



twimbit

White Paper

5G Fundamentals

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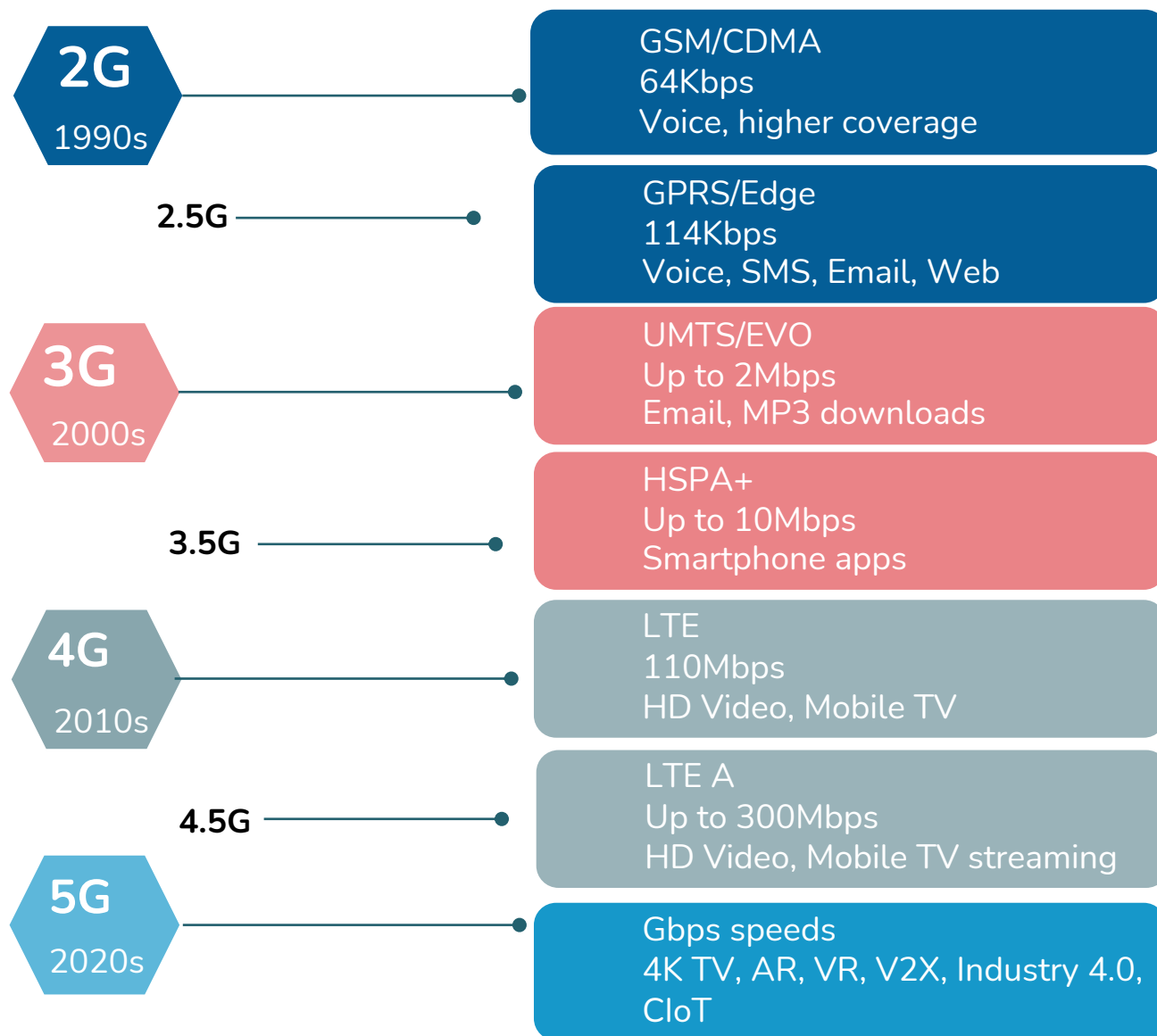
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5G evolution and its key features



