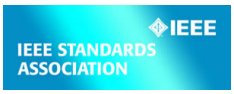

IEEE Silicon Valley 5G Summit

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5G Technology - Breaking Grounds from Thingbook to the Tactile Internet

Prof. Gerhard P. Fettweis
Vodafone Chair, TU Dresden

Abstract

Looking back, infrastructure based wireless systems have been deployed mainly for communicating content, i.e. messages, files, pictures, voice, and more. With the onset of 5G infrastructure, we have the chance to address two new application domains, firstly to deploy and connect any sensor, and secondly to control real and virtual objects (the Tactile Internet). Technology challenges for reaching these goals are manifold, as completely new requirements have to be met. The good news is that we do not to need to achieve simultaneously

- a data rate of 10Gb/s,
- a high reliability measured in an outage of 10^{-8},
- a 1ms round-trip latency
- and operation of 10 years running off a 1000mAh battery.

Instead we can we design a new framework for realizing 5G requirements by applying some novel key technologies.

Biography

Gerhard P. Fettweis earned his Ph.D. under H. Meyr's supervision from RWTH Aachen in 1990. After one year at IBM Research in San Jose, CA, he moved to TCSI Inc., Berkeley, CA. Since 1994 he is Vodafone Chair Professor at TU Dresden, Germany, with 20 companies from Asia/Europe/US sponsoring his research on wireless transmission and chip design. He coordinates 2 DFG centers at TU Dresden, namely cfaed and HAEC. Gerhard is IEEE Fellow, member of the German academy acatech, and his most recent award is the Stuart Meyer Memorial Award from IEEE VTS. In Dresden he has spun-out eleven start-ups, and setup funded projects in volume of close to EUR 1/2 billion. He has helped organizing IEEE conferences, most notably as TPC Chair of ICC 2009 and of TTM 2012, and as General Chair of VTC Spring 2013 and DATE 2014. Currently Gerhard is on sabbatical leave, and is a PI at ICSI/Berkeley as well as visiting professor at BWRC/Berkeley.

Disruptive Tech. Is 5G The Next Frontier?

Prof. Mischa Dohler
Kings College London

Abstract

Each Internet generation was believed to be the last, with designs pushed to

near perfection. The first and original Internet, a virtually infinite network of computers, was a paradigm changer and went on to define the economies of the late 20th century. However, after that Internet came the Mobile Internet, connecting billions of smart phones and laptops, and yet again redefining entire segments of the economy in the first decade of the 21st century. Today, we witness the emergence of the Internet of Things, shortly to connect trillions of objects and starting to redefine yet again various economies of this decade. Is that it? Surely, so we argue, there is something much, much bigger at stake still: the Tactile Internet. It is a true paradigm shift, in which sufficiently responsive, reliable network connectivity will enable it to deliver physical, tactile experiences remotely and thereby invoke an important shift from content-delivery to skillset-delivery networks. For this to work however we require some fundamental laws of physics to be reengineered. This keynote is all about the disruptive technology approaches, including 5G, which will allow us to break through this next tech frontier.

Biography

Mischa Dohler is full Professor in Wireless Communications at Kings College London, Head of the Centre for Telecommunications Research, co-founder and member of the Board of Directors of the smart city pioneer Worldsensing, Fellow and Distinguished Lecturer of the IEEE, and Editor-in-Chief of the Transactions on Emerging Telecommunications Technologies and the EAI Transactions on the Internet of Things. He is a frequent keynote, panel and tutorial speaker, and has received numerous awards. He has pioneered several research fields, contributed to numerous wireless broadband, IoT/M2M and cyber security standards, holds a dozen patents, organized and chaired numerous conferences, has more than 200 publications, and authored several books. He has a citation h-index of 40. He acts as policy, technology and entrepreneurship adviser, examples being Richard Bransons Carbon War Room, House of Parliament UK, UK Ministry BIS, EPSRC ICT Strategy Advisory Team, European Commission, Tech London Advocate, ISO Smart City working group, and various start-ups. He is also an entrepreneur, angel investor, passionate pianist and fluent in 6 languages. He has talked at TEDx. He had coverage by national and international TV and radio; and his contributions have featured on BBC News and the Wall Street Journal.

