

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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HEWLETT PACKARD ENTERPRISE COMPANY and  
CISCO SYSTEMS, INC.,  
Petitioners,

v.

COBBLESTONE WIRELESS LLC,  
Patent Owner.

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Case IPR2024-00707  
Patent 7,924,802

**EXHIBIT 2014**  
**SECOND DECLARATION OF PROFESSOR TODOR V. COOKLEV, PH.D.**

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## **I. INTRODUCTION**

1. My name is Todor V. Cooklev. I am an expert in mobile telecommunications and wireless technology. I have been retained as an expert witness to provide my independent opinion regarding certain matters at issue in *inter partes* review of U.S. Patent No. 7,924,802 (“the ’802 patent”) in IPR2024-00707. I have been retained by Cobblestone Wireless LLC (“Cobblestone”), the Patent Owner in the above proceedings. Petitioners are Hewlett Packard Enterprise Company and Cisco Systems Inc. (collectively “Petitioner”).

2. For my work on this case, I am being compensated for my time at my typical consulting rate of \$700 per hour. I am also being reimbursed for expenses that I incur during the course of this work. My compensation does not depend on the substance of my opinions or the outcome of any issues in this case.

3. My analysis of the materials produced in this matter is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to amend or supplement my opinions based on additional documents or evidence I am presented, including without limitation any arguments or expert declarations advanced by Petitioner in this case.

4. I am not a legal expert and offer no opinions on the law. However, I have been informed by counsel of the various legal standards that apply, and I have applied those standards in arriving at my conclusions.

## **II. QUALIFICATIONS**

5. I am currently a Professor in the Department of Electrical and Computer Engineering at Purdue University in Fort Wayne, Indiana, where I have held several faculty and administrative positions.

6. My teaching responsibilities have included courses in communication systems and networks, signals and systems, software-defined radio, and digital signal processing. My research interests include most aspects of modern wireless systems, including hardware and software architectures. A significant part of my research is specifically focused on standards-related issues. I have received a number of research grants in these areas.

7. I am a named inventor on more than thirty U.S. patents, most of which relate to the hardware or software aspects of communication systems. In 1999, I was inducted into the Purdue Inventors Hall of Fame. I have also authored and co-authored more than one hundred peer-reviewed articles. A list of my publications and patents appears in my *curriculum vitae* attached as Exhibit 2002.

8. I graduated from the Technical University of Sofia, Bulgaria in 1988 with a Diploma of Engineering in the field of Electrical Engineering. I graduated

from Tokyo Institute of Technology in Tokyo, Japan in 1995 with a Doctor of Philosophy (Ph.D.) degree in Electrical Engineering.

9. My experience is not only academic. I have worked in the computer and data communications industries. I worked in research and development, but also contributed to product firmware and software development, including digital signal processing algorithms for communication systems.

10. I have contributed to the development of several major standards for communication systems and numerous amendments, including Bluetooth, DSL, Wi-Fi, cellular, and military radio systems. I have participated in many meetings of standards committees and I have chaired some committee meetings and served in other leadership roles.

11. Around 1998 - 1999 I participated in the Bluetooth Special Interest Group (SIG). I was among the authors of the Bluetooth 1.0 specification, contributing to the Host Controller Interface (HCI). In 1999 I participated in the group that established the license agreement between the Bluetooth SIG and the IEEE 802. Subsequently I joined IEEE 802.

12. From 2000 to 2002, and from 2005 to 2008 I was a Voting Member of the IEEE 802.11 Working Group and attended almost all meetings during those years. Generally, meetings were held every other month. During that time, I prepared, submitted, and presented documents to IEEE 802.11. On a couple of

occasions, I was involved in the drafting of liaison letters between 802.11 and other standards committees.

13. From 2005-2006 to around 2007-2008 I was Chair of a Study Group within 802.11 until I convinced the entire Working Group to approve the creation of another Task Group. For my work I received an IEEE Standards Association award in 2012.

14. Even after 2008 I continued my involvement with 802.11. For example, until about 2020 I was reviewing and voting on most amendments to IEEE 802.11.

15. Consequently, I have extensive experience in connection with the development of the IEEE 802.11 standard that forms the basis of the references in both of the Petition's grounds.

16. In 2020 I was elected to serve on the Board of Governors of the IEEE Standards Association as Member-at-Large. The Board of Governors provides overall leadership of the IEEE Standards Association.

17. Since 2017 I have been the Series Editor for Wireless and Radio Communications for the IEEE Communications Standards Magazine (which is the premier journal in the field of communication standards). As member of the Editorial Board I coordinate the review of scholarly manuscripts that relate to the most recent communications standards.

18. A detailed record of my professional qualifications is set forth in Exhibit 2002, which is my *curriculum vitae*, including a list of publications, awards, courses I teach in electrical and computer engineering subjects, research grants, and professional activities. My *curriculum vitae* also lists the depositions, hearings, and trial at which I have testified.

### **III. LEGAL STANDARDS**

19. I am not a lawyer, and I do not intend to offer any opinions as to the interpretation of the law. When considering the '802 patent and stating my opinions, I rely on the following legal standards as described to me by the attorneys for Cobblestone Wireless.

#### **A. Priority Date Of a Patent.**

20. I understand that the analysis of alleged obviousness of the Patent should be performed from the perspective of a POSITA as of the priority date of the Patent. The Patent claims priority to January 23, 2008. My opinions in this matter are from the perspective of a POSITA as of that date; however, my opinions do not change if the priority date is slightly changed.

#### **B. Level Of Ordinary Skill In The Art.**

21. My opinions in this declaration are based on the understandings of a person of ordinary skill in the art, as of the time of the invention. I understand that the person of ordinary skill in the art is a hypothetical person who is presumed to

have known the relevant art at the time of the invention. By “relevant,” I mean relevant to the challenged claims of the ’802 patent.

22. I understand that various factors should be considered when determining the person of ordinary skill in the art in connection with a particular patent. I understand that these factors include, without limitation, the type of problems encountered in the art, the prior solutions to those problems found in the prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field, and my own experience working with those of skill in the art at the time of the invention.

23. I am readily familiar with the level of ordinary skill in the art as of the priority date of the Patent. My qualifications at that time far exceeded that of a POSITA, and I had worked with, as well as supervised, many POSITA’s throughout my work in the field.

24. Dr. Negus opines that a POSITA “would have had at least a Bachelor’s degree in Electrical Engineering or an equivalent field, and at least two years of work experience in developing wireless communications product based upon IEEE 802 standards. Alternatively, a POSITA would have had a more advanced degree, such as a Master’s degree in Electrical Engineering or an equivalent field, combined with at least one year of work experience in developing

wireless communications products based upon IEEE 802 Standards.” Ex. 1003 [Negus-Decl.] ¶ 25. For the purpose of this declaration, I will apply the same definition of the level of skill of a POSITA.

25. Based on my experience, education, and training, I met the definition of a POSITA as of the priority date of the Patent. My qualifications at that time far exceeded that of a POSITA, and I had worked with, as well as supervised, many POSITA’s throughout my work in the field. My opinions concerning the ’802 patent claims and the prior art are from the perspective of a POSITA, as set forth above.

26. As further discussed below, my opinions as stated in this declaration are valid even if the Board adopts a slightly different level of ordinary skill in the art.

**C. Claim Construction.**

27. I understand that claims in a patent-at-issue in an IPR are generally interpreted according to the district court-type claim construction.

28. I further understand that claim terms are interpreted as they would have been interpreted by a person of ordinary skill in the art at the time of the invention, in light of the specification and the patent’s prosecution history in the patent office.

**D. Obviousness Legal Standard.**

29. I understand that a patent claim is unpatentable if the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention.

30. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention in view of the prior art and in light of the general knowledge in the art as a whole. I also understand that obviousness is ultimately a legal conclusion based on underlying facts of four general types, all of which must be considered: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) any objective indicia of non-obviousness, including any praise of the invention. Objective indicia of non-obviousness may include, for example, commercial success of an embodiment, a long-felt need, skepticism, failure by others to find the solution provided by the claimed invention, copying by others of the subject matter of the claim invention, unexpected results of the claimed invention, acceptance of others and industry praise, and licensing of the patents.

31. I also understand that obviousness may be established under certain circumstances by combining or modifying the teachings of the prior art. However,

I have been informed that a claim is not proved obvious merely by demonstrating that each of the elements was independently known in the prior art. I have been informed that many, if not all, inventions rely on building blocks already previously known, and claimed discoveries almost of necessity will likely be combinations of what is already known. I have been informed that it is important to identify whether a reason existed at the time of the invention that would have motivated a person of ordinary skill in the art in the relevant field to combine the known elements in the way the claimed invention does. Specific teachings, suggestions, or motivations to combine any first prior art reference with a second prior art reference can be explicit or implicit, but must have existed before the date of purported invention. I understand that prior art references themselves may be one source of a specific teaching or suggestion to combine features of the prior art, but that such suggestions or motivations to combine art may come from the knowledge that a person of ordinary skill in the art would have had.

32. I understand that a reference may be relied upon for all that it teaches, including uses beyond its primary purpose, but also including teachings that lead away from the invention. I understand that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, although the mere disclosure of alternative designs does not teach away.

33. I further understand that whether there is a reasonable expectation of success in combining references in a particular way is also relevant to the analysis.

34. I understand that it is improper to use hindsight to combine references or elements of references to reconstruct the invention using the claims as a guide. My analysis of the prior art is made from the perspective of a person of ordinary skill in the art at the time of the invention.

35. I am not offering any legal opinions in this declaration nor am I qualified to do so. I only consider such legal standards in framing my opinions and conclusions as well as placing assertions made by Petitioners in the Petition into the proper context. Additionally, from a subject matter perspective, I understand that the petitioner always has the burden of persuasion regarding a challenge of patentability of an invention under an inter partes review.

#### **IV. CLAIMS-AT-ISSUE**

36. I understand that Petitioners have challenged claims 1-9 of the '802 Patent. As only claim 1 is in independent form, my opinions here only address claim 1.

## V. OPINIONS

### A. The '802 Patent's "Center Frequency" Refers To The Frequency Of The Transmission Carrier ("Transmission Carrier Frequency").

37. Claim 1 requires transmitting information across two frequency ranges, each with a different "*center frequency*." More specifically, "first information" must be transmitted across a "first frequency range having a *first center frequency*," and simultaneously, "second information" must be transmitted across a "second frequency range having a *second center frequency greater than the first center frequency*." Ex. 1001 ['802] cl. 1. Thus, the claim requires two frequency ranges, each with a different "center frequency" with one "center frequency" greater than the other. The '802's specification, confirmed by extrinsic evidence, confirms that the claimed "center frequency" refers to the frequency of the transmission carrier ("transmission carrier frequency").

#### 1. *Technology Background On Transmission Carrier Frequency.*

38. I will first provide a brief discussion of the underlying technology to better illustrate the meaning of "center frequency."

39. The claims concern wirelessly transmitted information. In order to wirelessly transmit information, the information is first converted into a signal (either an analog waveform or a digital signal) that can be transmitted. In modern systems, including at the time of the invention, the raw data is first transformed

into a baseband signal, which is a direct representation of the information to be transmitted.

40. The baseband signal, however, generally cannot be transmitted wirelessly for various reasons. For example, baseband signals are generally complex values and include frequencies that are very low and close to zero. Antennas cannot emit complex signals or zero-frequency signals and are ineffective when the frequency is too low. As another example, frequency ranges are typically assigned (*e.g.*, by a governmental regulatory body) such that baseband frequencies are not available for use in wireless transmission.

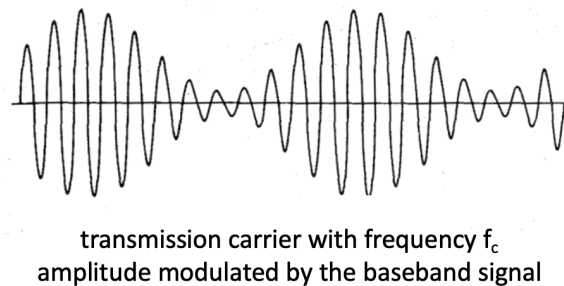
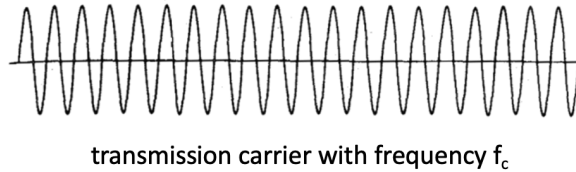
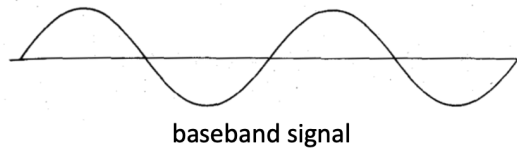
41. Therefore, the baseband signal often cannot be directly transmitted wirelessly. To be transmitted, it must be modulated on a signal at a much higher frequency. This higher frequency signal is called a carrier signal, and it is this modulated carrier signal that is transmitted out of the antenna. In such instances, the baseband signal is said to be “up-converted” to, or modulated on, the transmission carrier. As I will explain later in my declaration, the “center frequency” in the ’802 patent means this “transmission carrier frequency.”

