UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NEC CORPORATION (JAPAN)
Petitioner

v.

ADAPTIX, INC.
Patent Owner

Patent 8,934,445

TITLE: MULTI-CARRIER COMMUNICATIONS WITH ADAPTIVE CLUSTER CONFIGURATION AND SWITCHING

DECLARATION OF ZYGMUNT J. HAAS, PH.D. UNDER 37 C.F.R. § 1.68

I, Zygmunt Haas, do hereby declare:

1. I am making this declaration at the request of NEC Corporation (Japan) ("NEC") in the matter of the *Inter Partes* Review of U.S. Patent No. 8,934,445 ("the '445 patent") to Li *et al.*

2. In the preparation of this declaration, I have studied:

(1) The '445 Patent, Ex. 1001;

(2) Declaration of Dr. Sylvia Hall-Ellis, Ph.D., Ex. 1008;

(3) U.S. Patent No. 6,018,528 to Rich Gitlin ("*Gitlin*"), Ex. 1010;

(4) Van Nee, *et al.* "OFDM for Wireless Multimedia Communications" (1999) ("*Van Nee*"), Ex. 1011;

(5) U.S. Patent No. 6,473,467 to Mark Wallace ("*Wallace*"), Ex. 1013;

(6) Lajos Hanzo *et al.*, "Single- and Multi-carrier Quadrature Amplitude Modulation: Principles and Applications for Personal Communications, WLANs and Broadcasting" (1999) ("*Hanzo*") , Ex. 1014;

(7) Theodore Rappaport, "Wireless Communications: Principles & Practice" (1995) ("*Rappaport*"), Ex. 1016;

(8) U.S. Patent No. 6,985,433 to Laroia ("*Laroia*"), Ex. 1018;

(9) U.S. Patent No. 6,006,075 to Smith et al. ("*Smith*"), Ex. 1019;

(10) U.S. Patent No. 6,657,949 to Jones et al. ("*Jones*"), Ex. 1020;

(11) U.S. Patent No. 6,067,290 to Paulraj et al. ("*Paulraj*"), Ex. 1021; and

(12) Yiyan Wu et al., Orthogonal Frequency Division Multiplexing: A Multi-Carrier Modulation Scheme, IEEE Transactions on Consumer Electronics, Vol. 41, No. 3 (Aug. 1995), Ex. 1022;

(13) Prosecution history of 8,934,445 Patent, Ex. 1023; and

(14) Wong et al., "Multiuser OFDM with Adaptive Subcarrier, Bit, and Power

Allocation," IEEE Journal on Selected Areas in Communications, pp. 1747-1758, October 1999, Ex. 1024.

3. In forming the opinions expressed below, I have considered:

(1) The documents listed above, and

(2) My knowledge and experience based upon my work in this area as described below.

I. Qualifications

4. I am a Professor and Distinguished Chair in Computer Science at the University of Texas at Dallas. I am also Professor Emeritus at the School of Electrical and Computer Engineering at Cornell University. In addition, I provided technical consulting services in intellectual property matters, during which I have written expert reports and provided deposition and trial testimony involving wireless communication technologies.

5. My academic credentials include a Bachelor of Science Degree in Electrical Engineering, *summa cum laude*, from Technion (IIT), Israel, in 1979 and a Master of Science Degree in Electrical Engineering, *summa cum laude*, from Tel-Aviv University, Israel, in 1985. I subsequently authored my PhD thesis titled "Packet Switching in Fiber-Optic Networks" as part of earning my Ph.D. in Electrical Engineering from Stanford University in 1988.

6. My professional background and technical qualifications are stated

above and are also reflected in my *Curriculum Vitae,* which is attached as Ex. 1007. I am being compensated at a rate of $450.00 per hour, with reimbursement for actual expenses, for my work related to this Petition for *Inter Partes* Review. My compensation is not dependent on and in no way affects the substance of my statements in this Declaration.

7. I have worked and/or consulted for about 35 years in the field of Electrical Engineering. My primary focus has been on communication and networking systems, with an emphasis on wireless communication networks. I have authored and co-authored numerous technical (journal and conference) papers and book chapters related to wireless communication networks. I am an inventor or co-inventor on eighteen issued patents (including *Gitlin*, which is relied on by Petitioner as a primary reference for Grounds 1-3) in the fields of high-speed networking, wireless networks, and optical switching, with two other patents still pending.

8. My employment history following my graduation from Stanford University began at the Network Research Department of AT&T Bell Laboratories in 1988. At AT&T Bell Laboratories, I pursued research on wireless communications, mobility management, fast protocols, optical networks, and optical switching. During my tenure at AT&T, I also worked for the AT&T Wireless Center of Excellence, where I investigated various aspects of wireless and

mobile networks.

9. In 1995, I joined the faculty of the School of Electrical & Computer Engineering at Cornell University, first as Associate Professor and then I was promoted to Full (Tenured) Professor. At Cornell, I headed the Wireless Networks Lab, which has been an internationally recognized research group with extensive contributions in the area of wireless communication systems and networks. In 2013, I retired from Cornell with the title of Emeritus Professor and joined the Computer Science Department at the University of Texas at Dallas with the title of Professor and Distinguished Chair in Computer Science. At Cornell and at the University of Texas at Dallas, I have taught dozens of courses related to computer networking and wireless communications. I have also served on various committees for the benefit of the scientific community.

10. I am a member of professional societies, including the Institute of Electrical and Electronic Engineers (IEEE) and the Association for Computing Machinery (ACM). In 2007, I was elevated to an IEEE Fellow. I have been responsible for organizing several workshops, and delivering numerous tutorials at major IEEE and ACM conferences. I have served as editor of several publications including the IEEE Transactions on Networking, the IEEE Transactions on Wireless Communications, the IEEE Communications Magazine, the Springer "Wireless Networks" journal, the Elsevier "Ad Hoc Networks" journal, the "Journal

of High Speed Networks," and the Wiley "Wireless Communications and Mobile Computing" journal. I have also been a guest editor of *IEEE Journal on Selected Areas in Communications* issues on "Gigabit Networks," "Mobile Computing Networks," and "Ad-Hoc Networks." Finally, I have served as the Chair of the IEEE Technical Committee on Personal Communications (TCPC).

11. I have received multiple professional recognitions, especially in the field of wireless communications and networks. In 2012, I received the IEEE ComSoc WTC Recognition Award, which recognizes individuals "for outstanding technical contributions in the field for their service to the scientific and engineering communities." Also in 2012, I received the "Best Paper" Award for co-authoring "Collaborating with Correlation for Energy Efficient WSN" directed at Wireless Sensor Networking. I previously received the "Best Paper Award" for co-authoring "Optimal Resource Allocation for UWB Wireless Ad Hoc Networks" directed at ultra-wideband communication. Finally, in 2003, I received the "Highly Commended Paper Award" for co-authoring "Performance Evaluation of the Modified IEEE 802.11 MAC for Multi-Channel Multi-Hop Ad Hoc Network," directed at advanced wireless networking.

12. A copy of my *curriculum vitae* is attached as Ex. 1007. Additional information regarding my education, technical experience and publications, including a list of the US patents of which I am an inventor/co-inventor, is included

therein.

II. My Understanding of the Relevant Legal Standards

13. I have been asked to provide my opinions regarding whether the challenged claims of the ’445 patent are anticipated or would have been obvious to a person having ordinary skill in the art at the time of the alleged invention of the patent, in light of the prior art. I am not an attorney and provide no opinion on law. The following legal standard has been provided to me by the Petitioner’s counsel.

A. Anticipation

14. It is my understanding that, to anticipate a claim under 35 U.S.C. § 102, a single prior art reference must disclose each and every element of the claim at issue, either expressly or inherently. It is my understanding that a limitation is inherently disclosed by a prior art reference if the reference must necessarily function in accordance with, or include, the limitation in the context of the patented technology.

B. Obviousness

15. It is my understanding that a claimed invention is unpatentable 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 the invention was made to a person having ordinary skill in the art to which the subject matter pertains. I also understand that the obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and

content of the prior art, and the differences between the prior art and the claimed subject matter.

16. I have been informed that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of a claimed subject matter. I understand that some of these rationales include the following: 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 a similar device (method, or product) in the same way; applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; 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.

III. Level of Ordinary Skill in the Art

17. I am familiar with the technology claimed in the ’445 Patent. I am also aware of the state of the art at the time that the ’445 Patent was filed. The earliest priority date of the ’445 Patent is December 15, 2000. Based on the technologies disclosed in the ’445 patent and my experience in the communications field, one of ordinary skill in the art would have a B.S. degree in Electrical

Engineering, Computer Engineering, or equivalent training, with at least three to four years of experience in wireless communication technology, or a Master's degree in electrical engineering or an equivalent degree, with at least two years of experience in wireless communication technology. Such a person would be familiar with various well-known communication methodologies, multiple access protocols, and transmission techniques. For example, that person would be familiar with basic messaging protocols for passing control information between a base station and a subscriber unit. As another example, one of ordinary skill would have understood basic principles of FDM/OFDM, FDMA/OFDMA, and adaptive coding and modulation.

18. That person would also be familiar with the concepts of multipath propagation and fading, frequency selective fading, and frequency diversity. Also, one of ordinary skill in the art would know how to apply these different techniques to different communication systems and networks employing wireless communications. Each technique is associated with known advantages and disadvantages, such as speed, complexity, and cost, and a person of ordinary skill in the art would know how to choose from among the different techniques to balance the various goals of the communication systems and networks under consideration. My opinions with respect to the '445 Patent and the prior art referenced here are based on what a person of ordinary skill in the art would have

perceived at the time of invention of the ‘445 Patent. Unless otherwise stated, when I provide my understanding and analysis below, it is consistent with the level of one of ordinary skill in these technologies at and around the priority date of the ’445 patent.

IV. Technical Background and State of the Art

19. To facilitate the discussion pertaining to my specific findings and opinions with respect to the ‘445 Patent, I provide the following brief technological background explaining some basic telecommunications concepts as were known at the time of the alleged invention of the ‘445 Patent, including basic cellular concepts, FDM/OFDM, FDMA/OFDMA, coding and modulation, and adaptive channel allocation, and with which one of ordinary skill in the art would have been intimately familiar.

A. Cellular Telecommunications

20. Cellular telecommunications systems rely on a base station and remote station being able to “speak the same language” in order to communicate over a wireless transmission medium. In other words, the receiver must understand how to interpret the received data that is being transmitted by the transmitter. This means the remote station needs to be able to synchronize to the transmissions of the base station, must know which wireless channels to transmit on or receive from, and must know how the data is being encoded onto the radio waves by the base station. Depending on the technology, this type of information would have been

typically either known in advance by the mobile station or communicated to the mobile station via control messaging or other signaling.

21. In typical telecommunications systems, frequency bandwidth is a limited resource. Frequency resources are typically allocated based on an access protocol. Well known communication technologies at the time filing of the '445 Patent included FDM, OFDM, FDMA, and OFDMA. In addition, the concepts of modulation and coding, frequency diversity, and adaptive channel allocation were fundamental wireless communication concepts at the time of the '445 Patent. Each of these concepts are explained briefly below.

B. FDM/OFDM

22. The basic concept of Frequency Division Multiplexing was a well-known method of dividing the overall system bandwidth into frequency channels ("subcarriers"). *See* Ex. 1018, at 1:19-22 (" In Frequency Division Multiplexing (FDM) communication systems, the available spectral bandwidth W is divided into a number of spaced sub-carriers, f_1, . . . , f_N, which are used to transmit information."). The frequency channels in an ordinary FDM system consist of non-overlapping frequency bands with small, unused bandwidths between adjacent frequency bands called "guard bands." By using guard bands, the receiver can receive the transmission of information without significant interference from the adjacent channels.

23. One type of FDM is the Orthogonal FDM ("OFDM"). *Id.* at 1:30-32 ("Orthogonal Frequency Division Multiplexing (OFDM) is one particular example of FDM."). As in ordinary FDM, in OFDM there is a finite number of carrier frequencies that are available for use during communications. OFDM provided substantial improvements in spectral efficiency over ordinary FDM systems by eliminating the guard band, which allowed the subcarrier frequencies to be packed closer together, resulting in more efficient utilization of the radio spectrum.

24. Similar to ordinary FDM, OFDM's operational principle is that a bandwidth is divided into multiple subcarrier frequencies that are used to transmit information. *See id*. at 1:65-2:1 ("In the OFDM system [. . .], the analog signal to be amplified [*i.e.*, the OFDM signal] is the sum of many sinusoid waveforms, e.g., sub-carrier signal.").

25. In an OFDM system, each subcarrier in an OFDM system is arranged to be mathematically orthogonal with each other, such that the spectral shape of the individual subcarriers are zero at the other subcarrier frequencies and interference does not occur between subcarriers. *See* Ex. 1011, at 33-39; Figure 2.3. This mathematical property allows the subcarriers to overlap, as illustrated in the following Figure reproduced from *Van Nee*:

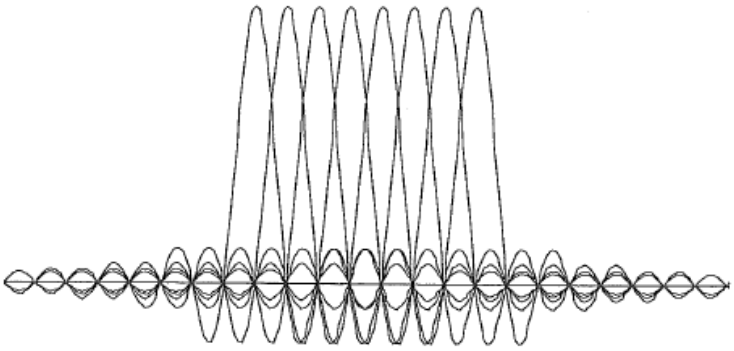


Figure 2.3 Spectra of individual subcarriers.

Ex. 1011, at 35; *See also id.* at 33-39 for a more technical description of the orthogonality of OFDM subcarriers.

26. As mentioned above, in OFDM systems, the subcarriers are permitted to "overlap" with one another in the frequency domain, so long as the orthogonality of the subcarriers is maintained. The overlap provides for a more efficient use of the frequency spectrum, *i.e.*, it allows a larger amount of information to be transmitted in a given bandwidth. *See, e.g.*, Ex. 1011, at 20-22.

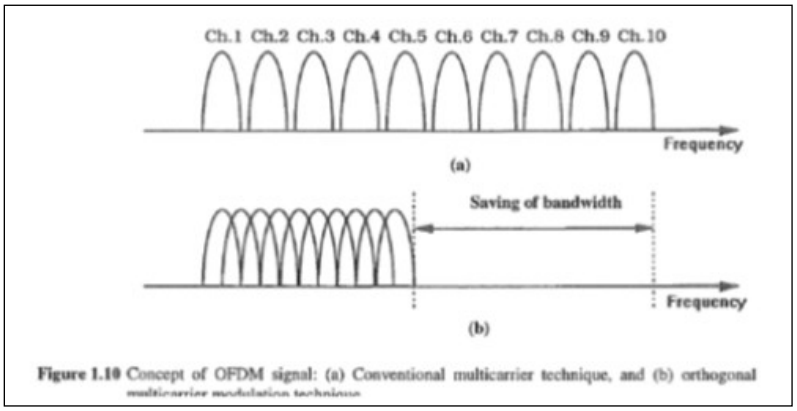


Figure 1.10 Concept of OFDM signal: (a) Conventional multicarrier technique, and (b) orthogonal

27. Consequently, the OFDM transmission technique provides larger spectral efficiency as compared to the ordinary FDM technique (a comparison of

the two techniques is set forth above in the reproduction of Figure 1.10 from *Van Nee*). OFDM has numerous advantages that would have been well known to one of ordinary skill in the art. *See, e.g.*, Ex. 1020, at 1:66-2:2 ("Orthogonal frequency division multiplexing (OFDM) systems offer significant advantages in many real world communication systems, particularly in environments where multipath effects impair performance."). These advantages include, for example, making efficient use of bandwidth, reducing interference caused by multipath propagation effects, and reducing intersymbol interference. Additional advantages that would have been known to one of ordinary skill in the art are set forth in my detailed analysis below.

C. FDMA/OFDMA

28. Many techniques are known in the art that enable multiple users to efficiently share a transmission medium using schemes for assignment of those resources to different accessing subscribers (for example, TDMA, FDMA, CDMA, or OFDMA). Allocating different users traffic channels over different frequency subcarriers is known as Frequency Division Multiple Access (FDMA).

29. One type of FDMA that was well known in the art is Orthogonal Frequency Division Multiple Access (OFDMA). OFDMA uses the basic format of OFDM to form the subcarriers, which may then be shared among multiple subscribers simultaneously. As noted in the Background of the '445 patent, OFDMA is a method for multiple access using the basic method of orthogonal

frequency division multiplexing (OFDM). Ex. 1001, at 1:51-53.

30. It was well known that OFDMA could be combined with various other multiple access techniques to provide an improved wireless system. For example, U.S. Patent No. 6,067,290 ("*Paulraj*") specifically discloses that it was obvious to those skilled in the art to combine OFDMA with numerous other multiple access methods. *See* Ex. 1021, at Figs. 9-12 (illustrating TDMA, FDMA, CDMA, and SDMA embodiments); *id.* at 32:38-47 (noting that "[a]lthough FIGS. 9-12 show four distinct multiple access methods, ***it will be obvious to those skilled in the art that each of these may be combined with*** one or more of the others without departing from the scope of this invention, as well as with such multiple access methods as: ***orthogonal frequency division multiple access (OFDMA)***, wavelength division multiple access (WDMA), wavelet division multiple access, or any other orthogonal division multiple access/quasi-orthogonal division multiple access (ODMA) techniques.").

31. Aside from the use of OFDM to create orthogonal frequencies, one of ordinary skill in the art would have understood that OFDMA is basically equivalent to ordinary FDMA from a multiple access perspective. This conclusion is supported by *Van Nee*, which explains that OFDMA "is equal to ordinary frequency division multiple access (FDMA); however, OFDMA avoids the relatively large guard bands that are necessary in FDMA to separate different users." Ex. 1011, at

213. As explained above, the elimination of guard bands is provided through the use of OFDM to produce mathematically orthogonal subcarriers.

D. Frequency Diversity

32. One of ordinary skill would have also been familiar with the concept of diversity in general, and frequency diversity in particular. As explained by *Rappaport*, diversity "exploits the random nature of radio propagation by finding independent (or at least highly uncorrelated signal paths) for communication." Ex. 1016, at 325. "The diversity concept can be explained simply. If one radio path undergoes a deep fade, another independent path may have a strong signal." *Id.* With reference to a frequency spectrum divided into multiple frequency channels, the concept that different channels have differing channel responses is known as frequency selective fading. *Id.* at 169-170 (explaining that "[f]requency selective fading channels are also known as *wideband* channels since the bandwidth of the signal s(t) is wider than the bandwidth of the channel impulse response"). One of ordinary skill would have recognized that diversity "is a powerful communication receiver technique that provides wireless link improvement at relatively low cost." *Id.*

33. *Rappaport* confirms that a coherence bandwidth is "a statistical measure of the range of frequencies over which the channel can be considered 'flat' (i.e., a channel which passes all spectral components with approximately equal gain

and linear phase)." *Id.* at 163. With respect to frequency diversity in particular, one of ordinary skill in the art would have understood that the "rationale behind this technique is that frequencies separated by more than the coherence bandwidth of the channel will not experience the same fades. Theoretically, if the channels are uncorrelated, the probability of simultaneous fading will be the product of the individual fading probabilities." *Id.* at 335*; see also* Ex. 1019, 3:50-54 ("[W]hen successive carriers upon which successive bursts of a communication signal are transmitted are of similar fading characteristics, little frequency diversity is created. The coherence bandwidth is a frequency range which exhibits similar fading characteristics. [. . .] Appropriate selection of the carriers upon which to transmit successive bursts of the communication signal would therefore advantageously better overcome the deleterious effects of multi-path fading."). Accordingly, one of ordinary skill in the art would have readily understood that obtaining frequency diversity was one advantageous way to combat frequency selective fading.

E. Coding and Modulation

34. Another concept that would have been well known to skilled artisans at the time of invention is the concept of coding and modulation. I will provide a brief explanation of these concepts below.

