

# The 5G Wireless Ecosystem: 2017 – 2030 – Technologies, Applications, Verticals, Strategies & Forecasts

https://marketpublishers.com/r/56013E09791EN.html

Date: March 2017 Pages: 363 Price: US\$ 2,500.00 (Single User License) ID: 56013E09791EN

# Abstracts

Despite the lack of sufficient LTE coverage in parts of the world, mobile operators and vendors have already embarked on R&D initiatives to develop 5G, the next evolution in mobile networks. 5G is expected to provide a single network environment to deliver not only existing mobile broadband and IoT services, but also new innovations such as self-driving cars, cloud robotics, 3D holographic telepresence and remote surgery with haptic feedback.

In fact, many mobile operators are betting on 5G to diversify their revenue streams, as conventional voice and data service ARPUs decline globally. For example, South Korea's KT has established a dedicated business unit for holograms, which it envisions to be a key source of revenue for its future 5G network.

At present, the 3GPP and other SDOs (Standards Development Organizations) are engaged in defining the first phase of 5G specifications. However, pre-standards 5G network rollouts are already underway, most notably in the United States and South Korea, as mobile operators rush to be the first to offer 5G services. SNS Research estimates that by the end of 2017, pre-standards 5G network investments are expected to account for over \$250 Million.

Although 2020 has conventionally been regarded as the headline date for 5G commercialization, the very first standardized deployments of the technology are expected to be commercialized as early as 2019 with the 3GPP's initial 5G specifications set to be implementation-ready by March 2018. Between 2019 and 2025, we expect the 5G network infrastructure market to aggressively grow a CAGR of nearly 70%, eventually accounting for \$28 Billion in annual spending by the end of 2025.



These infrastructure investments will be complemented by annual shipments of up to 520 Million 5G-capable devices.

The "5G Wireless Ecosystem: 2017 – 2030 – Technologies, Applications, Verticals, Strategies & Forecasts" report presents an in-depth assessment of the emerging 5G ecosystem including key market drivers, challenges, enabling technologies, usage scenarios, vertical market applications, mobile operator deployment commitments, case studies, spectrum availability/allocation, standardization, research initiatives and vendor strategies. The report also presents forecasts for 5G investments and operator services.

The report comes with an associated Excel datasheet suite covering quantitative data from all numeric forecasts presented in the report, as well as a 5G deployment tracking database covering over 60 global 5G trials, demos and commercial deployment commitments (as of Q1'2017).



# Contents

## CHAPTER 1: INTRODUCTION

- 1.1 Executive Summary
- 1.2 Topics Covered
- 1.3 Forecast Segmentation
- 1.4 Key Questions Answered
- 1.5 Key Findings
- 1.6 Methodology
- 1.7 Target Audience
- 1.8 Companies & Organizations Mentioned

## CHAPTER 2: THE EVOLVING 5G ECOSYSTEM

- 2.1 What is 5G?
- 2.2 High-Level Architecture of 5G Networks
- 2.2.1 5G NR (New Radio) Access Network
- 2.2.2 NextGen (Next Generation) Core Network
- 2.3 5G Performance Requirements
  - 2.3.1 Data Volume
  - 2.3.2 Data Rate
  - 2.3.3 Bandwidth
  - 2.3.4 Spectral Efficiency
  - 2.3.5 Response Time & Latency
  - 2.3.6 Connection Density
  - 2.3.7 Reliability
  - 2.3.8 Mobility
  - 2.3.9 Availability & Coverage
  - 2.3.10 Energy Efficiency

#### 2.4 5G Market Drivers

- 2.4.1 Why the Need for a 5G Standard?
- 2.4.2 Improving Spectrum Utilization
- 2.4.3 Advances in Key Enabling Technologies
- 2.4.4 Gigabit Wireless Connectivity: Supporting Future Services
- 2.4.5 Extreme Device Densities with the IoT (Internet of Things)
- 2.4.6 Moving Towards a Flatter Network Architecture
- 2.4.7 Role of Vertical Sectors & the 4th Industrial Revolution
- 2.5 Challenges & Inhibitors to 5G



- 2.5.1 Standardization Challenges: Too Many Stakeholders
- 2.5.2 Spectrum Regulation & Complexities
- 2.5.3 Massive MIMO, Beamforming & Antenna Technology Issues
- 2.5.4 Higher Frequencies Mean New Infrastructure
- 2.5.5 Complex Performance Requirements
- 2.5.6 Energy Efficiency & Technology Scaling

#### CHAPTER 3: 5G USAGE SCENARIOS, APPLICATIONS & VERTICAL MARKETS

- 3.1 Usage Scenarios
  - 3.1.1 eMBB (Enhanced Mobile Broadband)
  - 3.1.2 URLCC (Ultra-Reliable and Low Latency Communications)
  - 3.1.3 mMTC (Massive Machine-Type Communications)
- 3.2 Key Applications & Vertical Markets
  - 3.2.1 Consumer & Multi-Sector Applications
  - 3.2.1.1 FWA (Fixed Wireless Access)
  - 3.2.1.2 TV & Media Delivery
  - 3.2.1.3 3D Imaging & Holograms
  - 3.2.1.4 Virtual Presence
  - 3.2.1.5 AR (Augmented Reality)
  - 3.2.1.6 VR (Augmented Reality)
  - 3.2.1.7 Real-Time Gaming
  - 3.2.1.8 Tactile Internet
  - 3.2.1.9 Mobile Cloud Services
  - 3.2.1.10 5G Enabled Robotics
  - 3.2.1.11 Connected Drones
  - 3.2.1.12 Smart & Connected Homes
  - 3.2.1.13 Connectivity for Smart Wearables
  - 3.2.1.14 Conventional Mobile Broadband & Other Applications
  - 3.2.2 Healthcare
  - 3.2.2.1 Telemedicine
  - 3.2.2.2 Bio-Connectivity: Enabling Telecare
  - 3.2.2.3 Remote Surgery & Other Applications
  - 3.2.3 Automotive & Transportation
    - 3.2.3.1 Connected Cars: Infotainment, Navigation & Other Services
  - 3.2.3.2 C-V2X (Cellular Vehicle-to-Everything) Communications
  - 3.2.3.3 Autonomous Driving
  - 3.2.3.4 Intelligent Transportation
  - 3.2.3.5 Connectivity for High-Speed Railway, Aerial & Maritime Environments



