UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO. LTD.,
Petitioner,

v.

WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC,
Patent Owner.

Case IPR2025-00936
Patent 11,700,597

DECLARATION OF TODOR V. COOKLEV, PH.D.

TABLE OF CONTENTS

Page

I. INTRODUCTION 1

II. QUALIFICATIONS 1

III. COMPENSATION 4

IV. MATERIALS CONSIDERED 4

V. APPLICABLE LEGAL STANDARDS 5

A. Level Of Ordinary Skill In The Art 5

B. My Understanding Of Legal Standards 6

VI. OVERVIEW OF THE '597 PATENT 9

VII. OPINIONS 11

A. Ground 1A (Lee) 11

1. Lee does not disclose not using BSS color when signaling information indicates that an operation based on the BSS color is not allowed. 13

2. Dr. Mahon fails to show that Lee renders obvious that the Lee's processor would be configured "not to use [BSS] color" when the coloring disable bit indicates a trigger frame. 16

B. Ground 1B (Lee in combination with Stacey) 19

1. Dr. Mahon's proposed combination is nonsensical because it would require two bits of information to be indicated using only a single coloring disable bit. 20

2. Neither Lee nor Stacey discloses color collisions or disabling all BSS operations in response to color collisions. 24

C. Ground 2A (Choudhury) 29

1. Dr. Mahon's reliance on Choudhury's "Low Power/High Interference Indicator" bit fails because he fails to show how it indicates that an operation based on BSS color is not allowed. 30

2. Dr. Mahon's reliance on Choudhury's "Low Power/High Interference Indicator" bit additionally fails because he fails to show that Choudhury's processor is configured "not to use a [BSS] color indicated by the PPDU" when that bit is set to 1. 34

3. Dr. Mahon's reliance on Choudhury's "COLOR '0000' value" fails because channel access determination using the COLOR value would still occur under Dr. Mahon's theory, which Dr. Mahon explicitly alleges is a use of BSS color. 37

4. Dr. Mahon's reliance on Choudhury's "COLOR '0000' value" additionally fails because that theory is inconsistent with limitation [1.5]'s requirement that "the BSS color is an identifier of a BSS" in the context of Choudhary.....39

D. Ground 2B (Choudhury in combination with Stacey) 41

E. Ground 2C (Choudhury in combination with Zhou) 42

VIII. CONCLUSIONS 43

I. INTRODUCTION

1. My name is Todor V. Cooklev. I have been retained as an expert witness to provide my independent opinion in regard to the matters at issue in *inter partes* review of U.S. Patent No. 11,700,597 ("the '597 patent") in IPR2025-0093. I have been retained by Wilus Institute of Standards and Technology, Inc., the Patent Owner in the above proceedings. Petitioner is Samsung Electronics Co. Ltd. ("Petitioner").

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

II. QUALIFICATIONS

3. I am currently professor of electrical and computer engineering at Purdue University in Fort Wayne, Indiana. I teach several courses related to the hardware and software architectures of wireless systems and wireless devices. My research interests include most aspects of modern wireless systems, including hardware/software architectures.

4. I have received research funding from the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the U.S. Air Force Research Laboratory, the Office of Naval Research, and a number of private companies, including major technology companies.

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

6. I have authored and co-authored more than 100 peer-reviewed articles. I am also a named inventor on 32 U.S. patents, most of which relate to the hardware or software aspects of communication systems. For part of this work in 2019, I was inducted into the Purdue Inventors Hall of Fame. A list of my publications and patents appears in my *curriculum vitae* attached as Appendix 1. Among my publications is the textbook "Modern Communications Systems: A First Course", published by the University of Michigan at the beginning of 2024.

7. I have also experience in private industry. My work has been in the areas of communication protocols, software, digital signal processing, and integrated circuit design for communication systems.

8. I have contributed to the development of several major standards for communication systems and numerous amendments. I have participated in many meetings of standards committees. I have prepared, submitted, and presented documents relating to technical matters considered by these committees.

9. Between 2000-2002 and 2005-2008 I was a Voting Member of the IEEE 802.11 Working Group. Around 2005-2007 I was Chair or a Study Group within IEEE 802.11. For part of my work, I received an award from IEEE Standards Association in 2012. I have reviewed and voted on most IEEE 802.11

standards and amendments published since 2000. For example, I voted on IEEE 802.11-2016. *See* Exhibit 1020 at 9.

10. During this period, I have also reviewed and voted on other standards on wireless networking or on the implementation of wireless devices. Around 2007-2011 I participated in the Software-Defined Radio Forum (later the Wireless Innovation Forum). Around 2011-2012 I participated in the work of the 3GPP.

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

12. Between 2017 and 2025 I was Series Editor for Wireless and Radio Communications of the IEEE Communications Standards Magazine (which is the premier journal in the field of communication standards). As a member of the Editorial Board, I coordinated the review of scholarly manuscripts submitted to the wireless and radio communications series.

13. I am qualified by education and experience to testify as an expert with respect to subject matter in the fields of wireless communications, wireless communications protocols, hardware and software architectures for wireless devices, signal processing algorithms, and related areas.

14. I have attached a current copy of my curriculum *vitae* as Appendix 1, which includes a list of my publications. My CV also includes a list of cases

during at least the last five years in which I have testified as an expert either at a trial or deposition.

III. COMPENSATION

15. I am being compensated at my standard hourly rate of $700 for my time spent working in connection with this case. My compensation does not depend on my opinions or on the outcome of this litigation. If called as a witness, I would testify as to the statements and opinions contained in this report.

IV. MATERIALS CONSIDERED

16. In the course of conducting my analysis and forming my opinions, I have reviewed materials including those listed below:

i. U.S. Patent No. 11,700,597 (Ex. 1001) ("the '597 patent");

ii. The prosecution history of the '597 patent (Ex. 1002);

iii. The Declaration signed by Dr. Mark Mahon in IPR2025-00936 (Ex. 1003) (the "Mahon Declaration");

iv. Lee (Ex. 1005)

v. Stacey (Ex. 1006)

vi. Choudhury (Ex. 1009)

vii. The exhibits and other documents cited herein.

V. APPLICABLE LEGAL STANDARDS

A. Level Of Ordinary Skill In The Art

17. My opinions in this declaration are based on the understandings of a person of ordinary skill in the art, which I understand is sometimes referred to as an "ordinary artisan" or by the acronyms "POSITA" or "PHOSITA," as of the time of the invention, which I understand is here assumed to be the priority date (March 4, 2016). I understand that the person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. By "relevant," I mean relevant to the challenged claims of the '597 patent.

18. I understand that factual indicators of the level of ordinary skill in the art include the various prior art approaches employed, the types of problems encountered in the art, the rapidity with which innovations are made, the sophistication of the technology involved, and the educational background of those actively working in the field. I understand that, in assessing the level of skill of a person of ordinary skill in the art, one should consider the type of problems encountered in the art, the prior solutions to those problems found in the prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field, and my own experience working with those of skill in the art at the time of the invention.

19. In this case, Dr. Mahon has asserted in his declaration that a person of ordinary skill in the art as of the time of the ’597 patent would have had:

> a Bachelor’s degree in electrical engineering, computer engineering, computer science, or a related field, and at least 3 years of experience in the research, design or development of wireless communication devices, systems, and/or networks, or the equivalent. Increased educational experience can make up for less work experience, and vice versa.

Ex. 1003 [Mahon-Decl.] ¶ 33.

20. For the purposes of this declaration, I accept Dr. Mahon’s proposed qualifications of a POSITA.

21. Although my qualifications exceed those of a POSITA (and exceeded this level since before the priority date of the ’597 patent), my analysis and opinions are from the perspective of a POSITA, as set forth above.

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

B. My Understanding Of Legal Standards

23. When considering the ’597patent and stating my opinions, I rely on the following legal standards as described to me by the attorneys for Wilus Institute of Standards and Technology, Inc.

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

25. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention in view of the prior art and in light of the general knowledge in the art as a whole. I also understand that obviousness is ultimately a legal conclusion based on underlying facts of four general types, all of which must be considered: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) any objective indicia of non-obviousness, including any praise of the invention.

26. I also understand that obviousness may be established under certain circumstances by combining or modifying the teachings of the prior art. Specific teachings, suggestions, or motivations to combine any first prior art reference with a second prior art reference can be explicit or implicit, but must have existed before the date of purported invention. I understand that prior art references themselves may be one source of a specific teaching or suggestion to combine features of the prior art, but that such suggestions or motivations to combine art

may come from the knowledge that a person of ordinary skill in the art would have had.

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

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

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

30. I understand that claims are to be construed from the perspective of a POSITA, and should be given their plain meaning to a POSITA in light of the intrinsic record absent lexicography (e.g., a clear definition) or disclaimer (e.g., a clear narrowing of claim scope in the specification or prosecution history).

31. I am not offering any legal opinions in this declaration, nor am I qualified to do so. I only consider such legal standards in framing my opinions and

conclusions as well as placing assertions made by Petitioner in the Petition into the proper context. Additionally, from a subject matter perspective, I understand that the petitioner always has the burden of persuasion regarding a challenge of patentability of an invention under an inter partes review.

VI. OVERVIEW OF THE '597 PATENT

32. The '597 patent relates to WLAN device that classifies the data frames as Intra-Basic Service Set or Inter-BSS, depending on the BSS from which the frame is transmitted. The device is configured to access a channel depending on whether the frame is Intra- or Inter-BSS. *See* '597 patent at Abstract.

33. At a high level, the claims are directed to a device and method of using a device. In the independent device claim 1, a processor of the device is configured "not to use a Basic Service Set (BSS) color indicated by the PPDU when signaling information indicates that an operation based on the BSS color is not allowed, wherein the BSS color is an identifier of a BSS." In the independent method claim 9, the method entails "not using a Basic Service Set (BSS) color indicated by the PPDU when signaling information indicates that an operation based on the BSS color is not allowed, wherein the BSS color is an identifier of a BSS."

34. I understand that Petitioner has challenged claims 1-16 of the '597 patent. As explained in more detail below, claims 1–8 are claims reciting a wireless

communications terminal, and claims 9–16 are parallel method claims that are largely equivalent for purposes of the analysis in this declaration. Throughout this declaration I focus my analysis on aspects of claim 1 and its dependents. The limitations of claim 9 and its dependents are very similar, except that they recite a method instead of a wireless communication terminal. Claims 1–8 are equivalent, respectively, to claims 9–16 for purposes of my analysis, because my opinions are responsive to Dr. Mahon's opinions, and Dr. Mahon presents the same reasoning between these sets of claims. *See, e.g.*, Ex. 1003, ¶¶98–102 (Dr. Mahon's analysis of claim 9, restating a brief summary of his arguments from claim 1 and asserting the claim is satisfied). Accordingly, my opinions with respect to claim 1 should be understood as applying equally to claim 9, my opinions with respect to claim 2 should be understood as applying equally to claim 10, etc.

35. Claims 1 and 9 of the '597 patent are reproduced below.

> [1.1] A wireless communication terminal communicating wirelessly, the wireless communication terminal comprising:
>
> [1.2] a transceiver; and
>
> [1.3] a processor,
>
> [1.4] wherein the processor is configured to receive a physical layer convergence procedure (PLCP) Protocol Data Unit (PPDU) by using the transceiver, and not to use a Basic Service Set (BSS) color indicated

by the PPDU when signaling information indicates that an operation based on the BSS color is not allowed,

[1.5] wherein the BSS color is an identifier of a BSS,

[1.6] wherein the signaling information is transmitted from a base wireless communication terminal to which the wireless communication terminal is associated.

[9.1] A method of operating a wireless communication terminal communicating wirelessly, the method comprising:

[9.2] receiving a physical layer convergence procedure (PLCP) Protocol Data Unit (PPDU); and

[9.3] not using a Basic Service Set (BSS) color indicated by the PPDU when signaling information indicates that an operation based on the BSS color is not allowed,

[9.4] wherein the BSS color is an identifier of a BSS,

[9.5] wherein the signaling information is transmitted from a base wireless communication terminal to which the wireless communication terminal is associated.

VII. OPINIONS

A. Ground 1A (Lee)

36. Claim 1 includes the following limitation:

Limitation 1.4: "wherein the processor is configured to receive a physical layer convergence procedure (PLCP) Protocol Data Unit (PPDU) by using the transceiver, and not to use a Basic Service Set

(BSS) color indicated by the PPDU when signaling information indicates that an operation based on the BSS color is not allowed"

37. It is my opinion that Petitioner and Dr. Mahon have not demonstrated that the prior art either (1) discloses or (2) renders obvious "wherein the processor is configured to… not to use a Basic Service Set (BSS) color indicated by the PPDU when signaling information indicates that an operation based on the BSS color is not allowed," as the claim requires (or the corresponding requirements of claim 9).

38. Dr. Mahon maps Lee's "coloring disable bit" to the claimed "signaling information." *See* Ex. 1003, ¶89. According to Dr. Mahon, when the coloring disable bit is set to whatever value "indicates that the frame corresponds to a trigger frame"[1] (*see* Ex. 1005, [0068]), then Lee's device "may not perform the change of the CCA level irrespective of information indicated by the coloring bit." Ex. 1003, ¶89 (quoting Ex. 1005, [0068]). Dr. Mahon thus contends that the coloring disable bit "indicates that an operation based on the BSS color is not allowed"—specifically, that CCA level change is not allowed. *See* Ex. 1003, ¶89 (alleging that "the 'coloring disable bit' (i.e., signaling information) indicates that a CCA level change (i.e., an operation based on the BSS color) is not allowed").

[1] For purposes of discussion in this declaration, I assume that a "coloring disable bit" value of "1" indicates either a trigger frame or an RTS/CTS frame.

39. Dr. Mahon further contends that when the coloring disable bit indicates that a CCA level change is not allowed, "Lee renders obvious that the 'coloring bit' is not used." Ex. 1003, ¶89. As explained below, this is not accurate—at most, Lee discloses that the processor is configured not to change the CCA level based on the BSS color when the coloring disable bit indicates a trigger frame. Lee does ***not*** disclose or render obvious that Lee's processor would be configured "not to use BSS color" for any other operations as the claims require.

1. Lee does not disclose not using BSS color when signaling information indicates that an operation based on the BSS color is not allowed.

40. Dr. Mahon alleges that when Lee's coloring disable bit indicates a trigger frame, "the STA operates 'without regard to information indicated by the coloring bit.'" Ex. 1003, ¶89 (partially quoting Ex. 1005 at Abstract). In other words, Dr. Mahon alleges that Lee discloses that the coloring bit is not used to perform ***any*** operations when the coloring disable bit indicates a trigger frame, consistent with the claim requirement that the processor be "configured not to use BSS color."

