

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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AT&T MOBILITY LLC, AT&T SERVICES INC., ERICSSON INC.,  
NOKIA OF AMERICA CORPORATION, AND T-MOBILE USA, INC.,  
PETITIONERS,

v.

DAINGEAN TECHNOLOGIES LTD.,  
PATENT OWNER.

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CASE IPR2024-00510  
PATENT 10,484,976

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DECLARATION OF DR. KARTHIKEYAN SUNDARESAN

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**CURRENT EXHIBIT LIST**

| <b>No.</b> | <b>Brief Description</b>                                                                                                                                                                                                                                                                                                                             |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1001       | U.S. Patent No. 10,484,976 (“’976 Patent”)                                                                                                                                                                                                                                                                                                           |
| 1002       | File History for ’976 Patent                                                                                                                                                                                                                                                                                                                         |
| 1003       | Provisional Patent Application No. 62/443,464                                                                                                                                                                                                                                                                                                        |
| 1004       | Expert Declaration of Dr. Mark Mahon                                                                                                                                                                                                                                                                                                                 |
| 1005       | Curriculum Vitae of Dr. Mark Mahon                                                                                                                                                                                                                                                                                                                   |
| 1006       | U.S. Patent No. 10,959,218 (“Babaei”)                                                                                                                                                                                                                                                                                                                |
| 1007       | Provisional Patent Application No. 62/421,821 (“Babaei Provisional”)                                                                                                                                                                                                                                                                                 |
| 1008       | International Publication No. WO 2016/130175 A1 (“Fwu”)                                                                                                                                                                                                                                                                                              |
| 1009       | U.S. Patent Pub. No. 2018/0035332 (“Agiwal”)                                                                                                                                                                                                                                                                                                         |
| 1010       | Provisional Patent Application No. 62/368,369 (“Agiwal Provisional”)                                                                                                                                                                                                                                                                                 |
| 1011       | U.S. Patent No. 10,869,331 (“Lee”)                                                                                                                                                                                                                                                                                                                   |
| 1012       | International Publication No. WO 2017/171526 A1 (“Lee PCT Publication”)                                                                                                                                                                                                                                                                              |
| 1013       | Certified translation of Lee PCT Publication                                                                                                                                                                                                                                                                                                         |
| 1014       | Provisional Patent Application No. 62/403,061 (“Lee Provisional”)                                                                                                                                                                                                                                                                                    |
| 1015       | Certified translation of Lee Provisional                                                                                                                                                                                                                                                                                                             |
| 2001       | Declaration of Mr. Michael McBride in Support of Patent Owner’s Motion for Admission <i>Pro Hac Vice</i> of Michael McBride                                                                                                                                                                                                                          |
| 2002       | Expert Declaration of Dr. Karthikeyan Sundaresan                                                                                                                                                                                                                                                                                                     |
| 2003       | PCT/US18/12039 Application (filed Jan. 2, 2018) (published July 12, 2018 as PCT Publication No. WO2018 128970A1), <i>available at</i> <a href="https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2018128970">https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2018128970</a> (navigate to Documents then Application Body as Filed) |
| 2004       | U.S. Patent No. 11,778,633 to Liu <i>et al.</i> (claiming priority to CN 2017 10459498.1 Jun. 16, 2017)                                                                                                                                                                                                                                              |
| 2005       | ETSI TS 136 212 V13.6.0 (2017-07), ETSI Technical Specification, LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding (3GPP TS 36.212 version 13.6.0 Release 13)                                                                                                                                                |
| 2006       | U.S. Patent Publication No. 2022 0312395 A1 to Li <i>et al.</i> (claiming priority to provisional application no. 62/556,070 filed on Sept. 8, 2017)                                                                                                                                                                                                 |

## I. INTRODUCTION<sup>1</sup>

¶1. My name is Dr. Karthikeyan Sundaresan. I have been retained by Daingean Technologies Ltd. (“Patent Owner” or “DTL”) to provide my expert assessment and technical opinions in connection with the above captioned inter partes review (“IPR”) of U.S. Patent No. Patent 10,484,976 (“’976 Patent” or “Patent-at-Issue”), Ex. 1001.

¶2. Specifically, have been asked to provide my opinion regarding specific aspects of the how a person of ordinary skill in the art (“POSITA”) would understand certain teachings and aspects of the references Petitioners put forth vis-à-vis the Patent-at-Issue.

¶3. This declaration is based on information currently available to me. I reserve the right to expand, modify, or supplement my opinions if I become aware of evidence or information that was not available for review at the time I drafted this declaration.

¶4. DTL is paying me at a rate of \$450 per hour plus expenses for my study and testimony in this case. This compensation is not contingent upon my performance, the outcome of this IPR, or any issues involved in or related to this IPR.

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<sup>1</sup> All emphasis is added in this report unless otherwise noted.

## II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

¶5. I have attached my curriculum vitae (“CV”) as Appendix A to this declaration. My CV includes a list of publications on which I am an author. It contains further details regarding my experience, education, and other qualifications. Nonetheless, I now expound upon my qualifications and professional background related to the field of wireless communications, and particularly to methods and apparatus for requesting, transmitting, and using system information in wireless communications.

¶6. I am a Professor in the School of ECE, Georgia Tech. Prior to that, I spent fifteen years in wireless and telecom research at NEC Labs America, Princeton.

¶7. My research interests are broadly in wireless networking and mobile computing, and span both algorithm design as well as system prototyping.

¶8. I am the recipient of ACM Sigmobile’s Rockstar award (2016) for my contributions to mobile computing and wireless networking. I have also received several best paper awards at prestigious ACM and IEEE conferences. I also received a business contribution award for bringing research technology to commercialization at NEC.

¶9. I led the spin-out efforts of two innovative research technologies (NavigateIO Inc. and Wirinos Inc.) for infrastructure-free tracking of first responders in GPS-denied environments and sustainable product tracking in supply chains.

¶10. I have participated in various organizational and editorial roles for IEEE and ACM conferences and journals, and served as the program committee co-chair for ACM MobiCom'16. I am a Fellow of the National Academy of Inventors, Fellow of the IEEE, and an ACM distinguished member.

¶11. I am listed as an inventor/co-inventor on many patents and patent applications. The following list reflects some that are related to requesting, transmitting, and using system information in wireless communications.

| Number    | Title                                                                                                | Filed     |
|-----------|------------------------------------------------------------------------------------------------------|-----------|
| 8,098,609 | Integrated scheduling of unicast and multicast traffic in relay-enabled wireless networks            | 2/9/2009  |
| 8,134,946 | System and method for scheduling in relay-assisted wireless networks                                 | 6/27/2008 |
| 8,310,975 | Optimal beam scheduling for multicasting in wireless networks                                        | 1/22/2010 |
| 8,340,584 | Systems and methods for adaptive beamforming in indoor wireless networks                             | 2/9/2009  |
| 8,380,133 | Beamforming methods and systems employing measured power at a receiver to perform channel estimation | 3/16/2010 |
| 8,519,888 | Wireless multicasting with beamforming antennas                                                      | 3/11/2011 |
| 8,537,738 | Method and a system of video multicast scheduling                                                    | 11/2/2011 |
| 8,537,928 | Channel estimation methods and systems based on power measurement at receivers                       | 10/8/2010 |

