5G & WIFI Coexistent Mobile & Wireless Network

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Outline

- ❑ Co-Existence of Generational Wireless Networks and Heterogeneous Co-existence
- ❑ Spectrum Features of the WIFI and 5G Standards
- ❑ Innovative Use Cases & Services to development, which industries to support.
- ❑ Spectrum Allocation and Comparison of Standards & Current Status.

Generation of Wireless & Mobile Heterogeneous Networks

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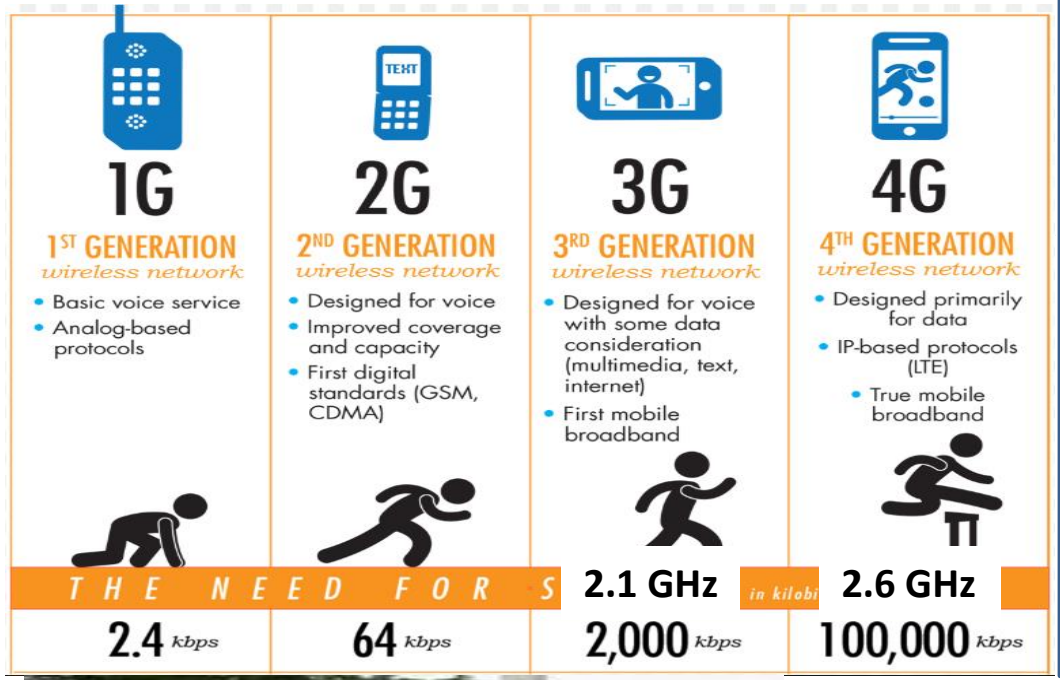
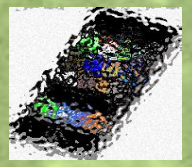


5G

Designed with
-Low Latency
-Reliable MTC
-Enhanced Mobile BB Emb
- Smart city
-Industrial Automation
- IoT,

1-2 Gbps



6G

Autonomic Networks, HetNets, Greenets, Broadband Everywhere

~20+ Gbps

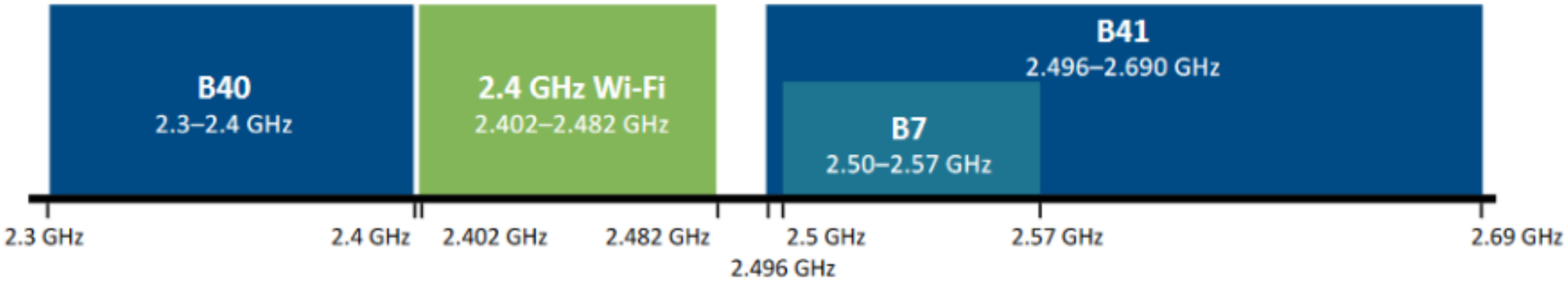
Networked Digital Society & Impact, Ethics.

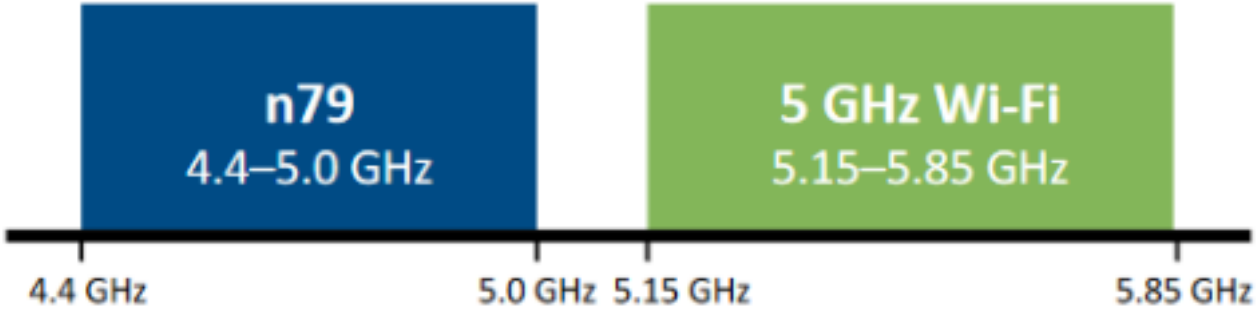
AI

Heterogeneuos Networks:
WIFI, TVWS, Sattelite, Fiber/IP, HAPS,LORA-WAN……

Digital Inclusion
Broadband internet as a Human right !

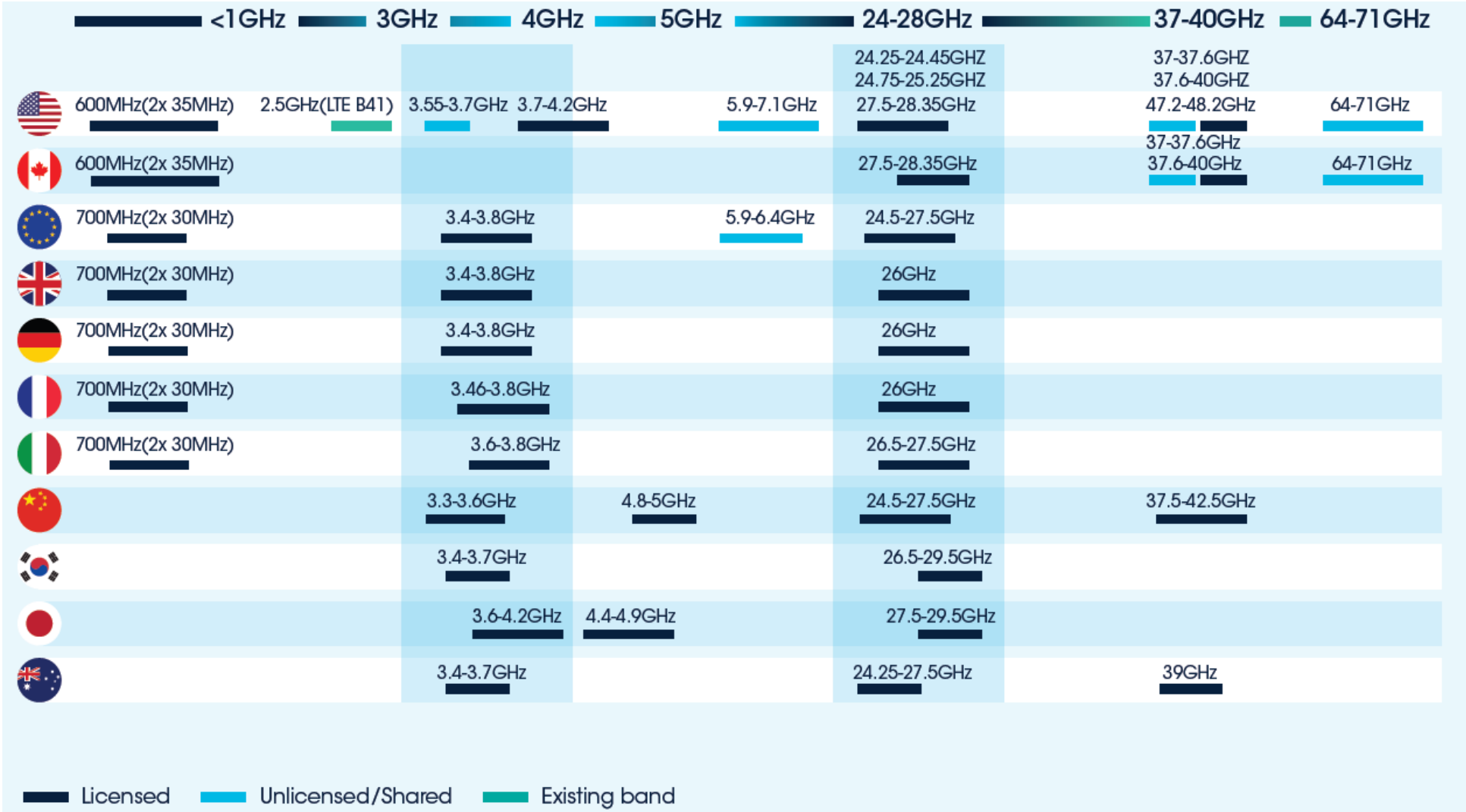
WIFI & 5G Spectrum Allocation: Interference Avoidance





