UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

COBBLESTONE WIRELESS LLC,
Patent Owner.

Case IPR2024-00707
Patent 7,924,802

PATENT OWNER'S RESPONSE

TABLE OF CONTENTS

Page

I. INTRODUCTION 1

II. PETITIONERS FAIL TO SHOW THAT THEIR GROUNDS DISCLOSE OR RENDER OBVIOUS TWO "CENTER FREQUENCIES" (ALL GROUNDS, ALL CLAIMS). 6

A. The '802 Patent's "Center Frequency" Refers To The Frequency Of The Transmission Carrier ("Transmission Carrier Frequency") 7

1. Technology Background On Transmission Carrier Frequency. 8

2. The '802 Patent's "Center Frequency" Refers To The Frequency Of The Transmission Carrier ("Transmission Carrier Frequency"). 10

3. Extrinsic Evidence Confirms The '802 Patent's Usage Of "Center Frequency" To Refer To The "Transmission Carrier Frequency." 22

4. Federal Circuit Authority Confirms That Under The Facts Of This Case, "Center Frequency" Means The Frequency Of The Transmission Carrier ("Transmission Carrier Frequency"). 27

B. Both of Petitioner's Grounds Are Based On Precisely The Prior Art Systems Distinguished And Improved Upon By The '802 Patent. 32

C. Petitioners' First Ground Does Not Disclose Or Render Obvious Two "Center Frequenc[ies]" As Claimed (Ground 1, All Claims). ... 39

D. Petitioners' Second Ground Does Not Disclose Or Render Obvious Two "Center Frequencies" As Claimed (Ground 2, All Claims). 56

III. CONCLUSION 67

TABLE OF AUTHORITIES

Page(s)

FEDERAL CIRCUIT DECISIONS

In re Abbott Diabetes Care Inc.,
696 F.3d 1142 (Fed. Cir. 2012).....30, 31

Bid for Position, LLC v. AOL, LLC,
601 F.3d 1311 (Fed. Cir. 2010).....29

Choon's Design, LLC v. IdeaVillage Prods. Corp.,
776 Fed App'x 691 (Fed. Cir. 2019).....29

Edwards Lifesciences LLC v. Cook Inc.,
582 F.3d 1322 (Fed. Cir. 2009).....31

Irdeto Access, Inc. v. Echostar Satellite Corp.,
383 F.3d 1295 (Fed. Cir. 2004).....31

Kinetic Concepts, Inc. v. Blue Sky Med. Grp., Inc.,
554 F.3d 1010 (Fed. Cir. 2009).....29

Phillips v. AWH Corp.,
415 F.3d 1303 (Fed. Cir. 2005) (en banc).....28, 31

SandBox Logistics LLC v. Proppant Express Invs. LLC,
813 Fed. Appx. 548 (Fed. Cir. 2020).....29

Sightsound Techs., LLC v. Apple Inc.,
809 F.3d 1307 (Fed. Cir. 2015).....30

VirnetX, Inc. v. Cisco Sys.,
767 F.3d 1308 (Fed. Cir. 2014).....28

Wisconsin Alumni Res. Found. v. Apple Inc.,
905 F.3d 1341 (Fed. Cir. 2018).....29

PATENT OWNER'S EXHIBIT LIST	
2001	Declaration of Professor Todor V. Cooklev, Ph.D. [Cooklev-Decl.]
2002	Curriculum Vitae of Professor Todor v. Cooklev, Ph.D.
2003	Federal Court Management Statistics for the Eastern District of Texas through December 2023, available at https://www.uscourts.gov/statistics-reports/federal-court-management-statistics-december-2023 [Trial-Statistics]
2004	*Cobblestone Wireless, LLC v. Cisco Systems Inc. et al.,* No. 2:23-cv-00454, Docket as of June 26, 2024
2005	*Cobblestone Wireless, LLC v. Cisco Systems Inc. et al.,* No. 2:23-cv-00454, Defendants' Invalidity Contentions for U.S. Patent No. 7,924,802 (E.D. Tex., served Feb. 26, 2024) [Invalidity-Contentions]
2006	United States Patent No. 7,742,388 [Shearer-Patent]
2007	*MyPort, Inc. v. Samsung Electronics Co., Ltd.,* No. 2:22-cv-00114, Dkt. No. 73 (E.D. Tex. Jun. 13, 2023) (order denying motion to stay) [Stay-Denial-Order]
2008	Declaration of Nathan Lowenstein in support of Motion for Admission *Pro Hac Vice*
2009	Request for *Ex Parte* Reexamination Control No. 90/019,458, [Request]
2010	Order Granting *Ex Parte* Reexamination in *Ex Parte* Reexamination Control No. 90/019,458 [Decision Granting EPR]
2011	Non-Final Office Action in *Ex Parte* Reexamination Control No. 90/019,458 [NFOA]

2012	Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. 84 Fed. Reg. 16,654, 16,657 (Apr. 22, 2019) [2019 Notice]
2013	Chart Comparing Ex. 1007 with Ex. 2006 [Shearer Comparison]
2014	Second Declaration of Professor Todor V. Cooklev, Ph.D. [Cooklev-2nd-Decl.]
2016	Deposition Transcript of Kevin Negus, Ph.D. [Negus-1st-Depo.]
2017	Kevin J. Negus and Dan Millicker, *RFICs for Reduced Size, Cost and Power Consumption in Handheld Wireless Transceivers*, October 1993 [Negus-Article-One]
2018	Bart Jansen, Kevin Negus, and Don Lee, *SP 23.8: Silicon Bipolar VCO Family for 1.1 to 2.2GHz with Fully-Integrated Tank and Tuning Circuits*, February 1997 [Negus-Article-Two]
2019	Andrew Lea, Kevin Negus, et al., *Spectrum Options for Wireless Backhaul of Small Cells*, April 2014 [Negus-Article-Three]
2024	U.S. Patent No. 10,708,918 [Negus-Patent]
2025	U.S. Patent Application Publication No. 2002/0021745 [Negus-Pat.-App.-Pub.]

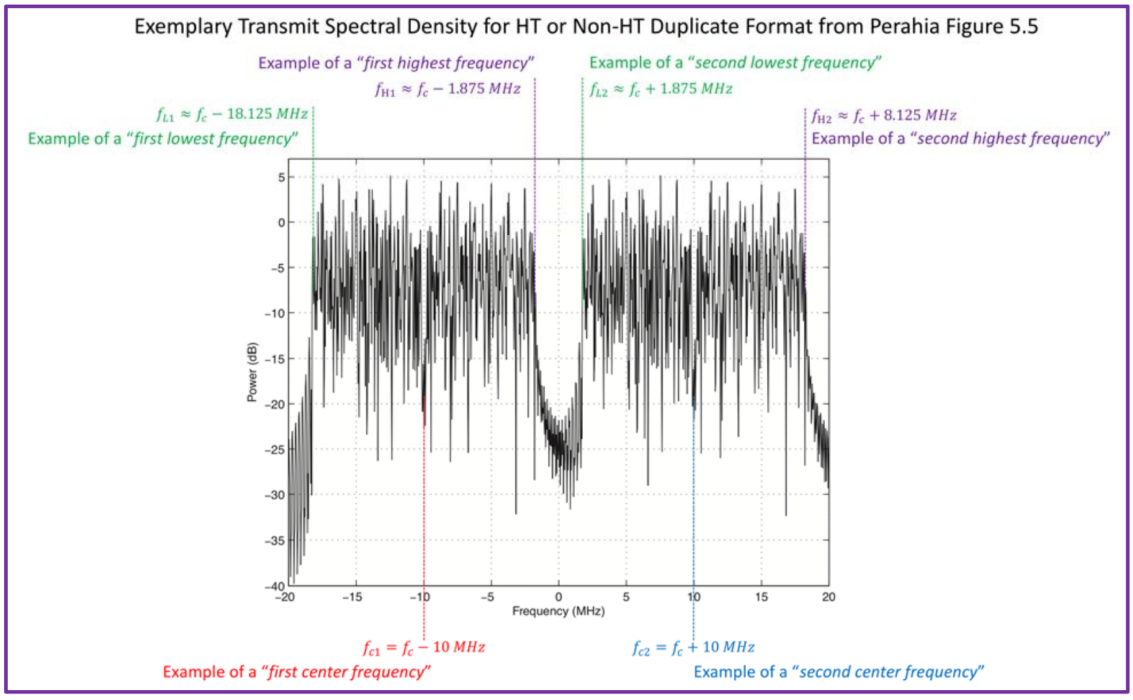
I. INTRODUCTION

The Petition's grounds fail to show the claims are disclosed or obvious. Instead, Petitioners' references disclose the same prior art systems disclosed and improved upon by the '802 patent.

Claim 1, the sole challenged independent claim, requires transmitting information across two frequency ranges, each with a different "***center frequency***." More specifically, the claim requires "transmitting first information across a first frequency range having a ***first center frequency***" and "simultaneously transmitting second information 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. Petitioners fail to demonstrate this limitation is disclosed and/or obvious under either of their grounds.

Petitioners present two grounds: one based on IEEE 802.11n D2.0 (Ground 1) and the other based on Shearer (Ground 2), which is based on the same IEEE 802.11 standard that forms Ground 1. Pet., 22. For both grounds, in arguing that the claimed two "center frequencies" are met, Petitioners identify two alleged frequency ranges in a signal and point to the middle frequency in those alleged frequency ranges as the claimed "center frequency." For instance, Petitioners point to a single baseband signal in IEEE 802.11n D2.0, and argue that because they can

point to two different frequency ranges within that 40 MHz channel, the middle of each frequency range discloses a claimed "center frequency":



Pet., 33 (Petitioners' annotation). The middle of a frequency range, however, is not a "center frequency" within the meaning of the '802 patent, as confirmed by the intrinsic and extrinsic record evidence.