35. **Modulation**: To understand this concept, it is first important to note that information in a wireless medium is transmitted using radio waves, which have

a particular frequency, amplitude, and phase. Information can be conveyed on radio waves by changing the waveform of the transmitted radio wave in such a way that the changes in the radio wave can be interpreted as information by the receiver of that radio wave based on detecting the waveform. For example, a receiver can be configured to know that a radio wave having a particular frequency, phase, and amplitude should be interpreted to have a certain meaning. As a simple example, a wave having a positive phase might be interpreted as the binary value '1', while that same wave having a different phase might be interpreted as the binary value of '0.' The act of producing a waveform to have properties that can be interpreted by the receiver as data is called "modulation."

36. The number of distinct waveforms that a receiver can detect determines how much digital information can be conveyed. For example, a receiver may be configured to detect up to 4 different possible waveforms in a particular radio transmission. Because there are four possibilities, each of those waveforms can be associated with a particular number between 1 and 4, or may represent a sequence of bits, *e.g.*, 00, 01, 10, or 11. This effectively allows 2 bits of information to be transmitted at once (*i.e.*, as one transmitted symbol). In fact, this is a well-known modulation called "QPSK." More advanced receivers can differentiate between even more possible waveforms, resulting in "higher order modulation" than QPSK. The possible waveforms in a given modulation format are

typically described as "constellations." The following figure from *Van Nee* illustrates various modulation formats as constellations, including QPSK, 16-QAM, and 64 QAM:

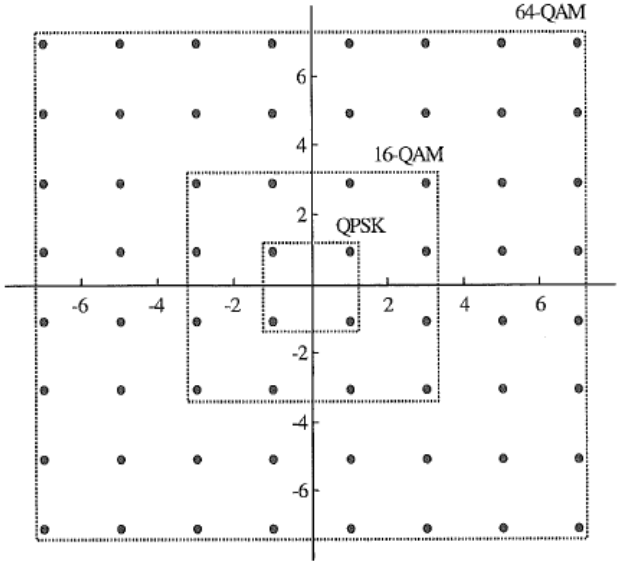


Figure 3.6 QPSK, 16-QAM, and 64-QAM constellations.

Ex. 1011, at 61.

37. In the case of basic QPSK modulation, there are four different signaling alternatives that allows for the transmission of up to 2 bits of information during each transmission interval (*i.e.*, transmitted symbol). By increasing the signaling alternatives to 16 (known as 16QAM modulation), the transmission may now contain 4 bits of information during each transmitted symbol. The signaling alternatives may increase to 64 different signaling alternatives (64QAM modulation) that allows for a transmission of 6 bits of information during each transmitted symbol. Note, however, that even though the higher-order modulation

schemes provides the possibility of higher bandwidth utilization through higher data rates, the higher-order modulation schemes provide less robustness against noise and interference. This is because, in the presence of noise and/or interference, there is a larger probability of the receiver making an error in detection when the higher order modulation schemes are employed. Modulation is described in more detail by *Van Nee* (Ex. 1011), at 60-62.

38. **Coding**: At a high level, coding is a way to add redundancy to a transmitted sequence of bits in order to account for the inherent losses and errors in transmitted information that are likely to occur due to the nature of a wireless propagation environment. This is explained, for example, by a chapter on Coding and Modulation in the *Van Nee* textbook. *See* Ex. 1011, at 53 (describing that "in a multipath fading channel, all subcarriers will arrive at the receiver with different amplitudes. In fact some subcarriers may be completely lost because of deep fades."). As noted by *Van Nee*, the nature of the interference is frequency dependent. *See id.* As mentioned above, this concept was commonly known as frequency-selective fading. The underlying cause is that in a multi-path propagation environment, the environment will affects signals of differing frequencies differently.

39. Coding introduces redundancy to a data stream, so that the receiver can detect and/or correct errors in the received data. Such redundancy is used to

overcome the effects of noise, interference, and fading. *See id.* ("To avoid this domination by the weakest subcarriers, forward-error correction coding is essential. By using coding across the subcarriers, errors of weak subcarriers can be corrected up to a certain limit that depends on the code and the channel."). A simple example of error correction coding would be that if I want to send a binary value to a receiver, I will repeat the transmission three times (what is referred to as a repetition code). Thus, if I want to transmit "1" to a receiver, I might instead transmit "111," so long as the receiver knows how to interpret the three bits as one bit of information. So even if there was an error in one of the transmitted bits out of the three, and the receiver received, for example, a "011," the receiver would still know to treat that as a "1." This is referred to as a "majority voting" scheme. The additional coding redundancy, however, comes at the expense of increasing the transmission bandwidth needed to transmit data. In our example above, we transmitted three times as many bits. Common prior art approaches to error detection/correction coding included, for example, "block coding" and "convolutional coding." *See id.* at 54-58.

40. Obviously, in order to be as bandwidth efficient as possible, one of skill would like to transmit the highest order modulation using the least level of coding possible. However, that person would have understood that the nature of the wireless channel may oftentimes dictate otherwise. For example, too much fading,

interference, or noise in the wireless channel may dictate that lower modulation formats and higher coding rates should be used. This is because the higher the modulation format that is used, the more sensitive the receiver is to environmental distortion. And the noisier the channel is, the more coding is required to ensure reliable communication.

41. For these reasons, different coding and modulation methods were created in the prior art to allow for different coding and modulation schemes to be used depending on what radio channel conditions the receiver was experiencing. This was a concept known as *adaptive* coding and modulation, because the particular coding and modulation rate used is *adapted* according to the radio channel conditions (and is described in detail by the *Hanzo* book, as discussed below). *See, e.g.* Ex. 1014 at 558 (stating that "transmission parameters can be ***adapted*** to the anticipated channel condition, such as the modulation and coding rates" with "the resulting set of parameters ***[having] to be communicated*** to the receiver in order to successfully demodulate and decode the OFDM symbol."). In order for the receiver to be able to interpret a particular transmission, it is essential for that receiver to know what modulation scheme and what coding scheme was used to transmit the wireless data. *See id.*

F. Channel Allocation

42. As was understood by the ordinary skilled artisan, channel assignment

(also called resource allocation) involves selecting the channel(s) that the subscriber should use. As demonstrated by *Van Nee* and discussed above, one of ordinary skill would have known that different frequency channels may have varying channel responses (*e.g.,* typically, some, but not all, may be in deep fade). *See* Ex. 1011, at 53. As explained above, this was a concept known in the art as frequency selective fading. This was recognized by the '445 Patentees as a prior art technique, as described in the '445 Patent Background section. Ex. 1001, at 2:2-7 (stating that "it is advantageous in an OFDMA system to adaptively allocate the subcarriers to subscribers so that each subscriber enjoys a high channel gain," citing to Wong et al., "Multiuser OFDM with Adaptive Subcarrier, Bit, and Power Allocation," IEEE Journal on Selected Areas in Communications, pp. 1747-1758, October 1999 (Ex. 1024)).

43. One known prior art approach was to allocate sets of consecutive subcarriers. To cite a specific example, *Van Nee* discloses an example method of adaptive channel allocation in an OFDMA system, in which communications take place over sets of consecutive subcarriers called "bandslots." *See* Ex. 1011 at 224; *see also* Figure 9.7. "The base station performs interference measurements in all bandslots, except at the timeslots in which it is transmitting." *Id.* at 224. "This information is used by the bandslot allocation algorithm to assign uplink transmissions to slots with minimal interference." *Id*.

44. To take advantage of the probability that non-consecutive subcarriers were likely to have uncorrelated channel responses, one known prior art approach was to allocate sets of disjoint subcarriers. One of ordinary skill would understand that "the data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity." Ex. 1013, at 7:1-3; 6:6-11; 6:51-58.

45. One of ordinary skill would have readily understood that channel assignment information needs to be communicated to the subscriber (so the subscriber knows which channels to use). For example, the example channel allocation method disclosed by *Van Nee* describes that the base station schedules the transmissions of the mobile users by "regularly transmit[ting] a frame map," which contains the "bandslot allocations for the next frame." *Id.*

V. Opinions on Invalidity of the '445 Patent

46. Based on my review of the '445 Patent (Ex. 1001) and the relevant state of the art at the time of invention, it is my opinion that Claims 1-14 are invalid. My opinions as presented below are based on my understandings of the art related to the '445 patent, as well as what I think that one of ordinary skill in the art would have understood at the time of and prior to December 15, 2000.

A. Background Of '445 Patent

47. The '445 patent relates to systems and methods for allocating sets of wireless channels, called "subcarriers," for use in communications between a base

station and multiple wireless subscribers. Ex. 1001, at Abstract.

48. The '445 Patent background recognizes that it was beneficial to allocate different clusters of subcarriers to different subscribers depending on, for example, frequency selective fading and interference. *Id.* at Background, *passim*. The "channels are typically uncorrelated for different subscribers" and "subcarriers that are in deep fade for one subscriber may provide high channel gains for another subscriber." *Id.* at 1:66-2:1. "Therefore, it is advantageous in an OFDMA system to adaptively allocate the subcarriers to subscribers so that each subscriber enjoys a high channel gain." *Id.* at 2:1-4. The idea that a subscriber's various frequencies will have different channel responses across a wideband channel was a well-known concept at the time of the alleged invention of the '445 Patent, as I explained in the background section above.

49. Figure 1A of the '445 Patent, shown below, illustrates multiple subcarriers including subcarrier 101 (shown in red) and subcarrier cluster 102 (shown in blue) of four consecutive subcarriers. Ex. 1001, at Fig. 1; 5:22-23. The '445 Patent contemplates that various subcarriers should be allocated as "clusters," or "sets," to subscribers. *Id.* at 5:22-31.

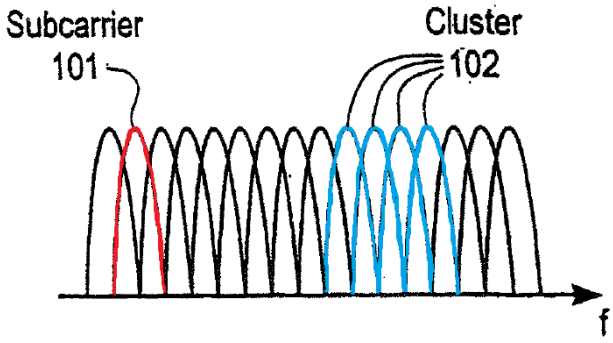
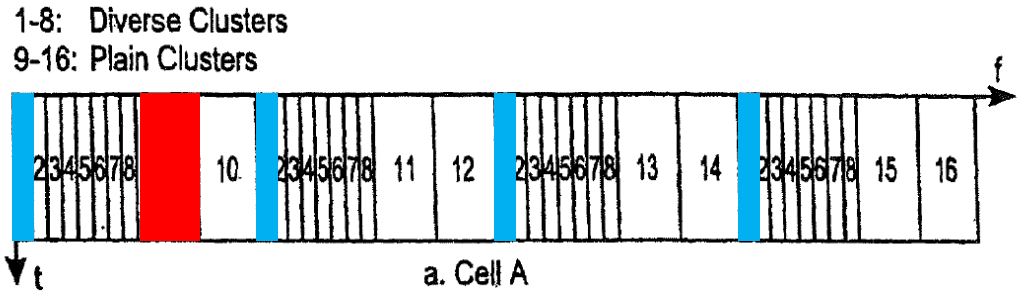


FIG. 1A

50. Grouping subcarriers into "clusters," or "sets," was a common and well-known technique in wireless systems at the time of the alleged invention. *See, e.g.,* Ex. 1013, at Fig. 2 (illustrating example sets of sub-carriers Data 1 - Data 6); *see also* Ex. 1011, at Figure 9.7 (illustrating example clusters of subcarriers called "bandslots.").

51. The '445 Patent describes that sets of subcarriers can have "consecutive" or "disjoint" subcarriers. *Id.* at 14:26-30. The patent illustrates an example allocation of such sets in Fig. 9.



Id. at Fig. 9 (annotated).

52. Referring to the annotated Fig. 9 above, an example set of subcarriers having "consecutive" subcarriers is cluster 9 (annotated in red) and an example set of subcarriers having "disjoint" subcarriers is cluster 1 (annotated in blue). The sets labeled "1" through 8" each individually represent sets having disjoint subcarriers (referred to as "diverse clusters" in Fig. 9). Ex. 1001 at 14:44-50. The sets labeled "9" through "16" each individually represent sets having "only consecutive" subcarriers (referred to as "plain clusters" in Fig. 9). *Id.*

53. The rationale provided in the patent for allocating a disjoint set of subcarriers is "to obtain frequency diversity." The '445 Patent goes on to describe allocating sets of subcarriers that are "spread far apart" by, for example, more than a coherence bandwidth. *See id.* at 14:26-29. Similarly, *Rappaport* explains that the "rationale" behind frequency diversity "is that frequencies separated by more than the coherence bandwidth of the channel will not experience the same fades." Ex. 1016, at 335.

54. The allocation of spread-apart subcarriers has the well-known propagation benefit of smaller variation in the average channel gain of the subcarriers. *Id.* at 15:6-9. Accordingly, sets of disjoint subcarriers can be more robust to changing channel conditions than sets of consecutive subcarriers, while yielding possibly less gain than cluster selection based on trying to find subcarriers with relatively "better" channel responses than other subcarriers. *Id.* at 15:1-13.

55. Claims 1-14 of the '445 Patent appear to be directed to allocating different sets of subcarriers in a frequency-selective channel, which (as discussed above and further detailed below) are covered by standard prior art techniques. The concepts described by these claims would have been well known to one of ordinary skill in the art at the time of the assumed priority date of the '445 Patent. For example, allocating the claimed sets of subcarriers recited by the challenged independent claims of the '445 Patent (Claims 1 and 8) were taught by the prior art.

In particular, both *Gitlin* and *Wallace* teach these concepts, as I explain in my detailed claim analysis set forth below.

56. Moreover, the dependent claims generally cover, at most, standard implementation details that would have been well known to one of ordinary skill in the art, including, for example, signaling allocations of subcarriers to subscribers and signaling what modulation and coding rate to use. References teaching the techniques recited in the challenged claims of the ’445 patent were readily available to those of ordinary skill in the art at the time of the assumed priority date of the ’445 patent, and combining those techniques to arrive at the claimed invention would have been obvious, as I set forth in detail below. Moreover, to the extent the claims are construed to require OFDMA systems, my opinions would not change. In particular, these concepts were well known and readily available in OFDMA systems, as well as other conventional systems, since well before the assumed priority date of the ‘445 Patent.

B. Meaning of Certain Terms of the ’445 Patent

57. It is my understanding that in order to properly evaluate the ’445 patent, the terms of the claims must be defined. It is my understanding that the claims are to be given their broadest reasonable interpretation (“BRI”) in light of the specification. It is my further understanding that claim terms are given their ordinary and accustomed meaning as would be understood by one of ordinary skill

in the art, unless the inventor, as a lexicographer, has set forth a special meaning for a term. The discussion of the claim terms below is my opinion regarding each of the referenced terms, as defined in accordance with the broadest reasonable construction standard, and based on the understanding of a person of ordinary skill in the art.

58. It is my understanding that the preambles of Claims 1 and 8 are not limiting. I have reviewed the preambles of those claims, the prosecution history, and the specification of the '445 Patent and have identified no reason one of ordinary skill in the art would consider the preambles to be limiting. In any event, independently of whether the preambles are limiting or not, I have found all of the elements recited by both the preambles and the body of the claims in the prior art (as explained in detail below), and I have concluded that the claims are invalid regardless of whether they are limited by their preambles.

59. The preambles of independent Claims 1 and 8 of the '445 patent use the term "orthogonal frequency division multiple access (OFDMA)." The term "orthogonal frequency division multiple access (OFDMA)" is also used and described in the specification. To the extent that the Patent Trial and Appeal Board (PTAB) finds that the claims are limited to OFDMA, I have been asked to give my opinion on the broadest reasonable meaning of the term OFDMA in the context of the '445 Patent.

60. At the time of the priority date of the '445 Patent, orthogonal frequency division multiple access (OFDMA) had a well-known meaning in the art. Specifically, one of ordinary skill in the art would have understood that term to refer to a multiple access scheme that uses an orthogonal frequency division multiplexing (OFDM) modulation technique, where multiple subscribers would simultaneously use different OFDM subcarriers. Ex. 1011, at 213 ("In OFDMA, multiple access is realized by providing each user with a fraction of the available number of subcarriers."). Consistently, the specification states that "[o]rthogonal frequency division multiple access (OFDMA) is another method for multiple access, ***using the basic format of OFDM***. In OFDMA, ***multiple subscribers simultaneously use different subcarriers***, in a fashion similar to FDMA."[1] Ex. 1001, at 1:51-56.

61. OFDM, in turn, was understood to refer to orthogonal frequency division multiplexing, which was a scheme in which subcarrier frequencies are specifically chosen, so that subcarriers are mathematically orthogonal to one another. Ex. 1011, at 21 (describing that in OFDM, the "word orthogonal indicates there is a precise mathematical relationship between the frequencies of the carriers in the system" such that they are "linearly independent"). Consistently, the specification states that OFDM is "an efficient modulation scheme for signal

[1] Unless otherwise noted, all emphasis in this document is added.

transmission over frequency-selective channels. ***In OFDM***, a wide bandwidth is divided into ***multiple narrowband subcarriers***, which are arranged to be ***orthogonal*** with each other." Ex. 1001, at 1:35-39. Accordingly, the specification clearly applies the same meaning of OFDMA as was well-understood in the art. Thus, one of ordinary skill in the art would understand that in the context of the '445 patent, the terms "orthogonal frequency division multiple access (OFDMA)" to mean "*a multiple access scheme, where multiple subscribers simultaneously use different orthogonal frequency division multiplexed (OFDM) frequencies*."

62. The '445 patent uses the terms "subcarriers" in the claims and the detailed description. The '445 patent does not set forth a special meaning for the above terms. The context of the challenged claims requires allocating a first set of "subcarriers" to a first subscriber and allocating a second set of "subcarriers" to a second subscriber. *See* Ex. 1001, at 17:7-21. I have been asked to give my opinion on how one of ordinary skill in the art would have understood that term in the context of the '445 Patent under a broadest reasonable interpretation. One of ordinary skill in the art would have understood the term "subcarriers" to broadly refer to frequency divided channels in which multiple frequency components are utilized within a system bandwidth. It is my opinion that, in the context of the '445 patent, the term "subcarriers" means "*narrower bandwidth frequency channels of a wider system bandwidth*." One of ordinary skill would not have understood the

term to be limited to OFDMA or OFDM embodiments, but to more generally refer to subcarriers in any frequency divided system.

63. This is consistent with the '445 Patent, which recognizes that subcarriers are arranged to be orthogonal in OFDM systems. Ex. 1001, at 1:37-39 ("In OFDM, a wide bandwidth is divided into multiple narrowband subcarriers, which are arranged to be orthogonal with each other."). This disclosure would confirm to one of ordinary skill in the art that while in OFDM subcarriers are arranged to be orthogonal, that is not generally the case for all FDM subcarriers. Furthermore, the '445 patent also suggests that subcarriers are also used in the context of ordinary FDMA, which is consistent with the ordinary meaning of the term "subcarriers." *Id*., at 1:53-56 ("In OFDMA, multiple subscribers simultaneously use different subcarriers, in a fashion similar to frequency division multiple access (FDMA)."). This is consistent with how one of ordinary skill in the art would have understood the term "subcarriers." *See* Ex. 1011, at 213 ("In OFDMA, multiple access is realized by providing each user with a fraction of the available number of subcarriers. ***In this way, it is equal to ordinary frequency division multiple access (FDMA)***[.]"); *see also id.* at 22 (recognizing that ordinary FDM had "banks of ***subcarrier*** oscillators"). Thus, it was commonly understood that subcarriers are used in ordinary FDMA as well as OFDMA.

