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Leading 5G and Beyond Business Solutions Market: Connected and Autonomous Vehicles, Mission Critical Services, Private Networks, Public Safety, Robotics, Satellites, Smart Cities and Surveillance

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Abstracts

Overview:

This research provides the most comprehensive assessment of the market for 5G business solutions. Analysis includes connected and autonomous vehicles, mission critical networks, private networks, public safety, satellites, smart cities, telerobotics and teleoperation, voice over 5G and video surveillance.

This comprehensive 5G research offering evaluates the 5G B2B market solutions for enterprise, industrial, and government users. It addresses specific opportunities such as 5G support of private wireless networks, WAN connectivity, and fixed wireless access for business. It also provides analysis for specific applications such as autonomous vehicles, telepresence, tele-robotics, video-related services, public safety and more. It also assesses 5G indoors, smart cities, and satellite market as well as the impact of 5G on the data analytics and data-as-a-service market.

This research also assesses the outlook for 5G equipment, software, and services as well as the market for infrastructure, devices, applications, and services beyond 5G (B5G). It analyzes the technologies, capabilities, and anticipated communications and computing solutions for 6G. It also investigates the impact of 5G evolution including anticipated 6G technologies. It provides analysis of the impact on the ICT ecosystem including infrastructure, business planning, and innovation areas necessary to realize future capabilities and solutions beyond 5G.

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Select Findings:

The global teleoperation and telerobotics market are poised to reach $76.5 billion by 2026

Global 5G in cloud robotics market will reach $10.6 billion by 2028, growing at 79.2% CAGR

5G narrow-band, mid-band and millimeter wave in smart cities to reach $104.8 billion by 2026

Combined 5G and mobile edge computing solutions to accelerate V2X growth in Asia Pacific and North America markets

The global 5G fixed wireless transport to smart buildings for specifically for support of WiFi connectivity/backhaul will reach $320.8M by 2026

The global satellite service market will spawn economic development value up to 50 times the combined cost of capital expenditures to deploy infrastructure and operational expense to maintain systems

5G subscription within public networks will exceed private through 2026, although the latter will experience a 20% faster growth rate, set to overtake the former by 2030

6G technologies are best characterized as ultra-secure, ultra-fast, ultra-reliable, and ultra-short-range oriented capabilities. 6G communication services will achieve initial commercialization in 2028 to 2030

Voice quality gained significant ground with Voice over LTE (VoLTE) with the deployment of 4G LTE networks. Voice over 5G (Vo5G) service will build on those advancements as evolved voice systems leverage combined 5G core network elements along with IP Multimedia Systems (IMS), VoLTE enhancements, 5G Evolved Packet Core (EPC), and other 5G New Radio (5GNR) 5G radio access network equipment such as smart antennas.

The vast majority of 5G service provider profits will result from the business market rather than the consumer segment. The latter will generate additional revenues, but

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margins will be very thin as compared to business segments including enterprise, industrial, and government sectors. Accordingly, the business to business (B2B) market is viewed as significantly more attractive than the business to consumer (B2C) market for 5G. The analyst sees the 5G business services market developing as communication service providers offer both B2B direct as well as B2B to business (B2B2B) through third party channels.

One of the primary 5G B2B market opportunities will be fixed wireless access (FWA) to enterprise and industrial customers as a complement (not a replacement) to cable, fiber and Ethernet. For certain situations, such as time sensitive networks that require ultra-reliability, 5G will be an alternative to other wireless options. However, WiFi 6 will be a viable option vs. 5G for indoor, driven by scenario specific issues such as existing wireless, solution requirements, and overall economics.

The 5G business services market will also be very important in support of private wireless networks for both fixed wireless WAN connectivity for business-owned networks as well as carrier turn-key solutions involving both 5G and edge computing deployments. Communication service providers will position turn-key offerings as a “future-proof” alternative to enterprise and industrial customer network ownership. Part of this turn-key value proposition is carrier managed services as opposed to the business customer managing in-house and/or hiring a third party for network and/or application management.

LTE Advanced (LTE-A) represents a major step in the evolution of 4G technology, providing mobile coverage, higher performance, and greater connection stability. The 5G New Radio (NR) access technology is a part of 5G Radio Access Network (RAN) architecture that is composed of LTE evolution and millimeter wave (mmWave) technology that will be operable from sub-1 GHz to 24+ GHz in a range of the low band, mid-band, and high band.