The introduction of two "center frequencies" is a focal point of the '802's background of the invention, a feature of every embodiment, a basis for distinguishing the prior art, and reflected in each of the claims. In every instance, a "center frequency" always means precisely the same thing and it does not refer to

the middle of a frequency range. Rather, a "center frequency" is the frequency of the transmission carrier ("transmission carrier frequency").[1]

To wirelessly transmit information, raw data is first represented as a signal called the "baseband signal." For various reasons, including because the frequency of the baseband signal is too low, the baseband signal cannot be transmitted as is. Instead, the baseband signal must be "upconverted" to a higher frequency carrier suitable for transmission (the transmission carrier). This is also known as modulating the baseband signal on the transmission carrier (the modulated transmission carrier). This modulated transmission carrier is then transmitted from the antenna.

The relationship between the transmission carrier and the baseband signal has been compared to a stone and a piece of paper. *See* Ex. 2014 [Cooklev-2nd-Decl.] ¶ 42. If one wishes to throw a piece of paper, it will not go very far by itself. But by wrapping the piece of paper around a stone (a transmission carrier), it can be thrown over a longer distance. The "center frequency," as the '802 makes clear, refers to this "transmission carrier frequency," *i.e.*, the frequency of the transmission carrier. In fact, "center frequency" is very commonly used in the

[1] As explained in Section II.A, *infra*, this construction is materially the same as the construction proffered in the preliminary response.

field the same way it is used by the '802 patent, as evidenced by the publications of Petitioner's own expert, and by the same IEEE 802.11n D2.0 standard Petitioners rely upon as a reference. *See* Section II.A, *infra*.

Indeed, consistent with the '802 patent's usage, the IEEE 802.11n D2.0 standard itself teaches that its "actual transmitted signal" within the 40 MHz channel has one "center frequency" (f_c), not two center frequencies as alleged by Petitioners:

> 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:
>
> $$r_{RF}(t) = \mathrm{Re}\{r(t)\exp(j2\pi f_c t)\} \quad (20\text{-}1)$$
>
> where
>
> $\mathrm{Re}\{\cdot\}$ 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.

In arguing that their grounds disclose or render obvious the claims, Petitioners' analysis is based on a fundamental misunderstanding of the claimed inventions and what the claimed "center frequency" means. Under the proper understanding of the inventions, both of Petitioners' grounds are precisely the prior art the '802 patent improved upon, which had a single "center frequency." *See* Sections II.A-B, *infra*. Specifically, the '802 patent explains that in its prior art, in order to increase information capacity, the bandwidth around a single center

frequency was increased. The increased bandwidth around the single transmission carrier frequency thus enabled a baseband with more information to be modulated on it.

The '802 patent took a different approach. Instead of increasing the bandwidth around a single "center frequency," the '802 patent utilized two distinct center frequencies. In practice, what that means is that two separate baseband signals are upconverted to two different transmission carrier signals, which are then transmitted from the antenna. The patent explains that its approach helps "improve reliability and/or increase the range of the system." Ex. 1001 ['802] 10:64-66; *see also* Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 89-91.

Both IEEE 802.11n D2.0 in Ground 1, and Shearer (which is based on the same IEEE 802.11 standard) in Ground 2, reflect the usage of a single "center frequency" that the '802 patent improved upon. Specifically, in IEEE 802.11n D2.0, the bandwidth around a single "center frequency" is increased from 20 MHz to 40 MHz. In other words, rather than utilize a 20 MHz bandwidth around one "center frequency," the standard employs a 40 MHz bandwidth around one "center frequency." Because the new channel can transmit more information, the baseband signal is doubled in size. In the implementations relied upon by Petitioners, the upper and lower halves of the 40MHz channel are mirror images of each other so that legacy devices that are only capable of receiving a 20 MHz bandwidth would

also be supported. But that does not change the operation of IEEE 802.11n D2.0, which increases the bandwidth around a single "center frequency" just as the prior art discussed in the '802 patent's background of the invention did. *See* Section II.C., *infra*. Petitioner's Shearer reference is also based on the same IEEE 802.11 standard and fails to disclose two "center frequencies" for similar reasons. *See* Section II.D., *infra*.

These points are discussed in more detail below.

II. PETITIONERS FAIL TO SHOW THAT THEIR GROUNDS DISCLOSE OR RENDER OBVIOUS TWO "CENTER FREQUENCIES" (ALL GROUNDS, ALL CLAIMS).

The claims require two "center frequencies," one center frequency greater than the other. The "center frequency" refers to the frequency of the transmission carrier, *i.e*., the transmission carrier frequency. *See* Section II.A., *infra*. The '802 patent's usage of "center frequency" as the transmission carrier frequency is common in the art and, indeed, both the IEEE 802.16n D2.0 reference and Petitioners' expert use "center frequency" in precisely this way.

Petitioners' references are just like the prior art discussed and improved upon by the '802 patent. Specifically, the '802 patent explains that its prior art, in order to improve throughput, increased the bandwidth around a single center frequency. In contrast, the '802 patent discloses using two different center frequencies. *See* Section II.A., *infra*. Similar to the '802 patent's prior art, both of

Petitioners' references increase throughput by increasing the channel bandwidth around a single center frequency from 20 MHz to 40MHz and fail to disclose or render obvious two center frequencies as claimed. *See* Sections II.C-D, *infra*.

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

The claims require transmitting data across two frequency ranges, each with its own "center frequency," with one center frequency "greater than" the other. Petitioners, which had the burden to "set forth … how the challenged claim is to be construed," provide no analysis whatsoever of the specification or the meaning of "center frequency." 37 C.F.R. § 42.104 (b)(3). Instead, Petitioners and their expert merely assume that "center frequency" "is just the middle of some kind of frequency range." Ex. 2016 [Negus-1st-Depo.] 67:1-3; Pet., 33, 36, 59, 61 (arguing that Petitioner's grounds disclose the "center frequency" by pointing to the middle of a frequency range in the references). Petitioners are incorrect. As explained in the subsections below, the intrinsic and extrinsic evidence, and Federal Circuit authority confirm that a "center frequency" refers to the frequency of the transmission carrier (*i.e.*, the "transmission carrier frequency").

1. Technology Background On Transmission Carrier Frequency.

Understanding what a "center frequency" is requires a brief discussion of the underlying technological background. As Professor Cooklev explains,[2] raw data (*e.g.*, a baseband signal) is generally not suitable for transmission because, *inter alia*, it is typically at too low a frequency. To address this issue, the baseband signal must be modulated on a transmission carrier:

> 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.
>
> 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

[2] Professor Cooklev has extensive personal experience working on the IEEE 802.11 standard that forms the basis of Petitioners' grounds. For example, he was a voting member of the IEEE 802.11 working group, he chaired a study group within 802.11, and he has won an IEEE Standards Association award in 2012 for his work on the standard. Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 5-18; Ex. 2002 [Cooklev-CV].

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.

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."

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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 39-42.

In light of this technology background, and as explained in the following section, the '802 patent is clear that its "center frequency" refers to the "transmission carrier frequency."

2. The ’802 Patent’s “Center Frequency” Refers To The Frequency Of The Transmission Carrier (“Transmission Carrier Frequency”).

As just discussed, data (such as a baseband signal) is modulated on a transmission carrier before it can be wirelessly transmitted. As Professor Cooklev explains, the frequency of this transmission carrier, *i.e*., the “transmission carrier frequency” is what the ’802 patent refers to by “center frequency”:

> 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.”
>
> 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”).

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 45-46.

Indeed, as Dr. Cooklev further explains, this usage of "center frequency" as the frequency of the transmission carrier is reflected in every embodiment:

> 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:

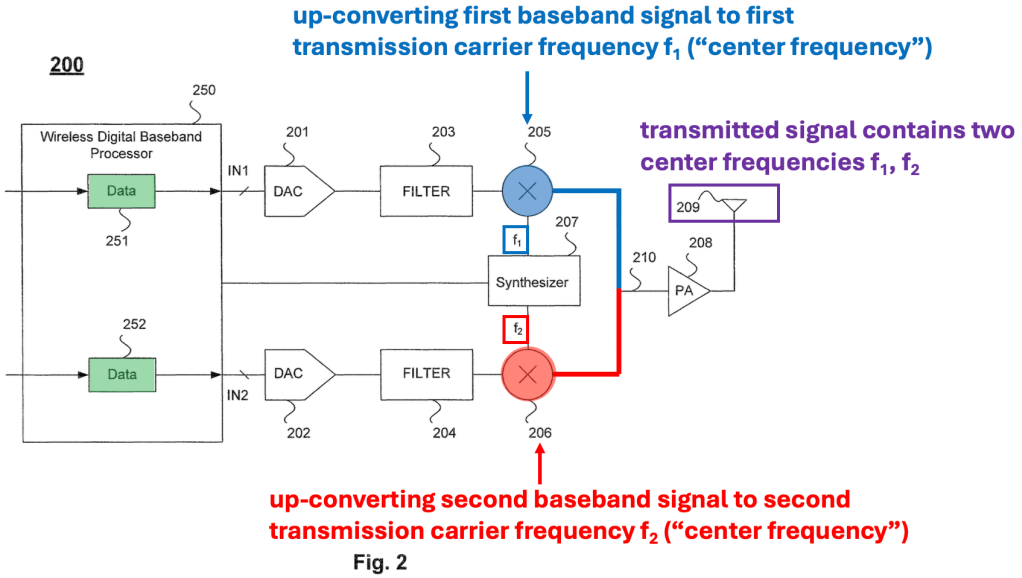


Fig. 2

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."[3] 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.[]

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

[3] 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"). Ex. 2014 [Cooklev-2nd-Decl.] ¶ 48 n.2.