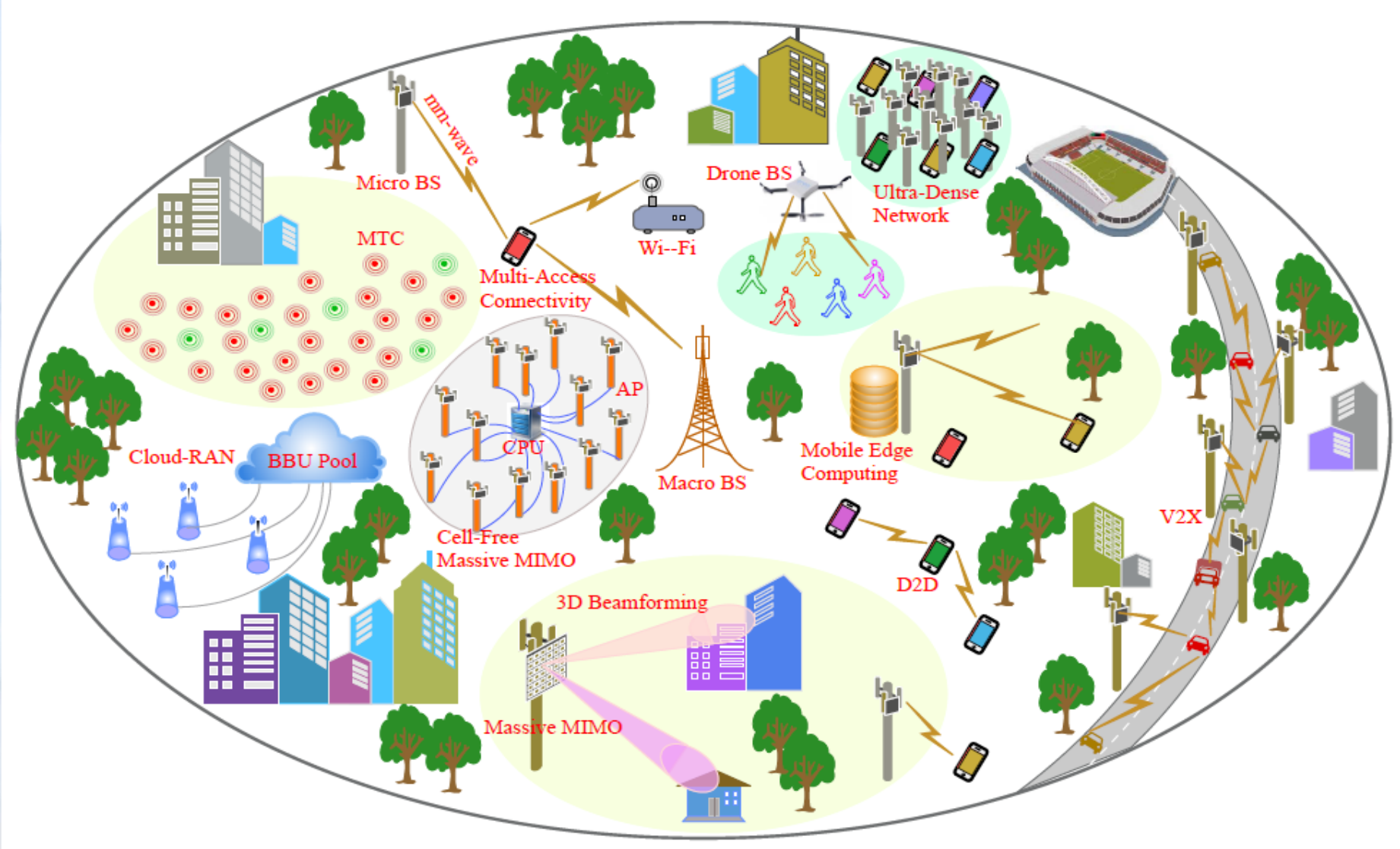
Collaborative Networks: Coexistence & Traffic Offloading

Global 5G Spectrum Allocation: Interference Avoidance



Source: https://cdn.everythingrf.com/live/5G%20bands%20snapshot_636543792416696911.PNG