A variety of complementary technologies will enable 5G NR supported systems including massive MIMO, advanced LPDC, TDD subframe, beamforming, and mmWave radiofrequency. For communication service providers, mmWave will bring both challenges and opportunities for general RAN infrastructure and in particular for the private Internet of Things (IoT) networks for industrial automation and mission-critical services for enterprise across many industry verticals.

The higher frequencies suffer from attenuation, which means they lose signal over distance and when they hit objects (even water vapor, but especially solid objects like

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trees, buildings, etc.). This is why there is a need for massive MIMO and other multi-signal approaches to help, along with beam-forming to direct RF energy to where it is needed, but the signal is so directional in nature that it is very hard to maintain with a moving object.

The business drivers for satellite communications and applications are clear. Satellites provide coverage in areas where terrestrial wireless cannot. In fact, land-based wireless-only covers roughly 12% of the globe. Certain verticals, such as the maritime industry, require global coverage. This will be especially important as shipping begins to adopt autonomous transport as vessels will continue to require ship-to-shore communications as well as a new need for signaling with onboard ship sensors for navigation and ship controls.

The asset management industry also requires satellite systems for coverage in support of fleet tracking, supply chain management, and general asset tracking needs. The advent of advanced Internet of Things (IoT) solutions leveraging machine-to-machine communications and other supporting technologies enables anytime, anywhere, any type of asset tracking. Satellites provide seamless M2M communications for the IoT-based asset tracking market.

Smart cities represent a combination of solutions deployed in an urban environment to transform the administration and support of living and working environments to meet these challenges. Accordingly, Information and Communications Technologies (ICT) are transforming at a rapid rate, driven by urbanization, the industrialization of emerging economies, and the specific needs of various smart city initiatives. Smart city development is emerging as a focal point for growth drivers in several key ICT areas including AI, IoT, connected devices, broadband wireless, edge computing, and big data analytics.

We anticipate that smart cities will increasingly become highly surveilled cities. By way of example, there are so many CCTV cameras in the UK that the average Londoner is caught on camera 300 times per day. It is estimated that there is 1 CCTV camera for every 13 people in London, meaning that there are approximately 700,000 cameras in this dense urban environment.

Traditional surveillance solutions are typically overseen by humans and are prone to error. 5G allows for new solutions, including those that are completely automated and can actively blur individual details of those being recorded, while also monitoring their activity for crime or suspicious activity. This is possible due to the processing and

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analysis of these video feeds being done locally through 5G edge clouds. Therefore, the software's decision making can be done with no human involvement.

Robotics is increasingly used to improve enterprise, industrial, and military automation. In addition, robots are finding their way into more consumer use cases as the general public's concerns fade and acceptance grows in terms of benefits versus risks. While many consumer applications continue to be largely lifestyle-oriented, enterprise, industrial, and military organizations utilize both land-based and aerial robots are used for various repetitive, tedious, and/or dangerous tasks. Adoption and usage are anticipated to rapidly increase with improvements to artificial intelligence, robotic form factors, and fitness for use, cloud computing, and related business models, such as robotics as a service.

The global robotics market is broadly segmented into enterprise, industrial, military, and consumer robotics. Major market segments that cross-over industries include healthcare bots, Unmanned Aerial Vehicles, and autonomous vehicles. Enterprise Robotics includes the use of robots for both business-to-business and business-to-consumer services and support. Functions include internal business operations and processes, delivery of goods and services, research, analytics, and other business-specific applications.

Smart machines collectively represent intelligent devices, machinery, equipment, and embedded automation software that perform repetitive tasks and solve complex problems autonomously. Along with AI, IoT connectivity, and M2M communications, smart machines are a key component of smart systems, which include many emerging technologies such as smart dust, neurocomputing, and advanced robotics. Smart machines will also benefit significantly from advancements in the convergence of AI and IoT, also known as the artificial intelligence of things (AIoT).

Teleoperation and telerobotics are both supported by ICT infrastructure including broadband communications, sensors, machine to machine (M2M) communications, and various Internet of Things (IoT) technologies. The combination of teleoperations, M2M/IoT, and 5G communications will enable entirely new use cases for robotics, supported by cloud-based robotics as a service business models.

