UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SAMSUNG ELECTRONICS CO. LTD.,
Petitioner,

v.

WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC,

Patent Owner.

_____

Case IPR2025-01069
Patent 10,313,077

_____

DECLARATION OF TODOR V. COOKLEV, PH.D.

TABLE OF CONTENTS

Page

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. 10,313,077 ("the '077 patent") in IPR2025-01069. 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.

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 served as Series Editor for Wireless and Radio Communications in the IEEE Communications Standards Magazine (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 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. 10,313,077 (Ex. 1001) ("the '077 patent");

ii. The prosecution history of the '077 patent (Ex. 1002);

iii. The Declaration signed by Dr. Zhi Ding in IPR2025-01069 (Ex. 1003) (the "Ding Declaration");

iv. Translated Korean Application No. 10-2015-0092525 (Ex. 1005)

v. U.S. Patent App. Pub. No. 2016/0345202 ("Bharadwaj") (Ex. 1006)

vi. U.S. Prov. App. No. 62/170,059 ("Bharadwaj-Prov059") (Ex. 1007)

vii. IEEE Std. 802.11-2012 (Ex. 1008)

viii. IEEE Std. 802.11ac-2013 (Ex. 1009)

i. U.S. Patent Application Publication No. 2015/0139205 (“Kenney”) (Ex. 1010)

ii. U.S. Patent App. Pub. No. 2012/0054587 (Ex. 1011)

iii. U.S. Patent App. Pub. No. 2016/0285596 (Ex. 1012)

iv. U.S. Patent App. Pub. No. 2015/0304077 (Ex. 1013)

v. U.S. Patent App. Pub. No. 2015/0139206 (Ex. 1014)

vi. U.S. Patent App. Pub. No. 2016/0127948 (Ex. 1015)

i. L-LENGTH Equation Update, IEEE submission document IEEE 802.11-15/1372 (Nov. 2015) (Ex. 1016)

ii. U.S. Prov. App. No. 62/165/848 (“Bharadwaj-Prov848”) (Ex. 1017)

iii. U.S. Patent App. Pub. No. 2012/0177144 (“Lee”) (Ex. 1018)

iv. U.S. Patent App. Pub. No. 2016/0286012 (“Yu”) (Ex. 1019)U.S. Prov. App. Pub. No. 62/145,428 (“Yu-Prov428”) (Ex. 1020)

v. U.S. Prov. App. Pub. No. 62138,294 (“Yu-Prov294”) (Ex. 1021)

vi. 802.11ax Preamble Design and Auto-detection, IEEE document 802.11-15/0579 (dated May 10, 2015) (Ex. 1022)

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 Critical Date (August 20, 2015). 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 '077 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. Ding has asserted in his declaration that a person of ordinary skill in the art as of the time of the ’07077 patent would have had:

> (1) a Bachelor’s degree in electrical engineering, computer engineering, computer science, or a related field, and (2) 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 [Ding-Decl.] ¶ 42.

20. For the purposes of this declaration, I accept Dr. Ding’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 ’077 patent), my analysis and opinions are from the perspective of a POSITA, as set forth above.

B. My Understanding Of Legal Standards

22. When considering the ’077 patent 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.

23. 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.

24. 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, failure of others, and long-felt but unsolved need.

25. 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.

26. I also understand that a claim may be obvious if it is "obvious to try," i.e., if there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions which would lead to anticipated success.

27. I further understand that, as a general matter, a POSITA would not attempt to solve a problem that the POSITA would not have been aware of.

28. 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.

29. 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.

30. 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.

31. 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).

32. 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 ALLEGED PRIOR ART

A. Bharadwaj (Ex. 1006) and Bharadwaj-Prov059 (Ex. 1007)

33. Bharadwaj (Ex. 1006) is a patent application publication. I offer no opinion on whether Bharadwaj legally constitutes "prior art," but I understand that to the extent it is prior art, it is only prior art to the extent it incorporates by reference a disclosure in an application (such as a provisional application) that had a filing date earlier than the critical date of the '077 patent (which I understand to be August 20). Because Dr. Ding relies on Bharadwaj-Prov059 as providing this disclosure, my analysis regarding Bharadwaj refers primarily to Bharadwaj-Prov059.

34. Bharadwaj-Prov059 discloses an L_{LENGTH} formula as follows:

$$L_{LENGTH} = \left\lceil \frac{TXTIME - 20}{4} \right\rceil \times 3 - 3 + m \text{ where } m = 1, 2$$

Ex. 1007, [0051] (Equation 2). As Dr. Ding recognizes, Bharadwaj-Prov059's formula provides a solution to a "need" to "distinguish between IEEE 802.11ax and IEEE 802.11ac transmissions" by having LLENGTH not be exactly a multiple of 3. *See* Ex. 1003, ¶64; Ex. 1007 at [0051] ("The value *m* shown above has been added in IEEE 802.11ax to ensure that L_{LENGTH} is not exactly a multiple of 3 and is therefore used to distinguish between IEEE 802.11ax and IEEE 802.11ac transmissions (e.g., autodetections).").

35. Although Dr. Ding is incorrect that Bharadwaj-Prov059 teaches that "m" is added in 802.11ax "***merely***" to "ensure that LLENGTH is not exactly a multiple of 3" so that legacy transmissions can be differentiated from non-legacy transmissions. *See* Ex. 1003, ¶63. Bharadwaj does not explicitly disclose any other importance to the "m" value. *See generally* Ex. 1007 at [0051]-[0052]. For example, Bharadwaj-Prov059 does not contemplate that the "m" values of 1 or 2 in Bharadwaj-Prov059's disclosure would have any detrimental downstream impacts on calculations of legacy receivers.

