UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

UNIFIED PATENTS, LLC
Petitioner,

v.

TOGAIL TECHNOLOGIES, LTD.
Patent Owner.

IPR2023-00338

Patent No. 10,791,502
Filing Date: April 1, 2019
Issue Date: September 29, 2020

Title: ON-DEMAND SYSTEM INFORMATION REQUEST PROCEDURE AND ERROR HANDLING

DECLARATION OF DR. ZYGMUNT J. HAAS

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I, Dr. Zygmunt Haas, declare as follows:

I. INTRODUCTION

1. I am over the age of eighteen (18) and otherwise competent to make this Declaration.

2. I have been retained by Unified Patents LLC ("Unified" or "Petitioner") as an independent, technical expert consultant in this proceeding before the United States Patent and Trademark Office. I am being compensated at my rate of $500 per hour for my services. No part of my compensation is dependent on my opinions or on the outcome of this proceeding. I have no financial interest in any of the parties to this proceeding.

3. This Declaration is in support of the petition ("Petition") for *inter partes* review IPR2023-00338 involving U.S. Patent No. 10,791,502 (the "'502 Patent" or "the Patent") (Ex-1001), entitled "On-Demand System Information Request Procedure And Error Handling" and listing Hung-Chen Chen, Chie-Ming Chou, and Yung-Lan Tseng as the inventors.

4. For the purposes of this *inter partes* review as I discuss later, I have been instructed to assume that the effective filing date of the Claims of the '502 Patent challenged by the Petitioner in this *inter partes* review is no earlier than April 2, 2018.

5. I understand that, according to USPTO records, the ’502 Patent is currently assigned to Togail Technologies, Ltd. (“Togail” or “Patent Owner”). I assume for purposes of this proceeding that Togail is the Patent Owner.

6. The ’502 Patent is generally directed to wireless communications. More particularly, the invention relates to providing an error handling procedure involving storing system information request, or “SI request,” failure information. The Challenged Claims (as defined in paragraph 8 below) are directed to system information acquisition procedures of user equipment such as a mobile phone. . I have been instructed to assume, for the purposes of this proceeding, that the priority date is April 2, 2018 (“Priority Date”). I am familiar with the technology described in the ’502 Patent as of the Priority Date.

7. In preparing this Declaration, I have reviewed the ’502 Patent (Ex-1001) and its prosecution history (Ex-1002), as well as the patents and documents cited herein, and I have considered these documents in light of the general knowledge of a person of ordinary skill in the art (“POSA”), who I describe below (§VI.A), as of April 2, 2018. In formulating my opinions, I have relied upon my experience in the relevant art, and I have considered the viewpoint of a POSA in the field, as of April 2, 2018. For convenience, the materials I considered in arriving at my opinions are listed in Appendix A.

8. I have been asked to provide my technical expertise, analysis, insights, and opinions regarding the ’502 Patent and relevant references that form the basis of the Grounds of unpatentability set forth in the accompanying Petition for *inter partes* review of the ’502 Patent. As described in detail below, I offer the following opinions in this Declaration regarding Claims 1, 4-7, 11, 14-17 (the “Challenged Claims”) of the ’502 Patent:

- A POSA would have found Claims 1, 4-7, 11, and 14-17 of the ’502 Patent to be obvious over *Lee* in view of the knowledge, skill, and creativity of a POSA. *Lee,* in view of the knowledge, skill, and creativity of a POSA, teaches each element of these claims to a POSA;
- A POSA would have found Claims 1, 4-7, 11, and 14-17 of the ’502 Patent to be obvious over *Oppo* in view of the knowledge, skill, and creativity of a POSA. *Oppo* in view of the knowledge, skill, and creativity of a POSA, teaches each element of these claims to a POSA;
- A POSA would have found Claim 1 of the ’502 Patent to be anticipated by *Oppo*. *Oppo* discloses each element of this claim.

9. Unless otherwise indicated, in this Declaration, the emphasis, including coloring and bolding, in quoted material has been added.

II. QUALIFICATIONS

10. I am the Professor and Distinguished Chair in Computer Science at the University of Texas at Dallas and Professor Emeritus of Electrical and Computer Engineering at Cornell University.

11. I received my Doctor of Philosophy (Ph.D.) degree in the field of Electrical Engineering from Stanford University in 1988. As part of my Ph.D. research, I authored the thesis titled "Packet Switching in Fiber–Optic Networks." In 1979, I received my Bachelor of Science (B.Sc.) degree in Electrical Engineering, *summa cum laude*, from the Technion, and in 1985, I received my Masters of Science (M.Sc.) degree in Electrical Engineering, *summa cum laude*, from Tel-Aviv University.

12. After receiving my Ph.D. degree from Stanford University, I worked as a member of the technical staff at AT&T Bell Laboratories from 1988 to 1995, initially in the Network Research Department in Holmdel, New Jersey. There, I performed research in the fields of wireless communications, mobility management, fast protocols, optical networks, and optical switching. During my tenure at AT&T, I also worked for the AT&T Wireless Center of Excellence, in Whippany, NJ. There, I studied various aspects of wireless and mobile networks.

13. After my work at AT&T Bell Laboratories, I joined the faculty of Electrical & Computer Engineering at Cornell University in 1995, and over time I

was promoted to Tenured Full Professor. While at Cornell, I headed my research group − the Wireless Networks Lab − which has had extensive contributions in the area of wireless communication systems and networks. I retired from Cornell University with the title of Emeritus Professor in 2013, and subsequently I joined the Computer Science Department at the University of Texas at Dallas with the title of Professor and Distinguished Chair in Computer Science. I have taught numerous courses related to computer networking and wireless communications both, at Cornell University as well at the University of Texas at Dallas. As part of my academic career, I have also served on numerous and various committees for the benefit of the scientific community.

14. I have served on the editorial board of a number of professional journals including Wireless Communications and Mobile Computing, Wireless Networks Journal, and the Journal of High Speed Networks. I have served as guest editor for the IEEE Journal on Selected Areas in Communications on several occasions.

15. I have worked for about 35 years in the fields of Electrical Engineering and Computer Science. The primary focus of my work has been, in general, on communication and networking systems, with an emphasis on wireless communication and wireless and mobile networks. I have authored and co-authored about 300 journal papers, conference papers, magazine articles, and book chapters. Also, I am named as an inventor or co-inventor on about twenty patents in the fields

of high-speed networking, wireless networks, optical switching, etc. Examples of some of my publications and articles that I have contributed to include:

- "How 5G Technology May Improve and Impact Our Lives" Authority Magazine Interview, June 4, 2021
- "5 Things to Know About 5G" UT Dallas Magazine, October 14, 2019
- J. Huang, C.C Xing, Y. Qian, and Z.J. Haas, "Resource Allocation for Multi-cell Device-to-Device Communications Underlying 5G Networks: A Game-Theoretic Mechanism with Incomplete Information," IEEE Transactions on Vehicular Technology, vol. PP, no. 99, October 23, 2017, DOI: 10.1109/TVT.2017.2765208
- Z.J. Haas and M. Nikolov, "Towards Optimal Broadcast in Wireless Networks," *IEEE Transactions on Mobile Computing,* vol. 14, no. 7, pp. 1530−1544, July 2015, DOI: 10.1109/TMC.2014.2356466
- J. Oh and Z.J. Haas, "Personal Environment Service based on the Integration of Mobile Communications and Wireless Personal Area Networks," *IEEE Communications Magazine,* vol. 48, no. 6, June 2010, pp. 66−72; DOI: 10.1109/MCOM.2010.5473866
- Z. J. Haas, "The Multiply-Detected Macrodiversity Scheme for Wireless Cellular Systems," EE Colloquium, School of Electrical Eng., Cornell University, April 22, 1997

16. I have received numerous accolades for my work. Among other organizations, I am a Fellow of the IEEE (Institute of Electrical and Electronics Engineers) and a Fellow of the ACM (Association for Computing Machinery), both well-known distinctions. For example, the total number of IEEE Fellows which are selected in any given year does not exceed 0.1% of the total number of voting members of IEEE. Alike, "ACM's most prestigious member grade recognizes the top 1% of ACM members for their outstanding accomplishments in computing and

information technology and/or outstanding service to ACM and the larger computing community." (available from https://awards.acm.org/fellows). In 2016, I received the IEEE ComSoc AHSN Recognition Award for "outstanding contribution to securing ad hoc and sensor networks" from the IEEE Communication Society in 2016. In 2012, I received the IEEE ComSoc WTC[1] Recognition Award, which recognizes individuals for outstanding technical contributions in the field for their service to the scientific and engineering communities. As another example, I received the "Best Paper Award" for the paper "Optimal Resource Allocation for UWB Wireless Ad Hoc Networks" from the IEEE International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC) conference in 2005. Finally, in 2003, I received the "Highly Commended Paper Award" for co-authoring "Performance Evaluation of the Modified IEEE 802.11 MAC for Multi-Channel Multi-Hop Ad Hoc Network," directed at advanced information networking and applications. Furthermore, many of my papers have been extensively cited by other authors, as indicated by various citation indices. For example, my paper on "Securing Ad Hoc Networks," co-authored with a Ph.D. student at the time, has been cited over 4000 times by other publications according to the *Google Scholar* index. I have also taught courses that cover wireless communications and networking technologies, at

[1] Wireless Communications Technical Committee.

the graduate and undergraduate levels. In addition, I have been invited to many international conferences to make keynote speeches regarding wireless and mobile networks.

17. I have previously testified in multiple IPR cases, including those concerning wireless networks.

III. RELEVANT LEGAL STANDARDS

18. I am not a lawyer, I do not opine on matters of law, and I do not provide any legal opinions in this Declaration. Although I am not a lawyer, I have been informed by counsel that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims. I have been asked by counsel to provide my opinions regarding whether the claims of the ’502 Patent would have been anticipated or would have been obvious to a person having ordinary skill in the art at the ’502 Patent’s effective filing date, in light of the prior art. I have been instructed to assume for the purposes of this proceeding that the Priority Date (defined above) is the effective filing date of the Challenged Claims.

A. Anticipation

19. I have been informed by counsel that a patent claim is unpatentable if the claimed invention is not new. For a challenged claim to be unpatentable because it is not new, all of its requirements must have been described in a single previous

publication or patent that predates the effective filing date of the challenged claim. In patent law, these previous publications or patents are called “prior art references.” If a patent claim is not new, then it is “anticipated” by a prior art reference.

20. I have been informed by counsel that to anticipate a challenged claim, the prior art does not have to use the same words as the claim, but all of the requirements of the claim must have been disclosed, either stated expressly or necessarily implied (i.e., “inherent”) such that one skilled in the art would reasonably understand or infer from the reference that every claim element is disclosed in that reference. In considering the disclosure of a reference, I am informed that it is proper to consider not only specific teachings of the reference, but also the inferences which one skilled in the art would reasonably be expected to draw therefrom. I have been informed by counsel that a claim element is inherently present in a prior art reference if the element must necessarily be present, and a skilled artisan would have recognized that the element must necessarily be present.

21. I have been informed by counsel that if the prior art necessarily functions in accordance with, or includes, the claimed limitations, it anticipates the limitations. I have been informed by counsel that if the disclosure of a prior art reference is sufficient to show that the natural result flowing from the operation as taught would result in the performance of the questioned function, the disclosure is regarded as sufficient to anticipate.

22. I have been informed by counsel that a reference need not state a feature's absence in order to disclose a negative limitation of a challenged claim.

23. In addition, I have been informed by counsel that for anticipation, the description provided in the reference must enable a person of ordinary skill in the art in the field of the invention to practice the invention without undue experimentation. Prior art patents are presumed to be enabled, unless the owner of the challenged patent, who bears the burden of showing prior art is not enabled, shows otherwise. A showing by the patent owner regarding the enablement of any prior art may be rebutted.

24. I have been informed by counsel that I may consider additional evidence not explicitly contained in a single prior art references for certain purposes, including:

- to show that the reference is enabled;
- to explain, but not expand, the meaning of terms and phrases used in the reference; and
- to show that something is inherent in the reference.

B. Obviousness

25. Further, I have been informed by counsel that a patent claim is not patentable as obvious (a requirement I have been informed by counsel to be governed by a statute, 35 U.S.C. § 103), if the differences between the patent claim and the prior art are such that the claimed subject matter as a whole would have been obvious

at the time the claimed invention was made to a person having ordinary skill in the relevant art. Obviousness, as I have been informed by counsel, is based on the scope and content of the prior art, the differences between the prior art and the claim, the level of ordinary skill in the art, and, to the extent that they exist, certain objective indicia of non-obviousness.

26. I have been informed by counsel that objective indicia can be important evidence regarding whether a patent is obvious or nonobvious, if it has an appropriate nexus to the claimed invention, *i.e.*, is a result of the merits of a claimed invention (rather than the result of design needs or market-pressure advertising or similar activities). Such indicia include: commercial success of products covered by the patent claims; a long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention as compared to the closest prior art; praise of the invention by the infringer or others in the field; the taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at the making of the invention; the patentee proceeding contrary to the accepted wisdom of the prior art, and, the contemporaneous development of the subject matter claimed by others.

27. I have been informed by counsel that whether there are any relevant differences between the prior art and the claimed invention is to be analyzed from

the view of a person of ordinary skill in the relevant art at the effective filing date. As such, my opinions below as to a person of ordinary skill in the art are as of the effective filing date, even if not expressly stated as such; for example, even if stated in the present tense.

28. In analyzing the relevance of the differences between the claimed invention and the prior art, I have been informed by counsel that I must consider the impact, if any, of such differences on the obviousness or non-obviousness of the invention as a whole, not merely some portion of it. I have been informed by counsel that the person of ordinary skill faced with a problem is able to apply his or her experience and ability to solve the problem and also look to any available prior art to help solve the problem.

29. I have been informed by counsel that if the prior art sometimes, but not always, embodies a claim limitation then the prior art nonetheless teaches that limitation.

30. I have been informed by counsel that a precise teaching in the prior art directed to the subject matter of the claimed invention is not needed. I have been informed by counsel that one may take into account the inferences and creative steps that a person of ordinary skill in the art would have employed in reviewing the prior art at the effective filing date. For example, if the claimed invention combined elements known in the prior art and the combination yielded results that were

predictable to a person of ordinary skill in the art at the effective filing date, then this evidence would make it more likely that the claim was obvious. On the other hand, if the combination of known elements yielded unexpected or unpredictable results, or if the prior art teaches away from combining the known elements, then this evidence would make it more likely that the claim that successfully combined those elements was not obvious.

31. I have been informed by counsel that there are recognized, exemplary, rationales for combining or modifying references to show obviousness of claimed subject matter. Some of the rationales include the following: combining prior art elements according to known methods to yield predictable results; simple substitution of one known element for another to yield predictable results; use of a known technique to improve a similar device (method or product) in the same way; applying a known technique to a known device (method or product) ready for improvement to yield predictable results; choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to

modify the prior art reference or to combine prior art teachings to arrive at the claimed invention.

IV. OVERVIEW OF THE ’502 PATENT

A. Claimed Priority

32. The ’502 Patent issued from U.S. Application 16/372,389, filed on April 1, 2019, and claims priority to Provisional Application 62/651,312, filed on April 2, 2018. Ex-1001 Cover, 1:8-14. I have been instructed to assume, for the purpose of this proceeding, that the Priority Date is April 2, 2018. I have also been instructed to assume for the purpose of this proceeding that this Priority Date is the “effective filing date” of the Challenged Claims.

B. Disclosure

33. The ’502 Patent is directed to an “on-demand system information request procedure and the corresponding error handling procedure for the next generation wireless communication networks.” Ex-1001 1:40-43. While the ’502 Patent acknowledges that the pre-existing 5G new radio (NR) network had “on-demand system information (SI) request” procedures, the applicant believed that the procedures lacked “an efficient mechanism for error handling associated with the on-demand SI request procedure.” Ex-1001 1:23-3.

34. The summary of invention and abstract state that the purported invention was providing an error handling procedure involving storing system information request, or “SI request,” failure information:

> A method of wireless communications **performed by a user equipment (UE)** is provided. The method includes performing an on-demand system information (SI) request procedure in a cell; and **performing an error handling procedure if the on-demand SI request procedure in the cell is unsuccessful**. **The error handling procedure includes storing SI request failure information.**

Ex-1001 Abstract; *see also* Ex-1001 1:40-62.

35. Although the alleged inventive error handling procedure involved storing "failure information," this feature is not recited in the Challenged Claims.

36. Instead, they are directed to the activation of a "prohibit timer" that prohibits the user equipment ("UE") from resending a request for SI for a period of time. The specification describes the prohibit timer as an optional feature:

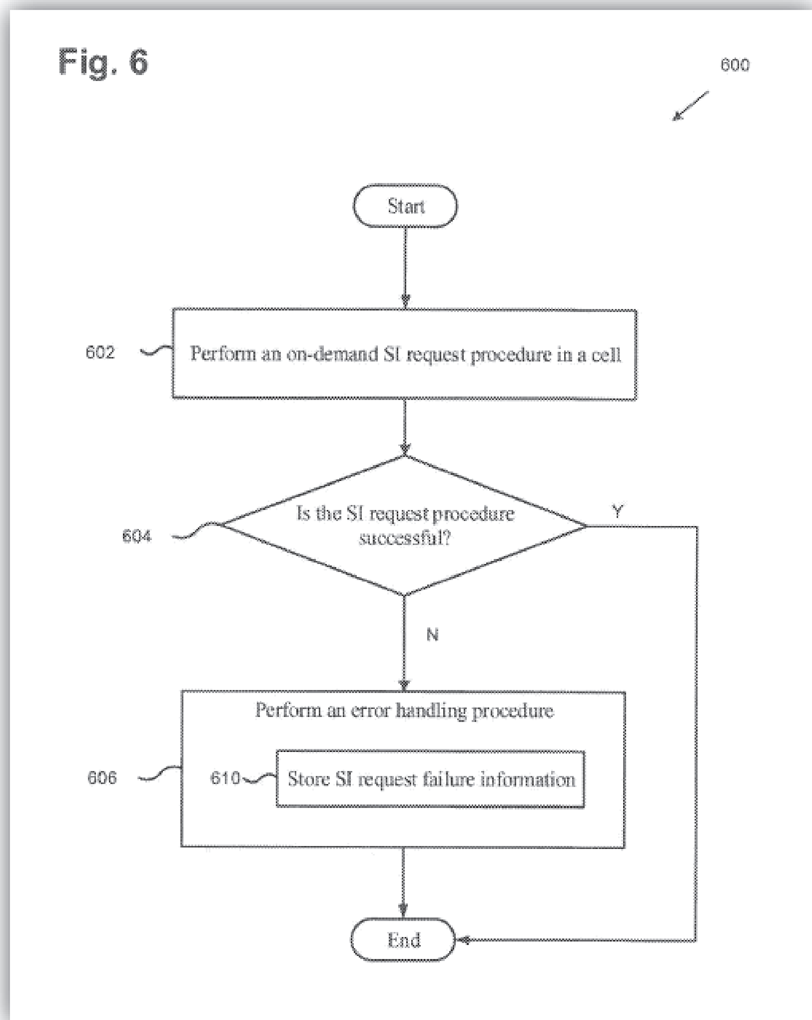
> **In one implementation**, the error handling procedure **may further include at least one of following: a prohibit timer activation**, a cell re-selection procedure, and a re-establishment procedure.

Ex-1001 15:51-62, *see also* 8:12-22 (similar).

37. The specification states that the prohibit timer can be used in an "unconnected state" (Ex-1001 6:47-49, 7:50-60) and a "connected state" (*id.*, 7:61-62, 8:12-22). While the specification does not explain what these states are, a POSA would have known them as the particular states of radio interface connectivity specified by the 3rd Generation Partnership Project (3GPP) standards body, as discussed below. Generally, UEs in an unconnected state had more limited radio

resources established for communication, whereas the connected state established specific bi-directional, point-to-point bearer channels to carry data and control messages between the UE and the network.

38. Although the specification references a few differences in optional implementation details for the prohibit timer in the two states, the differences are not described as being particularly important. *Compare* Ex-1001 6:47-49, 7:7-26, 7:50-60 (prohibit timer in the unconnected state) *with id.* 7:61-62, 8:12-22 (prohibit timer in the connected state). The prohibit timer is not shown in the ’502 Patent’s figures, which instead focus on claim scope withdrawn in the amendment shown in paragraph 39 below (§IV.C):



Ex-1001 Fig. 6.

C. Prosecution History

39. The ’502 Patent issued from U.S. Application 16/372,389, filed on April 1, 2019, and claims priority to Provisional Application 62/651,312, filed on April 2, 2018. Ex-1001 Cover, 1:8-14. The Examiner allowed the application after the applicant amended the claims to replace the error storage feature with the prohibit timer feature:

1. **(Currently amended)** A method of ~~wireless communications~~ an on-demand system information (SI) request procedure performed by a user equipment (UE), the method comprising:

transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);

activating a prohibit timer; and

transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.

~~performing an on-demand system information (SI) request procedure in a first cell; and~~

~~performing an error handling procedure if the on-demand SI request procedure in the first cell is unsuccessful, wherein the error handling procedure comprises:~~

~~storing SI request failure information.~~

Ex-1002 244.

40. The applicant argued that the prior art of record did not disclose a prohibit timer or the connected state. Ex-1002 251. The Examiner allowed the claims, referencing the applicant's amendment and arguments. Ex-1002 221.

41. As I explain below, the references of the Grounds of unpatentability set forth in the accompanying Petition—which references were not cited or relied upon during prosecution of the '502 Patent—disclosed the limitations allegedly missing from the art. Ex-1001 (56); Ex-1002 (generally).

V. CLAIM CONSTRUCTION

42. I have been advised by counsel that, in order to properly evaluate the claims of the '502 Patent, the terms of the claims must first be interpreted. I am

informed that the terms in the '502 Patent are to be given their plain and ordinary meaning in view of the specification and prosecution history as would have been understood by a POSA (defined below in §VI.A) as of the Priority Date. That is the meaning that I have applied in my analysis.

43. I have been informed by counsel that the Board does not construe claim terms unless the terms are in controversy, and then only to the extent necessary to resolve the controversy.

44. I have followed these principles in my analysis throughout this Declaration. It is my opinion that no specific construction of any term is required, because the relied-upon prior art meets each of the claimed terms under any proper construction.

45. If a Board or Court construes any term of the '502 Patent, I reserve the right to supplement my opinions in view of such a construction(s).

VI. STATE OF THE ART

A. Level of Ordinary Skill in the Art

46. I have been advised by counsel that a person of ordinary skill in the relevant art is a hypothetical person who is presumed to be aware of all pertinent prior art, thinks along conventional wisdom in the art, and is a person of ordinary creativity.

47. Unless otherwise stated, my testimony below refers to the knowledge

of one of ordinary skill in the art as of April 2, 2018, the date that I was advised by counsel to use as the Priority Date of the ’502 Patent. I am familiar with the knowledge and capabilities of one of ordinary skill in the art as of that Priority Date.

48. In my opinion, as to the ’502 Patent, a POSA in April 2018 would have had at least (1) a Bachelor’s degree in electrical engineering or a similar degree and (2) at least two years of professional experience with cellular wireless communications, including the 3GPP radio interface architecture and protocols for 4th and 5th Generation of cellular wireless systems. More experience could supplement for less education and vice versa. The level of skill in the art is further demonstrated by the references cited herein. Minor changes in the precise definition of a POSA would not change my analysis below. While this Declaration may occasionally use the present tense, my analysis is from the perspective of a POSA as of the time of the Priority Date.

49. By virtue of my education, experience, and training in academia and industry, I am familiar with the level of skill in the art of the ’502 Patent in the 2018 timeframe, and I had at least the qualifications of a POSA in 2018.

B. State of the Art and the General Knowledge of a POSA

50. In this section, I describe the state of the art, including the general knowledge, skill, common sense, and creativity possessed by a POSA as of the Priority Date.

1. The 3GPP Standards Body

51. A POSA was well aware of the 3rd Generation Partnership Project (3GPP) standards development for cellular technology, including 3GPP's Technical Specifications (TS's, e.g., TS-38.331 (Ex-1026)) and technical contributions (e.g., *Oppo* (Ex-1005)). Ex-1009. 3GPP is responsible for the various generations of cellular technology, including the 4th Generation (4G) (e.g. Evolved-Universal Terrestrial Radio Access (E-UTRA)/Long Term Evolution (LTE)) and the 5th Generation (5G) (e.g., the New Radio (NR)) standards. Ex-1015; Ex-1017; Ex-1011 (e.g., "With LTE and 5G work, 3GPP has become the focal point for the vast majority of mobile systems beyond 3G.").

52. 3GPP is the preeminent organization for standards development for the cellular industry. For example, 3GPP coordinates "some 140 meetings per year handling 100,000 contribution documents." Ex-1043. 3GPP has over 800 individual members, including industry leaders like Apple, Samsung, Ericsson, Nokia, and Huawei. Ex-1012.

53. A POSA was well aware that 3GPP develops its Technical Specifications (TS) in working groups (WG) organized by subject matter, in which delegates from industry members are tasked with preparing and considering proposals for the next version of a TS, including technological proposals for the information, discussion and approval of the WG. Ex-1010; *Baron* (Ex-1018).

