

ITUEvents

# ITU World Radiocommunication Seminar 2018

3-7 December 2018  
Geneva, Switzerland

[www.itu.int/go/ITU-R/WRS-18](http://www.itu.int/go/ITU-R/WRS-18)

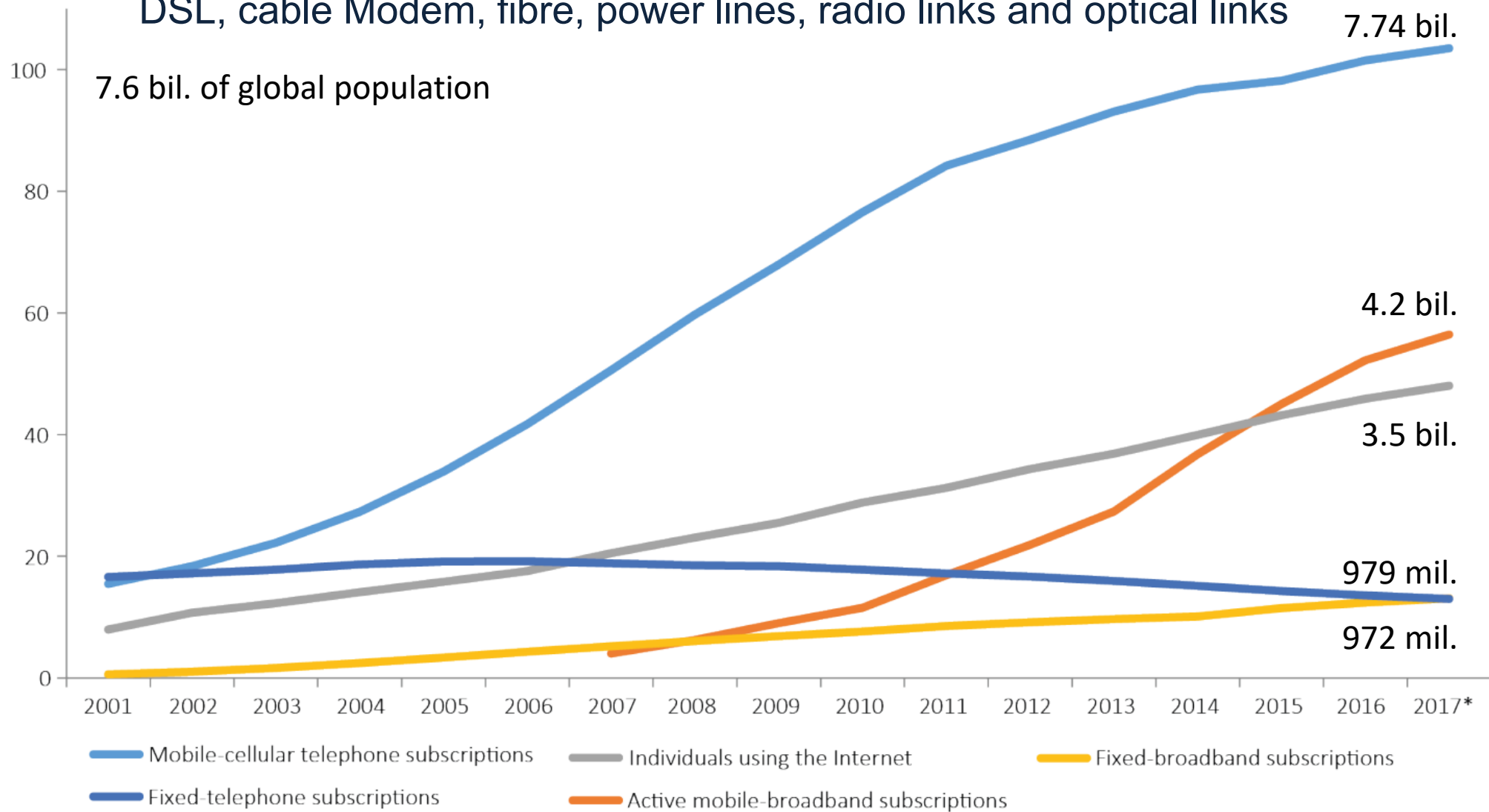


## Trends in broadband radio technologies

**Nikolai VASILLIEV**  
Chief, Terrestrial Services  
Departments  
ITU-R

# Broadband evolution

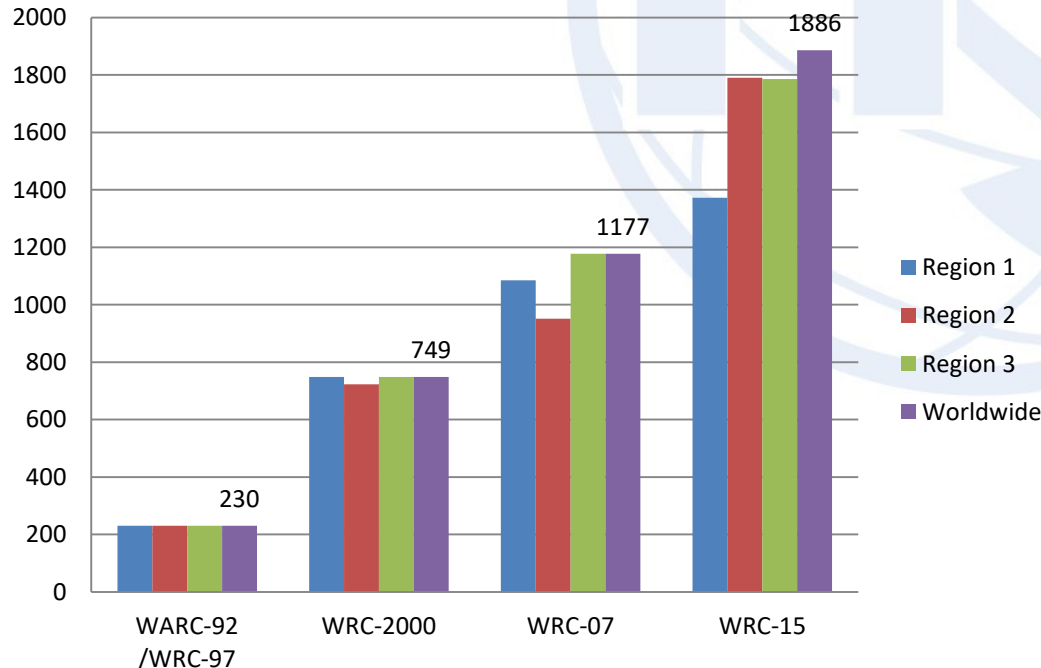
Broadband can be delivered by radio and wireline networks, such as DSL, cable Modem, fibre, power lines, radio links and optical links



# Broadband over IMT, today

- ITU contributes to MBB by:
  - Allocating mobile spectrum and identifying bands for IMT - at WRCs
  - Developing IMT high level standards (RAN specifications) – ITU-R Study Group 5