41. This, however, is not taught by Lee. Lee (including the portion of Lee that is only partially quoted by Dr. Mahon) is clear that "when the coloring disable bit indicates that the frame is a… trigger frame, ***the STA does not perform a change of the CCA level*** *without regard to information indicated by the coloring*

bit." Ex. 1005, Abstract; *id.*, [0007] ("[I]f the coloring disable bit indicates that the frame corresponds to a trigger frame…, *the STA does not perform the change of the CCA level* irrespective of information indicated by the coloring bit"); *id.*, [0008] ("If the coloring disable bit indicates [a trigger frame], *the STA does not perform the change of the CCA level* irrespective of information indicated by the coloring bit."). In other words, Lee's disclosure is limited to *restricting a specific operation (CCA level change)* that would normally depend on BSS color. Lee does not disclose the processor would be configured such that ***no*** operations using BSS color would occur, as required by the claim requirement that the processor be configured "not to use a [BSS] color."

42. Even if CCA level changes make use of the received BSS color value, that does not mean that the received BSS color value is not used, as Dr. Mahon's theory would require. There is nothing in Lee that prevents the coloring bit from being used for other types of operations. *See* Mahon Dep. Tr. at 35:4–7 (identifying no "language in Lee that would lead a POSITA to understand" that "Lee rule[s] out using the received BSS color for operations other than CCA level change and spatial reuse"). For example, in a different ground, Dr. Mahon himself refers to "other operations based on BSS color" including "NAV setting [and] power save mode" that would be "based on BSS color." Ex. 1003, ¶¶105–06. And Dr. Mahon acknowledges that there is no "language in Lee that would lead a

POSITA to understand that" "Lee rule[s] out using the received BSS color for operations other than CCA level change and spatial reuse" (such as NAV setting and power save mode). *See* Mahon Dep. Tr. at 35:4–7. I agree; in my opinion, Lee *at very least* leaves open the *possibility* that the processor could continue to use BSS color for other operations, such that it does not actually disclose that the processor would be configured "not to use [BSS] color" as claimed. Furthermore, in my opinion a POSITA would have recognized that Lee ***would*** continue to use BSS color for other operations such as NAV setting and power save mode, because Lee is an 802.11-type system that is an advance over 802.11ac. IEEE 802.11 systems beyond 802.11ac such as Stacey, Zhou, and Choudhury, use color for efficient operation.

43. And Dr. Mahon provided no evidence that Lee discloses not using BSS color for "any other color-based operations" beyond CCA level change or spatial reuse. *See* Mahon Dep. Tr. at 15:5–22. For instance, when asked "where does Lee specify that operations other than CCA level change []or spatial reuse operations are not performed when the color disable bit is set to 1," Dr. Mahon provided a discussion of obviousness (which did not refer to any specific disclosures in Lee), and then stated that "I don't see any other specific explicit references within Lee itself other than those two" operations. Mahon Dep. Tr. at 16:15–17:8. I agree with Dr. Mahon's assessment; I reviewed the entirety of Lee's

disclosure and found no teaching (either explicit or inherent) that Lee's processor would be configured "not to use [BSS] color" when Lee's coloring disable bit indicates a trigger frame. Instead, Lee at most discloses that when Lee's coloring disable bit indicates a trigger frame, no CCA level change will occur, regardless of the BSS color value.

2. Dr. Mahon fails to show that Lee renders obvious that the Lee's processor would be configured "not to use [BSS] color" when the coloring disable bit indicates a trigger frame.

44. As noted above, I disagree with Dr. Mahon's opinion as set forth in his declaration that Lee discloses its processor is configured "not to use a [BSS] color indicated by the PPDU" when the coloring disable bit indicates a trigger frame. (Notably, I ***agree*** with the portion of Dr. Mahon's deposition testimony in which he acknowledged that Lee does not rule out using BSS color for other operations, and that Lee does not disclose that the coloring disable bit would have any impact on those other operations—*see* Mahon Dep. Tr. at 15:5–22, 16:15–17:8, 35:4–7.)

45. I have reviewed Dr. Mahon's declaration for any theory as to why, if Lee does not ***disclose*** that its processor is not configured "not to use a [BSS] color indicated by the PPDU" when the color disable bit indicates a trigger frame, the limitation might nevertheless have been obvious to a POSITA. However, Dr. Mahon provides no explanation why it would have been obvious.

46. Dr. Mahon's sole discussion of the purported "obvious[ness]" of Lee not using the coloring bit when the coloring disable bit indicates a trigger frame is provided in paragraph 89 of his declaration, where he contends that Lee actually discloses that its "STA operates 'without regard to information indicated by the coloring bit.'" Ex. 1003, ¶89 (partially quoting Ex. 1005 at Abstract). (As explained in the preceding subsection, this is wrong.) Dr. Mahon then concludes paragraph 89 of his declaration (and his analysis of limitation [1.4]) by alleging: "***Through this disclosure***, Lee renders obvious that the 'coloring bit' (i.e., the BSS color indicated by the PPDU) is not used when the 'coloring disable bit' (i.e., signaling information) indicates that a CCA level change (i.e., an operation based on the BSS color) is not allowed." Ex. 1003, ¶89. Dr. Mahon's declaration does not provide any reason ***why*** Lee's disclosure supposedly renders obvious not using the "coloring bit" for any operations other than CCA level change when Lee's coloring disable bit indicates a trigger frame.

47. I note that during his deposition, although Dr. Mahon conceded that Lee does not actually *disclose* that "operations other than CCA level change [or] spatial reuse operations are not performed when the color disable bit is set to 1," he believed this would "obviously" happen because "when collisions happen, there are certain difficulties and challenges that are created in the system." Mahon Dep. Tr. at 16:15–17:8. I did not see any such opinion in Dr. Mahon's declaration

regarding Dr. Mahon's Ground 1A. But Dr. Mahon provided this testimony, apparently under the false assumption that Lee's "coloring disable bit" signals a color collision (rather than a trigger frame), and on that basis assumed that all use of BSS color would cease. *See* Mahon Dep. Tr. at 16:15–17:8 (Dr. Mahon's deposition obviousness testimony limited to what occurs "when collisions happen").

48. Ceasing use of BSS color in the case of color collision was inefficient and not obvious, as I explain further below. However, in my opinion, Dr. Mahon's testimony is not supported by Lee's disclosure, because Lee contains no teaching that its coloring disable bit is in any way indicative of a color collision; instead, as noted above, Lee's coloring disable bit indicates a ***trigger frame***, not a color collision, and a trigger frame occurs independently of a color collision. Dr. Mahon acknowledged at his deposition that Lee does not disclose that its coloring disable bit indicates a color collision. *See* Mahon Dep. Tr. at 18:23–20:2 ("I don't recall that Lee directly discusses that…."). Accordingly, I disagree with Dr. Mahon's testimony regarding obviousness provided at 16:15–17:8 of his deposition. Specifically, I do not believe that difficulties with color collision would have motivated a POSITA to avoid using BSS color when Lee's coloring disable bit indicates a trigger frame. Indeed, a POSITA would have understood that Lee's

coloring disable bit does ***not and cannot*** indicate a color collision because it indicates a trigger frame (which is entirely independent of color collisions).

B. Ground 1B (Lee in combination with Stacey)

49. Stacey is a proposed 802.11ax draft specification. Dr. Mahon's combination of Stacey with Lee is based on the premise that a POSITA would have modified Stacey to recognize color collisions, and then combined that modified version of the Stacey reference with the Lee reference to indicate color collisions using Lee's coloring disable bit. *See* Ex. 1003, ¶106 ("A POSITA would therefore have found obvious that an AP may incidentally select the same BSS color as another AP, leading to a BSS color collision. It would have also been obvious to a POSITA that, in such a situation, operations that are normally based on BSS color—including NAV setting, power save operations, and spatial reuse operations—should not be performed (at least not using BSS color). Thus a POSITA would have been motivated to combine the BSS color-based operations in Stacey with Lee's 'coloring disable bit' such that, upon an AP's recognition of a BSS color collision, the AP can signal to STAs in the BSS that operations based on BSS color are disabled and/or disallowed.").

50. As explained in more detail below, Dr. Mahon fails to establish the obviousness of his proposed combination because Lee's coloring disable bit cannot operate consistently with the teachings of Lee while also indicating a color

collision. Furthermore, even if it were obvious to combine Lee and Stacey (which was not, at least not in the manner suggested), the combination does not disclose recognizing a color collision and thus does not render obvious disabling all color operations on that basis.

1. Dr. Mahon's proposed combination is nonsensical because it would require two bits of information to be indicated using only a single coloring disable bit.

51. Lee is explicit that Lee's coloring disable bit indicates a trigger frame in the embodiment that Dr. Mahon relies upon. *See* Ex. 1005, [0067] (explaining that in Lee's Embodiment 1, "[i]f the received frame format corresponds to an OFDM-based frame format," the "frame can include a coloring disable bit" which can "indicate[] that the frame corresponds to a trigger frame related to multiuser transmission"); Mahon Dep. Tr. at 24:1–24:23 (Dr. Mahon testifying that a POSITA would understand that the "coloring disable bit set to 1" "corresponds to a trigger frame"). In a separate embodiment, the coloring disable bit being set to a value of "1" indicates an RTS/CTS frame. *See* Ex. 1005, [0082] ("In this case, a transmitter of the RTS/CTS sets a BSS coloring disable bit… to 1 to indicate that the frame corresponds to the RTS/CTS frame."). In other words, the coloring disable bit serves the important purpose of identifying whether or not the frame at issue is a trigger frame or not.

52. As noted above, Dr. Mahon proposes that Lee's coloring disable bit would serve a different purpose: indicating that a color collision has occurred. *See* Ex. 1003, ¶106 (alleging a POSITA would "combine the BSS color-based operations in Stacey with Lee's 'coloring disable' bit such that, upon an AP's recognition of a BSS color collision the AP can signal to STAs in the BSS that operations based on BSS color are disabled and/or disallowed"); *id.* ¶108 (alleging that Lee's "coloring disable bit" would "indicate[] that [Stacey's BSS color-based] operations should not be performed"); *id.* ¶109 (alleging that it would be obvious to create a modified system "whereby the coloring disable bit indicates that operations based on BSS color are not allowed" such that the system "does not perform inter-intra-BSS NAV setting, power save operations…, or spatial reuse operations using BSS color" (i.e., the operations that Dr. Mahon contends should be disabled in the event of a color collision)).

53. A POSITA, however, would understand that it is impossible and non-sensical for Lee's coloring disable bit to indicate ***both*** a color collision ***and*** indicate a trigger frame. This modification to Lee would cause two different types of serious errors within the system, as explained below.

54. Regarding the **first** type of error, a POSITA would understand that using the coloring disable bit for indicating a color collision would cause errors when a frame other than a trigger frame is received and a color collision has

occurred. Specifically, under Dr. Mahon's proposed combination, when a color collision occurs but the intended frame is ***not*** a trigger or RTS/CTS frame,[2] setting the color disable bit to 1 to indicate that a color collision has occurred and/or that all color-based operations should be disabled would cause an error in the system because the receiving station would incorrectly interpret the received frame as a trigger frame. This would be highly problematic because it would prevent Lee's device from accurately interpreting whether or not the received frame is a trigger frame. And knowledge of whether or not a received frame is a trigger frame is necessary for an STA to know whether a given STA "can transmit an uplink data." *See* Ex. 1005, [0065] ("An STA indicated by the trigger frame can transmit an uplink data."). Lee repeatedly describes the trigger frames as related to "multiuser transmission". See Ex. 1005, [0007] - [0009], [0018], [0068], [0069], [0073]. Lee requires trigger frames to be properly received so that multiuser transmission is performed. I conclude that Dr. Mahon's opinion is in conflict with the Lee reference itself, because it interferes with the proper identification of trigger frames.

[2] A POSITA would have understood that frames other than trigger frames and RTS/CTS frames can be received by Lee's station. *See, e.g.*, Ex. 1004, [0009] (discussing an "uplink frame" that is not a trigger frame, but is instead "related to the trigger frame).

55. Regarding the **second** type of error, a POSITA would also have understood that using the coloring disable bit to denote color collision, when the frame type is trigger frame and no color collision actually occurred is also improper. A POSITA would have understood that it is entirely possible for trigger frames to be received even when no color collision has occurred. I understand that Dr. Mahon agrees with this understanding. *See* Mahon Dep. Tr. at 40:21–41:5.

56. Thus, when a station receives a trigger frame (indicated by Lee's coloring bit being set to 1), Dr. Mahon's proposed modification would disable all color-based operations even in the more common scenario where no color collision has occurred. This would result in unnecessary disallowance of BSS color operations due to assumed color collisions, which would introduce significant inefficiency into the combined system (because color operations would frequently be disabled even when no color collision occurred). I further note that Dr. Mahon presents no alleged rationale to disable ***all*** color-based operations for any reason other than the scenario where a color collision has occurred.

57. Accordingly, it is my opinion that Dr. Mahon's proposed combination would render Lee's coloring disable bit inoperable for its original purpose of indicating a trigger frame. The coloring disable bit would not be able to simultaneously and accurately both (1) indicate a trigger frame ***and*** (2) indicate that all operations making use of BSS color should be disabled as a result of a

color collision. Dr. Mahon does not even acknowledge this problem, much less explain how a POSITA could have solved it consistent with his proposed combination of using Lee's coloring disable bit for both purposes. Thus, I disagree with Dr. Mahon's assertion that the "Lee-Stacey combination [would] be the mere combination of prior art elements… according to known methods to yield predictable results" or "the application of a known technique… to a known device or method… to yield predictable results." Ex. 1003, ¶108. In my opinion, this combination would have had severely negative results, and it certainly would not have been simple or predictable to resolve those problems consistent with the combination proposed by Dr. Mahon.

2. Neither Lee nor Stacey discloses color collisions or disabling all BSS operations in response to color collisions.

58. I additionally note that even if Lee and Stacey ***were*** obvious to combine, the combination of the references does not disclose either the concept of a color collision, or the concept of disallowing color operations in response to a color collision. Thus, their combination does not disclose that concept either.

59. Dr. Mahon additionally alleges that a POSITA would have found it to be "obvious that an AP may incidentally select the same BSS color as another AP." Ex. 1003, ¶106. But Dr. Mahon does not allege that a POSITA would understand this to be a sufficiently common occurrence. For example, Stacey does not indicate how many bits would be dedicated to the BSS color field (*see* Ex. 1005 at 26

(noting that bits 0 to TBD would be assigned this field)), and that number could be set such that the odds of a collision are small. Furthermore, Dr. Mahon does not explain why a POSITA would have sought to disable all operations based on color in response to color collisions as opposed to implementing techniques to avoid collisions in the first place (or resolve those collisions quickly through prompt color reassignment). In my opinion, Dr. Mahon fails to show that this would have been obvious in the context of two references which do not even mention color collision. It is my opinion that even if color collision occurs, disabling all color-based operations would not have been an obvious solution. Below, I explain and provide support for my opinion.

