

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SONY GROUP CORP. (JAPAN), SONY CORP. OF AMERICA, SONY  
INTERACTIVE ENTERTAINMENT LLC, SONY PICTURES  
ENTERTAINMENT INC., SONY ELECTRONICS INC.,  
and VERANCE CORP.,  
Petitioner,

v.

MZ AUDIO SCIENCES, LLC,  
Patent Owner.

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IPR2022-01544  
Patent 7,289,961 B2

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Before KARL D. EASTHOM, DAVID C. McKONE, and  
IFTIKHAR AHMED, *Administrative Patent Judges*.

Opinion for the Board filed by Administrative Patent Judge EASTHOM.

Opinion Dissenting filed by Administrative Patent Judge McKONE.

EASTHOM, *Administrative Patent Judge*.

DECISION  
Granting Institution of *Inter Partes* Review  
35 U.S.C. § 314

Sony Group Corp. (Japan), Sony Corp. of America, Sony Interactive Entertainment LLC, Sony Pictures Entertainment Inc., Sony Electronics Inc., and Verance Corp. (collectively “Petitioner”) filed a Petition requesting *inter partes* review of claims 1–10 of U.S. Patent No. 7,289,961 B2 (Ex. 1001, “the ’961 patent”). Paper 7 (“Pet.”).<sup>1</sup> MZ Audio Sciences, LLC (“Patent Owner”) timely filed a Preliminary Response. Paper 11 (“Prelim. Resp.”).

We have authority to determine whether to institute an *inter partes* review. See 35 U.S.C. § 314 (2018); 37 C.F.R. § 42.4(a) (2020). Institution of an *inter partes* review requires that “the information presented in the petition and . . . any response . . . shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a). For the reasons set forth below, we determine that there is a reasonable likelihood that Petitioner will prevail with respect to at least one challenged claim. Accordingly, we institute an *inter partes* review of the ’961 patent.

## I. BACKGROUND

### A. Related Matters

The parties indicate that Patent Owner asserted the ’961 patent in district court lawsuits, including *MZ Audio Sciences, LLC v. Sony Group Corp. (Japan)*, No. 1:21-cv-0166 (D. Del.), and *MZ Audio Sciences, LLC v. Sony Group Corp. (Japan)*, 2:22-cv-00866 (C.D. Cal.). Pet. xi; Paper 9, 1. The parties identify no other related proceedings.

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<sup>1</sup> The Petition also identifies Sony Interactive Entertainment Inc. and Sony DADC US Inc. as real parties in interest and states “other Sony affiliates could be real parties in interest.” Pet. xi.

*B. The Asserted Grounds*

Petitioner asserts the following grounds of unpatentability (Pet. 2):

| <b>Claim(s) Challenged</b> | <b>35 U.S.C.<sup>2</sup> §</b> | <b>Reference(s)/Basis</b>                                             |
|----------------------------|--------------------------------|-----------------------------------------------------------------------|
| 1–10                       | 103(a)                         | Srinivasan <sup>3</sup> , Cabot <sup>4</sup> , Kudumakis <sup>5</sup> |
| 2, 3, 5, 7, 8, 10          | 103(a)                         | Srinivasan, Cabot, Kudumakis, Hobson <sup>6</sup>                     |
| 1–10                       | 103(a)                         | Kudumakis, Tilki <sup>7</sup> , Cabot                                 |

In support, Petitioner relies on the testimony of Dr. Michael Scordilis (Ex. 1003).

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<sup>2</sup> The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), amended 35 U.S.C. § 103 (effective Mar. 16, 2013). Petitioner points out that “[t]he application from which U.S. Patent No. 7,289,961 issued claims priority to U.S. Provisional Application No. 60/479,438, filed June 19, 2003.” Pet. xi. Because the earliest possible effective filing date for the ’961 patent precedes the effective date of the applicable AIA amendment, the pre-AIA version of § 103 applies.

<sup>3</sup> Srinivasan, US 6,272,176 B1, issued Aug. 7, 2001. Ex. 1005.

<sup>4</sup> R. C. Cabot et al., *Detection of Phase Shifts in Harmonically Related Tones*, J. AUDIO ENG. SOC., VOL. 24, NO. 7 (Sept. 1976). Ex. 1006.

<sup>5</sup> Kudumakis et al., Int. Pub. WO 01/58063, published Aug. 9, 2001. Ex. 1007.

<sup>6</sup> Hobson et al., US 6,633,653 B1, issued Oct. 14, 2003, filed Feb. 4, 2000. Ex. 1042.

<sup>7</sup> J.F. Tilki et al., *Encoding a Hidden Auxiliary Channel onto a Digital Audio Signal Using Psychoacoustic Masking*, PROCEEDINGS IEEE SOUTHEASTCON ’97, “Engineering the New Century,” Apr. 12–14, 1997. Ex. 1008; *see also* Pet. 52–53 (arguing that Tilki is prior art under §§ 102(a)–(b)) (citing Ex. 1025, 1–8; Ex. 1026, 1–2; Ex. 1027, 2; Ex. 1030, 1–2; Ex. 1032, 48; Ex. 1033, 2719).

### *C. The '961 Patent*

The '961 patent relates to embedding data in an audio signal for watermarking, steganography, or other purposes. Ex. 1001, code (57). The process divides the audio signal into time frames that contain frequency bands representing the audio signal. *Id.* Then, “the relative phases of one or more frequency bands are shifted to represent the data to be embedded.” *Id.*

### *D. Challenged Claims*

Petitioner challenges all ten claims of the '961 patent. Of these, claims 1, 4, 6, and 9 are independent. For purposes of this Institution Decision, claim 1 is representative. Claim 1 follows (information added to conform to Petitioner’s nomenclature):

1. [1PRE] A method for embedding data in an audio signal, the method comprising:

[1A] (a) dividing the audio signal into a plurality of time frames and, in each time frame, a plurality of frequency components;

[1B] (b) in each of at least some of the plurality of time frames, selecting at least two of the plurality of frequency components; and

[1C] (c) altering a phase of at least one of the plurality of frequency components in accordance with the data to be embedded, wherein:

[1D] step (b) comprises selecting a fundamental tone and at least one overtone; and

[1E] step (c) comprises quantizing a phase difference of the at least one overtone relative to the fundamental tone to embed at least one bit of the data to be embedded.

## II. DISCRETIONARY DENIAL

Patent Owner contends that we should exercise our discretion under 35 U.S.C. § 325(d) to deny institution. Prelim. Resp. 63–66.

*A. Legal Standard for Exercising Discretion under Section 325(d)*

The Board has discretion to deny a petition. *See, e.g.*, 35 U.S.C. § 325(d); *Cuozzo Speed Techs., LLC v. Lee*, 579 U.S. 261, 273 (2016) (“[T]he agency’s decision to deny a petition is a matter committed to the Patent Office’s discretion.”). The PTAB’s Trial Practice Guide identifies considerations that may warrant exercise of this discretion. Consolidated Trial Practice Guide, 55–63 (Nov. 2019) (“Consolidated TPG”).<sup>8</sup>

The Board may discretionarily deny institution of an *inter partes* review when a petition presents “the same or substantially the same prior art or arguments [that] previously were presented to the Office.” 35 U.S.C. § 325(d); *see also* 37 C.F.R. § 42.4(a) (the Board institutes trial on behalf of the Director). To evaluate whether such a denial is appropriate, the Board determines

- (1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2)
- if either condition of first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.

*Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 8 (PTAB Feb. 13, 2020) (precedential). This two-part *Advanced Bionics* framework involves evaluating the following non-exclusive factors:

- (a) the similarities and material differences between the asserted art and the prior art involved during examination; (b) the cumulative nature of the asserted art and the prior art evaluated during examination; (c) the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection; (d) the extent of the overlap between

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<sup>8</sup> Available at <https://www.uspto.gov/TrialPracticeGuideConsolidated>.

the arguments made during examination and the manner in which petitioner relies on the prior art or patent owner distinguishes the prior art; (e) whether petitioner has pointed out sufficiently how the examiner erred in its evaluation of the asserted prior art; and (f) the extent to which additional evidence and facts presented in the petition warrant reconsideration of the prior art or arguments.

*Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17–18 (PTAB Dec. 15, 2017) (precedential as to Section III.C.5, first paragraph). Factors (a), (b), and (d) relate to the first part of the *Advanced Bionics* framework (i.e., whether the art or arguments presented in the Petition are the same or substantially the same as those previously presented to the Office), and factors (c), (e), and (f) relate to the second part (i.e., “whether the petitioner has demonstrated a material error by the Office” in its prior consideration of the prior art or arguments). *Advanced Bionics*, Paper 6 at 10. If a review of factors (a), (b), and (d) shows that the same or substantially the same art or arguments previously were presented to the Office, then we analyze factors (c), (e), and (f) to determine whether the petitioner demonstrates that the Office erred in a manner material to the patentability of the challenged claims. *See id.* at 9–10.

### *B. Analysis*

#### *Part 1: Whether the Same or Substantially the Same Art or Arguments Were Previously Presented*

Petitioner concedes that during prosecution, “[a] divisional of Srinivasan (published Application No. 2002/0034224) was cited but was neither applied nor commented on by the Examiner.” Pet. 76 (citing Ex. 1002 (prosecution history), 129). However, Petitioner contends that “[t]he Office lacked expert testimony regarding Srinivasan and did not consider Srinivasan *in combination with the other Ground 1 references.*” *Id.*

(emphasis added). Therefore, Petitioner asserts that “[d]iscretionary denial is not appropriate.” *Id.*

In other words, Petitioner appears to agree that with respect to Ground 1, Srinivasan (Ex. 1005) is cumulative to the Srinivasan publication (i.e., published Application No. 2002/0034224) cited by the Examiner during prosecution. *See* Ex. 1002, 129; *Regeneron Pharm., Inc. v. Merus N.V.*, 864 F.3d 1343, 1350 (Fed. Cir. 2017) (“A reference is cumulative when it ‘teaches no more than what a reasonable examiner would consider to be taught by the prior art already before the PTO.’” (citation omitted)).

On the other hand, as Petitioner indicates, the Examiner did not consider any other references the Petition employs in Ground 1, namely, Kudumakis and Cannon. *See* Pet. 76. In addition, the Examiner only considered Srinivasan (published Application No. 2002/0034224) and did not consider the other three references the Petitioner employs in Ground 2, namely, Cabot, Kudumakis, Hobson. *See* Ex. 1002. And finally, the Examiner did not consider any of the references the Petition employs in Ground 3, namely, Kudumakis, Tilki, and Cabot. *See id.*

Patent Owner “respectfully requests that the Board decline to institute on Grounds 1–2 under § 325(d).” Prelim. Resp. 66. Patent Owner bases this request on Petitioner’s “admi[ssion]” that the Examiner previously cited and considered Srinivasan (published Application No. 2002/0034224). *See id.* at 63–65.

Because the Examiner did not consider the specific combination of references asserted in the three grounds during prosecution and because those three grounds cover all the challenged claims, we find that the same or substantially the same art or argument was not presented to the Office.

Therefore, the first part of the framework in *Advanced Bionics* is not satisfied.

For the reasons above, we find that the same or substantially the same art was not presented to the Office under Part 1 of the *Advanced Bionics* framework. Accordingly, we do not exercise discretion to deny institution under § 325(d).

### III. ANALYSIS

#### A. Legal Standards

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to the patent owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

The legal question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness. *Graham v. John Deere Co. of Kan. City*, 383 U.S. 1, 17–18 (1966). One seeking to establish obviousness based on more than one reference also must articulate sufficient reasoning with rational underpinnings to combine teachings. *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007).

*B. Level of Ordinary Skill in the Art and Dr. Scordilis's Testimony*

Level of Ordinary Skill

Petitioner asserts that a person of ordinary skill in the art “would have had a bachelor’s degree in electrical engineering or a related field with coursework in signal processing, plus two years of academic and/or industry experience in signal processing or a related field. More education could substitute for experience, and vice versa.” Pet. 7. At this stage, “Patent Owner does not dispute Petitioners’ definition of a [person of ordinary skill in the art].” Prelim. Resp. 2.

Based on a review of the preliminary record, for purposes of the Institution Decision, we adopt Petitioner’s proposed level of ordinary skill in the art because it is consistent with the evidence of record, including the asserted prior art, other references of record, and the ’961 patent specification.

Dr. Scordilis’s Testimony

Patent Owner argues that prior statements by Dr. Scordilis “[c]ast [d]oubt on [h]is [p]resent [o]pinions.” Prelim. Resp. 40. To support this argument, Patent Owner argues that “Dr. Scordilis opines that the phase encoding techniques disclosed in the ’961 patent are allegedly obvious, despite the contrary statement in his own patent, which casts a shadow on his opinions.” *Id.* at 41. To support this argument, Patent Owner quotes “the ’521 patent” (Ex. 2008), which lists Dr. Scordilis as an inventor. *Id.* (referring to Iliev et al., US Patent No. 6,996,521 B2, filed Oct. 4, 2001, issued Feb. 7, 2006 (Ex. 2008)).<sup>9</sup> In particular, Patent Owner quotes the

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<sup>9</sup> See Ex. 2008; Ex. 1002, 118–19 (asserting that the ’521 patent anticipates claims during prosecution of the ’961 patent application).

'521 patent as follows: “While masking in the power spectrum of auditory signals dominates audio coding and watermarking techniques, **the phase information has not been involved to date.**” *Id.* at 40–41 (alteration in original) (quoting Ex. 2008, 2:17–24). According to Patent Owner, “[t]his statement is strong contemporaneous evidence that those skilled in the art were focused on masking in the power spectrum—and not on phase encoding—as a means for data encoding/decoding in audio signals.”

*Id.* at 41 (arguing that “nearly two decades after the fact, Dr. Scordilis opines that the phase encoding techniques disclosed in the '961 patent are allegedly obvious, despite the contrary statement in his own patent, which casts a shadow on his opinions”).

This line of argument is unavailing. Patent Owner notes that “the '521 patent formed the basis of prior art objections [sic: rejections] during prosecution.” Prelim. Resp. 41 n. 3 (citing Ex. 1002, 85, 118). In particular, during prosecution, the Examiner asserted in an anticipation rejection that the '521 patent discloses the claim limitation of “altering a phase of at least one of the plurality of frequency components in accordance with the data to be embedded,” (Ex. 1002, 119), because the '521 patent discloses an “FFT [(Fast Fourier Transform)] algorithm provided the phase value of each component” (*id.* (quoting Ex. 2008, 5:33–39)), and also describes “encoding a single-bit-per-frequency component” “to alter the phase of the left channel” (*id.* (quoting Ex. 2008, 6:48–64)). Therefore, contrary to Patent Owner’s arguments, as described by the Examiner during prosecution, the '521 patent does not undermine Dr. Scordilis’s testimony here, because the '521 patent provides further evidence that the technique of phase modulating frequency components for embedding data in an audio

signal was known before the effective date of the '961 patent. *See id.*, 118–119.

Patent Owner also argues that “[w]hile Dr. Scordilis states that he assumed ‘the perspective of a person having ordinary skill in the art,’ he fails to explain how he did so given his admission that he was ‘a person of more than ordinary skill in the art during the relevant timeframe.’” Prelim. Resp. 42 (citing Ex. 1003 ¶¶ 18, 39). Contrary to this argument, Dr. Scordilis testifies that “[i]n forming my opinions, I have studied and considered the materials identified in the list below.” Ex. 1003 ¶ 18. The list includes “materials . . . that experts in my field would have reasonably relied upon when forming their opinions,” including Exhibits 1001–20, 1031–33, 1035, 1042–46, 1053. *Id.* ¶ 19. These references represent the level of skill in the art, as determined above. Patent Owner does not allege that Dr. Scordilis provides testimony in his Declaration based on the perspective as an expert. *See id.* Experts of relatively higher skill routinely provide testimony from the perspective of artisans of ordinary skill. Accordingly, this argument does not undermine the testimony of Dr. Scordilis on this preliminary record.