5G Vision and Design

John Smee
Qualcomm

Abstract:

Mobile communications is evolving quickly with significant increases in the number of connected devices and applications demanding higher levels of performance. To support these expanded connectivity needs, the industry is actively engaging in 5G research, development, and standardization. This presentation summarizes key 5G design approaches for supporting diverse requirements across licensed, unlicensed and shared licensed spectrum in both sub-6GHz and above-6GHz bands including mmWave. We describe several key PHY/MAC techniques, including Massive MIMO, self-contained subframes, device-centric MAC, and low latency and high-reliability design, as well as network architecture improvements. The combination of advanced techniques is focused on providing not only the flexibility to support growing use cases and spectrum bands but also the performance, capacity, and scalability required for cost effective 5G services.

Biography:
Dr. John E. Smee is a Senior Director of Engineering at Qualcomm Technologies Inc. He joined Qualcomm in 2000, holds 54 US Patents, and has been involved in the system design for a variety of projects focused on the innovation of wireless communications systems such as CDMA EVDO, IEEE 802.11, and 3GPP LTE. His work involves taking advanced system designs and signal processing techniques from theory through design, standardization, implementation, and productization. He is currently the 5G project engineering lead in Qualcomms research and development group. John is a recipient of the Qualcomm Distinguished Contributor Award for Project Leadership and participated in the National Academy of Engineering Frontiers of Engineering program. He received his Ph.D. in electrical engineering from Princeton University, and also holds an M.A. from Princeton and an M.Sc. and B.Sc. from Queen's University.

The Future of Wireless: 5G and the impact on Society

Dr. Ian Wong
National Instruments

Abstract
Wireless data increasingly plays a key role in every aspect of our lives, and there is growing industry consensus that by 2020, networks can expect a 1,000-fold increase in mobile data traffic. What is beyond 4G? New and innovative approaches to solve these challenges include 5G waveforms, network densification, massive MIMO, and mmWave communications. Find how wireless researchers in academia, and industry are framing the future of wireless communication with 5G technologies. This session includes an

overview some of the latest candidate 5G technologies, their progress and their potential to address the 5G requirements.

Biography
Dr. Ian C. Wong manages the Advanced Wireless Research group at NI, where he oversees the companys 3GPP and 802.11 wireless standards strategy and platforms for wireless system design, simulation, prototyping, and implementation. From 2007 to 2009, he was a systems research and standards engineer with Freescale Semiconductor, where he represented Freescale in 3GPP LTE standardization efforts. Wong, who holds six patents, has coauthored the Springer book Resource Allocation for Multiuser Multicarrier Wireless Systems, written over 25 peer-reviewed journal and conference papers, and made over 40 standards contributions. He was awarded the Texas Telecommunications Engineering Consortium Fellowship in 2003, and he received the Wireless Networking and Communications Group student leadership award in 2007. He holds masters and doctorate degrees in electrical engineering from The University of Texas at Austin and a bachelors degree in electronics and communications engineering (magna cum laude) from the University of the Philippines.

Key Issues and Architecture for 5G

David Wolter
AT&T

Abstract
This talk will discuss some of the key trends and technologies required for 5G, and discuss key capabilities and implications of latency in transport networks that will be used. The system and equipment architecture must be defined in such a way that transport methods of varying latency can be used, implying the need to examine different approaches to functional layer splits and new open interfaces.

