

EE Future Networks Initiative

abling 5G and Beyond Chairs: Ashutosh Dutta (JHU/APL), Gerhard Fettweis (TUD), Timothy Lee (Boeing)

old Tepper, IEEE Senior Program Director

sented by: Ashutosh Dutta and Sudhir Dixit

rch 25, 2019





IEEE Membership By Region



2018 FDC Initiatives & Activities



Graduated Initiativ

From IEEE 5G to IEEE Future Networks

he Tech

munity!



• 5G has promised us ultralow latency and record-breaking data speeds, which will enable advances in everything from small cell research to virtual reality applications. This technology will create tremendous growth opportunities, but it won't stop there. That is why, in August 2018, the IEEE 5G Initiative has rebranded to become the IEEE Future Networks Initiative. The Initiative will pave a clear path through development and deployment of 5G and beyond. We will accomplish this through the creation of:



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IEEE OUs

- **IEEE STANDARDS ASSOCIATION**
- EEE EDUCATIONAL ACTIVITIES

Initiative Profile

- Launched August 2016
 - Technical Activities Board Funded
 - 20+ Participating Societies/OUs



enetworks.IEEE.org





o on 5G Technologies First Responder

and presentations of the 3 October 2018

Wireless Predictions 2019 Read more at ECN.

Low Min.

Are you Ready to Look at 6G? Read more at Telecoms.com.





EE Future Networks Initiative Organization Structure



ed by a steering committee of 30 leaders from a diverse set of Future Networks-related IEEE Societies



The global team of experts involved in IEEE Future Networks are producing programs and activities including...

ne Future Networks Roadmap	Standards	Conferences & Events
-term (~3 years), mid-term (~5 years), nd long-term (~10 years) research, nnovation, and technology trends	Global, open, and collaborative	IEEE 5G Summits IEEE 5G World Forums Future Networks-related IEEE conferen
Education	Expert Articles	Publications

oadmap Structure – Leadership and Working Group Co-chairs Leadership Team: Rose Quingyang Hu/co-chair, Chi-Ming Chen/co-chair Ashutosh Dutta, Gerhard Fettweis, Timothy Lee, Paolo Gargini

dardization Building Blocks	Massive MIMO	Security	NEW FOR 2019	
Paul Nikolich		Ashutosh Dutta	Systems Optimization	
Alex Gelman	Rose Quingyang Hu	Ana Nieto	Ashutosh Dutta	
Purva Rajkotia	Dongming Wang	Ahmad Cheema	Kaniz Mahdi	
Mehmet Ulema	Chris Ng	Satellite	Optics	
Wave and Signal Processing	Chi Ming Chen	Sastri Kota	Ashutosh Dutta	
Timothy Lee	Haijian Sun	Prashant Pillai	Feras Abou-Galala	
Harish Krishnaswamy	Applications and Services	Giovanni Giambene	Paul Littlewood	
Earl McCune	Ravi Annaswamy	Edge Automation Platform	Deployment	
dware	Narendra Mangra	Meryem Simsek	David Witkowski	
Dylan Williams	Testbed	Cagatay Buyukkoc	Connecting the Unconnected	
	Ivan Seskar	Kaniz Mahdi	Sudhir Dixit, Ashutosh . Dutta	
	Tracy Van Brakle	Paul Littlewood	TBD	

IEEE Standards Association

Drives the functionality, capability, and interoperability of a range of products and services that affect the way people live, work, and communicate.



EEE: Standards and Global Collaboration for 5G

EEE provides a complete, end-to-end, collaborative framework today for accelerating the realization of 5G and its revolutionary use cases tomorrow.



ComSoc IEEE Communications Society



Industry Input

AN INDUSTRY-WIDE DIALOGUE



You're invited to participate in the IEEE Beyond 5G Technology Roadmap effort to help stimulate an industry-wide dialogue to outline a technology and innovation vision of the development and deployment of 5G and beyond.

Your expertise as an industry subject matter expert is needed in the roadmap dialog regarding the evolution, the challenges faced, and identification of solutions and areas of innovation.