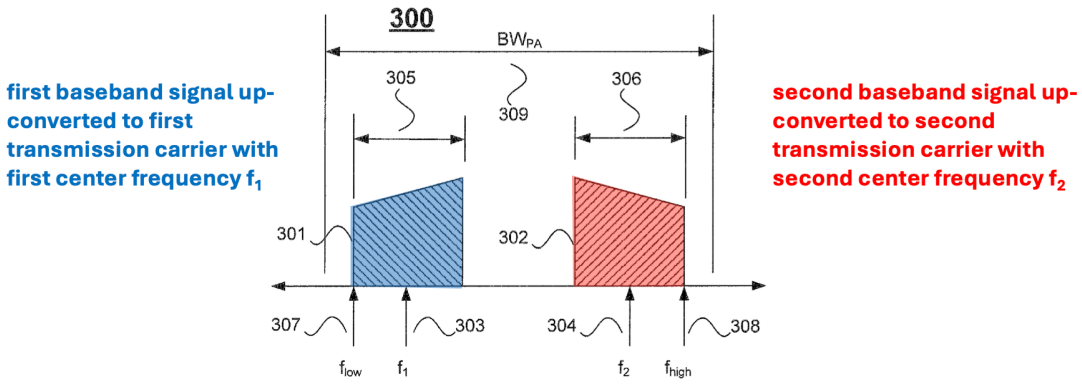


Fig. 3

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 up-converted frequency range, making clear that the location of "center frequency" does not have to be in the middle.

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).

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 47-51.

Petitioners in their preliminary reply relied upon the '802 patent's Figure 4 embodiment to support their contention that "center frequency" simply means the

middle of a frequency range. Paper 11 [Prelim.-Reply] 2. However, as Professor Cooklev explains, Petitioners are incorrect:

> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 52.

Significantly, 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. As Professor Cooklev explains:

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

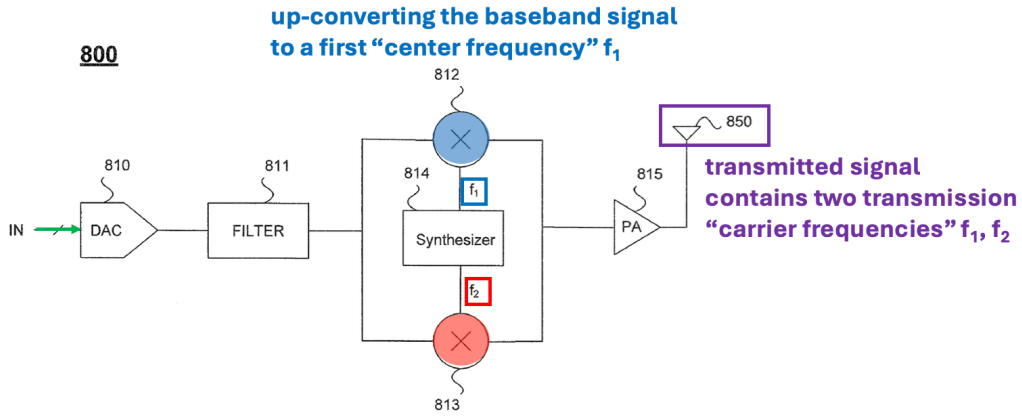


Fig. 8

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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 54-55. 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. As Professor Cooklev explains:

> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶ 57.

There are still additional indicia that in the '802 patent, "center frequency" means "transmission carrier frequency." As Professor Cooklev explains:

> 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."
>
> 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-1st-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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 58-59.

Claim differentiation further confirms that the claimed "center frequency" does not merely mean the middle of some frequency range. As Professor Cooklev explains:

> 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-1st-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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶ 60.

Applying the above discussion to claim 1, the meaning of "center frequency" as the "transmission carrier frequency" is clear to a POSITA. As Professor Cooklev explains:

> 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 …."
>
> 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.").

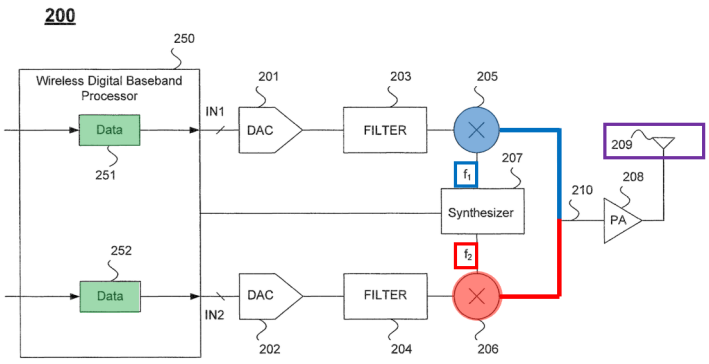


Fig. 2

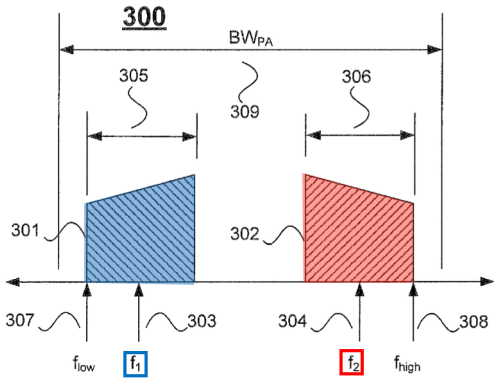


Fig. 3

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."

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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 61-64.

Finally, Patent Owner in its preliminary response offered to construe "center frequency" as "the frequency of the carrier to which the baseband signal is upconverted." *See, e.g.*, Paper 7 [Prelim.-Resp.] 5. The construction offered in this response is substantively identical to the one offered in the preliminary response but simplifies and clarifies it. As Professor Cooklev explains:

> 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-1st-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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶ 65.

Thus, the '802 patent is clear that its "center frequency" refers to the frequency of the transmission carrier. As explained in the following section, this usage of the term "center frequency" is common in the field.

3. Extrinsic Evidence Confirms The '802 Patent's Usage Of "Center Frequency" To Refer To The "Transmission Carrier Frequency."

The extrinsic evidence further confirms that the '802 patent's usage of the term "center frequency" to mean the frequency of the transmission carrier is consistent with common usage in the art, including in Petitioners' own reference and by Petitioners' own expert.

First, even Petitioners' own reference, IEEE 802.11n D2.0, uses "center frequency" in precisely the same way as the '802 patent, to refer to the transmission carrier frequency. As Professor Cooklev explains:

> For example, the standard explains that the "actual transmitted signal" is the output of equation 20-1. Ex. 1004 [802.11n D2.0] 240.[4] 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":

[4] All citations are to the documents' native page numbers.

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

where

$\mathrm{Re}\{\cdot\}$ 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 baseband signal is upconverted for transmission. Therefore, the standard also uses "center frequency" to refer to the transmission carrier frequency.

Ex. 2014 [Cooklev-2nd-Decl.] ¶ 68.

Additional disclosures in the standard confirm its usage of "center frequency" to refer to the frequency of the transmission carrier. As Professor Cooklev explains:

> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶ 69.

Additionally, just as in the '802 patent, Petitioner's own expert in a patent application publication where he is the sole inventor used "center frequency" and "carrier frequency" of the transmission carrier interchangeably:

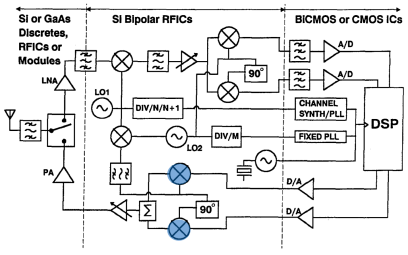
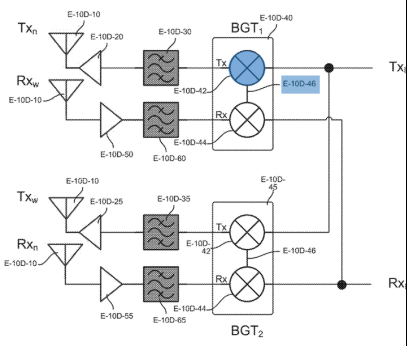
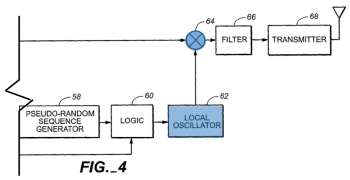
> Frequency-hopping wireless communication systems are systems ***that transmit data using a center frequency*** with hops about a relatively broad frequency bandwidth. Unlike conventional systems in which a fixed-frequency carrier is used, in frequency-hopping systems, ***the carrier frequencies***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

Ex. 2025 [Negus-Pat.-App.-Pub.] [0001]. As Professor Cooklev explains:

> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶ 71.

In fact, as summarized in the table below and further explained by Dr. Cooklev, across various articles, Petitioner's expert, Dr. Negus, alternatively refers to the transmission carrier frequency as the "RF carrier frequency" of the transmission carrier, "final transmit frequency" and "center frequency." Such usage is substantially identical to the '802 patent.

Ex. 2017 [Negus-Article-One]	**Ex. 2024 [Negus-Patent]**	**Ex. 2025 [Negus-Pat.-App.-Pub.]**
 Figure 4 - RF architecture of generic half-duplex transceiver. "The transmitter architecture of Figure 4 uses direct conversion from modulating baseband quadrature inputs I and Q ***to the RF carrier***. … Alternatively, IF quadrature modulation at the second LO frequency followed by an upconversion to the ***final RF carrier*** could be used to generate the transmit signal." Ex. 2017, 921	 FIG. 10-D "… 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. … The output of the up conversion is …. ***coupled to transmitted antenna*** …." Ex. 2024, 25:20-38	 *FIG._4* "… the logic 60 produces signals to the local oscillator 62 indicative of the ***center frequency***. …. The multiplier 64 and filter 66 ***up-converts either the low bandwidth or high bandwidth signal***. This signal is then ***transmitted out of the transmitter*** 68." Ex. 2025, [0015]

As Professor Cooklev explains:

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.