Enhancements in wireless broadband are untethering teleoperation. Prior to 5G and Mobile Edge Computing (MEC), Teleoperation is largely relegated to fixed communications connections. 5G and MEC will enable Teleoperation anywhere there is 5G coverage, enabling many new consumer and industrial automation scenarios

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involving robotics. In particular, we anticipate realization of substantial benefits as a result of the teleoperation market embracing cloud robotics deployment in conjunction with 5G in private wireless environments.

Expanding upon the trend started with technologies supporting 5G capabilities, 6G will be integrated with a set of previously disparate technologies. Several key technologies will converge with 6G including AI, big data analytics, and computing. 6G networks will extend the performance of existing 5G capabilities along with expanding the scope to support increasingly new and innovative applications across the realms of communications, sensing, wireless cognition, and imaging.

Whereas 5G leverages mmWave in the microwave frequency range, 6G will take advantage of even smaller wavelengths at the Terahertz (THz) band in the 100 GHz to 3 THz range. While the impact to the Radio Access Network (RAN) for 5G is substantial, it will be even bigger with 6G networks, which is driven largely by a substantial increase in frequency, which will facilitate the need for antennas virtually everywhere.

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5.4 China Mobile
5.5 China Telecom
5.6 Deutsche Telekom AG

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5.7 DU (Emirates Integrated Telecommunications Company)
5.8 KT Corporation
5.9 NTT DoCoMo
5.10 STC - Saudi Telecom Company
5.11 SK Telecom
5.12 Sprint Corporation
5.13 Telstra
5.14 Verizon
5.15 Vodafone Group
5.16 Telenor
5.17 T-Mobile USA
5.18 Rogers Communications
5.19 America Movil
5.20 Entel
5.21 Movistar
5.22 China Unicom
5.23 Ooredoo
5.24 Zain
5.25 Swisscom
5.26 Spark NZ
5.27 Telecom Italia
5.28 Orange SA
5.29 KDDI Corporation
5.30 LG Uplus
5.31 Softbank Group
5.32 SingTel
5.33 Telefonica
5.34 Apple
5.35 Facebook (Whatsapp)
5.36 Google
5.37 Microsoft
5.38 Rakuten (Viber)
5.39 Snap Inc.
5.40 Spotify AB
5.41 Tencent
5.42 Amazon Prime Video
5.43 WeChat
5.44 Skype
5.45 Telegram

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5.47 REVE Systems
5.48 Hulu
5.49 Netflix
5.50 Dish (Sling TV)
5.51 Sky Go
5.52 Roku
5.53 Sony (PlayStation Vue)
5.54 Fubo TV
5.55 Philo TV
5.56 ClipBucket
5.57 Muvi
5.58 Contus Vplay
5.59 Quickplay
5.60 Vplayed
5.61 Ooyala
5.62 Vidmind
5.63 Mobiotics
5.64 Nokia Network (Alcatel lucent)
5.65 Samsung Electronics
5.66 Cisco Systems
5.67 LG Electronics
5.68 Huawei Technologies
5.69 Ericsson
5.70 Qualcomm
5.71 Intel Corporation
5.72 NEC Corporation
5.73 ZTE Corporation
5.74 Ciena Corporation
5.75 Cavium Inc.
5.76 Qorvo Inc.
5.77 Fujitsu Ltd.
5.78 Broadcom Corporation
5.79 HPE
5.80 VMware Inc.
5.81 MediaTek Inc.
5.82 Juniper Network Inc.
5.83 Analog Devices Inc.
5.84 MACOM Technology

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5.85 Motorola
5.86 Ascom
5.87 Harris
5.88 Hytera
5.89 Cobham Wireless
5.90 Leonardo
5.91 Mentura Group
5.92 Inmarsat
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4.12 Velodyne Lidar, Inc.
4.13 Lyft
4.14 Uber Technologies
4.15 GrabTaxi Holdings
4.16 Voyage
4.17 AImotive
4.18 Idriverplus
4.19 Aurora
4.20 Nuro
4.21 Zoox Inc.

