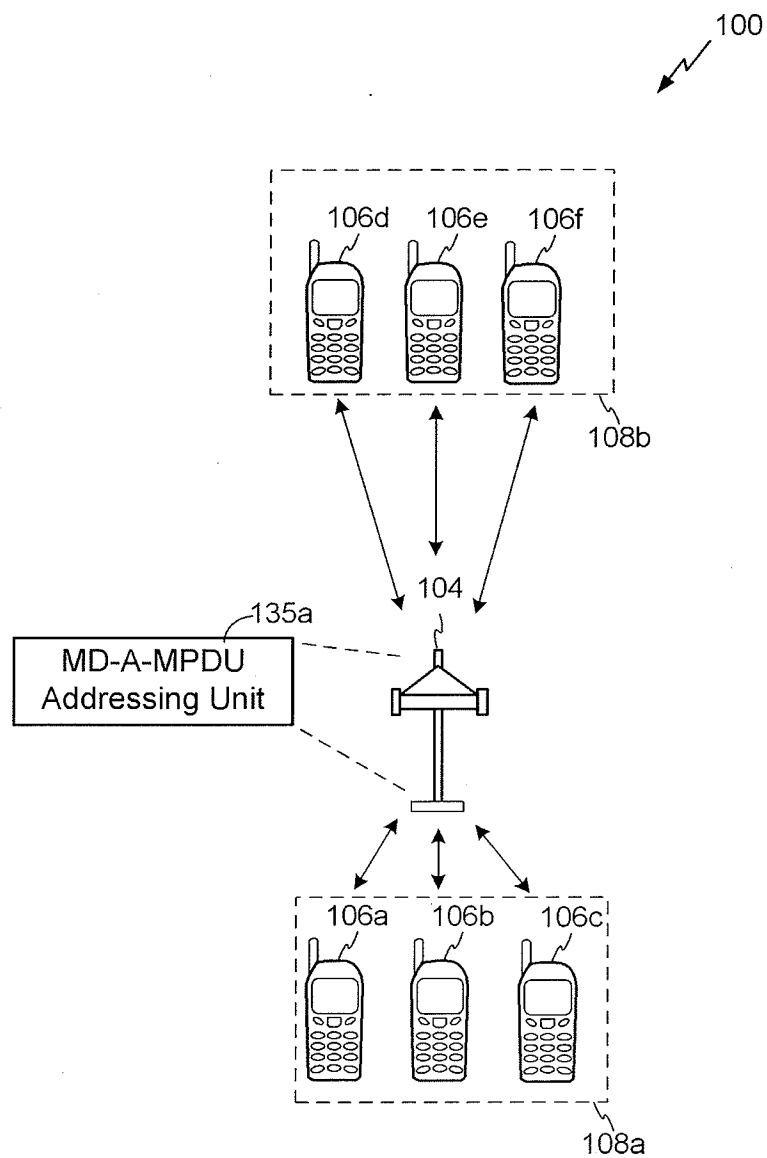


FIG. 1

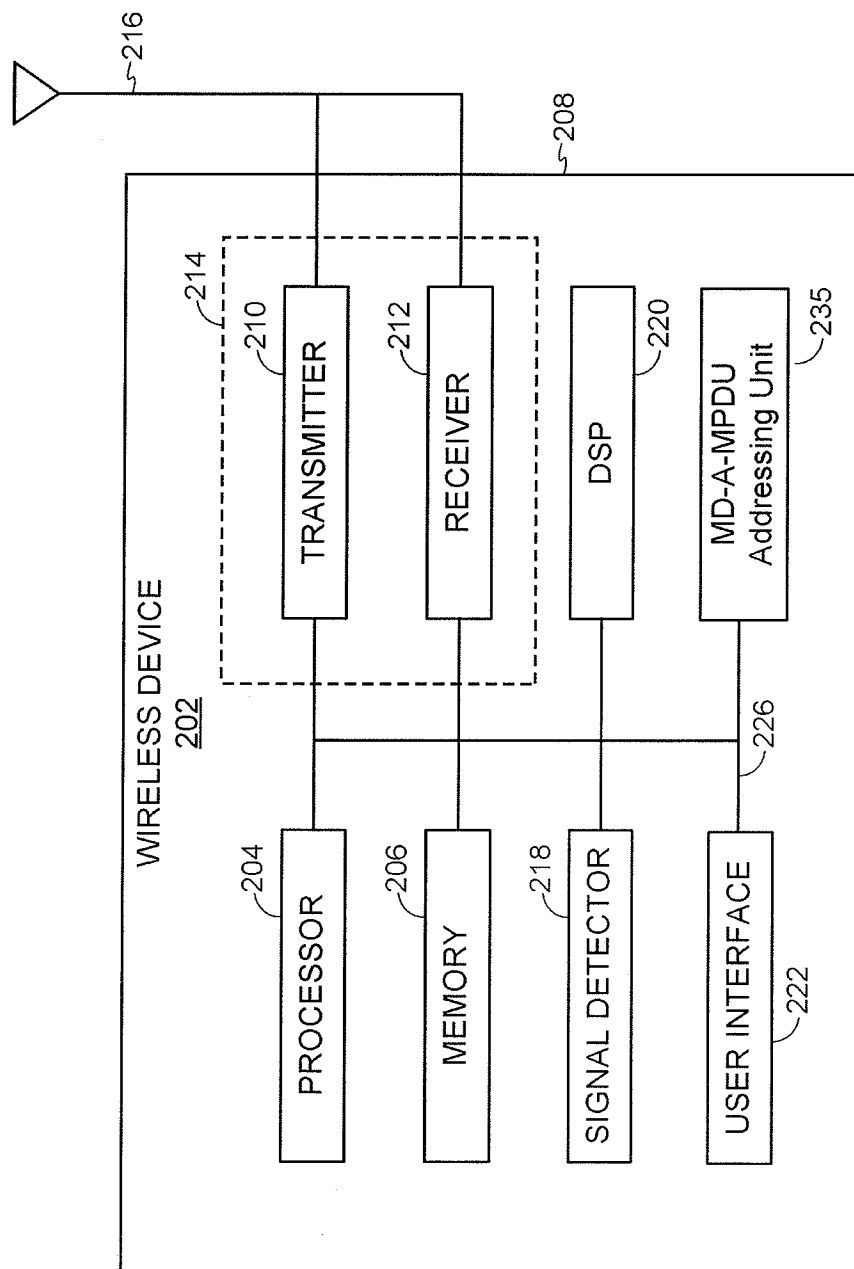


FIG. 2

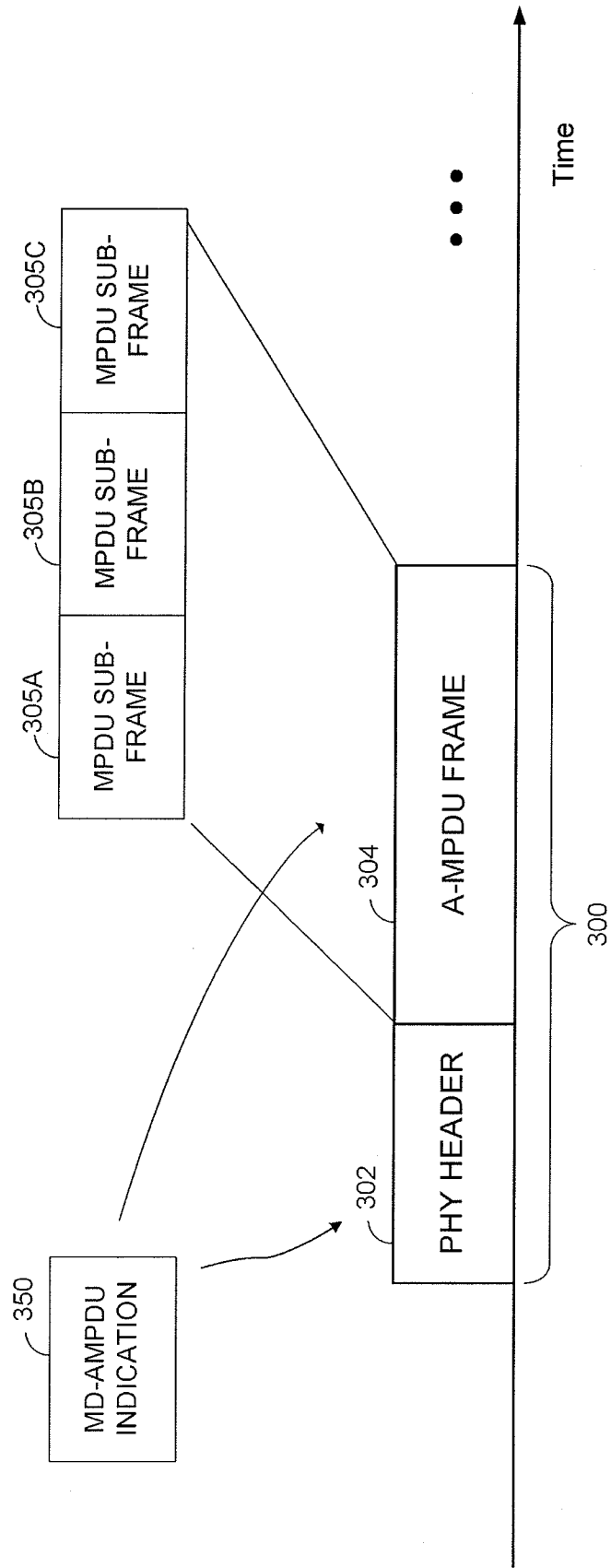


FIG. 3

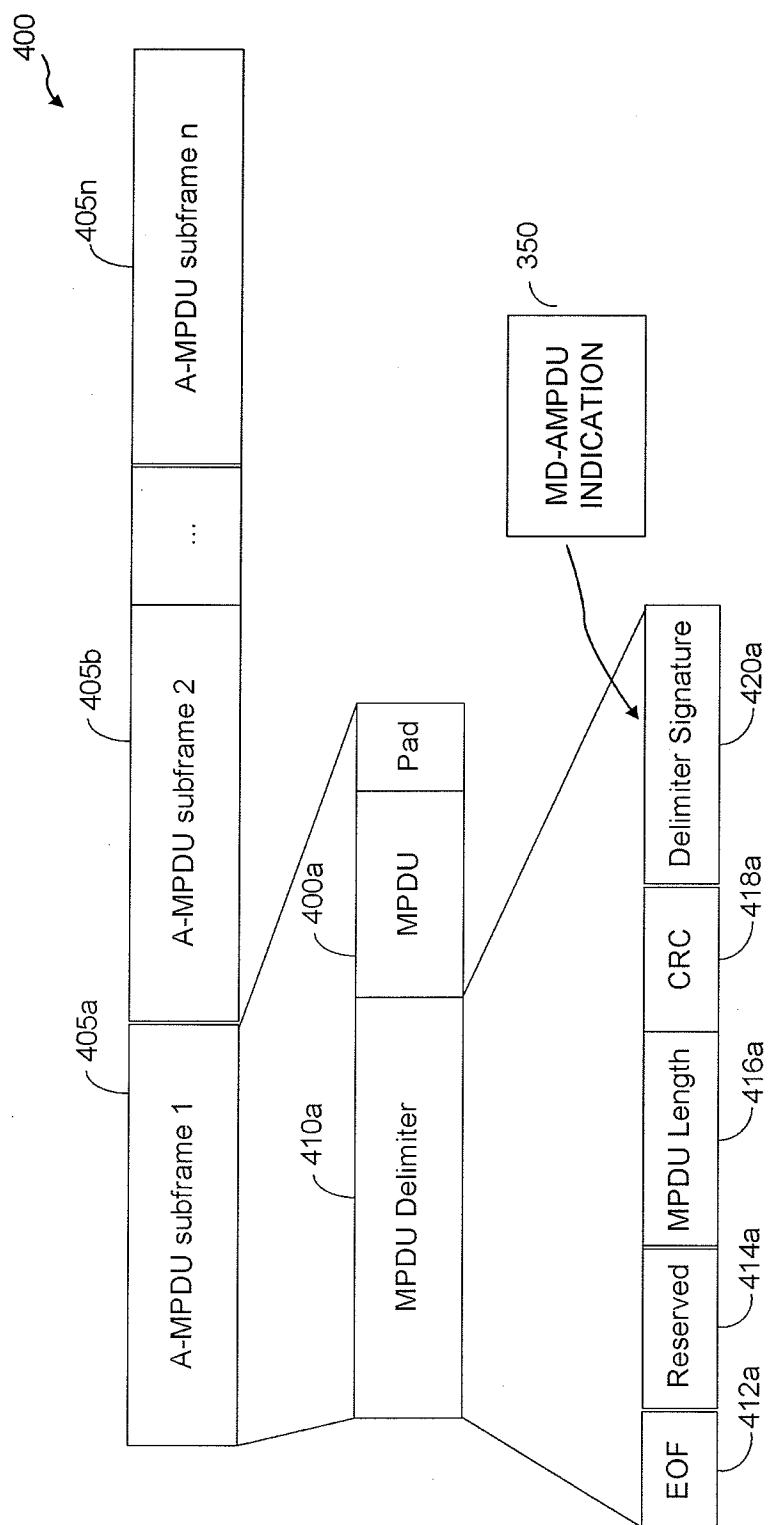


FIG. 4A

5/11

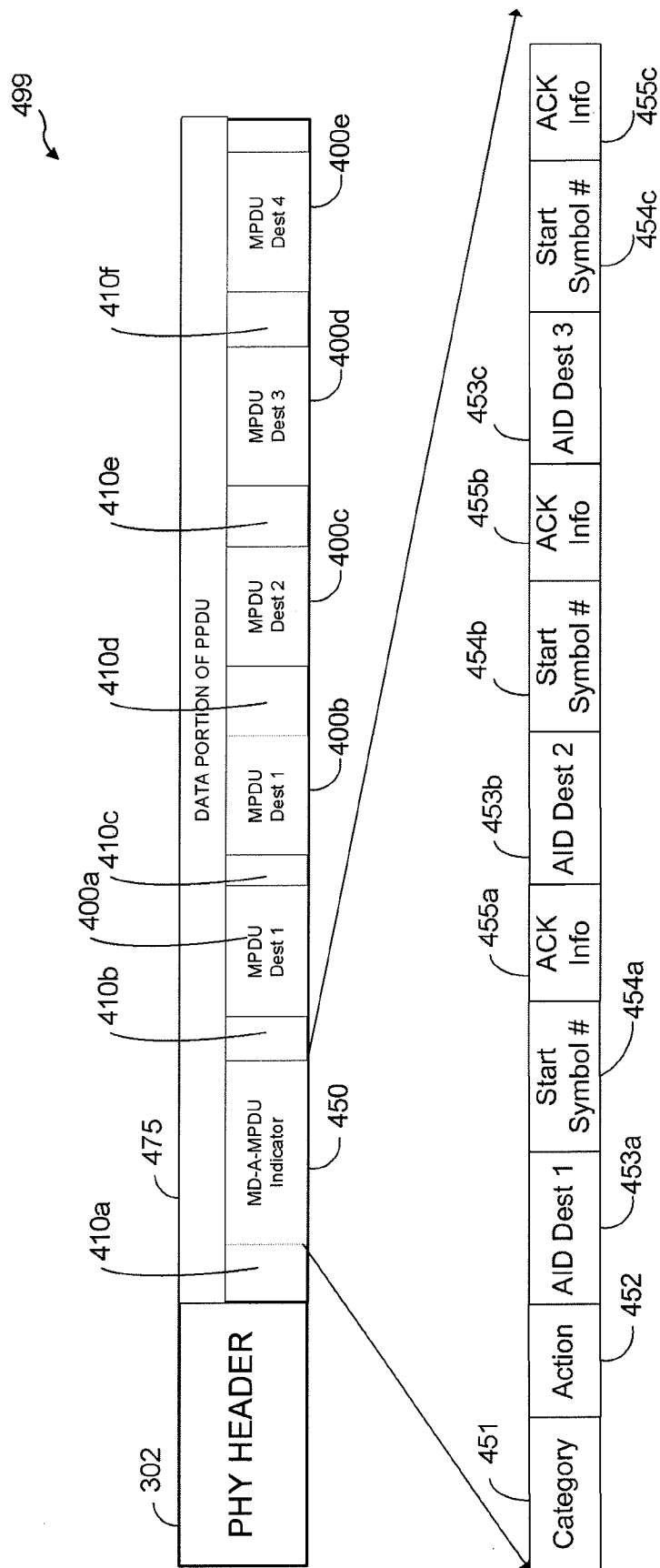


FIG. 4B

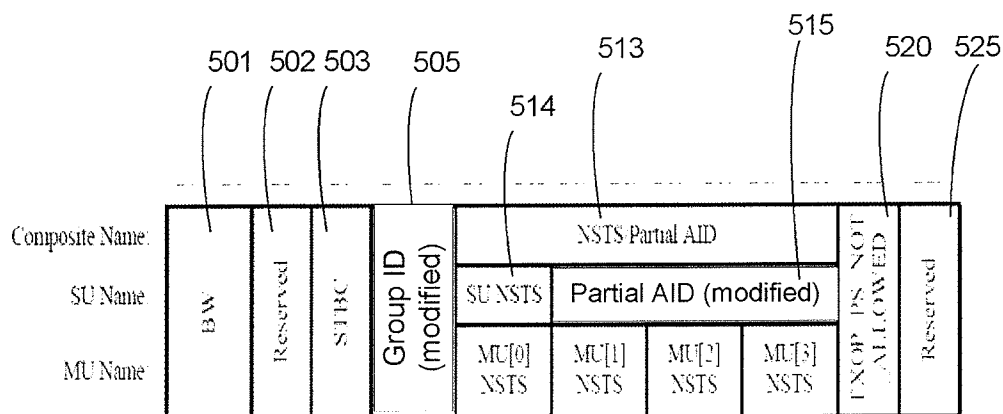


FIG. 5

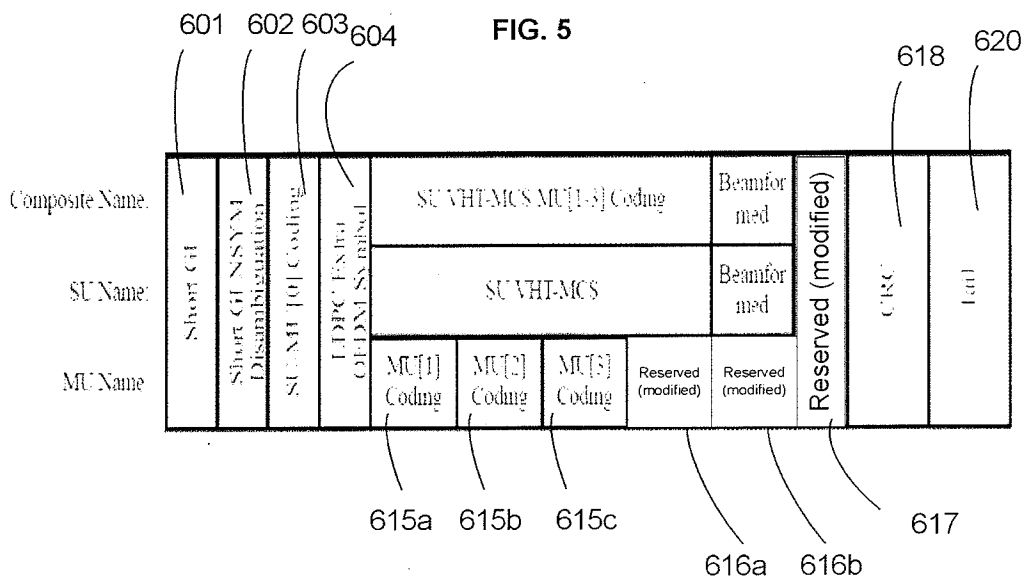


FIG. 6

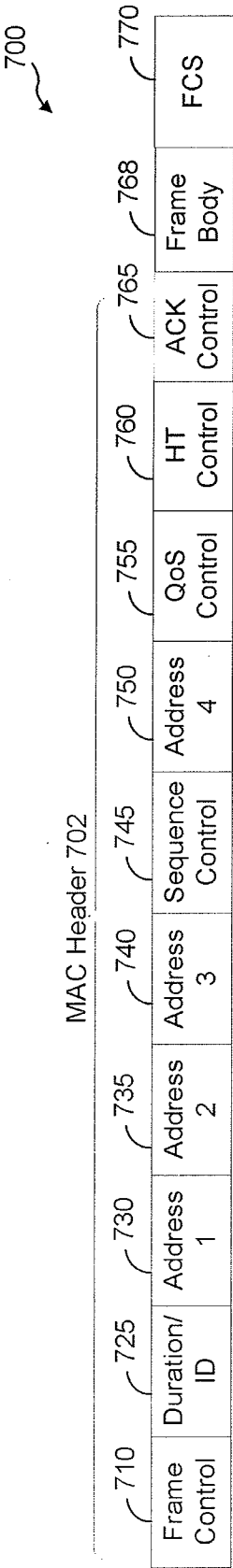


FIG. 7

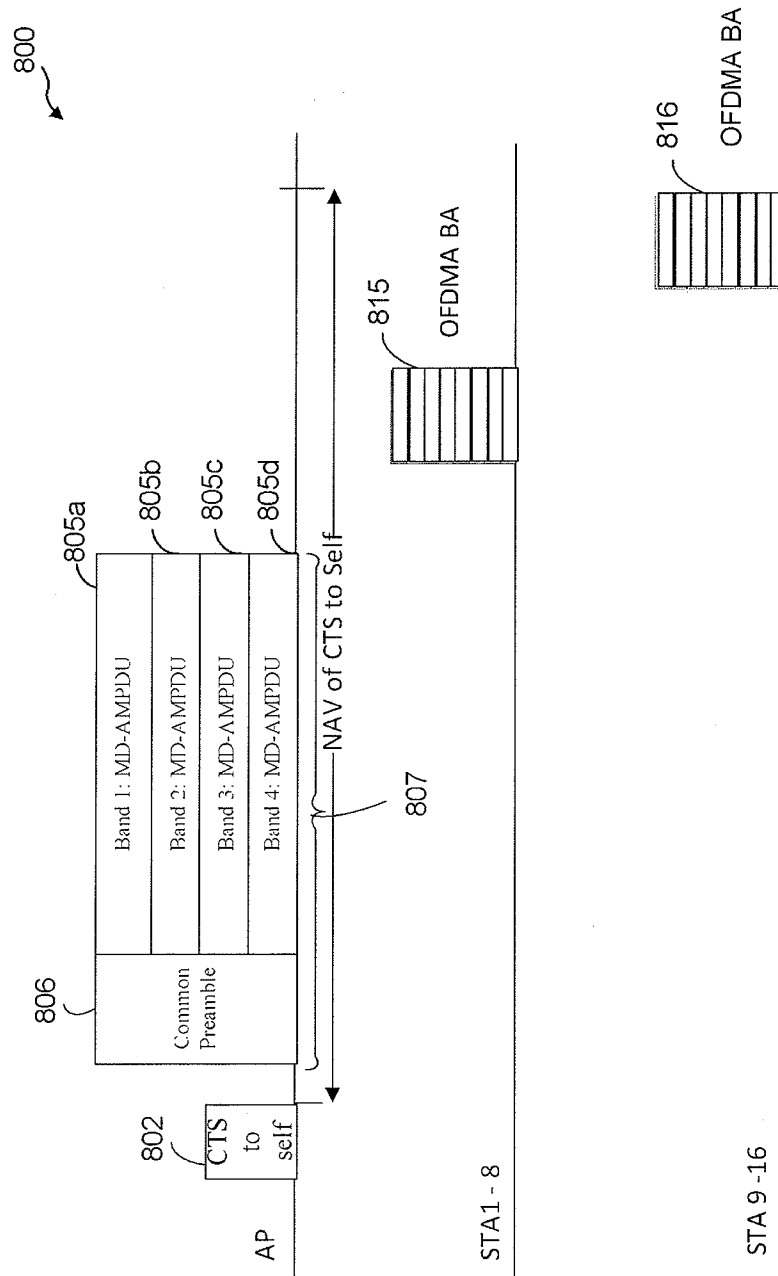


FIG. 8

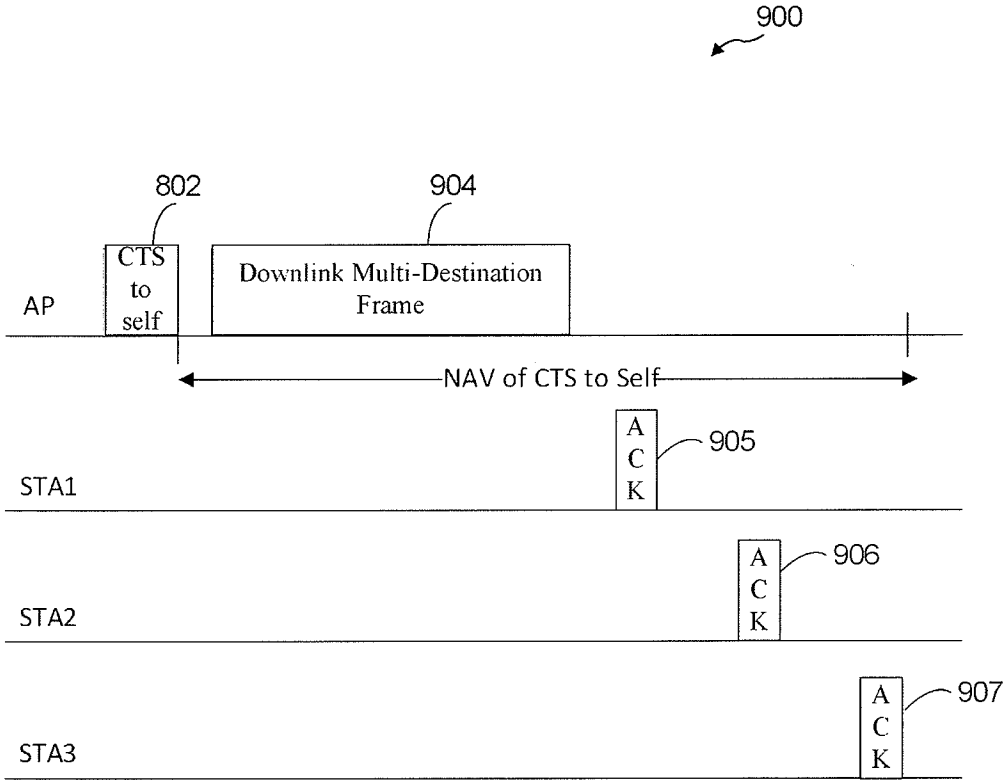


FIG. 9

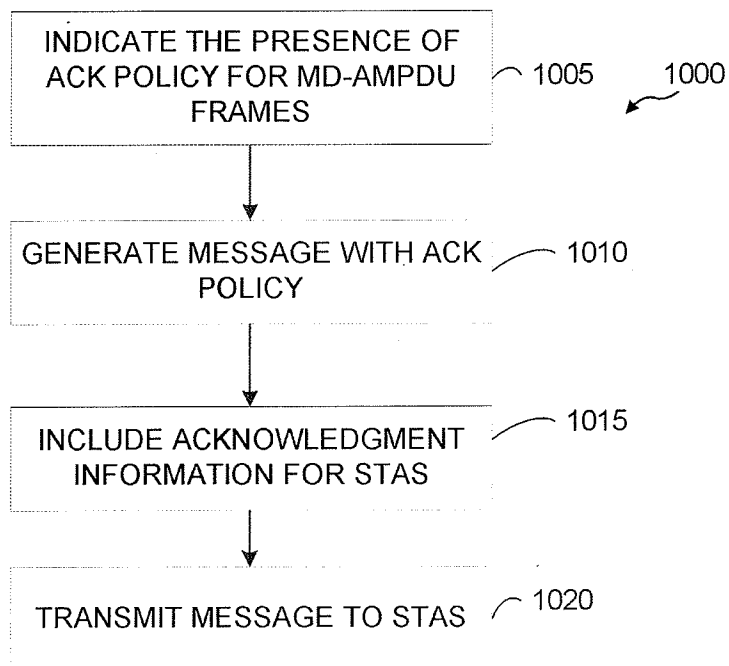


FIG. 10

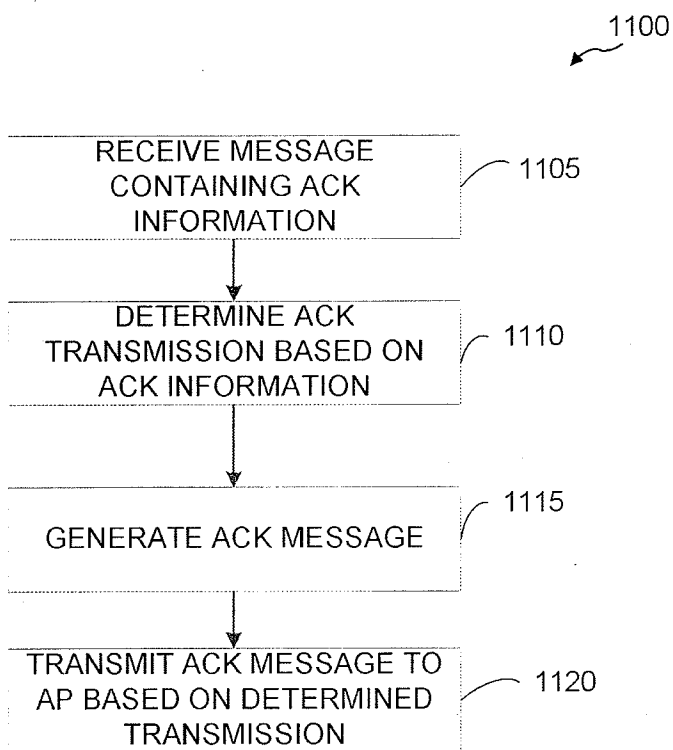


FIG. 11

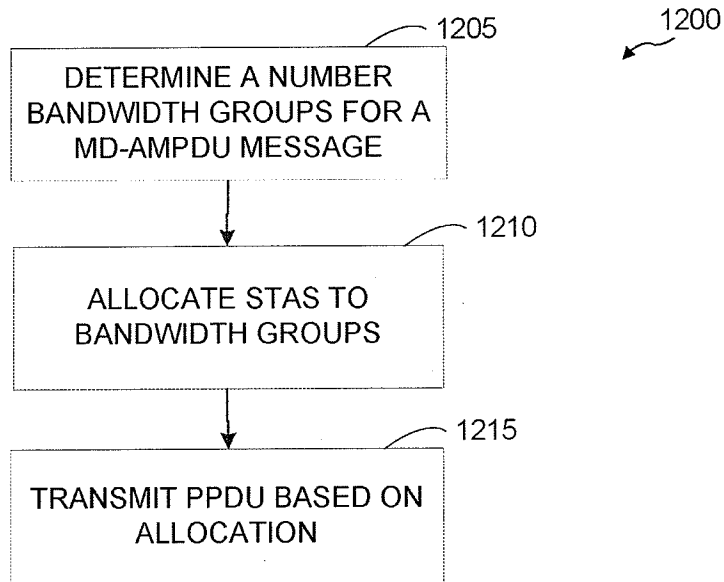


FIG. 12

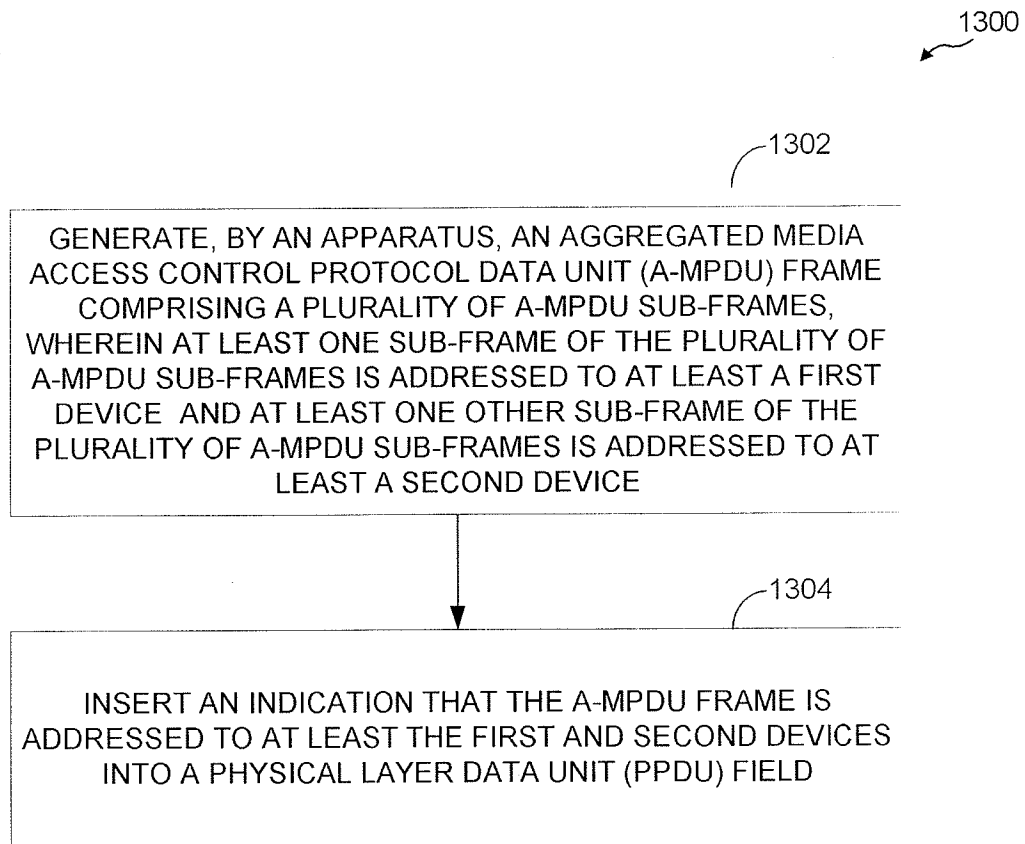


FIG. 13

**SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION
AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL
DATA UNITS IN A WIRELESS NETWORK**

BACKGROUND

Field

[0001] The present application relates generally to wireless communications, and more specifically to systems, methods, and devices for signaling aggregated multi-user media access control protocol data units (A-MPDUs) in a wireless network.

Background

[0002] In many telecommunication systems, communications networks are used to exchange messages among several interacting spatially-separated devices. Networks may be classified according to geographic scope, which could be, for example, a metropolitan area, a local area, or a personal area. Such networks would be designated respectively as a wide area network (WAN), metropolitan area network (MAN), local area network (LAN), wireless local area network (WLAN), or personal area network (PAN).

[0003] As wireless communications continue to advance, communication schemes continue to grow more complicated, prompting the aggregation of multiple message protocol data units (MPDUs) into a single physical layer data unit (PPDU). Aggregated MPDUs (A-MPDUs) for multiple destination may be efficient for transferring amounts of data to several devices without incurring large overhead. Techniques are needed to indicate the presence of multi destination A-MPDUs in a PPDU and the timing of the corresponding acknowledgments.

SUMMARY

[0004] The systems, methods, and devices of the invention each have several aspects, no single one of which is solely responsible for its desirable attributes. Without limiting the scope of this invention as expressed by the claims which follow, some features will now be discussed briefly. After considering this discussion, and particularly after reading the section entitled “Detailed Description” one will understand how the features of this invention provide advantages that include improved communications between access points and stations in a wireless network.

[0005] One aspect of the present application provides a method for wireless communication. The method comprises generating, by an apparatus, an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device. The method further comprises inserting an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field.