Faster speeds much faster data rates compared to previous network generations

Increased capacity Ability to handle large number of devices and data volumes

Low latencies 5 times lesser latencies proves beneficial for mission critical operations

Secure 5G ensures very high security levels which makes it the most reliable network ever

Comparing 5G vs 4G

	Speed (Peak Download/upload)	Latency	Availability Reliability Security	Mobility	Device density
5G	20/10 GBPS	1 ms	99.999%	310 mph	2.5 million per sq. mile
4G	1/0.2 GBPS	10 ms	99.99%	220 mph	250 per sq. mile

Primary applications of 5G

Enhanced Mobile
Broadband (eMBB)

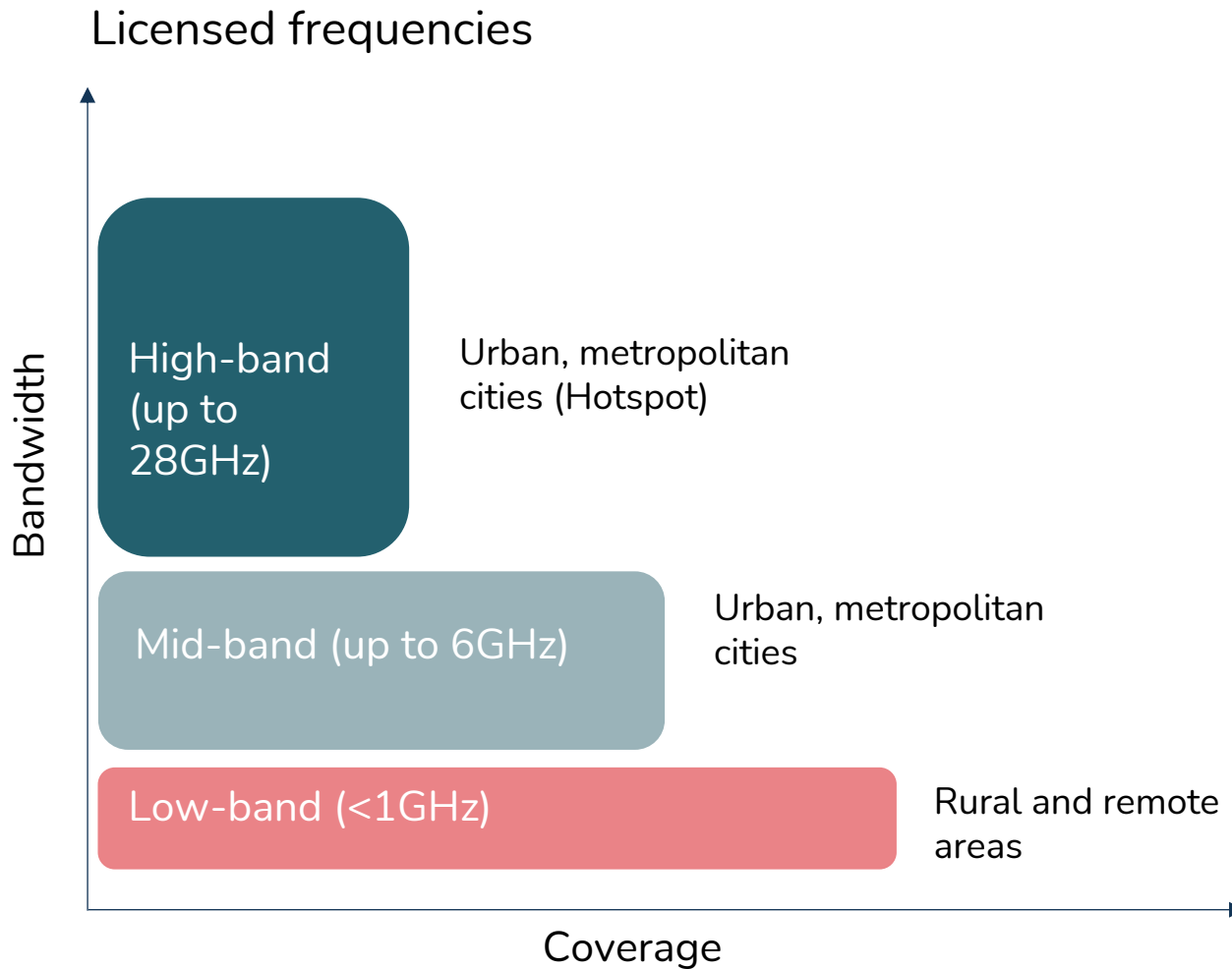


Massive machine type
communications
(mMTC)

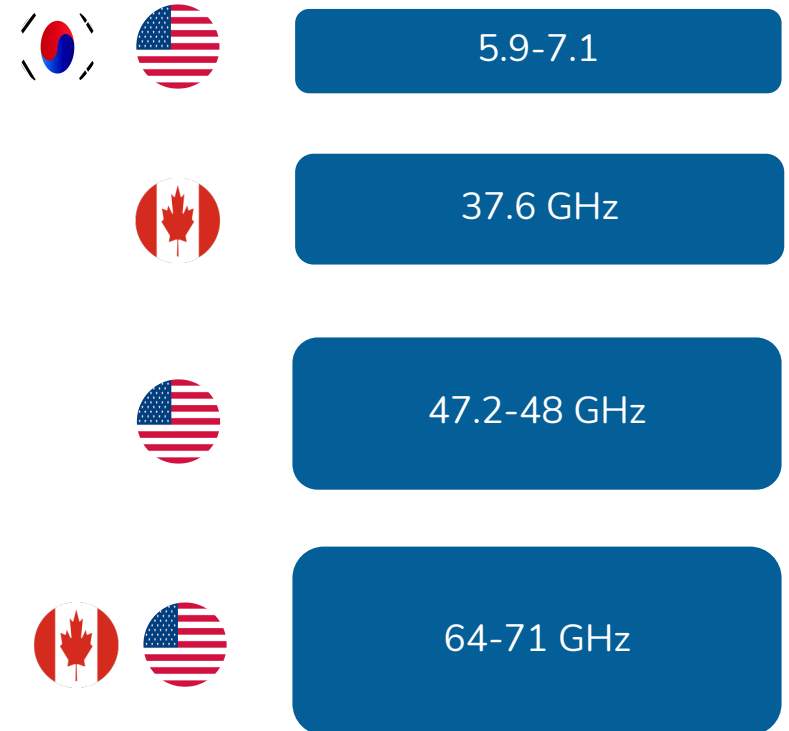
Ultra-reliable and low