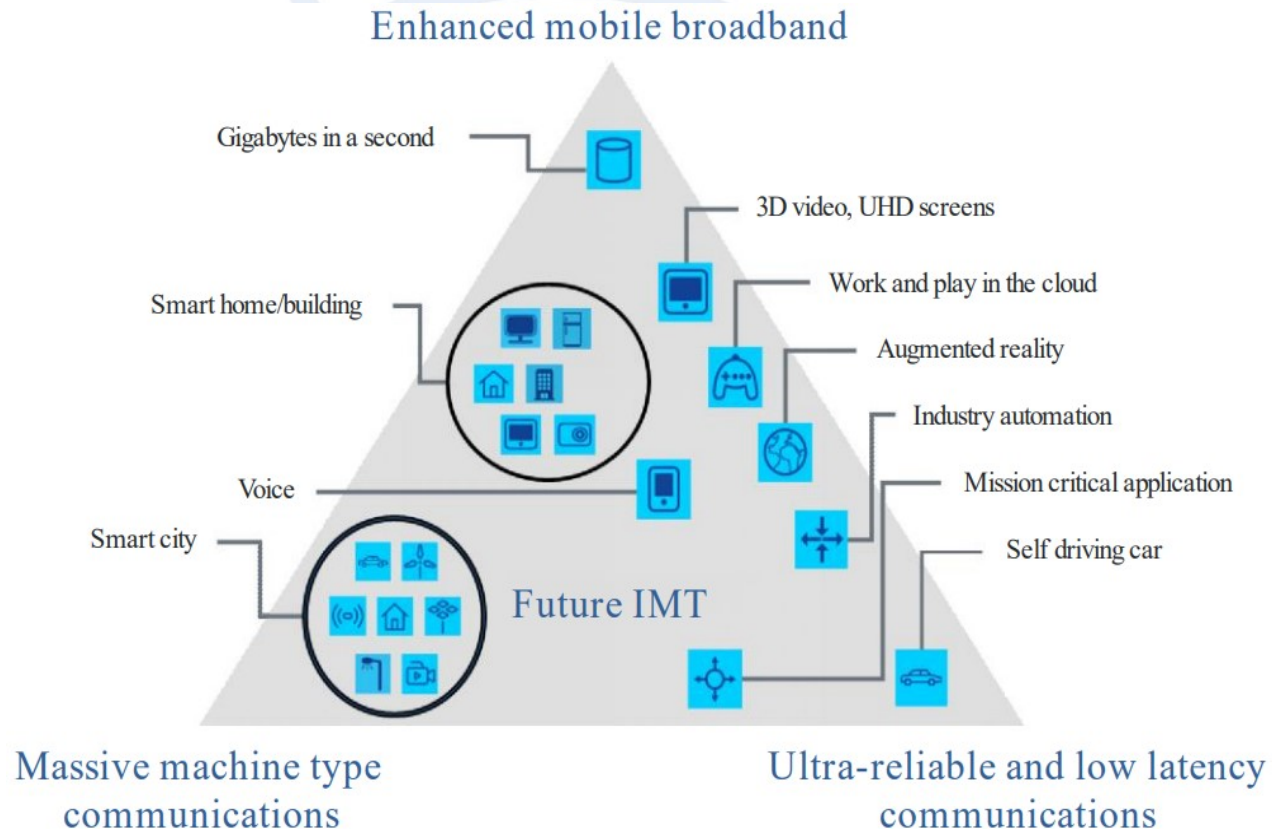
**Total amount of spectrum identified for IMT (MHz)**



**Current IMT standards**

IMT-2000 ( <a href="#">M.1457</a> )	IMT-Advanced ( <a href="#">M.2012</a> )
a) CDMA Direct Spread	a) LTE-Advanced ( <a href="#">3GPP</a> )
b) CDMA Multi-Carrier	b) WirelessMAN-Advanced ( <a href="#">IEEE</a> )
c) CDMA TDD	
d) TDMA Single-Carrier	
e) FDMA/TDMA	
f) OFDMA TDD WMAN	