[0006] Another aspect of the present application provides an apparatus for wireless communication. The apparatus comprises a processor configured to generate an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device. The processor further configured to insert an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field. The apparatus further includes a transmitter configured to transmit the A-MPDU frame.

[0007] Yet another aspect of the present application provides a non-transitory computer-readable medium comprising code that, when executed, causes the apparatus to generate an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device. The medium further comprises code that, when executed, causes the apparatus to insert an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field.

[0008] Yet another aspect of the present application provides an apparatus for wireless communication. The apparatus comprises means for generating an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device. The apparatus further comprises means for inserting an indication that the A-MPDU frame is addressed to at

least the first and second devices into a physical layer data unit (PPDU) field. The apparatus further includes means for transmitting the A-MPDU frame.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0009] FIG. 1 illustrates an example of a wireless communication system in which aspects of the present disclosure may be employed.
- [0010] FIG. 2 illustrates various components that may be utilized in a wireless device that may be employed within the wireless communication system of FIG. 1.
- [0011] FIG. 3 illustrates a physical layer data unit including an aggregated media access control protocol data unit as may be transmitted in the wireless communication system of FIG. 1.
- [0012] FIG. 4A shows an exemplary structure of an aggregated MPDU (A-MPDU) frame.
- [0013] FIG. 4B shows an exemplary structure of an physical layer data unit (PPDU).
- [0014] FIG. 5 shows an exemplary structure of a very high throughput (VHT) signal (SIG) field.
- [0015] FIG. 6 shows an exemplary structure of another very high throughput (VHT) signal (SIG) field.
- [0016] FIG. 7 shows an exemplary structure of a media access control protocol data unit (MPDU) frame.
- [0017] FIG. 8 shows an exemplary frame exchange between an access point and multiple stations using orthogonal frequency-division multiplexing (OFDM) and a multi-destination (MD) A-MPDU.
- [0018] FIG. 9 is a timing diagram of an exemplary frame exchange for scheduling acknowledgments in response to a downlink (DL) multi-destination frame.
- [0019] FIG. 10 is a flowchart of a method of wireless communication, in accordance with an implementation.
- [0020] FIG. 11 is a flowchart of a method of wireless communication, in accordance with an implementation.
- [0021] FIG. 12 is a flowchart of a method of wireless communication, in accordance with an implementation.
