

Exhibit 1006

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TCL Electronics Holdings Ltd. (f/k/a TCL Multimedia Technology Holdings, Ltd.
TCL Industries Holdings Co., Ltd.
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TCL King Electrical Appliances (Huizhou) Co. Ltd.
Manufacturas Avanzadas S.A. de C.V.
TCL Smart Device (Vietnam) Co., Ltd.
Shenzhen TCL New Technology Co., Ltd.
TCL Optoelectronics Technology (Huizhou) Co., Ltd.
TCL Overseas Marketing Ltd.
TCL Technology Group Corporation (f/k/a TCL Corp.),

Petitioners

v.

LG Electronics Inc.,
Patent Owner.

Case No. IPR2023-00866

U.S. Patent No. 9,788,346

**DECLARATION OF MARK R. LANNING IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 9,788,346**

***Expert Declaration of Mark R. Lanning in Support of
Petition for Inter Partes Review of U.S. Patent No. 9,788,346***

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Exhibit No.	Description
1001	U.S. Patent No. 9,788,346 (“the ’346 Patent”)
1002	Prosecution history of U.S. Patent No. 9,788,346
1003	U.S. Patent 7,349,436 of Maltsev et. al.
1004	U.S. Patent Publication 2007-0147322 of Agrawal et. al.
1005	U.S. Patent Publication 2007-0266157 of Xhafa et. al.
1006	Declaration of Mark Lanning
1007	C.V. of Mark R. Lanning
1008	IEEE P802.11 Wireless LANs: Proposal for PAR and 5 Criteria for Very High Throughput (VHT) SG for Below 6 GHz Operation, De Courville, Marie; Engwer, Darwin; Kraemer, Bruce; De Vegt, Rob; Erceg, Vinko; Perahta, Eldad; Fracchia, Roberta; Rouquette, Stephanie, (May 12, 2008)
1009	On the Feasibility of 1Gbps for Various MAC/PHY Architectures, Fracchia, Roberta, (March 2008)
1010	LG Electronics, Inc. Complaint for Case 2:22-cv-00122-JRG. 04/21/2022.
1011	FINTIV Stipulation
1012	Plaintiff LG Electronic Inc.’s Preliminary Claim Constructions and Supporting Materials
1013	Defendants’ Amended Patent Rule 4-2 Disclosures

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Exhibit No.	Description
1014	IEEE Standard for Information Technology; Telecommunications and Information Exchange between Systems; Local and Metropolitan Area Networks, Specific Requirements: PART 11” Wireless LAN Medium Access Control (MAC) and Physical Layer Specifications (2007) aka, IEEE 802.11-2007 Recommendation
1015	U.S. Patent 8,705,645 of Sadowsky et al.
1016	Reserved
1017	Reserved
1018	IEEE 802.11n WLAN Standard by electronics-notes. https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/802-11n.php (No date. Not a prior art article).
1019	What You Need to Know About Wi-Fi 4 (IEEE 802.11n – Keenetic. March 22, 2022 (Not a prior art article).
1020	802.11n Primer, Whitepaper by AirMagnet Wireless Network Assurance, August 05, 2008.
1021	IEEE P802.11 - Wireless LANs: TGn Channel Models; doc.: IEEE 802.11-03/940r4; May 10, 2004
1022	Adrian Stephens—Maltsev co-inventor’s Bio
1023	Chapter A1.A of Gast IEEE 802.11n book.
1024	The History of WiFi: 1971 to Today (Cablefree), May 18, 2017. (Not a prior art document. Used to provide history).
1025	IEEE Plenary Meeting 11-08-0428-00-0000-minutes-working- group-march-2008

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Exhibit No.	Description
1026	IEEE SA - About the New Standards Committee (NesCom)
1027	How does 802.11n get to 600Mbps? By Wirevolution.com dated 09/07/2007. https://wirevolution.com/2007/09/07/how-does-80211n-get-to-600mbps/ .
1028	Reserved.
1029	IEEE 802.11-10/0780r2. IEEE submission for Joint Multichannel CSMA.

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I, Mark R. Lanning, declare as follows:

I. INTRODUCTION

1. My name is Mark R. Lanning, and I have been retained by the Petitioners to offer technical opinions relating to U.S. Patent No. 9,788,346 (the “’346 patent”) and prior art references relating to its subject matter. My experience with many different types of Wi-Fi networks and Wi-Fi networks operating with audio and video products¹ provides me with an understanding of the subject matter described and claimed in the ’346 patent.

2. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the ’346 patent. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the ’346 patent and the prior art discussed below.

3. I have no financial interest in the party or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

¹ The patent owner has accused the Petitioner’s television products that comply with a Wi-Fi standard of infringing at least one claim of this patent. Ex. 1010, see e.g., ¶¶24, and 121-124.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

4. I have extensive experience in the field of telecommunications including circuit-switched networks; multiple generations of cellular networks; and packet-switched networks.

5. Further details on my education, work experience, and the cases in which I have previously given testimony in the past four years are contained in my curriculum vitae (CV). Ex. 1007.

6. I am currently the president of two consulting companies: Telecom Architects, Inc. and Reticle Consulting, LLC. Telecom Architects provides consulting services to fixed and wireless telecom service providers and their equipment suppliers. I have been President of Telecom Architects since 1999.

7. I have over 40 years of experience working in the telecommunications industry that began in the U.S. Army Signal Corp. My experience relevant to this case includes my work as an architect of various telecommunications systems and my work developing equipment used in telecommunications systems. This experience includes extensive design, implementation and testing work on the wireless interface functionality (between the base station and mobile phones) for multiple generations of cellular standards.

8. I received a B.S. in Computer Science from Southern Methodist University (SMU) in 1983.

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9. DSC, now a part of Alcatel, hired me in 1983 where I was a software development manager on the team responsible for turning DSC's PSTN telephone switch into a Mobile Switching Center (MSC) for Motorola to sell as a part of their cellular product offering in the U.S. and many other countries.

10. In 1991, I began working as a consultant to Motorola for its "SuperCell" base station product and as a consultant to British Telecom to upgrade its current analog cellular network and I was one of the network architects responsible for the design and rollout of its Global System for Mobile Communications ("GSM") network known as Cellnet. Beginning in the early 1990s, I was responsible for implementation of the SMS service, including working with suppliers of the SMS Center (SMSC), Mobile Switching Centers (MSCs) and cellular phones to define and roll out the functionality that was to be provided.

11. I was personally involved with Nokia, Ericsson, Motorola and other equipment suppliers in this effort.

12. Since 1995, I have also provided second generation (2G) and third generation (3G) Code Division Multiple Access ("CDMA") network architecture and equipment design and implementation consulting services to companies such as Sprint, Nextel, Nokia, and Ericsson. While consulting to Nextel, which has since become part of Sprint, as one of the network architects for its iDEN network,

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one of my responsibilities was to define the network and mobile phone functionality required to support MMS and advanced data communications capability.

13. In addition to my cellular experience listed above, for at least the past ten years, I have kept up to date my knowledge of the present-day 3G, 4G, and 5G cellular network and wireless standards and their associated equipment and protocols. I have done this through my study of each new release of these standards, technical books and trade publications as well as my expert work in legal cases, which has involved evaluating the functionality of many different types of network equipment, mobile devices, and baseband chipsets. I have also evaluated thousands of cellular technology patents and most of these were for cellular phone and/or base station functionality.

14. I have also been responsible for the procurement, configuration and implementation of multiple types of Wi-Fi networks and have served as a technical expert on multiple cases regarding Wi-Fi standards, technology, chipsets and products.

15. I am a member of the Institute of Electrical and Electronics Engineers (IEEE), including the IEEE Standards Association. I am also a member of the Association for Computing Machinery (ACM). While employed at DSC, I was a member of the ANSI T1 and T1X1 standard groups responsible for the definition

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and standardization of the Advanced Intelligent Network (AIN) and Signaling System 7 (SS7) protocol.

16. I was retained as a technical expert by defendants, TCL Electronics Holdings Ltd. (f/k/a TCL Multimedia Technology Holdings, Ltd.), TCL Industries Holdings Co., Ltd., TCL Industries Holdings (H.K.) Limited, TTE Technology, Inc. (d/b/a TCL North America), TTE Corporation, TCL Moka International Limited, TCL Moka Manufacturing S.A. de C.V., TCL King Electrical Appliances (Huizhou) Co. Ltd., Manufacturas Avanzadas S.A. de C.V., TCL Smart Device (Vietnam) Co., Ltd., Shenzhen TCL New Technology Co., Ltd., TCL Optoelectronics Technology (Huizhou) Co., Ltd., TCL Overseas Marketing Ltd., TCL Technology Group Corporation (f/k/a TCL Corp.).

III. DOCUMENTS AND OTHER MATERIALS REVIEWED

17. In forming the opinions set forth in this declaration, I have reviewed the documents Identified in the Exhibit List and the prosecution history of the '346 patent and of the patents and patent applications to which it claims priority.

18. Additionally, I have utilized my own experience and expertise, including that regarding the knowledge and capabilities of a person of ordinary skill in the relevant art in the timeframe of the claimed priority date of the '346 patent.

IV. UNDERSTANDING OF THE LAW

A. Date of Invention

19. I have been asked to use the date of the filing of the earliest application to which priority is claimed (*i.e.*, June 18, 2008) as the (“date of invention” or the “priority date”) for purposes of my analysis.

B. Obviousness

20. I am informed and understand that a patent claim is invalid under 35 U.S.C. § 103 if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention to a person having ordinary skill in the art to which the subject matter pertains. Obviousness, as has been explained to me, is based on (i) the scope and content of the prior art, (ii) the differences between the prior art and the claim, (iii) the level of ordinary skill in the art, and, (iv) any secondary indicia of non-obviousness (*e.g.*, “secondary considerations” such as commercial success in the market place of the claimed invention), to the extent that they exist.

21. I further understand that obviousness may be shown by showing that it would have been obvious to combine the teachings of more than one item of prior art. In determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person

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having ordinary skill in the art, the following are examples of approaches and rationales that may be considered:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of a known technique to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- Applying a technique or approach that would have been obvious to try (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a person having ordinary skill in the art; and
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

22. I further understand that an invention may be obvious if one of ordinary skill in the art, facing a wide range of needs created by developments in the field, would have seen an obvious benefit to the solutions tried by the

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applicant. When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, it may be obvious to a person of ordinary skill to try the known options. If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique would have been obvious.

23. I further understand that a person of ordinary skill in the art is a hypothetical person who is presumed to be aware of all of the relevant art at the time of the invention. The person of ordinary skill is not an automaton, and may be able to fit together the teachings of multiple patents and/or printed publications employing ordinary creativity and the common sense that familiar items may have uses in another context or beyond their primary purposes.

24. I also understand that when considering the obviousness of a patent claim, one should consider whether a teaching, suggestion, or motivation to combine the references exists so as to avoid impermissibly applying hindsight when combining or modifying the prior art. I understand this test should not be applied rigidly, but that the test can be important to avoid such hindsight.

25. I also understand that one of ordinary skill in the art must have a reasonable expectation of success in combining or modifying prior art references.

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26. I also understand that all elements of a claim must be considered in an obviousness analysis.

C. Standard Of Proof

27. I understand that the standard to prove unpatentability in an *inter partes* review proceeding is by a preponderance of the evidence, which means more likely than not.

V. RELEVANT TECHNOLOGY BACKGROUND

A. Background of the IEEE 802.11 Wi-Fi Recommendations (Standards)

28. Beginning in 1999, the products that comply with one or more of the IEEE 802.11 recommendations are typically referred to as “Wi-Fi” products. (See *e.g.*, Exh. 1024, p.1). The letter or letters following the 802.11 number, such as “a,” “b,” “g,” “n,” and “ac” are the specific version or recommendation of the 802.11 standard which have been issued over time. The Grounds discussed below rely upon prior art patents and published applications and not the prior art Wi-Fi standards *per se*. However, a discussion of the existing versions of the IEEE 802.11 standard and the stated objectives for future versions prior to the priority date of the ‘346 patent are useful in understanding the Wi-Fi systems and methods recited in the Challenged Claims.

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B. Prior Art IEEE 802.11 Recommendations

29. The first Wi-Fi recommendation (standard) was released in 1997 and it is now obsolete. The initial 802.11b (1999), 802.11a (1999, clause 17) and 802.11g (2003) recommendations were very popular and, based on my personal experience, were used by millions of computers, cell phones and Access Points/Routers in the U.S.

30. One of the more recent 802.11 amendments/recommendations, which is specifically relevant to this declaration, is IEEE 802.11n. The part of the technology industry associated with building and using Wi-Fi products came to a substantive agreement about the features that would be included the 802.11n amendment in 2006, which allowed the chip manufactures to start development. This draft was finalized in 2008, and the formal publication of the IEEE 802.11n recommendation was released in 2009 as described by the passages below.

The industry came to a substantive agreement about the features for the 802.11n wireless LAN system in early 2006. This gave many chip manufacturers sufficient information to get their developments under way.

IEEE 802.11n Wi-Fi

The draft was finalised in November 2008 with its formal publication in July 2009. Such was the anticipation of the standard, that many products became available on the market around the time of the standard launch as advance copies had been available for development and further work on the standard.

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Ex. 1018 (not a prior art article) at p.1.

C. Description of the IEEE 802.11n Recommendation

31. The definition of the 802.11n Recommendation began as the High Throughput (HT) Study Group that also had the formal name of “IEEE 802.11 HT SG (HTSG).” It was established in late 2002 and took seven years to produce from start to finish.” Ex. 1023, pp. 2-3. The HTSG produced a mouse pad to commemorate many of its key dates as shown below. The first key date was the formation of the HTSG on September 11, 2002. This mouse pad also shows that multiple draft versions of the 802.11n standard were published before the priority date of the ‘346 patent. The ‘346 patent additionally describes the IEEE 802.11n standard as prior art with at least “The IEEE 802.11n is a technical standard relatively recently introduced ...” (Ex. 1001 at 2:7-8). The following sections describe the relevant functionality used to increase the data throughput rate in the 802.11n recommendation.

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Id. at p. 4.

i. Doubling the Number of 20 MHz Subchannels Causes the Data Throughput to Double

32. IEEE 802.11n stations, e.g., computers, mobile phones, and routers, were known as High Throughput (HT) stations because, unlike prior stations that were compatible with earlier versions of the 802.11 standard that used a single 20 MHz wide channel, the channel bandwidth options for HT stations were either a

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single 20 MHz wide channel or a maximum 40 MHz wide channel using two bonded 20 MHz subchannels together. When two 20 MHz subchannels are used to create a 40 MHz channel, the data bandwidth is doubled over using a single 20 MHz channel as described by the passages below.

5. 40 MHz channels: all previous versions of 802.11 have a channel bandwidth of 20MHz. 802.11n has an optional mode (controversial and not usable in many circumstances) where the channel bandwidth is 40 MHz. While the channel bandwidth is doubled, the number of data subcarriers is slightly more than doubled, going from 52 to 108. This yields a total channel throughput of 150 Mbps. So again combining four channels with MIMO, we get 600 Mbps.

Ex. 1027 at p. 2 (all emphasis has been added unless otherwise noted).

Understanding 802.11n concepts

The 802.11n amendment includes many enhancements that improve WLAN range, reliability, and throughput. At the physical (PHY) layer, advanced signal processing and modulation techniques have been added to exploit multiple antennas and wider channels. At the Media Access Control (MAC) layer, protocol extensions make more efficient use of available bandwidth. Together, these High Throughput (HT) enhancements can boost data rates up to 600 Mbps – more than a ten-fold improvement over 54 Mbps 802.11a/g (now considered to be legacy devices).

Ex. 1019 at p. 4 (not a prior art article).

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40 MHz Channel Bandwidth

Another optional 802.11n feature that only benefits new devices are 40 MHz channels that use twice as much bandwidth to double throughput (Figure 2).

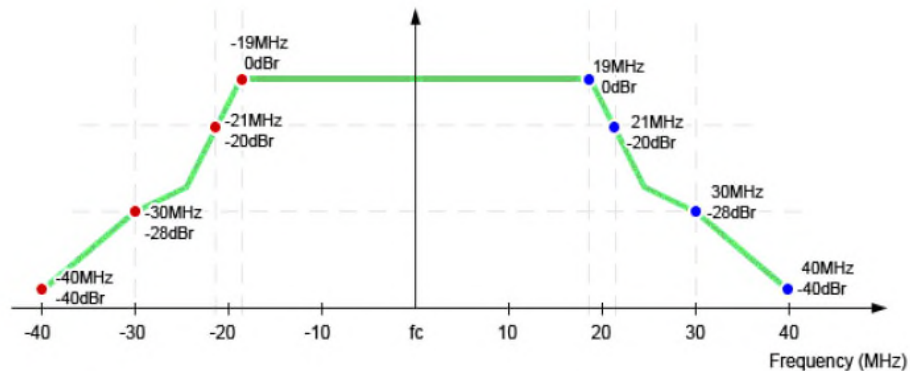


Figure 3. Spectrum Mask for 40 MHz Channel used by 802.11n

Id. at p. 6 (emphasis added).

33. I have often used an analogy similar to the one below to describe how additional subchannels can significantly increase the bandwidth and throughput in a Wireless Local Area Network (WLAN), like 802.11n. For example, 802.11n doubles the number of subchannels from one 20 MHz channel to two 20 MHz channels, which doubles the data throughput.

Compare those channels and APs to lanes and toll booths on a highway. Each old booth (802.11b/g AP) received cars from just one lane (20 MHz channel), while new booths (802.11n APs) can service two adjacent lanes (40 MHz channel). A new booth could handle twice as many vehicles per hour.

Ex. 1023 at p. 6 (emphasis added).

To increase speed beyond the capabilities offered by MIMO, 802.11n offers the option for wider channels. By doubling channel width, it is possible to double data rates. Network administrators must carefully consider a set of

Ex. 1023 at p. 6 (emphasis added).

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34. Stations using the 802.11n standard were capable of transferring data at a rates in a range from 54 Mbit/s (Million bits per second) to 600 Mbit/s as shown by the table below. The two numbers highlighted at the bottom of the table show that 802.11n's data throughput (Data Rate) was almost 300 Mbps using a 20 MHz wide channel and is a little over doubled using two 20 MHz channels together to create a 40 MHz wide channel and providing 600 Mbps.

MCS Index	Type	Coding Rate	Spatial Streams	Data Rate (Mbps) with 20 MHz CH		Data Rate (Mbps) with 40 MHz CH	
				800 ns	400 ns (SGI)	800 ns	400 ns (SGI)
0	BPSK	1 / 2	1	6.50	7.20	13.50	15.00
1	QPSK	1 / 2	1	13.00	14.40	27.00	30.00
2	QPSK	3 / 4	1	19.50	21.70	40.50	45.00
3	16-QAM	1 / 2	1	26.00	28.90	54.00	60.00
4	16-QAM	3 / 4	1	39.00	43.30	81.00	90.00
5	64-QAM	2 / 3	1	52.00	57.80	108.00	120.00
6	64-QAM	3 / 4	1	58.50	65.00	121.50	135.00
7	64-QAM	5 / 6	1	65.00	72.20	135.00	150.00
8	BPSK	1 / 2	2	13.00	14.40	27.00	30.00
9	QPSK	1 / 2	2	26.00	28.90	54.00	60.00
10	QPSK	3 / 4	2	39.00	43.30	81.00	90.00
11	16-QAM	1 / 2	2	52.00	57.80	108.00	120.00
12	16-QAM	3 / 4	2	78.00	86.70	162.00	180.00
13	64-QAM	2 / 3	2	104.00	115.60	216.00	240.00
14	64-QAM	3 / 4	2	117.00	130.00	243.00	270.00
15	64-QAM	5 / 6	2	130.00	144.40	270.00	300.00
16	BPSK	1 / 2	3	19.50	21.70	40.50	45.00
...	...	...	...	...	...	...	...
31	64-QAM	5 / 6	4	260.00	288.90	540.00	600.00

Table 1. Some 802.11n MCS Values

Ex. 1023 at p. 8 (emphasis added).

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ii. MIMO Multiplies the Data Throughput for Each Pair of Antennas

35. Another big boost to data throughput for the 802.11n standard was the inclusion of MIMO technology. By using multiple antennas at the transmitter and receiver (antenna pairs), multiple data streams can be transmitted in parallel, which multiplies the throughput by each data stream.

36. Therefore, a POSITA would have known that four pairs of antennas (4 spatial streams) at the transmitter and the receiver would have quadrupled the data throughput:

4. MIMO: thanks to the magical effect of spatial multiplexing, provided there are sufficient multi-path reflections, the throughput of a system goes up linearly with each extra antenna at both ends. Two antennas at each end double the throughput, three antennas at each end triple it, and four quadruple it. The maximum number of antennas in the receive and transmit arrays specified by 802.11n is four. This allows four simultaneous 72.2 Mbps streams, yielding a total throughput of 288.9 Mbps.

Ex. 1027 at pp. 1-2 (emphasis added).

Multiple Input Multiple Output (MIMO)

Behind most 802.11n enhancements lies the ability to receive and/or transmit simultaneously through multiple antennas. 802.11n defines many "M x N" antenna configurations, ranging from "1 x 1" to "4 x 4". This refers to the number of transmit (M) and receive (N) antennas – for example, an AP with two transmit and three receive antennas is a "2 x 3" MIMO device.

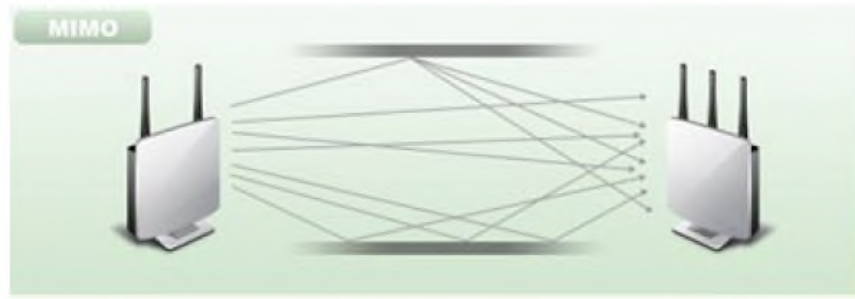


Figure 1. Multiple Input Multiple Output

Ex. 1020 at p. 4 (emphasis added).

37. MIMO is discussed in more detail in Section VII.B.iii, below.

iii. Increased Number of Data Subcarriers

38. The 802.11n recommendation also increased the number of data subcarriers in each 20 MHz subchannel from 48 to 52. These additional subcarriers also add to the increased data throughput as described below.

1. More subcarriers: 802.11g has 48 OFDM data subcarriers. 802.11n increases this number to 52, thereby boosting throughput from 54Mbps to 58.5 Mbps.

Ex. 1027 at p. 1 (emphasis added)

iv. The MAC Protocol Layer Efficiency was Improved.

39. The Medium Access Layer (MAC) protocol layer that is used to process the bits transferred by the physical (PHY) layer protocol into data packets

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was inefficient for these new data speeds in the pre-802.11n recommendations.

This inefficiency was typically 50% of the PHY layer data speed, which was significant. In other words, the pre-802.11n MAC protocol overhead decreased the PHY layer bit stream by half. MAC protocol layer changes for 802.11n reduced this overhead to at most 25% percent as described below.

Lower MAC overhead

But raw throughput is not a very informative number.

The 11a/g link rate is 54 Mbps, but the higher layer throughput is only 26 Mbps; the MAC overhead is over 50%! In 11n when the link rate is 65 Mbps, the higher layer throughput is about 50 Mbps; the MAC overhead is down to 25%.

Ex. 1027 at p. 2 (emphasis added).

MAC Layer Overhead Reduction

The PHY enhancements described thus far increase maximum PHY data rate, but would make very inefficient use of the airwaves without the following MAC layer enhancements also utilized by 802.11n.

- **Block Acknowledgement** reduces the number of ACKs that a receiver must send to a transmitter to confirm frame delivery. Legacy 802.11a/g transmitters expect an (almost immediate) ACK for each non-multicast/broadcast frame. But 802.11n transmitters also accept Block ACKs which confirm receipt of multiple unicast frames. For example, instead of sending 9 legacy ACKs to confirm frames 1 through 8 and 10, an 802.11n receiver can say the same thing with just one Block ACK.
- **Frame Aggregation** increases the payload that can be conveyed by each 802.11 frame, reducing MAC layer overhead from a whopping 83 % to as little as 58 % (using A-MSDU) and 14 % (when using A-MPDU). Legacy 802.11a/g devices can send no more than 2304 payload bytes per frame. But new 802.11n devices have the option of bundling frames together for transmission, increasing payload size to reduce the significance of the fixed overhead caused by inter-frame spacing and preamble. There are two aggregation options:

Ex. 1023 at p. 9 (emphasis added).

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v. Improvement to the Forward Error Correction Method

40. Forward Error Correction (FEC) codes use the input data and encode it with redundant bits to enable detection and correction at the receiver. These codes decrease the efficiency of the channel because they are adding extra bits to be transferred that are not the actual data. A key parameter for FEC codes is the code rate, which describes the number of data bits as a fraction to the total number of bits that need to be transmitted. For example, a $3/4$ code transmits 4 total bits for every 3 data bits that are input. The 802.11n recommendation added a $5/6$ FEC code that is slightly more efficient and helped to increase the overall data throughput as described below.

2. FEC: 802.11g has a maximum FEC (Forward Error Correction) coding rate of $3/4$. 802.11n squeezes some redundancy out of this with a $5/6$ coding rate, boosting the link rate from 58.5 Mbps to 65 Mbps.

Ex. 1027 at p. 1 (emphasis added)

41. The above statements, diagrams and table confirm that a POSITA would have known and understood much, if not all, the functionality included in the 802.11n recommendation and how the data throughput speed would increase using these different functions.

42. In summary, the relevant known 802.11n functionality and resulting throughput speed increases have been taken from documents published before the priority date of the '346 patent:

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- Doubling the number of 20 MHz subchannels—from one to two, doubled the data throughput (Ex. 1027 p. 1);
- Each MIMO antenna pair multiplied the data throughput—two pairs of antennas at each end of the wireless link doubled the throughput, three antennas at each end tripled it, and four quadrupled it (*Id.*);
- More data subcarriers (48 to 52) increases the data throughput (*Id.*);
- The MAC protocol layer overhead was improved from 50% down to 25% for 802.11n (*Id.*). In other words, these MAC changes increased the data throughput by 50%; and
- A 5/6 forward error correction increases the data rate over using 3/4 error correction (*Id.*).

D. The IEEE VHT Amendment

43. Even with the significantly higher throughput achieved by using 802.11n stations, the Wi-Fi industry sought even higher capacity as Wi-Fi was being used for video streaming and the like. Consequently, the IEEE 802.11 standards group began defining the successor to the 802.11n standard to provide even higher throughput. This is documented in IEEE P802.11 Wireless LANs: “*Proposal for PAR and 5 Criteria for Very High Throughput (VHT) SG for Below 6 GHz Operation*,” (hereafter “VHT Amendment,” Ex. 1008), which is dated May 12, 2008², and precedes the priority date of the ’345 patent, i.e., June 18, 2008.

² Ex. 1029 additionally supports the date of this document and its public availability on p. 13.

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44. The VHT Amendment was publicly available no later than May 12, 2008, because it is an actual IEEE submission document (bottom of p. 1) to the “NesCom Administrator³” as indicated by the term “Submission” at the bottom of each page. The table on pages 2-4 includes all of the required registration information to be approved, registered, and distributed to the IEEE 802.11 full working group that currently had 261 voting members on March 17th-20th, 2008, (Ex. 1025 p. 2) with 202 people in the room during this Plenary Meeting – Session #108. *Id.* Based on my personal ANSI and CCITT standard groups experience, these members are typically representatives from companies interested in the design, manufacture, sale, support, etc., of functionality being defined for the devices in each version of the IEEE standard. Again, based on my actual experience, the distribution of Ex. 1008 would not have been subject to any confidentiality restrictions and each of these representatives typically reports back to the appropriate groups in their organization. The 261 voting members could have easily reported the minutes and specific submissions such as Ex. 1008 to an average of at least five other members in their organization. I would expect that

³ The IEEE New Standards Committee (NesCom) Administrator “is responsible for ensuring that proposed standards project are within the scope and purpose of IEEE, assigned to the proper Society or other organizational body, and interested parties are appropriately represented in the development of IEEE standards....NesCom is comprised of at least 12 but no more than 18 IEEE SA members” Ex. 1026 at pp. 1-2.

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this would total over a 1,000 people that were in the public and interested in the progress of the IEEE current standards that would have included the VHT Working Group (WG).

45. The passages from VHT Amendment reproduced below define the basis for the VHT proposal and reference, *inter alia*, “5 five Criteria” for the VHT amendment. Reference to “VHT” terminology is found throughout this document, including in its title. The VHT amendment establishes that not only the terminology “VHT” was known before the priority date of the ‘346 patent, but also the desired characteristics of the VHT technology such as a multi-station data throughput of at least 1Gbps (one billion bits per second). A POSITA can be presumed to have been aware of VHT nomenclature and the desired 1Gbps data throughput before the priority date of ‘346 patent. This is clear from the passages below.

Proposal for PAR and 5 Criteria for Very High Throughput (VHT) SG for below 6 GHz operation
Date: May 12, 2008

Abstract

This document provides a proposed PAR and 5 Criteria for IEEE 802.11 VHT SG project for below 6GHz carrier frequency operation. The PAR form is copied from the IEEE web site official PAR submission form.

(Ex. 1008 at p. 1, emphasis added.

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46. As of May 12, 2008, five criteria (goals) were already established for this VHT 802.11 Amendment of which the following three criteria/goals are relevant to this declaration were:

- (1) Higher maximum throughput than 802.11n. Specifically, at least 1 Gbps (1 billion bits per second) multi-station throughput; and
- (2) at least 80 MHz bandwidth operation using 20 MHz subchannels;⁴
- and (3) backwards compatibility to previous 802.11 standards, which included the 802.11n recommendation. These criteria, which were known before the priority date of the '346 patent, are stated below.

This project will result in a wireless LAN with higher throughput than that provided by 802.11a, 802.11b, 802.11g and 802.11n. The goal is to increase the overall system throughput by considering new technologies, for the both PHY and MAC layers, operating below the 6GHz band.

VHT will allow a corporate or home user to roam from high-throughput, dense cells to wider area networks in a seamless manner while maintaining full support for the installed base security, management, diagnostics and backbone infrastructure. This will be supported by maintaining backwards compatibility to 802.11 standards like for instance 802.11 i/w for security, 802.11s for mesh networking, 802.11 k/v for network management.

Id. p. 6, emphasis added.

⁴ The feasibility studies referenced and linked in the “Demonstrated system feasibility” section of Ex. 1008 at p. 7 provide tests for 80 MHz and 100 MHz operation using two, three or four 20 MHz subchannels. These studies are included as Exs. 1009 and 1029 and are described below.

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b) One unique solution per problem (not two solutions to a problem).

There is no other wireless LAN standard providing significantly higher throughput than 802.11vht operating in bands below 6GHz.

c) Easy for the document reader to select the relevant specification.