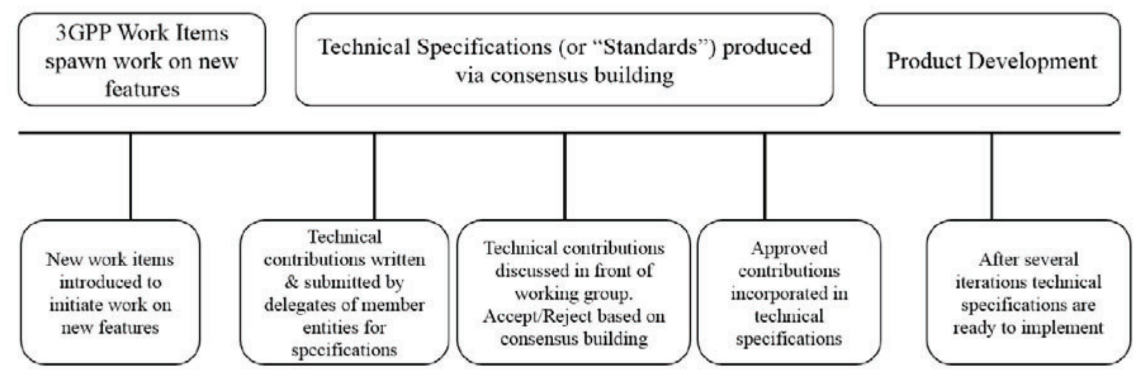


Figure 3: The Standard Setting Process

Barron (Ex-1018) 014.

54. The 3GPP Technical Specifications and the working group technical contributions make up a major portion of the body of publicly available technical literature concerning cellular technology.

55. The general knowledge of a POSA as of the Priority Date included the 4G and the 5G radio access technologies disclosed in 3GPP technical specifications. *See, e.g.,* Ex-1020 to Ex-1027. Of particular importance to the topic of this declaration were the specifications directed to Radio Resource Control (RRC) (Ex-1024, Ex-1026) in the context of other RAN specifications (e.g., Ex-1022, Ex-1025, Ex-1023).

2. Well Known 3GPP Concepts

a. <u>Radio Access Network</u>

56. It was well known to a POSA that in cellular wireless communications,

user equipment (UE) (e.g., a mobile phone) communicated with the network via the Radio Access Network (RAN), specifically with base stations (BS) of the RAN.

57. For example, the architecture of the 4G RAN (also called E-UTRAN or LTE) was well known:

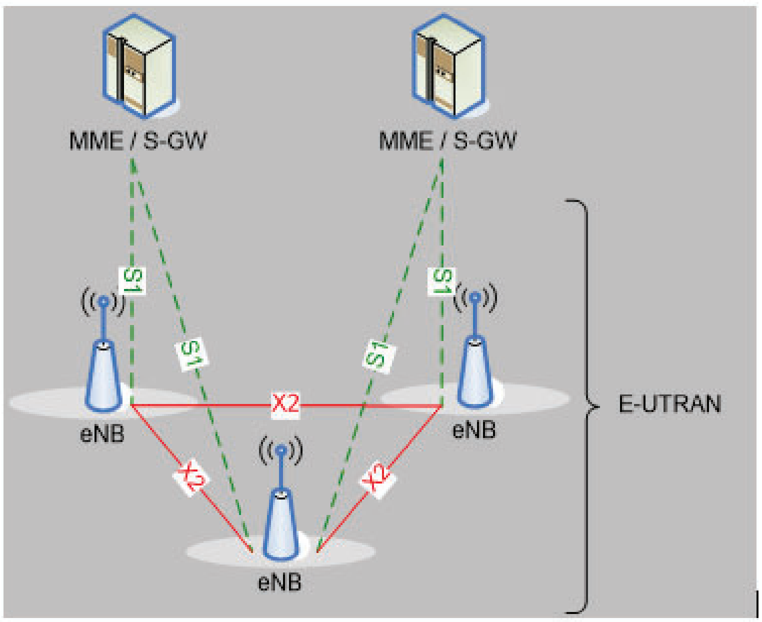


Figure 4-1: Overall Architecture

Ex-1022 Fig. 4-1, 27. A 4G base station is referred to as an "E-UTRAN NodeB" or simply "eNB." Ex-1022 23, 27 ("The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE.").

58. It was also well known to a POSA that the architecture of the 5G RAN was specified to use both New Radio (NR) and E-UTRA (4G) technology:

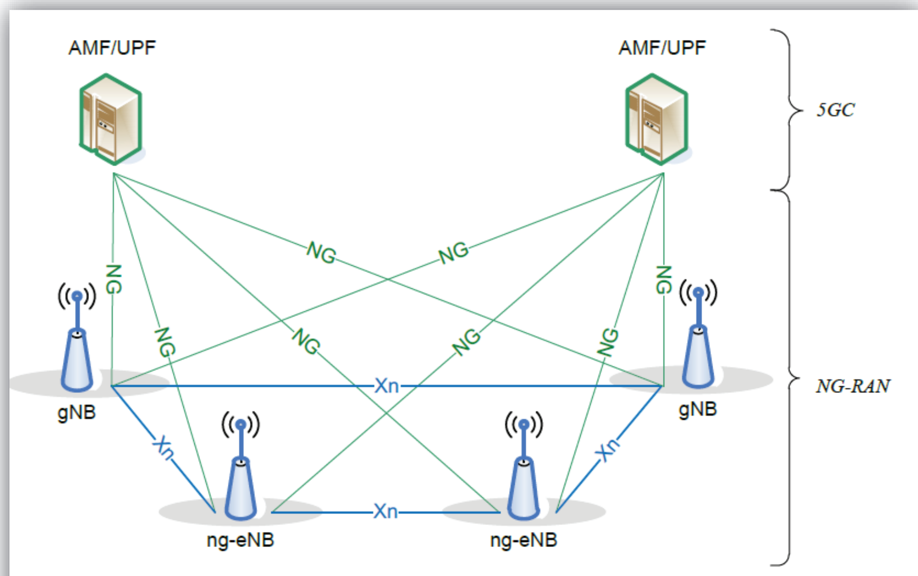


Figure 4.1-1: Overall Architecture

Ex-1025 Fig. 4.1-1, 10.

59. In the 5G RAN, there are two different types of base stations, "ng-eNBs"[2] and "gNBs"[3] where ng-eNBs provide 4G/LTE connectivity and gNBs provide 5G connectivity. Ex-1025 9-10. Thus, a "gNB" base station provided a

[2] An ng-eNB (ng-e-NodeB) is a base station that provides 4G (E-UTRA/LTE) user plane and control plane protocol terminations towards the UE and interfaces to the 5G Core Network (5GC). Ex-1025 9-10.

[3] A gNB (g-NodeB) is a base station that provides 5G New Radio, Radio Access (NR) user plane and control plane protocol terminations towards the UE and interfaces to the 5GC. Ex-1025 9-10.

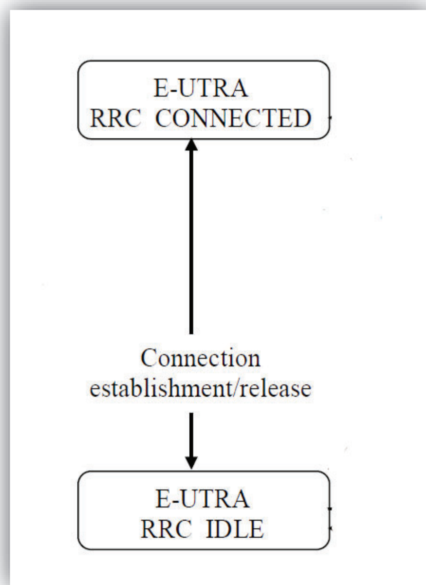
UE with 5G wireless connectivity, and an "ng-eNB" base station provided the UE with 4G wireless connectivity to the 5G core network ("5GC"). Ex-1025 9-10. It was well known to a POSA that some aspects of 4G would continue to be relied upon in 5G. *Id*. at 9-10, 16.

b. Radio Resource Control (RRC)

60. In cellular wireless communications, it was well known that the control plane for the UE-to-RAN radio interface was governed by 3GPP's Radio Resource Control (RRC) protocols. Ex-1024; Ex-1026 §§1, 4.1. "RRC refers to the signaling language spoken and associated behaviors undertaken between the network and a mobile device." Ex-1015; *see also* Ex-1026.

c. RRC STATES – IDLE, INACTIVE, CONNECTED

61. It was also well known to a POSA at Priority Date that 3GPP specified an RRC state machine for UEs that depended on the UE's state of radio interface connectivity with the RAN. Ex-1024 30-31; Ex-1026 12-14; Ex-1019. The RRC procedures for the UE differed depending on the state. *Id.* The RRC state determined the radio resources—e.g., Signalling Radio Bearers (SRBs) and Data Radio Bearers (DRBs)—usable by the UE when in a given state. Ex-1019. For example, it was known to a POSA that 3GPP RRC specified that a UE operating 4G (E-UTRA) was either in an "RRC_ IDLE" or "RRC_CONNECTED" state, depending on whether an "RRC connection" was established:



Ex-1024 Fig. 4.2.1-1 (reproduced in part).

62. When a UE was in the RRC_IDLE state, it had limited radio resources for communicating with the RAN, but could monitor a paging channel to detect incoming calls, and could acquire system information (*infra*) about the RAN that was necessary to perform cell selection/re-selection and establish an RRC connection. Ex-1024 30. In the RRC_CONNECTED state, the UE's RRC connection supported bidirectional, point-to-point communication between the UE and the RAN. Ex-1024 30-31. The UE could monitor a paging channel and/or System Information Block Type 1 (SIB1) content to detect system information changes and acquire further system information. Ex-1024 31.

63. In 5G, 3GPP defined a new state, RRC_INACTIVE, such that a UE could be in one of three RRC states: RRC_IDLE, RRC_INACTIVE, or

RRC_CONNECTED:

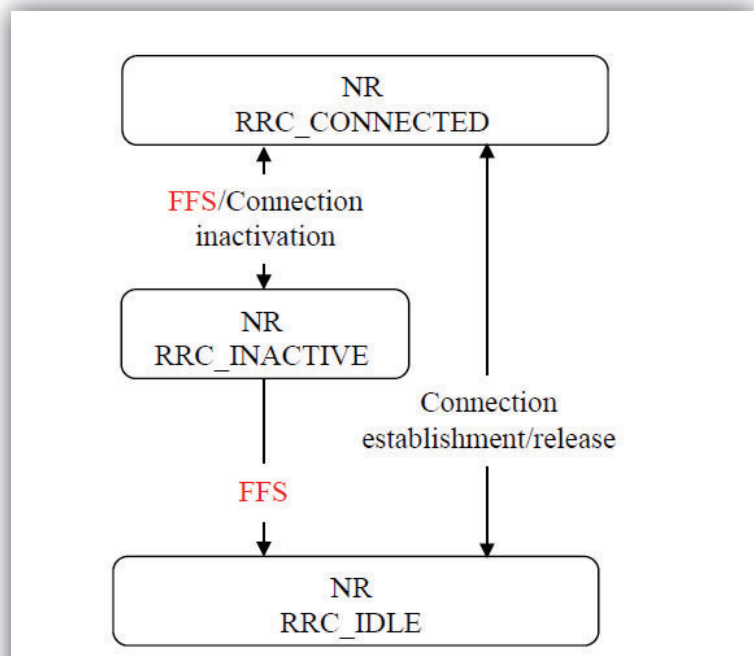


Figure 4.2.1-1: UE state machine and state transitions in NR

Ex-1026 Fig. 4.2.2-1, 13. The RRC IDLE and RRC CONNECTED states are generally similar to 4G. Ex-1026 12-13.

d. <u>RRC's System Information Acquisition</u>

64. It was also well known to a POSA that 3GPP specified procedures requiring a UE to acquire (and continue to maintain as valid) specific system information ("SI") necessary for connectivity. Ex-1024 §5.2.2 ("System Information Acquisition"); Ex-1026 16-21, §5.2.2

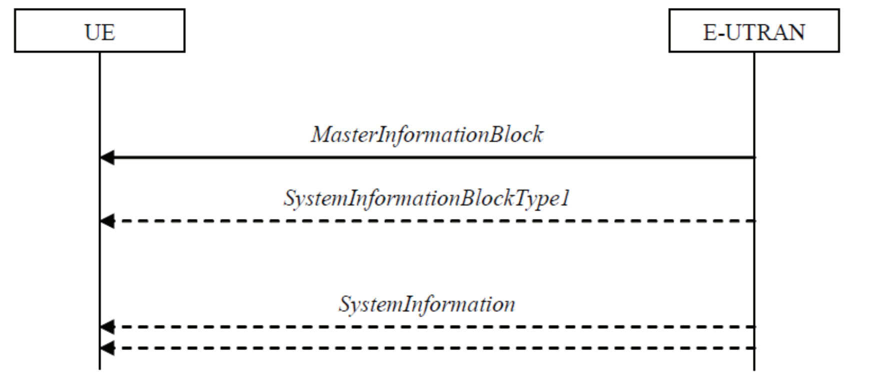


Figure 5.2.2.1-1: System information acquisition, normal

Ex-1024 41 (Fig. 5.2.2.1-1); *see also* Ex-1026 17, Fig. 5.2.2.1-1. As part of system information acquisition, the UE was required to monitor for system information broadcast from the network, and the UE was required to do so in each of the RRC states (for 4G these were the RRC_IDLE and RRC_CONNECTED states; for 5G those states also included the RRC_INACTIVE state). *Id.* For example, in 5G RRC_CONNECTED state, 3GPP specifications required that the UE "shall ensure having a valid version of (at least) the *MasterInformationBlock*, *SystemInformationBlockType1* as well as *SystemInformationBlockTypeX* (depending on support of mobility towards the concerned RATs)." Ex-1026 17. Under the acquisition procedure, the UE monitored and verified that it had the necessary SI as part of "cell selection (e.g., upon power on), cell-reselection, return from out of coverage, after handover completion, after entering RAN from another RAT; whenever the UE does not have a valid version in the stored SI." Ex-1026 17.

Specific types of system information were specified in the Master Information Block ("MIB"), System Information Block Type 1 (SIB1), System Information Block Type X (SIBX). Ex-1024 261-262, 321-355; Ex-1026 16 §5.2.1, 59-60 (*MIB*), 64-65 (*SIB1*); Ex-1025 31-32. The system information included configuration details necessary to access the network, such as system frame number, bandwidth, Public Land Mobile Network (PLMN) identity, cell selection and re-selection thresholds, etc. *Id.* The 4G standard defined some 22 different SIBs, from *SystemInformationBlockType1* to *SystemInformationBlockType22-NB*. Ex-1024 46-56, 261-262, 321-355; Ex-1026 16, §5.2.1, 64-65 (SIB1); Ex-1025 31-32.

e. **<u>"On-demand" System Information</u>**

65. For 5G, it was known to a POSA at the Priority Date that the system information acquisition procedures of 4G were being augmented in 5G to support an "on-demand" option, in which the UE sent a "system information request," which was a message to ask the network to send the UE certain SI when needed. Ex-1001 Abstract; Ex-1026 17, 20; Ex-1025 31-32. The new ability of an SI request was reflected in versions of the 3GPP technical specifications that were available before the Priority Date, e.g.:

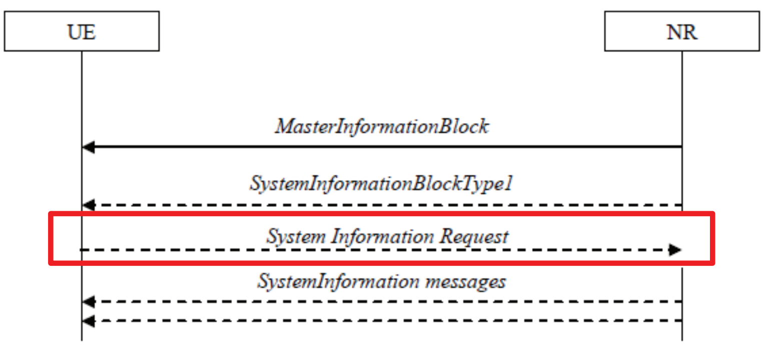


Figure 5.2.2.1-1: System information acquisition

Ex-1026 17, Fig. 5.2.2.1-1.

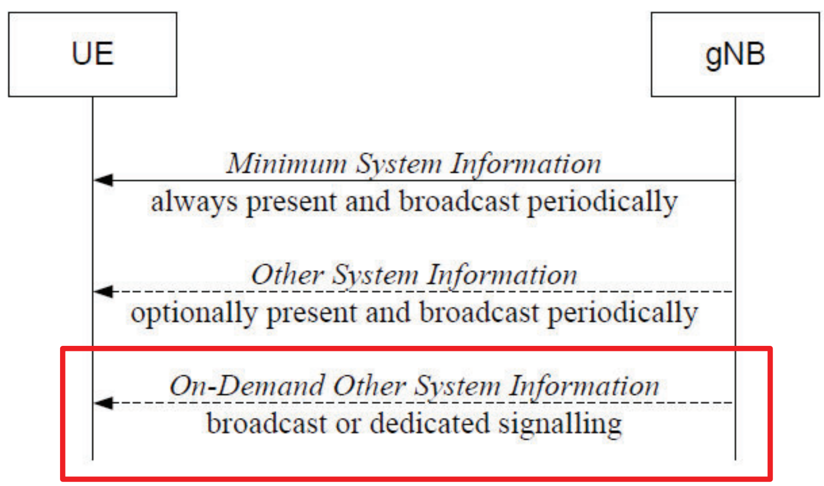


Figure 7.3-1: System Information Provisioning

3GPP TS 38.300 (Ex-1025) Fig. 7.3-1, 31-32.

66. The *5G RRC Specification* provided section 5.2.2.3.3, titled "**Request** for **on demand** system information," specifying how system information would be "provided upon UE request" (as opposed to being regularly broadcast by the

network). Ex-1026 20. In short, the "on-demand" procedures gave UE's the ability to send a System Information (SI) request message to the base station if particular SI was missing or was needed. *Id.* The on-demand SI procedures differed depending on the RRC state. Ex-1025 32. Specifically, the details of the SI information request and delivery depended on whether the UE was in the RRC_IDLE state or the RRC_CONNECTED state:

> **For UEs in RRC_CONNECTED**, dedicated RRC signalling is used for the request and delivery of the Other SI. **For UEs in RRC_IDLE and RRC_INACTIVE,** the request triggers a random access procedure (see subclause 9.2.6) and is carried over MSG3 unless the requested SI is associated to a subset of the PRACH resources, in which case MSG1 can be used.

Ex-1025 32.

67. Prior to the Priority Date, it was well known to a POSA what the proposed options for the on-demand system information procedures were, where to find those proposals, and that selecting the particular details of the procedures was a matter of mere consensus building by the industry participants at 3GPP. As such, further details were being decided upon, as reflected in publicly available technical contributions; e.g., *Oppo* (Ex-1005), which is discussed extensively below in connection with the RAN2 working group meeting held just before the Priority Date, RAN2#101. Ex-1005; Ex-1013; Ex-1014; Ex-1029, Ex-1032, Ex-1033. Thus, the state of the art for on-demand SI acquisition was at an advanced stage as part of the

ordinary process of 3GPP standardization. Ex-1025; Ex-1026; Ex-1033.

VII. GROUND 1: CLAIMS 1, 4-7, 11, 14-17 ARE OBVIOUS OVER *LEE*

A. *Lee* Is Pertinent, Analogous Prior Art

68. U.S. provisional application 62/334,418 to Lee ("*Lee*") was filed on May 10, 2016, describing an "On-Demand Delivery of System Information with RAN [Radio Access Network] Based Polling." Ex-1004 001-002.[4] I am informed by counsel that *Lee* is prior art as of November 16, 2017 due to the publication on that date of U.S. patent application publication 2017/0332372 ("the '372 Pub."), which claimed priority to *Lee* and incorporated it by reference in its entirety. *Lee* was not cited or discussed during prosecution of the '502 Patent. Ex-1001 (56); Ex-1002 (generally).

69. *Lee* is analogous art to the '502 Patent. For example, the field of endeavor of the '502 Patent "generally relates to wireless communication, and more particularly, to the on-demand system information (SI) request procedure for the next generation wireless communication networks." Ex-1001 1:17-20. *Lee* is in the same field of endeavor as the '502 Patent–"on-demand delivery of system

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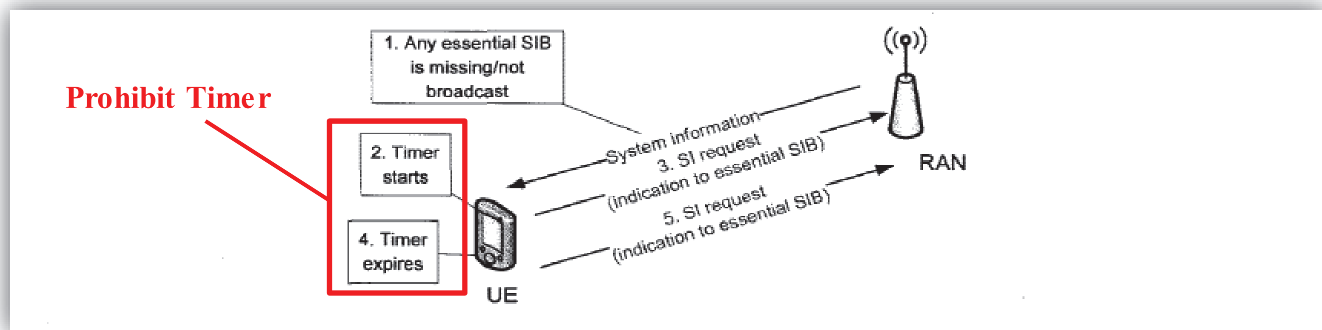
[4] Citations herein to *Lee* begin with the three digit pagination of the exhibit label in the footer of the document, followed by *Lee's* specific identifiers (e.g. section or paragraph numbers), if present.

information" (Ex-1004 013)–for not only 4G radio access technology (i.e., "LTE", "eNB"), but also for subsequent generations, i.e., 5G radio access technology (RAT): "In the inventions, **RAN is LTE base station** i.e. eNB **or** replaced by a **New RAT**." Ex-1004 046. *Lee* is also reasonably pertinent to at least one problem addressed by the '502 Patent, namely "that when UE frequently requests system information, uplink is congested." Ex-1004 045. Indeed, as discussed below, *Lee* described the same solution—a prohibit timer.

B. Overview of *Lee*

70. *Lee* taught on-demand SI acquisition improvements to 3GPP's Radio Resource Control (RRC) protocols. As background on "Prior Art," *Lee* reproduced extensive material from TS 36.331, the 4G RRC Protocol Specification. *Compare* Ex-1004 014-45 *with* Ex-1024 35-84. Because a POSA would have understood *Lee's* invention was disclosed with reference to the 3GPP 4G and 5G standards (Ex-1004 e.g. 014-45, 051-60, 046 "In the inventions, RAN is LTE base station i.e. eNB or replaced by a New RAT."), a POSA would have understood the terms, phrases and natural consequences of *Lee's* disclosure in the context of those 3GPP standards, as I explain below. For a background discussion of the knowledge of a POSA regarding these standards, see VI.B above.

71. *Lee* taught using a prohibit timer as part of an on-demand SI procedure:



Ex-1004 049 (annotated); Title ("**On-Demand** Delivery of System Information.").

72. *Lee's* prohibit timer limited the UE's ability to send repeated on-demand SI requests:

> **SI request when UE detects that any essential (i.e. required) SIB [System Information Block] is missing at a cell**
> If a cell does not broadcast essential SIBs which UE needs to acquire at a cell, the SI request from a UE may alternatively indicate to RAN that essential SIBs are missing...
>
> After sending the SI request at a cell, **UE starts a timer.** If UE does not receive the essential SIBs at the cell until the timer expires, UE considers the cell as barred, or **UE re-sends the SI request to RAN at the cell after the timer expires**.

Ex-1004 049. The timer prevented uplink congestion by prohibiting frequent UE SI requests. Ex-1004 045.

C. Detailed Application to the Claims

a. Claim 1

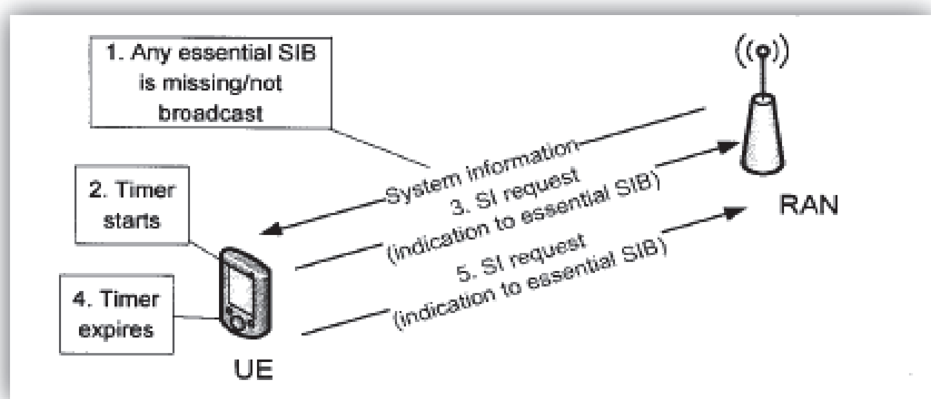
[Pre] A method of an on-demand system information (SI) request procedure performed by a user equipment (UE), the method comprising

73. To the extent the preamble is limiting, *Lee* disclosed or at least rendered obvious the preamble, [Pre], as explained below.

74. **First**, *Lee* taught *a method of an on-demand system information (SI) request procedure*. For example, *Lee* taught that a UE may request SI information if the "UE detects that any essential (i.e., required) SIB [System Information Block] is missing at a cell," explaining:

> **If a cell does not broadcast essential SIBs** which UE needs to acquire at a cell**, the SI request from a UE may** alternatively **indicate to RAN** [*i.e.,* Radio Access Network] **that essential SIBs are missing**. Upon receiving the SI request, RAN sends the essential SIBs that are not broadcast to the UE.