- [0022] FIG. 13 is a flowchart of a method of wireless communication, in accordance with an implementation.

DETAILED DESCRIPTION

[0023] Various aspects of the novel apparatuses and methods are described more fully hereinafter with reference to the accompanying drawings. The teachings disclosure may, however, be embodied in many different forms and should not be construed as limited to any specific structure or function presented throughout this disclosure. Rather, these aspects are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Based on the teachings herein one skilled in the art should appreciate that the scope of the disclosure is intended to cover any aspect of the novel systems, apparatuses, and methods disclosed herein, whether implemented independently of or combined with any other aspect of the invention. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, the scope of the invention is intended to cover such an apparatus or method which is practiced using other structure, functionality, or structure and functionality in addition to or other than the various aspects of the invention set forth herein. It should be understood that any aspect disclosed herein may be embodied by one or more elements of a claim.

[0024] Although particular aspects are described herein, many variations and permutations of these aspects fall within the scope of the disclosure. Although some benefits and advantages of the preferred aspects are mentioned, the scope of the disclosure is not intended to be limited to particular benefits, uses, or objectives. Rather, aspects of the disclosure are intended to be broadly applicable to different wireless technologies, system configurations, networks, and transmission protocols, some of which are illustrated by way of example in the figures and in the following description of the preferred aspects. The detailed description and drawings are merely illustrative of the disclosure rather than limiting, the scope of the disclosure being defined by the appended claims and equivalents thereof.

[0025] Wireless network technologies may include various types of wireless local area networks (WLANs). A WLAN may be used to interconnect nearby devices together, employing widely used networking protocols. The various aspects described herein may apply to any communication standard, such as WiFi or, more generally, any member of the IEEE 802.11 family of wireless protocols. For example, the various aspects described herein may be used as part of the IEEE 802.11ax, 801.11ac, 802.11n, 802.11g, and/or 802.11b protocols.

[0026] In some aspects, wireless signals may be transmitted according to an 802.11 protocol using orthogonal frequency-division multiplexing (OFDM), direct-sequence spread spectrum (DSSS) communications, a combination of OFDM and DSSS communications, or other schemes. Implementations of 802.11 protocols may be used for sensors, metering, and smart grid networks. Advantageously, aspects of certain devices implementing 802.11 protocols may consume less power or provide higher communication speeds than devices implementing other wireless protocols, such as 802.11b, 802.11g, 802.11n or 802.11ac for example.