64. The '445 Patent supports a broadest reasonable construction of

"subcarriers" as *"narrower bandwidth frequency channels of a wider system bandwidth*." *See* Ex. 1001, at 1:37-38 ("[A] wide bandwidth is divided into multiple narrowband subcarriers[.]"); 1:37-39. Fig. 1A of the '445 Patent specification illustrates this concept by showing that a subcarrier exists as a narrower frequency channel of a wider system bandwidth. *Id*. at Fig. 1A (annotated to highlight an individual subcarrier in red).

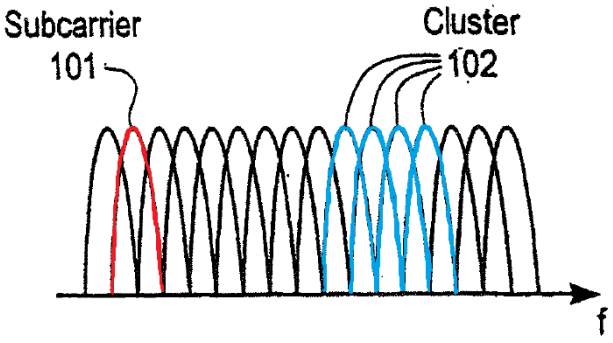


FIG. 1A

65. The '445 patent uses the term "first identification" in the dependent claims. The '445 patent does not set forth a special meaning for the term "first identification." The context of the challenged claims requires that a "first identification" be of the "allocation of the first set of subcarriers" (Claim 2) and include "a modulation and coding format to be used by the subscriber for the first data transmission to the subscriber (Claim 3).[2] I have been asked to give my opinion on the broadest reasonable interpretation of the term "first identification," as recited in the challenged claim and in the context of the '445 Patent. It is my opinion that in the context of the '445 patent, one of ordinary skill in the art would understand that under a broadest reasonable interpretation, the term "first

[2] Claims 9 and 10 include similar limitations, respectively, to Claims 2 and 3.

identification" means "*information about the first subscriber's subcarriers*."

66. This interpretation is consistent with the disclosure of the '445 patent. The plain language of the claims uses the term "first" to associate the "first identification" with the "first subscriber," similarly to how the term "second" associates the "second identification" with the "second subscriber" in Claim 4. The '445 patent does not describe embodiments of a "first identification," but instead more generally describes that information is sent about the subcarrier allocation and/or coding/modulation rates. For example, the '445 Patent states that the base station "***informs*** the subscribers about the subcarrier allocation and the coding/modulation rates to use." Ex. 1001, at 3:58-60; *see also id.* at 6:33-39; 11:33-36. Because of the limited description of any type of identification used by the base station to inform the subscriber about its allocation of the coding/modulation rates to use, the identification should be broadly construed to cover any information about the subscriber's subcarriers. This is consistent with the general description in the '445 patent (as cited above) on how the base station "informs" the subscriber.

67. Furthermore, there is no indication in the claims or in the specification that would leave one of ordinary skill in the art to conclude that the claimed "first identification" should be limited to a single communication. Instead, consistent with the specification, one of ordinary skill would understand that the term refers

more generally to informing the subscriber and is not limit to any particular form of communication, such as a single communication or a single message.

C. Summary of the Prior Art References

68. The primary prior art references used as grounds for invalidity of the '445 Patent, together with their presumed prior art dates, are set forth in the table below. A description of these prior art references follows.

No.	Prior Art Reference	Prior Art Date
1	Richard Gitlin, et al., "System and Method for Optimizing Spectral Efficiency Using Time-Frequency-Code Slicing," U.S. Patent No. 6,018,528 ("*Gitlin*")	April 28, 1994
2	Van Nee et al., "OFDM For Wireless Multimedia Communications" (1999) ("*Van Nee*")	October 7, 1999
3	L. Hanzo et al., "Single- and Multi-carrier Quadrature Amplitude Modulation" (1999) ("*Hanzo*")	December 17, 1999
4	Theodore Rappaport, "Wireless Communications: Principles & Practice" (1995) ("*Rappaport*")	November 30, 1995
5	Mark Wallace et al., "Method and Apparatus for Measuring Reporting Channel State Information in a High Efficiency, High Performance Communications System," U.S. Patent No. 6,473,467 ("*Wallace*")	March 30, 2000

69. My understanding of the prior art dates listed above is based on my review of the patent references themselves, as well as the declaration of Dr. Sylvia Hall-Ellis, Ph.D. (Ex. 1008), listed in my materials reviewed list above.

1. Gitlin

70. I have reviewed the reference referred to as *Gitlin*. I am also a co-inventor of the invention claimed in the *Gitlin* patent, so I was personally familiar with the teachings of this disclosure at the time of filing. *Gitlin* was filed on April 28, 1994 and published when it issued on January 25, 2000. It is titled "*System and Method for Optimizing Spectral Efficiency Using Time-Frequency-Code Slicing*."

71. *Gitlin* discloses a system and method for optimizing usage of a communications transmission medium where the transmission medium can be sliced into time, frequency, and code domains. *See* Ex. 1010, at Abstract. For example, a particular user can use contiguous or non-contiguous frequency bands at various times in order to maximize the use of the transmission medium. *See*, *e.g.*, *Gitlin*, at Abstract ("Through scheduling of the various speed users within the frequency and time domains, the system and method can efficiently allocate and make use of the available spectrum, thereby accommodating higher rate users requiring greater bandwidths and time slot assignments while still preserving cost-efficient access for lower speed users. Depending on the signal modulation scheme, the time-frequency slices may be allocated on non-contiguous frequency bands."); *See also id.* at 3:1-12. It is my opinion that *Gitlin* anticipates or renders obvious all asserted claims of the '445 patent.

72. Just like the '445 patent, *Gitlin* is concerned with efficiently allocating

frequency resources to users. *See* Ex. 1010, at Abstract ("Through scheduling of the various speed users within the frequency and time domains, the system and method can efficiently allocate and make use of the available spectrum[.]"). The frequency resources allocated by the *Gitlin* systems are called time-frequency slices of a wireless communication transmission medium. The frequency domain, for example, may be divided into different frequency-slices called "tones" and particular subscribers may be allocated a set of "tones" per their individual data transmission requirements. *Gitlin*'s frequency-slices and tones are equivalent to the claimed subcarriers at least because they are narrower bandwidth frequency channels of a wider system bandwidth. *See, e.g.,* Ex. 1010, Fig. 6. *Gitlin* discloses that these sets of subcarriers may be all contiguous or may include one or more subcarriers that are disjoint from the others. *See id.* at 5:46-57; Fig. 6.

73. *Gitlin* discloses assigning a set of non-contiguous frequencies (corresponding to "a first set" of "disjoint" subcarriers) to a first user, for example, to obtain propagation benefits (corresponding to "frequency diversity") and a set of contiguous frequencies (corresponding to "a second set" of "only consecutive" subcarriers) to a second user. *See, e.g., id*. at Fig. 6. Similar to the '445 patent, a base station in *Gitlin* communicates with the first user over the first set of non-contiguous frequencies and the second user over the set of contiguous frequencies simultaneously. *See, e.g., id*.

74. The allocation of a set of "disjoint" subcarriers in *Gitlin* provides a benefit of obtaining frequency diversity within the allocated set of subcarriers. In particular, *Gitlin* specifically describes the ability to spread the frequency allocation of high-speed users to reduce the signal degradation from frequency-selective multipath fading. Ex. 1010 at 6:12-16 ("In fact, it has been found that spreading the frequency allocations of a high-speed user may offer some propagation benefits (e.g., a reduction in the degradation from frequency-selective multipath fading)."). As is explained by *Rappaport* below, it was a well-known technique to reduce the degradation from frequency-selective multipath fading by spreading a user's frequency allocations across a frequency spectrum. Ex. 1016, at 335. One of ordinary skill would have understood this teaching of *Gitlin* to refer to a way of obtaining frequency diversity. *See id.*

75. Moreover, one of ordinary skill in the art would have immediately envisaged that the "eliminat[ion] of the need for guard bands between the frequencies assigned to a given user" referred to by *Gitlin* to be explicitly describing a limited set of known techniques for eliminating guard bands between subcarriers, which includes OFDM (and, since in *Gitlin*, not all subcarriers are necessarily allocated to each remote terminal, also OFDMA). In addition, given *Gitlin*'s disclosure of a system supporting a "multi-tone" scheme for transmitting data, one of skill in the art at the time would have immediately recognized that

multi-tone scheme would encompass a finite set of known multi-tone schemes that included OFDMA. *See, e.g.,* Ex. 1022, at 392 ("In the telecommunications field, the terms of discrete multi-tone (DMT) modulation, orthogonal multi-carrier modulation, multi-channel modulation, and multi-carrier modulation (MCM) are widely used, and they are often interchangeable with OFDM.").

76. It is also my opinion that *Gitlin* also discloses the basic concept of informing the subscribers of the set of subcarriers allocated by the base station, as claimed by Claims 2, 3, 4, 9, 11, and 13. *See* Ex. 1010, at 4:57-64.

2. Van Nee

77. "OFDM for Wireless Multimedia Communications" is a book by Richard *Van Nee* and Ramjee Prasad ("*Van Nee*"), which was published and was available to the public at least as early as October 7, 1999. Ex. 1008 at ¶¶ 16-18 (declaring that *Van Nee* was indexed and made available to the public as of October 7, 1999).

78. *Van Nee* explains the principles of OFDM and OFDMA that would have been understood by one of ordinary skill in the art. *Van Nee* describes that "[t]he basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers." Ex. 1011 at 213 ("In OFDMA, multiple access is realized by providing each user with a fraction of the available subcarriers."); 33 ("The basic

principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers."). *Van Nee* discloses that OFDMA "is equal to ordinary frequency division multiple access (FDMA); however, OFDMA avoids the relatively large guard bands that are necessary in FDMA to separate different users." *Id.* at 213.

79. *Van Nee* discloses that OFDMA was so well known and understood that it was considered for the European UMTS standard in 1997. *Van Nee* at p. 217 ("As an example of an OFDMA system, this section gives a description of a system that was proposed for the European UMTS"). Although it was not ultimately adopted for UMTS, the OFDMA concept had been identified as beneficial and was proposed for use in the 3G world standard by the European Telecommunications Standards Institute (ETSI). *Van Nee* at 217, 228.

80. *Van Nee* discloses concepts similar to the limitations of independent Claims 1 and 8, including allocating sets of subcarriers (called bandslots) to mobile terminals. *See* Ex. 1011 at 224-25. Because *Van Nee* discloses that these allocations can be made based on channel interference measurements, those allocations would have resulted in allocations of bandslots that are sometimes consecutive and sometimes spread apart.

81. *Van Nee* also teaches concepts related to the dependent claims of the '445 patent, including channel coding across subcarriers and informing subscribers

of coding and modulation rates. Ex. 1011, at 53. *Van Nee* also teaches that channel coding across subcarriers was a common and "essential" technique in OFDM/OFDMA systems. *Id*. at 53. One of ordinary skill in the art would have been motivated to follow these examples described by *Van Nee* to implement an OFDMA system.

82. *Van Nee* discloses numerous advantages of using OFDMA over ordinary FDMA.

83. **Elimination of guard bands.** As explained by *Van Nee*, the use of OFDM in OFDMA systems is what allows for the elimination of guard bands, resulting in greater spectral efficiency ("saving of bandwidth") relative to ordinary FDMA systems, as illustrated by Figure 1.10 of *Van Nee* (reproduced below). *Id.* at 22.

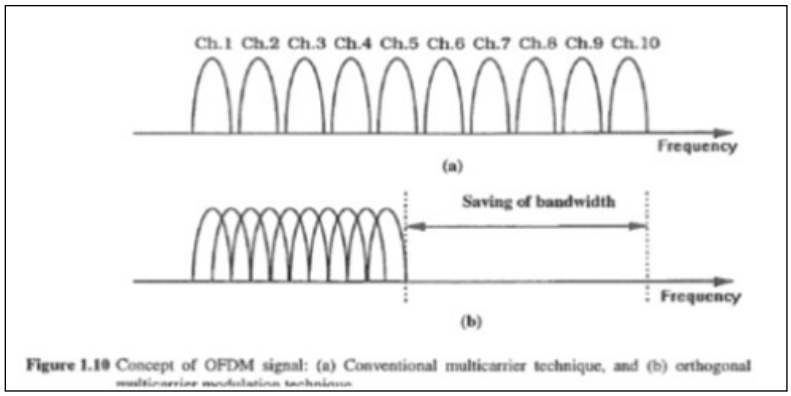


Figure 1.10 Concept of OFDM signal: (a) Conventional multicarrier technique, and (b) orthogonal

84. **The ability to function like ordinary FDMA**. As discussed above, *Van Nee* discloses that OFDMA is equal to FDMA other than the ability to eliminate guardbands. One of ordinary skill would have understood that, like the

'445 Patent, *Van Nee* also discloses the concept of "clustering" subcarriers into logical units, which *Van Nee* calls "bandslots" (and are depicted in Figure 9.7 of Van Nee as reproduced below).

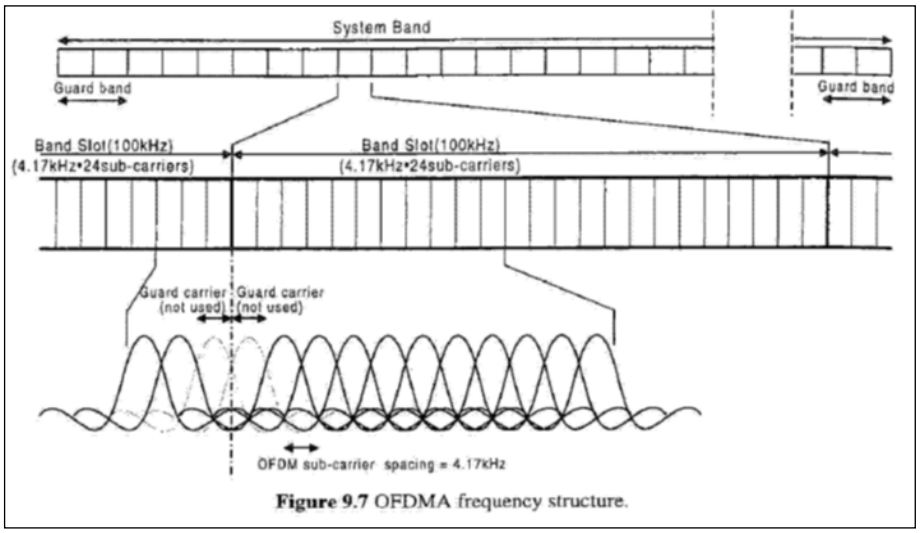


Figure 9.7 OFDMA frequency structure.

85. One purpose for these bandslots was to reduce signaling overhead and to better deal with the larger number of subcarriers that could be afforded due to the savings in spectral efficiency discussed above. Another advantage is to make OFDMA channels be configured similarly to ordinary FDMA channels. For example, *Van Nee* discloses that bandslots could be designed to ensure backward compatibility with GSM, which was a system that utilized ordinary FDMA channels. Ex. 1011, at 219 ("To maintain compatibility with GSM, a 100-kHz bandslot is chosen that consists of 24 subcarriers"). With respect to the access control scheme, what this means is that in OFDMA, once the OFDM layer is abstracted into logical channels, those logical channels can be treated as an

equivalent to ordinary FDMA channels.

86. **Eliminating any need for multiple transmitters.** *Van Nee* also discloses that another well-known advantage of OFDM and OFDMA was the ability to reduce the number of transmitters required by ordinary FDM systems down to a single transmitter. Ordinary FDM systems typically needed transmission hardware for each subcarrier frequency. *Id.* at 23 (noting that ordinary FDM required "banks of subcarrier oscillators and coherent demodulators"). OFDM, however, uses a fast Fourier transform (FFT) to "eliminate the need for banks of subcarrier oscillators and coherent demodulators." *Id.* ("[T]o eliminate the banks of subcarrier oscillators and coherent demodulators required by frequency-division multiplex, completely digital implementations could be built around special-purpose hardware performing the fast Fourier transform (FFT)."); *see also id.* at 22 (noting that a single OFDM receiver "acts as a bank of demodulators.").

87. **Additional advantages.** *Van Nee* describes that OFDMA has several other additional advantages over prior art technologies that would have been attractive to one of ordinary skill in the art to employ OFDMA, including that OFDMA is a "very flexible multiple access scheme," and that includes a "larger system capacity," is "flexible in terms of required bandwidth," and is "suited . . . for support of large data rates." *Id.* at 227-228.

3. Hanzo

88. "Single- and Multi-carrier Quadrature Amplitude Modulation" is a book by L. *Hanzo* et al. ("*Hanzo*"), which was published and available to the public at least as early as December 17, 1999. Ex. 1008 at ¶¶ 19-21 (declaring that *Hanzo* was indexed and made available to the public as of December 17, 1999).

89. The signaling process by which subscriber units and base stations exchange information, including identifying which coding and modulation scheme to use, were common principles that would have been well known, and indeed, were routine, to one of ordinary skill in the art. For example, *Hanzo* teaches a fundamental approach to variable coding and modulation that includes informing the subscriber of the particular coding and modulation format to be used in OFDMA systems. *Hanzo* specifically states that "transmission parameters can be adapted to the anticipated channel condition, such as the modulation and coding rates" with "the resulting set of parameters ***[having] to be communicated*** to the receiver in order to successfully demodulate and decode the OFDM symbol." Ex. 1014 at 558. One of ordinary skill in the art would have been motivated to implement this textbook approach described by *Hanzo* of informing the subscriber of a coding and modulation in an OFDMA system (like the one discussed in *Van Nee*).

4. Rappaport

90. "Wireless Communications: Principles & Practice," first edition" is a book by Theodore Rappaport ("*Rappaport*"), which was published and available to the public at least as early as November 30, 1995. Ex. 1008 at ¶¶ 22-24 (declaring that *Rappaport* was indexed and made available to the public as of November 30, 1995).

91. According to *Rappaport*, spreading frequency allocations by more than a coherence bandwidth is the underlying rationale for achieving frequency diversity. Ex. 1016, at 335 ("[f]requency diversity transmits information on more than one carrier frequency. The rationale behind this technique is that frequencies separated by more than the coherence bandwidth of the channel will not experience the same fades."). Spreading the frequencies by more than a coherence bandwidth was therefore a well- known concept with well-known benefits.

5. Wallace

92. U.S. Patent No. 6,473,467 to Mark *Wallace* ("*Wallace*") was filed on March 30, 2000, issued on October 29, 2002, and is entitled "Method and Apparatus for Measuring Reporting Channel State Information In a High Efficiency, High Performance Communications System." Ex. 1013.

93. *Wallace* covers the ability to optimize the transmission parameters for a transmission over a set of OFDM sub-channels between a transmitter and receiver

based on channel state information (CSI). *Wallace* at Abstract. Each OFDM sub-channel constitutes a portion of frequency used for transmission across the total operating bandwidth. Ex. 1013 at 6:55-61 ("With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data . . . . each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency."). *Wallace* discloses that the OFDM sub-channels can be shared amongst multiple users simultaneously, which one of ordinary skill in the art would understand to be describing OFDMA. *See id*. at 26:39-40 ("OFDM modulation can also afford extra flexibility in sharing the system bandwidth, W, ***among multiple users***."); *see also id.* at 26:61-66 (describing that OFDM "sub-channels can be allocated to a single data user or ***divided among multiple data users***.").

94. *Wallace* further discloses that transmitted data may be partitioned and transmitted over a defined set of sub-channels to provide frequency diversity. Ex. 1013 at 7:1-3. As an example, the frequency sub-channels (i.e., subcarriers) may be allocated to subscribers in any appropriate manner, including transmitting over consecutive sub-channels (e.g., sub-channels 1 and 2 in time slot 1), or disjoint sub-channels (e.g., sub-channels 4 and 6 in time slot 2). *Id.* at 7:6-10.