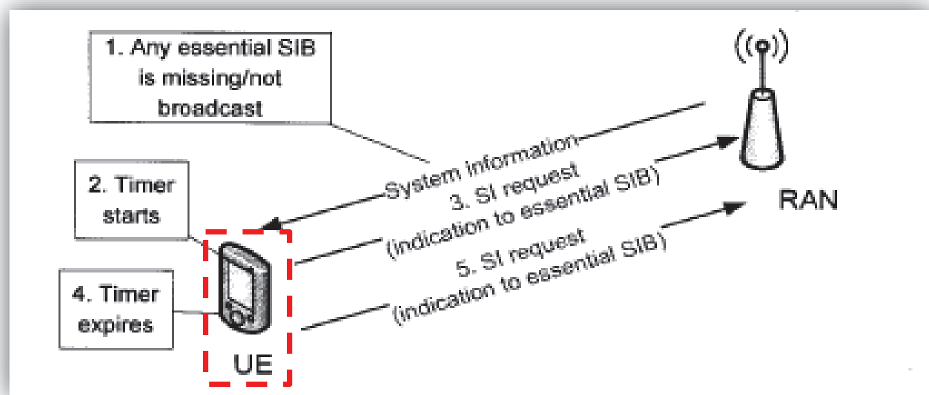
Ex-1004 049. *Lee* illustrated the SI request procedure as follows:



Ex-1004 049.

75. *Lee's* procedure was *on-demand,* because the UE was permitted to ask the network for particular SI, when needed. Ex-1004 045-046, 049-050. For example, *Lee* disclosed that a "UE **may request** system information at a cell. Then, when the network receives this request, the network sends system information to the UE." Ex-1004 045. Indeed, *Lee* was expressly directed to "**On-Demand** Delivery of System Information." Ex-1004 Title, *see also* 014, 045-046, 049-059. In fact, by the Priority Date, a POSA would have recognized that *Lee's* disclosure was directed to "on demand system information acquisition"—a 3GPP concept known from development of the 5G standard. I discussed this in more detail above in §VI.B.2.d-e. *See* TS 38.331 (Ex-1026 20) 20 ("§5.2.2.3.3 Request for **on demand system information**"); TS 38.300 (Ex-1025) 31-32 (discussing on-demand SI request procedures for 5G). This is also supported by the '502 Patent. Ex-1001 1:23-34 (admitting as background that in 5G, the UE can send SI requests when particular SI is needed). The "on-demand" procedures contrasted with 3GPP SI acquisition prior to *Lee,* in which a UE could not make such a request, but instead monitored SI broadcasts, and could not connect if necessary SI was missing. Thus, *Lee* disclosed an *on-demand system information request procedure* in the context that a POSA would have understood that terminology, all consistent with the general knowledge of a POSA as of the Priority Date.

76. **Second**, *Lee's* method was *performed by a user equipment (UE)* in that a "UE" carried out the method: the UE detected that it needed SI, sent an appropriate SI request, and started a prohibit timer. Ex-1004 049; *see also* 051 ("user equipment (UE)"). For example, *Lee* showed the UE performing the method as follows:



Ex-1004 049 (annotated).

[1a] transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);

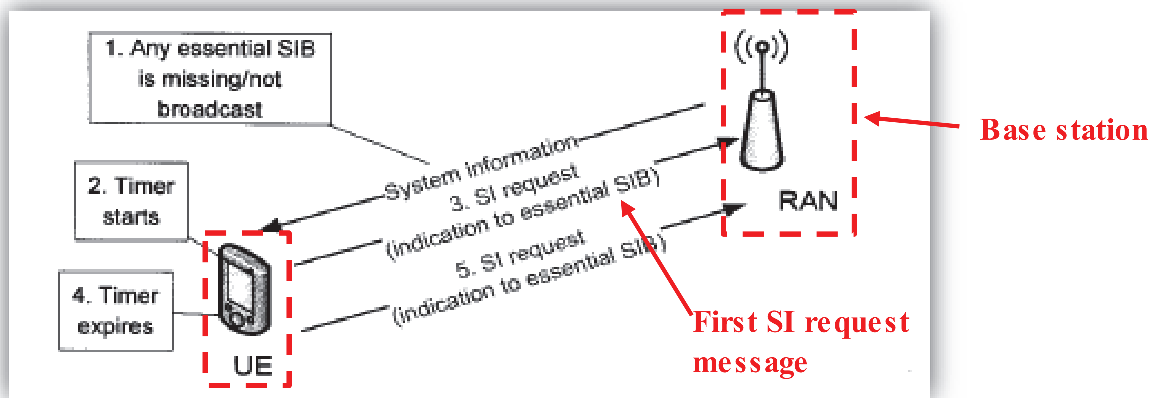
77. This limitation is disclosed or at least rendered obvious by *Lee*. Below, I address limitation [1a] in subparts.

[1a.1] transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state

78. As explained below, *Lee* taught or at least rendered obvious *transmitting a first SI request message to a base station (BS)*.

79. For example, *Lee* taught a UE sending an "SI request" (*transmitting a first SI request message*) to a Radio Access Network ("RAN") base station (a *base*

station (BS)). Ex-1004 046, 049. For example, the message labelled "3. SI request" in the figure below is *a first SI request message*:



Ex-1004 049 (annotated).

80. As shown in the figure, the SI request in item 3 (***first*** *SI request message*) is *first* because it was sent before the SI request in item 5. Ex-1004 049. *Lee* disclosed the SI request taking the form of an "RRC **message**" (*first SI request* ***message***). Ex-1004 046 ("**SI request** can be carried via … **a RRC message**"). Finally, in *Lee,* the UE sent the SI request messages to a 4G or a 5G base station of the RAN, i.e., *to a* ***base station*** *(BS)*. Ex-1004 046 ("In the inventions, **RAN is** LTE **base station** i.e. eNB or replaced by a New RAT **base[] station…** The RAN manages a cell."), 049 ("UE re-sends the SI request **to RAN**").

81. *Lee* also taught or at least rendered obvious a UE transmitting the first SI requests *in a connected state*.

82. While *Lee* did not expressly disclose that its SI request procedures

applied to a connected state, *Lee*'s disclosure was not tailored or limited to any particular state and a POSA would have understood *Lee* to teach sending SI requests in the 3GPP-defined RRC states, including the RRC_CONNECTED state (as well as the unconnected state, i.e., RRC_IDLE). Ex-1004 046, 049; Ex-1004 [0001] ("The RRC state may be divided into two different states such as a RRC_IDLE and a RRC_CONNECTED.").[5] **First**, as explained for [1pre] (§VII.C.a), *Lee's* "**on-demand** system information" procedures were an addition to the overall 3GPP SI acquisition procedures, which applied to the RRC_CONNECTED and the RRC_IDLE states, as confirmed by the 3GPP specification reproduced in *Lee*:

[5] *Lee* was directed to 3GPP's RRC protocols, using 3GPP terminology throughout. Ex-1004; [1pre] (§VII.C.a); *see also* §VI.B.2.b-d (3GPP RRC protocols). Indeed, *Lee* reproduced large portions of TS 36.331, the 4G RRC Protocol Specification. Ex-1004 014-45; Ex-1024 35-84.

1.1.2 5.2.2 System information acquisition

1.1.2.1 5.2.2.1 General

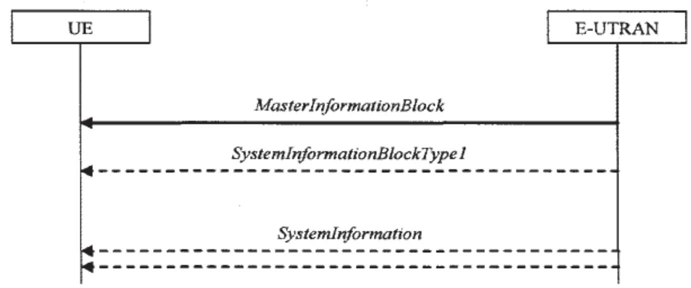


Figure 5.2.2.1-1: System information acquisition, normal

The UE applies the system information acquisition procedure to acquire the AS- and NAS- system information that is broadcasted by the E-UTRAN. The procedure applies to UEs in RRC_IDLE and UEs in RRC_CONNECTED.

Ex-1004 018, Figure 5.2.2.1-1 (annotated). As the highlighted text states, the SI acquisition procedure "**applies to UEs in RRC IDLE and UEs in RRC CONNECTED**." Ex-1004 018 (quoting TS 36.331). Because Lee taught that the SI requests augmented the SI acquisition procedures of 3GPP without restriction to any particular RRC state, and because 3GPP specified SI acquisition procedures for the RRC_CONNECTED state, a POSA would have understood that *Lee's* SI requests were sent in the RRC_CONNECTED state, or, at a minimum, that would have been obvious.

83. **Second**, *Lee* taught sending an SI request when essential SI was missing (Ex-1004 049), which would include missing essential information in the RRC_CONNECTED state. Ex-1004 015-016, 018-019 (quoting 3GPP requirements for SI in RRC_CONNECTED state). Accordingly, a POSA

appreciated that a UE in the RCC_CONNECTED state would encounter scenarios where it would be missing essential SI for that state—the predicate for *Lee's* SI request. *Id.* For example, when in the RRC_CONNECTED state, essential SI may never have been received, or it may be outdated, corrupted, change or otherwise be invalid by the time it is needed, thus prompting the UE to determine that the SI specified for its current state, RRC_CONNECTED, was missing. Ex-1004 015-016 §5.2.1.3. Thus, a POSA would have understood, or at least found it obvious, that *Lee's* SI request teachings applied to the RRC_CONNECTED state.

84. To the extent Togail argues that *Lee* does not sufficiently disclose sending SI requests in the RRC_CONNECTED state, a POSA would have found it at least obvious to send *Lee's* SI request messages in the RRC_CONNECTED state to achieve the purpose taught by *Lee*—prompting the network to send the UE the SI that it needed—given the POSA's general knowledge of the RRC_CONNECTED state. Ex-1004 046, 049. Without the benefit of the UE being able to send an SI request as taught by *Lee*, a UE in the RRC_CONNECTED state that is missing SI in the normal course of operation (e.g., the SI times out or becomes corrupt) would have to treat "the cell as barred" according to the legacy SI acquisition procedures. Ex-1004 021-022 §5.2.2.5; §VI.B.2.d-e. Therefore, a POSA readily recognized that *Lee's* SI requests would predictably and beneficially be used in the RRC_CONNECTED state to achieve the benefits of being able to request SI as

taught by *Lee*, thus improving connectivity by not having to unnecessarily treat a cell as barred. Applying the on-demand SI procedure to the RRC_CONNECTED state would require no more skill than applying the procedure in any RRC state, and thus, to the extent a modification to *Lee* was required, it would have been one within the skill of a POSA. Accordingly, to the extent not already taught, any modification to *Lee* would have involved no more than using a known technique (*Lee's* on-demand SI teachings) to improve similar methods (improving RRC_IDLE and RRC_CONNECTED) in the same way (allowing the UE to ask for needed SI).

85. Indeed, a POSA considering *Lee* at the time of the Priority Date would have known that sending SI request messages in the RRC_CONNECTED state was part of the general knowledge, as reflected by 3GPP 5G standards development. *Supra* §VI.B.2.c. *Lee* suggested applying its disclosure to 5G (Ex-1004 046 ("New RAT")), and by the Priority Date, 3GPP technical specifications specified details for sending SI request messages in the RRC_CONNECTED state. TS 38.300 (Ex-1025) 32 ("**For UEs in RRC_CONNECTED,** dedicated RRC signalling is used for the request and delivery of the Other SI."). This acceptance by the industry would have been known to a POSA, further establishing obviousness.

86. In at least three ways, *Lee* also taught or at least rendered obvious that the SI request was sent ***after determining*** *that the UE is in a connected state*, in view of the general knowledge of a POSA.

87. **First,** *Lee* taught that a UE had two RRC states which controlled the UE's operation (Ex-1004 054-055 [0001-0004]), consistent with the general knowledge of RRC states. §VI.B.2.c. A 3GPP UE like *Lee's* constantly knew (*determin[ed]*) which state it was in at all times, pursuant to the 3GPP radio resource control (RRC) layer specifications. Ex-1024 Fig. 4.2.1-1; §VI.B.2.c. For example, the UE first determined that it was in the RRC_CONNECTED state when it entered the state, before operating in that state. Ex-1004 054-055. Indeed, the '502 Patent specification does not disclose a distinct step for a UE "determining" that it is in one state or another, but refers to the different 3GPP RRC states for a UE, such as idle or connected. Ex-1001 4:56–5:21. Likewise, *Lee* disclosed that, "[t]he RRC state may be divided into two different states such as a RRC_IDLE and a RRC_CONNECTED." Ex-1004 054 [0001].

88. **Second,** *Lee's* SI request was precipitated by the UE determining that "essential (i.e. required) SIB is missing." Ex-1004 049. This determination is based on RRC state, because 3GPP identifies different SI as "essential (i.e. required)" depending on the RRC state. Ex-1004 018 (§5.2.2.2.3 defining "System information **required** by the UE" differently depending on UE being in "RRC_IDLE" or "RRC_CONNECTED" state). For example, *SystemInformationBlockType3* through *SystemInformationBlockType7* were required in RRC_IDLE, but not for RRC_CONNECTED. Ex-1004 018. Thus, *Lee's* disclosure of determining which

SI is missing taught, or at least rendered obvious, that the UE first determined its RRC state before sending any SI request, i.e., for a UE in the RRC_CONNECTED state, *Lee's* SI request was sent *after determining that the UE is in a connected state.* Ex-1004 18 (defining what SI is required in which state).

89. **Third,** this sequence is also taught or at least rendered obvious because *Lee* taught sending an "SI request" to the network (Ex-1004 049), and the type of messaging available to the UE depends on the RRC state. Specifically, *Lee* disclosed that a UE had different connectivity and procedures for sending messages depending on the RRC state: "In RRC_CONNECTED state, the **UE 10 has** an E-UTRAN **RRC connection**…." Ex-1004 054 [0002]. Without an RRC connection (e.g., in RRC_IDLE), the UE used the Common Control Channel (CCCH). Ex-1004 056 [0014]. In contrast, in RRC_CONNECTED, the UE used the Dedicated Control Channel (DCCH), which was "a point-to-point bi-directional channel used by UEs having an RRC connection" and "transmits dedicated control information between a UE and the network." Ex-1004 056 [014], *see also* Ex-1004 029 ("RRC connection establishment involves the establishment of SRB l.").[6] Thus, to send

[6] By way of background, SRB1 was a signalling radio barrier used for sending RRC messages over the DCCH. Ex-1024 32 (Defining SRB as a "Signalling Radio Bearer," which were "Radio Bearers (RB) that are used only for the transmission of

Lee's SI request to the network, the UE first determined, based on its state, how to format and send that message, i.e., the SI request was sent *after determining that the UE is in a connected state*. Ex-1004 056 [014], 029.

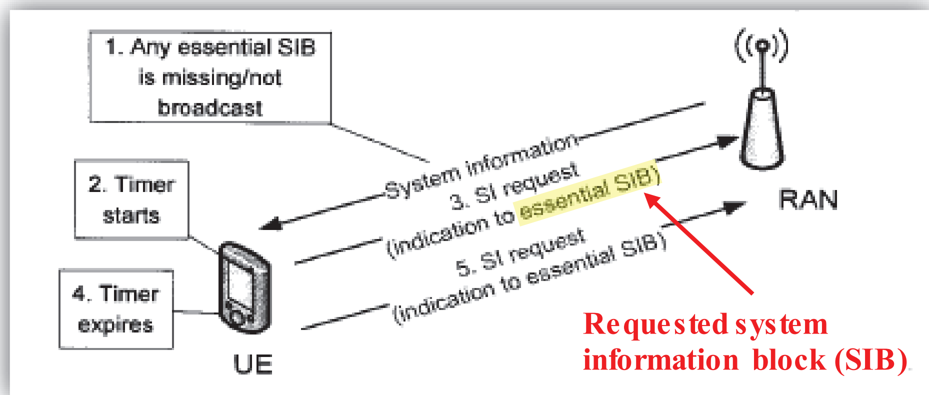
[1a.2] the first SI request message including at least one requested system information block (SIB);

90. *Lee* taught that an SI request (*first SI request message*) identified "[t]he number(s) of a **system information block** type on request" (*included at least one requested system information block (SIB)*). Ex-1004 046. In that way, the SI request would indicate which SIB the UE needed (*requested*). *Lee* explained further that:

> If a cell does not broadcast essential SIBs which UE needs to acquire at a cell, **the SI request from a UE may** alternatively **indicate to RAN that essential SIBs are missing**. Upon receiving the SI request, RAN sends **the** essential SIBs that are not broadcast to the UE.

Ex-1004 049. This is further supported by the description of the SI request in item 3 below, in the SI request indicated the needed "essential SIB":

RRC … messages. More specifically, the following SRBs are defined: … SRB1 is for RRC messages … using DCCH logical channel[.]").



Ex-1004 049 (annotated).

91. *Lee's* SI request message ***includes*** the *requested system information block (SIB)* in the sense of the preferred embodiments of the '502 Patent, in which the UE includes identifying information of the needed SIB. Ex-1001 1:24-34 (background discussion of 3GPP's on-demand SI procedure, in which the UE sends an SI request that identifies the SIB needed by the UE), 11:45-48 ("the UE **indicating** which SIB(s) is requested."). In both, the '502 Patent and *Lee,* the UE does not have the SIB and, therefore, would have been unable to literally include the needed SIB into the request. Thus, *Lee* described *including* requested information in the same context as the SI requests in the preferred embodiments of the '502 Patent. Ex-1004 046 ("The SI request can **include** … [t]he number(s) of a system information block type on request"), *id.*, 049 (the SI request "indicate[s] to RAN that essential SIBs are missing").

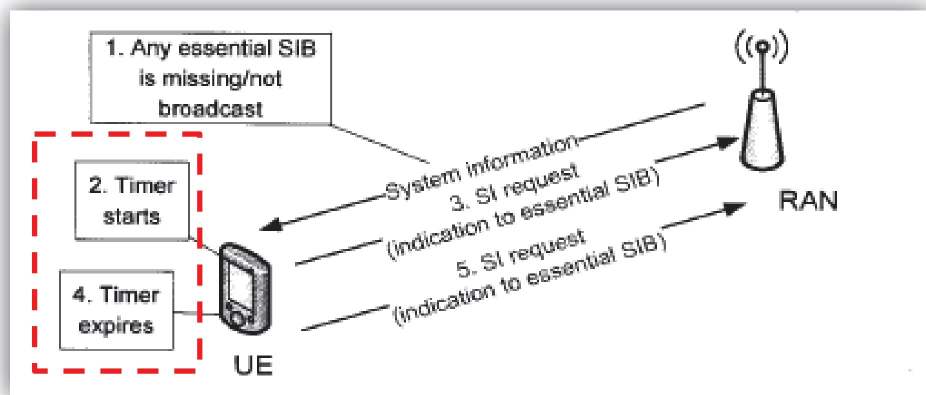
[1b] activating a prohibit timer; and

92. *Lee* disclosed or at least rendered obvious this element.

93. As explained below, *Lee* taught a UE that starts a timer after sending a first SI request (*activating a prohibit timer*), which prevents the UE from re-sending an SI request to RAN before the timer expires:

> **After** sending the SI request at a cell, **UE starts a timer**. If UE does not receive the essential SIBs at the cell until the timer expires, UE considers the cell as barred, or UE re-sends the SI request to RAN at the cell after the timer expires.

Ex-1004 049. *Lee* also provides a diagram illustrating the timer:



Ex-1004 049 (annotated).[7] The timer prevented congestion by prohibiting frequent UE SI requests (i.e., *a prohibit timer*). Ex-1004 045. This is consistent with the

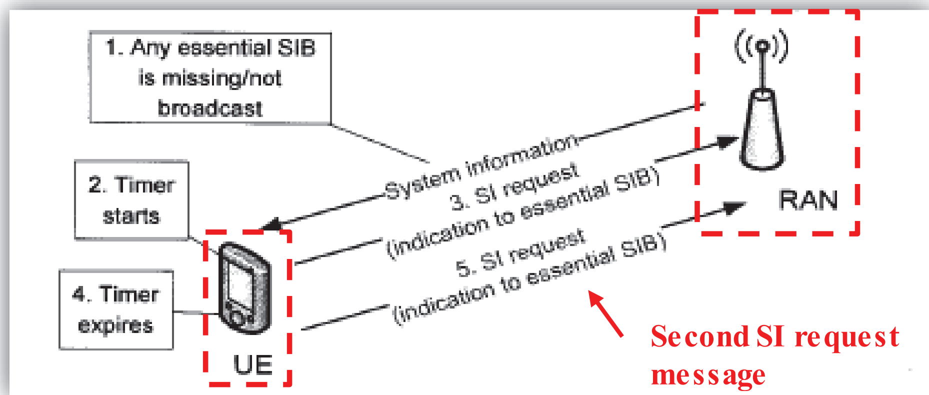
[7] Although the figure labels the "timer starts" block with a "2," the text of *Lee*'s disclosure explicitly states (twice) that the UE starts the timer **after** sending the SI

prohibit timer in the preferred embodiment of the ’502 Patent. Ex-1001 8:20-21 (“After the prohibit timer expires, the UE may perform an SI request procedure again.”).

[1c] transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.

94. *Lee* disclosed or at least rendered obvious this element.

95. First, *Lee* taught that the UE re-sends an SI request (*transmitting a second SI request message*) to the Radio Access Network (RAN) (*to the BS*). Ex-1004 049. For example, *Lee* illustrated a UE transmitting a second SI request to a RAN in item 5 below:



---

request. Ex-1004 049 (e.g., “**After** sending the SI request at a cell, UE starts a timer.”). To the extent Togail argues that the timer must start after the first SI request message is sent, that is taught at least by the text of *Lee*. Ex-1004 049.

Ex-1004 049 (annotated). The second SI request is a *message* and the RAN is a *base station* for the same reasons explained for [1a] (§VII.C.a).

96. Further, *Lee* taught re-sending the SI request if the UE did not receive the indicated essential SIBs at the cell and the timer expires (*only when the at least one requested SIB is not received and the prohibit timer expires*). For example:

> After sending the SI request at a cell, UE starts a timer. **If UE does not receive the essential SIBs at the cell until the timer expires**, UE considers the cell as barred, or **UE re-sends the SI request to RAN at the cell after the timer expires**.

Ex-1004 049. A POSA would have understood *Lee* to have thus described that the UE sent the SI request and started a timer. *Id.* If the UE did not receive the requested SIBs by the time the timer expired, the UE would have either considered the cell as barred or would have re-sent the SI request to the RAN after timer expiration. *Id.*

97. Likewise, *Lee* disclosed or at least rendered obvious that the second message was sent ***only when*** *the at least one requested SIB is not received and the prohibit timer expires*. *Lee* taught that the second SI request was sent (a) if the SIB had not been received and (b) the timer had expired: "**If UE does not receive the essential SIBs** … UE re-sends the SI request … **after the timer expires**." Ex-1004 049. By sending a further SI request only if the SI was still needed and only if the timer had expired, *Lee* avoided the congestion of UE's "frequently request[ing] system information." Ex-1004 045, 049. Unsurprisingly and noticeably, *Lee* also

did not teach any scenarios in which a UE sent an SI request during the period of the prohibit timer, further teaching the claim limitations.

98. Indeed, even if Togail were to argue some hypothetical scenario in which *Lee's* UE might send a second SI request prior to the expiration of *Lee's* prohibit timer, that would not negate *Lee's* teachings that disclose or render obvious the [1c] claim limitation. First, I have been informed by counsel that a reference need not state a feature's absence in order to disclose a negative limitation of a challenged claim. Second, *Lee's* UE would still, at minimum, embody this claim limitation for at least some scenarios, and I have been informed by counsel that if prior art sometimes, but not always, embodies a claim limitation then the prior art nonetheless teaches that limitation. Third, at minimum, modifying *Lee* to expressly forbid all SI requests would represent no more than an obvious modification to *Lee*, given *Lee's* broad teaching of a prohibit timer and *Lee's* goal of avoiding uplink congestion from SI requests. Ex-1004 045, 049. Consistent with these teachings in *Lee*, a POSA would have been motivated by the general knowledge in the art that 4G SI acquisition lacked procedures for on-demand SI requests, and thus merely temporarily prohibiting all new SI requests during the pendency of *Lee's* prohibit timer would have been readily recognized as a minor, acceptable modification to achieve *Lee's* congestion-avoidance. Ex-1024 41; §VI.B.2.d–e.

b. Claim 4

4. The method of claim 1, wherein the first SI request message is transmitted on signaling radio bearer 1 (SRB1).

99. *Lee* taught or rendered obvious this claim. As discussed above, claim 1 is obvious over *Lee*. While *Lee* did not expressly state that messages in the RRC_CONNECTED state were sent over SRB1, *Lee* taught that its SI request were carried by "control signaling" in the form of an "RRC message" or "NAS message" (Ex-1004 046), that establishing an RRC connection involved establishing SRB1 (Ex-1004 029) and taught that UE's having an RRC connection exchanged point-to-point control messages with the network over the Dedicated Control Channel ("DCCH") (Ex-1004 056 [0014]). *Lee* was directed to at least 4G and did not modify 3GPP's signalling radio bearers, and thus a POSA would have understood this disclosure in the context of 3GPP specifications. *See* Ex-1004 046, 051 [00001]. A POSA would have understood that 3GPP's SRB1 was the signalling radio bearer that allowed a UE to start sending RRC or NAS messages (the format of the SI Request taught by *Lee*) over the DCCH (the channel taught by *Lee*). Ex-1024 32 ("**SRB1 is for RRC messages** (which may include a piggybacked NAS message) **as well as for NAS messages** prior to the establishment of SRB2**, all using DCCH logical channel**"). SRB1 was well known to be a conventional, indeed the first, SRB available for sending *Lee's* RRC message-based SI request in the RRC_CONNECTED state. *Id.* Indeed, SRB1 was often the only SRB available for

the point-to-point control signaling of that state.[8] Ex-1024 32; Ex-1004 56 [0014]. Thus, a POSA would have understood, or at least found it obvious, to transmit *Lee's* SI requests over SRB1 when in the RRC_CONNECTED state. Ex-1024 32. Doing so would have involved nothing more than combining prior art elements (*Lee's* SI-request as an RRC or NAS message, and 3GPP's SRB1 for sending such messages) according to known methods (*Lee's* teachings of SI-requests, and standardized 3GPP techniques for sending control messages over SRB1) to yield predictable results (reliable transmission of a control message to a base station).

c. **Claim 5**

5. The method of claim 1, further comprising: receiving, from the BS, the at least one requested SIB via dedicated signaling that is transmitted in response to the first SI request message.