B. Yu (Ex. 1019) and Yu-Prov428 (Ex. 1020)

36. Like with Bharadwaj, I understand Yu is at most prior art to the extent it incorporates by reference a provisional having the relied-upon material. Because

Dr. Ding primarily relies on Yu-Prov428 as providing the relevant disclosures, my analysis herein is primarily focused on Yu-Prov428's disclosures.

37. Yu-Prov428 is concerned with a different problem than Bharadwaj-Prov059. Specifically, Yu-Prov428 is ***not*** concerned with ensuring that LLENGTH is not exactly a multiple of 3 (such that it can be used to 'distinguish between IEEE 802.11ax and IEEE 802.11ac transmissions'), because Yu-Prov428's "Length" formula explicitly allows Length to be a multiple of 3. Yu-Prov428's Length formula is reproduced below.

$$\text{Length} = \frac{\text{TXTIME-20}}{4} \times 3 - 3 - M,\ 0 \le M \le 2$$

Ex. 1020 at 16.

38. As can be seen above, Yu-Prov428 allows Length to be a multiple of 3, because the "M" offset can be 0 (which would not allow differentiation between legacy and non-legacy devices). Thus, rather than solving (or attempting to solve) the problem of ensuring that a length value is not a multiple of 3, Yu-Prov428 attempts to solve the problem of signaling three different frame structures to 802.11ax devices using a length offset modifier, and having a legacy receiver be agnostic to which of these three values was selected. *See* Ex. 1020 at 16 ("The L-LENGTH can imply three different states with the value of M without changing the operation of the legacy receiver. The cases 2, 3, and 4 can be information with

the following example: M= 0 : case 4 M= 1 : case 3 M = 2 : case 2"); *see also id.* at 12 (visually depicting the OFDM frame structures associated with each of cases 2, 3, and 4).

39. Yu-Prov428 also ensures that regardless of ***which*** of the three "M" values is chosen (between 0, 1, or 2), legacy receivers will calculate "the same packet duration" between any of these M values. For instance, the packet duration calculated by a legacy receiver will be identical regardless of whether 0, 1, or 2 is chosen for "M" in Yu-Prov428's equation. Yu-Prov428 teaches that this "same packet duration" will be recognized by legacy receivers regardless of which of the three possible "M" values are chosen, specifically "because one OFDM symbol with the lowest rate includes 3 bytes data." Ex. 1020, 16 ("Though 3 different values are possible with M = 0, 1, and 2, the legacy receiver [will] identify the same length (the same packet duration) because one OFDM symbol with the lowest rate includes 3 bytes data."

40. Thus, in contrast to Bharadwaj-Prov059's formula ensuring that the transmitted L_{LENGTH} value is not a multiple of 3, Yu-Prov428 seeks to accomplish a different goal by ***allowing*** the transmitted Length to be a multiple of 3, but allowing for three different frame structures to be indicated wherein a legacy receiver will calculate a consistent packet duration regardless of which frame structure is indicated.

41. In my opinion, a POSITA would not understand Yu-Prov428 to suggest any motivation regarding the operation of legacy receivers beyond ensuring that such receivers will operate consistently regardless of which M value is chosen. Instead, a POSITA would understand that Yu-Prov428 was concerned with solving a different problem—allowing "M" to represent three different frame structures, such that the same packet duration will be calculated by legacy receivers regardless of which "M" value is selected (such that, e.g., a legacy receiver will not calculate inconsistent results depending on whether M=1 or M=2 is selected).

VII. OVERVIEW OF L_LENGTH FORMULA DEVELOPMENT IN 802.11AX

42. Around July 13, 2015, a group of over 100 highly qualified authors from numerous leading companies including Marvell, Qualcomm, Broadcom, MediaTek, Apple, Huawei, LG, ZTE, Cisco, and Samsung proposed a means for "HE PHY Padding and Packet Extension," such that in 802.11ax, the L_LENGTH formula would be as follows:

$$L\_LENGTH = \left\lceil \frac{TXTIME - 20}{4} \right\rceil \times 3 - 3 + m,\ m = 1 \text{ or } 2$$

Ex. 2022 at 23.[1] As shown in the equation above, L_LENGTH is calculated with a positive offset of "m" at the end, where "m" is equal to either 1 or 2.

43. Among the large number of authors of this proposal were Arjun Bharadwaj and Bin Tian, listed inventors of Bharadwaj-Prov059 and Bharadwaj. *See* Ex. 2022 at 2; *see also* Ex. 1006 & 1007 (listing both Arjun Bharadwaj and Bin Tian as inventors). Both Mr. Bharadwaj and Dr. Tian had greater than ordinary skill in the art, with Dr. Tian having far greater than ordinary skill in the art. *See* Ex. 2037 (describing Arjun Bharadwaj as having a Master's degree in telecommunication plus several years of industry experience by September 2015); Ex. 2038 at 2 (describing Bin Tian as having a "Ph.D. degree in Electrical Engineering" and noting that "[s]ince 2012, he has contributed significantly to different generations of 802.11 standards including 802.11ah (Sub 1-Ghz)[and] 802.11ax (Wi-Fi6)"). This same group of numerous highly qualified authors submitted a different version of this proposal with the same proposed L_LENGTH formula on September 13, 2015. *See* Ex. 2023 at 23.[2]

44. During the week of September 17 (i.e., after the August 20, 2025 critical date of the '077 patent), a vote was held proposing the above L_LENGTH

[1] Ex. 2022 is dated July 10, 2015, but as shown by Exhibit 2024, it was uploaded to the IEEE Mentor website for distribution to participants in the IEEE 802.11ax working group on July 13, 2015.

[2] As shown in Ex. 2024, Ex. 2023 was uploaded to the IEEE Mentor website on September 13, 2015.

formula as "PHY Motion #61." *See* Ex. 2028 at 66–67. This proposal was "Accepted with no objection." *Id.* at 67.