| Number     | Title                                                                                                                                                                                                             | Filed      |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 8,767,580  | Femtocell resource management for interference mitigation                                                                                                                                                         | 2/29/2012  |
| 8,780,849  | Methods and systems for allocation of macro cell resources in a distributed femto cell network and a distributed relay station network                                                                            | 10/12/2012 |
| 8,837,332  | Method for a canceling self-interference signal using passive noise cancellation for full-duplex simultaneous (in time) and overlapping (in space) wireless transmission and reception on the same frequency band | 12/13/2011 |
| 8,891,604  | Coordinated multi-point transmission                                                                                                                                                                              | 9/27/2012  |
| 8,923,907  | Scalable network MIMO for wireless networks                                                                                                                                                                       | 1/31/2013  |
| 8,976,696  | Methods and systems for integrating batch scheduling with external beamforming                                                                                                                                    | 11/14/2012 |
| 9,066,351  | Tailoring wireless transmission strategies to user profiles                                                                                                                                                       | 7/19/2013  |
| 9,125,047  | Cloud-based radio access network for small cells                                                                                                                                                                  | 7/25/2013  |
| 9,137,788  | Multiple-input multiple-output wireless communications with full duplex radios                                                                                                                                    | 8/17/2012  |
| 9,337,966  | Carrier aggregation                                                                                                                                                                                               | 7/19/2013  |
| 9,537,587  | Efficient large-scale multiple input multiple output communications                                                                                                                                               | 6/12/2015  |
| 9,654,174  | Method and apparatus for managing a power line communication network in multi-flow environments                                                                                                                   | 9/4/2015   |
| 9,723,566  | Interference cancellation                                                                                                                                                                                         | 8/5/2015   |
| 9,813,944  | System and method for dynamic provisioning of Wi-Fi capacity in large venues using C-RAN architecture                                                                                                             | 12/20/2016 |
| 9,936,414  | Enabling long-term-evolution/Wi-Fi coexistence                                                                                                                                                                    | 9/20/2016  |
| 9,967,860  | Efficient network-wide broadcasting over LTE networks                                                                                                                                                             | 3/10/2016  |
| 10,021,172 | Software driven long-term-evolution core network for mobile access                                                                                                                                                | 9/23/2016  |
| 10,122,547 | Enabling high-bandwidth, responsive mobile applications in LTE networks                                                                                                                                           | 8/15/2016  |
| 10,292,054 | Enabling technologies for LTE on unlicensed spectrum                                                                                                                                                              | 2/1/2017   |

| Number      | Title                                                                                                                | Filed      |
|-------------|----------------------------------------------------------------------------------------------------------------------|------------|
| 10,405,373  | Distributed core architecture for implementing wireless communication networks                                       | 7/17/2018  |
| 10,410,025  | Product checkout and interest detection in retail environment using radio-frequency identification                   | 4/16/2018  |
| 10,469,188  | System and method for enabling interference-awareness for LTE operation in unlicensed spectrum                       | 7/19/2018  |
| 10,582,529  | Speculative scheduling in mobile networks                                                                            | 3/8/2018   |
| 10,616,880  | Signaling for coordinated multi-point transmission and reception (CoMP)                                              | 12/29/2017 |
| 11,054,843  | Self-configuring long term evolution radio access network on unmanned autonomous vehicles                            | 3/1/2019   |
| 11,356,172  | Unmanned aerial vehicle network                                                                                      | 3/12/2020  |
| 11,388,564  | Infrastructure-free RF tracking in dynamic indoor environments                                                       | 8/21/2020  |
| 11,595,934  | Infrastructure-free tracking and response                                                                            | 3/26/2021  |
| 2009 135777 | High performance scheduling methods and apparatus for leveraging diversity in relay-enabled wireless networks        | 11/24/2008 |
| 2009 310783 | Controlled Dissemination of Information in Mobile Networks                                                           | 2/17/2009  |
| 2010 046414 | Systems and methods for leveraging spatial reuse in OFDMA relay networks                                             | 2/18/2009  |
| 2010 054143 | Uplink connectivity for mobile clients                                                                               | 7/9/2009   |
| 2011 199913 | Multicast scheduling systems and methods for leveraging cooperation gains in relay networks                          | 10/18/2010 |
| 2012 026932 | High Performance and Low Complexity Scheduling Method for Adaptive Resource Usage in OFDMA Wireless Relay Networks   | 7/28/2011  |
| 2012 322454 | Resource management framework for distributed OFDMA femtocell networks                                               | 6/13/2012  |
| 2015 023248 | Multi-user multiple input multiple output (MIMO) communication with distributed antenna systems in wireless networks | 7/16/2014  |
| 2015 029904 | Enabling full-duplex communication in legacy LTE systems                                                             | 7/17/2014  |

| Number       | Title                                                                                         | Filed      |
|--------------|-----------------------------------------------------------------------------------------------|------------|
| 2015 029908  | Resource Management with Device-Device Communication in Next Generation Cellular Networks     | 7/24/2014  |
| 2015 117370  | Coordinated Multi-Point Transmission and Reception (CoMP) with Non-Ideal Backhaul (NIB)       | 10/30/2014 |
| 2015 163716  | Intelligent Wi-Fi-offloading for next-generation mobile networks                              | 12/9/2014  |
| 2015 281978  | Multicell beamforming system and methods for OFDMA small-cell networks                        | 3/31/2014  |
| 2015 372743  | Interference alignment in a network with asymmetrical channel dimensions                      | 6/17/2015  |
| 2016 269941  | Asynchronous access and synchronous transmission for coexistence of wireless standards        | 3/1/2016   |
| 2017 126798  | Design of randomization function and its application in load balancing                        | 11/1/2016  |
| 2018 270690  | Blue-printing interference for LTE access in unlicensed spectrum                              | 3/8/2018   |
| 2019 036786  | Interference topology inference to enhance performance of LTE unlicensed networks             | 7/24/2018  |
| 2021 294993  | Reading passive wireless tags using commodity devices                                         | 3/16/2021  |
| 2022 381870  | Visual and RF sensor fusion for multi-agent tracking                                          | 5/26/2022  |
| 2023 345207  | Realizing Enterprise-Grade Localization Using Wi-Fi 802.11mc Fine Tune Measurement            | 3/13/2023  |
| AU2018203448 | Signaling for coordinated multi-point transmission and reception (CoMP)                       | 5/16/2018  |
| EP3175562    | Scaling wireless full duplex in multi-cell networks with spatial interference alignment       | 7/29/2015  |
| JP20082891A  | Method for scheduling heterogeneous traffic in b3g/4g cellular network with multiple channels | 3/7/2008   |
| WO2016145137 | Scaling the LTE control plane for future mobile access                                        | 3/10/2016  |

### III. RELEVANT TIME

¶12. I have been asked to assume that the Patent-at-Issue has an effective priority date of January 6, 2017 (“Effective Priority Date”). I am aware that the Petitioner has argued that the ’976 Patent has an effective priority date of January 3, 2018. Pet. 7. None of my opinions in this declaration would change based on the Patent-at-Issue having an effective priority of either date.

¶13. To the extent that I cite to exhibits created or published after the Effective Priority Date, I consider that the reference is still relevant to what a POSITA would have understood the point for which I cite the reference at or around the time of the invention.

### IV. LEVEL OF ORDINARY SKILL IN THE ART

¶14. I understand that Petitioners have proposed that a person of ordinary skill in the art (“POSITA”) for the ’976 Patent “would have had a B.S. in Electrical Engineering or a related field with at least three years of experience designing, developing, and/or testing telecommunication systems” and “familiarity with the wireless standards and protocols related to data transmission and network management.” Pet. 5 (citing Mahon Dec’l ¶¶34–39). Petitioners view is also that more education may supplement practical experience or *vice versa*. *Id.*

¶15. I understand that Patent Owner generally concurs with Petitioner description, with the caveat that the experience would be two years and the relevant

field is, as noted in the '976 Patent, the “TECHNICAL FIELD” concerning “communication systems . . . specifically . . . new signaling, procedures, user equipment (UE) and base stations for uplink ultra-reliable low latency communications (URLLC).” *See* Ex. 1001 1:19–22.

¶16. I have considered both proposals, and my analysis would not change under either.

¶17. It is my opinion that I would at least qualify as a person of ordinary skill in the art at the relevant time under any of the above descriptions, and that I exceed this level of knowledge, experience, and education so that I am qualified to provide an expert opinion in this proceeding.

¶18. I have approached my analysis from the perspective of a POSITA as of the Effective Priority Date. To the extent that I cite documents that were created after the Effective Priority Date, I have considered that their teachings are still instructive.

## **V. MATERIALS CONSIDERED**

¶19. In forming my opinions expressed herein, I have considered the items listed in the Current Exhibit list found beginning on page ii and the Petition.

