



# Strategic path to **5G**

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April, 2014  
Celtic Plus - Monaco

# Turk Telekom Group



mobile operator



broadband provider



system integrator



network & group R&D



education software



fixed incumbent



call center



gaming

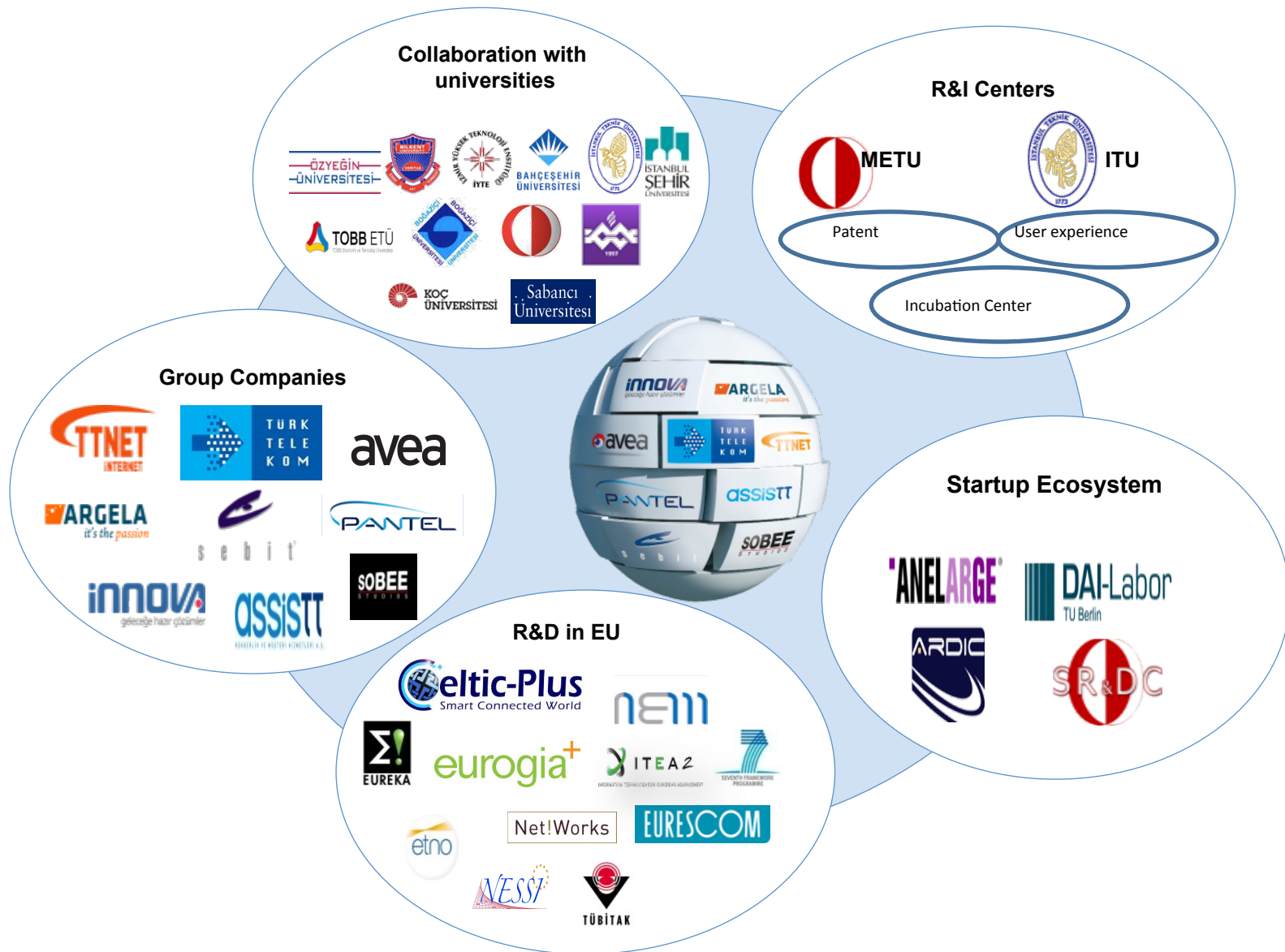


subsidiary operator



inter-country fiber

# Turk Telekom Group R&D



MAGICIAN | SIGMONA | MITSU | H2B2VS | TILAS  
PISCES | ROMEO | BATS | FORGET-IT | OFERTIE  
COMBO | I-TREASURES

# EU Projects in Numbers

-  Telecom
-  Media
-  Gaming
-  Education
-  Health
-  Transportation
-  Energy
-  Security