45. On approximately July 13, 2015, a different group of authors from Yeungnam University (all but one of these authors overlapping with the named inventors of the Yu and Yu-Prov428 references) made a proposal regarding a means for "Efficient padding for last OFDM Symbol." *See* Ex. 2025.[3] This proposal described some of the material described in Yu-Prov428, including "Case 2," "Case 3," and "Case 4" that Yu-Prov428 proposes would have been signaled by an M value of M=2, M=1, and M=0 respectively in Yu-Prov428's Length formula. *Compare* Ex. 2025 at 6, *with* Ex. 2023 at 12.

46. The same authors submitted a proposal regarding "Support of 1x/2x/4x OFDM Symbol in HE SU PPDU" dated September 14, 2015, which provided the same proposed frame structures. *See* Ex. 2026 at 4.[4] The authors of this proposal made clear that they had considered proposals regarding "PHY Padding and packet extension" submitted to the IEEE 802.11ax working group. *See* Ex. 2026 at 2 ("Furthermore, we analy[ze] relationship between our proposed method and PHY padding and packet extension method that was proposed in

[3] These authors include lead author (and lead inventor of Yu) Heejung Yu, who received a Master's Degree in Electrical Engineering in 2001 and a Ph.D. in Electrical Engineering in 2011. *See* Ex. 2039 at 10. He additionally had significant industry experience by 2015, given that he "has participated in the IEEE 802.11 standardization, where he has made technical contributions since 2003." *Id.*

[4] Although Exhibit 2026 is dated September 14, 2015, the document was uploaded on September 13, 2015. *See* Ex. 2027 (providing an uploaded date of "13-Sep-2015" for DCN 1092 revision 0.

[2].”); *id.* at 6 (“Relationship with PHY Padding Proposal in [2] • PHY Padding proposal in [2] addressed a different aspect of the decoding process.”); *id.* at 7 (The two proposal[s] actually have distinct use cases. —The PHY padding in [2] is useful when data rate is high and data bandwidth is large (in both OFDM and OFDMA transmissions).”).

47. Although Ex. 2026 does not provide the full title of the reference “[2]” that it discusses, it does describe this reference as a “PHY Padding and packet extension” proposal (Ex. 2026 at 2), such that it appears Ex. 2026 was referring to the proposal in either Ex. 2022 or 2023 detailing the same L_LENGTH formula provided in Bharadwaj-Prov059. Even if Ex. 2026 were not referring to the PHY padding and extension method involving the L_LENGTH formula with a positive “m” offset of 1 or 2, the authors of Ex. 2026 were clearly aware of proposals made in the 802.11ax working group relating to PHY padding and packet extensions by the time they submitted Ex. 2026. Despite this knowledge by extraordinarily skilled artisans such as Heejung Yu (*see* Ex. 2039 at 10), and despite having been aware of their own Length formula in Yu-Prov428 involving a negative “M” offset where “M” is 0, 1, or 2, the authors of Ex. 2026 raised no concern over a L_LENGTH formula with the positive “m” offset of 1 or 2 even though their own work regarding OFDM symbol structure used a different approach to Length offset (a negative M offset of either 0, 1, or 2).

48. As discussed below, the first recognition of any problem caused by Bharadwaj-Prov059's L_LENGTH formula was by the inventors of the '077 patent in the Korean Application No. 10-2012-0117434 ("KR-434 application"). But after that recognition, the next soonest recognition of the Bharadwaj-Prov059 formula was as a November 2015 document from a team of seven contributors from Marvell and Interdigital, which collectively had an extraordinary amount of skill in the art. *See* Ex. 1016 (listing Hongyuan Zhang, Lei Wang, Li Hsiang Sun, Hanqing Lou, Frank La Sita, Oghenekome Oteri, and Joseph Levy as authors).

49. And of the six of the authors of Exhibit 1016 for whom publicly available profile information was available, four had doctoral degrees, one had a master's degree, and all had *at least* a decade of experience. For instance, Hongyuan Zhang received a Ph.D. in Electrical Engineering from North Carolina State University, and had been working on wireless standards from May 2005, first as a "Research Intern" from May 2005 to August 2006, then as a "Principal Engineer" starting in August 2006, and then as a "Director of Engineering" of "PHY Systems" and "Wireless Connectivity" starting in January 2015. *See* Ex. 2030. In other words, by the time Ex. 1016 was submitted, Mr. Zhang had a Ph.D. (significantly more education than a POSITA) ***and*** over a decade of relevant experience (significantly more professional experience than a POSITA). Li-Hsiang Sun also had a Ph.D. in Electrical Engineering and over a decade of relevant work

experience (Ex. 2031), and Hanqin Lou had a Ph.D. in Electrical Engineering and nearly a decade of relevant work experience (Ex. 2032). Oghenekome Oteri appears to have gone by "Kome Oteri" (*see* Ex. 2033) and also had a Ph.D. in Electrical Engineering as well as over a decade of relevant experience (Ex. 2034). Joseph Levy had a Master's degree plus approximately 35 years of industry experience. Ex. 2035. And while Frank La Sita's level of education is unknown, he appears to have had at least 15 years of relevant experience. Ex. 2036.