42. Sometimes in the field, the carrier and the baseband signal are compared to a stone and a piece of paper. If one wishes to throw a piece of paper, it cannot go too far by itself. But by wrapping the piece of paper around a stone (a carrier), it can be thrown over a longer distance.

43. The relationship between a baseband signal and a carrier signal is also shown in the figure below. The top image shows a baseband signal with a low frequency.<sup>1</sup> The middle image shows the transmission carrier, which has a much higher frequency  $f_c$ . In practice this transmission carrier is generated by a local oscillator (LO). The third image shows the transmission carrier after it has been amplitude modulated by the baseband signal. This modulated transmission carrier is what would be transmitted out of the transmitter.

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<sup>1</sup> For ease of illustration, the shown signal is real-valued, even though baseband signals are generally complex-valued.



44. Note that even though in some very old systems the data may be directly modulated on a transmission carrier without first generating a baseband, the same analysis applies. That is, the data would be modulated on a high frequency transmission carrier so that it can be transmitted.

2. *“Center Frequency” In The Context Of '802 Patent Refers To The “Transmission Carrier Frequency.”*

45. The '802 patent mentions “center frequency” more than 90 times, including in its background of the invention, in all of its embodiments, and in each of the claims. Every time it is used, it means the frequency of the transmission carrier, *i.e.*, the “transmission carrier frequency.”

46. In the background of the invention, discussing Figure 1, the '802 patent explains that the baseband signal is up-converted to the frequency of the "local oscillator (LO)". Ex. 1001 ['802] 1:25-27. The output of this up-conversion is amplified and transmitted through the antenna. *Id.*, 27-30. The '802 patent then explains that its prior art Figure 1 transmitter was "limited to up-converting a [baseband] signal *to one center frequency* (or modulation frequency), *which is the LO frequency.*" *Id.*, 1:30-32. Thus, the '802 patent clearly states that the center frequency "*is the LO frequency.*" The LO frequency is the frequency of the transmission carrier as it is the frequency the baseband signal is upconverted to for transmission. Thus, from the very outset of its disclosure, the '802 patent uses "center frequency" to mean the frequency of the transmission carrier (the "transmission carrier frequency").

47. The '802 patent then similarly uses "center frequency" to mean the frequency of the transmission carrier in every embodiment. For example, Figure 2, annotated below, is illustrative:

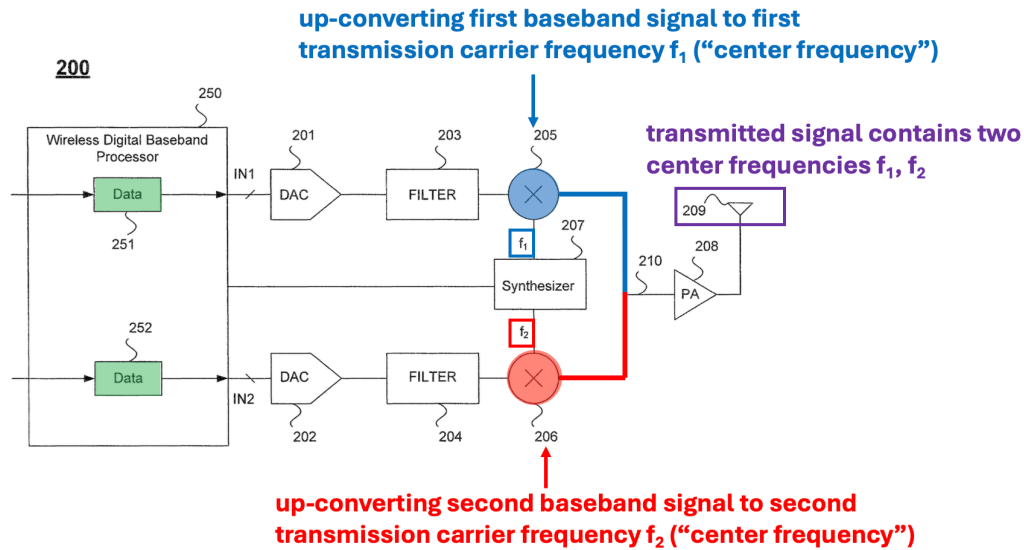


Fig. 2

48. Figure 2 discloses a wireless digital baseband processor 250 that provides data via two separate digital baseband signals 251 and 252 (green). Ex. 1001 [’802] 5:60-66. After being converted to analog in DAC 201/202 and filtered, signals 251 and 252 are fed into respective up-converters 205 and 206. Up-converter 205 accordingly upconverts data 251 onto a first “center frequency”  $f_1$  and, similarly, data 252 is up-converted by element 206 onto a second “center frequency”  $f_2$ . *Id.*, 6:22-56. These two up-converted signals are then combined, amplified and transmitted. *Id.*, 7:4-14. In this embodiment, again, the ’802 patent uses “center frequencies” to refer to the frequencies  $f_1$  and  $f_2$  of the transmission carriers to which the baseband signals are up-converted, thus again using “center

frequency” to mean “transmission carrier frequency.”<sup>2</sup> The frequencies  $f_1$  and  $f_2$  are produced by the synthesizer 207. In other words, these two frequencies are equal to two different local oscillator (LO) frequencies.<sup>3</sup>

49. The resulting signal is shown schematically in the annotated version of the '802 patent's Figure 3. The blue region shows the baseband signal upconverted to the first transmission carrier with a first center frequency  $f_1$ . The

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<sup>2</sup> A POSITA would have understood that there is sufficient separation between the two transmission carrier frequencies to ensure that the signals do not overlap and interfere. Consequently, although the outputs of the two up-conversions are added together in this exemplary embodiment before being transmitted, that addition of two upconverted signals does not change their respective center frequencies (or “transmission carrier frequencies”).

<sup>3</sup> Of course, the two frequencies could be generated by using two separate local oscillators, or by using one local oscillator with additional circuitry that generates two frequencies through addition/multiplication. Furthermore, up-conversion to the transmission carrier can be direct, or can be done in multiple stages through intermediate frequencies. These variations are within the scope of the invention and do not affect the meaning of “transmission carrier frequency.”

red region shows the baseband signal upconverted to the second transmission carrier with a second center frequency  $f_2$ .

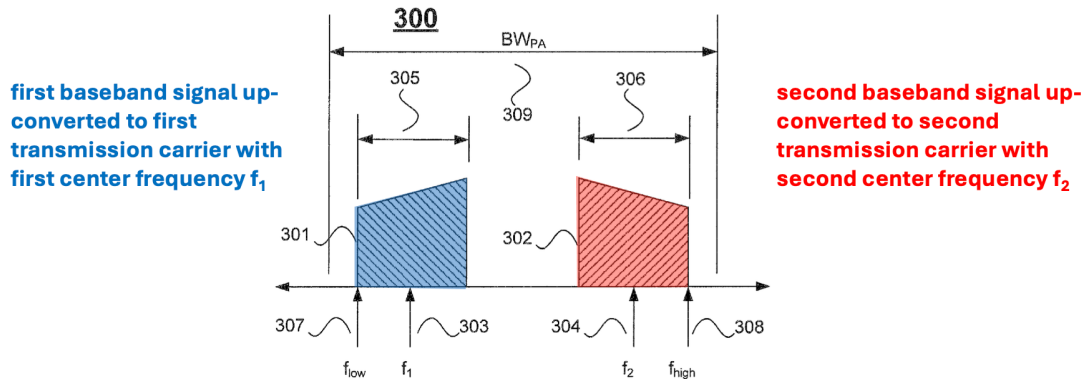


Fig. 3

50. As is clear from the above, even though  $f_1$  and  $f_2$  happen to fall in the center of their respective ranges in this example, that is not the focus or purpose of the embodiment describing it, as I described above. Rather,  $f_1$  and  $f_2$  are the frequencies produced by synthesizer 207, which provides the frequencies of the transmission carriers. Notably, as I explain in paragraph 60 below, claim 10 separately requires that the “center frequency” *also* be in the middle of the upconverted frequency range, making clear that the location of “center frequency” does not have to be in the middle.

51. This very same meaning of “center frequency” as the transmission carrier frequency is reflected in the ’802 patent’s other embodiments as well. *See, e.g.,* Ex. 1001 [’802] 9:9-57 (Figure 6 embodiment); 12:33-58 (Figure 10 embodiment).

52. The '802 patent's Figure 4 embodiment also operates similarly to Figure 2 above. In the Figure 4 embodiment, the “center frequency” changes over time. Ex. 1001 ['802] 7:19- 42. This is done by programming synthesizer 207 to generate different center frequencies at different times, “[a]s illustrated in FIG. 2.” *Id.*, 7:48-55. As explained above, Figure 2, in turn, teaches that synthesizer 207 provides the transmission carrier frequency to which the baseband signal is up-converted. POPR, 10. Thus, it is clear that the Figure 4 embodiment changes the “center frequency” by changing the transmission carrier frequency to which the baseband signal is upconverted—confirming that “center frequency” refers to the transmission carrier frequency.

53. The '802 patent expressly uses the terms “center frequency” and “carrier frequency” of the transmission carrier (*i.e.*, transmission carrier frequency) interchangeably, confirming that they mean the same thing. For example, in connection with its Figure 8 embodiment, the '802 patent explains:

This example provides a transmitter for sending the same data across a communication channel at ***two different RF carrier frequencies*** to improve reliability and/or increase the range of the system. ... Up-converter 812 includes a second input coupled to an output of a synthesizer 814, which may be used ***to up-convert the analog signal to a RF center frequency  $f_1$*** . Similarly, up-converter 813 includes a second input coupled to another output of a synthesizer 814 (or to a different synthesizer), which may be used to ***up-convert the analog***

*signal to a RF center frequency  $f_2$ . ... The output of power amplifier 815 is coupled to antenna 850 to **transmit the digital data simultaneously as an electromagnetic signal using two different RF carrier frequencies.***

Ex. 1001 ['802] 10:64-11:20.

54. I have reproduced the '802 patent's Figure 8 with annotations below:

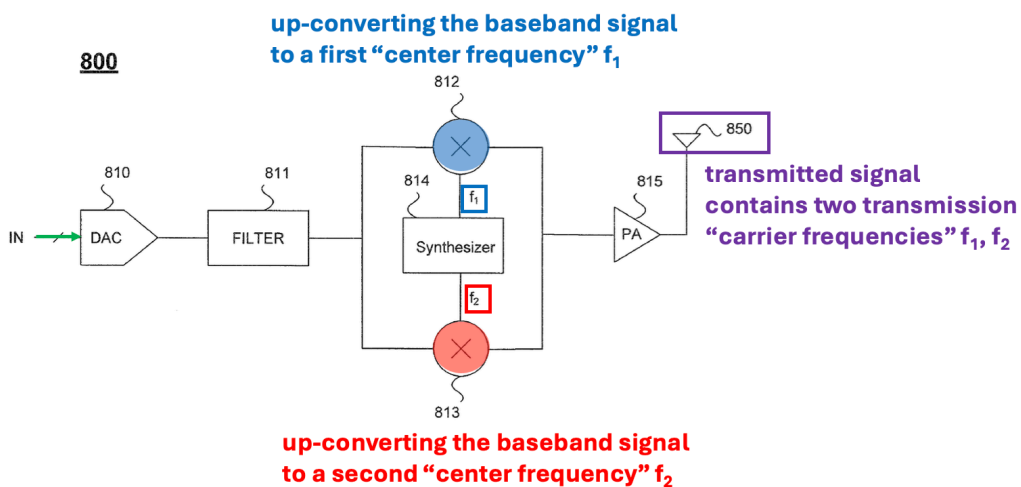


Fig. 8

55. As can be seen, here, the '802 patent is using “center frequency” interchangeably with “carrier frequency” of the transmission carrier. Specifically, the '802 patent explains that it transmits the data “using two different RF carrier frequencies.” Ex. 1001 ['802] 11:18-20. The '802 then explains that this signal that uses “two different RF carrier frequencies” is obtained through combining signals that are separately up-converted to “center frequencies”  $f_1$  and  $f_2$ . Ex. 1001 ['802] 10:64-11:20. Thus, a POSITA would understand that the '802 is using

“carrier frequency” of the transmission carrier and “center frequency” interchangeably. Note that even though the ’802 patent here does not expressly say “transmission” carrier frequency, its use of “carrier frequency” refers to the frequency of the transmission carrier since it states that the data is transmitted using two different RF carrier frequencies.