60. I further note that Dr. Mahon does not explain ***how*** the Lee and Stacey device would have ceased all color-based operations while maintaining network functionality. For example, as Dr. Mahon recognizes, Stacey's operations such as setting the NAV operations make use of BSS color.

61. Dr. Mahon suggests that in his combination, "NAV setting… should not be performed (at least not using BSS color)." Ex. 1003, ¶106. However, Stacey recognized that setting the NAV is an essential operation for 802.11 networks: "A virtual CS mechanism ***shall***[3] ***be provided*** by the MAC. This mechanism is referred

[3] In an IEEE 802 standard "shall" means a requirement: "In this document, the word shall is used to indicate a mandatory requirement." *See* Exhibit 1020 at p. 124.

to as the NAV." Ex. 1006, 28. The NAV is essential for the virtual carrier sense mechanism and without the NAV, the 802.11 network would be non-operational. If Dr. Mahon is suggesting not operating a NAV, that would certainly not be obvious. The NAV is a fundamental component in 802.11. *See* Exhibit 1020 at *inter alia* pp. 1311, 1323, 1338, 1398, 1450, 1757, 1904. The NAV timer is set based on duration information in the MAC header frames. "The duration information is also available in the MAC headers of all frames sent during the CP other than PS-Poll frames, and during the BTI, the A-BFT, the ATI, the CBAP, and the SP." [Ex. 1006 at p. 28]. Assuming Dr. Mahon is not suggesting to not operate a NAV entirely (which would contradict Stacey and the entire 802.11 standard), Dr. Mahon does not explain ***how*** in the context of Lee and Stacey the NAV could be set not using BSS color, much less explain or allege that such an implementation would be within the level of skill in the art or that a POSITA would have been motivated to implement such a system. At least because generally, the duration information is available in the MAC headers of all frames, setting the NAV not based on BSS color would prevent the device from transmitting even at times that it otherwise can transmit. A POSITA would have realized that this would considerably reduce the efficiency of the network and would not have been motivated to implement such a system. In other words, the solution of Dr. Mahon –

to operate the NAV not based on BSS color – is not a solution to the color collision problem.

62. Dr. Mahon's suggestions not to perform power save and spatial reuse (at least not based on BSS color) fare no better. Stacey teaches that "**The BSS Color** is an identifier of the BSS and **is used to** assist a receiving STA in identifying the BSS from which a PPDU originates **so that the STA can** use the channel access rules as described in 9.X.Y (Spatial Reuse) or **reduce power consumption as described in 25.13.1 (Intra-PPDU power save for HE non-AP STAs**)" (emphasis added) *See* Exhibit 1006 at p. 51. Thus, Stacey's power-save requires BSS color. Dr. Mahon is not combining Lee and Stacey but is modifying Stacey (to perform power-save not based on color) in a way that contradicts the Stacey reference. If Dr. Mahon is suggesting not performing power-save at all, there was no motivation for a POSITA to implement such a system because a POSITA would have realized this is disadvantageous.

63. Spatial reuse is the method according to which devices ignore weaker signals from neighboring networks and transmit on the same channel. "The objective of the HE spatial reuse operation is to improve the system level performance and the utilization of the spectrum resources in dense deployment scenarios by early identification of signals from overlapping basic service sets (OBSSs) and interference management." [Ex. 1006 at p. 48].

64. Stacey teaches that spatial reuse requires different CCA levels and BSS coloring. *See id*. at 48–49. Dr. Mahon does not explain ***why*** a POSITA would be motivated to perform spatial reuse without using BSS color, much less explain *how* spatial reuse can be performed "not based on BSS color"? Dr. Mahon does not give an answer. Spatial reuse requires identification of signals from OBSSs. Without BSS color, it is not possible to identify OBSSs, and consequently there is no spatial reuse. And if Dr. Mahon's suggestion is not to use spatial reuse at all (when there is a color collision), then clearly this would be disadvantageous. Not having simultaneous transmissions would reduce the throughput.

65. Even assuming that a POSITA recognizes the problem of color collision, I disagree that a POSITA would have suggested not to perform these operations (either at all or based on BSS color). A POSITA would have realized that BSS color is a useful concept and would have sought other solutions, such as reducing the likelihood of color collision and implementing techniques to promptly resolve collisions. For example, according to the Zhou reference on which Dr. Mahon also relies, when a color collision is detected "...[t]he node may trigger a change in color bits for one or both of the BSSs." *See* Exhibit 1007 at [0005]. I conclude that Dr. Mahon's theory not using color when a color collision occurs is not supported by (and to a significant extent contradicted by) the Zhou, Lee, and

Stacey references or, indeed, by any of the prior art references identified by himself.

66. Furthermore, because neither Lee nor Stacey teaches color collision or any solutions for color collision, that further supports my disagreement with Dr. Mahon's opinion that the "Lee-Stacey combination [would] be the mere combination of prior art elements… according to known methods to yield predictable results" or "the application of a known technique… to a known device or method… to yield predictable results." Ex. 1003, ¶108. Because neither Lee nor Stacey teaches recognizing color collisions or disabling use of BSS color on the basis of such recognition, even a combination of those references would not be a straightforward combination of prior art elements that would operate as Dr. Mahon proposes, because still further modification (to both recognize color collisions *and* take a specific type of action in response to such color collisions) would be necessary.

C. Ground 2A (Choudhury)

67. For Dr. Mahon's Ground 2A, he sets forth two alternative theories regarding what the claimed "signaling information" that "indicates that an operation based on the BSS color is not allowed" can be mapped to. *See* Ex. 1003, ¶166 (alleging that "Choudhury teaches multiple forms of this signaling

information, including (1) a 'Low Power/High Interference Indicator' bit, and (2) a reserved COLOR field value").

68. I disagree with both theories, because neither Choudhury's "Low Power/High Interference Indicator" bit (which I may refer to as simply a "Low Power Indicator") nor Choudhury's reserved COLOR field value signal satisfy the claim requirements, as explained in further detail below.

1. Dr. Mahon's reliance on Choudhury's "Low Power/High Interference Indicator" bit fails because he fails to show how it indicates that an operation based on BSS color is not allowed.

69. Dr. Mahon's first theory is that Choudhury's Low Power Indicator indicates that "operations based on the BSS color are not allowed," and that "the processor would be configured to receive the PPDU using the transceiver, and not use the BSS color" if the Low Power Indicator were set to 1. *See* Ex. 1003, ¶174 (alleging that "a POSITA would have found it obvious that the processor would be configured to receive the PPDU using the transceiver, and not use the BSS color when the signaling information, such as the 'Low Power/High Interference Indicator'… indicates that operations based on the BSS color are not allowed").

70. As an initial matter, the Low Power Indicator does not indicate that any "operation based on the BSS color is not allowed" as the claim requires. For instance, Dr. Mahon does not show that any operations that would allegedly be

disallowed are operations "based on the a [BSS] color indicated by the PPDU" as his theory requires.

71. In particular, Dr. Mahon alleges that "channel access determination based on BSS identification" is the "operation based on BSS color" that would not be allowed. Ex. 1003, ¶171. He alternatively states that "allowing access and re-using the channel" is an "operation based on BSS color" that "is not allowed." *Id.*, ¶170. Dr. Mahon thus appears to argue that (1) ***determining whether*** to access the channel; and (2) actually accessing the channel, are alternative operations based on BSS color that are disallowed. For the reasons set forth below, I disagree with both theories.

72. **Dr. Mahon's theory that "channel access determination based on BSS identification" is the "operation based on BSS color."** To the extent it is Dr. Mahon's opinion that merely determining ***whether*** an operation (such as channel access) is allowed constitutes "an operation based on the BSS color" (i.e., if it is his opinion that the *determining* decision is itself an operation based on the BSS color) Dr. Mahon fails to show that this determination is indicated as not being allowed when the Low Power Indicator is set to 1. Indeed, Dr. Mahon's own description of Choudhury makes clear that Choudhury ***does*** determine whether to allow channel access by looking at the received BSS color even when the Low Power Indicator is set to 1.

73. Specifically, a summary table of Choudhury's operation is provided below:

COLOR Field	Low Power/High Interference Indicator	Receiving STA
Not used	1	Limit Access
Not used	0	Allow Access
STA in same BSS (that is, same COLOR field as receiving STA	0 or 1	Limit Access
STA in different BSS (different COLOR field from receiving STA)	0	Allow Access
STA in different BSS (different COLOR field from receiving STA)	1	Limit Access

Ex. 1009, [0029]; Ex. 1003, ¶167 (Dr. Mahon's reproduction of this table).

74. As Dr. Mahon recognizes, ***even when the Low Power Indicator is set to 1***, Choudhury's device will evaluate the COLOR field to "determine[] [whether][4] the PPDU is part of an 'intra-BSS transmission.'" Ex. 1003, ¶168. This

[4] Dr. Mahon's full quoted sentence (and the following sentence) is as follows: "As shown in the third row, when the receiving STA determines that the PPDU is part of an 'intra-BSS transmission' and 'will not re-use the channel' (i.e., limits access to the channel) because it decoded 'a valid SIG field from the same BSS.' SAMSUNG-1009, [0025]. In this case, the value of the 'Low Power/High Interference Indicator' does not matter because receiving STAs always limit channel access by not re-using the channel when a transmission is from another station in the same BSS. *Id.*" Ex. 1003, ¶168. Of course, a POSITA would understand that Choudhury's STA cannot determine ***that*** the PPDU is part of an "part of an intra-BSS transmission" (i.e., whether "a transmission is from another station in the same BSS") unless Choudhury's STA determines ***whether*** the PPDU is part of an intra-BSS transmission. For instance, Choudhury's STA would be unable to evaluate the BSS color as part its channel access determination *only when the BSS color is different*, because Choudhury would first have to evaluate the BSS color to know *whether* the BSS color is different.

determination—whether the PPDU is part of an intra-BSS transmission—affects Choudhury's channel access determination. Specifically, if "the receiving STA determines that the PPDU is part of an 'intra-BSS transmission,'" it concludes that it "will not re-use the channel" "because it decoded 'a valid SIG field from the same BSS.'" Ex. 1003, ¶168. In this scenario, the STA does not need to evaluate the Low Power Indicator: as Dr. Mahon acknowledges, "[i]n this case, the value of the 'Low Power/High Interference Indicator' does not matter." Ex. 1003, ¶168. However, if the STA determines that the PPDU is ***not*** part of an intra-BSS transmission, the STA will then evaluate the Low Power Indicator to see if it "equals 1," and if so, the STA will "limit[] channel access." Ex. 1003, ¶170. In either scenario, the STA must evaluate the BSS color field to know whether (in the case of an intra-BSS transmission as shown in row 3 of Choudhury's table) channel access is limited *regardless* of the Low Power Indicator, or whether instead (in the case of the scenario when the BSS COLOR is determined to be "in a different BSS than the receiving STA"—*see* Ex. 1003, ¶169—as shown in rows 4–5 of Choudhury's table) the STA must look to the Low Power Indicator to determine whether or not channel access is allowed. If this channel access determination is the "operation based on BSS color" that Dr. Mahon contends is disallowed when the Low Power Indicator is set to 1, his assertion in that regard is

incorrect at least because that determination will always occur with respect to the received BSS COLOR field.

75. **Dr. Mahon's theory that "access[ing] and reusing the channel) is the "operation based on BSS color."** Furthermore, to the extent that Dr. Mahon contends that actually accessing and reusing the channel itself is the claimed "operation based on BSS Color," Dr. Mahon never explains how in the context of Choudhury, accessing and re-using the channel depends on a BSS color that is indicated by a received PPDU as the claims require. For example, he provides no evidence that actually accessing or using the channel is an operation based on the received BSS color in the context of Choudhury as his theory requires, and provides no examples of how the operations of accessing the channel or re-using the channel would be based on the received BSS color.

2. Dr. Mahon's reliance on Choudhury's "Low Power/High Interference Indicator" bit additionally fails because he fails to show that Choudhury's processor is configured "not to use a [BSS] color indicated by the PPDU" when that bit is set to 1.

76. As noted above, Dr. Mahon's declaration potentially sets forth two alternative theories regarding what operation based on BSS color is supposedly indicated as not being allowed by Choudhury's Low Power Indicator: either determining whether channel access / re-use is allowed, or channel access and re-use itself.

77. In ***either*** scenario, Dr. Mahon alleges that whatever operation based on BSS color is indicated as not being allowed is not performed. *See generally* Ex. 1003, ¶¶168–173. On this basis, Dr. Mahon concludes that "based on Choudhury's teachings, a POSITA would have found it obvious that the processor would be configured to… not use the BSS color when the signaling information" of a Low Power Indicator or COLOR '0000' value is present. *See id.* at ¶174.

78. However, even if Dr. Mahon's arguments in that regard are accepted as true, a POSITA would understand that there are ***other*** operations that use BSS color in an 802.11 system such as Choudhury's. For example, a POSITA would understand that in a system such as Choudhury's, there are operations that would not involve either (1) determining whether to access or re-use the channel, or (2) accessing or re-using the channel. For instance, changing the CCA level does not require either accessing or re-using the channel or determining whether to access or re-use the channel; instead, it requires only writing an updated value reflecting a CCA threshold into a memory location. *See* Mahon Dep. Tr. at 76:1–77:5 (noting that CCA level changes can "certainly be done in between accesses").

79. Dr. Mahon does briefly note that if channel access is not restricted, "a higher CCA threshold" might be allowed. *See* Ex. 1003, ¶169. But even if ***raising*** the CCA threshold might be restricted when the Low Power Indicator is 1, nothing in Choudhury precludes ***lowering*** the CCA threshold using BSS color when the

Low Power Indicator is 1. And as Dr. Mahon explicitly argues with regard to his Ground 1A, CCA level changes constitute uses of the BSS color. In other words, Choudhury does not disclose that its processor would be configured "not to use a [BSS] color when" the Low Power Indicator is set to 1.