50. This team of engineers having far greater than ordinary skill in the art—four of whom had Ph.Ds in Electrical Engineering one with a Master's degree in Electrical (and all of the six individuals for whom I was able to locate biographical data having had at least a decade, and in some cases as much as 35 years, of industry experience)—were able to collectively recognize an inefficiency in Bharadwaj-Prov059's formula such that when legacy devices calculate "NSYM" using Bharadwaj-Prov059's formula, the calculated NSYM is one greater than the "desired NSYM" value. *See* Ex. 1016 at 3:

- According to Clause 18, it is desirable to make legacy devices assuming the number data symbols in non-HT PPDU as:

$$N_{SYM,Non-HT} = \left\lceil \frac{8.L\_LENGTH + 16 + 6}{24} \right\rceil = \left\lceil \frac{TXTIME - 20}{4} \right\rceil$$

- With current 11ax L-LENGTH equation, we get (desired NSYM)

$$N_{SYM,Non-HT} = \left\lceil \frac{8.\left(\left\lceil \frac{TXTIME - 20}{4} \right\rceil \times 3 - 3 + m \right) + 16 + 6}{24} \right\rceil$$

$$= \left\lceil \left\lceil \frac{TXTIME - 20}{4} \right\rceil + \frac{m}{3} - 0.08 \right\rceil = \left\lceil \frac{TXTIME - 20}{4} \right\rceil + 1, \text{ for } m = 1 \text{ or } 2$$

51. Only after the named inventors of Bharadwaj (Ex. 1006) were exposed to this solution by virtue of their participation in 802.11ax did they adjust their formula to include a negative m offset rather than a positive m offset. *See* Ex. 1006 (filing date of May 19, 2016); *id.* at [0050] (updated equation to to include a negative "m" offset).

VIII. OVERVIEW OF THE '077 PATENT

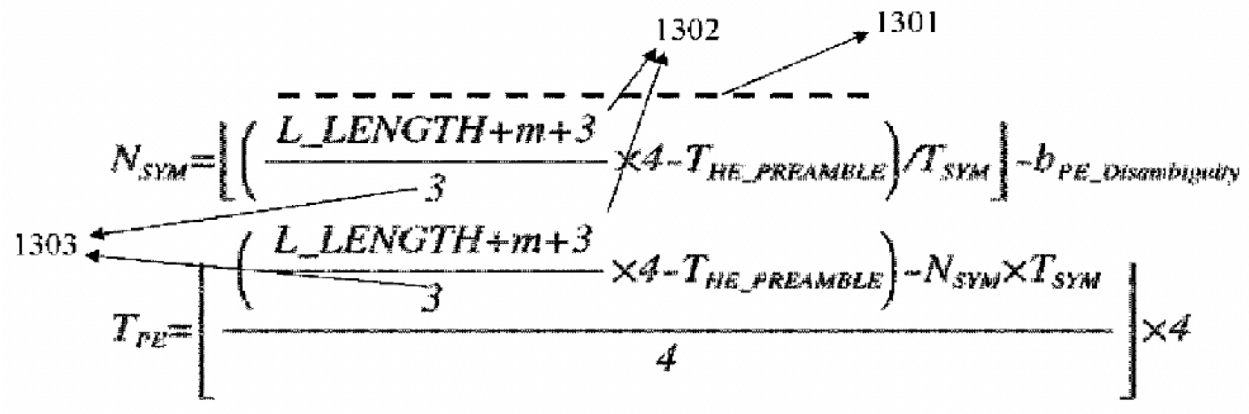
52. As noted above, the authors of Ex. 1016 may appear to be the first individuals to recognize the problem (and the corresponding solution) caused by the previous 802.11ax L_LENGTH formula, wherein the L_LENGTH formula would cause the calculated NSYM to be greater than the desired NSYM. However, the authors of Ex. 1016 were not actually the first to recognize the problem. Instead, the inventors of the '077 patent did so in their Korean Application 10-

2015-0117434 ("the KR-434 application") from August 20, 2015, predating Ex. 1016. Specifically, the inventors of the '077 patent recognized that using a formula with a ***negative*** m offset (as opposed to a positive m offset) was "fairer to legacy terminals compared to the L_LENGTH setting method [discussed in prior 802.11ax proposals and Bharadwaj-Prov059], which causes legacy terminals to defer longer than the actual packet length. *See* Ex. 2041 at <85> & FIG. 12. FIG. 12 of the KR-434 application, showing the use of a negative "m" offset for calculating L_LENGTH, is reproduced below.

$$L\_LENGTH_{fairness} = \left\lceil \frac{TXTIME - T_{L\_PREAMBLE}}{aSymbolLength} \right\rceil \times N_{OPS} - \left\lceil \frac{aPLCPServiceLength + aPLCPTailLength}{8} \right\rceil - m$$
$$= \left\lceil \frac{TXTIME - 20}{4} \right\rceil \times 3 - 3 - m \ , m = 1 \text{ or } 2$$

Ex. 2041 at FIG> 12; *see also id.* at FIG. 10 (showing prior art method of calculating L_LENGTH, which the KR-434 application contrasts with the negative-m offset technique disclosed in FIG. 12).

53. The KR-434 application goes on to disclose a method of calculating NSYM based on the disclosed L_LENGTH formula which solved the inefficiency of the prior art formula. The corresponding NSYM formula is shown in FIG. 13 and reproduced below.



Ex. 2041, FIG. 13.

54. It is particularly notable that this recognition of using a negative "m" offset of 1 or 2 in the 802.11ax L_LENGTH calculation was made by August 20, 2015, despite a large number of highly skilled artisans proposing a different (positive "m" offset) formula in July 2015 (*see* Ex. 2022 at 23) and the 802.11ax working group officially adopting that positive "m" offset proposal in September 2015 (*see* Ex. 2028 at 66–67). This supports my opinion that modifying Bharadwaj-Prov059's teachings to utilize a negative "m" offset would not have been merely conventional wisdom, but instead evaded numerous highly skilled engineers.