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4.22 Tencent
4.23 Deepmap
4.24 LeddarTech
4.25 Innoviz Technologies
4.26 Innovusion
4.27 Robosense
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4.35 Autotalks Ltd.
4.36 Cognata
4.37 Mighty AI
4.38 Volkswagen AG
4.39 Scania AB
4.40 Audi AG
4.41 BMW AG
4.42 Daimler AG (Mercedes Benz)
4.43 Ford Motor Company
4.44 Zhejiang Geely Holding Group
4.45 General Motors
4.46 Honda Motor Company
4.47 Nissan Motor Corporation
4.48 Tesla Inc.
4.49 Toyota Motor Corporation
4.50 Volvo Car Corporation
4.51 Zenuity
4.52 Mitsubishi Motors Corporation
4.53 Fiat Chrysler Automobiles
4.54 Porsche AG
4.55 Groupe Renault
4.56 Groupe PSA
4.57 Alibaba (SAIC Motors)
4.58 Autoliv Inc.
4.59 Ericsson
4.60 Intel Corporation (Mobileye)

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4.61 Continental AG
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9 CONCLUSIONS AND RECOMMENDATIONS

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4.6 Arabsat
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4.14 Casic
4.15 China Satcom
4.16 Cobham plc.
4.17 Commercial Space Technologies Ltd
4.18 Communications & Power Industries LLC
4.19 Comtech PST Corp
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4.21 Cosmos International
4.22 Digisat International Inc.
4.23 EchoStar Mobile Limited
4.24 Eric Communications
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4.27 Eutelsat
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4.29 General Dynamics Mission Systems
4.30 Gilat Satellite Networks
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4.33 L3Harris Technologies
4.34 Holkirk Communications Ltd
4.35 Hughes Satellite Systems Corporation
4.36 Inmarsat PLC
4.37 Intelsat General
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4.39 ISRO
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6.7 Deutsche Telekom AG
6.8 DU (Emirates Integrated Telecommunications Company)
6.9 KT Corporation
6.10 NTT DoCoMo
6.11 STC - Saudi Telecom Company
6.12 SK Telecom
6.13 Sprint Corporation (T-Mobile)
6.14 Telstra
6.15 Verizon
6.16 Vodafone Group
6.17 Telenor
6.18 T-Mobile USA
6.19 Rogers Communications
6.20 America Movil
6.21 Entel
6.22 Movistar
6.23 China Unicom
6.24 Ooredoo

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6.25 Zain
6.26 Swisscom
6.27 Spark NZ
6.28 Telecom Italia
6.29 Orange SA
6.30 KDDI Corporation
6.31 LG Uplus
6.32 Softbank Group
6.33 SingTel
6.34 Telefonica
6.35 Apple
6.36 Facebook (Whatsapp)
6.37 Google
6.38 Microsoft
6.39 Rakuten (Viber)
6.40 Tencent
6.41 WeChat
6.42 Skype (Microsoft)
6.43 Telegram
6.44 Ribbon Communications
6.45 REVE Systems
6.46 Hulu
6.47 Netflix
6.48 Dish (Sling TV)
6.49 Sky Go
6.50 Roku
6.51 Sony (PlayStation Vue)
6.52 Fubotv
6.53 Philo TV
6.54 ClipBucket
6.55 Muvi
6.56 Contus Vplay
6.57 Quickplay
6.58 Vplayed
6.59 Ooyala
6.60 Vidmind
6.61 Mobiotics
6.62 Nokia Networks
6.63 Samsung Electronics

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6.64 Cisco Systems
6.65 LG Electronics
6.66 Huawei Technologies
6.67 Ericsson
6.68 FirstNet
6.69 Qualcomm
6.70 Intel Corporation
6.71 NEC Corporation
6.72 ZTE Corporation
6.73 Ciena Corporation
6.74 Cavium Inc.
6.75 Qorvo Inc.
6.76 Fujitsu Ltd.
6.77 Broadcom Corporation
6.78 HPE
6.79 VMware Inc.
6.80 MediaTek Inc.
6.81 Juniper Network Inc.
6.82 Analog Devices Inc.
6.83 MACOM Technology
6.84 Motorola
6.85 Ascom
6.86 Harris
6.87 Hytera
6.88 Cobham Wireless
6.89 Leonardo
6.90 Mentura Group
6.91 Inmarsat
6.92 Zenitel
6.93 HTC
6.94 Airspan
6.95 Alvarion
6.96 Sierra Wireless (Accel Networks)
6.97 Coolpad Dyno
6.98 Mobvoi
6.99 Fitbit (Google)
6.100 Misfit
6.101 Asus
6.102 Netgear