80. Furthermore, as noted above, other uses of BSS color are possible such as setting the NAV or power save operations. None of these are precluded from occurring in Choudhury's system, such that Choudhury does not disclose that its processor would be configured "not to use" BSS color through those BSS-color operations as well. Dr. Mahon did not address whether other a POSITA would have understood that its system would make use of BSS Color in ways other than explicitly taught by Choudhury. *See* Mahon Dep. Tr. at 56:4–17 ("Q. Are there ways to use BSS color that do not involve accessing and reusing the channel? A. Well, that's a general[] question, and *certainly you can contemplate many uses of the BSS*. Choudhury, is specifically discussing channel access. So beyond that, I am not really sure how to answer that. *I would be speculating as giving examples, but that would be outside the context of my declaration.*"). In my opinion, a POSITA *would* have understood that usage of BSS color for operations other than channel access and reuse (or determination of whether to access / reuse the channel) would be allowed. Furthermore, Dr. Mahon did not provide any examples of Choudhury "disabling operations based on BSS color *other* than allowing access

and reusing the channel." Mahon Dep. Tr. at 55:17–56:3 ("So I am not recalling anything other than what I am pointing out in my declaration [regarding accessing the channel and limiting channel access].").

81. As such, it is my opinion that Choudhury does not disclose that its processor would be configured "not to use a [BSS] color indicated by the PPDU" when the Low Power Indicator is high. And Dr. Mahon also sets forth no theory as to ***why*** Choudhury would render that limitation obvious if it does not disclose the limitation. Instead, Dr. Mahon only alleges that a "POSITA would have found it obvious" with no supporting reasoning. Ex. 1003, ¶¶173–174. In my opinion, a POSITA would not have found it obvious for Choudhury's processor to be configured to "not use a [BSS] Color indicated by the PPDU" when Choudhury's Low Power Indicator is set to 1, and Dr. Mahon's declaration has set forth no articulated *rationale* undermining my opinion in that regard.

3. <u>Dr. Mahon's reliance on Choudhury's "COLOR '0000' value" fails because channel access determination using the COLOR value would still occur under Dr. Mahon's theory, which Dr. Mahon explicitly alleges is a use of BSS color.</u>

82. In addition to alleging that claimed "signaling information" is the Low Power Indicator, Dr. Mahon alternatively alleges that "the COLOR '0000' value[] indicates that operations based on the BSS color are not allowed." *See* Ex. 1003, ¶174. Dr. Mahon alleges that it would be obvious, if a COLOR value of '0000' was contained in the COLOR field of Choudhary's PPDU, that it would be obvious

"not [to] use the BSS color for operations that would normally rely on BSS identification." Ex. 1003, ¶173. However, Dr. Mahon acknowledges that Choudhary discloses that channel access determination (which he alleges to be a color based operation) would ***still*** use BSS color, because "devices decoding '0000' are 'required to defer channel access." Ex. 1003, ¶172; *see also* Ex. 1003, ¶171 (noting that "channel access determination based on BSS identification" is "an operation based on BSS color"). Thus, in order for Choudhary's STA to perform a channel access determination such that it can tell that it is "required to defer channel access" in the case of COLOR value '0000,' Choudhary would need to use BSS color (at least under Dr. Mahon's theory that using color for channel access determination is a use of BSS color).

83. I note that while Dr. Mahon asserts that a "channel access determination ***based on BSS identification***" is an "operation based on BSS color," he does not explicitly state that a channel access determination based on a COLOR value of '0000' is an "operation based on BSS color." To the extent that Dr. Mahon or Samsung attempts to allege that a channel access determination based on a COLOR value of '0000' is distinguishable from a channel access determination based on BSS identification because the BSS color is not functioning as an "identifier," I disagree that these two scenarios are distinguishable. In either scenario, the channel access determination requires reading the COLOR value and

making determinations on the basis of that COLOR value, such that if a channel access determination based on BSS identification is an "operation based on BSS color," then channel access determination based on COLOR value '0000' would likewise be an "operation based on BSS color."

84. Furthermore, as explained below in the following subsection, under Dr. Mahon's theory where "COLOR value '0000'" is the claimed "signaling information," that theory is directly inconsistent with the requirement of limitation [1.5] which requires that "the BSS color is an identifier of a BSS."

4. Dr. Mahon's reliance on Choudhury's "COLOR '0000' value" additionally fails because that theory is inconsistent with limitation [1.5]'s requirement that "the BSS color is an identifier of a BSS" in the context of Choudhary.

85. Dr. Mahon concedes that when the COLOR value '0000' is used, the BSS color is ***not*** "an identifier of a BSS" as claim limitation [1.5] requires. Notably, "the BSS color" in limitation [1.5] derives antecedent basis from, and thus refers to, the ***same*** "Basic Service Set (BSS) color" that the processor is configured "not to use" in limitation [1.4]. Thus, under Dr. Mahon's theory that the BSS COLOR of '0000' would not be used, Dr. Mahon must show that this BSS color value "is an identifier of a BSS."

86. It is clear, however, that Dr. Mahon ***cannot*** make such a showing, and indeed he has conceded that this limitation is not met when the BSS color is '0000.' Specifically, Dr. Mahon acknowledges that in the context of Choudhary, "a

POSITA would have understood or found obvious that a COLOR field value of '0000' ***does not represent a valid BSS identifier***," such that "[w]hen a device receives a PPDU with this reserved value, it cannot use the BSS color for its intended purpose of BSS identification because ***no valid BSS color has been provided***." Ex. 1003, ¶172.

87. Because Dr. Mahon acknowledges that in the context of Choudhary, the BSS color of "0000" that the processor would be configured "not to use" is ***not*** an identifier of a BSS, Dr. Mahon's theory that a BSS color equal to '0000' does not satisfy the claim requirements.

88. I note that Dr. Mahon alleges that limitation [1.5] is satisfied because Choudhury states that the "COLOR bit [in the COLOR field] can be used to set the basic service set identification (BSS ID)." Ex. 1003, ¶175 (quoting Ex. 1009, [0029]. Although Choudhury teaches that in certain instances, the COLOR bit "can" set an identification, Dr. Mahon himself concedes that it does ***not*** set an identification when the "COLOR field value of '0000'" is received because "'0000 does not represent a valid BSS identifier" in the context of Choudhury. Ex. 1003, ¶172. Thus, while the COLOR bit ***may*** serve as an identifier in certain scenarios, Dr. Mahon concedes that it is ***not*** an identifier in the scenario where a COLOR value of '0000' is received, such that the BSS color that Dr. Mahon alleges the

processor would be configured "not to use" is not "an identifier of a BSS" as the claim would require.

D. Ground 2B (Choudhury in combination with Stacey)

89. Dr. Mahon alleges that dependent claims 2–3, 6, 10–11, and 14 are obvious in view of Choudhury in combination with Stacey. However, for the combination to render obvious the dependent claims, it must also render obvious the independent claims. Thus, for example, for Dr. Mahon to show that Choudhury in view of Stacey renders obvious claims 2–3 and 6, he must establish that the combination renders obvious claim 1 (from which those claims depend).

90. Dr. Mahon cannot show that the combination of Choudhury and Stacey satisfies the requirements of claim 1, however. Importantly, in his combination of Choudhury with Stacey, Dr. Mahon relies solely on the COLOR '0000' value as being "the signaling information" that "indicates that an operation based on the BSS color is not allowed." *See, e.g.*, Ex. 1003, ¶207 (Dr. Mahon's analysis of limitation [2.1] which requires "not to set an Intra-BSS [NAV] by using the BSS color… when the signaling information indicates that the operation based on the BSS color is not allowed," alleging that a POSITA would have combined "Choudhury's '0000' signaling with Stacey's NAV framework, configuring the processor to bypass Intra-BSS NAV updates when '0000' is detected"); Ex. 1003, ¶¶214-215 (Dr. Mahon's analysis of claim 6, also relying on "Choudhury's '0000'

COLOR value"); *see also* Ex. 1003, ¶¶201–224 (Dr. Mahon's analysis for the entirety of Ground 2B, relying extensively on "Color '0000'" and not once relying on or mentioning Choudhury's Low Power Indicator as being the "signaling information" of claim 1). Thus, Dr. Mahon is relying on the COLOR '0000' value embodiment of Choudhury as satisfying the requirements of claim 1 in his Ground 2B combination.

91. But as discussed above in Sections VII.C.3 and VII.C.4, Dr. Mahon's theory where the "signaling information" is a COLOR value of '0000' does not satisfy the requirements of claim 1 (or the corresponding requirements of claim 9). Accordingly, Dr. Mahon's combination of Choudhury and Stacey, which relies on the COLOR value of '0000' embodiment of Choudhury, does not render obvious any of the challenged dependent claims.

E. Ground 2C (Choudhury in combination with Zhou)

92. Like with Dr. Mahon's Ground 2B, Dr. Mahon's Ground 2C relies solely on Choudhury's COLOR value '0000' embodiment as allegedly disabling use of the BSS color. That embodiment fails to satisfy the requirements of independent claims 1 and 9 for the reasons discussed above, and thus Dr. Mahon's combination of Choudhury with Zhou also does not satisfy the requirements of the dependent claims (which include all of the requirements of either claim 1 or claim 9).

VIII. CONCLUSIONS

93. Although my complete opinions are set forth above, for convenience I summarize several points of my opinions in conclusion. For the foregoing reasons, based on my expertise and experience and the record of this case that I have reviewed, it is my opinion that the claims of the '597 patent are not obvious over the identified prior art.

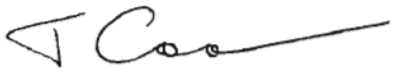
94. I understand that my opinions discussed above support a legal conclusion that claims of the '597 patent are not obvious.

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

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

Respectfully submitted,

Dated: February 20, 2026



Todor V. Cooklev, Ph.D.

APPENDIX 1A

Todor Cooklev, PhD.

Curriculum Vitae

Personal

1336 Sycamore Hills Parkway, Fort Wayne, IN 46814
Contact e-mail: tcooklev@gmail.com
Cell: 925-984-5283

Citizenship: United States (by naturalization)

Professional experience

2016 – **Professor of Electrical and Computer Engineering**
2101 E Coliseum Blvd., ETCS 349
Purdue University Fort Wayne, Indiana 46805

- Research on most aspects of wireless systems, including hardware, signal processing, and software techniques, in particular for software-defined radios.
- Courses:
  ECE 428 Communication Systems
  ECE 549 Software-Defined Radio
  ECE 543 Wireless Communications and Networks

2013 – 2017 **Co-founder and CEO, Adaptive RF, Fort Wayne, IN**

- Developed innovative RF technology and served as co-founder of a company that received funding from the Department of Defense

2018 – 2019 **Chief Technology Officer, Stryke Industries LLC**

- CTO of a company receiving a grant from the Air Force Research Laboratory, Rome, NY

2010 – 2016 **ITT Associate Professor of Wireless Communication and Applied Research,** *Purdue University Fort Wayne*

2008 – 2022 **Director, Wireless Technology Center**
Purdue University Fort Wayne

2005 – 2008 **Consultant, Hitachi America Ltd., San Jose, California**

- Voting Member, IEEE 802.11 WG; participated in the work on several 802.11 amendments
- Chair, IEEE 802.11 VTS Study Group; responsible for the proposal and approval to create a Task Group that lead to the IEEE 802.11aa standard

2011 – 2012 **Consultant, Hitachi America Ltd., San Jose, California**

- Attended meetings of the 3GPP RAN1 standardization committee in Dresden, Germany, Jeju Island, Korea, Prague, Czech Republic, and Qindao, China, 2012.
- Contributed to several documents submitted to 3GPP

2006 – 2008 **Consultant,** *Datamars, Lugano, Switzerland*

- Evaluated and produced reports on certain wireless technologies and standards
- Participated in the IEEE 802.15.4f committee

2004 – 2006 **Consultant,** *Leica Geosystems, Switzerland*

- IEEE 802.16 (WiMAX) and related technologies

2005 – 2007 **Technical Advisory Board Member***, Doceotech, San Ramon, CA*

2002 – 2008 **Assistant Professor** with tenure (2008), *San Francisco State University.*

2000 – 2002 **Member of the Technical Staff***, Aware, Inc., Bedford, MA and Lafayette, CA*

- Worked on DSL standards. Participated in the International Telecommunications Union, Study Group 15, Question 4. Chaired the session on coding for DSL at the session in Antwerp, Belgium, June 2000. Participated in the Telecommunications Industry Association T1E1 Committee on DSL
- Developed advanced coding and decoding methods for DSL
- Worked on the design of an IEEE 802.11a chipset.
- Voting member, IEEE 802.15; Co-Founder and First Vice-Chair of IEEE 802.15.3 (High-data rate wireless personal area networking

1998-1999 **Consultant***, Quantronix, Framingham, Utah*

- Image processing; developed software for edge detection and wrote a report

1996-1997 **Consultant,** *Communications Research Center, Government of Canada.*

- Designed digital filter banks for communication systems and wrote two technical reports

1997-1999 **Senior Engineer,** *3Com Corporation*

- Worked on V.90 voice-band modems
- Implemented data compression and other signal processing algorithms V.42 and V.42bis
- Worked on the Bluetooth Standard, one of the first contributors to the Host Controller Interface of Bluetooth.
- Participated in the Bluetooth/IEEE group, which drafted the license agreement between Bluetooth and the IEEE 802, which in turn led to the establishment of the IEEE 802.15 Working Group.

Grants Awarded

1. Office of Naval Research Summer Fellow 2020, Naval Surface Warfare Center Crane

2. National Science Foundation S^2ERC I/UCRC, "FPGA implementation of shared-memory middleware", 2017-2019, PI

3. National Science Foundation S^2ERC I/UCRC, "Shared-memory middleware", 2016-2017, PI

4. City of Fort Wayne, Economic Development Fund, 2013-15, co-PI.

5. Allen County Capital Improvement Board (CIB), 2013-15, co-PI

6. U.S. Defense Advanced Research Projects Agency (DARPA) Small Business Technology Transfer (STTR) Phase I "A flexible and extensible solution to incorporating new RF devices and capabilities into EW/ISR networks, co-PI, August 2013 – February 2014.

7. National Science Foundation S^2ERC I/UCRC, "The performance of middleware solutions for SDR", 2013-2014, PI

8. National Science Foundation S^2ERC I/UCRC, "Cognitive decision applications for embedded use," 2011-2012, PI

9. Visiting Fellowship, National Institute of Communication Technology (Japan), 2011

10. National Science Foundation S^2ERC I/UCRC, "Signal processing techniques for multicarrier modulation," 2009-2011, PI

11. NMDG, Belgium, laboratory grant 2010, PI

12. National Science Foundation, Professional Science Master's Program, MS in engineering, with concentration in wireless and systems engineering, 2010-2013, Co-PI.

13. Emona Instruments, Sydney, Australia, Laboratory exercises in communications, Principal Investigator, 2008.

14. Lilly Endowment, wireless laboratory grant, 2010, PI.

15. ITT (now Harris) Communications Systems, 2007-2011, PI.

16. State of Indiana, workforce development, 2008-2010, PI

17. National Science Foundation DUE-0442313, "Standards in Education for Product, Process, and Service Design and Development: A Proof-of-Concept Project," 2005-2008, PI.