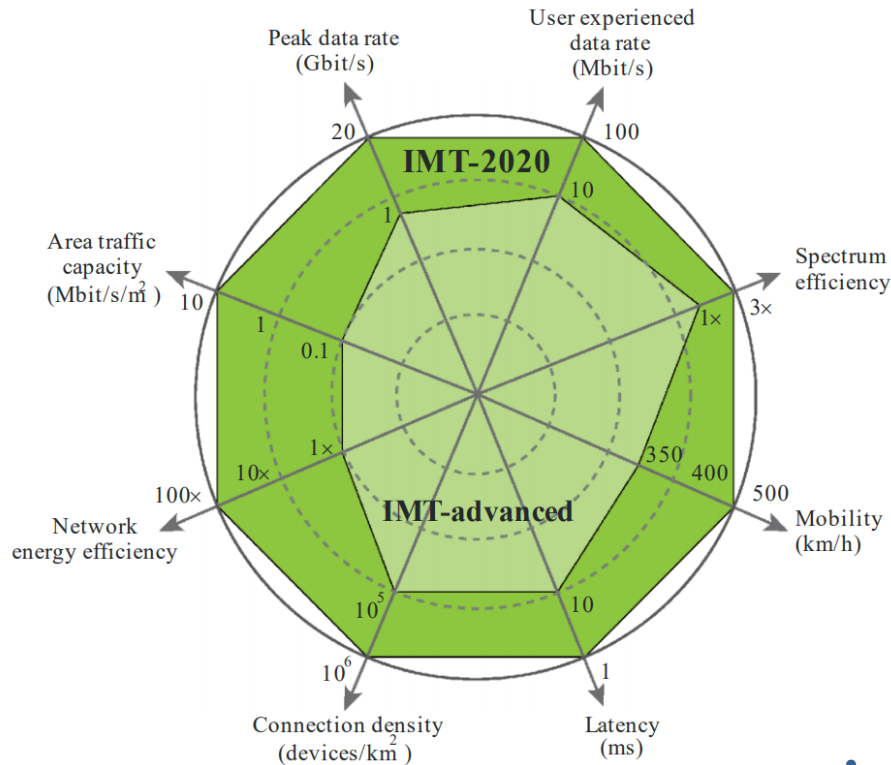
# IMT-2020/5G components



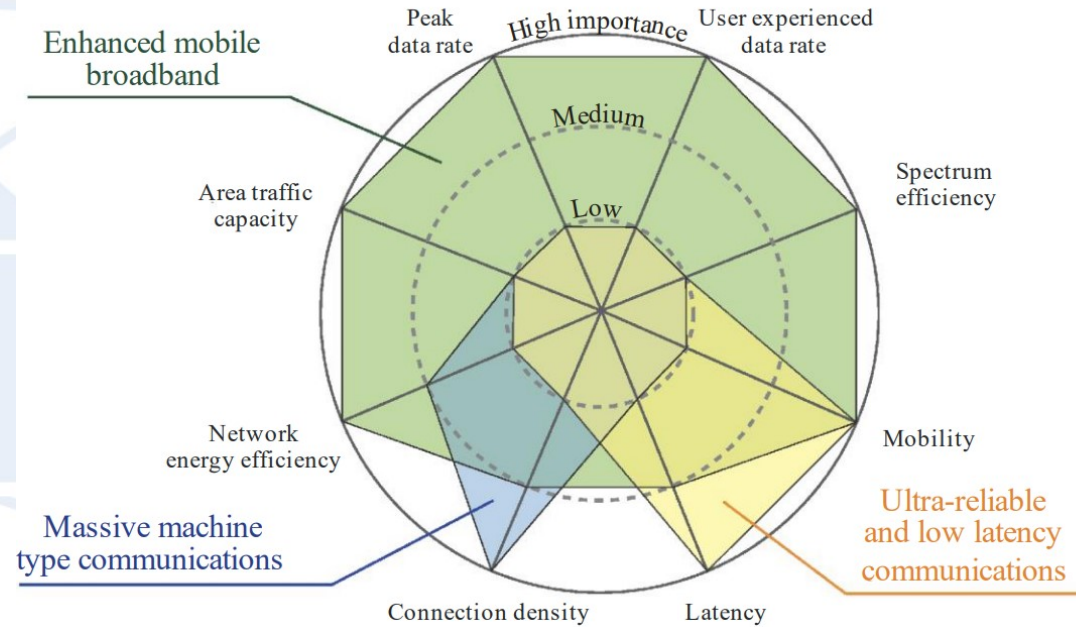
[Rec. ITU-R M.2083](#): IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond.  
See also [Document IMT-2020/1](#)

# IMT-2020/5G – Key parameters

Enhancement of key capabilities from IMT-Advanced to IMT-2020



The importance of key capabilities in different usage scenarios



## IMT-2020 Target requirements

- Downlink/uplink peak data rate : 20/10 Gbit/s
- Downlink/uplink user experienced data rate : 100/50 Mbit/s
- Downlink/uplink peak spectral efficiency : 30/15 bit/s/Hz
- User plane latency for eMBB/ URLLC : 4 ms/1 ms
- Connection density : 1M devices per km<sup>2</sup>
- Mobility : 120 – 500 km/h

# IMT-2020 spectrum

- Bands above 24 GHz are critical for IMT-2020. They provide wide channels and high data rates, they are convenient for MIMO and small cells -> importance of **WRC-19** to identify and harmonize the bands
- There is growing consensus of countries, regional groups and industry on some initial 5G bands, for example 700 MHz + 3.4 GHz + 26 GHz

