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# 5G Evolution and Its Key Features

<table>
<thead>
<tr>
<th>Generation</th>
<th>Time Period</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>2G</td>
<td>1990s</td>
<td>GSM/CDMA: 64Kbps, Voice, higher coverage</td>
</tr>
<tr>
<td>2.5G</td>
<td></td>
<td>GPRS/Edge: 114Kbps, Voice, SMS, Email, Web</td>
</tr>
<tr>
<td>3G</td>
<td>2000s</td>
<td>UMTS/EVO: Up to 2Mbps, Email, MP3 downloads</td>
</tr>
<tr>
<td>3.5G</td>
<td></td>
<td>HSPA+: Up to 10Mbps, Smartphone apps</td>
</tr>
<tr>
<td>4G</td>
<td>2010s</td>
<td>LTE: 110Mbps, HD Video, Mobile TV</td>
</tr>
<tr>
<td>4.5G</td>
<td></td>
<td>LTE A: Up to 300Mbps, HD Video, Mobile TV streaming</td>
</tr>
<tr>
<td>5G</td>
<td>2020s</td>
<td>Gbps speeds: 4K TV, AR, VR, V2X, Industry 4.0, CIoT</td>
</tr>
</tbody>
</table>

### 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

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

Source: Ericsson
Primary applications of 5G

- **Enhanced Mobile Broadband (eMBB)**
  - HD video streaming, AR/VR gaming, stadiums, concerts

- **Massive machine type communications (mMTC)**
  - Smart cities, manufacturing industry, agriculture, logistics, energy & Utilities

- **Ultra-reliable and low latency communications (URLLC)**
  - Remote control operations, autonomous vehicles, remote surgeries

About 5G
5G spectrum bands

Licensed frequencies

- **High-band** (up to 28GHz)
  - Urban, metropolitan cities (Hotspot)

- **Mid-band** (up to 6GHz)
  - Urban, metropolitan cities

- **Low-band** (<1GHz)
  - Rural and remote areas

Unlicensed frequencies

- **5.9-7.1 GHz**
- **37.6 GHz**
- **47.2-48 GHz**
- **64-71 GHz**

Source: twimbit analysis, Qualcomm, Industry reporting
# 5G spectrum allocation in Asia-Pacific

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

Source: twimbit analysis, Industry reporting
# 5G subscribers in Asia-Pacific

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

No operator has launched 5G
Few operators have launched 5G
All operators have launched 5G

Source: twimbit analysis, Industry reporting
## Key use cases of 5G - consumer

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud gaming</td>
<td>SKT in partnership with Microsoft launched 5GX cloud game, a subscription-based service that allows users to play more than 100 games.</td>
</tr>
<tr>
<td>Augmented and virtual reality</td>
<td>LG U Plus launched GeForce now, world’s first 5G cloud game in partnership with NVIDIA.</td>
</tr>
<tr>
<td>Enhanced video streaming</td>
<td>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.</td>
</tr>
<tr>
<td>Consumer IoT</td>
<td>Smart home is an optional premium service provided to U+ 5G customers. This enables customers to turn on their home devices by voice.</td>
</tr>
<tr>
<td>Music</td>
<td>T Mobile 5G plan bundles free Netflix and 4K video streaming.</td>
</tr>
<tr>
<td>Fixed Wireless Access (FWA)</td>
<td>Verizon bundles free Disney+/Hulu/ESPN+ Apple music and Discovery+</td>
</tr>
<tr>
<td></td>
<td>Optus 5G home internet that comes with Plug and play feature. Many operators other than Optus are also providing 5G FWA services.</td>
</tr>
</tbody>
</table>

Source: twimbit analysis, Industry and company reports
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**

- **Dedicated, On prem networks**
- **Hybrid networks**
  - **Hybrid Model 1:**
    - Public Radio
    - Public Edge
    - On prem dedicated packet core
  - **Hybrid Model 2:**
    - Public Core
    - Private Edge
    - On prem radio network