The 802.11vht amendment will differentiate itself from other IEEE 802 wireless standards via the title which stresses the specification of gigabit speed WLAN technology.

Id., emphasis added.

47. The links to the two feasibility studies conducted are shown below. These were performed to show that a 1 Gbps data throughput was possible were part of the initial VHT work and the links to these studies were provided in the initial VHT proposal as shown by the subsection of the document below:

a) Demonstrated system feasibility.

Feasibility of multiple STAs 1Gbps and single link 500Mbps MAC SAP throughput links has been assessed in simulations and presented in documents 11-08-0307-01-0vht (<https://mentor.ieee.org/802.11/file/08/11-08-0307-01-0vht-on-the-feasibility-of-1gbps-for-various-mac-phy-architectures.ppt>) and 11-08-0535-00-0vht (<https://mentor.ieee.org/802.11/file/08/11-08-0535-00-0vht-phy-and-mac-throughput-analysis-with-80-mhz-for-vht-below-6-ghz.ppt>) for 80MHz bandwidth operation.

Id. p. 7, emphasis added.

48. One of the key differences between the 802.11n recommendation and the stated goals (criteria) of the proposed VHT amendment is the amount of bandwidth that can be allocated for the transmission of data. As described above for the 802.11n standard, a station can either use a 20 MHz channel or a 40 MHz channel where the 40 MHz channel is created by bonding two 20 MHz subchannels together. As described in VHT Amendment, the aggregate data speed

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(multistation throughput) would be 1 Gbps using an 80 MHz or higher channel width.

VI. LEVEL OF ORDINARY SKILL

49. I have considered the level of ordinary skill in the art relevant to the '346 patent. I understand that factors such as the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, the prior art solutions to those problems, and the speed at which innovations are made may help establish the level of skill in the art.

50. After reviewing the '346 patent, the relevant portions of the prosecution history of the '346 patent, and cited references, it is my opinion that the relevant art of the '346 patent is in the general field of wireless communication systems. See Ex. 1001, Abstract, 1:22-23.⁵

51. Specifically, the '346 patent relates to techniques for “a wireless local access network (WLAN), and more particularly, to a channel access mechanism in a very high throughput (VHT) WLAN system and a station supporting the channel access mechanism.” Ex. 1001 at 1:27-30.

52. The '346 patent invention allegedly:

⁵ All cites to the exhibits are to the original exhibit page numbers.

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[P]rovides a new channel access method for achieving an aggregate throughput of 1 Gbps or more in a very high throughput (VHT) system.

[P]rovides a channel access method for allowing simultaneous channel access of a plurality of VHT stations (STAs) in a VHT system.

[A]lso provides a new channel access method for achieving an aggregate throughput of 1 Gbps or more in a medium access control (MAC) service access point (SAP) in a VHT system.

Ex. 1001 at 3:62 – 4:4.

53. Based upon my knowledge of this field, I conclude that a POSITA at the time of the alleged invention of the '346 patent, and for that matter, at all subsequent times through the present, would have held at least a degree in electrical engineering, computer engineering, computer science or a similar discipline, with at least two years of relevant industry or research experience, including experience designing or implementing Wireless Local Area Networks (WLANs). Additional work or research experience can substitute for less or different education, and vice-versa. A person of ordinary skill in the art would also have had familiarity with the IEEE 802.11 WLAN (Wi-Fi) technical standards (recommendations/amendments) at the time. Ex. 1001, 1:32 - 2:20.

54. I am, and was at the time of the alleged invention, at least a person of skill in the relevant art, of a level at least as high as or more than ordinarily skilled

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persons, and I am able to provide insight and opinions into the understandings of such persons at all relevant times by virtue of my education, training and experience.

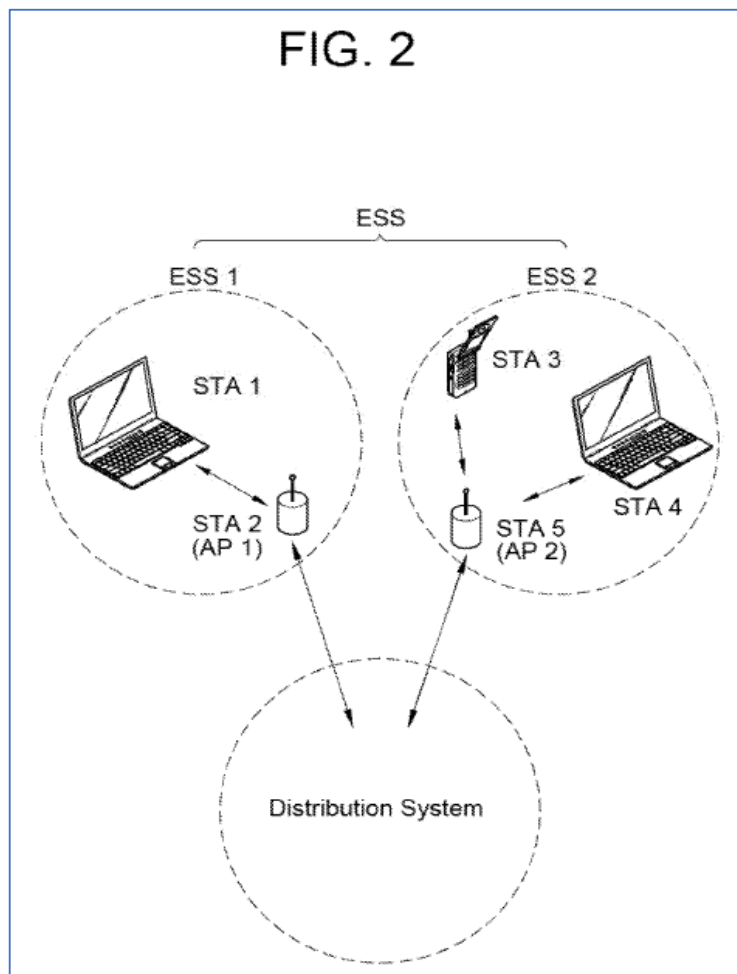
VII. OVERVIEW OF THE '346 PATENT

A. Summary of the Disclosure of the '346 Patent

55. The '346 patent, titled "Channel Access Method for Very High Throughput (VHT) Wireless Local Access Network System and Station Supporting the Channel Access Method" issued on October 10, 2017, from an application filed on November 21, 2016. Counsel has informed me that this application claims priority to a Korean patent application filed on June 18, 2008. Ex. 1001 at (30).

56. The '346 patent relates to a channel access mechanism in a very high throughput (VHT) WLAN (wireless local access network) system. Ex. 1001 at 1:27-30. The disclosed prior art IEEE 802.11 access network (WLAN) systems are also referred to as various versions of Wi-Fi standards ("The IEEE 802.11n is a technical standard relatively recently introduced to overcome a limited data rate which has been considered as a drawback in the WLAN.")

57. FIG. 2 of the '346 patent is a schematic view showing an exemplary structure of a wireless local access network (WLAN) system. Ex. 1001 at 5:33-35.



Id. at FIG. 2

The AP ... is a functional entity for providing connection to a distribution system (DS) through a wireless medium for an associated STA. A VHT AP supports the super high-speed data processing speed of 1 GHz or more in the multi-channel environment.

Id. at 6:20-32.

58. The '346 patent also states that, even though the 802.11n recommendation was recently released with significant throughput increases, there

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was still a demand for higher throughput systems and these new systems would need the have specific functionality with:

With the widespread use of WLAN and the diversification of applications using the WLAN, there is a demand for a new WLAN system to support a higher throughput.

Id. at 3:6-9

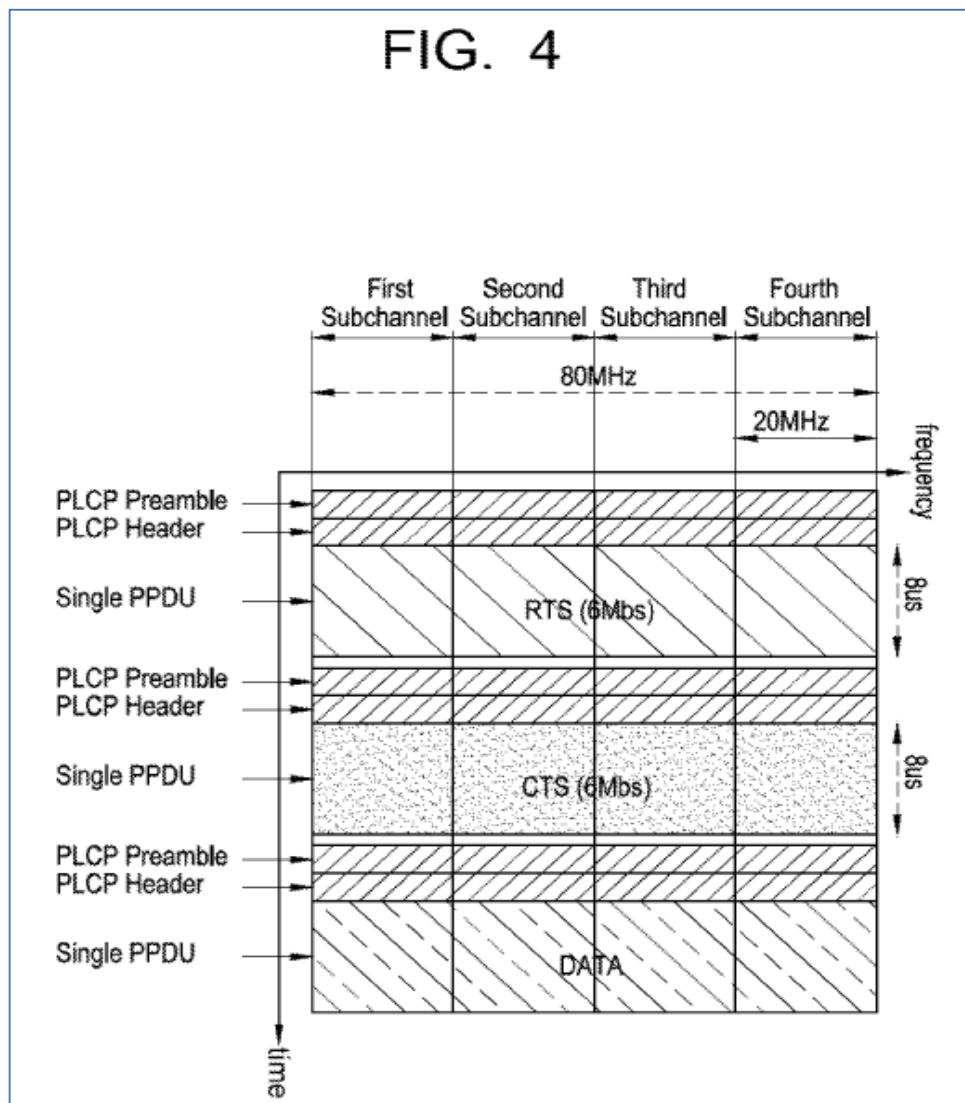
i. The RTS/CTS Protocol

59. The '346 patent is directed to a device that transmits a plurality of request to send (RTS) frames though a plurality of subchannels and receives at least one clear to send (CTS) frame though at least one idle subchannel. *Id.* at Abstract.

60. Figures 4 and 5 of the '346 patent and their descriptions included below further describe the RTS/CTS protocol.

FIG. 4 of the '346 patent shows a channel access mechanism in a VHT WLAN system, in which the entire bonding channel is used to exchange a request to send (RTS) frame, a clear to send (CTS) frame, and data between two VHT STAs performing communication with each other.

Id. at 7:30-40.



Id. at FIG. 4

61. The passages below from the '346 patent describe the prior art method of sending a RTS and receiving the corresponding CTS over the “entire bonding channel” and, instead of doing it this way, this embodiment of the alleged invention the station that has data to send only sends the RTS on the desired

subchannels and will only receive a CTS over the subchannels that are available for transmission with at least:

Referring to FIG. 5, the source VHT STA or the transmitting VHT STA (indicated by 'STA1' in FIG. 5), which intends to transmit data, transmits an RTS frame by using the entire bonding channel. **In the present embodiment, the RTS frame is transmitted for each subchannel by regarding each subchannel as an independent channel, instead of regarding the entire bonding channel as one channel.** In FIG. 5, a process of transmitting the RTS frame for each subchannel is indicated by a PLCP preamble, a PLCP header, and a single PPDU for each subchannel.

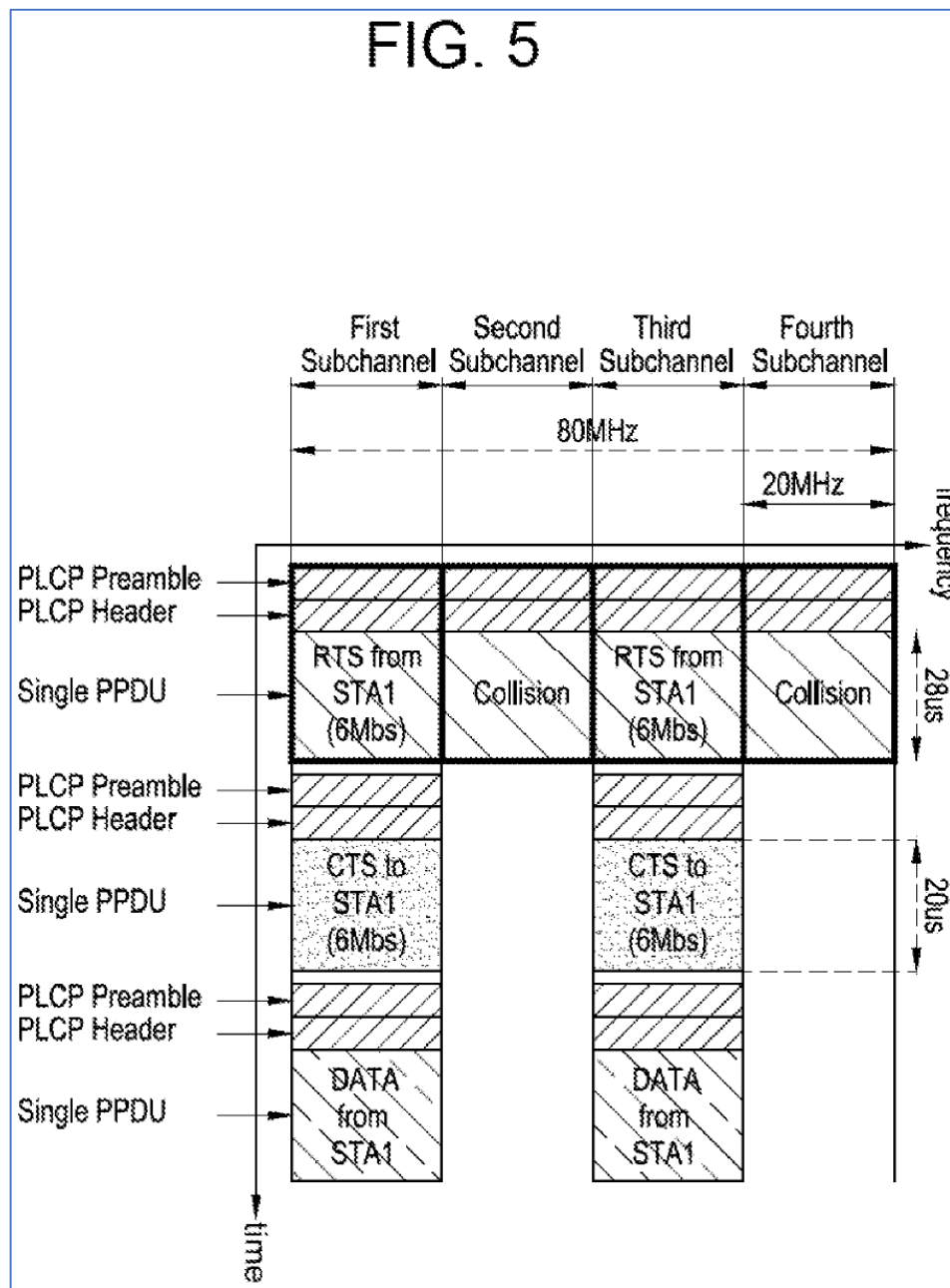
However, according to the present embodiment, among all subchannels, a 2nd subchannel and a 4th subchannel are used by the legacy STA. The 2nd subchannel and the 4th subchannel may be in use by different legacy STAs. Although the 2nd subchannel and the 4th subchannel are used by the legacy STA herein, this is for exemplary purposes only, and thus the embodiment of the present invention is not limited thereto. If the 2nd subchannel and the 4th subchannel are already being used, RTS frames transmitted through these subchannels may be unsuccessfully transmitted due to collision, **and a destination**

VHT STA may successfully receive RTS frames transmitted through a 1st subchannel and a 3rd subchannel.

Upon receiving the RTS frames through all or some of subchannels, the destination VHT STA or **the receiving VHT STA transmits a CTS frame for each subchannel by using corresponding subchannels.** In FIG. 5, a process of transmitting the CTS frame is indicated by a PLCP preamble, a PLCP header, and a single PPDU in the 1st and 3rd subchannels.

Upon receiving the CTS frame through the 1st and 3rd subchannels, the source VHT STA transmits data or the like by using corresponding subchannels (i.e., the 1st and 3rd subchannels). In FIG. 5, a process of transmitting the data through the 1st and 3rd subchannels is indicated by a PLCP preamble, a PLCP header, and a single PPDU in the 1st and 3rd subchannels.

Id. at 9:1-37 (emphasis added).



Id. at FIG. 5.

ii. Bonding of Multiple OFDM Subchannels

62. The passages below from the '346 patent describe the bonding of three or more OFDM subchannels together. When four 20 MHz subchannels are

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bonded together, the channel bandwidth would be 80 MHz, the channel bandwidth would be 100 MHz for five 20 MHz bonded subchannels, etc.

Although the embodiments described below relate to a VHT system using a bonding channel in which contiguous 4 subchannels having a bandwidth of 20 MHz are combined (i.e., a bonding channel having a channel bandwidth of 80 MHz), this is for exemplary purposes only. The embodiments described below can equally apply to a VHT system including a plurality of subchannels (e.g., 3 or 5 or more subchannels), which is apparent to those skilled in the art. In addition, the embodiments of the present invention are not limited to the VHT system whose subchannel has a bandwidth of 20 MHz.

Id. at 7:19-29.

The WLAN system including one or more basis service sets (BSSs) that is a set of stations (STAs). A very high throughput (VHT) BSS supports a super high-speed data processing speed of 1 GHz or more. A VHT system including one or more VHT BSSs can use a channel bandwidth of 80 MHz or a channel bandwidth of 60 MHz or 100 MHz or more.

Id. at 5:43-46.

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The VHT system operates in a multi-channel environment where a plurality of subchannels having a specific size, e.g., a channel bandwidth of 20 MHz, are included.

Id. at 5:47-49.

iii. MAC Protocol Layer Efficiency Modifications

63. The '346 patent describes that MAC protocol layer will need to undergo changes in order to process the 1 Gbps data rate with at least the following passages:

To achieve a data processing speed of 1 Gbps or more in the wireless communication system, a very high throughput (VHT) system different from the conventional IEEE 802.11n medium access mechanism (MAC)/physical layer (PHY) protocol (i.e., single station (STA) architecture), which supports a high throughput (HT), i.e., a data processing speed of up to 540 Mbps, has been proposed.

Id. at 3:23-35.

The STA is an arbitrary functional medium including a medium access control (MAC) and wireless-medium physical layer (PHY) interface.

A VHT STA supports the super high-speed data processing speed of 1 GHz or more in the multi-channel environment.

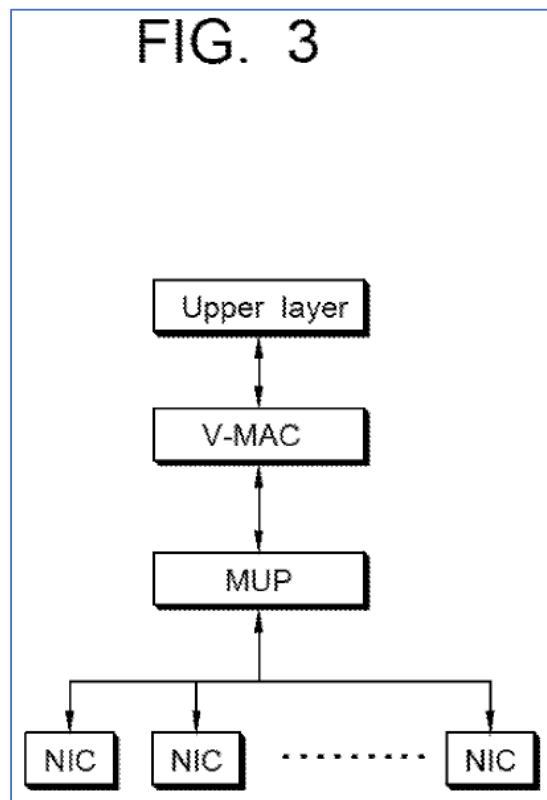
Id. at 5:60-67.

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64. The '346 patent also describes changes that can be made to the hardware and the software to optimize the MAC processing.

FIG. 3 of the '346 patent [below] shows “a block diagram showing a multi-radio unification protocol (MUP) as an example of a protocol applicable to a very high throughput (VHT) system including a plurality of network interface cards (NICs) each having an independent radio interface.

Id. at 5:14-18.



Id. at FIG. 3.

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iv. Using Multiple Antennas at the Transmitter and Receiver (MIMO)

65. The '346 patent describes how the prior art standard (802.11n) uses MIMO to either optimize the data rate or increase data reliability.

More specifically, the IEEE 802.11n supports a high throughput (HT), i.e., a data processing speed of up to 540 Mbps at a frequency band of 5 GHz, and is based on a multiple input and multiple output (MIMO) technique which uses multiple antennas in both a transmitter and a receiver to minimize a transmission error and to optimize a data rate. In addition, this standard may use a coding scheme which transmits several duplicated copies to increase data reliability and also may use the OFDM to support a higher data rate.

Id. 2:12-20.

B. Known Functionality Described by the '346 Patent

66. The '346 patent discloses technology that was well known well before its priority date. I understand this is referred to as “admitted prior art.” The relevant technology for this declaration and the Challenged Claims includes at least: (1) the request-to-send/clear-to-send RTS/CTS protocol; (2) OFDM used for the physical layer radio interface and bonding of OFDM subchannels; and (3) Multiple Input Multiple Output (MIMO) antenna techniques; and (4) a VHT system including a plurality of network interface cards (NICs) each having an

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independent radio interface. These known technologies are explained in detail below.

i. The RTS/CTS Protocol

67. The Request To Send/Clear To Send (RTS/CTS) protocol is a request/response mechanism where the station that wants to send data to another station must first send it a request (RTS) and wait for a positive response (CTS) before sending the data. The RTS/CTS protocol was initially defined for use in Wi-Fi networks in the 802.11-1999 recommendation, long before the '346 patent's priority date. The passages below are from the IEEE 802.11-2007 version of the standard that was publicly approved on 8 March 2007,⁶ more than one year before the priority date of the '346 patent. The main purpose of this version of the recommendation was to combine all the earlier standards into one document and provide corrections and clarifications.⁷

⁶ Ex. 1014 at p. i.

⁷ *Id.* at p. ii.

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This revision gives users, in one document, the IEEE 802.11 standard for wireless local area networks (WLANS) with all the amendments that have been published to date. The original standard was published in 1999 and reaffirmed in 2003. The following documents have been rolled into this revision and are, therefore, now retired along with the original, reaffirmed edition of IEEE Std 802.11:

- IEEE Std 802.11a™-1999 (Amendment 1)
- IEEE Std 802.11b™-1999 (Amendment 2)
- IEEE Std 802.11b-1999/Corrigendum 1-2001
- IEEE Std 802.11d™-2001 (Amendment 3)
- IEEE Std 802.11g™-2003 (Amendment 4)
- IEEE Std 802.11h™-2003 (Amendment 5)
- IEEE Std 802.11i™-2004 (Amendment 6)
- IEEE Std 802.11j™-2004 (Amendment 7)
- IEEE Std 802.11e™-2005 (Amendment 8)

Ex. 1014 at p. iv (emphasis added).

68. As shown by the passages below, Section 9.2 of the 802.11-2007 standard defines the Distributed Coordination Function (DCF) described by the ‘346 patent specification (*See e.g.*, Ex. 1001 FIG. 1 and 2:21-34.) and the (RTS/CTS) functions described by the ‘346 patent specification (*See e.g.*, *id.* 2:48-57) and is also included in the Challenged Claims (defined below).

9.2 DCF

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.

The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long data frame had been transmitted and a return ACK frame had not been detected.

Ex. 1014 at p. 256 (emphasis added).

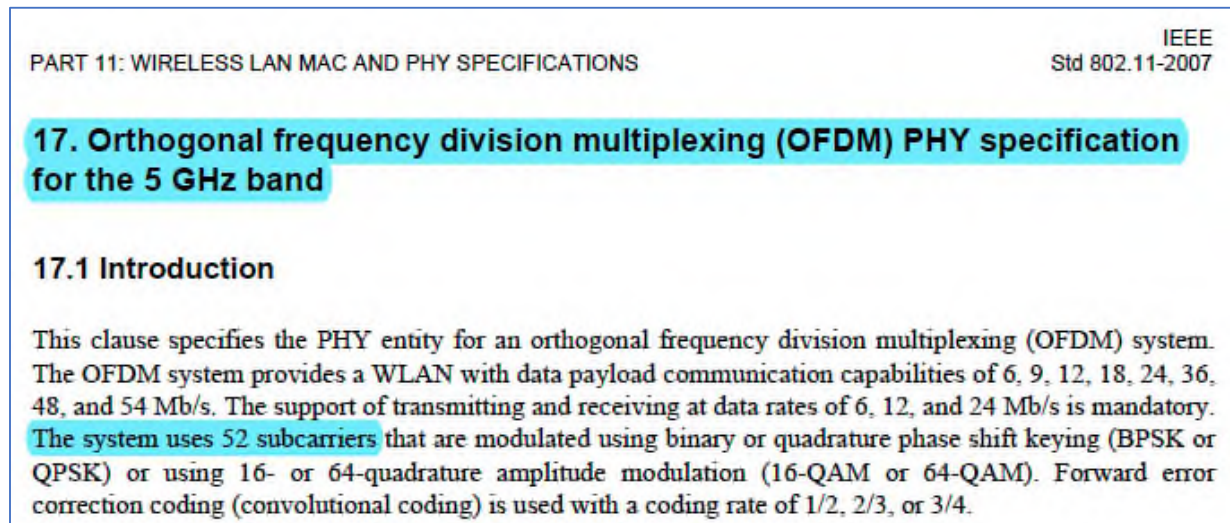
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69. Thus, the DCF and the RTS/CTS functionality were defined much before one year before the priority date of the '346 patent.

ii. OFDM and Bonding of Sub-Channels

70. Orthogonal Frequency Division Multiplexing (OFDM) operation is a specific type of multiplexing method defined for some of the IEEE 802.11 recommendations and is relevant for the Challenged Claims. OFDM is a method of data transmission where a single high-speed stream of data bits is divided into multiple lower-speed data streams and these data streams are typically transmitted on the same number of closely spaced narrowband subchannel frequencies instead of using a single wideband channel frequency. As also described by the passages below, the 802.11-2007 recommendation also defined OFDM operation and the use of multiple subchannels on the radio interface referred to as the PHYsical (PHY) layer. The OFDM physical layer was initially defined for 802.11a amendment released in 1999 before it was rolled up into this 2007 recommendation.

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Ex. 1014 at p. 591 (emphasis added).

71. Thus, the concepts of using an OFDM physical layer with multiple subchannels were known well in advance of one year before the priority date of the '346 patent and also were not novel to the '346 patent.

iii. Multiple Input Multiple Output (MIMO) Antenna Techniques.

72. As I describe above in Section V.C.ii, the Multiple Input Multiple Output (MIMO) technique is method that typically uses multiple antennas at the transmitter that are concurrently transmitting output data and multiple antennas at the receiver are receiving the transmitted data. The data to be transferred can be communicated over these multiple antennas based on many different techniques to either increase the reliability of the data being received or to increase the overall data throughput rate. In one relevant MIMO configuration, each transmit antenna is paired with a receive antenna (antenna pair) and a different stream of data is

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communicated over each antenna pair, which multiplies the data throughput by the number of antenna pairs being used.

73. The '346 patent admits that MIMO configurations using multiple antennas in both a transmitter and a receiver to optimize the data rate in the 802.11n OFDM system previously existed as stated by the passage below taken from the "Background of the Invention" section of the specification specifically describing the prior art 802.11n standard.

The IEEE 802.11n is a technical standard relatively recently introduced to overcome a limited data rate which has been considered as a drawback in the WLAN. The IEEE 802.11n is devised to increase network speed and reliability and to extend the operational distance of a wireless network. More specifically, the IEEE 802.11n supports a high throughput (HT), i.e., a data processing speed of up to 540 Mbps at a frequency band of 5 GHz, and **is based on a multiple input and multiple output (MIMO) technique which uses multiple antennas in both a transmitter and a receiver** to minimize a transmission error and **to optimize a data rate**. In addition, this standard may use a coding scheme which transmits several duplicated copies to increase data reliability and **also may use the OFDM to support a higher data rate**.

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Id. 2:7-20 (emphasis added).

74. In other words, the '346 patent is describing the techniques that were/are used in the prior art 802.11n standard to get a ten-fold increase in the data processing speed over its predecessor Wi-Fi recommendations (*See e.g., Id.* 1:48-50). One of these techniques is MIMO and the other technique is bonding OFDM subchannels.⁸

iv. MAC Protocol Layer Efficiency Modifications

75. Multiple ways to improve the efficiency of the MAC protocol layer were also known before the '346 patent. For example, Ex. 1029 describes multiple methods to modify the MAC protocol layer, so its efficiency increases by 25% as described in detail below for Ground V.

v. A Plurality of Network Interface Cards (NICs) Each Having an Independent Radio Interface

76. Network Interface Cards (NICs) are typically used in a computer type device to transmit and receive the physical (PHY) layer signals that are to be communicated over the radio frequency interface between IEEE 802.11 Wi-Fi stations⁹. Each NIC receives the analog radio frequency waves and converts them

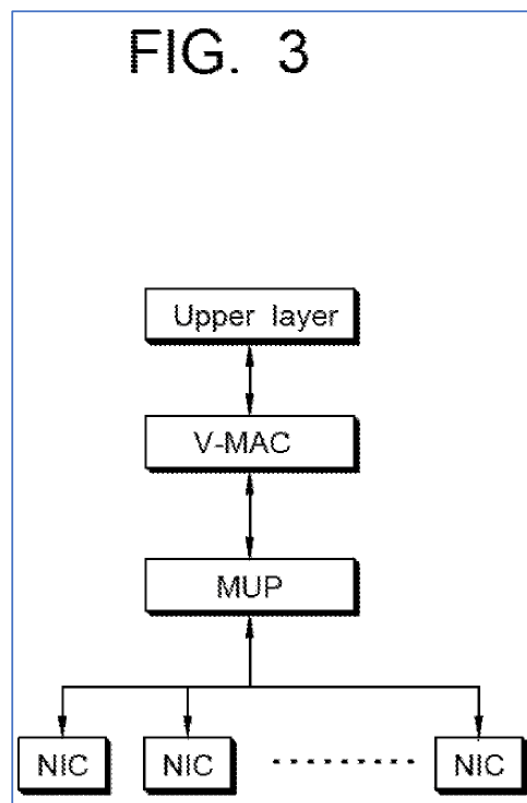
⁸ As described for the 802.11n recommendation in Section V.C above, this prior art recommendation defines bonding two 20 MHz OFDM subchannels together to create a 40 MHz channel, which doubles the data processing speed of a single 20 MHz subchannel.