## ■ Candidate frequency bands for IMT-2020

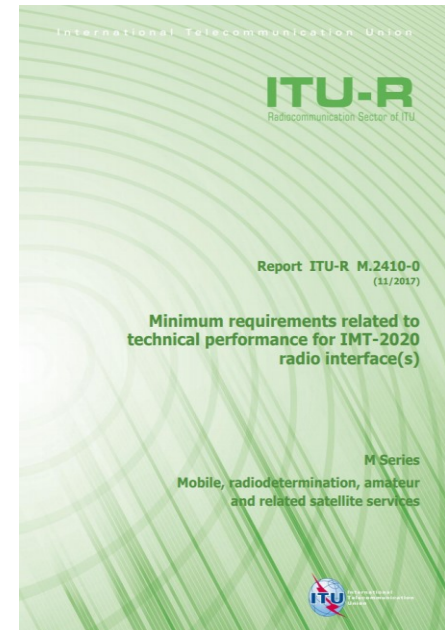
Frequency bands	Frequency bands	Frequency bands that may need mobile allocation
24.25 – 27.5 GHz	31.8-33.4 GHz	24.25 – 25.25 GHz (R1 & R2)
37 – 43.5 GHz	37 – 43.5 GHz	31.8 – 33.4 GHz
45.5 – 50.2 GHz	50.4 – 52.6 GHz	40.5 – 42.5 GHz
66 – 76 GHz	81 – 86 GHz	47 - 47.2 GHz

- Harmonized channeling arrangements are also essential (work on Rec. M. 1036)

# IMT-2020 standardization

- Detailed studies of IMT-2020 (5G) are in ITU-R study groups, mainly WP 5D
- To date ITU developed: IMT-2020 Vision (Recommendation ITU-R M.2083) and technical requirements for its systems (Report ITU-R M. 2410)
- 2018 – July 2019 -> Submission of candidate radio interface technologies for IMT-2020, their analysis by independent evaluation groups
- October 2019 -> Consolidation of assessments in ITU WP 5D, consensus building and decision
- 2020 -> Detailed specification of the IMT-2020 standard
- 2017-2020: trials of 5G technologies contributing to the development of a detailed IMT-202 specification

<http://www.itu.int/en/ITU-R/studygroups/rsg5/rwp5d/imt-2020/Pages/default.aspx>



# Broadband over other platforms - RLANs

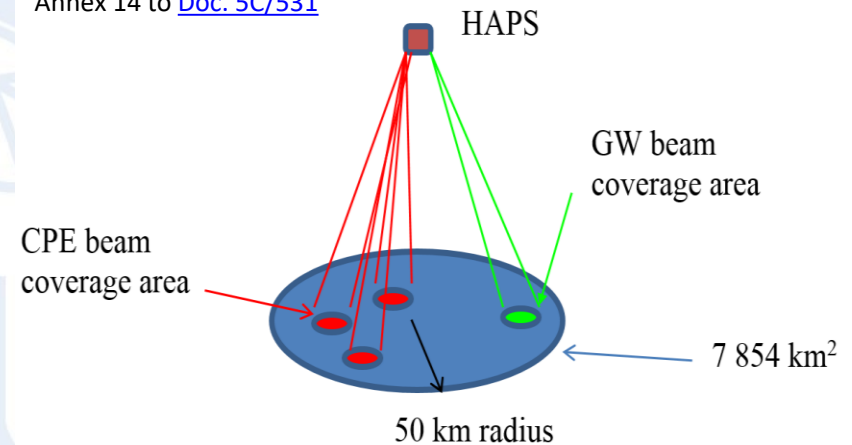
- WAS/RLAN has been providing broadband over fixed radio networks since 1997. From 1 Mbps in the beginning, up to multi Gbps today
  - RLAN in 2.4 GHz and 5 GHz bands (Wi-Fi)  
(Rec. ITU-R [M.1450](#), ETSI [EN300 328](#), IEEE [802.11](#))
  - Multi-Giga bits/sec RLAN in 60 GHz band (WiGig)  
(Rec. ITU-R [M.2003](#) , [ISO/IEC 13156](#), ETSI [EN302 567](#))
- WRC-19 (under Agenda Item 1.16) is going to review:
  - RLANs spectrum in the 5 150 – 5 925 MHz
- Wi-Fi is extensively used for offloading mobile traffic
- 5G industry is also preparing for LAN type service within IMT-2020