Biography
Dave Wolter is the Assistant Vice President of the Radio Technology and Strategy group at AT&T Labs. He directs a team responsible for identification, assessment and evolution of leading edge radio technologies and architecture in support of AT&T.s wireless businesses. The scope of his responsibilities includes mobile systems, Wi-Fi, and fixed wireless access systems with a focus on radio system performance. His group also supports strategic analysis, spectrum strategy, and standards development. Dave began his career with what was then SBC in 1991. Prior to joining SBC, he was

a Unit Chief in the Electronics Technology division of the McDonnell Aircraft Company where he performed avionics, communication, and reconnaissance systems simulation and led a team of engineers in the analysis and specification of advanced stealth aircraft communication systems. Dave holds BS and MS degrees in Electrical Engineering from Washington University in St. Louis.

5G and the Network of Tomorrow

Udayan Mukherjee,
Intel

Abstract

Contemporary wireless networks must efficiently handle large traffic volumes generated by a variety of mobile platforms. These networks connect mobile devices to the servers in the data center and traditionally consist of static well defined, vertical nodes like Radio Access Network and Core Network. However, the network architecture as we know today, may not be sufficient to serve the use cases of next 10 years and beyond. The requirements from tomorrows 5G use cases as well as new deployments, deplorers and disruptors are bringing fundamental changes and the need a collective rethinking of how a network needs to get designed/deployed. In this talk we will discuss some of these evolving use cases, trends and architectural evolution that that we foresee for the network of tomorrow.

Biography

Udayan Mukherjee is the Senior Principal Engineer at DCGs Network platform Group and leads Intels technology and product architecture effort for Wireless Network. Udayans architecture work involves LTE as well as system design for next gen radio access and core network, including Cloud-RAN, Macro & Micro base stations, Small Cells, Mobile edge Platforms, as well as various Gateways and Core. Udayan has over 25 years experience in designing Communications/ compute systems in various companies and startups, including last 15 years at Intel. Over the years, Udayan has worked on design & development of various carrier grade network systems, led various technology, architecture and product teams as well as worked closely with external MNOs, Equipment manufacturers, software developers, and standard bodies. Prior to the current role, Udayan was the chief technologist for the AdvancedTCA* based Telco server products at Intel and was involved in original development work on blade based Highly-Available switched architecture for dense server and telecom appliances at Intel. Udayan led technology direction of a 100+ engineers organization that was involved in developing key elements of PICMGs ATCA blade specification as well as developing Industrys first set of ATCA carrier grade products for core network and gateways. Udayan also directed Intels architecture effort in developing Telecom Software program for Telco industries including the release for Industrys first Telecom Linux specification which formed the draft based on which open-source Carrier Grade Linux specification was later developed. Before joining

Intel in 2000, Udayan spent 10+ years in leading Engineering and system level engineering teams in various companies and startups including more than 7 years at Hewlett Packard, defining high availability SW/system products on PA RISC/HPUX and working with telecom carriers to help shape HP's HA product plans with carriers/service provider/telco market segments. Udayan is a senior member of both IEEE & ACM. He has around 10 issued patents from US patents office as well as around 2 pending in areas of signal processing/wireless, carrier grade, interconnect, memory power management and high availability.

5G: Path to Zettabyte Mobile Internet

Dr. Farooq Khan
Samsung Research

Abstract
Wireless communications along with the Internet has been the most transformative technology in the past 50 years. We expect that wireless data growth driven by new mobile applications, need to connect all humankind (not just 1/3) as well as Billions of things to the Internet will require Terabit/s data rates and Zetabyte/ month capacity. We present a new scalable radio architecture that we refer to multi-comm-core (MCC) to enable low-cost ultra-high speed wireless communications using both traditional and millimeter wave spectrum.

Biography
Farooq is currently President of Samsung Research America in Dallas, Texas, where he leads high impact collaborative research programs in mobile communications and IoT. Farooq sees a World where Internet of connected people and things will make us more aware of humanity as a whole and help create a shared wisdom to solve Humanity's greatest challenges. Farooq is also a distinguished inventor, author and speaker. He holds over 200 U.S. patents, has written 50 research articles and authored a book on LTE for 4G Mobile Broadband.

Multiuser MIMO for MM Band

Prof. Arogyaswami Paulraj
Stanford University

Abstract
This talk describes some of the air interface drivers for 5G mobile standard and the emerging thinking about services, technologies and architectures.