Source: twimbit analysis
## Why Private 5G over legacy networks

<table>
<thead>
<tr>
<th></th>
<th>Bandwidth</th>
<th>Coverage</th>
<th>Latency</th>
<th>Mobility</th>
<th>Security</th>
<th>Scalability</th>
<th>Quality of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wifi</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Private LTE (cellular)</td>
<td>Very High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Private 5G (Cellular)</td>
<td>Very High</td>
<td>Very high</td>
<td>Ultra low latency</td>
<td>Very High</td>
<td>Very high</td>
<td>Very High</td>
<td>Very High</td>
</tr>
</tbody>
</table>

Source: twimbit analysis
5G use cases in vertical industries
Private networks across key APAC countries

- **South Korea**
  - Smart shipping/ports
  - Digital healthcare
  - Autonomous robots
  - Unmanned self-construction 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

Source: twimbit analysis
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

<table>
<thead>
<tr>
<th>Use case</th>
<th>Role of 5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote control of gantry cranes</td>
<td>• 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.</td>
</tr>
<tr>
<td>Machine vision and video surveillance</td>
<td>• 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.</td>
</tr>
<tr>
<td>Smart Ships</td>
<td>• URLLC &amp; mMTC plays a crucial role in improving safety and security during navigation.</td>
</tr>
<tr>
<td>Cargo handling optimisation</td>
<td>• URLLC, mMTC, network slicing and eMBB enables a shorter time to find cargo.</td>
</tr>
<tr>
<td>Automated Guided Vehicles (AGVs)</td>
<td>• 5G network have better capabilities to support LIDAR sensors, surveillance cameras and other technologies used in AGVs over legacy networks.</td>
</tr>
<tr>
<td>Drones</td>
<td>• eMBB enables improved security for data transmission, better capacity to identify potential threats, and greater data reliability.</td>
</tr>
<tr>
<td>Autonomous trucks</td>
<td>• 5G network slicing enhances safety in self driving. A separate network level can be dedicated to safety related notifications.</td>
</tr>
</tbody>
</table>

Source: twimbit analysis
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

<table>
<thead>
<tr>
<th>Use case</th>
<th>Role of 5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR for remote expertise</td>
<td>• 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 <strong>low latency</strong> for the information to reach in real time</td>
</tr>
<tr>
<td>Remote robot control</td>
<td>• Remote controlled robots can be used for hazardous activities. <strong>Ultra low latency</strong> is a necessity for this use case.</td>
</tr>
<tr>
<td>Predictive and preventive maintenance</td>
<td>• Predictive maintenance involves use of multiple sensors to provide timely information about any breakdown of the machinery. <strong>5G is reliable in terms of real-time data collection</strong> from these sensors. It is also capable of handling such a device density. This reduces the downtime and also lowers the production costs</td>
</tr>
<tr>
<td>Automated guided vehicles</td>
<td>• **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.</td>
</tr>
</tbody>
</table>

Source: twimbit analysis
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

<table>
<thead>
<tr>
<th>Use case</th>
<th>Role of 5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predictive maintenance</td>
<td>• 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</td>
</tr>
<tr>
<td>Drones for exploration</td>
<td>• 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</td>
</tr>
<tr>
<td>Remote management of unmanned oil production platforms</td>
<td>• 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</td>
</tr>
<tr>
<td>Autonomous vehicles for mining</td>
<td>• 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</td>
</tr>
</tbody>
</table>

Source: twimbit analysis
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

<table>
<thead>
<tr>
<th>Use case</th>
<th>Role of 5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual consultations</td>
<td>• 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</td>
</tr>
<tr>
<td>Distraction therapy with AR/VR</td>
<td>• 5G enables smooth streaming of AR/VR based applications</td>
</tr>
<tr>
<td>Enhancing surgeries</td>
<td>• Low latency allows a surgeon to control a robotic equipment from a far location and get haptic input with a greater accuracy</td>
</tr>
<tr>
<td>Connected ambulances</td>
<td>• 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</td>
</tr>
<tr>
<td>Automated robotic surgery</td>
<td>• 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</td>
</tr>
</tbody>
</table>

Source: twimbit analysis
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

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

- AWS
  - 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

- Cisco
  - 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

Source: twimbit analysis, company reporting
Its Quiz time!
Are you ready?

Scan QR code for quiz

How can we help?
reachus@twimbit.com