[0027] Certain of the devices described herein may further implement Multiple Input Multiple Output (MIMO) technology. This may also be implemented as part of 802.11 protocols. A MIMO system employs multiple (N_T) transmit antennas and multiple (N_R) receive antennas for data transmission. A MIMO channel formed by the N_T transmit and N_R receive antennas may be decomposed into N_S independent channels, which are also referred to as spatial channels or streams, where $N_S \leq \min\{N_T, N_R\}$. Each of the N_S independent channels corresponds to a dimension. The MIMO system can provide improved performance (e.g., higher throughput and/or greater reliability) if the additional dimensionalities created by the multiple transmit and receive antennas are utilized.

[0028] In some implementations, a WLAN includes various devices which are the components that access the wireless network. For example, there may be two types of devices: access points (“APs”) and clients (also referred to as stations, or “STAs”). In general, an AP serves as a hub or base station for the WLAN and an STA serves as a user of the WLAN. For example, an STA may be a laptop computer, a personal digital assistant (PDA), a mobile phone, etc. In an example, an STA connects to an AP via a WiFi (e.g., IEEE 802.11 protocol such as 802.11ax) compliant wireless link to obtain general connectivity to the Internet or to other wide area networks. In some implementations an STA may also be used as an AP.

[0029] An access point (“AP”) may also comprise, be implemented as, or known as a NodeB, Radio Network Controller (“RNC”), eNodeB, Base Station Controller (“BSC”), Base Transceiver Station (“BTS”), Base Station (“BS”), Transceiver Function (“TF”), Radio Router, Radio Transceiver, or some other terminology.

[0030] A station “STA” may also comprise, be implemented as, or known as an access terminal (“AT”), a subscriber station, a subscriber unit, a mobile station, a remote

station, a remote terminal, a user terminal, a user agent, a user device, user equipment, or some other terminology. In some implementations an access terminal may comprise a cellular telephone, a cordless telephone, a Session Initiation Protocol (“SIP”) phone, a wireless local loop (“WLL”) station, a personal digital assistant (“PDA”), a handheld device having wireless connection capability, or some other suitable processing device connected to a wireless modem. Accordingly, one or more aspects taught herein may be incorporated into a phone (e.g., a cellular phone or smartphone), a computer (e.g., a laptop), a portable communication device, a headset, a portable computing device (e.g., a personal data assistant), an entertainment device (e.g., a music or video device, or a satellite radio), a gaming device or system, a global positioning system device, or any other suitable device that is configured to communicate via a wireless medium.

