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I joined Microsoft on June 2, 1997 after working at Digital Equipment Corporation for 9 years [June 1988 – May 1997]. Today, I am one of eleven distinguished scientists at Microsoft. In my 30 years of work experience I spent 9 years in product engineering & advanced development and the rest in research. During this time, I have advised Microsoft CEOs Bill Gates & Steve Balmer, and current CEO Satya Nadella and his senior leadership team on technical strategy and long-term vision related to networked and mobile systems. I serve on Microsoft Research Redmond Lab Leadership Team overseeing 200+ researchers, engineers and staff. Previously, I served on Microsoft Research Labs Global Leadership Team working directly with the head of MSR Labs on matters related to the health, technical strategy and vibrant functioning of our domestic and international Labs. In Redmond, I lead a group that executes on our vision through research, technology transfers to product groups, product incubations, industry partnerships, and associated policy engagement with governments and research institutions around the world.

I started networking research at Microsoft and formally founded Microsoft's *Networking Research Group* in 2001, then expanded it to *Mobility & Networking Research Group* in 2010. Over the years I have delivered consistently and substantially. For example, my group completely re-designed Microsoft's Azure global data center networks and its big components incl. software load balancers, remote direct memory access, and inter-DC wide-area (software defined) networks. Cloud providers have adopted these designs as de-facto industry standards. We caused a paradigm shift with edge computing, which the company is whole-heartedly adopting. We built bestselling features (e.g. Mixer HypeZone), cloud-scale network emulators (e.g. Open Network Emulator), devices (XBOX wireless controllers), and services (Embedded Social, Rocket). Additional technologies I delivered include white space networking, which opened 180 MHz of US spectrum for unlicensed use. It is now set to provide broadband access to over two million US consumers. I developed the world's first Wi-Fi hotspot, indoor localization system, wireless virtualization and multi-radio system. For seminal contributions, I have been honored with numerous research & leadership awards including IEEE's top award in networking (2018) and ACM's lifetime achievement award in mobile systems (2013). My research has been cited heavily (h-index 90; 44K+ citations) and incorporated into several industry standards and commercial products. I have authored over 150 US issued patents, many of which have been led to significant business wins. I have also given close to four dozen keynotes, five dozen seminars and a commencement speech at a major public university.

My group is considered the strongest and most respected networking research group in the world. Members have graduated to become executives in Microsoft product teams (incl. a corporate vice president, a distinguished engineer, and several partner-level FTEs); some are heading up new product incubation teams; some have started their own research groups; others have become professors at top Universities (MIT, UCLA, UW, & UTA) incl. a chancellor's professor and some hold senior positions in Alibaba, Google & Amazon. My group has published well over 500 papers, created a portfolio of over 350 patents, won numerous prestigious international awards, and received world-wide press accolades in over a thousand articles. We have engaged closely with academia and government organizations world-wide, funding significant research projects, research centers, conferences, and workshops. Our software has been downloaded more than a million times and our academic tool kits have been used by over a 1000 university's world-wide.

Impact on Microsoft Engineering & Products

Below is a sample of substantial technologies I have delivered to Microsoft engineering / product groups. These technologies were developed under my direction / watch. Several of these have defined or redefined significant parts of our industry (see "Awards").

1) **XBOX Mixer HypeZone (2017-18):** a highly-scalable service that inexpensively analyzes video game streams in real-time to connect spectators to the top-performing streamers closest to winning the game. Our technology does not require modifications to the game. The XBOX Mixer team at Microsoft launched the HypeZone on Dec. 12, 2017 with their most popular PUBG game and received rave reviews for it. In just under 75 days, HypeZone increased Mixer's customer base by over 10%. Parts of this technology are now being incubated as a separate business unit.

2) **Microsoft Cloud-Scale Network Emulator CrystalNet (2016-2017):** a high-fidelity, cloud-scale emulator that is routinely used by Azure network engineers to validate and reduce the risk of new network designs, major network architecture changes, network firmware/hardware upgrades and network configuration updates. They use it as a realistic test environment for developing network automation tools and for developing our in-house switch operating system called SONIC. CrystalNet was critical in enabling the migration of Microsoft Azure's regional backbones to a new standardized architecture with zero user impacting incidents, even though production traffic flowed through the network continuously during the migrations.