100. *Lee* taught or at least rendered obvious this claim. As discussed above, claim 1 is obvious over *Lee*. *Lee* also taught *receiving, from the BS, the at least one requested SIB,* where the SIB *is transmitted in response to the first SI request message*. [1c] (§VII.C.a). For example, *Lee* taught that "upon receiving the SI

[8] There is also SRB0, but that is for RRC_IDLE (*see* [1a]). Ex-1004 056 [0014]; Ex-1024 32, 30. Another bearer (SRB1bis) is for special IoT communications (NB-IoT). *Id*. Finally, there is SRB2, but SRB1 is established before SRB2, and has a "lower-priority than SRB1." *Id.*

request, RAN sends the essential SIBs that are not broadcast to the UE." Ex-1004 049. The RAN sends the requested SIBs upon receiving the SI request for those SIBs, and thus the sending is *in response to* the *first SI request* (at least in scenarios where the *first SI request* is successful). As described for [1a.1] (§VII.C.a), *Lee* taught that the "RAN" would have had a 4G or 5G base station. Ex-1004 046. Thus, the UE receives from the RAN (*receiving, from the BS*) *the at least one requested SIB . . . in response to the first SI request message*.

101. *Lee* further taught or rendered obvious that the transmission would be *via* ***dedicated signaling***. For a UE in the RRC_CONNECTED state (*see* [1a.1] (§VII.C.a)), *Lee* taught that the RRC connection supported the "**dedicated** control channel", called DCCH, "for "dedicated control information" (*i.e., dedicated signaling*). Ex-1004 056 [0014] ("**The DCCH is a point-to-point bidirectional channel used** by UEs having **an RRC connection** that transmits **dedicated control information between a UE and the network**."). *Lee* taught: "**In RRC_CONNECTED state**, the **UE** 10 **has** an E-UTRAN **RRC connection** and a context in the E-UTRAN, **such that** transmitting and/or **receiving data** to/**from the network** (eNodeB) **becomes possible."** *Id.*, 054 [0002], *see also id.*, 054-055 [0003] (similar). Indeed, a POSA would have readily understood that in RRC_CONNECTED, the DCCH provided dedicated signalling for RRC messages, or at minimum would have found that obvious. Ex-1024 32.

d. Claim 6

6. The method of claim 1, further comprising: transmitting a fourth SI request message to the BS after determining that the UE is not in the connected state, the fourth SI request message including at least one requested SI message.

102. As discussed above, claim 1 is obvious over *Lee*. Furthermore, as explained below, *Lee* taught or at least rendered obvious this claim.

[6a] transmitting a fourth SI request message to the BS after determining that the UE is not in the connected state

103. **First,** *Lee* taught or rendered obvious sending *SI Request messages* when the UE was ***not*** *in the connected state. See* [1a.1] (§VII.C.a).

104. As explained for [1a.1] (§VII.C.a), *Lee* broadly taught sending SI requests to augment 3GPP's SI acquisition procedures (Ex-1004 049, 018-019), which acquisition occurred in both the RRC_IDLE and RRC_CONNECTED state in the normal course of UE operation (Ex-1004 018-019, 054-055F). Ex-1004 049, 018 ("§5.2.2 System information acquisition"; ("The [SI acquisition] procedure applies to UEs in RRC IDLE and UEs in RRC CONNECTED."). A UE in the RRC_IDLE state was **not** in the RRC_CONNECTED state and had no RRC connection, and thus *is not in the connected state. See* Ex-1024 30 ("If … no RRC connection is established, the UE is in RRC_IDLE state.").

105. As apparent from these sections of *Lee*, a 3GPP UE was specified to continually undergo SI acquisition and validation in both the RRC states and, as such, a POSA would have understood that *Lee's* SI request messages would have

applied to and benefit both states. [1a.1] (§VII.C.a).[9] As explained for [1a.1] (§VII.C.a), *Lee* reproduced 3GPP specifications having different SI requirements and different communications capabilities depending on the RRC state. Thus, for the same reasons described for the RRC_CONNECTED state, *Lee* taught or at least rendered obvious that before sending an SI request message indicating a missing SIB, the UE knew (*determined*) that it was in the RCC_IDLE state, so that it knew what specific SI was required and missing for that state, and so that the UE knew what type of messaging was available for the SI request—i.e., the UE *[first] determin[ed] that the UE is not in the connected state*. *See* [1a.1] (§VII.C.a).

106. **Second**, *Lee* further taught or rendered obvious that *Lee's* on-demand

[9] Sending SI requests in the RRC_IDLE state was also consistent with Lee's statement that "[i]f the cell broadcasts all essential SIBs but does not broadcast SIBs related to a certain feature, UE does not send SI request e.g. while UE is in RRC_IDLE or while UE is not using the feature." Ex-1004 049. A POSA would have understood that this sentence stated an exception that was consistent with the general case, *i.e.,* that an SI request ***would*** be sent if any essential SIBs were missing in the RRC_IDLE state, or if a missing SIB related to a feature used by the UE . Ex-1004 018-019, 049.

SI procedure would result in a UE, *after determining* it was in the RRC_IDLE state, sending (*transmitting*) additional SI requests (including a *fourth SI request message*) to the RAN (*the BS*).[10] [1a.1] (§VII.C.a). For example, the *first* and *second SI request message*s would be the SI requests sent and re-sent, respectively, in the RRC_CONNECTED state, as explained for [1a.1] and [1c] (§VII.C.a). Then, when the UE transitioned to the RRC_IDLE state, as any 3GPP UE did in the ordinary course of operation,[11] but then needed SI in that state (e.g. because SI became outdated, corrupt or the UE moved in and out of coverage, transitioned to a new cell etc. (Ex-1004 018-019)), *Lee's* on-demand SI procedure would generate a third SI request message, start the prohibit timer, and, if still missing the SI on timer expiration, would re-send that SI request, *i.e., transmitting a fourth SI request message.* Ex-1004 049, 018; [1a.1] (§VII.C.a).

[6b] the fourth SI request message including at least one requested SI message.

107. As a preliminary observation, and as explained for Claim 1 ([1a.2] (§VII.C.a)), *Lee's* SI request ***includes*** a requested item in the sense of the preferred

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[10] As explained for [1a.1] (§VII.C.a), *Lee* taught sending SI requests (*SI request messages*) to the RAN (*the BS*).

[11] UEs would typically transition back and forth between RRC states, which in 4G are RRC_IDLE and RRC_CONNECTED. Ex-1024 31, Fig. 4.2.1-1.

embodiments of the '502 Patent, i.e., including identifying information of the requested item (as opposed to including the entire item). Ex-1001 1:24-34 (SI request used to "**ask** the network [for] **the required"** item), 11:35 ("e.g. the UE **indicates which** SI message(s) **is requested**").

108. Although *Lee* did not explicitly disclose SI requests identifying an ***SI message,*** that nonetheless would have been understood, or at least rendered obvious, to POSA by *Lee*'s teaching of SI requests that identify a "set" of SIBs. Ex-1004 046.

109. First, it was would have been understood because *Lee* taught that the "SI request can include" the "**set** of system information blocks on request" and identifying an *SI message* was the conventional way that 3GPP identified a set of SIBs, collectively. Ex-1004 046, 014. Indeed, *Lee* reproduced the 3GPP specifications that confirm, in 3GPP, a particular set of SIBs was carried by, and mapped to, a particular "SI message" broadcast by the network. Ex-1004 014 (SIBs "are carried in ***SystemInformation*** **(SI) messages** and **mapping of SIBs to SI messages** is … included in *SystemInformationBlockType1,* with restrictions that: each SIB is contained only in a single **SI message**, and at most once in that message; only SIBs having the same scheduling requirement (periodicity) can be mapped to the same **SI message**[.]"). Furthermore, the UE stored and tracked SI on an SI-message basis. Ex-1004 016 ("*SystemInformationBlockTypel* includes **a value tag**, *systemInfoValueTag,* that **indicates if a change** has occurred in the **SI messages**.

UEs may use [the value tag] to **verify if the** previously **stored SI messages are still valid**.”). Thus, a UE monitored periodic SI messages, knew the set of SIBs carried in each SI message, and if a particular set of SIBs were needed, knew which particular SI message to seek from the network. Indeed, 3GPP’s 5G specifications at the time of the alleged invention confirm that a POSA equated an SI message to its set of SIBs. TS 38.300 (Ex-1025) 32 (“For UEs in RRC_IDLE … MSG1 can be used [for the SI request]. When MSG1 is used, **the minimum granularity of the request is one SI message (i.e. a set of SIBs)**,…”). This is also supported by the ’502 Patent. Ex-1001 (“In an MSG1-based SI request, ... **the minimum granularity for a requested SI may be one SI message (for a set of SIBs, as in an LTE scenario)**.”). Thus, *Lee’s* teaching that the “SI request can include” the “set of system information blocks on request” reasonably disclosed to a POSA an *SI request message including at least one requested SI messag*e. Ex-1004 046, 014, 016.

110. Second, alternatively, to the extent a POSA did not already understand that *Lee’s* teaching of identifying “sets” of SIBs reasonably included identifying the SI message for that set, at a minimum that would have been obvious based on the general knowledge of a POSA concerning SI messages reflected by the quotes above. Ex-1004 046 (*Lee* teaching identifying “sets” of SIBs), 014 and 016 (*Lee* quoting 4G specifications describing SI message mapping to sets of SIBs, and storing and tracking SI validity of sets of SIBs on an SI message-basis); (Ex-1025)

32 (5G specifying for SI requests in RRC_IDLE, the "minimum granularity" is for the SI request to ask for "one SI message (i.e. a set of SIBs)"). Doing so would have involved no more than a simple substitution of one known element (identifying set of SIBs by SIB numbers) for another (identifying sets of SIBs by their SI message) to obtain predictable results (prompting the RAN to deliver the SI message established for the needed set of SIBs). A POSA would have been able to readily modify the type of identifier used by *Lee,* as a matter of design choice which was well within the skill of a POSA.

e. <u>Claim 7</u>

7. The method of claim 6, wherein the fourth SI request message is transmitted on signaling radio bearer 0 (SRB0).

111. *Lee* taught or at least rendered obvious this claim. As discussed above, claim 6 is obvious over *Lee.* Furthermore, as explained for Claim 6, *Lee* taught or rendered obvious sending the fourth SI request message in the RRC_IDLE state. *See* Claim 6. *Lee* taught use of SRB0 because *Lee* disclosed using the Common Control Channel (CCCH) if the UE lacked an RRC connection, *i.e.* was in the RRC_IDLE state: "The CCCH is used by UEs having no RRC connection with the network." Ex-1004 056 [0014]. A POSA would have appreciated that SRB0 was used for *Lee's* CCCH and *Lee's* statement about lack of an RRC connection signified the RRC_IDLE state. Ex-1024 32 ("SRB0 is for RRC messages using the CCCH logical channel."); Ex-1004 056 [0014] ("The CCCH is used by UEs having no RRC

connection with the network."), Ex-1024 30 ("If … no RRC connection is established, the UE is in RRC_IDLE state."). At a minimum, it would have been obvious to transmit the SI request on SRB0 as that was the conventional and common signalling channel used by UE's for sending control messages (i.e., signalling) in the RRC_IDLE state. Ex-1024 30-32.

f. Claim 11

[11pre] A user equipment (UE), comprising:

[11a] one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

[11b] at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to perform operations for an on-demand system information (SI) request procedure, the operations comprising:

[11c] transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);

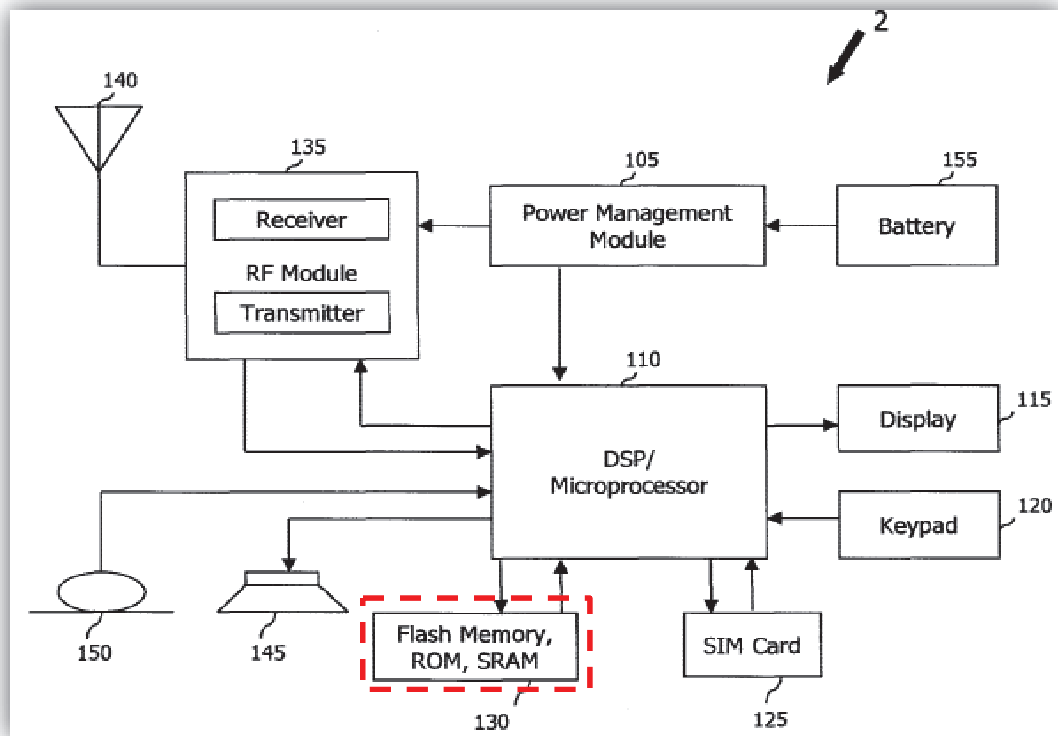
[11d] activating a prohibit timer; and

[11e] transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.

112. Independent Claim 11 is directed to a UE that performs the method of Claim 1. Claim 11 is substantively identical except for elements ([11a] and [11b]), which are directed to computer-readable media. Claim 11 is disclosed or at least rendered obvious for the reasons discussed above for Claim 1 (§VII.C.a) and the additional reasons discussed below for [11a] and [11b].

[11a] one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

113. *Lee* taught or rendered obvious this element. For example, *Lee* described that "UE 10 refers to communication equipment carried by a user and may be also referred to as a mobile station (MS)[.]" Ex-1004 051-052. Such UEs were known to include a processor and memory, with the memory storing computer instructions executed by the processor. For example, *Lee* illustrated a block diagram of a mobile station (i.e., *a UE*) that comprised a "memory" for a "Microprocessor" that performed the operations of the UE (*one or more non-transitory computer-readable media having computer-executable instructions embodied thereon*):

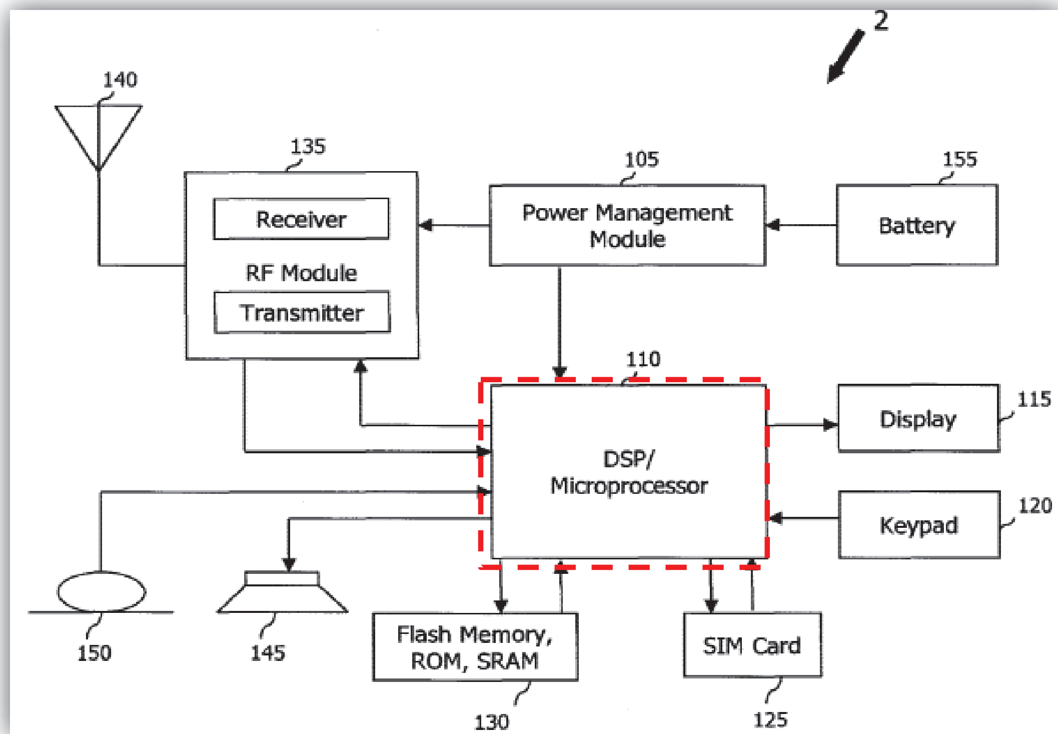


Ex-1004 060, 067 (annotated).

114. A POSA would have understood, or would have at least found it obvious, that the Flash Memory, ROM, SRAM (*one or more non-transitory computer-readable media*) had code stored on it (*computer-executable instructions embodied thereon*). This is because a mobile station/UE like the one shown in Figure 6 is controlled by code that is commonly stored in memory such as memory 130 and executed by a processor such as DSP/Microprocessor 110 to control the operations of the UE. A POSA would have found this obvious because it reflected nothing more than combining prior art components (*Lee's* UE memory and processor) according to known methods (computer programming) to yield predictable results (a UE programmed to carry out particular functionality).

[11b] at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to perform operations for an on-demand system information (SI) request procedure, the operations comprising:

115. *Lee* taught or at least rendered this element obvious. For example, *Lee*'s "Microprocessor" (*processor*) was connected to the memory and, as it would have been understood and obvious to a POSA, executed code to operate (*execute the computer-executable instructions to perform operations*). *Lee* disclosed:



Ex-1004 060, 067.

116. As explained for Claim 1 ([1pre] (§VII.C.a)), *Lee* taught *user equipment (UE) … to perform operations for an on-demand system information (SI) request procedure*. Ex-1004 Title, 049.

117. A POSA would have understood, or at least found it obvious, that the processor 110 shown in Fig. 6 carried out *Lee's* on-demand SI procedure disclosure (*configured to execute the computer-executable instructions to perform operations for an on-demand system information (SI) request procedure*), including the functionality for each step of Claim 1 (§VII.C.a). This is because a mobile station/UE like that one shown in Figure 6 is controlled by its DSP/microprocessor

110, and the microprocessor uses the other structures shown in Fig. 6, including the RF module 135, to carry out the radio resource control (RRC) processes of 3GPP, including the operations discussed for the steps of the method of Claim 1 (§VII.C.a), (*the operations comprising:…*). A POSA would have found this obvious because it reflected nothing more than combining prior art components (*Lee's* UE memory and processor, as well as *Lee's* teaching of the steps of on-demand SI request) according to known methods (computer programming) to yield predictable results (a UE programmed to carry out particular 3GPP functionality).

g. Dependent Claims 14-17

118. Claims 14-17 depend from Claim 11. As discussed above, Claim 11 is obvious over *Lee,* and the additional features of Claims 14-17 and are obvious over *Lee* for the reasons explained for the corresponding claims depending from Claim 1:

Dependent Claim	Corresponds to Claim	Obviousness Citations
14	4	*See* Claim 4 §VII.C.b.
15	5	*See* Claim 5 §VII.C.c.
16	6	*See* Claim 6 §VII.C.d.
17	7	*See* Claim 7 §VII.C.e.

VIII. GROUNDS 2 AND 3: CLAIMS 1, 4-7, 11, 14-17 ARE OBVIOUS OVER *OPPO*; AND CLAIM 1 IS ANTICIPATED BY *OPPO*

A. *Oppo* Is Pertinent, Analogous Prior Art

119. The 3GPP technical contribution "*Discussion on SI Request Prohibit Timer*" by OPPO ("*Oppo*") is from a 3GPP working meeting, RAN2#101, that was

held from February 26, 2018 to March 2, 2018. Ex-1005; Ex-1029 to Ex-1036. *Oppo* was not cited or discussed during prosecution of the ’502 Patent. Ex-1001 (56); Ex-1002 (generally).

120. *Oppo* was available for download on the 3GPP website of the working group responsible for radio resource control (RRC) procedures, named RAN2. Ex-1031; Ex-1013; Ex-1014. RAN2 identified *Oppo* in an index of publicly available documents, under the topic of “on demand system information”:

	A	B	C	K	L	P
1	Tdoc	Title	Source	Agenda	Agenda item description	Uploaded
2	R2-1801780	Clarifications on Upper Layer Actions Upon RACH Problem for SI Request	OPPO	10.4.1.6.6	On demand system information	13-Feb-18
3	R2-1801791	Discussion on Indication of On-Demand SI in RMSI and TP to TS 38.331	OPPO	10.4.1.6.6	On demand system information	13-Feb-18
7	R2-1801795	Discussion on SI request prohibit timer	OPPO	10.4.1.6.6	On demand system information	13-Feb-18
11	R2-1801809	Remain issues of on-demand SI	Beijing Xiaomi Mo	10.4.1.6.6	On demand system information	12-Feb-18

Ex-1033; *see also* Ex-1031-32.

121. As I *discussed* above (§VI.B.1), a POSA was well aware of 3GPP as the preeminent standards body for the cellular industry, with its documents making up a major portion of the publicly available literature concerning cellular technology. *Oppo,* like the ’502 Patent, was directed to 3GPP specifications for on-demand SI acquisition being specified for 5G by the RAN2 Working Group. Ex-1023; Ex-1024. Just before the Priority Date, RAN2 held its regular working meeting, RAN2#101 (Ex-1029-36), that included about 40 technical contributions directed to on-demand SI acquisition, including *Oppo*. Ex-1033. Organizations conducting

research, consulting, or development concerning on-demand SI acquisition at the time of the Priority Date would have reviewed these papers (if not authored them) to keep abreast of current developments in SI acquisition.

122. In my experience, the public 3GPP website stores and organizes 3GPP documents under the meeting pages, organizing the documents by topics pertinent to the sections of the standards that are being worked on. The RAN2 working group index of documents for the RAN2#101 meeting identified *Oppo* by Title ("Discussion on SI request prohibit timer"), source ("OPPO"), and under the topic of "on-demand system information." Ex-1032, Ex-1033. For example:

	A	B	C	K	L	P
1	Tdoc	Title	Source	Agenda	Agenda item description	Uploaded
2	R2-1801780	Clarifications on Upper Layer Actions Upon RACH Problem for SI Request	OPPO	10.4.1.6.6	On demand system information	13-Feb-18
3	R2-1801791	Discussion on Indication of On-Demand SI in RMSI and TP to TS 38 331	OPPO	10.4.1.6.6	On demand system information	13-Feb-18
7	R2-1801795	Discussion on SI request prohibit timer	OPPO	10.4.1.6.6	On demand system information	13-Feb-18
11	R2-1801809	Remain issues of on-demand SI	Beijing Xiaomi Mo	10.4.1.6.6	On demand system information	12-Feb-18

Ex-1033.

123. *Oppo's* title, which references an "SI request prohibit timer" and the topic of "on-demand system information" were both highly pertinent to the subject matter of *Oppo* and the '502 Patent. To the extent they had not already reviewed *Oppo*, skilled individuals interested in these topics would have readily been able to browse or search the RAN2#101 index to identify *Oppo* as a document available from 3GPP for further review.

B. Overview of *Oppo*

124. As part of the 3GPP working groups developing the 3GPP's on-demand SI specifications for 5G, *Oppo* proposed using a prohibit timer for SI requests to prevent a UE from sending frequent and unnecessary SI requests. Ex-1005 001-002. *Oppo* taught:

> **Observation 3 For RRC-based SI request for RRC_Connected UEs, after UE send one SI request to gNB, it should not send another one before check the latest SIB1 to know if the request SIB has been available, otherwise, there can be frequent SI request which is unnecessary.**
>
> Based on the above observations, we think that RAN2 need to introduce SI request prohibit timer in order to avoid the UE to generate frequent SI request.