95. *Wallace* further teaches that the communication system can support

multiple subscriber units having different requirements, such that the total operating bandwidth can be efficiently shared among users that require different types of services. *Id.* at 4:64-5:4. Given that *Wallace* emphasizes efficiently sharing resources among users and also discloses allocating sets of disjoint sub-channels and sets of consecutive sub-channels, it would have been apparent to a person of ordinary skill in the art to allocate and simultaneously communicate over a set of consecutive subcarriers to a first user and a set of disjoint sub-channels to a second user at the same time.

96. *Wallace* also teaches many of the common design choices presented in the dependent claims, including the basic concept of informing the subscribers of the set of subcarriers allocated by the base station, as claimed by Claims 2, 3, 4, 9, 11, and 13. *Id.* at 28:24-27 ("Allocation and de-allocation of resources (on both the forward and reverse links) can be controlled by the system and can be communicated on the control channel in the forward link.").

97. As another example, *Wallace* teaches channel coding can be performed "across a set of sub-channels" as claimed by Claims 7 and 14. *See id.* at 19:47-55. Moreover, *Wallace* discloses informing the subscriber of the coding and modulation format to use as claimed by Claims 3 and 10. *Id.* at 7:59-63.

98. I have been asked to consider whether the mention of CDMA at points in Wallace changes my opinion with respect to *Wallace*'s disclosure of OFDMA. It

would not, for two reasons: (1) *Wallace* clearly discloses OFDMA as a standalone embodiment (s*ee* Ex. 1013, at 26:39-40); and (2) even if *Wallace* was suggesting a combination of CDMA and OFDMA, the combination would have still been an OFDMA system. Specifically, an OFDMA system may implement both CDMA and OFDM. The use of OFDM modulation in a system allows each individual sub-channel to be treated independently. Ex. 1013, at 6:55-58.

D. Comparison of The Claims of The '445 Patent to the Prior Art

99. I believe that the elements of Claims 1-14 of the '445 patent are taught by at least the prior art references discussed below. I have included claim charts that map Claims 1-14 to the prior art in the pages that follow. These charts support my finding that the differences between the claims of the '445 patent and the prior art discussed herein are such that the subject matter as a whole would have been obvious at the time of the filing of the '445 patent to a person having ordinary skill in the art to which the subject matter pertains. Reasons to combine are discussed above and are also provided in the charts below. The prior art elements combined as detailed in the below charts yield predictable results.

Ground 1:

Claims 1-2, 4, 6-9, 11, 13, and 14 are unpatentable under 35 U.S.C. § 103(a) over *Gitlin* and *Van Nee*.

Ground 2:

Claims 3 and 10 are unpatentable under 35 U.S.C. § 103(a) over *Gitlin*, *Van Nee*, and *Hanzo*.

Ground 3:

Claims 5 and 12 are unpatentable under 35 U.S.C. § 103(a) over *Gitlin*, *Van Nee*, and *Rappaport*.

Ground 4:

Claims 1-4, 6-11, 13, and 14 are unpatentable under 35 U.S.C. § 102(e) over *Wallace*.

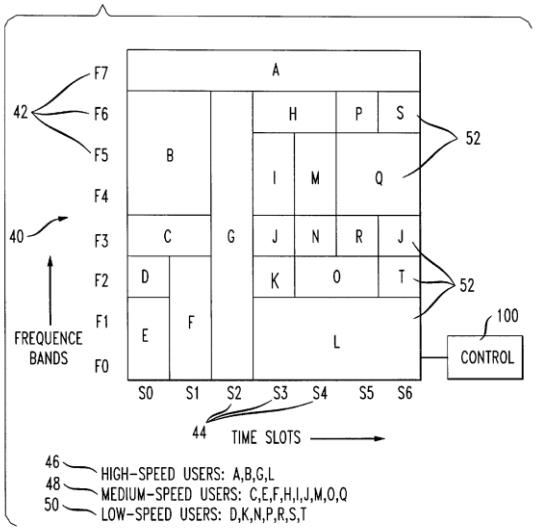
Ground 5:

Claims 5 and 12 are unpatentable under 35 U.S.C. § 103(a) over *Wallace* and *Rappaport*.

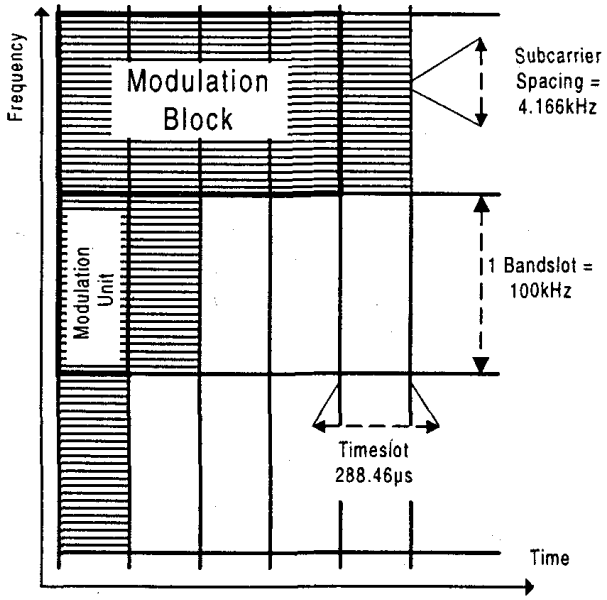
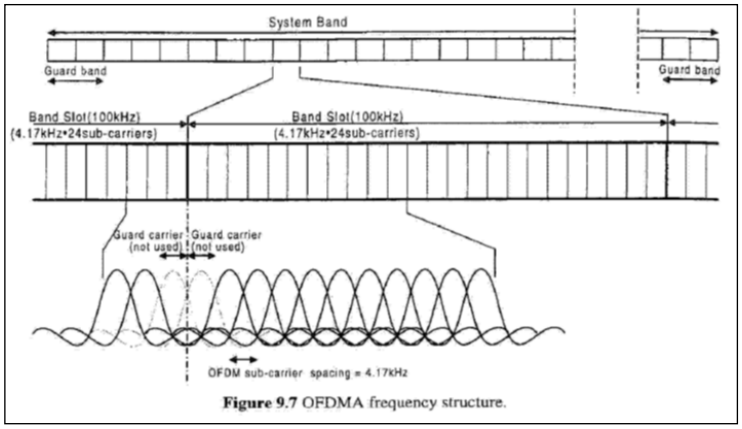
1. Ground 1- Claims 1-2, 4, 6-9, 11, 13, and 14 are unpatentable over *Gitlin* and *Van Nee*

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
1.0.1	"A method of allocating sets of subcarriers,"	To the extent the preamble is found to be limiting, *Gitlin* provides a method of allocating sets of time-frequency slices. The time-frequency slices (also called "tones") correspond to "subcarriers," and an allocated set of multiple time-frequency slices corresponds to "sets of subcarriers." As discussed in further detail above, a person of ordinary skill in the art would understand the term "subcarriers" under the broadest reasonable interpretation to mean, in the context of the '445 Patent, "*narrower bandwidth*

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		frequency channels of a wider system bandwidth." To the extent that the preamble is found to be limiting, *Gitlin*'s method for allocating sets of "time-frequency slices" of the wider system bandwidth, or "tones," to users meets the purported limitations of the preamble. Ex. 1010, at 3:1-5 (disclosing a system and method where the transmission resource is "divided into a plurality of time-frequency 'slices' that are allocated to users according to their various transmission requirements."); *see id.* at 5:52-60 (referring to time-frequency slices as "tones"). Subcarriers "As illustrated [in Fig. 5], the overall time-frequency spectrum (or medium) 40 can be partitioned in both the time and frequency domains as a plurality of frequency bands ("slices") 42 (F0, F1, . . . FN) extending over a plurality of individual time slots ("slices") 44 (S0, S1, . . . SN)." *Id.* at 3:66-4:3. "A further assumption is that one 'unit' of 'slice', which is taken to be one frequency band allocation for one time slot allocation, is the minimum amount of communications resource which will be available to a user." *Id.* at 4:23-26.

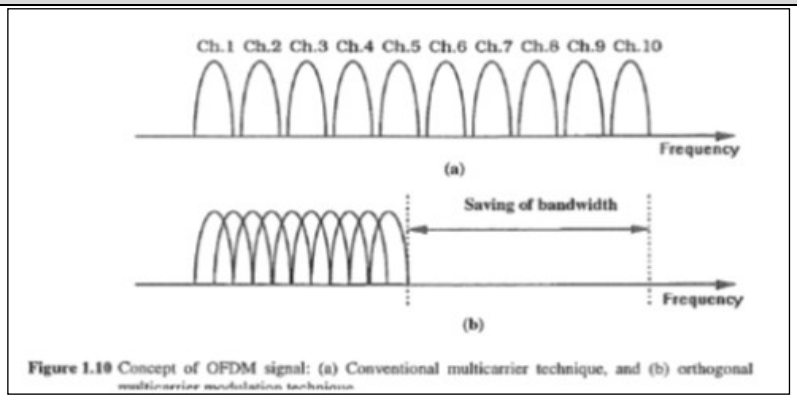
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		FIG. 5  The broadest reasonable interpretation of a subcarrier for a person of ordinary skill in the art in the context of the '445 patent is "narrower bandwidth frequency channels of a wider system bandwidth." *Gitlin* discloses subcarriers as time-frequency slices, or tones, that are narrower "slices" of the "overall time-frequency spectrum." *Id.* at 3:66-4:3. Sets of Subcarriers "In one embodiment of the system and method according to the invention, the transmission resource, partitioned into the 'time-frequency' domain, is divided into a plurality of time-frequency 'slice' that are allocated to users according to their various transmission requirements." *Id.* at 3:1-5. "Based on the availability of the medium 40, central control 100 can thus allocate particular time-frequency slices 52 to a given user so as to anticipate 'future' requests which will be made by users 46, 48, 50 so as to best optimize full use of the overall medium 40." *Id.* at 4:64-5:1.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		Method for Allocating Sets of Subcarriers "In one embodiment of the system and method according to the invention, the transmission resource, partitioned into the 'time-frequency' domain, is divided into a plurality of time-frequency 'slice' that are allocated to users according to their various transmission requirements." *Id.* at 3:1-5. OFDMA Subcarriers To the extent that these claims are construed to be limited to OFDMA or OFDM subcarriers, it would be obvious to use the teachings of *Gitlin* to implement an "OFDMA system" (and thereby use OFDM or OFDMA subcarriers) as disclosed by *Van Nee*. Ex. 1011, at 217-19. Bandslots are made of 24 OFDM subcarriers and can be allocated "to the base station for downlink transmission to a single terminal" or "for an uplink transmission." *Id.* at 219, 225. "Figure 9.4 illustrates the time-frequency grid of the OFDMA system. The resources (time and frequency) are allocated based on the type of services and operational environment. The number of timeslots and bandslots per user is variable to realize variable data rates. The smallest data rate is obtained for one bandslot of 24 subcarriers per timeslot of 288.46 μs." *Id.* at 217. Fig. 9.4 of *Van Nee*

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		 **Figure 9.4** Time-frequency grid. *Id.* at 217.  **Figure 9.7** OFDMA frequency structure. *Id.* at 220. Reasons to Combine *Van Nee* with *Gitlin* It would have been obvious to one of ordinary skill in the art to combine the teachings of *Gitlin* and *Van Nee* to form an OFDMA system that uses the channel allocation method of *Gitlin* to allocate OFDM subcarriers for the following reasons.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		Simple Substitution of One Known Element for Another First, to the extent the PTAB limits the claims to OFDMA, *Gitlin*'s method differs from the claimed approach in the '445 Patent at most by the substitution of OFDMA subcarriers with FDMA channels. It was well-known in the art that OFDMA was essentially equivalent to FDMA from a multiple access perspective. *See* Ex. 1011, at 213 (noting that with the exception of the elimination of guard bands, OFDMA "is equal to ordinary frequency division multiple access (FDMA))." *Gitlin*, at the very least, discloses an FDMA system wherein frequency tones are allocated. Similar to FDMA, an OFDMA system contains OFDM subcarriers that are allocated. As stated by *Van Nee*, it was well known in the art that the OFDMA and its allocated OFDMA subcarriers were equivalent to FDMA and its frequency tones in its multiple access perspective. *See* Ex. 1011, at 213 (noting that with the exception of the elimination of guard bands, OFDMA "is equal to ordinary frequency division multiple access (FDMA)." One of ordinary skill could have substituted one known element (FDMA) for the other (OFDMA) and the results would have been predictable (an OFDMA system that implemented the allocation methods of *Gitlin*). Substituting the frequency tones of FDMA in *Gitlin* with OFDMA subcarriers would have predictably resulted in an OFDMA system that implemented the allocation methods of *Gitlin*, that has all of the advantages of OFDMA as described by *Van Nee*. By the time of the '445 patent, it was well known to one of ordinary skill in the art that channel allocation techniques applicable to ordinary FDMA devices or systems would have also been applicable to OFDMA

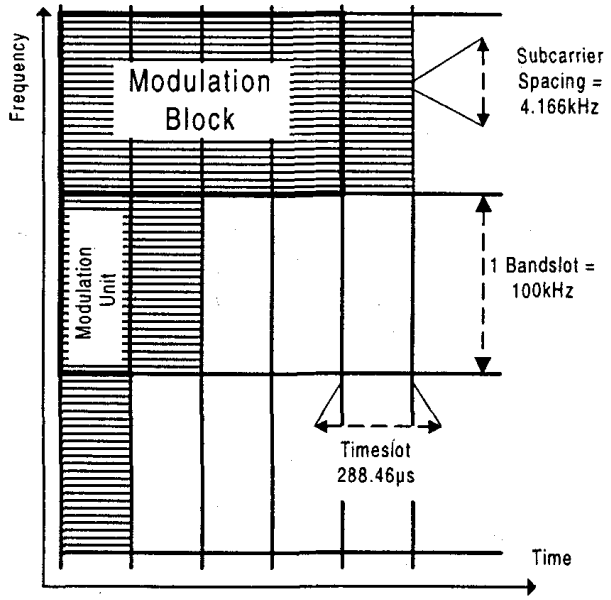
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		devices or systems. These predictable results would have incorporated the advantages of reducing the degradation from frequency selective multipath fading by allocating disjoint frequency channels spread across the system bandwidth as explained in Gitlin with the known advantages of "larger system capacity," "flexib[ility] in terms of required bandwidth," and "suit[ability] . . . for support of large data rates" in an OFDMA system. Ex. 1010, at 6:10-16; Ex. 1011, at 227-28. *Explicit Teaching to Combine* *Gitlin* also discloses elements that would have motivated one of ordinary skill to modify *Gitlin* with the teachings of *Van Nee*. *Gitlin* expressly teaches to eliminate the guard bands for contiguous assignments. Ex. 1010, at 5:33-37 ("Such contiguous assignments eliminate the need for guard bands between the frequencies assigned to a given user. Depending on the modulation scheme, however, certain adjacency requirements may be relaxed."). *Van Nee* discloses that OFDMA is one such modulation scheme that eliminates the need for guard bands. Ex. 1011, at 213 ("OFDMA avoids the relatively large guard bands that are necessary in FDMA to separate different users."). As illustrated by Figure 1.10 of *Van Nee*, the elimination of guard bands results in greater spectral efficiency ("saving of bandwidth") as compared to ordinary FDMA systems. *Id.* at 22.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		 **Figure 1.10** Concept of OFDM signal: (a) Conventional multicarrier technique, and (b) orthogonal multicarrier modulation technique Moreover, *Gitlin* expressly recognizes that a problem with multi-tone approach was the potential need for multiple transmitters. Ex. 1010, at 6:20-23. *Van Nee*, however, discloses that OFDMA eliminates the need for guard bands and eliminates any potential need for multiple transmitters. Ex. 1011, at 213 ("OFDMA avoids the relatively large guard bands that are necessary in FDMA to separate different users."); *see also id.* at 22-23 (discussing the ability to eliminate multiple transmitter hardware). A person of ordinary skill in the art would have rightly been motivated by the express teachings of *Gitlin* to modify the channel allocation method disclosed in *Gitlin* with the OFDMA system described in *Van Nee*. The elimination of guard bands results in greater spectral efficiency to support higher data rates as compared to ordinary FDMA systems, as illustrated by Figure 1.10 of *Van Nee*. *Id.* at 22. A person of ordinary skill in the art would have been motivated to implement the advantages of the method of *Gitlin* of reducing degradation from frequency selective multipath fading by allocating disjoint frequency channels and also implementing OFDMA to gain the advantages of eliminating guard bands and the ability to use a single transmitter for OFDM transmission. The person of ordinary skill in the art

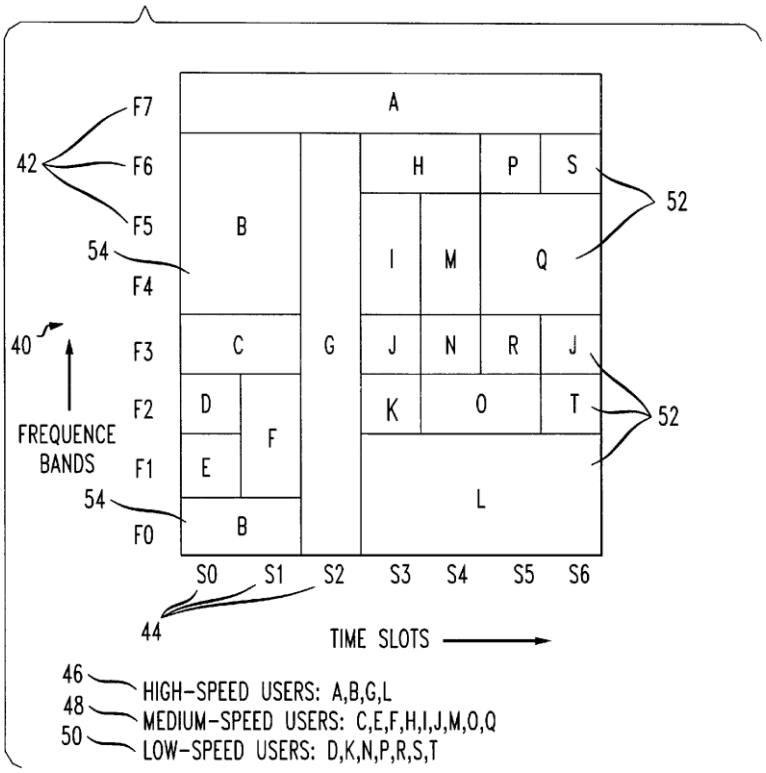
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		would have been especially motivated to look to the teachings of the prior art with respect to FDMA systems due to *Van Nee*'s description of OFDMA and FDMA systems as "equivalent" with respect to multiple access. *Known Technique to a Known Device to Yield Predictable Results* Finally, the known technique of allocating sets of OFDMA subcarriers to different mobile terminals to the known FDMA system implementing the channel allocation method taught by *Gitlin* would have yielded predictable results. Combining the channel allocation system of *Gitlin* with the OFDMA system of *Van Nee* would have predictably resulted in a base station that communicates with subscribers over OFDMA subcarriers with the known benefit of avoiding guard bands and eliminating the need for multiple transmitters, while retaining the advantages of the method of *Gitlin* of reducing degradation from frequency selective multipath fading by allocating disjoint frequency channels. Controller 100 in *Gitlin* allocates sets of time-frequency slices (i.e., tones) to a plurality of users (i.e., subscribers). *Gitlin* further discloses that the guard bands between adjacent frequency tones can be eliminated. Ex. 1010, at 5:33-37. It was well known to a person of ordinary skill in the art at the time of the '445 patent that an OFDMA base station can allocate sets of OFDMA subcarriers to different mobile terminals (i.e., subscribers). As shown in Chapter 9 of *Van Nee*, an example OFDMA system was proposed for use in the 3G world standard by the European Telecommunications Standards Institute (ETSI) in 1997. *Id.* at 217. *Van Nee* describes that an OFDMA system is a "very flexible multiple access scheme," and

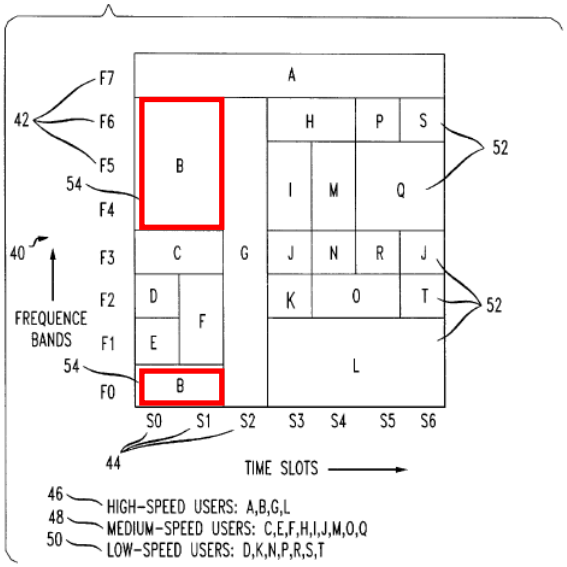
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		that includes a "larger system capacity," is "flexible in terms of required bandwidth," and is "suited . . . for support of large data rates." *Id.* at 227-228. As one of ordinary skill in the art would have recognized, combining the channel allocation method of *Gitlin* with the OFDMA system of *Van Nee* would have therefore yielded the predictable result of an OFDMA system as an improved system that included the channel allocation methods taught by *Gitlin* and OFDMA as taught by *Van Nee*. Further, both *Gitlin* and *Van Nee* are directed to efficient use of bandwidth in a multiple access system, including through allocation of shared resources to multiple users. Accordingly, OFDMA (and the use of OFDMA subcarriers), as taught by *Van Nee*, would have been an obvious and highly desirable design choice for a person of ordinary skill seeking to implement in the channel allocation method of *Gitlin*.
1.0.2	"each of the sets of subcarriers including a plurality of subcarriers,"	To the extent the preamble is found to be limiting, *Gitlin* discloses allocating sets of multiple time-frequency slices or tones (corresponding to "subcarriers"). As discussed in further detail above, a person of ordinary skill would understand the term "subcarriers" under the broadest reasonable interpretation to mean "*narrower bandwidth frequency channels of a wider system bandwidth*." To the extent that the preamble is found to be limiting, *Gitlin* discloses the allocation of sets of multiple "time-frequency slices," or "tones," to users. Ex. 1010, at 4:65-66 ("[C]entral control 100 can thus allocate particular time-frequency slices 52 to a given user[.]"); *see also* 6:7-10 ("[T]ransmission speed of a user can thus determine the number of tones and, thus, the number of frequencies 42 allocated for that user[.]").