**VI. ISSUES CONCERNING PETITIONERS USE OF U.S. PATENT NO. 10,959,218 (“BABAEI”)****A. A Base Station Generally Uses CSI Request to Trigger an Aperiodic CSI Report from a Particular UE**

¶20. A base station can configure the UEs for reporting CSI that is measured on reference signals, which are also configured by the BS. When configuring the UEs for CSI reporting through RRC, a BS can determine if it needs the UEs to report CSI periodically or based on a trigger (aperiodic). Configuring the periodic CSI reporting can be done at the start of the session through an RRC command, while aperiodic reporting is triggered by the BS on-demand every time a report is needed. Both options are available in the standard to allow the BS to balance the utility of CSI against the overhead of reporting. For example, periodic CSI reporting for a UE that does not have much traffic is a waste of precious BS spectrum resources, where an aperiodic, on-demand CSI reporting is beneficial only when there is traffic to the UE. On the other hand, for a UE with continuous traffic, using a trigger-based CSI report, would be inefficient and increase the overhead with the BS having to send repeated triggers in its downlink transmissions.

¶21. When triggering a UE to send aperiodic CSI report, this is accomplished by the BS setting the “CSI request” field in its DCI element transmitted on the downlink control channel to non-zero. Further DCI format 0 is used for transmitting this trigger for the aperiodic CSI report.

**B. The DCI Format 0 Restrictions That the “2-bit” or “3-bit” CSI Request Field Must Be Mapped onto the UE Specific Search Space Given by the C-RNTI Comes from ETSI TS 136 212 V13.6.0**

¶22. Petitioners cite to Babaei’s discussion of the DCI Format 0’s channel state information (“CSI” ) request field, Pet. 33-34 (citing Ex. 1006 14:52–15:04 (“[T]he fields for DCI format 0 may comprise . . . [a] CSI request e.g. 1, 2 or 3 bits.”)), as “suggest[ing] that the DCI format 0 used for scheduling could be sent in the common rather than UE-specific search space.” The use for this DCI format 0 and its CSI request field is explicitly defined in the standard specified in Ex. 2005 at pages 2 to 3. It clearly indicates that the 2-bit of the CSI request field in DCI format 0 is to be used for UEs that are configured with no more than 5 downlink cells when requesting their aperiodic CSI report. Similarly, the 3-bit field is to be used for UEs that are configured with more than 5 downlink cells. This is also in agreement with the Babaei reference that petitioners rely upon [Ex 1006 14:50-15:31]. In both these cases, the DCI format 0 is addressed to a specific UE and is transmitted in the UE-specific search space, contrary to Petitioners’ view to use it to transmit it in the common search space. Again, as previously explained, a DCI format 0 with the CSI request field is used to trigger an aperiodic CSI report, which means that it is specific to a UE and is not common to multiple UEs and hence needs to be addressed to a specific UE. Hence, it is obvious why a DCI format 0 transmission with CSI request field set needs to be sent on a UE-specific search space.

**C. Having Different UEs Share a SPS C-RNTI, Where an SPS-ConfigIndex Determines to which UE the SPS C-RNTI Is Addressed, Increases the Processing or Power Any UE Spends to Decode a Shared SPS C-RNTI**

¶23. Configurations regarding operations, transmissions, etc. are indicated by the BS to the UEs through DCI elements in the downlink control channel. A DCI element can be transmitted in the common search space or in a UE-specific search space depending on the format used. Irrespective of where the element is transmitted, every UE will have to decode the element to obtain the desired information. Hence, transmitting a DCI element in a common search space, where multiple UEs can access it, does not reduce the processing burden of any of the UEs, where each of them still has to individually decode the DCI element. On the contrary, as I describe next, it can increase the processing burden for the UEs compared to transmitting on the UE-specific search space.

¶24. Petitioners suggest a modification to the references such that the SPS-ConfigIndex bits will be used to address the UEs and the DCI control element will be transmitted in the common search space of the downlink control channel. This is problematic for two reasons. First, with USS, a UE only needs to determine if the CRC scrambling produces a valid result. With CSS, in addition to de-scrambling the CRC bits using the common, shared SPS RNTI, each of the UEs will need to decode the SPS-ConfigIndex bits to determine if the DCI element is being addressed

to them. This additional decoding incurs more processing for the UE that is not experienced if transmitted in the UE-specific search space.

¶25. Second, decoding elements from the common search space (CSS) is less efficient compared to the user-specific search space (USS). DCIs in CSS are meant for common information and require blind decoding over a large resource region to accommodate several common information to UEs. A UE will have to decode all the resources in the CSS using each specific RNTI corresponding to information it is interested in, to locate and decode where information relevant to it is encoded. This is unlike USS, where the UE knows which specific set of resources have been allocated to its USS and hence to consider for decoding (non-blind). USS decoding saves on time and processing complexity for the UE. Given the additional overhead from using the USS, a POSITA would not be motivated to place it in the CSS.

**D. UEs Sharing a SPS RNTI Removes the Security Gained from Scrambling the DCI Format CRC Bits**

¶26. DCI elements carrying information common to multiple UEs (e.g. cell-specific configuration parameters) are placed in the CSS through a DCI element, whose CRC bits are scrambled with a shared RNTI for use by multiple UEs. Since a CSS carries multiple such common information and UEs are not aware of where different elements are placed, each UE needs to blindly decode the CSS looking for the various elements using shared RNTIs specific to those elements. By the very

nature of CSS and the common process used by UEs to decode common information using shared RNTIs from CSS, security is not the primary focus for information placed in CSS. In contrast, UE-specific information carried in the USS, are scrambled with a UE-specific RNTI, restricting information access to un-intended UEs. Placing UE-specific information in CSS and sharing the corresponding RNTI with multiple UEs, will allow other un-intended UEs access to the desired UE's information, removing the security guards available when placing information in the USS and leads to a security concern.

## **VII. ISSUES CONCERNING PETITIONERS USE OF U.S. PATENT PUB. NO. 2018/0035332 (“AGIWAL”)**

### **A. UEs Must Expend Processing Resources and Power to Send Skip Confirmations**

¶27. Petitioners propose a new Skip confirmation element that will be sent by the UE, in response to a Skip command from the BS that is used in Agiwal [Ex. 1009]. Pet. 56–61. They posit that such a Skip confirmation element can address the limitation of MAC confirmation elements taught by the '976 Patent. A POSITA would not be motivated to redesign Agiwal and combine it with Babaei in the manner articulated by the petitioners since it runs into two major problems. First, skip commands are used in Agiwal for BS to reallocate uplink resources to a different UE that needs to send URLLC data on the uplink. Since these resources are being re-allocated from another UE(s), the BS needs to instruct those a priori

allocated UE(s) to skip their uplink transmission in those resources, which have now been allocated to a different UE. Expecting the UE(s) that relinquished the previously-allocated resources to send a confirmation back to the BS for the same, requires those UEs to spend additional processing resources and power to construct the Skip confirmation element message as well as transmit it back to the BS.

**B. A Base Station Cannot Wait for Skip Confirmations with URLLC**

¶28. Second, the added complication that is not resolved by such a Skip confirmation option it is unclear what that BS should do when these confirmation element transmissions get lost, and/or the UE(s) decide not to relinquish their prior allocation. This will lead to collisions of uplink transmissions and affect the success of the URLLC transmission, for whom the BS's Skip transmission was designed in the first place in Agiwal. The reason for these complications is clear. Agiwal is not intended to be used in the manner argued by the Petitioners. Indeed, it never teaches a Skip confirmation element, and Agiwal's teachings make it clear why such an option, as envisioned by the petitioners, would be detrimental. The Skip command by the BS taught by Agiwal is primarily to help a UE with a stringent QoS (e.g. URLLC) traffic get an opportunity to transmit quickly on the uplink at the expense of less stringent QoS (e.g. eMBB) traffic by reallocating resources. Agiwal explicitly teaches that Skip command is sent in the preceding frame N+3 for the immediately next frame N+4 URLLC transmission [Ex. 1009 [0061]]. Agiwal also teaches that

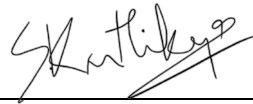
the schedule of the URLLC transmission N2 is equal or prior to the Skip instruction transmission N3,  $N3 \geq N2$  [Ex. 1009 [0064-0066, 0071]]. This clearly teaches that the Skip instruction is meant to serve as a command rather than an option that needs confirmation from the UEs, who are allocated resources that have been repurposed to the URLLC UE. Notwithstanding the problems identified in sending a Skip confirmation, even if the UEs want to send a confirmation, there is not sufficient time for such a confirmation to be useful at the BS, since it would arrive after the expiry of the desired transmission, and the BS cannot use such confirmation since it has already scheduled the URLLC traffic before sending the Skip command. Hence, sending a Skip confirmation would not serve any utility. A POSITA would thus clearly understand from Agiwal that a Skip element from the BS is meant to serve as a command without confirmations for it to be useful in preempting resources successfully for URLLC traffic.