Ex-1005 001. *Oppo* described the specific functionality of an SI prohibit timer. *Oppo* suggested that the prohibit timer be configured by RRC, and be started when a UE initiated an SI request. Ex-1005 002 (proposals 3 and 4). *Oppo* further proposed that when the prohibit timer expired, the UE should trigger a further SI request if the UE still needed the SI that it had previously requested. Ex-1005 002 (proposal 5). *Oppo* provided the table below describing when the prohibit timer should be started, stopped and the next steps at expiry of the timer:

The following table summarize proposal 4 and proposal 5.

Timer	Start	Stop	At expiry
Txxx	Transmission of SI request by RRC signalling or trigger MAC to perform Random Access for SI request	Reception of SI request acknowledgement; The requested SI has been available in latest SIB1	Trigger another SI request if the SI is still needed in the concern cell

Ex-1005 002. Because a POSA would have understood that *Oppo* was directed to RAN2's work on the 3GPP 5G standard, which built on concepts and terminology of the 4G standard, a POSA would have understood the terms, phrases and natural consequences of *Oppo's* disclosure in the context of those 3GPP standards, as I explain below. For a background discussion of the knowledge of a POSA regarding the 4G and 5G standards, see VI.B above.

C. Detailed Application to the Claims

a. <u>Claim 1</u>

[Pre] A method of an on-demand system information (SI) request procedure performed by a user equipment (UE), the method comprising

125. To the extent that the preamble is limiting, *Oppo* disclosed or at least rendered obvious the preamble.

126. *Oppo* disclosed or at least rendered obvious *a method of an on-demand system information (SI) request procedure*. For example, *Oppo* explained that "[i]n this contribution, we discuss prohibit timer for **On-Demand SI request** and we have the following observations and proposals." Ex-1005 002.

127. *Oppo*'s SI request procedure is *performed by a user equipment (UE). See, e.g.*, Ex-1005 001 ("**UE** can try to **send SI request**. If after certain time of retrying, SI can still not be acquired, **then UE** can **decide whether the cell is barred depends on whether this SI is essential or not**.").

[1a] transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);

128. As explained below, *Oppo* disclosed, or at least rendered obvious, this limitation.

[1a.1] transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state

129. As explained below, *Oppo* disclosed or at least rendered obvious *transmitting a first SI request message to a base station (BS)*.

130. *Oppo's* UE sent an SI request as an RRC Signalling message to the gNB base station (*transmitting a first SI request message to a base station (BS)*). Ex-1005 001-002. For example, *Oppo* disclosed "**Transmission of SI request by RRC signalling**":

The following table summarize proposal 4 and proposal 5.

Timer	Start	Stop	At expiry
Txxx	Transmission of SI request by RRC signalling or trigger MAC to perform Random Access for SI request	Reception of SI request acknowledgement; The requested SI has been available in latest SIB1	Trigger another SI request if the SI is still needed in the concern cell

Ex-1005 002 (annotated).

131. *Oppo* described that the SI request message was sent to a gNB, i.e., a *base station*. Ex-1005 002 ("For RRC-based SI request for RRC_Connected UEs, after UE send one SI request **to gNB**, …"); Ex-1025 9-10; §VI.B.2.a.

132. Next, *Oppo* also disclosed or at least rendered obvious that the SI

request message was sent *after determining that the UE is in a connected state.* *Oppo* disclosed that the "SI request" would take one of two forms—"RRC signalling" **or** "perform Random Access"—the former being a messaging type available in the RRC_CONNECTED state, and the latter being a messaging type available in the RRC_IDLE and RRC_INACTIVE states:

The following table summarize proposal 4 and proposal 5.

Timer	Start	Stop	At expiry
Txxx	Transmission of SI request by RRC signalling or trigger MAC to perform Random Access for SI request	Reception of SI request acknowledgement; The requested SI has been available in latest SIB1	Trigger another SI request if the SI is still needed in the concern cell

Ex-1005 002 (annotated). A POSA would have readily recognized that *Oppo* was disclosing on-demand SI procedures for both the RRC_CONNECTED, as well as the RRC_IDLE and RRC_INACTIVE states, with the SI request message taking a form appropriate for each state. For example, *Oppo* confirmed that the SI request would take the form of RRC signalling and be RRC-based if the UE was in the RRC_CONNECTED state. Ex-1005 002 ("For **RRC-based** SI request **for RRC_Connected UEs**, after UE send one SI request to gNB,..."). This is consistent with 3GPP's 5G specifications at the time, in which SI requests took the form of "RRC signalling" for RRC_CONNECTED UEs, but took the form of a "Random Access" procedure for RRC_IDLE and RRC_INACTIVE UEs. TS 38.300 (Ex-1025) 32 ("**For UEs in RRC_CONNECTED, dedicated RRC signalling is used**

for the request and delivery of the Other SI**. For UEs in RRC_IDLE and RRC_INACTIVE, the request triggers a random access procedure** (see subclause 9.2.6)"). Thus, in order to send an SI request in the RRC_CONNECTED state, the UE first determined that it was in the RRC_CONNECTED state and then generated the SI request as "RRC signalling" (as opposed to using Random Access type SI requests), i.e., the UE first *determining that the UE is in a connected state.* Moreover, a UE determines that it is in the RRC_CONNECTED state as part of entering the state and that determination precedes the UE's operations in the state, including sending messages in that state. *See, e.g.*, Ex-1026 12-14 (defining 5G's RRC state machine, e.g., "A UE is either in RRC_CONNECTED state or in RRC_INACTIVE state when an RRC connection has been established.", "UE has only one RRC state in NR at one time.", Fig. 4.2.1-1 (showing UE RRC state machine)); Ex-1025 §9.2.2.4 (describing UE coordination of state transitions with RAN).

[1a.2] the first SI request message including at least one requested system information block (SIB);

133. *Oppo* disclosed, or at least rendered obvious, this limitation. *Oppo* described that the first SI request identified a requested SIB, i.e., *the first SI request message including at least one requested system information block (SIB*). Ex-1005 001 ("after **UE send one SI request** to gNB, it should not send another one before check the latest SIB1 to know if **the request SIB** has been available, otherwise, there

can be frequent SI request which is unnecessary."); *see also, id.* ("Depends on the SI/ **SIBs being requested**. If these are not the **essential SIBs** (according to NR RRC) then UE refrains from retrying until a certain time."). In RRC_CONNECTED, a 5G UE's SI request could be for SIB2 and above. TS 38.300 (Ex-1025) 32 ("Other SI is transmitted in *SystemInformationBlockType2* and above. For UEs in RRC_CONNECTED, dedicated RRC signalling is used for **the request** and delivery **of the Other SI**.") Thus, a POSA would have understood that in RRC_CONNECTED state, the SI request identified at least one requested SIB.

134. As explained for Ground 1 ([1a.2] (§VII.C.a)), *Oppo's* SI request message ***includes*** the requested SIB in the sense of the preferred embodiments of the '502 Patent, in which the SI request includes identifying information for the requested item, not the item itself. Ex-1001 1:24-34, 11:45-48.

135. At a minimum, it would have been obvious to a POSA for the SI request in *Oppo* to include identifying information of at least one requested SIB, *i.e., the first SI request message including at least one requested system information block (SIB)*. As just explained, *Oppo* disclosed that the UE sends a first SI request for one or more SIBs. A POSA would readily implement such an SI request message by including identifying information of the SIBs needed, such as "SIB2" or SIB3". Doing so would be a simple and predictable way for the UE to identify the needed SI to the network, was well within the skill of a POSA, and was with a reasonable

expectation of success.

[1b] activating a prohibit timer; and

136. *Oppo* disclosed or at least rendered obvious this element. As explained below, *Oppo* disclosed the use of an SI prohibit timer (*prohibit timer*) that started when the first SI request was transmitted (*activating a prohibit timer*).

137. *Oppo* is titled "Discussion on SI Request **Prohibit Timer**" and discussed the need for an SI prohibit timer: "Based on the above observations, we think that RAN2 need to introduce **SI request prohibit timer in order to avoid the UE to generate frequent SI request**." Ex-1005 001. *Oppo* explained that the prohibit timer "is started when [the] SI request is initiated." Ex-1005 002. *Oppo* further described when the prohibit timer is **started** and stopped and what occurs when the timer expires:

The following table summarize proposal 4 and proposal 5.

Timer	Start	Stop	At expiry
Txxx	Transmission of SI request by RRC signalling or trigger MAC to perform Random Access for SI request	Reception of SI request acknowledgement; The requested SI has been available in latest SIB1	Trigger another SI request if the SI is still needed in the concern cell

Ex-1005 002 (annotated).

[1c] transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.

138. *Oppo* disclosed or at least rendered obvious this element. As explained below, *Oppo* disclosed triggering another SI request (*transmitting a second SI*

request message to the BS) when the SI is still needed in the concerned cell and the prohibit timer has expired (*only when the at least one requested SIB is not received and the prohibit timer expires*).

139. For example, *Oppo* disclosed that "When Timer expires, **SI request can be triggered** [if the] UE still need[s] the SI on the concern[ed] cell." Ex-1005 002. Likewise, in the following chart, *Oppo* disclosed that at expiry of the prohibit timer, another SI request (i.e., *a second SI request message*) is triggered "if the SI is still needed in the concern[ed] cell":

The following table summarize proposal 4 and proposal 5.

Timer	Start	Stop	At expiry
Txxx	Transmission of SI request by RRC signalling or trigger MAC to perform Random Access for SI request	Reception of SI request acknowledgement; The requested SI has been available in latest SIB1	Trigger another SI request if the SI is still needed in the concern cell

Ex-1005 002 (annotated). As discussed above for [1a.1] (§VIII.C.a), *Oppo* disclosed sending SI requests to gNB (i.e., *the BS*).

140. *Oppo* also disclosed that the second SI request message should be transmitted *only when the at least one requested SIB is not received and the prohibit timer expires*. For example, *Oppo* described that "after one SI request, UE **should not send another one to gNB before it check[s] the latest SIB1 to know if the request[ed] SIB has been** [made] **available.**" Ex-1005 001. *Oppo* further explained that at "expiry" of the "prohibit timer," another SI request was triggered "**if the SI**

is still needed in the concern[ed] cell." Ex-1005 002. By disclosing a "**prohibit timer** in order **to avoid** the UE to generate **frequent SI request**" (Ex-1005 001)), and describing that the UE would trigger another SI request at the expiry of the "prohibit timer" if the "SI is still needed," (Ex-1005 002) *Oppo* disclosed to a POSA that a second SI request would be issued *only when* the prohibit timer had expired **and** the needed SIB had not been received. A POSA would have understood that "SI is still needed" when the SIB has not been received.

141. This is further supported by *Oppo's* description of the "prohibit" timer and its purpose. Specifically, in its discussion of the "Necessity of SI Prohibit Timer," *Oppo* described that "UE should not send SI request[s] endlessly." Ex-1005 001; *see also id.,* 001-002 ("[W]e think that RAN2 need[s] to introduce SI request prohibit timer in order to avoid the UE to generate frequent SI request[s]. Proposal[] 1 … **SI prohibit timer** is introduced … t**o suppress** UE to generate **frequent SI request signalling**."). Thus, if *Oppo* were to allow the UE to generate a second SI request when the UE had received the necessary SIB, or before the expiration of the prohibit timer, that would be contrary to the term "prohibit timer" and contradictory to *Oppo*'s goal of suppressing frequent SI requests.

142. Moreover, for the same reasons explained for Ground 1 ([1c] (§VII.C.a)), *Oppo's* disclosures that satisfy claim element [1c] are not negated by arguing hypothetical scenarios in which *Oppo's* UE might send a second SI request

before expiration of *Oppo's* prohibit timer. First, I have been informed by counsel that a reference need not state a feature's absence in order to disclose a negative limitation of a challenged claim. Second, I have been informed by counsel that if the prior art sometimes, but not always, embodies a claim limitation then the prior art nonetheless teaches that limitation. Third, at minimum, modifying *Oppo* to completely forbid all SI requests during the prohibit timer would represent no more than an obvious modification suggested by *Oppo*'s broad teachings and purpose of the prohibit timer (Ex-1005 001-002) in view of the general knowledge in the art from 4G that one need not use on-demand SI requests at all (§VI.B.2.d–e), and, thus, a mere temporary prohibition during the timer would be readily recognized as an acceptable modification. Ex-1024 41.

b. <u>Claim 4</u>

4. The method of claim 1, wherein the first SI request message is transmitted on signaling radio bearer 1 (SRB1).

143. Claim 4 is obvious over *Oppo*. As discussed above, Claim 1 is obvious over *Oppo*. While *Oppo* did not expressly refer to SRB1, *Oppo* disclosed its UE in the "RRC_CONNECTED" state transmitting the SI request as "RRC signalling," which a POSA would have understood or at least found obvious to be transmitted over Signalling Radio Bearer 1:

The following table summarize proposal 4 and proposal 5.

Timer	Start	Stop	At expiry
Txxx	Transmission of SI request by RRC signalling or trigger MAC to perform Random Access for SI request	Reception of SI request acknowledgement; The requested SI has been available in latest SIB1	Trigger another SI request if the SI is still needed in the concern cell

Ex-1005 002 (annotated).

144. It would have been obvious to send the SI request as RRC signalling over SRB1, because SRB1 is one of a handful of SRBs used to carry RRC messages and is the SRB established during RRC connection establishment. TS 38.331 (Ex-1026) 23 ("SRB1 … is established during RRC connection establishment"), 61-63 (specifying RRC messages sent over SRB1), 153-154 (specifying existence of a handful of SRBs: SRB1, SRB2/SRB2S and SRB3/SRB3S). Similar to 4G, SRB1 is used for RRC messages. Ex-1024 32 (Defining SRB as a "Signalling Radio Bearer," which were "Radio Bearers (RB) that are used only for the transmission of RRC and NAS messages. More specifically, the following SRBs are defined: ... SRB1 is for RRC messages[.]").

145. Doing so would have been at least obvious, because a POSA would have been motivated to send *Oppo's* SI request on SRB1 as a conventional and common radio bearer for sending RRC signalling messages. Ex-1026 23, 61-63, 153-154; Ex-1024 32. Doing so would have involved nothing more than combining prior art elements (*Oppo's* SI-request as RRC signalling, and 3GPP's SRB1 intended

for RRC signalling) according to known methods (3GPP techniques for sending RRC signalling over SRB1) to yield predictable results (reliable transmission of RRC signalling to the base station).

c. Claim 5

5. The method of claim 1, further comprising: receiving, from the BS, the at least one requested SIB via dedicated signaling that is transmitted in response to the first SI request message.

146. Claim 5 is obvious over *Oppo*. As discussed above, Claim 1 is obvious over *Oppo*.

147. *Oppo* taught or at least rendered obvious, that in response to an SI request the UE would receive the requested SI (*receiving, from the BS, the at least one requested SIB … that is transmitted in response to the first SI request message.*). As explained for [1a] and [1c] (§VIII.C.a), *Oppo* taught sending SI requests using RRC signalling and then checking to see if the requested SI was still needed before sending a second SI request. Ex-1005 002 ("When Timer expires, **SI request** can be triggered [if the] UE still need[s] the SI on the concern[ed] cell."). The purpose of the SI request is to prompt the base station to respond by transmitting the requested SI.

148. Furthermore, *Oppo* taught or at least rendered obvious that the base station's delivery of the requested SI was *via dedicated signaling*. *Oppo* taught sending SI requests using RRC signalling in the RRC_CONNECTED state. *See*

[1a.1] (§VIII.C.a). Likewise *Oppo* described the base station sending an RRC message for RRC signalling-type SI requests. Ex-1005 001 ("For RRC-based SI request, usually we think the **gNB can send a RRC message**."). Finally, *Oppo* was directed to 3GPP specifications in which the network delivered the SI to the UE via "dedicated RRC signalling." TS 38.300 (Ex-1025) 32 ("For UEs in RRC_CONNECTED, **dedicated RRC signalling is used for** the request and **delivery of the** Other **SI**.").

d. <u>Claim 6</u>

6. The method of claim 1, further comprising: transmitting a fourth SI request message to the BS after determining that the UE is not in the connected state, the fourth SI request message including at least one requested SI message.

149. As explained below, Claim 6 is obvious over *Oppo*. As discussed above, Claim 1 is obvious over *Oppo*.

[6a] transmitting a fourth SI request message to the BS after determining that the UE is not in the connected state

150. **First,** *Oppo* taught or rendered obvious sending *SI Request messages* when the UE was ***not*** *in the connected state.*

151. As discussed for [1a.1] (§VIII.C.a), a 5G UE always knew what RRC state it was in and thus continually *determined* its state, which for 5G was one of the three states of RRC_CONNECTED, RRC_IDLE, and RRC_INACTIVE. At least the RRC_IDLE state was **not** in the RRC_CONNECTED state and had no RRC connection, and thus *is not in the connected state.* TS 38.331 (Ex-1026) 12-13 ("If

… no RRC connection is established, the UE is in RRC_IDLE state"; "UE has only one RRC state in NR at one time."; Fig. 4.2.1-1 (RRC state machine showing the RRC_INACTIVE, the RRC_CONNECTED, and the RRC_IDLE states)).

152. Moreover, *Oppo* taught differing SI request procedures in the RRC_IDLE state as compared to RRC_CONNECTED. *See, e.g.,* Ex-1005 001 ("we discuss the SI prohibit timer **for MSG1 and MSG3 based SI request** especially **for RRC Idle**/inactive **UEs**), 002 (table identifying prohibit timer starting upon "Transmission of SI request by RRC signalling or **trigger MAC to perform Random Access for SI request**."). As discussed for [1a.1] (§VIII.C.a), the "RRC signalling" type of SI request was only applicable to the RRC_CONNECTED state. Thus, when sending an SI request when the UE is **not** in the connected state, the UE first determined that it was not in the connected state to know to send the MSG1 or MSG3 type SI request of the Random Access procedure. *See* [1a.1] (§VIII.C.a); TS 38.300 (Ex-1025) 32 ("**For UEs in RRC_IDLE** and RRC_INACTIVE, **the request triggers a random access procedure** (see subclause 9.2.6) and is **carried over MSG3 unless** the requested SI is associated to a subset of the PRACH resources, **in which case MSG1** can be used."), 10 (defining "**MSG1**: preamble transmission of the random access procedure." and "**MSG3**: first scheduled transmission of the random access procedure.").

153. **Second,** *Oppo* disclosed at least four SI request messages, with two in

the RRC_CONNECTED state—the original SI request message discussed for [1a.1] (§VIII.C.a) and the follow-up SI request message discussed for [1c] (§VIII.C.a)—and another two in the RRC_IDLE/RRC_INACTIVE states (a MSG1 SI request and a MSG3 SI request). Ex-1005 001 ("we discuss the SI prohibit timer for MSG1 and MSG3 based SI request especially for RRC Idle/inactive UEs"; "MSG1-based SI request"; "MSG3-based SI request"); TS 38.300 (Ex-1025) 32 ("**For UEs in RRC_IDLE** and RRC_INACTIVE, **the request triggers a random access procedure** (see subclause 9.2.6) and is **carried over MSG3 unless** the requested SI is associated to a subset of the PRACH resources, **in which case MSG1** can be used."). Furthermore, *Oppo's* MSG1-type and MSG3-type SI requests would each be repeated if the requested SI was still missing at expiration of *Oppo's* prohibit timer in the RRC_IDLE state. Ex-1005 002 (table showing timer starting at "perform Random Access for SI request" and then, at timer expiration, "[t]rigger another SI request if the SI is still needed in the concern cell.").

154. Each of *Oppo's* SI request types are sent to the gNB base station, i.e., *transmitt[ed] ... to the BS*. TS 38.300 (Ex-1025) 32 ("When MSG1 is used, … **the gNB** acknowledges the request in MSG2. When MSG 3 is used, **the gNB** acknowledges the request in MSG4.); *see also* [1a.2]. *Oppo*'s UE would generate a *fourth SI request* to the same base station in multiple scenarios because *Oppo's* on-demand SI request procedures would apply in each RRC state, and a 3GPP UE would

transition between the RRC states as part of the normal operation of a UE. Ex-1026 Fig. 4.2.2-1, 13. *Oppo's* SI request procedures would continue to apply as the UE transitioned among RRC states, and a POSA recognized that many SI requests (3^{rd}, 4^{th}, 5^{th} and many more requests) would be generated. Ex-1025 32 ("**For UEs in RRC_CONNECTED**, dedicated RRC signalling is used for the request and delivery of the Other SI. **For UEs in RRC_IDLE** and RRC_INACTIVE, the request triggers a random access procedure (see subclause 9.2.6) and is carried over MSG3 unless the requested SI is associated to a subset of the PRACH resources, in which case MSG1 can be used."); §VI.B.2.c-e.

155. Accordingly, *Oppo* taught *transmitting a fourth SI request message to the BS* in multiple scenarios, including a UE in the RRC_IDLE state sending repeated SI requests on expiration of *Oppo's* prohibit timer, in which a repeated MSG1 (or MSG3) SI request would be the *fourth SI request message.* Ex-1005 002 (table including prohibit timer operation for "Random Access for SI request"). For example, *Oppo's* disclosure would include a UE in the RRC_CONNECTED state issuing first and second SI requests as explained for Claim 1, then transitioning to the RRC_IDLE state (for example, because the user restarted the UE), then sending a third SI request (either a MSG1 or MSG3) and starting a prohibit timer because SI was missing for RRC_IDLE, and then if the SI was still needed upon prohibit timer expiry, resending the SI request, i.e., sending *a fourth SI request*. Thus, *Oppo* readily

disclosed to a POSA a *fourth SI request* in an unconnected state. At a minimum, this would have been obvious as an intended and expected scenario of a 3GPP UE using *Oppo's* SI request procedures in the RRC states as disclosed by *Oppo*.

[6b] the fourth SI request message including at least one requested SI message.

156. *Oppo* taught or rendered obvious the *fourth SI request message including at least one requested SI message*.

157. A POSA understood, for example, that an "SI message" was used to deliver SIBs and that an SI request in the form of a MSG1 was specified to identify an "SI message" as a way of identifying the set of SIBs carried by that message. TS 38.300 (Ex-1025) 32 ("For UEs in RRC_IDLE … MSG1 can be used [for the SI request]. **When MSG1 is used, the minimum granularity of the request is one SI message (i.e. a set of SIBs), one RACH preamble can be used to request multiple SI messages** …"). This is the same as the preferred embodiments of the '502 Patent. Ex-1001 ("**In an MSG1-based SI request,** in some implementations, **the minimum granularity for a requested SI may be one SI message (for a set of SIBs**, as in an LTE scenario). In some of such implementations, **one RA preamble may be used to request for multiple SI messages**.").

158. Furthermore, as explained for [1a.2] (§VIII.C.a), *Oppo's* SI request ***includes*** the SI message in the sense of the preferred embodiments of the '502 Patent.

e. **Claim 7**

7. The method of claim 6, wherein the fourth SI request message is transmitted on signaling radio bearer 0 (SRB0).

159. Claim 7 is obvious over *Oppo*. As discussed above, Claim 6 is obvious over *Oppo*. While *Oppo* did not expressly refer to SRB0, *Oppo's* MSG1 or MSG3 (both *the fourth SI request message*) were transmitted by the UE in the RRC_IDLE state, as explained for Claim 6 (§VIII.C.e). For these SI requests, it would have at least been obvious to use SRB0, because they were RRC messages transmitted in the RRC_IDLE state and SRB0 was the conventional SRB to use for RRC messages in that state. TS 36.331 (Ex-1024) 32 ("**SRB0 is for** RRC messages using the **CCCH logical channel**."); TS 36.300 (Ex-1022) 74 ("**"Common Control Channel (CCCH)** Channel for transmitting control information between UEs and network. **This channel is used for UEs having no RRC connection with the network**."); TS 38.300 (Ex-1025) 25 (same); Ex-1024 30 ("**If … no RRC connection** is established, **the UE is in RRC_IDLE state**."). Thus, it was within the general knowledge of a POSA that 3GPP's SRB0 was used for sending RRC messages in the RRC_IDLE state. *Id.* Consistent with that knowledge, a POSA would have understood that the '502 Patent does not purport to invent using signaling radio bearer 0 ("SRB0") in the RRC_IDLE state. Ex-1001 10:57-59.

f. Claim 11

[11pre] A user equipment (UE), comprising:

[11a] one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

[11b] at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to perform operations for an on-demand system information (SI) request procedure, the operations comprising:

[11c] transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);

[11d] activating a prohibit timer; and

[11e] transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.

160. Independent Claim 11 is directed to a UE that performs the method of Claim 1. Claim 11 is substantively identical except for elements ([11a] and [11b]), which are directed to computer-readable media. Claim 11 is disclosed or at least rendered obvious for the reasons discussed above for Claim 1 (§VIII.C.a) and the additional reasons discussed below for [11a] and [11b].

[11a] one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

161. This element is obvious over *Oppo*. While *Oppo* does not describe the components of a UE, *Oppo's* UE was a 3GPP UE, such as a smartphone. It was general knowledge in the art around the time of the alleged invention that smartphones, such as a mobile phone, had memory, including random access

memory and read only memory (*one or more non-transitory computer-readable media*) that stored executable code (*having computer-executable instructions embodied thereon*). *See, e.g.,* Ex-1007, Fig. 3, 9:6 ("exemplary block diagram of a UE"), 9:42-46 (UE includes a "processor" configured to operate "by executing program instructions stored on a memory medium (e.g., a non-transitory computer-readable memory medium)."), 8:7-9 ("UE 106 … configured to communicate using … a 3GPP cellular communication standard (such as LTE)"), 19:41-50 (UE "a processor; and a non-volatile memory device storing program instructions executable by the processor to cause the UE" to carry out Radio Resource Control ("RRC") procedures in a connected state)).