Patent Owner also argues that “Petitioners’ expert declaration does nothing more than parrot the Petition and, thus, is entitled to no weight.” Prelim. Resp. 29 (citing 37 C.F.R. § 42.65(a) (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”)). Patent Owner’s generic argument without specifics does not undermine Petitioner’s showing or provide a sufficient reason to discount the weight of Dr. Scordilis’s testimony. Where appropriate, Dr. Scordilis routinely cites to record evidence to support his

testimony and Patent Owner does not argue otherwise. *See, e.g.,* Ex. 1003 ¶¶ 46–137.

### *C. Claim Construction*

In *inter partes* reviews, the Board interprets claim language using the district-court-type standard, as described in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 37 C.F.R. § 42.100(b) (2020). Under this standard, claim terms have their ordinary and customary meaning, as would be understood by a person of ordinary skill in the art at the time of the invention, in light of the language of the claims, the specification, and the prosecution history. *See Phillips*, 415 F.3d at 1313–14.

Petitioner relies on the plain and ordinary meaning and contends that it is unnecessary to construe any claim terms explicitly at this stage. *See* Pet. 8 (citing 37 C.F.R. §42.100(b)). Patent Owner “agrees with Petitioners that, for purposes of this Preliminary Response only, all terms of the ’961 patent have their plain and ordinary meaning.” Prelim. Resp. 23.

As Petitioner contends, it is not necessary to construe any claim terms explicitly at this stage. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (stating that “we need only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

*D. Summary of Asserted Prior Art References*

*1. Srinivasan (Ex. 1005)*

Srinivasan relates to an encoder that adds an inaudible binary code to an audio signal, and a decoder for retrieving that code, using a phase modulation scheme. *See* Ex. 1005, code (57), 1:5–7, 3:16–19, 11:25–30. The code “may be used . . . in order to identify a broadcast program.” *Id.* at 1:8–10.

Srinivasan’s Figure 1 follows:

**FIGURE 1**

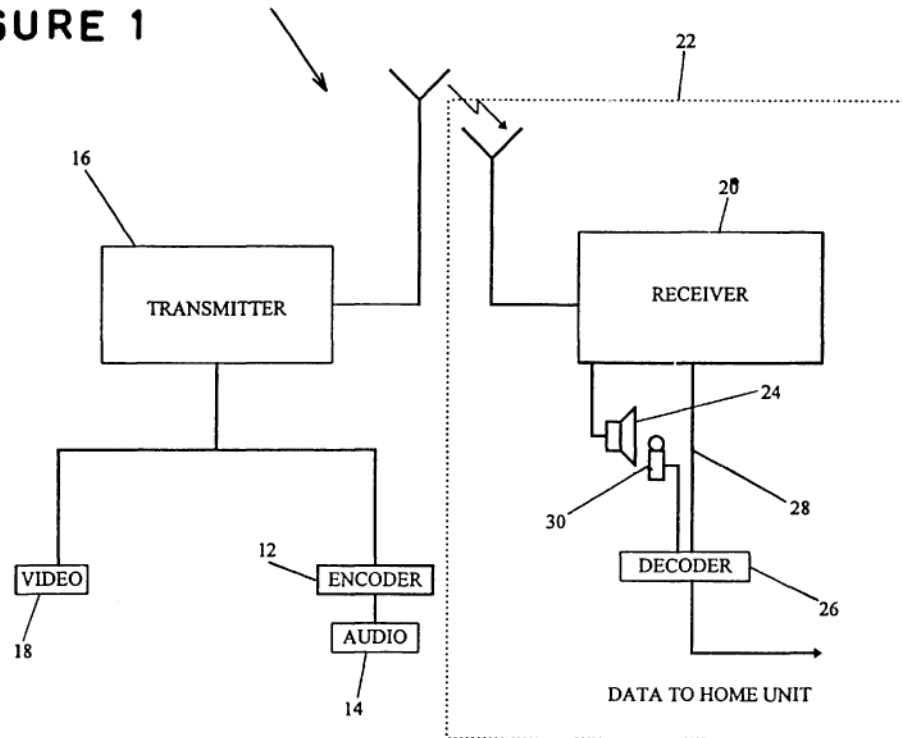


Figure 1 illustrates encoder 12 for adding codes to a digital representation of audio signal derived from audio signal portion 14 of a broadcast signal transmitted to receiver 20 for decoding the codes via decoder 26 and replaying the audio in speaker 24. *See* Ex. 1005, 7:29–41.

After sampling an audio block to provide 512 samples and computing a Fast Fourier Transform (FFT) of the block (*see* steps 40–44, Fig. 2),

Srinivasan's "method comprises the following steps," which result in phase encoding of frequency components of the audio signal:

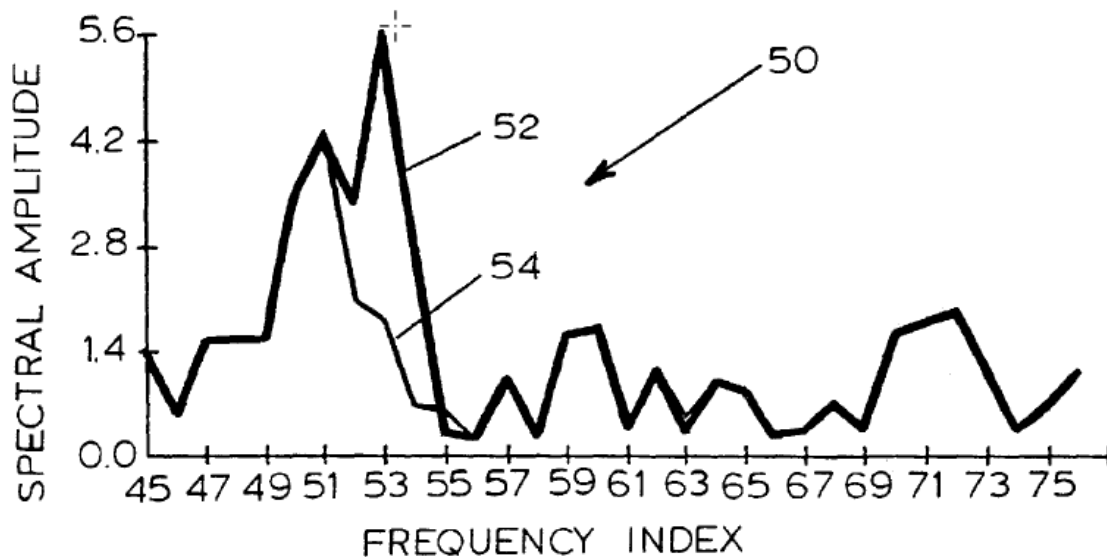
a) selecting, within the block, (i) a reference frequency within the predetermined signal bandwidth, (ii) a first code frequency having a first predetermined offset from the reference frequency, and (iii) a second code frequency having a second predetermined offset from the reference frequency; b) comparing the spectral amplitude of the signal near the first code frequency to the spectral amplitude of the signal near the second code frequency; c) selecting a portion of the signal at one of the first and second code frequencies at which the corresponding spectral amplitude is smaller to be a modifiable signal component, and selecting a portion of the signal at the other of the first and second code frequencies to be a reference signal component; and d) selectively changing the phase of the modifiable signal component so that it differs by no more than a predetermined amount from the phase of the reference signal component.

Ex. 1005, 3:3–19.

To select the frequencies to encode, Srinivasan's method "determine[s] a frequency index  $I_{max}$  at which the spectral power of the audio signal, as determined as the step 44 [of Figure 2], is a maximum in the low frequency band extending from zero Hz to two kHz." Ex. 1005, 8:51–54. Then, "[t]he code frequency indices  $l_1$  and  $l_0$  are chosen relative to . . .  $I_{max}$  so that they lie in a higher frequency band at which the human ear is relatively less sensitive." *Id.* at 8:59–63. Srinivasan teaches that the less sensitive frequency ranges involve frequencies in the 4.8–6 kHz range "in order to exploit the higher auditory threshold in this band." *Id.* at 7:64–67. "[E]ach successive bit of the code may use a different pair of code frequencies  $f_1$  and  $f_0$  denoted by corresponding code frequency indexes  $I_1$  and  $I_0$ ." *Id.* at 7:67–8:3. "[T]wo preferred ways of selecting the code frequencies  $f_1$  and  $f_0$  . . . create an inaudible wide-band noise like code."

*Id.* at 8:3–5.

Srinivasan’s Figure 3 follows:



Srinivasan’s Figure 3 above, is a spectral plot illustrating the result of taking the FFT (Fast Fourier Transform) of a time block, where as a result of amplitude modulation coding, “spectrum 52 shows the audio block after coding of a ‘1’ bit, and a spectrum 54 shows the audio block before coding.” *See* Ex. 1005, 7:48–63. In other words, there is a visual difference between encoded audio waveform and the original audio waveform.

Srinivasan describes one phase encoding technique as follows:

In order to encode a binary number, the phase angle of one of these components, usually the component with the lower spectral amplitude, can be modified to be either in phase (i.e.,  $0^\circ$ ) or out of phase (i.e.,  $180^\circ$ ) with respect to the other component, which becomes the reference. In this manner, a binary 0 may be encoded as an in-phase modification and a binary 1 encoded as an out-of-phase modification.

Ex. 1005, 11:26–32.

To minimize the audible perception of coding the phase shifts, Srinivasan explains that “it is not essential to perform phase modulation to

th[e] extent of [a maximum phase change of  $180^\circ$ ], as it is only necessary to ensure that the two components are either ‘close’ to one another in phase or ‘far’ apart.” *Id.* at 11:49–54. Therefore, Srinivasan “assign[s] two phase neighborhoods,” “one  $\pm 45^\circ$  ( $\pm \pi/4$  radians) for a reference phase,” and another . . .  $\pm 45^\circ$  of . . .  $180^\circ$  . . . out of phase with” the reference phase, to “represent a ‘0’ and ‘1,’” and then “modif[es] the phase angle . . . of the modifiable spectral component . . . into one of these phase neighborhoods depending upon whether a binary ‘0’ or a binary ‘1’ is being encoded.” *Id.* (citing Ex. 1005, 11:26–54). With this variation, “approximately 30% of the segments are ‘self-coded’ . . . and no modulation is required.” *Id.* at 11:56–57.

## 2. *Kudumakis (Ex. 1007)*

Kudumakis relates to “a method of labelling . . . an audio or video signal prior to broadcast or distribution to provide an audit trail.” Ex. 1007, 1:4–8. Because prior art systems employed watermarking techniques using frequency notches at predictable frequencies to embed an inaudible code, Kudumakis “appropriately select[s] the part of the frequency spectrum where each watermark code is inserted, providing improved audio quality and extra security in the form of frequency hopping.” *Id.* at 2:23–25. The location in the frequency spectrum that includes the embedded code “is chosen adaptively with regard to the frequency content of the signal.” *Id.* at 2:29–30. Therefore, Kudumakis’s frequency selection techniques introduce unpredictability as to the frequency location of the embedded codes. *Id.* at 3:17–18.

Kudumakis embeds the codes using the same notch filtering as the prior art, which places “notches” in the audio signal to remove the original

signal, and then replaces the removed signal with a frequency carrying the desired code using either amplitude or phase modulation. Ex. 1007, 1:17–18, 3:4–9, 6:1–2.

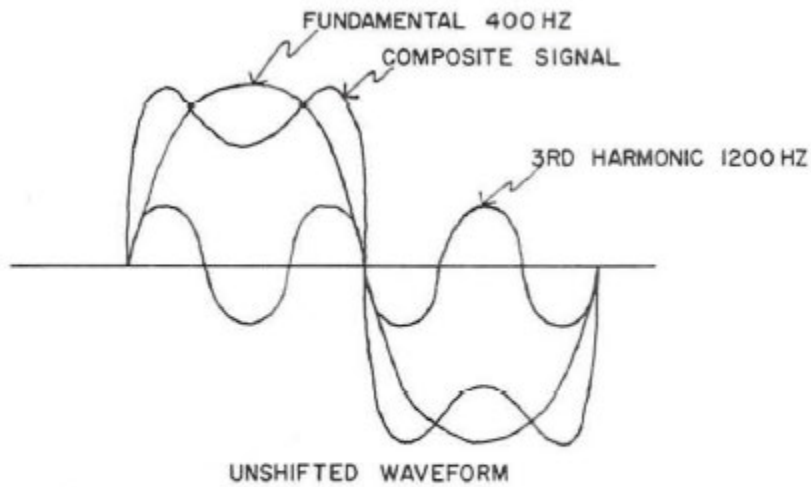
For each input block, Kudumakis’s system “find[s] both the fundamental and its harmonics” of the audio input signal using known techniques such as FFT. Ex. 1007, 4:26–30. Using the fundamental and its harmonics to determine where to embed the codes enhances security against malicious attacks because those frequencies vary throughout the audio signal. *Id.* at 4:26–5:9. Kudumakis’s disclosed embodiments embed the notch filters and codes at the “edges” of “these harmonics.” *Id.* at 4:30–31. Codes are more perceptible if they “coincide with the main frequency component of the signal,” yet “they have to be placed in a part of the spectrum with sufficient energy so that frequent masking conditions can be met.” *Id.* at 3:5–9.

### 3. *Cabot (Ex. 1006)*

Cabot relates to testing “the audibility of phase shifts in two component octave complexes.” Ex. 1006, 568. The tests involved groups listening to “headphones with fundamental and third-harmonic signals” of an audio signal. *Id.*

“The experiment shows phase shifts of harmonic complexes to be detectable, but judging from the difficulty experienced by the subjects, the effect appear to be small.” Ex. 1006, 570. In one experiment, subjects correctly identified a phase shift of 22.5 degrees between a fundamental and a harmonic with a 60 % corrected rate P. *Id.* at 570 (Table II). This appears to be a rate that “was only slightly better than chance,” where flipping a coin is a 50% chance. *See id.* at 568 (describing another experiment).

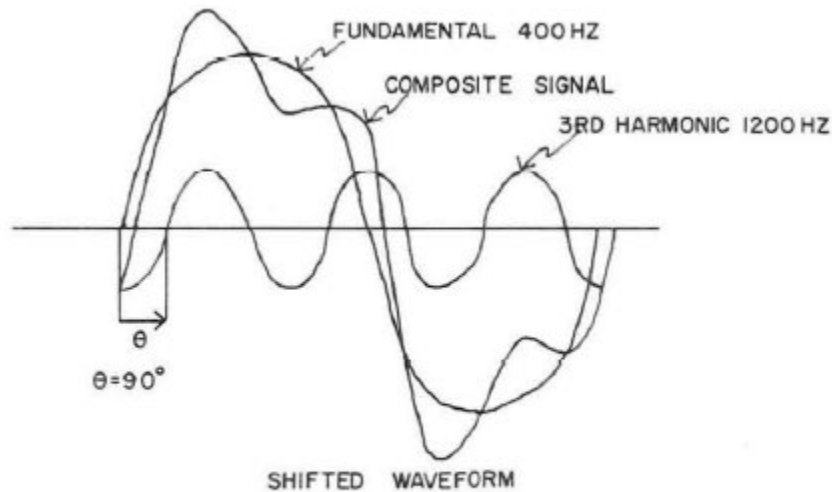
Cabot's Figure 2a follows:



**a**

Figure 2a above illustrates a time varying waveform (with time along the horizontal axis and amplitude along the vertical axis), which is equal to the sum of its fundamental harmonic at 400Hz plus its third harmonic at 1200 Hz, as depicted.

Cabot's Figure 2b follows:



**b**

Figure 2b above illustrates a time varying composite signal (with time along the horizontal axis and amplitude along the vertical axis), which is equal to the sum of its fundamental harmonic at 400Hz plus its third harmonic at 1200 Hz, which is shifted by a phase of 90 degrees relative to the fundamental harmonic, as depicted. Notice that the composite signal in Figure 2a is different from the composite signal in Figure 2b, due to the relative phase shift of the third harmonic.