## VIII. DECLARATION

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

¶30. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. Further, these statements are made with the knowledge that willful false statements are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and may jeopardize the validity of the Patent-at-Issue.

Executed on May 15, 2024, at Suwanee, GA.



Dr. Karthikeyan Sundaresan

**APPENDIX A (RESUME)**

**KARTHIKEYAN (KARTHIK) SUNDARESAN**

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|                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
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| <b>Education</b>                                                          | <ul style="list-style-type: none"> <li>Georgia Institute of Technology, USA - Ph.D (ECE), 2006; M.S (ECE), 2003</li> <li>Anna University, India - B.S. (Electronics and Communications), 2001</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| <b>Professional Experience</b>                                            | <table> <tr> <td>Professor<br/>School of ECE, Georgia Institute of Technology, Atlanta, USA</td><td>Oct 2021 – Present</td></tr> <tr> <td>Co-founder, CTO<br/>NavigateIO Inc.</td><td>Apr 2022 – Present</td></tr> <tr> <td>Senior Researcher<br/>NEC Labs America, Princeton NJ, USA</td><td>Aug 2006 – Sep 2021</td></tr> <tr> <td>Research Assistant<br/>Georgia Tech, Atlanta, USA</td><td>Aug 2001 – July 2006</td></tr> <tr> <td>Research Intern<br/>Intel Research, Cambridge, UK</td><td>Jan 2006 – Mar 2006</td></tr> <tr> <td>Research Intern<br/>Los Alamos National Lab, Los Alamos, USA</td><td>May 2005 – Aug 2005</td></tr> <tr> <td>Research Fellow<br/>AU-KBC Research Center, Chennai, India</td><td>May 2001 – Jul 2001</td></tr> </table>                                                                                                                                                                                       | Professor<br>School of ECE, Georgia Institute of Technology, Atlanta, USA | Oct 2021 – Present | Co-founder, CTO<br>NavigateIO Inc. | Apr 2022 – Present | Senior Researcher<br>NEC Labs America, Princeton NJ, USA | Aug 2006 – Sep 2021 | Research Assistant<br>Georgia Tech, Atlanta, USA | Aug 2001 – July 2006 | Research Intern<br>Intel Research, Cambridge, UK | Jan 2006 – Mar 2006 | Research Intern<br>Los Alamos National Lab, Los Alamos, USA | May 2005 – Aug 2005 | Research Fellow<br>AU-KBC Research Center, Chennai, India | May 2001 – Jul 2001 |
| Professor<br>School of ECE, Georgia Institute of Technology, Atlanta, USA | Oct 2021 – Present                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| Co-founder, CTO<br>NavigateIO Inc.                                        | Apr 2022 – Present                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| Senior Researcher<br>NEC Labs America, Princeton NJ, USA                  | Aug 2006 – Sep 2021                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| Research Assistant<br>Georgia Tech, Atlanta, USA                          | Aug 2001 – July 2006                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| Research Intern<br>Intel Research, Cambridge, UK                          | Jan 2006 – Mar 2006                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| Research Intern<br>Los Alamos National Lab, Los Alamos, USA               | May 2005 – Aug 2005                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| Research Fellow<br>AU-KBC Research Center, Chennai, India                 | May 2001 – Jul 2001                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |
| <b>Awards/Honors</b>                                                      | <b>Professional/Academic</b> <ul style="list-style-type: none"> <li>IEEE Fellow, 2020 for contributions to algorithms for mobile networking and computing</li> <li>ACM Distinguished Member, 2018 for outstanding scientific contributions to computing.</li> <li>Association for Computing Machinery (ACM) SIGMOBILE Rockstar Award, 2016 – for early-career contributions to wireless connectivity (<a href="#">Citation</a>).</li> <li>Business Contribution Award for LTE Small-cell Technology Commercialization, NEC 2015.</li> <li>University Gold Medal; ranking FIRST in academic performance, School of ECE, Anna University, Aug. 2001.</li> <li>Ramanujan Centennial Gold Medal for ranking FIRST in Mathematics courses across all disciplines during the four year under-graduate tenure, Anna University, Aug. 2001.</li> <li>Alumni Association's Best Outgoing Student Award, School of ECE, Anna University, Aug 2001.</li> </ul> |                                                                           |                    |                                    |                    |                                                          |                     |                                                  |                      |                                                  |                     |                                                             |                     |                                                           |                     |

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#### Research

- Best Paper Award: "Is WiFi 802.11mc FTM Ready for Prime-time Deployment?", ACM Workshop on Wireless Network Testbeds, Experimental Evaluation and Characterization, Oct 2022.
- Best Paper Award: "SkyCore: Moving Core to the Edge for Untethered and Reliable UAV-based LTE Networks", ACM International Conference on Mobile Networking and Computing (MobiCom), Oct 2018.
- Best Paper Finalist: "BLU: Blue-printing Interference for Robust LTE Access in Unlicensed Spectrum", ACM International Conference on Emerging Networking Experiments and Technologies (CoNEXT), Dec 2017.
- Best Paper Award: "MIDAS: Empowering 802.11ac Networks through Multiple-input Distributed Antenna Systems", ACM International Conference on Emerging Networking Experiments and Technologies (CoNEXT), Dec 2014.
- Best Paper Award: "On Exploiting Diversity and Spatial Reuse in Relay-enabled Wireless Networks", in ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc), May 2008.
- Best Paper Award: "Routing in Ad-Hoc Networks with MIMO Links", in IEEE International Conference on Network Protocols (ICNP), Nov 2005.
- Best Paper Award: "Practical Limits on Achievable Energy Improvements and Useable Delay Tolerance in Correlation Aware Data Gathering in Wireless Sensor Networks", in IEEE International Conference on Sensing, Communication and Networking (SECON), Sept. 2005.

#### Dissertations

- Sigma Xi Best Doctoral Thesis Award, Georgia Institute of Technology, USA, Apr. 2007. Thesis title: "Network Protocols for Ad-hoc Networks with Smart Antennas"
- Sigma Xi Best Master's Thesis Award, Georgia Institute of Technology, USA, Apr. 2004. Thesis title: "MAC Protocols for Ad-hoc Networks with Switched Beam Antennas"
- Alumni Association's Best Undergraduate Thesis Award, Anna University, INDIA, Aug. 2001. Thesis title: "Energy Allocation and Multiple Access for Multi-carrier Communication"

#### Commercialization/ Start-up

My work has also focused on translating research to high impact commercialization and technology transfer activities.

- NavigatelO: Infrastructure-free Tracking of First Responders in Dynamic GPS-denied Indoor Environments  
Led its productization through NECx and Alchemist start-up accelerator programs. Successfully raised seed funding; ran numerous proof-of-concept trials with first responders since 2019; co-founder and chief technical advisor of NavigatelO Inc.
- FERMI: Self-Organizing Network Solution for Interference Management in Heterogeneous LTE Networks  
Technology-transferred to NEC business units for commercialization through LTE small cell base stations, 2015. Received business award for commercialization.

#### Technical/Industry Experience

• Leading end-to-end R&D visions and groups targeting challenging problems in the wireless (networking, sensing, embedded and autonomous systems) space:

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identifying the key problems, coming up with technically (algorithmically) sound solutions, translating solutions to real-world systems

- Leading and mentoring a team of researchers in accomplishing challenging R&D projects, as well as numerous Ph.D students and contributing to their thesis
- Translating research ideas to commercialization: deploying research prototypes in real-world, continuous iteration of solution (towards productization) based on user feedback
- Taking research solutions through start-up incubation and accelerator programs

## Work Experience

Professor, School of ECE, Georgia Tech, Atlanta GA — Oct 2021 - Present

Director, MARGA (Mobile Advanced Research Lab at Georgia Tech) Lab

Leading a highly motivated group of graduate students on cutting-edge problems in mobile and wireless networks, sensing and computing.