Future Wireless Networks & Complexity of Network Standards & Resources for IoT



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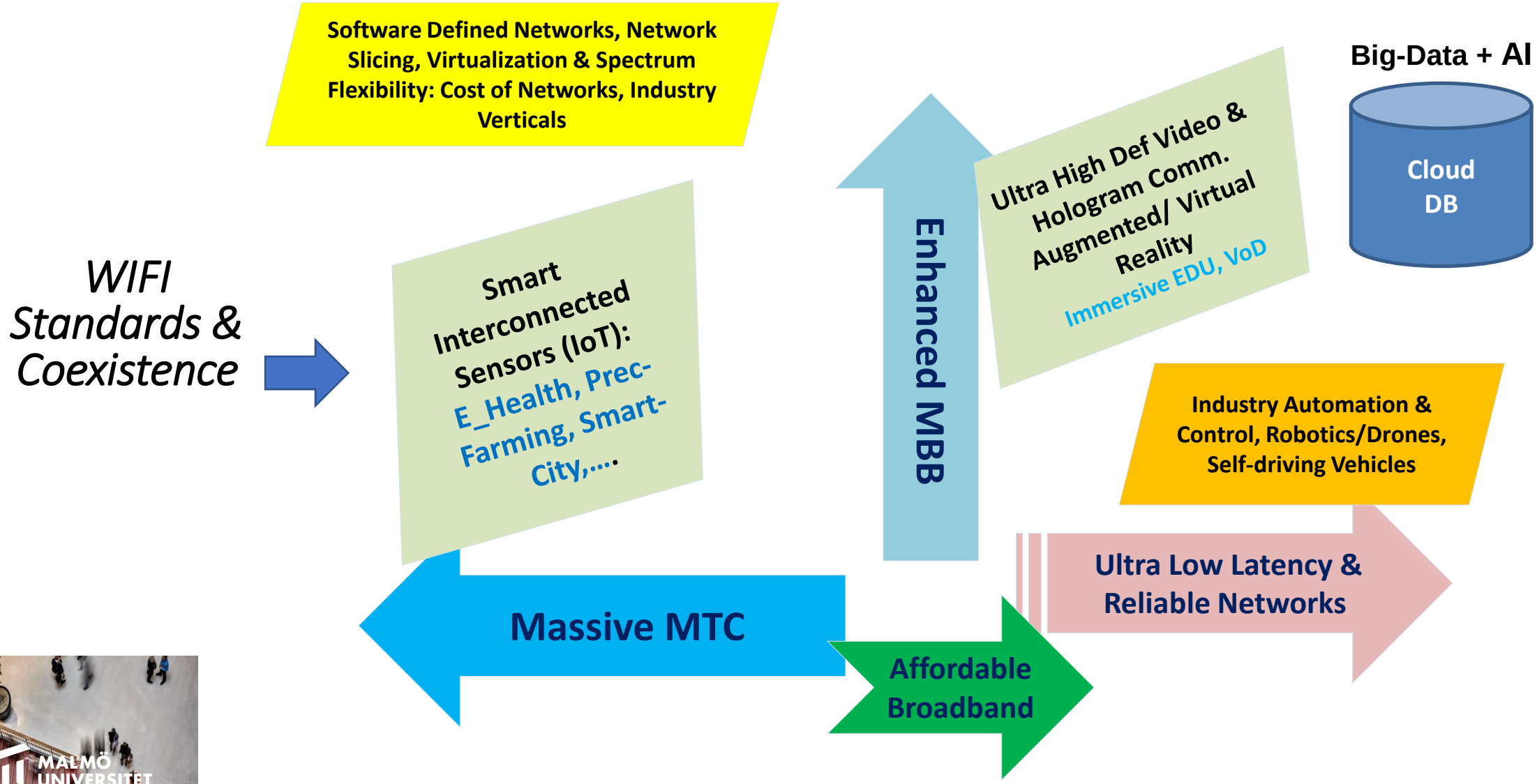
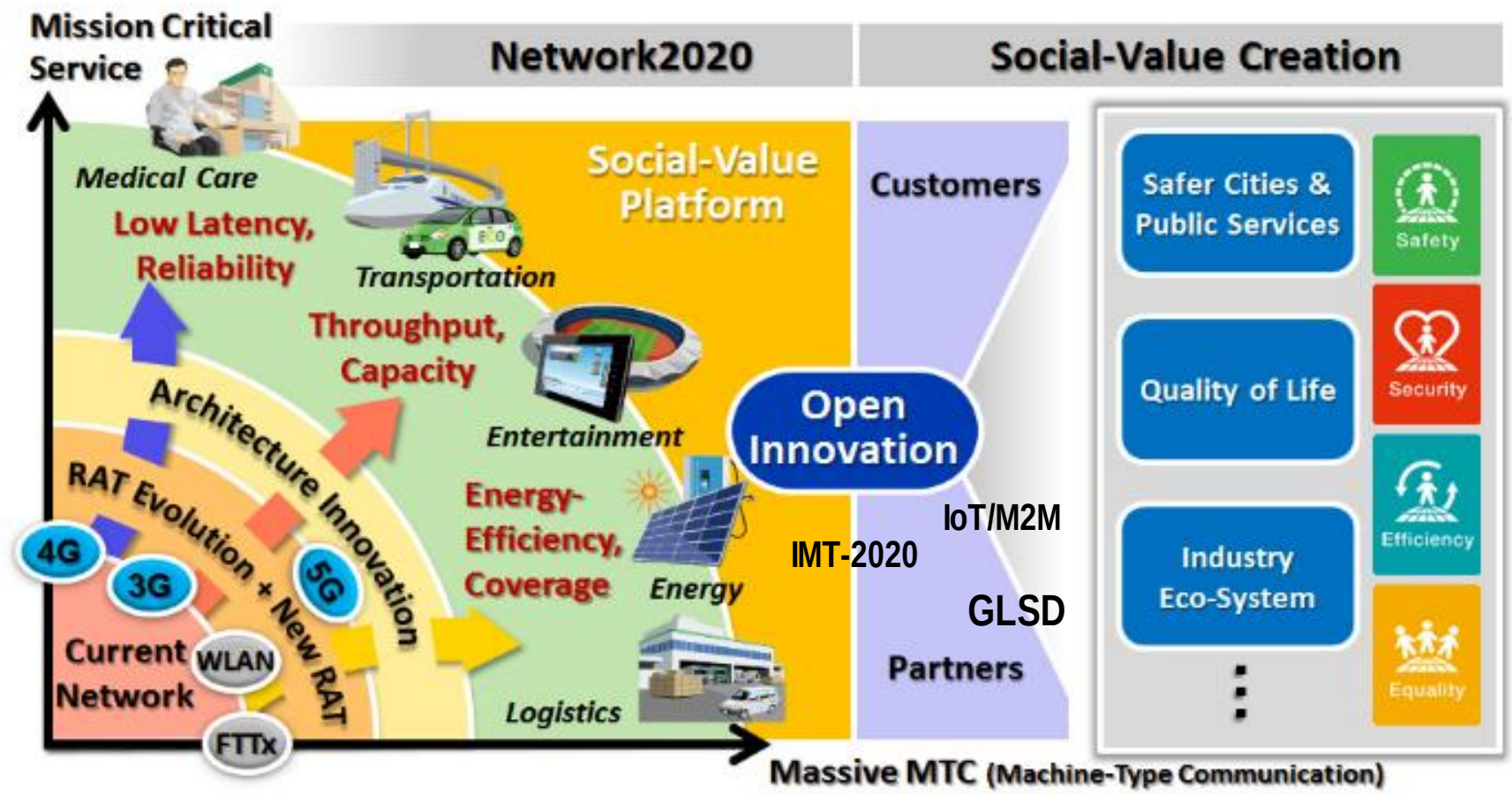
The 5G Ecosystem of Standards & Use Cases Collaborative and Heterogeneous Networks.



The Reasons for New Wireless Technologies

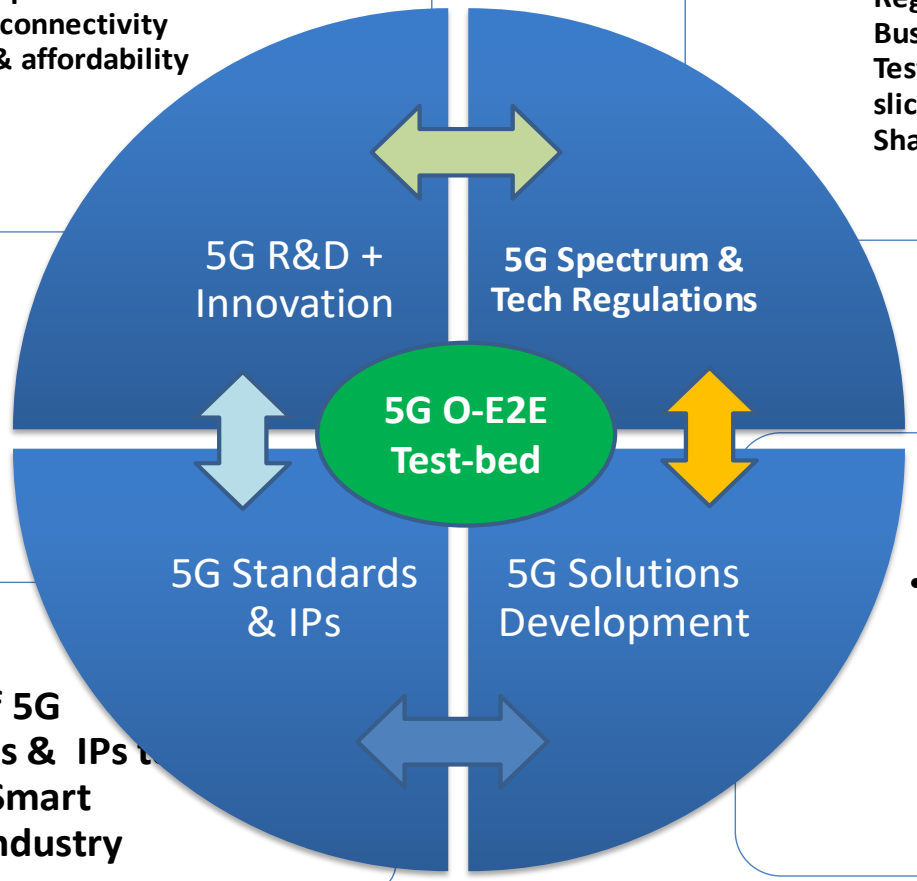


Creation of Innovative Smart Industries, Digital Businesses & Economic Empowerment !