- 3.2.4 Public Safety & Critical Communications
  - 3.2.4.1 MCPTT (Mission-Critical Push-to-Talk)
  - 3.2.4.2 Off-Network Secure Communications
  - 3.2.4.3 Situational Awareness
  - 3.2.4.4 Disaster Relief & Other Applications
- 3.2.5 Industrial Automation
  - 3.2.5.1 5G Enabled Smart Factories
  - 3.2.5.2 Machine Vision
  - 3.2.5.3 Extending the Factory Floor To the Cloud
- 3.2.5.4 Real-Time Assistance & Other Applications
- 3.2.6 Other Vertical Sector Applications
  - 3.2.6.1 Agriculture
  - 3.2.6.2 Asset Management & Logistics
  - 3.2.6.3 Construction
  - 3.2.6.4 Education
  - 3.2.6.5 Energy, Utilities & Smart Grids
  - 3.2.6.6 Fitness & Sports
  - 3.2.6.7 Retail, Advertising & Vending
  - 3.2.6.8 Smart Cities & Other Sectors

# **CHAPTER 4: ENABLING TECHNOLOGIES FOR 5G**

- 4.1 Key Technologies & Concepts
  - 4.1.1 Flexible Air Interface Design
    - 4.1.1.1 Frame Structure
    - 4.1.1.2 Multiple Numerologies
    - 4.1.1.3 Other Aspects
  - 4.1.2 5G Waveform Candidates
  - 4.1.2.1 CP-OFDM (OFDM with Cyclic Prefix)
  - 4.1.2.2 CP-OFDM with WOLA (Weighted Overlap and Add)
  - 4.1.2.3 FCP-OFDM (Flexible CP-OFDM)
  - 4.1.2.4 F-OFDM (Filtered OFDM)
  - 4.1.2.5 BF-OFDM (Block Filtered OFDM)
  - 4.1.2.6 FBMC (Filter Bank Multi-Carrier)/FB-OFDM (Filter Bank OFDM)
  - 4.1.2.7 UFMC (Universal Filtered Multi-Carrier)/UF-OFDM (Universal Filtered OFDM)
  - 4.1.2.8 GFDM (Generalized Frequency Division Multiplexing)

4.1.2.9 SC-FDM (Single Carrier FDM)/DFT-S OFDM (Discrete Fourier Transform-Spread OFDM)

4.1.2.10 Zero-Tail SC-FDM/DFT-S OFDM



- 4.1.2.11 SC-FDE (Single-Carrier Frequency Domain Equalization)
- 4.1.2.12 Other Options
- 4.1.3 Modulation Schemes
- 4.1.3.1 Initial Baseline for 5G NR
- 4.1.3.2 Going Beyond 256-QAM: Higher Order Modulations
- 4.1.3.3 Other Advanced Modulation Schemes
- 4.1.4 Multiple Access Schemes
- 4.1.4.1 OFDMA (Orthogonal Frequency Division Multiple Access)
- 4.1.4.2 SC-FDMA (Single-Carrier Frequency Division Multiple Access)
- 4.1.4.3 SDMA (Spatial Division Multiple Access)
- 4.1.4.4 Power Domain NOMA (Non-Orthogonal Multiple Access)
- 4.1.4.5 Code Domain Techniques
- 4.1.4.5.1 MUSA (Multi-User Shared Access)
- 4.1.4.5.2 RSMA (Resource Spread Multiple Access)
- 4.1.4.5.3 LSSA (Low Code Rate and Signature Based Shared Access)
- 4.1.4.5.4 NOCA (Non-Orthogonal Coded Access)
- 4.1.4.5.5 NCMA (Non-Orthogonal Coded Multiple Access)
- 4.1.4.5.6 GOCA (Group Orthogonal Coded Access)
- 4.1.4.6 Hybrid-Domain & Interleaver-Based Techniques
- 4.1.4.6.1 SCMA (Spare Code Multiple Access)
- 4.1.4.6.2 PDMA (Pattern Division Multiple Access)
- 4.1.4.6.3 IDMA (Interleaver Division Multiple Access)
- 4.1.4.6.4 IGMA (Interleave-Grid Multiple Access)
- 4.1.4.6.5 RDMA (Repetition Division Multiple Access)
- 4.1.4.7 Other Methods
- 4.1.5 Channel Coding Schemes
- 4.1.5.1 LDPC (Low Density Parity Check) Coding
- 4.1.5.2 Polar Coding
- 4.1.6 Duplex Schemes
- 4.1.6.1 Dynamic TDD for Higher Frequencies
- 4.1.6.2 FDD and FDP (Flexible Duplexing on Paired Spectrum)
- 4.1.6.3 Full Duplex
- 4.1.7 Centimeter & Millimeter Wave Radio Access
- 4.1.8 Advanced Antenna Technologies
- 4.1.8.1 Massive MIMO & MU-MIMO
- 4.1.8.2 Phased Array Antennas
- 4.1.8.3 Beamforming & Beam Tracking
- 4.1.9 D2D (Device-to-Device) Connectivity & Communication
- 4.1.10 Self-Backhauling & Mesh Networking



- 4.1.11 Spectrum Sharing & Aggregation
  - 4.1.11.1 Complex Carrier Aggregation Schemes
  - 4.1.11.2 LSA (Licensed Shared Access): Two-Tiered Sharing
  - 4.1.11.3 SAS (Spectrum Access System): Three-Tiered Sharing
- 4.1.11.4 LAA (License Assisted Access): Licensed & Unlicensed Spectrum Aggregation
  - 4.1.11.5 New Mechanisms for 60 GHz Unlicensed Spectrum Sharing
  - 4.1.11.6 MulteFire
  - 4.1.11.7 Cognitive Radio & Spectrum Sensing
- 4.1.12 Multi-Site & Multi-RAN Connectivity
- 4.1.12.1 Dual-Connectivity with LTE
- 4.1.12.2 Interoperability with Wi-Fi & Other Networks
- 4.1.12.3 Multi-Site Connectivity & User Centric Cell Access
- 4.1.13 Control and User Plane Separation
- 4.1.14 Network Slicing
- 4.1.14.1 RAN Slicing
- 4.1.14.2 Core Network Slicing
- 4.1.14.3 End-to-End Network Slicing
- 4.1.15 Service Based Architecture
- 4.1.16 Network Security & Privacy Enhancements
- 4.2 Complementary Technologies
  - 4.2.1 NFV & SDN
  - 4.2.2 Cloud Computing & Hyperscale Data Centers
  - 4.2.3 DevOps & Other IT Concepts
  - 4.2.4 Big Data & Analytics
  - 4.2.5 UDNs (Ultra Dense Networks) & HetNets
  - 4.2.6 RAN Centralization & Functional Splitting
  - 4.2.6.1 C-RAN (Centralized RAN)
  - 4.2.6.2 RAN Functional Split Options
  - 4.2.7 Cloud RAN
  - 4.2.8 MEC (Multi-Access Edge Computing)
  - 4.2.9 Wireline Fiber Infrastructure
  - 4.2.9.1 Impact of 5G Rollouts on the Fiber Industry
  - 4.2.9.2 Delivering Tbps Data Rates
  - 4.2.9.3 Current Investment Trends
  - 4.2.9.4 Role of Other Wireline Technologies
  - 4.2.10 VLC (Visible Light Communication) & Li-Fi (Light Fidelity)
  - 4.2.11 Satellites, Drones & Balloons
    - 4.2.11.1 Satellite Integration for 5G Access & Transport Networking