[0031] As discussed above, certain of the devices described herein may implement 802.11 protocols. Such devices, whether used as an STA or AP or other device, may be used for smart metering or in a smart grid network. Such devices may provide sensor applications or be used in home automation. The devices may instead or in addition be used in a healthcare context, for example for personal healthcare. They may also be used for surveillance, to enable extended-range Internet connectivity (e.g. for use with hotspots), or to implement machine-to-machine communications.

[0032] FIG. 1 illustrates an example of a wireless communication system 100 in which aspects of the present disclosure may be employed. The wireless communication system 100 may operate pursuant to a wireless standard, for example at least one of the the 802.11ac, 802.11n, 802.11g and 802.11b standards. The wireless communication system 100 may include an AP 104, which communicates with STAs 106a-106f. In some embodiments, the AP 104 may comprise a MD-A-MPDU Addressing Unit 135a. The MD-A-MPDU Addressing Unit 135a may be configured to address MPDUs of an A-MPDU frames to different stations. The MD-A-MPDU Addressing Unit 135a may also be configured to indicate that the AP 104 is transmitting a multiple destination A-MPDU.

[0033] A variety of processes and methods may be used for transmissions in the wireless communication system 100 between the AP 104 and the STAs 106a-106f. For example, signals may be transmitted and received between the AP 104 and the STAs 106a-106f in accordance with OFDM/OFDMA techniques. If this is the case, the wireless communication system 100 may be referred to as an OFDM/OFDMA system. Alternatively, signals may be transmitted and received between the AP 104 and the

STAs 106a-106f in accordance with CDMA techniques. If this is the case, the wireless communication system 100 may be referred to as a CDMA system.

[0034] In FIG. 1, the STAs 106a-106c may comprise high efficiency (HEW) wireless stations (e.g., stations that operate according to 802.11ax or later developed communication protocols), while the STAs 106d-106f may comprise “legacy” wireless stations (e.g., stations that operate according to one or more of 802.11a/b/g/n/ac communication protocols). For example, any of the STAs 106a-106c may be configured to communicate at higher data rates and/or to utilize less energy during communication or operation as compared to the legacy wireless STAs 106d-106f. Thus, for the purposes of this disclosure, the STAs 106a-106c may be considered part of a first group of STAs 108a, while the STAs 106d-106f may be considered part of a second group of STAs 108b.

[0035] It should be noted that the wireless communication system 100 may not have a central AP 104, but rather may function as a peer-to-peer network between the STAs 106a-106f. Accordingly, the functions of the AP 104 described herein may alternatively be performed by one or more of the STAs 106a-106f.

[0036] FIG. 2 illustrates various components that may be utilized in a wireless device 202 that may be employed within the wireless communication system 100. The wireless device 202 is an example of a device that may be configured to implement the various methods described herein. For example, the wireless device 202 may comprise the AP 104 or one of the STAs 106a-106f.

[0037] The wireless device 202 may include a processor 204 which controls operation of the wireless device 202. The processor 204 may also be referred to as a central processing unit (CPU). Memory 206, which may include both read-only memory (ROM) and random access memory (RAM), provides instructions and data to the processor 204. A portion of the memory 206 may also include non-volatile random access memory (NVRAM). The processor 204 typically performs logical and arithmetic operations based on program instructions stored within the memory 206. The instructions in the memory 206 may be executable to implement the methods described herein.

[0038] The processor 204 may comprise or be a component of a processing system implemented with one or more processors. The one or more processors may be implemented with any combination of general-purpose microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate array

(FPGAs), programmable logic devices (PLDs), controllers, state machines, gated logic, discrete hardware components, dedicated hardware finite state machines, or any other suitable entities that can perform calculations or other manipulations of information.

[0039] The processing system may also include non-transitory machine-readable media for storing code or software. Software shall be construed broadly to mean any type of instructions, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. Instructions may include code (e.g., in source code format, binary code format, executable code format, or any other suitable format of code). The instructions, when executed by the one or more processors, cause the processing system to perform the various functions described herein.

[0040] The wireless device 202 may also include a housing 208 that may include a transmitter 210 and a receiver 212 to allow transmission and reception of data between the wireless device 202 and a remote location. The transmitter 210 and receiver 212 may be combined into a transceiver 214. An antenna 216 may be attached to the housing 208 and electrically coupled to the transceiver 214. The wireless device 202 may also include (not shown) multiple transmitters, multiple receivers, multiple transceivers, and/or multiple antennas, which may be utilized during MIMO communications, for example.

[0041] The wireless device 202 may also include a signal detector 218 that may be used in an effort to detect and quantify the level of signals received by the transceiver 214. The signal detector 218 may detect such signals as total energy, energy per subcarrier per symbol, power spectral density and other signals. The wireless device 202 may also include a digital signal processor (DSP) 220 for use in processing signals. The DSP 220 may be configured to generate a data unit for transmission. In some aspects, the data unit may comprise a PPDU. In some aspects, the PPDU may be referred to as a packet. In some aspects, the PPDU may comprise an aggregated MPDU comprising a plurality of MPDUs.

[0042] The wireless device 202 may further comprise a user interface 222 in some aspects. The user interface 222 may comprise a keypad, a microphone, a speaker, and/or a display. The user interface 222 may include any element or component that conveys information to a user of the wireless device 202 and/or receives input from the user.

[0043] In some aspects, the wireless device 202 may further comprise a MD-A-MPDU Addressing Unit 235. The MD-A-MPDU Addressing Unit 235 may be configured to

address each MPDU of an A-MPDU frames to a different station. The MD-A-MPDU Addressing Unit 235 may also be configured to indicate that the AP 104 is transmitting a multiple destination A-MPDU. In some aspects, the MD-A-MPDU Addressing Unit 235 is similar to and performs similar functions as the MD-A-MPDU Addressing Unit 135a of FIG. 1.

[0044] The various components of the wireless device 202 may be coupled together by a bus system 226. The bus system 226 may include a data bus, for example, as well as a power bus, a control signal bus, and a status signal bus in addition to the data bus. Those of skill in the art will appreciate the components of the wireless device 202 may be coupled together or accept or provide inputs to each other using some other mechanism.

[0045] Although a number of separate components are illustrated in FIG. 2, those of skill in the art will recognize that one or more of the components may be combined or commonly implemented. For example, the processor 204 may be used to implement not only the functionality described above with respect to the processor 204, but also to implement the functionality described above with respect to the signal detector 218 and/or the DSP 220. Further, each of the components illustrated in FIG. 2 may be implemented using a plurality of separate elements.

[0046] As discussed above, the wireless device 202 may comprise an AP 104 or an STA 106a-106f, and may be used to transmit and/or receive communications. The communications exchanged between devices in a wireless network may include data units which may comprise packets or frames. In some aspects, the data units may include data frames, control frames, and/or management frames. Data frames may be used for transmitting data from an AP and/or a STA to other APs and/or STAs. Control frames may be used together with data frames for performing various operations and for reliably delivering data (e.g., acknowledging receipt of data, polling of APs, area-clearing operations, channel acquisition, carrier-sensing maintenance functions, etc.). Management frames may be used for various supervisory functions (e.g., for joining and departing from wireless networks, etc.).

[0047] An aggregate media access control protocol data unit (A-MPDU) frame allows a device to send multiple data frames in a single physical layer frame. Typically a physical layer frame is intended only for a single destination. Each physical layer frame transmission, however, requires a certain amount of overhead (e.g., preamble overhead, sounding, and channel state information feedback). In many downlink traffic situations,

small frames are sent to multiple destinations. Some examples for downlink traffic sources for small frames include downlink transmission control protocol (TCP) acknowledgments (e.g., in response to audio/video/data uploads, http get etc.), phone applications (e.g., receiving posts via Facebook or Twitter, ad push notifications, email notifications), and VoIP sessions. In such situations where multiple small frames are sent to multiple destinations, it may be desirable to send a single A-MPDU containing frames for multiple destinations. Embodiments described herein relate to signaling the presence of multiple destination (MD) A-MPDUs and relate to acknowledgments by stations receiving the MD-AMPDU.

[0048] FIG. 3 illustrates a physical layer data unit 300 including a physical layer (PHY) header 302 and an aggregated media access control protocol data unit 304 as may be transmitted in the wireless communication system 100 of FIG. 1. As shown, time increases horizontally across the page on the x-axis. If the AP 104 of FIG. 1 has buffered units to send to more than one of the STAs 106a-106f, instead of transmitting multiple wireless messages, the AP 104 may transmit a single aggregated MPDU frame 304. The A-MPDU frame 304 may include multiple A-MPDU sub-frames 305A-305C. One or more of the multiple A-MPDU sub-frames 305A-305C may be addressed to a different STA than one or more of the multiple A-MPDU sub-frames 305A-305C. In some embodiments, the A-MPDU Addressing Unit 235 of FIG. 2 may be configured to address the A-MPDU sub-frames 305A-305C to each of the different STAs (e.g., STAs 106a-106f).

[0049] However, the 802.11a/b/g/n/ac wireless communication protocols prescribe that all MPDU frames in a PPDU comprising an A-MPDU are addressed to the same STA. Thus, the legacy STAs 106d-106f, operating according to one or more of the 802.11a/b/g/n/ac wireless communication protocols may discontinue processing the A-MPDU frame 304 (or transition to a power save mode) if the first MPDU sub-frame 305A is not addressed to the particular legacy STA 106d-106f receiving the PPDU 300. HEW STAs 106a-106c however, may require a particular indication that the A-MPDU frame 304 is meant for multiple destinations. In some embodiments, the indication that the A-MPDU frame 304 is meant for multiple destinations may comprise MD-AMPDU indication 350 which may be included in either the PHY header 302 portion or the A-MPDU frame 304 portion of the PPDU 300.

[0050] FIG. 4A shows an exemplary structure of an aggregated MPDU (A-MPDU) frame 400. As shown, the A-MPDU frame 400 includes a variable number (n) of A-

MPDU sub-frames, as shown 405a, 405b, and 405n. In some embodiments each of the A-MPDU sub-frames 405a, 405b, and 405n may be intended for different stations. Each of the A-MPDU sub-frames 405a, 405b, and 405n may in some aspects be comprised of an MPDU delimiter field 410a, an MPDU frame 400a, and zero or more pad bytes. The MPDU frames 300a may in some aspects conform substantially with the MPDU frames 305a-305c illustrated in FIG. 3.

[0051] Each of the MPDU delimiter fields, for example, MPDU delimiter field 410a, may include an end of frame (EOF) field 412a, a reserved field 414a, an MPDU length field 416a, a CRC field 418a, and a delimiter signature field 420a. The delimiter signature field 420a may to indicate a difference between two MSDU subframe delimiter signature fields. Typically, this field is set to the hexadecimal value 7E.