The Need for 5G Open & End2-end Testbed

- Promote a Smooth 5G Migration & Support Sustainable 5G connectivity Greenetworks & affordability

- New Spectrum Regulations & Business models. Testing Network slicing & RAN Sharing



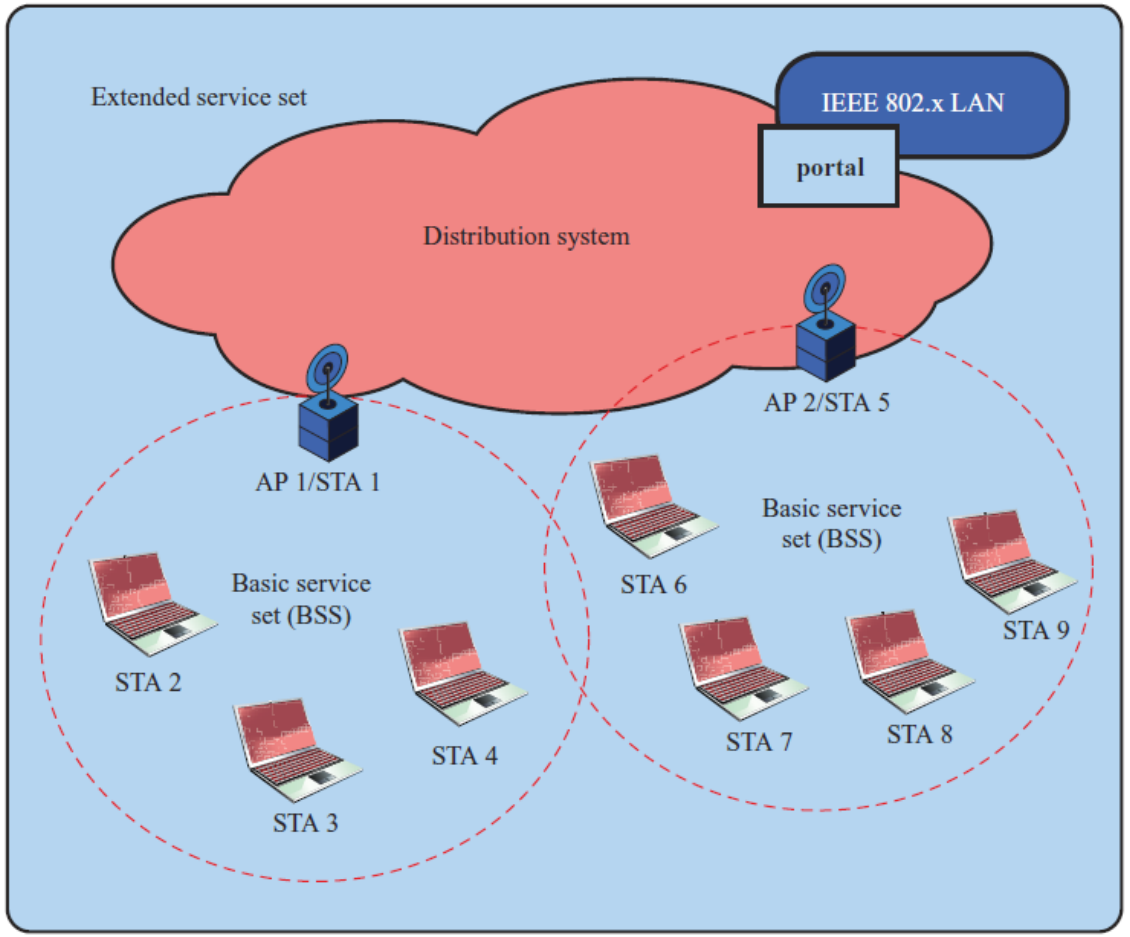
- 5G-E2ET as enabler for Digital Transformation & 4IR
- 5G-E2ET For Bio-diversity Protection & Restoration (UN Decade 2021-2030)

- 4th Leg of 5G Standards & IPs t SMEs & Smart Service industry

- Innovative 5G Use cases, Apps & Services: The MPESA's of 5G, Smart Industry Verticals

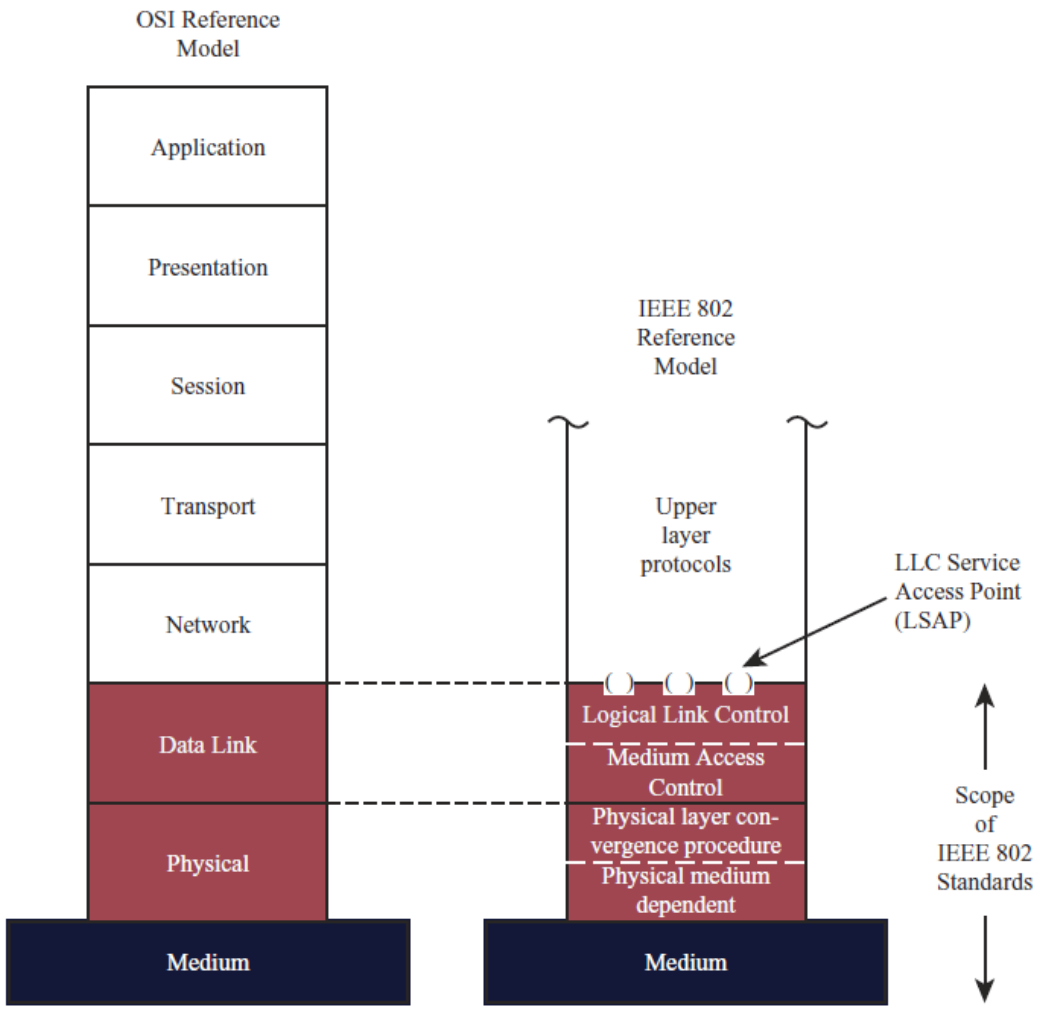
WiFi architecture

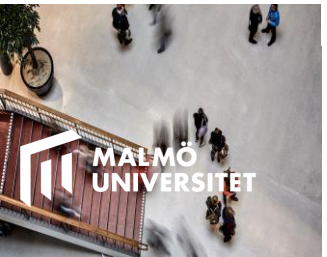
- Distribution system (DS)
- Access point (AP)
- Basic service set (BSS)
  - Stations competing for access to shared wireless medium
  - Isolated or connected to backbone DS through AP
- Extended service set (ESS)
  - Two or more basic service sets interconnected by DS



WiFi protocols

- Designed to connect easily to Ethernet
  - Reuses many Ethernet components
- Uses layering of protocols
- LAN protocols focus on the lower layers of the OSI model
- Physical layer:
  - Direct Sequence Spread Spectrum (DSSS)
  - Uses the entire frequency band to transmit information
  - Capable of data rates of up to 11 Mbps





Comparison of Wireless Networking Standards

	Long Range	Low Power	Continuous Availability	High Bandwidth	Low Latency	"Just Works" Setup
Ethernet	🔴	🔴	🔴	🟢	🟢	🔴
Wi-Fi	🟡	🔴	🔴	🟢	🟢	🟡
Cellular IoT	🟢	🟢	🟢	🟡	🔴	🔴
LoRa	🟢	🟢	🔴	🔴	🔴	🟡
BLE	🔴	🟢	🟡	🔴	🟢	🟡