Cabot reports that in a prior study, researchers “reported that their listeners were unable to detect a 180° phase shift in this same-different test arrangement.” Ex. 1006, 570. Cabot states that its “results, both quantitative and qualitative, correlate well with those of previous researchers using both similar and very different experimental techniques.” *Id.* at 571. In other words, “[a]lthough differences were detectable, they were subtle,” and “[t]his raises the question of its audibility compared to the more familiar forms of distortion.”

*E. Obviousness Ground 1: Based on Srinivasan, Cabot, and Kudumakis*

Petitioner contends that the subject matter of claims 1–10 would have been obvious over Srinivasan, Cabot, and Kudumakis. Pet. 2. Patent Owner argues that Petitioner’s showing is insufficient. Prelim. Resp. 24–43.

*1. Independent Claim 1*

*a. Step 1PRE: “A method for embedding data in an audio signal, the method comprising:”*

Petitioner contends that “Srinivasan’s differential phase encoding method that ‘add[s] an inaudible code to an audio signal’ as ‘bit[s]’” satisfies the preamble. Pet. 29 (citing Ex. 1003 ¶ 139; quoting Ex. 1005, 1:5–7, 7:67)

Even if the preamble is limiting, the preliminary record supports Petitioner's assertions and explanations. *See* Pet. 29 (citing Ex. 1003 ¶ 139; Ex. 1005, 1:5–7, 7:64–8:3), 9–14 (describing Srinivasan's system).

Petitioner sufficiently shows for institution purposes that Srinivasan teaches claim 1's preamble. At this stage, Patent Owner does not allege any deficiencies in this aspect of Petitioner's showing.

*b. Step 1A: “(a) dividing the audio signal into a plurality of time frames and, in each time frame, a plurality of frequency components”*

Petitioner contends that Srinivasan discloses this step. Pet. 29–31. According to Petitioner, Srinivasan discloses sampling an audio signal, dividing the digitized audio signal into a plurality of time frames called “blocks,” and then dividing each block into a plurality of frequency components by taking the FFT (Fast Fourier Transform). *See id.* (reproducing Ex. 1005, Figs. 2, 5; quoting *id.* at 7:33–42 (“a first block  $v(t)$  of  $jN_c$  samples is derived from the audio signal portion 14 . . . where  $v(t)$  is the time-domain representation of the audio signal within the block”).

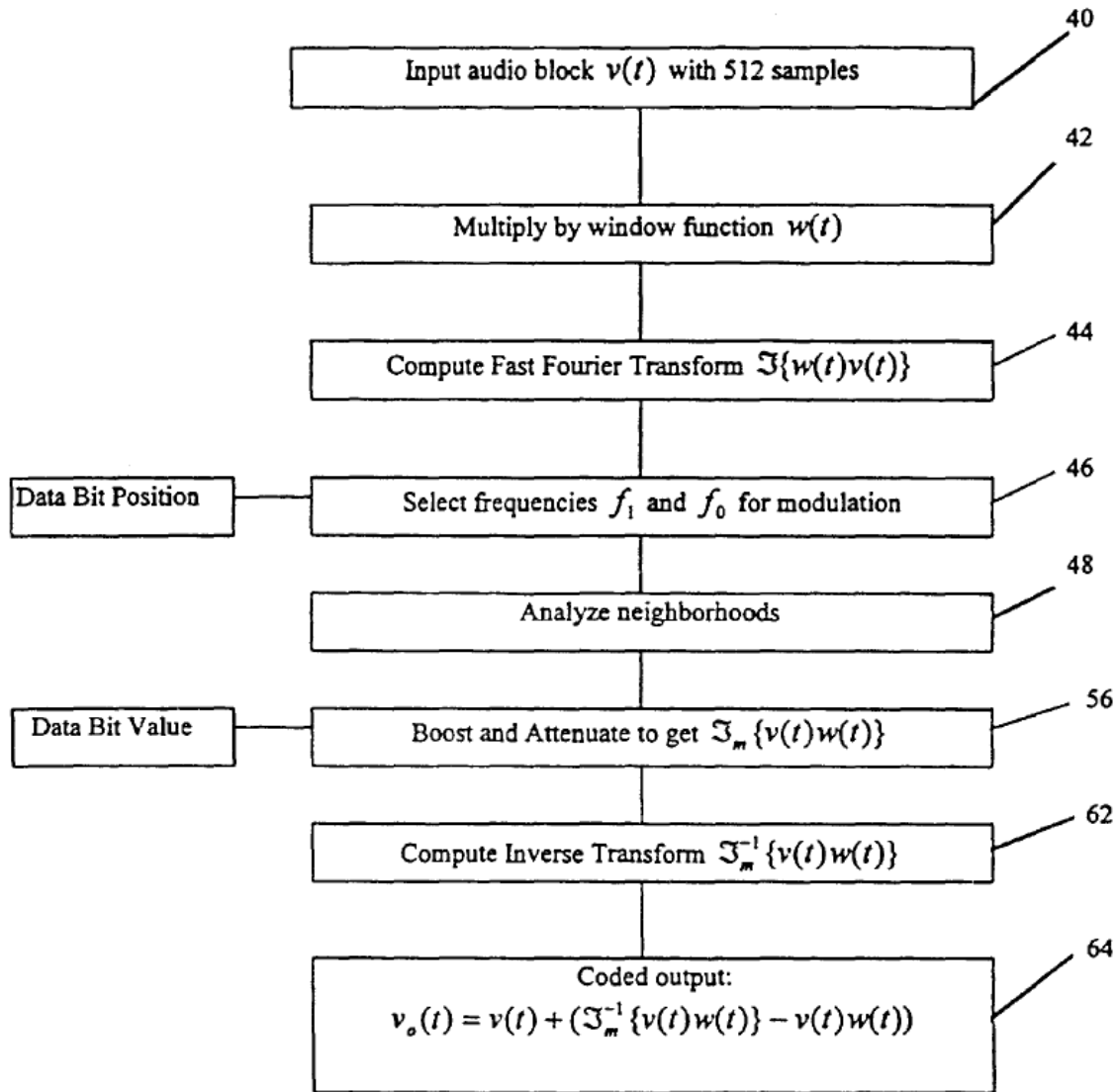
The preliminary record supports Petitioner's assertions and explanations. *See* Pet. 29–31 (reproducing Ex. 1005, Figs. 2, 5; citing *id.* at 7:33–42, 9:47–49; Ex. 1003 ¶¶ 140–142). On this record, Petitioner sufficiently shows that Srinivasan teaches step 1A. At this stage, Patent Owner does not allege any deficiencies in this aspect of Petitioner's showing.

*c. Step 1B: “(b) in each of at least some of the plurality of time frames, selecting at least two of the plurality of frequency components; and”*

Petitioner contends that Srinivasan's method selects “two of the plurality of frequency components as the code frequencies  $f_1$  and  $f_0$  (also represented by frequency indices  $I_1$  and  $I_0$ , respectively).” Pet. 32 (citing

Ex. 1005, 7:64–8:3; Ex. 1003 ¶ 143). Petitioner quotes Srinivasan as teaching that “[t]he code frequencies  $f_i$  used for coding a block may be chosen from the Fourier Transform  $\mathfrak{F}\{v(t)\}$  at a step 46” of Figure 2. *Id.* (quoting Ex. 1005, 7:64–66).

Srinivasan’s Figure 2 follows:



Srinivasan’s Figure 2 is a flow chart of steps performed by an encoder. Ex. 1005, 5: 56–57. Petitioner relies on Srinivasan’s Figure 2 above (step 46) to illustrate that Srinivasan’s technique involves selecting

two frequencies  $f_1$  and  $f_0$  in each audio block of 512 samples (step 40). *See* Pet. 32–33 (citing Ex. 1003 ¶¶ 143–144).

The preliminary record supports Petitioner’s assertions and explanations. On this record, Petitioner sufficiently shows that Srinivasan teaches step 1B. At this stage, Patent Owner does not allege any deficiencies in this aspect of Petitioner’s showing.

*d. Step 1C: “altering a phase of at least one of the plurality of frequency components in accordance with the data to be embedded, wherein,”*

Petitioner contends that Srinivasan’s system modifies “the phase of one of the spectral components  $f_0$  or  $f_1$  . . . with respect to the other,” where Srinivasan refers to modified and reference phases as  $\phi_M$  and  $\phi_R$ , respectively. Pet. 34 (citing Ex. 1005, 11:26–39). Petitioner explains that Srinivasan’s method

assign[s] two phase neighborhoods (one being  $\pm 45^\circ$  ( $\pm \pi/4$  radians) of reference phase  $\phi_R$  and another being  $\pm 45^\circ$  of . . .  $180^\circ$  ( $\pi$  radians) out of phase with  $\phi_R$ ) to represent, e.g., a “0” and “1,” respectively, and by modifying the phase angle  $\phi_M$  of the modifiable spectral component “at the step 56 so as to fall into one of these phase neighborhoods depending upon whether a binary ‘0’ or a binary ‘1’ is being encoded.

*Id.* (citing Ex. 1005, 11:26–54; Ex. 1003 ¶ 145; Pet. § VI.A).

Srinivasan explains that generally, “[i]n order to accomplish [phase modulation], one of the spectral components may have to undergo a maximum phase change of  $180^\circ$ , *which could make the code audible.*” Ex. 1005, 11:40–43 (emphasis added). To minimize the audible perception of this large phase change, Srinivasan employs the method as described in the block quote above, explaining that “it is not essential to perform phase modulation to th[e] extent of [a maximum phase change of  $180^\circ$ ], as it is

only necessary to ensure that the two components are either ‘close’ to one another in phase or ‘far’ apart.” *Id.* at 11:49–54; *see also* Pet. 13–14 (discussing Srinivasan’s “variation . . . to reduce perceptibility” (citing Ex. 1005, 11:47–54; Ex. 1003 ¶ 72)). Using the disclosed variation, “approximately 30% of the segments are ‘self-coded’ in this manner and no modulation is required.” Ex. 1005, 11:56–57. In addition, “[c]hoosing the lower amplitude component to be the modifiable spectral component *minimizes the change in the original audio signal.*” *Id.* at 11:37–40 (emphasis added).

In other words, Srinivasan teaches that even though frequencies “may be chosen from the Fourier Transform . . . at a step 46 in the 4.8 kHz to 6 kHz range in order to exploit the higher auditory threshold in this band,” the phase changes may be audible to some extent, so Srinivasan’s method minimizes the changes in the original signal by selecting lower amplitude frequencies and also by assigning phase neighborhoods to minimizing the differential phase shift of the coded frequency component. *See* Ex. 1005, 7:64–67, 11:37–40; Pet. 43 (discussing the technique).

The preliminary record supports Petitioner’s assertions and explanations. On this record, Petitioner sufficiently shows that Srinivasan teaches step 1C. At this stage, Patent Owner does not allege any deficiencies in this aspect of Petitioner’s showing.

*e. Step 1C-1: “wherein . . . step b comprises selecting a fundamental tone and at least one overtone”*

Petitioner contends that “[t]he Srinivasan/Cabot/Kudumakis Combination selects a fundamental tone and the third harmonic (an overtone) as the code frequencies based on Kudumakis’s and Cabot’s teachings.” Pet. 35 (citing Pet. §§ VI.E, VI.E.3; Ex. 1003 ¶ 147).

Petitioner explains that a person of ordinary skill in the art “would have been motivated by Cabot and Kudumakis to modify Srinivasan to use the fundamental and third harmonic as the coding frequencies  $f_0$  and  $f_1$  to improve robustness and expand the applications for which Srinivasan’s system was suitable.” Pet. 22. Petitioner provides several reasons as to why an artisan of ordinary skill would have selected the fundamental and third harmonic as the coding frequencies. *See id.* at 21–28.

For example, Petitioner contends that it would have been obvious to implement Cabot’s and Kudumakis’s suggestions to use the fundamental and third harmonic frequencies to modify Srinivasan’s system so that it can protect spoken speech and word recordings, which involve lower frequencies of the human audio spectrum than music. *See* Pet. 26–27. According to Petitioner, “[b]ecause such audio [speech] content commonly has frequencies up to about only 4 kHz, Srinivasan’s embedding band from 4.8 kHz–6 kHz would not work with such narrowband voice applications.” *Id.* (citing Ex. 1003 ¶ 132). Petitioner explains that “[c]hoosing the fundamental and third harmonic as the coding frequencies would have expanded the useful applications of Srinivasan’s watermarking system to narrowband voice applications.” *Id.* at 27.

The preliminary record supports Petitioner’s reason for modifying Srinivasan. On this record, Petitioner sufficiently shows that Srinivasan teaches limitation 1C. At this stage, Patent Owner does not address Petitioner’s showing that using the fundamental and third harmonic in Srinivasan’s system as suggested by Cabot and Kudumakis would have expanded Srinivasan’s data embedding system to include a narrowband voice information system. Although Patent Owner alleges that Srinivasan and Cabot teach away from the claimed invention as discussed further

below, Patent Owner does not address Petitioner’s argument that absent Petitioner’s proposed modification, Srinivasan’s system would not work for spoken speech and word recording systems—i.e., systems that have no perceptible frequency components in the 4.8–6 kHz range. *See* Prelim. Resp. 24–39. On this preliminary record, Srinivasan and Cabot do not teach away from speech systems, and Patent Owner does not allege that they do. *See id.*

Petitioner also contends that modifying Srinivasan’s method using the fundamental and harmonic of the original audio to shift the phase of the harmonic relative to the fundamental improves security and robustness. *See* Pet. 23–27. Petitioner explains that a person of ordinary skill in the art would have “understood from Cabot that there was an alternative way to achieve low-visibility differential phase encoding.” *Id.* at 22 (citing Ex. 1003 ¶ 120).

According to Petitioner,

Cabot confirmed that modifying the phase of the third harmonic relative to the fundamental is inaudible for small phase changes and “subtle” at larger phase changes, even under pristine listening conditions where (1) the fundamental and third harmonic are isolated from all other sounds that might mask the phase change and (2) the listener, wearing headphones, is familiarized with the sound of the difference and given unlimited opportunities to try to detect the difference.

Pet. 22–23 (citing Ex. 1006, Abstract, 570–71 (Observations & Discussions at ¶ 4, Conclusions); Ex. 1003 ¶ 120).

Petitioner explains that a person of ordinary skill in the art would have understood that using the third harmonic and fundamental as Srinivasan’s code frequencies  $f_1$  and  $f_0$  (*supra* § VI.A.1) would have provided the low visibility Srinivasan

desires, particularly *under real-world conditions where the listener is unaware of the phase shift and the audio signal has other sounds masking the phase shift.*

Pet. 23 (emphasis added) (citing Ex. 1003 ¶¶ 121–124; Ex. 1006, 570–71; Ex. 1028 (Risset), 114 (noting there is a “remarkable insensitivity to phase” between harmonics of periodic tones and stating further that although changing the phase between the harmonics of a periodic tone can alter the timbre of audio under certain conditions, “this effect is quite weak, and it is generally inaudible in a normally reverberant room where phase relations are smeared.”); Ex. 1031 (Lipshitz), 584 (noting symmetrical waveforms like those resulting from Cabot’s use of the fundamental and third harmonic give rise to “much less pronounced phase effects” than those displayed by asymmetrical signals).

With respect to security, Petitioner explains that “because the fundamental frequency and its harmonics change unpredictably throughout the audio signal, using them to determine where to embed a code ‘[e]nhance[s] security against malicious attacks’ seeking to remove the code.” Pet. 24 (quoting Ex. 1007, 5:3; citing *id.* at 3:3–18, 6:1–2; Ex. 1003 ¶ 127). In other words, “[i]f the code frequencies change frequently, then it becomes more difficult for an attacker to remove all the codes without introducing significant distortion to the original signal content.” Ex. 1007, 5:5–7.