[0052] In some embodiments, the delimiter signature field 420a may indicate to stations equipped with a protocol to decode MD-AMPDUs (e.g., HEW stations) that the A-MPDU is a MD-AMPDU. For example, in MD-AMPDU frames, the delimiter signature field 420a may comprise the MD-AMPDU indication 350 to indicate the presence of the MD-AMPDU frame 400. In some embodiments, the delimiter signature field 420a may be set a different value than 7E, such as 7D, and that different value is specified and known to all HEW stations. Legacy stations (e.g., STAs 106d-106f) that receive and decode the delimiter signature field 420a as 7D will drop the frame, whereas HEW stations (e.g., STAs 106a-106c) will decode the delimiter signature field 420a as 7D will know that the A-MPDU frame 400 is a MD-AMPDU. In some embodiments, the A-MPDU Addressing Unit 235 of FIG. 2 may be configured to address each of the A-MPDU sub-frames 405a-405n to different STAs (e.g., STAs 106a-106f).

[0053] FIG. 4B shows an exemplary structure of an MD PPDU 499. The MD PPDU frame 499 comprises the PHY header 302 and the data portion of the PPDU 475. In some embodiments, the data portion of the PPDU 475 may comprise the A-MPDU frame 304 of FIG. 3. As shown, the data portion of the PPDU 475 comprises MPDU delimiters 410a-410f, a MD-AMPDU indicator field 450 and MPDUs 400a-400e. The MD-AMPDU indicator field 450 may comprise a single management MPDU as the first MPDU which indicates that the MD PPDU 499 comprises a MD-AMPDU frame and indicates the destinations of MPDUs 400 that are included in the data portion of the PPDU 304. As shown, the MD-AMPDU indicator 450 comprises a category field 451 which indicates the category for the MD-AMPDU indicator field 450, an action field 452 to specify certain actions for the stations receiving the MD PPDU 499, an address

identifier (AID) field (e.g., 453a-453c) of destination STAs, an approximate symbol start field (e.g., 454a-454c) of the destination STAs, and an acknowledgement information (ACK Info) field (e.g., 455a-455c) which includes information on how the uplink acknowledgement should be sent for the destination STAs.

[0054] In some embodiments, a very high throughput (VHT) signal (SIG) field of a physical layer header (e.g., PHY header 302) may indicate to stations equipped with a protocol to decode MD-AMPDUs (e.g., HEW stations) that an A-MPDU is a MD-AMPDU. FIG. 5 shows an exemplary VHT-SIG-A field 500. In some embodiments, the name of sub-fields of the VHT-SIG-A field 500 may depend on the type of transmission. For example, as shown in FIG. 5 (and similarly in FIG. 6), the name of certain subfields depends on whether the VHT-SIG-A field 500 is transmitted under a composite transmission (e.g., composite name), a single user transmission (e.g., SU name), or a multi-user transmission (e.g., MU name). The names of sub-fields for the different transmissions correspond to rows of FIG. 5 and FIG. 6 indicating the transmission type.

[0055] As shown in FIG. 5, the VHT-SIG-A field 500 comprises bandwidth field 501, a reserved field 502, a space-time block coding field 503, a group identifier field (ID) 505, a transmission opportunity power save not allowed field 520, and a second reserved field 525. Under the composite name for the VHT-SIG-A field 500, the VHT-SIG-A field 500 comprises a number of space time streams (NSTS)/partial address identifier field 513. Under a single user transmission, the VHT-SIG-A field 500 comprises single user NSTS field 514 and a partial address identifier (AID) field 515. In some embodiments, the AP 104 may determine and communicate to stations associated with the AP 104 that a certain partial AID value is reserved to indicate that an A-MPDU with that particular partial AID is a MD-AMPDU. The partial AID field 515 may be modified to indicate the presence of a MD-AMPDU. In some aspects, the MD-AMPDU Addressing Unit 135a of FIG. 1 may be configured to indicate that an A-MPDU with that particular partial AID is a MD-AMPDU. Stations not associated with the AP 104 may read and drop the MD-AMPDU because the partial AID field 515 does not match their AID or partial AID. In some embodiments, the partial AID field 515 may comprise 9 bits.

[0056] The group ID field 505 may identify a group of stations that should receive the A-MPDU. In some embodiments, the group ID field 505 may be configured or modified to indicate the presence of a MD-AMPDU frame. For example, the AP 104

may determine and communicate that a certain group ID, or a set of group IDs, is reserved to indicate to receiving stations that the frame is a MD-AMPDU frame. In some embodiments, the reserved group ID may be in the range of 01 to 62. In some aspects, the use of a group ID to indicate the presence of a MD-AMPDU frame can help some devices to shutoff receiver circuitry when the A-MPDU does not contain MPDUs for them. In some aspects, the MD-AMPDU Addressing Unit 135a of FIG. 1 may be configured to indicate that an A-MPDU with a particular group ID value is a MD-AMPDU. In some embodiments, the group ID field may comprise 6 bits.

[0057] In other embodiments, a reserved bit of the VHT-SIG-A field may indicate that a A-MPDU is a MD-AMPDU. FIG. 6 is a diagram of an exemplary VHT-SIG-A2 field 600 structure. The VHT-SIG-A2 field 600 comprises a short guard interval (GI) field 601, a short GI number of transmission symbols (NSYM) disambiguation field 602, a single/multi-user (SU/MU) coding field 603, a low-density parity check (LDPC) extra OFDM symbol field 604, a reserve field 617, a cyclic redundancy check (CRC) field 618, and a tail field 620. Under multiple user transmissions, the VHT-SIG-A2 field 600 comprises MU coding fields 615a, 615b, 615c and reserve bits 616a and 616b. Typically, if a bit is marked reserved, the bit is set to zero. In some embodiments, in order to indicate the presence of a MD-AMPDU frame, one or more of the reserved bits may modified and/or set to 1. In these embodiments, legacy stations (e.g., stations (e.g., STAs 106d-106f) that receive and decode the VHT-SIG-A2 field 600 with one or more of the reserve bits 616a, 616b and 617 set to 1 will be unable to decode the frame and will drop the rest of the frame. HEW stations (e.g., STAs 106a-106c) will be equipped with the protocol to know which reserve bits indicate the presence of the MD-AMPDU frame and will decode the remainder of the frame. In some aspects, the MD-AMPDU Addressing Unit 135a of FIG. 1 may be configured to indicate that an A-MPDU with one or more of the reserved bits 616a, 616b and 617 set to 1 is a MD-AMPDU.

[0058] In some embodiments, a SIG field with a different frame format than those shown in FIGs. 5 and 6 may be used. This SIG field may be used for all MD-AMPDUs and may be decodable only by HEW stations. In some aspects, the same indications described above may be applied to PPDU's using this SIG field with a different frame format.

[0059] In some embodiments, the AP 104 may set an acknowledgment policy for stations receiving MD-AMPDUs (e.g., A-MPDU 400). To coordinate acknowledgements from each of the STAs, one or more of the A-MPDU sub-frames

305a-305c or 405a-405n (See FIGs. 3 and 4) may include one or more fields defining an acknowledgement policy for the A-MPDU sub-frame. For example, the acknowledgement policy may indicate whether an acknowledgement for the A-MPDU sub-frame should be transmitted by an addressed receiver, the type of acknowledgement that should be transmitted (e.g., whether an acknowledgement or block acknowledgement should be transmitted) and/or a delay time period between when the A-MPDU wireless message 304 is received and when an acknowledgement to any MPDU sub-frame included in the message 304, 404 is transmitted. The indicated acknowledgement policy of each A-MPDU sub-frame 305a-c, 405a-405n functions to coordinate acknowledgements of each of the MPDU sub-frames 305a-305c, 405a-405n so as to reduce the probability of collisions occurring if each of the MPDU sub-frames 305a-305c, 405a-405n is acknowledged.

[0060] In order to set the acknowledgment, the AP 104 may include an indication of the acknowledgment policy in the MAC header portion of a frame. FIG. 7 shows an exemplary structure of a media access control protocol data unit (MPDU) frame 700. The MPDU frame 700 may correspond to any of the MPDU sub-frames 305A-305C or 405A-406N, as previously described in connection with FIGs. 3 and 4, respectively. As shown, the MPDU frame 700 includes 12 different fields: a frame control (fc) field 710, a duration/identification (dur) field 725, a receiver address (a1) field 730, a transmitter address (a2) field 735, a destination address (a3) field 740, a sequence control (sc) field 745, a fourth address (a4) field 750, a quality of service (QoS) control (qc) field 755, a High Throughput (HT)/VHT control field 760, an acknowledgment (ACK) control field 765, a frame body 768, and a frame check sequence (FCS) field 770. Some or all of the fields 710-765 make up the MAC header 702.

[0061] The ACK control field 765 may indicate to a station receiving the MPDU frame 700 when and how a BA is sent and a time gap (or frequency offset or spatial stream gap) between successive BAs. For example, ACK control field 765 may indicate that one or more stations should send a BA a Short Interframe Space (SIFS) time period after the PPDU carrying the MPDU frame 700. In some embodiments, the presence of the ACK control field 765 may be indicated using a reserved bit/bit combination in the frame control field 710, QoS control field 755 or the HT/VHT control field 760. Information that may be included in the ACK control field 765 may include: BA modulation and coding scheme (MCS); bandwidth and/or spatial stream information such as total uplink bandwidth, per STA bandwidth for BA, or the total number of

uplink spatial streams; and BA index in which each STA determines the time, exact bandwidth and spatial stream index from its BA index and the bandwidth and spatial stream information.

[0062] In some embodiments, any two octet field may be sufficient to create the ACK control field 765. In some embodiments, 10 bits of the ACK control field 765 may be partitioned as follows: 3 bits to indicate one of 8 spatial stream indices, 4 bits to indicate one of 16 frequency bands, and 3 bits to indicate a time position for the BA. From the 10 bits of the ACK control field 765, a device can determine exactly how and when to send the BA. In some embodiments, the BA MCS is to be set to MCS of the downlink PPDU.

[0063] In some embodiments, OFDMA and MD-AMPDU can be combined to optimize the time taken for the entire PPDU transmission. OFDMA allows different data rates per STA because with OFDMA, each STA is not restricted to the minimum MCS across all STAs. In some embodiments, STAs located further away from the AP 104 may have lower a MCS than STAs located closer to the AP 104. In some embodiments, STAs having higher MCSs can be combined using MD-AMPDU and this further combined with OFDMA, to transmit the higher MCSs on a specific frequency bandwidth. In some embodiments, the STAs with lower MCSs can be combined using MD-AMPDU and transmitted on a different bandwidth using OFDMA to attain an overall lower length PPDU to be transmitted and increase the data rate of the system.