🟢
🟡
🔴

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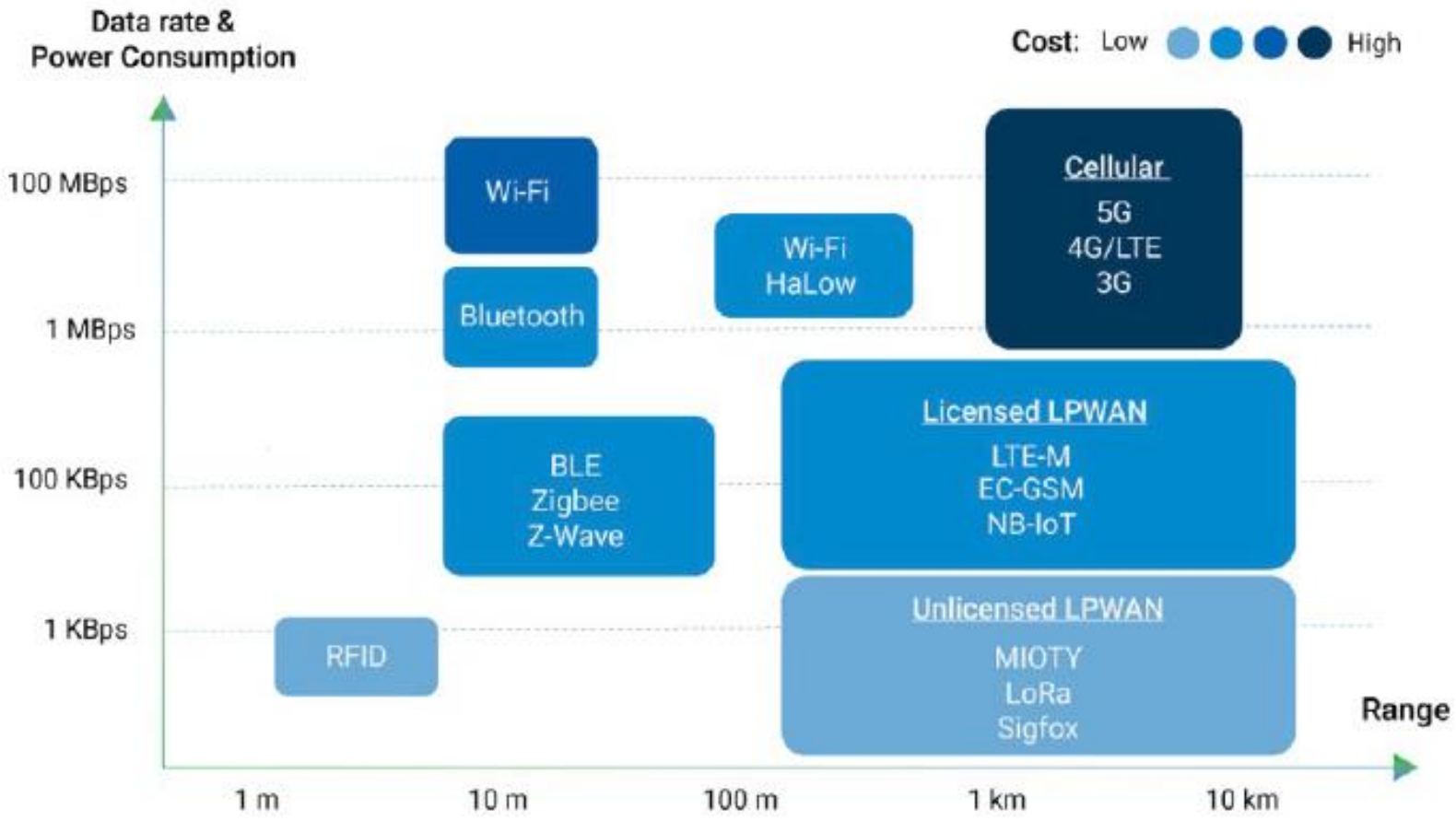
Four-Dimensional Comparison of Wireless Networking Standards:

1-Datathroughput, 2-Energy Efficiency, 3-Range, 4-Cost (CAPEX-&-OPEX)

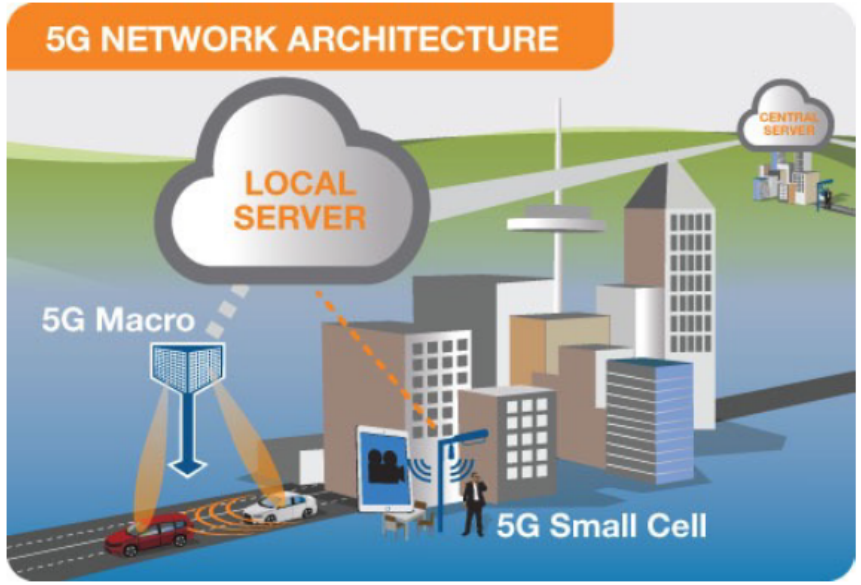


5G

- Evolution of cellular networks
  - Low latency
  - High bandwidth
- Includes machine-to-machine scenarios and low power modes
- Expected data speed up to 10Gbps
- Works in conjunction with 4G networks where 4G works as “control plane” (signalling) and 5G as “user plane” (data and services)

5G architecture

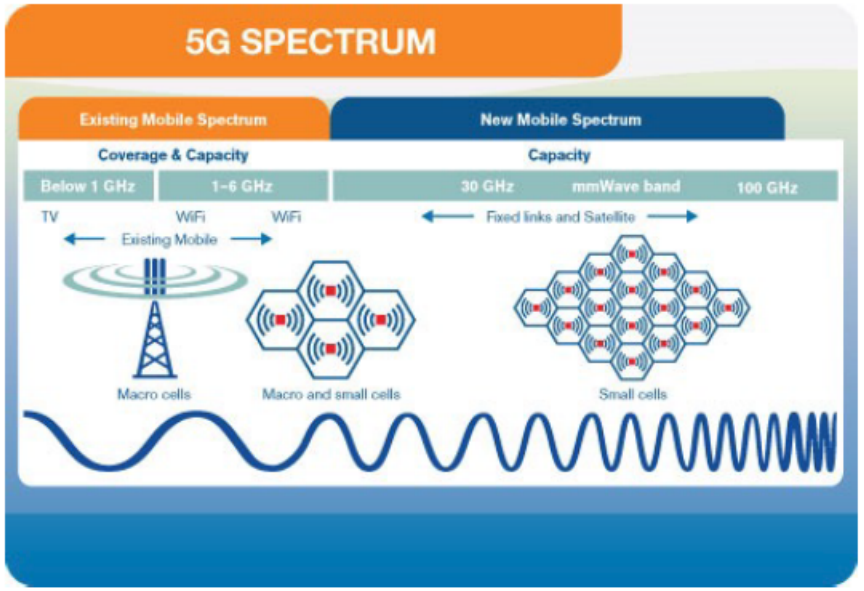
- **Radio Access Network**
  - Connects mobile users and wireless devices to the main core network
  - Cells, towers, masts and dedicated in-building and home systems
  - Small cells offer high-speed, short-range connectivity at mm wave frequencies
  - Macro Cells use “massive) MIMO (multiple input, multiple output) antennas (100 antennas or more!)
- **The Core Network**
  - Manages all of the mobile voice, data and internet connections
  - Redesigned to better integrate with the internet and cloud based services
  - Highly virtualised infrastructure
- **Network Function Virtualization (NVF)**
  - Can instantiate network functions (like firewall and encryption) in real time on a virtual machine

