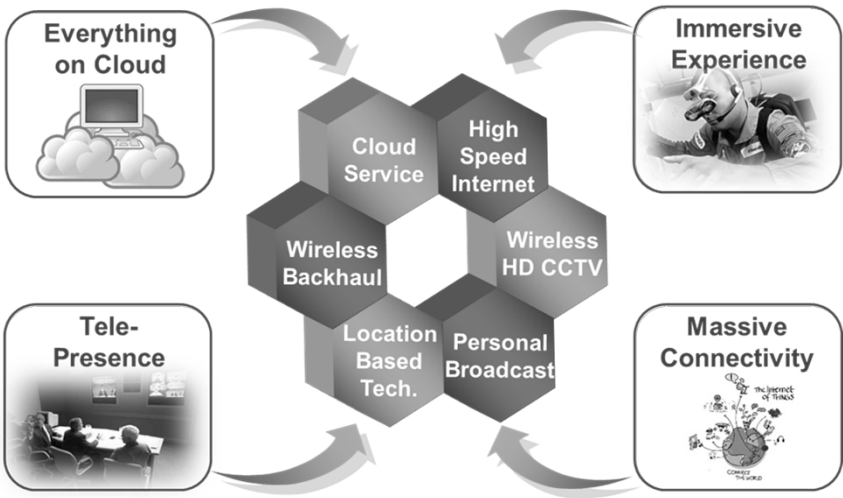


4G & 5G Mobile Technology

5G Technology

5G Technology



## 5G Technology

### ❖ 5G Technology

- ITU-R IMT-2020 & 3GPP 5G-NR
  - High Quality Multimedia
  - Self Driving & Smart Car
  - AR (Augmented Reality)
  - Massive IoT network
  - Cloud-based services
- Higher Performance than LTE
  - Higher data rate ( $\times 20$ )
  - Low latency (1/10)
  - Higher device density (1 million)

## 5G Technology

### ❖ Standardization Organizations

- **ITU-R: ITU Radiocommunication Sector**
  - One of 3 sector of the ITU (International Telecommunication Union)
  - Responsible for radio communication standards and regulations
- **3GPP: 3rd Generation Partnership Project**
  - Provides mobile communications standardization for
    - RAN (Radio Access Network)
    - Services & Systems
    - CN (Core Network)
    - Terminals (e.g., UE)

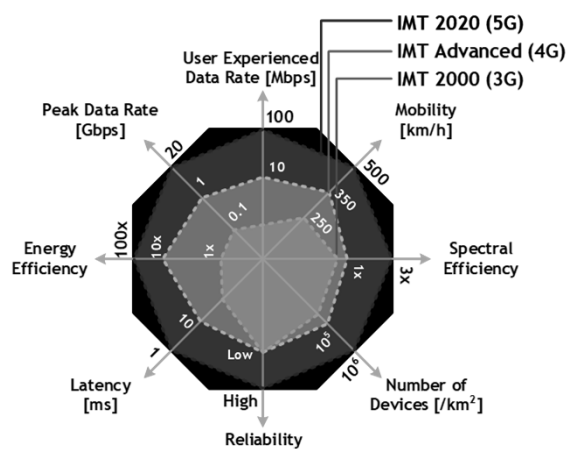
## 5G Technology

### ❖ IMT-2020 Target Performance

- Data rate
  - 20 Gbps (Peak)
  - 100 Mbps (User Experienced)
- Connection density
  - $10^6$  devices/km<sup>2</sup>
- Mobility, Latency
  - Up to 500 km/h
  - Less than 5 ms end-to-end
  - Less than 1 ms over-the-air

## 5G Technology

### ❖ IMT-2020 Target Performance



## 5G Technology

### ❖ 3GPP 5G-NR Usage Scenarios

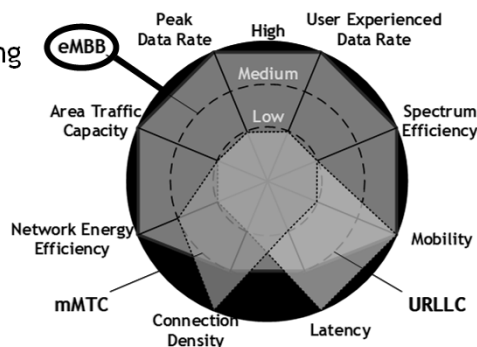
#### ▪ eMBB (enhanced Mobile BroadBand)

- High user density, High Data Rate

- Peak 20 Gbps, Edge 100 Mbps

- eMBB applications

- Mobile Cloud Computing
- Smart Devices
- UHD streaming



## 5G Technology

### ❖ 3GPP 5G-NR Usage Scenarios

#### ▪ URLLC (Ultra-Reliable and Low Latency Communication)

- Latency

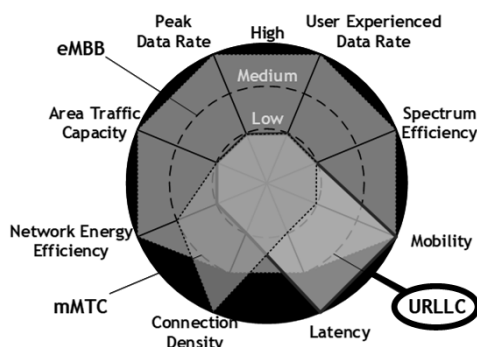
- 1 ms Latency

- Reliability

- $10^{-9}$  Error-rate

- URLLC applications

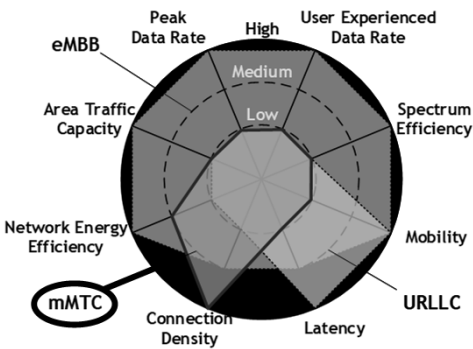
- Smart Vehicles
- Industrial Automation



## 5G Technology

### ❖ 3GPP 5G-NR Usage Scenarios

- mMTC (massive Machine Type Communication)
  - Connectivity
    - 10<sup>6</sup> Connections/km<sup>2</sup>
  - Battery Life Time
    - 10 year-lifetime
  - mMTC applications
    - Smart Home
    - Smart City
    - U-Health
    - Wearables, etc.



## 5G Technology

### ❖ 5G Performance Requirement

	eMBB <sup>1)</sup>	mMTC <sup>2)</sup>	URLLC <sup>2)</sup>
Data rate	UL: 10 Gbps DL: 20 Gbps	Low data rate, 1 to 100 kbps	Low to medium data rate, 50 kbps to 10 Mbps
Spectrum efficiency	UL: 15 bps/Hz DL: 30 bps/Hz	Not Defined	Not Defined
User experienced data rate	UL: 50 Mbps DL: 100 Mbps	Not Defined	Not Defined
Area traffic capacity	10 Mbps/m <sup>2</sup>	Not Defined	Not Defined
Network energy efficiency	Defined, but not specified	Low power, up to 15 years battery life	Not Defined
Mobility interruption time	0 ms	Not Defined	0 ms
Latency	4 ms	Seconds to hours	0.5 ms
Connection density	Not Defined	1M devices/km <sup>2</sup>	Not Defined

1) Radiocommunication SG, "Minimum requirements related to technical performance for IMT-2020 radio interface(s)," ITU-R Documents, Feb., 2017  
2) InterDigital, 5G Vision. Available: <http://www.interdigital.com/presentations/mwc17-5g-vision>