3) **Microsoft Embedded Social (2015-17):** a highly-scalable, highly-reliable Azure service that gives application developers complete access to a full social network stack, which they can tailor to their application, something they cannot do with the existing large social networks. Embedded Social powers the social features in the Windows 10 Creator's Update Remix 3D, a new Microsoft community where Windows users can share their 3D creations. It also powers the social features of several important Microsoft & non-Microsoft mobile applications incl. *OneBusAway.* As of December 1, 2017*,* Embedded Social was servicing ~18 million users.

4) **Bandwidth Variable Transceivers for Microsoft Global Optical Networks (2015-16):** built the world's largest optical network monitoring tool to understand the behavior of the physical layer. Encouraged by the results of our analysis Azure Networking purchased bandwidth variable transceivers, which when fully deployed will upgrade 99 percent of the our 100 Gbps network segments to operate at 150 Gbps by simply changing the modulation at the two ends. This will significantly improve the efficiency and capacity of Azure's optical networking without incurring big expenses of changing the fiber and/or intermediate amplifiers.

5) **Azure Pricing Tool (2015**): we built and transferred an automatic and comprehensive software service that compares the performance and cost of Azure to other cloud providers along various standard and non-standard metrics under various conditions. Azure changed the pricing methodology of its core services based on the output of our service.

6) **Windows Azure Network State Service (2013-2014) –** maintains the states of all network devices for all network management applications. NSS is deployed world-wide in all Microsoft Azure datacenters. As of January 2014, it was managing more than a million links and 25,000 network devices. Azure Networking Corporate Vice President publicly called it the fundamental building block for Microsoft cloud networking.

7) **Microsoft's Wide Area Software Defined Network (2013-14)** - a centralized traffic engineering software system that led to an improvement of the inter-DC WAN bandwidth utilization from ~40% to over 90%+, thus freeing tens of thousands of servers and saving Microsoft millions of dollars annually.

8) **XBOX One Wireless Controller Protocol (2013-14)** - a high throughput, low latency, energy efficient propriety protocol between the XBOX One console and controllers. It won numerous accolades of mainstream press as the best controller in the gaming market.

9) **XBOX Service Graphs** (**2012**) – (Project name **Sherlock**) - a distributed dependency extraction technology, reduced performance diagnostics in enterprise & data center networks from days to minutes helping meet customer SLAs. A significant number of network diagnostic tools followed the approach (of dependency extraction and inference graphs) pioneered by Sherlock.

10) **Bing's Network Failure Recovery Technology (2012)** - reduced the recovery time for the common data center network failures from a few hours to tens of minutes (another version of Project Sherlock)

11) **Windows RT Firmware TPM (2011-12)** - enabled Microsoft to run software written for Intel® TPM on ARM TrustZone® thus enabling the widely used BitLocker and DirectAccess features and a new security feature called Virtual Smart Cards on Surface class devices.

12) **GreenUp (2011-12)** – delivers significant power & monetary savings for enterprise customers by enabling seamless remote access to sleeping desktop machines. Ships as a feature in Microsoft Systems Center product

13) **Windows Server Network Virtualization Technology (2011)** - enabled Windows to provide seamless connectivity between Microsoft's datacenters and customers' on-premise networks. Our design heavily influenced the Hyper V network virtualization feature that shipped in Windows Server 2012.

14) **Windows Azure Software Load Balancer (2011)** – shifted load balancing to end-nodes already present in the cloud. Reduced cost by a factor of 15 [$60K versus $1M] by removing dependence on expensive hardware load balancers and improved cloud manageability.

15) **Windows Azure TCP for Datacenter Networking (2010-12)** - improved performance of data centers networks without incurring cost for expensive (big-buffer) hardware switches. It is implemented in our core networking stack and deployed in Microsoft's data centers world-wide.

16) **Windows Azure Q10 Network (2009-10) -** hailed as one of the most significant recent advances in computer science, our CLOS network design led to an 80x improvement in dollars/Mbit/sec over previous designs. It has enabled blockbuster features such as highly-scalable Windows Azure Flat Network Storage. The researcher who developed this is now the Corporate Vice President and head of Azure Networking.

17) **Windows Virtual Wi-Fi (2009)** – allows an IEEE 802.11 miniport driver to connect to, or host, multiple simultaneous connections on a single wireless interface. Starting with Windows 7, it enabled concurrent corporate and guest access, range extension, and Internet gateway functionality. Before shipping, our prototype was downloaded 500,000+ times becoming one of the most popular MSR software download. **Wi-Fi Direct,** which ships in every Windows device (and in other OSs), uses Virtual Wi-Fi.

