

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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.

CASE IPR2024-00310
PATENT 10,932,207

DECLARATION OF DR. KARTHIKEYAN SUNDARESAN

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CURRENT EXHIBIT LIST

No.	Brief Description
1001	U.S. Patent 10,932,207 (“’207 Patent”)
1002	Prosecution History of U.S. Patent 10,932,207 (“’207 File History”)
1003	Declaration of Mark Mahon, Ph.D. (“Mahon Declaration”)
1004	Curriculum Vitae of Mark Mahon, Ph.D.
1005	US Patent Publication No. 2017/0019930 (“Lee1”)
1006	US Patent Publication No. 2010/0255847 (“Lee2”)
1007	Dahlamn et al. 4G, LTE-Advanced Pro and the Road to 5G (3rd ed. 2016)
1008	Harri Holma and Antti Toskala LTE for UMTS (2009)
1009	Nokia, “Considerations on NR RACH procedures,” R2-168013 (Nov. 2016)
1010	3GPP TS 36.331 v13.0.0 (2016) (“TS 36.331”)
1011	3GPP TS 25.214 v3.2.0 (Mar. 2000) (“TS 25.214 Release 1999”)
1012	3GPP TS 38.321 v16.1.0
2001	Intentionally Left Blank
2002	Intentionally Left Blank
2003	U.S. Patent Publication No. 2015 0296525A1 to Kim (“Kim”)

I. INTRODUCTION¹

¶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 10,932,207 (“’207 Patent” or “Patent-at-Issue”), Ex. 1001.

¶2. Specifically, I 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 references US Patent Publication No. 2017/0019930 (“Lee1”), US Patent Publication No. 2010/0255847 (“Lee2”), and the ’207 Patent.

¶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.

¹ 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
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

Number	Title	Filed
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
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

Number	Title	Filed
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
2015 029908	Resource Management with Device-Device Communication in Next Generation Cellular Networks	7/24/2014

Number	Title	Filed
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 February 20, 2017 (“Effective Priority 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 ’207 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,” including “familiarity with the wireless standards and well-known protocols for accessing wireless networks,” and that “[m]ore education may supplement practical experience or *vice versa*.” Pet. 10 (citing Ex. 1003 ¶36).

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

¶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.

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. MY OPINION REGARDING SELECTED ISSUES

A. A POSITA Understood that the Format of the Items in Limitations 4c and 4d, `preamble→Initial→Received→Target→Power()` and `power→Ramping→Step()`, are Functions

¶20. The use of a name followed by parentheses is obvious to one of ordinary skill in the art that it represents a function. It is a widely used convention in any form of execution logic or code that one comes across in engineering and computer science. The latter are fields highly pertinent to the patent under consideration. The variable that is used within the parentheses represents the variable that serves as input to the function. The nature of the function can range from a simple look-up table to a series of instructions.

¶21. When the function is a simple look-up table, the input variable *x* serves as the index to the table. Depending on the value of *x* that is input to the function, a different entry from the table is obtained and returned as output. For example, consider a function: `Map(x)` that performs the role of a simple table lookup mapping small integers to large real values as shown below.

x	Map(x)
0	521.75
1	1965.30
2	4500.50
3	521.75

When $x=1$, the function $\text{Map}(x)$ returns the output of 1965.30, while it returns an output of 521.75 when $x=0$.

¶22. The function can also perform a set of instructions that is dependent on the input given to it. For example, consider a simple quadratic function: $\text{Quad}(x) = 10 \cdot x^2$, that takes as input, values for the variable 'x', squares it and multiplies it by a constant 10 to yield the corresponding output. When $x=2$, $\text{Quad}(2)$ equates to 40, and when $x=4$, $\text{Quad}(4)$ equates to 160.

¶23. Irrespective of the role performed by the function, it is important to note that the output of a function depends on the input provided to it.

¶24. It would be obvious to a POSITA that the claims of the patent under consideration clearly indicate the use of functions `preambleinitialReceivedTargetPower()` and `powerRampingStep()`, both taking an input variable. When the input is one value, indicated by '0' in the claims, the functions return the corresponding initial power `preambleinitialReceivedTargetPower(0)` and power ramping step

powerRampingStep(0) values corresponding to the 4-step procedure case. When the input is a different value, indicated by '1' in the claims, the functions return the corresponding initial power preambleinitialReceivedTargetPower(1) and power ramping step powerRampingStep(1) values corresponding to the 2-step procedure case. Under plain and ordinary meaning, it is straightforward for a POSITA to see that these two functions use different input values to correspond to the 4-step and 2-step procedure cases.

¶25. It is important to note that a function can return the same output for multiple values. However, this must not be interpreted as the function being independent of any input. Considering our earlier example function: $Quad(x) = 10 * x^2$, we find that the function will yield the same output for a pair of values, each being negative of the other. For example, $Quad(4) = Quad(-4) = 160$. However, this does not mean that $Quad()$'s output is independent of 'x'. For example, $Quad(2)$ is not equal to $Quad(4)$. Similarly, in the $Map()$ function example, while $Map(0) = Map(3)$ from the table, $Map(0)$ is not equal to $Map(1)$ and hence the $Map()$ function is dependent on an input. It is known to a POSITA that if the output of a function is always the same, it is not dependent on any input. On the other hand, if the output varies based on input, then it does depend on the input. From the plain and ordinary meaning of the patent's claim elements, it is clear to a POSITA that the functions preambleinitialReceivedTargetPower() and powerRampingStep() take different

input values for the 4-step ('0' input) and 2-step ('1' input) procedures to be capable of outputting different values based on the input.