latency
communications
(URLLC)

- **eMBB** HD video streaming, AR/VR gaming, stadiums, concerts
- **mMTC** Smart cities, manufacturing industry, agriculture, logistics, energy & Utilities
- **URLLC** Remote control operations, autonomous vehicles, remote surgeries

5G spectrum bands



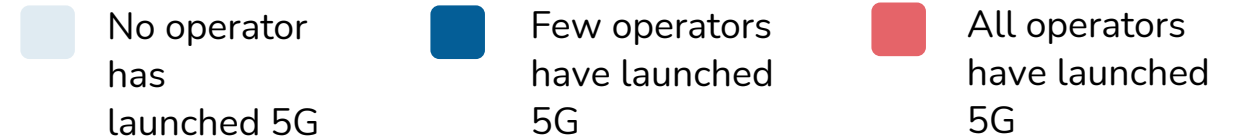
Unlicensed frequencies



5G spectrum allocation in Asia-Pacific

Markets	Low band	Mid band	MmWave
China	700 MHz	2.6 GHz, 3.5 GHz, 4.9 GHz	24.75 GHz, 27.5 GHz, 37 GHz, 42.5 GHz
South Korea	-	3.5 GHz	28 GHz
Indonesia	-	2.3 GHz	-
Japan	-	3.7 GHz, 4.5 GHz	28 GHz
Philippines	450 MHz, 700 MHz	2.6 GHz, 3.5 GHz	-
Thailand	700 MHz	2.6 GHz	26 GHz
Taiwan	-	1.8 GHz, 3.5 GHz	28 GHz
Australia	850/900 MHz	3.6 GHz	26 GHz
Singapore	-	3.5 GHz	26 GHz, 28 GHz