In particular the use of massive MIMO in the millimetric band is discussed. While this approach promises significant increases in throughput and spectral efficiency, the talk will summarize a number challenges around propagation and implementation technology.

Biography
Prof. Paulraj is an Emeritus Professor at Stanford University. After a 30 year R&D career in India, Paulraj joined Stanford University in 1992. He proposed the MIMO (Multiple Input Multiple Output) concept in 1992 which is the key to todays 4G cellular and WiFi wireless networks. Paulraj has published over 350 archival papers and a co-inventor in over 60 patents. Paulraj founded two companies in wireless semiconductors. Paulrajs recognitions include the 2014 Marconi Prize, the 2011 IEEE Alexander Graham Bell medal and 2010 Padma Bhushan (Indian National Award). He is a member of eight national academies including the US National Academy of Engineering.

Riding the mobile traffic tsunami: Opportunities and threats in the making of 5G Mobile broadband

Jerry Pi
Straight Path Communications

Abstract

5G is shaping up to be the solution to the explosive demand for mobile broadband in the next decade. From technology perspective, the change of carrier frequency from ¡3 GHz to mmWave frequencies is nothing short of a paradigm shift, which requires new RF systems with antenna arrays, power amplifiers, and RFICs that are completely different from 1/2/3/4G cellular systems. In addition, the economics of mobile broadband dictates that 5G networks must achieve wide area coverage with similar level of total cost of ownership as previous generation networks. In this talk, we explain how this mandate translates into key performance and cost metrics for 5G network architecture and radio air interface design, and how these requirements impact the design of key building blocks. In some cases, these new building blocks do not align well with the current cellular transceiver architecture and how the current mobile communication ecosystem is structured. On the one hand this misalignment presents exciting new business opportunities. On the other hand it may threaten some of the current businesses. We identify these areas where disruptions may occur and suggest strategies for incumbents and new entrants in these areas. In addition, 5G will also enable disruptive innovations beyond smartphones. We discuss a few possibilities that have the potential to leverage the power of wide area Gbps mobile broadband enabled by 5G.

Biography

Jerry Pi is the Chief Technology Officer of Straight Path Communications Inc., a leading communication asset company with one of the largest 39 GHz and 28 GHz spectrum portfolios in the United States. He leads the mobile communication technology strategy and R&D that maximize the value of these assets. Prior to joining Straight Path, Jerry was a Senior Director at Samsung Research America in Dallas, Texas, where he led system research, standardization, and prototyping activities in 4G and 5G. Jerry pioneered the development of millimeter-wave technologies for 5G. He authored the world's first invention and first journal article on millimeter-wave mobile broadband. He also led the development of the worlds first 5G baseband and RF system prototype that successfully demonstrated the feasibility of 5G mobile communication at 28 GHz. During his tenure at Samsung, Jerry has also managed a variety of emerging technology research programs in smart home and IoT solutions, wearable devices, bio-signal processing and computing, mobile health, and medical imaging. Before joining Samsung in 2006, he was

with Nokia Research Center in Dallas and San Diego, where he was a leading contributor to Nokia's 3G wireless standardization and modem development efforts for 3GPP2 1xEV-DV, 1xEV-DO, and Ultra Mobile Broadband systems. He has authored more than 30 technical journal and conference papers and is the inventor of more than 100 patents. He holds a B.E. degree from Tsinghua University (with honor), a M.S. degree from the Ohio State University, and an MBA degree from Cornell University (with distinction). He is a Senior Member of IEEE.