- 4.2.11.2 Low-Earth Orbit Satellites for Gigabit Speeds: Existing Investments
- 4.2.11.3 Drones & Balloons for Coverage Extension
- 4.2.11.4 Interest from Mobile Operators

### **CHAPTER 5: 5G INVESTMENTS & FUTURE FORECAST**

- 5.1 How Much is Being Invested in 5G R&D?
- 5.2 R&D Investments by Technology
  - 5.2.1 New Air Interface & Millimeter Wave Radio Access
  - 5.2.2 MIMO, Beamforming & Advanced Antenna Technologies
  - 5.2.3 Spectrum Sharing, Aggregation & Interference Management
  - 5.2.4 Virtualization & Cloud RAN
  - 5.2.5 Network Slicing & Other Technologies
- 5.3 Pre-Standards 5G Network Investments
- 5.3.1 Segmentation by Submarket
- 5.3.2 Base Stations
- 5.3.3 User Equipment
- 5.3.4 Transport Networking & Other Investments
- 5.4 Global Outlook for Standardized 5G Infrastructure
- 5.4.1 Segmentation by Submarket
- 5.4.2 5G NR
- 5.4.2.1 Distributed Macrocell Base Stations
- 5.4.2.2 Small Cells
- 5.4.2.3 RRHs (Remote Radio Heads)
- 5.4.2.4 C-RAN BBUs (Baseband Units)
- 5.4.3 NextGen Core Network
- 5.4.4 Fronthaul & Backhaul Networking
- 5.4.5 Segmentation by Region
- 5.5 Global Outlook for Standardized 5G User Equipment
  - 5.5.1 Segmentation by Form Factor
  - 5.5.2 Handsets
  - 5.5.3 Tablets
  - 5.5.4 Embedded IoT Modules
  - 5.5.5 USB Dongles
  - 5.5.6 Routers
  - 5.5.7 Segmentation by Region

5.6 Global Outlook for 5G Operator Services

- 5.6.1 Subscriptions
- 5.6.2 Service Revenue



- 5.6.3 Regional Segmentation
- 5.7 Asia Pacific
  - 5.7.1 Infrastructure
  - 5.7.2 User Equipment
  - 5.7.3 Subscriptions
  - 5.7.4 Service Revenue
- 5.8 Eastern Europe
  - 5.8.1 Infrastructure
  - 5.8.2 User Equipment
  - 5.8.3 Subscriptions
  - 5.8.4 Service Revenue
- 5.9 Latin & Central America
  - 5.9.1 Infrastructure
  - 5.9.2 User Equipment
  - 5.9.3 Subscriptions
  - 5.9.4 Service Revenue
- 5.10 Middle East & Africa
  - 5.10.1 Infrastructure
  - 5.10.2 User Equipment
  - 5.10.3 Subscriptions
  - 5.10.4 Service Revenue
- 5.11 North America
  - 5.11.1 Infrastructure
  - 5.11.2 User Equipment
  - 5.11.3 Subscriptions
  - 5.11.4 Service Revenue
- 5.12 Western Europe
  - 5.12.1 Infrastructure
  - 5.12.2 User Equipment
  - 5.12.3 Subscriptions
  - 5.12.4 Service Revenue

#### **CHAPTER 6: MOBILE OPERATOR CASE STUDIES & COMMITMENTS**

- 6.1.1 Mobile Operator Case Studies
  - 6.1.1.1 AT&T
  - 6.1.1.2 BT Group
  - 6.1.1.3 China Mobile
  - 6.1.1.4 DT (Deutsche Telekom)



- 6.1.1.5 KT Corporation
- 6.1.1.6 NTT DoCoMo
- 6.1.1.7 SK Telecom
- 6.1.1.8 Telefonica
- 6.1.1.9 Verizon Communications
- 6.1.1.10 Vodafone Group
- 6.2 Review of Mobile Operator 5G Commitments
  - 6.2.1 Asia Pacific
    - 6.2.1.1 Australia
    - 6.2.1.2 China
    - 6.2.1.3 Hong Kong
    - 6.2.1.4 India
    - 6.2.1.5 Japan
    - 6.2.1.6 Philippines
    - 6.2.1.7 Singapore
    - 6.2.1.8 South Korea
    - 6.2.1.9 Taiwan
    - 6.2.1.10 Thailand
  - 6.2.2 Europe
    - 6.2.2.1 Belgium
    - 6.2.2.2 Finland
    - 6.2.2.3 France
    - 6.2.2.4 Germany
    - 6.2.2.5 Italy
    - 6.2.2.6 Netherlands
    - 6.2.2.7 Russia
    - 6.2.2.8 Sweden
    - 6.2.2.9 Switzerland
    - 6.2.2.10 Turkey
    - 6.2.2.11 United Kingdom
  - 6.2.2.12 Other Countries
  - 6.2.3 Latin & Central America
  - 6.2.3.1 Brazil
  - 6.2.3.2 Mexico
  - 6.2.4 Middle East & Africa
  - 6.2.4.1 Bahrain
  - 6.2.4.2 Kuwait
  - 6.2.4.3 Other Countries
  - 6.2.4.4 Qatar



6.2.4.5 Saudi Arabia6.2.4.6 UAE6.2.5 North America6.2.5.1 Canada6.2.5.2 United States

# **CHAPTER 7: SPECTRUM FOR 5G NETWORKS**

- 7.1 Potential Frequency Bands for 5G
  - 7.1.1 Sub-1 GHz Bands
  - 7.1.2 1-6 GHz Bands
  - 7.1.2.1 3.4 GHz
  - 7.1.2.2 3.5 GHz
  - 7.1.2.3 4.5 GHz
  - 7.1.2.4 5 GHz
  - 7.1.3 Bands Above 6 GHz
  - 7.1.3.1 15 GHz
  - 7.1.3.2 24-30 GHz
  - 7.1.3.3 30-60 GHz
  - 7.1.3.4 E-Band (60-90 GHz)
  - 7.1.3.5 Higher Bands
- 7.2 Status of 5G Spectrum Allocation
- 7.3 Asia Pacific
  - 7.3.1 Australia
  - 7.3.2 China
  - 7.3.3 Japan
  - 7.3.4 Singapore
  - 7.3.5 South Korea
  - 7.3.6 Taiwan
  - 7.3.7 Other Countries
- 7.4 Europe
  - 7.4.1 European Commission & CEPT Recommendations
  - 7.4.2 National Initiatives
- 7.5 Latin & Central America
  - 7.5.1 CITEL Recommendations
- 7.5.2 National Initiatives
- 7.6 Middle East & Africa
- 7.6.1 GCC Countries
- 7.6.2 Africa & Other Countries