56. As another example of the interchangeable use of “center frequency” and “carrier frequency” of the transmission carrier, the ’802 patent explains:

Typical prior art approaches to improving the information capacity in a wireless communication system involve maximizing the bandwidth around the *center frequency* to increase the amount of information that may be modulated on to the *carrier frequency*.

Ex. 1001 [’802] 1:35-40.

57. Here, too, at 1:35-40, the ’802 patent is using “center frequency” and “carrier frequency” of the transmission carrier interchangeably. The ’802 patent explains that in its prior art, in order to increase throughput, the bandwidth around the “center frequency” was increased. It then states that such an increase in bandwidth would permit more data to be modulated “on to the carrier frequency.” A POSITA would understand that “center frequency” and “carrier frequency” are each used to refer to the “transmission carrier frequency.” Again, even though the ’802 patent here uses “carrier frequency” and not “transmission carrier frequency,” it is clearly referring to the carrier frequency of the transmission carrier. This is

clear because it states that the information is “modulated on to the carrier frequency” (Ex. 1001 [’802] 1:40), the purpose of which is to transmit the carrier signal after it is modulated.

58. The ’802 patent’s use of “modulation frequency” further supports the conclusion that “center frequency” means “transmission carrier frequency.” For example, the ’802 patent also uses “center frequency” interchangeably with “modulation frequency.” *See, e.g.*, Ex. 1001 [’802] 1:29-32 (“The transmitter 100 is limited to up-converting a signal to one ***center frequency (or modulation frequency)***, which is the LO frequency.”). A “modulation frequency” here clearly means the LO frequency, which is the frequency of the transmission carrier. This is the frequency upon which the baseband signal is modulated. Thus, the patent’s equating of “modulation frequency” and “center frequency” further supports that “center frequency” in the ’802 patent means “transmission carrier frequency.”

59. As another example, the ’802 patent explains that in its Figure 3 embodiment, the up-converter 205 receives “a first ***modulation signal having a first RF center frequency*** 303 ( $f_1$ ) as shown in FIG. 3.” Ex. 1001 [’802] 6:22-26. A “modulation signal” in this sentence refers to a transmission carrier, since that is the signal upon which the baseband is modulated. I understand that Dr. Negus also agrees that “modulation signal” here can only be interpreted to mean a “carrier signal.” Ex. 2016 [Negus-1<sup>st</sup>-Depo.] 111:7-11 (“Q. Now, is the patent in column

six line 25 using the phrase ‘modulation signal’ to refer to the carrier signal? A. That’s—that’s the only way to read it that seems to square with the words in it.”). A carrier signal having “a first RF center frequency” would be understood by a POSITA to simply mean in this sentence to be the first carrier frequency. Thus, the patent’s reference to a “modulation signal having a first RF center frequency” further supports that, in the ’802 patent, “center frequency” means the frequency of the transmission carrier.

60. Claim 10 further confirms that “center frequency” means “transmission carrier frequency” and does not merely “mean the middle of some frequency range” as Dr. Negus contends (*see* Ex. 2016 [Negus-1<sup>st</sup>-Depo.] 67:1-3). Claim 10 recites “up-converting the first analog signal to a first RF center frequency to produce a first up-converted analog signal.” Ex. 1001 [’802] 14:56-57. Claim 10 continues to recite an additional limitation that requires the “first RF center frequency” to be in the middle of the frequency range of the “first up-converted signal.” *Id.*, 14:58-62 (“wherein the first up-converted analog signal comprises a first up-converted frequency range from the first RF center frequency minus one-half the first frequency range to the first RF center frequency plus one-half of the first frequency range.”). If “RF center frequency” meant the middle of the frequency range, then the entire limitation that follows, requiring the RF center frequency to be in the middle of the range, would be superfluous.

61. Applying the above discussion to claim 1, the meaning of “center frequency” as the “transmission carrier frequency” is clear to a POSITA. Claim 1 recites “transmitting first information across a first frequency range using a wireless transmitter, the first frequency range having a first center frequency, a first highest frequency, and a first lowest frequency;” and “simultaneously transmitting second information across a second frequency range ... having a second center frequency greater than the first center frequency ....”

62. Interpreting the claims in light of the specification, a POSITA would understand that the first and second “center frequenc[ies]” in the first and second frequency ranges are not merely the middle of the frequency ranges. For example, the Figure 3 embodiment, discussed above and reproduced below with annotations, discloses two frequency ranges, each with a higher frequency, a lower frequency and a “center frequency.” *Id.*, Fig. 3. However, as a comparison of Figures 2 and 3 shows (discussed above and reproduced below with added annotations), the “center frequency” of each frequency range is not determined by what is merely in the middle of the up-converted frequency range. Rather, the “center frequency” is the transmission carrier frequency to which the baseband signal was up-converted in Figure 2. *Id.* 5:58-60 (“FIG. 3 illustrates an example of the frequency content of the transmitted signal 300 which may result from system 200.”).

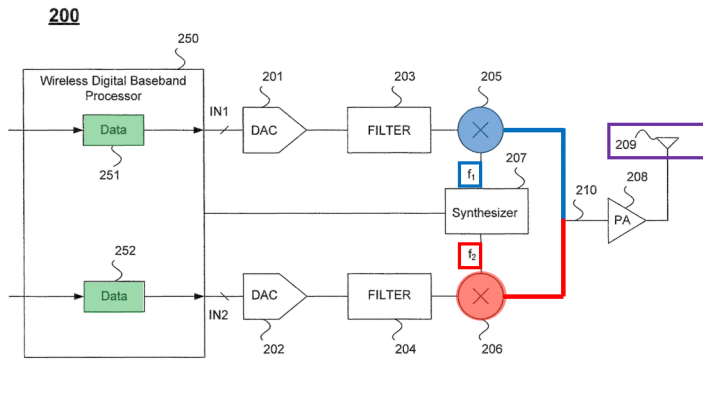


Fig. 2

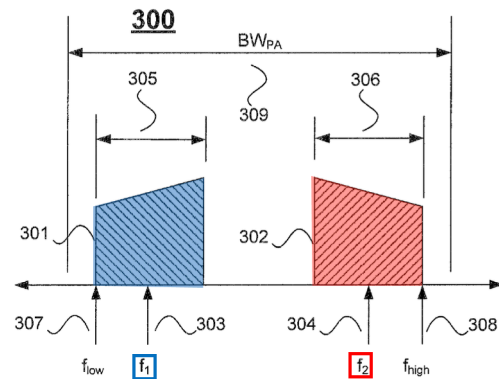


Fig. 3

63. While it is true that the “center frequency” may happen to also be in the middle of the frequency range of the up-converted signal as shown in Figure 3, that is not the defining feature of what a “center frequency” refers to in the ’802 patent, for reasons discussed above. In fact, as also discussed in paragraph 60, claim 10 separately recites that the “center frequency” must be, in that claim, in the middle of the up-converted frequency range—confirming that being in the middle is not an intrinsic property of “center frequency.”

64. I also note that challenged claims 1-9 expressly refer back to the claimed “highest” and “lowest” frequencies to define the bandwidth of the power amplifier, not to define the claimed “center frequency.” *See, e.g., id.*, cl. 4 (“the bandwidth of said power amplifier is greater than the difference between the first lowest frequency and the second highest frequency.”); cl. 5 (similar); *accord id.*, 6:65-7:2; 9:51-55; 10:29-32.

65. Note that in my first declaration, I opined that “center frequency” refers to the frequency of the carrier the baseband signal is upconverted to. Ex. 2001 [Cooklev-1<sup>st</sup>-Decl.] ¶ 42. My proposed construction of “center frequency” as the “transmission carrier frequency” in this declaration is substantively the same as the one in my earlier declaration but simplifies and clarifies its meaning. Specifically, as I explained above, the “transmission carrier frequency” is the frequency of the transmission carrier that is modulated by the data (such as the baseband signal) to be transmitted. In order to obtain an RF signal containing the data to be transmitted at certain transmission carrier, the baseband signal is upconverted to the frequency of the transmission carrier. Therefore, both constructions materially convey the same meaning.

66. For the foregoing reasons, a POSITA would understand that “center frequency” in light of the ’802 patent’s specification refers to the frequency of the transmission carrier (transmission carrier frequency).

3. *Extrinsic Evidence Confirms The ’802 Patent’s Usage Of “Center Frequency” To Refer To “Transmission Carrier Frequency.”*

67. As explained in this section, the extrinsic evidence confirms that the ’802 patent’s usage of the term “center frequency” to mean the frequency of the transmission carrier is not unusual in the field.

68. First, Petitioners' reference, IEEE 802.11n D2.0, uses "center frequency" in precisely the same way as the '802 patent, as the transmission carrier frequency. For example, the standard explains that the "actual transmitted signal" is the output of equation 20-1. Ex. 1004 [802.11n D2.0] 240.<sup>4</sup> Equation 20-1 upconverts the baseband signal to the transmission carrier frequency for transmission. *See also* paragraphs 94-98, *infra* (detailed explanation of the operation of the standard). In this equation,  $f_c$  is referred to as "the center frequency of the carrier":

$$r_{RF}(t) = \text{Re}\{r(t)\exp(j2\pi f_c t)\}$$

where

$\text{Re}\{\cdot\}$  represents the real part of a complex variable;

$f_c$  is the center frequency of the carrier.

Ex. 1004 [802.11n D2.0] 240-241. A POSITA would understand that  $f_c$  is the frequency of the transmission carrier, because it is the frequency to which the

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<sup>4</sup> All citations are to the documents' native page numbers.

baseband signal is upconverted for transmission. Therefore, the standard also uses “center frequency” to refer to the transmission carrier frequency.

69. Additional disclosures in the standard confirm its usage of “center frequency” to mean the frequency of the transmission carrier. For example, in the section addressing the “overview” of the encoding process in the standard, the last step is:

*Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit.*

Ex. 1004 [802.11n D2.0] 237. Here, the “center frequency of the desired channel” is the frequency of the transmission carrier, which is the frequency of the carrier signal to which the “complex baseband waveform” is up-converted for transmission.

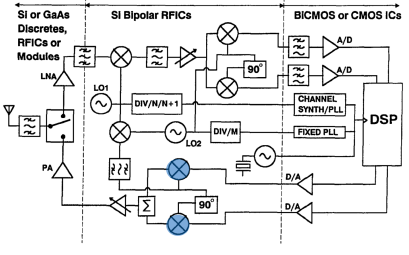
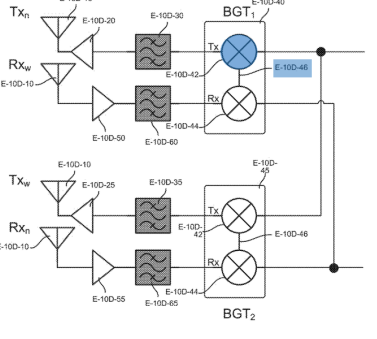
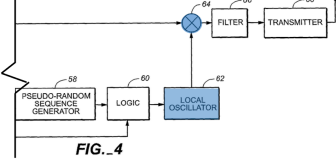
70. I also note that Dr. Negus himself in a patent application publication where he is the sole inventor used “center frequency” and “carrier frequency” of the transmission carrier interchangeably similar to the ’802 patent:

Frequency-hopping wireless communication systems are systems *that transmit data using a center frequency* with hops about a relatively broad frequency bandwidth. Unlike conventional systems in which a fixed-frequency carrier is used, in frequency-hopping systems, *the carrier frequencies* are approximately pseudo-randomly determined.

Ex. 2025 [Negus-Pat.-App.-Pub.] [0001].

71. A POSITA reviewing this paragraph by Dr. Negus would understand that “center frequency” is used interchangeably with the “carrier frequency” of the transmission carrier. Specifically, this paragraph discusses that the frequency of the transmission carrier (“the center frequency”) in its prior art was fixed, whereas in the system described by this paper, the frequency of the transmission carrier “hops” around in a pseudo-random fashion to achieve various benefits. Just as in the ’802 patent, both “center frequency” and “carrier frequency” are used here to mean the frequency of the transmission carrier.