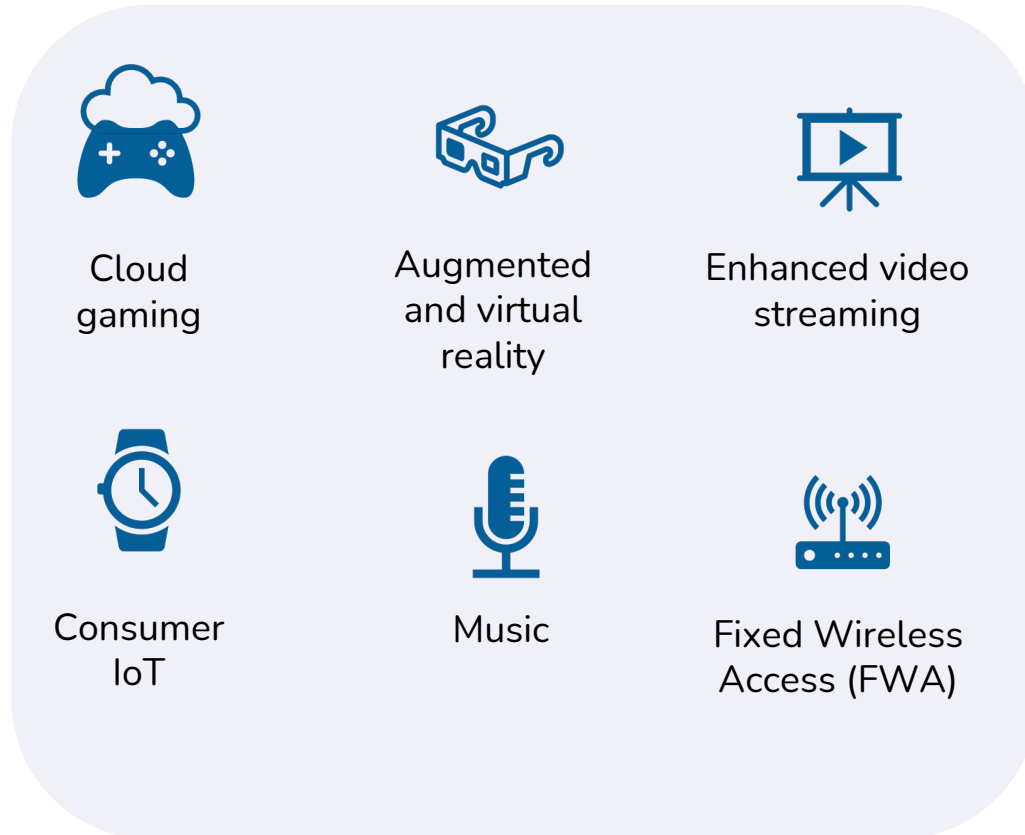
5G subscribers in Asia-Pacific



Markets	Subscribers (in million)	5G penetration (% of total subscribers)
China	490	30%
South Korea	20	28%
Japan	14	8%
Indonesia	15	4%
Philippines	7	4%
Thailand	5	4%
Taiwan	4	13%
Australia	2.2	3%
Singapore	0.34	4%



Key use cases of 5G - consumer



SKT in partnership with Microsoft launched **5GX cloud game**, a subscription-based service that allows users to play more than 100 games



LG U plus launched **GeForce now, world's first 5G cloud game** in partnership with NVIDIA

LG U plus is building **AR VR content** to further distribute it through its own 5G plans as well as selling it to other telcos through contracts

Smart home is an optional premium service provided to U+ 5G customers. This enables customers to turn on their home devices by voice



T Mobile 5G plan bundles free Netflix and **4K video streaming**



Verizon bundles **free Disney+/Hulu/ESPN+ Apple music and Discovery+**



5G home internet that comes with Plug and play feature. Many operators other than Optus are also providing 5G **FWA** services

Enterprise business transformation with Private 5G

What is a private 5G network?