7



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**Turk Telekom is  
Core Group  
Member at  
Celtic Plus &  
Eurogia Plus**

**NetWorld2020 – Steering Board Member**

**5G PPP – Steering Board Member**

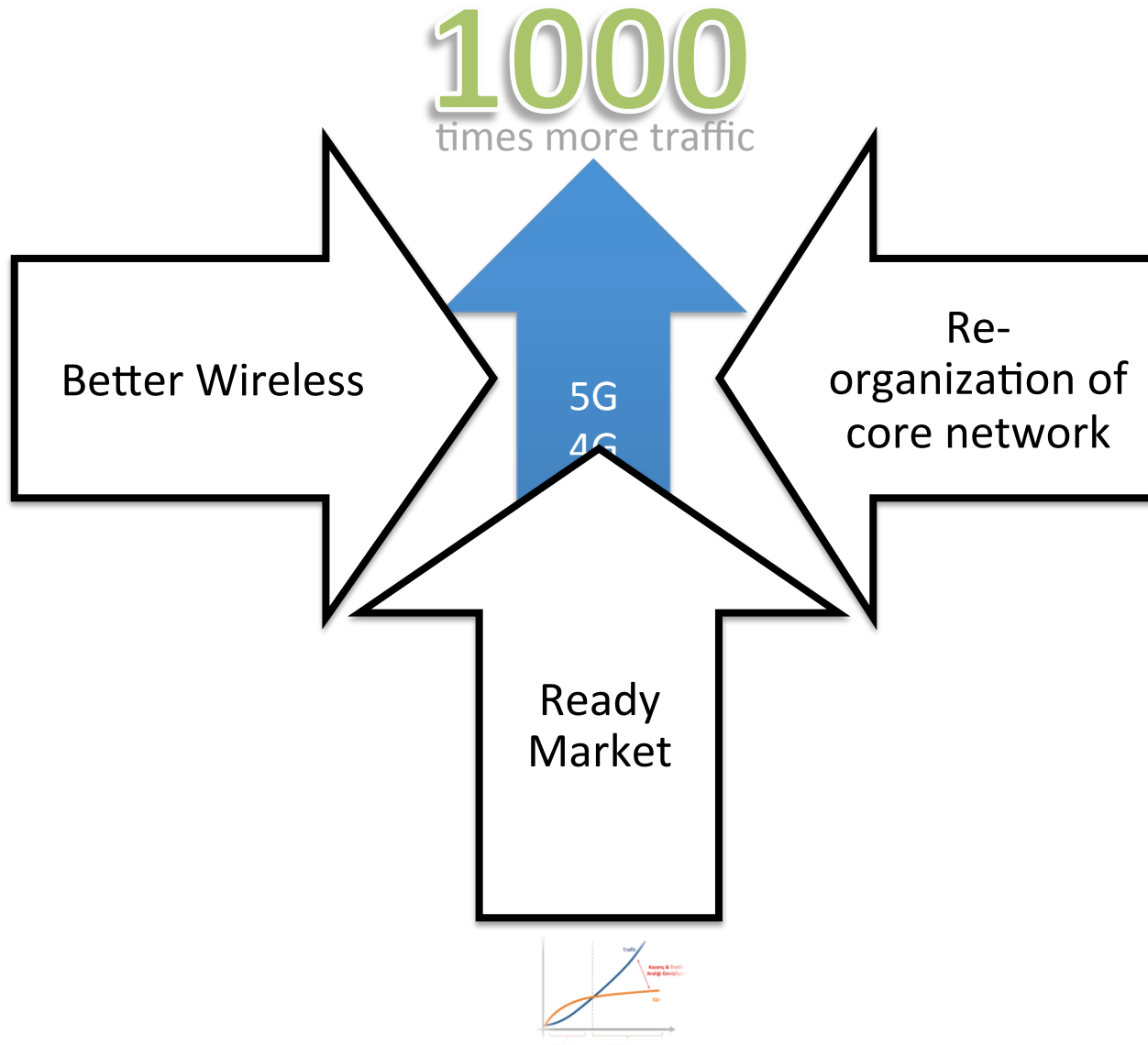
**Celtic-Plus – Core Group Member**

**ETNO – R&D Member**

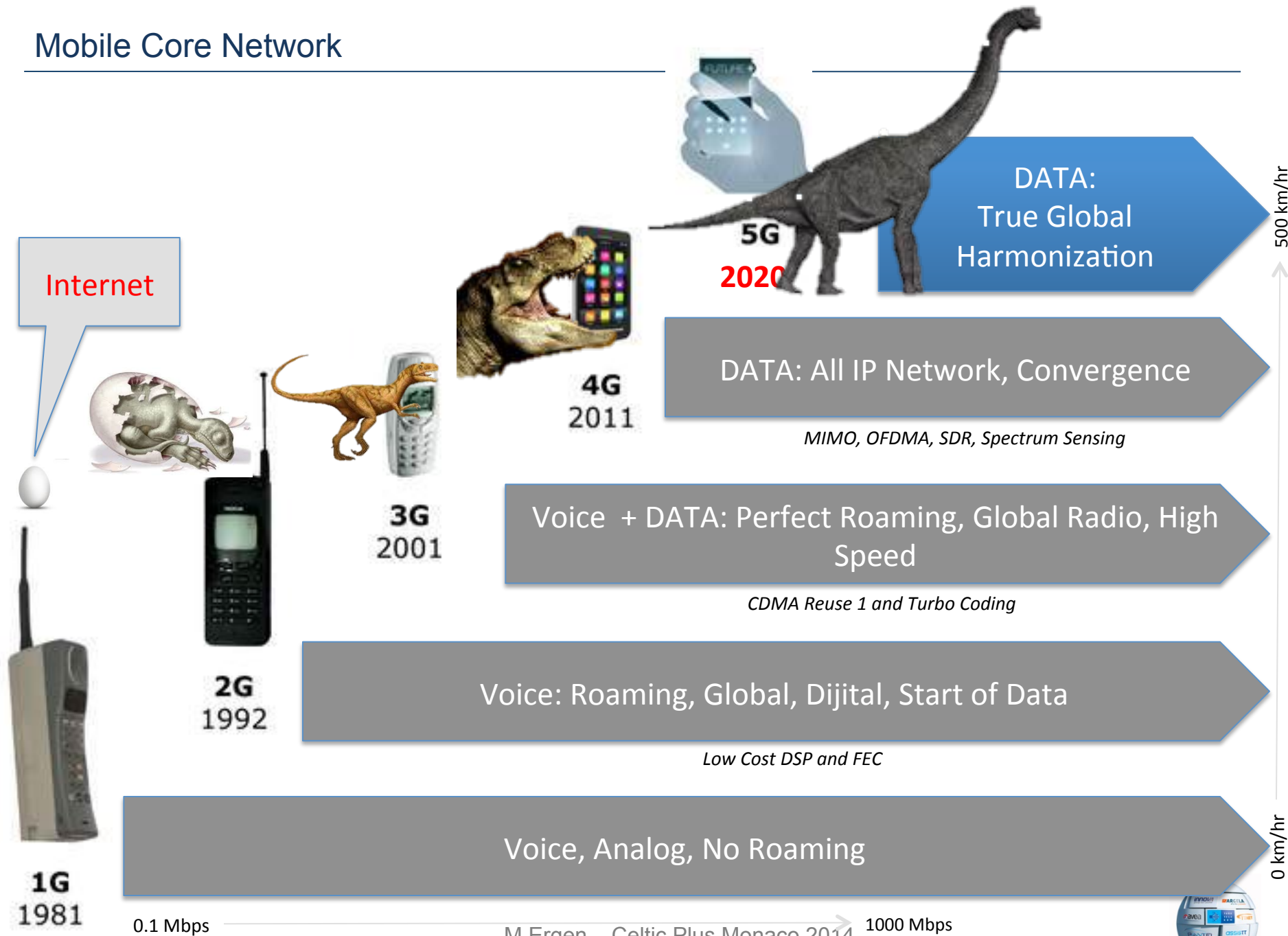
**NEM – Steering Board Member**



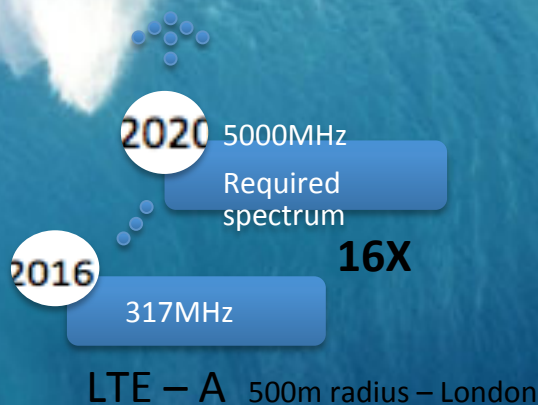
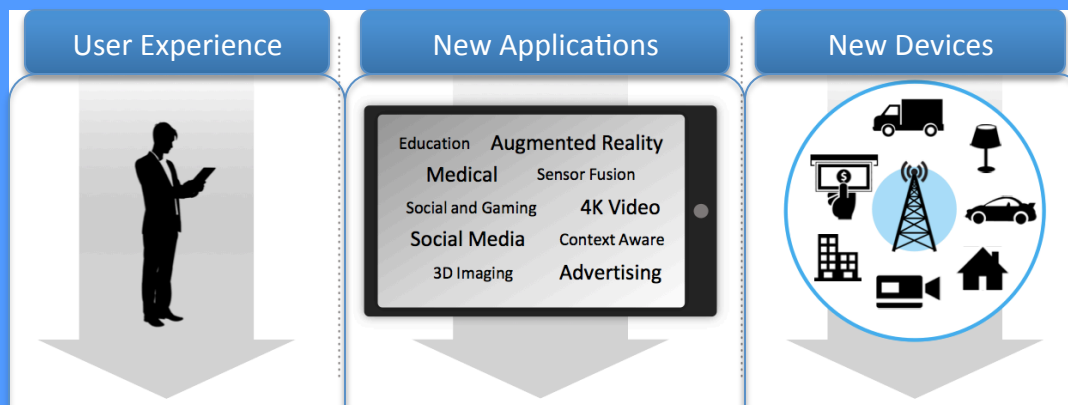
# Why New Generation?



# Mobile Core Network



# Data Tsunami when?



Year		Speed	Population	Device	Usage	Required Capacity	
2012		0.3Mbps	4984/km <sup>2</sup>	1.2	15%	0.26Gbps/km <sup>2</sup>	
2016	<b>4 Year</b>	2.9Mbps	5191/km <sup>2</sup>	1.4	20%	4.2Gbps/km <sup>2</sup>	<b>16X</b>
2020	<b>4 Year</b>	30Mbps	5477/km <sup>2</sup>	1.7	25%	69.8Gbps/km <sup>2</sup>	<b>16X</b>





# 5G will redefine everything...

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Autonomic  
Communications

Cloud  
Networking

Human Centric  
Sensing and  
Communications

Internet of  
Things

Nano-scale  
Networking

Situation  
Management

Smart Grid  
Communications

Social Networks

Vehicular  
Networks

New Fiber and  
Cable

Visual Light  
Communication



# 5G started in European Union

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- EU started **5G Public Private Partnership Association** in order to define 5G business requirements, technical architecture, standards and research.