72. As summarized in the table below, Dr. Negus has variably referred to the transmission carrier frequency as the “RF carrier frequency” of the transmission carrier, “final transmit frequency” and “center frequency” in different articles, but all referring to the transmission carrier frequency in a manner substantially identical to the ’802 patent:

| Ex. 2017<br>[Negus-Article-One]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Ex. 2024<br>[Negus-Patent]                                                                                                                                                                                                                                                                                                                                                               | Ex. 2025<br>[Negus-Pat.-App.-Pub.]                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>Figure 4 - RF architecture of generic half-duplex transceiver.</p> <p>“The transmitter architecture of Figure 4 uses direct conversion from modulating baseband quadrature inputs I and Q <i>to the RF carrier</i>. ... Alternatively, IF quadrature modulation at the second LO frequency followed by an upconversion to the <i>final RF carrier</i> could be used to generate the transmit signal.”</p> <p>Ex. 2017, 921</p> |  <p>FIG. 10-D</p> <p>“... a <i>baseband</i> in-phase (I) and quadrature-phase (Q) signal is <i>converted to</i> an <i>RF carrier frequency</i> such as those of the 60 GHz band. ... The output of the up conversion is .... <i>coupled to transmitted antenna</i> ....”</p> <p>Ex. 2024, 25:20-38</p> |  <p>FIG..4</p> <p>“... the logic 60 produces signals to the local oscillator 62 indicative of the <i>center frequency</i>. .... The multiplier 64 and filter 66 <i>up-converts either the low bandwidth or high bandwidth signal</i>. This signal is then <i>transmitted out of the transmitter</i> 68.”</p> <p>Ex. 2025, [0015]</p> |

73. A POSITA would understand that in the three documents in the table above, Dr. Negus is using the terms “RF carrier,” “final RF carrier,” “RF carrier frequency” and “center frequency” to all refer to the transmission carrier frequency. Dr. Negus’s usage of these terms is substantially identical to the ’802 patent, where, as I explained in paragraphs 53-55 above, the ’802 patent similarly

explains that the local oscillator provides the center frequency for the up-conversion of the baseband signal, which is then transmitted out of the antenna.

74. In Exhibit 2017 [Negus-Article-One], Dr. Negus explains that the architecture of Figure 4 “uses direct conversion from modulating baseband quadrature inputs I and Q to the RF carrier.” *Id.*, 921. Here, Dr. Negus uses “RF carrier” to refer to the “transmission carrier frequency.” Dr. Negus follows to explain that upconverting the baseband signal to this transmission carrier frequency can be done directly by directly upconverting the baseband to the “final RF carrier,” or it can be done in stages, by first upconverting the baseband to an intermediate frequency (IF), followed by another upconversion to the transmission carrier (“final RF carrier.”). *Id.* Both the “RF carrier” and “final RF carrier” refer to the transmission carrier frequency.

75. Similarly, in Exhibit 2024 [Negus-Patent], Dr. Negus explains that “a baseband in-phase (I) and quadrature-phase (Q) signal is converted to an RF carrier frequency such as those of the 60 GHz band.” *Id.*, 25:20-24. The frequency of up-conversion to the RF carrier frequency is provided by a local oscillator. *Id.*, 25:30-37. The output of the up-conversion is then transmitted to the antenna for transmission. *Id.*, 25:38-41. Here, too, a POSITA would understand that the “RF carrier frequency” as used by Dr. Negus refers to the frequency of the transmission

carrier, which is provided by the local oscillator for the up-conversion of the baseband signal to the transmission carrier.

76. In Exhibit 2025 [Negus-Pat.-App.-Pub.], Dr. Negus explains that “a local oscillator 62” provides a “center frequency.” *Id.*, [0015]. The signal is then up-converted using this “center frequency,” and then transmitted out of the antenna. *Id.* Here, again, Dr. Negus’s use of “center frequency” is identical to that of the ’802 patent, where it refers to the transmission carrier frequency, which in this case also dictated by the local oscillator. Of course, as noted above, Exhibit 2025 expressly uses “center frequency” and “carrier frequency” of the transmission carrier interchangeably. Ex. 2025 [Negus-Pat.-App.-Pub.] [0001].

77. Thus, the extrinsic evidence confirms that a POSITA would understand “center frequency” in the context of the ’802 patent to refer to “transmission carrier frequency.”

**B. Both of Petitioner’s Grounds Disclose Precisely The Prior Art Systems Distinguished And Improved Upon By The ’802 Patent.**

78. As I will explain in this section, Petitioners’ references disclose systems that are just like the prior art systems disclosed and improved upon in the ’802 patent itself.

79. The ’802 patent explains that in its prior art systems, in order to increase throughput, the typical approach was to increase the bandwidth around a single “center frequency.” Specifically, the ’802 patent explains that “the amount

of information transmitted around the center frequency is limited by the bandwidth of the transmitter around the center frequency.” Ex. 1001 [’802] 1:32-34. The ’802 patent then explains that “[t]ypical prior art approaches to improving the information capacity in a wireless communication system involve maximizing the bandwidth around the center frequency to increase the amount of information that may be modulated onto the carrier frequency.” *Id.*, 1:35-40.

80. The ’802 patent’s Figure 1, depicting its prior art systems, is reproduced below with annotations added.

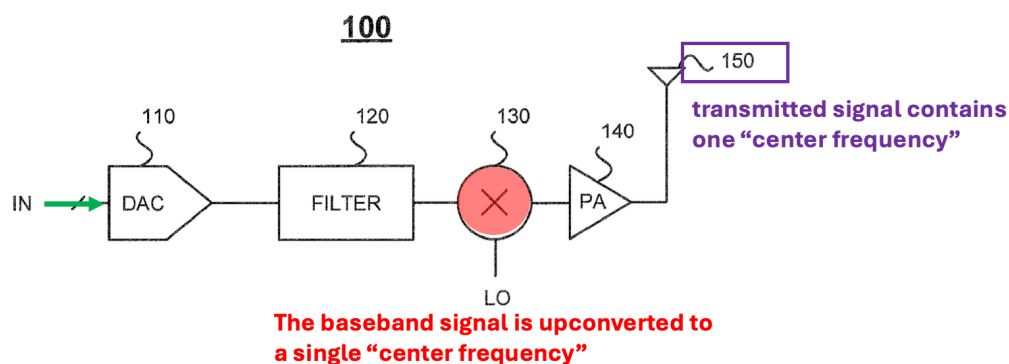


**Fig. 1**  
**(prior art)**

81. As seen in the figure, a single baseband signal is input into the local oscillator 130 (red), which then upconverts the baseband signal to a single center frequency (transmission carrier frequency) that is then transmitted out of the antenna 150 (purple). As the ’802 patent explains, throughput was typically increased by increasing the bandwidth around that single transmission carrier frequency.

82. In contrast to the prior art, which sought to improve throughput by increasing bandwidth around a single center frequency, the '802 patent increases throughput in a different fashion. It increases throughput by, *inter alia*, disclosing up-conversion to two, different, center frequencies (rather than just one). By utilizing two, different, center frequencies, the bandwidth can effectively be increased by aggregating the capacities of two different carrier frequencies together.

83. For example, as I explained in paragraphs 53-55 in connection with the embodiment of the '802 patent's Figure 2 (reproduced below again with the same annotations), two baseband signals (green) are up-converted to two “center frequencies” (blue and red), which are then transmitted out of the antenna (purple).

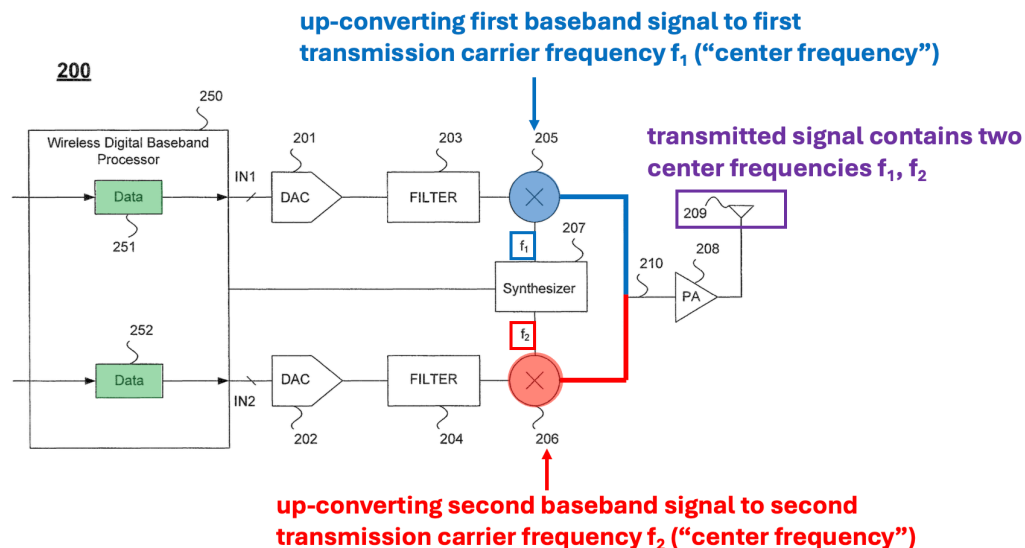
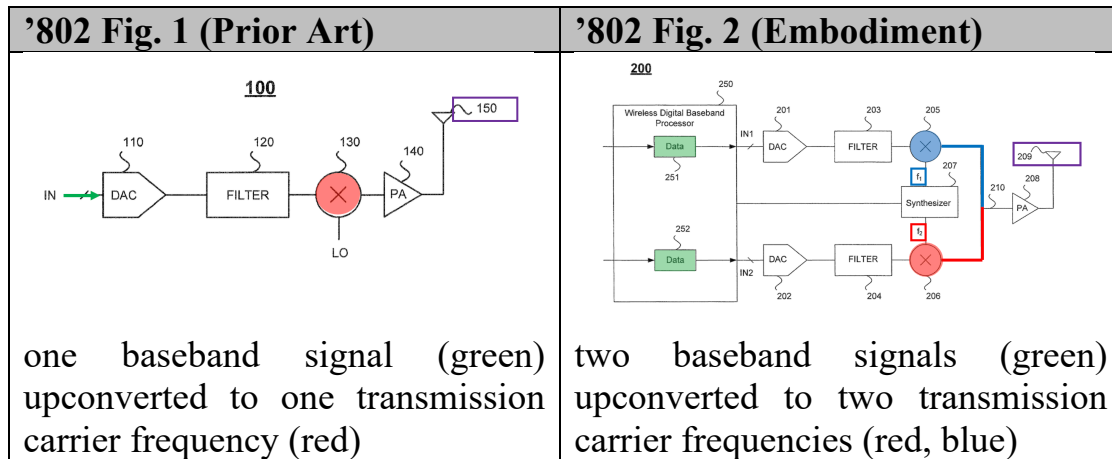


Fig. 2

84. The difference between the prior art and the '802 patent's improved method is shown through a side-by-side comparison of its Figures 1 and 2, reproduced below with annotations added:<sup>5</sup>:



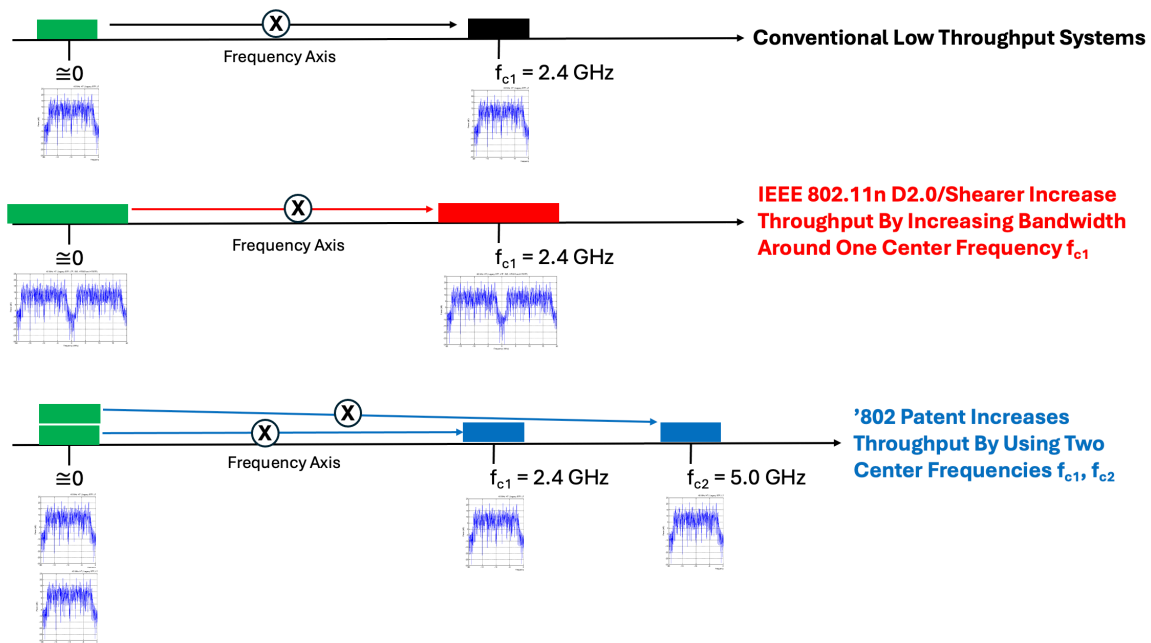
85. As I explain in more detail in sections V.C-D, both IEEE 802.11n D2.0 and Shearer (which is also based on the IEEE 802.11 standard) disclose systems that, just like the '802 patent's prior art, increase the bandwidth around a single "center frequency," as opposed to using two "center frequencies."