⁹ A NIC is also used to connect to a wired connection, e.g., an Ethernet/Internet connection.

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into data bits. At the PHY layer, the data is just a stream of bits that needs to be converted into data packets/frames. This conversion into packets/frames is done at the Medium Access Protocol (MAC) layer. In each device there can be one or more NICs and one or more MAC layers. To process these PHY layer bits at higher speeds, multiple NICs are used in parallel to distribute the processing load. In turn, to process the higher rate of PHY data bits, multiple MAC protocol layers may also be used in parallel.

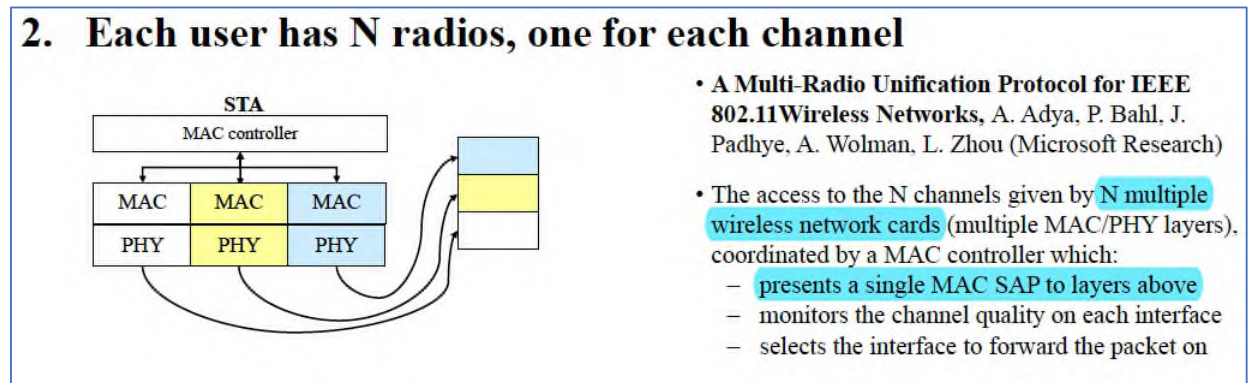
77. The diagrams below are from the FIG. 3 of the '346 patent and a figure in the March 2008 feasibility study cited by the VHT Proposal document described above (Ex. 1008).



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‘346 patent FIG. 3.

78. The ‘346 patent describes the “NIC” (Network Interface Card) in each box of Fig. 3 above as “each NIC independently operates a MAC/PHY module. That is, the NICs are distinctively depicted in FIG. 3 to show that the NICs are logical entities operating according to individual MAC/PHY protocols.



Ex. 1009 at p. 7¹⁰, (only highlighting of the text on the right has been added).

79. The vertical combination of the three “MAC and PHY” boxes in the diagram above is the same as the “NICs” in FIG. 3 as described by the text on the right side of the diagram. The “VMAC” box in FIG. 3 above is the same as the “MAC controller” on the right side of the diagram above.

80. Thus, the concept shown in and described for. FIG. 3 of the ‘346 patent was publicly known before the priority date of the ‘346 patent.

¹⁰ Ex. 1029 at p. 13 cites Fracchia (Ex. 1009) as Reference [3] and supports the publication date of Fracchia as March 2008.

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C. Challenged Claims

81. The Petitioners challenge claims 9, 10, 12, 13, 14, and 16 (the “Challenged Claims”). Of these, claims 9 and 13 are independent claims and claims 10, 12, 14, and 16 are dependent claims.

D. Prosecution History

82. As originally filed, the ’346 patent comprised 6 claims. Ex. 1002 at (November 21, 2016, Claims). These were cancelled and claims 15-37 were added. Ex. 1002 at 73 (December 4, 2007, Claims).

83. The examiner rejected claims 1-6 under the judicially created doctrine of obviousness-type double patenting. Further, the examiner states that claims 1-6 would be allowable if a Terminal Disclaimer is filed to overcome the double patenting rejections. Ex. 1002 at (January 31, 2017, Non-Final Rejection).

84. In response to the initial Office Action, the applicant cancelled claims 2, 3, 5, and 6, and added claims 7-20. Ex. 1002 at (May 1, 2017, Claims). Further, the applicant submitted a Terminal Disclaimer to overcome the double patenting rejections. On June 8, 2016, the examiner issued a Notice of Allowance. Ex. 1002 at (June 8, 2016, Notice of Allowance and Fees Due).

VIII. CLAIM CONSTRUCTION

85. I understand that patent claim terms are generally given their ordinary and customary meaning as understood by a POSITA. *Vitronics Corp. v.*

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Conceptronic, Inc., 90 F.3d 1576 (Fed. Cir. 1996)). I further understand that if a claim term is to be construed, proper claim construction requires a review of the patent's intrinsic evidence and, when appropriate, extrinsic evidence. *Phillips v. AWH Corp.*, 415 F3d 1303 (Fed. Cir. 2005) (en banc). Intrinsic evidence includes the language of the claims, the specification of the patent, and the prosecution history of the patent. *Id.* at 1314.

86. It is my understanding that the '346 patent is involved in litigation in the Eastern District of Texas, captioned *LG Electronics Inc. v. TCL Electronics Holdings Ltd. (f/k/a TCL Multimedia Technology Holdings, Ltd.) et al.*, Case No. 2:22-cv-00122-JRG ("Related Litigation").

87. It is further my understanding that on March 28, 2023, Petitioner and Patent Owner exchanged preliminary claim constructions in which each party have submitted construction for the following terms: "station," "Access Point or AP," and "Very High Throughput/VHT." Patent Owner's Patent Local Rule P.R.3-2 Submission of Preliminary Claim Constructions is attached as Exhibit 1012.

A. Interpretation of "Station"

88. In its P.R.3-2 Submission of Preliminary Claim Constructions, Patent Owner proposed construction of "station/STA" as "plain and ordinary meaning, which includes an Access- Point (AP) station (such as a wireless router at home) or a non-AP station (such as a laptop, smartphone, or smart television), that includes

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Medium Access Control (MAC) and a physical layer interface to the wireless medium.” Ex. 1012 at p. 3.

89. In its P.R.3-2 Submission of Preliminary Claim Constructions, Petitioners proposed construction of “station/STA” as “a device that contains an IEEE 802.11- conformant media access control (MAC) and physical layer (PHY) to the wireless medium (WM).” Ex. 1013 at p. 5. This is the definition for this term provided in the 802.11 standard. See, IEEE Standard for Information Technology; Telecommunications and Information Exchange between Systems; Local and Metropolitan Area Networks, Specific Requirements: PART 11” Wireless LAN Medium Access Control (MAC) and Physical Layer Specifications (2007), definition 3.136. Ex. 1014 at 14.

90. My analysis in this Declaration is not affected by the differences between the proposed constructions of “station/STA” proposed by the parties in the Related Litigation.

B. Interpretation of “Access Point/AP”

91. In its P.R.3-2 Submission of Preliminary Claim Constructions, Patent Owner proposed construction of “Access Point/AP” as “the station included in an Access Point (such as in a wireless router at home).” Ex. 1012 at p. 5.

92. In its P.R.3-2 Submission of Preliminary Claim Constructions, Petitioners proposed construction of “Access Point/AP” as “an entity that has

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(STA) functionality and provides access to the distribution services, via the wireless medium (WM) for associated STAs.” Ex. 1013 at p. 7. This is the definition for this term provided in the 802.11 standard. See, IEEE Standard for Information Technology; Telecommunications and Information Exchange between Systems; Local and Metropolitan Area Networks, Specific Requirements: PART 11” Wireless LAN Medium Access Control (MAC) and Physical Layer Specifications (2007), definition 3.3. Ex. 1014 at p. 5.

93. Patent Owner’s proposed construction defines “Access Point” in terms of itself, which I do not find appropriate or helpful. Petitioners’ construction is the definition for this technical term provided by the IEEE Standard and it is both accurate and helpful.

94. My analysis in this Declaration is not affected by the differences between the proposed constructions of “Access Point” proposed by the parties in the Related Litigation.

C. Interpretation of “Very High Throughput/VHT”

95. In its P.R.3-2 Submission of Preliminary Claim Constructions, Patent Owner proposed construction of “Very High Throughput/VHT” as “a next generation of the IEEE 802.11n WLAN system, now known as 802.11ac or Wi-Fi 5.” Ex.1012 at p. 4.

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96. In its P.R.3-2 Submission of Preliminary Claim Constructions, Petitioners proposed construction of “Very High Throughput/VHT” as “processing speed of 1 Gbps or more in the multi-channel environment.” Ex. 1013 at p. 6.

97. In my opinion, because the term being construed is “Very High Throughput/VHT” Patent Owner’s construction as “a next generation of the IEEE 802.11n WLAN system” is both inaccurate and unhelpful. “Throughput” is a measuring of processing speed. Patent Owner’s proposed construction is ambiguous as to whether the construction includes all, a portion of, or none of the IEEE 802.11ac standard. This make is indefinite as to what is encompassed within the scope of the term “Very High Throughput.”

98. To the contrary, Petitioners’ proposed construction is appropriately a value for processing speed and is grounded in intrinsic evidence found in the ‘346 patent.

- “a very high throughput (VHT) system is a next version of the IEEE 802.11n WLAN system, and is one of IEEE 802.11 WLAN systems which have recently been proposed to support a data processing speed of 1 Gbps or more in a MAC service access point (SAP). Ex. 1001 at 3:26-31, emphasis added.
- “to provide a throughput of 1 Gbps or more, a feasibility test is currently being conducted for the VHT system using 4x4 MIMO and a channel bandwidth of 80 MHz. *Id.* at 3:32-35, emphasis added.

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- “to achieve a data processing speed of 1 Gbps or more in the wireless communication system, a new system different from the conventional IEEE 802.11n MAC/PHY protocol (i.e., single STA architecture) is required.” *Id.* at 3:23-26, emphasis added.
- “A very high throughput (VHT) BSS is defined as a BSS that supports a super high-speed data processing speed of 1 GHz or more.” 5:40-42;
- “A VHT STA is defined as an STA that supports the super high-speed data processing speed of 1 GHz or more in the multi-channel environment to be described below.” *Id.* at 5:65-67, emphasis added.
- “A non-AP VHT-STA is defined as a non-AP STA that supports the super high-speed data processing speed of 1 GHz or more in the multi-channel environment to be described below.” *Id.* at 6:16-19 emphasis added.
- “A VHT AP is defined as an AP that supports the super high-speed data processing speed of 1 GHz or more in the multi-channel environment to be described below.” *Id.* at 6:29-32, emphasis added.

99. My analysis in this Declaration is not affected by the differences between the proposed constructions of “Access Point” proposed by the parties in the Related Litigation.

IX. OVERVIEW OF THE PRIOR ART

A. U.S. Patent 7,349,436 - Maltsev (Ex. 1003)

100. Maltsev (“Maltsev”) issued on March 25, 2008, from an application filed on September 30, 2003, and I understand it is prior art against the ‘346 patent under pre-AIA 35 U.S.C. §102 (a) and (e).

101. Maltsev is directed to a high-throughput (HT) communication station (STA) and method for communicating over a primary and a secondary channel. Ex. 1003 at Abstract.

102. Maltsev’s priority date of September 30, 2003, is a little over a year after the IEEE 802.11n High Throughput Study Group (HTSG) was established on September 11, 2002.¹¹ At least one of Maltsev’s inventors, Adrian Stephens, was a member of the IEEE working group that created the IEEE 802.11-2007 amendment (See e.g., Ex. 1014 at pp. vii-viii), was a member of the IEEE Task Group for the 802.11n (IEEE TGn) amendment (See e.g., Ex. 1021, p. 3), and was also actively involved with developing the 802.11n amendment because he was the chair of multiple TGn committees as described in his Bio below.

¹¹ As described above for the 802.11n amendment.

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Adrian Stephens is a management consultant, specializing in standards development. He was the IEEE 802.11 chair and a member of the IEEE Standards Association Standards Board. Stephens was also a Senior Principal Engineer at Intel where his job focus was on developing IEEE 802.11 standards. He coordinated Intel's MAC proposal for IEEE 802.11n and chaired both the TGnSync and Joint Proposal teams that generated a proposal. He has been chair of various IEEE 802.11 TGn committees and was technical editor of the IEEE 802.11n (High Throughput) amendment. He was managing chair of a group of companies that successfully proposed an initial draft for the IEEE 802.11ac (Very High Throughput, < 6 GHz) amendment. He was technical editor for the 2012 and 2016 revisions of IEEE Std 802.11.

Ex. 1022 at p. 1, (highlighting added).

103. The following passage from an IEEE TGn standards group participant list corroborates Stephens' bio that he was actively involved in the initial TGn meetings. Therefore, at least one of the inventors of Maltsev was intimately aware of: (1) the 802.11n objectives/goals of achieving a data throughput of 600 Mbps using two 20 MHz subchannels to create a 40 MHz channel; and (2) the use of four or more 20 MHz subchannels to increase data throughput over more than the two channels defined for 802.11n because he was also the "managing chair of a group of companies that successfully proposed an initial draft for the IEEE 802.11ac (Very High Throughput, <6 GHz) amendment." *Id.*

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List of Participants	
Vinko Erceg (Zyray Wireless)	Hemanth Sampath (Marvell)
Laurent Schumacher (Namur University)	H. Lou (Marvell)
Persefoni Kyritsi (Aalborg University)	Ravi Narasimhan (Marvell)
Daniel Baum (ETH University)	Pieter van Rooyen (Zyray Wireless)
Andreas Molisch (Mitsubishi Electric)	Pieter Roux (Zyray Wireless)
Alexei Gorokhov (Philips Research)	Majid Malek (HP)
Valentine J. Rhodes (Intel)	Timothy Wakeley (HP)
Srinath Hosur (Texas Instruments)	Dongjun Lee (Samsung)
Srikanth Gummadi (Texas Instruments)	Tomer Bentzion (Metalink)
Eilts Henry (Texas Instruments)	Nir Tal (Metalink)
Eric Jacobsen (Intel)	Amir Leshem (Metalink, Bar Ilan University)
Sumeet Sandhu (Intel)	Guy Shochet (Metalink)
David Cheung (Intel)	Patric Kelly (Bandspeed)
Qinghua Li (Intel)	Vafa Ghazi (Cadence)
Clifford Prettie (Intel)	Mehul Mehta (Synad Technologies)
Heejung Yu (ETRI)	Bobby Jose (Mabuhay Networks)
Yeong-Chang Maa (InProComm)	Charles Farlow (California Amplifier)
Richard van Nee (Airgo)	Claude Oestges (Louvain University)
Jonas Medbo (Ericsson)	Robert W. Heath (Univ. of Texas at Austin)
Eldad Perahia (Cisco Systems)	Dave Michelson (UBC)
Brett Douglas (Cisco Systems)	Mark Webster (Intersil)
Helmut Boelcskei (ETH Univ.)	Dov Andelman (Envara)
Yong Je Lim (Samsung)	Colin Lanzl (Aware)
Massimiliano Siti (ST)	Kai Yu (KTH)
Stefano Valle (ST)	Irina Medvedev (Qualcomm)
Steve Howard (Qualcomm)	John Ketchum (Qualcomm)
Bjorn Bjerke (Qualcomm)	Adrian Stephens (Intel)
Qinfang Sun (Atheros)	Jack Winters (Motia)
Won-Joon Choi (Atheros)	
Ardavan Tehrani (Atheros)	
Jeff Gilbert (Atheros)	

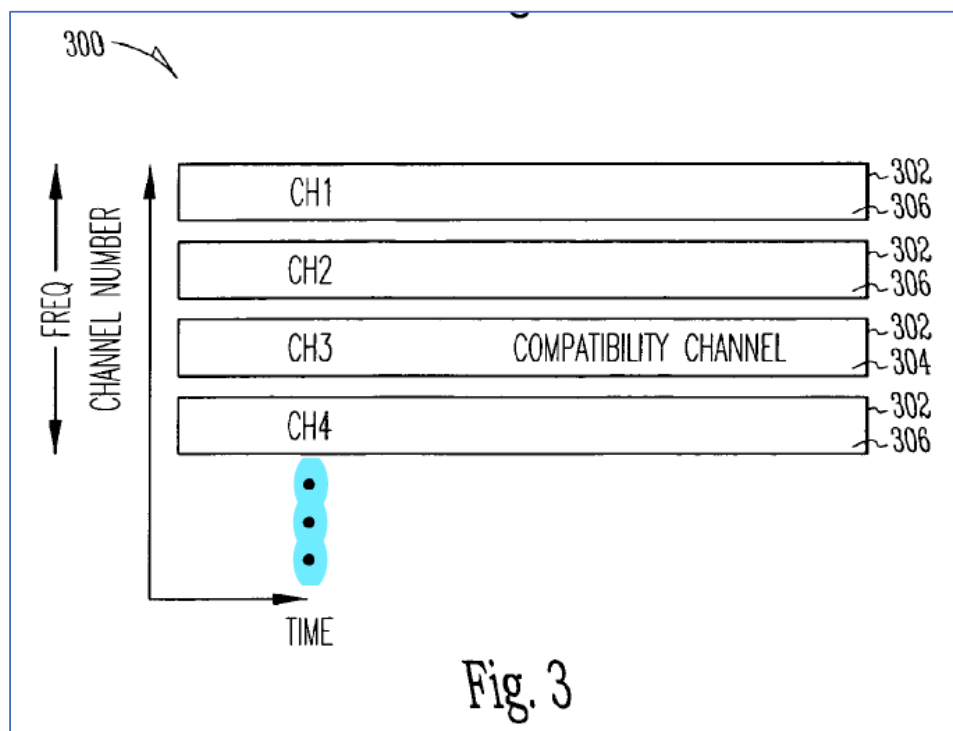
Ex. 1021 at p. 3, (emphasis added).

104. Thus, at least one of the Intel-employed co-inventors of Maltsev were intimately aware of the early 802.11n standard requirements being defined in IEEE TGn working group and the fact that two 20 MHz subchannels were being used together to form a 40 MHz channel, which doubled the data throughput of a single 20 MHz subchannel. Maltsev also uses the same High Throughput (HT) station terminology that was defined by the IEEE TGn (HTSG).

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105. In fact, Maltsev discloses a HT plus (HT+) station because its invention describes additional features over those that were defined for a station in the 802.11n amendment by the TGn (HTSG) group. These HT+ features include at least using: (1) four or more 20 MHz subchannels to get a higher data throughput; and (2) using a combined channel size of 80 MHz or greater. Referring to Fig. 3, Maltsev illustrates the use of four or more channels within an allocated portion of frequency spectrum. Ex. 1003 at 4:32-53. For some embodiments, Maltsev also states the subchannels may be 20 MHz channels and frequency spectrum may comprise at least a contiguous 80 MHz portion of the spectrum. Id.

106. Maltsev further discloses that more than 4 subchannels can be used to create a larger contiguous bandwidth than 80 MHz as shown by Fig. 3 below. Fig 3 first lists channels 1 – 4 (CH1- CH4) and then, by including the 3 highlighted dots below the list of channels, which a POSITA would understand to be an expansion that the number of channels could be greater than four. See e.g., Ex. 1003, 3:45-47 and 4:47-49, and Fig. 3.



Ex. 1003 at Fig. 3, (highlighting added).

B. U.S. Patent Publication 2007-0147322 - Agrawal et. al. (Ex. 1004)

107. Agrawal et. al. (“Agrawal”) was published on June 28, 2007, and issued on November 5, 2013, as USP 8,576,872. I understand it is prior art against the ‘346 patent under pre-AIA 35 U.S.C. §102 (a) and (e).

108. Agrawal relates to a wireless mesh network wherein nodes utilize an OFDM physical layer with multiple subchannels. A request-to-send/clear-to-send (RTS/CTS) protocol through which a node may contend for one or more subcarriers by sending RTS signals over the desired subcarriers, and the requesting node may receive a CTS signal over some or all the contended subcarriers, wherein

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the CTS signal indicates which subcarriers the node may use to transmit data frames. Ex. 1004 at Abstract, [0006], [0037], [0062], and [0067].

109. Agrawal also discloses using the RTS/CTS protocol to mitigate the same “hidden node” issues that were/are defined for the prior art 802.11 Wi-Fi amendments as discussed in section VII.B.ii. above. For example, Agrawal states “[s]ystems and methodologies are described that facilitate mitigating a hidden node condition in a wireless mesh network wherein nodes utilize a request-to-send/clear-to send (RTS/CTS) protocol.” See e.g., Ex. 1004, Abstract, [0010], [0040-0041], and [0046].

110. Agrawal also discloses that the invention can be used for “802.11 networks” and the RTS/CTS protocol can be applied to these networks to solve the “hidden node” problem. See e.g., [0040 – 0041].

111. Further, Agrawal uses the 802.11 “Access Point” terminology over 15 times in its specification and claims. See also, Ex. 1014 —IEEE 802.11-2007, p. 5 “3.3 access point (AP): Any entity that has station (STA) functionality and provides access to the distribution services, via the wireless medium (WM) for associated STAs.”

112. Still further, as will be discussed below, Agrawal defines the circuitry that would be included in a wireless station compatible with the 802.11 standard in more detail than what is required by the Challenged Claims.

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C. U.S. Patent Publication 2007-0266157 - Xhafa et. al. (Ex. 1005)

113. U.S. Patent Publication 2007-0266157 to Xhafa et. al. (“Xhafa,” Ex. 1005) is directed to techniques for reducing/eliminating data collisions on wireless network channels including Wi-Fi channels in the systems defined by the 802.11a, 802.11b, 802.11g and 802.11n recommendations. Ex. 1005 at [0002 and 0004]. Xhafa was published on November 15, 2007, and I understand it is prior art against the ‘346 patent under pre-AIA 35 U.S.C. §102(a) and (e).

114. Xhafa also describes the 802.11n physical layer (described above in the 802.11n section at V.A.ii where the OFDM subchannels are 20 MHz in size and two of these subchannels can be combined to make a “super channel” that has a bandwidth of 40 MHz. See e.g., Id. at [0003].

115. Xhafa also correlates the terminology used in its specification with what is defined in the “IEEE 802.11n protocol” (V.A.ii above) and clearly defines channels that are the same channels as defined by the ‘346 patent with at least:

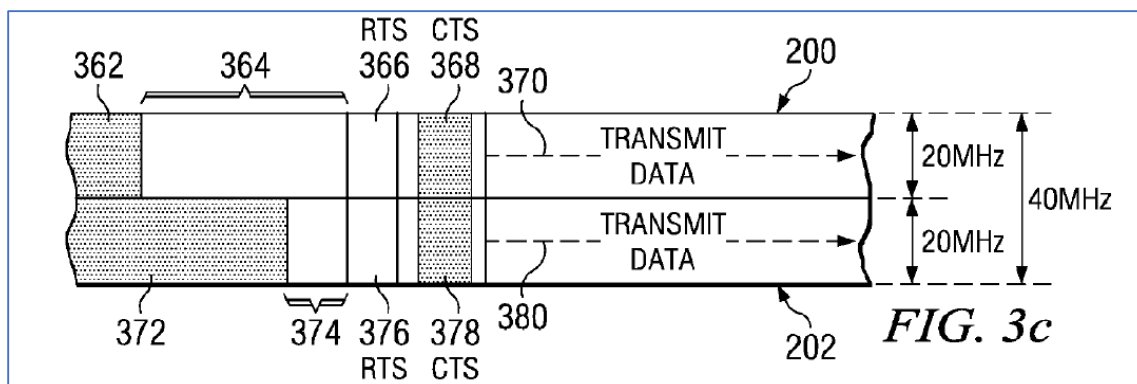
Also, the terms "control channel" and "extension channel" are defined in **accordance with the Institute of Electrical and Electronics Engineers (IEEE) 802.11 protocol (e.g., 802.11n protocol)**. The terms "control channel" and "extension channel" may be considered substantially equivalent to other terms used in other wireless communication protocols, where the other terms denote wireless

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channels similar to the control and extension channels. Further, **the terms "primary channel," "first channel," and "control channel" are related and may be considered equivalent in at least some embodiments.** Further still, **the terms "secondary channel," "second channel" and "extension channel" are related and may be considered equivalent in at least some embodiments.**

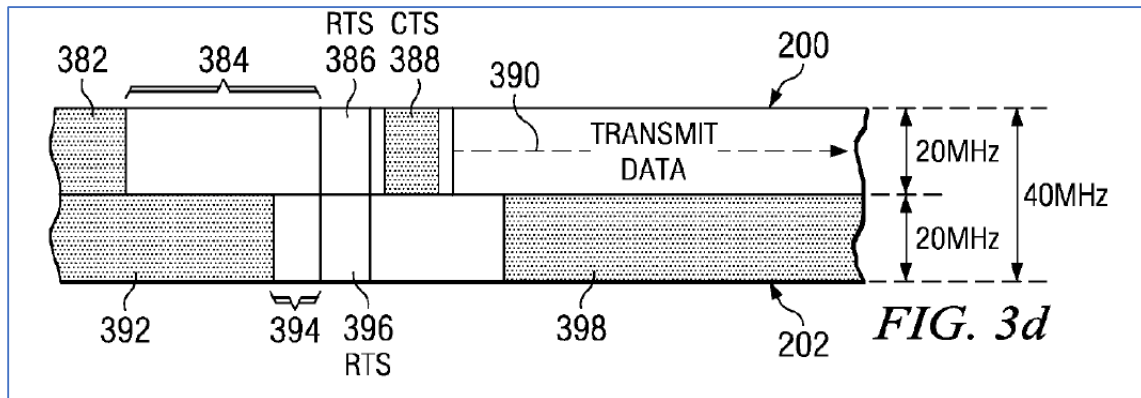
Ex. 1005 at [0015] (emphasis added).

116. Xhafa further discloses using the same RTS/CTS protocol as required by the Challenged Claims. Specifically, Xhafa discloses multiple embodiments where the RTS and corresponding CTS are sent on one subchannel or the RTS and corresponding CTS are sent on each of a plurality of subchannels where the CTS is only sent on the available subchannels. *See e.g., Id.* at [0025 – 0031]. At least FIGs 3c and 3d shown below are relevant embodiments for this declaration.



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117. Fig 3c shown above and its descriptive text describe disclose a RTS is sent on both of the subchannels (366 and 376) and a CTS is also received on both subchannels (368 and 378) so data is sent on both subchannels (370 and 380). See *e.g.*, *Id.* I at [0025 – 0026].



118. Fig 3d shown above and its descriptive text describe disclose that RTS signals are sent on both of the subchannels (386 and 396) but a CTS signal is only received on subchannel (388) so data is only sent on subchannel 200 (390). See *e.g.*, *Id.* at [0027].

D. The IEEE VHT Amendment (Ex. 1008)

119. The document with the title “IEEE P802.11 Wireless LANs: Proposal for PAR and 5 Criteria for Very High Throughput (VHT) SG for Below 6 GHz Operation,” (the “VHT Amendment,” Ex. 1008) identified the criteria for the successor recommendation over the current IEEE 802.11n standard to be at least a VHT device having multistation throughput of 1Gbps.

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a) Demonstrated system feasibility.

Feasibility of multiple STAs 1Gbps and single link 500Mbps MAC SAP throughput links has been assessed in simulations and presented in documents 11-08-0307-01-0vht (<https://mentor.ieee.org/802.11/file/08/11-08-0307-01-0vht-on-the-feasibility-of-1gbps-for-various-mac-phy-architectures.ppt>) and 11-08-0535-00-0vht (<https://mentor.ieee.org/802.11/file/08/11-08-0535-00-0vht-phy-and-mac-throughput-analysis-with-80-mhz-for-vht-below-6-ghz.ppt>) for 80MHz bandwidth operation.

Ex. 1008 at p. 7, (emphasis added).

120. The VHT Amendment was published on May 12, 2008, and I understand that it qualifies as prior art under pre-AIA 35 U.S.C. §102(a).

E. On the Feasibility of 1Gbps for Various MAC/PHY Architectures, Fracchia, Roberta, (March 2008) (“Fracchia,” Ex. 1009)

121. This is a feasibility study included as one of the links in the VHT Amendment document (Ex. 1008) in the section titled “Demonstrated system feasibility” as shown in the caption above.

122. The feasibility study, “On the Feasibility of 1Gbps for Various MAC/PHY Architectures,” authored by Roberta Fracchia and others (“hereafter “Fracchia”), was published on March 17, 2008, and I understand is prior art under pre-AIA 35 U.S.C. §102 (a). Fracchia also includes the notation “Submission” at the bottom of each page which, as discussed above with regard to VHT Amendment (Ex. 1008), indicates that Fracchia is an actual IEEE submission document and was publicly available no later than the indicated date of March 17, 2008.

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123. The first link identified in the following passage of Ex. 1008 is to Fracchia, which is additional evidence of the public availability of Fracchia on March 17, 2008.

a) Demonstrated system feasibility.

Feasibility of multiple STAs 1Gbps and single link 500Mbps MAC SAP throughput links has been assessed in simulations and presented in documents 11-08-0307-01-0vht (<https://mentor.ieee.org/802.11/file/08/11-08-0307-01-0vht-on-the-feasibility-of-1gbps-for-various-mac-phy-architectures.ppt>) and 11-08-0535-00-0vht (<https://mentor.ieee.org/802.11/file/08/11-08-0535-00-0vht-phy-and-mac-throughput-analysis-with-80-mhz-for-vht-below-6-ghz.ppt>) for 80MHz bandwidth operation.

Ex. 1008 at p. 7, (emphasis added).