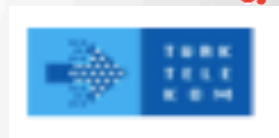
[http://ec.europa.eu/research/press/2013/pdf/ppp/5g\\_factsheet.pdf](http://ec.europa.eu/research/press/2013/pdf/ppp/5g_factsheet.pdf)

## 5G-ppp.eu

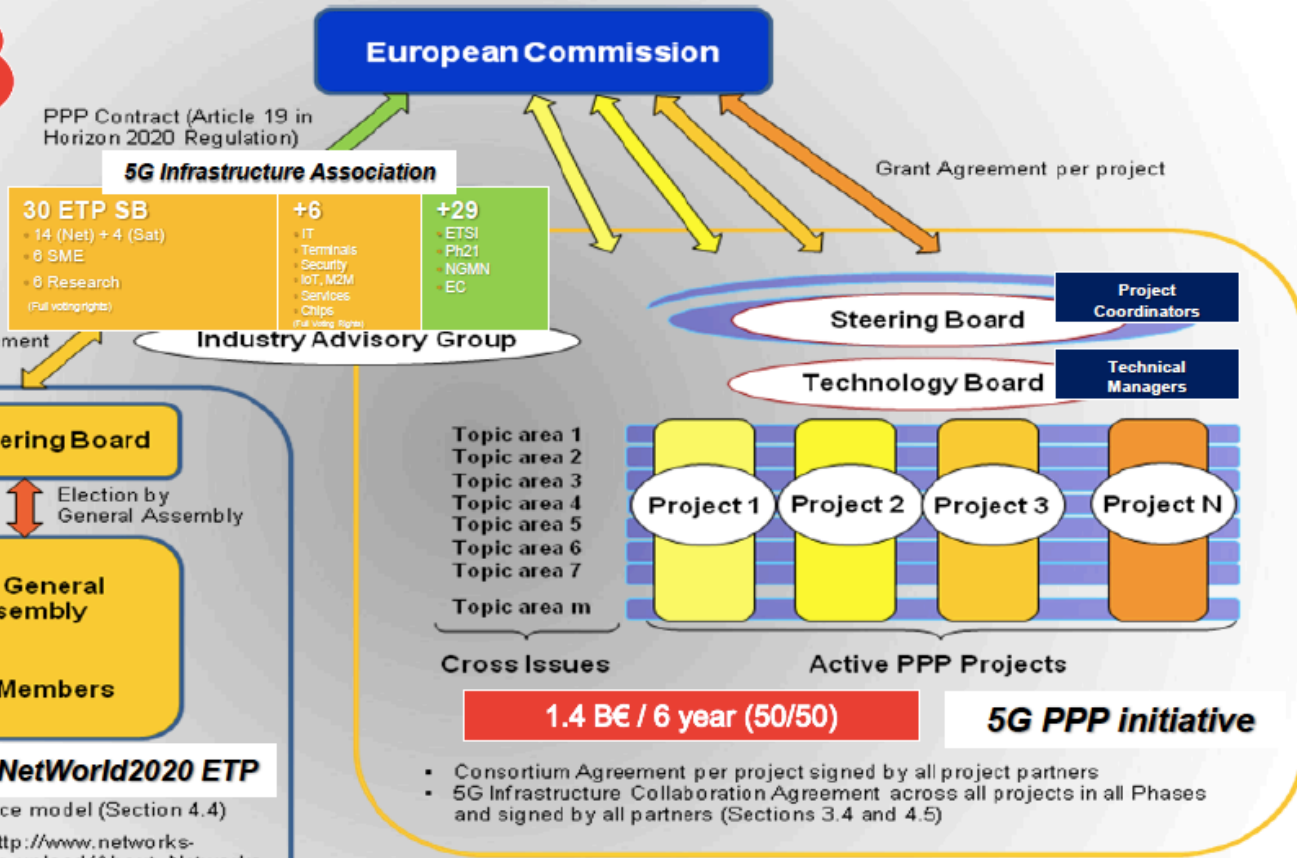
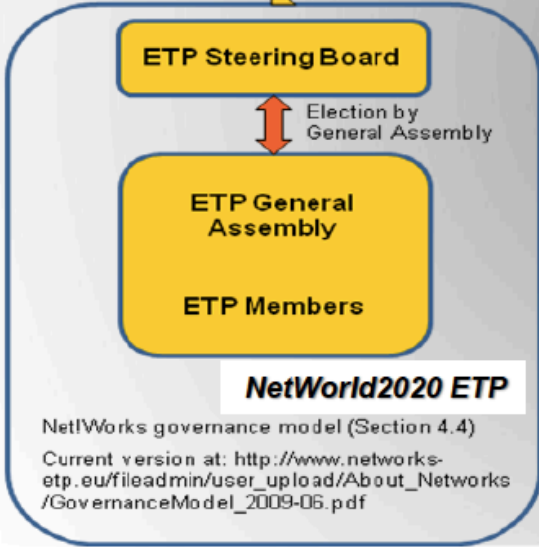