Ecosystem Stakeholders

✓ End users

- ✓ Application developers
- ✓ Service providers
- ✓ Equipment manufacturers
- ✓ Component suppliers
- ✓ Technology innovators
- ✓ Governments
- Standards and guidelines producing bodies
 - IEEE-SA
 - 3GPP
 - ITU

Industry Interaction at Large

- The Roadmap effort will also include a series of meetings to gather additional inputs and feedback on trends related to:
- ✓ Business
- V Technology
- ✓ Societal
- ✓ New fields
- ✓ Other industries



ynote Speakers World Forum 2018



Bains ebook



Lee Chen A10 Networks



Adam Drobot **OpenTechWorks**



Monisha Ghosh NSF



Andrea Goldsmith **Stanford University**





Egil Gronstad **T-Mobile USA**

Michae FCC



ih-Lin I ina Mobile



James Kimery National Instruments



David Lu AT&T



Geoff Mulligan Skylight



Constantine Polychronopoulos **VMWare**







Peter V Nokia

ogram

G Technical Paper Tracks G Technologies G Application and Services G & IoT G Security and Privacy G Trials, Experimental Results and ployment Scenarios G Hardware and Test / Measurements fork-in-Progress D Forum

5G Vertical Tracks •Automotive Intelligent Transport •5G for the Industrial Internet of Things (IIoT) •E-Health and Mobile Health over 5G Networks •Disrupting Media and Entertainment in the 5G Era •5G Applications 5G Topical Tracks
5G Security and Privacy
Open API, Unbundled, Open Source, and Testbeds
Policy and Regulation in the 5G Era
Standards and Deployment
5G Optics
5G Design, Test, and Measurement Challenges
5G Satellite Integration
The Evolving Patent Law Landscape and its Effect on 5G Innovation

<u>orkshops</u> G Cloud Native Design Workshop actile Internet Workshop Start-up Forum

Worldwide 5G Industry Fora Session Tutorials •5G Core / Fundamentals •5G Applications

Industry Panels

5G World Forum 2019 and 2020

5G World Forum 2019 – Dresden, Germany



5G World Forum 2020, India







Whether you are a platform provider, operator, manufacturer, or service/ content provider, there is a path for you and your business to be seen, heard, and make an impact in 5G and Beyond



...contribute to the IEEE Future Network Initiative Roadmap Working Groups ...

...contribute to our publication, IEEE 5G Tech Focus...

...lead an IEEE 5G use case or infrastructure project.

and JOIN US FOR THE INNOVATION REVOLUTION





Standards Applicable to 5G

Computer Society:

IEEE 802.1 - Higher Layer LAN Protocols Working Group

- IEEE P802.1CM Profile of Ethernet networks utilizing Time Sensitive Networking
- IEEE P802.1CF Netw. Ref. Model, and Func. Description of IEEE 802 Access Network

IEEE 802.3 - Ethernet Working Group § IEEE P802.3bs

IEEE STANDARDS

ASSOCIATION

200 Gb/s and 400 Gb/s Ethernet

Up to 7 Gbps in 5 GHz

Up to 7 Gbps in 60 GHz

IEEE P802.3ca 25 Gb/s, 50 Gb/s, and 100 Gb/s Ethernet Passive Optical Networks Ş (EPON)

50Gb/s, 100 Gb/s, and 200 Gb/s Ethernet

- § IEEE P802.3cc 25 Gb/s Ethernet over Single-Mode Fiber
- § IEEE P802.3cd

IEEE 802.11 - Wireless LAN (aka Wi-Fi) Working Group

- § IEEE 802.11ac-2013
- IEEE 802.11ad-2012
- IEEE P802.11ax Ş
- § IEEE P802.11ay
- Up to 20 Gbps in the 60 GHz band
- § IEEE 802.11ah-2016 "HaLow": Massive Machine Type Communications

Up to 10 Gbps in the 5 GHz





Standards Applicable to 5G (Cont'd)

- Computer Society:

IEEE 1903–2011 Standard for the Function Architecture of Next Generation Overlay Network