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<sup>5</sup> Figure 2 of the '802 patent does *not* illustrate a quadrature upconverter because  $f_1$  and  $f_2$  are different frequencies. Each of the separate upconversions to  $f_1$  and  $f_2$  can be a quadrature upconversion (for complex signals), and that would still be within the scope of the invention.

86. Specifically, as discussed in paragraphs 100-102 below, IEEE 802.11n D2.0 improves the throughput of its legacy channels by increasing the bandwidth around a single center frequency from 20 MHz to 40 MHz. As further explained in paragraphs 94-99, because of the increased bandwidth around the single center frequency, the standard combines two conventional baseband signals together for up-conversion to the single center frequency. Shearer similarly operates by increasing the bandwidth around a single center frequency from 20 MHz to 40 MHz. *See ¶¶ 126-128, infra.*

87. The distinction between the '802's inventions and the prior art methods of increasing throughput (including as disclosed in Petitioners' references) is shown in the schematic below:



88. In the schematic above, the first row shows a conventional low throughput system, where the baseband (green) is upconverted ( $\otimes$ ) to a transmission carrier with a frequency  $f_{c1}=2.4$  GHz having a certain bandwidth (denoted with black). The second row shows the '802 patent's prior art approach for increasing throughput, which is also the approach adopted by Petitioners' references. As can be seen, the bandwidth (red) around the single center frequency  $f_{c1}=2.4$  GHz is doubled in size. Correspondingly, the size of the baseband (green) is also doubled since more information can now be modulated on this increased-bandwidth transmission carrier. The third row shows the '802 patent's approach to increasing throughput. Instead of doubling the bandwidth around one center frequency, the '802 modulates the basebands on two separate center frequencies  $f_{c1}=2.4$  GHz and  $f_{c2}=5.0$  GHz.

89. Using two separate center frequencies as the '802 patent does, has multiple advantages over increasing the bandwidth around a single center frequency as Petitioners' reference do. Available spectrum is typically not contiguous. By combining multiple different carriers, the '802 patent allows flexibility in utilizing available spectrum, providing service to more users, and achieving higher data rates by combining multiple carriers. Ultimately, the '802 patent maximizes the value of spectrum assets. Prior art systems—including the

prior art relied upon by the petitioner—do not even recognize the problem and do not achieve this advantage.

90. For example, using the '802's inventions, if there are two noncontiguous, smaller channels available, the transmitter can modulate different pieces of the data on each of the two carrier frequencies, and use both transmission carriers in order to increase data rate to a given user.

91. As an additional benefit, the '802 patent in an embodiment explains that it sends “the same data across a communication channel at two different RF carrier frequencies to improve reliability and/or increase the range of the system.” Ex. 1001 ['802] 10:64-66. Specifically, because the '802 patent embodiment discussed transmits the data across two different transmission carrier frequencies, it achieves higher reliability because if one of the two channels (corresponding to one of the transmission carrier frequencies) deteriorates, it does not generally affect the transmission in the other channel (corresponding to the second transmission carrier frequency). This same benefit is not achieved by the prior art systems such as IEEE 802.11n D2.0. I note that even though in the duplicate HT format, the standards duplicates the data across the upper and lower portions of the 40 MHz channel, it does not achieve the same degree of reliability as the '802 patent's method because the upper and lower portions of the 40 MHz channel are not sufficiently separated because a single transmission carrier is used. For similar

reasons, the '802 patent's use of two transmission carrier frequencies also achieves better range for the transmitted data. Ex. 1001 ['802] 10:64-66.

92. Thus, as summarized above and explained in more detail in the following sections, Petitioners' references disclose systems similar to the prior art disclosed and improved upon in the '802 patent.

**C. The 40 MHz Channel In IEEE 802.11n D2.0 Does Not Disclose Two “Center Frequenc[ies]” As Claimed In The '802 Patent.**

93. In Ground 1, Petitioners rely on the 40 MHz channel disclosed in IEEE 802.11n D2.0 as disclosing two “center frequencies.” Pet., 29-36.

Petitioners rely in the alternative on two specific data formats to transmit data within the 40 MHz channel of IEEE 802.11n D2.0: the HT duplicate and non-HT duplicate data formats. Pet., 29-36. The standard itself teaches that the “actual transmitted signal” for the 40 MHz channel has only one “center frequency of the carrier.” Ex. 1004 [802.11n D2.0] 240-241. The IEEE 802.11n D2.0's teaching that its 40 MHz channel has only one center frequency is correct because the data within the entire 40 MHz channel is contained within a single baseband signal, which is then upconverted to a single transmission carrier, which therefore has one transmission carrier frequency. Petitioners argue that the standard's 40 MHz channel discloses two “center frequencies” by assuming that “center frequency” “is just the middle of some kind of frequency range.” Ex. 2016 [Negus-1<sup>st</sup>-Depo.] 67:1-3; Pet., 33, 36, 59, 61 (arguing that Petitioner's grounds disclose the “center

frequency” by pointing to the middle of some arbitrarily and conveniently-chosen frequency range in the references). But as I explained in section II.A, Petitioners’ assumption about the meaning of “center frequency” as just the middle of some frequency range in the context of the ‘802 patent is incorrect. As I will explain in this section, the standard is clear that under the correct understanding of “center frequency,” it fails to disclose or render obvious transmitting information across two “center frequencies.”

94. The standard discloses that the baseband signal in the 40 MHz channel for the HT duplicate format is represented by  $r_{HT-DATA}^{i_{TX}}(t)$ , which is a single baseband signal obtained by the standard’s equation 20-60. Ex. 1004 [802.11n D2.0] 279 (cited by Pet., 30). Similarly, the standard discloses that the baseband signal in the 40 MHz channel for the non-HT duplicate format is represented by  $r_{LEG-DUP}^{i_{TX}}(t - nT_{SYM})$ , which is a single baseband signal obtained by the standard’s equation 20-61. Ex. 1004 [802.11n D2.0] 280 (cited by Pet., 31). The standard is clear that those equations represent a single baseband signal. Ex. 1004 [802.11n D2.0] 240 (“The transmitted signal is described in complex base-band signal notation.”).

95. The standard, in the “overview” of its encoding process, explains that the single baseband signal of the 40 MHz channel is upconverted in equation 20-1 to “*the* center frequency of *the* desired carrier signal”:

*Up-convert the resulting complex baseband waveform* associated with each transmit chain to an RF signal according to *the center frequency of the desired channel* and transmit. Refer to 20.3.7 (Mathematical description of signals) for details.

Ex. 1004 [802.11n D2.0] 237. Thus, the standard makes clear that only one “center frequency” is utilized for the entire 40 MHz channel.

96. This is also confirmed by the discussion of equation 20-1. As the standard explains, the signal actually transmitted by the transmitter (purple) is obtained by up-converting this single, complex baseband signal (green) on a single transmission carrier with a single transmission carrier frequency (red), which the standard, similar to the '802 patent, also calls center frequency  $f_c$ :

The transmitted signal is described in complex base-band signal notation. The actual transmitted signal is related to the complex baseband signal by the following relation:

$$r_{RF}(t) = \text{Re}\{r(t)\exp(j2\pi f_c t)\} \quad (20-1)$$

where

$\text{Re}\{ \cdot \}$  represents the real part of a complex variable;

$f_c$  is the center frequency of the carrier.

Ex. 1004 [802.11n D2.0] 240-241.

97. In the equation above,  $r_{RF}(t)$  is the real-valued signal that is ultimately transmitted from the antenna. It is obtained by quadrature up-converting the complex baseband signal  $r(t)$  to the frequency  $f_c$  of the transmission carrier. The

complex baseband signal  $r(t)$  is the baseband signal obtained from either equation 20-60 for HT duplicate format, or equation 20-61 for non-HT duplicate format.

This is schematically shown by superimposing equations 20-60 on equation 20-1:

**The entire output of equation 20-60 (or 20-61) is one complex baseband signal upconverted in equation 20-1 to one “center frequency”  $f_c$  for transmission**

$$r_{RF}(t) = \text{Re}\{r(t) \exp(j2\pi f_c t)\} \quad (20-1)$$

$$\begin{aligned} r_{HT-DA\text{TA}}^{i_{TX}}(t) &= \frac{1}{\sqrt{N_{\text{Duplicate}}^{T_{\text{tone}}}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM}) \\ &\cdot \sum_{k=-N_{SR}}^{N_{SR}} (D_{k,n} + p_{n+z} P_k) ([Q_{k-32}]_{i_{TX},1} \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI})) \\ &+ j[Q_{k+32}]_{i_{TX},1} \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI}))) \end{aligned} \quad (20-60)$$

98. A similar schematic would also apply to equation 20-61. As is clear from the above, regardless of which format is used, a single baseband signal is upconverted to a single transmission carrier with a single transmission carrier frequency (“center frequency”).

99. In fact, the 40 MHz channel relied upon by Petitioners from IEEE 802.11n D2.0 is an attempt at increasing throughput through increasing bandwidth, which is what the ’802 patent distinguished as its prior art.

100. The old IEEE 802.11-2007 standard provided channels that were 20 MHz in bandwidth. *See* Ex. 1005 [802.11-2007] at p. 594 (“The allowed values of

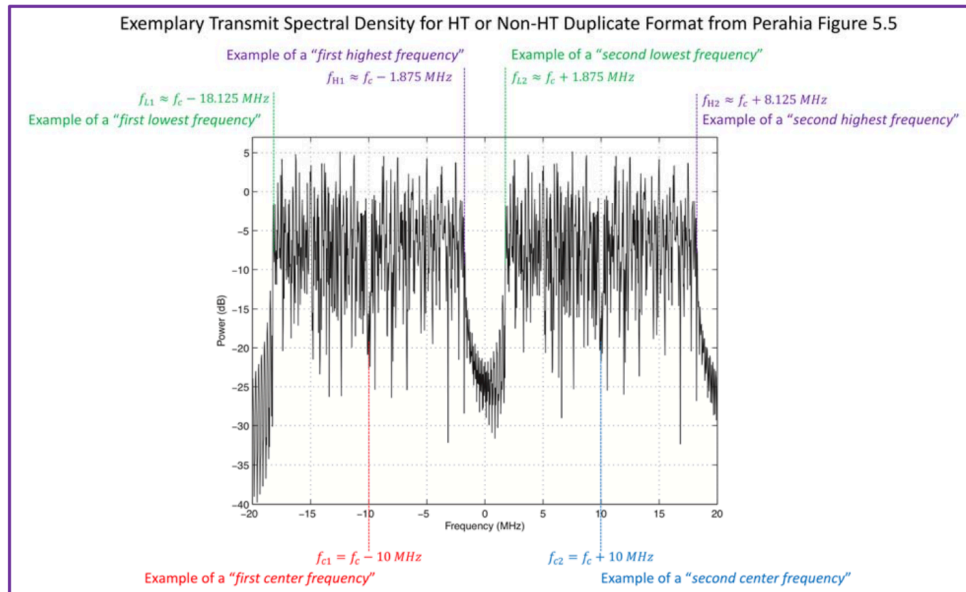
the DATARATE are 6, 9, 12, 18, 24, 36, 48, or 54 Mb/s for 20 MHz channel spacing”). The newer IEEE 802.11n standard relied upon by Petitioner for the disclosure of the 40 MHz channel “is the high throughput amendment to the 802.11 standard.” Ex. 1006 [Perahia] 101. One of the ways IEEE 802.11n increased throughput was to increase the channel bandwidth from 20 MHz to 40 MHz. Ex. 1004 [802.11n D2.0] 292 (“When using 20 MHz channels it uses channels defined in 17.3.8.3 (5 GHz band) or 18.4.6 (2.4 GHz band). When using 40 MHz channels, it can operate in the channels defined in 20.3.14.1 (Channel allocation in the 2.4 GHz Band) and 20.3.14.2 (Channel allocation in the 5 GHz band).”); *see also* Ex. 1006 [Perahia] 101 (“The other significant increase in data rate is derived from the new 40MHz channel width.”); Pet., 14 (“As particularly relevant here, IEEE 802.11n D2.0 introduced 40 MHz channels ....”).