With respect to robustness, Petitioner provides evidence that “the modification would have resulted in using perceptually more significant lower frequencies less susceptible to common signal distortions and malicious attacks.” Pet. 24 (citing Ex. 1003 ¶ 128; Ex. 1020, Abstract (“a watermark must be placed in perceptually significant components of a signal

if it is to be robust to common signal distortions and malicious attack.”); Ex. 1018, 4:32–37 (“The higher the level of embedded signal, the more corrupted a copy can be and still be identified.”)).

Petitioner explains that for audio files including speech, “the perceptually significant frequencies with the most energy were well below the 4.8–6 kHz range Srinivasan used and include the fundamental and its harmonics.” Pet. 24 (citing Ex. 1003 ¶ 128; Ex. 1008 (Tilki), 331 (“lower frequencies (below say 2 kHz) . . . typically contain the most energy in common audio signals”); Ex. 1020 (“Cox-1995”), 11 (“spectrum analysis of images and sounds reveals that most of the information in such data is located in the low frequency regions”); Ex. 1055 (“Cox-SWW”), 1667).

Therefore, according to Petitioner, “[p]lacing the watermark in perceptually less-significant regions (like Srinivasan did) leaves it susceptible to low-pass filtering that would remove the code by only retaining lower frequencies of the signal perceptible to the listener.” Pet. 25 (citing Ex. 1003 ¶ 129; Ex. 1020, Abstract; Ex. 1021 (“Wu”), Table 4, 390 (“[L]ow pass filtering . . . could effectively eliminate the embedded watermark. However, since our watermark is embedded in the frequency bands with the highest energy, filtering out the inserted watermark also greatly effects the sound quality.”)).

Petitioner also explains that “by placing the embedded data in frequency components that will typically be of relatively low energy, Srinivasan risks having the data be non-recoverable due to common signal distortions like additive noise.” Pet. 25 (citing Ex. 1003 ¶ 129; Cox-1995, Abstract; Ex. 1021, Table 4, 390 (revealing that white noise is detrimental to watermarks in weaker frequencies)).

Petitioner contends that a person of ordinary skill in the art “would have understood the fundamental and at least some of its harmonics are commonly strong, perceptually-significant frequency components in typical audio files.” Pet. 25 (citing Ex. 1003 ¶ 130; Ex. 1007, 3:5–14, 4:26–31 (implying fundamentals and harmonics are “in a part of the spectrum with sufficient energy so that frequent masking conditions can be met”); Ex. 1043, 9:3–6). Therefore, Petitioner asserts that selecting code frequencies in the 4.8–6 kHz range “made Srinivasan’s system susceptible to the above-discussed types of intentional (malicious attacks) and unintentional (common distortions) watermark destruction.” *Id.* at 25–26 (citing Ex. 1003 ¶ 131). Based on the considerations as outlined above, Petitioner asserts that a person of ordinary skill in the art “would have understood selecting the fundamental and third harmonic (typically below 4 kHz as in Cabot) would have improved the robustness of Srinivasan’s watermarking system by placing the watermark in perceptually significant frequencies less susceptible to intentional or unintentional destruction.” *Id.* at 26 (citing Ex. 1003 ¶ 131).

Petitioner also explains that because “Srinivasan uses *differential phase encoding* instead of notch encoding [as Kudumakis teaches], a [person of ordinary skill in the art] would have understood it was unnecessary for inaudibility to place the codes at the ‘edges’ of the fundamental and its harmonics.” Pet. 28 (citing Ex. 1003 ¶ 136; Pet. § VI.B (asserting phase shifts were known to be inaudible)). Petitioner also alleges a reasonable expectation of success based on the use of known techniques to identify a fundamental and its harmonics for use in embedding a code in an audio signal. *See id.* (citing Ex. 1003 ¶ 136; Ex. 1005, 7:43–47; Ex. 1007, 3:22–30, 4:21–30).

Reasons to Combine Analysis

Patent Owner contends that “Petitioners provide only conclusory statements, with no legally permissible or reasoned explanation, as to why a POSA would have been motivated to combine Srinivasan, Cabot, and Kudumakis, much less why a [person of ordinary skill in the art] would modify Srinivasan in light of Cabot and Kudumakis as Petitioner[] propose[s].” Prelim. Resp. 34–35. To support this argument, Patent Owner contends that “*Srinivasan* recognized that it was desirable to avoid inserting codes in a manner that might ‘distract[] a listener of program audio,’” and “[t]his statement contradicts the Petitioners’ suggestion of encoding at frequencies lower than 4.8 kHz, which falls more within the everyday human hearing range.” *Id.* at 36–37. For similar reasons, Patent Owner contends that implementing fundamental and harmonic code frequencies is incompatible with Srinivasan’s higher frequency range. *Id.* at 30–34. Patent Owner also relies on its central premise that Cabot teaches that modifying a harmonic is too perceptible for consideration as a coding method for audio signals, which we largely address below in connection with Patent Owner’s teaching away arguments. *See id.* at 35.

As summarized above, Patent Owner does not challenge Petitioner’s showing that the proposed modification results in increased security and robustness. *See* Prelim. Resp. 24–40. Rather, Patent Owner relies on teaching away arguments that do not address the improvements in robustness and security as advanced by Petitioner. *See, e.g.,* Prelim. Resp. 33 (“In other words, the 4.8–6 kHz range articulated in *Srinivasan* teaches away from Petitioners’ proposed modification.”), 35 (“[E]xplicit statements would dissuade a [person of ordinary skill in the art] from looking to

*Cabot.*”), 37 (“*Kudumakis* teaches away from encoding data at such points.”).

Patent Owner’s arguments are unavailing. We address Patent Owner’s teaching away arguments more fully in the next section and address them to a lesser extent here. As summarized above and further below, the preliminary record shows that artisans of ordinary skill would have known based on *Cabot* and other references of record that Petitioner relies upon and Patent Owner ignores (e.g., Lipshitz, Risset), that modifying the phase of an audio signal’s third harmonic, under *real-world conditions*, does not distract a listener. *See* Pet. 23; *infra* (Teaching Away Analysis). *See id.* at 20 (citing Ex. 1007, 5:1–2, 13–18), 23 (arguing that an artisan of ordinary skill would have recognized that implementing *Cabot*’s phase shifting “would have provided the low visibility Srinivasan desires, particularly under real-world conditions where the listener is unaware of the phase shift and the audio signal has other sounds masking the phase shift”), 25 (arguing that *Cabot*’s phase modulation scheme would have provided benefits to Srinivasan’s scheme).

Some of Patent Owner’s arguments support Petitioner. To begin, the disclosed ’961 patent system employs materially the same harmonic phase shift system that Petitioner argues shows obviousness. *See, e.g.*, Prelim. Resp. 9–11 (describing the ’961 patent system). Patent Owner argues that with respect to the ’961 patent, “while shifting one frequency component relative to a fundamental might alter the composite waveform (to account for the shift), *it does not impact the ultimate sound perceived by the human ear.*” *Id.* at 11 (citing Ex. 1001, 4:14–21) (emphasis added). The ’961 patent further supports Petitioner at the cited passage by stating that “[w]hen the phases of the overtones are modulated to create a composite waveform

different from the original, *the difference will not be easily detected.*” Ex. 1001, 4:16–19 (emphasis added). At this preliminary stage, Patent Owner does not argue that the inventors of the ’961 patent *discovered* this phenomenon of relative imperception of harmonic phase shifts. See Prelim. Resp. 7 (arguing that the “inventors *recognized*” that in phase modulating overtones of an original signal, the difference will not be easily detected (emphasis added)).<sup>10</sup> To the contrary, as discussed above and further below, the preliminary record evidence suggests that artisans of ordinary skill were aware of this phenomenon before the date of the invention, as indicated above and further below.

To further support its arguments alleging a lack of motivation, Patent Owner argues that “the systems disclosed in Srinivasan and Kudumakis operate in fundamentally different ways.” Prelim. Resp. 38. Patent Owner explains that “*Srinivasan* uses phase encoding, while *Kudumakis* uses notch encoding.” *Id.* Patent Owner argues that “Kudumakis does not teach embedding codes at a fundamental or a harmonic; it teaches removing data near the fundamentals and harmonics (i.e., notches) and replacing the removed data with a code.” *Id.* at 39.

Patent Owner also argues that “Petitioners conclusorily argue that a [person of ordinary skill in the art] would modify Srinivasan to encode fundamentals and harmonics based on Kudumakis and Cabot.” Prelim.

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<sup>10</sup> The Dissent faults our reliance on this portion of the specification as “precisely the sort of hindsight we must avoid.” Dissent 7–8. We do not, however, look to the ’961 patent specification as primary evidence of skilled artisans’ knowledge. Instead, these statements, combined with Patent Owner’s characterization, simply corroborate Petitioner’s other evidence, discussed above and below, showing that the relative imperception of harmonic phase shifts was well known in the art.

Resp. 38. And Patent Owner argues that “Petitioners do not attempt to reconcile the systems’ fundamentally different operations, with neither making spectral modifications to the fundamental and harmonics of a signal.” *Id.* at 38.

These arguments do not undermine Petitioner’s showing, which relies on the combined teachings of the references as viewed from the perspective of one of ordinary skill in the art. As Patent Owner recognizes, “Petitioners . . . argue that a [person of ordinary skill in the art] would modify Srinivasan to encode fundamentals and harmonics based on Kudumakis and Cabot.”

Prelim. Resp. 38. However, for the reasons explained above and below (addressing teaching away arguments), Petitioner’s showing is not conclusory. Rather, Petitioner’s showing relies on stated benefits of robustness, security, and use of the combined system for audio speech systems, which Patent Owner does not address with particularity at this stage. Petitioner also sufficiently shows how to modify Srinivasan’s method (i.e., by simply altering the coding frequencies), which Patent Owner also does not address with particularity at this stage. *See* Pet. 27 (modifying Srinivasan’s method by “selecting the fundamental and third harmonic as the code frequencies  $f_0$  and  $f_1$ ”). Patent Owner is correct in arguing that Petitioner does not propose “making spectral modifications to the fundamental.” Prelim. Resp. 38. This argument supports Petitioner, because the challenged claims do not require modifying the phase of the fundamental, and Petitioner does not propose that modification. *See* Pet. 34 (modifying the phase of the third harmonic—“[t]he phase of one of the spectral components  $f_0$  or  $f_1$  is modified with respect to the other, which becomes a reference”).

In addition, Petitioner explains that Cabot’s phase-testing scheme, supplemented by the knowledge of an artisan of ordinary skill, suggests modifying the phase of harmonics under real-world conditions because that type of phase shift results in imperceptible changes (Pet. 23), and as Kudumakis suggests, “enhances security against malicious attacks because those frequencies vary throughout the audio signal” (*id.* at 20). *See also id.* at 17–18, 22–23. As Petitioner also notes, Kudumakis states that its system may employ “[a]mplitude or phase modulation,” so that it is similar to Cabot’s and Srinivasan’s phase modulation teachings and systems. *Id.* at 20 (citing Ex. 1007, 6:1–2; Ex. 1003 ¶ 87).

With respect to Kudumakis’s notch filtering technique, Petitioner explains that “[s]ince Srinivasan uses ***differential phase encoding*** instead of notch encoding, a [person of ordinary skill in the art] would have understood it was unnecessary for inaudibility to place the codes at the ‘edges’ of the fundamental and its harmonics.” Pet. 28 (citing Ex. 1003 ¶ 136). In other words, with differential phase shift encoding, Kudumakis’s harmonic frequency does not undergo a change in amplitude, which an artisan of ordinary skill would have recognized is more perceptible than a phase change. *See id.* As Petitioner notes, Kudumakis teaches that codes are more perceptible if they “coincide with the main frequency component of the signal.” *Id.* at 20 (quoting Ex. 1007, 3:4–9). Patent Owner argues that Kudumakis “cautions against making modifications to the strongest frequency components of a signal (those that are audible or not masked by other tones, such as its fundamental and harmonics) because the inserted codes would be more perceptible in that case.” Prelim. Resp. (citing Ex. 1007, 3:4–6). This argument mischaracterizes Kudumakis to a certain extent, because Kudumakis cautions against placing the codes at the “main

frequency component of the signal”—the fundamental tone—not the harmonics of the fundamental tone. *See* Ex. 1007, 3:6.

Therefore, Petitioner’s modification is in line with Kudumakis’s teaching of using tones masked by other frequency components and noise in the “real-world.” That is, Petitioner’s proposed modification does not involve modifying the fundamental frequency (strongest frequency) of an audio signal. Rather, it involves modifying a harmonic thereof, so that on this preliminary record, other nearby frequency components (including the strong fundamental) will mask the phase-altered harmonics in a real-world audio signal. *See* Pet. 23 (citing “real-world conditions where . . . the audio signal has other sounds masking the phase shift”), 26 (citing Ex. 1022, 2:49–63 (relying on the teaching of injecting hidden data in the passband to avoid being filtered out), 36 (modifying the phase of the third harmonic). In other words, Petitioner proposes using the fundamental frequency as a reference phase for adjusting the phase of its third harmonic (masked by other unchanged frequencies nearby and noise in a real-world audio signal) in Srinivasan’s modified system as further suggested by Cabot and Kudumakis. *See id.* at 36 (“[T]he Srinivasan/Cabot/Kudumakis Combination quantizes a phase difference of at least one overtone (third harmonic) relative to the fundamental tone to embed at least one bit of the data to be embedded as claimed.”).

On this limited record, Petitioner proposes a simple variation of the frequency range and relationship (harmonic) of Srinivasan’s coding frequencies, so that the systems do not operate in fundamentally different ways, contrary to Patent Owner’s arguments. *See* Pet. 27, 36. As indicated above, Petitioner provides several beneficial reasons for the proposed modification, including that modulating the phase of (symmetrical)

harmonics prevents low-pass filtering of the code to provide robustness and security, provides more readily recoverable data for the code as compared to Srinivasan's system, and it extends Srinivasan's system to speech applications (which are at lower frequencies). Patent Owner's arguments neither undermine nor address with particularity Petitioner's sufficient showing with respect to these beneficial reasons for modifying Srinivasan at this preliminary stage.

#### Teaching Away Analysis

Patent Owner contends that Cabot teaches away from the claimed invention. Prelim. Resp. 24–30. Patent Owner contends that Cabot teaches that “[t]he experiment shows phase shifts of harmonic complexes to be detectable” and that “it was found that a 30° shift was still fairly well recognized.” *Id.* at 26 (quoting Ex. 1006, 570). Patent Owner presents similar arguments, for example asserting that in Cabot “phase shifts of 22.5 degrees were detected 60% of the time and shifts of 15 degrees were detected 46% of the time.” *Id.* (citing Ex. 1006, Table II). Therefore, Patent Owner contends that Cabot “directly undermine[s] Petitioner[’s] contention that phase shifts between a fundamental and a third harmonic are inaudible.” *Id.* Based on these arguments, Patent Owner maintains that “Cabot would **dissuade** a person skilled in the art from employing phase shifts as a data hiding method.” *See id.* at 27–28 (quoting *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004)) (“[a] reference teaches away from a claimed invention if it ‘criticizes, discredits, or otherwise discourages’ modifying the reference to arrive at the claimed invention.”).

The preliminary record does not support Patent Owner's teaching away arguments based on its reading of Cabot for several reasons. Primarily, Patent Owner views Cabot's teachings by picking and choosing

isolated statements therein without considering the view and knowledge of an artisan of ordinary skill in the art. For example, recognizing a phase shift 50% of the time is merely recognizing it as a matter of mere chance—predicting a phase change based on a coin flip achieves the same recognition of 50%. *See* Ex. 1006, 568 (describing a prior art experiment in which “listeners required extensive training sessions, and the resultant accuracy of detection *was only slightly better than chance*”). Similarly, detecting “phase shifts of 22.5 degrees . . . 60% of the time” is also “only slightly better than chance.” *Compare* Prelim. Resp. 26, with Ex. 1006, 568.