IEEE 802.15 - Wireless Personal Area Network (WPAN) Working Group

- IEEE 802.15.6 Wireless Body Area Networks (BAN)
- IEEE 802.15.7 Visible Light Communications
- IEEE 802.15.12
 Upper Layer Interface (ULI)
- IEEE 802.16 Broadband Wireless Access Working Group
- IEEE 802.18 Radio Regulatory Technical Advisory Group
- IEEE 802.19 Wireless Coexistence Working Group
 IEEE 802.19.1 TV White Space Coexistence Methods
- IEEE 802.21 Media Independent Handover Services Working Group
 - IEEE 802.22 Point-to-Multipoint Wireless Broadband
- IEEE 802.11P Vehicular Communication System (amendment to 802.11)





Standards Applicable to 5G (Cont'd)

- IEEE Vehicular Technology Society/ Intelligent Transportation Systems:
 - 1609 Series IEEE Wireless Access in Vehicular Environments (WAVE)
 - IEEE Antennas and Propagation Society/Antennas and Propagation:
- P211 Standard Definitions of Terms for Radio Wave Propagation
- P149 Recommended Practice for Antenna Measurements
- 1720-2012 IEEE Recommended Practice for Near-Field Antenna Measurements
 - SASB/SCC39-SCC39 International § Committee on Electromagnetic Safety:

1528-2013 - IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

– Instruments & Measurements:

- § 1451 Series Smart Transducer Interface for Sensors and Actuator Wireless Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats
 - Audio Video Coding Working Group:
- § IEEE P1857.6[™] Standard for Digital Media Content
- § IEEE P1857.9™ Standard for Immersive Visual Content Coding
 - 3D Based Medical Application Working Group:
 - IEEE P3333.2.4[™] Standard for Three-Dimensional (3D) Medical Simulation





Standards in Development Applicable to 5G

(Cont'd)

- IEEE SA Design Automation Standards Committee (DASC)
 - IFFF 1666 (SystemC) Modeling of 5G designs at a pre-implementation level
 - IFFF 1666.1 SystemC AMS)
 - **IEEE 1800** (SystemVerilog) Design/Verification of 5G devices
 - **IEEE 1076** (VHDL)
 - IEEE 1076.1.1 (VHDL AMS)
 - IEEE 1647 (the e language)
 - (UVM) IEEE P1800.2

IEEE 1685

- **IEEE 1801** (UPF) Low power hardware analysis 5G hardware designs
 - (IPXACT) 5G Semiconductor IP design
- **IEEE 1734**
- (IP quality) **IEEE 1735** (IP encryption)





Standards in Development Applicable to 5G

Communications Jociety

- IEEE P1903.1 Content Delivery Protocols of Next Generation Service Overlay Network (NGSON)
- IEEE P1903.2 Service Composition Protocols of NGSON
- IEEE P1903.3 Self-Organizing Management Protocols of NGSON
- IEEE P2413 Architectural Framework for the Internet of Things
- IEEE P1914.1 Standard for Packet-based Fronthaul Transport Networks
- IEEE P1915.1 SDN and NFV Security
- IEEE P1916.1 SDN and NFV Performance
- IEEE P1917.1 SDN and NFV Reliability
- IEEE P1918.1 Tactile Internet
- IEEE P1918.1.1 Haptic Codecs for the Tactile Internet
- IEEE P1921.1 SDN Bootstrapping Procedures
- IEEE P1930.1 Recommended Practice for (SDN) Middleware
 - Architectural "ROOF "Framework for the IoT





- IFFF 1931.1



Standards in Development Applicable to 5G

(Cont'd)

- IEEE Microwave Theory and Techniques:
 - IEEE P1765 Recommended Practice for Estimating the Uncertainty In Measurements

of Modulated Signals for Wireless Communications with Application to Error Vector Magnitude and Other System-Level Distortion Metrics

IEEE P1770 Recommended Practice for The Usage of Terms Commonly Employed In

the Field of Large-Signal Vector Network Analysis

- IEEE P1785 IEEE Frequency Bands and Waveguide Dimensions
- IEEE Instrumentation and Measurement Society:
 - IEEE P287 Standard for Precision Coaxial Connectors at RF, Microwave and Millimeter-wave Frequencies
 - IEEE P1415-99 Harmonization of Internet of Things (IoT) Devices and Systems
- Augmented Reality Learning Experience Model:
 - IEEE P1589 Standard for an Augmented Reality Learning Experience Model