[0064] FIG. 8 is a timing diagram of an exemplary frame exchange using OFDMA and MD-AMPDU. In FIG. 8, the AP 104 sends a clear to send (CTS) to self message 802 to reserve the medium for the MD-AMPDU transmission and the corresponding uplink acknowledgments from the STAs receiving the MD-AMPDU. The AP 104 next transmits a PPDU message 807 which comprises a common preamble portion 806 and MD-AMPDU messages 805a-d. In some embodiments, the MD-AMPDU message 805a transmitted over a first bandwidth may comprise the MD-AMPDU frames 304, 400, and 475 of FIGs. 3, 4A and 4B. In some embodiments, the common header portion 806 may comprise the PHY header portion 302 of FIG. 3. Additionally each MD-AMPDU 805a-d is transmitted over a different frequency bandwidth. In some embodiments, the MD-AMPDU message 805a may be addressed to STAs having a higher MCS than the STAs addressed in the MD-AMPDU messages 805b-805d

[0065] The MD-AMPDUs 805a-d may also include an indication of which STAs should send an acknowledgment and at what time, as discussed above. For example, the

MD-AMPDU messages 805a and 805b may be addressed to STAs 1-8 and may have an indication in a MAC header of a MDPU that indicates that the STAs 1-8 should send their ACK messages over different frequencies a SIFS time after receiving the MD-AMPDU messages 805a and 805b. The MD-AMPDU messages 805c and 805d may be addressed to STAs 9-16 and may have an indication in a MAC header of a MDPU that indicates that the STAs 9-16 should send their ACK messages over different frequencies a specific time after receiving the MD-AMPDU messages 805c and 805d. The specific time may be determined by the AP 104 by calculating the transmission time for the PPDU 810 based on the MCS of the STAs and based on the estimated transmission time of the ACK messages from STAs 1-8. As shown, 8 STAs (e.g., STAs 1-8) send uplink BAs 815 over 8 different bandwidths a short time (e.g., SIFS) after receiving MD-AMPDUs 805a-d. A short time after the uplink BAs 815, 8 more STAs (e.g., STAs 9-16) send uplink BAs 816 over 8 different bandwidths to the AP 104.

[0066] This combination of OFDMA and MD-AMPDU may require that the AP 104 indicate to each station the particular frequency band and the particular MCS for the combined OFDMA and MD-AMPDU transmission. Accordingly, AP 104 may indicate one or more groups of STAs to participate in the combined OFDMA and MD-AMPDU transmission and may indicate the particular frequency bandwidth for each group. In some embodiments, the indication of how the bandwidth is allocated may comprise two bits. For example, if both bits are set to zero, then the bandwidth is not divided and 8 stations may share that frequency bandwidth. If the bits are set to “01” the bandwidth may be divided into two different frequency bandwidths and 4 stations may be assigned to each bandwidth. In some embodiments, if the bits are set to “10” then the frequency may be split into 4 different bandwidths with 2 STAs assigned to each bandwidth. In some embodiments, if the bits are set to “11” then the frequency may be split into 8 different bandwidths with a single STA assigned to each bandwidth.

[0067] In some embodiments, a six bit group identifier (ID) is used to indicate a particular bandwidth for a STA in the PPDU according to the bandwidth allocation. In these embodiments, in each group ID a STA is assigned a position in the bandwidth according to the highest bandwidth division. In embodiments that have fewer frequency bandwidth divisions, the STA position may be determined according to its position in the highest bandwidth division. For example, if a STA is allocated a position in the third bandwidth of the eight bandwidths, then if the bandwidth is divided into 4 different bandwidths, it would allocated a position in the second bandwidth position. If the

bandwidth is divided into 2 different bandwidths, the STA would be allocated a position in the first bandwidth group.

[0068] FIG. 9 is a timing diagram of an exemplary frame exchange 900 for scheduling acknowledgments in response to a downlink (DL) MD frame. As shown, the AP 104 sends a CTS to self frame 802 which reserves the medium for the transmission of the downlink frame and the subsequent acknowledgment frames. The AP 104 then transmits the DL MD frame 904 to the STAs 1-3. The DL MD frame 904 may comprise a MD-AMPDU. In some embodiments, the DL MD frame 904 comprises the ACK control field 765 or other indication of the ACK policy. Using the information in the ACK control field 765 (e.g., BA MCS, total uplink bandwidth, per STA bandwidth, total uplink spatial streams, BA index, etc.) the STAs 1-3 can determine when to send ACK messages 905, 906, and 907 so that they don't interfere with each other and fit within the time reserved by the network allocation vector (NAV) of the CTS to self 802.

[0069] FIG. 10 is a flowchart of a method 1000 for wireless communication, in accordance with an implementation. In some aspects, the method 1000 may be performed by the wireless device 202, shown above with respect to FIG. 2. In some aspects, method 1000 may be performed by the AP 104 or any suitable device. At block 1005, the AP 104 indicates the presence of an acknowledgment policy for responding to MD-AMPDU frames. In some embodiments, AP 104 may include this indication in the ACK control field 765. In some embodiments, the indication may be included in a portion of the FC field 710, QoS control field 755, or the HT control field 760. In some aspects, the indication may be included in the MD-AMPDU indicator 450. At block 1010, the AP 104 may generate a message with the ACK policy for responding to the MD-AMPDU. In some embodiments, the message may comprise the PPDU 300 which may comprise the A-MPDU frame 304 and MPDU 700.

[0070] At block 1015, the AP 104 may include ACK information for each of the STAs receiving the MD-AMPDU. In some embodiments, the ACK information may comprise BA MCS, total uplink bandwidth, per STA bandwidth, total uplink spatial streams, BA index, or any other information facilitate the STA determining when and how to send its ACK to the AP 104. At block 1020, the AP 104 may then transmit the message to the different STAs.

[0071] FIG. 11 is a flowchart of a method 1100 for wireless communication, in accordance with an implementation. In some aspects, the method 1100 may be performed by the wireless device 202, shown above with respect to FIG. 2. In some

aspects, method 1100 may be performed by the STA 106a or any suitable device. At block 1105, the STA 106a may receive a message containing ACK information. In some embodiments, the message may comprise a MD-AMPDU frame from the AP 104 which comprises the ACK control field 765. At block 1110, the STA 106a may then determine when and how to send its ACK message transmission based on the ACK information. For example, the ACK control field 765 may include a MCS, a bandwidth allocated to the STA 106a, and an order of when the STA should send its ACK message. The STA 106a may then determine based on such information the specific time to transmit the ACK and type of transmission (e.g., BA, MU-MIMO, FDMA, OFDMA, etc.). At block 1115, the STA 106a may then generate the ACK message. In some embodiments, the ACK message is generated based on the determination in block 1110. At block 1120, the STA 106a transmits the ACK message to the AP 104 based on the determined transmission.

[0072] FIG. 12 is a flowchart of a method 1200 for wireless communication, in accordance with an implementation. In some aspects, the method 1200 may be performed by the wireless device 202, shown above with respect to FIG. 2. In some aspects, method 1200 may be performed by the AP 104 or any suitable device. At block 1205, the AP 104 may determine a number of bandwidth groups for a MD-AMPDU message. For example, with reference to FIG. 8, the AP 104 determines that the bandwidth for the PPDU 807 transmission should be divided into 4 different bandwidths. At block 1210, the AP 104 then allocates STA to each bandwidth group. As discussed above with reference to FIG. 8, in some embodiments, the AP 104 may allocate STAs 1-8 to bandwidth groups 1 and 2 (e.g., MD-AMPDU messages 805a-b) and may allocate STAs 9-16 to bandwidth groups 3 and 4 (e.g., MD-AMPDU messages 805c-d). At block 1215, the AP 104 may then transmit the PPDU based on the bandwidth allocation. For example, the AP 104 may transmit PPDU 807 of FIG. 8 based on the bandwidth allocation of the 4 different bandwidths shown.

[0073] FIG. 13 is a flowchart of a method 1300 of wireless communication, in accordance with an implementation. In some aspects, the method 1300 may be performed by the wireless device 202, shown above with respect to FIG. 2. In some aspects, method 1300 may be performed by the AP 104. The method 1300 may correspond to one or more implementations, as previously described in connection with FIGs. 3-9.

Block 1302 includes generating, by an apparatus, an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device. For example, as previously described in connection with FIG. 4, the A-MPDU 400 comprises a plurality of A-MPDU sub-frames 405a-405n. As previously described, the plurality of MPDU sub-frames are intended for one or more devices. In one aspect the MPDU 405a may be addressed to a first device (e.g., STA 106a of FIG. 1) and the MPDU 405b may be addressed to a second device (e.g., STA 106d of FIG. 1).

[0074] Block 1304 includes inserting an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field. For example, as previously described in connection with FIG. 4, a value may be inserted into the delimiter signature field 420a of the MPDU delimiter field 410a of at least a first A-MPDU sub-frame 405a, to indicate that the MPDU 405a is intended for the legacy STA 106a. In some implementations of FIG. 5, a value may be inserted into the partial AID field 515 to indicate that the A-MPDU frame that follows (e.g., the A-MPDU frame 304 of FIG. 3) is a multi-destination A-MPDU with the MPDU 305a addressed to a first device (e.g., STA 106a of FIG. 1) and the MPDU 305b addressed to a second device (e.g., STA 106d of FIG. 1). In some embodiments, the delimiter signature field 420a may comprise 8 bits.

[0075] As used herein, the term “determining” encompasses a wide variety of actions. For example, “determining” may include calculating, computing, processing, deriving, investigating, looking up (e.g., looking up in a table, a database or another data structure), ascertaining and the like. Also, “determining” may include receiving (e.g., receiving information), accessing (e.g., accessing data in a memory) and the like. Also, “determining” may include resolving, selecting, choosing, establishing and the like. Further, a “channel width” as used herein may encompass or may also be referred to as a bandwidth in certain aspects.

[0076] As used herein, a phrase referring to “at least one of” a list of items refers to any combination of those items, including single members. As an example, “at least one of: a, b, or c” is intended to cover: a, b, c, a-b, a-c, b-c, and a-b-c.

[0077] The various operations of methods described above may be performed by any suitable means capable of performing the operations, such as various hardware and/or

software component(s), circuits, and/or module(s). Generally, any operations illustrated in the Figures may be performed by corresponding functional means capable of performing the operations.

[0078] As used herein, the term interface may refer to hardware or software configured to connect two or more devices together. For example, an interface may be a part of a processor or a bus and may be configured to allow communication of information or data between the devices. The interface may be integrated into a chip or other device. For example, in some embodiments, an interface may comprise a receiver configured to receive information or communications from a device at another device. The interface (e.g., of a processor or a bus) may receive information or data processed by a front end or another device or may process information received. In some embodiments, an interface may comprise a transmitter configured to transmit or communicate information or data to another device. Thus, the interface may transmit information or data or may prepare information or data for outputting for transmission (e.g., via a bus).