Characterizing mmWave Channels for 5G

Gregory VanWiggeren
Keysight

Abstract

"To accommodate continued rapid growth (60+% annually) in demand for wireless data, future 5G networks must provide orders of magnitude increases in both data rate and capacity. Given the limited prospects for new spectrum or efficiencies below 6 GHz, network operators are compelled to look to higher frequency bands (millimeter waves) to meet these needs. Many potentially suitable millimeter-wave (mmW) bands have been identified, and their associated bandwidths are typically significantly larger than what is available below 6-GHz. However, a simple extrapolation of todays wireless technologies to mmW bands will not be sufficient. Millimeter wave signals, for example, suffer from much higher path losses that must be mitigated with new technologies and approaches, e.g. massive MIMO. Furthermore, fundamental physics suggests that the properties of mmW channels are dramatically different than those of todays sub-6 GHz channels. Accurate channel sounding of real-life mmW channels is a pre-requisite for understanding the impact of these differences and for the design of robust mmW networks. In this presentation, I will discuss the concept of channel sounding and describe existing methods for doing soincluding the benefits and challenges of each approach. Ill then highlight an approach developed in Keysights central research laboratories for MIMO mmW channel sounding and describe its realization using mmW test instrumentation. Finally, Ill discuss actual measurement results and show how these results can be translated, using SW tools, into channel models to support the design of future 5G mmW networks.

Biography

Greg VanWiggeren manages the physical measurements group in Keysight's central research laboratories. In that role, he oversees a diverse portfolio of research spanning the electromagnetic spectrum from RF to photonics. 5G and its related measurement challenges are an important research focus for Greg and his group. Prior to joining Keysight Technologies (then Agilent Technologies) in 2000, Greg earned his Ph.D. and M.S. in physics from Georgia Tech. He also earned a B.S. in physics (summa cum laude) from the Univ. of Illinois in 1995. //

Vertical Industry Platform (VIP) for 5G (a WWRF platform addressing the challenges of IoT in 5G)

Ming Lei
Huawei and WWRF

Abstract

WWRF is the unique global forum that brings together industry and academia to address research and other challenges to developing a really wireless world. In June 2015, ITU-R officially released the naming, usage scenarios and requirements of 5G (IMT-2020). Among the three usage scenarios (enhanced mobile broadband, massive machine-type communications and ultra-reliable low-latency communications) defined by ITU-R, the latter two belong to the category of vertical industry applications. However, the introduction of vertical industries into 5G mobile network will not be straightforward, as they have different knowledge sets and speak in different technical languages. Taking vehicular communications as an example, the automotive engineers may not understand what modulation, channel coding or multiple access means while the telecom engineers may have very limited knowledge of the mechanics, radar and sensors built in a car. These gaps between the telecom and vertical industries have become a stumbling block on the road towards 5G. To address this challenge, WWRF has devised a platform called the vertical industry platform (VIP) for 5G. VIP is a pre-standards platform where the important standardization topics especially the use cases and technical requirements related to the vertical industries in 5G will be developed. WWRF is also planning on creating more VIP working groups to address the different vertical industry applications including e-Health, wearables, energy, smart metering, home automation and so on.

Biography

Ming Lei received the B.Eng. degree from the Southeast University in 1998 and the Ph.D. degree from BUPT (Beijing University of Posts & Telecommunications) in 2003, all in Electrical Engineering. From April 2003 to February 2008, he was a research scientist with the National Institute of Information and Communications Technology (NICT), Japan, where he contributed to Japans national projects on 4G mobile communications (MIRAI projects) and IEEE standardization of 60-GHz multi-gigabit WPAN (IEEE 802.15.3c). From March 2008 to May 2009, he was a project lead of Intel Corporation, where he contributed to the standardization of WiGig (60-GHz WPAN), IEEE 802.11ad (60-GHz WLAN) and IEEE 802.16m (mobile WiMAX). From May 2009 to January 2014, he was with NEC Laboratories China, NEC Corporation, as the department head managing the wireless research & standardization projects on 4G cellular mobile communications

(LTE and LTE-Advanced), 60-GHz and mobile backhaul. From February to September, 2013, he was with Stanford University as a distinguished visiting scholar. From February 2014 to February 2015, he was with Samsung Electronics as a research manager. In March 2015, he joined Huawei Technologies as the technical lead of 5G standards. In April 2015, he was appointed by WWRF as the vice chair. Dr. Ming Lei was elected to IEEE Senior Member in 2009.