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 upconverstion to the transmission carrier ("final RF carrier."). *Id*. Both the "RF carrier" and "final RF carrier" refer to the transmission carrier frequency.

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.

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].

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 73-76.

Thus, the extrinsic evidence confirms that a POSITA would understand "center frequency" in the context of the '802 patent to refer to the "transmission carrier frequency."

4. Federal Circuit Authority Confirms That Under The Facts Of This Case, "Center Frequency" Means The Frequency Of The Transmission Carrier ("Transmission Carrier Frequency").

As explained in the preceding subsections, the '802 patent's interchangeable use of "center frequency" with the "carrier frequency" of the transmission carrier, the patent's consistent use of "center frequency" in dozens of instances all meaning

the "transmission carrier frequency," similar use of the phrase "center frequency" by Petitioner's own expert in his publications, and similar use of the phrase "center frequency" by Petitioner's own reference, all confirm that a POSITA would readily understand that "center frequency" in the '802 patent refers the frequency of the transmission carrier (the "transmission carrier frequency").

Even though center frequency in some other contexts may mean the middle of some frequency range, *Phillips* makes clear that "[t]he claims . . . do not stand alone. Rather they are part of a fully integrated written instrument, consisting principally of a specification that concludes with the claims." *Phillips v. AWH Corp*., 415 F.3d 1303, 1315 (Fed. Cir. 2005) (en banc) (internal quotation marks and citations omitted). The specification is "always highly relevant to the claim construction analysis," "the single best guide to the meaning of a disputed term," and "[u]sually … dispositive." *Id.*

In fact, *Phillips* overruled prior cases where "the role of the specification in claim construction" was limited to "serving as a check on the dictionary meaning of a claim term if the specification requires the court to conclude that fewer than all the dictionary definitions apply, or if the specification contains a sufficiently specific alternative definition or disavowal." *Id*., 1320. In accord, and subsequent to *Phillips*, the Federal Circuit has repeatedly relied on the specification to understand the meaning of a claimed term in the context of the specification. *See,*

e.g., VirnetX, Inc. v. Cisco Sys., 767 F.3d 1308, 1317-1319 (Fed. Cir. 2014) (reversing construction of "secure communication link" that did not require anonymity, where "the specification appear[ed] to use the terms 'secure communication link' and 'VPN' interchangeably, suggesting that the inventors intended the disputed term to encompass the anonymity provided by a VPN" and no embodiments or disclosure "expressly divorc[ed]" the two terms); *SandBox Logistics LLC v. Proppant Express Invs. LLC*, 813 Fed. Appx. 548, 554 (Fed. Cir. 2020) ("while the claims may suggest that 'bottom' refers to something other than a wall, the broader specification makes clear that 'bottom' refers to a 'bottom wall.'"); *Bid for Position, LLC v. AOL, LLC*, 601 F.3d 1311, 1318 (Fed. Cir. 2010) (construing "bid" and "value of bid" to mean the same thing because "'value,' as used in that passage [of the specification], can only refer to the bid amount"); *Kinetic Concepts, Inc. v. Blue Sky Med. Grp., Inc*., 554 F.3d 1010, 1018-19 (Fed. Cir. 2009) (limiting "wound" to "skin wounds" where "[a]ll of the examples described in the specification involve skin wounds"); *Wisconsin Alumni Res. Found. v. Apple Inc*., 905 F.3d 1341, 1351-52 (Fed. Cir. 2018) (limiting "prediction" to dynamic prediction where all embodiments describe dynamic prediction and allowing the term to cover static prediction "would 'expand the scope of the claims far beyond anything described in the specification'"); *Choon's Design, LLC v. IdeaVillage Prods. Corp*., 776 Fed App'x 691, 695-96 (Fed. Cir.

2019) (construing "at least one pin bar" to extend only to detachable pin bars, where "the specification discloses only loom kits having detachable bases and pin bars"); *Sightsound Techs., LLC v. Apple Inc.*, 809 F.3d 1307, 1316-1317 (Fed. Cir. 2015) (construing "secondary memory" to exclude "records, tapes and compact disks" because of the specification disparagement of them).

In re Abbott is particularly instructive. *In re Abbott Diabetes Care Inc*., 696 F.3d 1142 (Fed. Cir. 2012) (construing "electrochemical sensor" based on patent's specification as encompassing only an "electrochemical sensor without external cables or wires"). There, the Office construed "electrochemical sensor" under its plain meaning to exclude wired connections. *Id*., 1146. The Federal Circuit reversed, explaining:

> Even more to the point, ***every embodiment disclosed in the specification shows an electrochemical sensor without external cables or wires***. Indeed, the only mention of a sensor with external cables or wires in Abbott' s patents is a single statement addressing the primary deficiency of the prior art. It is true that the specification does not contain an explicit statement disclaiming electrochemical sensors with external cables or wires. …. We have held that "[e]ven when guidance is not provided in explicit definitional format, the specification may define claim terms by implication such that the meaning may be found in or ascertained by a reading of the patent documents." *Irdeto Access, Inc. v. Echostar Satellite Corp.*, 383 F.3d 1295, 1300 (Fed. Cir. 2004) (internal quotation marks omitted). ***Here,***

> ***Abbott's patents "repeatedly, consistently, and exclusively" depict an electrochemical sensor without external cables or wires while simultaneously disparaging sensors with external cables or wires.*** *Id*. at 1303.

Id., 1149-1150. Similar to *In re Abbott*, the '802 patent "repeatedly, consistently, and exclusively" uses "center frequency" in every embodiment to mean the frequency of the transmission carrier.

Indeed, the plain meaning of "center frequency" in the context of the '802 patent is so clear that it even rises to the level of lexicography. As the Federal Circuit has explained, "[e]ven when guidance is not provided in explicit definitional format, the specification may define claim terms by implication such that the meaning may be found in or ascertained by a reading of the patent documents." *Irdeto Access, Inc. v. Echostar Satellite Corp*., 383 F.3d 1295, 1300 (Fed. Cir. 2004) (*quoted by Phillips*, 415 F.3d at 1321). In accord, the Federal Circuit has held that the specification may define a term by implication in various ways, such as by interchangeably using it with another term. *See, e.g*., *Edwards Lifesciences LLC v. Cook Inc*., 582 F.3d 1322, 1329 (Fed. Cir. 2009) ("The interchangeable use of the two terms is akin to a definition equating the two."). In the instant case, the specification interchangeably uses "center frequency" with the "carrier frequency" of the transmission carrier. Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 53-59. The '802 patent also consistently and in every embodiment uses "center

frequency" to mean the transmission carrier frequency. *Id*., ¶¶ 47-52. The '802 patent's background of the invention and its distinction from the prior art also unambiguously uses "center frequency" to mean the transmission carrier frequency. *Id*., ¶¶ 46, 79-84. Under these facts, the plain meaning of "center frequency" in the context of the '802 patent also clearly rises to the level of lexicography.

For the foregoing reasons, "center frequency" means the frequency of the transmission carrier (the transmission carrier frequency).

B. Both of Petitioner's Grounds Are Based On Precisely The Prior Art Systems Distinguished And Improved Upon By The '802 Patent.

As explained in this section, using two "center frequencies," as opposed to one, was a focal point of the '802's claimed inventions. The '802 patent explains that in its prior art, in order to increase throughput, the bandwidth around the "center frequency" was increased. In contrast, the '802 patent explains, its inventions increase throughput by using two different "center frequencies" and aggregating them together. This approach has numerous benefits compared to the '802's prior art. Furthermore, as summarized in this section and explained in detail in the following sections, Petitioners' references disclose systems that are just like the '802 patent's prior art: they increase the bandwidth around a single "center frequency" as opposed to using two "center frequencies."

As Professor Cooklev explains, increasing the bandwidth around a single "center frequency" was the prior art system disclosed and improved upon by the '802 patent:

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

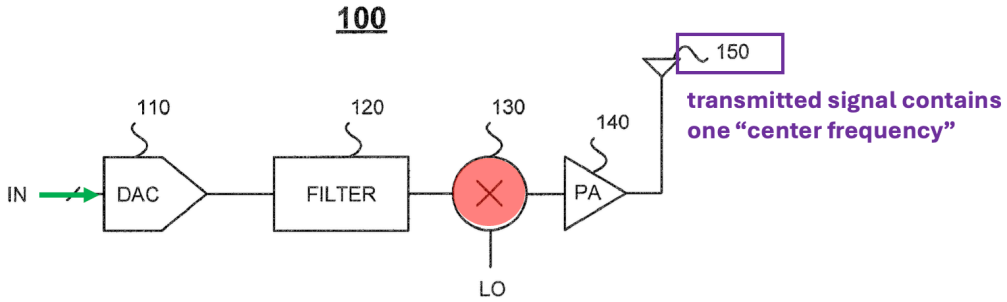


Fig. 1
(prior art)

> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 79-81.

The '802 patent sought to improve upon the prior art by introducing two different center frequencies, a focal point of the claimed inventions reflected in every embodiment of the patent. Per Professor Cooklev:

> 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.
>
> 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).