[11b] at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to perform operations for an on-demand system information (SI) request procedure, the operations comprising:

162. This element is obvious over *Oppo*. As explained for [11a], *Oppo's* UE was a 3GPP UE, such as a smartphone, and it was general knowledge in the art around the time of the alleged invention that such UEs had one or more processors (*at least one processor*) coupled to memory, including random access memory and read only memory (*one or more non-transitory computer-readable media*) and configured to run code (*configured to execute the computer-executable instructions*). *See, e.g.*, Ex-1007, Fig. 3, 9:6, 9:42-46, 8:7-9, 19:41-50).

163. As explained for Claim 1 ([1pre] (§VIII.C.a), *Oppo* taught *user*

equipment (UE) … to perform operations for an on-demand system information (SI) request procedure. A POSA would have understood, or would have at least found it obvious, that the UE carrying out *Oppo's* on-demand SI request procedures as described for Claim 1 (§VIII.C.a) would have done so using the standard components of a UE, including a processor running code stored in memory (*configured to execute the computer-executable instructions to perform operations for an on-demand system information (SI) request procedure*). This is because it was generally known in the art that a mobile station/UE is controlled by *at least one processor* and code that runs on it to carry out the radio resource control (RRC) processes of 3GPP, including the operations discussed for the steps of the method of Claim 1 (§VIII.C.a), (*the operations comprising:…*). Ex-1007 8:7-9. A POSA would have found this obvious because it reflected nothing more than combining prior art components (conventional UE memory, processor and software, with *Oppo's* teaching of on-demand SI request procedures) according to known methods (UE computer programming) to yield predictable results (a UE programmed to carry out particular 3GPP functionality).

g. <u>Dependent Claims 14-17</u>

164. Claims 14-17 depend from Claim 11. As discussed above, Claim 11 is obvious over *Oppo*. The additional features of Claims 14-17 are obvious over *Oppo* for the reasons explained for the corresponding claims depending from Claim 1:

Dependent Claim	Corresponds to Claim	Obviousness Citations
14	4	*See* Claim 4 §VIII.C.b.
15	5	*See* Claim 5 §VIII.C.c.
16	6	*See* Claim 6 §VIII.C.d.
17	7	*See* Claim 7 §VIII.C.e.

CONCLUSION AND DECLARATION

My findings and opinions set forth in this Declaration are based on my work and examination to date. I may continue my examinations in view of additional documents and/or other factual evidence over the course of this proceeding that may necessitate supplementing and/or refining my opinions. I reserve the right to add to, alter, or delete my opinions and my Declaration upon discovery of additional information. I reserve the right to make such changes as necessary.

In signing this Declaration, I understand 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 acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were 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.

Executed at Richardson, TX on February 2, 2023:

By: ______________________

Dr. Zygmunt Haas

APPENDIX A – MATERIALS RELIED UPON

Exhibit #	***Description***
1001	U.S. Patent 10,791,502 (“the ’502 Patent”)
1002	Prosecution history of the ’502 Patent (“File History”)
1004	U.S. Provisional Application 62/334,418 to Lee (“*Lee*”)
1005	OPPO, *Discussion on SI Request Prohibit Timer,* 3GPP TSG-RAN WG2#101, R2-1801795, Athens, Greece, (Feb. 26 – Mar. 2, 2018), (“*Oppo*”)
1006	U.S. Publication No. 2017/0332372 (“the ’372 Pub.”)
1007	U.S. Patent 9,832,686 to Belghoul
1009	3GPP Partners, *available at* https://www.3gpp.org/about-us/partners
1010	3GPP Working Procedures, 20 October 2016
1011	Introducing 3GPP, *available at* https://www.3gpp.org/about-us/introducing-3gpp
1012	3GPP Membership database, identifying individual members from “all partners”, report *available at* https://webapp.etsi.org/3gppmembership/Results.asp?Member=ALL_PARTNERS&SortMember=Name&DirMember=ASC&SortPartner=Name&DirPartner=ASC&SortMarket=Name&DirMarket=ASC&SortObserver=Name&DirObserver=ASC&SortGuest=Name&DirGuest=ASC&Name=&search=Search
1013	3GPP RAN2 – Radio Layer 2 and Radio Layer 3 RRC, *available at* https://www.3gpp.org/3gpp-groups/radio-access-networks-ran/ran-wg2
1014	3GPP Specifications for Working Group RAN2, *available at* https://www.3gpp.org/dynareport?code=TSG-WG--R2.htm
1015	Ericsson Post, LTE-NR tight-interworking and the first steps to 5G (Nov. 21, 2017), *available at* https://www.ericsson.com/en/blog/2017/11/lte-nr-tight-interworking-and-the-first-steps-to-5g

Exhibit #	***Description***
1016	3GPP 4th Generation (LTE), *available at* https://www.etsi.org/technologies/mobile/4G
1017	3GPP 5th Generation, *available at* https://www.etsi.org/technologies/mobile/5g
1018	*J. Baron,* Unpacking 3GPP standards, March 24, 2015, *available at* https://wwws.law.northwestern.edu/research-faculty/clbe/innovationeconomics/documents/baron_gupta_unpacking_3gpp_standards.pdf
1019	5G NR RRC Procedure and Its States (Nov. 19, 2017), *available at* https://www.techplayon.com/5g-nr-rrc-procedure-states/
1020	3GPP TR 21.905 v15.0.0 (2018-03), Vocabulary for 3GPP Specifications (Release 15), *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=558 ("Versions" tab, link "15.0.0" uploaded April 1, 2018)
1021	3GPP TS 23.501 v15.1.0 (2018-03), System Architecture for the 5G System; Stage 2 (Release 15), *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3144 ("Versions" tab, link "15.1.0" uploaded March 28, 2018)
1022	3GPP TS 36.300 v15.0.0 (2017-12), Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 15), *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2430 ("Versions" tab, link "15.0.0" uploaded January 7, 2018)

Exhibit #	***Description***
1023	3GPP TS 36.304 v14.5.0 (2017-12), Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode, *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2432 ("Versions" tab, link "14.5.0" uploaded January 7, 2018)
1024	3GPP TS 36.331 v14.5.1 (2018-01), Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC) Protocol Specification (Release 14), ("*4G RRC Specification"*), *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2440 ("Versions" tab, link "14.5.1" uploaded January 9, 2018)
1025	3GPP TS 38.300 v15.0.0 (2017-12), NR; NR and NG-RAN Overall description; Stage 2 (Release 15), *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3191 ("Versions" tab, link "15.0.0" uploaded January 4, 2018)
1026	3GPP TS 38.331 v15.0.0 (2017-12), NR Radio Resource Control (RRC) protocol specification (Release 15), ("*5G RRC Specification"*), *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3197 ("Versions" tab, link "15.0.0" uploaded January 4, 2018)
1027	3GPP TS 38.401 v15.0.0 (2017-12), NG-RAN; Architecture description," *available at* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3219 ("Versions" tab, link "15.0.0" uploaded January 19, 2018)
1028	3GPP Meetings for Group RAN2 https://www.3gpp.org/dynareport?code=Meetings-R2.htm#R2-101

Exhibit #	***Description***
1029	3GPP FTP page for the 101st meeting of RAN2 WG, held Feb. 26-2018 to March 2, 2018, *available at* https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_101/
1030	3GPP RAN2#101 Meeting Information page, *available at* https://portal.3gpp.org/Meetings.aspx#/meeting?MtgId=18770
1031	3GPP FTP page publishing each technical contribution associated with the RAN2#101 meeting of RAN2 WG, held Feb. 26-2018 to March 2, 2018, *available at* https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_101/Docs
1032	*RAN2#101 Documents Index* - 3GPP index of the technical contributions associated with the RAN2#101 meeting of RAN2 WG (last modified March 2, 2018), *available at* https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_101/Tdoclists (uploaded March 2, 2018).
1033	*Filtered RAN2#101 Documents Index* – Filtered version of 3GPP index of the technical contributions associated with the RAN2#101 meeting of RAN2 WG (last modified March 2, 2018), *available at* https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_101/Tdoclists (uploaded March 2, 2018) (filtered to documents indexed to "On demand system information").
1034	*RAN2#101 Agenda* - 3GPP TSG-RAN WG2 Meeting #101 Agenda (R2-1801700), *available at* https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_101/Docs (link "R2-1801700.zip")
1035	*RAN2#101 Report* - Report of 3GPP TSG RAN WG2 meeting #101 Athens, Greece, 26 February - 2 March, 2018, *available at* https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_101/Report
1036	*RAN2#101 Report TDoc_List* - TDoc-list attached to *RAN2#101 Report*, *available at* https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_101/Report
1043	ETSI 3GPP page, *available at* https://www.etsi.org/committee/3gpp

APPENDIX B – CURRICULUM VITAE

Zygmunt J. Haas

I. GENERAL INFORMATION

(i) Personal Information

Name: Zygmunt J. Haas

Titles: ① Professor and Distinguished Chair in Computer Science (Univ. of Texas at Dallas)
② Professor Emeritus (Cornell University; Electrical and Computer Engineering)

Professional Contact Information:

② **Cornell University:**
Address: School of Elect. & Comp. Eng, Ithaca, NY 14853
E-mail: *zhaas@cornell.edu*
URL: *http://people.ece.cornell.edu/~haas*
Lab URL: *http://wnl.ece.cornell.edu*

① **University of Texas at Dallas**
Address: Erik Jonsson School of Engineering and Computer Science
ECSS Room 4.405
Richardson, TX 75080
Phone: (972)-883-3571
E-mail: *haas@utdallas.edu*
URL: *http://www.utdallas.edu/~haas*

(ii) Main Research Interests

- **Wireless and Mobile Systems and Networks**
  - Wireless Communications
  - Communication Protocols for Wireless Networks
  - Security in mobile and wireless networks
  - Ad Hoc and Sensor Networking Technologies
  - Energy-efficient Protocols
- **Information Assurance and Network Security**
- **Cyber-Physical Systems (CPS) and Internet of Things**
- **Design, Modeling, and Implementation of Multimedia Protocols and Systems**
- **Modeling of Communication Systems**
  - Complex Networks
  - Stochastic Routing
- **Cross-Disciplinary Research Initiatives**

(iii) Education/Degrees (in reverse chronological order)

- **Ph.D.,** Electrical Engineering, Stanford University, CA, May 1988
  - Advisor: Prof. David Cheriton, Computer Science, Stanford University
  - Thesis: "Packet Switching in Fiber-Optic Networks"
- **M.Sc.,** (*Summa Cum Laude*) Electrical Engineering, Tel-Aviv University, Israel, Feb. 1985
- **B.Sc.,** (*Summa Cum Laude*) Electrical Engineering, Technion (IIT), Israel, August 1979

(iv) Employment History (in reverse chronological order)

8/13 – present: University of Texas at Dallas, Computer Science Department
Erik Jonsson School of Engineering and Computer Science, Richardson, TX
Title: Professor and Distinguish Chair in Computer Science

8/95 – present: Cornell University, School of Electrical and Computer Engineering, Ithaca, NY
Title: Professor Emeritus (as of 10/13)

- **7/2004 –10/2013:** Tenured Full Professor
- **11/1998 - 6/2004:** Tenured Associate Professor
- **8/1995 - 10/1998:** Associate Professor

5/10 – 6/11: National Science Foundation, Engineering Directorate, Arlington, VA; Title: Program Director; Comment: on leave from Cornell University

1/03-05/03: Visiting Fellow, Princeton University, EE Department

09/94 - 7/95: AT&T Business Communication Services, Murry Hill, NJ; Title: Member of Technical Staff

05/88 - 7/95: AT&T Bell Laboratories, Network Research, Holmdel, NJ; Title: Member of Technical Staff

09/85 - 5/88: Electrical Eng. Dept., Stanford University, CA, Title: Research Assistant

10/79 - 8/85: R&D Department of Government of Israel, Tel-Aviv, Israel; Title: Engineer

10/81 - 6/85: Electrical Eng. Dept., Tel-Aviv University, Israel; Title: Teaching Assistant

8/79 - 10/79: Philips Research Laboratories, Eindhoven, Holland; Title: Engineer

(v) Selected Awards and Honors

- Fellow of the *Association for Computing Machinery (ACM),* 2021 (UTD ann.) (certificate)
- "How 5G Technology May Improve and Impact Our Lives" *Authority Magazine* Interview, June 4, 2021 (link) (UTD Announcement)
- Fellow of the AAIA (Asia-Pacific Artificial Intelligence Association), 6/2021 (9/28/2021)
- Best Paper Award for the paper [Z.J. Haas and Z. Zheng, "Engineering a Network in the Sky," The 35th International Conference on Information Networking, (*ICOIN21*), January 13−16, 2021, Jeju Island, S. Korea] (UTD announc.) (Cornell announc.)
- *Guide2Research* Scientists 2020 Ranking: 315th (US) and 495 (Worldwide)
- Distinguished Member of the European Alliance for Innovation (EAI), 2021
- Fellow of the *European Alliance for Innovation (EAI),* May 2019 (Fellow selection)
- Fellow of *The Institute of Engineering and Technology (IET),* March 2019
- "5 Things to Know About 5G" *UT Dallas Magazine*, October 14, 2019
- 2016 IEEE ComSoc AHSN Recognition Award ("for outstanding contributions to securing ad hoc and sensor networks") presented at *IEEE Globecom 2016,* December 5, 2016, Washington DC (*AHSN Recognition Award*); Cornell's faculty awards
- Elevation to *IEEE Fellow*, January 2007, *"for contribution to wireless and mobile ad hoc networks"* (award letter)
- Status of "Professor Emeritus" at Cornell University (as of October 15, 2013)

- 2012 IEEE ComSoc WTC Recognition Award (the award recognizes individuals for "*outstanding technical contributions in the field and for his service to the scientific and engineering communities*") presented at *IEEE Globecom 2012,* December 5, 2012, Anaheim, CA *(WTC Recognition Awards)*
- Distinction of *Classic Paper by Google Scholar* for the paper "Gossip-based Ad Hoc Routing," *IEEE/ACM Transactions on Networking,* vol.14, no.3, June 2006
- "Best Paper Award" for the paper "Collaborating with Correlation for Energy Efficient WSN," [M. Nikolov and Z.J. Haas], *First ACM Annual International Workshop on Mission-oriented Wireless Sensor Networking (ACM MiSeNet 2012),* in conjunction with *ACM MobiCom 2012,* Istanbul, Turkey, August 26, 2012
- IEEE Distinguished Lecturer Tour, Scandinavian Countries, May 25 – June 5, 2009
- Promotion to the rank of *Full Professor,* School of ECE, Cornell Univ., July 1, 2004
- Distinguish Lecturer, IEEE Communications Society, (two terms) 01/2004 - 12/2005, 01/2005 - 12/2007
- IEEE Distinguished Lecturer Tour, Australia, September 26-October 3, 2005
- Expert Lecturer, IEEE Communications Society, 2002-2004
- Michael Tien'72 Excellence in Teaching Award, Cornell College of Engineering for 2002-2003 academic year, November 2003
- "Best Paper Award" for the paper "Optimal Resource Allocation for UWB Wireless Ad Hoc Networks," [C. Zou and Z.J. Haas], IEEE 16th International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC'05), ICC Berlin, Germany, September 11-14, 2005
- Michael Tien'72 Excellence in Teaching Award, Cornell College of Engineering for 2002-2003 academic year, November 2003
- "Highly Commended Paper Award" for the paper "Performance Evaluation of the Modified IEEE 802.11 MAC for Multi-Channel Multi-Hop Ad Hoc Network," [J. Li, Z.J. Haas, M. Sheng, and Y. Chen], IEEE International Conference on Advanced Information Networking and Applications (AINA 2003)
- Elected Chair of the IEEE Technical Committee on Personal Communications (TCPC), Jan. 2001 – Nov. 2002 (previously elected Vice Chair and Secretary)
- Michael Tien'72 Excellence in Teaching Award, Cornell College of Engineering for 1999-2000 academic year, September 2000
- Election to *Indefinite Tenure,* Cornell University, October 1998
- Michael Tien'72 Excellence in Teaching Award, Cornell College of Engineering for 1996-1997 academic year, September 1997 (letter) (banquet)
- AT&T Foundation Award, September 1995
- President Award, Technion, Israel (1976, 1977, 1978, and 1979)
- B.Sc. w/ "*Summa Cum Laude*," Aug. 1979; M.Sc. w/ "*Summa Cum Laude*," Feb. 1985

(vi) Memberships in Professional Societies

- IEEE Communications Society (ComSoc)
- Association for Computing Machinery (ACM)
- Special Interest Group on Mobile Communications (SIGMOBILE)

(vii) Membership in Graduate Fields + Affiliate Membership (date awarded)

- Electrical and Computer Engineering, Cornell University, August 1995
- Computer Science, Cornell University, February 2001
- Center for Applied Math, Cornell University, April 2003
- Electrical Engineering, University of Texas at Dallas, April 4, 2015

II. TALKS, INVITED TALKS, & KEYNOTE SPEECHES

Invited and Keynote Talks (in reverse chronological order)

- **Zygmunt J. Haas, "Reconfigurable Distributed MIMO for Physical-layer Security in Mobile Networks,"** ***Invited Talk,*** **40th IEEE Sarnoff Symposium, NJIT, Newark, NJ, Sep. 23, 2019 (Invited Talks) (plaque)**
- **Z.J. Haas, "Reconfigurable Distributed MIMO for Physical-layer Security in Mobile Networks,"** ***ECE Seminar Series*****, Stevens Institute of Technology, March 27, 2019 (announcement)**
- **Z.J. Haas, "Reconfigurable Distributed MIMO for Physical-layer Security in Mobile Networks,"** ***Invited Talk*****, Joint ECE/CS Seminar, Stony Brook University, February 28, 2019 (announcement)**
- **Z.J. Haas, "Reconfigurable Distributed MIMO for Physical-layer Security in Mobile Networks,"** ***ACCESS*** **Distinguished Lecture, KTH Royal Institute of Technology, Stockholm, Sweden, September 13, 2018 (announcement)**
- **Z.J. Haas, "Challenges of Internet of Things," Spring 2017 Computer Science Distinguished Lecture Series, Norfolk State University, Computer Science Department, April 6, 2017 (plaque)**
- **Z.J. Haas, "Research Directions of the Wireless Networks Lab," Computer Science Department, Wesleyan University, Fort Worth, TX, March 31, 2016**
- **Z.J. Haas, "Challenges of Internet of Things," Fourth Annual International Workshop on Mission-Oriented Wireless Sensor Networking (*****MiSeNet 2015*****), Dallas, TX, October 19, 2015**
- **Z.J. Haas, "Security of Big Data," Third Annual International Workshop on Mission-Oriented Wireless Sensor Networking (*****MiSeNet 2014*****), Philadelphia, PA, October 27, 2014**
- **Z.J. Haas, "Big Data and Its Security Implications," National Taiwan University (NTU), Taipei, Taiwan, December 16, 2013**
- **Z.J. Haas, "Big Data and Its Security Implications," National Sun Yat-sen University, Kaohsiung, Taiwan, December 18, 2013**
- **Z.J. Haas, "Big Data and Its Security Implications," National Tsing Hua University, Hsinchu, Taiwan, December 19, 2013**
- **Z.J. Haas, "Big Data and Security Implications," Keynote Speech,** ***EUSPN'13, 4th International Conference on Emerging Ubiquitous Systems and Pervasive Networks,*** **Niagara Falls, Ontario, Canada, October 21-24, 2013**
- **Z.J. Haas, "Security of Big Data," at the Cornell Engineering Alumni Association conference, Washington, DC, May 13, 2013**
- **Z.J. Haas, "Stochastic Routing," DIMACS Workshop on Connectivity and Resilience for Large-Scale Networks, Rutgers University, Piscataway, NJ, April 12-13, 2012**
- **Z.J. Haas, "*****Information Assurance for Sensor Networks,*****" Winter 2012 CIS Distinguished Lecture Series, Computer and Information Science Department, College of Engineering and Computer Science. University of Michigan-Dearborn, March 16, 2012**
- **Z.J. Haas, "*****Information Assurance for Sensor Networks,*****" Invited Talk, Department of Electrical Engineering and Computer Science, UC Berkeley, Berkeley, CA, September 7, 2011**
- **Z.J. Haas, "*****Information Assurance for Vehicular Sensor-based Networks,*****" Closing Keynote, 4th** ***IEEE International Symposium on Wireless Vehicular Communications (WiVeC'11)*****, San Francisco, CA, September 6, 2011**

- Z.J. Haas, "*Information Assurance for Sensor Networks,*" Invited Talk, Department of Electrical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan, August 15, 2011 (program)
- Z.J. Haas, "*New Directions and Challenges in Information Assurance with Applications for Sensor Networks,*" Invited Talk, Department of Electrical Engineering, NCTU, Hsinchu, Taiwan, August 12, 2011
- Z.J. Haas, "*New Directions and Challenges in Information Assurance with Application to Sensor Networks,*" Invited Talk, Department of Electrical Engineering, Boston University, July 14, 2011
- Z.J. Haas, "*Information Assurance and Sensor Network Security,*" Department of Electrical and Computer Engineering, University of Florida, Gainesville, FL, April 14, 2011
- Z.J. Haas, "*Information Assurance and Sensor Network Security,*" Computer and Information Sciences department, Temple University, Philadelphia, PA, March 31, 2011
- Z.J. Haas, "*Information Assurance for Sensor Networks,*" Keynote Speech, *IEEE PerCom 2011 (Information Quality and Quality of Service (IQ2S) Workshop*), Seattle, WA, March 21, 2011
- Z.J. Haas, "*Stochastic Routing for Delay Tolerant Networks,*" Invited Talk, IEEE Communications Society North Jersey Chapter, NJIT Department of ECE, Newark, NJ, November 29, 2010
- Z.J. Haas, "*Stochastic Routing for Delay Tolerant Networks,*" Keynote Talk, *Symposium for Emerging Trends in Mobile, Sensor, and Social Networks (MSS 2010), CReWMaN 10th Anniversary Celebration,* University of Texas at Arlington, October 7-8, 2010
- Z.J. Haas, "On Networking in the `Final Frontier'," Invited Talk, Air Force Research Laboratory, Rome, NY, August 6, 2010
- Z.J. Haas, "*The Ad Hoc and Sensor Networking Technology: Past, Presence, and Future,*" Keynote Speech, *The Second International Conference on Ubiquitous and Future Networks (ICUFN'10),* Jeju Island, South Korea, June 16-18, 2010
- Z.J. Haas, "Engineering Education for the 21st Century," Invited Talk, Kookmin University, Seoul, South Korea, June 21, 2010
- Z.J. Haas, "*3D Wireless Networks,*" Plenary Speaker, *Wireless Telecommunications Symposium (WTS 2010),* April 21-23, 2010, Tampa, FL (*WTS 2010*)
- Z.J. Haas, "*Stochastic Routing for Delay Tolerant Networks,*" Electrical and Computer Engineering Seminar, Technion, Israel Institute of Technology, July 13, 2009
- Z.J. Haas, "*Stochastic Routing for Delay Tolerant Networks,*" Nordic IEEE/ComSoc Distinguish Lecturer Tour (DLT), May 24, 2009 – June 5, 2009:
    - KTH Royal Institute of Technology, Stockholm, Sweden
    - Helsinki University of Technology (TKK), Helsinki, Finland
    - Linköpings Universitet, Dept. of Computer & Info. Science, Linköpings, Sweden
    - Lund Technical University and Ericsson, Lund, Sweden
    - Oulu University, Oulu, Finland
    - Aalborg University, Aalborg, Denmark
    - Danmarks Tekniske Universitet (DTU), Copenhagen, Denmark
- Z.J. Haas, "*Implications of Reconfiguration at the Network Layer,*" US-Australia NSF Workshop: Self-Organizing Wireless Networks Based on Cross-Layer Interactions, Darling Harbour, Sydney, Australia, December 17-19, 2008