PI on grant proposals (awarded):

- “ARMIN: Autonomous, Resilient Mobility Inverted Networks”, OUSD, Co-PI.
- “Adaptive 5G Core Network”, Strategic Initiative Proposal, Georgia Tech Research Institute (GTRI), Co-PI.
- “Seamless Coexistence of Positioning and Communications in 5G and Beyond Wireless Systems”, Sole PI, NSF.

Co-founder and Chief Technology Officer, NavigatelO Inc. — 2022 - Present

Inventor of an infrastructure-free, real-time, wireless tracking solution for challenging, GPS-denied indoor environments. Led the research solution from NEC labs through start-up incubation and co-founded the start-up. Numerous successful PoCs with first responder departments across the country, and federal grant recipient for the same.

Senior Researcher, NEC Labs America, Princeton NJ — 2006 - 2021

Led several challenging research projects in the Mobile Communications and Networking department. Recent research thrusts have been along three directions: (1) Confluence of 5G Networks and Autonomous Systems — exploring an alternate, paradigm of rapidly-deployable, on-demand, self-configurable mobile networks that can be hosted and driven by future, pervasive autonomous platforms (UAVs and AGVs). (2) Ultra Low Power Sensing — aims to remove several of the critical barriers in enabling future on-body healthcare applications, by leveraging wireless backscattering to design novel, ultra low power (micro-W) wireless tags with significantly enhanced deployment, communication and sensing capabilities. (3) Tracking in Resource-constrained Environments — rethinking wireless localization and tracking solutions for practical applications like first responder (zero infrastructure support) situations, or massive scale (low-cost, low-power beacons) inventory tracking in warehouses that inherently operate in resource-constrained regimes.

Prior to these, earlier research thrusts have targeted: (i) wireless connectivity: pushed the performance envelope across multiple dimensions (capacity, latency, density, heterogeneity, user experience, availability) through novel network-level as well cross-layer (PHY+MAC) solutions. (ii) software-defined mobile computing: bringing software-defined computing and mobile connectivity together to enable demanding future

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applications ranging from massive scale Internet of Things (IoT) to high-bandwidth, low-latency Continuous Mobile Vision (eg. augmented/virtual reality), over mobile networks.

In addition to numerous publications and patents, work has received recognition through numerous awards both from company (for commercialization, startup incubation), as well as the broader research community (IEEE Fellow, ACM distinguished member, ACM early career award, and numerous best paper awards).

More information available at: <https://sites.google.com/view/karthik-s/home/research-latest>; some demos at: <https://sites.google.com/view/karthik-s/home/research/demos>.

Research Assistant, Georgia Tech, Atlanta GA — 2001 - 2006

Graduate research in the [GNAN](#) research group: focused on designing efficient network protocols for wireless networks that leveraged various forms of smart antennas. While advanced antenna technologies like MIMO were becoming popular at the physical layer (on isolated links), it was unclear how they can be effectively leveraged at higher layers of the protocol stack to deliver value to the network as a whole and to end applications. My thesis pushed the boundaries in this direction, and made significant advances in the design of algorithmically-sound solutions for leveraging such smart antennas in the network. My masters and doctoral theses received the best thesis awards at GaTech.

Research Intern, Intel Research, Cambridge UK, Jan – Mar 2006

Designed and implemented algorithms for self-organizing wireless LANs. The algorithms leveraged several cross layer parameters such as load, average contention duration, etc. that were measured at the firmware and instrumented for access at the driver. The algorithms were implemented in the device driver and tested in Intel's wireless LAN access points & client devices. This work was published in ACM IMC 2006.

Research Intern, Los Alamos National Lab, Los Alamos NM, May - Aug 2005

Investigated the problem of communication in multi-hop wireless networks with smart antennas from a combinatorial perspective in the discrete simulation science division. This involved the design of efficient centralized as well as purely localized algorithms with performance guarantees to help nodes determine the optimal usage of available degrees of freedom to improve network utilization; and resulted in a publication in ACM MobiHoc 2006. I also designed and implemented MAC protocols for wireline networks as part of a highly scalable network simulator.

Research Fellow, AU-KBC Research Center, Chennai India, May - Aug 2001

Designed a novel, adaptive allocation algorithm for multi-user OFDM communication systems that minimizes the total transmit power by optimally allocating OFDM sub-carriers and data bits based on instantaneous channel information. This work was later published in Wireless Personal Communications Journal, (Kluwer) Apr 2003.

#### Research Contributions

- 60+ awarded patents (Appendix A)
  - 100+ research papers in top-tier IEEE and ACM conferences and journals, and book chapter (Appendix B)
  - Several invited talks, tutorials, seminars, keynotes and panels (Appendix C)
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**Professional  
Activities**

- Several leadership (technical and organizational) roles in top tier conferences; service on numerous international-level research review panels, committees and editorial boards (Appendix D)

**Patents  
(Appendix A)**
**Expert Reviewer**

- Broadcom vs. Netflix, retained by Adsero IP LLC, 2022; US Patent # 7,103,794
- Broadcom vs. Netflix, retained by Adsero IP LLC, 2022; US Patent # 8,646,014