55. The recognition of the inventors of the '077 patent that its negative "m" offset as used in the context of 802.11ax solved a problem caused by the prior art positive "m" offset's formula is reflected in the claims of the '077 patent. For example, claim 1 of the '077 patent recites the solutions disclosed in Figures 12 and 13 and associated text of the KR-434 application:

1[pre]. A wireless communication terminal that communicates wirelessly, the terminal comprising:
1[1]. a transceiver; and a processor, wherein the processor is configured to
1[a]. receive a non-legacy physical layer frame by using the transceiver,
1[b]. obtain a legacy signaling field including information decodable by a legacy wireless communication terminal from the non-legacy physical layer frame,
1[c]. obtain length information indicating information on a duration of the non-legacy physical layer frame, from the legacy signaling field,
1[d]. obtain information other than information on the duration of the non-legacy physical layer frame through a remaining value obtained by dividing the length information by a data size transmittable by a symbol of a legacy physical layer frame, wherein the data size transmittable by a symbol of the legacy physical layer frame is 3 octets when a data rate of the legacy physical layer frame is 6 Mbps, and
1[e]. determine the number of symbols of data of the non-legacy physical layer frame according to a following equation, $N_{SYM} = \left\lfloor \left(\frac{\text{L\_LENGTH} + m + 3}{3} \times 4 - T_{HE\_PREAMBLE} \right) / T_{SYM} \right\rfloor - b_{PE\_Disambiguity}$ where $\lfloor x \rfloor$ denotes a largest integer less than or equal to x, L_LENGTH denotes the length information, m denotes a value obtained by subtracting the remaining value from the data size transmittable by a symbol of the legacy physical layer frame, $b_{PE\_Disambiguity}$ denotes a value of PE Disambiguity field, $T_{HE\_PREAMBLE}$ denotes a duration of non-legacy preamble of the non-legacy physical layer frame, T_{SYM} denotes a duration of a symbol of the data of the non-legacy physical layer frame, wherein the PE Disambiguity field is set based on the duration of a symbol of the data of the non-legacy physical layer frame and an increment of duration to set a value of the length information based on a duration of a symbol of the legacy physical layer frame.

IX. OPINIONS

A. Ground 1A (Bharadwaj in view of Yu)

56. I understand that there is a dispute regarding whether Bharadwaj (Ex. 1006) and Yu (Ex. 1019) constitute prior art to the ’077 patent. However, for

purposes of my analysis, I assume that Bharadwaj and Yu do constitute prior art, but only to the extent that teachings were contained in the provisional applications of Bharadwaj-Prov059 (Ex. 1007), Yu-Prov428 (Ex. 1020), or Yu-Prov294 (Ex. 1021). Dr. Ding's analysis focuses primarily on the disclosures of Bharadwaj-Prov059 and Yu-Prov428, and in my opinion the disclosures of those references (or any other prior art relied on by Dr. Ding) do not disclose or render obvious the inventions claimed in the '077 patent.

57. Bharadwaj-Prov059 teaches what was, at the time of the filing of that provisional, the current L_{LENGTH} formula in the development of the 802.11ax standard:

$$L_{LENGTH} = \left\lceil \frac{TXTIME - 20}{4} \right\rceil \times 3 - 3 + m \text{ where } m = 1, 2$$

Ex. 1007, [0051] ("The value m shown above has been added in IEEE 802.11ax…."); *see also* Ex. 1016 at 2 (noting that the "Current L-LENGTH Equation" in the development of 802.11ax is the same as Baradwaj-Prov059's equation).[5] Bharadwaj-Prov059 teaches that by adding m to the L_{LENGTH} calculation, it "ensures that L_{LENGTH} is not exactly a multiple of 3" and can thus be

[5] Ex. 1016 is not prior art, at least because it post-dates the critical date of the '077 patent. However, it confirms Bharadwaj's teachings that adding an "m" value of 1 or 2 was consistent with what was then contemplated by 802.11ax.

"used to distinguish between IEEE 802.11ax and IEEE 802.11ac transmissions." *Id.*; *see also* Ex. 1003 ¶63 ("From the above equation of L_{LENGTH}, a POSITA would have understood that so long as *m* is not chosen as 0 or as a multiple of 3, then L_{LENGTH} is not exactly a multiple of 3.").

58. Dr. Ding alleges that "a POSITA would have understood that there were only a small number of candidate values for *m* that could be applied to L_{LENGTH} by the transmitter and that could be uniquely recovered by the receiver through a calculation of the remainder from the division L_{LENGTH} / 3—namely, a non-zero remainder could be only be either 1 or 2, which are the only values less than the divisor of 3. Any larger values of *m* added to L_{LENGTH} at the transmitter (e.g., m=4, 5, 7, or 8) would still produce the two remainder values of m=1 or 2 at the receiver." Ex. 1003, ¶65. On this basis, Dr. Ding appears to imply that "m" values other than 1 or 2 would not be considered for use in Bharadwaj-059's equation, because any other "m" values "would still produce the two remainder values of m=1 or 2 at the receiver." *Id.*

59. However, this is inconsistent with Dr. Ding's allegation later in his declaration that a POSITA would have found it "obvious to try other predictable potential values for m, including m = -1 or -2." Ex. 1003, ¶73. There are only two possibilities. The first possibility is that, as Dr. Ding originally stated, m = 1 or 2 would have been seen as the relevant options by a POSITA in the context of

802.11ax in order to differentiate between legacy vs non-legacy transmissions. This is the understanding I agree with.

60. However, the second possibility is that values *other than* m = 1 or 2 (such that any other value that is not exactly a multiple of three such as -5, -4, -2, - 1, 1, 2, 4, 5, 7, 8 etc.) would have been potential candidates for consideration. I disagree that this would have been obvious in view of the prior art, but I note that even if this alternative understanding were adopted, this would allow for an infinite number of potential "m" values (i.e., every integer value where m is not exactly divisible by 3). Of course, which "m" value was selected in this process would need to be reflected in the non-legacy receiver's LLength calculation, but these are all possible values of "m" that could be chosen (so long as the chosen values were consecutive integers not divisible by 3, and non-legacy receivers were made aware of the candidate m values).