18. France Telecom, Paris, France, "New methods for multicarrier modulation for high data-rate wireless systems," Principal Investigator, 2006.

19. Agilent Technologies/Sun Microsystems, Palo Alto, CA, "Distributed wireless sensor network for environmental monitoring," Co-principal Investigator, 2005.

20. CSU summer research grant, 2004.

21. U.S. Air-Force Research Laboratory, Wright-Patterson AFB, "Data over voice communications," Principal Investigator, 2004.

Honors and Awards

2012	IEEE Standards Association, "for outstanding contributions to the development of IEEE 802.11aa"
2006	Wireless Educator of the Year Award with the citation "In recognition of the pivotal role of educators in preparing tomorrow's wireless technology leaders".
2005	Duke's Choice Award, Sun Microsystems, (group award)
2003	IEEE Communications Society Oakland/East Bay Chapter Achievement Award, (group award)
1999	3Com Inventor Award
1995-1997	NATO Science Fellowship
1994	IEEE Asia - Pacific Conference on Circuits and Systems Best Paper Award for the paper "Theory of filter banks over finite fields"

Education

1995 *Tokyo Institute of Technology, Tokyo, Japan,*
Doctor of Philosophy in Electrical Engineering
Dissertation: Regular Perfect-Reconstruction Filter Banks and Wavelet Bases

1988 *Technical University of Sofia, Bulgaria,* Dipl. Eng. in Electrical Engineering

Professional Activities

Board Membership:
Board of Governors, IEEE Standards Association, 2021-2022

Committee/Editorial Board Membership:
IEEE Communications Standards Magazine, Series Editor, Wireless and Radio Communications, 2017-

Committee Membership:
- IEEE 802.11 Working Group Voting Member, 2001-2003, 2006-present

- IEEE 802.15 Working Group Voting Member 1999-2001
- Chairman, IEEE Standards in Education Committee, 2006 – present
- Member of the Editorial Board, Journal of Networks.
- 2004-2005 Chairman and 2003-2004 Secretary of the Oakland/East Bay Chapter of the IEEE Communication Society.

Program Committee Membership:

- General Chair, Tactical Communications and Interoperability Conference, 2011
- General Chair, Fort Wayne Wireless Summer School 2009 and 2010
- Program Committee Member, Int. Conf. on Wireless Applications and Computing, 2007.
- Program Committee Member, Int. Conference on WLAN, WPAN, and WMAN, Hawaii, Aug. 2007.
- Program Committee Member, Int. Joint Conf. e-Business and Telecommunications, Barcelona, Spain, 2007.
- Program Committee Member, Int. Conf. Wireless Information Networks and Systems, Lisbon, Portugal, 2006.
- Technical Program Committee Member, Int. Conf. Networking and Services, ICNS 2006, Santa Clara, CA.
- Technical Program Committee Member, Advanced Int. Conference on Telecommunications, AICT, Guadeloupe, French Caribbean 2006.
- Program Committee Member, Int. Joint Conf. e-Business and Telecommunications, Reading, UK, 2005.
- Technical Program Committee Member, Int. Conf. Convergent Services and Next-Generation Networks, June 2005, Chicago, IL.
- Technical Program Committee Member, Int. Conference on Service Assurance with Partial and Intermittent Resources, Lisbon, Portugal, July 2005.
- Technical Program Committee Member, Int. Conf. Telecommunications, 2004, Brazil.
- 3rd Int. Workshop on Signal and Image Processing, Manchester, UK, Special session on wavelets in communication systems, signal and image processing, special session co-organizer, Nov. 1996.

Tutorials at International Conferences

1) T. Cooklev, "The analog RF-digital interface: the VITA 49 standard and evolution roadmap," First IEEE Next G Summit, Johns Hopkins University, June 14, 2022.
2) T. Cooklev, "Open RF-digital interfaces and wireless ontologies," IEEE BlackSeaCom, 4th International Black Sea Conference on Communications and Networking, Varna, Bulgaria, June 2016.
3) M. Cummings, T. Cooklev, "Software Defined Radio Technology", Tutorial at the 2008 Symposium System on Chip, Tampere, Finland, Nov. 2008.
4) M. Cummings, T. Cooklev, "Software Defined Radio Technology", Tutorial at the IASTED Int. Conference Computer Communications, Palma de Mallorca, Spain, Sept. 2008.
5) M. Cummings, T. Cooklev, "Software Defined Radio Technology", Tutorial at the 2007 International Conference on Computer Design, Squaw Creek, CA 2007.
6) T. Cooklev, "Wireless communication standards: 802.11, 802.15, and 802.16," Int. Conference Telecommunications, Fortaleza, Brazil, Aug. 2004, tutorial.
7) T. Cooklev, "Wireless data communication standards, IEEE Globecom 2003, Dec. 2003, San Francisco, CA, tutorial.

Short Courses and Invited Talks excluding conferences:

1) T. Cooklev, "Open RAN", Technical University of Sofia, Bulgaria, November 2019.
2) T. Cooklev, "Software-defined radio technology," Oulu University, Finland, Oct. 2017.
3) T. Cooklev, "Software-defined radio technology," Aarhus University, Denmark, Oct. 2017.
4) T. Cooklev, "Modern wireless systems," Technical University of Sofia, Bulgaria, 2014.
5) T. Cooklev, "Modern Wireless Systems," Featured faculty presentation, Feb. 2012, IPFW.
6) T. Cooklev, "Software-defined radio technology," Tokyo Institute of Technology, Dec. 2011.
7) T. Cooklev, "Software-defined radio technology," University of Akron, OH, 2010.
8) T. Cooklev, "Modern wireless systems," Catholic University of Leuven, Leuven. Belgium, 2010
9) T. Cooklev, "Modern wireless systems," University of Qatar, Doha, Qatar, 2009.
10) T. Cooklev, "Modern wireless systems," Technical University of Sofia, Bulgaria, 2009.
11) T. Cooklev, "Modern wireless systems: from Marconi's radio to cognitive radio," Sigma Xi presentation, February 2009, IPFW.
12) T. Cooklev "Software-Defined Radio Technology," Talk at IPFW, Oct. 2008.
13) M. Cummings, T. Cooklev, "Software Defined Radio Technology", IEEE Communication Society, Oakland/East Bay Chapter, presentation, Oct. 2007, San Ramon, CA.
14) T. Cooklev, "Engineering Standards in Engineering Education," presentation and a panel participant, Standards Engineering Society Annual Conference, San Francisco, CA, August. 2007. (panelist and presenter)
15) T. Cooklev, "Vector transform for multicarrier modulation", France Telecom, June 2007, Rennes, France.
16) T. Cooklev, "Wireless Communication Standards," Distinguished Lecture, IEEE Communication Society, Oct. 2006, University of Maine.
17) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Short Course, April 2006, Lietuvos Telekomas, Vilnius, Lithuania,
18) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Short Course, Feb. 2006, Austin, TX.
19) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Invited Talk, Dec. 2005, Cisco Systems, San Jose, CA.
20) Wireless local area networks, Hitachi Ltd., Brisbane, CA, June 2005.
21) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Invited Talk, May 2005, Texas Instruments, Dallas, TX.
22) T. Cooklev, "Standards for the Wireless Internet", IEEE Communication Society, Oakland/East Bay Chapter, presentation, January 2005. Freemont, CA.
23) T. Cooklev, "Wireless data communication standards, IEEE Wescon, Aug. 2003, San Francisco, CA, tutorial.
24) Short Course on 802.11, 802.15, 802.16, West Long Branch, NJ, August 2003
25) Wireless data communication standards, Lockheed Palo Alto Research Center, June 5, 2003.
26) Short Course on IEEE 802.11, 802.15, and 802.16, San Francisco, CA, Dec. 2002.
27) Standards for wireless data communications, University of Utah, Salt Lake City, UT, 1999
28) OFDM for wireless communications, 3Com Technology Forum, Boston, MA, Nov. 1998.
29) Filter banks and wavelets: a modern applied mathematics tool, Invited Lecture at the Analysis Day, Department of Mathematics and Statistics, Carleton University, Ottawa, Canada, 1997
30) Filter banks and wavelets for video signal processing, Genesis Microchip Inc, Markham, Ontario, Canada, July 1996.

31) Advanced topics in filter banks, wavelets, and their applications in modern communications systems, CRC, Ottawa, March and August 1996.
32) Digital filter banks and wavelets, Dept. Elect. Eng., University of Ottawa, March 1996.
33) Digital filter banks and wavelets, Dept. Elect. Eng., Queen's University, Kingston, March 1996.
34) Perfect-reconstruction filter banks and wavelet bases and their applications in digital communications, Fujitsu Laboratories, Kawasaki, Japan, July 1994.
35) Fast algorithms for signal processing, Istanbul University, Istanbul, Turkey, Jan. 1994.

Publications

Books and Monographs

1) T. Cooklev and A. Yagle, *Modern Communication Systems: A first course*, Michigan Publishing, 2023. (Available at https://services.publishing.umich.edu/Books/M/Modern-Communications-Systems)
2) T. Cooklev, W*ireless communications standards: A Study of IEEE 802.11, 802.15, 802.16*, IEEE Press, New York, NY. 2004.

Chapters in Books

1) A. Vlahov, D. Elkova, V. Poulkov, T. Cooklev, Virtualized, open, and intelligent: the evolution of the Radio Access Network," River Publishers, 2021.

2) Subbu Ponnuswamy, Todor Cooklev, Yang Xiao, and Krishna Sumanth Velidi, "Security in fixed and mobile IEEE 802.16 networks," Chapter 4, *WiMAX/MobileFi: Advanced Research and Technology*, edited by Yang Xiao, Taylor and Francis, January 2008.

3) T. Cooklev and A. Hristozov, "The Software Communications Architecture," in *Resource Management in Future Internet*, edited by Ramjee Prasad, River Publishers, Denmark, 2015.

Journal Papers

1) V. Kolev, T. Cooklev, F. Keinert, "Bauer's spectral factorization method for low order multiwavelet filter design", *Journal of Computational and Applied Mathematics*, vol. 441, May 2024.

2) Kolev, T. Cooklev, F. Keinert, "Design of a Simple Orthogonal Multiwavelet Filter by Matrix Spectral Factorization*," Circuits, Systems, and Signal Processing*, 2019.

3) Y. Acar and T. Cooklev, "High performance OFDM with index modulation", *Physical Communication*, vol. 32, pp. 192-199, 2019.

4) M. Sherman and T. Cooklev, "Abstract descriptions of spectrum: VITA 49 and IEEE 1900.5.2", *IEEE Communications Standards Magazine*, vol. 2, no. 4, pp. 43-48, December 2018.

5) T. Cooklev, V. Poulkov, D. Bennett, K. Tonchev, "Enabling RF data analytics services and applications via cloudification," *IEEE Aerospace Electronic Systems Magazine*, vol. 33, no. 5-6, pp. 44-55, May-June 2018.

6) V. Kolev, T. Cooklev, F. Keinert, "Matrix spectral factorization for the SA4 multiwavelet," *Journal of Multidimensional Systems and Signal Processing*, vol.29, Issue 4, pp 1613–1641, 2018.

7) H. Dogan, T. Cooklev, and J. Darabi, "Improved low-complexity zero-padded OFDM receivers", *Digital Signal Processing*, vol. 51, pp. 92–100, April 2016.

8) P. Baltiiski, I. Iliev, B. Kehaiov, V. Poulkov, and T. Cooklev, "Long-Term Spectrum Monitoring with Big Data Analysis and Machine Learning for Cloud-Based Radio Access Networks," *Wireless Personal Communications*, vol. 87, issue 3, pp. 815-835, April 2016.

9) T. Cooklev, J. Darabi, C. McIntosh, and M. Mosaheb, "Cloud-based approach for spectrum monitoring," *IEEE Instrumentation and Measurement Magazine*, vol. 18, no. 2, pp. 33-37, April 2015.

10) Sven Bilen, A. Wyglinski, C. Anderson, T. Cooklev, C. Dietrich, B. Farhang-Boroujeny, "On Software-Defined Radio as an integrative educational resource," *IEEE Communications Magazine*, vol. 52, no. 5, pp. 184-193, May 2014.

11) Hakan Yıldız, Yusuf Acar, Todor Cooklev, Hakan Dogan, "Generalized Prefix for Space-Time Block Coded OFDM Wireless Systems over Correlated MIMO Channels," *IET Communications*, vol. 8, no. 9, pp. 1589-1598, June 2014.

12) T. Cooklev, A. Nishihara, "An Open RF-Digital interface for software-defined radios," *IEEE Micro,* vol. 33, no. 6, pp. 47-55, Dec. 2013.

13) T. Cooklev, R. Normoyle, and D. Clendenen, "The VITA 49 RF-digital interface," *IEEE Circuits Systems Magazine*, vol. 12, no. 4, pp. 21-32, Dec. 2012.

14) T. Cooklev, "An improved prefix for OFDM-based cognitive radios", *Electron. Lett.*, vol. 48, No. 4, Feb. 2012.

15) Y. Alqudah and T. Cooklev, "Hands-on open access broadband wireless technology lab", *Int. J. Interactive Mobile Tech.*, Vol. 6, No 4, 2012, pp. 13-18.

16) T. Cooklev, H. Dogan, R. Cintra, H. Yildiz, "Generalized prefix for OFDM wireless systems over quasi-static channels," *IEEE Transactions on Vehicular Technology,* vol. 60, No. 8, pp. 3684 – 3693, *Nov.* 2011.

17) F. Ramirez-Mireles, T. Cooklev, and G. A. Paredes-Orozco, "UWB-FSK: Performance tradeoffs for high-complexity receivers," *IEEE Transactions on Consumer Electronics*, vol. 56, no. 4, pp. 2123-2131, 2010.

18) S. Hossain, D. Batovski, and T. Cooklev, "Eight-channel transmultiplexer with binary matrix sequences," *Assumption Univ. Journal of Technology (Thailand),* vol. 13, No. 4, pp. 193-202, 2010.

19) T. Cooklev, “Engineering standards and engineering education,” *Journal of IT Standardization Research*, vol. 8, 2010, pp. 1-10.

20) R. Cintra and T. Cooklev, “Robust image watermarking using non-regular wavelets,” *Journal of Signal, Image, and Video Processing*, 2008.

21) T. Cooklev, A. Pakdaman, J. Eidson, “IEEE 1588 over IEEE 802.11 for synchronization of wireless local area nodes,” *IEEE Trans. Instrumentation and Measurement*, vol. 56, No. 5, pp. 1632-1639, Oct. 2007.

22) T. Cooklev and A. Nishihara, “Analytic constructions of complementary sequences,” *IEICE Trans. Fundamentals*, November 2006.