**Awarded**

1. Infrastructure-free RF Tracking in Dynamic Indoor Environments, US patent # 11,388,564, Jul 2022.
  2. Un-manned Aerial Vehicle Network, US patent # 11,356,172, Jun 2022.
  3. Tracking Indoor Objects with Inertial Sensor Measurements, US patent # 11,169,518, Nov 2021.
  4. Tracking Indoor Objects from an Unmanned Aerial Vehicle, US patent # 11,089,432, Aug 2021.
  5. Self-configuring Long Term Evolution Radio Access Network on Unmanned Autonomous Vehicles, US patent # 11,054,843, Jul 2021.
  6. Backscatter-aided Navigation System, US patent # 10,852,415, Dec 2020.
  7. In-home Inventory and Location System, US patent # 10,852,414, Dec 2020.
  8. Tagging Objects in Indoor Spaces using Ambient, Distributed Backscatter, US patent # 10,852,413, Dec 2020.
  9. In-store Interaction and Location System for Interfacing Users with Products, US patent # 10,852,416, Dec 2020.
  10. Signaling for Coordinated Multi-point Transmission and Reception, US patent # 10,616,880, Apr 2020.
  11. Speculative Scheduling in Wireless Networks, US patent # 10,582,529, Mar 2020.
  12. Interference Topology Inference to Enhance Performance of LTE Unlicensed Networks, US patent # 10,574,535, Feb 2020.
  13. Implementing Wireless Communication Networks using Unmanned Aerial Vehicles, US patent # 10,470,243, Nov 2019.
  14. System and Method for Enabling Interference Awareness for LTE Operation in Unlicensed Spectrum, US patent # 10,469,188, Nov 2019.
  15. Product Checkout and Interest Detection in Retail Environment using Radio Frequency Identification, US patent # 10,410,025, Sept 2019.
  16. Distributed Architecture for Implementing Wireless Communication Networks, US patent # 10,405,373, Sept 2019.
  17. Blue-printing Interference for LTE Access In Unlicensed Spectrum, US patent # 10,405,209, Sept 2019.
  18. Battery-free Touch-aware User Input using RFID Tags, US patent # 10,346,655, July 2019.
  19. Systems and Methods for Distributed Assignment of Task Identifiers, US patent # 10,331,493, June 2019.
  20. Design of Randomization Function and its Application in Load Balancing, US patent # 10,298,671, May 2019.
  21. Consistent Hashing, US patent # 10,296,394, May 2019.
  22. Enabling Technologies for LTE on Unlicensed Spectrum, US patent # 10,292,054, May 2019.
  23. Enabling High-bandwidth Responsive Mobile Applications in LTE Networks, US patent # 10,122,547, Nov 2018.
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24. Interference Alignment in a Network with Asymmetrical Channel Dimensions, US patent # 10,110,293, Oct 2018.
  25. Asynchronous Access and Synchronous Transmission for Coexistence of Wireless Standards, US patent # 10,091,114, Oct 2018.
  26. Software-driven Long-Term Evolution Core Network for Mobile Access, US patent # 10,021,172, July 2018
  27. Efficient Network-wide Broadcasting over LTE Networks, US patent # 9,967,860, May 2018.
  28. Enabling Long Term Evolution/WiFi Coexistence, US patent # 9,936,414, Apr 2018.
  29. System and method for dynamic provisioning of Wi-Fi capacity in large venues using a C-RAN architecture, US patent # 9,813,944, Nov 2017.
  30. Scaling Wireless Full-Duplex in Multi-Cell Networks, US patent # 9,722,720, Aug 2017.
  31. Intelligent WiFi-offloading for Next-generation Mobile Networks, US patent # 9,723,532, Aug 2017.
  32. Degrees of Freedom in Multi-cell Wireless Systems with Full-duplex Base Stations using Interference Alignment, US patent # 9,736,785, Aug 2017.
  33. Method and Apparatus for Powerline Communication and Networking in Multi-flow Environments, US patent # 9,654,174, May 2017.
  34. Efficient Large Scale Multiple Input Multiple Output Communications, US patent # 9,413,474, Sept 2016.
  35. Multi-user Multiple Input Multiple Output (MIMO) Communication with Distributed Antenna Systems in Wireless Networks, US patent # 9,450,654, Sept 2016.
  36. Carrier Aggregation, US patent # 9,337,966, May 2016.
  37. Multiple-Input Multiple-Output Wireless Communications With Full-Duplex Radios, US patent # 9,137,788, Sept 2015.
  38. A Cloud Based Radio Access Network for Small Cells, US patent # 9,125,047, Sept 2015.
  39. Tailoring Wireless Transmission Strategies to User Profiles in Cloud Based Radio Access Networks, US patent # 9,066,351, Jun 2015.
  40. Methods and Apparatus for Integrating Batch Scheduling with External Beamforming, US patent # 8,976,696, Mar 2015.
  41. Scalable Network MIMO for Wireless Networks, US patent # 8,923,907, Dec 2014.
  42. Coordinated Multi-Point Transmission, US patent # 8,891,604, Nov 2014.
  43. Method for a Canceling Self Interference Signal Using Active Noise Cancellation for Full- Duplex Simultaneous (in time) and overlapping (in space) Wireless Transmission and Reception on the Same Frequency Band, US patent # 8,879,433, Nov 2014.
  44. Method for a Canceling Self Interference Signal Using Passive Noise Cancellation for Full- Duplex Simultaneous (in time) and overlapping (in space) Wireless Transmission and Reception on the Same Frequency Band, US patent # 8,837,332, Sep 2014.
  45. Femtocell Resource Management for Interference Mitigation, US patent # 8,767,580, July 2014.
  46. Methods and Systems for Allocation of Macro Cell Resources in a Distributed Femtocell Network and a Distributed Relay Station Network, US patent # 8,780,849, July 2014.
  47. High Performance and Low Complexity Scheduling Method for Resource Usage in OFDMA Wireless Relay Networks, US patent # 8,660,030, Feb 2014.
  48. Channel Estimation Methods and Systems Based on Power Measurement at Receivers, US patent # 8,537,928, Sep 2013.
  49. Video Multicast Scheduling, US patent # 8,537,738, Sep 2013.
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50. Multicast Scheduling Systems and Methods for Leveraging Cooperation Gains in Relay Networks, US patent # 8,537,693, Sep 2013.
  51. Link Layer Multicasting Systems and Methods, US patent # 8,520,764, Aug 2013.
  52. Wireless Multicasting with Beamforming Antennas, US patent # 8,519,888, Aug 2013.
  53. Beamforming methods and systems employing measured power at a receiver to perform channel estimation, US patent # 8,380,133, Feb 2013.
  54. Methods and systems for location-based allocation of macro cell resources, US patent # 8,374,135, Feb 2013.
  55. Systems and methods for adaptive beamforming in indoor wireless networks, US patent # 8,340,584, Dec 2012.
  56. Methods and systems for allocation of macro cell resources in a distributed femto cell network and a distributed relay station network, US patent # 8,311,005, Nov 2012.
  57. Optimal beam scheduling for multicasting in wireless networks, US patent # 8,310,975, Nov 2012.
  58. Systems and methods for leveraging spatial reuse in OFDMA relay networks, US patent # 8,218,472, Jul 2012.
  59. High performance scheduling methods and apparatus for leveraging diversity in relay-enabled wireless networks, US patent # 8,170,031, May 2012.
  60. System and Method for Scheduling in Relay-assisted Wireless Networks, US patent # 8,134,946, Mar 2012.
  61. Integrated scheduling of unicast and multicast traffic in relay-enabled wireless networks, US patent # 8,098,609, Dec 2012.
  62. Method for scheduling heterogeneous traffic in B3G/4G cellular networks with multiple channels, US patent # 7,856,004, Jan 2010.