18) **NDIS WLAN extensions in Windows 2000, Windows XP, Vista & Windows 7 & 8 –** is the first set of industry-leading Network Device Interface Specification (NDIS) Wireless LAN (WLAN) OIDs (similar to IOCTLs) that enhanced the interface exposed by WinSock to program Wi-Fi cards. This lead to the successful Windows Native Wi-Fi program, which has lasted over 15 years.

Several additional projects e.g. cloud services for mobile (**Project Hawaii**), virtual compass, mesh networking, indoor localization (**RADAR**) etc. have influenced the design of various commercial products. Other recent success stories from my group include **Torch -** cloud testing for concurrency bugs (2017) and **Optimized DNN for CNTK** (2017). Early in my career at Microsoft, I led the initiative to bring Wi-Fi to the entire Microsoft Redmond Campus.

In-flight Technologies

1) **Video Analytics for Urban Mobility** (2015 -): is a highly-scalable, real-time, geo-distributed hybrid-cloud system, nick-named Rocket, for accurately analyzing live videos from city traffic cameras for reducing accidents and congestion and improving efficiency of movement on city roads. Rocket is deployed in Bellevue, Washington and as of Dec. 15, 2016 has been operating 24/7/365 covering five intersections, analyzing the number and direction of vehicles, pedestrians and bicyclist. Many other jurisdictions have requested us to deploy similar systems in their cities. We have received two national awards (a Mayor's award and a DOT award) with lots of favorable media coverage.

2) **IoT- Programming and Intelligent Edge Management** (2016 -): we are working closely with Azure IoT and Windows IoT to lower the barrier-to-entry for IoT applications. We have developed an easy to use programming framework and technology that increase the efficiency of the Azure IoT Edge with real-time monitoring and automatically partitioning computations between the edge and the Azure cloud. Windows IoT is evaluating our technologies as a differentiator from Linux IoT

Non-MSFT Shipping Technologies

Technologies shipped in Digital's (now Hewett Packard) Products and IEEE Standards

- **Digital's FullVideo** & **FullVideo Supreme (1992-95),** a special projects initiative that turned into a flagship audio/video multimedia hardware-software product for VAX, Alpha, and Pentium systems
- **Digital's Multimedia Library (1990-92)** an advanced development effort that became a stand-alone video compression and image rendering software library, shipping with every Ultrix and VMS machine
- **Image Rendering (1989-91)** state of art algorithms, shipped in several of Digital's graphic chips
- **Influence on IEEE 802.11 Standards**
  - IEEE 802.11ba is based on my MobiCom 2003 paper "Wake on Wireless"
  - IEEE 802.11e incorporates my distributed weighted fair scheduling algorithm;
  - IEEE 802.11s incorporates my ideas on multiple radios and fast channel switching, and
  - IEEE 802.15 (Bluetooth) local positioning incorporates my signal strength matching techniques

Awards & Recognition

- COMMENCEMENT SPEAKER 2018, School of Engineering & Applied Sciences, University of Buffalo, Amherst
- ACM FELLOW 2003; IEEE FELLOW 2008; AAAS FELLOW 2010
- IEEE KOJI KOBAYASHI COMPUTERS & COMMUNICATIONS AWARD 2018 (top award in networking)
- ACM SIGMOBILE LIFETIME OUTSTANDING CONTRIBUTIONS AWARD 2013 (top award in mobile systems)
- DISTINGUISHED ALUMNI AWARD, University of Buffalo (2017) (presented at CSE's 50th anniversary)
- DISTINGUISHED ALUMNI AWARD, University of Massachusetts (2012) (presented at Boston City Hall)
- ACM TEST OF TIME AWARD 2018 for *pioneering a multi-radio system that increases the lifetime of IoT devices*
- ACM TEST OF TIME AWARD 2016 for *pioneering a RF indoor location & tracking systems for mobile devices*
- BEST PAPER AWARDS: MOBISYS 2013; SIGCOMM 2009; CONEXT 2008
- National Awards from the US Government:
  - TRANSPORTATION ACHIEVEMENT AWARD 2017 for Safety via Video Analytics, Institute of Transportation Engineers & Canadian Institute of Transportation Engineers
  - U.S. MAYORS' CHALLENGE AWARD 2016 for Pedestrian & Bicycle Safety (Safer People, Safer Streets Summit, Washington, D.C.)
  - U.S. FEDERAL COMMUNICAIONS COMISSION (FCC) OPEN INTERNET APP AWARD 2011
  - U.S. FCC PEOPLE'S CHOICE APP. AWARD 2011 for a Mobile Network Measurement System
- IEEE OUTSTANDING LEADERSHIP & PROFESSIONAL SERVICE AWARD 2013, REGION 6
- IEEE OUTSTANDING ENGINEER AWARD 2010, IEEE REGION 6
- SIGMOBILE DISTINGUISHED SERVICE AWARD 2001, Association of Computing Machinery
- Awards from Microsoft:
  - HACKATHON 2017 GRAND PRIZE WINNER (4,750 projects/18K participants from 400+ cities, 75 countries)
  - INDIVIDUAL PERFORMANCE AWARDS 2007, 2010 & 2011 (top performing employees)
  - Microsoft's nominee to IPO's NATIONAL INVENTOR OF THE YEAR AWARD 2006 (reached final four)
  - SENIOR LEADER BENCH PROGRAM, Executive management for high performing Microsoft employees 2005
- By the numbers:
  - h-index: 90; citation count: 44,300+ (120+ papers); top 6 papers have 18,280+ citations; 77 papers have 100+ citations each (*source: Google Scholar*)
  - 150 United States Patents issued
  - 45+ keynote and plenary talks at major international conferences, symposiums & workshops
  - 60+ Distinguished seminars at MIT, Stanford, Berkeley, CMU, ETH, EPFL, UCL, UW, Yale, UTA, Wisconsin, UIUC, Rice, WUSTL, IIT-D…