61. Dr. Ding proposes that, despite Bharadwaj-Prov059's teaching that in the LLENGTH calculation formula, m should be set to 1 or 2 consistent with the current 802.11ax standards development process, a POSITA would have chosen an "m" value of *negative* 1 or *negative* 2. He makes this allegation on the basis of Yu-Prov428's teaching that Length can be calculated as follows (which is equivalent to subtracting m, where m = 1 or 2 at the end of the Length formula rather than adding m, where m = 1 or 2).

62. Dr. Ding proposes that this would be obvious in view of Yu's teachings (as expressed in Yu-Prov428). But critically, neither Yu-Prov428 or ***any*** prior art recognized the problem with Bharadwaj-Prov059's formula, such that there would be no motivation for a POSITA to "fix" Bharadwaj-Prov059's formula in the way that Dr. Ding proposes would have been obvious to a POSITA. For instance, Bharadwaj-Prov059 itself does not disclose any problem with its equation 2.

63. Likewise, nothing in Yu-Prov428 suggests that if a positive value of "m" (where m = 1 or 2) were added to the Length formula, the outcome would be less desirable in any way than what Yu-Prov428 proposes to be the length formula. Indeed. Simply put, Yu-Prov428 provides no motivation for a POSITA to modify Bharadwaj-Prov059's formula in view of Yu-Prov428—it teaches no advantage relative to Bharadwaj-Prov059's formula, and teaches no problem in Bharadwaj-Prov059's formula that a POSITA would recognize as needing solving in the context of Bharadwaj-Prov059.

64. In my opinion, none of Dr. Ding's stated obviousness rationales are correct, as I explain below.

65. Dr. Ding alleges that it would have been obvious to "subtract[] m in the L_{LENGTH} equation, rather than adding m as Bharadwaj-Prov059 originally proposed," in order "to provide additional information (e.g., information

distinguishing between 802.11ax and 802.11ac transmissions) through L_LENGTH 'without changing the operation of the legacy receiver' and to allow legacy devices to correctly calculate Nsym and RXTIME so that the legacy devices need not defer transmissions for a longer duration than required." Ex. 1003, ¶66 (quoting Yu-Prov428, Ex. 1020 at 16). These are two distinct alleged motivations – ***(1)*** an alleged motivation to not "chang[e] the operation of the legacy receiver" (quoting language in Yu-Prov428 at 16), and ***(2)*** an alleged motivation "to allow legacy devices to correctly calculate Nsym and RXTIME so that the legacy devices need not defer transmissions for a longer duration than required." *See id.*

66. Regarding Dr. Ding's alleged first motivation (which refers to a quotation from Yu-Prov428 as allegedly supplying the motivation to modify Bharadwaj-Prov059's formula), a POSITA would not have viewed Bharadwaj-Prov059's formula as changing the operation of the legacy receiver within the meaning of Yu-Prov428's disclosure. Yu-Prov428 teaches that its formula does not "chang[e] the operation of the legacy receiver" regardless of whether M = 0, 1, or 2 is used in its equation, and the "the legacy receiver [will] identify the same length (the same packet duration) ***because one OFDM symbol with the lowest rate includes 3 bytes [of] data***." Ex. 1020, 16. In other words, the choice of M value (between M = 0, 1, or 2) does not change legacy calculation of "packet duration" relative to any other choice of M value (between M = 0, 1, or 2) in Yu-Prov428's

formula, because legacy calculation of M value is based on a multiple of 3. *See id.* For instance, selecting M = 1 (i.e., a "-1" offset to the length calculation) would necessarily return the same packet duration as if M = 2 (i.e., a "-2" offset to the length calculation) were selected. A POSITA would have readily understood that the ***same*** would be true as applied to Bharadwaj-Prov059's formula – selecting "m=1" (i.e., a "+1" offset to the LLENGTH calculation" would necessarily return the same packet duration as if "m=2" (i.e., a "+2" offset to the LLENGTH calculation) for exactly the same reason that Yu-Prov428 recognized: "Because one OFDM symbol with the lowest rate includes 3 bytes [of] data" (Ex. 1020 at 16), such that any two consecutive-integer offsets that are not a multiple of 3 will necessarily result in "the same packet duration" regardless of which of those offsets is chosen.

67. Accordingly, Dr. Ding's first motivation—not changing the operation of the legacy receiver—would not have motivated a POSITA to modify Bharadwaj-Prov059's formula in any way. Instead, a POSITA would have understood that Bharadwaj-Prov059 *conformed to* Yu-Prov428's teaching that when a range of offsets is provided as a possibility, the range should be set such that regardless of which of the possible offsets are provided, "the operation of the legacy receiver" will not be changed between offsets. And regardless of whether "m=1" or "m=2" in Bharadwaj-Prov059 is chosen, the legacy receiver will operate

exactly the same between those two options for exactly the reasons expressed in Yu-Prov428, such that Yu-Prov428 provides no motivation to modify Bharadwaj-Prov059's formula.

68. I also disagree with Dr. Ding's assertion that a POSITA would be motivated to modify Bharadwaj-Prov059's formula "to allow legacy devices to correctly calculate Nsym and RXTIME so that the legacy devices need not defer transmissions for a longer duration than required." *See* Ex. 1003, ¶66. As explained above, legacy devices deferring transmissions for a longer duration than required is a problem identified by the inventors of the '077 patent, but ***not*** identified in the prior art. None of Dr. Ding's alleged prior art identified any problem in Bharadwaj-Prov059's formula of longer-than-necessary transmission deferral. And Yu-Prov428 itself does not even mention legacy deferral in the context of any length calculation, such that this motivation could not come from Yu-Prov428.