Patent Owner’s arguments ignore Cabot’s *conclusion* that “[a]lthough differences were detectable, *they were subtle*,” and that the results “*correlate well with those of previous researchers*.” Ex. 1006, 571 (emphasis added); *see also* Pet. 15 (arguing that “Cabot explains that the audibility of phase shifts in harmonically related tones had been studied ‘for many years’ and reported to be inaudible” (citing Ex. 1006, 568 (Introduction)). One researcher cited in Cabot “reported that *their listeners were unable to detect a 180° phase shift*.” Ex. 1006, 571 (emphasis added). Another researcher cited in Cabot “ran crude experiments to show that *phase shifts were not audible*.” *Id.* at 568 (emphasis added). Cabot’s conclusion and these descriptions are similar to how the ’961 patent describes a materially similar phase shift system: “When the phases of the overtones are modulated to create a composite waveform different from the original, *the difference will not be easily detected*.” Ex. 1001, 4:14–21 (emphasis added); *see also* Prelim. Resp. 7 (quoting same). It follows that Cabot does not teach away

from the invention, because the invention includes the same characteristics.<sup>11</sup>

Patent Owner also does not address Petitioner's reliance on other evidence of record that correlates with the cited researchers in Cabot and further shows that phase shifting of harmonics does not cause appreciable perception or distortion of the audio signal. For example, Petitioner relies on Lipshitz, a prior art document in the field of endeavor. Pet. 23 (citing Ex. 1031, 584). Lipshitz supports Petitioner's view of Cabot, because Lipshitz *describes Cabot as teaching* that the fundamental and third harmonic give rise to "much less pronounced phase effects than those displayed by asymmetrical signals." Ex. 1031, 584. Patent Owner also does not address Petitioner's reliance on Risset, which further supports Petitioner. *See* Pet. 24 (citing Ex. Ex. 1028, 114). Risset states that there is a "*remarkable insensitivity to phase . . . for the phase relationship between the harmonics of periodic tones.*" Ex. 1028, 114 (emphasis added). On the same page, Risset states that "*phase relationship[s] between the harmonics . . . is quite weak, and it is generally inaudible.*" *Id.* (emphasis added). It also states that "a listener *will be unable to perceive a difference between . . . two sounds*" that "have the same pattern of harmonic amplitudes *but have different patterns of phase relationships.*" *Id.* (emphasis added).

On this preliminary record, these independent prior art sources and researchers constitute reliable and unbiased evidence supporting Petitioner's

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<sup>11</sup> As indicated above and further below, Srinivasan's system also is not perfect in obscuring perception. *See* Ex. 1005, 11:37–59 (noting that a "maximum phase change of 180° could make the code audible," and "[c]hoosing the lower amplitude component to be the modifiable spectral component *minimizes* the change in the original audio signal" (emphasis added)).

assertion that an artisan of ordinary skill would have recognized from Cabot and general knowledge in the relevant art that employing a third harmonic for phase shifting relative to a fundamental is not sufficiently perceptible, especially under “real-world conditions” as opposed to “pristine listening conditions” involved in Cabot’s testing method involving a single fundamental and single harmonic. *See* Pet. 22–23. During trial, Patent Owner will have the opportunity to address further whether an artisan of ordinary skill reading Cabot and the references relied upon and cited by Petitioner would have known that harmonic phase shifts are relatively not perceptible under real-world conditions.

As Petitioner also explains, even under these “pristine listening conditions” (Pet. 22), Cabot reports that it trained its listeners because they “refused to believe that there was a difference until they were shown traces of the signals on an oscilloscope.” Ex. 1006, 570; *see also* Pet. 18 (quoting part of same). In other words, “real-world” audio signals are time varying waveforms that comprise multiple frequency components and noise that help to mask the ability of a user to perceive difference in phase shift. *See, e.g.*, Pet. 18 (arguing that Cabot’s “controlled environment . . . signal had only components at the fundamental and third harmonic and was free of components at other frequencies that could mask audibility of the phase shift”); Ex. 1001, 4:14–16 (“Naturally occurring audio signals such as music or voice contain a fundamental frequency and a spectrum of overtones with well-defined relative phases.”).<sup>12</sup>

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<sup>12</sup> As Patent Owner notes, “*Tilki* explains ‘stronger low frequency components help to mask the changes made in the higher frequency region.’” Prelim. Resp. 60 (quoting Ex. 1008, 331). In other words, in the “real-world,” stronger frequency components (e.g., the fundamental or

At this stage, Patent Owner does not directly address Petitioner’s explanation that Cabot involves “pristine listening conditions” as opposed to “real-world conditions.” *See* Prelim. Resp. 15–17 (describing Cabot’s teachings). In any event, Patent Owner agrees that “*Cabot’s ‘experiment shows phase shifts of harmonic complexes to be detectable, but judging from the difficulty experienced by the subjects, the effect appears to be small.’*”). *Id.* at 16 (second emphasis added) (quoting Ex. 1006, 570).

Similar to Cabot’s pristine testing conditions and the ’961 patent’s system (for which Patent Owner argues that “the [phase] difference will not be easily detected” (Prelim. Resp. 7)), Srinivasan also suggests that its system also is not perfect in lack of phase difference perception. Patent Owner agrees that “*Srinivasan concludes that modifications to an audio signal in the frequency range are difficult for the human ear to detect.*” Prelim. Resp. 33 (second emphasis added). Therefore, on this preliminary record, teaching a different way to minimize phase perception is not teaching away from Srinivasan or the claimed invention. *Fulton*, 391 F.3d at 1201 (The “mere disclosure of alternative designs does not teach away.”). In addition, even if Cabot’s phase modulation technique results in slightly more audible phase shifts than Srinivasan’s technique (which has not been shown), our reviewing “court has further explained that just because better alternatives exist in the prior art does not mean that an inferior combination is inapt for obviousness purposes.” *In re Mouttet*, 686 F.3d 1322, 1334 (Fed. Cir. 2012) (citing *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994)).

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second harmonic) in the audio signal also mask phase changes in other frequency components (e.g., a third harmonic).

Srinivasan supports Patent Owner's observation that Srinivasan's system is not perfect in terms of imperception. For example, Srinivasan recognizes that "[c]hoosing the lower amplitude component to be the modifiable spectral component minimizes the change in the original audio signal" and notes that "approximately 30% of the segments are 'self-coded'" (i.e., fewer phase changes to perceive). Ex. 1005, 11:37–59; Pet. 13 (discussing reducing perception via limiting the maximum phase shift (citing Ex. 1003, 11:16–40, 47–54)). That is, as Patent Owner suggests, Srinivasan teaches that its method is also perceptible to some degree and seeks to minimize it. Moreover, under Petitioner's proposed method of modifying Srinivasan's method, not only is Cabot's third harmonic the modifiable *lower amplitude* component relative to the fundamental (*see* Ex. 1005, Fig. 2b), which Srinivasan teaches is less perceptible, the third harmonic is *symmetrical* relative to the fundamental tone, thereby improving masking in line with Srinivasan's goals. *See* Pet. 23 (citing Lipshitz as "noting symmetrical waveforms like those resulting from Cabot's use of the fundamental and third harmonic give rise to 'much less pronounced phase effects' than those displayed by asymmetrical signals" (quoting Ex. 1031, 584)).

Importantly, neither the '961 patent nor the challenged claims specify any degree of audible perception of phase shifts for the phase coding method. Therefore, Patent Owner's "teaching away argument is of questionable relevance," because Patent Owner's "evidence" does not "relate to and is" not "commensurate in scope with the ultimate claims at issue." *See Idemitsu Kosan Co., Ltd., v. SFC Co., Ltd.*, 870 F.3d 1376, 1381 (Fed. Cir. 2017) ("Idemitsu's teaching away argument is of questionable relevance anyway. Evidence concerning whether the prior art teaches away

from a given invention must relate to and be commensurate in scope with the ultimate claims at issue.”) (citing *In re Zhang*, 654 F. App’x. 488, 490 (Fed. Cir. 2016) (“While a prior art reference may indicate that a particular combination is *undesirable for its own purposes*, the reference can nevertheless teach that combination if it remains suitable *for the claimed invention*.”) (first emphasis added, second alteration in original)).

Patent Owner also fails to quantify how perceptible the phase shift is. As noted above, Patent Owner also does not address Petitioner’s sufficient showing that an artisan of ordinary skill would have recognized several benefits in modifying Srinivasan’s system, including benefits of robustness, security, and providing embedded data for audible speech. *See* Pet. 21–26. Even if phase shifting of harmonics introduces some mild perception relative to Srinivasan’s method (which is not shown on this preliminary record), Patent Owner does not address Petitioner’s argument that “visibility (perceptibility), robustness, and data capacity were known attributes of a watermark and were in tension with each other because improving one attribute may worsen another.” *See id.* at 21.

Therefore, under these conditions on this preliminary record, there is insufficient evidence to undermine Petitioner’s sufficient showing, for the purposes of institution, based on teaching away. *See Intel Corp. v. PACT XPP Schweiz AG*, 2023 WL 2198649 at \*4 (Fed. Cir. Feb. 24, 2023) (reversing the Board and finding patent owner’s expert’s testimony did not support the Board’s finding of a lack of motivation where the “expert does not opine *how much the modification would increase latency* or whether the latency introduced by the additional arbitration logic would be offset by the ability for the cache cores to operate as a single large cache” or “[i]n other words, . . . *merely opines that there is an unspecified processing speed ‘cost’*”).

associated with implementing Arimilli's L3 caches in King's bus system but *does not opine on whether the benefits of the implementation outweigh the cost*" (emphasis added)); Prelim. Resp. 6–8 (acknowledging trade-offs exist).

Patent Owner also argues that "the modifications proposed by Petitioners are incompatible with the explicit frequency range taught in Srinivasan, which was selected specifically because Srinivasan concludes that modifications to an audio signal in the frequency range *are difficult for the human ear to detect*." Prelim. Resp. 33 (emphasis added). Srinivasan states that higher frequencies "*may be chosen . . . to exploit the higher auditory threshold at this band*." Ex. 1006, 7:64–67 (emphasis added). The fact that these higher frequencies "may be chosen" suggests that Srinivasan recognizes that its system is compatible with other frequency ranges (and must be modified to accommodate lower frequency speech systems according to Petitioner's unchallenged assertions as noted above). Petitioner's sufficient showing that an artisan of ordinary skill would have known that shifting the phase of harmonics is relatively imperceptible in a real-world setting supports Petitioner's proposed combination for audio systems in general, because that harmonic phase shifting scheme satisfies Srinivasan's argued goal of providing "modifications to an audio signal in the frequency range [that] are difficult for the human ear to detect." *See* Prelim. Resp. 33.

#### Summary of Analysis of Arguments for Step 1C-1

Based on the foregoing discussion and analysis of the parties' showings, the preliminary record supports Petitioner's assertions and explanations. On this record, Petitioner sufficiently shows that Srinivasan teaches step 1C-1.

f. Step 1C-2: *“and step (c) comprises quantizing a phase difference of the at least one overtone relative to the fundamental tone to embed at least one bit of the data to be embedded.”*

Petitioner relies on Srinivasan’s method as described above, which quantizes a phase differences between code frequencies  $f_0$  and  $f_1$  to represent either a binary 1 or 0. According to Petitioner, a person of ordinary skill in the art

would have understood that establishing one phase difference value ( $0^\circ$ ) or neighborhood of values (within  $45^\circ$  of in-phase) to represent one binary value, and another phase difference value ( $180^\circ$ ) or neighborhood of values (within  $45^\circ$  of out-of-phase) to represent a different binary value is quantizing the phase difference between the two frequency components as claimed.

Pet. 35–36 (citing Ex. 1003 ¶ 149).

The preliminary record supports Petitioner’s assertions and explanations. On this record, Petitioner sufficiently shows that Srinivasan teaches step 1C-2. At this stage, Patent Owner does not allege any deficiencies in this aspect of Petitioner’s showing.

g. Summary as to Claim 1

Based on the foregoing analysis and discussion, we determine that Petitioner establishes a reasonable likelihood of prevailing on its showing that claim 1 would have been obvious over the combined teachings of Srinivasan, Kudumakis, and Cabot.

## 2. Claims 2–10

Petitioner also contends that the subject matter of independent claims 4, 6, and 9, and dependent claims 2, 3, 5, 7, 8, and 10 would have been obvious over Srinivasan, Kudumakis, and Cabot. Pet. 36–50.

Petitioner substantiates its contentions with analysis that addresses each

claim limitation and identifies supporting evidence, relying partly on its analysis of claim 1. *See id.*

Other than its arguments presented regarding claim 1, Patent Owner does not dispute Petitioner’s showing for these claims. *See Prelim. Resp.* 24–43. On this record, we determine that Petitioner establishes a reasonable likelihood of prevailing on its showing that claims 2–10 would have been obvious over the combined teachings of Srinivasan, Kudumakis, and Cabot.

*F. Obviousness Ground 2: Based on Srinivasan, Cabot, Kudumakis, and Hobson*

Petitioner contends that the subject matter of claims 2, 3, 5, 7, 8, and 10 would have been obvious over Srinivasan, Cabot, Kudumakis, and Hobson. *Pet.* 50–52. Petitioner relies on Hobson in the event that “the Board disagree[s] that Kudumakis teaches encoding data at multiple frequencies in a time frame as relied on in Ground 1.” *Id.* at 50–51. Petitioner sufficiently substantiates its contentions with analysis that relies on Hobson to suggest selecting multiple harmonics in Srinivasan’s system in order to embed the same watermark multiple times to achieve redundancy and improve the recovery of the watermark data. *See id.*

Patent Owner disputes Petitioner’s showing. *See Prelim. Resp.* 43–52. In addition to relying on its arguments against Ground 1, Patent Owner argues that Hobson is not analogous art. *See id.*

The legal framework for determining if a reference qualifies as analogous art involves “[t]wo separate tests,” as follows:

Two separate tests define the scope of analogous prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor’s endeavor, whether the reference still is

reasonably pertinent to the particular problem with which the inventor is involved.

*In re Bigio*, 381 F.3d 1320, 1324 (Fed. Cir. 2004) (citing *In re Deminski*, 796 F.2d 436, 442 (Fed. Cir. 1986); *In re Wood*, 599 F.2d 1032, 1036 (CCPA 1979)).

Patent Owner asserts that Hobson does not satisfy the “field of endeavor” test of the analogous art framework. Prelim. Resp. 46–50. Patent Owner argues that Hobson relates to encoding digital *image* systems with watermarks instead of encoding *audio* systems with watermarks. Prelim. Resp. 47 (citing Ex. 1042, code (54), 1:6–7) Patent Owner attempts to support this argument by arguing that

[t]he ’961 patent is entitled “Data Hiding Via Phase Manipulation of **Audio Signals**” and “is directed to a system and method for insertion of hidden data into audio signals and retrieval of such data from **audio signals** and is more particularly directed to such a system and method using a phase encoding scheme.”

Prelim. Resp. 46 (quoting Ex. 1001, code (54), 1:1–24). Patent Owner also argues that Hobson is in a different patent classification than the ’961 patent. *Id.* at 48–50.

Patent Owner argues that “the ‘field of the art’ statement in the Background of Invention section of the specification as a ‘more realistic description of the field in which appellants endeavored.” Prelim. Resp. 46 (quoting *Wood*, 599 F.2d at 1036). On the other hand, in the “Description of Related Art” section, the ’961 patent states that as a “basic example” of “[s]tenography,” which “shares many of the attributes and techniques of watermarking,” “a message can be embedded in a bitmap image.” Ex. 1001, 1:42–50.

During trial, the parties will have the opportunity to raise and/or address this issue further. At this time, we need not decide the issue given that Petitioner sufficiently shows a reasonable likelihood of prevailing on Grounds I and III, as determined above and further below.

On this record, based on the foregoing discussion, we do not address whether Petitioner establishes a reasonable likelihood of prevailing on its showing that claims 2, 3, 5, 7, 8, and 10 would have been obvious over the combined teachings of Srinivasan, Kudumakis, Cabot, and Hobson.