7.7 North America

- 7.7.1 Canada
- 7.7.2 United States

# CHAPTER 8: 5G STANDARDIZATION, DEVELOPMENT & RESEARCH INITIATIVES

- 8.1 3GPP (Third Generation Partnership Project)
  - 8.1.1 Phased Standardization Approach
    - 8.1.1.1 Phase 1: Release
  - 8.1.1.2 Phase 2: Release
  - 8.1.1.3 Enhancements to Address 5G Objectives in Earlier Releases
- 8.1.2 Key Aspects of 5G Standardization
  - 8.1.2.1 5G NR Access Network
  - 8.1.2.2 Support for Other Access Networks
  - 8.1.2.3 NextGen System Architecture
  - 8.1.2.4 Deployment Modes: Non-Standalone vs. Standalone Operation
- 8.2 5G Americas
- 8.2.1 5G Advocacy Efforts
- 8.3 5GAA (5G Automotive Association)
  - 8.3.1 Advocacy for 5G & Cellular V2X Technology
- 8.3.2 Other Alliances in the Automotive Sector
- 8.4 Broadband Forum
- 8.4.1 Broadband 20/20 Vision: Convergence of 5G Mobile & Fixed Networks
- 8.5 CableLabs
  - 8.5.1 Research on High Capacity Millimeter Wave Small Cells
- 8.5.2 Other Work Relevant to 5G
- 8.6 DSA (Dynamic Spectrum Alliance)
  - 8.6.1 Dynamic Spectrum Sharing for 5G
- 8.7 ETSI (European Telecommunications Standards Institute)
- 8.7.1 ISGs (Industry Specification Groups) for 5G Enabling Technologies
  - 8.7.1.1 mWT ISG (Millimeter Wave Transmission ISG)
  - 8.7.1.2 ISG NFV (ISG for Network Functions Virtualization)
  - 8.7.1.3 OSG OSM (Open Source Group for Open Source MANO)
  - 8.7.1.4 ISG MEC (ISG for Multi Access Edge Computing)
  - 8.7.1.5 ISG NGP (ISG for Next Generation Protocols)
  - 8.7.1.6 ISG MBC (ISG for Mobile/Broadcast Convergence)
- 8.7.2 Other Work
- 8.8 GSMA
  - 8.8.1 5G Program & Spectrum Policy



#### 8.9 GTI

- 8.9.1 5G Innovation Program
- 8.10 IEEE (Institute of Electrical and Electronics Engineers)
- 8.10.1 IEEE Future Directions 5G Initiative
- 8.10.2 Contribution to 5G Standards Development
- 8.11 IETF (Internet Engineering Task Force)
- 8.11.1 Contribution to 5G NextGen Core Standards
  - 8.11.1.1 5Gangip (5G Aspects of Next Generation Internet Protocols) Special Group
- 8.11.1.2 Proposed NMLRG (Network Machine Learning Research Group)
- 8.11.1.3 Internet-Draft on Network Slicing
- 8.11.1.4 Other Work Relevant to 5G
- 8.12 ITU (International Telecommunication Union)
- 8.12.1 IMT-2020 Family of Standards
- 8.12.2 WP 5D (Working Party 5D)
- 8.12.3 FG IMT-2020 (Focus Group on IMT-2020)
- 8.12.4 Spectrum Allocation
- 8.13 NGMN (Next Generation Mobile Networks) Alliance
- 8.13.1 5G Work Program
  - 8.13.1.1 Ecosystem Building & Interaction
  - 8.13.1.2 Guidance to SDOs & the Wider Industry
  - 8.13.1.3 Evaluation of Test & PoC Results
- 8.13.2 New Work-Items
  - 8.13.2.1 5G Trial & Testing Initiative
  - 8.13.2.2 End-to-End Architecture
- 8.13.2.3 Vehicle-to-X
- 8.14 OCP (Open Compute Project) Foundation
- 8.14.1 Telco Project
- 8.15 ONF (Open Networking Foundation) & ON.Lab (Open Networking Lab)
- 8.15.1 CORD (Central Office Re-Architected as a Datacenter)
- 8.15.2 M-CORD (M-Central Office Re-Architected as a Datacenter)
- 8.16 SIMalliance
- 8.16.1 5GWG (5G Working Group): Recommendations for 5G Security
- 8.17 Small Cell Forum
- 8.17.1 Mapping 5G Requirements for Small Cells
- 8.18 TIP (Telecom Infra Project)
  - 8.18.1 OpenCellular Access Platform
  - 8.18.2 Open Optical Packet Transport
- 8.18.3 Mobile Core Simplification
- 8.19 TM Forum



- 8.19.1 5G Working Group
- 8.20 Wi-Fi Alliance
- 8.20.1 Positioning WiGig as a 5G Technology
- 8.20.2 Other Work Relevant to 5G
- 8.21 WBA (Wireless Broadband Alliance)
- 8.21.1 Advocacy Efforts for 5G Convergence with Wi-Fi
- 8.22 WinnForum (Wireless Innovation Forum)
- 8.22.1 Spectrum Sharing Specifications for LTE & 5G Networks
- 8.23 WWRF (World Wireless Research Forum)
- 8.23.1 New WGs (Working Groups) for 5G
  - 8.23.1.1 WG High Frequency Technologies
  - 8.23.1.2 WG 5G e/m-Health and Wearables
  - 8.23.1.3 WG The Connected Car
  - 8.23.1.4 WG End-to-End Network Slicing
- 8.24 xRAN Consortium
- 8.24.1 Standardization for Software-Based RAN
- 8.25 Other Collaborative & Standardization Organizations
- 8.26 European Initiatives
  - 8.26.1 5G PPP (5G Infrastructure Public Private Partnership)
    - 8.26.1.1 5G IA (5G Infrastructure Association)
    - 8.26.1.2 Key Working Groups
  - 8.26.1.3 Major Research Projects
- 8.26.2 European Commission's 5G Roadmap
  - 8.26.2.1 Phase 1: The Future of 5G Network Architecture
  - 8.26.2.2 Phase 2: Demonstrations & Experiments
- 8.26.2.3 Phase 3: Integration of End-to-End 5G experimental network infrastructure
- 8.26.3 5G Manifesto
- 8.26.4 5G Action Plan
- 8.27 National Initiatives
  - 8.27.1 United States
  - 8.27.1.1 NSF (National Science Foundation)
  - 8.27.1.2 NIST (National Institute of Standards and Technology)
  - 8.27.1.3 ATIS (Alliance for Telecommunications Industry Solutions)
  - 8.27.1.4 TIA (Telecommunications Industry Association)
  - 8.27.2 South Korea
    - 8.27.2.1 5G Forum
    - 8.27.2.2 ETRI (Electronics and Telecommunications Research)
  - 8.27.2.3 TTA (Telecommunications Technology Association of Korea)
  - 8.27.3 Japan