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		Gitlin, therefore, discloses allocating multiple tones or frequency slices (i.e., sets of subcarriers) to users. See Ex. 1010, at 4:1-2 (describing frequencies 42 as "slices"). Sets of Subcarriers *See supra* analysis at 1.0.1. Plurality of Subcarriers "Based on the availability of the medium 40, central control 100 ***can thus allocate particular time-frequency slices 52 to a given user*** so as to anticipate 'future' requests which will be made by users 46, 48, 50 so as to best optimize full use of the overall medium 40." Ex. 1010, at 4:64-5:1. "The transmission speed of a user can thus determine ***the number of tones*** and, thus, ***the number of frequencies 42 allocated for that user***." *Id.*, at 6:7-10. OFDMA Subcarriers To the extent that these claims are construed to be limited to OFDMA or OFDM subcarriers, it would be obvious to use the teachings of *Gitlin* to implement an "example OFDMA system" (and thereby use OFDM or OFDMA subcarriers) as disclosed by *Van Nee*. Ex. 1011, at 217-19. "Figure 9.4 illustrates the time-frequency grid of the OFDMA system. The resources (time and frequency) are allocated based on the type of services and operational environment. ***The number of*** timeslots and ***bandslots per user is variable*** to realize variable data rates. The smallest data rate is obtained for one bandslot of 24 subcarriers per timeslot of 288.46 μs." *Id.* at 217.

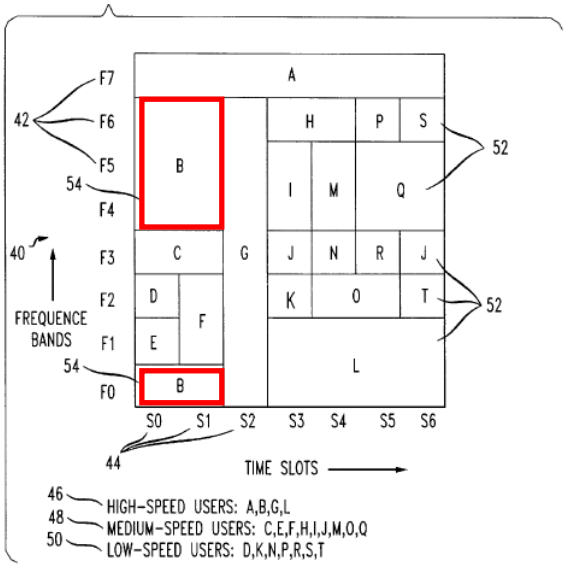
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		 **Figure 9.4** Time-frequency grid. *Id.* at 217. Reasons to Combine *Van Nee* with *Gitlin* *See supra* analysis at 1.0.1.
1.0.3	"by a base station which communicates with a plurality of subscribers using an OFDMA system, the method comprising:"	To the extent the preamble is found to be limiting, it would have been obvious to a person of ordinary skill in the art to implement the claimed method in a base station that communicates with a plurality of subscribers using an OFDMA system in view of *Van Nee*. To the extent that the preamble is found to be limiting, implementing the method described by *Gitlin* in a base station that uses OFDMA in view of *Van Nee* would have been obvious to a person of ordinary skill in the art. In particular, *Gitlin* discloses that its method for allocating subcarriers is performed by a central control 100 (corresponding to the claimed base station). Ex. 1010, at 4:65-66 (stating that "central control 100 can thus allocate particular time-frequency slices 52 to a

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		given user."). *Gitlin* also discloses the allocation of time-frequency resources to a plurality of users (e.g., users 46, 48, and 50), which are the claimed "subscribers." Id. at 4:12-14. Base Station "[C]entral control 100 can thus allocate particular time-frequency slices 52 to a given user." *Id.* at 4:65-66. "However, it will be understood that as opposed to contiguous transmissions entailing the entire frequency spectrum, for non-contiguous multi-tone transmissions, the base station receiver itself may be simplified, in that only a fixed number ("n") tones in specific frequency bands 42 will need to be received, so that only a single, low bit rate transmitter/receiver pairing may need to be used." *Id*. at 6:23-30. Base Station Communicating with a Plurality of Subcarriers "[C]entral control 100 may then award particular time-frequency slice 52 allocations to the individual users 46, 48, 50 based on such factors as the amount of the medium 40 requested by the users and/or the amount of medium 40 already allocated to users." *Id.* at 4:57-61.

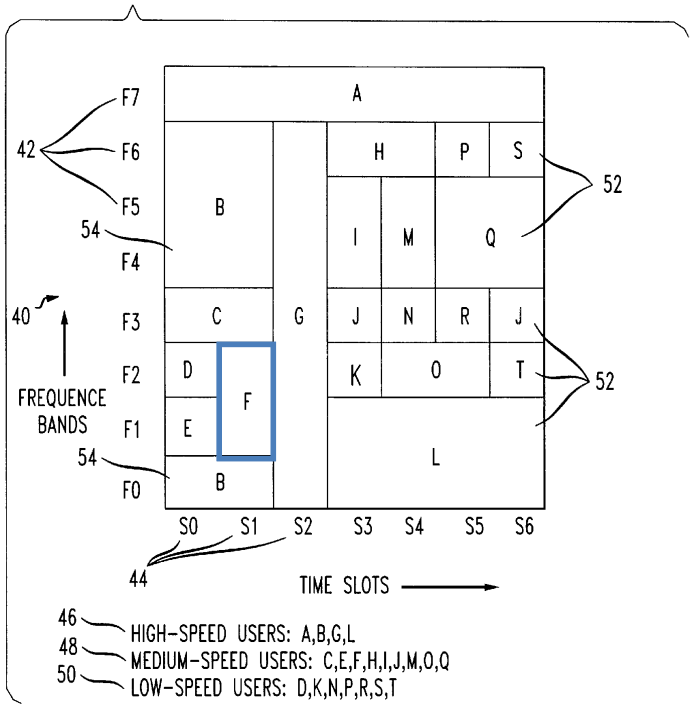
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		FIG. 6  *Id.* at Fig. 6. Base Station Which Communicates with a Plurality of Subscribers Using an OFDMA System To the extent that *Gitlin* does not explicitly disclose that its method may be performed by a base station using an OFDMA system, it would have nevertheless been obvious to do so in view of *Van Nee*. In particular, *Van Nee* discloses "an example OFDMA system" (Ex. 1011, at 217) in which "the transmissions of mobile users are scheduled by the base station" (*id*. at 225). Reasons to Combine *Van Nee* with *Gitlin* *See supra* analysis at 1.0.1.

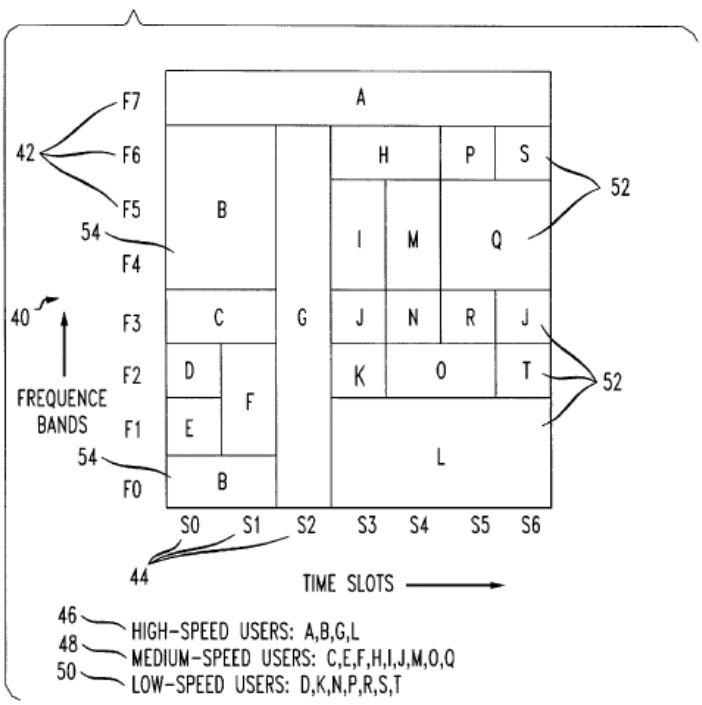
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
1.1.1	"allocating to a first subscriber a first set of subcarriers to be used for a first data transmission to the first subscriber, the allocated first set of subcarriers including a plurality of subcarriers at least one subcarrier of the plurality of subcarriers being disjoint in frequency from another subcarrier of the plurality of subcarriers"	As a preliminary matter, *Gitlin* discloses a number of different users or subscribers labeled A-T in its figures where High-Speed users are labeled A, B, G, and L. Medium-Speed users are labeled C, E, F, H, I, J, M, O, and Q. Low-speed users are labeled D, K, N, P, R, S, and T. *See* Ex. 1010, at 3:63-4:10 Allocating a Set of Subcarriers with at Least One Subcarrier Being Disjoint in Frequency from Another Subcarrier In Fig. 6 of *Gitlin* (as annotated in red below), *Gitlin* discloses allocating a set of frequency bands F0 and F4-F6 to high-speed User B for a first data transmission. *FIG. 6*  *Gitlin* explains that "FIG. 6 [. . .] depicts a variation of the time-frequency slicing method of the invention ***where noncontiguous frequency arrangements may be employed***. For instance, higher-speed users 46 operating on multi-tone modulation may benefit from

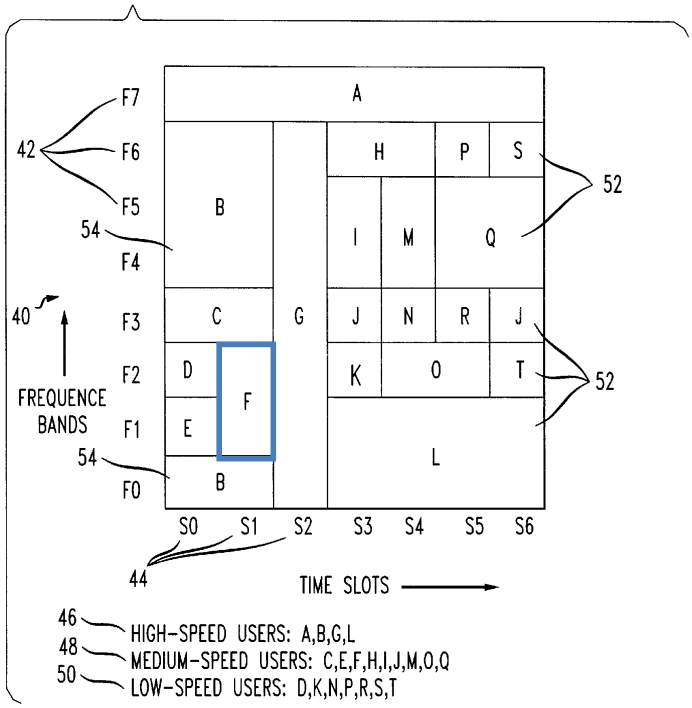
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		non-contiguous frequency arrangements. Here, ***a particular high speed user B (designated on FIG. 6 by numeral 54) has been assigned two non-contiguous frequency assignments ('slices') F0 and F5-F6 [sic, B is actually allocated frequency assignments F4-F6] in the bandwidth***, rather than the single contiguous assignment F4-F6 that the same user B might have employed without multi-tone modulation as depicted in FIG. 5." Ex. 1010, at 5:46-57. In other word, in time slot S1 of Fig. 6 (depicted above), a subscriber B is allocated a set of subcarriers with at least one subcarrier being disjoint from another subcarrier in the plurality of subcarriers (i.e., F0 is disjoint from F4-F6). Allocating a First Set of Subcarriers to a First Subscriber to be Used for a First Data Transmission "Thus, through use of their respective transmitters (not shown), the ***various of the users 46, 48, 50 can modulate their signals into one or more of the available frequency bands 42 on a time slot-by-slot 44 basis*** in order to effect optimum scheduling of the users within the medium 40 to efficiently make use of the available time-frequency medium 40." *Id.* at 4:40-46.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		FIG. 6  As shown by annotated Figure 6 above, *Gitlin* discloses allocating to a first subscriber (user B) a first set of subcarriers (frequency tones F0 and F4-F6) to be used for a first data transmission. *Gitlin* confirms that "higher data rates will be available to high speed users 46." *Id.* at 6:4-6. Thus, it would be understood that User B (i.e., high-speed user 46) is allocated a set of subcarriers that are to be used for a first "high speed" data transmission.
1.1.2	"to obtain frequency diversity"	Allocating to Obtain Frequency Diversity "[I]t will be realized that higher data rates will be available to higher-speed users 46 by signaling on a combination of tones, whereas the lower-speed user 50 would occupy only a single frequency slice of the bandwidth. The transmission speed of a user can thus determine the number of tones and, thus, the number of frequencies 42 allocated for that user. These tones may be scheduled in possibly non-contiguous frequency slots within one or more time slots, as, for example, for user B in FIG. 6. ***In fact, it has been found that spreading the frequency allocations of a high-speed***

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		user may offer some propagation benefits (e.g., a reduction in the degradation from frequency selective multipath fading)." Ex. 1010, at 6:4-16; *see also id.* at 6:22-30. *Gitlin* is suggests that there are benefits in allocating to a user tones that are sufficiently separated that they fade independently. By spreading the frequency allocations of a user, the user has a lower chance of all of its frequency allocations being lost in a deeply-fading area of the spectrum and, thereby, improves that user's frequency diversity. Accordingly, one of ordinary skill in the art would understand that reducing the degradation from frequency selective multipath fading by allocating non-contiguous frequencies is a way of obtaining frequency diversity.
1.2.1	"allocating to a second subscriber a second set of subcarriers to be used for a second data transmission to the second subscriber,"	As explained above, *Gitlin* discloses a number of subscribers labeled A-T in its figures where High-Speed users are labeled A, B, G, and L. Medium-Speed users are labeled C, E, F, H, I, J, M, O, and Q. Low-speed users are labeled D, K, N, P, R, S, and T. *See* Ex. 1010, at 3:63-4:10. Allocating a Second Set of Subcarriers to a Second Subscriber to be Used for a Second Data Transmission "Thus, through use of their respective transmitters (not shown), the ***various of the users 46, 48, 50 can modulate their signals into one or more of the available frequency bands 42 on a time slot-by-slot 44 basis*** in order to effect optimum scheduling of the users within the medium 40 to efficiently make use of the available time-frequency medium 40." *Id.* at 4:40-46.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		FIG. 6  As shown by annotated Figure 6 above in blue, *Gitlin* discloses allocating to a second subscriber (user F) a second set of subcarriers (frequency tones F1 and F2) to be used for a second data transmission (with "medium speed" data rates). One of ordinary skill would understand that as compared to high speed users 46 who have access to higher data rates (*Id.* at 6:4-6), medium speed users 48, such as User F, will have access to medium data rates. Thus, it would be understood that User F's set of subcarriers are to be used for a second "medium speed" data transmission.
1.2.2	"the second data transmission to occur simultaneously with the first data transmission to the first subscriber using the first set of subcarriers"	First and Second Data Transmission Occurs Simultaneously "Thus, through use of their respective transmitters (not shown), the ***various of the users 46, 48, 50 can modulate their signals into one or more of the available frequency bands 42 on a time slot-by-slot 44 basis*** in order to effect optimum scheduling of the users

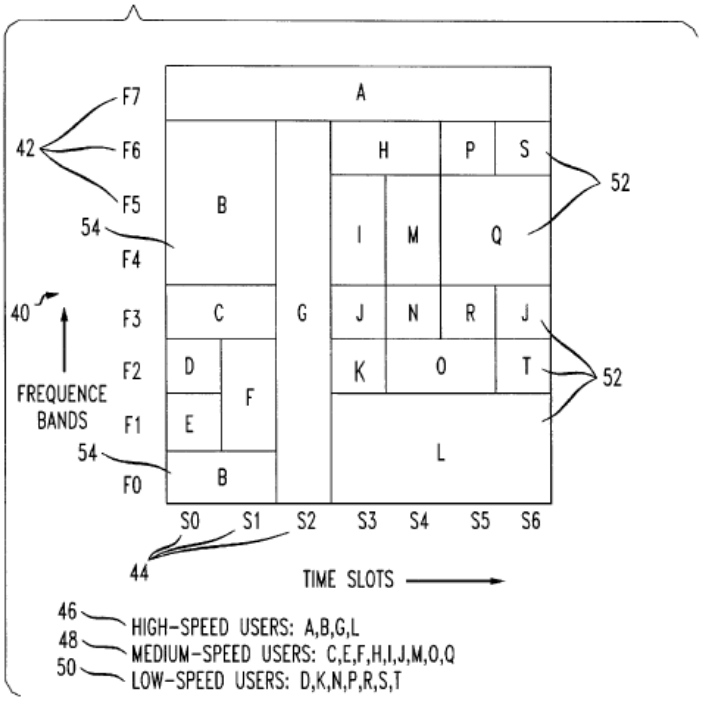
	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		within the medium 40 to efficiently make use of the available time-frequency medium 40." Ex. 1010, at 4:40-46. *FIG. 6*  As shown by Figure 6, the first data transmission to User B occurs in time slots S0 and S1, while the second data transmission to User F occurs in time slot S1. During time slot S1, the data transmission to User F occurs simultaneously with the data transmission to User B.
1.2.3	"the allocated second subcarriers including only consecutive subcarriers."	Allocating a Set of Subcarriers Including Only Consecutive Subcarriers In Fig. 6 of *Gitlin* (as annotated in blue below), *Gitlin* discloses allocated frequency bands F1 and F2 to medium-speed User F.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		FIG. 6  *Gitlin* explains the advantages of allocating sets of contiguous subcarriers: "Oftentimes, it is advantageous that high-speed users 46 be assigned contiguous frequencies 42. Such contiguous assignments eliminate the need for guard bands between the frequencies assigned to a given user." Ex. 1010, at 5:32-35. In other word, in time slot S1 of Fig. 6 (depicted above), the subscriber F is allocated a set of subcarriers, wherein the allocated set of subcarriers include only consecutive subcarriers (i.e., F1 and F2 contain only consecutive subcarriers).
2.0	"The method of claim 1, wherein the allocation of the first set of subcarriers is identified by a first identification."	As discussed above, the combination of *Gitlin* and *Van Nee* discloses and/or renders obvious the method of Claim 1. *See supra* analysis at 1.0.1-1.2.3. Moreover, as discussed in further detail above, a personal of ordinary skill in the art would understand "first