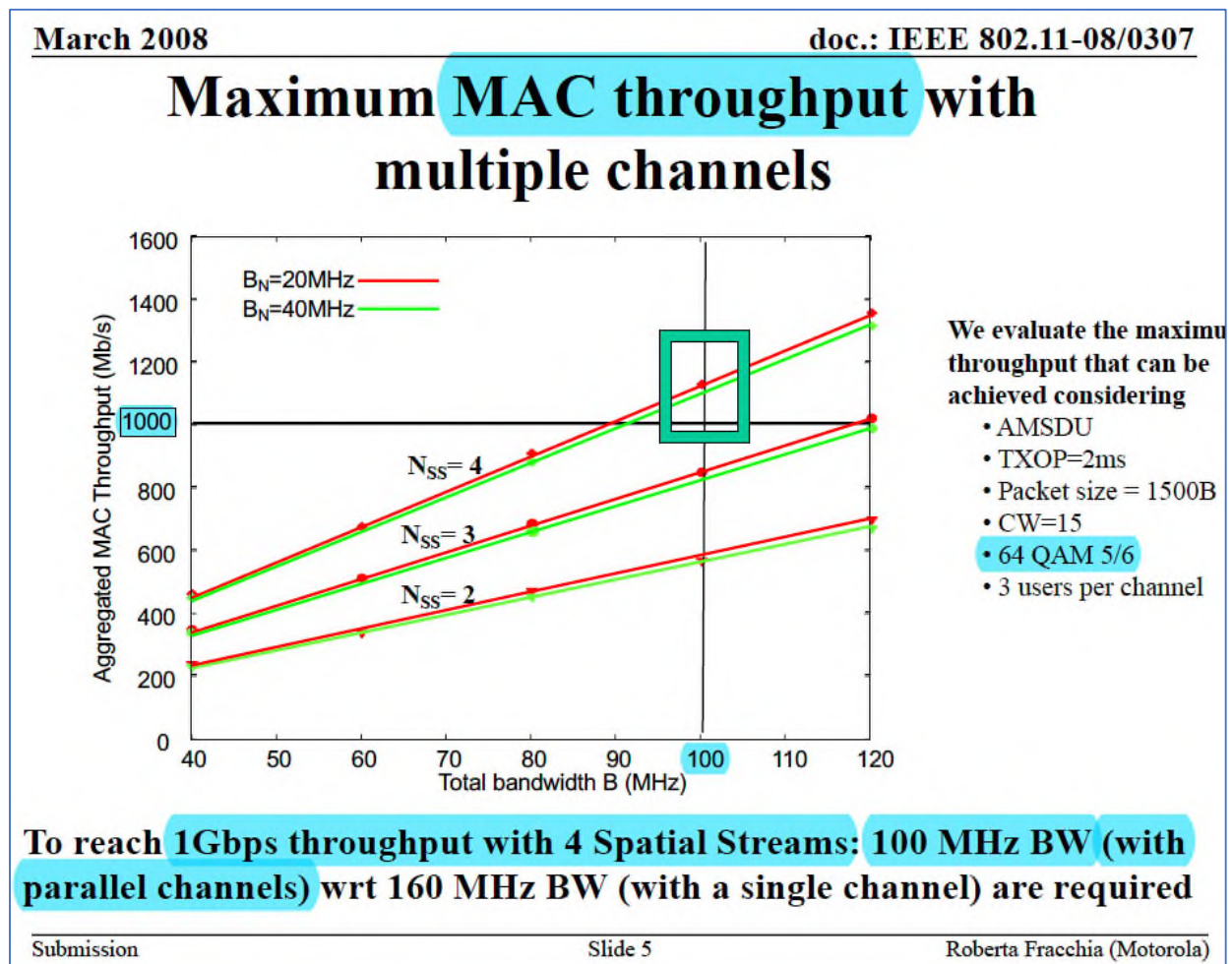
124. Fracchia includes at least the following relevant text and diagrams.

Abstract

This analysis provides inputs on the technical feasibility of achieving 1Gbps aggregated MAC SAP throughput for below 6GHz amendment, by using different MAC layers which manage the access to different parallel channels

Ex. 1009 at p. 2, (emphasis added).

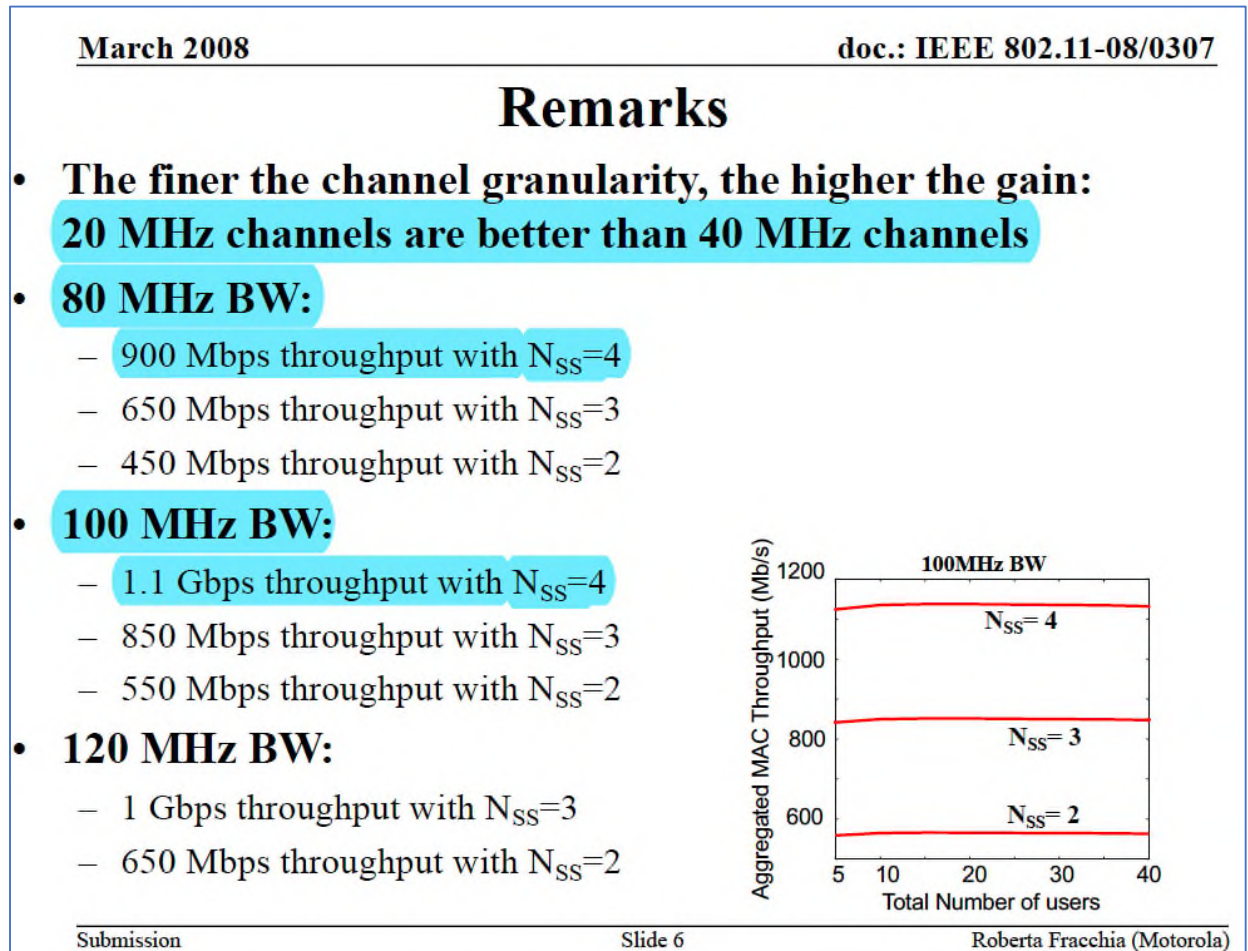
125. The text above states the criteria of 1 Gbps aggregated MAC SAP throughput using different parallel channels.



Id. at p. 5, (emphasis added).

126. The slide above shows that the 1 Gbps requirement would be significantly exceeded (Green Rectangle) when using a 100 MHz bandwidth (as shown by the 100 MHz bandwidth highlighted in Blue on the horizontal axis) using four MIMO Spatial Streams ($N_{ss} = 4$). The 1000 Aggregated MAC Throughput (Mb/s) is highlighted in Blue on the vertical axis (1 Gbps). The “64 QAM 5/6” highlighted in Blue on the right side of the diagram was one of the

existing modulation (64 QAM) and error correction (5/6) methods defined in the prior art 802.11n recommendation.



Id. at p. 6, (emphasis added).

127. A POSITA would have understood multiple relevant pieces of information are disclosed in the slide above: (1) using two 20 MHz subchannels is better than using a single 40 MHz subchannel for data throughput; (2) that an 80 MHz channel bandwidth would provide 900 Mbps data throughput (almost 1 Gbps) when using four OFDM 20 MHz subchannels and four MIMO Spatial

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Streams ($N_{SS}=4$); and (3) a 100 MHz channel bandwidth (greater than 80 MHz) with four OFDM 25 MHz subchannels or five 20 MHz subchannels would provide a data throughput above 1 Gbps.

F. U.S. Patent 8,705,645 – Sadowsky et al. (Ex. 1015)

128. US 8,705,645 patent (“Sadowsky”) issued on April 22, 2014, from an application filed on June 6, 2012, which claims priority through a series of continuation applications to application no. 10/750,587 filed on December 29, 2003, and is now USP 7,394,858. Ex. 1015 at (63). Sadowsky is prior art against the ‘346 patent under pre-AIA 35 U.S.C. §102 (a) and (e). I note that the same Alexander A. Maltsev for the prior art reference Ex. 1003 (Maltsev) is also a co-inventor of this patent. The title of Sadowsky is “MIMO Transmitter and Method for Transmitting OFDM Symbols.”

129. Sadowsky is directed to a OFDM transmitter that transmits data on OFDM subcarriers of at least 20 MHz wide and significantly increases the data throughput of an OFDM system by using multiple-input multiple-output (MIMO) techniques. In general, Sadowsky teaches that instead of transmitting a single stream of data from one antenna at the transmitter to one antenna at the receiver (1 antenna pair), Sadowsky’s invention sends multiple streams of data between each of the antenna pairs concurrently in parallel. Because the antennas at the transmitter and the receiver are physically (spatially) separated (even by a small

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distance) the data throughput is multiplied by the number of these “spatial streams” as described by at least the following passage:

An **orthogonal-frequency division multiplexed (OFDM)** transmitter is configured to transmit a data unit in accordance with **a multiple-input multiple-output (MIMO) technique** over a wideband channel comprising a **20 MHz channel** and another channel **using a plurality of spatially diverse antennas**. The transmitter is further configured to include in the data unit, a parameter indicating a modulation and coding scheme and a parameter indicating number of spatial streams. Each of the spatial streams is encoded and beamformed for receipt by one or more different receiving stations.

Ex. 1015 at Abstract (emphasis added).

130. Fig 2 included below also shows that the “RF” box 212 and antennas 214 can also be replicated many times. As described in detail below, the data throughput of the system is multiplied by the number of these transmitter/receiver antenna pairs when they are configured to carry a separate spatial stream of data.

131. Some of Sadowsky’s embodiments are also in accordance with the relevant IEEE 802.11 Wi-Fi standards operating in the relevant 2.4 GHz and 5 GHz Wi-Fi frequency spectrum:

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In some embodiments, transmitter 100 (FIG. 1) and/or receiver 200 may transmit and/or receive RF signals in accordance with specific communication standards, **such as the IEEE 802.11(a), 802.11(b), 802.11(g/h)** and/or 802.16 standards for wireless local area network (WLAN) communications . . . In some embodiments, RF signals may comprise OFDM signals **comprising a plurality of symbol-modulated subcarriers in either a 5 GHz frequency spectrum or 2.4 GHz frequency spectrum.**

Id. at 7:5-15 (emphasis added)

The channels may **comprise a plurality of orthogonal subcarriers.**

In some embodiments, the orthogonal subcarriers of a channel may be closely spaced OFDM subcarriers.

Id. at 2:14-17 (emphasis added).

132. Sadowsky also teaches that this additional MIMO data throughput can be achieved without increasing the frequency bandwidth of the OFDM system. For example, given a 100 MHz bandwidth OFDM system, its invention can multiply the data throughput many times using MIMO without increasing the system bandwidth above 100 MHz. This is explained with at least the following passages:

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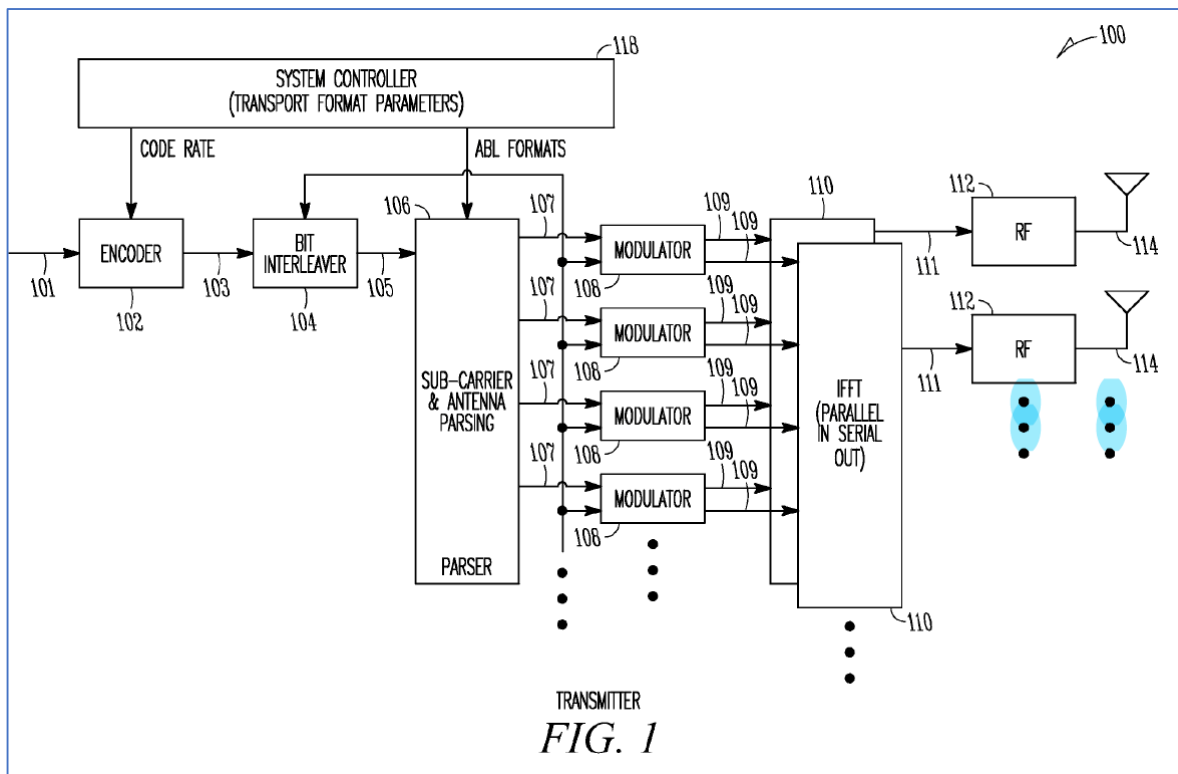
The data rate of many conventional orthogonal frequency division multiplexed (OFDM) systems is limited by a maximum modulation order (e.g., bits per symbol) that may be effectively communicated on the symbol-modulated subcarriers of an OFDM channel. **Thus, there are general needs for apparatus and methods for communicating additional data without an increase in frequency bandwidth.**

Id. 1:27-34 (emphasis added).

In some embodiments, **each transmit antenna 114 may define one spatial channel.** In other embodiments, beamforming may be used to "divide" the channel into spatial channels. In these embodiments, **each spatial channel may be used to communicate separate or independent data streams** on the same subcarriers as the other spatial channels, **allowing the communication of additional data without an increase in frequency bandwidth.**

Id. 2:23-30 (emphasis added).

133. Fig. 1 below shows that many transmitter antennas (114) can be used to transmit many spatial data streams. I note that the two groups of 3 vertical dots I have highlighted on the right-hand side of the figure represent that box 112 labelled "RF" and antennas labelled 114 can be replicated many times.



Id. at Fig. 1 (highlighting added).

134. The data throughput multiplying effect of the invention for each addition spatial channel is further disclosed by the following passages. Sadowsky teaches that the number of spatial channels defined as the variable “M” that are multiplying the data throughput can be as many as 99 with:

IFFT circuitry 110 may generate time domain waveforms from the symbol-modulated subcarriers for subsequent RF transmission over the spatial channels. **In these embodiments, the number of groups of bits may be equal to a number of spatial channels multiplied by a number of the OFDM subcarriers of the channel.**

In some embodiments, transmitter 100 may include an RF chain for each spatial channel. The RF chain may comprise one of RF circuitry 112 and an associated one of IFFT circuitry 110 for each spatial channel. Although one of antennas 114 is illustrated for each RF chain, this is not a requirement.

Id. 4:47-57 (emphasis added).

In some embodiments, **where there are N OFDM subcarriers and M spatial channels, parser 106 may provide N x M groups of bits.** In some embodiments, **N and M may be positive integers less than 100.** In some example embodiments in which there are forty-eight data subcarriers and ten spatial channels, there may be up to 480 groups of bits. Each group of bits, for example, may have up to six bits each when a maximum modulation of 64 QAM is used, although the scope of the present invention is not limited in this respect.

Id. 4:64 – 5:5 (emphasis added).

135. Another relevant aspect of the disclosed Sadowsky invention is regarding the type of modulation that can be supported for each OFDM symbol. In general, the type of modulation used defines the number of data bits that are carried in each OFDM symbol. The OFDM symbol rate stays constant in the

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relevant 802.11 systems at 250,000 symbols per second¹², so the number of bits carried by each symbol significantly affects the data bit rate of each spatial channel. For example, the QPSK modulation method carries 2 data bits per symbol and the 256-QAM modulation method carries 8 bits per symbol. Thus, if an OFDM system was able to use 256-QAM for each spatial channel, the data rate would be four times higher than QPSK. This is explained in more detail by the passages below:

In some embodiments, these spatial frequency subcarrier modulation assignments **may range from zero bits per symbol to up to ten or more bits per symbol**. In terms of modulation levels, the spatial-frequency subcarrier modulation assignments may comprise binary phase shift keying (BPSK), which communicates one bit per symbol, quadrature phase shift keying (**QPSK**), **which communicates two bits per symbol**, 8PSK, which communicates three bits per symbol, 16-quadrature amplitude modulation (16-QAM), which communicates four bits per symbol, 32-QAM, which communicates five bits per symbol, 64-QAM, which communicates six bits per symbol, 128-QAM, which communicates seven bits per symbol, and **256-QAM**,

¹² Described in more detail in the claim analysis section of Ground 5.

which communicates eight bits per symbol. Subcarrier modulation assignments with **higher data communication rates per subcarrier (e.g., ten bits) may also be used.**

Id. 2:44-59 (emphasis added).

An OFDM symbol may be viewed as the combination of the symbols modulated on the individual subcarriers of all the spatial channels. Because of the variable number of bits per symbol-modulated subcarrier and the variable number of spatial channels that may be used, the number of bits per OFDM symbol may vary greatly. **For example, when four transmit antennas are used to provide four spatial channels,** when each spatial channel uses up to 48 OFDM data subcarriers, and when each subcarrier has a spatial-frequency subcarrier modulation assignment ranging between zero and six bits per symbol, **the number of bits per OFDM symbol may range up to 1152 bits** (4 spatial channels x 48 data subcarriers per spatial channel x 6 bits per symbol), depending on the channel conditions of the spatial channels, among other things.

Id. 2:60 – 3:6 (emphasis added).

136. Like one of Maltsev’s teachings, Sadowsky also teaches that “a wideband channel may comprise up to four or more subchannels, and each

subchannel may have up to forty-eight or more orthogonal data subcarriers.” *Id.* 5:38-41 (emphasis added).

137. Sadowsky further discloses, like Maltsev, that the RTS/CTS signaling protocol can be used with the invention. *Id.* 8:64-67 (“In some embodiments, a request-to-send/clear-to-send (RTS/CTS) signaling structure may be used, although the scope of the invention is not limited in this respect”).

X. GROUND 1: CLAIMS 9, 10, 13, AND 14 OF THE '346 PATENT ARE UNPATENTABLE UNDER 35 U.S.C. §103 OVER MALTSEV IN VIEW OF AGRAWAL

A. Motivation to Combine

138. A POSITA would have been motivated to combine Maltsev with Agrawal for at least the reasons discussed below.

139. First, Maltsev and Agrawal are concerned with solving the same problem—efficient operation of wideband OFDM wireless networks using multiple subchannels. Maltsev’s title is “Systems and Methods for High-throughput Wideband Wireless Local Area Network Communications.” Ex. 1003. Maltsev also states that it is for OFDM communications using subcarriers (subchannels):

Orthogonal frequency division multiplexing (OFDM) is an example of a multi-carrier transmission technique that uses symbol-modulated orthogonal subcarriers to transmit information within an available

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spectrum. Many modern digital communication systems, **including wireless local area networks (WLANS)**, are using symbol-modulated orthogonal subcarriers as a modulation scheme to help signals survive in environments having multipath reflections and/or strong interference.

Id. 1:15-27. (emphasis added).

140. Agrawal states “The following description relates generally to wireless communications, and more particularly to reducing interference in a wireless communication environment.” Ex. 1004 at [0003]. Like Maltsev, Agrawal is also for a OFDM communications system using subchannels as it discloses:

One known variant is an **orthogonal frequency division [OFDM]** technique that effectively partitions the overall system bandwidth into multiple orthogonal subbands. These subbands are also referred to as tones, carriers, subcarriers, bins, and/or frequency channels. **Each subband is associated with a subcarrier that can be modulated with data.**

Id. at [0006] (emphasis added).

141. Second, both Maltsev and Agrawal use the RTS/CTS protocol to facilitate efficient communications between the stations. Maltsev states “For

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example, a RTS/CTS exchange may be used with control frames in the wideband channel with channelization information. This may be done for almost any number of channels 302 (FIG. 3) in addition to compatibility channel 304 (FIG. 3). Ex. 1003 at 7:45-49.

142. Agrawal states:

With regard to a multi-hop wireless mesh network medium access control, approaches may include carrier sense multiple access/collision avoidance (CSMA/CA), and **request-to-send/clear-to-send (RTS/CTS)**. CSMA/CA is a protocol for carrier transmission in **802.11 networks**. For instance, when a user device has data to send, the user device senses the channel to see if it is idle. If the channel is idle, then the user device transmits the data, otherwise the user backs off for a random period of time before it senses the channel again. In a mesh network environment where all users may not be able to communicate with each other, CSMA/CA leads to a "hidden node" problem where a user may sense the channel idle and start sending data, creating undesirably high interference at a nearby receiving node (e.g., when the user could not hear the transmitting node).

Ex. 1004 at [0040] (emphasis added).

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143. Third, both Maltsev and Agrawal disclose that their invention applies to IEEE 802.11 Wi-Fi networks. For example, Maltsev states “[t]he frame formats of embodiments of the present invention may be suitable for WB OFDM data communication systems and **may be implemented in IEEE 802.11 standards** for HT communication units. Ex. 1003 at 11:18-21 (emphasis added).

144. Agrawal states “[w]ith regard to a multi-hop wireless mesh network medium access control, approaches may include carrier sense multiple access/collision avoidance (CSMA/CA), and **request-to-send/clear-to-send** CSMA/CA is a protocol for carrier transmission **in 802.11 networks (RTS/CTS)**. Ex. 1004 at [0040] (emphasis added).

145. A POSITA would have had a reasonable expectation of success combining Maltsev and Agrawal because they both use employ the RTS/CTS protocol in the conventional manner long known in the art. The teachings of Agrawal enhance the use of the RTS/CTS protocol by allowing CTS signals to be returned on a subset of the subchannels, i.e., only the idle subchannels, even if the number of such subchannels is less than the total number of subchannels. All in a manner that maintains the functionality of the RTS/CTS protocol.