8.27.3.1 ARIB (Association of Radio Industries and Businesses)

8.27.3.2 TTC (Telecommunication Technology Committee)

8.27.3.3 5GMF (Fifth Generation Mobile Communications Promotion Forum)

8.27.4 China

8.27.4.1 IMT-2020 5G Promotion Group

8.27.4.2 CCSA (China Communications Standards Association)

8.27.4.3 863 Research Program

8.27.4.4 FuTURE Mobile Communication Forum

8.27.5 Taiwan

8.27.5.1 ITRI (Industrial Technology Research Institute)

8.27.5.2 TAICS (Taiwan Association of Information and Communication Standards) 8.27.6 Turkey

8.27.6.1 ICTA (Information and Communication Technologies Authority)

8.27.6.2 5GTR (Turkish 5G Forum)

8.27.7 Malaysia

8.27.7.1 MTSFB (Malaysian Technical Standards Forum Bhd)

- 8.27.7.2 Malaysia 5G Committee
- 8.27.8 Indonesia
- 8.27.8.1 i5GF (Indonesia 5G Forum)

8.27.9 India

8.27.9.1 TSDSI (Telecommunications Standards Development Society India)

8.27.9.2 GISFI (Global ICT Standardization Forum for India)

8.27.10 Russia

8.27.10.1 5GRUS

8.28 Mobile Operator Led Initiatives & Innovation Labs

8.28.1 Pre-Standards Deployment Initiatives

8.28.1.1 5G TSA (5G Open Trial Specification Alliance)

8.28.1.2 5GTF (5G Technical Forum), Verizon Communications

8.28.1.3 5G-SIG (Special Interest Group), KT Corporation

8.28.1.4 5G-DF (5G Development Forum), KT Corporation

8.28.2 Innovation Labs

8.28.2.1 5G Innovation Center, China Mobile

8.28.2.2 5G:Haus, DT (Deutsche Telekom)

8.28.2.3 5TONIC, Telefonica

8.28.2.4 Others

8.29 Academic & Research Institute Initiatives

8.29.1 5G Lab Germany at TU Dresden

8.29.2 5G Playground, Fraunhofer FOKUS

8.29.3 5GIC (5G Innovation Center, University of Surrey)



- 8.29.4 5GTNF (5G Test Network Finland), University of Oulu
- 8.29.5 Hiroshima University
- 8.29.6 NYU WIRELESS (New York University)
- 8.29.7 OSA (OpenAirInterface Software Alliance), EURECOM
- 8.29.8 Tokyo Institute of Technology
- 8.29.9 UC Berkeley (University of California, Berkeley)
- 8.29.10 USC (University of Southern California) Viterbi School of Engineering
- 8.29.11 UT Austin (University of Texas at Austin)
- 8.29.12 WINLAB (Wireless Information Network Laboratory), Rutgers University

## **CHAPTER 9: VENDOR DEMONSTRATIONS, COMMITMENTS & STRATEGIES**

- 9.1 Argela
  - 9.1.1 5G Strategy
- 9.1.2 Demonstrations & Trial Commitments
- 9.2 Cisco Systems
  - 9.2.1 5G Strategy
  - 9.2.2 Demonstrations & Trial Commitments
- 9.3 Cohere Technologies
  - 9.3.1 5G Strategy
- 9.3.2 Demonstrations & Trial Commitments
- 9.4 Ericsson
  - 9.4.1 5G Strategy
- 9.4.2 Demonstrations & Trial Commitments
- 9.5 Fujitsu
  - 9.5.1 5G Strategy
  - 9.5.2 Demonstrations & Trial Commitments
- 9.6 Google
  - 9.6.1 5G Strategy
- 9.6.2 Demonstrations & Trial Commitments
- 9.7 Huawei
  - 9.7.1 5G Strategy
  - 9.7.2 Demonstrations & Trial Commitments
- 9.8 Intel Corporation
  - 9.8.1 5G Strategy
  - 9.8.2 Demonstrations & Trial Commitments
- 9.9 InterDigital
  - 9.9.1 5G Strategy
  - 9.9.2 Demonstrations & Trial Commitments



- 9.10 Juniper Networks
  - 9.10.1 5G Strategy
  - 9.10.2 Demonstrations & Trial Commitments
- 9.11 Keysight Technologies
- 9.11.1 5G Strategy
- 9.11.2 Demonstrations & Trial Commitments
- 9.12 Kumu Networks
  - 9.12.1 5G Strategy
- 9.12.2 Demonstrations & Trial Commitments
- 9.13 LG Electronics
- 9.13.1 5G Strategy
- 9.13.2 Demonstrations & Trial Commitments
- 9.14 Mitsubishi Electric
- 9.14.1 5G Strategy
- 9.14.2 Demonstrations & Trial Commitments
- 9.15 NEC Corporation
- 9.15.1 5G Strategy
- 9.15.2 Demonstrations & Trial Commitments
- 9.16 NI (National Instruments)
  - 9.16.1 5G Strategy
- 9.16.2 Demonstrations & Trial Commitments
- 9.17 Nokia Networks
  - 9.17.1 5G Strategy
- 9.17.2 Demonstrations & Trial Commitments
- 9.18 Panasonic Corporation
  - 9.18.1 5G Strategy
  - 9.18.2 Demonstrations & Trial Commitments
- 9.19 Qorvo
  - 9.19.1 5G Strategy
- 9.19.2 Demonstrations & Trial Commitments
- 9.20 Qualcomm
  - 9.20.1 5G Strategy
  - 9.20.2 Demonstrations & Trial Commitments
- 9.21 Rohde & Schwarz
  - 9.21.1 5G Strategy
  - 9.21.2 Demonstrations & Trial Commitments
- 9.22 Samsung Electronics
  - 9.22.1 5G Strategy
  - 9.22.2 Demonstrations & Trial Commitments