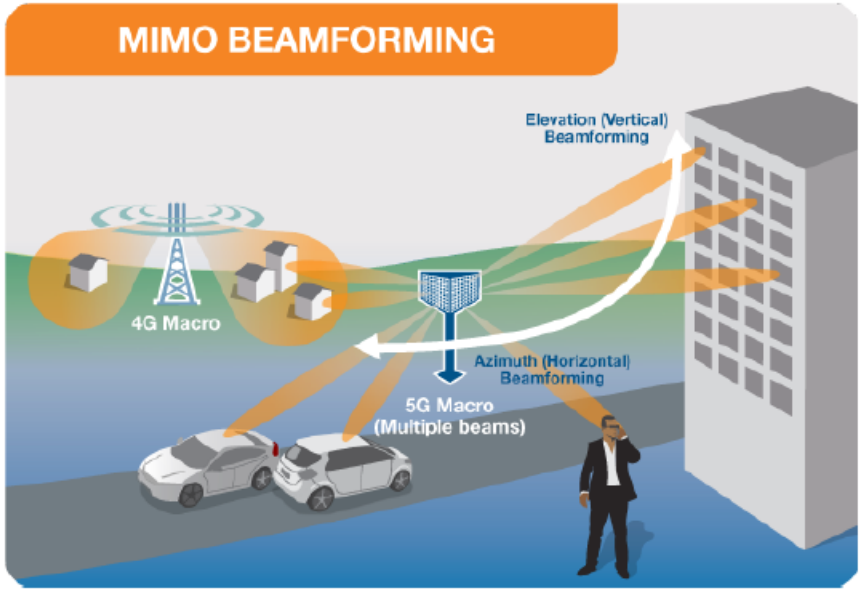


- Network Slicing: Industry Verticals

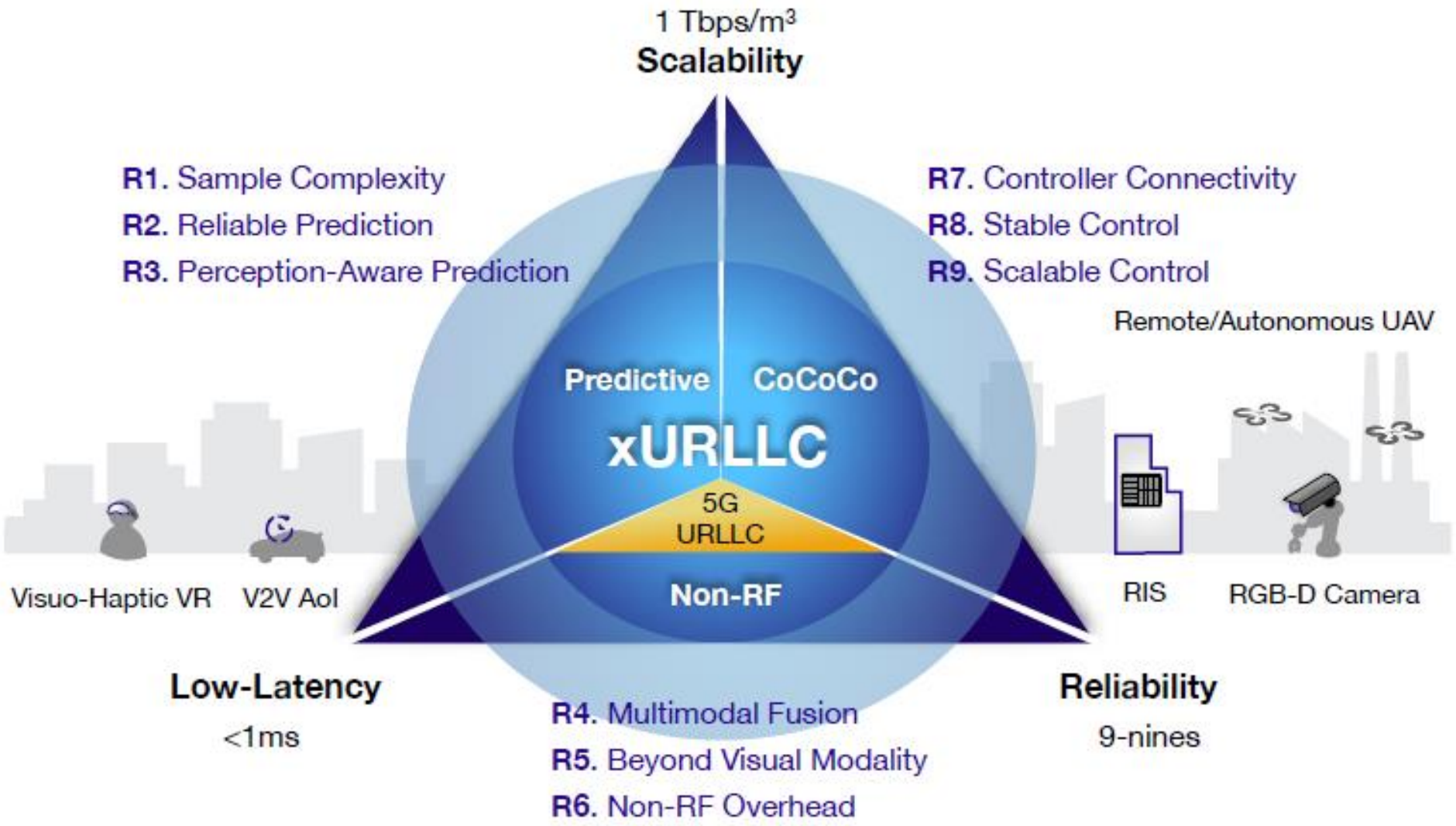
5G Spectrum and antennas

- Initial frequency bands are below 6 GHz (3.3-3.8 GHz bands)
- Additional mobile spectrum in the 26-28 GHz bands (mm wave) and up to 86GHz
  - Adds more capacity but lower ranges
- Physical size of the 5G base station antenna is similar to a 4G base station antenna
- MIMO base stations allow **beam steering:** to direct the radio signal to the users and devices rather than in all directions
- Higher throughout allows to put chips in sleep mode longer
  - time between mandatory transmissions up to 160ms (0.20ms in 4G)