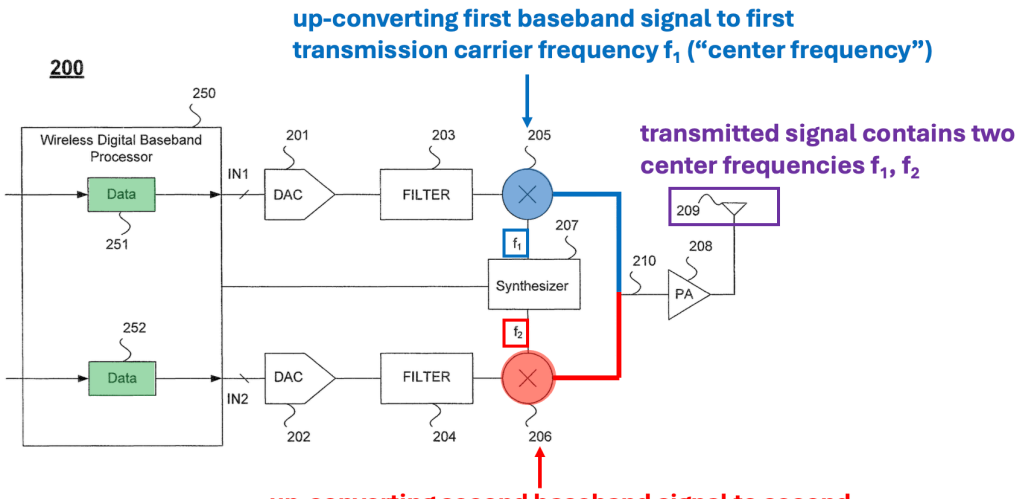
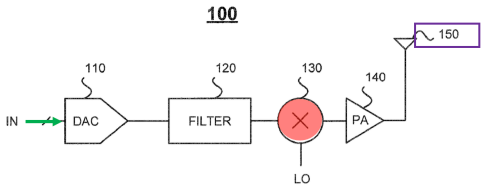
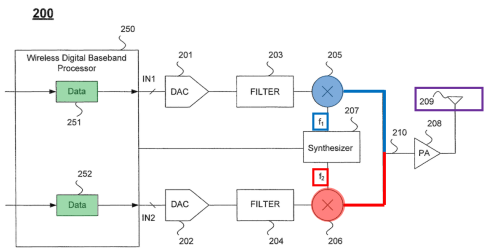


Fig. 2

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: []

'802 Fig. 1 (Prior Art)	'802 Fig. 2 (Embodiment)
	
one baseband signal (green) upconverted to one transmission carrier frequency (red)	two baseband signals (green) upconverted to two transmission carrier frequencies (red, blue)

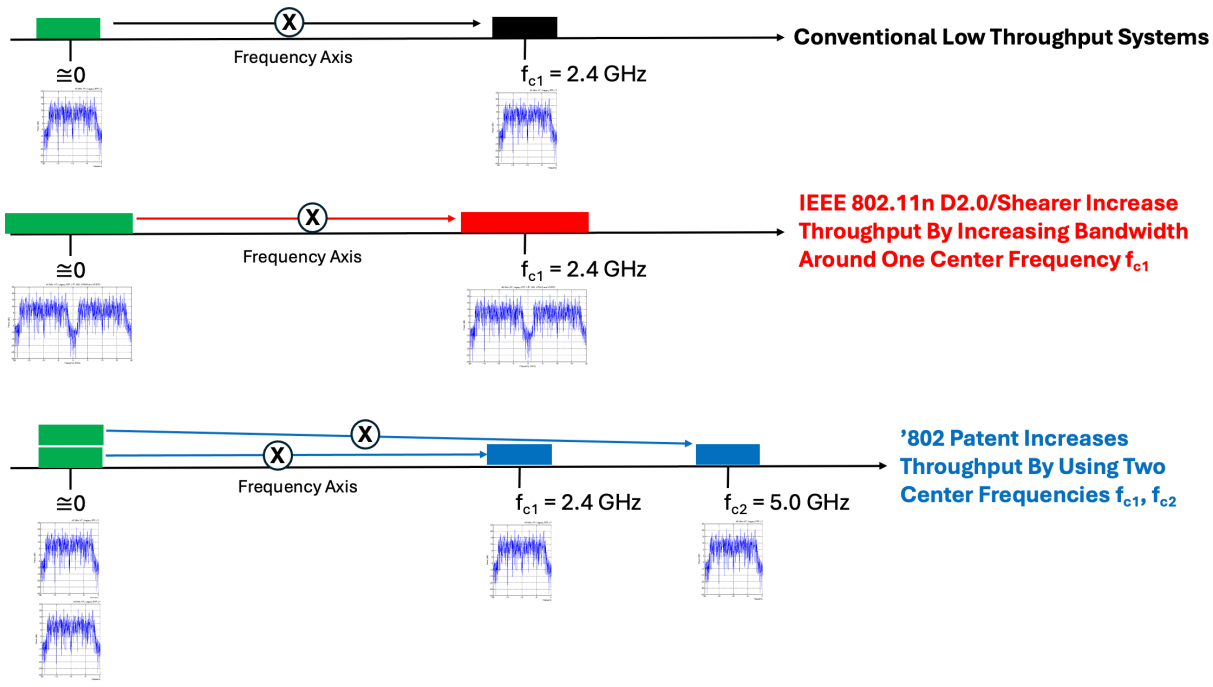
Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 82-84.

As Professor Cooklev explains, Petitioners' references disclose precisely the prior art disclosed and improved upon by the '802 patent:

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."

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*.

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:



In the schematic above, the first row shows a conventional low throughput system, where the baseband (green) is upconverted (⊗) 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 85-88.

As Professor Cooklev further explains, the ’802 patent’s approach for increasing throughput has multiple advantages over the prior art such as Petitioners’ references:

> 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.
>
> 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.
>
> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 89-91.

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. Petitioners' First Ground Does Not Disclose Or Render Obvious Two "Center Frequenc[ies]" As Claimed (Ground 1, All Claims).

Claim 1 requires transmitting information across two frequency ranges with two different "center frequencies," one greater than the other. 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.

Critically, however, the standard itself teaches that its "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 correctly teaches that its 40 MHz channel has only one center frequency 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. Ignoring the express teaching of its own reference and the meaning of "center frequency" in both the standard and the '802 patent, Petitioners nonetheless 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-1st-Depo.] 67:1-3; Pet., 33, 36, 59, 61 (arguing that Petitioner's grounds disclose the "center frequency" by pointing to the middle of a frequency range in the references). As discussed in Section II.A, *supra*, Petitioners' assumption about the meaning of "center frequency" as just the middle of some frequency range is incorrect and refuted by the '802 patent, the IEEE 802.11n D2.0 standard itself, and other extrinsic evidence. As discussed 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."

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. But as discussed in detail below, regardless of which of the two data formats is used, the standard expressly teaches that its "actual transmitted signal" (purple) for the 40 MHz channel is obtained by upconverting a single baseband signal (green) and contains a single "center frequency" (f_c) (red):

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:

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

where

$\mathrm{Re}\{\cdot\}$ 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. As explained below, the standard's express teaching that it transmits information on one "center frequency" within its 40 MHz channel is correct.

Both Petitioners and their expert admit that the entirety of the 40 MHz channel in IEEE 802.11n D2.0, including the data in the lower and upper 20 MHz portions of the channel, is a single baseband signal. Pet., 36 ("a POSA would understand that the HT duplicate and non-HT duplicate formats disclose ***both 'first information' and 'second information' within <u>a single composite complex</u>***

baseband signal ….”); Ex. 1003 [Negus-Decl.] ¶ 318 (similar). This is confirmed by the standard itself. As Professor Cooklev explains:

> 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.”).

Ex. 2014 [Cooklev-2nd-Decl.] ¶ 94.

The standard is also clear that the single baseband signal representing all data within its 40 MHz channel is upconverted to a single transmission carrier with a single transmission carrier frequency, which the standard, just like the ’802 patent, also calls the “center frequency” f_c. As Professor Cooklev explains:

> 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.

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:

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

where

$\mathrm{Re}\{\cdot\}$ 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.

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

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

$$r_{HT-DATA}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{Duplicate}^{Tone}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM}) \cdot \sum_{k=-N_{SR}}^{N_{SR}} (D_{k,n} + p_{n+z} P_k)([Q_{k-32}]_{i_{TX},1} \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI})) + j[Q_{k+32}]_{i_{TX},1} \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI})))$$

(20-60)

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").

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 95-98.

Thus, the 40 MHz channel relied upon by Petitioners from IEEE 802.11n D2.0 discloses one center frequency, not two. In fact, the 40 MHz channel of IEEE 802.11n D2.0 is an attempt at increasing throughput through increasing bandwidth. As explained in Section II.C, this is precisely the prior art method the '802 patent distinguished and sought to improve upon. Specifically, as Professor Cooklev explains:

> 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 ….").

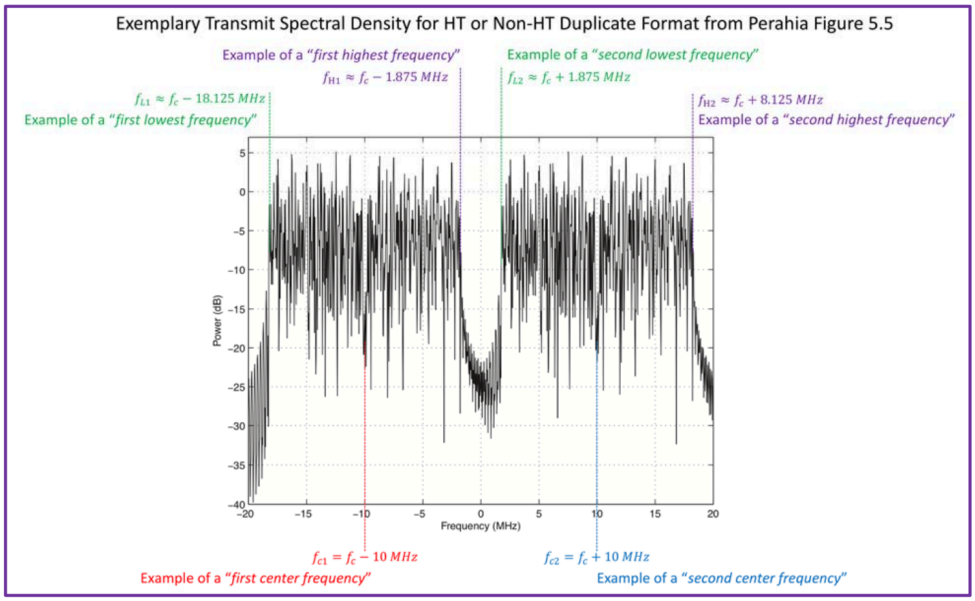
But increasing channel bandwidth around a single center frequency is precisely the approach the '802 patent describes as its prior art. The '802 patent explained that in the prior art illustrated in its Figure 1, the transmitters were "limited to up-converting a signal to one center frequency (or modulation 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.
>
> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 100-102.