# Networld 2020 & 5G PPP

Note: The Association will be bound by the terms of the Members Agreement, which makes sure that the decision taken by the Association is in line with the decision taken by the bodies of the NetWorld2020 ETP



Member Agreement (Section 4.3.5)



Grant Agreement per project

<http://new-etp.eurescom.eu/>

The spectrum crunch is a recognized issue driving 5G.

3G was looking for the “killer App”.

Then came the smartphone with “The App”

and 5G is now looking for “The Killer Tech” to avoid the “killed App”.

This trend is a result of the data demand outstripping wireless transmission capabilities where the major limitations stem from the limited available spectrum in the preferred frequency range below 10 GHz. It is inevitable that the solution will involve the use of radio spectrum beyond 10 GHz.

- In this context, there have been emerging activities around mmWave communication, tera Hertz communication, visible light communication, or ‘Li-Fi’.
- Underpinning all of them are large scale MIMO systems.



## Advancement in Wireless Technologies

- Better technology than OFDMA
- Full Duplex Transmission
- Millimeter Wave & Terra Hertz Communication
- Visual Light Communication
- Device to Device

## Re-organization of core network

- SDN + NFV
- Dynamic Spectrum Usage
- Small Cells and HetNets
- Intelligent Video Deliver
- Vehicular Communications
- Internet of Things



Non-Orthogonal  
Multiple Access  
(NOMA)

Filter Bank  
Multicarrier  
(FBMC)