101. But increasing channel bandwidth around a single center frequency is precisely the approach the ’802 patent describes as its prior art. The ’802 patent explained that in the prior art illustrated in its Figure 1, the transmitters were “limited to up-converting a signal to one center frequency (or modulation frequency).” Ex. 1001 [’802] 1:29-31. Thus, the ’802 patent explains, “the amount of information transmitted around the center frequency is limited by the bandwidth of the transmitter around the center frequency,” which limits the amount of data that can be transmitted. Ex. 1001 [’802] 1:32-35. The ’802 patent

then explains that “[t]ypical prior art approaches to improving the information capacity in a wireless communication system involve maximizing the bandwidth around the center frequency to increase the amount of information that may be modulated onto the carrier frequency.” Ex. 1001 [’802] 1:25-32.

102. Thus, the IEEE 802.11n D2.0’s approach of increasing the channel bandwidth from 20 MHz to 40 MHz is precisely the prior art improved upon in the ’802 patent.

103. To argue that the frequency profile of the signal transmitted within the 40 MHz channel of IEEE 802.11n D2.0 has two frequency ranges, contrary to the reference’s own express teaching, Petitioners rely upon an annotated version of Figure 5.5 from Ex. 1006 [Perahia] to argue that the 40 MHz channel in IEEE 802.11n D2.0 contains two frequency ranges, which in Petitioners’ view would disclose two center frequencies because each frequency range has a “middle” frequency:



Pet., 33.

104. As support, the Petition also relies on the baseband signal equations for the HT duplicate format and the non-HT duplicate format of the 40 MHz channel. Pet., 30-31. Petitioners annotate each equation to supposedly show two frequency ranges with first and second center frequencies:

IEEE 802.11n D2.0 Eq. (20-60) describing HT Duplicate Format

Example disclosure of both a "first highest frequency" and a "second highest frequency"

$$r_{HT-DATA}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{Duplicate}^{Tone}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM})$$

$$\sum_{k=-N_{SR}}^{N_{SR}} (D_{k,n} + p_{n+z} P_k) ([Q_{k-32}]_{i_{TX},1} \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI}))$$

$$+ j[Q_{k+32}]_{i_{TX},1} \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI})))$$

Example disclosure of a "first center frequency"

Example disclosure of both a "first lowest frequency" and a "second lowest frequency"

Example disclosure of both "first information" and "second information"

Example disclosure of a "second center frequency" that is "greater than the first center frequency"

EX-1003 ¶ 279.

IEEE 802.11n D2.0 Eq. (20-61) describing Non-HT Duplicate Format

Example disclosure of both a "first highest frequency" and a "second highest frequency"

$$r_{LEG-DUP}^{i_{TX}}(t - nT_{SYM}) = \frac{1}{\sqrt{N_{Duplicate}^{Tone}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM})$$

$$\cdot \sum_{k=-26}^{26} (jD_{k,n} + p_n P_k) (\exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})))$$

$$+ j \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})))$$

Example disclosure of a "first center frequency"

Example disclosure of both a "first lowest frequency" and a "second lowest frequency"

Example disclosure of both "first information" and "second information"

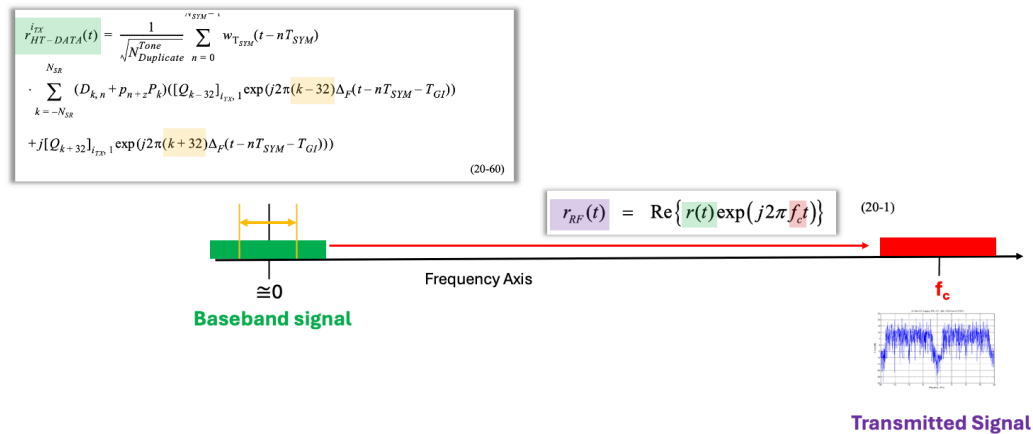
Example disclosure of a "second center frequency" that is "greater than the first center frequency"

Pet., 35.

105. I disagree with Petitioners' view. As a preliminary matter, the claim requires "transmitting" first and second data across first and second frequency ranges with first and second center frequencies, one greater than the other. Ex. 1001 [’802] cl. 1. The standard is clear that equations 20-60 and 20-61 are baseband signals, which are never transmitted; instead, "the actual transmitted signal" is the up-converted baseband signals, which have been up-converted to the carrier signal with a single center frequency  $f_c$ . Ex. 1004 [802.11n D2.0] 240-241.

Petitioner’s annotation of what are supposedly first and second lowest and highest frequencies – the numbers -26, 26, -N<sub>SR</sub>, and N<sub>SR</sub> are not the frequency values of the signal that is actually transmitted. Further Petitioners’ annotations of “-32)Δ<sub>F</sub>” and “+32)Δ<sub>F</sub>” as the claimed first and second “center frequencies” are similarly wrong, even setting aside the fact that a “center frequency” is not simply the middle frequency of a frequency range.

106. But even if that could be overlooked, Petitioners’ argument is fundamentally flawed, as explained below with reference to the following annotation:



107. As shown in the schematic above, equation 20-60 does not describe two different “center frequencies” (transmission carrier frequency) as that term is used in either IEEE 802.16n D2.0 itself, or in the ’802 patent. Instead, equation 20-60 assembles the baseband signal by duplicating the data on the two sides of the baseband signal. Dr. Negus points to -32) Δ<sub>F</sub> and +32) Δ<sub>F</sub>, highlighted in orange

above, in equation 20-60 as the claimed first and second “center frequencies.”

These parameters merely show the -10 MHz and +10 MHz that simply move the data to the two sides of 0 Hz so that the entire baseband signal can be assembled.

The baseband signal (which is the output of equation 20-60 and shown in green above) can be transmitted only after upconversion on a transmission carrier

frequency.<sup>6</sup> There is only one center frequency in IEEE 802.11n D2.0, as this term is used in both the standard itself and in the context of the ‘802 patent, and that is  $f_c$  in equation 20-1. The transmitted RF signal is obtained after the entire baseband

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<sup>6</sup> The transmission carrier frequency must exceed (and typically considerably exceeds) the bandwidth of the baseband signal. Since  $\Delta_F$  is equal to 312.5 kHz (ignoring the mathematical awkwardness of the expression  $\mp 32) \Delta_F$ ),  $-32) \Delta_F$  and  $+32) \Delta_F$  are equal to -10 MHz and +10 MHz. Consequently, based on the above, -10 MHz cannot be the center frequency of any transmitted signal (*See ¶ 40 supra*). Even +10 MHz cannot be the center frequency of any transmitted signal if the bandwidth of that signal is 20 MHz. As a matter of fundamental principles of wireless communication -10 MHz and +10 MHz cannot be the claimed first and second center frequencies. And yet this is what Dr. Negus points to in his annotated equations (20-60) and (20-61).

signal is quadrature upconverted according to equation 20-1 to a single “center frequency”  $f_c$ , which is the frequency of the transmission carrier. Equation 20-61 describes another baseband signal and a similar diagram can be made for it.

108. In the institution decision, the Board preliminary relied on Petitioners’ incorrect explanation of the standard at section § 20.3.8:

According to Petitioner, Patent Owner’s assertion that equations (20-60) and (20-61) show that there is only one center frequency “conveniently ignore[s] § 20.3.8 (Ex. 1004, p. 267)<sup>7</sup>,” which states that “‘in the upper/lower 20 MHz of a 40 MHz channel’ the ‘mathematical definition of transmission shall follow that of a 20 MHz channel with  $f_c$  in Equation (20-1) replaced by  $f_c \pm 10$  MHz,’ i.e., two center frequencies at ‘+10’/’-10.’” *Id.* (citing Ex. 1003 ¶ 101).

Paper 17 [Inst.-Dec.] 27.

109. I respectfully disagree with the Institution Decision. As I explain below, IEEE 802.16n D2.0 § 20.3.8 does not disclose that the baseband signal is upconverted to two different center frequencies,  $f_c \pm 10$  MHz. Additionally, § 20.3.8 is also unrelated, and does not apply, to equations 20-60 and 20-61 for HT duplicate and non HT duplicate formats relied upon by Petitioners. Rather, as I

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<sup>7</sup> The Institution Decision cite the Exhibit page number.

explain below, § 20.3.8 applies to the “40 MHz HT Upper Format” and “40 MHz HT Lower Format.” § 20.3.8 explains that in these formats, which use only the upper or lower 20 MHz bandwidth of the 40 MHz channel, the “center frequency”  $f_c$  in equation 20-1 would be substituted with either  $f_c+10$  MHz or  $f_c-10$  MHz, depending on whether the lower or upper 20 MHz format is used. In either case, there is only a single center frequency:  $f_c+10$  MHz for the “40 MHz HT Upper Format”, and  $f_c-10$  MHz for the “40 MHz HT Lower Format.” I explain this in more detail below.

110. While the standard discloses a 40 MHz channel, it does not require the use of the entire 40 MHz bandwidth. Instead, it permits the use of 20 MHz in bandwidth, including to support legacy devices. Thus, the standard discloses that in the case of “40 MHz HT Upper Format,” only the upper 20 MHz of the 40 MHz channel is used, and the data is only transmitted on the subcarriers -60 to -4 of the upper 20 MHz. Ex. 1004 [802.11n D2.0] 240. Similarly, in the case of “40 MHz HT Lower Format,” only the lower 20 MHz of the channel is used.

111. The table in § 20.3.2 defines the various formats in the standard and also confirms the above. Ex. 1004 [802.11n D2.0] 214-217. For example, the standard explains that the “40 MHz HT Upper Format” uses a “20 MHz bandwidth” “in the upper 20 MHz of a 40 MHz channel.” *Id.*, 215. Similarly, the standard explains that the “40 MHz HT Lower Format” uses a “20 MHz

bandwidth” “in the lower 20 MHz of a 40 MHz channel.” *Id.*, 215. In contrast, the standard explains that HT duplicate and non HT duplicate formats use the entire 40 MHz bandwidth. *Id.*, 216-217.

112. In that context, § 20.3.8 states that when data is transmitted in only the upper or lower 20 MHz portions of the 40 MHz channel, i.e., for the “40 MHz HT Upper Format” and “40 MHz HT Lower Format,” then  $f_c$  has to be substituted with either  $f_c+10$  MHz or  $f_c-10$  MHz to adjust the transmission carrier frequency to correspond to the used portion of the channel:

**20.3.8 Transmission in the upper/lower 20 MHz of a 40 MHz channel**

When transmitting in the upper/lower 20 MHz portion of a 40 MHz channel, the mathematical definition of transmission shall follow that of a 20 MHz channel with  $f_c$  in Equation (20-1) replaced by  $f_c \pm 10\text{MHz}$ .

Ex. 1004 [802.11n D2.0] 243.

113. Thus, as is clear above, § 20.3.8 does not apply to the HT duplicate and non HT duplicate formats relied upon by Petitioners (equations 20-60 and 20-61), and does not teach two center frequencies in any event.

114. The HT Duplicate and the non-HT Duplicate formats (equations 20-60 and 20-61) relied upon by Petitioners are different formats from the “40 MHz Upper Format” and the “40 MHz Lower Format” to which § 20.3.8 applies. Ex. 1004 [802.11n D2.0] 214-217. In the HT and non-HT duplicate formats, the entirety of the 40 MHz channel, consisting of 128 subcarriers, is used (in contrast to using only 64 subcarriers in case of HT Upper and Lower formats discussed

above). Ex. 1004 [802.11n D2.0] 241; *see also id.*, 216-217 (explaining that the HT duplicate and non-HT duplicate formats use a 40 MHz bandwidth). In such a scenario, there is a single up-conversion according to equation 20-1 that uses the center frequency  $f_c$ , and there is no need to shift the center frequency by either +10 or -10 MHz.