* **Z.J. Haas, "*Stochastic Routing,*" US-Australia NSF Workshop: Self-Organizing Wireless Networks Based on Cross-Layer Interactions, Darling Harbour, Sydney, Australia, December 17-19, 2008**
* **Z.J. Haas, "*Stochastic Routing for Sensor- and Ad Hoc-Networks,*" Keynote Speech, *International Conference on Intelligent Sensors, Sensor Networks, and Information* Processing (ISSNIP 2008), December 15-18, 2008, Sydney, Australia**
* **Z.J. Haas, "What's in My Crystal Bowl," Keynote Speech, Australasian Telecommunication Networks and Applications Conference 2008 (ATNAC 2008), Adelaide, South Australia, December 7-10, 2008**
* **Z.J. Haas, "*On Networking in the Final Frontier*," University of South Florida, Tampa, FL, December 5, 2008**
* **Z.J. Haas, "*On Networking in the Final Frontier*," CSE Colloquium, Department of Computer Science and Engineering, University of Buffalo, Buffalo, NY, Nov. 6, 2008**
* **Z.J. Haas, "*On Networking in the `Final Frontier',*" ECE Seminar Series, Carnegie Mellon University, Pittsburgh, PA, November 20, 2008**
* **Z.J. Haas, "Stochastic Routing," *Brown-Bag Series,* Computer Science Department, Cornell University, Ithaca, NY, March 4, 2008**
* **Z.J. Haas, "The Untold Story about the Romance between Mr. *A.H Network* and Mrs. *S. Network* and about their Son, Mr. *D.-T Network," ECE Colloquium,* Department of Electrical and Computer Engineering, Boston University, February 22, 2008**
* **Z.J. Haas, "Research in Wireless Ad Hoc Networks at the Cornell's Wireless Networks Laboratory," Iowa State University, Computer Science Department, July 6, 2007**
* **Z.J. Haas et al, "How to Circumvent the Scalability Curse," IMANET Workshop, Arlington, VA, March 7, 2006**
* **Z.J. Haas, "On Some Choices in QoS Design of Ad Hoc and Sensor Networks," *Bell Laboratories, Lucent Technologies,* Murray Hill, NJ, January 27, 2006**
* **Z.J. Haas, "On Some Choices in QoS Design of Ad Hoc and Sensor Networks," Keynote Speech, 2nd *IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS 2005),* Washington, DC, November 9, 2005**
* **Z.J. Haas, "Research in Wireless Ad Hoc Networks at the Cornell's Wireless Networks Laboratory," Keynote Speech, *2005 Asia-Pacific Conference on Communications*, Perth, Australia, October 3-5, 2005**
* **Z.J. Haas, "Mobility and its Effects on Networks Performance," *MiNEMA Summer School 2005*, Klagenfurt University, Klagenfurt, Austria, July 11-15, 2005**
* **Z.J. Haas, "Research in Wireless Ad Hoc Networks at the Cornell's Wireless Networks Laboratory," *IEEE Communications Society and IEEE Aerospace and Electronics Systems,* Joint Chapter, Rochester, NY, *Rochester Institute of Technology*, Rochester, NY, October 19, 2004**
* **Z.J. Haas, "Research in Wireless Ad Hoc Networks at the Cornell's Wireless Networks Laboratory," *University of Pennsylvania, Electrical Engineering Department*, Philadelphia, PA, November 8, 2004**
* **P. Papadimitratos and Z.J. Haas, "Secure Routing for Mobile Ad Hoc Networks," *Working Session on Security in Wireless Ad Hoc Networks,* Swiss Federal Institute of Technology – Lausanne (EPFL), Switzerland, June 12, 2002**
* **Z.J. Haas and E.Y. Hua, "Multipath Routing – A Cross-Layer Design Tool for QoS Provisioning in MANETs," Cross-Layer Design Workshop, Naval Research Laboratory, Washington, DC, June 2, 2004**

- Z.J. Haas, "Ad Hoc Research at the Wireless Networks Laboratory (WNL) at Cornell University," EE Seminar, Columbia University, April 16, 2001
- Z.J. Haas, "Predictive Distance-Based Mobility Management for PCS Networks," Telcordia, Morristown, NJ, April 7, 2000
- Z. Haas, "The Design and Performance of Mobile TCP for Wireless Networks," *Seminar on Networks Research, Center for Advanced Technology in Telecommunications,* March 26, 1999
- Z.J. Haas, "Scalability of Wireless Ad Hoc Networks," *The International Workshop on Theoretical and Algorithmic Aspects of Sensor, Ad Hoc Wireless and Peer-to-Peer Networks,* Keynote Speech, Fort Lauderdale, FL, February 20–21, 2004
- Speaker at the "NSF Networking Principal Investigators' Workshop," session on Wireless/Mobile, Loews L'Enfant Plaza Hotel, Washington, DC, January 21–23, 1999
- Z. Haas, "Networking Issues in Wireless Technologies," *IEEE Multiaccess, Mobility and Teletraffic for Personal Communications* Workshop 1998, Washington, DC, October 21, 1998
- Z.J. Haas, "Zone Routing: A New Routing Protocol for the Reconfigurable Wireless Networks," *Science Advisory Board Associates (SABA),* Motorola, Arlington Heights, November 18, 1997
- Z.J. Haas, "Routing in Highly Reconfigurable Wireless Networks," *8th Maryland Workshop on Very High Speed Networks*, University of Maryland Baltimore County, November 12-13, 1997
- Z. J. Haas, "The Multiply-Detected Macrodiversity Scheme for Wireless Cellular Systems," *EE Colloquium, School of Electrical Eng.*, Cornell University, April 22, 1997
- Z. J. Haas, J. H. Winters, and D. S. Johnson, "Simulation Results of Cellular Capacity Bounds," *5th Maryland Workshop on Very High Speed Networks,* Baltimore, MD, March 14-16, 1994
- Z. J. Haas, J. H. Winters, and D. S. Johnson, "On the Capacity Bounds in Cellular Systems," *Allerton Conf. on Comm., Control, and Comp.,* Monticello, IL, Sept. 29 - Oct. 1, 1993
- Z. Haas, "Gigabit Connectivity with the `Staggering Switch': An Electronically Controlled Optical Packet Switch," *4th Maryland Workshop on Very High Speed Network*, March 15-17, 1993
- Z. Haas, "The `Staggering Switch' – A Scheme for Collision Resolution in Optical Packet Switches," ECE Seminar, Amherst University, Feb. 22, 1993
- Zygmunt Haas, "Communication in the Gbps Era: Some Answers," *Washington University at St. Louis*, St. Louis, MO, September 1990

Tutorial Courses:

- Z.J. Haas, "The Ad Hoc Networking Technology," *Thales Communications, Land and Joint Systems Division,* Clarksburg, MD, May 21-24, 2006
- Z.J. Haas, "Mobility and Its Effects On Network Performance," ESF'05 Workshop, November 7, 2005
- Z.J. Haas, "Mobility and Its Effects On Network Performance," *Middleware for Network Eccentric and Mobile Applications (MiNEMA) Workshop, MiNEMA Summer School,* Klagenfurt University, Klagenfurt, Austria, July 11-15, 2005
- Z.J. Haas, "Inside the Communication Protocols: Teletraffic Engineering & Performance Evaluation," *Telefocal Asia,* Singapore, March 22, 2004
- Z. Haas, Ad Hoc Networks – A New Communication Paradigm?" *Mobile Terrestrial & Space Networking Workshop,* NASA Ames Research Center, Moffett Field, CA, June 26, 2001

- **Z.J. Haas, "Mobile Ad Hoc Networks," IEEE Wireless Communications and Networking Conference (WCNC'00), Chicago, IL, September 23-28, 2000**
- **Z.J. Haas, "Mobile Ad-Hoc Networks,"** ***DIMACS Summer School on Foundations of Wireless Networks and Applications,*** **Rutgers University, Piscataway, NJ, Aug. 7 - 18, 2000**
- **Z.J. Haas, "Wireless Networks: from Cellular to Ad-Hoc,"** ***DIMACS Summer School on Foundations of Wireless Networks and Applications,*** **Rutgers University, Piscataway, NJ, August 7 - 18, 2000**
- **Z.J. Haas, "Queueing Theory for Network Engineering,"** ***MITRE Corporation*****, Eatontown, NJ, 2000**
- **Z.J. Haas, "Wireless Networks - from Cellular to Ad Hoc," IEEE Military Communications Conference (MILCOM'99), Atlantic City, NJ, Oct. 31 – Nov. 3, 1999**
- **Z.J. Haas, "Mobile Ad Hoc Networks," IEEE Wireless Communications and Networking Conference (WCNC'99), New Orleans, LA, September 21-24, 1999**
- **Z.J. Haas, "Mobile Ad Hoc Networks," IEEE Military Communications Conference (MILCOM'98), Bedford, MA, October 20-23, 1998**
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III. PUBLICATIONS

(i) Refereed Journal/Archival Publications (in reverse chronological order)

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(iii) Books & Book Chapters

1. Q. Wang, and Zygmunt J. Haas, "Performance Analysis of Epidemic Routing for Delay-Tolerant Networks," in *Resource Management in Mobile Computing Environments,* Modeling and Optimization in Science and Technologies, volume 3, (2014), *Springer International Publishing,* DOI: 10.1007/978-3-319-06704-9_26

2. Zygmunt J. Haas, Lin Yang, Meng-Ling Liu, Qiao Li, and Fangxin Li, "Current Challenges and Approaches in Securing Communications for Sensors and Actuators," Chapter 17 in the "Art of Wireless Sensor Networks," H.M. Ammari, ed., Springer-Verlag Berlin Heidelberg, 2014, pp. 569-608; DOI: 10.1007/978-3-642-40009-7_17

3. Zygmunt J. Haas, Seung-Keun Yoon, and J.H. Kim, "Energy-Efficient Routing in Delay-Tolerant Networks," in "Green IT: Technologies and Applications," chapter 5, Springer-Verlag, 2011

4. Seung-Keun Yoon and Zygmunt J. Haas, "Energy-aware Routing Protocol for Delay Tolerant Networks," in "Delay Tolerant Networks: Protocols and Applications," CRC Press, Editors: Edited by A. Vasilakos, Y. Zhang, and T. Spyropoulos, 2010, ISBN: 978-1-4398110-8-5

5. S.M. Nazrul Alam and Zygmunt J. Haas, "Topology Control of Three-Dimensional Underwated Wireless Sensor Networks," in *Underwater Acoustic Sensor Networks,* Y. Xiao, editor, CRC Press, Chapter 3, pp.45-70, May 2010; ISBN: 9781420067118 (book)

6. J. Jeong, G.Y Lee, and Z.J. Haas, "Prevention of Black-Hole Attack Using One-Way Hash Chain Scheme in Ad Hoc Networks," T. Vazão, M.M. Freire, and I. Chong (eds.), LNCS 5200, Springer-Verlag Berlin Heidelber, pp. 564-573, 2008, (revised paper from ICOIN 2007, Estoril, Portugal, January 22-25, 2007)

7. Z.J. Haas, J.Y. Halpern, L. Li, S.B. Wicker, "A Decision-Theoretic Approach to Resource Allocation in Wireless Multimedia Networks," in *Resource Allocation in Next Generation Wireless Networks, Volume 5,* W. Li and Y. Pan (eds), Nova Science Publishers, May 14, 2006, chapter 1, pp.1-23; ISBN-13: 978-1594545832

8. R. Barr, Z.J. Haas, and R. van Renesse, "Scalable Wireless Ad Hoc Network Simulation," *Handbook on Theoretical and Algorithmic Aspects of Sensor, Ad Hoc Wireless, and Peer-to-Peer Networks*, Jie Wu, Editor, CRC Press, 2005 (announcement)

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10. T. Small, Z.J. Haas, A. Purgue, and K. Fristrup, "A Sensor Network for Biological Data Acquisition," *Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems,* M. Ilyas and I. Mahgoub, Editors, CRC Press, 2004, ISBN 9780849319686, pp. 11-1 – 11-17
11. D-S. Kim and Z.J. Haas, "Virtual Factory Communication Systems using ISO 9506 standard and Its Application to Networked Factory Machine," *The Industrial Communication System Handbook*, CRC Press, FL, January, 2005
12. P. Papadimitratos, and Z.J. Haas, "Secure Communication in Adverse Mobile Ad Hoc Networks," *Ad Hoc Wireless Networking,* X. Cheng, X. Huang, and D-Z. Du *eds.,* Kluwer Academic Publisher, 2004, pp. 447–485
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17. P. Samar, M. R. Pearlman, and Z.J. Haas, "Hybrid Routing: The Pursuit of an Adaptable and Scalable Routing Framework for Ad Hoc Networks," *The Handbook of Ad Hoc Wireless Networks,* CRC Press, Chapter 14, pp. 14-1 -- 14-18, 2003
18. Z.J. Haas "On the Performance of a Medium Access Control Scheme for the Reconfigurable Wireless Networks," in *Advances in Wireless Communications*, J.M. Holtzman and M. Zorzi (eds), *The International Series in Engineering and Computer Science,* vol. 435, pp. 269–284, Springer, Boston, MA, 2002
19. Z.J. Haas and M.R. Pearlman, "Evaluation of the Ad-Hoc Connectivity with the Zone Routing Protocols," *Wireless Personal Communications*, W.H. Tranter, T.S. Rappaport, B.D. Woerner, and J.H. Reed (eds), International Series in Engineering and Computer Science, vol. 482, 2002, pp. 201–212; Springer, Boston, MA, DOI: 10.1007/0-306-47046-2_19; presented at the 8th Virginia Tech/MPRG Symposium on Wireless Personal Communications, June 10–12, 1998, Blacksburg, VA
20. Z.J. Haas and M.R. Pearlman, "ZRP: a hybrid framework for routing in Ad Hoc networks," *Ad Hoc Networking,* C. Perkins, ed., pp. 221-253, Addison Wesley, March 2001
21. M. Sanchez, P. Manzoni, and Z.J. Haas, "Determination Of Critical Transmission Range In Ad-Hoc Networks," in *Multiaccess, Mobility and Teletraffic in Wireless Communications: Volume 4,* eds. Biglieri, Fratta, and Jabbari, pp.293–304, Kluwer Academic Publ., 1999
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25. Z. Haas, "Packet Switching," article in *Encyclopedia of Computer Science and Technology,* vol. 27, supplement 12, pp. 215–222, 1993

(iv) Miscellaneous Publications

1. S. Milner, C. Davis, Z. Haas, and P.R. Kumar, "Quantifying and Assuring Information Transfer in Dynamic Heterogeneous Wireless Networks," Final Report for Contract number: AFOSR FA9550-09-1-0121, July 31, 2012
2. Z.J. Haas, "A Quest for the Future of Wireless Communications or It's Tough to be a Seer," *Connections,* School of Electrical and Computer Engineering, Cornell University, Fall 2005, pp. 12-14
3. O. Arpacioglu, T. Small, and Z.J. Haas, "Notes on Scalability of Wireless Ad Hoc Networks," Internet Draft, October 20, 2003, `draft-irtf-ans-scalability-notes-01.txt`
4. O. Arpacioglu, T. Small, and Z.J. Haas, "Notes on Scalability of Wireless Ad Hoc Networks," Internet Draft, August 2, 2003, `draft-irtf-ans-scalability-notes-00.txt`
5. P. Papadimitratos, Z. J. Haas, and P. Samar, "The Secure Routing Protocol (SRP) for Ad Hoc Networks," Internet Draft, `draft-papadimitratos-secure-routing-protocol-00.txt`, December 2002
6. Z. J. Haas, M.R. Pearlman, P.Samar, "The Interzone Routing Protocol (IERP) for Ad Hoc Networks," Internet Draft, `draft-ietf-manet-zone-ierp-00.txt`, January 2001, (`draft-ietf-manet-zone-ierp-01.txt`, June 2001), (`draft-ietf-manet-zone-ierp-02.txt`, July 2002)
7. Z.J. Haas and M.R. Pearlman, "The Zone Routing Protocol (ZRP) for Ad Hoc Networks," Internet Draft, draft-haas-zone-routing-protocol.00.txt, November 1997 (draft-haas-zone-routing-protocol.01.txt, August 1998), (`draft-ietf-manet-zone-zrp-02.txt`, June 1999), (`draft-ietf-manet-zone-zrp-03.txt`, March 2000), (`draft-ietf-manet-zone-zrp-04.txt`, July 2002)
8. Zygmunt Haas, "Routing Protocol for Smart Radio Ad-Hoc Networks," AFRL-IF-RS-TR-1999-138, Air Force Research Laboratory, Information Directorate, Rome Research Site, Rome, NY, June 1999
9. Z.J. Haas, R-H. Gau, and E. McCarthy, "Reliable Mobile Multicast Protocols," Cornell University Report, 1999
10. Zygmunt Haas, "Packet-Switching in Future Fiber-Optic Wide-Area Networks," Ph.D. thesis, Stanford University, Electrical Engineering Department, May 1988
11. Z. Haas and D.R. Cheriton, "Blazenet and the Arguments for Very High-Speed Photonic Packet-Switching," *unpublished*, March 15, 1988
12. Z. Haas and D. Cheriton, "Blazenet: A Photonic Implementable Wide-Area Network," Technical Report, STAN-CS-87-1185 (and CSL-TR-87-346), Stanford University, Oct. 1987
13. Zygmunt Haas, "Local Area Networks and Access Techniques in Local Area Networks," *M.Sc. thesis*, Tel-Aviv University, Spring 1985
14. Zygmunt Haas, "Measuring Lag Phenomena in Plumbicons," Technical Report, Philips Research Labs., ELCOMA division, September 1979

IV. TEACHING & ADVISING

(i) Courses Taught (semester; course #/title; number of students/credit hours)

- Fall 2021: 3341.HON/Probability and Statistics for CS; 28 students; UTD/CS
- Spring 2021: CS 6340/Wireless Networks; 14 students/42 credit hours; UTD/CS
- Spring 2021: CS/CE 4390/Computer Networks; 68 students/204 credit hours; UTD/CS
- Fall 2020: 3341.HON/Probability and Statistics for CS; 31 students; UTD/CS
- Fall 2019: 3341.HON/Probability and Statistics for CS; 21 students; UTD/CS
- Spring 2019: CS 6390/Advanced Computer Networks; 19 students; UTD/CS
- Fall 2018: 3341.HON/Probability and Statistics for CS; 31 students; UTD/CS
- Fall 2018: CS 6301/Wireless Networks; 7 students; UTD/CS
- Spring 2018: CS 4390/Computer Networks; 43 students; UTD/CS
- Spring 2018: CS 6390/Advanced Computer Networks; 18 students; UTD/CS
- Fall 2017: CS 6301/Wireless Networks; 11 students; UTD/CS
- Spring 2017: CS 4390/Computer Networks; 40 students; UTD/CS
- Spring 2017: CS 6390/Advanced Computer Networks; 28 students; UTD/CS
- Fall 2016; CS 6301/Wireless Networks; 7 students; UTD/CS
- Spring 2016: CS 6390/Advanced Computer Networks; 31 students; UTD/CS
- Spring 2016: CS 4390/Computer Networks; 23 students; UTD/CS
- Spring 2015: CS 6301/Wireless Networks; 23 students; UTD/CS
- Spring 2015: CE/CS 6390/Advanced Computer Networks; UTD/CS
- Spring 2014: CS 6301/Wireless Networks; 42 students/126 credit hours; UTD/CS
- Fall 2013: CE/CS 6390/Advanced Computer Networks; 48 students/144 credit hours; UTD/CS
- Spring 2013:ECE 4960/Wireless Networks; 30 students/120 credit hours; Cornell/ECE
- Fall 2012: ECE 3100/Probability and Inference; 60 students/240 credit hours; Cornell/ECE
- Spring 2012: ECE 5660/Fundamentals of Networks; 11 students/44 credit hours; Cornell/ECE
- Fall 2011: "Wireless Networks", Technion, Israeli Institute of Technology, Haifa, Israel
- Spring 2011: Leave of Absence (NSF)
- Fall 2010: Leave of Absence (NSF)
- Spring 2010: ECE 3200/Networks and Systems; 36 students/144 credit hours; Cornell/ECE
- Fall 2009: ECE 5660/Fundamentals of Networks; 15 students/60 credit hours; Cornell/ECE
- Spring 2009: Sabbatical Leave; Cornell/ECE
- Fall 2008: ECE 5660/Fundamentals of Networks; 20 students/80 credit hours; Cornell/ECE
- Spring 2008: ECE 3100/Introduction to Probability and Random Phenomena; 79 students/316 credit hours; Cornell/ECE
- ECE 566/ Fundamentals of Networks; Fall 2007; 10 students/40 credit hours; Cornell/ECE
- ENGRG150/Freshmen Seminar; Fall 2007; 19 students/19 credit hours; Cornell/ECE

* ECE 310/Introduction to Probability and Random Phenomena; Spring 2007; 77 students/308 credit hours; Cornell/ECE
* ECE 566/ Fundamentals of Networks; Fall 2006; 27 students/108 credit hours
* ECE 691/ECE Colloquium; Fall 2006 (Plus); ECE Colloquium; 28 students; 28 student credit hours; Cornell/ECE
* ECE 310/Introduction to Probability and Random Phenomena; Spring 2006; 75 students/300 credit hours; Cornell/ECE
* ECE 566/Wireless Networks; Fall 2005; 26 students/104 credit hours; Cornell/ECE
* ECE 310/Introduction to Probability and Random Phenomena; Spring 2005; 71 students/284 credit hours; Cornell/ECE
* ECE 566/Wireless Networks; Fall 2004; 16 students/64 credit hours; Cornell/ECE
* ECE 566/Wireless Networks; Spring 2004; 28 students/112 credit hours; Cornell/ECE
* ECE 563/Communication Networks; Fall 2003; 19 students/76 credit hours; Cornell/ECE
* Spring 2003: Sabbatical Leave - no teaching assignment
* ECE 230/Introduction to Digital Logic Design; Fall 2002; Cornell/ECE
* ECE 563/Communication Networks; Fall 2002; 19 students/76 credit hours; Cornell/ECE
* ENGRG150/Freshmen Seminar; Fall 2003; 18 students/18 credit hours; Cornell/ECE
* ECE 566/Wireless Networks; Spring 2002; 73 students/292 credit hours; Cornell/ECE
* ECE 445/Computer Networks; Fall 2001; 146 students/584 credit hours; Cornell/ECE
* ECE 566/Wireless Networks; Spring 2001; 74 students/296 credit hours; Cornell/ECE
* ECE 445/Computer Networks; Fall 2000; 144 students/576 credit hours; Cornell/ECE
* EE 597/Wireless Information Technology Seminar (WITS); Fall 2000; 12 students/24 credit hours; Cornell/ECE
* ENGRG 150/Engineering Seminar; Fall 2000; 19 students/19 credit hours; Cornell/ECE
* EE 566/Wireless Networks; Spring 2000; 58 students/232 credit hours; Cornell/ECE
* EE 595/Wireless Information Technology Seminar (WITS); Spring 2000; 13 students/26 credit hours; Cornell/ECE
* ELE 936/Wireless Networks I; Fall 1999; 43 students; Polytechnic University, NYC, NY
* EE 566/Wireless Networks; Spring 1999; 42 students/168 credit hours; Cornell/ECE
* EE 445/Computer Networks; Fall 1998; 147 students/588 credit hours; Cornell/ECE
* EE 597/Wireless Information Technology Seminar (WITS); Fall 1998; 9 students/18 credit hours; Cornell/ECE
* EE 566/Wireless Networks; Spring 1998; 43 students/172 credit hours
* EE 597/Wireless Information Technology Seminar (WITS); Spring 1998; 11 students/22 credit hours
* EE 445/Computer Networks; Fall 1997; 99 students/396 credit hours
* EE 566/Wireless Networks; Spring 1997; 45 students/180 credit hours
* EE 445/Computer Networks; Fall 1996; 122 students/366 credit hours
* EE 595/Wireless Information Technology Seminar (WITS); Fall 1996; 20 students/40 credit hours
* EE 566/Wireless Networks; Spring 1996; 74 students/296 credit hours
* EE 445/Computer Networks; Fall 1995; 155 students/465 credit hours

V. PROFESSIONAL & SCIENTIFIC SERVICE

(i) University Committees

- **Member of the Search Committee for the Inaugural Associate Dean for Diversity and Strategic Initiatives, Eric Jonsson School of Engineering and Computer Science, UTD, 2021**
- **Member of Annual Review Committee, Computer Science Department, UTD, 2019-present**
- **Member of Committee on Qualifications of Academic Personnel, UTD, 09/01/2020-08/31/2022**
- **Member of Dean's Teaching Task Force for Fall 2020, Jonsson School of Engineering and Computer Science, UTD, June 2020**
- **Member of Committee on Qualifications of Academic Personnel, UTD, 09/01/2018-08/31/2020**
- **Chair of Committee for Affiliated Faculty Appointment Rules, CS/UTD, Fall 2017**
- **Member of UTD Committee on Qualifications of Academic Personnel, UTD, 09/01/2016-08/31/2017**
- **Chair of "Ph.D. Committee," Computer Science Department, UTD, Fall 2016 - now**
- **Member of "Graduate Admission Committee," Computer Science Department, UTD, 2014-2019**
- **Member of "Web Design and Marketing Committee," Computer Science Department, UTD, 2014-present**
- **Member of "Recruiting Committee," Computer Science, UTD, 2014-2016**
- **Member of *Center for Applied Math (CAM) Graduate Admission Committee,* Cornell University, 2012-2013**
- **Member of the *College Admissions Advisory Committee*, College of Engineering, Cornell University, June 2012 - June 2013**
- **Member of the *Engineering Courses Subcommittee,* CCGB, College of Engineering, Cornell University, 2009 – 2010**
- **Member of the *Technical Writing Subcommittee,* CCGB, College of Engineering, Cornell University, 2009 –2010**
- **Member of the *College Curriculum Governing Board (CCGB)*, College of Engineering, Cornell University, 2009 – 2010**
- **Member of the *Faculty Admissions Advisory Committee*, College of Engineering, Cornell University, (third term) June 2009 - June 2012**
- **Multiple *Ad Hoc Tenure Promotion*, School of Electrical Engineering, Cornell University 1998 – 2013**
- **Multiple *Ad Hoc Promotion Committees, Ad Hoc Reappointment Committees,* and *Ad Hoc Tenure Promotion*, College of Engineering, Cornell University 1998 – 2013**
- **Member of Policy Committee, School of Electrical and Computer Engineering, Cornell University, 2008 – 2010 (elected)**
- **Member of Graduate Committee, School of Electrical and Computer Engineering,**