5G Advanced & URLLC Standard



5G is a Heterogeneous Standard Supporting the Success of the 4IR

Digital Inclusion
NDPs / SDGs
Multi-Sectoral Policy

Network Softwarization

Edge & Cloud Computing

Smart Mobile Devices

AI & Blockchain Technologies

Augmented & Virtual Reality, Wearables

Low Latency & Reliable High Speed Networks

Haptics, robotics, automation & drones

Multilevel Customer Interaction & Customer Profiling

Advanced human-machine Interfaces

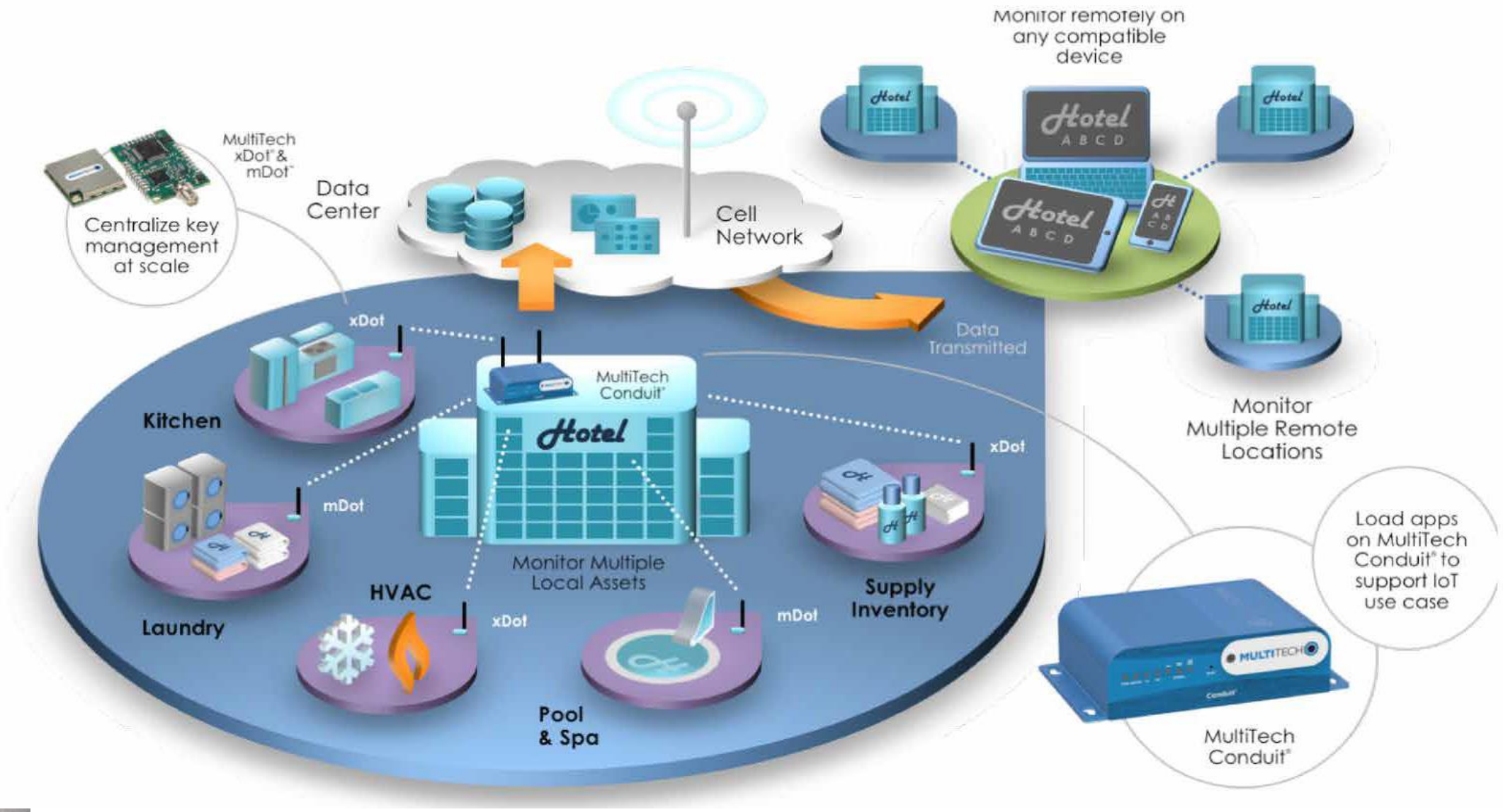
Big-data & Advanced Analytics, Algorithmic Identity

Cyber Security, Fraud Detection & Authentication

Smart & Internetworked Sensors

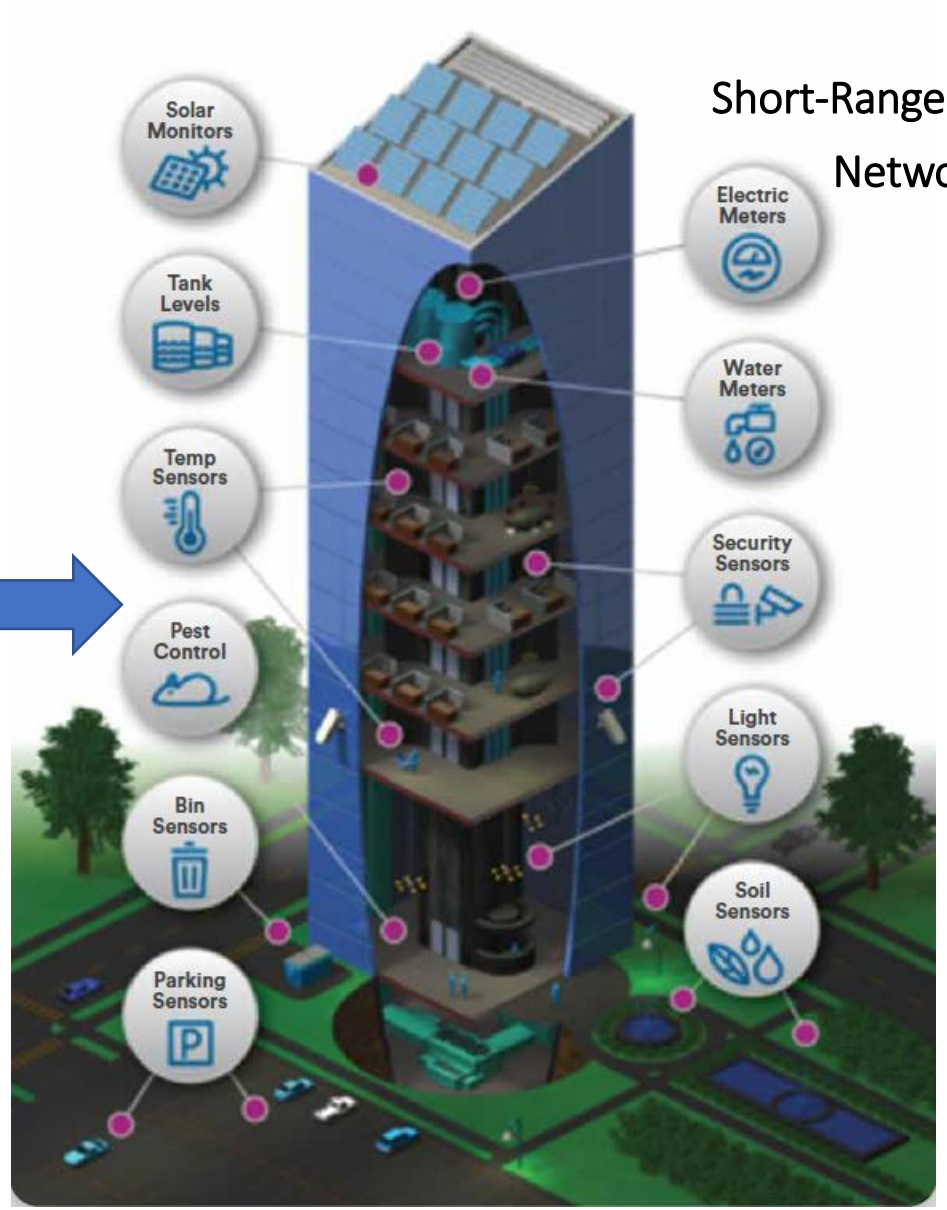
High Bandwidth Networks: Spectrum Toolboxes

A Heterogeneous Wireless Network Application 1: Smart Hotel



A Heterogeneous Wireless Network Application 2: Smart Building

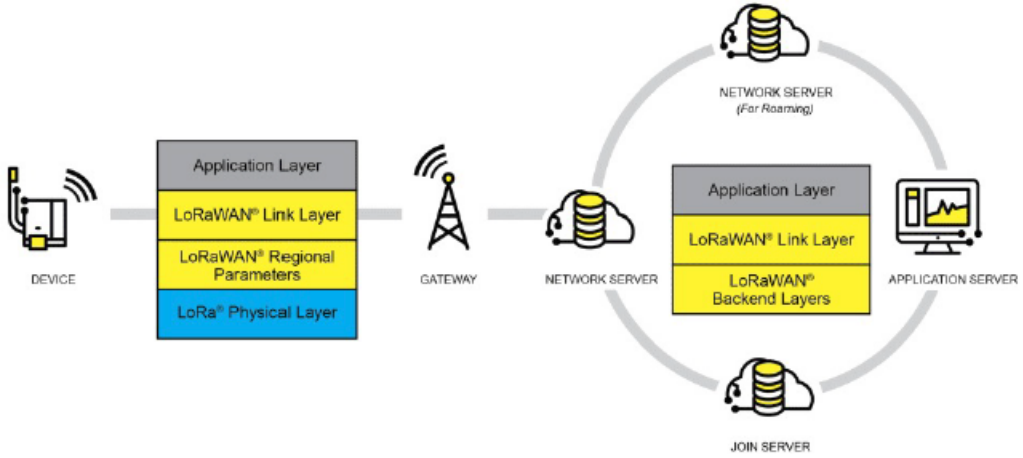
Cellular & Cloud Network



Short-Range Wireless Network

LoraWan

- **LoRa** is a proprietary low-power wide-area network modulation technique.
  - 433.05-434.79 MHz and 863–870/873 MHz
  - Data rates between 0.3 kbit/s and 27 kbit/s
  - Chirp Spread Spectrum modulation
    - Can trade transfer time for reliability
  - Typical ranges: 5 km (cities) to 15 km (rural)
- **LoraWAN**
  - Adds data link and networking
  - End nodes
    - transmit when they have data available to send
  - Gateways
    - Work as routers
  - Servers
    - Provides services



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Salient Features of Wireless Networks, Systems, Devices & Service Parameters