B. Independent Claim 9

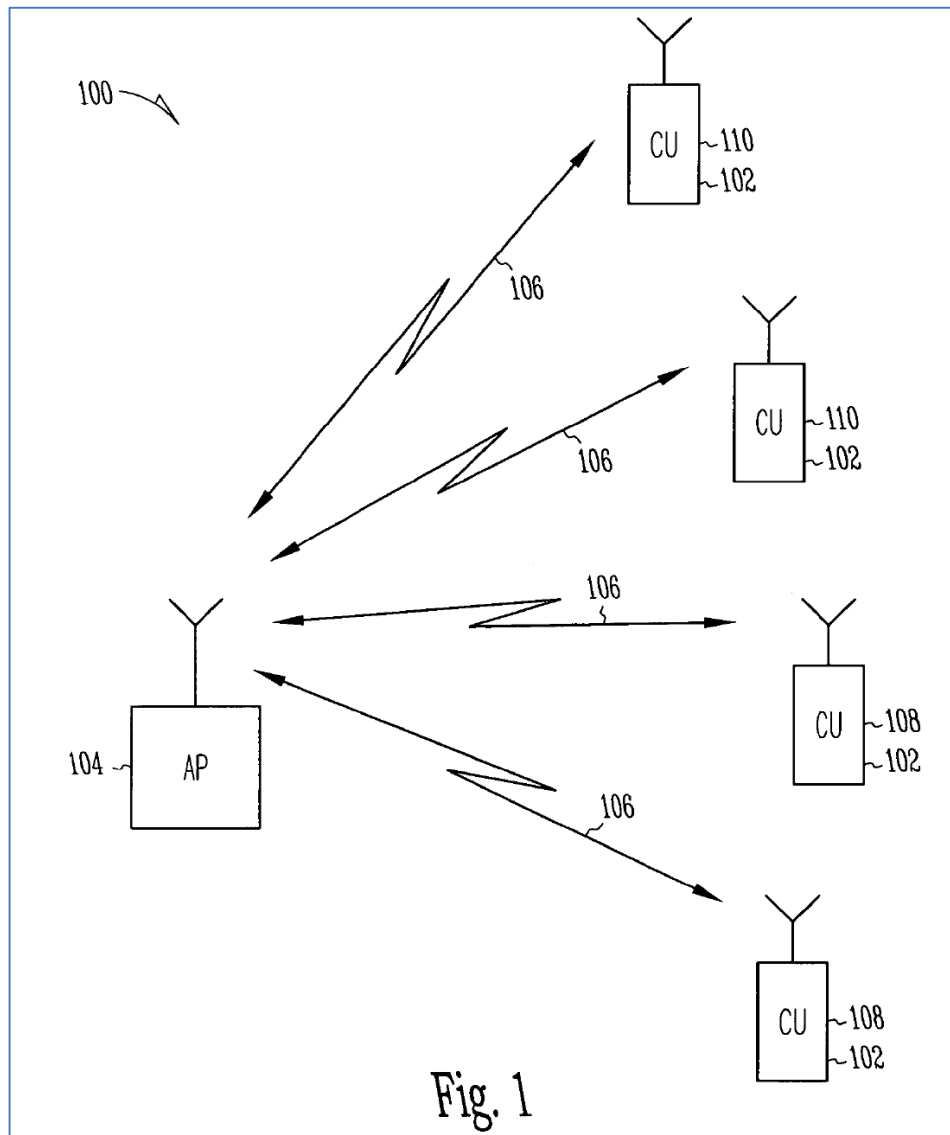
**i. Limitation 9

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[pre]: “A method for receiving data in a wireless communication system, method comprising:”
```**

146. To the extent the preamble is limiting, Maltsev discloses a method for receiving data in a wireless communication system. Ex. 1003 at Abstract.

147. Maltsev discloses a communication unit suitable for use as one or more of communication units (“CUs”) 102 (FIG. 1) and/or a HTAP (High Throughput access point) such as access point (“AP”) 104 (FIG. 1). *Id.* at 3:58-60. A POSITA would have understood that “CUs 102 may include, for example, mobile units such as personal digital assistants (PDAs), laptop and portable computers with wireless communication capability, web tablets, wireless telephones, wireless headsets, pagers, instant messaging devices, MP3 players, digital cameras, and other devices that may receive and/or transmit information wirelessly.” *Id.* at 2:8-14. Similarly, a POSITA would have understood an AP to be a 802.11 Access Point.

148. FIG. 1 of Maltsev illustrates an operational environment where the embodiments of the alleged invention may be practiced. Communication environment 100 may include one or more communication units (CUs) 102, which may communicate with one or more access points (AP) 104 over wireless communication links 106. Ex. 1003 at 2:3-8.



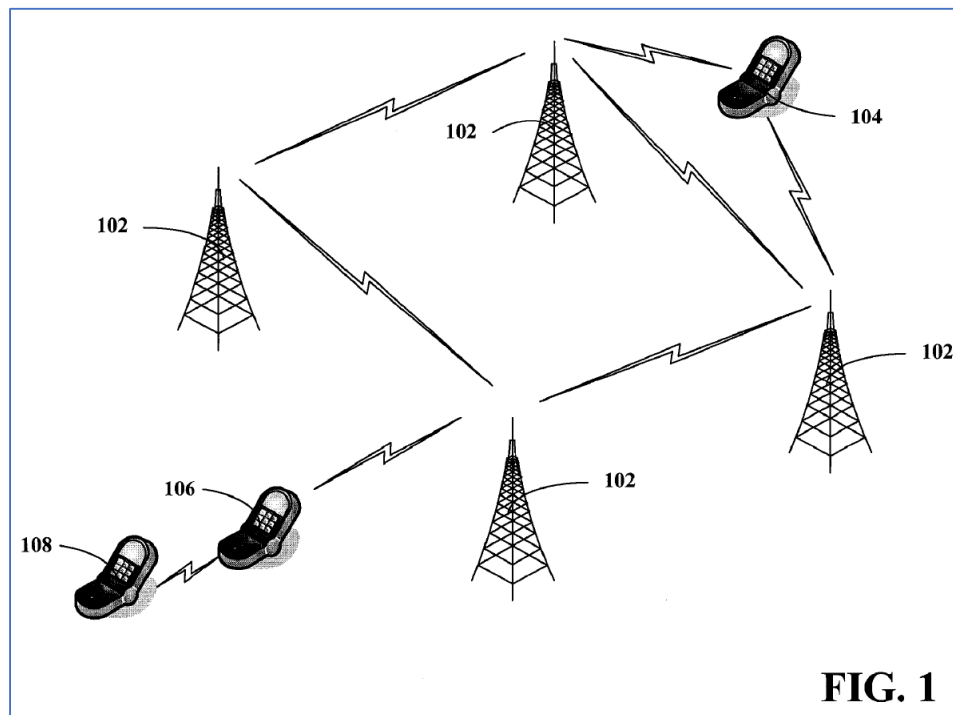
Ex. 1003, Fig. 1.

149. The CUs 102 and AP 104 may be referred to as a transmitting unit, a receiving unit, or both. *Id.* at 2:60-61. The CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110. *Id.* at 3:29-30. A POSITA would have understood a wider-band CU 108 to communicate on multiple subchannels and a narrower-band CU 108 to communicate on a single channel. *Id.* at 3:29-50.

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150. The terms "transmitting" and "receiving" are applied to communication units 102 and AP 104 for ease in understanding the embodiments, and that CUs and APs may include both transmitting and receiving capability to establish duplex communications therebetween. *Id.* at 2:60-67.

151. FIG. 1 of Agrawal is an illustration of an *ad hoc*, or mesh, wireless communication environment 100. System 100 can comprise one or more access points 102 that receive and transmit wireless communication signals to each other and to one or more access terminals 104, 106, 108. Ex. 1004 at [0033].



Ex. 1004 at Fig. 1.

152. Terminals 104, 106, 108 are dispersed throughout the system and may also be called a mobile station, user equipment, or a user device. A terminal may

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be a wireless device, a cellular phone, a personal digital assistant (PDA), a wireless modem card, and the like. *Id.* at [0034].

153. To the extent the preamble is limiting, it is met by both Maltsev and by Agrawal.

- ii. Limitation 9[1], “receiving, by a first station, a plurality of request to send (RTS) frames from a second station through a plurality of subchannels, each of the plurality of RTS frames being received through a corresponding one of the plurality of subchannels, each of the plurality of subchannels having a 20 megahertz (MHz) bandwidth;”**

154. Maltsev discloses the use of the RTS/CTS protocol in communications between two stations, such as two CUs 102 and a CU 102 and an Access Point (AP) 104. Ex. 1003 at 7:45-47, FIG. 1. Sending RTS signals over a plurality of subchannels is a way for the sender [second station in claim 9] to inform a targeted receiver [station 1 in claim 9] that it has a data frame to send. By sending RTS signals over multiple subchannels the sender [second station] increases the likelihood that the receiver [first station] will receive at least one of the RTS signals and thereby locate a communication path – “an idle subchannel” -- that is not busy and is a candidate for transferring a data frame from the second station to the first station.

155. The CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110. Narrower-band CUs 110 may communicate on a single channel

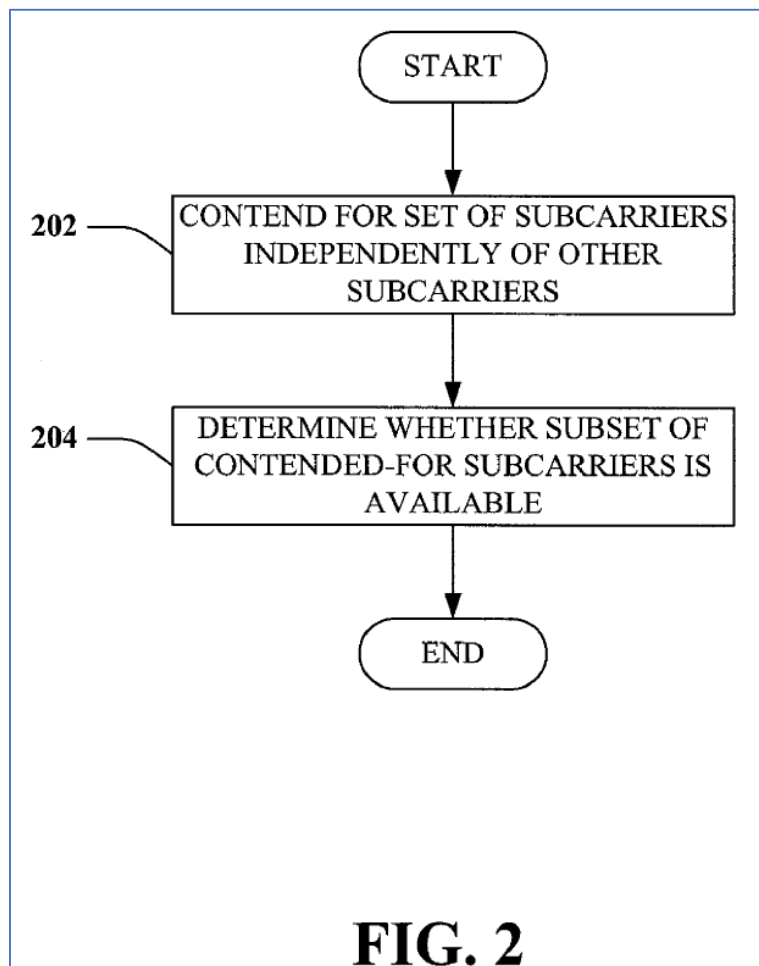
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while wider-band CUs 108 may communicate on one or more channels to provide wider-bandwidth communications. Wider-band CUs 108 may be referred to as high-throughput (HT) CUs, and in some embodiments, wider-band CUs 108 may communicate in accordance with an IEEE 802.11 standard for HT WLAN communications. Narrower-band CUs 110 may communicate in accordance with the IEEE 802.11(a/g) standard for WLAN communications. The terms narrower-band and wider-band refer to relative communication bandwidths that are utilized by the communication units. For example, narrower-band CUs 110 may communicate on a single narrow band channel (e.g., a 20 MHz channel), while wider-band CUs 108 may communicate on one or more subchannels using a wider bandwidth (e.g., channels of up to 80 MHz or greater). For one embodiment, the AP 104 may include the capability for communicating with both wider-band CUs 108 and narrower-band CUs 110. *Id.* at 3:29-50. A POSITA would have understood that an 80 MHz channel in a wider-band CU 108 would operate with four 20 MHz subchannels and for a 100 MHz channel (greater than 80 MHz), CU 108 would operate with four 25 MHz subchannels or five 20 MHz subchannels. Thus, the text of Maltsev in combination with FIG. 3 indicated to a POSITA that the number of subchannels and the bandwidth of each subchannel are variables that affect the throughput of a system, e.g., five or more subchannels are available for use wherein each subchannel is a 20 MHz or greater portion of the total spectrum 300.

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Moreover, a POSITA would have understood that the probability of all the available subchannels having acceptable noise characteristics to support a High Throughput connection would not always be 100 percent. Therefore, a POSITA would have appreciated a situation where RTS signals would be sent on more subchannels by a second station than the number of subchannels over which CTS signals would be transmitted by a first station.

156. FIG. 2 of Agrawal illustrates a methodology 200 that uses the CTS/RTS protocol to contend for subcarriers in a multi-carrier wireless communication environment Ex. 1004 at [0038].



Ex. 1004 at FIG. 2.

157. At 202, a node contends for a subcarrier independently of other subcarriers. For instance, when available bandwidth is divided into separate and distinct subcarriers, a request-to-send (RTS)/clear-to-send (CTS) protocol may be executed for each subcarrier independently. A station may transmit an RTS signal over a set of subcarriers and at 204, may determine whether a subset of the contended subcarriers is available for use during a subsequent transmission. The determination of subcarrier availability may be based on, for instance, CTS signals

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received over all or a subset of the contended subcarriers, i.e., the subcarriers over which RTS signals were sent. Thus, the station may submit an RTS over each specific subcarrier over which the terminal would like to transmit. *Id.* at [0038].

158. Agrawal further teaches that the RTS/CTS protocol can be implemented on each subcarrier so that each subcarrier can be contended for independently. *Id.* at [0044]. This is achieved by the second station sending an RTS and waiting for a response CTS on each subcarrier from the first station. One method of sending a RTS signal disclosed by Agrawal is for transmitter to send a 1-bit RTS on each of the desired subcarriers and then utilize the subset of subcarriers that it receives a CTS signal on. *Id.* The first (transmitting) station determines subchannel quality from a received RTS signal on the subchannel and indicates the idle/busy state of a subchannel by the transmission of a CTS signal over each idle subchannel and the non-transmission of a CTS signal over busy subchannels.

159. Therefore, Agrawal teaches sending an RTS signal independently over each subcarrier in a desired set, which meets the limitation of "transmitting, by a first station, a plurality of request to send (RTS) frames to a second station through a plurality of subchannels, each of the plurality of RTS frames being transmitted through a corresponding one of the plurality of subchannels." Maltsev also discloses that a channel of 80 MHz or larger can be subdivided into

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subchannels of 20 MHz each. Thus, Maltsev modified in view of Agrawal discloses a station independently sending to another station RTS signals over a plurality of subchannels wherein each of the plurality of subchannels has a 20 megahertz (MHz) bandwidth in a manner to render limitation 9[1] obvious.

iii. Limitation 9[2], “transmitting, by the first station, at least one clear to send (CTS) frame in response to at least one of the plurality of RTS frames from the second station through at least one idle subchannel of the plurality of subchannels; and”

160. Transmitting CTS frames can be thought of as a reply by the first Station that it received one or more RTS signals sent to it over the subchannels by the second station. If no RTS signals are received by the first station then no CTS signal will be transmitted because the first station is unaware of the second station’s intent. Maltsev discloses an RTS/CTS exchange used with control frames in the wider-band channel with channelization information. Ex. 1003 at 7:45-47.

161. Frames of format 400 are used by a MAC layer of a CU to adapt dynamically to channel conditions by measuring the state of a channel and providing feedback on channel state. The RTS/CTS exchange is used with control frames in the wider-band channel with channelization information. *Id.* at 7:42-47.

162. Channels 306 may be suitable for HT communications depending on each individual channel’s busy/idle state or channel quality. The decision about current channel state is dynamically made by a wider-band CU based on current

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measurements, information obtained from received packets, and statistical information. *Id.* at 4:65-5:3.

163. Agrawal teaches that a node contends for a subcarrier independently of other subcarriers. For instance, when available bandwidth may be divided into separate and distinct subcarriers, a request-to-send (RTS)/clear-to-send (CTS) protocol is executed for each subcarrier independently. *Id.* at [0038]. “An access terminal may transmit an RTS signal over a set of subcarriers, and may determine whether a subset of the contended subcarriers is available for use during a subsequent transmission at 204. [FIG. 2]. The determination of subcarrier availability may be based on, for instance, CTS signals received over all or a subset of the contended subcarriers. Thus, the access terminal does not need to submit a request for a predetermined number of subcarriers and wait to receive a subcarrier assignment like prior art systems, but it can submit an RTS over each specific subcarrier that it would like to transmit.” *Id.*

164. Agrawal also teaches that the RTS/CTS may be implemented on each subcarrier using one or more of a variety of approaches. “A second approach is to contend jointly across subcarriers and then encode the data packet across the successfully achieved subcarriers. When contending jointly across subcarriers, a transmitter may send a 1-bit RTS on each of the desired subcarriers and utilize the subset of subcarriers on which it receives a CTS signal. *Id.* at [0044].

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165. It would have been obvious to a POSITA to modify the wider-band channel (80 MHz or greater) divided into 20 MHz subchannels as taught by Maltsev with Agrawal's RTS/CTS protocol to send an RTS signal on each desired subchannel and to receive a CTS signal on each subcarrier that is available, i.e., idle, to meet limitation 9[2].

iv. Limitation 9[3], “receiving, by the first station, a data frame from the second station after transmitting the at least one CTS frame,”

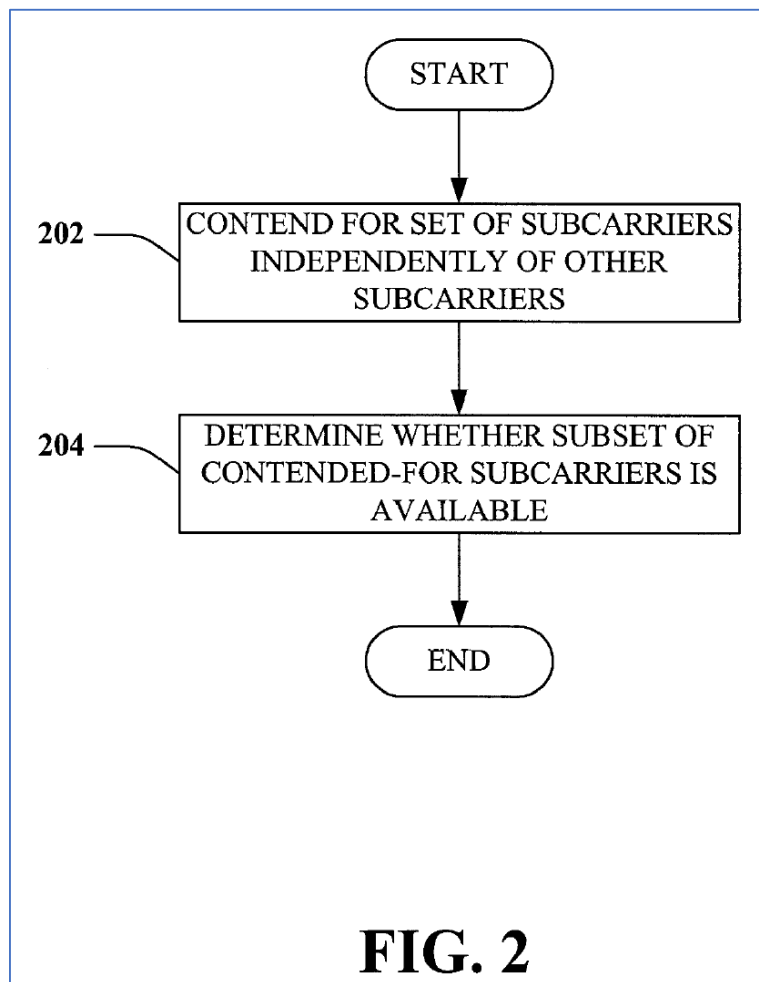
166. Maltsev discloses that frames of format 500 allow high-speed data transmission for a dynamically changed channelization can be sent by the CU (second station) and received the first station. More specifically, “frames of format 500 may be used to transmit data-carrying MPDUs in an environment that includes narrower-band CUs and wider-band CUs. Frames of format 500 may allow high-speed data transmission for a dynamically changed channelization, which may be determined for a given moment from a prior training phase, such as an RTS/CTS signal exchange, which may be carried in frames of long-compatibility format 400 (FIG. 4).” Ex. 1003 at 7:42-47.

167. Therefore, Maltsev teaches limitation 9[3].

168. Agrawal also discloses using an RTS/CTS protocol. Referring to FIG. 2 and its associated text, Agrawal states: “At 202, a node may contend for a subcarrier independently of other subcarriers. For instance, when available

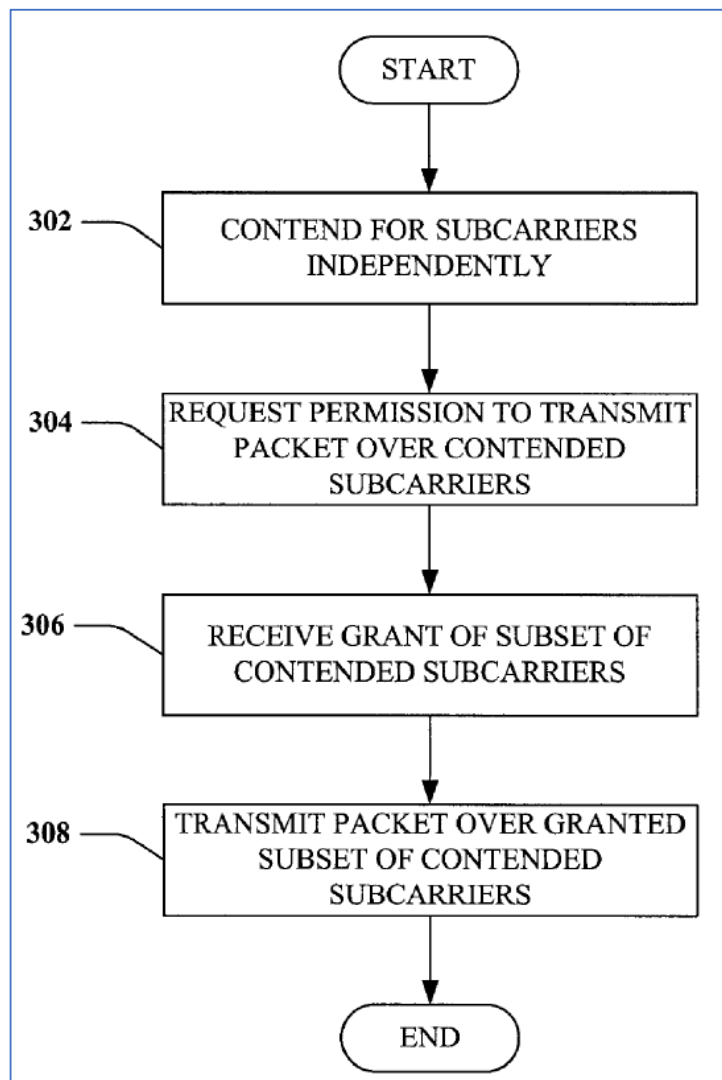
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bandwidth may be divided into separate and distinct subcarriers, a request-to-send (RTS)/clear-to-send (CTS) protocol may be executed for each subcarrier independently. An access terminal (second station) may transmit an RTS signal over a set of subcarriers, and may determine whether a subset of the contended subcarriers is available for use during a subsequent transmission, at 204. The determination of subcarrier availability may be based on, for instance, CTS signals received over all or a subset of the contended subcarriers from the first station. Thus, the access terminal does not need to submit a request for a predetermined number of subcarriers and wait to receive a subcarrier assignment like prior art systems, but instead, can submit an RTS over each specific subcarrier over which the terminal would like to transmit. Ex. 1004 at [0038].



Id. at FIG. 2.

169. Upon receipt of a grant (e.g., a CTS signal) of the contended subcarrier at step 306 of FIG. 3, the method proceeds to step 308, where the data packet may be transmitted over the contended subcarrier(s). Ex. 1004 at [0039]. Therefore, Agrawal also meets limitation 9[3].



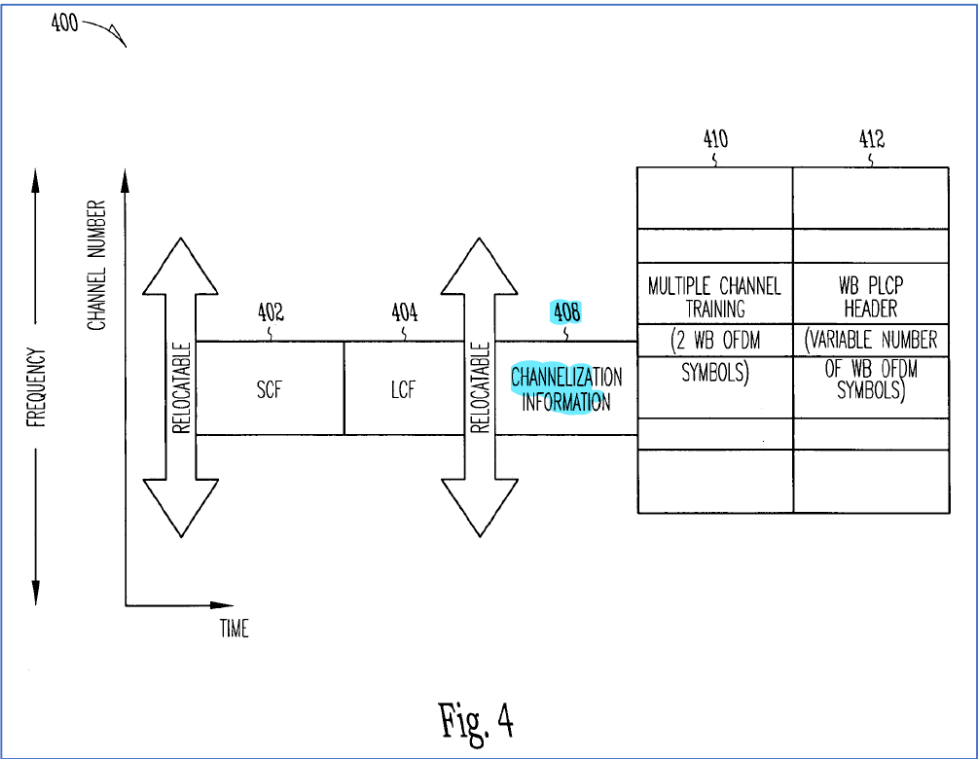
Id. at FIG. 3.

- v. **Limitation 9[4], “wherein the at least one CTS frame includes channel information related to the at least one idle subchannel through which the CTS frame is transmitted by the first station and the data frame is received through the at least one idle subchannel indicated by the channel information, and”**

170. Maltsev discloses “channel information” in the form of a “channelization field” many times. For example, the Abstract states that Maltsev’s frame format includes a “channelization field identifying channels that are used for

communicating subsequent wideband fields of a packet, and a wideband header field communicated on the identified channels.” Ex. 1003 at Abstract. These frames are “communicated on the identified channels” means that they are communicated on the same channels as the CTS frame.

171. For example, Fig. 4 below shows this “channelization information” in contained in field 408 of the frame transmitted on the same subchannel that the CTS was received on.



Id. Fig. 4 (highlighting added).

172. Specifically, as shown by at least the captured text below describing Fig. 4, Maltsev discloses that that: (1) the frame format 400 can be used between the wider-band CUs (second station) and the AP (first station); (2) it can carry the

“channelization information” field 408; and (3) this frame may be sent on a compatibility channel, such as compatibility channel 304 (FIG. 3), which may be relocatable to any of the narrower-band channels. *Id.* 5:26-42. Because this frame can be sent on the channel designated as the “compatibility channel” and the compatibility channel may be relocated to any of the 20 MHz narrow-band channels, the compatibility channel can be the same channel as the claimed “through the at least one idle subchannel indicated by the channel information.”

FIG. 4 illustrates a structure of a long-compatibility frame in accordance with some embodiments of the present invention. Long-compatibility frame format 400 is an example of an HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1), although other frame formats may also be suitable. Frame format 400 may include short-compatibility field 402, long-compatibility field 404, channelization field 408, multiple-channel training field 410, and wideband-header field 412. In some embodiments, short-compatibility field 402, long-compatibility field 404, and channelization field 408 may be sent on a compatibility channel, such as compatibility channel 304 (FIG. 3), which may be relocatable to any of the narrower-band channels. Multiple-channel training field 410 and wideband-header field 412 may be sent on one or more channels, such as channels 306 (FIG. 3) including compatibility channel 304 (FIG. 3).

Id. at 5:26-42, (highlighting added.)

173. Maltsev further discloses that the format 400 frames for a CU (second station) adapt dynamically to channel conditions by measuring the state of a channel and providing feedback on channel state to the AP (first station). For

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example, Maltsev additionally teaches that control frames can be transmitted on any of the channels that contain an RTS/CTS exchange and the channelization information. *Id.* at 7:42-49.

174. According to Agrawal, the “determination of subcarrier availability may be based on, for instance, CTS signals received over all or a subset of the contended subcarriers. Thus, the access terminal need not submit a request for a predetermined number of subcarriers and wait to receive a subcarrier assignment like prior art systems, but rather may submit an RTS over each specific subcarrier over which the terminal would like to transmit.” Ex. 1004 at [0038].

175. A POSITA would have understood from Agrawal that the CTS signal is used for determining the availability of the subcarrier on which it has been received and that the data frame is transmitted over the available subchannel associated with the same subchannel number of the CTS signal. A POSITA would have understood from both Maltsev and Agrawal that CTS frames include channel information and are sent over each idle subchannel which meets the limitation of “at least one subchannel. Limitation 9[4] is fully met by the combination of Maltsev and Agrawal.

- vi. Limitation [9.5]: “wherein a number of the at least one idle subchannel through which the CTS frame is transmitted is less than a number of the plurality of subchannels through which the plurality of RTS frames are received.”**

176. Maltsev teaches that channel conditions can change for one or more of the subchannels and the system needs to adjust accordingly to the number of subchannels used for wideband communications. The RTS/CTS mechanisms disclosed by Maltsev include frames of format 400 that can be used by a MAC layer of a CU to adapt dynamically to channel conditions by measuring the state of a channel and providing feedback on channel state to the transmitter. A POSITA would have understood that as these channel conditions change, the number of subchannels that can be used for a High Throughput connection changes with them.

177. The Maltsev frame formats for some of the embodiments also allow estimating the channel variation and applying channel prediction techniques and adaptive fragmentation capability for High Throughput OFDM systems. The frame formats of some embodiments also allow precision channel estimation for more effective performance of Adaptive Bit Power Loading (ABPL) algorithms and better use of available channel capacity. The frame formats also allow for detecting the frequency configuration of an incoming packet on the fly. Ex. 1003 at 11:43-53.

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178. Maltsev additionally teaches that the CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110. Narrower-band CUs 110 may communicate on a single channel while wider-band CUs 108 may communicate on one or more of the channels to provide wider-bandwidth communications. *Id.* at 3:29-33.

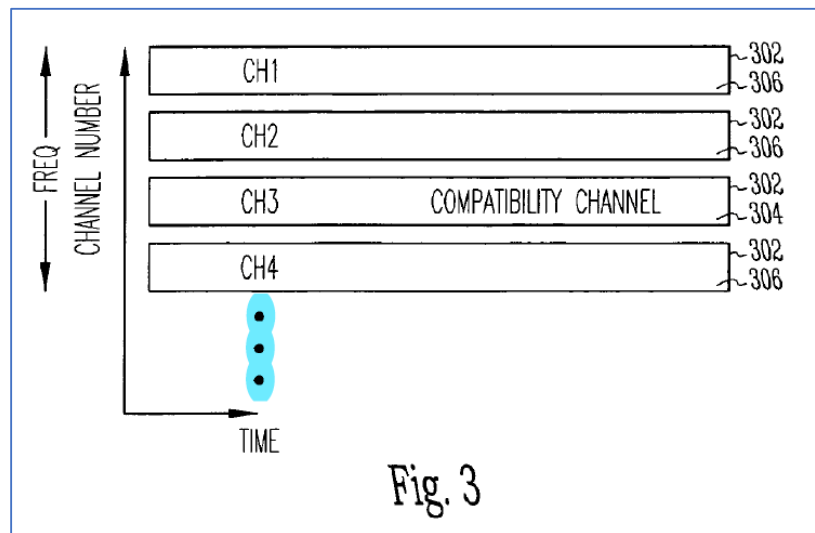
179. Maltsev further describes that its subchannels may be suitable for HT communications depending on each individual channel's busy/idle state or channel quality and that the decision about current channel state may be dynamically made by a wider-band CU based on current measurements, information obtained from received packets and statistical information. *Id.* at 4:65-5:3.

180. Although Maltsev discloses “wider-band channels and narrower-band channels” in multiple places as cited above, Maltsev does not expressly disclose that a number of the subchannels through which the CTS frame is transmitted is “less than” a number of subchannels through which the RTS frames are received.

181. However, a POSITA would have understood that Maltsev’s dynamic bandwidth operation of using one or multiple subchannels for a HT connection inherently utilizes transmission of an RTS on each of multiple desired subchannels and receiving less CTS frames to indicate which associated subchannels are interference-free and can be used for the HT connection. As shown by the highlighted ellipses in Fig. 3 below, Maltsev has also defined that more than four

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subchannels can be used for the invention. Taking Fig. 3 to its logical extreme, five or more possible subchannels could be available for use. However, the greater the number of total subchannels the lower the probability that all of the subchannels would have the acceptable noise characteristics to be used for a High Throughput connection. Therefore, a POSITA would have easily appreciated a situation where RTS signals would be sent on more subchannels than the number of subchannels over which CTS signals would be received as required by this limitation.



Ex. 1003 at Fig. 3 (highlighting added)

182. This limitation is explicitly found in Agrawal. Agrawal teaches dividing the available bandwidth into separate and distinct subcarriers (subchannels) and implementing a request-to-send (RTS)/clear-to-send (CTS) protocol for each subcarrier independently. *Id.* at [0038]. “An access terminal may

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transmit an RTS signal over a set of subcarriers, and may determine whether a **subset** of the contended subcarriers is available for use during a subsequent transmission, [FIG. 2] at 204.” *Id.*, (emphasis added). Thus, the access terminal submits “an RTS over each specific subcarrier over which the terminal would like to transmit.” *Id.* “[A] transmitter may send a 1-bit RTS on all of the desired subcarriers and utilize the **subset** of subcarriers on which it receives a CTS signal.” *Id.* at [0044], (emphasis added).

183. Based on the teachings of at least the previous paragraph, a POSITA would have understood from Agrawal that a sender of an RTS frame learns the available and unavailable subchannels based on the subchannels that have replied with CTS frames and the subchannels where no CTS is received because the decision about channel state is dynamically made based on the received CTS frames. Ex. 1004 at [0028], [0043].

184. Thus, Agrawal discloses receiving CTS signals over a subset of the contended subcarriers over which RTS signals were and meets the limitation “wherein a number of the at least one idle subchannel through which the CTS frame is transmitted is less than a number of the plurality of subchannels through which the plurality of RTS frames are received.”

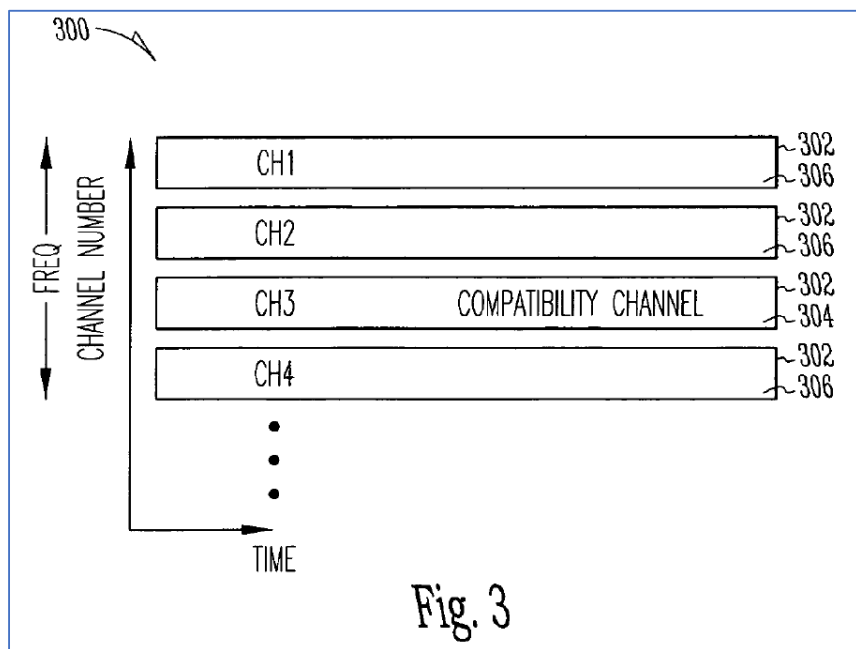
185. Claim 9 is obvious over the combined teachings of Maltsev and Agrawal.

C. Claim 10: “The method of claim 9, wherein the number of the at least one idle subchannel is 1 or 2 when the number of the plurality of subchannels is 4.”

186. I understand the conjunction “or” is met by satisfying either or both of the first and second conditions, therefore the presence of one or two idle subchannels meets this limitation.

187. Maltsev combined with Agrawal discloses this limitation.

188. Fig. 3 of Maltsev shown below illustrates an allocation of frequency spectrum 300 for communications among CUs 102 and for communications between CUs 102 (FIG. 1) and AP 104. Ex. 1003 at 4:32-36.



Id., Fig. 3.

189. Maltsev teaches that the frequency spectrum 300 shown above is comprised of four channels (subchannels) labelled as 302 that are, for example, 20