- 17 Doctoral Dissertation Committees including MIT (5), Cornell, Harvard, UIUC, UCSD (2), Duke, Rice (2), University of Toronto, University of Maryland, and University of Roma, Rutgers
- 1000+ press articles in mainstream media including The New York Times, Technology Review, EE Times, Ars Technica, Boston Globe, Seattle PI, Information Week, Network World, New Scientist, DataQuest, Wired News, Geekwire, KIRO TV, etc.

- FEATURED in "People of Association of Computing Machinery" Feb. 19, 2015
- ACM DISTINGUISHED SPEAKER (2007-11); IEEE COMMUNICATIONS SOCIETY DISTINGUISHED LECTURER (2007-10)
- CHAIR, ACM Outstanding Contributions Award Committee on Mobility (1996-2011); IEEE Fellow Selection Committee, IEEE Computer Society (2009-10, 12); Fellow, University of Buffalo Research Foundation, 1986-88
- PHD FELLOWSHIP AWARD, Digital Equipment Corporation (now Hewlett Packard) 1994-96

Systems & Networking Research: Contributions & Impact

- **Edge Computing / Intelligent Edge / Disaggregated Clouds (micro datacenters, cloudlets)** (2009 -): Along with Mahadev Satyanarayanan (CMU), I envisioned, developed, & popularized edge computing, which has subsequently become a major technology extension of cloud computing. Published the first set of peer-reviewed papers that demonstrated how edge computing reduces latency and bandwidth to the cloud, dependence on the Internet, and reduces energy consumption of mobile and IoT devices. Introduced techniques for **cloud offloading** and **geo-distributed cloud analytics.** Microsoft's Azure IoT Edge, Amazon's AWS GreenGrass, IBM's Edge, Cisco's Fog, along with telecommunication companies and academic institutes have embraced our ideas. As of late 2017, the first two papers we published, in 2009 & 2010, have a citation count of 4200+. Also, I co-founded IEEE/ACM Symposium on Edge Computing and helped put together an NSF workshop on this topic. Currently working on a **real-time video analytics hybrid-cloud service** for urban mobility and Vison Zero. **Microsoft's CEO Satya Nadella** publicly announced "Intelligent Edge" as a Microsoft IoT strategy with an investment of $5B.

- **The world's first urban white space network (WSN)** (2003-10): Led a small team of researchers that designed, built and deployed the world's first WSN, nick-named "WhiteFi", on Microsoft's Redmond campus on Oct. 16, 2009. Spearheaded Microsoft's spectrum management proposals to the FCC. Published seminal papers in top conferences, started conferences & workshops (SIGCOMM, DySPAN, INFOCOM's CWCN, MSR's CogNet), edited special issues of IEEE Journals, gave close to a dozen keynotes, influenced government policy world-wide (FCC, TRAI, SARFT, ANATEL etc.) & funding (NSF). Became the focus of world-wide press coverage. Co-led the MS team that had a significant hand in the Nov. 4, 2008 and Sept. 23, 2010 FCC ruling that opened 180 MHz+ of spectrum for unlicensed use in the United States. Microsoft has deployed more than **twenty large-scale WSNs world-wide** (search for **"***Microsoft 4Africa***") connecting >185,000 students/people to the Internet**. Microsoft's Airband initiative has promised to connect **two million people** in rural America by July 4, 2022**.**