# Broadband over other platforms - HAPS

- High Altitude Platform Station (**HAPS**) can provide BB connectivity to remote areas
- Flying at 20-26 km serves to a ground area of 50 km radius
- WRC-19 under AI 1.14 will consider the following frequency bands for HAPS:

Annex 14 to [Doc. 5C/531](#)



Frequency band	Use	Dir.	Band.	Identification	RR No.	Incumbent services
6 440-6 520 MHz	GW	↓	80 MHz	5 ADMs (R1, R3)	RR 5.547	FS, MS, EESS (7.19-7.25 GHz)
6 560-6 640 MHz	GW	↑	80 MHz	5 ADMs (R1, R3)	RR 5.547	FS, MS, EESS (7.19-7.25 GHz)
27.9-28.2 GHz	GW, CPE	↓	300 MHz	23 ADMs (R1, R3)	RR 5.537A	FSS, MS
31-31.3 GHz	GW, CPE	↑	300 MHz	23 ADMs (R1, R3)	RR 5.543A	FS, EESS/RAS (31.3-31.8 GHz)
47.2-47.5 GHz	GW, CPE	↑↓	300 MHz	Worldwide	RR 5.552	FS, MS, FSS, RAS (48.94-49.04 GHz)
47.9-48.2 GHz	GW, CPE	↑	300 MHz	Worldwide	RR 5.552	FS, MS, FSS, RAS (48.94-49.04 GHz)
21.4-22 GHz and 24.25-27.5 GHz	GW, CPE	↑↓	600 MHz/3.25 GHz	Region 2	[TBD]	FS, MS, FSS, EESS (21.2-21.4 GHz and 23.6-24.2 GHz), RAS (22.21-22.5 GHz)
38-39.5 GHz	GW, CPE	↑↓	1.5 GHz	Worldwide	[TBD]	FS, MS, FSS, SRS (37-38 GHz)

# Technology trends – radio access technologies

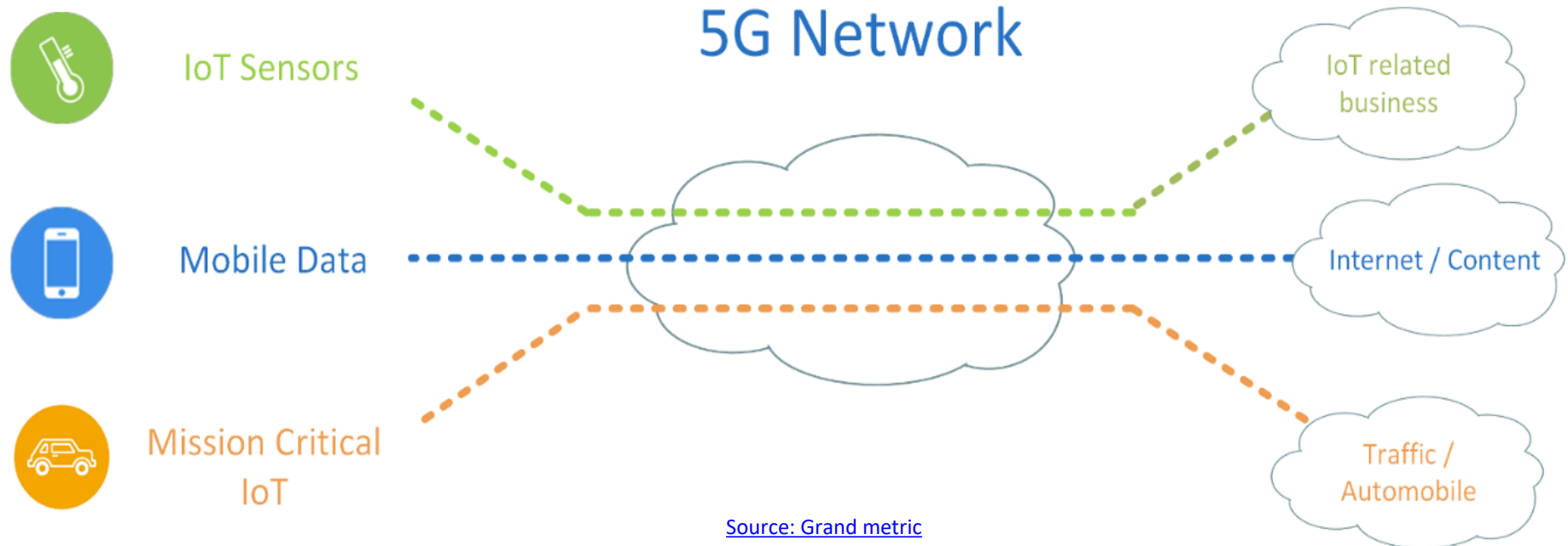
- Carrier aggregation (CA)
  - Within same frequency block and
  - Among different bands (e.g. 700 MHz / 1.8 GHz / 3.6 GHz / mm Wave)
- Advancements in antenna
  - Massive MIMO, Active antenna system (AAS)
  - 3D-beamforming
  - Network MIMO
- Advancements in modulation
  - Filtered OFDM (FOFDM)
  - Filter bank multi-carrier (FBMC) modulation
- Non-orthogonal multiple access
  - PDMA (Pattern division multiple access)
  - IDMA (Interleave division multiple access)
  - SCMA (Sparse code multiple access), etc.