115. To the extent Petitioners argue that the baseband signals from equations 20-60 or equation 20-61 are somehow up-converted to both (or even either) center frequencies  $f_{c\pm 10}$  MHz, Petitioners are wrong. First, as I explained above, § 20.3.8 is clear that it relates to the Upper and Lower Formats that use only 20 MHz of the 40 MHz channel. Furthermore, as I also explained above, the standard is clear that in case of equations 20-60 or 20-61, the output of those equations contains a single complex baseband signal for the entire 40 MHz channel. This is also clear from Dr. Negus's annotation of the equations, which shows the baseband signal that is output from equations 20-60 and 20-61, contains portions corresponding to both the lower 20 MHz portion (shown as (k-32)) and the upper 20 MHz portion (shown as (k+32)) of the channel:

IEEE 802.11n D2.0 Eq. (20-60) describing HT Duplicate Format

$$r_{HT-DATA}^{t_{TX}}(t) = \frac{1}{\sqrt{N_{Tone}^{Duplicate}}} \sum_{n=0}^{N_{SYM}-1} w_{r_{SYM}}(t - nT_{SYM})$$

$$\sum_{k=-N_{SR}}^{N_{SR}} (D_{k,n} + p_{n+z}P_k) [(Q_{k-32})_{t_{TX},1} \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI}))$$

$$+ j(Q_{k+32})_{t_{TX},1} \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI}))]$$

Example disclosure of both a "first highest frequency" and a "second highest frequency"

Example disclosure of a "first center frequency"

Example disclosure of both a "first lowest frequency" and a "second lowest frequency"

Example disclosure of both "first information" and "second information"

Example disclosure of a "second center frequency" that is "greater than the first center frequency"

EX-1003 ¶ 279.

IEEE 802.11n D2.0 Eq. (20-61) describing Non-HT Duplicate Format

$$r_{LEG-DUP}^{t_{TX}}(t - nT_{SYM}) = \frac{1}{\sqrt{N_{Tone}^{Duplicate}}} \sum_{n=0}^{N_{SYM}-1} w_{r_{SYM}}(t - nT_{SYM})$$

$$\sum_{k=-26}^{26} (jD_{k,n} + p_nP_k) (\exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{t_{TX}})))$$

$$+ j \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{t_{TX}})))$$

Example disclosure of both a "first highest frequency" and a "second highest frequency"

Example disclosure of a "first center frequency"

Example disclosure of both a "first lowest frequency" and a "second lowest frequency"

Example disclosure of both "first information" and "second information"

Example disclosure of a "second center frequency" that is "greater than the first center frequency"

Pet., 35.

116. As I explained above, this single complex baseband signal corresponding to the entire 40 MHz channel is then upconverted to a single center frequency  $f_c$  of the 40 MHz channel in equation 20-1.

117. I would also like to address another aspect of the standard for completeness. The standard refers to the 20 MHz subparts of the 40 MHz channel as "primary" and "secondary" channels within the 40 MHz channel. Ex. 1004 [IEEE 802.11n D2.0] at 292 ("The 40 MHz channels are specified by two fields: (Nprimary\_ch, Secondary)"). This allows the standard to specify what is transmitted in different portions of the 40 MHz channel for various reasons. For example, to allow legacy devices that were designed for the old 20 MHz channel to

operate with the new 40 MHz channel, the standard provides that in the non-HT duplicate format, the primary and secondary 20 MHz portions of the 40 MHz channel are duplicates of each other. Ex. 1004 [IEEE 802.11n D2.0] at p. 301 (“And furthermore, if the FORMAT field is set to NON\_HT and CH\_BANDWIDTH indicates NON\_HT\_CBW40, follow the transmit procedure as in Clause 17 duplicated on both channels.”), where Clause 17 describes the operation of legacy devices.

118. This logical division of the 40 MHz channel, however, does not change the fact that, as I discussed above, the entire signal of the 40 MHz channel, containing both the 20 MHz primary and secondary portions within it, is a single baseband signal that is up-converted to a single center frequency. See ¶¶ 54-57, *supra*. I understand that Dr. Negus also agrees with me on this point. Ex. 1003 [Negus-Decl.] ¶318 (“a POSITA would understand that the ‘first information’ and the ‘second information’ are disclosed by either of the ‘*HT duplicate format*’ and ‘*non-HT duplicate format*’ as being ***within a single composite complex baseband signal*** ....”).

119. Therefore, this is not a case where the two 20 MHz primary and secondary portions of the 40 MHz channel are separately up-converted to a different carrier signal with a different center frequency. Instead, as explained (*see* ¶¶ 94-98, *supra*), the standard is clear that the data within the 40 MHz channel is

contained within a single baseband signal up-converted to a single frequency. Ex. 1004 [802.11n D2.0] 240-241, 237.

120. Therefore, for the reasons I explained above, the 40 MHz channel within IEEE 802.11n D2.0 does not disclose two “center frequenc[ies]” as claimed.

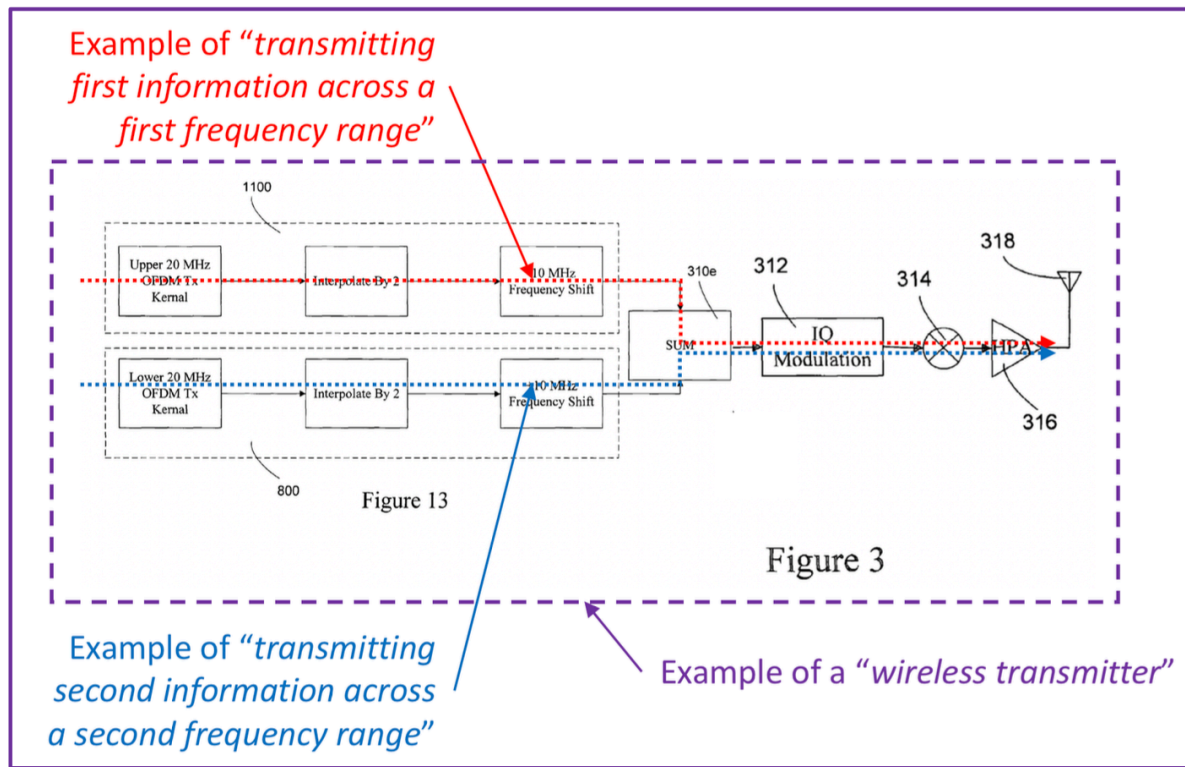
**D. The 40 MHz Channel In Shearer Does Not Disclose Two “Center Frequenc[ies]” As Claimed In The ’802 Patent.**

121. Petitioners’ Ground 2 relies on Shearer alone. Pet., 22. As I will explain below, this ground fails for reasons similar to Petitioners’ ground 1.

122. Shearer explains that the “legacy” IEEE 802.11a/g systems utilized 20 MHz channels. Ex. 1007 [Shearer] [0044]. Shearer then discloses a method to create a 40 MHz channel. *Id.*, [0047]. Shearer creates this new 40 MHz channel by aggregating two legacy 20 MHz channels. *Id.* Shearer Figure 7 shows three ways of combining the legacy 20 MHz channels. *Id.* All three ways shown in Figure 7 are materially the same for the purposes of this discussion as they only differ in which subcarriers are set to zero as guard subcarriers within the channel. *Id.*

123. As I will explain below, Shearer obtains the new 40 MHz channel by first creating the baseband signals for each of the legacy 20 MHz channels, then aggregating the two baseband signals to create a single baseband signal for the new 40 MHz channel, and then upconverting the single baseband signal to a single transmission carrier with a single transmission carrier frequency (“center

frequency”). Thus, Shearer’s 40 MHz channel does not disclose two center frequencies because its transmitted signal does not contain two transmission carrier frequencies. I understand that an annotation provided by Dr. Negus similarly shows the operation of Shearer:



Ex. 1003 [Negus-Decl.] ¶ 428.

124. Shearer’s Figure 3, reproduced below, discloses a legacy transmitter for transmitting a 20 MHz baseband signal. Ex. 1007 [Shearer] [0040].

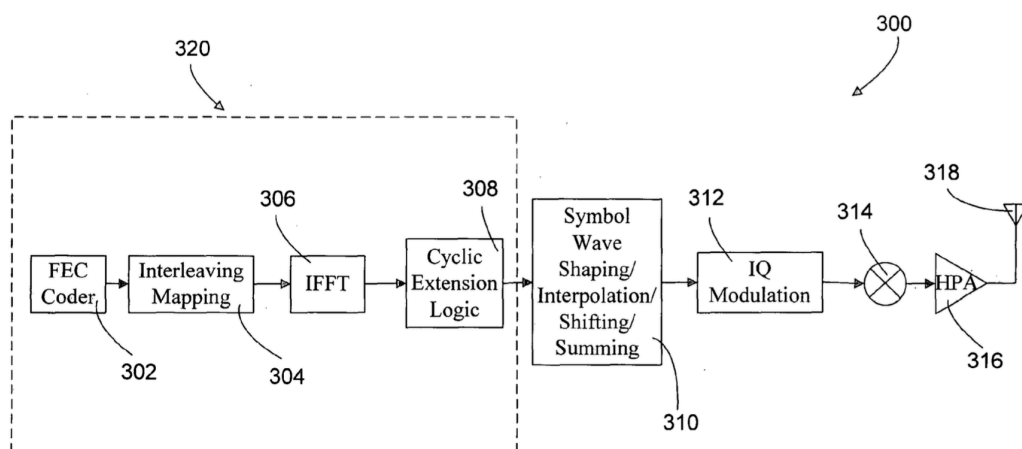


Figure 3

125. Once the baseband signal is created, it is “sent to mixer 314 where it is upconverted to *the* desired transmit frequency.” Ex. 1007 [0043]. Thus, Shearer’s Figure 3 discloses a single “center frequency.”

126. To create the 40 MHz signal, Shearer duplicates element 320 to create two 20 MHz baseband signals, which are then combined in element 310 into a single 40 MHz baseband signal. That single 40 MHz baseband signal is then upconverted in mixer 314 to a single transmission carrier with a single transmission carrier frequency (“center frequency”). Shearer’s Figure 13, reproduced below, discloses the parallel components to create the baseband signals for the upper and lower portions of the 40 MHz channel. Ex. 1007 [Shearer] [0062].