9.23 SiBEAM

9.23.1 5G Strategy

9.23.2 Demonstrations & Trial Commitments

9.24 ZTE

- 9.24.1 5G Strategy
- 9.24.2 Demonstrations & Trial Commitments



# **List Of Figures**

#### LIST OF FIGURES

- Figure 1: 5G Network Architecture & Interaction with Other Networks
- Figure 2: 5G Performance Requirements
- Figure 3: 5G FWA (Fixed Wireless Access) Deployment Alternatives
- Figure 4: Convergence of 5G with Wireline Networks
- Figure 5: 5G for TV & Media Delivery
- Figure 6: Example Usage Scenarios for C-V2X (Cellular Vehicle-to-Everything)
- Figure 7: Example Channel Bandwidths for 5G Networks
- Figure 8: Impact of Massive MIMO on Cell Coverage & Capacity
- Figure 9: Sidelink Air Interface for ProSe (Proximity Services)
- Figure 10: LSA (License Shared Access) Regulatory Architecture
- Figure 11: Conceptual Architecture for End-to-End Network Slicing in Mobile Networks
- Figure 12: Service Based Architecture for 5G
- Figure 13: NFV Concept
- Figure 14: Transition to UDNs (Ultra-Dense Networks)
- Figure 15: C-RAN Architecture
- Figure 16: RAN Functional Split Options
- Figure 17: Performance Comparison of RAN Functional Split Options
- Figure 18: Cloud RAN Concept
- Figure 19: Global 5G R&D Investments: 2016 2020 (\$ Million)
- Figure 20: Global 5G R&D Investments by Technology: 2016 2020 (\$ Million)
- Figure 21: Global 5G R&D Investments on New Air Interface & Millimeter Wave Radio Access: 2016 2020 (\$ Million)

Figure 22: Global 5G R&D Investments on MIMO, Beamforming & Advanced Antenna Technologies: 2016 - 2020 (\$ Million)

Figure 23: Global 5G R&D Investments on Spectrum Sharing, Aggregation & Interference Management: 2016 - 2020 (\$ Million)

Figure 24: Global 5G R&D Investments on Virtualization & Cloud RAN: 2016 - 2020 (\$ Million)

Figure 25: Global 5G R&D Investments on Network Slicing & Other Technologies: 2016 - 2020 (\$ Million)

Figure 26: Global Pre-Standards 5G Network Investments: 2016 - 2018 (\$ Million)

Figure 27: Global Pre-Standards 5G Network Investments by Submarket: 2016 - 2018 (\$ Million)

Figure 28: Global Pre-Standards 5G Base Station Shipments: 2016 - 2018 (Units) Figure 29: Global Pre-Standards 5G Base Station Shipment Revenue: 2016 - 2018 (\$



Million)

Figure 30: Global Pre-Standards 5G User Equipment Shipments: 2016 - 2018 (Units)

Figure 31: Global Pre-Standards 5G User Equipment Shipment Revenue: 2016 - 2018 (\$ Million)

Figure 32: Global Transport Networking & Other Investments for Pre-Standards 5G Networks: 2016 - 2018 (\$ Million)

Figure 33: Global 5G Infrastructure Investments: 2019 - 2030 (\$ Million)

Figure 34: Global 5G Infrastructure Investments by Submarket: 2019 - 2030 (\$ Million)

Figure 35: Global 5G NR Investments: 2019 - 2030 (\$ Million)

Figure 36: Global 5G NR Investments by Submarket: 2019 - 2030 (\$ Million)

Figure 37: Global 5G Distributed Macrocell Base Station Shipments: 2019 - 2030 (Thousands of Units)

Figure 38: Global 5G Distributed Macrocell Base Station Shipment Revenue: 2019 - 2030 (\$ Million)

Figure 39: Global 5G Small Cell Shipments: 2019 - 2030 (Thousands of Units)

Figure 40: Global 5G Small Cell Shipment Revenue: 2019 - 2030 (\$ Million)

Figure 41: Global 5G RRH Shipments: 2019 - 2030 (Thousands of Units)

Figure 42: Global 5G RRH Shipment Revenue: 2019 - 2030 (\$ Million)

Figure 43: Global 5G C-RAN BBU Shipments: 2019 - 2030 (Thousands of Units)

Figure 44: Global 5G C-RAN BBU Shipment Revenue: 2019 - 2030 (\$ Million)

Figure 45: Global NextGen Core Network Investments: 2019 - 2030 (\$ Million)

Figure 46: Global 5G Fronthaul & Backhaul Investments: 2019 - 2030 (\$ Million)

Figure 47: 5G Infrastructure Investments by Region: 2019 - 2030 (\$ Million)

Figure 48: Global 5G Device Unit Shipments: 2019 - 2030 (Millions of Units)

Figure 49: Global 5G Device Unit Shipment Revenue: 2019 - 2030 (\$ Billion)

Figure 50: Global 5G Device Unit Shipments by Form Factor: 2019 - 2030 (Millions of Units)

Figure 51: Global 5G Device Unit Shipment Revenue by Form Factor: 2019 - 2030 (\$ Billion)

Figure 52: Global 5G Handset Shipments: 2019 - 2030 (Millions of Units)

Figure 53: Global 5G Handset Shipment Revenue: 2019 - 2030 (\$ Billion)

Figure 54: Global 5G Tablet Shipments: 2019 - 2030 (Millions of Units)

Figure 55: Global 5G Tablet Shipment Revenue: 2019 - 2030 (\$ Billion)

Figure 56: Global 5G Embedded IoT Module Shipments: 2019 - 2030 (Millions of Units)

Figure 57: Global 5G Embedded IoT Module Shipment Revenue: 2019 - 2030 (\$ Billion)

Figure 58: Global 5G USB Dongle Shipments: 2019 - 2030 (Millions of Units)

Figure 59: Global 5G USB Dongle Shipment Revenue: 2019 - 2030 (\$ Billion)

Figure 60: Global 5G Router Shipments: 2019 - 2030 (Millions of Units)

Figure 61: Global 5G Router Shipment Revenue: 2019 - 2030 (\$ Billion)