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		identification" is "*information about the first subscriber's subcarriers*" under a broadest reasonable interpretation in the context of the '445 patent. First Identification Identifying the Allocation of the First Set of Subcarriers One of ordinary skill in the art would understand that the limitations of dependent Claim 2 are fundamental implementation details required in any wireless system so that the subscriber can be informed about the allocated set of subcarriers in order to use them. Nevertheless, this basic concept is disclosed by *Gitlin*. "The central controller 100 may then award particular time-frequency slice 52 allocations to the individual users 46, 48, 50[.]" Ex. 1010, at 4:57-58. "Individual users may thus align themselves within their assigned-time frequency slices 52 through appropriate signal configuration and/or modulation." *Id.* at 4:61-64. One of ordinary skill in the art would understand that "awards" of allocations disclosed by *Gitlin* would include identifications of the assigned time-frequency slices in order for the users to then align themselves to their assigned time-frequency slices. *See id*. at 4:57-64. One of ordinary skill would understand that this process would be used to inform, for example, User B and User F of their allocations as shown in Figure 6. Moreover, signaling allocations to a user, including allocations in an OFDMA system, was common practice at the time of the '445 patent. For example, *Van Nee* teaches ***transmitting a frame map*** from the base station to the user ***indicating "bandslot allocations for the next frame***." Ex. 1011, at 225.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		These frame maps in *Van Nee* could convey, among other things, the allocated bandslots for "downlink transmission to a single terminal" or "a single terminal for uplink transmission." *Id*.
4.0	"The method of claim 1, wherein the allocation of the second set of subcarriers is identified by a second identification provided from the base station to the second subscriber."	As discussed above, the combination of *Gitlin* and *Van Nee* discloses and/or renders obvious the method of Claim 1. *See supra* analysis at 1.0.1-1.2.3. Second Identification Identifying the Allocation of the Second Set of Subcarriers *See supra* analysis at 3.0. One of ordinary skill in the art would understand that the limitations of dependent Claim 2 are fundamental implementation details required in a wireless system so that the subscriber can be informed of the allocated set of subcarriers in order to use them. Nevertheless, this basic concept is disclosed by *Gitlin*. "The central controller 100 may then award particular time-frequency slice 52 allocations to the individual users 46, 48, 50[.]" Ex. 1010, at 4:57-58. "Individual users may thus align themselves within their assigned-time frequency slices 52 through appropriate signal configuration and/or modulation." *Id.* at 4:61-64. One of ordinary skill in the art would understand that "awards" of allocations disclosed by *Gitlin* would include identifications of the assigned time-frequency slices in order for the users to then align themselves to their assigned time-frequency slices. *See id*. at 4:57-64. One of ordinary skill would understand that this process would be used to inform, for example, User B and User F of their allocations as shown in Figure 6.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		Moreover, signaling allocations to a user, including allocations in an OFDMA system, was common practice at the time of the '445 patent. For example, *Van Nee* teaches ***transmitting a frame map*** from the base station to the user ***indicating "bandslot allocations for the next frame***." Ex. 1011, at 225. These frame maps in *Van Nee* could convey, among other things, the allocated bandslots for "downlink transmission to a single terminal" or "a single terminal for uplink transmission." *Id*.
6.0	"The method of claim 1, wherein the allocated first set of subcarriers is specified by a cluster index."	As discussed above, the combination of *Gitlin* and *Van Nee* discloses and/or renders obvious the method of Claim 1. *See supra* analysis at 1.0.1-1.2.3. Cluster Index "As illustrated, the overall time-frequency spectrum (or medium) 40 can be partitioned in both the time and frequency domains as ***plurality of frequency bands ("slices") 42 (F0, F1, . . . FN)*** extending over a plurality of individual time slots ("slices") 44 (S0, S1, . . . SN)." Ex. 1010, at 3:66-4:3.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		FIG. 6  *Gitlin* discloses partitioning the overall time-frequency spectrum into frequency bands, which are respectively identified as F0, F1, . . . FN. Ex. 1010, at 4:1-3; s*ee also id.* at Fig. 6. *Gitlin* further discloses that central controller 100 is able to award allocations of particular time-frequency slices 52 to users, thus informing them of their respective allocated time-frequency slices. *See id.* at 4:57-64 (the "central controller 100 may then award particular time-frequency slice 52 allocations to the individual users 46, 48, 50."); 4:61-64 ("[U]sers may align themselves to their assigned time-frequency slices through appropriate signal configuration and/or modulation."). The signaling process by which subscriber units and base stations exchange information, including identifying which subcarrier frequencies to use and/or what coding and modulation

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		scheme to use, were common principles that would have been well known, and indeed, routine, to one of ordinary skill in the art. Ex. 1011, at 225. Furthermore, one of ordinary skill in the art would understand that in order for the user to assign themselves to their assigned time-frequency slices, the base station must communicate the assigned time-frequency slices to the user. One obvious method to specify which set of subcarriers has been awarded to the subscriber is to use the identifiers F0, F1, . . FN together as an index to the assigned cluster.
7.0	"The method of claim 1, wherein the first data transmission to the first subscriber includes channel coding across the plurality of subcarriers of the allocated first set of subcarriers."	As discussed above, the combination of *Gitlin* and *Van Nee* discloses and/or renders obvious the method of Claim 1. *See supra* analysis at 1.0.1-1.2.3. Channel Coding Across a Plurality of Subcarriers "Depending on the modulation scheme, however, certain adjacency requirements can be relaxed. For instance, as will be appreciated, users modulating their signals according to a 'multi-tone' scheme may not require contiguous frequency assignments in order to transmit their data. As those skilled in the art will discern, tones represent multi-bit symbols, with each tone toggling at a rate corresponding to the bandwidth of one frequency band. Thus, with multi-tone transmission two bits can be transmitted as one 4-ary symbol using 2-tone modulation instead of two symbols on a binary channel." Ex. 1010, at 5:35-45. A person of ordinary skill in the art would understand that signaling on a combination of tones and/or using one 4-ary symbol using 2-tone modulation discloses channel coding across subcarriers, which would apply to User B (as a high speed user 46).

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		To the extent that *Gitlin* is found to not explicitly disclose these limitations, a person of ordinary skill in the art would nevertheless look to *Van Nee* to perform channel coding across the subcarriers. *Van Nee* describes channel coding as essential: "[F]orward-error correction coding is essential. By using ***coding across the subcarriers***, errors of weak subcarriers can be corrected up to a certain limit that depends on the code and the channel. A powerful coding means that the performance of an OFDM link is determined by the average received power, rather than by the power of the weakest subcarrier." Ex. 1011, at 53. Forward-error correction coding is a type of channel coding. Ex. 1016 at 338-41 Reasons to Combine *Van Nee* with *Gitlin* As discussed above with respect to Claim 1, it would have been obvious to combine *Gitlin* and *Van Nee* to form an OFDMA system. *See supra* analysis at 1.0. For substantially similar reasons, it would have also would have been obvious to combine the teachings of *Gitlin* and *Van Nee* to include channel coding across subcarriers in the combined *Gitlin*-*Van Nee* system. *Known Technique to a Known Device to Yield Predictable Results* Application of the known technique of forward-error correction (a form of channel coding) as disclosed in *Van Nee* to the transmitted 4-ary signal in *Gitlin* would predictably result in an improved transmission system. In particular, combining the signal transmission of *Gitlin* with the forward-error correction of *Van Nee* would predictably result in improving the bit-error ratio of the transmitted data signals in *Gitlin*. Controller 100 in *Gitlin* allocates sets of time-frequency slices, or tones, to a plurality of users (i.e.,

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
		subscribers). Ex. 1010, at 4:57-58. *Gitlin* discloses a base system that signals using 2-tone modulation on a combination of tones. Ex. 1010, at 5:35-45. For the same reasons discussed above with respect to claim 1, a personal of ordinary skill in the art would have been motivated to combine the system in *Gitlin* with the teachings of *Van Nee* to arrive at an OFDMA system that implemented the channel allocation methods of *Gitlin*. *See* supra analysis at 1.0. Moreover, *Van Nee* explicitly teaches that channel coding is "essential" to OFDMA systems. Ex. 1011, at 53. *Van Nee* further discloses that channel coding across subcarriers allows for error correction of weak subcarriers. *Id.* at 53. *Van Nee* further discloses that this error correction improves the performance of an OFDM link from the performance of the weakest subcarrier to the performance of the average subcarrier. *Id.* at 53. Accordingly, one of ordinary skill in the art would have been motivated to combine the OFDMA channel allocation system disclosed by the combination of *Van Nee* and *Gitlin* with the "essential" forward-error correction disclosed in *Van Nee*. In addition, one of ordinary skill in the art would have been motivated to include channel coding across subcarriers because *Van Nee* discloses this as a method to implement the "essential" forward-error correction. This combination would have resulted in an improved system that included both the advantages of OFDMA and the advantages of forward-error correction, such as correcting errors in weak subcarriers.
8.0	"A base station that communicates with a plurality of subscribers and allocates sets of	Independent Claim 8 is a parallel apparatus claim to independent Claim 1 and recites substantially similar limitations to Claim 1. Claim 8 is directed to a base station that communicates with a plurality of

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
	subcarriers, each of the sets of subcarriers including a plurality of subcarriers, using an orthogonal frequency-division multiple access (OFDMA) system, the base station comprising: a controller configured to: allocate to a first subscriber a first set of subcarriers to be used for a first data transmission to a first subscriber, an allocated first set of subcarriers including a plurality of subcarriers at least one subcarrier of the plurality of subcarriers being disjoint in frequency from another subcarrier of the plurality of subcarriers to obtain frequency diversity; and allocate to a second subscriber a second set of subcarriers to be used for a second data transmission to a second subscriber, the second data transmission to occur simultaneously	subscribers that includes a "controller configured to" perform the method steps of independent Claim 1. *Gitlin* discloses that its channel allocation method may be implemented by such a "controller." Ex. 1010, at 4:51-5:1. As such, *Gitlin* renders obvious Claim 8 for substantially similar reasons to independent Claim 1. *See supra* analysis at 1.0.1-1.2.3.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
	with the first data transmission to the first subscriber using the allocated first set of subcarriers, an allocated second set of subcarriers including only consecutive subcarriers."	
9.0	"The base station of claim 8, further comprising: receive/transmit circuitry configured to: provide the first subscriber with a first identification identifying the allocated first set of subcarriers."	*Gitlin* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 9 of the '445 Patent recites substantially similar limitations as Claim 2. As such, *Gitlin* renders obvious Claim 9 for similar reasons as those discussed with reference to Claim 2. *See supra* analysis at 2.0. Dependent Claim 9 further recites that a "receive/transmit circuitry" performs the limitations of Claim 2. *Gitlin* discloses that its channel allocation method may be implemented by a "controller" that can "allocate particular time-frequency slices to a given user." Ex. 1010, at 4:64-5:1; *see also id*. at 4:57-61. Although not discussed in detail in *Gitlin*, the reference discloses that its channel allocation method may be implemented by a "controller" that can "allocate particular time-frequency slices to a given user" based on such facts like the amount of medium requested by the user. *Id.* at 4:51-5:1. One of ordinary skill in the art would understand that the base station in *Gitlin*—in order to receive requests from a user and then allocate time-frequency slices to the user—must contain receive/transmit circuitry capable of the functions described above.
11.0	"The base station of claim 8, further comprising:	*Gitlin* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
	receive/transmit circuitry configured to: provide the second subscriber with a second identification identifying the allocated second set of subcarriers."	Claim 11 of the '445 Patent recites substantially similar limitations as Claim 4. As such, *Gitlin* renders obvious Claim 11 for similar reasons as those discussed with reference to Claim 4. *See supra* analysis at 2.0. Dependent Claim 11 recites that a "receive/transmit circuitry" performs the limitations of Claim 2. *Gitlin* discloses that its channel allocation method may be implemented by a "controller" that can "allocate particular time-frequency slices to a given user." Ex. 1010, at 4: 64-5:1; *see also id*. at 4:57-61. Although not discussed in detail in *Gitlin*, the reference discloses that its channel allocation method may be implemented by a "controller" that can "allocate particular time-frequency slices to a given user" based on such facts like the amount of medium requested by the user. *Id*. at 4:51-5:1. One of ordinary skill in the art would understand that the base station in *Gitlin*—in order to receive requests from a user and then allocate time-frequency slices to the user—must contain receive/transmit circuitry capable of the functions described above.
13.0	"The base station of claim 8, wherein the allocated first set of subcarriers is specified by a cluster index."	*Gitlin* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 13 recites substantially similar limitations as Claim 6. As such, *Gitlin* renders obvious Claim 13 for similar reasons as those discussed with reference to Claim 6. *See supra* analysis at 6.0.
14.0	"The base station of claim 8, wherein the first data transmission to the first subscriber includes channel coding across the plurality of subcarriers of the	*Gitlin* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 14 recites substantially similar limitations as Claim 7. As such, *Gitlin* renders obvious Claim 14 for similar reasons as those discussed with reference to Claim 7. *See supra* analysis at 7.0.

	US 8,934,445	**Claims 1-2, 4, 6-9, 11, and 13 are unpatentable over *Gitlin* and *Van Nee***
	allocated first set of sub carriers."	

2. Ground 2- Claims 3 and 10 are unpatentable over *Gitlin*, *Van Nee*, and *Hanzo*

	US 8,934,445 (*Gitlin*)	**Claims 3 and 10 are unpatentable over *Gitlin*, *Van Nee*, and *Hanzo***
3.0	"The method of claim 2, wherein the first identification includes a modulation and coding format to be used by the first subscriber for the first data transmission to the first subscriber."	As discussed above, the combination of *Gitlin* and *Van Nee* discloses and/or renders obvious the method of Claim 2. *See supra* analysis at 2.0. Moreover, as discussed in further detail above, a personal of ordinary skill in the art would understand "first identification" is "*information about the first subscriber's subcarriers*" under a broadest reasonable interpretation in the context of the '445 patent. An Identification That Includes a Modulation and Coding Format One of ordinary skill in the art would understand that the limitations of dependent Claim 3 are fundamental implementation details required in a wireless system so that the subscriber can be informed about what coding and modulation format to use in order to allow the user to correctly decode and demodulate the data transmitted on the assigned subcarriers. *Gitlin* suggests that a skilled artisan is capable of choosing to implement additional, higher level modulation, schemes. *Gitlin* indicates that "***[h]igher-level modulations are also possible*** in the system and method according to the invention." Ex. 1010, at 6:33-34. By 2000, higher-level modulation schemes were commonplace in OFDMA systems. *See* Ex. 1014 at 1-14 (conveying that various forms of modulation methods–including phase shift keying (PSK) and

	US 8,934,445 (*Gitlin*)	**Claims 3 and 10 are unpatentable over *Gitlin*, *Van Nee*, and *Hanzo***
		quadrature amplitude modulation (QAM) were available for OFDM systems). As an example of higher-level modulation schemes, as suggested by *Gitlin*, is the adaptive coding and modulation rate in an OFDMA system as disclosed by *Van Nee*. Ex. 1011, at 220 (describing that its system uses "***variable coderates in the range of 1/4 to 3/4***." and can support "QPSK and 8-PSK" modulation schemes). The ability to use additional modulation schemes (like the system described in *Van Nee*) allows for greater throughput capacity and allows for greater frequency reuse. One of ordinary skill would have immediately recognized the benefits of implementing adaptive coding and modulation as described by *Van Nee*. *Hanzo* also teaches that adaptive coding and modulation can "improve the BER [(bit error rate)] performance." Ex. 1014, at 556. A well-known (and common) method of informing the receiver of the modulation and coding format in order for the receiver to demodulate and decode the signal properly is to exchange the coding and modulation rate to use with the receiver. For example, *Hanzo* includes a chapter on "Adaptive Single- and Multi-user OFDM Techniques" that teaches a textbook approach to variable coding and modulation that includes informing the subscriber of the particular coding and format to be used. The *Hanzo* book teaches that "transmission parameters can be adapted to the anticipated channel condition, such as the modulation and coding rates." Ex. 1014, at 556. *Hanzo* stresses that "the resulting set of parameters ***has to be communicated*** to the receiver in order to successfully demodulate and decode the OFDM symbol." *Id.* at 558.

	US 8,934,445 (*Gitlin*)	**Claims 3 and 10 are unpatentable over *Gitlin*, *Van Nee*, and *Hanzo***
		It would have been immediately obvious to inform the users in order to allow the user to correctly decode and demodulate the data. A modulation scheme defines how a radio wave is to be varied to convey information. Consequently, knowledge of the modulation scheme, which was used for transmission, is required at the receiver, so that the receiver can interpret this information. Coding is the addition of redundancy to information to be transmitted, so that a receiver can detect and/or correct errors in the received data. Without knowing the modulation and coding scheme of a specific transmission, the receiver cannot extract the information underlying the transmitted signal. Essentially, the wireless transmission would be worthless to the receiver if modulation and coding scheme were unknown to the receiver. Reasons to Combine *Gitlin*, *Van Nee*, and *Hanzo* As discussed above with respect to Claim 1, it would have been obvious to combine *Gitlin* and *Van Nee* to form an OFDMA system. *See supra* analysis at 1.0. It would have further been obvious to combine the teachings of *Gitlin* and *Van Nee* to include first identification that includes a modulation and coding format to be used by the first subscriber for the first data transmission as described in *Hanzo* in the combined *Gitlin-Van Nee* system. *Known Technique to a Known Device to Yield Predictable Results* The combination of the known systems disclosed in *Gitlin*, *Van Nee*, and *Hanzo* would produce predictable results and an improved system. Controller 100 in *Gitlin* allocates sets of time-frequency slices, or tones, to a plurality of users (i.e.,

	US 8,934,445 (*Gitlin*)	**Claims 3 and 10 are unpatentable over *Gitlin*, *Van Nee*, and *Hanzo***
		subscribers) in an FDMA system. *Gitlin* suggests that additional modulations are possible in the *Gitlin* system. Ex. 1010, at 6:33-34. *Van Nee* discloses that additional modulation and coding rates can be allocated through adaptive coding and modulation. Ex. 1011, at 220. *Hanzo* further describes that adaptive coding and modulation "improves BER performance," and that the user has to be informed of the coding and modulation to use in order to correctly decode and demodulate the data. Ex. 1014, at 556, 558. Combining the higher modulation rate (i.e., adaptive coding and modulation) in the *Gitlin* and *Van Nee* combination with the signaling of the coding and modulation scheme to use would predictably result in a functioning system that allows users to correctly decode and demodulate the transmitted data. To the extent that the "first identification" is construed to be a single message that includes both the identification of the allocated set of subcarriers and the coding and modulation rate (a construction that is not supported by the specification), including both pieces of information in same message would have been an obvious, natural, and efficient design choice. Armed with the knowledge that the base station must identify both the allocated set of subcarriers and the coding and modulation rate, one of ordinary skill in the art would have been motivated to look to signal messaging references, such as portions of *Hanzo*, to learn the details of how to implement a signal messaging system to include information about both the allocated set of subcarriers and the coding and modulation rate. *See* Ex. 1014 at 558 ("[T]he resulting set of parameters has to be communicated to the receiver in order to

	US 8,934,445 (*Gitlin*)	**Claims 3 and 10 are unpatentable over *Gitlin*, *Van Nee*, and *Hanzo***
		successfully demodulate and decode the OFDM symbol."). Incorporating two sets of signaling information into one message would have been a matter of design choice and is not inventive.
10.0	"The base station of claim 9, wherein the first identification includes a modulation and coding format to be used by the first subscriber for the first data transmission to the first subscriber."	*Gitlin* renders obvious the base station of Claim 9, as discussed above. *See supra* analysis at 9.0. Claim 10 recites substantially similar limitations as Claim 3. *Gitlin* further discloses that its channel allocation method may be implemented by a "central control" of a base station. Ex. 1010, at 4:51-5:1. As such, *Gitlin* renders obvious Claim 10 for similar reasons as those discussed with reference to Claim 3. *See supra* analysis at 3.0.