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6.103 Zyxel
6.104 Alibaba
6.105 D-Link
6.106 UniFi
6.107 Altair Semiconductor
6.108 SimNet Wireless
6.109 Siretta
6.110 Cradlepoint
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6.113 Rohde # Schwarz
6.114 Gemalto
6.115 Netcracker (NEC)
6.116 Texim Europe
6.117 M2M Connectivity
6.118 Eurotech
6.119 RedLinX
6.120 MYCOM OSI
6.121 Colt
6.122 ADLINK Technology Inc.
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6.124 Cloudify
6.125 EdgeConnex
6.126 Edgeworx
6.127 InterDigital Inc.
6.128 Mimic Technology
6.129 MobiledgeX
6.130 Ori
6.131 Pixeom
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5.1 Americas
5.2 2G Engineering
5.3 3D Robotics
5.4 Adept Technology Inc.
5.5 Aethon Inc.
5.6 Alphabet, Inc. (Google)
5.7 Amazon Robotics
5.8 Anki Inc.
5.9 Apex Automation and Robotics
5.10 Auris Surgical Robotics Inc.
5.11 Autonomous Solutions, Inc.
5.12 Axium Inc.
5.13 Canvas Technology
5.14 Carbon Robotics
5.15 Carbon3D
5.16 Celera Motion
5.17 Clearpath Robotics
5.18 Construction Robotics
5.19 CyPhy Works
5.20 Denso Wave Inc.
5.21 Ekso Bionics
5.22 Ellison Technologies Inc.
5.23 Energid Technologies
5.24 Epson Robots
5.25 Fetch Robotics
5.26 Ghost Robotics LLC
5.27 Greensea Systems Inc.
5.28 Hypertherm Inc.
5.29 IAM Robotics
5.30 inVia Robotics
5.31 iRobot
5.32 Intuitive Surgical, Inc.
5.33 Jibo
5.34 Kairos Autonomi
5.35 Knightscope
5.36 Kraken Sonar Systems Inc.
5.37 Lockheed Martin
5.38 Locus Robotics

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5.39 Micromo
5.40 Modbot Inc.
5.41 Octopuz Inc.
5.42 Omnicell Inc.
5.43 PrecisionHawk
5.44 ReWalk Robotics
5.45 RobotLAB Inc.
5.46 Rockwell Automation Inc.
5.47 Rokid Inc.
5.48 SapientX Inc.
5.49 Savioke
5.50 Seegrid
5.51 Sharp Electronics Corp.
5.52 SkySpecs
5.53 Soft Robotics Inc.
5.54 Softweb Solutions Inc.
5.55 SRI International
5.56 Staubli
5.57 Stryker (MAKO Surgical)
5.58 Suitable Technologies
5.59 SynTouch
5.60 Teradyne Inc.
5.61 Titan Medical
5.62 TM Robotics
5.63 TORC Robotics
5.64 Transcend Robotics
5.65 ULC Robotics Inc.
5.66 Universal Robotics
5.67 Vecna Technologies
5.68 Verb Surgical
5.69 VEX Robotics
5.70 VGo Communications
5.71 Vigilant Robots
5.72 Virtual Incision Corporation
5.73 Willrich Precision Instrument Co.
5.74 World Drone Academy
5.75 Wynright (Daifuku Co Ltd)
5.76 Yaskawa Motoman
5.77 Asia-Pacific

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5.78 Aurotek Corp.
5.79 Cyberdyne
5.80 Daihen Corp.
5.81 DJI
5.82 FANUC Robotics
5.83 Foxconn Technology Group
5.84 GreyOrange
5.85 Hanson Robotics Ltd.
5.86 Kawasaki
5.87 Mitsubishi Electric Corp.
5.88 Nachi Fujikoshi Corp.
5.89 Pari Robotics
5.90 Qihan Technology Co.
5.91 Samsung
5.92 Seven Dreamers Laboratories Inc.
5.93 Siasun Robot and Automation Co Ltd.
5.94 SoftBank Robotics Corporation
5.95 Sony
5.96 Toyota
5.97 WaveBot
5.98 Yamaha Robotics
5.99 Europe
5.100 ABB Robotics
5.101 AMS RBR
5.102 Blue Ocean Robotics ApS
5.103 Comau Robotics
5.104 Delphi Automotive
5.105 Kuka Robotics
5.106 Milvus Robotics
5.107 Mobile Industrial Robots ApS
5.108 Open Bionics
5.109 Reis Robotics
5.110 Roboplan
5.111 Robosoft Services Robots
5.112 Schunk
5.113 Siemens
5.114 Soil Machine Dynamics Ltd.
5.115 SSI Schaefer
5.116 Starship Technologies