*G. Obviousness Ground 3: Based on Kudumakis, Cabot, and Tilki*

Petitioner contends that the subject matter of claims 1–10 would have been obvious over Tilki, Kudumakis, and Cabot. Pet. 52–64. Patent Owner argues that Petitioner’s showing is insufficient. Prelim. Resp. 24–43.

*1. Tilki (Ex. 1008)*

Tilki relates to “a method of encoding an auxiliary channel onto a digital audio signal such that it is imperceptible to human observers.” Ex. 1008, 331 (Abstract). Tilki explains that “[t]he ability to add extra hidden information to a signal could be useful in many applications,” including modifying audio compact discs to “to contain artist information, song titles, song lyrics, karaoke information, still images, and perhaps even video clips.” *Id.* at 331 (Introduction).

In Tilki’s method, in one embodiment, “[a] differential phase of  $\pi/8$  [(22.5°)] was used to modify the phase of every fourth FFT bin above 2 kHz in 2048 point FFT blocks.” Ex. 1008, 332 (Simulation Results).

Tilki suggests future variations for investigation, noting that encoding frequencies degrades performance due to quantization effects:

Finally, adaptive encoding based on local power levels and frequency content in the primary audio signal can perhaps increase the effective capacity of the auxiliary channel. A related variation would be adaptation of the differential phase change based on the local frequency content and on some measure of phase deviation in the region. *This could be used to compensate for the fact that frequency regions with lower energy are more sensitive to quantization effects than regions with more energy.*

Ex. 1008, 332 (Future Improvements) (emphasis added).

## 2. Independent Claim 1

a. Step 1PRE: “A method for embedding data in an audio signal, the method comprising:”

Petitioner contends that it would have been obvious to employ Tilki’s differential phase encoding technique in Kudumakis’s system, or to employ Kudumakis’s fundamental and harmonics in Tilki’s system, thereby embedding data in an audio signal.<sup>13</sup> See Pet. 53, 62 (citing Pet. § VIII.B.3; Ex. 1003 ¶ 207). Petitioner generally relies on the combined teachings of

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<sup>13</sup> In other words, on this preliminary record, Petitioner implicitly advances either of Tilki or Kudumakis as the “primary” reference, with teachings from the other “secondary” reference modifying the “primary” reference. See Pet. 57–58, 74–76 (addressing claims 9–10); *Mouttet*, 686 F.3d at 1333 (“[W]here the relevant factual inquiries underlying an obviousness determination are otherwise clear, characterization by the examiner of prior art as ‘primary’ and ‘secondary’ is merely a matter of presentation with no legal significance.”) (citing *In re Bush*, 49 CCPA 752, 296 F.2d 491, 496 (1961) (Rich, J.); *In re Krammes*, 50 CCPA 1099, 314 F.2d 813, 816–17 (1963)). *Mouttet* also cautions that “[w]hile we recognize that there may be some cases in which relevant factual determinations inhere in such characterization of prior art references, this case is not one.” *Id.* Similar to the factual situation in *Mouttet*, Petitioner’s implicit characterization of either reference as serving as the “primary” reference is sufficiently clear on this preliminary record for institution purposes.

Kudumakis, Tilki, and Cabot to teach implementing Tilki's phase shifting technique using the fundamental and harmonic tones as suggested by Kudumakis and Cabot. *See id.* at 57–62 (providing reasons for the combination and resulting system, including that phase shifting of harmonics is relatively imperceptible and provides a robust, secure system). Petitioner argues that it would have been obvious “to combine Kudumakis's teaching of using the fundamental and overtones to determine where to embed a watermark to enhance security, with Tilki's differential phase encoding.” *Id.* at 57.

Even if the preamble is limiting, the preliminary record supports Petitioner's assertions and explanations. *See, e.g.*, Pet. 53 (arguing that “Tilki adds hidden information to an audio signal— to create an ‘auxiliary’ or ‘secondary’ channel in addition to the “primary audio channel”—by quantizing the relative phase of two frequency components of the audio signal.”).

Petitioner sufficiently shows for institution purposes that the combined teachings of Kudumakis, Tilki, and Cabot meet claim 1's preamble. At this stage, Patent Owner alleges deficiencies in combining the teachings of Kudumakis, Tilki, and Cabot, which we address below.

*b. Step 1A: “(a) dividing the audio signal into a plurality of time frames and, in each time frame, a plurality of frequency components”*

Petitioner contends that Tilki and Kudumakis each disclose this step. Pet. 62–63. According to Petitioner, “Kudumakis's ‘frames’ are time frames” and “each is ‘transform[ed] into the frequency domain’ which is dividing the audio signal into frequency components.” Pet. 63 (quoting Ex. 1007, 3:11–12). Petitioner also contends that Tilki discloses a “‘modified signal block’ and ‘subsequent signal blocks’ of [an] audio signal

which are time frames” and “each is divided into ‘FFT bin[s]’ which are frequency components.” *Id.* (quoting Ex. 1008, 331–332; citing Ex. 1003 ¶ 208).

The preliminary record supports Petitioner’s assertions and explanations. On this record, Petitioner sufficiently shows that Kudumakis or Tilki teaches step 1A. At this stage, Patent Owner alleges deficiencies in combining the teachings of Kudumakis, Tilki, and Cabot, which we address below.

*c. Step 1B: “(b) in each of at least some of the plurality of time frames, selecting at least two of the plurality of frequency components; and”*

Petitioner relies on Kudumakis’s fundamental and harmonic tones as the frequency components in the combined system, as further suggested by Cabot and Tilki. *See* Pet. 57 (arguing that Tilki teaches that “that humans are relatively insensitive to certain types of phase distortions” (quoting Ex. 1008, 332)), 60 (“Cabot teaches differential phase shifts of the third harmonic relative to the fundamental are inaudible even under extreme testing conditions” (citing Pet. § VI.B; Ex. 1003 ¶ 200)), 63 (relying on the “Kudumakis/Tilki/Cabot Combination” to teach employing “the fundamental and the third harmonic (which are ‘at least two of the plurality of frequency components’) as the reference and signal bins based on Kudumakis and Cabot” (citing Pet. § VIII.B.3; Ex. 1003 ¶ 209)).

The preliminary record supports Petitioner’s assertions and explanations. At this stage, Patent Owner alleges deficiencies in combining the teachings of Kudumakis, Tilki, and Cabot, which we address below.

*d. Step 1C: “altering a phase of at least one of the plurality of frequency components in accordance with the data to be embedded, wherein,”*

Petitioner relies on the combined teachings of Kudumakis, Tilki, and Cabot to suggest implementing Tilki’s phase shifting technique using the fundamental and harmonic tones as suggested by Kudumakis and Cabot. *See* Pet. 57–62 (providing reasons for the combination and resulting system, including that phase shifting of harmonics is relatively imperceptible), 63–64. Petitioner contends that “Tilki’s differential phase encoding . . . alters the phase of the signal bin (corresponding to the third harmonic [of Kudumakis] which is ‘one of the plurality of frequency components’) in accordance with the data to be embedded such that the phase difference between the signal and reference bins is either  $+\phi$  or  $-\phi$  (where  $\phi$  can be  $\pi/8$ ) to embed a digital one or zero, which are data.” *Id.* (citing Ex. 1008, 331–32; Ex. 1003 ¶ 210).

The preliminary record supports Petitioner’s assertions and explanations. On this record, Petitioner sufficiently shows that the combined teachings of Kudumakis, Tilki, and Cabot to satisfies step 1C. At this stage, Patent Owner alleges deficiencies in combining the teachings of Kudumakis, Tilki, and Cabot, which we address below.

*e. Step 1C-1: “wherein . . . step b comprises selecting a fundamental tone and at least one overtone”*

As indicated above, Petitioner relies on implementing the fundamental tone and harmonic tones of Kudumakis for phase shifting as suggested by the combined teachings of Kudumakis, Tilki, and Cabot. Pet. 63. Petitioner states as follows:

In the Kudumakis/Tilki/Cabot Combination, the selection of Tilki's reference and signal frequency bins is modified, based on Kudumakis and Cabot, to select the fundamental and the third harmonic (which is an overtone) to achieve a robust low-visibility watermarking system, as explained *supra* [Pet.] § VIII.B; [Ex. 1003] ¶ 211. As Kudumakis explains, numerous known techniques (e.g., FFT) could be used "to find both the fundamental and its harmonics." [Ex. 1007] 4:26–30; [Ex. 1003] ¶ 211.

Pet. 64.

f. Step 1C-2: *"and step (c) comprises quantizing a phase difference of the at least one overtone relative to the fundamental tone to embed at least one bit of the data to be embedded."*

As indicated above, Petitioner relies on Tilki's differential phase encoding operating on Kudumakis's fundamental and harmonic tones. According to Petitioner,

[t]he Kudumakis/Tilki/Cabot Combination uses Tilki's differential phase encoding that quantizes the phase difference between the signal bin (the third harmonic [of Kudumakis] which is "at least one overtone") and the reference bin (fundamental tone) to embed at least one bit of data by adjusting the phase of the signal bin so that the phase difference is one of two values, either  $+\phi$  (clockwise rotation) which represents a data bit of "1" or  $-\phi$  (counterclockwise rotation) which represents a data bit of "0."

Pet. 64–65 (citing Pet. § VIII.B; Ex. 1008, 331–332 (Encoding); Ex. 1003 ¶ 212 (setting the phase difference to one of two values is quantization)).

g. Reasons to Combine/Teaching Away Analysis

Petitioner provides several reasons to combine the teachings of Kudumakis, Tilki, and Cabot. *See* Pet. 57–62. Petitioner contends that Tilki's phase encoding is "a suitable alternative to Kudumakis's notch encoding for embedding a watermark for at least four reasons." Pet. 57.

First, Petitioner contends that Tilki's differential phase encoding provides embedded data advantageous for watermarks because it uses "fast algorithms which allow real time processing." *Id.* (quoting Ex. 1008, Abstract). Second, Petitioner contends that "phase encoding avoids the complexity of removing a portion of the audio signal that notch encoding requires." *Id.* at 58 (citing Ex. 1003 ¶ 191). Third, Petitioner contends that "notch encoding and phase encoding were known alternatives for encoding an audio signal." *Id.* (citing Ex. 1003 ¶ 192; Ex. 1005, 1:44–58, 11:17–59). Fourth, Petitioner contends that Tilki bases its technique on the "well-known [principle] that humans are relatively insensitive to certain types of phase distortions," rendering it useful to imperceptibly embed a watermark. *Id.* (alteration in original) (quoting Ex. 1008, 332) (citing Ex. 1003 ¶ 193).

Petitioner also argues that "Tilki's differential phase encoding/decoding with frequencies selected based on the fundamental and harmonics" improves the security of Kudumakis for reasons further suggested by Kudumakis. Pet. 58. According to Petitioner, Kudumakis teaches that a "watermark should be inaudible and robust against 'malicious attacks.'" *Id.* (quoting Ex. 1007, 5:1–5; citing Ex. 1003 ¶ 195; Pet. § VI.D). Petitioner explains that "Kudumakis teaches the fundamental and its harmonics were advantageous selections for determining the location of a watermarking code because they vary through the audio signal which introduces security-enhancing unpredictability." *Id.* at 59. On the other hand, Tilki's "frequency selection technique . . . 'modif[ies] the phase of every fourth FFT bin above 2 kHz.'" *Id.* (citing Ex. 1008, 332). Therefore, according to Petitioner, employing harmonics for coding provides robustness enhancement because 1) "Tilki's frequencies remain constant across time frames and do not unpredictably vary like the fundamental and its harmonics

do,” and 2) “the fundamental and its harmonics (e.g., third harmonic) are typically in the perceptually more-significant frequencies (below 2 kHz) in speech-dominated audio content, and it was known that robustness increases by embedding hidden data in the most perceptually significant frequencies.” *Id.* (citing Ex. 1020, Abstract; Pet. § VI.E.1.b).

Similar to its showing for Ground 1, Petitioner also relies on Cabot to “teach that imperceptibility is instead achieved by performing the [differential] phase shift [of Tilki] directly at the fundamental and the third harmonic.” *See* Pet. 60 (citing Pet. § VI.B; Ex. 1003 ¶ 201). Petitioner contends that Cabot suggests modifying “Kudumakis’s *notch* encoding” to place the codes directly at the harmonic. *See id.* Petitioner explains that in Kudumakis’s notch encoding system, “the fundamental and its harmonics determine where to insert the codes, but the codes are placed at their ‘edges’ because the ““codes are more perceptible if the notch frequencies coincide with the main frequency component[] of the signal.”” *Id.* (quoting Ex. 1007, 3:4–9; citing *id.* at 3:30–4:5, 4:26–5:2; citing Pet. § VI.B; Ex. 1003 ¶ 201).

Petitioner also contends that “Tilki describes techniques for achieving a high data rate that provides additional bandwidth – including encoding at multiple frequencies in a timeframe to encode multiple bits – but recognizes a tradeoff between higher data rate and lower perceptibility.” Pet. 61 (citing Ex. 1008, 331 (Introduction), 332 (Simulation Results – “the perceived quality of the primary signal suffers as the data rate . . . increases”). However, according to Petitioner, an artisan of ordinary skill “would have understood that a high data rate is unnecessary for many watermark applications and that embedding one bit of data per time frame would suffice.” *Id.* (citing Ex. 1003 ¶ 202; Ex. 1046, 589 (referencing a data rate of 2 bits per 100 frames for copyright control watermarks)).

Patent Owner contends there is no motivation to combine Cabot, Kudumakis, and Tilki. Prelim. Resp. 52–62. Patent Owner asserts teaching away to support this argument:

*Kudumakis* teaches away from encoding data at the fundamental and overtones. Rather, *Kudumakis* teaches that data should be embedded in the weaker masked spectral components near stronger harmonics, and cautions against modifying the strongest frequency components of the signal (such as a fundamental and its overtones) themselves. *Kudumakis* discloses that “codes are ***more perceptible*** if the notch frequencies ***coincide with the main frequency component*** of the signal.”

Prelim. Resp. 53 (alteration in original) (quoting Ex. 1007, 3:4–6).

Contrary to this argument, Kudumakis does not teach away from embedding codes at the harmonic as similarly explained above in addressing Ground 1. As Patent Owner notes, Kudumakis discloses that “codes are more perceptible if the notch frequencies ***coincide with the main frequency component of the signal***.” Prelim. Resp. 53 (quoting Ex. 1007, 3:4–6). But Petitioner does not propose inserting a phase shifted code at the fundamental—the main frequency component. Rather, Petitioner relies on Tilki’s “differential phase encoding” to insert the code at a harmonic. Pet. 63–64.

Patent Owner argues that Petitioner’s assertion that “Tilki’s encoding method is fast, ‘which was advantageous for many watermarking applications’” is a “conclusory assertion” without “any [cited] support.” See Prelim. Resp. 53–54 (quoting Pet. 57–58; citing Ex. 1003 ¶ 190). Contrary to this argument, Petitioner cites Tilki’s abstract, which states that it “encode[s] an auxiliary channel onto a digital audio signal such that it is imperceptible to human observers,” and “the encoding and decoding are achieved via fast algorithms which allow real time processing.” Ex. 1008,

331 (Abstract). Tilki’s abstract also states that “the method is applicable for any digitized audio signal containing voice, music, or other acoustic signals to be heard by humans.” *Id.* The ’961 patent admits that “[d]igital watermarking currently is receiving a great amount of attention” and “[a] watermark is data that is embedded in a media or document file that serves to identify the integrity, the origin or the intended recipient of the host data file.” Ex. 1001, 1:28–34. In other words, Petitioner sufficiently supports its showing that an artisan of ordinary skill would have recognized that Tilki’s method is advantageous for watermarking because it employs fast algorithms, where watermarking is merely a type of embedded digital audio data well known to those of ordinary skill in the art.