Millimetre  
frequencies/  
waves

3D Massive  
MIMO

Cognitive radio  
spectrum sensing

Super wideband  
spectrum

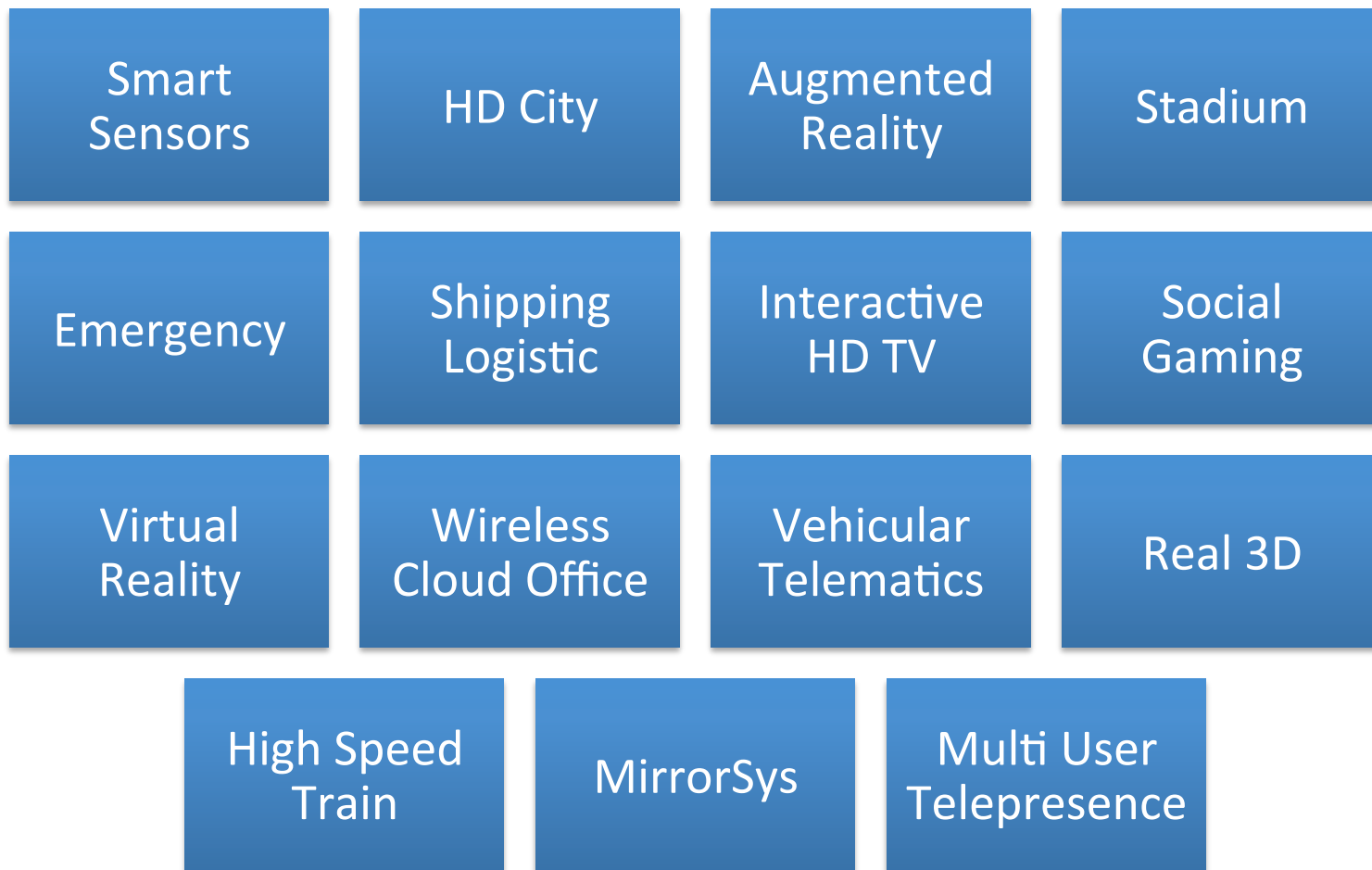
Smaller cells and  
ultra dense  
HetNets