3. Ground 3- Claims 5 and 12 are unpatentable over *Gitlin*, *Van Nee*, and *Rappaport*

	US 8,934,445 (*Gitlin*)	**Claims 5 and 12 are unpatentable over *Gitlin*, *Van Nee*, and *Rappaport***
5.0	"The method of claim 1, wherein the allocated first set of subcarriers includes two or more subcarriers spread farther apart than a coherence bandwidth of a respective channel."	As discussed above, the combination of *Gitlin* and *Van Nee* discloses and/or renders obvious the method of Claim 1. *See supra* analysis at 1.0-1.2.3. The '445 Patent states that the "coherence bandwidth" is "the bandwidth within which the channel response remains roughly the same." Ex. 1001, at 11:59-62. Allocated Set of Subcarriers Includes Two or More Subcarriers Spread Farther Apart than a Coherence Bandwidth of a Respective Channel

	US 8,934,445 (*Gitlin*)	**Claims 5 and 12 are unpatentable over *Gitlin*, *Van Nee*, and *Rappaport***
		In view of *Rappaport*, *Gitlin* teaches and/or renders obvious that the first set of subcarriers (F0, F4-F6) are spread farther apart than a coherence bandwidth. *Gitlin* teaches that "spreading the frequency allocations of a high-speed user may offer some propagation benefits (e.g., a reduction in the degradation from frequency-selective multipath fading)." Ex. 1010 at 6:12-16. It was well known and/or obvious to obtain frequency diversity by spreading frequency allocations by more than a coherence bandwidth. *Rappaport* describes that spreading frequencies by at least a coherence bandwidth is the basic rational underlying the concept of frequency diversity. Ex. 1016, at 335. Specifically, *Rappaport* explains that "[f]requency diversity transmits information on more than one carrier frequency. The rationale behind this technique is that frequencies separated by more than the coherence bandwidth of the channel will not experience the same fades." *Id*. Moreover, as one of ordinary skill in the art would know, *Gitlin* would not likely achieve the propagation benefits of reducing the degradation from frequency-selective multipath fading unless the allocated frequencies were spread farther apart than the coherence bandwidth of the channel, as fading of frequencies of less than coherence bandwidth is highly correlated. *Rappaport* confirms that a coherence bandwidth is "a statistical measure of the range of frequencies over which the channel can be considered 'flat' (i.e., a channel which passes all spectral components with approximately equal gain and linear phase)." *Id.* at 163. Accordingly, using a frequency range within the coherence bandwidth to contain the allocated set of frequencies in *Gitlin* would expose the transmission to frequency-selective fading and channel

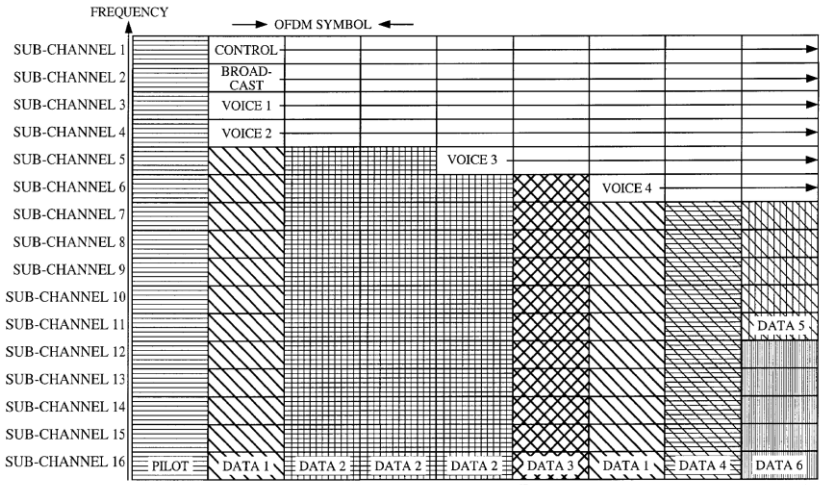
	US 8,934,445 (*Gitlin*)	**Claims 5 and 12 are unpatentable over *Gitlin*, *Van Nee*, and *Rappaport***
		distortion—the very thing that the spreading of the frequency allocations in *Gitlin* intended to avoid. It would have therefore been obvious to spread the frequencies of User B by more than a coherence bandwidth in the system of *Gitlin*. Reasons to Combine *Gitlin*, *Van Nee*, and *Rappaport* As discussed above with respect to Claim 1, it would have been obvious to combine *Gitlin* and *Van Nee* to form an OFDMA system that allocates a set of disjoint subcarriers. *See supra* analysis at 1.0. It would have further been obvious to combine the teachings of *Gitlin* and *Van Nee* to allocate a set of two or more disjoint subcarriers spread farther apart than a coherence bandwidth of a respective channel to obtain frequency diversity as taught by *Rappaport* in the combined *Gitlin-Van Nee* system. *Known Technique to a Known Device to Yield Predictable Results* The combination of the known systems disclosed in *Gitlin*, *Van Nee*, and *Rappaport* would produce predictable results and an improved system. Controller 100 in *Gitlin* allocates sets of time-frequency slices, or tones, to a plurality of users (i.e., subscribers) in an FDMA system. In Fig. 6 of *Gitlin* (as annotated in red below), *Gitlin* discloses allocated frequency bands F0 and F4, F5, and F6 to high-speed User B for a first data transmission. In other word, in time slot S1 of Fig. 6 (depicted above), a subscriber B is allocated a set of subcarriers with at least one subcarrier being disjoint from another subcarrier in the plurality of subcarriers (i.e., F0 is disjoint from F4, F5, or F6). *Rappaport* states that the basic rational underlying the

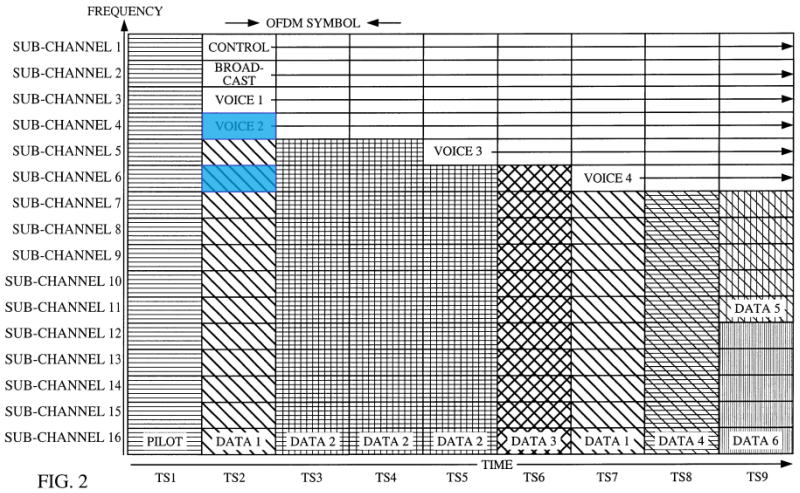
	US 8,934,445 (*Gitlin*)	**Claims 5 and 12 are unpatentable over *Gitlin*, *Van Nee*, and *Rappaport***
		concept of frequency diversity is spreading frequencies by at least a coherence bandwidth is. Ex. 1016, at 335. *Rappaport* explains that "[f]requency diversity transmits information on more than one carrier frequency. The rationale behind this technique is that frequencies separated by more than the coherence bandwidth of the channel will not experience the same fades." Ex. 1016, at 335. Because using only frequencies inside the coherence bandwidth would expose each of the frequencies used for the transmission to correlated frequency-selective fading and channel distortion and would thereby not achieve frequency diversity, a person of ordinary skill in the art would have been highly motivated to spread the subcarriers in the set of disjoint subcarriers described by *Gitlin* by more than the coherence bandwidth of the channel to achieve frequency diversity as taught by *Rappaport*.
12.0	"The base station of claim 8, wherein the allocated first set of subcarriers includes two or more subcarriers spread farther apart than a coherence bandwidth of a respective channel."	*Gitlin* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 12 of the '445 Patent recites substantially similar limitations as Claim 5. As such, the combination of *Gitlin*, *Van Nee*, and *Rappaport* renders obvious Claim 12 for similar reasons as those discussed with reference to Claim 5. *See supra* analysis at 5.0.

4. Ground 4- Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace*

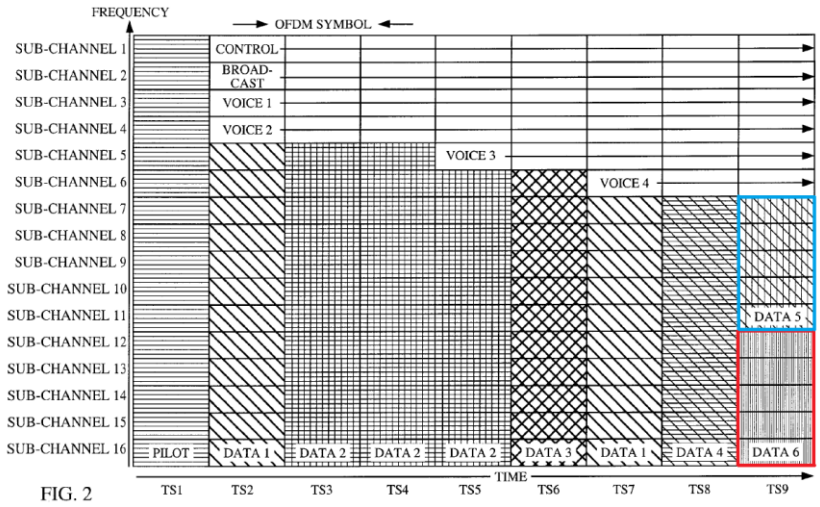
	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
1.0.1	"A method of allocating sets of subcarriers,"	As discussed in further detail above, a person of ordinary skill in the art would understand the term "subcarriers" under the broadest reasonable interpretation in the context of the '445 patent to mean "narrower bandwidth frequency channels of a wider system bandwidth." To the extent the preamble is found to be limiting, *Wallace* discloses a method of allocating different sets of OFDM sub-channels over time (which discloses allocating sets of subcarriers). *See* Ex. 1013, at 6:55-58; 26:61-66; 7:1-14; 26:61-66. Sets of sub-channels in *Wallace* are equivalent to sets of subcarriers (defined under a broadest reasonable interpretation as "narrower bandwidth frequency channels of a wider system bandwidth"). *Wallace* discloses that sub-channels modulate a particular sub-band within the operating bandwidth (*id*. at 6:6-10) and that the sub-bands are used collectively to form an OFDM symbol that modulates the entire system bandwidth (*id*. at 10:33-37). Subcarriers "With ***OFDM*** modulation, the overall transmission channel is essentially divided into a number of (L) ***parallel sub-channels*** that ***are used*** to transmit the same or different data." *Id.*, at 6:55-58. Sub-channels are equivalent to "subcarriers" at least because *Wallace* discloses that sub-channels are used to modulate a particular sub-band within the operating bandwidth (*Id.* at 6:6-11), and that the sub-bands are used collectively to form an OFDM symbol that modulates the entire operating bandwidth (*Id.* at 10:33-

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		37). Sets of Subcarriers "The ***data may be*** partitioned and ***transmitted over any defined set of two or more sub-bands*** . . . . ***Transmission of data over different sub-channels over time*** can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of ***OFDM modulation*** are described below." *Id.* at 7:1-14. Allocating Sets of Subcarriers "[S]ub-channels can be allocated to a single data user or divided among multiple data users.") *Id.* at 26:61-66.
1.0.2	"each of the sets of subcarriers including a plurality of subcarriers,"	To the extent the preamble is found to be limiting, *Wallace* discloses that using OFDM modulation, the data may be partitioned and transmitted over defined sets of two or more sub-bands (the sets include a plurality of subcarriers). *See* Ex. 1013, at 11:20-24. Sets of Subcarriers *See supra* analysis at 1.0.1. Plurality of Subcarriers "As shown in FIG. 2, a particular data transmission (e.g., data 2) may occur over multiple sub-channels and/or multiple time slots, and multiple data transmissions (e.g., data 5 and 6) may occur at one time slot." Ex. 1013, at 11:20-24.

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		 FIG. 2
1.0.3	"by a base station which communicates with a plurality of subscribers using an OFDMA system, the method comprising:"	To the extent the preamble is found to be limiting, *Wallace* discloses that a base station may be used to perform its allocation method and also implements an OFDMA system by using OFDM modulation to share OFDM sub-channels amongst multiple users simultaneously. Ex. 1013, at 18:55-57; 26:39-40; 26:63-66. Base Station Which Communicates with a Plurality of Subscribers Using an OFDMA System "The base station may then include this factor in scheduling the use of the forward and reverse links." *Id*. at 18:55-57. "OFDM modulation can also afford extra flexibility in sharing the system bandwidth, W, ***among multiple users***." *Id.* at 26:39-40. OFDM "sub-channels can be allocated to a single data user or ***divided among multiple data users***." *Id.* at 26:63-66.
1.1.1	"allocating to a first subscriber a first set of subcarriers to be used for a first data transmission to the first subscriber, the allocated first set of	Allocating a Set of Subcarriers with at Least One Subcarrier Being Disjoint in Frequency from Another Subcarrier *Wallace* discloses allocating sets of subcarriers to different subscribers by disclosing that "data may be partitioned and transmitted over any ***defined set*** of two

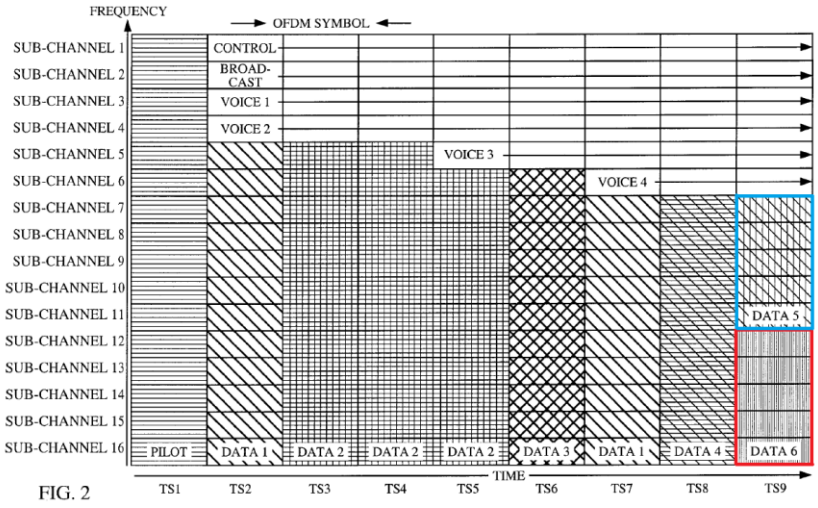
	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
	subcarriers including a plurality of subcarriers at least one subcarrier of the plurality of subcarriers being disjoint in frequency from another subcarrier of the plurality of subcarriers"	or more sub-bands" and that "sub-channels can be allocated to a single data user or ***divided among multiple data users***." Ex. 1013, at 7:1-2; 26:64-66. An example of an allocation to a particular subscriber unit in *Wallace* is a set of sub-channels consisting of disjoint OFDM sub-channels 4 and 6 during, for example, time slot 2. *Id.* at 7:6-10 ("[D]ata for a particular subscriber unit may be transmitted over . . . ***sub-channels 4 and 6 at time slot 2***, only sub-channel 2 at time slot 3, and so on."); *see also id.* at 6:6-10. In this example embodiment of allocation, *Wallace* discloses allocating a defined set of sub-channels 4 and 6 at time slot 2 (as annotated in blue below in Fig. 2), which comprise the claimed disjoint set of subcarriers. *Id.* at 7:6-10. The sub-channel 4 is "disjoint" in frequency from the sub-channel 6 at least because it is separated from the sub-channel 6 by the sub-channel 5.  FIG. 2 *Id.* at Fig. 2 (annotated).
1.1.2	"to obtain frequency diversity"	<u>Obtaining Frequency Diversity</u> *Wallace* teaches that the allocation of the disjoint set of sub-bands 4 and 6 to the particular subscriber is made to obtain frequency diversity. *Wallace* conveys that "the data may be partitioned and transmitted over any

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		defined set of two or more sub-bands ***to provide frequency diversity***." Ex. 1013, at 7:1-3; *see also id.* at 6:6-11; 6:51-58.
1.2.1	"allocating to a second subscriber a second set of subcarriers to be used for a second data transmission to the second subscriber,"	Allocating a Second Set of Subcarriers to a Second Subscriber to be Used for a Second Data Transmission *Wallace* renders obvious allocating a second subscriber a second set of sub-channels to be used for a second data transmission. For example, Figure 2 (as annotated below) illustrates two different sets of subcarriers to be allocated in time-slot 9. A first set of subcarriers consists of sub-channels 7-11 (called Data 5), and the second set of sub-channels consists of sub-channels 12-16 (called Data 6). *Wallace* teaches that "Data 1 through 6 transmissions can represent transmissions of traffic data to ***one or more receiver units***." Ex. 1013, at 11:16-18. One of ordinary skill in the art would understand that the teachings of *Wallace* to convey that Data 5 could be allocated to a different subscriber than the subscriber allocated Data 6. Similarly, as discussed above in 1.1.1, the example allocation of disjoint OFDM sub-channels 4 and 6 could be made in the same time-slot and to a different user than the allocation of consecutive sub-channels 12-16 (Data 6). *See supra analysis* at 1.1.1; Ex. 1013, at 7:6-10, Fig. 2.

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		 FIG. 2 As such, one of ordinary skill in the art would understand that *Wallace* renders obvious allocating a second set of subcarriers to be used for a second data transmission.
1.2.2	"the second data transmission to occur simultaneously with the first data transmission to the first subscriber using the first set of subcarriers"	<u>Second Data Transmission to Occur Simultaneously with the First Data Transmission to the First Subscriber Using the First Set of Subcarriers</u> *Wallace* discloses a first data transmission with a first set of sub-channels 4 and 6 in time slot 2 to a particular first subscriber. Ex. 1013 at 7:6-10; *see also supra analysis* at 1.1.1. *Wallace* further discloses "data" transmissions 1-6 in Fig. 2 that "can represent transmissions of traffic data to ***one or more receiver units***.") Ex. 1013, at 11:16-18. As an example, *Wallace* discloses a second data transmission with a second set of sub-channels 12-16 (Data 6) consisting of only consecutive sub-carriers in time slot 9. *Id.* at Fig. 2; *see also supra analysis* at 1.1.2. It would have been obvious to one of ordinary skill in the art that *Wallace* encompasses transmitting a first data transmission with a first set of disjoint sub-channels 4 and 6 and a second set of consecutive sub-channels 12-16 to different users in the same time-slot.

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		Given that *Wallace* teaches allocating any remaining sub-channels and also allocating a set of disjoint sub-channels 4 and 6 to a particular subscriber as discussed above (*Id.* at 7:6-10), *Wallace* renders obvious the use of the remaining sub-channels within that time slot for allocations of a set of sub-channels for a second data transmission to a second subscriber, including the allocation of a second set consisting of sub-channels 12-16 (Data 6). Specifically, it would have been obvious to a person of ordinary skill in the art, that after allocation of disjoint subcarriers 4 and 6 to the first subscriber, that the remaining sub-channels could, and should, be allocated to one or more other subscribers to efficiently use the frequency bandwidth (especially considering that frequency bandwidth is a limited resource). Moreover, it would have been obvious to a person of ordinary skill in the art that sets of consecutive sub-channels (e.g., Data 6 comprising sub-channels 12-16) could be allocated to a second subscriber in the same timeslot as the allocation of disjoint sub-channels 4 and 6 to the first subscriber. To explain more fully, *Wallace* discloses an example in which the frequency band may be divided into 16 OFDM sub-channels. *Id.* at 10:33-37 ("In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels."); *see also id*. at Fig. 2. *Wallace* discloses that pilot tones and control data will occupy some of the 16 OFDM sub-channels for each OFDM symbol. *Id.* at 10:58-67. However, *Wallace* clearly states that "[v]oice and data traffic can be transmitted ***in the remaining sub-channels***." *Id.* at 10:58-67. *Wallace* again emphasizes that "the remaining sub-channels can be allocated to a single data user or divided among

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		multiple data users." *Id*. at 26:64-66. The disclosure in Wallace therefore teaches that an allocation system could use the remaining frequency sub-bands within each time slot. Applying these teachings, one of ordinary skill in the art would understand that in the example in *Wallace* where a particular subscriber is allocated sub-channels 4 and 6 within time slot 2, the remaining sub-channels (e.g., sub-channels 1-3, 5, and 7-16) within that time slot can be allocated among a single data user or divided among multiple other data users in any appropriate manner. *See id.* at 7:6-10; 26:64-66. *Wallace* even provides an example that remaining consecutive sub-channels (e.g., sub-channels 12-16 (Data 6) can be assigned to a single user. In Figure 2, *Wallace* illustrates a set of consecutive subcarriers to be allocated in time slot 9 consisting of sub-channels 12-16 (called Data 6). *Wallace* further teaches that "***Data 1 through 6*** transmissions ***can represent transmissions of traffic data to one*** or more ***receiver units***."). 11:16-18. Accordingly, one of ordinary skill in the art would immediately understand that an allocation may consist of disjoint sub-channels 4 and 6 to a first user (as disclosed by *Wallace* at 7:6-10) and an allocation of consecutive sub-channels 12-16 (Data 6) to a second user (as disclosed by time slot 9 in Fig. 2) in the same time-slot. It would have thus been obvious to a person of ordinary skill in the art in view of the teachings of *Wallace* to allocate a second set of sub-channels to a second subscriber consisting of all or some portion of the remaining sub-channels—including, for example, a second set comprising only consecutive sub-channels 12-16 (Data 6 in Fig. 2).