Patent Owner also argues that Petitioner’s allegation that “phase encoding is less complex than notch encoding” is conclusory. *See* Prelim. Resp. 54 (citing Pet. 58). Patent Owner’s argument is unavailing. As Patent Owner acknowledges, Dr. Scordilis explains that “a notch filter requires designing a notch filter to have the desired characteristics of how much of the original signal to remove and where,” and that this “complexity can be avoided by simply phase shifting a portion of the original audio signal.” *Id.* (quoting Ex. 1003 ¶ 191). This explanation is reasonable on this preliminary record. Petitioner sufficiently shows that Tilki’s phase shifting scheme does not require a notch filter, and as discussed above in connection with Ground 1, Kudumakis describes its notch filter technique as applicable for amplitude or phase modulation. *See* Ex. 1003 ¶¶ 87, 191; *supra* § I.C.1.e (citing Pet. 20; Ex. 1007, 6:1–2; Ex. 1003 ¶ 87).

Patent Owner also argues that “Dr. Scordilis does not . . . explain how” a person of ordinary skill in the art would “simply phase shift[] a portion of the audio signal.” Prelim. Resp. 54 (quoting Ex. 1003 ¶ 191).

This argument also is unavailing. The preliminary record includes references describing phase shifting a portion of the audio, which signifies that artisans of ordinary skill knew how to phase shift audio. *See, e.g.*, Pet. 52–57 (describing Tilki’s phase shifting technique); 9–18 (describing Srinivasan’s and Cabot’s phase shifting techniques).

Patent Owner also challenges as conclusory and unsupported Petitioner’s rationale that notch encoding and phase encoding “were known alternatives for encoding an audio signal.” Prelim. Resp. 54–55 (citing Pet. 58). This argument also is unavailing. As Patent Owner acknowledges, Petitioner and Dr. Scordilis each provide citations to Srinivasan to support this contention, and Patent Owner agrees that Srinivasan describes “notch filtering as a prior art method in ‘the field of encoding audio signals for broadcast audience measurement purposes,’” and “describes encoding binary data using phase shifts.” *Id.* (quoting Ex. 1005, 1:44–58; citing *id.* at 11:17–59).<sup>14</sup>

Patent Owner also challenges Petitioner’s rationale that Tilki bases its technique on the “well-known [principle] that humans are relatively insensitive to certain types of phase distortions,” rendering it useful to imperceptibly embed a watermark. *See* Pet. 58 (quoting Ex. 1008, 331); Prelim. Resp. 56 (citing Pet. 58). According to Patent Owner, Tilki employs a phase shift of “ $\pi/8$  radians [which] equals a shift of 22.5 degrees,” and “Cabot determined that a phase shift of 22.5 degrees was detectable by human listeners 60% of the time.” *Id.* at 55. Therefore, Patent Owner

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<sup>14</sup> At the cited passage, Srinivasan states that this prior art “notch” technique “led to codes that were audible when the original audio signal containing the code was of low intensity.” Ex. 1001, 1:49–51.

contends that “Tilki’s phase encoding method could not ‘imperceptibly embed a watermark,’ as Petitioners allege.” *Id.* at 56 (quoting Pet. 58).

Patent Owner’s argument lacks sufficient support on this preliminary record to distinguish Tilki’s general statement that “[i]t is a well-known [principle] that humans are relatively insensitive to certain types of phase distortions.” *See* Ex. 1008, 331. Tilki does not qualify this statement as limited to certain frequency ranges and if anything, on this preliminary record, Cabot’s method of phase modulating symmetrical harmonics is an exemplary form of phase modulation falling under the ambit of Tilki’s general statement.<sup>15</sup>

Patent Owner’s argument is also unavailing for the reasons explained in addressing Ground 1 above. In summary, as determined above on this preliminary record, Cabot’s 60% detection rate for a third harmonic phase shift is only slightly better than chance (i.e., 50%), that rate only is accurate for ideal testing conditions, the ’961 patent’s disclosed technique is no better in terms of insensitivity than real-world harmonic phase shifts because it employs materially the same scheme as Petitioner’s proposal, and the arguments and evidence of teaching away are not commensurate in scope with the broad challenged claims because they do not require a level of insensitivity. *See supra* § I.C.1.e. As indicated above (*id.*), preliminary record evidence suggests that Cabot’s phase shifts of symmetrical harmonics

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<sup>15</sup> Tilki suggests that its technique is also advantageous for coding the lower part of the audio spectrum, because higher frequency “regions with lower sensitivity are more sensitive to quantization effects.” *See* Ex. 1008, 331 (Future Improvements); Pet. 24–25 (quoting Tilki as teaching that “lower frequencies (below say 2 kHz) . . . typically contain the most energy in common audio signals” (quoting Ex. 1003, 331)).

relative to the fundamental are less perceptible than phase shifts of more generic frequency components. *See* Ex. 1031 (Lipshitz), 584 (noting symmetrical waveforms like those resulting from Cabot’s use of the fundamental and third harmonic give rise to “much less pronounced phase effects” than those displayed by asymmetrical signals).

Patent Owner also argues that “Tilki does not teach how to identify a fundamental or overtones, or how to implement a variable bin spacing between the reference bin and signal bin.” Prelim. Resp. 58. This argument does not undermine Petitioner’s obviousness showing. Petitioner relies on Kudumakis to teach how to identify a fundamental or overtones in a process that involves variable frequency FFT spacings as the fundamental changes depending on the audio signal. *See* Pet. 61–62; Ex. 1008, 3–5 (describing notch filter designs based on finding FFT frequency bands with the most energy content).

Patent Owner also argues that modifying Tilki’s method to include a fundamental and harmonic results in a gap between coding bins of either 94 or 186 bins, depending on the hypothetical scenario advanced by Patent Owner. *See* Prelim. Resp. 57–58. According to Patent Owner, a person of ordinary skill in the art “reading Kudumakis alongside Tilki would understand that Tilki’s phase encoding method could not be implemented using a fundamental and third harmonic.” *Id.* at 59.

Contrary to this line of argument, Patent Owner simply shows that the gap between Tilki’s frequency bins increases in the modification, but this does not show that the proposed modification “could not be implemented using a fundamental and third harmonic.” *See* Prelim. Resp. 59. Patent Owner also argues that bin gaps of 94 or 186 between a fundamental and third harmonic is counter to Tilki’s teachings, because Tilki teaches

“modifying the phase of a signal bin *relative to the immediately preceding bin*, not the bin 186 [or 94] bins away.” *See id.* 57–58 (emphasis added). But increasing the bin spacing according to a disclosed embodiment to accommodate a harmonic does not show the modification “could not be implemented.” *See id.*

Moreover, this attorney argument rests on Patent Owner’s hypothetical selection of a *fundamental* tone above 2000Hz for encoding and posits that the fundamental tone must be coded under Petitioner’s showing. *See* Prelim. Resp. 57–58. Patent Owner selects this frequency because it asserts that Tilki teaches selecting tones for encoding “say 2kHz” (i.e., above 2000 Hz). *See id.* This hypothetical scenario mischaracterizes Petitioner’s showing.

Petitioner proposes modifying Tilki’s differential phase encoding scheme to phase modulate the *third harmonic*, which does not require phase modulating (encoding) the *fundamental* tone. *See* Pet. 63–64 (the modification “alters the phase of the signal bin (corresponding to the third harmonic which is ‘one of the plurality of frequency components’ [as claimed]).” Therefore, employing Patent Owner’s math under one of its hypothetical scenarios, but selecting a fundamental tone of 667.529 Hz (which equals  $2002.588 \text{ Hz}/3$ ) for example (i.e., a tone in the stronger more perceptible portion of the audio frequency range as Kudumakis and Cabot suggest), results in a third harmonic of 2002.588 Hz (relative to 667.529 Hz) for encoding at bin 93 (i.e., within Tilki’s preferred range). *Cf.* Prelim. Resp. 58 (“Assuming bin 93 contains a fundamental tone, its corresponding third harmonic at 6,077.763 Hz ( $2,002.588 * 3$ ) would be within bin 279—a difference of 186 bins.”). That is, in this hypothetical scenario (which modifies Patent Owner’s hypothetical scenario), the resulting bin for the

fundamental tone would not be bin 93 as Patent Owner posits, but rather, roughly bin 93/3, or bin 31. *See id.* at 57–58 (describing a “well known” bin calculating formula). Therefore, with the bin of the third harmonic at 2002.588 Hz falling at bin 93, this results in a gap between bins of 62 (93–31). The bins would be even closer together by roughly a factor of 2 (i.e., 31), with an FFT size of 1024 and a fundamental tone of 667.529 Hz.<sup>16</sup>

Patent Owner also contends that “Petitioners’ theoretical method would encode a single bit in the span of 186 FFT bins—or more or less, depending on FFT size.” Prelim. Resp. 59. Patent Owner maintains that “Petitioners do not explain why a POSA would have been motivated to modify Tilki’s method to be less efficient.” *Id.* at 58–59 ((arguing that “Figure 1 discloses encoding 5 bits of data in the span of roughly 20 FFT bins using Tilki’s method of shifting a bin’s phase relative to its immediately preceding neighbor”).

These arguments assume large bin gaps that do not exist under Petitioner’s modification as explained above. To the extent the modification results in fewer embedded coding bits per frame, contrary to Patent Owner’s arguments, Petitioner accounts for this, arguing that its modification results in benefits. For example, as explained above, Petitioner explains that “it was known that robustness increases by embedding hidden data in the most perceptually significant frequencies” (Pet. 59 (citing Ex. 1020 (“Cox-1995”), Abstract; Ex. 1003 ¶ 199)), but the proposed modification results in “[e]nhanced security against malicious attacks” (*id.* (quoting Ex. 1007, 5:16)).

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<sup>16</sup> *Cf.* Prelim. Resp. 58 (“For example, with an FFT size of 1024, the above scenario would result in a gap of 94 bins between a fundamental at bin 47 (2,025.7 Hz) and its third harmonic in bin 141 (6,077.1 Hz)).

Petitioner also acknowledges that Tilki provides high data rates, but argues that Tilki “recognizes a tradeoff between higher data rate and lower perceptibility.” Pet. 61 (citing Ex. 1008, 331 (Introduction), 332 (Simulation Results—“the perceived quality of the primary signal suffers as the data rate . . . increases”). Petitioner also argues that high data rates are unnecessary “for many watermark applications and . . . embedding one bit of data per time frame would suffice.” *Id.* (citing Ex. 1003 ¶ 202; Ex. 1046, 589 (referencing a data rate of 2 bits per 100 frames for copyright control watermarks)).

The preliminary record supports Petitioner. Tilki specifically notes that its technique of embedding digital audio information is useful for a wide variety of applications, including to embed “artist information, song titles, song lyrics, karaoke information, still images, and perhaps even video clips.” *See* Ex. 1008, 331. An artisan of ordinary skill would have recognized that a typical song title requires fewer encoding data than a typical video clip, signifying that Tilki, like the challenged claims, contemplates a wide range of data rates, even if some of Tilki’s examples provide high data rates.

Further addressing Tilki’s disclosed high data rate applications, Patent Owner challenges Petitioner’s reliance on Cox 1998 (Ex. 1046) to show that “embedding one bit of data per time frame would suffice” for a watermark. Prelim. Resp. 61 (quoting Pet. 61; citing Ex. 2003 ¶ 202). Patent Owner argues Cox 1998 “is not analogous art” because it relates to “watermark bits in the frames of a video signal, not an audio signal.” *Id.* Patent Owner also raises an issue about the propriety of applying Cox 1998’s video frame data and data rates to Tilki to show that one bit of data per an audio frame suffices for a watermark. *See id.* at 61–62. At this preliminary stage, it is not necessary to reach these issues about Cox 1998, because the challenged

claims do not specify a lower data rate or require a watermark, and the broad teachings of Tilki apply to a range of data rates.

Patent Owner does not disagree that “robustness increases by embedding hidden data in the most perceptually significant frequencies.” *See* Prelim. Resp. 59–61. Rather, Patent Owner argues that “Petitioner[] and Dr. Scordilis conclusorily assert that ‘Tilki’s frequencies remain constant across time frames and do not unpredictably vary like the fundamental and its harmonics do.’” Prelim. Resp. 59 (quoting Pet. 59). Contrary to this argument, Petitioner argues that “Tilki’s frequency selection technique which ‘modif[ies] the phase of every fourth FFT bin above 2 kHz’ (Tilki, 332) was more susceptible to detection and malicious removal of a watermark than Kudumakis’s.” Pet. 59. Patent Owner does not address this showing at this stage, in which Petitioner sufficiently shows for institution purposes that Tilki’s frequencies *in every fourth FFT bin* “do not unpredictably vary.” *Id.*

Patent Owner also argues that “Petitioner[’s] assertion [about increases in robustness] contradicts Tilki’s directive that ‘the lower **frequencies (below** say 2 kHz), which typically contain the most energy in common audio signals, **are left untouched.**’” Prelim. Resp. 60. Again, this argument does not disagree that robustness increases with the modification as proposed by Petitioner. Rather, it is a teaching away argument. *See id.* (“Tilki teaches away from encoding in frequencies below 2 kHz.”). Even if Tilki’s teaching to use codes at frequencies “below say 2 kHz” is a teaching away, rather than a mere preference, the argument incorrectly assumes that the third harmonic always lies below 2 kHz in Petitioner’s proposed modification.

The argument also ignores that the challenged claims allow for encoding harmonics below 2 kHz. Therefore, Patent Owner’s “teaching away argument is of questionable relevance,” because Patent Owner’s “evidence” does not “relate to and is” not “commensurate in scope with the ultimate claims at issue.” *See Idemitsu*, 870 F.3d at 1381 (“Evidence concerning whether the prior art teaches away from a given invention must relate to and be commensurate in scope with the ultimate claims at issue.”). In other words, “[a] reference teaches away *from a claimed invention* if it ‘criticizes, discredits, or otherwise discourages’ *modifying the reference to arrive at the claimed invention*.” *Fulton*, 391 F.3d at 1201 (emphasis added)).

As indicated above, the claimed invention does not preclude coding frequencies in harmonics below 2 kHz, or a set data rate. Therefore, under *Idemitsu* and *Fulton*, Tilki’s preference for codes at frequencies “say below 2KHz,” or its disclosure of high data rates, do not undermine Petitioner’s obviousness showing or teach away from the (full scope of the) claimed invention, especially where Petitioner advances advantages. *See also Allied Erecting & Dismantling Co. v. Genesis Attachments, LLC*, 825 F.3d 1373, 1381 (Fed. Cir. 2016) (“[A] given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine.” (internal quotation omitted)); *Mouttet*, 686 F.3d at 1330 (noting that the Board found adequate reasons to combine the cited references because, among other things, the Board found that “the relative advantages and disadvantages in selecting electrical circuitry in lieu of optical circuitry amounts to an engineering trade-off—a decision well within the level of ordinarily skilled artisans”).

In addition, on this preliminary record, Patent Owner does not challenge the competing benefits of robustness and security versus any quantifiable decrease in alleged increase in phase shift perception. *See Intel Corp.*, 2023 WL 2198649 at \*4 (reversing the Board and finding patent owner’s expert’s testimony did not support the Board’s finding of a lack of motivation where the “expert does not opine *how much the modification would increase latency* or whether the latency introduced by the additional arbitration logic would be offset by the ability for the cache cores to operate as a single large cache” or “[i]n other words, . . . *merely opines that there is an unspecified processing speed ‘cost’ associated with implementing Arimilli’s L3 caches in King’s bus system but does not opine on whether the benefits of the implementation outweigh the cost*” (emphasis added)); Prelim. Resp. 6–8 (acknowledging trade-offs exist).

Patent Owner also argues that “*Tilki* explains ‘stronger low frequency components help to mask the changes made in the higher frequency region’” and alleges this supports teaching away “from encoding in frequencies below 2 kHz.” Prelim. Resp. 60 (quoting Ex. 1008, 331). It is not clear on this preliminary record how this masking of higher frequencies teaches away from encoding lower frequencies. Assuming that energy from stronger low frequency components masks coding changes at higher frequencies, *Tilki* does not state that the unmodified lower frequency components (including the fundamental tone), which necessarily exist in real-world audio signals, do not also mask coded frequencies *near those frequencies*. In context, *Tilki* merely expresses how lower frequency components mask coding for its embodiment that includes coding at higher frequencies. *See* Ex. 1008, 331.

h. Reasonable Expectation of Success Analysis

Based on its showing as summarized above, Petitioner asserts that a person of ordinary skill in the art “would have had a reasonable expectation of success in implementing Tilki’s differential phase encoding with the fundamental and third harmonic as the reference and signal bins, as suggested by Kudumakis and Cabot.” Pet. 61 (citing Ex. 1003 ¶ 204).