#### Publications (Appendix B)

#### Conference

1. M. Dasari, R. Sephardi, K. Sundaresan, S. Das, "RoVaR: Robust Multi-agent Tracking through Dual-layer Diversity in Visual and RF Sensing", Proceedings of ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT), 2023.
  2. M. Rostami, K. Sundaresan, "Enabling High Accuracy Pervasive Tracking with Ultra Low Power UWB Tracking Tags", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Oct 2022.
  3. S. Aggarwal, R. Seshadri, K. Sundaresan, D. Koutsoukolas, "Is WiFi 802.11mc FTM Ready for Prime-time Deployment", Proceedings of ACM Workshop on Wireless Network Testbeds, Experimental Evaluation and Characterization, **Best Paper Award**, Oct 2022.
  4. T. Woodford, X. Zhang, E. Chai and K. Sundaresan, "FishEye: Leveraging Diverse Reflector Geometries for Omni-directional Around-corner Automotive Radar", Proceedings of ACM International Conference on Mobile Systems, Applications and Services (MOBISYS), June 2022.
  5. M. Rostami, X. Chen, Y. Feng, K. Sundaresan, D. Ganesan, "MIXIQ: Re-thinking Ultra Low Power Receiver Design for Next-generation On-body Applications", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Oct 2021.
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6. R. Seshadri, E. Chai, K. Sundaresan, S. Rangarajan, "SkyHaul" A Self-Organizing Gigabit Network in the Sky", Proceedings of ACM International Symposium on Theory, Algorithmic Foundations and Protocol Design for Mobile Networks and Mobile Computing (MOBIHOC), July 2021.
  7. T. Woodford, X. Zhang, E. Chai and K. Sundaresan, "SpaceBeam: Lidar-driven One-Shot mmWave Beam Management", Proceedings of ACM International Conference on Mobile Systems, Applications and Services (MOBISYS), June 2021.
  8. H. Alhulayyil, K. Apicharttrisor, J. Chen, K. Sundaresan, S. Oymak and S. Krishnamurthy, "WOLT: Auto-configuration of Integrated Enterprise PLC-WiFi Networks", Proceedings of IEEE International Conference on Distributed Computing Systems (ICDCS), Nov 2020.
  9. M. Rostami, K. Sundaresan, E. Chai, S. Rangarajan, and D. Ganesan, "Redefining Passive in Backscattering with Commodity Devices", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Oct 2020.
  10. A. Dhekne, A. Chakraborty, K. Sundaresan, S. Rangarajan, "TrackIO: Tracking First Responders Inside Out", USENIX Symposium on Networked Systems Design and Implementation (NSDI), Feb 2019.
  11. A. Chakraborty, E. Chai, K. Sundaresan, A. Khojastepour, S. Rangarajan, "SkyRAN: A Self-Organizing LTE RAN in the Sky", ACM International Conference on emerging Networking EXperiments and Technologies (CONEXT), Dec 2018.
  12. M. Moradi, K. Sundaresan, E. Chai, S. Rangarajan, "SkyCore: Moving Core to the Edge for Un-tethered and Reliable UAV-based LTE Networks", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), **Best Paper Award**, Oct 2018.
  13. R. Sheshadri, K. Sundaresan, E. Chai, S. Rangarajan, "ELI: Empowering LTE with Interference Awareness in Unlicensed Spectrum", IEEE International Conference on Network Protocols (ICNP), July 2018.
  14. R. Sheshadri, K. Sundaresan, E. Chai, S. Rangarajan and D. Koutsonikolas, "BLU: Blue-printing Interference for Robust LTE Access in Unlicensed Spectrum", ACM International Conference on emerging Networking EXperiments and Technologies (CONEXT), **Best Paper Finalist**, Dec 2017.
  15. S. Pradhan, E. Chai, K. Sundaresan, S. Rangarajan, L. Qiu, "RIO: A Pervasive RFID-based Touch Gesture Interface", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Oct 2017.
  16. R. Sivaraj, M. Arslan, K. Sundaresan, S. Rangarajan, P. Mohapatra, "BoLTE: Efficient Network-wide LTE Broadcasting", Proceedings of IEEE International Conference on Network Protocols (ICNP), Oct 2017.
  17. A. Banerjee, R. Mahindra, K. Sundaresan, S. Rangarajan, S. Kasera, K. V-D. Merwe, "Orchestrating the Data Plane of Virtual LTE Core Networks", Proceedings of IEEE International Conference on Sensing, Communication and Networking (SECON), June 2017.
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18. S. Pradhan, E. Chai, K. Sundaresan, S. Rangarajan, L. Qiu, "Konark: A RFID-based System for Enhancing In-Store Shopping Experience", Workshop on Physical Analytics, Co-located with ACM MobiSys, June 2017.
  19. K. Apichattrisorn, A. Fatya, J. Chen, K. Sundaresan, S. Krishnamurthy, "Enhancing WiFi Throughput with PLC Extenders", Passive and Active Measurements Conference (PAM), Mar 2017.
  20. J. Cho, K. Sundaresan, R. Mahindra, S. Rangarajan, J. V-d. Merwe, "ACACIA: Context-aware Edge Computing over Mobile Networks", ACM International Conference on emerging Networking EXperiments and Technologies (CONEXT), Dec 2016.
  21. R. Seshadri, M. Arslan, K. Sundaresan, S. Rangarajan, D. Koutsonikolas, "AmorFi: Amorphous WiFi Networks for High Density Deployments", ACM International Conference on emerging Networking EXperiments and Technologies (CONEXT), Dec 2016.
  22. E. Chai, K. Sundaresan, M. Khojastepour, S. Rangarajan, "LTE in Un-licensed Spectrum: Are We There Yet?", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Oct 2016.
  23. A. Atya, K. Sundaresan, S. Krishnamurthy, M. Khojastepour, S. Rangarajan, "BOLT: Enabling High-Throughput Powerline Communication Networks", ACM International Conference on emerging Networking EXperiments and Technologies (CONEXT), Dec 2015.
  24. A. Banerjee, R. Mahindra, K. Sundaresan, S. Kasera, J. Van Der Merwe, S. Rangarajan, "SCALE: Scaling the LTE Control Plane for Future Wireless Access", ACM International Conference on emerging Networking EXperiments and Technologies (CONEXT), Dec 2015.
  25. J. Xiong, K. Sundaresan, K. Jamieson, "ToneTrack: Leveraging Frequency-agile Radios for Time-based Indoor Wireless Localization", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Sept 2015.
  26. X. Xie, E. Chai, X. Zhang, K. Sundaresan, M. Khojastepour, S. Rangarajan, "Hekaton: Efficient and Practical Large-Scale MIMO", Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Sept 2015.
  27. S. Singh, K. Sundaresan, S. Krishnamurthy, X. Zhang, M. Khojastepour, S. Rangarajan, "Trinity: A Practical Transmitter Cooperation Framework to Handle Heterogeneous User Profiles in Wireless Networks", Proceedings of ACM International Conference on Mobile Ad Hoc Networking and Computing (MOBIHOC), July 2015.
  28. M. Lotfi, K. Sundaresan, M. Khojastepour, S. Rangarajan, "The Economics of Quality-Sponsored Data in Wireless Networks", International Symposium on Modeling and Optimization in Mobile, Ad-hoc and Wireless Networks (WiOPT), May 2015.
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29. M. Khojastepour, K. Sundaresan, S. Rangarajan, "Scaling Wireless Full-duplex to Multi-cell Networks", IEEE International Conference on Computer Communications (INFOCOM), Apr 2015.
  30. J. Xiong, K. Sundaresan, K. Jamieson, M. Khojastepour, S. Rangarajan, "MIDAS: Empowering 802.11ac Networks with Multiple-input Distributed Antenna Systems", **Best Paper Award**, ACM International Conference on emerging Networking EXperiments and Technologies (CONEXT), Dec 2014.
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- Proceedings of IEEE International Conference on Network Protocols (ICNP), Oct 2013.
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#### Journals

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86. S. Singh, K. Sundaresan, S. Krishnamurthy, X. Zhang, M. Khojastepour, "Trinity: Tailoring Wireless Transmission Strategies to User Profiles in Enterprise Wireless Networks", in IEEE/ACM Transactions on Networking, 2017.
87. J. Yoon, K. Sundaresan, M. Khojastepour, S. Rangarajan, S. Banerjee, "Joint Multi-cell Beamforming and Client Association in OFDMA Small-cell Networks", in IEEE Transactions on Mobile Computing, 2016.
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91. J. Yoon, M. Arslan, K. Sundaresan, S. Krishnamurthy, S. Banerjee, "Self-Organizing Resource Management Framework in OFDMA Femtocells", IEEE Transactions on Mobile Computing, 2015.
92. M. Arslan, I. Singh, S. Singh, H. Madhyastha, K. Sundaresan, S. Krishnamurthy, "CWC: A Distributed Computing Infrastructure using Smartphones", in IEEE Transactions on Mobile Computing, 2015.
93. S. Singh, M. Shahbazi, K. Pelechrinis, K. Sundaresan, S. Krishnamurthy, K. Satish, "Adaptive Sub-carrier Level Power Allocation in OFDMA Networks", IEEE Transactions on Mobile Computing, 2015.
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  97. E. Aryafar, M. Khojastepour, K. Sundaresan, S. Rangarajan, M. Chiang, "ADAM: An Adaptive Beamforming System for Multicasting in Wireless LANs", in IEEE/ACM Transactions on Networking, 2013.
  98. M. Arslan, J. Yoon, K. Sundaresan, S. Rangarajan, S. Krishnamurthy, "A Resource Management System for Interference Mitigation in Enterprise OFDMA Femtocells", in IEEE/ACM Transactions on Networking, 2013.
  99. H. Zhang, J. Tanis, K. Sundaresan, S. Rangarajan and B. Zhao, "Wireless Multicast Scheduling with Switched Beamforming Antennas", in IEEE/ACM Transactions on Networking, 2012.
  100. K. Sundaresan and R. Sivakumar, "Cooperating with Smartness: Using Heterogeneous Smart Antennas in Multi-hop Wireless Networks", in IEEE Transactions on Mobile Computing, Dec 2011.
  101. S. Lakshmanan, K. Sundaresan and R. Sivakumar, "Multi-gateway Association in Wireless Mesh Networks", in Ad-Hoc Networks Journal, Elsevier, May 2009.
  102. K. Sundaresan, and R. Sivakumar, "Routing in Ad-hoc Networks with MIMO Links: Optimization Considerations and Protocols", in Computer Networks Journal, Elsevier, 2008.
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  104. K. Sundaresan, and R. Sivakumar, "Ad-hoc Networks with Heterogeneous Smart Antennas: Performance Analysis and Protocols", in Wireless Communication and Mobile Computing Journal, Special Issue on Wireless Ad-hoc Networks: Technologies and Challenges, 2006.
  105. K. Sundaresan, V. Anantharaman, H.-Y. Hsieh and R. Sivakumar, "ATP: A Reliable Transport Protocol for Ad-hoc Networks", in IEEE Transactions on Mobile Computing, Nov-Dec 2005.
  106. K. Sundaresan, R. Sivakumar, M. A. Ingram and T.-Y. Chang, "Medium Access Control in Ad-hoc Networks with MIMO Links: Optimization Considerations and Algorithms", in IEEE Transactions on Mobile Computing, Oct-Nov 2004.
  107. K. Sundaresan, H.-Y. Hsieh, and R. Sivakumar, "IEEE 802.11 over Multi-hop Wireless Networks: Problems and New Perspectives", in Ad-hoc Networks Journal, Elsevier, Feb 2004. WCMC
  108. V. Anantharaman, S.-J. Park, K. Sundaresan, and R. Sivakumar, "TCP Performance over Mobile Ad-hoc Networks: A Quantitative Study", In Wireless Communications
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- 109.V. Rajendran, K. Sundaresan and S. Subramanian, "Performance of an OFDM Based Downlink Multiple Access System for Indoor Wireless Communications", in Wireless Personal Communications, Kluwer Academic Publishers, April 2003.