- ✓ A private network is an enterprise owned local-Area network deployed in a large area such as a manufacturing concern
- ✓ The performance attributes of private 5G are quite like those of public 5G such as low latencies and higher throughput
- ✓ Private 5G has unique capabilities required to address the needs of mission and business critical communications

Key attributes of Private 5G

High availability and reliability

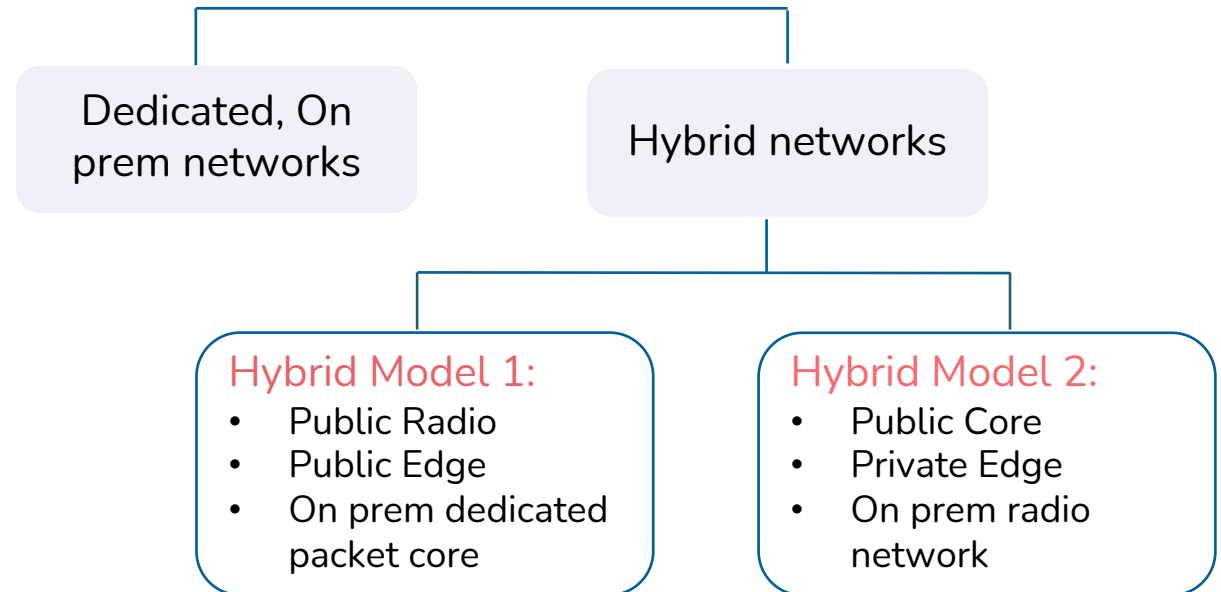
High security

Interconnection

Customisation of services

Quality of Service(QoS)

Private 5G deployment models



Why Private 5G over legacy networks

	Bandwidth	Coverage	Latency	Mobility	Security	Scalability	Quality of Service
Wifi	High	Low	High	Low	Low	Low	Low
Private LTE (cellular)	Very High	High	Low	High	High	High	High
Private 5G (Cellular)	Very High	Very high	Ultra low latency	Very High	Very high	Very High	Very High

5G use cases in vertical industries



Private networks across key APAC countries



South Korea

- Smart shipping/ports
- Digital healthcare
- Autonomous robots
- Unmanned self-constructing robots
- Self-driving robots for food delivery