23) T. Cooklev, “An efficient architecture for orthogonal wavelet transforms,” *IEEE Signal Processing Letters*, Feb. 2006.

24) T. Cooklev, “Standards for the wireless Internet,” *Annual review of communications*, vol. 57, Dec. 2004.

25) T. Cooklev, G. Berbecel and A. N. Venetsanopoulos, ``Wavelets and differential-dilation equations,'' *IEEE Trans. Signal Processing*, vol. 48, pp. 2258-2268, 2000.

26) T. Cooklev and A. Nishihara, “Biorthogonal coiflets,”*IEEE Trans. Signal Processing*, vol. 47, pp. 2582-2588, 1999.

27) T. Cooklev, A. Nishihara, T. Yoshida, and M. Sablatash, ``Multidimensional two-channel linear phase FIR filter banks and wavelet bases with vanishing moments," *Journal of Multimensional Systems and Signal Processing*, vol. 9, pp. 39-76, January 1998.

28) T. Cooklev, A. Nishihara and M. Sablatash ``Regular orthonormal and biorthogonal wavelet filters," *Signal Processing*, vol. 57, pp. 121-137, Feb. 1997.

29) T. Yoshida, T. Cooklev, A. Nishihara, and N. Fujii, "Design of non-separable 3-D QMF banks using McClellan transformations," *IEICE Trans. Fundamentals*, vol. E79-A, No. 5, May 1996, pp. 716-720.

30) M. Sablatash and T. Cooklev ``Coding of high-quality audio signals by wavelets and wavelet packets," *Digital Signal Processing: A Review Journal*, vol. 6, No. 2, pp. 96-107, April 1996.

31) V. Dimitrov, T. Cooklev, and B. Donevsky ``Number-theoretic transforms over the golden-section quadratic field," *IEEE Trans. Signal Processing*, No. 8, pp. 1790-1797, August 1995.

32) V. Dimitrov and T. Cooklev, ``Hybrid algorithm for computing the matrix polynomial," *IEEE Trans. Circuits Syst.*, No. 7, pp. 377-380, July 1995.

33) V. Dimitrov and T. Cooklev ``Two algorithms for modular exponentiation based on nonstandard arithmetics,'' Special issue on cryptography and information security, *IEICE Transactions on Fundamentals*, Jan. 1995.

34) M. Sablatash , Todor Cooklev and Takuro Kida,``The coding of image sequences by wavelets, wavelet packets and adaptive wavelet packets," *IEEE Trans. Broadcasting*, Dec. 1994.

35) T. Cooklev and A. Nishihara, ``Partial and generalized FFT," *IEICE Trans. on Fundamentals*, Sept. 1994.

36) V. Dimitrov, T. Cooklev and B. Donevsky, "Generalized Fermat-Mersenne number theoretic transforms," *IEEE Trans. Circuits Syst.,* vol. 41, pp. 133-139, Feb. 1994.

37) T. Cooklev, T. Yoshida and A. Nishihara, ``Maximally flat half-band diamond-shaped FIR filters using the Bernstein polynomial," *IEEE Trans. Circuits Syst.,* vol. 40, pp. 749-751, Nov. 1993.

38) T. Cooklev and A. Nishihara, ``Maximally flat FIR Hilbert transformers," *Int. Journal Circuit Theory and Applications*, vol. 21, pp. 563-570, 1993.

39) T. Cooklev, S. Samadi, A. Nishihara and N. Fujii, Efficient implementation of all maximally flat FIR filters of a given order," *Electronics Lett.,* vol. 29, No. 7, pp. 598-599, 1993.

40) S. Samadi, T. Cooklev, A. Nishihara and N. Fujii, ``Multiplierless structure for maximally flat linear phase FIR filters," *Electronics Lett.,* vol. 29, No. 2, pp. 184-185, 1993.

41) V. Dimitrov, T. Cooklev and B. Donevsky, "Generalized Fermat number transforms," *ASME Journal on Numerical Modeling*, 1992, N. 4 pp. 11-22.

42) T. Cooklev, V. Dimitrov and B. Donevsky, "Systolic implementation of the complex Chebyshev structure," *Int. J. Electronics*, vol. 73, pp. 1247-1252, Dec. 1992.

43) T. Cooklev and A. Nishihara, "Efficient design of N--D hyperspherically symmetric FIR filters," *IEICE Transactions on Fundamentals of Electronics, Inform. and Comput. Sci.*, vol. E75-A, pp. 1739-1742. Dec. 1992.

44) T. Cooklev, V. Dimitrov and B. Donevsky, "An improved systolic implementation of complex digital filters," *Archiv fuer Elektronik und Uebertragungstechnik (Germany)*, vol. 46, pp. 434-436, Nov.-Dec. 1992.

45) V. Dimitrov, T. Cooklev and B. Donevsky, "On the multiplication of reduced biquaternions and applications," *Information Processing Letters,* vol. 43, pp. 161-164, Sept. 1992.

Conference Papers

1) T. Cooklev, “The analog RF-digital interface: the VITA 49 standard and evolution roadmap” First IEEE Next G Summit, Johns Hopkins University, June 2022.

2) Plamen Semov, Pavlina Koleva, Vladimir Poulkov, and Todor Cooklev, “Evolution of Mobile Networks and C-RAN on the Road Beyond 5G,” 43rd Int. Conf. on Telecommunications and Signal Processing, Milan, Italy, July 2020.

3) Y. Acar, S. Colak, T. Cooklev, “Dual-Mode Index Modulation Aided OFDM with Generalized Prefix”, *Int. Symp. Networks, Computers, and Communications*, June 2019, Istanbul, Turkey.

4) T. Cooklev, “Making Software Defined Networks Semantic,” *Proc. WINSYS*, July 2015, Colmar, France.

5) T. Cooklev, L. Stanchev, “A comprehensive and hierarchical ontology for wireless systems,” *Wireless World Research Forum*, Marrakech, Morocco, May 2014.

6) Yusuf Acar, H. Yildiz, H. Dogan, and H. Dogan, “Generalized Prefix Approach for Alamouti Coded OFDM Systems over Gaussian Channels Correlated in Space,” IEEE 2014 World Congress on Computer Applications and Information Systems (WCCAIS), Hammamet, Tunisia, January17-19, 2014.

7) Yusuf Acar, H. Yildiz, H. Dogan, and H. Dogan, “Performance Improvement for Correlated 4x4 MIMO-OFDM Systems by Generalized Prefix Approach,” 2013 Int. Conference on Signal Processing and Communications, Dec. 12-14, Noida, Uttar Pradesh, India.

8) T. Cooklev, L. Stanchev, C. Chen, “Wireless cloud architecture based on thin clients and ontologies,” *Proc. IEEE Midwest Symp. Circuits and Systems*, Columbus, OH, Aug. 2013

9) Acar, Y.; Yildiz, H.; Cooklev, T.; Dogan, H., "High-performance MIMO OFDM wireless systems with generalized prefix," *21st Signal Processing and Communications Applications Conference (SIU), 2013*, 24-26 April 2013, North Cyprus.

10) Dogan, H. Yildiz, T. Cooklev, Y. Acar, “Coded OFDM wireless systems with generalized prefix”, Int. Conf. on Application of Information and Communication Technologies, Tbilisi, Georgia, Oct. 2012.

11) A. Madanayake, C. Wijenayake, Nghi Tran, T. Cooklev, Sean V Hum, L. T. Bruton, “Directional Spectrum Sensing using Tunable Multi-D Space-Time Discrete Filters,“ First IEEE International Workshop on Emerging COgnitive Radio Applications and aLgorithms (IEEE CORAL), San Francisco, CA June 2012.

12) Yazan A. Alqudah and T. Cooklev, Hands-On Open Access Broadband Wireless Technology Lab, *Proc. IEEE Global Engineering Education Conference (IEEE EDUCON),* Marrakech, Morocco, April 2012.

13) Yazan A. Alqudah and T. Cooklev, Hands-On Open Access Broadband Wireless Technology Lab, ASEE Illinois/Indiana Section Conference, Valparaiso, IN, March 2012.

14) D. Mueller, T. Cooklev, H. Oloomi, C. Pomalaza-Ráez, and S. Walter, "A Graduate Program In Wireless Technology And Systems Engineering: Overview And Initial Experiences", ASEE Illinois/Indiana Section Conference, Valparaiso, IN, March 2012.

15) L. Stanchev and T. Cooklev, "Describing Radio Hardware and Software Using OWL for Over-The-Air Software Download," SDR Forum Tech. Conference, Washington, DC, Dec. 2010.

16) A. Marcum, T. Cooklev, and Carlos Pomalaza-Raez, "Simple OFDM," Virginia Tech Wireless Summer School, June 2010.

17) C. Chen, Z. Chen, T. Cooklev, and C. Pomalaza-Raez, "On spectrum probing in cognitive radio networks: does randomization matter," IEEE Int. Conf. Communications, May 2010.

18) Z. Chen, T. Cooklev, C. Chen, and Carlos Pomalaza-Raez, "Modeling primary user emulation attacks and defenses in cognitive radio networks," Int. Performance Computing and Communications Conference, Dec. 2009, Phoenix, AZ

19) T. Cooklev and M. Cummings, "Changing metalanguage landscape," SDR Forum Technical Conference, Washington, DC, Dec. 2009.

20) F. Ramirez-Mireles, T. Cooklev, and M. Sablatash, "Analysis of filter-based non-coherent detection of UWB FSK with antenna and multipath effects," IEEE MILCOM 2008.

21) T. Cooklev and M. Cummings, "Networking description language for ubiquitous cognitive networking," SDR Forum Technical Conference, Washington, DC, Nov. 2008.

22) M. Cummings, T. Cooklev, B. Lyles, P. A. Subrahmanyam, "Commercial wireless metalanguage scenario," Software Defined Radio Technical Conference, Denver, CO, November 2007.

23) T. Cooklev and A. Abedi, "Teaching the IEEE wireless communication standards dynamically," 2007 Frontiers in Education Conference, Milwaukee, WI, Oct. 10-13, 2007.

24) S. Gaur and T. Cooklev, "Using Finer AIFSN granularity to Accurately Tune the Flow Ratios in IEEE 802.11e," The 18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Sept. 2007, Athens, Greece.

25) S. Gaur and T. Cooklev, ""Performance Enhancement of IEEE 802.11e EDCA by Random AIFSN", 2007 3rd International Conference on Testbeds and Research Infrastructures for the Development of Networks & Communities (TridentCom), Grosvenor Resort, Orlando, FL, May 21-23, 2007.

26) F. Ramirez-Mireles, and T. Cooklev, "Effects of Antenna and Multipath Frequency Selectivity on UWB Using Non-coherent FSK," World Wireless Forum, Stanford, CA, May18-20 2007.

27) F. Ramirez-Mireles, and T. Cooklev, "An Investigation of Antenna and Multipath Effects on Pulse-Based UWB Using FSK," IEEE Globecom, San Francisco 2006.

28) T. Cooklev and P. Siohan “Vector-transform-based OFDM”, Asilomar Conf. On Computers and Comm., Pacific Grove, Nov. 2006.

29) S. Gaur and Cooklev, T. “Performance enhancement of IEEE 802.11e EDCA by random AIFSN,” IEEE Wireless multimedia communication conf., Vancouver, BC, Canada, July 2006.

30) T. Cooklev, Keh-Gang Lu “A wavelet transform approach to the design of complementary sequences for communications, 39th Asilomar Conference on Systems, Signals, and Computers, Pacific Grove, CA Nov. 2005.

31) M. Goins, T. Cooklev, and J. W. Hines, “System-on-a-chip design for lab-on-a-chip in space-flight systems,” Proc. Information Systems: New Generations, Las Vegas, NV, April 2005.

32) Y. Bai and T. Cooklev, “An improved method for lossless data compression” IEEE Data Compression Conference, Snowbird, Utah, March 2005.

33) A. Pakdaman, J. Eidson, T. Cooklev, “Synchronization of wireless LAN over IEEE 1588,” Int. Conference on IEEE 1588, Baltimore MD, Sept. 2004.

34) T. Cooklev, “Dynamic bandwidth allocation and channel coding for providing QoS in wireless networks,” Int. Conference on Telecommunications, Feb. 2003, Papeete, Tahiti.

35) T. Cooklev and M. Sablatash ``A wavelet transform approach to the design of sequences for communications," Wireless Communications'97, Calgary, July 1997.

36) M. Sablatash, John Lodge, and T. Cooklev ``Transmitter and receiver filter bank designs for bandwidth-on-demand multiple access communications combining wavelet packet filter bank trees and DFT polyphase filter banks" IEEE Int. Conference on Communications, Montreal, 1997.

37) G. Berbecel, T. Cooklev and A. N. Venetsanopoulos, ``A practical wavelet-based approaches to watermarking digital images," IEEE Conf. on Consumer Electronics, Chicago, IL, 1997.

38) T. Cooklev, G. Berbecel, A. N. Venetsanopoulos, ``Wavelets and differential-dilation equations" Canadian Workshop on Information Theory, Toronto, June 1997.

39) T. Cooklev, G. Berbecel, and A. N. Venetsanopoulos, ``Construction of an infinitely differentiable continuous-time wavelet and differential dilations equations," Int. Workshop on Signal and Image Processing, Manchester, UK, Nov. 1996.

40) T. Cooklev, A. Nishihara, M. Kato, and M. Sablatash ``Lattice structures for two-channel paraunitary filter banks that yield symmetric wavelet bases," EUSIPCO'96, Trieste, Italy, Sept. 1996

41) D. Androutsos, T. Cooklev, A. N. Venetsanopoulos, ``Multifilter banks and multiwavelets for multispectral image compression," World Congress of Nonlinear Analysts, Athens, July 1996.

42) T. Cooklev, ``On the design of orthogonal filter banks and wavelets with complex coefficients," Queen's Biennial Symposium on Communications, Kingston, June 1996.

43) T. Cooklev, ``Filter banks and wavelet transforms over finite fields," Queen's Biennial Symposium on Communications, Kingston, June 1996.

44) T. Cooklev, ``1-D and 2-D biorthogonal filter banks with vanishing moments and biorthogonal wavelet packets" Queen's Biennial Symposium on Communications, Kingston, June 1996.

45) T. Cooklev, ``Multichannel filter banks, vector transforms, and multiwavelets with applications in color image compression," Queen's Biennial Symposium on Communications, Kingston, June 1996.

46) T. Cooklev, A. Nishihara, M. Kato, and M. Sablatash ``Two-channel multifilter banks and multiwavelets," IEEE ICASSP'96, Atlanta, GA, pp. 2769-2773, May 1996.