[0079] The various illustrative logical blocks, modules and circuits described in connection with the present disclosure may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array signal (FPGA) or other programmable logic device (PLD), discrete gate or transistor logic, discrete hardware components or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any commercially available processor, controller, microcontroller or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0080] In one or more aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage

devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray® disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Thus, in some aspects, computer readable medium may comprise non-transitory computer readable medium (e.g., tangible media). In addition, in some aspects computer readable medium may comprise transitory computer readable medium (e.g., a signal). Combinations of the above should also be included within the scope of computer-readable media.

[0081] Thus, certain aspects may comprise a computer program product for performing the operations presented herein. For example, such a computer program product may comprise a computer readable medium having instructions stored (and/or encoded) thereon, the instructions being executable by one or more processors to perform the operations described herein. For certain aspects, the computer program product may include packaging material.

[0082] The methods disclosed herein comprise one or more steps or actions for achieving the described method. The method steps and/or actions may be interchanged with one another without departing from the scope of the claims. In other words, unless a specific order of steps or actions is specified, the order and/or use of specific steps and/or actions may be modified without departing from the scope of the claims.

[0083] Software or instructions may also be transmitted over a transmission medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of transmission medium.

[0084] Further, it should be appreciated that modules and/or other appropriate means for performing the methods and techniques described herein can be downloaded and/or

otherwise obtained by a user terminal and/or base station as applicable. For example, such a device can be coupled to a server to facilitate the transfer of means for performing the methods described herein. Alternatively, various methods described herein can be provided via storage means (e.g., RAM, ROM, a physical storage medium such as a compact disc (CD) or floppy disk, etc.), such that a user terminal and/or base station can obtain the various methods upon coupling or providing the storage means to the device. Moreover, any other suitable technique for providing the methods and techniques described herein to a device can be utilized.

[0085] It is to be understood that the claims are not limited to the precise configuration and components illustrated above. Various modifications, changes and variations may be made in the arrangement, operation and details of the methods and apparatus described above without departing from the scope of the claims.

[0086] While the foregoing is directed to aspects of the present disclosure, other and further aspects of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

WHAT IS CLAIMED IS:

1. A method of wireless communication, comprising:
generating, by an apparatus, an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device; and
inserting an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field.
2. The method of claim 1, wherein the A-MPDU sub-frame, comprises a media access control protocol data unit (MPDU) delimiter field, wherein the indication comprises a value in the MPDU delimiter field.
3. The method of claim 2, wherein MPDU delimiter field comprises a delimiter signature field, wherein the indication comprises a value in the delimiter signature field.
4. The method of claim 1, wherein the PPDU comprises a physical layer header field, wherein the indication is a value in the physical layer header field.
5. The method of claim 4, wherein the physical layer header field comprises a very high throughput (VHT) signal (SIG) field, wherein the indication is a value in the VHT-SIG field.
6. The method of claim 5, wherein the VHT-SIG field comprises a partial address identifier (AID) field, wherein the indication comprises a value in the partial AID field.
7. The method of claim 5, wherein the VHT-SIG field comprises a group identifier field, wherein the indication comprises a value in the group identifier field.
8. The method of claim 5, wherein the VHT-SIG field comprises a reserve field, wherein the indication comprises a value in the reserve field.

9. A method of wireless communication, comprising:

generating, by an apparatus, an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device; and

inserting an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field, wherein the at least one sub-frame comprises a media access control (MAC) header, the MAC header comprising an acknowledgement control field.

10. The method of claim 9, wherein the acknowledgement control field comprises ten bits for indicating a number of spatial streams allocated, a number of frequency bands, or a time position for acknowledgment frames.

11. The method of claim 9, wherein the acknowledgement control field indicates an acknowledgment modulation and coding scheme.

12. The method of claim 9, wherein the acknowledgement control field indicates a bandwidth allocated to the first device and second device for sending an acknowledgment message in response to the A-MPDU frame.

13. The method of claim 9, further comprising inserting an indication of the acknowledgement control field into one or more of a frame control field, a very high throughput (VHT) control field, or a quality of service (QoS) control field.

14. An apparatus for wireless communication, comprising:
a processor configured to:

generate an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device;

insert an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field; and

a transmitter configured to transmit the A-MPDU frame.

15. The apparatus of claim 13, wherein the A-MPDU sub-frame, comprises a media access control protocol data unit (MPDU) delimiter field, wherein the indication comprises a value in the MPDU delimiter field.

16. The apparatus of claim 15, wherein MPDU delimiter field comprises a delimiter signature field, wherein the indication comprises a value in the delimiter signature field.

17. The apparatus of claim 13, wherein the PPDU comprises a physical layer header field, wherein the indication is a value in the physical layer header field.

18. The apparatus of claim 17, wherein the physical layer header field comprises a very high throughput (VHT) signal (SIG) field, wherein the indication is a value in the VHT-SIG field.

19. The apparatus of claim 18, wherein the VHT-SIG field comprises a partial address identifier (AID) field, wherein the indication comprises a value in the partial AID field

20. The apparatus of claim 18, wherein the VHT-SIG field comprises a group identifier field, wherein the indication comprises a value in the group identifier field.

21. The apparatus of claim 18, wherein the VHT-SIG field comprises a reserve field, wherein the indication comprises a value in the reserve field.

22. An apparatus for wireless communication, comprising:
a processor configured to:

generate an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device, the at least one sub-frame

comprises a media access control (MAC) header, the MAC header comprising an acknowledgement control field;

insert an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field; and
a transmitter configured to transmit the A-MPDU frame.

23. The apparatus of claim 22, wherein the acknowledgement control field comprises ten bits for indicating a number of spatial streams allocated, a number of frequency bands, or a time position for acknowledgment frames.

24. The apparatus of claim 22, wherein the acknowledgement control field indicates an acknowledgment modulation and coding scheme.

25. The apparatus of claim 22, wherein the acknowledgement control field indicates a bandwidth allocated to the first device and second device for sending an acknowledgment message in response to the A-MPDU frame.

26. A non-transitory computer-readable medium comprising code that, when executed, causes an apparatus to:

generate an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device; and

insert an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field.

27. The non-transitory computer-readable medium of claim 25, wherein the A-MPDU sub-frame, comprises a media access control protocol data unit (MPDU) delimiter field, wherein the indication comprises a value in the MPDU delimiter field.

28. The non-transitory computer-readable medium of claim 27, wherein MPDU delimiter field comprises a delimiter signature field, wherein the indication comprises a value in the delimiter signature field.

29. The non-transitory computer-readable medium of claim 25, wherein the PPDU comprises a physical layer header field, wherein the indication is a value in the physical layer header field.

30. The non-transitory computer-readable medium of claim 29, wherein the physical layer header field comprises a very high throughput (VHT) signal (SIG) field, wherein the indication is a value in the VHT-SIG field.

31. The non-transitory computer-readable medium of claim 30, wherein the VHT-SIG field comprises a partial address identifier (AID) field, wherein the indication comprises a value in the partial AID field.

32. The non-transitory computer-readable medium of claim 30, wherein the VHT-SIG field comprises a group identifier field, wherein the indication comprises a value in the group identifier field.

33. The non-transitory computer-readable medium of claim 30, wherein the VHT-SIG field comprises a reserve field, wherein the indication comprises a value in the reserve field.

34. A non-transitory computer-readable medium comprising code that, when executed, causes an apparatus to:

generate an an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device, the at least one sub-frame comprises a media access control (MAC) header, the MAC header comprising an acknowledgement control field; and

insert an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field.

35. The non-transitory computer-readable medium of claim 34, wherein the acknowledgement control field comprises ten bits for indicating a number of spatial streams allocated, a number of frequency bands, or a time position for acknowledgment frames.

36. The non-transitory computer-readable medium of claim 34, wherein the acknowledgement control field indicates an acknowledgment modulation and coding scheme.

37. The non-transitory computer-readable medium of claim 34, wherein the acknowledgement control field indicates a bandwidth allocated to the first device and second device for sending an acknowledgment message in response to the A-MPDU frame.

38. An apparatus for wireless communication, comprising:

means for generating an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device;

means for inserting an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field; and

means for transmitting the A-MPDU frame.

39. The apparatus of claim 37, wherein the A-MPDU sub-frame, comprises a media access control protocol data unit (MPDU) delimiter field, wherein the indication comprises a value in the MPDU delimiter field

**SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION
AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL
DATA UNITS IN A WIRELESS NETWORK**

ABSTRACT

Systems, methods, and apparatuses for aggregating multi-user media access control protocol data units (MPDU) in a wireless network are provided. One aspect of this disclosure provides a method of wireless communication. The method includes generating, by an apparatus, an aggregated media access control protocol data unit (A-MPDU) frame comprising a plurality of A-MPDU sub-frames, wherein at least one sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a first device and at least one other sub-frame of the plurality of A-MPDU sub-frames is addressed to at least a second device. The method comprises inserting an indication that the A-MPDU frame is addressed to at least the first and second devices into a physical layer data unit (PPDU) field.

18724345
082214

Electronic Patent Application Fee Transmittal

Application Number:

Filing Date:

Title of Invention:

SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION
AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA
UNITS IN A WIRELESS NETWORK

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Attorney Docket Number:

QTELE.158PR / 146852P1

Filed as Large Entity

Provisional Filing Fees

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USD(\$)**

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Provisional Application Filing

1005

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Pages:

Claims:

Miscellaneous-Filing:

Petition:

Patent-Appeals-and-Interference:

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Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Total in USD (\$)				260

Electronic Acknowledgement Receipt

EFS ID:	19992966
Application Number:	62043061
International Application Number:	
Confirmation Number:	4740
Title of Invention:	SYSTEMS AND METHODS FOR SIGNALING MULTI-DESTINATION AGGREGATED MULTI-USER MEDIA ACCESS CONTROL PROTOCOL DATA UNITS IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Santosh Paul Abraham
Customer Number:	14870
Filer:	Eric M. Nelson/Heide Young
Filer Authorized By:	Eric M. Nelson
Attorney Docket Number:	QTELE.158PR / 146852P1
Receipt Date:	28-AUG-2014
Filing Date:	
Time Stamp:	15:25:23
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$ 260
RAM confirmation Number	1793
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Authorized User	KNOBBE MARTENS OLSON AND BEAR

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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	QTELE-158PR_ADS.pdf	497669	no	8
			003b1398435d81f37b1e2e17d1430d76b11ca1c4		
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
2	Drawings-only black and white line drawings	QTELE-158PR_Figs.pdf	197177	no	11
			c18545fb3f2ebaf675b02d1791ec747f5b7c07e3		
Warnings:					
Information:					
3		QTELE-158PR_Spec.pdf	1459140	yes	29
			72ca587f3669952c6c66f069f09a5ed7ebf64941		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	22	
	Claims		23	28	
	Abstract		29	29	
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30073	no	2
			9501cff8007bf886292f06b441807c8165e0b00		
Warnings:					
Information:					
Total Files Size (in bytes):			2184059		

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