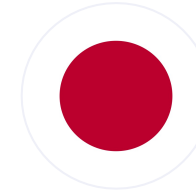
Singapore

- Smart ports
- Urban mobility solutions
- Smart manufacturing
- Smart Estates



Australia

- Sydney ferries 5G trials for surveillance
- AI-enabled inspection of waste-water pipes
- Livestock counting
- AGVs
- Real-time streaming of construction sites



Japan

- Mobility test center
- HD image analysis integrated with AI (movement of people and unmanned vehicles)
- Smart cities



China

- Smart Grid
- Smart mining
- Smart manufacturing
- Smart healthcare
- Connected vehicle infrastructure cooperative system
- 5G digital twin space

5G enables opportunities in maritime

About the industry

- ✓ 90% of world's trade is dependent upon sea trade
- ✓ Maritime, on an average contributes 5-10% to the country's GDP (refers to key economies where ports/maritime is a significant sector such as Singapore, China)

Challenges



High Labour
cost/harsh working
conditions



Increasing trade
volumes



Time constraints
for the ships



Limitations of
fixed network

Use cases in maritime

Use case	Role of 5G
Remote control of gantry cranes	<ul style="list-style-type: none"> Remote control is possible by installing multiple cameras and PLCs on the crane. Low latency and uplink bandwidth supports video uploads and reliable PLC communications.
Machine vision and video surveillance	<ul style="list-style-type: none"> Multi access Edge computing (MEC) improves data processing and reduces the machine vision system cost. This allows for automatic monitoring of berths, personnel and traffic flow
Smart Ships	<ul style="list-style-type: none"> URLLC & mMTC plays a crucial role in improving safety and security during navigation
Cargo handling optimisation	<ul style="list-style-type: none"> URLLC, mMTC, network slicing and eMBB enables a shorter time to find cargo
Automated Guided Vehicles (AGVs)	<ul style="list-style-type: none"> 5G network have better capabilities to support LIDAR sensors, surveillance cameras and other technologies used in AGVs over legacy networks
Drones	<ul style="list-style-type: none"> eMBB enables improved security for data transmission, better capacity to identify potential threats, and greater data reliability
Autonomous trucks	<ul style="list-style-type: none"> 5G network slicing enhances safety in self driving. A separate network level can be dedicated to safety related notifications

5G enables opportunities in manufacturing

About the industry

- ✓ According to World Bank, manufacturing sector contributes 16% to the Global GDP
- ✓ Post pandemic, historic Labour and supply chain challenges continue to loom on the manufacturing industry in many economies

Challenges



Skilled labor
shortages



Production
inefficiencies



Data security
issues



Changing
consumer needs



Global
competition

Use cases in manufacturing

Use case	Role of 5G
AR for remote expertise	<ul style="list-style-type: none">Using AR headsets provides near instant access to the data and the equipment especially in case of maintenance. This requires high bandwidth for video uploads as well low latency for the information to reach in real time
Remote robot control	<ul style="list-style-type: none">Remote controlled robots can be used for hazardous activities. Ultra low latency is a necessity for this use case.
Predictive and preventive maintenance	<ul style="list-style-type: none">Predictive maintenance involves use of multiple sensors to provide timely information about any breakdown of the machinery. 5G is reliable in terms of real-time data collection from these sensors. It is also capable of handling such a device density. This reduces the downtime and also lowers the production costs
Automated guided vehicles	<ul style="list-style-type: none">5G network have better capabilities to support LIDAR sensors, surveillance cameras and other technologies used in AGVs over legacy networks. Low latency, network slicing and reliability are some of the key 5G attributes that are required for this use case.

5G enables opportunities in mining

About the industry

- ✓ Mining is a process which involves extraction, beneficiation and processing of various commodities like oil, gas, and various metal ores and other solid materials.
- ✓ According to IDC, miners have significant investment plans for technologies like IoT, Cloud, AI/ML, AR/VR driving the need for 5G networks.