69. Reviewing Dr. Ding's opinions that follow, it is clear that Dr. Ding's ultimate opinion is that a POSITA would have independently discovered that Bharadwaj-Prov059's formula would lead to longer-than-necessary deferral of transmission, despite this problem not being taught in any prior art reference. I strongly disagree with Dr. Ding's conclusion in this regard. A POSITA would not have made this discovery without the benefit of hindsight.

70. For instance, Dr. Ding alleges (in the context of legacy 802.11ac devices):

> [A] POSITA would have been motivated to use m=-1 or -2 (i.e., "-m" with m=1, or 2) to allow legacy 802.11ac devices to correctly calculate RXTIME and other parameters based on L_LENGTH, e.g., so that the legacy receiver devices would not defer channel access for a longer duration than required based on an incorrect RXTIME or other parameter incorrectly derived from an L_LENGTH value to which m had been added at the transmitter."

Ex. 1003, ¶67. But this assumes that a POSITA would have ***recognized*** that Bharadwaj-Prov059's LLength formula would have resulted in "an incorrect RXTIME or other parameter incorrectly derived from an L_LENGTH value to which m had been added at a transmitter"—of course, if a POSITA would not have ***recognized*** the problem, they would not have been motivated to ***solve*** that problem.

71. But in my opinion, the only way to ***recognize*** the problem (given that no prior art identifies the problem of Bharadwaj-Prov059's formula leading to an incorrect parameter calculation) would be for a POSITA to conduct significant independent testing and analysis of the formula. Of course, there are a large number of formulas disclosed in 802.11 standards, and each of those formulas may have potential effects on devices (both within the particular 802.11 standard itself, and on devices practicing other standards such as legacy devices). Verifying all of

these formulas would have been an immense undertaking, and even if a POSITA were to test the formula using simulations, it is not clear that the transmission deferral duration impact would have been recognized because legacy devices still would have functioned (just at lesser efficiency) using the prior art 802.11ax formula discussed in Bharadwaj-Prov059.

72. Furthermore, a POSITA typically does not engage in this sort of verification analysis regarding developmental standards. In my personal experience, almost all members of the IEEE 802.11 Working Group have a skill level higher than a POSITA. Standards development (and the interaction between standards) is almost exclusively evaluated by persons of greater than ordinary skill in the art, and the effect of one standard's requirements on other standards is a complex analysis with a potentially infinite scope for analysis. For example, while Dr. Ding focuses exclusively on Bharadwaj-Prov059's length formula and the impact that this formula would have on legacy 802.11ac and 802.11n devices, there were a significant number of requirements in 802.11ax, all of which could potentially have had downstream effects on legacy standards in a number of ways.

73. Without guidance pointing a POSITA to believe that Bharadwaj-Prov059's formula in particular was problematic, it would not be realistic to expect a POSITA to discover any resulting inefficiency on their own. People of ordinary skill in the art use creativity and reasoning to guide their endeavors, and do not

slavishly verify every single formula in the prior art through double-checking or simulation to see if modification of those formulas might result in some increased accuracy or efficiency. Given that there is no evidence that a POSITA would have been aware that Bharadwaj-Prov059's formula would have caused any error in legacy 802.11 devices, it is my opinion that a POSITA would not have identified this problem on their own because checking legacy impact of each requirement in the in-development 802.11ax standard would have been an enormous undertaking.

74. Likewise, in the context of 802.11n, Dr. Ding states that "a POSITA would have recognized that an L_LENGTH equation using m = +1 or +2 would result in an error in the calculation of Nsym whereas an L_Length equation using m = -1 or -2 (i.e., "-m" with m=1 or 2) would result in the desired NSYM value…. Thus, a POSITA would have been motivated to use m = -1 or -2 (i.e., "-m" with m=1 or 2) to allow legacy 802.11n devices to correctly calculate NSYM so that the legacy devices need not defer transmission for a duration longer than required." Ex. 1003, ¶68. But in my opinion, a POSITA would not have recognized any error in the desired NSYM calculation for legacy devices, because, as noted above any error that might result was not known in the prior art, and a POSITA would not have engaged in checking to see if the formula resulted in any error or inaccuracy as applied to legacy devices.

75. Indeed, Dr. Ding asserts that any inefficiency of Bharadwaj-Prov059's formula as applied to 802.11n devices would be recognized "[b]y performing these calculations of NSYM for 802.11n devices" (where "these calculations" constitutes applying Bharadwaj-Prov059's formula in a set of legacy calculations). *See* Ex. 1003, ¶68 (top of page 44). A POSITA would not actively go searching for potential inefficiencies to devices that do not practice the standard under consideration (in this case, 802.11ax) caused by every single equation in the standard under consideration—this would be a monumental task, and without any guidance as to which equations were inefficient in the first place, a POSITA would not have engaged in such a process.

76. The fact that a POSITA would not have recognized any problem that needed correction in Bharadwaj-Prov059 itself is strongly suggested by the development timeline of 802.11ax itself. As noted above, the development of 802.11ax involved the named inventors of both Yu-Prov428 and Bharadwaj-Prov059. However, despite having being aware of the teachings of their own references (and the fact that inventors of Yu-Prov428 would have been aware been aware of both Yu-Prov428—by virtue of having authored it—***and*** the formula from Bharadwaj-Prov059 by virtue of it being submitted in 802.11ax and citing to a similar if not the same proposal in Ex. 2026 – *see* Ex. 2026 at 2 (citing a "PHY padding and packet extension" method, extremely similar to the title of Ex. 2022),

none of these individuals recognized the problem with Bharadwaj-Prov059's formula (at least, not prior to this formula being introduced to the 802.11ax working group in the submission provided at Exhibit 1016).