Cornell University, 2007 – 2008

- Member of Recruiting Committee, School of Electrical and Computer Engineering, Cornell University, 2007 – 2008
- Member of the *Faculty Admissions Advisory Committee*, College of Engineering, Cornell University, (second term) June 2006 – June 2009
- *Associate Director for Academic Affairs*, School of Electrical and Computer Engineering, Cornell University, 2005 – 2006
- Review Board Member, *Learning Initiatives For Engineers (LIFE),* Undergraduate Research Program, College of Engineering, Cornell University, 2005 – 2006
- Member of the *Policy Committee*, School of Electrical and Computer Engineering, Cornell University, 2005 – 2006 (elected)
- Member of *Curriculum and Standards Committee,* School of Electrical and Computer Engineering, Cornell University, 2005 – 2006
- Member of the *M. Eng Committee*, School of Electrical and Computer Engineering, Cornell University, 2004 – 2007
- Member of the *Faculty Admissions Advisory Committee*, College of Engineering, Cornell University, June 2004 – June 2006
- Member of *Recruiting Committees*, School of Electrical and Computer Engineering, Cornell University, 2004 – 2006
- Member of the *College of Engineering Nomination Committee*, Cornell University, 1997 – 1999
- Member of *Faculty Advisory Board on Information Technologies (FABIT),* Cornell University, 1997/98 and 1999/00 (Cornell Faculty Senate appointment)
- Member of the *Computer Science Recruiting Committee*, Cornell University, 1996
- Member of the *Circuit Recruiting Committee*, Cornell Univ., School of EE, 1996 – 1997
- Member of the *Long Term Recruiting Committee*, Cornell Univ., School of EE, 1996 – 1997 (elected)
- Member of the *Engineering Distribution CCGB Standing Committee*, Cornell University, 1995 – 1998

(ii) Editorial Service

- Member of the Editorial Board of *MDPI Drones, Section Board for Drone Communications*
- Member of the Editorial Board of *MDPI Sensors, Section Board for Intelligent Sensors*
- Editor-in-Chief of *eScripts,* a novel publication enterprise of the European Commission
- Served on the Advisory Board and the Editorial Board of the *Wireless Communications and Mobile Computing* journal (John Wiley & Sons)
- Served on the Editorial Board of Springer *Wireless Networks (WINET)* Journal
- Serving on the Editorial Board of *Journal of High Speed Networks* (JHSN)
- Served on the Editorial Board of *ACM/IEEE Transactions on Networking*
- Served on the Editorial Board of *IEEE Transactions of Wireless Communications*
- Served on the Editorial Board of *IEEE Communications Magazine*
- Served on the Editorial Board of *Computer Networks and ISDN Systems* Journal
- Served on the Editorial Board of *IEEE Personal Communications Magazine*

- **Served on the Editorial Board of *Elsevier Ad Hoc Networks* journal**
- **Lead guest editor for the *IEEE Journal on Selected Areas in Communications,* issue on "Mobile Computing Networks," vol.13, no.5, June1995**
- **Lead guest editor for the *IEEE Journal on Selected Areas in Communications*, issue on "Wireless Ad Hoc Networks," vol.17, no.8, August 1999**
- **Co-guest editor of special issue of Wireless Networks journal on "Mobicom'96," 1997**
- **Lead guest editor for the *IEEE Journal on Selected Areas in Communications,* issue on "Protocols for Gigabit Networks," vol. 12, no. 2, February 1993**

(iii) Service to the Scientific Community at Large

- **General co-Chair of *EAI WiCON 2022,* November 17, 2022, Dallas, TX and Cyberspace**
- **Steering Committee co-Chair of the "Workshop on Securing Next-Generation Connected Healthcare Systems using Futuristic Technologies," *IEEE GLOBECOM'21*, December 7-11, 2021, Madrid, Spain (Hybrid: In-Person and Virtual) (abstract)**
- **International Advisory Committee Member of the 11th International Conference on ICT Convergence (ICTC 2020) Conference, October 21 – 23, 2020, Jeju Island, Korea**
- **International Advisory Committee of the *12th International Conference on Ubiquitous and Future Networks (ICUFN)* Conference, *June 30 – July 3, 2020, Porto, Portugal***
- **Technical Program Vice-Chair of the Research Track of Mobile and Wireless Computing of 39th IEEE International Conference on Distributed Computing System (ICDCS 2019), Dallas, Texas, July 7-10, 2019**
- **General and Technical Program Chair of the "Signal Processing for Wireless Network Security" Symposium at the *2018 6th IEEE Global Conference on Signal and Information Processing (GlobalSIP),* Anaheim, CA, November 26–29, 2018**
- **International Advisory Committee of the International Conference on Ubiquitous and Future Networks (ICUFN) Conference**
- **General Chair of the Fifth IEEE Annual International Workshop on Mission-Oriented Wireless Sensor Networking (IEEE MiSeNet 2016), in conjunction with IEEE INFOCOM 2016**
- **Workshop Technical Program Co-Chair of the *2015 IEEE International Conference on Healthcare Informatics,* Dallas, TX, October 21-23, 2015 (CFP)**
- **Member of the Advisory Committee of the *American Amazing Teens (AAT)* program (Role: Educator)**
- **Member of International Advisory Committee of the *IEEE ICUFN 2014, Sixth International Conference on Ubiquitous and Future Networks 2014*, Shanghai, China, July 8-11, 2014 (CFP)**
- **Member of the International Advisory Committee of the *International Conference on Information and Communication Technology Convergence 2013 (ICTC 2013),* Jeju Island, S. Korea, October 14-16, 2013 (CFP)**
- **Member of the Steering Committee of *The Second ACM Annual International Workshop on Mission-oriented Wireless Sensor Networking (ACM MiSeNet 2013),* in conjunction with ACM MobiCom 2013, Miami, FL, September 30, 2013**

- **Member of International Advisory Committee of the *IEEE ICUFN 2013, Fifth International Conference on Ubiquitous and Future Networks 2013,* Da Nang, Vietnam, July 2-5, 2013 (CFP)**
- **Member of the Steering Committee of *The First ACM Annual International Workshop on Mission-oriented Wireless Sensor Networking (ACM MiSeNet 2012),* in conjunction with ACM MobiCom 2012, Istanbul, Turkey, August 26, 2012 (technical program)**
- **Member of the International Advisory Committee of the *IEEE International Conference on Information and Communication Technology Convergence 2012 (ICTC 2012)*, Jeju Island, S. Korea, October 15-17, 2012**
- **Member of the Steering Committee of *ACM MSWiM, 2012,* Istanbul, Turkey, August 26, 2012**
- **General co-chair of "*The Fourth International Workshop on Information Quality and Quality of Service for Pervasive Computing (IQ2S'12)*," in Conjunction with *IEEE PERCOM 2012*, Lugano, Switzerland, March 19-23, 2012 (website) (CFP)**
- **Member of International Advisory Committee of the *IEEE ICUFN 2012* (*The Fourth International Conference on Ubiquitous and Future Networks*), *Puket, Tailand, July 4-6, 2012***
- **Moderator and Presenter at the *2010 NSF ECSS Grantees' Conference, Hilton Hawaiian Village, Honolulu, Hawai'i, Nov. 30-Dec 2, 2010***
- **Moderator and Panelist of the "What's Next for Underwater Networks?" Panel, "*The Fifth International Workshop on UnderWater Networks (WUWNets'10),"* Woods Hole, MA, September 30 – October 1, 2010**
- **Member of the International Advisory of the "*International Conference on ICT Convergence 2010 (ICTC 2010)*," Jeju, Jeju Island, South Korea, Nov. 17-19, 2010**
- **Member of International Advisory Committee of the "*Second IEEE International Conference on Ubiquitous and Future Networks (ICUFN 2010*),*"* June 16-18, 2010, Jeju Island, Korea (*ICUFN 2010*)**
- **Member of International Advisory Committee of the "*First IEEE International Conference on Ubiquitous and Future Networks (ICUFN 2009*),*"* June 7-9, 2009, Hong Kong, China**
- **Chair of the Steering Committee of *IEEE Pervasive Computing* magazine, January 1, 2005 – December 31, 2007**
- **Member of the *IEEE TCPC Award Committee*, September 2004 - September 2007**
- **Chair, Technical Program Committee, "*First Workshop on free and commercial Wireless Mesh Networks (OpComm'2006)*," Berlin, Germany, September 18-19, 2006 (cfp) (tpc)**
- **Member of the Steering Committee, *ACM MOBICOM,* 2004**
- **General Chair, Workshop on "Intermittently Connected Mobile Ad Hoc Networks (ICMAN), in conjunction with IEEE *PerCom 2007,* New York, NY, March 26-30, 2007**
- **Member of Advisory Committee of "The First International Conference on Sensor Technologies and Applications (SENSORCOMM 2007), sponsored by IARIA, Valencia, Spain, October 14-20, 2007 (cfp)**
- **General Co-Chair, "*Fifth Workshop on Applications and Services in Wireless Networks (ASWN 2005)*," Maison de la Chimie, Paris, France, June 28 - July 1, 2005 (cfp)**
- **General Chair, *ACM MOBICOM 2004*, Philadelphia, PA, Sept. 26 – Oct. 1, 2004**

- Panelist and Moderator of the "Ad Hoc Networks" panel, *IEEE MILCOM'97*, Monterey, CA, November 2-5, 1997
- Steering Committee and TPC Member of the *Fourth High Performance Communication Subsystems Workshop,* Sani Beach, Chalkididi, Greece, June 23-25, 1997
- Elected and served as the secretary (01/01/1997-12/31/1998), vice-chair (01/01/199-12/31/2000), and chair (01/01/2001-12/31/2002) of *IEEE Technical Committee on Personal Communications (TCPC),* later renamed as *IEEE Wireless Communications Technical Committee*
- Member of the NSF-NCR Workshop on "Research Priorities in Networking and Communications," May 12-14, 1994, Airlie House, Virginia
- Representing AT&T on *the Personal Conferencing Specification Working Group*
- Served on National Science Foundation review panels
- Vice-chair of the *2nd Workshop on High Performance Communication Subsystems (HPCS'93)*
- Organized and chaired "Who needs all-optical networks?" panel at *INFOCOM'93*
- Organized a session "Packet-switched Lightwave Networks: Comparison of Approaches" at the *Computer Communications Workshop*, Hilton Head Island, SC, October 20-22, 1992
- Member of *High-speed Protocols Panel* at *INFOCOM'91*, San-Francisco, CA, June 5-7, 1991

(iv) Technical Program Committees (chairing, co-chairing, and membership)

- Member of Technical Program Committee of the IEEE Wireless Communications and Networking Conference (WCNC 2023), March 26-29, 2023, Glasgow, Scotland, UK
- Member of Technical Program Committee of the 13th International Conference on Information and Communication Technology Convergence (ICTC 2022), October 19-21, 2022, Jeju Island, South Korea
- Member of Technical Program Committee of the 2022 IEEE Autonomous and Trusted Vehicles Conference (ATC 2022), December 15-18, 2022, Haikou, China
- Member of Technical Program Committee of the 37th International Conference on Information and Networking (ICOIN 2023), January 11-14, 2023, Bangkok, Kingdom of Thailand
- Member of Technical Program Committee of the 2022 International Conference on Internet of Things and Intelligent Systems (IoTaIS'2022) Nov. 24-26, 2022, Bali, Indonesia
- Member of Technical Program Committee of the IEEE 9th International Conference on Communications and Electronics (ICCE 2022), July 27-29, 2022, Nha Trang City, Vietnam
- Member of Technical Program Committee of the 4th International Conference on Artificial Intelligence in Information and Communication (ICAIIC 2022), February 21-24, 2022, Guam, U.S.A and Cyberspace
- Member of Technical Program Committee of the 36th International Conference on Information Networking (ICOIN 2022), January 12-15, 2022, Thailand
- Member of Technical Program Committee of the Internet of Things and Intelligence Systems (IoTaIS'21), November 22-23, 2021, Cyberspace
- Member of Technical Program Committee of the 5th Symposium on Future Telecommunication Technologies (SOFTT'21), Dec. 6 – 7, 2021, Cyberspace (cert)

- **Member of Technical Program Committee of the IEEE Wireless Communications and Networking Conference (WCNC'22), April 10-13, 2022, Austin, TX**
- **Member of Technical Program Committee of the *2021 IEEE International Conference on Industry 4.0, Artificial Intelligence, and Communication Technology (IAICT'21)*, July 27-28, 2021, Indonesia**
- **Member of Technical Program Committee of the 2021 International Conference on Advanced Technologies for Communications (ATC'21), October 7 – 9, 2021, Ho Chi Minh City, Vietnam**
- **Member of Technical Program Committee of the 3rd International Conference on Artificial Intelligence in Information and Communication (ICAIIC'21), April 20 – 23, 2021, Jeju Island, S. Korea (CFP)**
- **Member of Technical Program Committee of IEEE Wireless Communications and Networking Conference (WCNC'21), March 29 – April 1, 2021, Nanjing, China**
- **Member of Technical Program Committee of the 2021 International Symposium on Electrical and Electronics Engineering (ISEE 2021), April 15–16, 2022, HCMUT, Ho Chi Minh City, Vietnam (CFP)**
- **Member of Technical Program Committee of the 2020 International Conference on Advanced Technologies for Communications (ATC-2020), October 8–10, 2020, Nha Trang, Vietnam**
- **Member of Technical Program Committee of the 2021 Asia Pacific Conference on Wireless and Mobile (APWiMob'21), April 8 – 10, 2021, Bandung, Indonesia (CFP)**
- **Member of Technical Program Committee of The 35th International Conference on Information Networking (ICOIN 2021), January 13 – 16, 2021, Jeju Island, Korea (CFP)**
- **Member of Technical Program Committee of 2019 International Symposium on Electrical and Electronics Engineering (ISEE2019), October 10–12, 2019, Ho Chi Minh City, Vietnam**
- **Member of Technical Program Committee of 8th International Conference on Advances in Computing, Communications and Informatics (ICACCI'19), December 18–21, 2019, Trivandrum, Kerala, India**
- **Member of Technical Program Committee of *IEEE ATC 2019,* International Conference on Advanced Technologies for Communications, Oct. 17–19, 2019, Hanoi, Vietnam**
- **Member of Technical Program Committee of *IAICT 2019,* International Conference on Artificial Intelligence and Communications Technology, July 1–3, 2019, Bali, Indonesia**
- **Member of Technical Program Committee of *IEEE IoTaIS 2019,* International Conference on Internet of Things and Intelligence Systems, Nov. 5–7, 2019, Bali, Indonesia**
- **Member of Technical Program Committee of *IEEE ICUFN 2019,* 11th International Conference on Ubiquitous and Future Networks, July 2–5, 2019, Zagreb, Croatia**
- **Member of Technical Program Committee of *IEEE* Wireless Communications and Networking Conference (WCNC), 15–19 April 2019, Marrakech, Morocco**
- **Member of Technical Program Committee of the *3rd International Conference on Circuits, System and Simulation (ICCSS 2019),* June 13–15, 2019, Nanjing, China**
- **Member of Technical Program Committee of *4th International Conference on Computer, Communication, and Control Technology*, 20 – 22 March 20-22, 2018, Krabi, Thailand**

- **Member of International Advisory Committee of the *IEEE ICUFN 2017, Eight International Conference on Ubiquitous and Future Networks 2017*, July 3 – July 7, 2017, Milan, Italy**
- **Member of Technical Program Committee of the *Second International Conference on Computing and Network Communications (CoCoNet'18)*, August 15-17, 2018, Astana, Kazakhstan**
- **Member of Technical Program Committee of the *IEEE Asia Pacific Conference on Wireless and Mobile (APWiMob 2016),* September 13-15, 2016, Bandung, West Java, Indonesia**
- ***Member of Technical Program Committee of the 22nd Asia-Pacific Conference on Communications (APCC 2016), August 25-27, 2016, Yogyakarta, Indonesia***
- **Member of Technical Program Committee of the *The Eighth International Conference on Ubiquitous and Future Networks (ICUFN 2016),* July 5-8, 2016, Vienna, Austria (CFP)**
- **Member of Technical Program Committee of the *4th International Conference on Connected Vehicles and Expo,* October 19-23, 2015, Shenzhen, China (CFP)**
- **Member of Technical Program Committee of the *6th International Conference on Data Communication Networking (DCNET 2015), July 20-22, 2015, Colmar, Alsace, France***
- **Member of Technical Program Committee of the *18th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM'15), November 2-6, 2015, Cancun, Mexico***
- ***Member of Technical Program Committee of IEEE International Conference on Advanced Technologies for Communications 2015 (ATC'15), October 14-16, 2015, Ho Chi Minh City, Vietnam (CFP)***
- **Member of the Technical Program Committee of *IEEE 2014 Globecom, Wireless Networks Track,* December 8-12, 2014, Austin, TX**
- **Member of the Technical Program Committee of the Workshop on *Security in Ad Hoc Networks (SecAN),* Benidorm, Spain, June 22-27, 2014 (CFP)**
- **Member of the Technical Program Committee of *IEEE Wireless Communications and Networking Conference, (WCNC'14) Track 3:NET,* Istanbul, Turkey, April 6-9, 2014**
- **Member of the Technical Program Committee of *IEEE 5th International Congress on Ultra Modern Telecommunications and Control Systems (ICUMT 2013),* Almaty, Kazakhstan, September 10-13, 2013**
- **Member of the Technical Program Committee of *IEEE IFIP Networking 2013 Conference,* Brooklyn, New York, May 22-24, 2013 (CFP)**
- **Member of the Technical Program Committee of *IEEE ICUFN 2013*, *Fifth International Conference on Ubiquitous and Future Networks 2013*, Da Nang, Vietnam, July 2-5, 2013 (CFP)**
- **Member of Technical Program Committee of *IEEE WCNC 2013,* Shanghai, China, April 7-10, 2013 (CFP)**
- **Member of Technical Program Committee of *IEEE PIMRC'12* (*23rd IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*), Sidney, Australia, September 9-12, 2012 (CFP)**
- **Member of the Technical Program Committee of ACM MSWiM 2012, Paphos, Cyprus Island, October 21-25, 2012 (CFP)**
- **Member of Technical Program Committee of ICUFN 2012 (The Fourth International Conference on Ubiquitous and Future Networks), Puket, Tailand, July 4-6, 2012 (CFP)**

- **Member of Technical Program Committee of IEEE WCNC 2012, Track 3 Mobile and Wireless, Paris, France, April 1-4, 2012**
- **Member of Technical Program Committee of IEEE ICUMT 2011, Budapest, Hungary, October 5-7, 2011**
- **Member of Technical Program Committee of the "*IEEE WCNC 2011, Network Track*," Cancun, Mexico, March 28-31, 2011**
- **Member of Technical Program Committee of the "*International Conference on ICT Convergence 2010 (ICTC 2010)*," Jeju, Jeju Island, South Korea, Nov. 17-19, 2010**
- **Member of the International Program Committee of the "*IASTED Asian Conference on Robotics and Control (AsiaRC 2010)*," November 24-26, 2010, Bangkok, Thailand**
- **Member of the International Program Committee of the "*IASTED International Conference on Robotics and Applications (RA 2010)*," November 1-3, 2010, Cambridge, MA**
- **Member of the Technical Program Committee of "*The 16th Asia-Pacific Conference on Communications (APCC 2010)*," October 31-Nov. 3, 2010, Auckland, New Zealand**
- **Member of the International Program Committee (IPC) of the "*IASTED International Conference on Wireless Communications (WC 2010)*," July 15 – 17, 2010, Banff, Alberta, Canada**
- **Member of Technical Program Committee of the "*IEEE Wireless Communication and Networking Conference (WCNC 2010),*" April 18-21, 2010, Sydney, Australia**
- **Member of the International Technical Committee of the "*IASTED International Conference on Robotics, Telematics and Applications (RTA 2009)*," October 12-14, 2009, Beijing, China**
- **Member of Technical Program Committee of the "*IEEE Vehicular Technology Conference (VTC'09/Fall),*" Anchorage, Alaska, September 20-23, 2009**
- **Member of Technical Program Committee of the "*IFIP Second Joint IFIP Wireless and Mobile Networking Conference (WMNC),*" Gdansk, Poland, Sept. 9-11, 2009**
- **Member of the International Program Committee of the "*IASTED International Conference on Robotics, Telematics and Applications (*RTA 2009)," October 12 – 14, 2009, Beijing, China (http://www.iasted.org/conferences/home-661.html)**
- **Member of the Technical Program Committee of the "*Fifth IEEE International Conference on Mobile Ad-hoc and Sensor Systems (IEEE MASS 2008)*," Atlanta, GA, October 6-9, 2008**
- **Member of the Technical Program Committee of the "*27th IEEE Conference on Computer Communications (INFOCOM 2008)*," Phoenix, AZ, April 13-19, 2008**
- **Chair, Technical Program Committee, "*Third IEEE International Conference on Mobile Ad Hoc and Sensor Systems (MASS 2006)*," Vancouver, Canada, October 9-12, 2006 (message from TPC chairs)**
- **Member of the Technical Program Committee of the "*Third International Conference on Broadband Communications, Networks, and Systems (BROADNETS 2006)*," San Jose, CA, October 1-5, 2006**
- **Member of the Technical Program Committee of the "*1st International Workshop on Decentralized Resource Sharing in Mobile Computing and Networking*," in conjunction with ACM MOBICOM 2006, Los Angeles, CA, September 25, 2006**
- **Member of the Technical Program Committee of the "*26th Annual IEEE Conference on Computer Communications (INFOCOM'07)*," Anchorage, Alaska, May 6-12, 2007**

- **Member of the Technical Program Committee of the "*IEEE VANET Workshop*, in conjunction with the *IEEE INFOCOM 2007* conference," May 6-12, 2007, Anchorage, AL**
- **Member of the Technical Program Committee of the "*Seventh ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc'06)*," Florence, Italy, May 22-25, 2006**
- **Member of the Technical Program Committee of "*MADNES'06*," Pythagorion, Samos, Greece, 2006**
- **Technical Program Committee member of the "*2006 IEEE International Conference on Networking, Sensing and Control*," Ft. Lauderdale, FL, April 23-25, 2006**
- **Member of the Technical Program Committee of "*International Workshop on Delay Tolerant Mobile Networks (DTMN)*," in conjunction with IWCMC 2006, Vancouver, Canada, July 3-6, 2006**
- **Member of the Technical Program Committee, "*The 16th Annual IEEE International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC 2005)*," International Congress Center (ICC), Berlin, Germany, September 11-14, 2005**
- **Member of the Technical Program Committee, "*1st International Workshop on Security, Privacy and Trust in Pervasive and Ubiquitous Computing (SecPerU'05),"* Santorini Island, Greece, July 14, 2005**
- **Member of the Technical Program Committee, "*The First International Workshop on Security, Privacy and Trust in Pervasive and Ubiquitous Computing (SecPerU 2005)*," Santorini Island, Greece, July 14, 2005**
- **Member of the Technical Program Committee, "*ACM MobiHoc 2005*," Urbana-Champaign, IL, May 24-28, 2005**
- **Member of the Technical Program Committee, "*MADNES'05*," Singapore, 2005**
- **Member of the Technical Program Committee, "*2004 ACM Workshop on Security of Ad Hoc and Sensor Networks (SASN 2004)*," October 25, 2004, Wyndham City Hotel, Washington DC**
- **Technical Program Committee member, "*First IEEE International Conference on Sensor and Ad hoc Communications and Networks (SECON 2004)*," October 4-7, 2004, Santa Clara, CA**
- **Technical Program Committee member of the "*Fourth Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom'98),*" Dallas, TX, October 25–30, 1998**
- **Technical Program Committee member of the *IEEE Multiaccess, Mobility and Teletraffic for Personal Communications* Workshop 1998, Washington, DC, October 21-23 , 1998**
- **Technical Program Committee member of the "*Fourth Mobile Multimedia Communications Workshop (MoMuC'98)*," Berlin, Germany, October 12-14, 1998**
- **Technical Program Committee member of the "*Ninth IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'98)*," Boston, MA, September 8-11, 1998**
- **Technical Program Committee member of the "*IEEE International Conference on Universal Personal Communications (ICUPC'98)*," Florence, Italy, October 5–9, 1998**
- **Technical Program Committee member of the "*Ninth IEEE Workshop on Local and Metropolitan Area Networks,"* Banff, Alberta, Canada, May 17–20, 1998**
- **Technical Program Committee member of the "*Workshop on Nomadic Computing*," Geneva, Switzerland, April 1-5, 1997**

- **Technical Program Committee member of "*MOBICOM'97*"**
- **Technical Program Committee member of "*IEEE INFOCOM'97*"**
- **Technical Program Committee member of "*The Seventh IFIP Conference on High Performance Networking (HPN'97)*"**
- **Technical Program Co-Chair of "*ACM MOBICOM'96*"**
- **Technical Program Committee member of "*The 3rd International Workshop on Mobile Multimedia Communications (MoMuc-3)*," Princeton, NJ, Sept. 25-27, 1996**
- **Technical Program Committee member of "*The 6th IFIP International Conference on High Performance Networking (HPN'95),*" Palma De Mallorca, Balearic Islands, Spain, September 11-15, 1995**
- **Technical Program Committee member of the "*IEEE MILCOM'95*" conference**
- **Technical Program Committee member of the "*IEEE PIMRC'95*" conference**
- **Technical Program Committee member of the "*IEEE Wireless Computer Networks'94*" conference**
- **Technical Program Committee member of the "*IEEE GLOBECOM'94,*" representing the *IEEE Personal Communication Committee***
- **Served on the Technical Program Committee of "*ACM SIGCOMM'93*"**
- **Technical Program Committee member of the *4th IFIP Conference on High Performance Networking,* Liège, Belgium, December 14-18, 1992**
- **Served on the Technical Program Committees of "*IEEE INFOCOM'90*", "*IEEE INFOCOM'91*", "*IEEE INFOCOM'92*", "*IEEE INFOCOM '93*", and "*IEEE INFOCOM '94*"**

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