- **The first RF signal strength based indoor location determination system** (1999) Original papers have been cited over 10,000 times and in large part created the field of indoor positioning systems using commodity wireless LAN hardware. Several companies including Ekahau, Symbol, Nortel, Intel, Cisco, Nokia, NextNav, Google, and Microsoft have worked on commercializing similar ystem and many universities include this as part of their course work, using it as a foundation for research in wireless systems that go beyond communications, and specifically in location and context aware systems. Awarded 12 U.S. and international patents and received **ACM SIGMOBILE 2016 Test of Time Award** for this work**.**

- **The first wake-on-wireless system** (2003) Introduced the notion of using a low power radio (as a control channel) to "wake up" the high-power system to improve its energy profile. The original MobiCom paper, cited over 500 times, opened a new thread of research and products incl. UMASS's Turduken, Intel's CoolSpots, MSR's Cell2Notify, Somniloquy, GreenUp etc. Awarded 4 US patents for this work. Our paper (850+ citations) received the **ACM SIGMOBILE 2018 Test of time Awar**d and this work is the subject of the **IEEE 802.11ba** standard
- **The first multi-radio mesh & wireless LAN system** (2003) Introduced important new design ideas on using multiple radios to improve the performance of wireless mesh networks, wireless LANs, and cell phones. These designs have proliferated deeply into the computer and telecommunication industry. Awarded 8 patents,

published several papers with thousands of citations, and received considerable coverage from mainstream media for this work.

- **The first wireless virtualization architecture** (2002): Designed the first wireless virtualization architecture that enables a Wi-Fi card to connect to multiple networks simultaneously. Software downloads in the first year exceeded over 100,000 making it one of the most popular download in Microsoft Research's history. *Virtual Wi-Fi* became part of Windows 7 and Windows 8 and shipped to millions of users around the world. **It also powers** Window's (and other OS's) **implementation of Wi-Fi Direct**. Received many accolades from mainstream media. The design is fundamental to NSF's GENI WLAN virtualization efforts.

- **The world's first public Wi-Fi hotspot** (1999-2001): Deployed a Wi-Fi network in the Crossroads Shopping Center in Bellevue, Washington from June 11, 1999 to June 2001 (New York Times Article, Feb. 28, 2000). Today, the wireless edge server design is being used by all the major Wi-Fi equipment vendors (Aruba, Cisco, Meru, Broadcom etc.), beating out the competing IEEE 801.1x design. Published several papers, awarded 8 international patents & received significant press accolades.

- **Cognitive services for mobile computing** (2009 – 2012): Envisioned, developed, deployed and operated a *service-store* (**Project Hawaii**) that enabled developers to build sophisticated cloud-enhanced applications. Deployed a variety of cloud services (optical character recognition, speech-to-text, path prediction, social fabric, translation, relay, rendezvous, etc.) for Windows, Android, & IOS devices. Over 60 universities world-wide included our services in teaching senior and graduate-level mobile computing courses. 2015 onward similar cloud services were commercialized by all major cloud providers under the banner of **cognitive services.**

- **60 GHz (mm-wave) wireless links in datacenters (**2009-11): Demonstrated how mm-wave point-to-point links, built into top-of-the-rack (ToR) switches, can relieve congestion hot-spots in oversubscribed datacenter networks. Contrary to concerns about interference and link reliability, our design allowed many wireless links to operate concurrently at multi-Gbps rates. The design avoided rewiring costs in DCs and provided an intermediate step towards full bi-section bandwidth networks. The work resulted in multiple papers, patents, and was covered by popular press including the New York Times (July 14, 2012 issue).

- **Community mesh networking** (2003-07). Demonstrated mesh networking as an alternative broadband access technology in cities, neighborhoods, offices, and rural areas. Delivered keynotes & plenaries, and taught courses at premier conferences. Published multiple papers, awarded 8 international patents, received world-wide press coverage and accolades, and licensed our technology to several start-up companies. Put-together Microsoft's *Digital Inclusion Program* that provided $1.5M in research funding. Developed the **Mesh Networking Academic Resource Kits 2005 & 2007** as a teaching & research aid. Our kit was used by over 1200 Universities world-wide.