47) T. Cooklev, et. al., ``Multifilters and multiwavelets," Wavelets in signal and image processing, Centre de recherche mathematique, Universite de Montreal, Montreal, Quebec, Canada, March 1996.

48) T. Cooklev, et al ``Regular biorthogonal filter banks and wavelet bases: new design and implementation," Int. Conf. Digital Signal Processing,, Limmasol, Cyprus, 1995.

49) T. Cooklev, A. Nishihara, T. Yoshida, and M. Sablatash ``Regular multidimensional linear phase FIR perfect-reconstruction filter banks and wavelet bases," IEEE ICASSP'95, Detroit, MI, May 1995.

50) T. Cooklev, A. Nishihara, and M. Sablatash ``Theory of digital filter banks over finite fields," IEEE Asia-Pacific Conf. Circuits Systems (APCCAS), Taipei, Taiwan, Dec. 1994.

51) T. Cooklev, T. Yoshida, A. Nishihara, ``Multidimensional linear phase FIR perfect-reconstruction filter banks," DSP Symposium, Nov. 1994, Kyoto, Japan.

52) M. Sablatash , Todor Cooklev and Takuro Kida, ``The coding of image sequences by wavelets, wavelet packets and adaptive wavelet packets," Int. Broadcasting Convention, Amsterdam, Holland, Sept. 1994.

53) Mike Sablatash , Todor Cooklev, ``Compression of high quality audio signals by wavelet packets and other methods," Kingston Biennial Symp. Communications, Kingston, Ontario, Canada, June 1994.

54) M. Sablatash , Todor Cooklev and Takuro Kida, ``The coding of image sequences by wavelets, wavelet packets, adaptive wavelet packets and other subband coding schemes," Kingston Biennial Symp. Communications, Kingston, Ontario, Canada, June 1994.

55) M. Sablatash , J. Lodge, and Todor Cooklev, ``Wavelets, matrices and filter banks," Canadian Applied Mathematics Symp., Montreal, Canada, June 1994.

56) Todor Cooklev, Toshiyuki Yoshida, Akinori Nishihara and Mike Sablatash, ``Multidimensional perfect reconstruction linear phase digital filter banks and wavelets,'' Canadian Applied Mathematics Symp., Montreal, Canada, June 1994.

57) V. Dimitrov and T. Cooklev, ``Hybrid algorithm for computing the matrix polynomial using a fractal number system,'' Proc. IEEE ISCAS, pp. 5.129-5.132, London, UK, 1994.

58) T. Cooklev and A. Nishihara, ``Multidimensional perfect-reconstruction linear-phase digital filter bank,'' Karuizawa Workshop on Circuits Systems, Karuizawa, Japan, April 1994.

59) T. Cooklev and A. Nishihara, ``Partial FFT,'' Proc. 8th Digital Signal Processing Workshop, Sendai, Japan, pp. 37-42, Oct. 1993.

60) T. Cooklev, S. Samadi, A. Nishihara and N. Fujii, ``Maximally flat approximation for two-dimensional FIR digital filters with applications in sampling structure conversion," ECCTD'95, Davos, Switzerland, pp. 385--390, Aug. 1993.

61) T. Cooklev and A. Nishihara, ``Maximally flat FIR filters," IEEE ISCAS, Chicago, IL, pp. 96-99, May, 1993.

62) T. Cooklev and A. Nishihara, ``Maximally flat FIR Hilbert transformers,'' Karuizawa Workshop on Circuits and Systems, Karuizawa, Japan, pp. 37-42, April 1993.

63) T. Cooklev and A. Nishihara, "Systolic structures for linear-phase FIR filters," 1st IEEE Asia Pacific Conference on Circuits and Systems, pp. 304-306, Sydney, Australia, Dec. 1992.

64) T. Cooklev and A. Nishihara, "A new class of 2--D FIR maximally-flat digital filters," 7th Digital Signal Processing Symposium, Fuji Res. Inst., Japan, pp. 115-120. Nov. 1992.

65) T. Cooklev and A. Nishihara, "Design of N-D hyper spherically symmetric FIR filters," IEICE Fall Conference, pp. A-82, Tokyo, Sept. 1992.

66) V. Dimitrov, T. Cooklev, B. Donevsky, "Fibonacci-based complex number theoretic transform," IASTED Int. Symposium Circuits Systems, Zurich, Switzerland, pp. 69-72, July 1991.

United States Patents

1) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, "Systems and methods for high rate OFDM communications" U.S. Patent 9,949,148, April 17, 2018.
2) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, "Systems and methods for high rate OFDM communications" U.S. Patent 9,936,401, April 3, 2018.
3) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, "Systems and methods for high rate OFDM communications" U.S. Patent 9,461,857, October 4, 2016.

4) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, “Systems and methods for high rate OFDM communications” U.S. Patent 9,450,794, September 20, 2016.
5) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, “Systems and methods for high rate OFDM communications” U.S. Patent 9,148,806, September 29, 2015.
6) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, Multicarrier packet communication system, U.S. Patent 9,148,801, September 29, 2015.
7) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, “Systems and methods for high rate OFDM communications” U.S. Patent 8,958,350, February 17, 2015.
8) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, “Systems and methods for high rate OFDM communications” U.S. Patent 8,842,570, September 23, 2014.
9) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, “Systems and methods for high rate OFDM communications” U.S. Patent 8,755,264, June 17, 2014.
10) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, “Systems and methods for high rate OFDM communications” U.S. Patent 8,553,579, Oct. 8, 2013.
11) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, Multicarrier packet communication system, U.S. Patent 8,537,703, September 17, 2013.
12) M. Tzannes, D. Lee, T. Cooklev, and C. Lanzl, Systems and methods for high rate OFDM communications using first and second cyclic prefix lengths and first and second pilot tones, U.S. Patent 8,416,677, April 9, 2013.
13) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, OFDM communications using bit allocation tables, U.S. Patent 8,284,800, October 9, 2012.
14) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, Systems and methods for high rate OFDM communications using first and second cyclic prefix lengths, U.S. Patent 8,159,969, April 17, 2012.
15) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, High rate OFDM communications using bit allocation tables, 7,924,841, May 17, 2011
16) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, Method for packet communication using training packets, U. S. Patent 7,944,851, May 17, 2011
17) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, Method for variable cyclic length in OFDM communications, 7,916,625, March 29, 2011
18) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, High rate OFDM communications with a variable cyclic prefix, 7,804,765, September 28, 2010
19) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, Multicarrier packet communication method, 7,729,281, June 1, 2010
20) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, Systems and methods for high rate OFDM communications, 7,590,071, September 15, 2009
21) M. Tzannes, D. Lee, T. Cooklev, C. Lanzl, Systems and methods for high rate OFDM communications, 7,522,514, April 21, 2009
22) Kenneth Morley; Todor Cooklev, Mark Gray; Darrin Gibbs; Video signal processing method and apparatus for internet appliances or embedded systems, US Patent 6,795,869, September 2004.
23) Todor Cooklev, Darrin Gibbs; Mark Gray; Ken Morley; Method and system for performing speech recognition for an internet appliance using a remotely located speech recognition application, US Patent 6,772,123, August 2004.
24) T. Cooklev, Device and method for compensating or creating doppler effect using digital signal processing, US Patent, 6,633,617, Oct. 2003.
25) S. Messerly, T. Cooklev, “Adaptive filter size for the efficient computation of wavelet packet trees,” US Patent 6,581,081, June 2003.

26) T. Cooklev, "Method and system for spatially-disjoint joint source and channel coding for high-quality real-time multimedia streaming over connection-less networks via circuit-switched interface links," US Patent 6,574,218, June 2003.
27) T. Cooklev, M. Gray, "System and method for precise DTMF detection," US Patent 6,560,331, May 2003.
28) T. Cooklev, K. Smart, "High-speed modem operating over two or more telephone lines," US Patent 6,490,295, Dec. 2002.
29) T. Cooklev, M. Gray, D. Gibbs, K. Morley, "Method and apparatus for continuously variable slope delta modulation coding of signals," US Patent 6,486,810, Dec. 2002.
30) S. Messerly, T. Cooklev, "Reduced computation system for wavelet transforms," US Patent 6,466,957, Oct. 2002.
31) T. Cooklev, "Method and apparatus for wavelet-based digital watermarking of signals", US Patent, March 2002.
32) T. Cooklev, ``Method for real-time lossless data compression of computer data, US Patent 6,289,130, Sept. 11, 2001.

Selected non-refereed publications

Contributions to 3GPP

1) "CQI Definition for CoMP," 3GPP TSG-RAN WG1 Meeting #68 R1- 120243, Dresden, Germany, February 6th – 10th 2012. (on behalf of Hitachi)
2) "Specification Impact of Non-Zero Power ABS", 3GPP TSG-RAN WG1 Meeting #68R1-120241, Dresden, Germany, February 6th – 10th 2012. (on behalf of Hitachi)
3) "Way Forward on CSI Feedback for CoMP," R1-120901, (authored by a group of companies)
4) "WF on CSI-RS based measurement," R1-120895 (authored by a group of companies)
5) LS to RAN3 – "X2 enhancements in support of non-zero power ABS," 3GPP TSG RAN WG1 Meeting #69, Prague, Czech Republic, May 2012 (on behalf of Hitachi)
6) "WF on signalling details for non-zero transmit power ABS," R1-123948, (co-authored with representatives from several companies), Prague, Czech Republic, May 2012 (on behalf of Hitachi)
7) "WF on X2 signalling for reduced power ABS for FeICIC," (co-authored with representatives from several companies) R1-123881, Prague, Czech Republic, May 2012

Contributions to IEEE 802.11

8) G. Venkatesan, A. Ashley, Ed Reuss, and T. Cooklev, "IEEE 802 Tutorial: Video over 802.11," March 2007. (on behalf of Hitachi America Ltd)
9) T. Cooklev, "Video over WLAN", doc. 11-07-0105r0, 2007. (on behalf of Hitachi America Ltd)
10) S. Gaur, T. Cooklev, "MAC improvement using random AIFSN," doc. 802.11-06/0657, July 2006. (on behalf of Hitachi America Ltd)
11) C. Tavares, T. Cooklev, S. Gaur, "On video over 802.11," doc. 802.11-06/0039, Jan. 2006. (on behalf of Hitachi America Ltd)

12) C. Tavares, T. Cooklev, “MAC extensions for HDTV,” doc. 802.11-05/0632, July 2005. (on behalf of Hitachi America Ltd)
13) M. Tzannes, T. Cooklev, D. Lee, C. Lanzl, “Extended data rate 802.11a”, doc. 802.11-02/232, March 2002. (on behalf of Aware, Inc.)
14) S. Prestwich, D. Ostermiller, K. Dobson, T. Cooklev, “Dynamic frequency hopping,” IEEE 802.15, Tel Aviv, Israel, January 2000. (on behalf of Aware, Inc.)

Contributions to ITU-T SG15 Q4 on DSL technology

15) T. Cooklev, A. Freedman, and M. Tzannes, “Low-density parity check codes (LDPC) for ADSL,” ITU-T SG15 Q4 BI-068, Bangalore, India, Nov. 2000. (on behalf of Aware, Inc.)
16) T. Cooklev, M. Tzannes, A. Freedman, “Low-density parity check coded modulation for ADSL,” ITU-T SG15 Q4 BI-081, Bangalore, India, 2000. (on behalf of Aware, Inc.)
17) T. Cooklev, “Error-correcting codes for ADSL,” ITU-T SG15 Q4, BA-108, Antwerp, Belgium, June 2000. (on behalf of Aware, Inc.)

Other non-referred publications and technical reports

18) T. Cooklev, “Standards, regulation, and compliance,” IEEE Standards University, [online] https://www.standardsuniversity.org/e-magazine/september-2017/standards-regulation-compliance/
19) T. Cooklev A wavelet transform approach to the design of sequences for communications, Communications Research Centre, Ottawa, Tech. Report U6800-6-2438, 1997.
20) I. Rabinovitch, A. N. Venetsanopoulos, and T. Cooklev, ``Perceptually lossless still image compression using the wavelet transform, considering the properties of the Human Visual System," ITRC, Kingston, Ontario, 1996.
21) T. Cooklev, On the design and implementation of filter banks and filter bank trees with finite wordlength, Communications Research Centre, Ottawa, Tech. Report 67CRC-5-3315, 1996.
22) T. Cooklev, M. Kato, A. Nishihara, M. Sablatash ``Multifilter banks and multiwavelets," IEICE Tech. Report, Tokyo, Japan, May 1995.
23) T. Cooklev, A. Nishihara, ``Regular biorthogonal filter banks and wavelet bases: new design and implementation," IEICE Tech. Report, presented at KDD Research Institute, Kamifukuoka, Saitama, Japan, April 1995.
24) V. Dimitrov and T. Cooklev, ``Two algorithms for modular exponentiation using non-standard arithmetics,'' IEICE Tech. Report, ISEC93-98, 1994. (in Japanese), presented at the IEICE meeting on information security and cryptography, Osaka, Japan, March 1994.
25) T. Cooklev and A. Nishihara, ``Pruning the real-valued FFT algorithms for efficient time-domain interpolation and linear convolution,'' IEICE Tech. Report, CAS93-14, VLD93-14, DSP93-24, May 1993.
26) T. Cooklev and A. Nishihara, ``Band pass maximally flat FIR filters and Hilbert transformers," IEICE Tech. Report, CS92-88, DSP92-88, Jan. 1993.

APPENDIX 1B

Expert Witness Engagements

2025 – Expert for Pantech
- Law firm: Mayer Brown LLP
- ITC Investigation: No. 337-TA-1456

2025 – Expert for Vasu Holdings, LLC
- Law firm: Herbert Smith Freehills Kramer LLP, Redwood City, CA
- Case names: *Vasu Holdings, LLC v. Samsung Electronics Co. Ltd., and Samsung Electronics America, Inc.*
- Civil Action No. 2:24-cv-00034-JRG-RSP *(E. D. Tex.)*
- Submitted infringement report
- Technology at issue: switching between Wi-Fi and cellular communications

2024 – Expert for XR Communications LLC
- Law firm: Russ August Kabat, Los Angeles, CA
- Case names: *XR Communications LLC v. AT&T Services Inc., AT&T Mobility LLC, and AT&T Corp.*
- Civil Action No. 2:23-cv-00202-JRG-RSP *(E. D. Tex.)*
- Submitted infringement and validity reports
- Testified at deposition
- PTAB Case IPR2024-00868, submitted declaration
- Technology at issue: beamforming in cellular communications

2025 – Expert for D-Link
- Law firm: Pillsbury Winthrop Shaw Pittman LLP
- ITC Investigation: No. 337-TA-1454

2025 – Expert for Intellectual Ventures II LLC
- Law firm: Volpe Koenig, Philadelphia, PA
- Case name: *Tesla, Inc., v. Intellectual Ventures II LLC*
- Case Nos. IPR2025-00220
- Submitted declaration
- Technology at issue: cellular communication

2025 – Expert for Ford Motor Company
- Law firm: Brooks Kushman P.C.
- Case name: Ford Motor Company v. Autoconnect Holdings LLC
- Case Nos. IPR2026-00171
- Technology at issue: vehicle communication systems, sensors, and infotainment systems

2025 – Expert for TOT Power Control, S.L.
- Law firm: DiNovo Price, Austin, TX

- Case name: *TOT Power Control, S.L. v. AT&T Mobility, Inc.,*
- Case name: *TOT Power Control, S.L. v. AT&T USA Inc.,*
- *Case name: TOT Power Control, S.L. v. T-Mobile USA Inc.,*
- Civil action No. *2:21-CV-00107-ADA,* No. *2:21-CV-00109-ADA (W.D. Tex.)*
- Technology at issue: cellular communication

2025 – 2025 Expert for Netflix, Inc.