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MHz each. Narrower-band CUs, such as CUs 110 of Fig. 1 communicate using a single channel such as one of the channels 302. Wider-band CUs 108 simultaneously use a plurality of channels 302 such as the four channels (CH1-CH4) shown in Fig. 3. The aggregate spectrum of the channels used by wider-band CUs is a contiguous 80 MHz portion of the spectrum 300. Fig. 3 illustrates frequency spectrum 300 having four channels 302 (CH1-CH4) each of which is 20 MHz. *Id.* at 4:37-53. Therefore, the “the number of the plurality of subchannels” disclosed is four as required by this limitation.

190. Channels 306 are suitable for HT communications depending on each individual channel's busy/idle state or channel quality. The decision about current channel state may be dynamically made by a wider-band CU based on current measurements, information obtained from received packets and statistical information. *Id.* at 4:65-5:3.

191. A MAC layer of a CU is used to adapt dynamically to channel quality conditions by measuring the state of a channel and providing feedback on channel state. A RTS/CTS exchange is used with control frames in the wideband channel 300 with channelization information. *Id.* at 7:42-49.

192. A POSITA would have understood that if, as shown in Fig. 3, the spectrum is 80 MHz divided into four 20 MHz channels 302 and that the status (“idle” or “busy”) of a channel is individually and dynamically determined

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depending on each individual channel's busy/idle state or channel quality, i.e., “[a] decision about current channel state may be dynamically made by a wider-band CU based on current measurements, information obtained from received packets and statistical information,” (*id.* at 4:65-5:3), then all or fewer than all four channels may be determined to be idle and that at least one channel must be idle for a communication exchange to occur. Thus, the teachings of Maltsev render the limitations of claim 10 obvious.

193. Moreover, a POSITA would have understood from Agrawal that, as described for element [9e] above, CTS signals may be received over a subset of the channels contended for by the sent RTS signals. Maltsev teaches that RTS signals are transmitted over each of the four 20 MHz channels that comprise the 80 MHz spectrum available for transmission. Thus, where the number of 20 MHz channels is 4, a subset of those channels may be determined to be idle. A POSITA would have understood that such subset would include one or two idle 20 MHz channels depending upon the dynamically changing quality state of each of 20 MHz channels.

194. A POSITA would have additionally realized this to be a viable situation for a CU communicating with an AP in an environment with a high amount of interference (noise). In this situation, only 1 or 2 subchannels could be used for data communication because the others would be experiencing excessive

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noise. This is because the amount of interference is typically different for each subchannel frequency.

D. Independent Claim 13

195. Independent claim 13 is a device claim corresponding to the method recited in independent claim 9. The steps of the method of claim 9 are expressed as operations instructed by a processor. The following table shows the close similarity between the two independent claims.

| Method Claim 9 | Device Claim 13 |
|--|---|
| Limitation 9[pre]
A method for receiving data in a wireless communication system, method comprising: | Limitation 13[pre]
A device comprising:
Limitation 13[1]
a transceiver; and

Limitation 13[2]
a processor operatively connected to the transceiver and configured to: |
| Limitation 9[1]
receiving, by a first station,

a plurality of request to send (RTS) frames from a second station through a plurality of subchannels, each of the plurality of RTS frames being received through a corresponding one of the plurality of subchannels, each of the plurality of subchannels having a 20 megahertz (MHz) bandwidth; | Limitation 13[3]
instruct the transceiver to receive

a plurality of request to send (RTS) frames from a station through a plurality of subchannels, each of the plurality of RTS frames being received through a corresponding one of the plurality of subchannels, each of the plurality of subchannels having a 20 megahertz (MHz) bandwidth, |
| Limitation 9[2]
transmitting, by the first station, | Limitation 13[47]
instruct the transceiver to transmit |

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| | |
|--|--|
| at least one clear to send (CTS) frame in response to at least one of the plurality of RTS frames to the second station through at least one idle subchannel of the plurality of subchannels; and | at least one clear to send (CTS) frame in response to at least one of the plurality of RTS frames to the station through at least one idle subchannel of the plurality of subchannels, and |
| Limitation 9[3]
receiving, by the first station,

a data frame from the second station after transmitting the at least one CTS frame, | Limitation 13[5]
instruct the transceiver to receive

a data frame from the station after transmitting the at least one CTS frame, |
| Limitation 9[4]
wherein the at least one CTS frame includes channel information related to the at least one idle subchannel through which the CTS frame is transmitted by the first station and the data frame is received through the at least one idle subchannel indicated by the channel information, and | Limitation 13[6]
wherein the at least one CTS frame includes channel information related to the at least one idle subchannel through which the CTS frame is transmitted by the device and the data frame is received through the at least one idle subchannel indicated by the channel information, and |
| Limitation 9[5]
wherein a number of the at least one idle subchannel through which the CTS frame is transmitted is less than a number of the plurality of subchannels through which the plurality of RTS frames are received. | Limitation 13[7]
wherein a number of the at least one idle subchannel through which the CTS frame is transmitted is less than a number of the plurality of subchannels through which the plurality of RTS frames are received. |

i. Limitation 13[pre]: “A device comprising:

196. The preamble of independent claim 13 is not limiting.

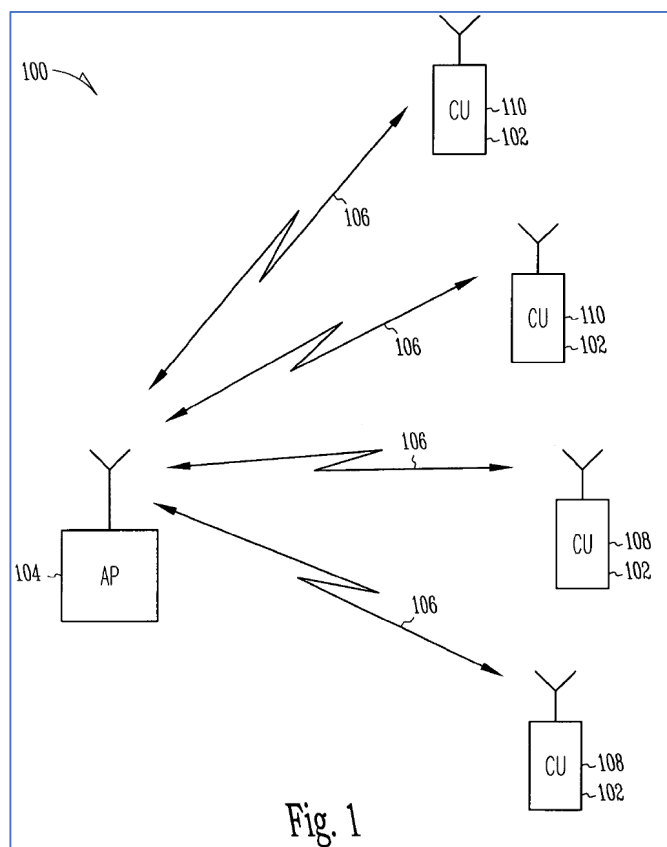
ii. Limitation 13[1]: “a transceiver; and”

197. Maltsev teaches this limitation.

198. As shown in FIG. 1 communication environment 100 include one or more communication units (CUs) 102, which communicate with access points

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(AP) 104 over wireless communication links 106. CUs 102 may include, for example, mobile units such as personal digital assistants, (PDAs), laptop and portable computers with wireless communication capability, web tablets, wireless telephones, wireless headsets, pagers, instant messaging devices, MP3 players, digital cameras, and other devices that may receive and/or transmit information wirelessly. Ex. 1003 at 2:3-35.



Id. at Fig. 1.

199. In some embodiments, CUs 102 and AP 104 may communicate in accordance with one or more communication standards, such as one of the Institute

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of Electrical and Electronics Engineers (I.E.E.E.) 802.11 standards. CUs 102 may communicate among each other using a multi-carrier transmission technique, such as an orthogonal frequency division multiplexing (OFDM) technique that uses orthogonal subcarriers to transmit information within an assigned spectrum. *Id.* at 2:18-28.

200. A POSITA would have understood that each of the CUs 102 includes a transmitter.

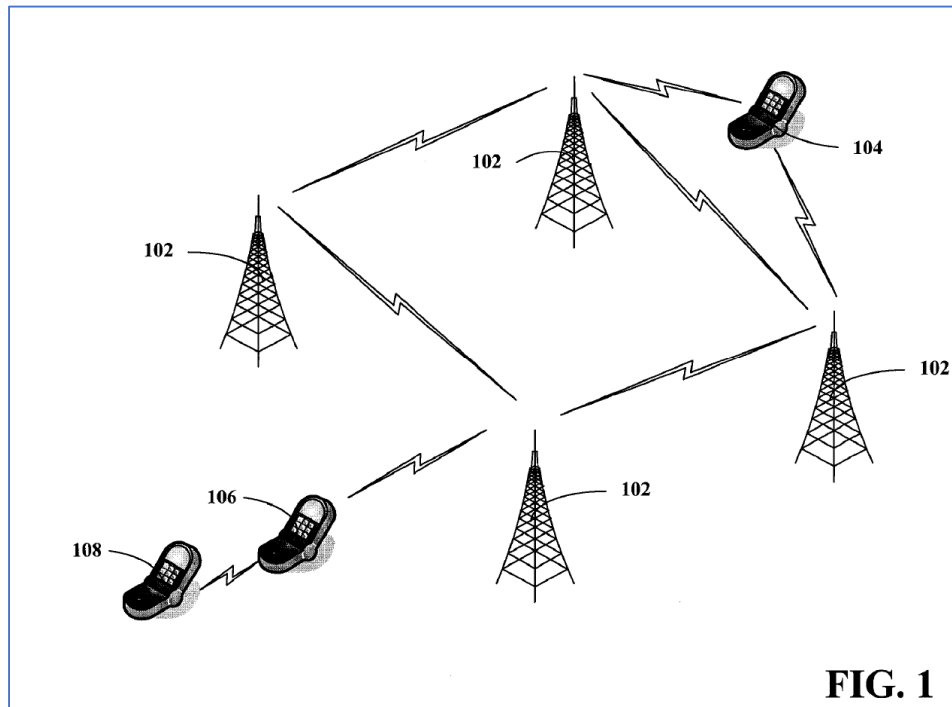
201. Agrawal also teaches this limitation.

202. According to Agarwal et al. an aspect of the disclosed invention is a processor for facilitating multi-carrier wireless transmission. The processor is configured to contend for one or more subcarriers independent of contending for other subcarriers and to determine whether a subset of the one or more contended subcarriers is available for data transmission. Ex. 1004 at [0015].

203. FIG. 1 illustrates a wireless communication system 100 that includes access points 102 that receive, transmit, repeat etc., wireless communication signals with each other and with access terminals 104, 106, 108. Each access point 102 comprises a transmitter chain and a receiver chain, each of which can in turn comprise a plurality of components associated with signal transmission and reception (e.g., processors, modulators, multiplexers,

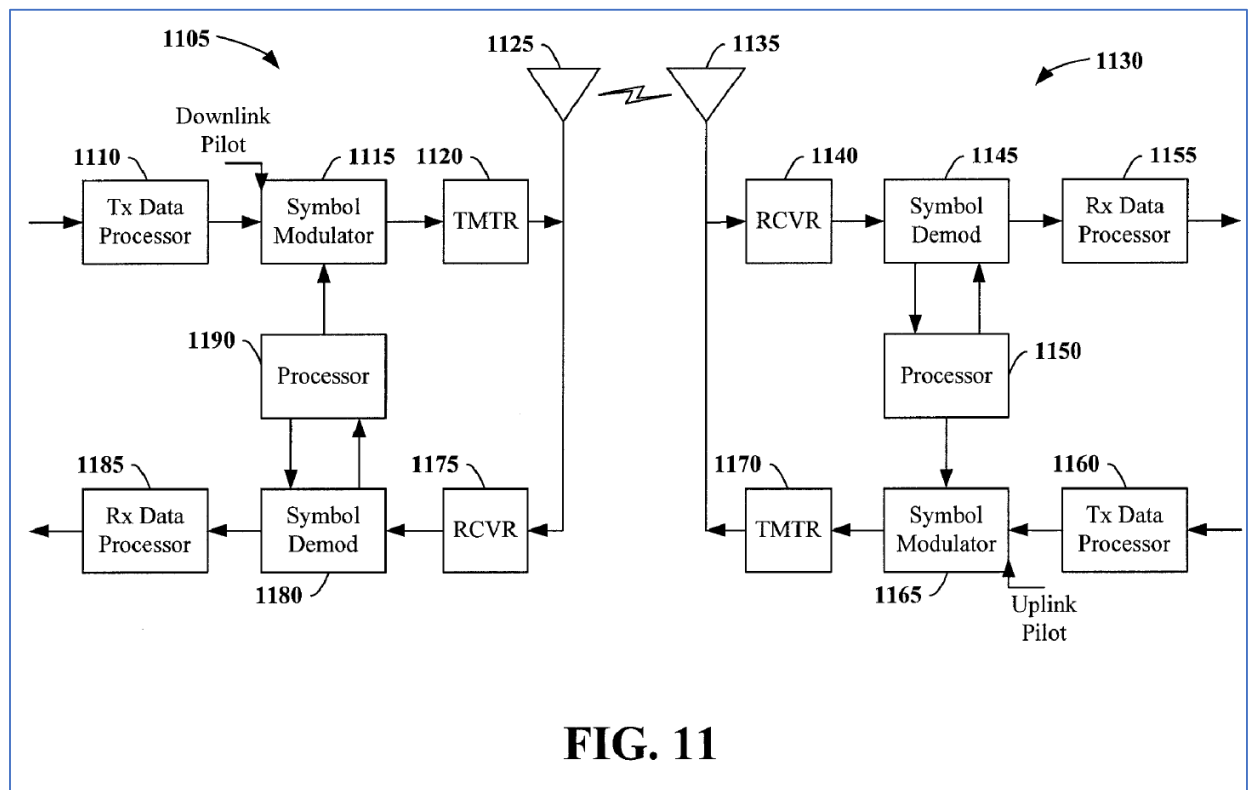
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demodulators, demultiplexers, antennas, etc.), as will be appreciated by one skilled in the art. *Id.* at [0033].



Id. at Fig. 1.

204. Referring further to Agrawal FIG. 11, on a downlink, at access point 1105, a transmit (TX) data processor 1110 receives, formats, codes, interleaves, and modulates (or symbol maps) traffic data and provides modulation symbols ("data symbols"). *Id.* at [0062].



Id. at Fig. 11.

205. At the access point AP, TMTR 1120 receives and converts the stream of symbols into one or more analog signals and further conditions (e.g., amplifies, filters, and frequency upconverts) the analog signals to generate a downlink signal suitable for transmission over the wireless channel. The downlink signal is then transmitted through an antenna 1125 to the terminals.

206. At terminal 1130, an antenna 1135 receives the downlink signal and provides a received signal to a receiver unit (RCVR) 1140. Receiver unit 1140 conditions the received signal and digitizes the conditioned signal to obtain samples. A symbol demodulator 1145 demodulates and provides received pilot

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symbols to a processor 1150 for channel estimation. Symbol demodulator 1145 provides the data symbol estimates to an RX data processor 1155, which demodulates, deinterleaves, and decodes the data symbol estimates to recover the transmitted traffic data. On the uplink, a TX data processor 1160 processes traffic data and provides data symbols. A transmitter unit 1170 then receives and processes the stream of symbols to generate an uplink signal, which is transmitted by antenna 1135 to access point 1105. *Id.* at [0064].

207. At access point 1105, the uplink signal from terminal 1130 is received by antenna 1125 and processed by a receiver unit 1175 to obtain samples. An RX data processor 1185 processes the data symbol estimates to recover the traffic data transmitted by terminal 1130. A processor 1190 performs channel estimation for each active terminal transmitting on the uplink. Multiple terminals may transmit pilot concurrently on the uplink on their respective assigned sets of pilot subbands [subchannels], where the pilot subband sets may be interlaced. *Id.* at [0064], [0065].

208. With reference to FIG. 12, Agrawal discloses an apparatus 1200 comprising a series of interrelated functional blocks that represent functions implemented by a processor, software, or firmware) and including a module for contending 1202 that contends for a particular subcarrier or set of subcarriers. *Id.* at [0068]. Module 1202 is coupled to a module for determining subcarrier availability

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1204, which generates and transmits a request that indicates a desire to transmit a data packet over the contended subcarrier(s) (e.g., a "request-to-send") within a portion of available bandwidth that is used for multiple access. *Id.* at [0068].

209. A POSITA would understand that this functionality in the context of the overall teachings of Agrawal discloses the limitations of a transmitter, multiple subcarriers, and recited use of RTS signal.

210. As previously noted, the portion of available bandwidth may be less than all available bandwidth used for multiple access in a wireless communication environment in which apparatus 1200 is employed. The module for determining sub-carrier availability 1204 receives a grant (e.g., a "clear-to-send" signal) of the contended subcarrier(s) and the apparatus 1200 employs a module for transmitting to transmits the data packet over the contended subcarrier(s). *Id.*

211. A POSITA would have understood that disclosure of Agrawal discussed above corresponds to receipt of CTS signal and transmission of data on one or more subcarriers.

212. A POSITA would have understood that Agrawal teaches a transmitter in the access terminals.

iii. Limitation 13[2]: “a processor operatively connected to the transceiver and configured to:”

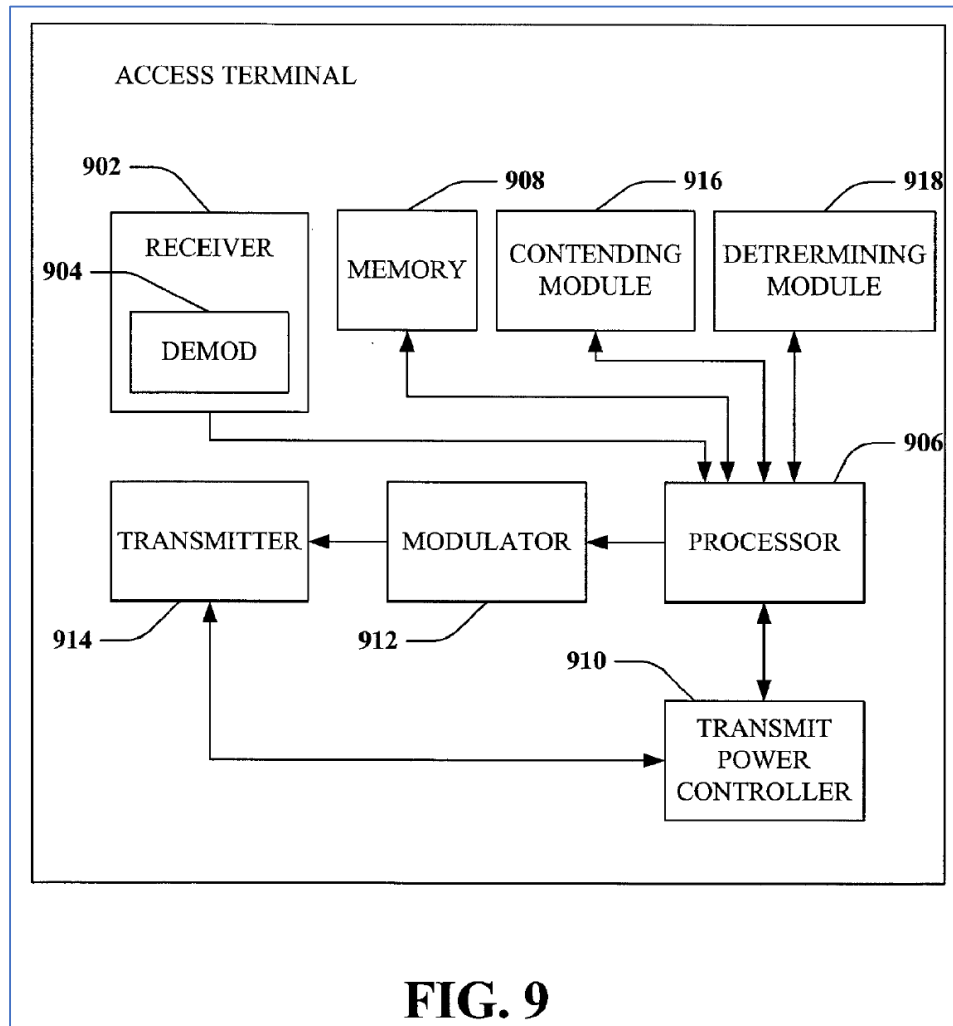
213. Maltsev discloses this limitation. More specifically, CU 200 may be implemented by software-configured elements, such as processing elements including digital signal processors (DSPs) or other hardware elements such as microprocessors, DSPs, application specific integrated circuits (ASICs), and combinations of various hardware and logic circuitry for performing at least the functions described herein. Ex. 1003 at 4:6-15.

214. Agrawal also meets the limitation of a processor.

215. FIG. 9 illustrates an access terminal 900 of Agrawal that comprises a receiver 902 that receives a signal via a receive antenna (not shown). Receiver 902 comprises a demodulator 904 that demodulates received symbols and provides them to a processor 906 for channel estimation. Processor 906 both analyzes information received by receiver 902, generates information for transmission by transmitter 914, and controls other components of access terminal 900.

Additionally, processor 906 may be operatively associated with a contending module 916, which may execute instructions for contending for subcarriers, individually or in sets, independently of contending for other subcarriers or sets of subcarriers. Processor 906 may be coupled to or include a determining module 918 that determines whether one or more contended subcarriers is available for

transmissions. For instance, determining module may execute instructions for performing RTS/CTS protocols. *Id.* at [0054], [0060].



Id. at Fig. 9.

216. Processor 906 is further operatively coupled to transmit power controller 910, which may adjust a transmit power level for one or more of a RTS message, a CTS message, a data message in order to permit transmission over a subcarrier for which another node has won contention, as described above. Access

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terminal 900 further comprises a modulator 912 and a transmitter 914 that transmits the signal to, for instance, a base station, an access point, another access terminal, a remote agent, etc. A determining module determines whether contended subcarriers are available by executing instructions for performing RTS/CTS protocols, for comparing interference and/or thermal noise levels to one or more predetermined threshold levels and determining whether to adjust transmission power levels to permit transmission over a contended subcarrier etc. Id. at [0060].

217. The processor may be implemented within one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a combination thereof. Id. at [0067].

218. Although depicted as being separate from the processor 906, it is to be appreciated that transmit power controller 910, contending module 916, and/or determining module 918 may be part of processor 906. Id. at [0057].

219. Maltsev and Agrawal both meet Limitation 13[3].

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- iv. Limitation 13[3]: “instruct the transceiver to receive a plurality of request to send (RTS) frames from a station through a plurality of subchannels, each of the plurality of RTS frames being received through a corresponding one of the plurality of subchannels, each of the plurality of subchannels having a 20 megahertz (MHz) bandwidth,”**

220. As shown in the table in ¶160, *supra*, this limitation is substantially identical to limitation 9[1] discussed above. This limitation is taught by Maltsev and Agrawal for the reasons discussed with reference to limitation 9[1].

- v. Limitation 13[4]: “instruct the transceiver to transmit at least one clear to send (CTS) frame in response to at least one of the plurality of RTS frames to the station through at least one idle subchannel of the plurality of subchannels, and”**

221. As shown in the table in ¶160, *supra*, this limitation is substantially identical to limitation 9[2] discussed above. This limitation is taught by Maltsev and Agrawal for the reasons discussed with reference to limitation 9[2].

- vi. Limitation 13[5]: “instruct the transceiver to receive a data frame to the station after transmitting the at least one CTS frame,”**

222. As shown in the table in ¶195, *supra*, this limitation is substantially identical to limitation 9[3] discussed above. This limitation is taught by Maltsev and Agrawal for the reasons discussed with reference to limitation 9[3].

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- vii. Limitation 13[6]: “wherein the at least one CTS frame includes channel information related to the at least one idle subchannel through which the CTS frame is transmitted by the device and the data frame is received through the at least one idle subchannel indicated by the channel information, and”**

223. As shown in the table in ¶195, *supra*, this limitation is substantially identical to limitation 9[3] discussed above. This limitation is taught by Maltsev and Agrawal for the reasons discussed with reference to limitation 9[4].

- viii. Limitation 13[7]: “wherein a number of the at least one idle subchannel through which the CTS frame is transmitted is less than a number of the plurality of subchannels through which the plurality of RTS frames are received.”**

224. As shown in the table in ¶195, *supra*, this limitation is substantially identical to limitation 9[3] discussed above. This limitation is taught by Maltsev and Agrawal for the reasons discussed with reference to limitation 9[5].

- E. Claim 14: “The device of claim 13, wherein the number of the at least one idle subchannel is 1 or 2 when the number of the plurality of subchannels is 4.”**

225. The additional limitation of Claim 14 is identical to the limitation of claim 10 and is met by Maltsev and Agrawal for the reasons discussed with regard to Ground 1, claim 10.

XI. GROUND 2: CLAIMS 12 AND 16 OF THE '346 PATENT ARE UNPATENTABLE UNDER 35 U.S.C. §103 OVER MALTSEV IN VIEW OF AGRAWAL MODIFIED IN VIEW OF FRACCHIA

A. Motivation to Combine Fracchia with Maltsev and Agrawal.

226. The Background of the Invention section of the '346 patent and Fracchia state the continuing motivation to increase the throughput of systems compatible with the various versions of the 802.11 Wi-Fi standards. This motivation continued even after the previously released 802.11n standard increased the data throughput over the previous Wi-Fi systems by ten-fold (*See e.g.*, Section V.C).

With the widespread use of WLAN and the diversification of applications using the WLAN, there is a demand for a new WLAN system to support a higher throughput.”

Ex. 1001 at 3:6-9.

This analysis provides inputs on the technical feasibility of achieving 1Gbps aggregated MAC SAP throughput for below 6GHz amendment, by using different MAC layers which manage the access to different parallel channels.

Ex. 1009 at p.2.

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227. I have described the reasons that a POSITA would combine Maltsev and Agrawal in Ground 1 above. A POSITA would be motivated to further combine Fracchia with Maltsev and Agrawal for at least the following reasons.

228. First, they all have at least one embodiment or example that is specific to IEEE 802.11 (Wi-Fi) wireless communications. *See e.g.*, Ex. 1003 at 3:1-50, Ex. 1004 at [0040] and Ex. 1009 at slide 3. Second, they all are in regard to OFDM wireless communications. *See e.g.*, Ex. 1003 at 2:18-32; Ex. 1004 at [0037], [0062] and [0067]; and Ex. 1009 at slide 2. Third, they are all focused on the same objective—improving the throughput (data speed) of high throughput/wideband wireless networks. *See e.g.*, Ex. 1003 at 1:7-27; Ex. 1004 at Abstract; and Ex. 1009 at pp. 2-9. Fourth, Ex. 1009 is an analysis of OFDM wideband techniques and provides specific objectives and functionality that a POSITA would have used to understand the direction of the next IEEE 802.11 release.

229. For this ground, Fracchia provides simulation test data that supports more than the required 1 Gbps throughput will be achieved by: (1) bonding four or more 20 MHz OFDM subchannels together.¹³ As described above for Ground 1, Maltsev teaches that each additional bonded OFDM subchannel continues to

¹³ The prior art 802.11n standard defines bonding two 20 MHz channels together to make a 40 MHz channel.

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increase the overall data throughput and four or more subchannels can be used for significant increases; (2) that each additional MIMO spatial data stream (antenna pair)¹⁴ will continue to multiply the data throughput when using the four or more of Maltsev's bonded OFDM subchannels; and (3) the 1 Gbps throughput requirement can be exceeded when using five 20 MHz subchannels and four MIMO Spatial Streams (antennas pairs).

B. Claim 12: "The method of claim 9, wherein the first station is a Very High Throughput (VHT) non-Access Point (AP) station and the second station is a VHT AP station."

230. It is important to note that claim 12 requires a plurality of subchannels having a 20 MHz bandwidth but, in contrast to claim 10, which requires a total of four for the number of the plurality of subchannels, claim 12 places no specific limit on the number of the plurality of 20 MHz subchannels used to implement the RTS/CTS protocol. Thus, two or more subchannels and also more than four subchannels meet the "plurality" limitation. In other words, the number of the plurality of 20 MHz subchannels within the scope of claim 12 can be more than four, e.g., five subchannels.

¹⁴ As described above in sections V.C and V.B regarding the prior art 802.11n recommendation, each additional Spatial Stream (antenna pair) multiplies the data throughput when using two 20 MHz OFDM subchannels.

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231. In applying the prior art to claim 12, I have applied the constructions set forth in Section VIII.B.i.-iii, *supra*, for “Very High Throughput (VHT)” which is “processing speed of 1 Gbps or more in the multi-channel environment.” Ex. 1013 at p. 6.

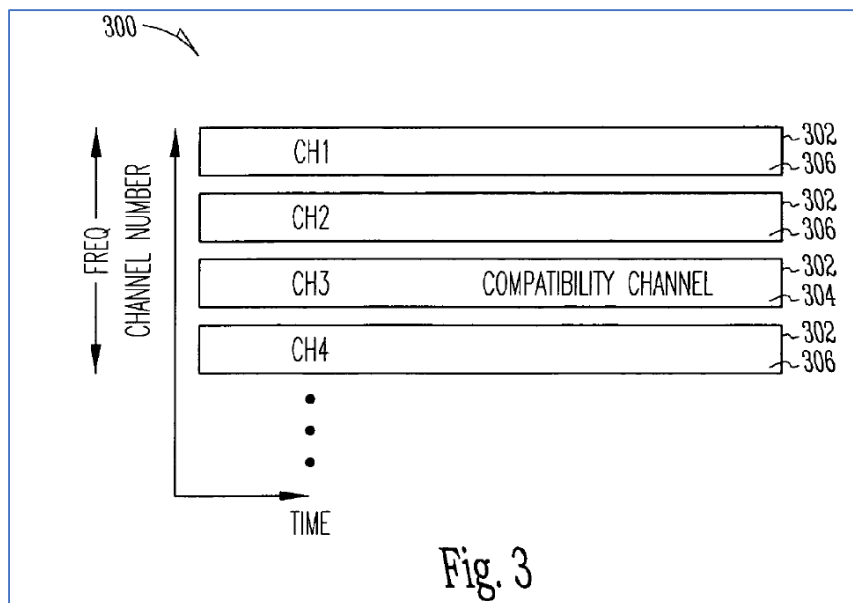
232. I additionally note that, other than using the RTS/CTS protocol over the “plurality of subchannels” as required Claim 12 does not require any additional steps or technology to be applied to the prior art narrowband stations to make them Very High Throughput (VHT) stations. Based on at least the prior art 802.11n Wi-Fi recommendation (*See e.g.*, section V above) and its capability to support at least 540 Mbps throughput using two 20 MHz OFDM subchannels and four MIMO spatial streams (antenna pairs), a POSITA would have known that at least four (double the amount of 802.11n) 20 MHz subchannels and at least four MIMO spatial streams (antenna pairs) would be needed to meet or exceed the 1 Gbps throughput requirement.

233. A POSITA would have also realized that the 1 Gbps throughput requirement could have been met by: (1) increasing the number of bonded OFDM subchannels above four; or by (2) increasing the number of MIMO spatial streams (antenna pairs) being used above four; or (3) a combination of these two configurations.

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234. The limitations set forth in claims 9/13 would have been obvious to a POSITA for the reasons discussed regarding Ground 1, claim 9/13. Maltsev discloses both non-Access Point (AP) stations (Fig. 1, CU 102) and AP stations (Fig. 1, AP 104). Agrawal also discloses both non-Access Point (AP) stations (106, 108) and AP stations (102, 104).

235. Maltsev discloses an OFDM system having a channel divided into subchannels. Specifically, Fig. 3 shows the channel bandwidth being divided into four 20 MHz subchannels, CH1-CH4. Referring to Fig. 3, embodiments of Maltsev are equally suitable for use on four or more subchannels within an allocated portion of frequency spectrum 300. In some embodiments, the subchannels may be 20 MHz wide and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum. *Id.* at 4:44-49.



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EX1003, Fig. 3

236. A POSITA would have understood that in Fig. 3 the use of ellipses indicates that more than four subchannels could be employed in a channel.

Maltsev further teaches that the subchannels can each have a bandwidth of 20 MHz for a total channel bandwidth of 80 MHz. *Id.* at 4:44-49.