- **Enterprise & datacenter network management** (2005-10): Developed a unique end-to-end approach for diagnosing performance problems in large-scale enterprise & datacenter networks. Reduced diagnostics from days to minutes helping meet customer SLAs. In this approach, end-hosts collaboratively detect, diagnose, and recover from network performance problems. Unlike existing products, end-hosts gather, aggregate, and analyzing data at all layers of the networking stack to determine the root cause. Our system is being used actively by Microsoft XBox Live services

- **Co-designed & built the world's first commodity multimedia adapter for PCs** (1992). The hardware / software combination had real-time audio-video coding/decoding and image rendering capabilities. It was used world-wide for research in high-speed (ATM, FDDI) and packet video networks (Sequoia 2000, BERKOM, BAGnet & MBONE) and successfully productized by Digital Equipment Corporation.

Service and Professional Impact - Highlights

Founded / Co-Founded

- **ACM SIGMOBILE (Special Interest Group on Mobility of Systems, Users, Data and Computing)**. SIGMOBILE (1996 – present) is a non-profit professional organization that promotes research in a broad spectrum of topics sharing mobility as the common theme. I built this international organization from scratch. Managed

MobiCom, MobiSys, SenSys and MobiHoc and brought HotMobile and UbiComp conferences under its fold. Instituted prestigious awards (Outstanding Contributors Award & RockStar Award) and international chapters. The 1500+ members include researchers, academicians, practitioners, and government officials.

- **ACM MobiSys (International Conference on Mobile Systems, Applications and Services).** MobiSys (2003 – present) is the most prestigious mobile systems conference in the world. Architected a deal between the two largest computer science organizations. Authored the bylaws governing the conference, which were then used by other joint events (e.g. NSDI, SenSys). Chair of the Steering Committee since inception in 2003.

- **ACM Mobile Computing and Communications Review**, now called **GetMobile** (1997 – present), is a quarterly scientific Newsletter that contains peer-reviewed papers, standards reports, RF related health articles, conference and workshop reports, opinion columns, news stories etc. related to wireless communications and mobility. 1200+ subscribers worldwide. Editor-in-chief for 5 years, now a Senior Advisor to the editorial board

- Co-founded (& served on steering committee)
  - IEEE/ACM Symposium on Edge Computing (SEC) (2016 - …)
  - IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN) (2005 - 2016)
  - ACM Conference on Embedded Networked Sensor Systems (SenSys) (2003 - 2010)
  - International Conference on COMmunication Systems & NETworkS (COMSNET) (2009 -2012)
  - IEEE International Symposium of Wireless Communication Systems and
  - ACM Mobile Cloud Computing and Services Workshop (MCS) (2010- 2015)

- **Chair of MobiCom Steering committee** since 2001 & member since inception. Provided ~25 years of continuous leadership to one of the most cited conference in computer science. I am also its longest serving TPC member (since inception)

Advisory Boards

- WASHINGTON UNIVERSITY ST. LOUIS - Dept. of Computer Science & Engineering, (2017 – Present)
- UNIVERSITY OF MARYLAND - Institute for Systems Research, School of Engineering, (2013 – 2015)
- MASSACHUSETTS INSTITUTE OF TECHNOLOGY - Wireless Research Center, CSAIL (2012 – 2015)

PhD Student Advising / Thesis Committees (17)

- SHADI ABDOLLAHIAN NOGHABI, Building *Large-scale Systems for Latency-sensitive Applications (*UIUC – 2018)
- CLAYTON W. SHEPARD, *Design & Implementation of Many-Antenna Wireless Systems* (Rice University – Sept, 2017)
- SHUBHAM JAIN, *Design of Inertial & Camera Sensing for Smart Intersections* (Rutgers University – June 2017)
- TIFFANY YUAN CHEN **,** *Interactive Object Recognition and Search over Mobile Video* (MIT – June 2017)
- FADEL ADIB, *RF as a Sensing Modality for Wireless Networks* (MIT – August 2016) - **SIGMOBILE Doctoral Dissertation Award** winner
- ROBERT LIKAMWA, *Vision Sensing Pipeline for Efficiency & Privacy* (Rice University - 2016)
- HAITHAM HASSANIEH, *The Sparse Fourier Transform: Theory & Practice* (MIT- October 2015) - **ACM Doctoral Dissertation Award** winner
- HARIHARAN SHANKAR RAHUL, *Improving Spectrum Utilization in Wireless Networks* (MIT- August 2012)
- JUSTIN MANWEILER, *Building Blocks for Tomorrow's Mobile App Store* (Duke University - June 2012)
- ROHAN N. MURTY, *Opportunistic Wireless Network Architectures* (Harvard University – June 2011**)**
- YUVRAJ AGARWAL, *Aggressively Duty-Cycled Platforms to Achieve Energy Efficiency* (UCSD - 2009)
- IQBAL MOHOMED, *Interactive Content Adaptation* (University of Toronto – October 2008)
- SRIKANTH KANDULA, *Increasing the Robustness of Networked Systems* (MIT- July 2008)
- YUAN YUAN, *Enabling Dynamic Spectrum Allocation in Cognitive Radio Networks* (UMD College Park – 2007)
- RANVEER CHANDRA, *A Virtualization Architecture for Wireless Network Cards* (Cornell University – Sept. 2005)
- ANAND BALACHANDRAN, *Incorporating Location Awareness in Public-Area Wireless Networks* (UCSD- 2003)
- CHIARA PETRIOLI, *Energy Conserving Protocols for Wireless Comm.* (Univ. of Roma "La Sapienza" – June 1998)