Information Theoretic Concepts of 5G

Ivana Maric
Ericsson

Abstract

I will review several 5G scenarios that lead to information theoretic problems, and will then focus on two of them. In the first scenario, I will consider communications in wireless networks with relays. These networks will find applications in 5G systems to enable mesh networking, e.g. in wireless backhaul at high frequencies and massive machine-type-communications. For such networks, noisy network coding (NNC) achieves the best known performance that is within a constant gap from the network capacity. In 5G multihop applications, however, this gap may not be negligible. Furthermore, the implementation of NNC is challenging. I will present a low complexity NNC scheme that overcomes these problems and can lead to practical solutions for 5G mesh networking. I will then discuss channel coding problems arising in 5G. Recent breakthroughs in polar codes have posed them as a promising candidate for 5G. While polar codes can achieve the capacity of large class of channels, previous constructions of rate-compatible polar codes that can be used for HARQ-IR have a gap to capacity. I will present a novel design of rate-compatible polar codes that are capacity-achieving. Based on joint work with Song-Nam Hong, Dennis Hui and Giuseppe Caire.

Biography

Ivana Maric is a Senior Researcher at Ericsson Research, San Jose, CA. She received her B.S. degree from the University of Novi Sad, Serbia. She received her M.S and Ph.D. at the Wireless Network Information Laboratory (WINLAB), Rutgers University in 2000 and 2006, respectively. From 2006 to 2010 she was a postdoctoral scholar at Stanford University. Prior to joining Ericsson Research in 2013, she worked at Aviat Networks, Santa Clara, CA. Focus of her research is on network information theory and wireless communications. Together with Gerhard Kramer and Roy Yates, she is a co-author of the monograph Cooperative Communications published by NOW Publishers

in 2006. From 2009 to 2012 she served as an Associate Editor for the IEEE Communications Letters. In 2013, together with Andrea Goldsmith, Syed Ali Jafar and Sudhir Srinivasa, she was awarded the 2013 IEEE Communications Society Best Tutorial Paper Award for the paper ""Breaking Spectrum Gridlock with Cognitive Radios: An Information Theoretic Perspective.

Why Virtualization is Essential for 5G

Francis Chow
Altera

Abstract

The wide success of wireless connectivity is undeniable as connecting people anytime anywhere, but so too are the issues that are emerging: high network operating expenses, insufficient flexibility and lack of scalability. The 5G wireless network is targeted to achieve a much higher capacity, but perhaps more importantly it needs to be designed to reduce the total cost of ownership of connecting a massive network of people and also things. Moreover, as emerging over-the-top providers challenge the preeminence of existing network operators, there is a strong need to support new business models and diverse value-added services via building an elastic infrastructure. One key technology in achieving these disparate goals is Network Function Virtualization(NFV), where flexible and general purpose hardware resources can be used to support an elastic infrastructure, such as Cloud RAN. FPGA plays a pivotal role in this environment, acting as a reprogrammable hardware accelerator to reduce total cost of ownership and enable virtualization of processing resources for network optimization, value-added services and future-proofing.

Biography

Francis Chow has been with Altera for 10 years and is currently Vice President and General Manager of the Communications Business Unit, responsible for the wireline and wireless business. He has previously held leadership roles in field applications engineering, business management and corporate development. Prior to Altera, Mr. Chow managed an ASIC design team at Texas Instruments focusing on DSL and VoIP chips. He has 6 patents on DSL and FPGA technologies. He has published and presented a number of papers in key conferences, such as IEEE ISSCC and IEEE GLOBECOM, and has a number of ITU standard contributions for DSL. Mr. Chow holds an MBA and an MSEE from UC Berkeley, and a BSEE from Rensselaer Polytechnic Institute.