77. Instead, the very first recognition of the problem with Bharadwaj-Prov059's formula was when the inventors of the '077 patent recognized it, which was at least as early as August 20, 2015. And while Dr. Ding alleges that the KR-525 Application was insufficient to disclose the claimed invention (such that the '077 patent is not entitled to a June 29, 2015 priority date), he does not dispute that the '077 patent is entitled to a priority date (or "Critical Date") of August 20, 2015. *See generally* Ex. 1003, ¶¶51-54. And as discussed above regarding the timeline of 802.11ax L_LENGTH development, ***after*** the August 20, 2015 Critical Date of the '077 patent, the *next* recognition of any problem in Bharadwaj-Prov059's provisional was provided in Exhibit 2016, which was submitted to the 802.11ax working group on November 8, 2015. And as noted above, Ex. 2016 was submitted not by a POSITA, but by numerous individuals having extraordinary skill in the art, including at least four with Ph.Ds and nearly all with at least a decade of experience. Accordingly, Ex. 2016 sheds no light on what would have been obvious to a person of ***ordinary*** skill in the art.

78. Dr. Ding also relies on the fact that "Bharadwaj, the non-provisional application of Bharadwaj-Prov059, implemented this change to the LLENGTH

equation," as supposedly being "contemporaneous evidence" that modifying Bharadwaj-Prov059's formula to include a negative integer offset as opposed to a positive integer offset would have been obvious. *See* Ex. 1003, ¶¶69, 71–72. But Dr. Ding's statement that the Bharadwaj publication itself (as distinct from Bharadwaj-Prov059) is "contemporaneous evidence that using m = -1 or -2… would have been within the knowledge and capability of a POSITA" (*see* Ex. 1003, ¶¶69, 71) is not accurate for at least two reasons. **First**, the Bharadwaj inventors did not independently arrive at this solution by virtue of the fact that they would have had knowledge of it due to Arjun Bharadwaj and Bin Tian's participation in 802.11ax development (*see* Ex. 2015, listing both individuals as authors) and the submission of Ex. 1016. And **second**, the inventors of Bharadwaj were both individuals of greater than ordinary skill in the art (with Bin Tian being an individual having ***significantly greater*** than ordinary skill in the art). *See* Exs 2037, 2038.

79. Dr. Ding also cites to the "Lee" reference as proposing a negative "n" offset for L_Length value. *See* Ex 1003, ¶69 (citing Ex. 1018, [0078]-][0079]. But this is applicable to 802.11n, not 802.11ax, and Lee is also not evidence that a POSITA would have viewed ***adding*** a positive offset would have caused any inefficiency even as applied to 802.11n Length; Lee does not even mention the

result that its proposed L_Length formula would have on any calculation of any other values.

80. Finally, I disagree with Dr. Ding's conclusion that "it would have been obvious to try other predictable potential values for m, including m= -1 or -2, to address the need to 'ensure that L_{LENGTH} is not exactly a multiple of 3… to distinguish between IEEE 802.11ax and IEEE 802.11ac transmissions' and to ensure compatibility with legacy devices." Ex. 1003, ¶73 (quoting Ex. 1006, [0050] and Ex. 1007, [0051]). First, Bharadwaj-Prov059's formula ***already*** ensures that L_{LENGTH} is not exactly a multiple of three, because a multiple of three plus one or two is necessarily not a multiple of three. Therefore, this would not have provided a motivation for a POSITA to try any other values for m. Second, a POSITA would not have viewed modifying Bharadwaj-Prov059's "m" value as helpful to "ensure compatibility with legacy devices" as Dr. Ding implies. As discussed above, a POSITA would not have recognized any problem that Bharadwaj-Prov059's formula would have caused for legacy devices (much less a problem of incompatibility). Indeed, as Dr. Ding appears to acknowledge, Bharadwaj-Prov059's formula would have been compatible with legacy devices, it simply would have introduced caused some amount of inefficiency (which a POSITA would not have recognized, as discussed above) as a result of legacy devices "defer[ring] channel access for a longer duration required." *See* Ex. 1003,

¶67; *see also id.*, ¶68 (alleging that his modification would cause "legacy devices" to "not defer transmissions for a duration longer than requires"). Accordingly, in my opinion there would not have been any recognized design need or market pressure to solve any problem that would have motivated a POSITA to attempt modifications to Bharadwaj-Prov059's equation 2.

B. Ground 2A (Bharadwaj alone)

81. Dr. Ding's analysis for his invalidity ground based on Bharadwaj alone is very short (*see* Ex. 1003, ¶115), and simply merely alleges that a POSITA would recognize that an "m" offset of -1 or -2 would accomplish exactly what Bharadwaj-Prov059's formula already accomplishes, which is "to distinguish between IEEE 802.11ax and IEEE 802.11ac transmissions. In my opinion, this is not a motivation to modify Bharadwaj-Prov059's teachings, particularly given that those teachings were at the time adopted by the 802.11ax standard working group. As explained above with respect to Dr. Ding's proposed combination of Bharadwaj in combination with Yu, Dr. Ding does not satisfactorily explain why a POSITA would find his proposed modification to Bharadwaj-Prov059 to be obvious, particularly in light of the strong evidence of that highly skilled engineers failed to solve the problem recognized and solved by the inventors of the '077 patent prior to the critical date.

X. CONCLUSIONS

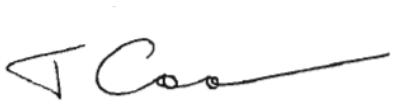
82. Although my complete opinions are set forth above, for convenience I summarize several points of my opinions in conclusion. For the foregoing reasons, based on my expertise and experience and the record of this case that I have reviewed, it is my opinion that the claims of the ‘077 patent are not obvious over the identified prior art.

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: March 25, 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.

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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.

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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.

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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.

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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.

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

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United States Patents

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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