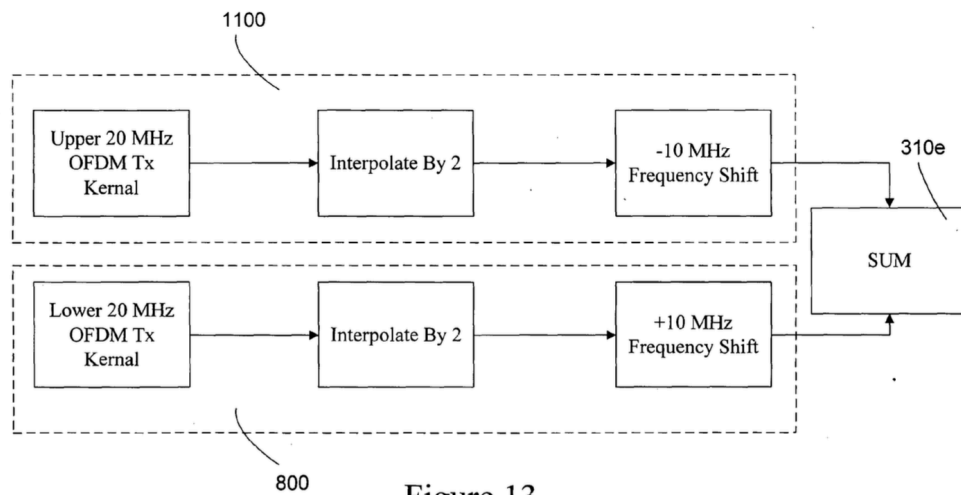


Figure 13

127. The baseband signal for the lower 20 MHz portion of the 40 MHz signal is created in element 1100. Ex. 1007 [Shearer] [0062]. Similarly, the baseband signal for the upper 20 MHz portion of the 40 MHz signal is created in element 800. *Id.* This is shown schematically in Shearer's Figures 10 and 12, reproduced below:

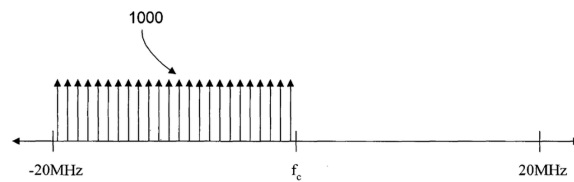


Figure 10

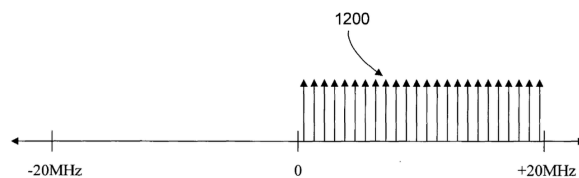


Figure 12

128. These two baseband signals are then “aggregated in adder 310e” to create a 40 MHz baseband signal. Ex. 1007 [Shearer] [0062]. The aggregated 40 MHz baseband signal is shown in Figure 14, reproduced below:

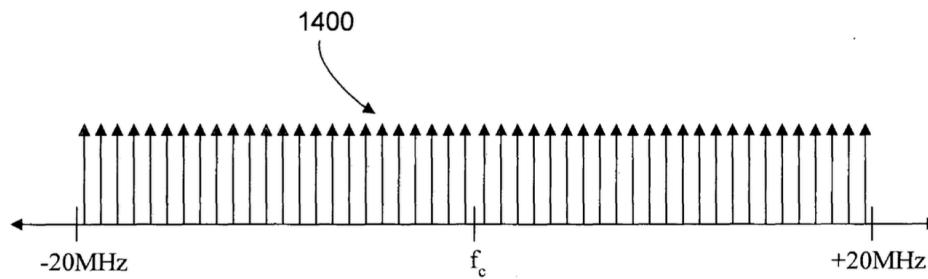


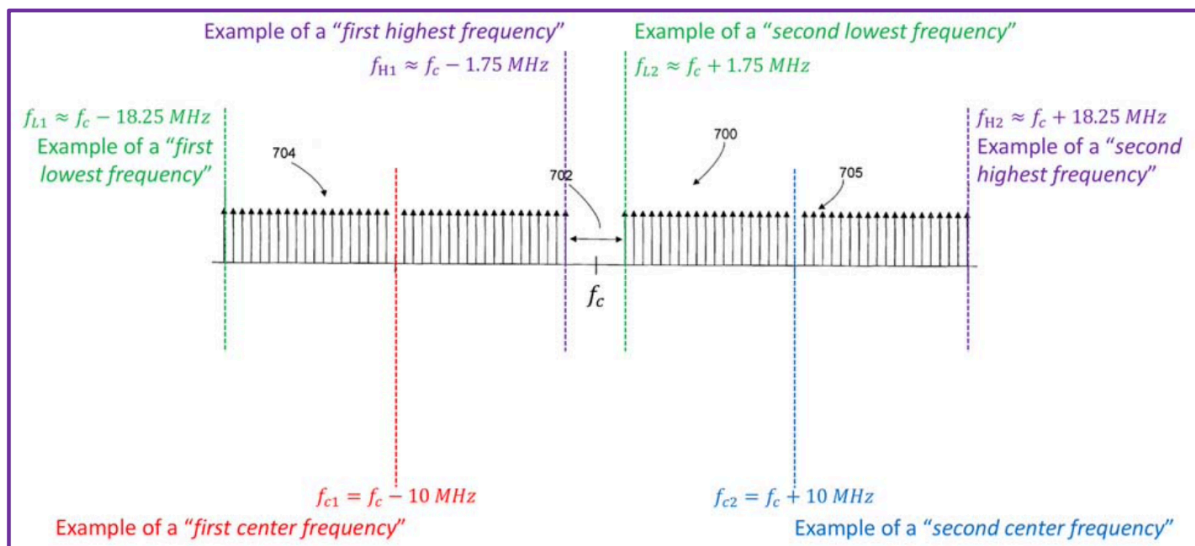
Figure 14

129. Note that, as Dr Negus also showed in his annotation (Ex. 1003 [Negus-Decl.] ¶ 428), a POSITA would understand that the summer 310e in Figure 13 corresponds to element 310 in Figure 3. Ex. 1007 [Shearer] [0012] (“In the figures, like reference numerals designate corresponding parts throughout the different views.”); [0041] (“The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below.”); [0060] (“Interpolator stage 310c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. ... Frequency shift stage 310d corresponds to shaper/interpolator/shifter 310 of FIG. 3.”).

130. Thus, as shown in Fig. 3, after the two 20 MHz baseband signals are separately produced and aggregated in element 310e, the produced 40 MHz

baseband signal is upconverted by mixer 314 to a single transmission carrier with a single transmission carrier frequency “center frequency”).

131. In arguing that Shearer discloses the claimed first and second center frequencies, Petitioners again rely on an incorrect understanding of the meaning of “center frequency.” Instead, as with Ground 1, Petitioners simply point to the middle frequency of two frequency ranges within the 40 MHz channel:



Pet., 59.

132. But as with Ground 1, even if one were to assume that the guard bands around the DC frequency in the middle of the 40 MHz channel create two “frequency ranges” to the left and right of the guard bands, this does not disclose two different center frequencies as claimed. The entirety of the signal shown above is still a single baseband signal that is upconverted by a single mixer 314 to a single transmission carrier with a single transmission carrier frequency (“center

frequency.”). Ex. 1007 [Shearer] [0043] (“The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency.”). Thus Shearer’s teaching expressly contradicts Dr. Negus’ annotation of the figure adding  $f_c+10$  MHz and  $f_c-10$  MHz.

133. The Institution Decision appears to preliminarily rely on the fact that the baseband signal in Shearer is created by shifting two baseband signals corresponding to the legacy 20 MHz channels by 10 MHz so that they can be assembled together to form a larger baseband signal before up-conversion:

Based on Dr. Negus’s testimony and the underlying disclosures of the references, the first and second frequency ranges appear to represent signals that were upconverted from baseband signals at carrier frequencies of  $f_{c1} = f_c - 10$  MHz and  $f_{c2} = f_c + 10$  MHz. Therefore, these center frequencies appear to be “carrier signal frequencies” that “the baseband signal is upconverted to.”

Paper 17 [Institution-Decision] 44.

134. I respectfully disagree with the Institution Decision’s view. Just like the IEEE 802.11n D2.0, Shearer creates a larger baseband signal corresponding to the new, larger 40 MHz channel. Shearer creates this larger baseband signal by shifting two baseband signals by 10 MHz each so that they can be assembled together, as shown in its Figure 12:

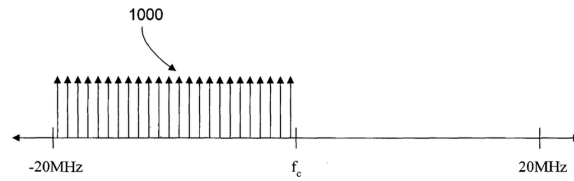


Figure 10

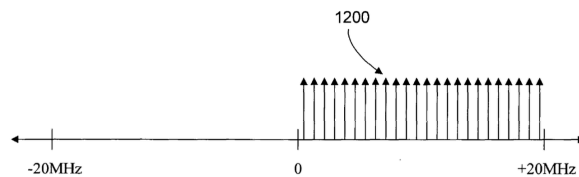


Figure 12

Ex. 1007 [Shearer] [0062].

135. These two shifted baseband signals are then “aggregated in adder 310e” to create a new 40 MHz baseband signal. Ex. 1007 [Shearer] [0062]. The aggregated 40 MHz baseband signal is shown in Figure 14, reproduced below:

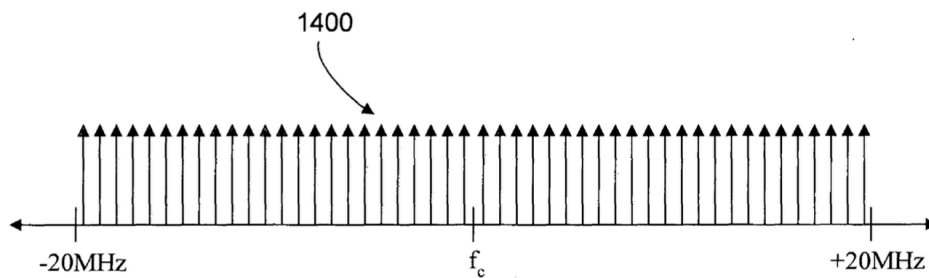
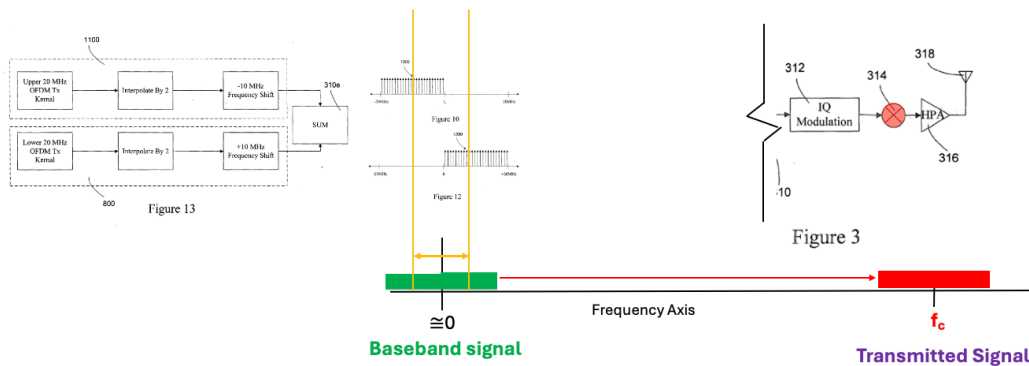


Figure 14

136. The Institution Decision appears to rely on this shift of the two portions of the composite baseband signal by 10 MHz each for the disclosure of two “center frequencies.” I respectfully disagree.

137. The baseband signal created by Shearer Figure 14 is up-converted to a single transmission carrier frequency. Ex. 1007 [0043] (the combined baseband is “sent to mixer 314 where it is upconverted to *the* desired transmit frequency.”). The manner by which the baseband signal was created does not create distinct transmission carriers. This is shown schematically below:



138. As shown above, the composite baseband signal is created by Shearer’s Figures 12 and 13. The composite baseband signal is then up-converted to a single transmission carrier frequency by mixer 314, as shown in Shearer’s Figure 314. The final transmitted signal has a single transmission carrier with a single transmission carrier frequency.

139. I also note that the 10 MHz frequency to which a portion of Shearer’s baseband signal is shifted in order to create the complex baseband signal is not generally referred to in the art as a “carrier” frequency, and certainly not a transmission carrier frequency. Instead, carrier frequency generally refers to the transmission carrier frequency. This is confirmed by Dr. Negus’s own

publications. For example, Dr. Negus explains that a baseband signal may be directly upconverted to “an RF carrier frequency,” or may first be shift to an “intermediate frequency” before being “upconverted to an RF carrier frequency.” Ex. 2024 [Negus-Patent] 25:20-38. In this instance, Dr. Negus does not refer to the intermediate frequency as the “carrier frequency.” Rather, he only refers to the final, 60 Hz transmission carrier frequency as the carrier frequency.

140. Therefore, for the reasons I explained above, Shearer does not disclose two “center frequenc[ies]” as claimed in the '802 patent.

## **VI. CONCLUSION**

141. For the foregoing reasons, based on my expertise and experience and the record of this case that I have reviewed, it is my opinion that the challenged claims are not shown to be disclosed or obvious.

142. I understand that my opinions discussed above support a legal conclusion that the challenged claims are nonobvious.

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

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

Respectfully Submitted,

A handwritten signature in black ink, appearing to read 'T Cooklev', with a long horizontal stroke extending to the right.

January 8, 2025

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Todor V. Cooklev, Ph.D.