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
1.2.3	"the allocated second subcarriers including only consecutive subcarriers."	Allocated Second Subcarriers Including Only Consecutive Subcarriers *Wallace* renders obvious allocating a second subscriber a second set of sub-channels to be used for a second data transmission. Specifically, *Wallace* renders obvious that the allocated second subcarriers (i.e., sub-channels 12-16 (Data 6)) include only consecutive subcarriers. For example, Figure 2 illustrates a set of consecutive subcarriers to be allocated in time slot 9 consisting of sub-channels 12-16 (called Data 6). *Wallace* further teaches that Data 6 can represent a transmission to a single receiver unit. Ex. 1013 at 11:16-18 ("***Data 1 through 6*** transmissions ***can represent transmissions of traffic data to one*** or more ***receiver units***.").  FIG. 2
2.0	"The method of claim 1, wherein the allocation of the first set of subcarriers is identified by a first identification."	*Wallace* renders obvious the method of Claim 1, as discussed above. Moreover, one of ordinary skill in the art would understand that the term "first identification" refers to "*information about the first subscriber's subcarriers*" under a broadest reasonable interpretation. First Identification Identifying the Allocation of the

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		First Set of Subcarriers One of ordinary skill in the art would understand that the limitations of dependent Claim 2 are fundamental implementation details required in a wireless system so that the subscriber can be informed of the allocated set of subcarriers in order to use them. Nevertheless, this basic concept is taught by *Wallace*. *Wallace* teaches that an identification of channel allocations is sent by the system (i.e., base station) to the subscriber on a control channel that communicates the allocation and de-allocation of resources. Ex. 1013, at 28:24-27 ("Allocation and de-allocation of resources (on both the forward and reverse links) can be controlled by the system and can be communicated on the control channel in the forward link."). This teaching is readily applicable to all allocations described by *Wallace*. Accordingly, it would have been obvious to a person of ordinary skill in the art to identify to a first subscriber the claimed allocation of the first set of subcarriers (e.g., sub-channels 4 and 6).
3.0	"The method of claim 2, wherein the first identification includes a modulation and coding format to be used by the first subscriber for the first data transmission to the first subscriber."	*Wallace* renders obvious the method of Claim 2, as discussed above. Moreover, as discussed in further detail above, a personal of ordinary skill in the art would understand "first identification" is "*information about the first subscriber's subcarriers*" under a broadest reasonable interpretation in the context of the '445 patent. An Identification That Includes a Modulation and Coding Format One of ordinary skill in the art would understand that the limitations of dependent Claim 3 are fundamental implementation details required in a wireless system so that the subscriber can be informed of what coding and modulation format to use in order to allow the user to

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		correctly decode and demodulate the data. Nevertheless, this basic concept is taught by *Wallace*. *Wallace* teaches that, before the transmission of the data, a modulation and coding scheme is negotiated for a specific user via a common control channel. Ex. 1013, at 7:60:8-3 ("[T]he transmitter unit selects ***a modulation and coding scheme (i.e., configuration)*** from a finite set of possible configurations, which are known to the receiver units. [. . .] When using the diversity communications mode for a specific user (e.g., for a voice call or a data transmission), the mode and/or ***configuration may be known a priori*** (e.g., from a previous set up) ***or negotiated (e.g., via a common channel) by the receiver unit***."). Negotiating the modulation and coding scheme via the common channel discloses information identifying the modulation and coding format to be used by the first subscriber. To the extent that the "first identification" is construed to be a single message that includes both the identification of the allocated set of subcarriers and the coding and modulation rate (a construction that is not supported by the specification), including both pieces of information in the same message would have been an obvious, natural, and efficient design choice. Armed with the knowledge that the base station must identify both the allocated set of subcarriers and the coding and modulation rate, one of ordinary skill in the art would have been motivated to look to signal messaging references such as portions of *Hanzo* to learn the details of how to implement a signal messaging system to include information about both the allocated set of subcarriers and the coding and modulation rate. *See* Ex. 1014 at 558 ("[T]he resulting

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		set of parameters has to be communicated to the receiver in order to successfully demodulate and decode the OFDM symbol."). Incorporating two sets of signaling information into one message would have been a matter of design choice and is not inventive.
4.0	"The method of claim 1, wherein the allocation of the second set of subcarriers is identified by a second identification provided from the base station to the second subscriber."	*Wallace* renders obvious the method of Claim 1, as discussed above. Second Identification Identifying the Allocation of the Second Set of Subcarriers One of ordinary skill in the art would understand that the limitations of dependent Claim 4 are fundamental implementation details required in a wireless system so that the subscriber can be informed of the allocated set of subcarriers in order to use them. Nevertheless, this basic concept is taught by *Wallace*. *Wallace* teaches that an identification of channel allocations is sent by the system (i.e., base station) to the subscriber on a control channel that communicates the allocation and de-allocation of resources. Ex. 1013, at 28:24-27 ("Allocation and de-allocation of resources (on both the forward and reverse links) can be controlled by the system and can be communicated on the control channel in the forward link."). This teaching is readily applicable to all allocations described by *Wallace*. Accordingly, it would have been obvious to a person of ordinary skill in the art to identify to a second subscriber the claimed allocation of the second set of subcarriers (e.g., sub-channels 12-16 (Data 6 in Figure 2)).
6.0	"The method of claim 1, wherein the allocated first set of subcarriers is specified by a cluster index."	*Wallace* renders obvious the method of Claim 1, as discussed above. The Allocated First Set of Subcarriers Is Specified by a Cluster Index *Wallace* renders obvious the method of Claim 1 as

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
		discussed above. *Wallace* discloses assigning numerical values to the sub-channels. Ex. 1013 at 7:6-10 ("[D]ata for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time-slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on."); *see also* Figure 2 (disclosing sub-channels 1 to 16). It would have been obvious to a person of ordinary skill in the art to use the sub-channel identifiers together as a "cluster index" specifying the "allocated first set of subcarriers." *Wallace* discloses that the allocation of resources occurs over the control channel. Ex. 1013, at 28:24-27 ("Allocation and de-allocation of resources (on both the forward and reverse links) can be controlled by the system and can be communicated on the control channel in the forward link."). The resources (i.e., sub-channels) are used by the subscriber unit to transmit data. *See id.* at 7:6-10. One of ordinary skill in the art would understand that a subscriber unit cannot transmit over its allocated sub-channel without knowledge of its allocated sub-channel prior to transmission. Rather, the subscriber unit must know its allocated set of sub-channels in order to transmit data over those sub-channels. To inform the subscriber of its allocated sub-channels, it would have been obvious and efficient to a person of ordinary skill in the art to use the numerical values of the sub-channels together as a "cluster index" of the sets (e.g., clusters) of sub-channels that had been allocated to the subscriber.
7.0	"The method of claim 1, wherein the first data transmission to the first subscriber includes channel coding across	*Wallace* renders obvious the method of Claim 1, as discussed above. <u>Channel Coding Across a Plurality of Subcarriers</u> *Wallace* further discloses various forms of channel

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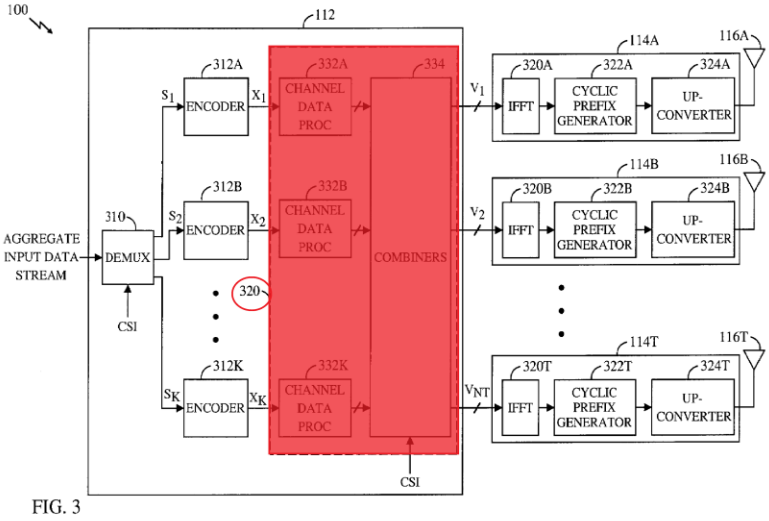
	the plurality of subcarriers of the allocated first set of subcarriers."	coding and that the channel coding can be performed "across a set of sub-channels." Ex. 1013, at 19:47-55 ("The encoding can be performed on a per channel basis, i.e., on each channel data stream, as shown in FIG. 3. However, the encoding may also be performed on the aggregate input data stream, on a number of channel data streams, on a portion of a channel data stream, across a set of antennas, across a set of sub-channels, across a set of sub-channels and antennas, across each sub-channel, on each modulation symbol, or on some other unit of time, space, and frequency."); *see also id.* at 19:33-39 (describing that the "encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others.").
8.0	"A base station that communicates with a plurality of subscribers and allocates sets of subcarriers, each of the sets of subcarriers including a plurality of subcarriers, using an orthogonal frequency-division multiple access (OFDMA) system, the base station comprising: a controller configured to: allocate to a first subscriber a first set of	Independent Claim 8 is a parallel apparatus claim to independent Claim 1 and recites substantially similar limitations to Claim 1. Claim 8 is directed to a base station that communicates with a plurality of subscribers that includes a "controller configured to" perform the method steps of independent Claim 1. *Wallace* discloses that a base station can implement its allocation method. Ex. 1013, at 15:66-16:6 (disclosing that the "use of disjoint sub-channel subsets can further be applied in a system wherein multiple links, e.g., a propagation channel from a transmitter unit to one or more receiver units, are located in close proximity. In a system where a base station transmits signals according to sectors, the transmission area of a sector can overlap the transmission area of another sector.").

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
	subcarriers to be used for a first data transmission to a first subscriber, an allocated first set of subcarriers including a plurality of subcarriers at least one subcarrier of the plurality of subcarriers being disjoint in frequency from another subcarrier of the plurality of subcarriers to obtain frequency diversity; and allocate to a second subscriber a second set of subcarriers to be used for a second data transmission to a second subscriber, the second data transmission to occur simultaneously with the first data transmission to the first subscriber using the allocated first set of subcarriers, an allocated second set of subcarriers including only consecutive subcarriers."	Figure 3 of *Wallace*, as highlighted in red below, discloses an embodiment of a base station that includes channel data processor 320 (the claimed "controller") that is configured to assign each channel data stream to one or more sub-channels:  FIG. 3 *Id*. at 19:58-59 (disclosing that "data processor 320 assigns each channel data stream to one or more sub-channels[.]"). *Wallace* states that data processor 320 can "assign the available resources such that the system goals of high performance and high efficiency are achieved. The data transmissions are thus 'scheduled' to achieve the system goals." *Id*. at 20:6-9. One of ordinary skill in the art would understand that data processor 320 (which is highlighted in red above and is not to be confused with elements 320A to 320T) could be an embodiment of a base station controller that decides channel assignments, and that its assignment algorithm can be programmed to perform the method steps of Claim 1. *See, e.g., id*. at 19:58-20:59. (describing that the base station controller functionality performed by processor 320); *supra* analysis at 1.0.1-1.2.3. The steps of Claim 8 are substantially similar to the method steps of Claim 1 and

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		are disclosed for the same reasons discussed above with respect to Claim 1. *See supra* analysis at 1.0.1-1.2.3.
9.0	"The base station of claim 8, further comprising: receive/transmit circuitry configured to: provide the first subscriber with a first identification identifying the allocated first set of subcarriers."	*Wallace* renders obvious the base station of Claim 8, as discussed above. *See supra*, analysis at 8.0. Claim 9 of the '445 Patent recites substantially similar limitations as Claim 2. As such, *Wallace* renders obvious Claim 9 for similar reasons as those discussed with reference to Claim 2. Dependent Claim 9 recites that a "receive/transmit circuitry" performs the limitations of Claim 2. Figure 3 of *Wallace*, as discussed above with respect to Claim 8, illustrates a possible embodiment of a base station, including a "data processor 320" that corresponds to the claimed controller. <u>Transmit Circuitry</u> Data processor 112 contains a subcomponent called data processor 320. Data processor 112 is also coupled to modulators 114 (the claimed "transmit circuitry"). Ex. 1013, Fig. 3. Modulators 114, as disclosed by Figure 3, generate a signal that is suitable for transmission to the respective receiving unit. *See id.* at 19:22-24 ("Fig. 3 is a block diagram of a data processor 112 and modulator 114 of system 110 of Fig. 1A"); *see also id.* at 3:62-67 ("confirming that each modulator 114 further processes the modulation symbols and generates an RF modulated signal suitable for transmission. The RF modulated signals from modulators 114a through 114t are then transmitted from respective antennas 116a through 116t over communications links 118 to system 120.").

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		Receive Circuitry For example, *Wallace* discloses that a transmitter unit may contain multiple transmit antennas and multiple receive antennas. *Id.* at 4:28-32 ("For simplicity, communications system 100 is shown to include one transmitter unit (i.e., system 110) and one receiver unit (i.e., system 120). However, ***in general, multiple transmit antennas and multiple receive antennas are present on each transmitter unit and each receiver unit***."). Moreover, *Wallace* acknowledges that the base station may both transmit data and receive data from a number of remote systems. *Id.* at 4:40-47 ("For example, the ***communications system may include a central system*** (i.e., similar to a base station in the IS-95 CDMA system) ***having a number of antennas that transmit data to, and receive data from, a number of remote systems*** (i.e., subscriber units, similar to remote stations in the CDMA system), some of which may include one antenna and others of which may include multiple antennas."). One of ordinary skill in the art would understand that the base station in *Wallace* —in order to transmit and receive data—must contain receive/transmit circuitry capable of informing a given user of the particular sub-channels allocated to that user. It would be readily understood to one of ordinary skill in the art that such receive/transmit circuitry, would be used to inform the given user of the particular allocations as determined by data processor 320, including the claimed first set of sub-channels. *Wallace* discloses that modulator generates an RF modulated signal that is transmitted next over transmit antennas to the receiver units. *Id.* at 3:62-67. One of ordinary skill in the art would understand that the base station's modulator, which *Wallace* already discloses

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		has an existing transmission link to the remote units, could provide a given user their particular allocations.
10.0	"The base station of claim 9, wherein the first identification includes a modulation and coding format to be used by the first subscriber for the first data transmission to the first subscriber."	*Wallace* renders obvious the base station of Claim 9, as discussed above. *See supra* analysis at 9.0. Claim 10 of recites substantially similar limitations as Claim 3. As such, *Wallace* renders obvious Claim 10 for similar reasons as those discussed with reference to Claim 3. *See supra* analysis at 3.0.
11.0	"The base station of claim 8, further comprising: receive/transmit circuitry configured to: provide the second subscriber with a second identification identifying the allocated second set of subcarriers."	*Wallace* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 11 of the '445 Patent recites substantially similar limitations as Claim 4. As such, *Wallace* renders obvious Claim 11 for similar reasons as those discussed with reference to Claim 4. *See supra* analysis at 2.0. Dependent Claim 11 recites that a "receive/transmit circuitry" performs the limitations of Claim 4. These limitations are disclosed for reasons substantially similar to those discussed above with respect to Claim 9. *See supra* analysis at 9.0.
13.0	"The base station of claim 8, wherein the allocated first set of subcarriers is specified by a cluster index."	*Wallace* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 13 recites substantially similar limitations as Claim 6. As such, *Wallace* renders obvious Claim 13 for similar reasons as those discussed with reference to Claim 6. *See supra* analysis at 6.0.

	US 8,934,445	**Claims 1-4, 6-11, 13, and 14 are unpatentable over *Wallace***
14.0	"The base station of claim 8, wherein the first data transmission to the first subscriber includes channel coding across the plurality of subcarriers of the allocated first set of sub carriers."	*Wallace* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 14 recites substantially similar limitations as Claim 7. As such, *Wallace* renders obvious Claim 14 for similar reasons as those discussed with reference to Claim 7. *See supra* analysis at 7.0.

5. Ground 5- Claims 5 and 12 are unpatentable over *Wallace* and *Rappaport*

	US 8,934,445	**Claims 5 and 12 are unpatentable over *Wallace* and *Rappaport***
5.0	"The method of claim 1, wherein the allocated first set of subcarriers includes two or more subcarriers spread farther apart than a coherence bandwidth of a respective channel."	*Wallace* renders obvious the method of Claim 1, as discussed above. *See supra* analysis at 1.0. Allocated Set of Subcarriers Includes Two or More Subcarriers Spread Farther Apart than a Coherence Bandwidth of a Respective Channel *Wallace* discloses that "the data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity." Ex. 1013, at 7:1-3. The basic rationale, as described in *Rappaport*, underlying the concept of frequency diversity is spreading frequencies by at least a coherence bandwidth. Ex. 1016, at 335. *Rappaport* explicitly explains that "[f]requency diversity transmits information on more than one carrier frequency. The rationale behind this technique is that frequencies separated by more than the coherence bandwidth of the channel will not experience the same fades." *Id*. One of ordinary skill in the art would understand that frequency diversity techniques separate frequencies by

	US 8,934,445	**Claims 5 and 12 are unpatentable over *Wallace* and *Rappaport***
		more than the coherence bandwidth of the channel so that the frequencies will not experience correlated fades. As explained in *Rappaport*, a coherence bandwidth is "a statistical measure of the range of frequencies over which the channel can be considered 'flat' (i.e., a channel which passes all spectral components with approximately equal gain and linear phase)." *Id.* at 163. Consequently, one of ordinary skill in the art would understand that allocating frequencies inside the coherence bandwidth would not be likely to achieve the frequency diversity benefits described by *Wallace*. Moreover, a system allocating frequencies over a limited frequency range would expose the transmission to frequency-selective fading and channel distortion. It would have therefore been obvious to one of ordinary skill in the art to spread the frequencies by more than a coherence bandwidth in the system of *Wallace*, either in the set comprising sub-bands 4 and 6 or in the consecutive data sets comprising sub-bands 12-16 (Data 6).
12.0	"The base station of claim 8, wherein the allocated first set of subcarriers includes two or more subcarriers spread farther apart than a coherence bandwidth of a respective channel."	*Wallace* renders obvious the base station of Claim 8, as discussed above. *See supra* analysis at 8.0. Claim 12 of the '445 Patent recites substantially similar limitations as Claim 5. As such, the combination of *Wallace* and *Rappaport* renders obvious Claim 12 for similar reasons as those discussed with reference to Claim 5. *See supra* analysis at 5.0.

IV. CONCLUSION

100. This declaration and my opinions herein are made to the best of my knowledge and understanding, and based on the material available to me, at the time of signing this declaration. I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 or Title 18 of the United States Code.

May 25, 2016
Date

Zygmunt Haas, Ph.D.