Government Policy & Study Group Contributions

- Federal Communications Commission
  - Best Application and People's Choice Award in FCC Open Internet App. Challenge Award 2011
  - *White Space Networking,* Presentation to the FCC Chairman Genachowski, Redmond, WA (Aug. 14, 2010)
  - *White-Fi Network using TV white spaces spectrum*, FCC. Ex Parte (Apr. 29, 2010)
  - *Research Recommendation for National Broadband Task Force,* Washington, DC (Nov. 23, 2009)
  - *Broadband Spectrum: A Looming Crisis?* National Broadband Plan Field Hearing on Mobile Broadband, San Diego, CA (Oct. 8, 2009)
- National Science Foundation
  - Advisor & organizing committee, Workshop on *Edge Computing*, Washington DC (Oct. 26, 2016)
  - Critic, Workshop on *Future Directions in Wireless Networking, Arlington*, VA (Nov 4-5, 2013)
  - *Reactions & Perspectives on Future Wireless Communication Networks*, Arlington, VA (Nov. 2-3, 2009)
  - *Site Visitor*, $25M Renew Funding for Center for Embedded Network Sensing, UCLA, (June 7, 2006)
  - *NeTs Program PI Research Review,* UCLA August 5, 2010
  - *Study Group on Perspectives on Peer-to-Peer Networks,* Dagstuhl, Germany, April 20, 2005
  - *Study Group on Residential Broadband Revisited: Research Challenges in Residential Networks, Broadband Access and Applications*, Chicago, Illinois, USA (October 23-24, 2003)
  - *Network Research Testbed*, Chicago, IL, USA (October 17-18, 2002)
  - *Wireless Information Technology and Networking Initiative*, Study conducted by the Division of Advanced Networking Infrastructure and Research (CISE/ANIR) (July 1999)
  - *Networking Research Program*, Div. of Advanced Networking Infrastructure & Research, (Jan. 1999)
- COST (European Union*), Exchanges and Trends in Networking*, Chania, Greece (June 23, 2003)
- National Research Council, *The Intersection of Geospatial Information and Information Technology,* Study conducted by the CS and Telecommunications Board (CSTB), sponsored by NASA & NSF (Sept. 2001)

Noteworthy Leadership Activities / Positions

- ASSOCIATE EDITOR, ACM Transactions on Internet of Things (2018 -)
- ADVISORY BOARD MEMBER, IEEE Internet of Things Journal (2013 -)
- ASSOCIATE EDITOR, IEEE Transactions on Service Computing (2017 -)
- FOUNDER & CHAIR OF TECHNICAL COMMUNITY LEADERSHIP TEAM (2011-14), Mobile & Networked Systems Technical Community for senior level Microsoft employees
- GENERAL CHAIR, IEEE DySPAN 2012, ACM SIGCOMM 2008, IEEE IWCS 2007, IEEE COMSWARE/COMSNET 2005, IEEE ISWC 2001, and ACM MobiCom 1999
- STEERING COMMITTEE CHAIR, MobiCom (2002-present), MobiSys (2002-present), MCS (2009-14)
- STEERING COMMITTEE MEMBER**,** IEEE/ACM Symposium on Edge Computing (2015 – present); IEEE DySPAN (2004-16); IEEE Wearable Information Systems (2002-12); IEEE Communications Systems Software and Middleware (2005-10); IEEE Symposium on Wireless Com. Systems (2006 – present); ACM SenSys (2002-05))
- SEARCH COMMITTEES: IEEE Pervasive Computing EiC 2009, ACM MC2R EiC 2010, IEEE ISWC 2001-present
- PROGRAM COMMITTEE CHAIR, ACM/IEEE Symposium on Edge Computing (2018): ACM Vehicular Ad hoc Networking Workshop (2006), IEEE Symposium on Wearable Computers (2001), IEEE Conference on Wireless Mobile Multimedia (2001)
- ACM SIGMOBILE CHAIR (2001-05); Vice Chair (1996– 2001), Executive Committee (2005-09)
- PROGRAM COMMITTEE MEMBER of over <u>six dozen</u> technical conferences, symposiums, and workshops
- EDITOR-IN-CHIEF, Mobile Computing and Communications Review (1996 - 2001), SENIOR ADVISOR (2001-)
- EDITORIAL BOARD MEMBER**,** Kluwer's Telecommunications Systems Journal (2001-06), Elsevier's Adhoc Networks Journal (since inception in 2002-05), IEEE Journal on Selected Areas in Communications (1997-1999), ACM Journal on Wireless Networks (1997-2003)