Figure 62: 5G Device Unit Shipments by Region: 2019 - 2030 (Millions of Units) Figure 63: 5G Device Unit Shipment Revenue by Region: 2019 - 2030 (\$ Billion) Figure 64: Global 5G Subscriptions: 2019 - 2030 (Millions) Figure 65: Global 5G Service Revenue: 2019 - 2030 (\$ Billion) Figure 66: 5G Subscriptions by Region: 2019 - 2030 (Millions) Figure 67: 5G Service Revenue by Region: 2019 - 2030 (\$ Billion) Figure 68: Asia Pacific 5G Infrastructure Investments: 2019 - 2030 (\$ Million) Figure 69: Asia Pacific 5G Device Unit Shipments: 2019 - 2030 (Thousands of Units) Figure 70: Asia Pacific 5G Device Unit Shipment Revenue: 2019 - 2030 (\$ Billion) Figure 71: Asia Pacific 5G Subscriptions: 2019 - 2030 (Millions) Figure 72: Asia Pacific 5G Service Revenue: 2019 - 2030 (\$ Billion) Figure 73: Eastern Europe 5G Infrastructure Investments: 2019 - 2030 (\$ Million) Figure 74: Eastern Europe 5G Device Unit Shipments: 2019 - 2030 (Thousands of Units) Figure 75: Eastern Europe 5G Device Unit Shipment Revenue: 2019 - 2030 (\$ Billion) Figure 76: Eastern Europe 5G Subscriptions: 2019 - 2030 (Millions) Figure 77: Eastern Europe 5G Service Revenue: 2019 - 2030 (\$ Billion) Figure 78: Latin & Central America 5G Infrastructure Investments: 2019 - 2030 (\$ Million) Figure 79: Latin & Central America 5G Device Unit Shipments: 2019 - 2030 (Thousands of Units) Figure 80: Latin & Central America 5G Device Unit Shipment Revenue: 2019 - 2030 (\$ Billion) Figure 81: Latin & Central America 5G Subscriptions: 2019 - 2030 (Millions) Figure 82: Latin & Central America 5G Service Revenue: 2019 - 2030 (\$ Billion) Figure 83: Middle East & Africa 5G Infrastructure Investments: 2019 - 2030 (\$ Million) Figure 84: Middle East & Africa 5G Device Unit Shipments: 2019 - 2030 (Thousands of Units) Figure 85: Middle East & Africa 5G Device Unit Shipment Revenue: 2019 - 2030 (\$ Billion) Figure 86: Middle East & Africa 5G Subscriptions: 2019 - 2030 (Millions) Figure 87: Middle East & Africa 5G Service Revenue: 2019 - 2030 (\$ Billion) Figure 88: North America 5G Infrastructure Investments: 2019 - 2030 (\$ Million) Figure 89: North America 5G Device Unit Shipments: 2019 - 2030 (Thousands of Units) Figure 90: North America 5G Device Unit Shipment Revenue: 2019 - 2030 (\$ Billion) Figure 91: North America 5G Subscriptions: 2019 - 2030 (Millions) Figure 92: North America 5G Service Revenue: 2019 - 2030 (\$ Billion) Figure 93: Western Europe 5G Infrastructure Investments: 2019 - 2030 (\$ Million) Figure 94: Western Europe 5G Device Unit Shipments: 2019 - 2030 (Thousands of



Units)

Figure 95: Western Europe 5G Device Unit Shipment Revenue: 2019 - 2030 (\$ Billion)

- Figure 96: Western Europe 5G Subscriptions: 2019 2030 (Millions)
- Figure 97: Western Europe 5G Service Revenue: 2019 2030 (\$ Billion)

Figure 98: Configuration and Key Performance Metrics for KT's Pre-Commercial 5G Network

- Figure 99: NTT DoCoMo's 5G Roadmap
- Figure 100: SK Telecom's Phased 5G Approach
- Figure 101: SK Telecom's View on BBU-RRH Functional Split Options for 5G C-RAN
- Figure 102: Key Characteristics of Verizon's 5G Specifications
- Figure 103: Distribution of 5G Trials & Demos by Frequency Band: Q1'2017 (%)
- Figure 104: 3GPP 5G Standardization Roadmap
- Figure 105: High Level View for NextGen System Architecture

Figure 106: Key Features in Phase 1 of 3GPP's NextGen System Architecture

- Figure 107: Non-Standalone Deployment Mode for 5G Networks
- Figure 108: Standalone Deployment Mode for 5G Networks
- Figure 109: Comparison of IMT-2020 and IMT-Advanced Performance Requirements
- Figure 110: IMT-2020 Development Roadmap
- Figure 111: M-CORD Focus Areas
- Figure 112: Common Security Threats in 5G Networks
- Figure 113: European Commission's 5G Networks & Service Vision
- Figure 114: European Commission's 5G Roadmap
- Figure 115: ARIB's Vision of Radio Access Technologies for 5G
- Figure 116: 5GMF's 5G Implementation Roadmap
- Figure 117: IMT-2020 5G Promotion Group's 5G Implementation Roadmap

# LIST OF COMPANIES MENTIONED

3GPP (Third Generation Partnership Project)

- 5G Americas
- 5G Forum, South Korea

5G PPP (5G Infrastructure Public Private Partnership)

5G TSA (5G Open Trial Specification Alliance)

- 5GAA (5G Automotive Association)
- 5GMF (Fifth Generation Mobile Communications Promotion Forum, Japan)

5GRUS

5GTF (5G Technical Forum)

5GTR (Turkish 5G Forum)

Alcatel-Lucent



**Alpental Technologies** Alphabet America Movil Anatel (Agencia Nacional de Telecomunicacoes) Arcep Argela ARIB (Association of Radio Industries and Businesses) Arqiva Ascenta AT&T AT&T Mexico Athena Wireless Communications ATIS (Alliance for Telecommunications Industry Solutions) Avanti Communications **AVC Networks Company Batelco Bell Canada BMW Group Broadband Forum BT Group** C Spire CableLabs CAICT (China Academy of Information and Communications Technology) CCSA (China Communications Standards Association) CEA (French Alternative Energies and Atomic Energy Commission) CEA Tech CEA-Leti CEPT (European Conference of Postal and Telecommunications Administrations) China Mobile China Telecom China Unicom Chunghwa Telecom Cisco Systems CITEL (Inter-American Telecommunication Commission) **Claro Brasil** CMHK (China Mobile Hong Kong) CMRI (China Mobile Research Institute) CNIT (Italian National Consortium for Telecommunications) **Cobham Wireless** 