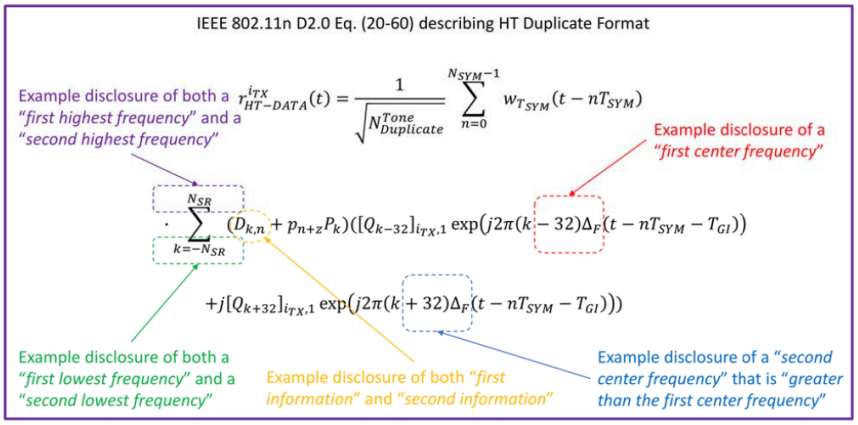
Thus, the 40 MHz channel of the standard Petitioners rely upon expressly discloses only a single "center frequency," not two. It, moreover, exemplifies the increased bandwidth prior art approach that the '802 patent distinguished and improved upon.

To argue that the frequency profile of the signal transmitted within the 40 MHz channel of IEEE 802.111n 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 Perahia (Ex. 2006) as representing the frequency profile of the standard's transmitted signal. Pet., 33. Petitioner then argues 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:

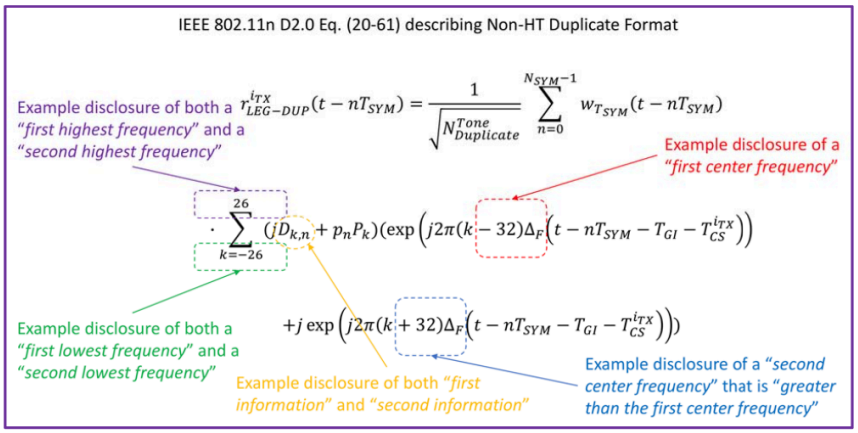


Pet., 33.

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:



EX-1003 ¶ 279.



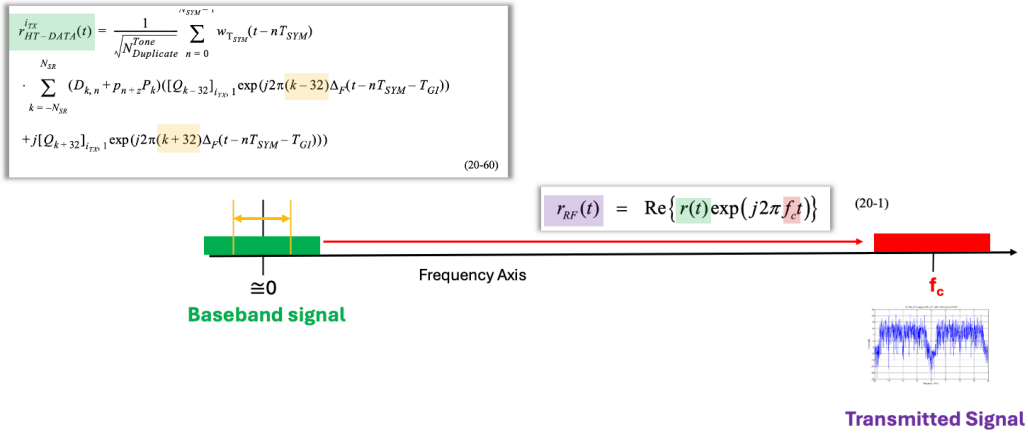
Pet., 35.

As Professor Cooklev explains, however, Petitioners argument fails:

As a preliminary manner, 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_{SR}, and N_{SR} are not the frequency values of the signal that is actually transmitted. Further Petitioners' annotations of "-32)Δ_F" and "+32)Δ_F" 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.

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



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_F and +32) Δ_F, 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.[] 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 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 105-107.

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)[5]," 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 fc in Equation (20-1) replaced by fc±10 MHz,' i.e., two center frequencies at '+10'/'-10.'" *Id*. (citing Ex. 1003 ¶ 101).

Paper 17 [Inst.-Dec.] 27.

[5] The Institution Decision cite the Exhibit page number.

As Professor Cooklev explains, Petitioners' explanation of the standard's section § 20.3.8 is incorrect:

> 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±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 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 fc-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.
>
> 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.

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.

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-10MHz 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 $f_c \pm 10MHz$.

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

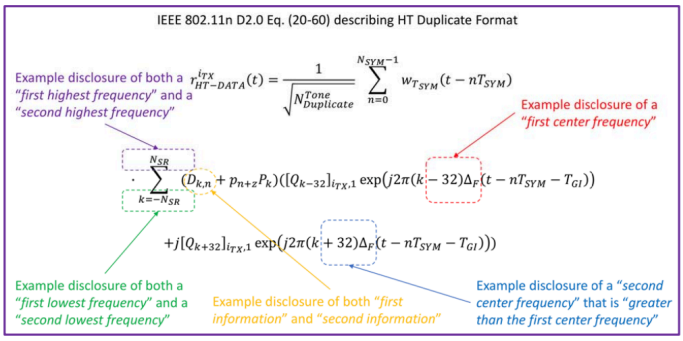
Thus, as is clear above, § 20.3.8 does not apply to the HT duplicate and non HT duplicate formats relied upon by Petitioners (equations 20-60 and 20-61), and does not teach two center frequencies in any event.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 109-113.

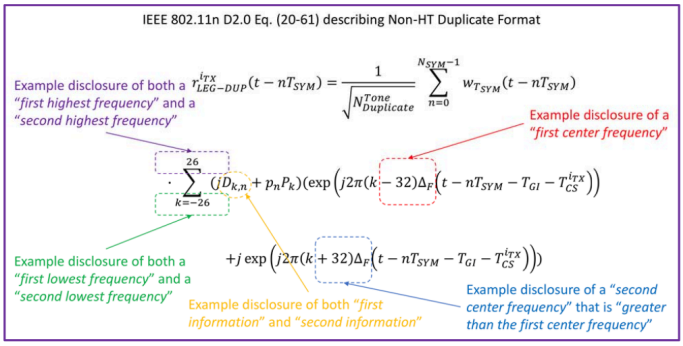
The standard is clear that in the HT Duplicate and the non-HT Duplicate formats relied upon by Petitioners, both the upper and lower 20 MHz portions of the 40 MHz channel is used, and the baseband signal is upconverted to a single center frequency f_c:

> 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.
>
> 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:



EX-1003 ¶ 279.



Pet., 35.

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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 114-116.

Finally, certain portions of Petitioners' expert declaration which are either not cited at all in the Petition or are improperly incorporated by reference imply that the 40 MHz channel contains two center frequencies because it is formed by combining two adjacent 20 MHz channels, referred to as "primary" and

"secondary" portions of the 40 MHz channel. *See, e.g.*, Ex. 1003 [Negus-Decl.] ¶ 199. These improperly incorporated portions of the declaration should be disregarded. *See, e.g.*, 37 C.F.R. § 42.6 (a)(3). But even if they were to be considered, they would not help Petitioners. As Dr. Cooklev explains:

> 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.
>
> 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*** ….").

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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 117-119.

For the foregoing reasons, Petitioners fail to show that its Ground 1 discloses or renders obvious two "center frequencies" as claimed.

D. Petitioners' Second Ground Does Not Disclose Or Render Obvious Two "Center Frequencies" As Claimed (Ground 2, All Claims).