# Technology trends - Networks

- **Dual connectivity and heterogeneous networks** - 4G evolution and 5G NR connectivity, cooperative operation of FDD/TDD, IMT and RLAN
- **Cloud RAN (C-RAN)** – replaces signal processing units at base stations by centralized unit -> cost savings, energy efficiency
- **Artificial Intelligence** – improves ability to extract knowledge from data -> automatization of network management and processing information, e.g. processing information from millions of sensors in IoT
- **Software-defined networking (SDN)** – allows dynamic reconfiguration of network in real-time -> improvement of network resilience, performance and quality of service
- **Network slicing** – multiple virtual networks within one physical network

# Technology trends - networks

- Network slicing is as a key for 5G success
- Separation of a physical network into multiple virtual networks to support various customer segments -> reduction of network costs, efficient use of network resources



# Concluding remarks

- Mobile broadband is beneficial for economies, it brings new services, transform societies. 10% MBB increase -> 0.8% increase in GDP
- MBB provides necessary connectivity for various sectors, such as smart cities, smart homes, smart factories, connected cars, M2M, etc
- It ensures higher data rates, higher mobility, higher spectrum efficiency, massive connectivity, higher energy efficiency, ultra low latency
- Challenges: spectrum, backhaul, convergence with broadcasting
- ITU contributes to broadband developments by:
  - providing spectrum and stable regulatory environment
  - developing IMT Vision and Standards
- BB development should be balanced. 5G should not limit or hamper the current 4G deployment. 5G is expensive and it is difficult to invest in 4G and 5G simultaneously

# ITU-R reference documents

- WRC-19 issues related to broadband ([Draft CPM Report](#))
  - Spectrum and identification for **IMT-2020** - Agenda item 1.13
  - Spectrum for **HAPS** - Agenda item 1.14
  - Spectrum for **WAS/RLAN** in the 5 GHz band - Agenda item 1.16
  - Spectrum for **NGSO FSS** – Agenda item 1.6
- ITU-R standardization activities in Working Party 5D
  - Vision and requirement (Recommendation ITU-R [M.2083](#))
  - Technical trends and necessary information (Report ITU-R [M.2320](#) on IMT, [M.2405](#) on CRS, [M.2228](#) on ITS,...)
  - RAN specifications (Rec.ITU-R [M.1457](#), [M.2012](#), [M.1450](#), [M.2003](#),)
  - IMT channelling arrangements (Rec. ITU-R M.1036)