Patent Owner relies on its teaching away arguments based on Cabot and Tilki, as indicated above. Prelim. Resp. 62–63. These arguments are unavailing for the reasons addressed above. Based on the foregoing discussion, Petitioner shows a reasonable expectation of success for institution purposes in implementing Tilki’s differential phase encoding with the fundamental and third harmonic as the reference and signal bins, as suggested by Kudumakis and Cabot. On this preliminary record, the proposed modification simply involves altering the coding frequencies of Tilki or Kudumakis so that they include the fundamental and (phase-shifted) harmonics of the audio frequency, as suggested by the combined teachings of Cabot and Kudumakis.

i. Summary of Claim 1

Based on the foregoing analysis and discussion, we determine that Petitioner establishes a reasonable likelihood of prevailing on its showing that claim 1 would have been obvious over the combined teachings of Tilki, Kudumakis, and Cabot.

3. *Claims 2–10*

Petitioner also contends that the subject matter of independent claims 4, 6, and 9, and dependent claims 2, 3, 5, 7, 8, and 10 would have been obvious over Kudumakis, Tilki, and Cabot. Pet. 62–76. Petitioner

substantiates its contentions with analysis that addresses each claim limitation and identifies supporting evidence, relying partly on its analysis of claim 1. *See id.*

Other than its arguments presented regarding claim 1, Patent Owner does not dispute Petitioner's showing for these claims. *See* Prelim. Resp. 24–43. On this record, we determine that Petitioner establishes a reasonable likelihood of prevailing on its showing that claims 2–10 would have been obvious over the combined teachings of Kudumakis, Tilki, and Cabot.

#### IV. CONCLUSION

After considering the evidence and arguments of record, we determine that Petitioner has demonstrated a reasonable likelihood of success with respect to at least one of the challenged claims. Accordingly, an *inter partes* review of all of the claims and all of the grounds presented in the Petition is hereby instituted. *See* 37 C.F.R. § 42.108(a).

At this stage of the proceeding, the Board has not made a final determination as to the patentability of any challenged claims or any underlying factual or legal issues. The final determination will be based on the record as developed during the *inter partes* review.

#### V. ORDER

In consideration of the foregoing, it is hereby

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of the challenged claims of the '961 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the '961 patent shall commence

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on the entry date of this Order, and notice is hereby given of the institution  
of a trial.

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SONY GROUP CORP. (JAPAN), SONY CORP. OF AMERICA, SONY  
INTERACTIVE ENTERTAINMENT LLC, SONY PICTURES  
ENTERTAINMENT INC., SONY ELECTRONICS INC.,  
and VERANCE CORP.,  
Petitioner,

v.

MZ AUDIO SCIENCES, LLC,  
Patent Owner.

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Before KARL D. EASTHOM, DAVID C. McKONE, and  
IFTIKHAR AHMED, *Administrative Patent Judges*.

McKONE, *Administrative Patent Judge*, dissenting.

I dissent because I would find that the prior art teaches away from  
Petitioner's proposed combinations.

“When a piece of prior art ‘suggests that the line of development  
flowing from the reference’s disclosure is unlikely to be productive of the  
result sought by the applicant’ the piece of prior art is said to ‘teach away’  
from the claimed invention.” *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d

1157, 1165 (Fed. Cir. 2006) (quoting *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994)). “A reference does not teach away, however, if it merely expresses a general preference for an alternative invention but does not ‘criticize, discredit, or otherwise discourage’ investigation into the invention claimed.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009) (citing *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004)). “The prior art’s mere disclosure of more than one alternative does not constitute a teaching away from any of these alternatives because such disclosure does not criticize, discredit, or otherwise discourage the solution claimed in the [challenged invention].” *Fulton*, 391 F.3d at 1201. Moreover,

obviousness must be determined in light of all the facts, and there is no rule that a single reference that teaches away will mandate a finding of nonobviousness. Likewise, a given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine. . . . Where the prior art contains “apparently conflicting” teachings (i.e., where some references teach the combination and others teach away from it) each reference must be considered “for its power to suggest solutions to an artisan of ordinary skill . . . . consider[ing] the degree to which one reference might accurately discredit another.”

*Medichem*, 437 F.3d at 1165 (quoting *In re Young*, 927 F.2d 588, 591 (Fed. Cir. 1991)) (internal citation omitted).

Starting with Petitioner’s proposed combination of Srinivasan, Cabot, and Kudumakis, the preliminary record suggests that a skilled artisan would have been dissuaded from modifying Srinivasan’s technique to select, as  $f_1$  and  $f_0$ , a fundamental tone and at least one overtone, as required by claim 1. Srinivasan is directed to “a system and method for adding an *inaudible* code to an audio signal and subsequently retrieving that code.” Ex. 1005, 1:5–7

(emphasis added). Srinivasan describes ways of encoding information in code frequencies  $f_i$ , where the code frequencies “may be chosen . . . in the 4.8 kHz to 6 kHz range in order to exploit the higher auditory threshold in this band.” *Id.* at 7:64–67. In one example, code frequencies  $f_1$  and  $f_0$  are selected using a frequency hopping technique with a reference frequency  $f_{5k}$  “chosen because it is above the average maximum sensitivity frequency of the human ear.” *Id.* at 8:8–28. In another example, code frequency indices (corresponding to code frequencies) are chosen by determining “a frequency index  $I_{max}$  at which the spectral power of the audio signal . . . is a maximum in the low frequency band extending from zero Hz to two kHz” and choosing code indices  $I_1$  and  $I_0$  relative to  $I_{max}$  “so that they lie in a higher frequency band at which the human ear is relatively less sensitive,” for example using “reference frequency  $f_{5k}$  is five kHz.” *Id.* at 8:50–65. Additionally, in its example of phase modulating between  $f_1$  and  $f_0$ , Srinivasan notes that a maximum phase modulation of 180 might make the code audible, and prefers “a phase neighborhood extending over a range of  $\pm\pi/4$  around  $\varphi_R$ , the reference component, and another neighborhood extending over a range of  $\pm\pi/4$  around  $\varphi_R+\pi$  may be chosen.” *Id.* at 11:41–49.

As Srinivasan’s description shows, Srinivasan placed its encoding in a frequency range above the sensitivity of the typical human ear in order to keep the encoding inaudible. This makes sense, as Srinivasan’s invention is in the context of encoding information in audio and video, such as television and radio, that humans would expect to listen to without distraction. *Id.* at 1:13–2:44. Petitioner does not contend that “selecting a fundamental tone and at least one overtone,” as recited in claim 1, would fall within the range selected by Srinivasan for inaudibility. In all but extreme cases, it would

not. Thus, I would find that Srinivasan “criticize[s], discredit[s], or otherwise discourage[s]” selecting a fundamental tone and at least one overtone, and that a skilled artisan would have concluded that Srinivasan’s “disclosure is unlikely to be productive of the result sought by the applicant.” *Fulton*, 391 F.3d at 1201; *Gurley*, 27 F.3d at 553. *Cf. DePuy Spine* 567 F.3d 1314 at 1328 (“The Puno ’602 patent consistently views low rigidity as an advantage and high rigidity as a disadvantage, one that should be avoided whenever possible. The Puno ’602 patent thus bolsters, rather than undermines, the district court’s finding that the prior art teaches away from rigid pedicle screws.”).

Petitioner’s first argument as to why a skilled artisan would nevertheless select the fundamental and an overtone for  $f_1$  and  $f_0$  is that the artisan would have “understood from Cabot that there was an alternative way to achieve low-visibility differential phase encoding.” Pet. 22. Cabot describes experimenting with “[o]ne channel of a Crown DC-300-A amplifier [being] fed a mixture of the fundamental (400 Hz) and the third-harmonic (1200 Hz) signals,” and “[t]he other channel is fed with a mixture of the fundamental and the phase -shifted third -harmonic signals.” Ex. 1006, 568. Cabot confirms that encoding in the frequency range Srinivasan avoids would in fact be audible: “The experiment shows phase shifts of harmonic complexes to be detectable, but judging from the difficulty experienced by the subjects, the effect appear to be small.” *Id.* at 570. As noted above, in one example, Srinivasan describes encoding information using a  $\pm\pi/4$  phase shift. Ex. 1005, 11:46–49. Petitioner relies on this example. Pet. 34. However, at a phase shift of  $45^\circ$ , Cabot’s experimental data show a 75% to 89% probability that phase shift would be audible. Ex. 1006, 570 (Table II, Experiment 1, Fig. 3).

Nevertheless, Petitioner argues that, according to Cabot, the encoding, although audible, would still be hard to hear. Pet. 22–23 (citing Ex. 1006, 571; Ex. 1028, 114; Ex. 1031, 584). I do not find persuasive Petitioner’s reliance on Risset and Lipshitz to bolster Cabot’s teaching, as Risset and Lipshitz merely cite to Cabot for this point, but do not add to it. Ex. 1028, 114; Ex. 1031, 584. Dr. Scordilis largely copies the arguments in the Petition without adding to them materially, so I do not find that testimony particularly persuasive. Ex. 1003 ¶¶ 119–124. Specifically, I would not find that Cabot, and the references discussing Cabot, would have persuaded a skilled artisan to disregard Srinivasan’s concerns and move in the direction of the claimed invention. A greater than 75% chance of hearing the encoding at Cabot’s frequencies, per Cabot’s own test data, is more consistent with Srinivasan’s choice of frequencies outside the range of typical human hearing to make the encoding inaudible. Thus, the preliminary record suggests to me that Cabot confirms Srinivasan’s concerns and, along with Srinivasan, would have led a skilled artisan away from the claimed invention.

Petitioner further argues that a skilled artisan, when encoding data in “audio files including speech,” would have downplayed Srinivasan’s concerns and disregarded its teachings in favor of an approach that uses “perceptually more-significant lower frequencies,” those “well below the 4.8–6 kHz range Srinivasan used,” in order to be less susceptible to distortion and malicious attacks. Pet. 24–26. Kudumakis, Petitioner argues, suggests the fundamental frequency and its harmonics for encoding data. *Id.* at 24 (citing Ex. 1007, 5:3–16, 3:17–18, 6:1–2). Kudumakis explains that

[t]he placement of the notch frequencies plays a significant role to the subjective quality of the coded signals. The codes are more perceptible if the notch frequencies coincide with the main frequency component of the signal. On the other hand, they have to be placed in a part of the spectrum with sufficient energy so that frequen[cy] masking conditions can be met.

Ex. 1007, 3:4–8. Kudumakis then describes expressly avoiding encoding in the fundamental and its harmonics and, instead, teaches encoding in neighboring frequencies. *Id.* at 3:22–4:5. Kudumakis is clear that “[c]are must be taken to ensure the insertion is not audible.” *Id.* at 5:1. Thus, Kudumakis is consistent with Srinivasan in leading a skilled artisan away from encoding information in the fundamental and its lower-order harmonics within the frequency range of typical human hearing. Srinivasan itself expressed concern about a similar system that encoded in notches made at low frequencies (e.g., 40 Hz), noting that “[t]his approach led to codes that were audible when the original audio signal containing the code was of low intensity.” Ex. 1005, 1:43–50.

Petitioner goes so far as to say that, for applications involving only vocalized speech, “[b]ecause such audio content commonly has frequencies up to about only 4 kHz, Srinivasan’s embedding band from 4.8 kHz–6 kHz would not work with such narrowband voice applications” as telephony and videoconferencing. *Id.* 26–27. However, Srinivasan describes its invention in the context of television and radio; thus, Srinivasan’s technique presumably works in contexts where speech predominates. Ex. 1005, 1:13–2:44, 6:18–23. I would find Dr. Scordilis’s testimony to the contrary to lack credibility.

Petitioner, in essence, wants us to find that Srinivasan got it wrong, and that Srinivasan’s concerns about the audibility of encoding at lower

frequencies were unfounded; enlightened by Cabot, Srinivasan would have used much lower frequencies (e.g., the fundamental and lower-order harmonics taught by Kudumakis) for encoding information to make it safer and easier to detect, while still being inaudible. However, I am not persuaded that the teachings of Cabot and Kudumakis effectively impeach the teachings of Srinivasan. Rather, Cabot and Kudumakis bolster Srinivasan's concerns about humans being able to hear information encoded in the frequency range of typical human hearing. In sum, I am not persuaded that the evidence in the preliminary record shows that a skilled artisan would have disregarded Srinivasan's teachings and sought to make the encoding safer and easier to detect, in effect moving in a direction contrary to Srinivasan's teachings and placing the encoding in audible frequencies. Instead, the artisan would have been led away from that solution.

The Majority is also particularly persuaded by the disclosure in the '961 patent, which observes that

[n]aturally occurring audio signals such as music or voice contain a fundamental frequency and a spectrum of overtones with well-defined relative phases. When the phases of the overtones are modulated to create a composite waveform different from the original, the difference will not be easily detected. Thus, the manipulation of the phases of the harmonies in an overtone spectrum of voice or music may be exploited as a channel for the transmission of hidden data.

Ex. 1001, 4:14–21. The Majority finds that this shows that skilled artisans were aware of the relative imperception of harmonic phase shifts. This strikes me as precisely the sort of hindsight we must avoid. That the inventors bucked the conventional wisdom reflected in Srinivasan is as much evidence of inventiveness as it is an admission of the scope of the

prior art. Petitioner has not asserted applicant admitted prior art, and I would avoid characterizing the specification in that way through hindsight.

In sum, I would find that the combination of Srinivasan, Cabot, and Kudumakis teaches away from the claimed invention and, thus, would not have rendered the invention obvious.

My concerns with Petitioner's ground based on Kudumakis, Tilki, and Cabot are similar. Tilki describes adding hidden information in high frequencies well beyond the fundamental and third harmonic: "A differential phase of  $\pi/8$  was used to modify the phase of every fourth FFT bin above 2 kHz in 2048 point FFT blocks." Ex. 1008, 332. Tilki chose this range deliberately for reasons similar to those articulated in Srinivasan:

It is well known that humans are relatively insensitive to certain types of phase distortions. We use this fact to encode additional information onto the phase of selected bins of an FFT. The signal bins are selected according to human sensitivity in the corresponding frequency bands, and are spaced to facilitate masking by unmodified neighboring bins in the same spectral region. In particular the lower frequencies (below say 2 kHz), which typically contain the most energy in common audio signals, are left untouched. The stronger low frequency components help to mask the changes made in the higher frequency region. Additionally, the unmodified FFT bins in the higher frequency region help to mask their modified neighbors.

*Id.* at 331. Petitioner's reasons for disregarding the teachings of Tilki are similar to those it gives for Srinivasan. Pet. 57–60. I am not persuaded for the reasons given above.

Additionally, Petitioner admits that lowering the frequency range of Tilki's encoding would have the additional drawback of lowering its data rate, but downplays this concern by arguing that high data rates as unnecessary in some applications. Pet. 61. Specifically, Tilki states

A secondary channel resulted with a capacity of over 5000 bits per second with little or no degradation in the perceived quality of the primary audio signal.

Higher data rates can be achieved by expanding the frequency region used for coding and using smaller spacing between signal bins in the FFT. However, as would be expected, the perceived quality of the primary signal suffers as the data rate of the auxiliary channel increases.

Ex. 1008, 332. I am not persuaded by Petitioner's dismissal of this concern; instead, I would find this to be one more teaching of Tilki that leads in a direction divergent from the claimed invention. Thus, I would find that the combination of Tilki, Kudumakis, and Cabot teaches away from the claimed invention and, thus, would not have rendered the invention obvious.

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