- Law firm: Baker Botts LLP, San Francisco, CA
- Case names: *Netflix, Inc. v. Broadcom, Inc., and VM Ware, LLC*
- Civil Action No. 3:25-cv-3738-TLT *(N. D. Cal.)*
- Submitted declaration
- Technology at issue: IEEE 1588

2024 – 2025 Expert for Headwater Research LLC

- Law firm: Russ August Kabat, Los Angeles, CA
- Case names: *Headwater Research LLC v. Cellco Partnership D/B/A Verizon Wireless and Corporate Services Group, Inc.*
- Civil Action No. 2:23-cv-00352-JRG-RSP *(E. D. Tex.)*
- Submitted infringement and validity reports
- Testified at deposition
- Technology at issue: cellular communications

2023 – 2024 Expert for Pantech Corporation

- Law firm: Mayer Brown LLP
- Case names: *Pantech Corporation and Pantech Wireless LLC v. LG Electronics Inc., and LG Electronics U.S.A., Inc.* and *Pantech Corporation and Pantech Wireless LLC v. OnePlus Technology (Shenzhen) Co. Ltd.*
- Civil Action Nos. *5:22-cv-00113-RWS-JBB, 5:22-cv-00069-RWS (E. D. Tex.)*
- Submitted report in connection with claim construction, infringement and validity reports
- Testified at a deposition and at trial
- Technology at issue: cellular communications

2024 – Expert for Sckipio Technologies SI, Ltd.

- Law firm: Fish & Richardson, New York, NY
- Technology at issue: DSL communications

2024 – 2025 Expert for Scosche Industries, Inc.

- Law firm: ArentFox Schiff, LLP, Los Angeles, CA
- Case name: *Fleet Connect Solutions, LLC v. Scosche Industries, Inc.*
- Civil action No. *2:23-CV-09324 HDV (AJRx) (C.D. Cal.)*
- Technology at issue: Wi-Fi and Bluetooth wireless communication

2023 – 2024 Expert for Hytera Communications Corporation,

- Law firm: Steptoe LLP, Washington, DC

- Case name: *United States of America v. Hytera Communications Corporation*
- Case No. 1:20-cr-00688 *(N. D. Ill.)*
- Technology at issue: software-defined radio

2024 – Expert for Cobblestone Wireless LLC

- Law firm: Russ August Kabat, Los Angeles, CA
- Case name: *Hewlett Packard Enterprise Company and Cisco Systems, Inc., v. Cobblestone Wireless, LLC*
- Case No. IPR2024-00707
- Submitted declaration
- Technology at issue: hardware architecture of wireless devices

2024 – 2024 Expert for Broadphone LLC

- Law firm: Russ August Kabat, Los Angeles, CA
- Case name: *Samsung Electronics Co. Ltd., v. Broadphone, LLC*
- Case Nos. IPR2024-00153, IPR2024-00154, IPR2024-00155
- Submitted declaration
- Technology at issue: wireless communication systems

2020 – Expert for Smart Mobile Technologies LLC

- Law firm: Hagens Berman Sobol Shapiro, Pasadena, CA (2020-2022); Graves and Shaw LLP, Los Angeles, CA (2022 – present).
- Case names: *Smart Mobile Technologies LLC v. Apple Inc., and Smart Mobile Technologies LLC v. Samsung Electronics Co. Ltd. and Samsung Electronics America, Inc.*
- Case Nos: *6:21-cv-00603, 6:21-cv-00701 (W.D. Tex.)*
- PTAB case Nos. IPR2022-00766, IPR2022-00807, IPR2022-00808, IPR2022-01002, IPR2022-01003, IPR2022-01004, IPR2022-01005, IPR2022-00979, IPR2022-00980, IPR2022-00981, IPR2022-00982, IPR2022-01222, IPR2022-01223, IPR2022-01248, IPR2022-01249
- Submitted multiple declarations
- Testified at multiple depositions
- Technology at issue: cellular and Wi-Fi communications and networking

2022 – 2023 Expert for XR Communications, LLC d/b/a Vivato Technologies

- Law firm: Russ August Kabat, Los Angeles, CA
- Case name: *XR Communications, LLC, dba Vivato Technologies v. Asustek Computer, Inc.*
- Case No. 6:21-cv-00622-ADA (*W. D. Texas*)
- Reports on infringement and technical scope of license
- Testified at a deposition
- Technology at issue: beamforming in wireless communications

2023 – 2023 Expert for Metrom Rail LLC

- Law firm: McAndrews, Held & Malloy, Chicago, IL

- Case name: *Siemens Mobility, Inc., Ground Transportation Systems USA, Inc., Humatics Corp., and Piper Networks, Inc., v. Metrom Rail LLC*
- Case Nos. IPR2023-00468 & IPR2023-00470
- Submitted declaration
- Technology at issue: ultra-wideband (UWB) sensing for collision avoidance

2023 – 2024 Expert for Mitsubishi Electric Corporation

- Law firm: Xsensus LLP, Alexandria, VA
- Case name: *TCL Communication Technology Holdings Limited, TCT Mobile International Limited, TCT Mobile, Inc., TCT Mobile (US) Inc., TCT Mobile (US) Holdings Inc.* v. *Mitsubishi Electric Corp.*
- PTAB Case Nos. IPR2023-00957, IPR2023-00997
- Submitted declarations

- Law firm: Devlin Law Firm, LLC, Wilmington, DE
- Case name: *Mitsubishi Electric Corporation and Sisvel International S.A., vs. TCL Communication Technology Holdings Limited, TCT Mobile International Limited, TCT Mobile (US) Inc., and TCT Mobile (US) Holdings Inc.*
- Case No. 8:22-cv-01073-GW-DFM (C.D. Cal.)
- Submitted declarations
- Technology at issue: cellular communications

2023 – 2023 Expert for Lemko Corp.

- Law firm: Kramer Levin, New York, NY
- Case name: *Microsoft Corporation and Affirmed Networks, Inc. v. Lemko Corporation*
- PTAB Case Nos. IPR2023-00529, IPR2023-00530, IPR2023-00531, IPR2023-00570
- Technology at issue: implementation of cellular networks
- Submitted a declaration
- Testified at deposition

2022 – 2025 Expert for Ford Motor Company

- Law firm: Latham and Watkins (2022-2023); Brooks Kushman P.C. (2023-)
- Case name: Neo Wireless LLC v. Ford Motor Company, General Motors, and Nissan North America, Inc.
- PTAB Case No. IPR 2023-00763
- Submitted declarations in support of petitions for *Inter Partes* review
- Testified at depositions
- Technology at issue: wireless communications

2021 – 2024 Expert for Flexiworld Technologies

- Law firm: Nelson Bumgardner Conroy, Dallas, TX
- Case name: *Roku, Inc.* v. *Flexiworld Technologies*

- PTAB Case Nos. IPR2021-00713, IPR2021-00714, IPR2021-00715, PGR2021-00112, IPR2022-00775
- Submitted multiple declarations
- Testified at multiple depositions

2014 – 2023 Expert for TQ Delta, Austin, TX

- Law firm: McAndrews, Chicago, IL
- Case name: TQ Delta, LLC v. Adtran
  Civil Action *No. 14-cv-00954-RGA (D-Del.)*, Civil Action *No. 15-cv-00121-RGA* (*D-Del*.)
- Case name: TQ Delta, LLC v. 2Wire
  Civil Action *No. 13-cv-1835-RGA (D-Del.)*
- Case name: TQ Delta, LLC v. Zhone Technologies, Inc.
  Civil Action *No. 13-cv-1836-RGA (D-Del.)*
- Case name: TQ Delta, LLC v. Zyxel Communications, Inc. and Zyxel Communications Corporation
  Civil Action *No. 13-cv-2013-RGA (D-Del.)*
- Submitted product testing reports, computer simulation reports, a report on the terms of a license agreement, a report on standards essentiality, infringement reports, validity reports
- Testified at depositions and trials
- Technology at issue: Digital signal processing in Digital Subscriber Line communication systems

2022 – 2024 Expert for Bell Northern Research

- Law firm: Devlin Law Firm LLC
- Case name: *Bell Northern Research, LLC v. HMD America, Inc. et al.*,
- Civil Action No. *1:22-cv-22706-RNS (S.D. Fla)*
- ITC Investigation: No. 337-TA-1367
- Technology at issue: wireless communications
- Submitted declaration
- Testified at deposition

2023 – 2024 Expert for Bell Northern Research

- Law firm: Devlin Law Firm LLC
- Case Name: International Trade Commission Investigation No. 337-TA-3568, Certain Electronic Devices Having Wireless Communication Capabilities and Components Thereof
- Technology at issue: wireless local area networking
- Submitted declaration and reports
- Testified at deposition

2023 – 2023 Expert for WSOU Investments, LLC d/b/a Brazos Licensing and Development

- Law firm: Folio Law Group

- Case name: *WSOU Investments, LLC d/b/a Brazos Licensing and Development v. Google, LLC*.,
- Case No. *6:20-cv-00585-ADA (W.D. Tex.)*
- Submitted a validity report
- Testified at a deposition
- Technology at issue: determining a location of a mobile device and location-based services

2021 – 2023 Expert for TQ Delta, Austin, TX

- Law firm: Davis Law Firm, P.C., Longview TX, and McAndrews, Chicago, IL
- Case name: TQ Delta, LLC, v. Commscope Holding Company, Inc., Commscope Inc., Arris International Limited, Arris Global Ltd, Arris US Holdings, Inc., Arris Solutions, Inc., Arris Technology, Inc., and Arris Enterprises, LLC
- Civil Action No: 2:21-cv-310-JRG, 2:21-cv-309-JRG (*E.D. Tex*.)
- Submitted a declaration in connection with claim construction, infringement report, validity report, and reports on testing and simulation
- Testified at two depositions and at trial

2021 – 2023 Expert for WSOU Investments, LLC d/b/a Brazos Licensing and Development

- Law firm: Kasowitz Benson Torres LLP
- Case name: *WSOU Investments, LLC d/b/a Brazos Licensing and Development v. Canon, Inc*.,
- Case Nos. *6:20-cv-00980-ADA, 6:20-cv-00981-ADA (W.D. Tex.)*
- Submitted a declaration in connection with claim construction.
- Testified at a deposition
- Technology at issue: frequency-hopping wireless communication

2021 – 2022 Expert for NXP

- Law firm: Jones Day, Washington, DC
- Case name: Certain Integrated Circuits, Chipsets, and Electronic Devices, and Products Containing the Same, ITC 337-TA-1287
- Technology at issue: IEEE 802.11
- Submitted a validity report
- Deposition

2021 – 2022 Expert for Barkan Wireless IP Holdings, L.P.

- Law firm: Heim, Payne & Chorush, LLP, Houston, TX
- Case name: *Barkan Wireless* v. *T-Mobile, Inc. and Nokia of America Corp.*
- Civil Action No. *2:21-CV-00034-JRG (E. D. Tex.)*
- Submitted a validity report
- Testified at a deposition
- Technology at issue: cellular network architecture involving home base stations (femtocells)

2021 – 2022 Expert for 3G Licensing

- Law firm: Devlin Law Firm LLC
- Case name: *Cradlepoint, Inc., Dell Inc., Honeywell International, Inc., Sierra Wireless, Inc., TCL Communication Technology Holdings Limited, TCT Mobile International Limited, TCT Mobile, Inc., TCT Mobile (US) Inc., TCT Mobile (US) Holdings Inc., Thales DIS AIS Deutschland Gmbh, ZTE Corporation, and ZTE (USA) Inc.* v. *3G Licensing, S.A.*
- PTAB Case Nos. IPR2021-00640, IPR2021-01141
- Technology at issue: cellular communications
- Submitted declarations
- Testified at a deposition

2019 – 2022 Expert for Evolved Wireless LLC, Austin, TX

- Law firm: Nelson Bumgardner Albritton P.C., Fort Worth, TX (2019–22); Bruster PLLC, Southlake, TX (2022–present)
- Patent portfolio review
- IPR2021-00943
- Technology at issue: 4G cellular communications

2020 – 2021 Expert for General Access Solutions, Dallas, TX

- Law firm: Bartlit Beck, Denver, CO
- Case name*: General Access Solutions, LTD. v. Virgin Mobile USA, L.P., Boost Mobile, LLC, and Sprint Spectrum L.P.*
- Civil Action *No. 2:20-cv-00007-RWS (E. D. Tex.)*
- Submitted a report on standards essentiality
- Testified at a deposition
- Technology at issue: protocol architecture to support beamforming in 4G and 5G cellular standards

2015 – 2019 Expert for Evolved Wireless, Austin, TX

- Law firm: Robins Kaplan, Minneapolis, MN
- Civil Actions *No. 15-cv-542-SLR-SRF, No. 15-cv-543-SLR-SRF, No. 15-cv-544-SLR-SRF, No. 15-cv-545-SLR-SRF, No. 15-cv-546-SLR-SRF*, and *No. 15-cv-547-SLR-SRF (D-Del.)* brought against Apple, HTC, Lenovo, Samsung, ZTE, and Microsoft.
- Submitted infringement and validity reports
- Testified at deposition and trial
- Technologies at issue: 4G cellular communications

2013 – 2015 Expert for Inter-Digital

- Law firm: Latham and Watkins
- Subject matter: dual-mode 3G cellular/Wi-Fi devices in connection with Civil Actions *No. 13-cv-00009-RGA* and *No. 13-cv-00010-RGA (D-Del.)* brought against ZTE and Microsoft Mobile Oy.

- For the purpose of infringement analysis wrote a 3G mobile phone application and server software
- Produced six expert reports, deposed twice and testified at jury trial