- GUEST EDITOR, IEEE Journal on Selected Topics in Communications, (Sept. 2009), IEEE Journal on Selected Topics in Communications, (May 1999), ACM Mobile Networks and Applications Journal (June 1998), IEEE Communications Magazine (June 1998)
- WORKING GROUP CHAIR, Bluetooth WG on Location determination & management (1999-2000)
- PANELIST ACM/IEEE SEC'17, MobiCom'14**,** DySPAN'10, MobiSys'09, MobiCom'07, ISWCS'07, DySPAN'06, MobiHoc'05, MobiCom'04, NOSSDAV'04, WMASH'03, WoWMoM 2003, Hot Interconnects'02, ISSCC'00, MobiCom'97, IC3N'95 (incomplete)
- DIVERSITY: Invited speaker at N2Women workshops (4 times); ACM Women's Workshop '17

Mind-Swaps / Brain-Storming

I have organized over a dozen internal brainstorming events, which led to several successful cross-organizational projects. I have also organized several **external** events (here's a sample):

- UW/MSR Summer Institute on *Unfolding the Future of IoT*, Snoqualmie, WA (July-Aug. 2017)
- Microsoft 17th Annual *Faculty Summit*, Redmond, WA (July 2016) (Chief guest: Bill Gates)
- Microsoft Research ***25th Anniversary Celebrations,*** Redmond, WA (July 2016)
- Microsoft Research *Graduate Student Summit* on *Networked Systems,* California (Feb. 2016)
- Annual (NSF style) Networking Summits (general 2.5 days each) on
  - *Data analytics & networking, Woodinville, WA (2012)*
  - *Mobile + Cloud, Bellevue, WA (2010)*
  - *Edge networking* (2006);
  - *Self-managing networks* (2005)
  - *Networking dreams*, Redmond, WA (2011)
  - *Cognitive networking, Redmond, WA (2008)*
  - *Wireless networking*, Goa, India (2005)
  - *Mesh networking*, Redmond, WA (2004)

Executive Leadership Training

Leadership Principles • Business and Organizational Leadership • Leading Across Enterprise • Advanced Technology Pitch • Media/PR Training • Coaching High Potential Employees • Senior Corporate Bench Program • The Leaders Voice: Values in Action • Dialog across Differences • Standards of Business Conduct • Data Privacy • Inclusive Hiring • Objective Interviewing • Growth Mindset …

Education

DOCTOR OF PHILOSOPHY, Electrical & Computer Engineering — June 1997
Thesis: *Real-Time Visual Communications Over Narrowband Wireless Radio Networks*
University of Massachusetts, Amherst, MA (**Digital Equipment Corporation PhD Fellowship 1995-97**)

MASTER OF SCIENCE & BACHELOR OF SCIENCE, Electrical & Computer Engineering — Jun. 1988 / Jun. 1986
MSEE Thesis: *Recognition of Handwritten Script: A Hidden Markov Model Approach*
BSEE Thesis: *Conic Shape Detection Using a Non-Linearized Iterative Approach*
University of Buffalo, State University of New York, New York

Personal

US citizen; married (28+ years), two children: son is in 3rd year medical school, daughter recently graduated from Cornell University with a degree in computational Biology; wife is founder & CEO of Computing Kids (CK) whose mission is to empower every student in every school by teaching them computer science and its applications. CK focuses on middle school students, especially underrepresented minorities. In 2015 my wife & I co-founded a 501(c)(3) non-profit organization Computing For All, which organizes a state-wide middle school computer science competition.

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