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5.117 Staubli International AG
5.118 Swisslog
5.119 Teun
5.120 Touch Bionics
5.121 Universal Robots A/S
5.122 Visual Components Oy
5.123 ZenRobotics

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5.5 China Telecom
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5.7 DU
5.8 KT Corporation
5.9 NTT DoCoMo
5.10 STC - Saudi Telecom Company
5.11 SK Telecom
5.12 Sprint Corporation
5.13 Telstra
5.14 Verizon
5.15 Vodafone Group
5.16 Telenor
5.17 T-Mobile USA
5.18 Rogers Communications
5.19 America Movil
5.20 Entel
5.21 Movistar

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5.22 China Unicom
5.23 Ooredoo
5.24 Zain
5.25 Swisscom
5.26 Spark NZ
5.27 Telecom Italia
5.28 Orange SA
5.29 KDDI Corporation
5.30 LG Uplus
5.31 Softbank Group
5.32 SingTel
5.33 Telefonica
5.34 Apple
5.35 Facebook (Whatsapp)
5.36 Google
5.37 Microsoft
5.38 Rakuten (Viber)
5.39 Snap Inc.
5.40 Spotify AB
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5.43 WeChat
5.44 Skype
5.45 Telegram
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5.47 REVE Systems
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5.50 Dish (Sling TV)
5.51 Sky Go
5.52 Roku
5.53 Sony (PlayStation Vue)
5.54 Fubo TV
5.55 Philo TV
5.56 ClipBucket
5.57 Muvi
5.58 Contus Vplay
5.59 Quickplay
5.60 Vplayed

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5.61 Ooyala
5.62 Vidmind
5.63 Mobiotics
5.64 Nokia Network (Alcatel lucent)
5.65 Samsung Electronics
5.66 Cisco Systems
5.67 LG Electronics
5.68 Huawei Technologies
5.69 Ericsson
5.70 Qualcomm
5.71 Intel Corporation
5.72 NEC Corporation
5.73 ZTE Corporation
5.74 Ciena Corporation
5.75 Cavium Inc.
5.76 Qorvo Inc.
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5.78 Broadcom Corporation
5.79 HPE
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5.81 MediaTek Inc.
5.82 Juniper Network Inc.
5.83 Analog Devices Inc.
5.84 MACOM Technology
5.85 Motorola
5.86 Ascom
5.87 Harris
5.88 Hytera
5.89 Cobham Wireless
5.90 Leonardo
5.91 Mentura Group
5.92 Inmarsat
5.93 Zenitel
5.94 HTC
5.95 Airspan
5.96 Alvarion
5.97 Sierra Wireless (Accel Networks)
5.98 Coolpad Dyno
5.99 Mobvoi

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5.100 Fitbit
5.101 Misfit
5.102 Asus
5.103 Netgear
5.104 Zyxel
5.105 Alibaba
5.106 D-Link
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7.6 Intel Corporation
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7.8 SK Telecom Co. Ltd.
7.9 Verizon Communications
7.10 China Mobile
7.11 NTT DoCoMo Inc.
7.12 Vodafone
7.13 Samsung Electronics Co. Ltd.
7.14 LG Electronics Inc.
7.15 T-Mobile US Inc.
7.16 KT Corporation
7.17 NEC Corporation
7.18 Fujitsu Ltd.
7.19 ZTE Corporation

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7.20 Deutsche Telekom AG
7.21 Broadcom Corporation
7.22 LG Uplus Corp.
7.23 SingTel
7.24 Telefonica
7.25 HPE
7.26 VMware Inc.
7.27 MediaTek Inc.
7.28 Juniper Networks, Inc.
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9.2 Atos SE

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9.4 Dataminr
9.5 Enforsys
9.6 ESRI
9.7 General Dynamics Corporation
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9.16 NEC Corporation
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9.19 Northrop Grumman Corporation
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4.8 DARPA
4.9 DeepSig
4.10 Ericsson
4.11 Facebook Connectivity
4.12 Federated Wireless
4.13 Fujitsu
4.14 Google
4.15 Huawei
4.16 InterDigital
4.17 Karlsruhe Institute of Technology

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4.18 Keysight Technologies
4.19 LG Corporation
4.20 MediaTek
4.21 Motorola Solutions
4.22 Nanyang Technological University
4.23 National Science Foundation
4.24 Nokia (Bell Labs)
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