**Cohere Technologies** ComReg (Commission For Communications Regulation, Ireland) CpqD (Center for Research and Development in Telecommunications, Brazil) CTTC (Centre Tecnologic de Telecomunicacions de Catalunya) **Datang Mobile Datang Telecom Group Dish Network** DSA (Dynamic Spectrum Alliance) DT (Deutsche Telekom) Du (Emirates Integrated Telecommunications Company) EE Elisa EPFL (Ecole Polytechnique Federale de Lausanne) Ericsson Etisalat ETRI (Electronics and Telecommunications Research) ETSI (European Telecommunications Standards Institute) **EURECOM** Eutelsat Facebook FET (Far EasTone Telecommunications) FiberTower Corporation FICORA (Finnish Communications Regulatory Authority) Fraunhofer FOKUS Fraunhofer HHI Fraunhofer IIS Fraunhofer-Gesellschaft Fujitsu FuTURE Mobile Communication Forum, China GISFI (Global ICT Standardization Forum for India) **Globe Telecom** Google GSA (Global mobile Suppliers Association) **GSMA** GTI Hiroshima University HPE Huawei Hughes Network Systems



i5GF (Indonesia 5G Forum) ICASA (Independent Communications Authority of South Africa) ICTA (Information and Communication Technologies Authority, Turkey) IEEE (Institute of Electrical and Electronics Engineers) IETF (Internet Engineering Task Force) IFT (Instituto Federal de Telecomunicaciones) IIC (Industrial Internet Consortium) IMDA (Info-communications Media Development Authority of Singapore) **IMDEA Networks Institute** IMT-2020 (5G) Promotion Group, China Inatel (National Institute of Telecommunications, Brazil) Industry Canada Inmarsat Intel Corporation **InterDigital** Istanbul University ITRI (Industrial Technology Research Institute) ITU (International Telecommunication Union) JRC (Japan Radio Company) **Juniper Networks** KCL (King's College London) **KDDI** Corporation **Keysight Technologies KPN KT** Corporation **KUKA** Kumu Networks LG Electronics LG Uplus Ligado Networks Linux Foundation M1 MACOM Technology Solutions Malaysia 5G Committee MCMC (Malaysian Communications and Multimedia Commission) MCTIC (Ministry of Science, Technology, Innovation and Communications of Brazil) MediaTek MegaFon METU (Middle East Technical University)



MIC (Ministry of Internal Affairs and Communications, Japan) **Microsoft Corporation** MIIT (Ministry of Industry and Information Technology, China) Mitsubishi Electric Mobilv MOEA (Ministry of Economic Affairs, Taiwan) Moogsoft MOST (Ministry of Science & Technology, China) MOST (Ministry of Science & Technology, Taiwan) MSIP (Ministry of Science, ICT and Future Planning, South Korea) MTS (Mobile TeleSystems) MTSFB (Malaysian Technical Standards Forum Bhd) Murata Manufacturing NBTC (National Broadcasting and Telecommunications Commission, Thailand) NDRC (National Development and Reform Commission, China) **NEC** Corporation Net4Mobility NGMN (Next Generation Mobile Networks) Alliance NI (National Instruments) NICT (National Institute of Information and Communications Technology, Japan) Nokia Nokia Networks NTT Communications NTT DoCoMo NYU (New York University) O3b OCP (Open Compute Project) Foundation OFCA (Office of the Communications Authority, Hong Kong) Ofcom OMA (Open Mobile Alliance) ON.Lab (Open Networking Lab) ONF (Open Networking Foundation) Ooredoo Optus Orange Panasonic Avionics Corporation Panasonic Corporation PLTD Proximus



PTS (Swedish Post and Telecom Authority) pureLiFi Qorvo Qualcomm **RF DSP RF360 Holdings Rogers Communications** Rohde & Schwarz Roskomnadzor **Rutgers University** Samsung Electronics Samsung Group SES SiBEAM SIMalliance SingTel SK Telecom Small Cell Forum **Smart Communications** SmarTone SoftBank Group Sonera Sony Corporation SpaceX (Space Exploration Technologies Corporation) **Sprint Corporation** StarHub STC (Saudi Telecom Company) Stromnetz Berlin Swisscom TAICS (Taiwan Association of Information and Communication Standards) **Taiwan Mobile** Taiwan Star Telecom Corporation TCG (Trusted Computing Group) **TDK** Corporation Tele2 Telecom Italia Group Telefonica Telenor **Telia Company** 



Telstra Telus **Thales Group** TI (Texas Instruments) TIA (Telecommunications Industry Association) TIM (Telecom Italia Mobile) **Time Warner Titan Aerospace** TM Forum T-Mobile USA Tokyo Institute of Technology TRA (Telecommunications Regulatory Authority, UAE) TSDSI (Telecommunications Standards Development Society, India) TTA (Telecommunications Technology Association of Korea) TTC (Telecommunication Technology Committee, Japan) TU Dresden Turkcell U.S. Cellular U.S. Department of Commerce U.S. Department of Defense U.S. FCC (Federal Communications Commission) U.S. NIST (National Institute of Standards and Technology) U.S. NSF (National Science Foundation) UN (United Nations) University of California San Diego University of Edinburgh University of Kaiserslautern University of Oulu University of Southern California University of Surrey UT Austin (University of Texas at Austin) UTS (University of Technology Sydney) Verizon Communications VimpelCom Vodafone Australia Vodafone Germany Vodafone Group Vodafone Hutchison Australia Vodafone Qatar

The 5G Wireless Ecosystem: 2017 – 2030 – Technologies, Applications, Verticals, Strategies & Forecasts



Vodafone Turkey VTT Technical Research Center W3C (World Wide Web Consortium) WBA (Wireless Broadband Alliance) Wi-Fi Alliance WinnForum (Wireless Innovation Forum) WWRF (World Wireless Research Forum) Xilinx XO Communications xRAN Consortium Yonsei University Zain Group ZTE



### I would like to order

Product name: The 5G Wireless Ecosystem: 2017 – 2030 – Technologies, Applications, Verticals, Strategies & Forecasts

Product link: https://marketpublishers.com/r/56013E09791EN.html

Price: US\$ 2,500.00 (Single User License / Electronic Delivery)

If you want to order Corporate License or Hard Copy, please, contact our Customer Service: info@marketpublishers.com

# Payment

To pay by Credit Card (Visa, MasterCard, American Express, PayPal), please, click button on product page <u>https://marketpublishers.com/r/56013E09791EN.html</u>

To pay by Wire Transfer, please, fill in your contact details in the form below:

First name: Last name: Email: Company: Address: City: Zip code: Country: Tel: Fax: Your message:

\*\*All fields are required

Custumer signature \_\_\_\_\_

Please, note that by ordering from marketpublishers.com you are agreeing to our Terms & Conditions at <u>https://marketpublishers.com/docs/terms.html</u>

To place an order via fax simply print this form, fill in the information below and fax the completed form to +44 20 7900 3970



The 5G Wireless Ecosystem: 2017 – 2030 – Technologies, Applications, Verticals, Strategies & Forecasts