### Book Chapters

- 110.K. Sundaresan, S-J. Park, and R. Sivakumar, "Transport Layer Solutions for Ad-hoc Networks", in Ad-hoc Networks: Technologies and Protocols, Kluwer, 2005.

### Posters/Demos

- 111.J. Cho, K. Sundaresan, R. Mahindra, S. Rangarajan, J. V-d. Merwe, "ACACIA: Context-aware Edge Computing over Mobile Networks", Demo, Proceedings of ACM International Conference on Mobile Computing and Networking (MOBICOM), Oct 2016.
- 112.K. Sundaresan and R. Sivakumar, "Rate vs. Range vs. Reliability: How to Best Exploit MIMO in Ad-hoc Networks", Poster, Proceedings of ACM International Symposium on Mobile Ad Hoc Networking and Computing (MOBIHOC), Illinois, May 2005.
- 113.Y. Zhu, K. Sundaresan and R. Sivakumar, "Exposing Two Critical Myths About Correlation-Aware Data Aggregation", Poster, Proceedings of ACM International Symposium on Mobile Ad Hoc Networking and Computing (MOBIHOC), Illinois, May 2005.
- 114.K. Sundaresan and R. Sivakumar, "On the Medium Access Control Problem in Ad-hoc Networks with Smart Antennas", Poster, Proceedings of ACM International Symposium on Mobile Ad Hoc Networking and Computing (MOBIHOC), MD USA, June 2003.

### Talks (Appendix C)

#### Tutorials

- "Networks in the Sky: Potential and Challenges", at IEEE-sponsored COMSNETS, India, Jan 2022.
  - "5G: An Evolution towards a Revolution", at ACM MobiCom, India, Oct 2018.
  - "5G: An Evolution towards a Revolution", at Signal Processing and Communications Conference (SPCOM), IISC, Bengaluru, India, July 2018.
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**Invited Panels, Tutorials and Talks**

- “Networks in the Sky: Enabling Ubiquitous Connectivity and Sensing”, Seminar talk at Georgia Tech, School of ECE, Feb 2021.
  - “Untethering 5G for Ubiquitous Connectivity”, Invited talk at Comsnets, Jan 2021.
  - “Making Mobile Networks Fly”, Seminar talk (Leaders and Innovators Series), at Texas A&M University, Nov 2019.
  - “Making Mobile Networks Fly”, Keynote talk at ACM S3 workshop, co-located with ACM MobiCom, Oct 2018.
  - “Triple Play: The Confluence of Connectivity, Computing and User Experience in Mobile Networks”, School of Computer Science, University of California, Santa Barbara, Apr 2017.
  - “Connectivity meets Computing: A Wireless Networking Perspective”, School of Electrical Engineering, University of Washington, Seattle, Feb 2017.
  - “Evolving Shades of Wireless Access Research”, ACM Sigmobile Rockstar Award talk, ACM MobiCom, Oct 2016.
  - “Converged Wireless Access: The New Normal”, Talk at Wireless Co-existence Workshop, Univ. of Washington, June 2016.
  - “Blurred Boundaries in Future Wireless Access”, Talk at 5G Forum, UCSD, May 2016.
  - “Connectivity meets Computing: A Wireless Networking Perspective”, School of Computer Science, University of Utah, Apr 2016.
  - “Blurred Boundaries in Future Wireless Access”, Talk at ACM Wireless Networking Industry Day, Mar 2016.
  - “Blurred Boundaries in Future Wireless Access”, Talk at ACM HotWireless Workshop, Sept 2015.
  - “Connectivity meets Computing in the Path to 5G”, Talk at Telecom ParisTech Workshop on 5G, Sept 2015.
  - “Connectivity meets Computing: A Wireless Networking Perspective”, School of ECE, UCSD, Feb 2015.
  - “Cloud-driven Architectures for Next Generation Small Cell Networks”, Keynote at ACM MobiArch workshop, co-located with ACM MobiCom, 2013.
  - “Cloud-driven Architectures for Next Generation Small Cell Networks”, Talk at University of Delaware, CS seminar, 2013.
  - “Realizing the Potential of Small Cells: An Experimental Approach”, Talk at Columbia University, EE seminar, 2012.
  - MIMO in Sensor and Ad Hoc Networks: Challenges and Opportunities” Panel at IEEE SECON 2008.
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**Professional  
Activities  
(Appendix D)**

**Editorial Board**

Associate Editor, IEEE Transactions on Mobile Computing, Associate Editor, 2012-2018.

**Conference/Workshop Organization**

- Area Chair for IEEE ICNP, 2020.
- Track Chair for IEEE ICDCS 2017, "Mobile and Wireless Network Computing" Track.
- Program Co-Chair for ACM MobiCom 2016.
- Program Co-Chair for IEEE ICC Workshop on "LTE in Unlicensed Bands: Potential and Challenges", June 2015.
- Program Co-chair for IEEE SECON 2013.
- Poster Chair for ACM MobiHoc 2012.
- Publicity Chair for ACM MobiCom 2010.
- Publicity Chair for ACM MobiHoc 2010.
- Poster and Demo Chair for IEEE SECON 2010.
- Program Co-chair for IEEE Workshop on Wireless Mesh Networks (WiMesh) 2009; co-located with IEEE SECON 2009.
- Publications Chair for ACM Workshop on Dependability Issues in Wireless Ad-hoc and Sensor Networks (DIWANS) 2006; co-located with ACM MOBICom 2006.

**Technical Program Committee Memberships**

- ACM MOBICom 2008, 2011, 2012, 2014 - 2023.
- ACM SIGCOMM 2009.
- IEEE INFOCOM 2012, 2013, 2014, 2015 (advisory TPC), 2016, 2017.
- IEEE SECON 2009, 2012.
- IFIP Networking 2007, 2008.
- IEEE ICC 2010, 2012.
- IEEE MASS 2009.
- IEEE WoWMoM 2010.
- IEEE WiMesh 2009, 2010.

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**Referee/Panelist for Journals, Conferences and Review Panels**

- Journals: IEEE/ACM Transactions on Networking, IEEE Transactions on Mobile Computing, IEEE Transactions on Wireless Communications, IEEE Journal on Selected Areas in Communications, ACM Mobile Computing and Communications Review
- Conferences: ACM MobiCom, ACM SIGCOMM, ACM CONEXT, IEEE INFOCOM, IEEE ICNP
- Evaluation committee of "MIMONet" project - a 3 year project on MIMO networks funded by Italian National Research Council, along with Dr. Robert Heath; Jan 2012.
- NSF Panelist for Network Technology and Systems 2012, 2013, 2014, 2017, 2019.

**Ph.D. Dissertation Committees**

- Shruti Lall, School of ECE, Georgia Tech, Atlanta, 2022.
- Yuchen Liu, School of ECE, Georgia Tech, Atlanta, 2022.
- Mallesham Dasari, Computer Science, Stony Brook University, New York, 2021.
- Mohammad Rostami, Computer Science, University of Massachusetts, Amherst, 2021.
- Swadhin Pradhan, Computer Science, University of Texas, Austin, 2020.
- Ashutosh Dhekne, School of ECE, UIUC, 2019