B. Lee2's Distance Rationale for having Different Power Parameters for the Connection Cases Is No Rationale to Have Different Power Parameters for Two- and Four-Step Access Procedures

¶26. Lee2 teaches that different events have different power control parameters. Lee2 further teaches that events relating to handoff and data resume operate with a higher initial power than the events relating to idle-to-connected and RRC reconnection. Of course, Lee2's reasoning for using different power settings for different procedures—certain procedures are usually performed at a farther distance from the base station—is inapplicable to the 2-step and 4-step access procedures, because any of the different events could rely on a two or four step access procedure.

¶27. Indeed, the '207 Patent explicitly teaches that within each of these events, one could use either the 2-step or 4-step access procedure based on a RSRP threshold. *See* Ex. 1001 at 16:32-17:15. RSRP may or may not correspond to distance in the real world due to various wireless artifacts like shadowing or multipath fading that make signal propagation deviate from a simple path loss model and hence distance—a client close to the base station could have low RSRP but not be in need of a handoff. However, RSRP does relate to decoding capability and hence is employed for making the decision of 2-step versus 4-step in the '207 Patent. Hence, irrespective of the event, the '207 Patent teaches how to decide between using a 2-step and 4-

step procedure with correspondingly different power control parameters based on RSRP. In short, Lee2's teachings that applies different power control parameters to events would not lead a POSITA to arrive at the '207 Patent solution of using a 2-step versus 4-step power control parameter selection.

¶28. Also, a POSITA would have had no motivation to modify Lee2 to arrive at '207 Patent's teachings, particularly when such an application can lead to a detrimental effect. With 2-step and 4-step access procedures being possible with each event contemplated by Lee2, it is unclear if two power control decisions will be made – one decision at the event level and another decision at the 2-step vs 4-step level. If so, these two decisions could be conflicting with each other and could lead to unintended and potentially detrimental consequences for the connection. On the other hand, if they were to be combined into a single decision, it would not have been obvious to a POSITA how to arrive at this combined decision for power control parameter selection from Lee2's teachings. Either way, Lee2's teachings that address power control at an event level do not motivate or teach a POSITA to arrive at '207 Patent's teachings.

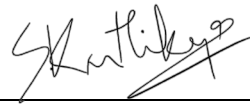
VII. DECLARATION

¶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.

Executed on June 18, 2024, at SUWANEE, GA.



Dr. Karthikeyan Sundaresan

APPENDIX A (RESUME)

KARTHIKEYAN (KARTHIK) SUNDARESAN

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 75 5th St NW, Atlanta GA 30308
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karthik@ece.gatech.edu
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Education	- Georgia Institute of Technology, USA - Ph.D (ECE), 2006; M.S (ECE), 2003 - Anna University, India - B.S. (Electronics and Communications), 2001	
Professional Experience	Professor School of ECE, Georgia Institute of Technology, Atlanta, USA	Oct 2021 – Present
	Co-founder, CTO NavigateIO Inc.	Apr 2022 – Present
	Senior Researcher NEC Labs America, Princeton NJ, USA	Aug 2006 – Sep 2021
	Research Assistant Georgia Tech, Atlanta, USA	Aug 2001 – July 2006
	Research Intern Intel Research, Cambridge, UK	Jan 2006 – Mar 2006
	Research Intern Los Alamos National Lab, Los Alamos, USA	May 2005 – Aug 2005
	Research Fellow AU-KBC Research Center, Chennai, India	May 2001 – Jul 2001
Awards/Honors	Professional/Academic - IEEE Fellow, 2020 for contributions to algorithms for mobile networking and computing - ACM Distinguished Member, 2018 for outstanding scientific contributions to computing. - Association for Computing Machinery (ACM) SIGMOBILE Rockstar Award, 2016 – for early-career contributions to wireless connectivity (Citation). - Business Contribution Award for LTE Small-cell Technology Commercialization, NEC 2015. - University Gold Medal; ranking FIRST in academic performance, School of ECE, Anna University, Aug. 2001. - Ramanujan Centennial Gold Medal for ranking FIRST in Mathematics courses across all disciplines during the four year under-graduate tenure, Anna University, Aug. 2001. - Alumni Association's Best Outgoing Student Award, School of ECE, Anna University, Aug 2001.	

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:

-
- 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

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)
-

**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.
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 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.
 103. K. Sundaresan and R. Sivakumar, "A Unified MAC Framework for Ad-hoc Networks with Smart Antennas", in IEEE/ACM Transactions on Networking, 2007.
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 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.
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and Mobile Computing Journal (WCMC), Special Issue on Performance Evaluation of Wireless Networks, Mar 2004.

- 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