Petitioners' Ground 2 relies on Shearer alone. Pet., 22. Petitioners' second ground shares the same infirmities as its first. Indeed, as Petitioners admits, "Shearer teaches its methods with specific relations to the IEEE 802.11 standard" that formed the basis of Petitioners' Ground 1. Pet., 55 (*citing* Ex. 1007 [Shearer] [0035]). Similar to Ground 1, Petitioners rely on Shearer's disclosure of a 40 MHz channel formed by combining two 20 MHz channels in IEEE 802.11. Pet., 57-61. Just as with Ground 1, Petitioners fail to show that Shearer discloses or renders obvious two center frequencies. Instead, it is undisputed that Shearer's 40 MHz

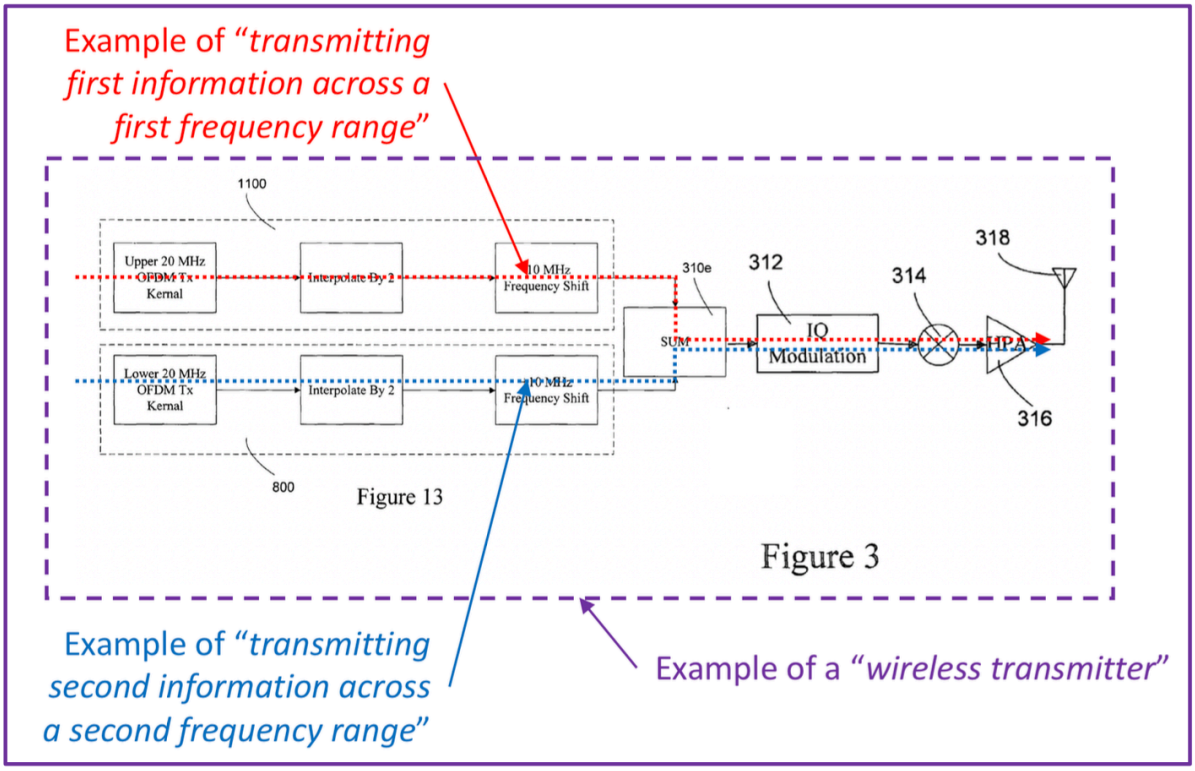
channel is formed by upconverting the baseband signal to a single transmission carrier signal, which thus has a single transmission carrier frequency ("center frequency"). Petitioners fail to show that Shearer's teachings are superior to or more relevant than Ground 1's in any significant way on this issue.

As Professor Cooklev explains:

> 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*.
>
> 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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 122-123.

It is undisputed that the signal of Shearer's 40 MHz channel is created by aggregating two baseband signals into a single baseband signal and then upconverting the baseband signal to a single transmission carrier frequency. This is confirmed by the superimposition of Shearer's Figures 3 and 13 created by Petitioners' own expert, reproduced below:



Ex. 1003 [Negus-Decl.] ¶ 428. As shown in this figure, the "upper 20 MHz" baseband signal (red) is created in box 1100. The "lower 20 MHz" baseband signal (blue) is created in box 800. The two baseband signals are aggregated in element 310e to create a 40 MHz baseband signal. This 40 MHz baseband signal is then upconverted in the single upconverter 314, before it is amplified and

transmitted. Thus, as the figure created by Petitioners' own expert confirms, Shearer's 40 MHz channel performs a single up-conversion to a single transmission carrier with a single transmission carrier frequency ("center frequency")—it does not contain two center frequencies as claimed. This is, of course, in contrast to the '802 patent's embodiments that show two up-conversions, each one to a different transmission carrier with a different transmission carrier frequency ("center frequency"), as shown, for example, in its Figure 2 (annotations added):

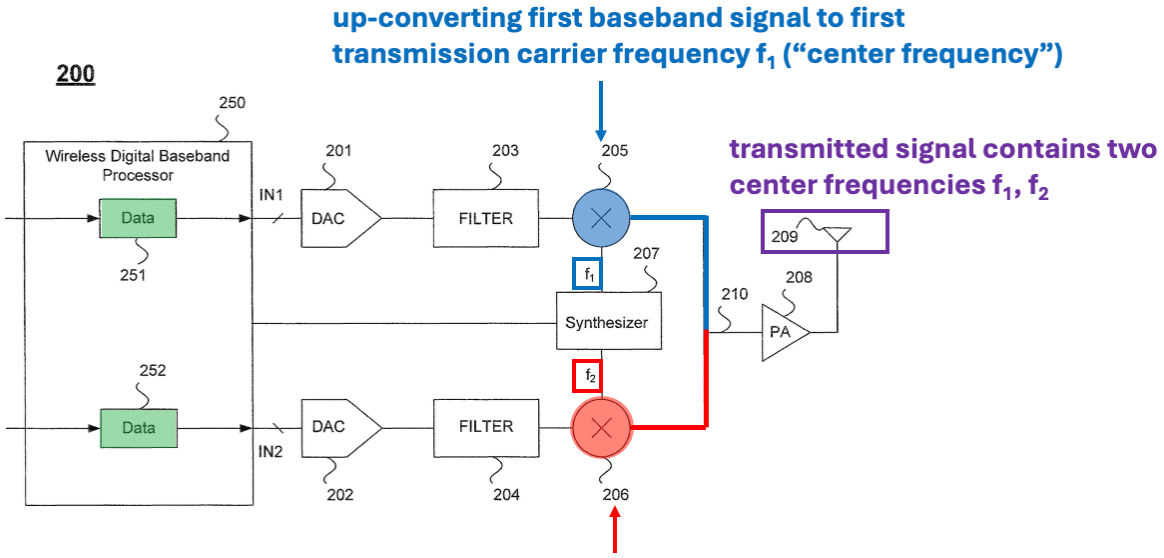


Fig. 2

As Professor Cooklev explains, Petitioners are correct that Shearer's 40 MHz channel performs a single up-conversion to a single transmission carrier with a single center frequency, but that does not help Petitioner's argument that there

are two center frequencies as claimed, for there is only a ***single*** transmission carrier frequency:

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

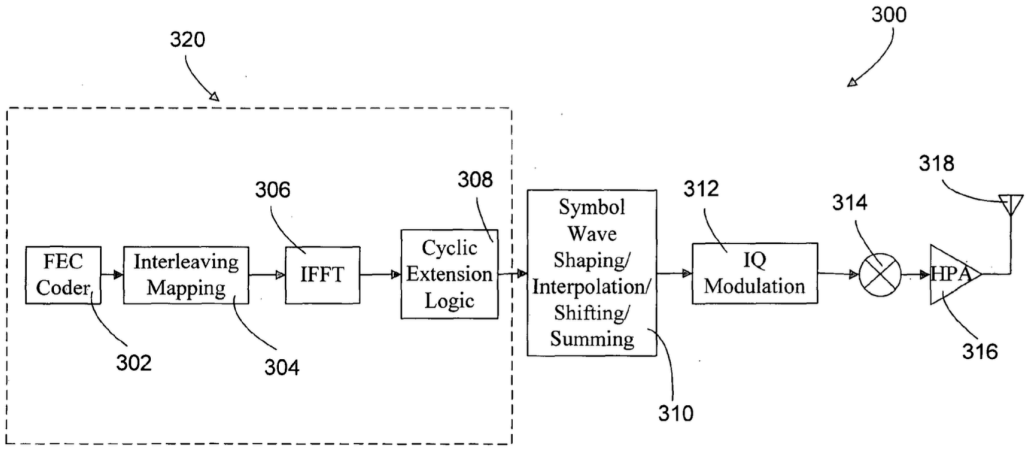


Figure 3

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."

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 up-converted 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].