237. Fracchia identified multiple OFDM configurations that would provide a throughput of 1Gbps or more. These different configurations for the next generation of the Wi-Fi protocol would have motivated a POSITA working in the field of Wi-Fi communications to consider the best combinations for the optimal number of subchannels and MIMO spatial streams to use to meet or exceed the 1 Gbps throughput goal.

238. Fracchia clearly states that its analysis is to determine the feasibility for achieving 1 Gbps throughput for the current Wi-Fi networks (below 6 GHz) with:

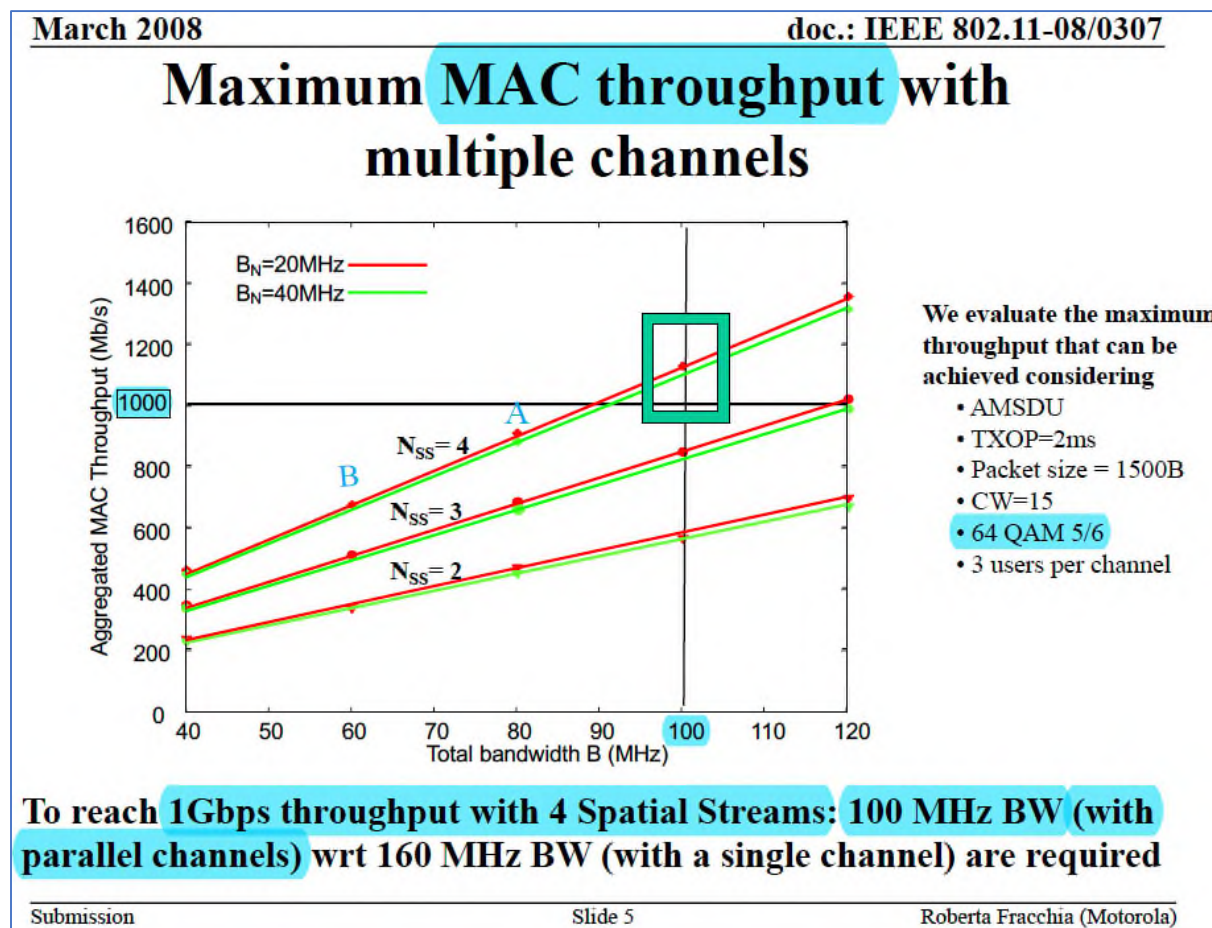
Abstract

This analysis provides inputs on the technical feasibility of achieving 1Gbps aggregated MAC SAP throughput for below 6GHz amendment, by using different MAC layers which manage the access to different parallel channels

Ex. 1009 at p. 2, emphasis added.

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239. In its configuration and performance results graph shown below, Fracchia shows the resulting throughput as a function of channel width for the number of OFDM subchannels being used when they are transmitted over four MIMO “Spatial Streams” (antenna pairs).



Id. at p. 5.

For example, this graph indicates that an 80 MHz channel with four 20 MHz subchannels¹⁵ ($4 * 20 = 80 \text{ MHz}$) could provide a MAC throughput on the X axis

¹⁵ The throughput for 20 MHz subchannels is shown by the red line in the graph.

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of around 900 Mbps (Annotation “A”), which is just below the target of 1 Gbps (1,000 Mbps). Fracchia further provides empirical support that additional subchannels provide a significant increase in the data throughput. Specifically, by increasing from three 20 MHz subchannels with a 60 MHz channel bandwidth (Annotation “B”) to four 20 MHz subchannels with an 80 MHz channel (A), the MAC throughput on the X axis increases from about 700 Mbps to around 900 Mbps. From this resulting increase of about 200 Mbps in data throughput for one 20 MHz subchannel, a POSITA would have readily understood that by increasing the number of 20 MHz subchannels from four to five with a 100 MHz channel bandwidth, the data throughput would increase to well over 1Gbps as shown by green rectangle annotation. In other words, Fracchia shows that the throughput goal of 1Gbps would be exceeded when using five 20 MHz subchannels.

240. As also discussed for Ground 1 above, Maltsev disclosed in Fig. 3 and its associated text that more than four subchannels can be used to increase the data throughput. Referring to Fig. 3, Maltsev teaches that some of its embodiments are said to be equally suitable for use of four **or more channels within an allocated portion of frequency spectrum 300**. *Id.* at 4:44-49. Thus, a POSITA would have easily understood from Fracchia that 1Gbps data throughput could be accomplished by using the system of Fig. 3 of Maltsev with five 20 MHz subchannels.

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241. In sum, prior to the earliest priority date of the '346 patent, Fracchia demonstrated a significant increase in data throughput when increasing the number of 20 MHz subchannels from two to five (40 MHz to 100 MHz channel bandwidth). Thus, a POSITA would have had a reasonable expectation of success in achieving the data throughput goal of 1Gbps by adopting an OFDM system with five 20 MHz subchannels using a 100 MHz channel bandwidth. This is also consistent with Maltsev's disclosure in Fig. 3 that more than four 20 MHz subchannels can be used. Therefore, the end result of this combination would be a VHT device as recited in claim 12.

242. Thus, given the motivation to provide a station with a higher data throughput of at least 1Gbps, a POSITA would have used Fracchia, which shows the 1 Gbps throughput would be exceeded when using five 20 MHz subchannels and four MIMO spatial streams and combine it with the teachings of Maltsev and Agrawal to achieve the limitations of claim 12 and independent claim 9. This would be the same for a "non-Access Point (AP) station" and a "VHT AP station."

C. Claim 16: "The device of claim 13, wherein the device is a Very High Throughput (VHT) non-Access Point (AP) station and the station from which the plurality of RTS frames are received is a VHT AP station."

243. In applying the prior art to claim 16, I have applied the constructions set forth in Section VIII.B.i.-iii, supra, for "Very High Throughput (VHT)" which

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is "processing speed of 1 Gbps or more in the multi-channel environment." Ex. 1013 at p. 6.

244. The additional limitations of claim 16 are fully met by the combination of Maltsev and Agrawal further modified by the teaching of Fracchia for the reasons provided above for Ground 2, Claim 12.

XII. GROUND 3: CLAIMS 12 AND 16 OF THE '346 PATENT ARE UNPATENTABLE UNDER 35 U.S.C. §103 OVER MALTSEV IN VIEW OF AGRAWAL MODIFIED IN VIEW OF SADOWSKY

A. Motivation to Combine Sadowsky with Maltsev and Agrawal.

245. I have described the motivation to combine Maltsev and Agrawal in Ground 1 above. A POSITA would have been motivated to combine Sadowsky with Maltsev and Agrawal for multiple reasons. First, as described above in section IX.F, Maltsev is also Sadowsky a co-inventor. Second, the Maltsev and Sadowsky patents were created during the same time frame. See section IX subsections A and F. Third, both patents are regarding OFDM transmission in a wireless network with embodiments for the IEEE 802.11 Wi-Fi standard. See *e.g.*, Ex. 1003 at 3:1-50 and Ex. 1015 at 7:5-15. Fourth, both patents are focused on improving the efficiency and throughput of wideband wireless communications.

246. Therefore, a POSITA would have looked to Sadowsky to understand how multiple MIMO spatial streams that are being communicated using multiple

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antenna pairs can be combined with Maltsev's multiple bonded OFDM 20 MHz subchannels to increase the data throughput in a Wi-Fi system and how to use the RTS/CTS protocol for individual subchannels as defined in both Maltsev and Agrawal as described above in Ground 1 above.

B. Claim 12: “The method of claim 9, wherein the first station is a Very High Throughput (VHT) non-Access Point (AP) station and the second station is a VHT AP station.”

247. Again, it is important to note that claim 12 requires a plurality of subchannels having a 20 MHz bandwidth, but places no specific limit on the number of the plurality of 20 MHz subchannels used to implement the RTS/CTS protocol. Thus, two or more subchannels and also more than four subchannels meet the “plurality” limitation. In other words, the number of the plurality of 20 MHz subchannels within the scope of claim 12 can be more than four, e.g., five subchannels.

248. In applying the prior art to claim 12, I have applied the constructions set forth in Section VIII.B., *supra*, for “Very High Throughput (VHT)” which is “processing speed of 1 Gbps or more in the multi-channel environment.” Ex. 1013 at p. 6.

249. I additionally note that, other than using the RTS/CTS protocol over the “plurality of subchannels” as required by Claim 9, Claim 12 does not recite any additional steps or elements to be applied to provide Very High Throughput (VHT)

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stations. Based on at least the prior art 802.11n Wi-Fi recommendation (See e.g., section V above) and its capability to support at least 540 Mbps throughput using two 20 MHz OFDM subchannels and four MIMO spatial streams (antenna pairs), a POSITA would have known that at least four (double the amount of 802.11n) 20 MHz subchannels and at least four MIMO spatial streams (antenna pairs) would result 1 Gbps or higher throughput.

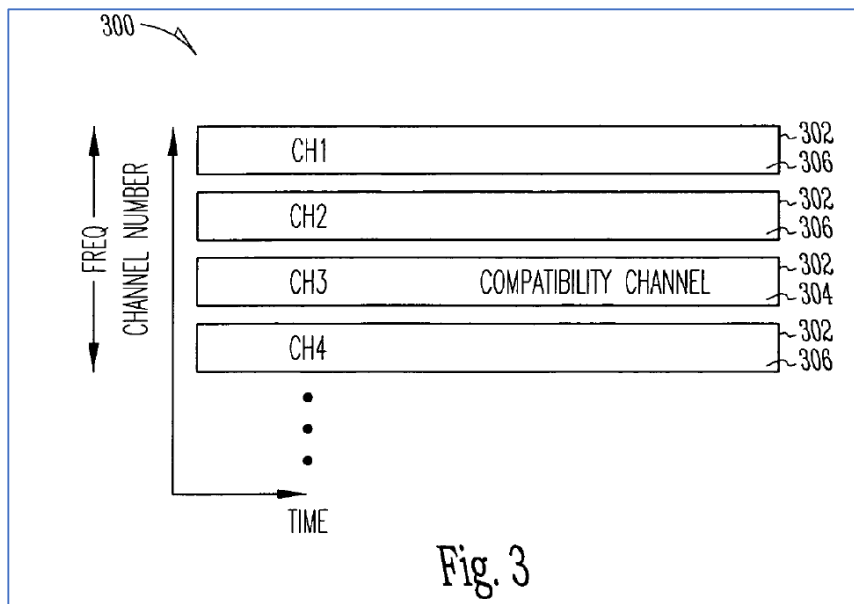
250. A POSITA would have also realized that the 1 Gbps throughput requirement could have been met by: (1) increasing the number of bonded OFDM subchannels above four; (2) increasing the number of MIMO spatial streams (antenna pairs) being used above four; or (3) a combination of these two configurations.

251. The limitations set forth in claim 9 would have been obvious to a POSITA for the reasons discussed regarding Ground 1, claim 9. Maltsev discloses both non-Access Point (AP) stations (Fig. 1, CU 102) and AP stations (Fig. 1, AP 104). Agrawal also discloses both non-Access Point (AP) stations (106, 108) and AP stations (102, 104).

252. Maltsev discloses an OFDM system having a channel divided into subchannels. Specifically, Fig. 3 shows the channel bandwidth being divided into four 20 MHz subchannels, CH1-CH4. Referring to Fig. 3, embodiments of Maltsev are equally suitable for use on four or more subchannels within an

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allocated portion of frequency spectrum 300. In some embodiments, the subchannels may be 20 MHz wide and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum. *Id.* at 4:44-49.



EX1003, Fig. 3

253. A POSITA would have understood that in Fig. 3 the use of ellipses indicates that more than four subchannels could be employed in a channel. Maltsev further teaches that the subchannels can each have a bandwidth of 20 MHz for a total channel bandwidth of 80 MHz. *Id.* at 4:41-49.

254. As described above in Section IX.F, above, Sadowsky's invention can create many separate MIMO spatial data streams (antenna pairs) to transfer the data for four or more OFDM subchannels. Sadowsky discloses these capabilities in multiple places in its specification, but the passage below provides a good

overview for most of the techniques used by Sadowsky to increase the data throughput capability of a device.

In some embodiments, transmitter 100 may transmit an OFDM symbol on a wideband communication channel. **The wideband channel may comprise one or more subchannels.** The subchannels may be frequency-division multiplexed (i.e., separated in frequency) and may be within a predetermined frequency spectrum. **The subchannels may include more than one spatial channel** and the spatial channels of a particular subchannel may use the same set of orthogonal subcarriers. In some embodiments, **a wideband channel may comprise up to four or more subchannels, and** each subchannel may have up to forty-eight or more orthogonal data subcarriers. Each subchannel may have a **number of spatial channels determined by the number of RF chains.** In some of these embodiments, the subchannels may have bandwidths of approximately **20 MHz**, and each OFDM subcarrier of each spatial channel of a subchannel may be assigned an individual spatial-frequency subcarrier modulation assignment between zero and ten or more bits per symbol. In these embodiments, **transmitter 100 may transmit the OFDM symbol over the spatial channels of the**

subchannels that comprise the wideband channel. Subchannels with greater or lesser bandwidths may also be suitable.

Ex. 1015 at 5:30-51 (emphasis added).

255. Based on the teachings of Sadowsky, a POSITA would have understood that its invention: (1) is a device for use in a wireless communication system that has a channel bandwidth of 60 MHz or higher; (2) has a channel bandwidth that comprises three or more contiguous subchannels with an equal bandwidth; and (4) it can achieve a throughput of 1 Gbps or more, which are the requirements stated by the construction for a VHT device above.

256. Based on the teachings of Sadowsky, there are multiple configurations that a POSITA could have used to meet or exceed a 1 Gbps throughput.

257. Two significant variables that affect throughput taught by Maltsev and Sadowsky are the number of subchannels and the number of MIMO spatial streams used. Sadowski teaches that each of these variables can be configured independently and the addition of a subchannel and/or a MIMO spatial stream provides significant additional throughput. As described in section IX.F above for Sadowsky, the addition of each OFDM subchannel provides an equal contribution to the overall throughput. For example, the throughput for two subchannels would double the throughput of one subchannel and the throughput for four subchannels would be double the throughput of two channels. This concept is also supported

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by the prior art 802.11n Wi-Fi standard described section V.C. above. Sadowsky also teaches that the addition of each MIMO spatial stream (antenna pair) linearly increases the throughput and then number of spatial streams can be less than 100.

258. To achieve the 1 Gbps throughput requirement based on the teachings of Sadowski and knowledge of the prior art 802.11n standard, a POSITA would have understood that if the two OFDM subchannels defined for 802.11n is increased to four subchannels as taught by Maltsev, the throughput would be doubled. Thus, the throughput, as stated by the '346 patent for the 802.11n standard of 540 Mbps (Ex. 1001 at 2:12-17), would be doubled to 1.08 Gbps, which exceeds the 1 Gbps requirement.

259. A POSITA would have also understood from Sadowsky that in addition to adding additional OFDM subchannels, one or more additional MIMO spatial streams could also be added, which would further increase the throughput well above the 1 Gbps requirement. Using these teachings of Maltsev and Sadowsky, a POSITA would understand that the combination of Maltsev and Agrawal modified in view of Sadowsky would provide VHT Access Point stations and non-Access Point stations and would have rendered Claim 12 obvious at the time.

260. Using additional subchannels and/or additional MIMO spatial streams to increase the throughput for the next generation of the Wi-Fi standard would

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have motivated a POSITA working in the field of Wi-Fi communications to consider the best combination for the optimal number of subchannels and MIMO spatial streams to use in order to meet or exceed the 1 Gbps throughput goal for each type of device being designed.

261. Given the fact that 802.11 had already demonstrated the successful combination of OFDM and MIMO technologies, A POSITA would have had a reasonable expectation of success in achieving the data throughput goal of 1Gbps according to the teachings of Sadowsky and Maltsev.

C. Claim 16: “The device of claim 13, wherein the device is a Very High Throughput (VHT) non-Access Point (AP) station and the station from which the plurality of RTS frames are received is a VHT AP station.”

262. In applying the prior art to claim 16, I have applied the constructions set forth in Section VIII.B.i.-iii, supra, for "Very High Throughput (VHT)" which is "processing speed of 1 Gbps or more in the multi-channel environment." Ex. 1013 at p. 6.

263. The additional limitations of claim 16 are fully met by the combination of Maltsev and Agrawal further modified by the teaching of Sadowsky for the reasons provided above for Ground 3, Claim 12.

XIII. GROUND 4: CLAIMS 9, 10, 13, AND 14 OF THE '346 PATENT ARE UNPATENTABLE UNDER 35 U.S.C. §103 OVER MALTSEV IN VIEW OF XHAFA

264. The Maltsev reference is described above for Ground 1. As indicated by its title, “Reducing Collisions in Wireless Systems” Xhafa et. al. (“Xhafa”, Ex. 1005) is directed to techniques for reducing/eliminating data collisions on wireless network channels. Ex. 1005 at [0004].

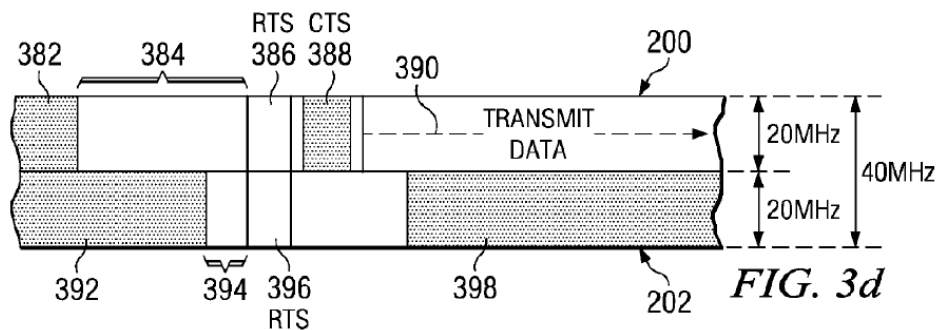
265. Specifically, Xhafa discloses Wireless Local Area Network (WLAN) systems for various IEEE 802.11 Wi-Fi standards where the access points (APs) and stations (STAs) communicate with each other by transmitting data in channels with 20 MHz bandwidths. Id. at [0002]. Xhafa also teaches that the members of the WLAN may communicate with each other “using multiple channels of 20 MHz each, effectively transmitting data in a ‘superchannel’ with 40 MHz of bandwidth.” Id. at [0003].

266. Like discussed in Ground 1 in relation to Maltsev and Agrawal, Xhafa also teaches using the RTS/CTS protocol to minimize collisions. See e.g., Id. at [0027].

267. Xhafa further teaches that when RTS signals are sent on multiple subchannels and a resulting CTS may be received on only one subchannel so the transmitting station only sends data on the same subchannel over which it received the CTS signal: “Thus, because the logic 302 does not receive a CTS in response to

its RTS on the extension channel 202, the logic 302 determines that the extension channel is busy and transmits data only on the control channel 200.” Id.

268. This situation is shown by Fig. 3d below and is described at id. at [0028-29].



Id. Fig. 3d.

269. Described briefly, the station that desires to transmit on both 20 MHz subchannels, sends a RTS 386 and 396 on each of the 20 MHz subchannels. In response to the RTS, it only receives the CTS 388 on the idle 20 MHz channel 200 and, therefore, only sends the “transmit data 390” on the same channel over which it received the CTS. No CTS signal is sent over channel 202 because it is not idle.

A. Motivation to Combine Maltsev with Xhafa

270. A POSITA would be motivated to combine Maltsev and Xhafa for at least the following reasons and as described in the paragraphs directly above. First, both references have at least one embodiment for 20 MHz bonded subchannel operation in a wireless OFDM system. Second, both references teach that the RTS/CTS protocol (See, section VII.B above) can be used for more

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efficient operation in an IEEE 802.11 wireless network. A POSITA would look to Xhafa to understand multiple methods the RTS/CTS protocol could be used on an OFDM system that uses multiple subchannels to transfer data on one or more of the available subchannels because it provides more embodiments, detail, and drawings than Maltsev's disclosure of using the RTS/CTS protocol on the subchannels.

B. Independent Claim 9

i. Limitation 9[pre]: “A method for receiving data in a wireless communication system, method comprising:”

271. Maltsev teaches this limitation for the reasons discussed for Ground 1, Claim 9, Limitation 9[pre].

ii. Limitation 9[1], “receiving, by a first station, a plurality of request to send (RTS) frames from a second station through a plurality of subchannels, each of the plurality of RTS frames being received through a corresponding one of the plurality of subchannels, each of the plurality of subchannels having a 20 megahertz (MHz) bandwidth;”

272. Maltsev teaches this limitation for the reasons discussed regarding Ground 1, Claim 9, Limitation 9[1].

iii. Limitation 9[2], “transmitting, by the first station, at least one clear to send (CTS) frame in response to at least one of the plurality of RTS frames from the second station through at least one idle subchannel of the plurality of subchannels; and”

273. Maltsev discloses an RTS/CTS exchange used with control frames in the wider-band channel with channelization information. Ex. 1003 at 7:45-47.

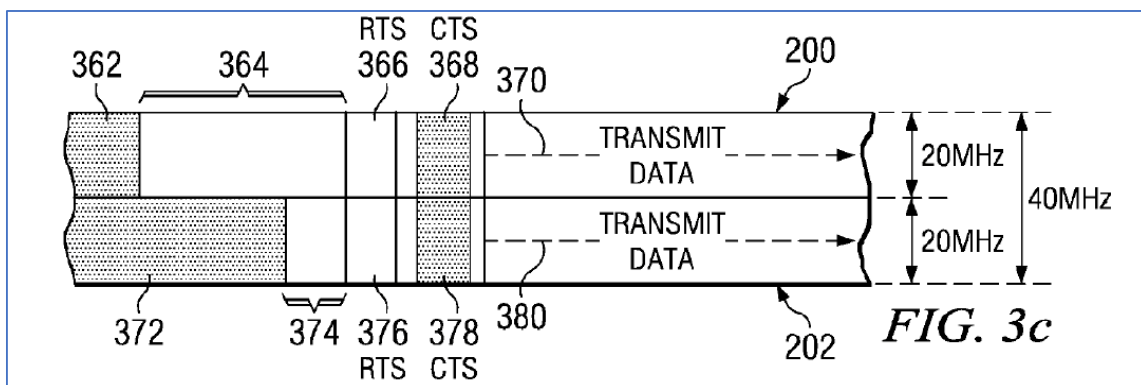
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274. Frames of format 400 are used by a MAC layer of a CU to adapt dynamically to channel conditions by measuring the state of a channel and providing feedback on channel state. The RTS/CTS exchange is used with control frames in the wider-band channel with channelization information. Id. at 7:42-47.

275. Maltsev discloses that decisions about current channel state are dynamically made by a wider-band CU based on current measurements, information obtained from received packets, and statistical information. Id. at 4:65-5:3.

276. Xhafa further discloses using the same RTS/CTS protocol as used in Maltsev. While Maltsev discloses four or more subchannels, the examples of Xhafa focus on a bandwidth of 40 MHz “super channel” comprising two 20 MHz channels 200, 202. Id. at [0023], [0026].

277. FIGs 3c and 3d shown below are relevant embodiments for the operation of Xhafa.

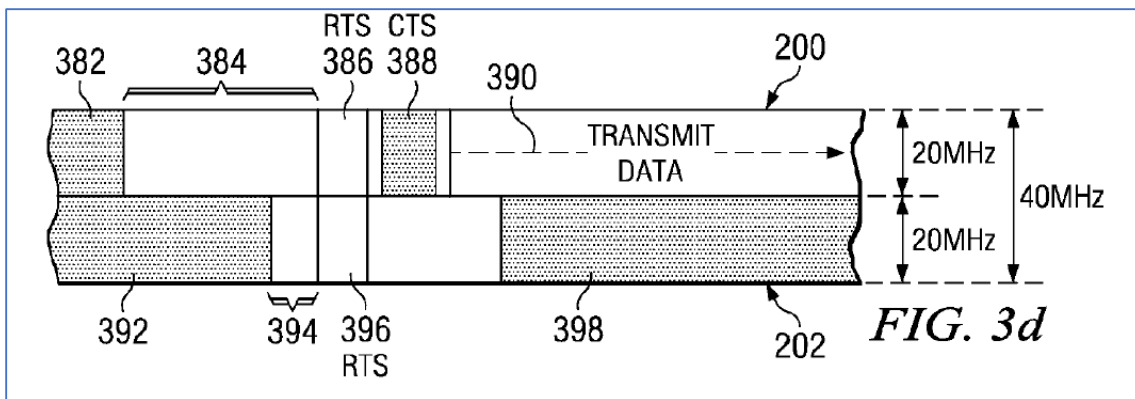


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Ex. 1005 at FIG. 3c.

278. Fig 3c shown above and its descriptive text disclose that RTS signal 366 is transmitted on channel 200 and RTS signal 376 is transmitted on channel 202. In response to the RTS signals 366, 376, CTS signals 368 and 378 are received on channels 200 and 202, respectively. *Id.* at [0025 – 0026].

279. Fig 3d shows an alternate embodiment.



Ex. 1005 at FIG. 3d.

280. Fig 3d and its descriptive text describe disclose that RTS signals 386 and 396 are sent on the channels 200 and 202, respectively. However, CTS signal 388 is received only on channel 388 because a collision on channel 202 prevented the RTS signal 396 from being received, i.e., channel 202 was not idle. Consequently, data is only sent on channel 200. See e.g., *Id.* at [0028], [0029].

281. Thus, if it is determined that Maltsev does not disclose this limitation, Xhafa would have taught a POSITA to modify Maltsev to transmit “by the first station, at least one clear to send (CTS) frame in response to at least one of the

plurality of RTS frames from the second station through at least one idle subchannel of the plurality of subchannels” as recited in limitation 9[2].

iv. Limitation 9[3]: “receiving, by the first station, a data frame from the second station after transmitting the at least one CTS frame,”

282. Maltsev teaches this limitation for the reasons discussed in Ground 1, claim 9, Limitation 9[3]/13[5].

283. Further, Xhafa shows this in FIG. 3d, above, and its corresponding description in the specification. *Id.* at [0029].

v. Limitation 9[4]: “wherein the at least one CTS frame includes channel information related to the at least one idle subchannel through which the CTS frame is transmitted by the first station and the data frame is received through the at least one idle subchannel indicated by the channel information, and”

284. Maltsev discloses this limitation as discussed with respect to Ground 1, claim 1, Limitation 9[4].

285. Xhafa also teaches this limitation as described above regarding the embodiment of FIG. 3d and its description text. *Id.* at [0028], [0029].

vi. Limitation [9.5]: “wherein a number of the at least one idle subchannel through which the CTS frame is transmitted is less than a number of the plurality of subchannels through which the plurality of RTS frames are received.”

286. This additional limitation is met because Xhafa discloses sending a separate RTS signal on each of two 20 MHz channels 200, 202 of the 40 MHz

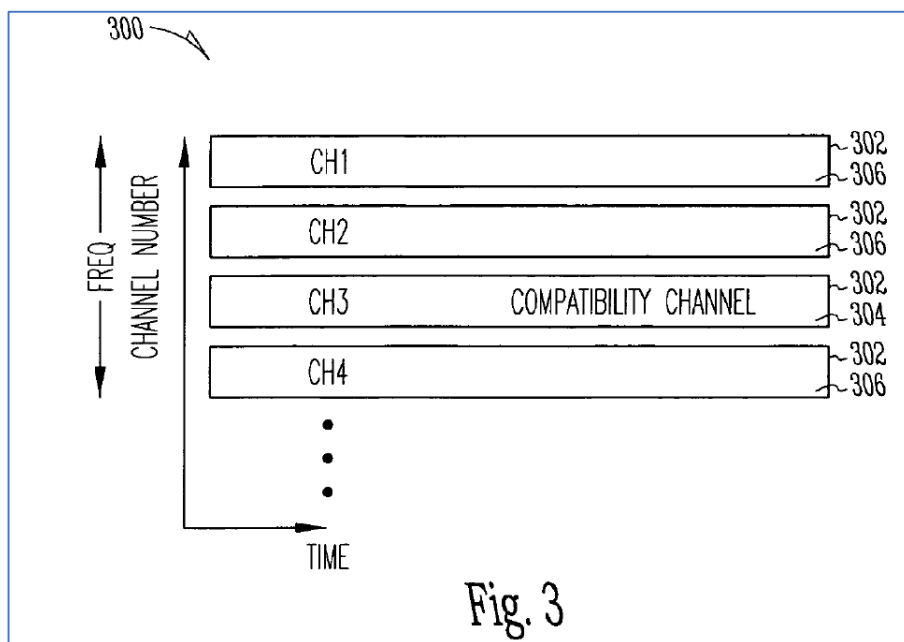
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super-channel and receiving a CTS signal 388 on only one channel, i.e., channel 200 and not channel 202. Id. at FIG. 3d and [0028], [0029].

C. Claim 10: “The method of claim 9, wherein the number of the at least one idle subchannel is 1 or 2 when the number of the plurality of subchannels is 4.”

287. Claim 10 is obvious over the combination of Maltsev modified in view of Xhafa.

288. Maltsev discloses a system having a channel divided into subchannels. Specifically, Fig. 3 shows the channel bandwidth being divided into four 20 MHz subchannels, CH1-CH4. Referring to Fig. 3, embodiments of Maltsev are equally suitable for use on four or more subchannels within an allocated portion of frequency spectrum 300. In some embodiments, the subchannels may be 20 MHz wide and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum. Id. at 4:44-49.



EX1003, Fig. 3

289. Thus, while Maltsev discloses the use of four or more 20 MHz subchannels, in Fig. 3 Maltsev explicitly teaches an embodiment using subchannels CH1-CH4, i.e., wherein the “number of the plurality of subchannels is 4.”

290. As discussed with regard to Ground 4, limitation 9[5]/13[5], Xhafa teaches transmitting RTS signals over all 20 MHz channels that comprise the 40 MHz super channel but only receiving a CTS signal on one of the 20 MHz channels because the other 20 MHz channel was busy. A POSITA would have understood that in modifying Maltsev’s four 20 MHz subchannel embodiment in view of the teachings of Xhafa, CTS signals would be received only on subchannels that were not busy.

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291. Maltsev further teaches that frames of format 400 are used by a MAC layer of a CU to adapt dynamically to channel quality conditions by measuring the state of a channel and providing feedback on channel state. *Id.* at 7:42-47.

292. A POSITA would have recognized from Maltsev and Xhafa that channel conditions change dynamically as channels transition between the busy and idle states due to communication traffic from other stations over the channel. The amount of interference (noise) on each subchannel is typically different because each subchannel uses a different frequency and they are affected differently. Xhafa in FIG. 3d shows a two-channel system where RTS signal are transmitted over all (both) of the 20 MHz channels 200 and 202 and a CTS signal is transmitted over only one channel because the other channel has transitioned to the busy state such that the RTS signal on that channel was not received. Thus, a POSITA would have understood, that in the four subchannel embodiment of Maltsev, if due to the dynamic transitions in channel state or different levels of interference, only two subchannels were idle or met the quality requirement, CTS signals would be received over only the remaining two idle subchannels and if only one subchannel is idle or has an acceptable interference level, only a single CTS signal would be received.