Challenges



Worker
safety



Operational
inefficiencies



Volatility of
commodity prices



Weak public
network in
remote locations

Use cases in mining

Use case	Role of 5G
Predictive maintenance	<ul style="list-style-type: none">• Predictive maintenance involves use of multiple sensors installed in remote and underground sites. 5G connectivity can provide reliable real time data about any breakdown of equipments
Drones for exploration	<ul style="list-style-type: none">• In mining, drones can be used for patrolling the mines, checking gas leakages, seismic changes, fire, to monitor the movement of people working in the oil fields to ensure their safety against disasters. A reliable private 5G network and low latency powered by edge computing are required in such mission critical operations
Remote management of unmanned oil production platforms	<ul style="list-style-type: none">• In the past, this could not be achieved with 4G/LTE. The latest computing platforms require high bandwidth to deliver information from the unmanned oil production platform to the central remote-control unit
Autonomous vehicles for mining	<ul style="list-style-type: none">• With low latency, 5G enables long range remote control of autonomous trucks. 5G networks have also led to increase in speed limits for the mining trucks, thus achieving transport efficiency gains

5G enables opportunities in healthcare

About the industry

- ✓ Healthcare is a universal necessity and will continue to expand with the growth in population and rising needs for quality experience for health services.
- ✓ According to World Bank, the per capita expenditure on health has grown from USD 479 in 2000 to 1,111 in 2018

Challenges



Massive data
generation



Distance between
hospital and patient

Use cases in healthcare

Use case	Role of 5G
Virtual consultations	<ul style="list-style-type: none">It will enable doctors to provide remote care to their patients through 3D/UHD video conferencing. 5G devices consume less power compared to 4G. Also, its lower latency will improve the accuracy of virtual consulting with a more immersive experience
Distraction therapy with AR/VR	<ul style="list-style-type: none">5G enables smooth streaming of AR/VR based applications
Enhancing surgeries	<ul style="list-style-type: none">Low latency allows a surgeon to control a robotic equipment from a far location and get haptic input with a greater accuracy
Connected ambulances	<ul style="list-style-type: none">5G network slicing plays a role here, allowing for prioritizing specific types of data on sub-networks such as one dedicated to ambulatory services, further increasing connection reliability and speed
Automated robotic surgery	<ul style="list-style-type: none">Fully automated robotic surgery which requires no human intervention is a long-term opportunity expected to ride on 5G network. Doing so with the existing networks lacks reliability

New business models - NaaS

What is NaaS?

Network as a service (NaaS) is an emerging model for organizations to consume network infrastructure through flexible operating expense (OPEX) subscriptions, inclusive of hardware, software, management tools, licenses, and lifecycle services.

NaaS Benefits

- 1 Faster deployment of new technologies, features, and functionality
- 2 Reduced maintenance and support costs of infrastructure hardware and software
- 3 Free up IT staff to work on enabling business
- 4 Lowered capital investments with shift to Opex model
- 5 Improved operational efficiencies and optimized network performance

NaaS emerging vendors



- P5G/LTE network & edge devices
- Open & licensed spectrum
- Global operations Centers
- Managed Network Services
- Global Connectivity
- Secure by design
- System Integration Services



- CBRS LTE band in the US
- Small cell radio unit
AWS managed SIMs
AMS managed on-prem infrastructure
- 5G core and RAN software
- Spectrum access system (SAS) for CBRS operation



- Cloud management platform
Leveraged from Cisco IoT Control Center
- Identity & policy management
Integrated into enterprise existing systems
- Packet core & RAN
Leveraging partners for system integration, core, and RAN solution



Where the world **discovers**
and **shapes** research

The twimbit experience:



Subscriptions



Communities

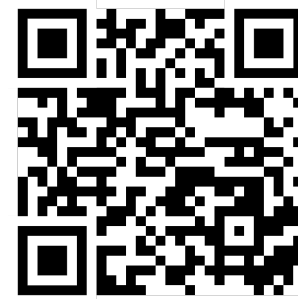


Advisory

How can we help?

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Its Quiz time !
Are you ready?



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