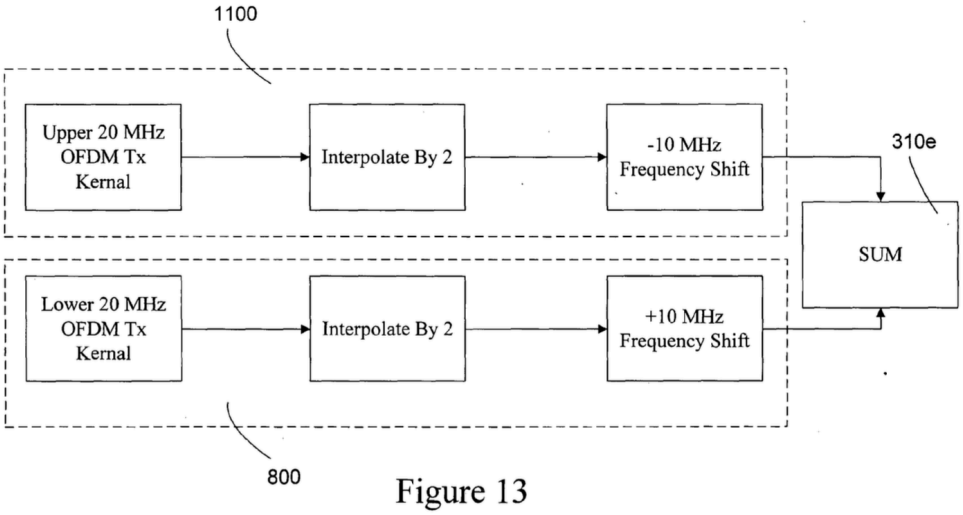


Figure 13

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:

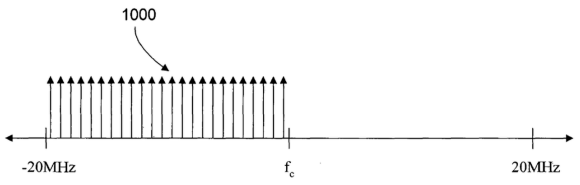


Figure 10

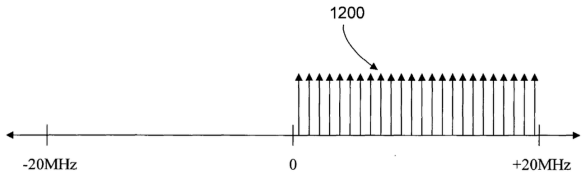


Figure 12

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:

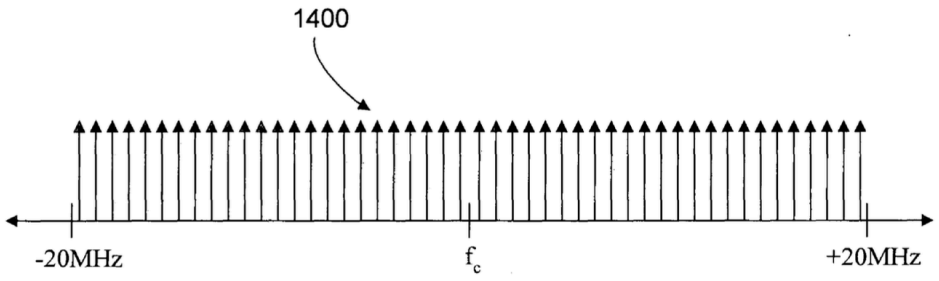


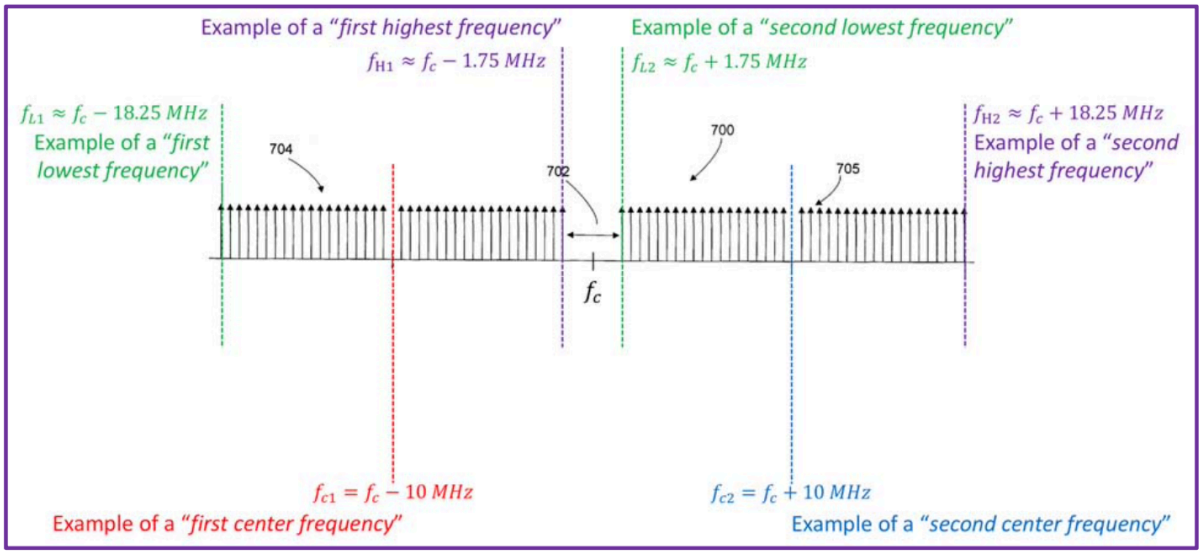
Figure 14

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.").

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").

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 124-130.

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 supposed frequency ranges within the 40 MHz channel:



Pet., 59. 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.").

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. As Professor Cooklev explains, this aspect of Shearer does not disclose two "center frequencies" as claimed:

> 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:

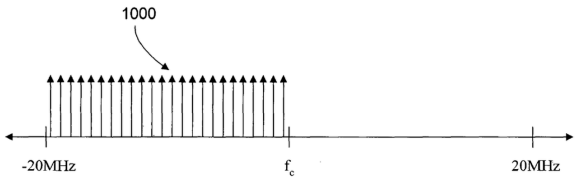


Figure 10

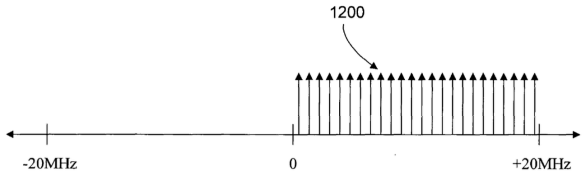


Figure 12

Ex. 1007 [Shearer] [0062].

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:

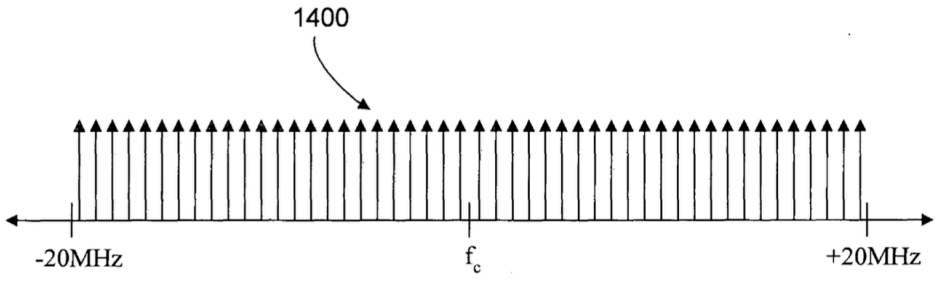
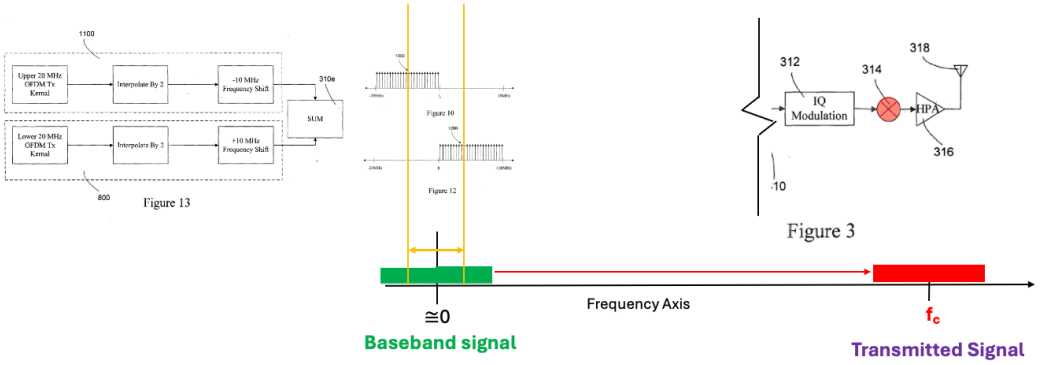


Figure 14

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.

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:



As shown above, the composite baseband signal is created by Shearer's Figures 12 and 13. The composite baseband signal is then upconverted 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.

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.

Ex. 2014 [Cooklev-2nd-Decl.] ¶¶ 134-139

For the foregoing reasons, Petitioners fail to show that its Ground 2 discloses or renders obvious the claims.

III. CONCLUSION

For the foregoing reasons, Petitioner has failed to show that any of the challenged claims are unpatentable.

Respectfully submitted,

____/ Parham Hendifar /_____

Kenneth J. Weatherwax, Reg. No. 54,528
Nathan Lowenstein, *pro hac vice*
Parham Hendifar, Reg. No. 71,470
LOWENSTEIN & WEATHERWAX LLP

Date: January 8, 2025

CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITS

This Patent Owner Response (the "POR") consists of 12,854 words, excluding table of contents, table of authorities, certificate of service, this certificate, or table of exhibits. The POR complies with the type-volume limitation of 14,000 words as mandated in 37 C.F.R. § 42.24. In preparing this certificate, counsel has relied on the word count of the word-processing system used to prepare the paper (Microsoft Word).

Respectfully submitted,

/ Parham Hendifar /

Date: January 8, 2025

CERTIFICATE OF SERVICE

The undersigned hereby certifies that the following documents were served by electronic service, by consent between the parties, on the date signed below:

PATENT OWNER'S RESPONSE

EXHIBITS 2014, 2016-2019, 2024-2025

The names and address of the parties being served are as follows:

PCMuldoon@duanemorris.com (Patrick Muldoon)
PDMcPherson@duanemorris.com (Patrick D. McPherson)
MSYungwirth@duanemorris.com (Matthew S. Yungwirth)
DC_IPDocketing@duanemorris.com

Respectfully submitted,

/ Parham Hendifar /

Date: January 8, 2025