293. Thus, dependent claim 10 would have been obvious over Maltsev modified in view of Xhafa.

D. Independent Claim 13

i. Limitation 13[pre]: “A device comprising:”

294. The preamble of independent claim 13 is not limiting.

ii. Limitation 13[1]: “a transceiver; and”

295. Maltsev teaches this limitation for the reasons discussed for Ground 1, Claim 13, Limitation 13[1].

iii. Limitation 13[2]: “a processor operatively connected to the transceiver and configured to:”

296. Maltsev teaches this limitation for the reasons discussed for Ground 1, Claim 13, Limitation 13[2].

iv. Limitation 13[3]: “instruct the transceiver to receive a plurality of request to send (RTS) frames from a station through a plurality of subchannels, each of the plurality of RTS frames being received through a corresponding one of the plurality of subchannels, each of the plurality of subchannels having a 20 megahertz (MHz) bandwidth,”

297. This limitation is met by Maltsev for the reasons provided for Ground 4, Claim 9, Limitation 9[1].

v. Limitation 13[4]: “instruct the transceiver to transmit at least one clear to send (CTS) frame in response to at least one of the plurality of RTS frames to the station through at least one idle subchannel of the plurality of subchannels, and”

298. This limitation is met for the reasons provided for Ground 4, Claim 9, limitation 9[2].

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- vi. Limitation 13[5]: “instruct the transceiver to receive a data frame to the station after transmitting the at least one CTS frame,”**

299. This limitation is met for the reasons provided for Ground 4, Claim 9, limitation 9[3].

- vii. Limitation 13[6]: “wherein the at least one CTS frame includes channel information related to the at least one idle subchannel through which the CTS frame is transmitted by the device and the data frame is received through the at least one idle subchannel indicated by the channel information, and”**

300. This limitation is met for the reasons provided for Ground 4, Claim 9, limitation 9[4].

- viii. Limitation 13[7]: “wherein a number of the at least one idle subchannel through which the CTS frame is transmitted is less than a number of the plurality of subchannels through which the plurality of RTS frames are received.”**

301. This limitation is met for the reasons provided for Ground 4, Claim 9, limitation 9[5].

- E. Claim 14: “The device of claim 13, wherein the number of the at least one idle subchannel is 1 or 2 when the number of the plurality of subchannels is 4.”**

302. This limitation is met for the reasons provided for Ground 4, Claim 10.

**XIV. GROUND 5: CLAIMS 12 AND 16 OF THE '346 PATENT ARE
UNPATENTABLE UNDER 35 U.S.C. §103 OVER MALTSEV IN
VIEW OF XHAFA MODIFIED IN VIEW OF FRACCHIA**

A. Motivation to Combine Maltsev and Xhafa with Fracchia

303. The Background of the Invention section of the '346 patent and Fracchia state the continuing motivation to increase the throughput of systems compatible with the various versions of the 802.11 Wi-Fi standards. This motivation continued even after the previously released 802.11n standard increased the data throughput over the previous Wi-Fi systems by ten-fold (See e.g., Section V.C).

With the widespread use of WLAN and the diversification of applications using the WLAN, there is a demand for a new WLAN system to support a higher throughput.”

Ex. 1001 at 3:6-9.

This analysis provides inputs on the technical feasibility of achieving 1Gbps aggregated MAC SAP throughput for below 6GHz amendment, by using different MAC layers which manage the access to different parallel channels.

Ex. 1009 at p.2.

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304. I have described the reasons that a POSITA would combine Maltsev and Xhafa in Ground 4 above. A POSITA would be motivated to further combine Fracchia with Maltsev and Xhafa for at least the following reasons.

305. First, they all have at least one embodiment or example that is specific to IEEE 802.11 (Wi-Fi) wireless communications. See e.g., Ex. 1003 at 3:1-50, Ex. 1004 at [0040] and Ex. 1005 at [0002-0004]. Second, they all are in regard to OFDM wireless communications. See e.g., Ex. 1003 at 2:18-32; Ex. 1004 at [0037], [0062] and [0067]; and Ex. 1005 at [0002-0003]. Third, they are all focused on the same objective—improving the throughput (data speed) of high throughput/wideband wireless networks. See e.g., Ex. 1003 at 1:7-27; Ex. 1004 at Abstract; and Ex. 1005 at [0003-0004]. Fourth, Ex. 1009 is an analysis of OFDM wideband techniques and provides specific objectives and functionality that a POSITA would have used to understand the direction of the next IEEE 802.11 release.

306. For this ground, Fracchia provides simulation test data that supports more than the required 1 Gbps throughput will be achieved by: (1) bonding four or more 20 MHz OFDM subchannels together.¹⁶ As described above for Ground 4, Maltsev teaches that each additional bonded OFDM subchannel continues to

¹⁶ The prior art 802.11n standard defines bonding two 20 MHz channels together to make a 40 MHz channel.

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increase the overall data throughput and four or more subchannels can be used for significant increases; (2) that each additional MIMO spatial data stream (antenna pair) will continue to multiply the data throughput when using the four or more of Maltsev's bonded OFDM subchannels; and (3) the 1 Gbps throughput requirement can be exceeded when using five 20 MHz subchannels and four MIMO Spatial Streams (antennas pairs).

B. Claim 12: “The method of claim 9, wherein the first station is a Very High Throughput (VHT) non-Access Point (AP) station and the second station is a VHT AP station.”

307. It is important to note that claim 12 requires a plurality of subchannels having a 20 MHz bandwidth but, in contrast to claim 10, which requires a total of four for the number of the plurality of subchannels, claim 12 places no specific limit on the number of the plurality of 20 MHz subchannels used to implement the RTS/CTS protocol. Thus, two or more subchannels and also more than four subchannels meet the “plurality” limitation. In other words, the number of the plurality of 20 MHz subchannels within the scope of claim 12 can be more than four, e.g., five subchannels.

308. In applying the prior art to claim 12, I have applied the constructions set forth in Section VIII.B.i.-iii, *supra*, for “Very High Throughput (VHT)” which is “processing speed of 1 Gbps or more in the multi-channel environment.” Ex. 1013 at p. 6.

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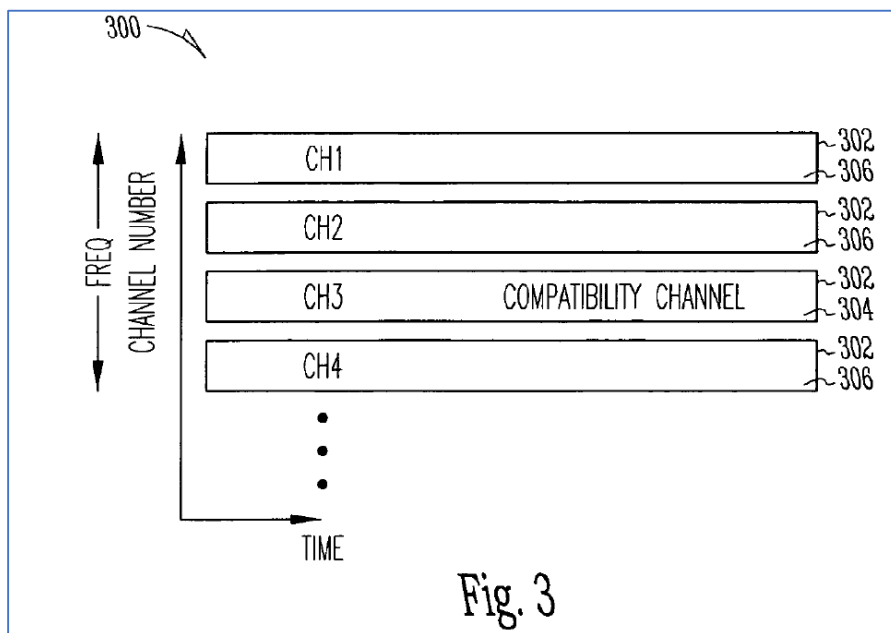
309. I additionally note that, other than using the RTS/CTS protocol over the “plurality of subchannels” as required Claim 9, Claim 12 does not require any additional steps or technology to be applied to the prior art narrowband stations to make them Very High Throughput (VHT) stations. Based on at least the prior art 802.11n Wi-Fi recommendation (See e.g., section V above) and its capability to support at least 540 Mbps throughput using two 20 MHz OFDM subchannels and four MIMO spatial streams (antenna pairs), a POSITA would have known that at least four (double the amount of 802.11n) 20 MHz subchannels and at least four MIMO spatial streams (antenna pairs) would be needed to meet or exceed the 1 Gbps throughput requirement.

310. A POSITA would have also realized that the 1 Gbps throughput requirement could have been met by: (1) increasing the number of bonded OFDM subchannels above four; or by (2) increasing the number of MIMO spatial streams (antenna pairs) being used above four; or (3) a combination of these two configurations.

311. The limitations set forth in claim 9 would have been obvious to a POSITA for the reasons discussed regarding Ground 4, claim 9. Maltsev discloses both non-Access Point (AP) stations (Fig. 1, CU 102) and AP stations (Fig. 1, AP 104). Agrawal also discloses both non-Access Point (AP) stations (106, 108) and AP stations (102, 104).

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312. Maltsev discloses an OFDM system having a channel divided into subchannels. Specifically, Fig. 3 shows the channel bandwidth being divided into four 20 MHz subchannels, CH1-CH4. Referring to Fig. 3, embodiments of Maltsev are equally suitable for use on four or more subchannels within an allocated portion of frequency spectrum 300. In some embodiments, the subchannels may be 20 MHz wide and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum. Id. at 4:44-49.



EX1003, Fig. 3

313. A POSITA would have understood that in Fig. 3 the use of ellipses indicates that more than four subchannels could be employed in a channel. Maltsev further teaches that the subchannels can each have a bandwidth of 20 MHz for a total channel bandwidth of 80 MHz. Id. at 4:44-49.

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314. Fracchia identified multiple OFDM configurations that would provide a throughput of 1Gbps or more. These different configurations for the next generation of the Wi-Fi protocol would have motivated a POSITA working in the field of Wi-Fi communications to consider the best combinations for the optimal number of subchannels and MIMO spatial streams to use to meet or exceed the 1 Gbps throughput goal.

315. Fracchia clearly states that its analysis is to determine the feasibility for achieving 1 Gbps throughput for the current Wi-Fi networks (below 6 GHz) with:

Abstract

This analysis provides inputs on the technical feasibility of achieving 1Gbps aggregated MAC SAP throughput for below 6GHz amendment, by using different MAC layers which manage the access to different parallel channels

Ex. 1009 at p. 2, emphasis added.

316. In its configuration and performance results graph shown below, Fracchia shows the resulting throughput as a function of channel width for the number of OFDM subchannels being used when they are transmitted over four MIMO “Spatial Streams” (antenna pairs). For example, this graph indicates that

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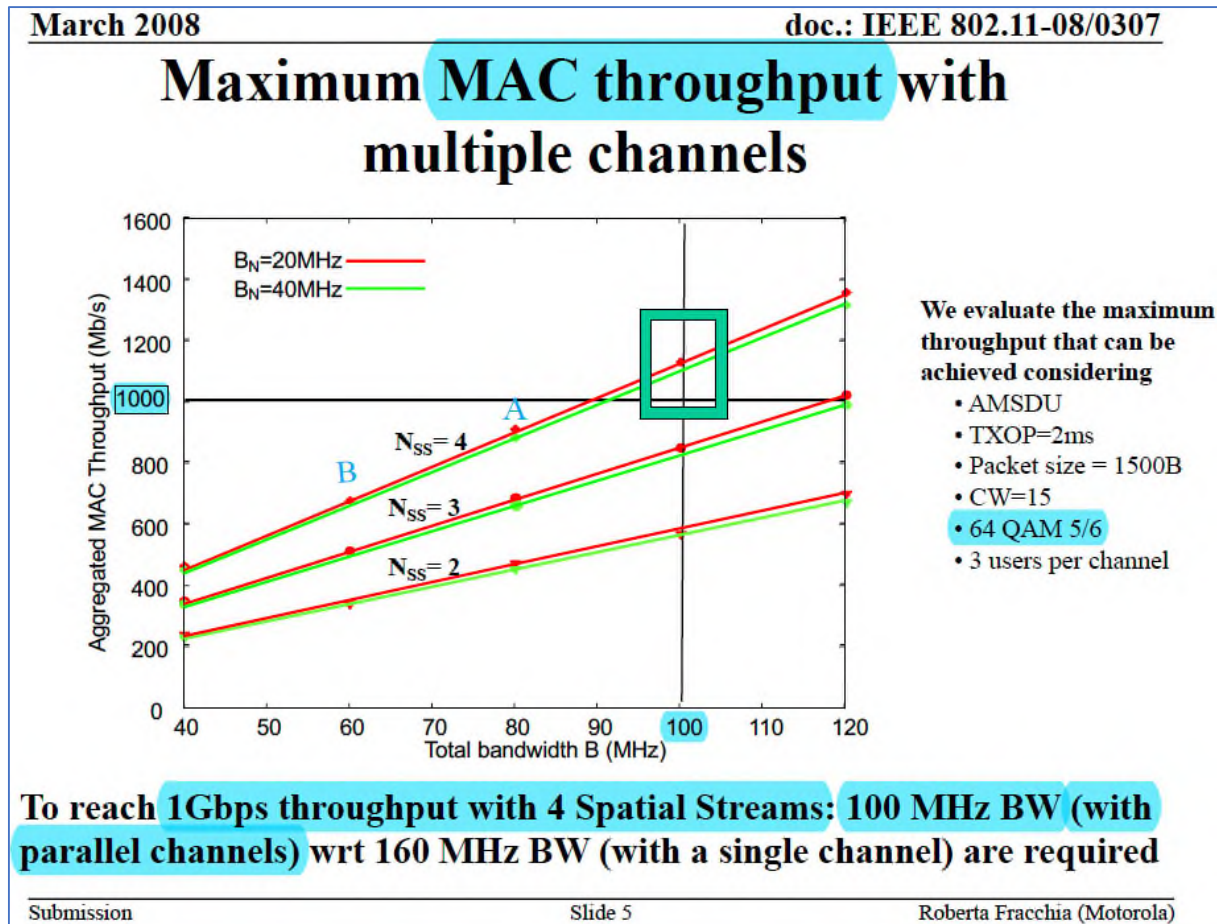
an 80 MHz channel with four 20 MHz subchannels¹⁷ ($4 * 20 = 80$ MHz) could provide a MAC throughput on the X axis of around 900 Mbps (Annotation “A”), which is just below the target of 1 Gbps (1,000 Mbps). Fracchia further provides empirical support that additional subchannels provide a significant increase in the data throughput. Specifically, by increasing from three 20 MHz subchannels with a 60 MHz channel bandwidth (Annotation “B”) to four 20 MHz subchannels with an 80 MHz channel (A), the MAC throughput on the X axis increases from about 700 Mbps to around 900 Mbps. From this resulting increase of about 200 Mbps in data throughput for one 20 MHz subchannel, a POSITA would have readily understood that by increasing the number of 20 MHz subchannels from four to five with a 100 MHz channel bandwidth, the data throughput would increase to well over 1Gbps as shown by green rectangle annotation. In other words, Fracchia shows that the throughput goal of 1Gbps would be exceeded when using five 20 MHz subchannels.

317. As also discussed for Ground 1 above, Maltsev disclosed in Fig. 3 and its associated text that more than four subchannels can be used to increase the data throughput. Referring to Fig. 3, Maltsev teaches that some of its embodiments are said to be equally suitable for use of four or more channels within an allocated

¹⁷ The throughput for 20 MHz subchannels is shown by the red line in the graph.

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portion of frequency spectrum 300. *Id.* at 4:44-49. Thus, a POSITA would have easily understood from Fracchia that 1Gbps data throughput could be accomplished by using the system of Fig. 3 of Maltsev with five 20 MHz subchannels.



Id. p. 5 (highlighting added).

318. In sum, prior to the earliest priority date of the '346 patent, Fracchia demonstrated a significant increase in data throughput when increasing the number of 20 MHz subchannels from two to five (40 MHz to 100 MHz channel bandwidth). Thus, a POSITA would have had a reasonable expectation of success

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in achieving the data throughput goal of 1Gbps by adopting an OFDM system with five 20 MHz subchannels using a 100 MHz channel bandwidth. This is also consistent with Maltsev's disclosure in Fig. 3 that more than four 20 MHz subchannels can be used. Therefore, the result of this combination would be a VHT device as recited in claim 12.

319. Thus, given the motivation to provide a station with a higher data throughput of at least 1Gbps, a POSITA would have used Fracchia, which shows the 1 Gbps throughput would be exceeded when using five 20 MHz subchannels and four MIMO spatial streams and combine it with the teachings of Maltsev and Xhafa to achieve the limitations of claim 12 and independent claim 9. This would be the same for a "non-Access Point (AP) station" and a "VHT AP station."

C. Claim 16: "The device of claim 13, wherein the device is a Very High Throughput (VHT) non-Access Point (AP) station and the station from which the plurality of RTS frames are received is a VHT AP station."

320. In applying the prior art to claim 16, I have applied the constructions set forth in Section VIII.B.i.-iii, supra, for "Very High Throughput (VHT)" which is "processing speed of 1 Gbps or more in the multi-channel environment." Ex. 1013 at p. 6.

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321. The additional limitations of claim 16 are fully met by the combination of Maltsev and Xhafa further modified by the teaching of Fracchia for the reasons provided above for Ground 4, Claim 12.

XV. GROUND 6: CLAIMS 12 AND 16 OF THE '346 PATENT ARE UNPATENTABLE UNDER 35 U.S.C. §103 OVER MALTSEV IN VIEW OF XHAFA MODIFIED IN VIEW OF SADOWSKY

A. Motivation to Combine Sadowsky with Maltsev and Xhafa.

322. I have described the motivation to combine Maltsev and Xhafa in Ground 4 above. A POSITA would have been motivated to combine Sadowsky with Maltsev and Xhafa for multiple reasons. First, as described above in section IX.F, Maltsev is also Sadowsky a co-inventor. Second, the Maltsev and Sadowsky patents were created during the same time frame. See section IX subsections A and F. Third, both patents are regarding OFDM transmission in a wireless network with embodiments for the IEEE 802.11 Wi-Fi standard. See e.g., Ex. 1003 at 3:1-50 and Ex. 1015 at 7:5-15. Fourth, both patents are focused on improving the efficiency and throughput of wideband wireless communications.

323. Therefore, a POSITA would have looked to Sadowsky to understand how multiple MIMO spatial streams that are being communicated using multiple antenna pairs can be combined with Maltsev's multiple bonded OFDM 20 MHz subchannels to increase the data throughput in a Wi-Fi system and how to use the

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RTS/CTS protocol for individual subchannels as defined in both Maltsev and Xhafa as described above in Ground 4 above.

B. Claim 12: “The method of claim 9, wherein the first station is a Very High Throughput (VHT) non-Access Point (AP) station and the second station is a VHT AP station.”

324. It is important to note that claim 12 requires a plurality of subchannels having a 20 MHz bandwidth but, in contrast to claim 10, which requires a total of four for the number of the plurality of subchannels, claim 12 places no specific limit on the number of the plurality of 20 MHz subchannels used to implement the RTS/CTS protocol. Thus, two or more subchannels and also more than four subchannels meet the “plurality” limitation. In other words, the number of the plurality of 20 MHz subchannels within the scope of claim 12 can be more than four, e.g., five subchannels.

325. In applying the prior art to claim 12, I have applied the constructions set forth in Section VIII.B.i.-iii, supra, for “Very High Throughput (VHT)” which is “processing speed of 1 Gbps or more in the multi-channel environment.” Ex. 1013 at p. 6.

326. I additionally note that, other than using the RTS/CTS protocol over the “plurality of subchannels” as required Claim 9, Claim 12 does not require any additional steps or technology to be applied to the prior art narrowband stations to make them Very High Throughput (VHT) stations. Based on at least the prior art

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802.11n Wi-Fi recommendation (See e.g., section V above) and its capability to support at least 540 Mbps throughput using two 20 MHz OFDM subchannels and four MIMO spatial streams (antenna pairs), a POSITA would have known that at least four (double the amount of 802.11n) 20 MHz subchannels and at least four MIMO spatial streams (antenna pairs) would be needed to meet or exceed the 1 Gbps throughput requirement.

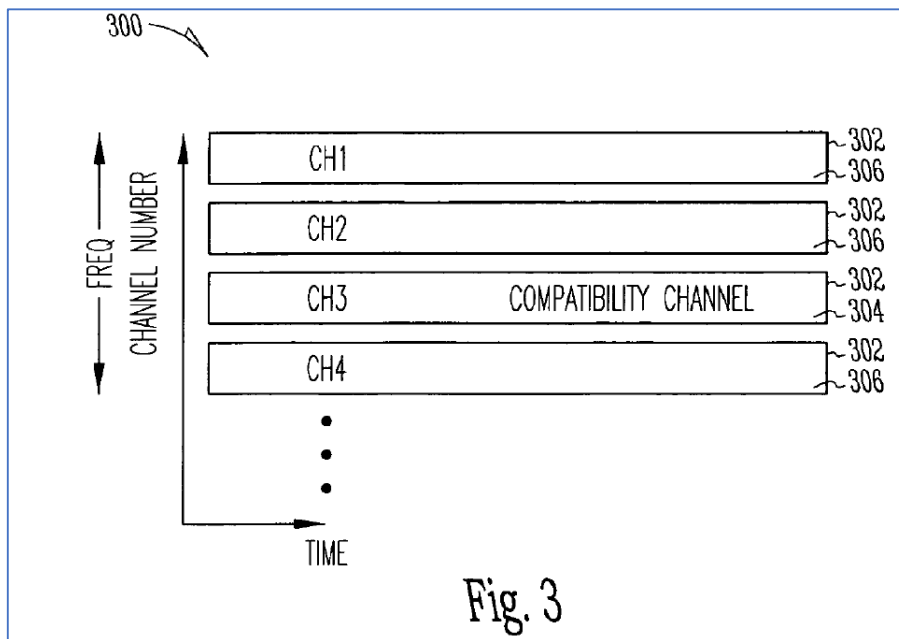
327. A POSITA would have also realized that the 1 Gbps throughput requirement could have been met by: (1) increasing the number of bonded OFDM subchannels above four; or by (2) increasing the number of MIMO spatial streams (antenna pairs) being used above four; or (3) a combination of these two configurations.

328. The limitations set forth in claim 9 would have been obvious to a POSITA for the reasons discussed regarding Ground 1, claim 9. Maltsev discloses both non-Access Point (AP) stations (Fig. 1, CU 102) and AP stations (Fig. 1, AP 104). Agrawal also discloses both non-Access Point (AP) stations (106, 108) and AP stations (102, 104).

329. Maltsev discloses an OFDM system having a channel divided into subchannels. Specifically, Fig. 3 shows the channel bandwidth being divided into four 20 MHz subchannels, CH1-CH4. Referring to Fig. 3, embodiments of Maltsev are equally suitable for use on four or more subchannels within an

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allocated portion of frequency spectrum 300. In some embodiments, the subchannels may be 20 MHz wide and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum. Id. at 4:44-49.



EX1003, Fig. 3

330. A POSITA would have understood that in Fig. 3 the use of ellipses indicates that more than four subchannels could be employed in a channel. Maltsev further teaches that the subchannels can each have a bandwidth of 20 MHz for a total channel bandwidth of 80 MHz. Id. at 4:44-49.

331. As described above in Section IX.F, Sadowsky's invention can create many separate MIMO spatial data streams (antenna pairs) to transfer the data for four or more OFDM subchannels. Sadowsky discloses these capabilities in multiple places in its specification, but the passage below provides a good

overview for most of the techniques used by Sadowsky to increase the data throughput capability of a device.

In some embodiments, transmitter 100 may transmit an OFDM symbol on a wideband communication channel. **The wideband channel may comprise one or more subchannels.** The subchannels may be frequency-division multiplexed (i.e., separated in frequency) and may be within a predetermined frequency spectrum. **The subchannels may include more than one spatial channel** and the spatial channels of a particular subchannel may use the same set of orthogonal subcarriers. In some embodiments, **a wideband channel may comprise up to four or more subchannels, and** each subchannel may have up to forty-eight or more orthogonal data subcarriers. Each subchannel may have a **number of spatial channels determined by the number of RF chains.** In some of these embodiments, the subchannels may have bandwidths of approximately **20 MHz**, and each OFDM subcarrier of each spatial channel of a subchannel may be assigned an individual spatial-frequency subcarrier modulation assignment between zero and ten or more bits per symbol. In these embodiments, **transmitter 100 may transmit the OFDM symbol over the spatial channels of the**

subchannels that comprise the wideband channel. Subchannels with greater or lesser bandwidths may also be suitable.

Ex. 1015 at 5:30-51 (emphasis added).

332. Based on the teachings of Sadowsky, a POSITA would have understood that its invention: (1) is a device for use in a wireless communication system that has a channel bandwidth of 60 MHz or higher; (2) has a channel bandwidth that comprises three or more contiguous subchannels with an equal bandwidth; and (4) it can achieve a throughput of 1 Gbps or more, which are the requirements stated by the construction for a VHT device above.

333. Based on the teachings of Sadowsky, there are multiple configurations that a POSITA could have used to meet or exceed a 1 Gbps throughput.

334. The two most significant variables that affect throughput taught by Sadowsky are the number of subchannels and the number of MIMO spatial streams used. Sadowski teaches that each of these variables can be configured independently and the addition of a subchannel and/or a MIMO spatial stream provides significant additional throughput. As described in section IX.F above for Sadowsky, the addition of each OFDM subchannel provides an equal contribution to the overall throughput. For example, the throughput for two subchannels would double the throughput of one subchannel and the throughput for four subchannels would be double the throughput of two channels. This concept is also supported

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by the prior art 802.11n Wi-Fi standard described section V.C. above. Sadowsky also teaches that the addition of each MIMO spatial stream (antenna pair) linearly increases the throughput and then number of spatial streams can be less than 100.

335. To achieve the 1 Gbps throughput requirement based on the teachings of Sadowski and knowledge of the prior art 802.11n standard, a POSITA would have understood that the two OFDM subchannels defined for 802.11n could be increased to four subchannels and the throughput would be doubled. Thus, the throughput, as stated by the '346 patent for the 802.11n standard of 540 Mbps (Ex. 1001 at 2:12-17), would be doubled to 1.08 Gbps, which exceeds the 1 Gbps requirement.

336. A POSITA would have also understood that in addition to adding additional OFDM subchannels, one or more additional MIMO spatial streams could also be added, which would further increase the throughput well above the 1 Gbps requirement.

337. Using additional subchannels and/or additional MIMO spatial streams to increase the throughput for the next generation of the Wi-Fi standard would have motivated a POSITA working in the field of Wi-Fi communications to consider the best combination for the optimal number of subchannels and MIMO spatial streams to use in order to meet or exceed the 1 Gbps throughput goal for each type of device being designed.

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338. In sum, prior to the earliest priority date of the '346 patent, Sadowsky demonstrated a significant increase in data throughput when increasing the number of 20 MHz subchannels from two to four (40 MHz to 80 MHz channel bandwidth). Thus, a POSITA would have had a reasonable expectation of success in achieving the data throughput goal of 1Gbps by adopting an OFDM system with four 20 MHz subchannels using an 80 MHz channel bandwidth. This is also consistent with Maltsev's disclosure for Fig. 3 that four or more 20 MHz subchannels can be used. Therefore, the result of this combination would be a VHT device as recited in claim 12.

C. Claim 16: "The device of claim 13, wherein the device is a Very High Throughput (VHT) non-Access Point (AP) station and the station from which the plurality of RTS frames are received is a VHT AP station."

339. In applying the prior art to claim 16, I have applied the constructions set forth in Section VIII.B.i.-iii, supra, for "Very High Throughput (VHT)" which is "processing speed of 1 Gbps or more in the multi-channel environment." Ex. 1013 at p. 6.

340. The additional limitations of claim 16 are fully met by the combination of Maltsev and Agrawal further modified by the teaching of Sadowsky for the reasons provided above for Ground 3, Claim 12.

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XVI. CONCLUSION

341. For at least the reasons addressed above, it is my opinion that every claim of the '346 patent is invalid as obvious.

342. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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343. I declare that all statements made herein of my knowledge are true, that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

344. I declare under penalty of perjury that the foregoing is true and correct.

Executed on: April 20, 2023 Mark R. Lanning
Mark R. Lanning