Panel: The Journey to 5G Market, Standardization and Adoption

Don Clark, Rob Fish, Christoph Thuemmler, Paul Polakos
Cable Labs, IEEE Communications Society, TUM, Cisco

Biography

Don Clarke is a leading member of the Network Technologies team at CableLabs. In his former R&D leadership role at BT, Don initiated and co-founded the ETSI Network Functions Virtualisation Industry Specification Group (NFV ISG). The NFV ISG is the leading industry forum converging telecommunications industry requirements for NFV technology. He is a member of the NFV ISG leadership team and chairs the Network Operator Council. Don edited the joint-carrier white paper on NFV published in October 2012 co-authored by 13 carriers. This document is widely regarded as the seminal document heralding NFV as the future direction for telecommunications networks. Working with industry colleagues, Don was instrumental in the creation of the open source community Open Platform for NFV (OPNFV) launched in September 2014. CableLabs is a founding board member of OPNFV. He holds a BSc. (Hons) Degree in Computer Systems from the University Of Essex, England and he is registered in the UK as a Chartered Engineer. He has co/authored nine patents relating to PON technology. Don is based in Joplin-Missouri USA and commutes regularly to the CableLabs locations in Louisville-Colorado and Sunnyvale-California.

Robert S. Fish received his Ph.D. from Stanford University. Currently, Dr. Fish is President of NETovations, LLC, a consulting company focused on the creation of communications and networking technology innovation. From 2007 to 2010, he was Chief Product Officer and Senior VP at Mformation, Inc. specializing in carrier software for mobile device management. From 1997 to 2007, Rob was Vice President and Managing Director of Panasonic US R&D laboratories working on the embedding of networking in consumer devices. Prior to this, he was Executive Director, Multimedia Communications Research at Bellcore after starting his career at Bell Laboratories. Dr. Fish has over 30 publications and 17 patents. During his career, Dr. Fish and his organizations have initiated and managed standards development activities in IEEE, ISO/IEC JTC1, 3GPP, OMA, IETF, ATSC, CableLabs, OSGi, and several others. Rob is the Vice President of Standards Activities of the IEEE Communications Society. He is a member of the Board of Governors of the IEEE Standards Association, Chair of IEEE-SAs Global Committee, and a founding member of the IEEE-SA Corporate Advisory Group. He co-edited a series in IEEE Communications Magazine on IEEE standards in communications and networking. He is Co-founder and Steering Committee Chair of ComSocs Consumer Communications and Networking Conference and a member of the IEEE Conferences Committee. For his leadership and

contributions to the Multimedia Communications Technical Committee, Dr. Fish was the recipient of MMTCs Distinguished Service Award.

Christoph studied Medicine, Political Science and Education at Heidelberg University and spent time for a clinical Internship at SUNY at Stoney Brook, New York. He completed a Ph.D on Cerebral Haemodynamics with distinction at Heidelberg University, Germany. After completing specialist training in General Internal Medicine, Geriatric Medicine and Emergency Medicine in Germany and the United Kingdom he focused on applications of the Internet of Things in e-health, virtualization of care and cloud computing. He is Professor of E-Health at Edinburgh Napier University and Technical University Munich and is working with several large multi-national enterprises on the development of next generation health care services. He serves as an expert on the EU-China advisory board on the Internet of Things and is the convener of the Health-Vertical Group of the European 5G Association. His current research focus is Health 4.0.

Paul Polakos is a Cisco Fellow in the Chief Technology and Architecture office at Cisco Systems. He joined Cisco in 2012 and currently leads the effort to define a new foundation for 5G mobile networks based on Information Centric Networking research. Prior to joining Cisco, Paul was the Director of Wireless Networking Research at Bell Labs (Alcatel-Lucent) in Murray Hill, NJ and in Paris, France. In his 28 years in Bell Labs Research, he worked on a broad variety of topics in physics and wireless networking and led teams that were instrumental in the creation of key technologies for digital cellular systems including flat-IP cellular networks, femtocells, intelligent antennas and MIMO processing, radio signal-processing ASICs, and dynamic network optimization for autonomic networking. //

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