- **Range:** Short & Long-range, **How close to a provider's gateway does my wireless device have to be? Are there indoor vs outdoor (or line-of-sight) considerations I need to be aware of?**
- **Energy Efficiency: Is my hardware connected to a consistent and reliable power source? Or is it off-grid and connected to solar or battery? How long must the device last on battery power? Is the device able to forage energy from the environment in a biodiversity aware manner?**
- **Continuous Availability: Is it ok if my device shuts down completely in the event of a local power failure…or should it continue to record (and even send) data white on a backup power source? How does a mobile system recover from network instability?**
- **Data Throughput and Latency: How much data rate is required & whether Rural or City Environment? Does my solution require low latency between the device, the base station/cloud, and beyond? How is the QoS requirement ?**
- **End User Experience: Short range wirless systems deployment in the field? Is it a consumer-installable product that requires setup by a non-technical user? Are there platforms for end-users to develop innovative applications, or does the device need to "just work" when powered on?**
- **Sustainability: Standards compliance and Interoperability of wireless devices. Device recyclability and life cycle ecosystem. What is the energy efficiency ?**

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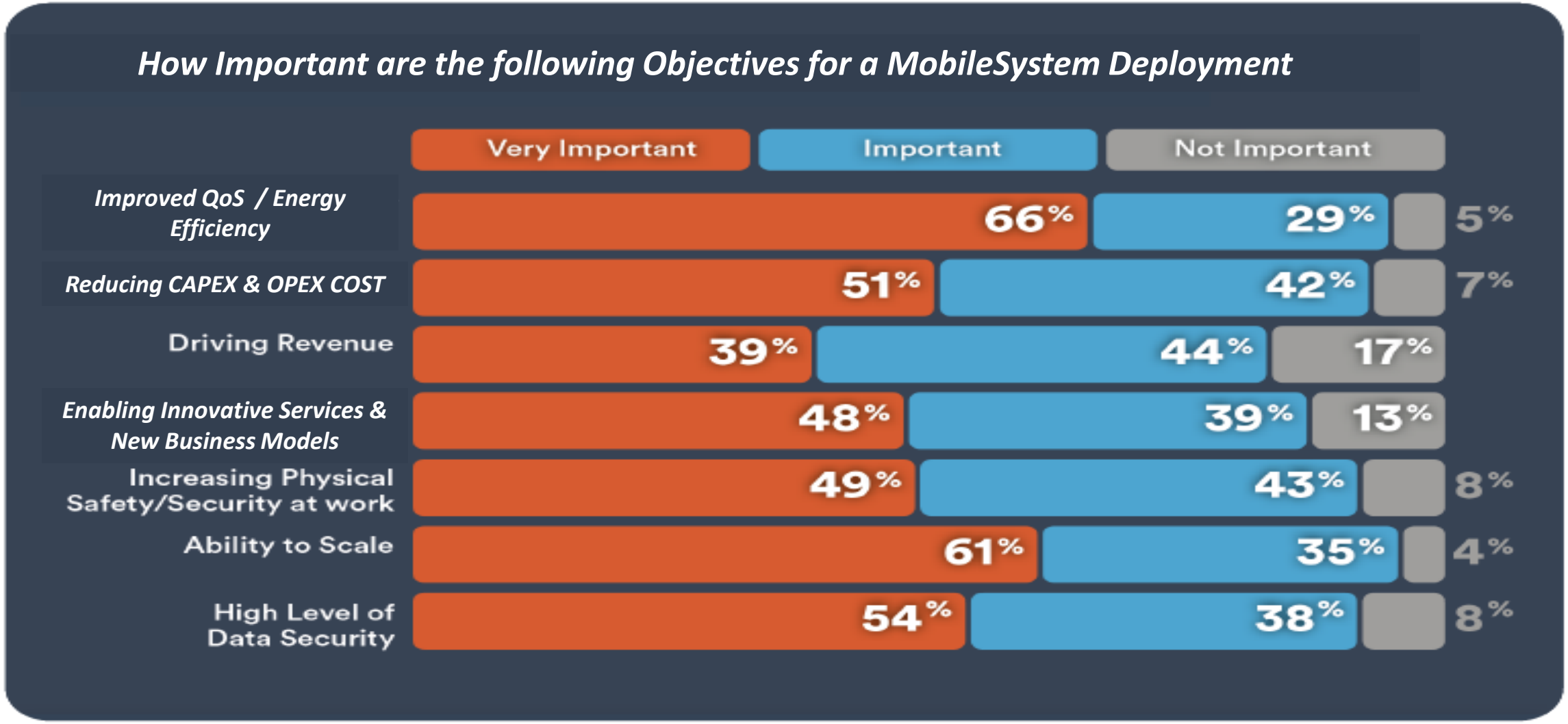
Industry Survey: Success Factors for Mobile Systems Operators Business



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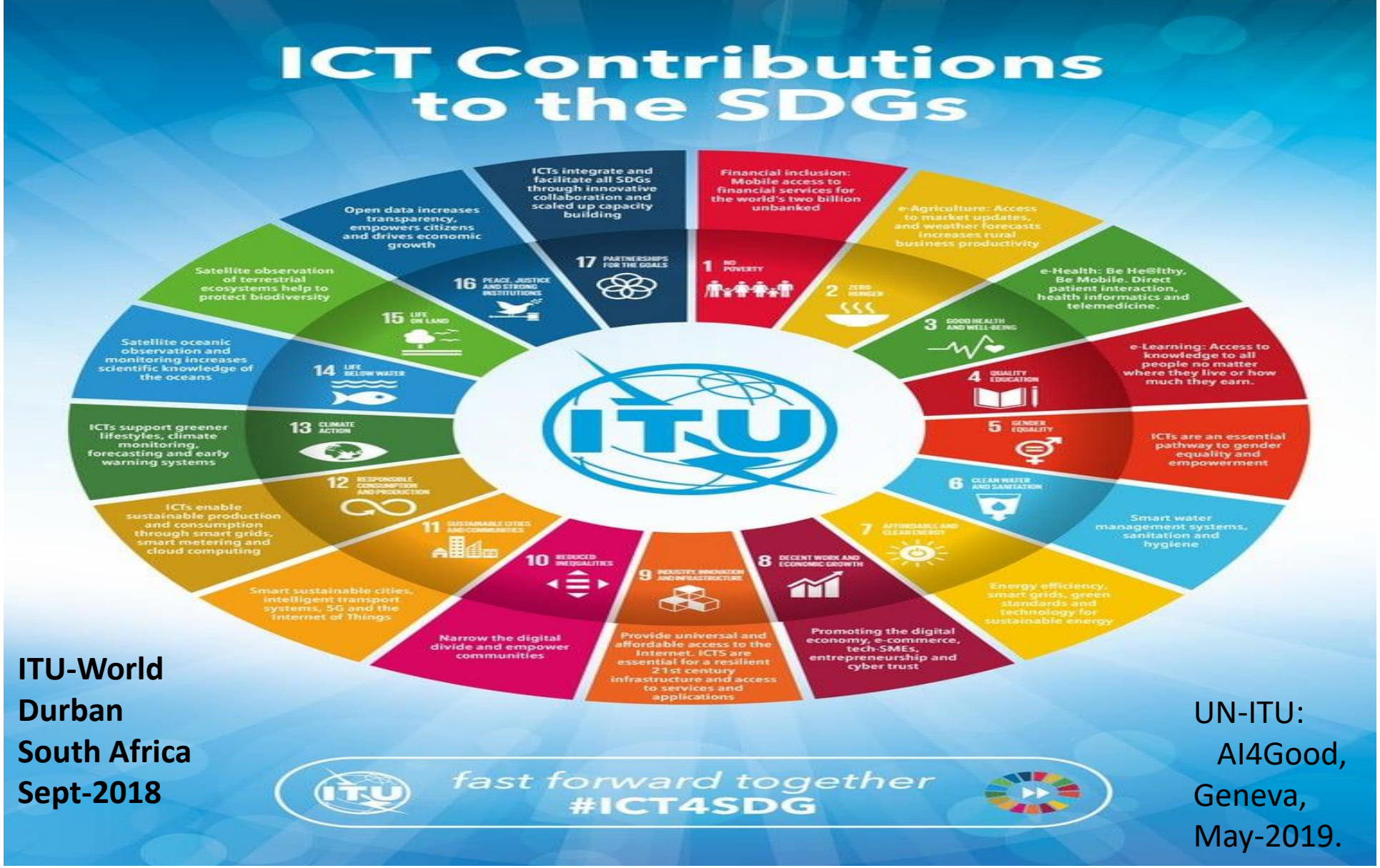

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Emerging Digital Technologies & Role of IoT for finding Solutions to the UN-SDGs!