Multi-technology  
Carrier  
Aggregation

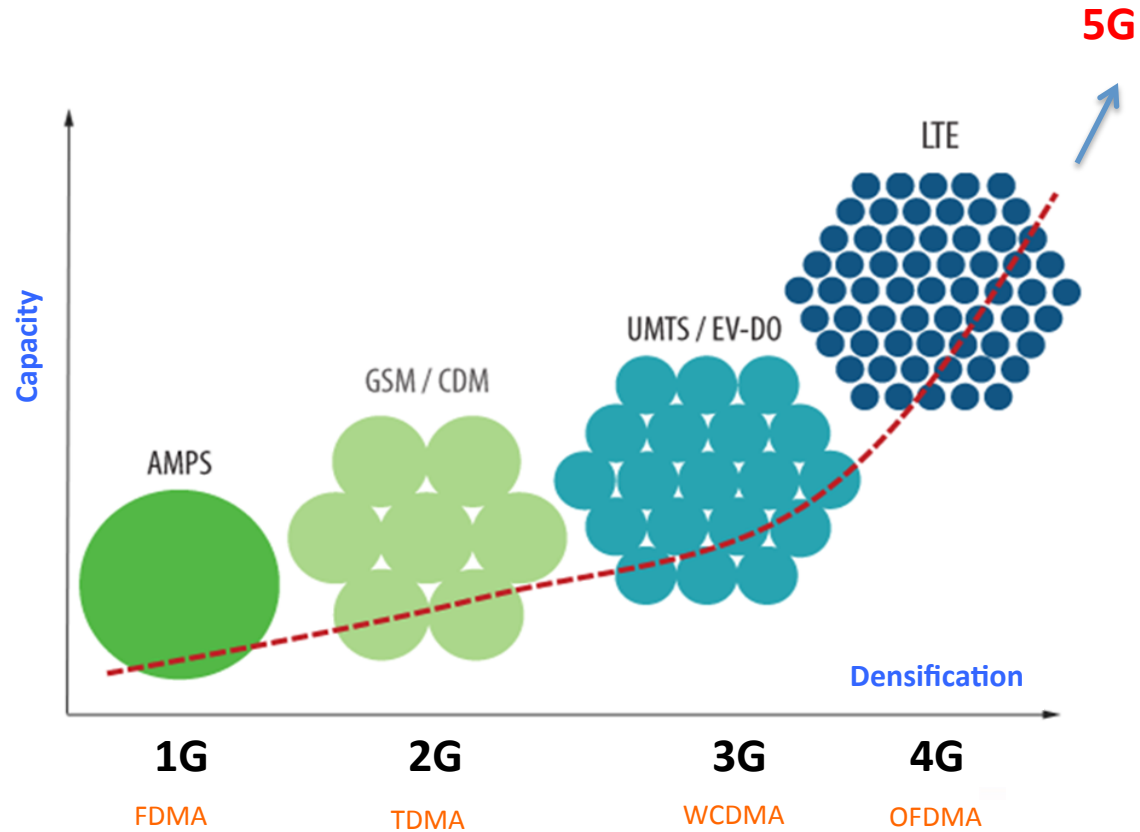
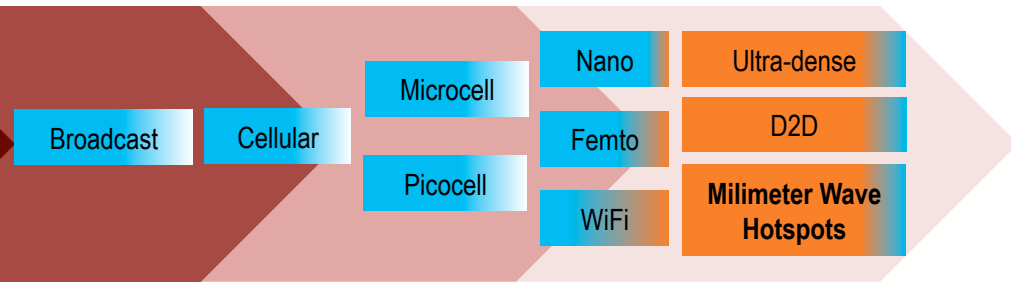
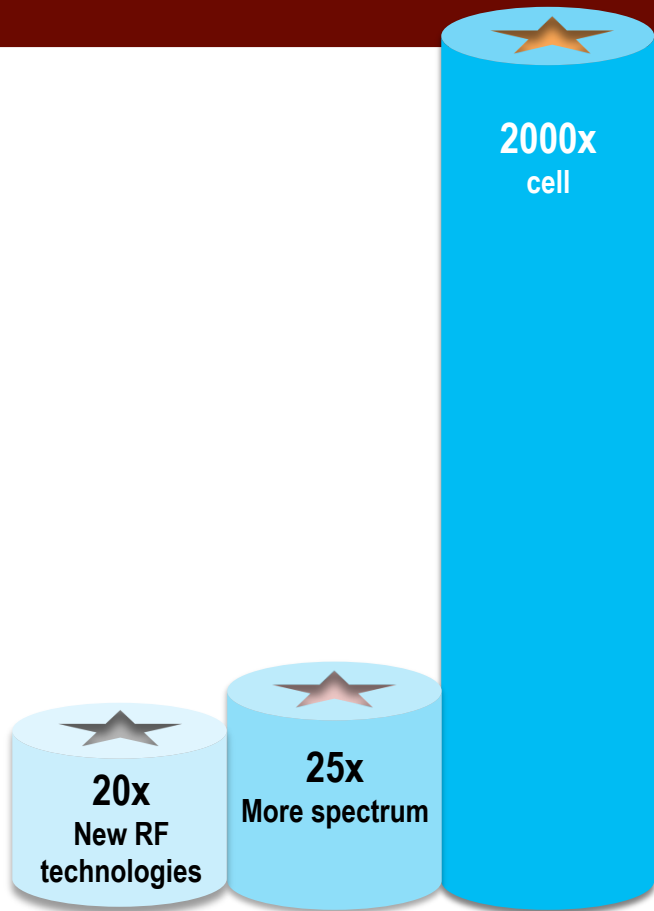


# Possible 5G Use Cases

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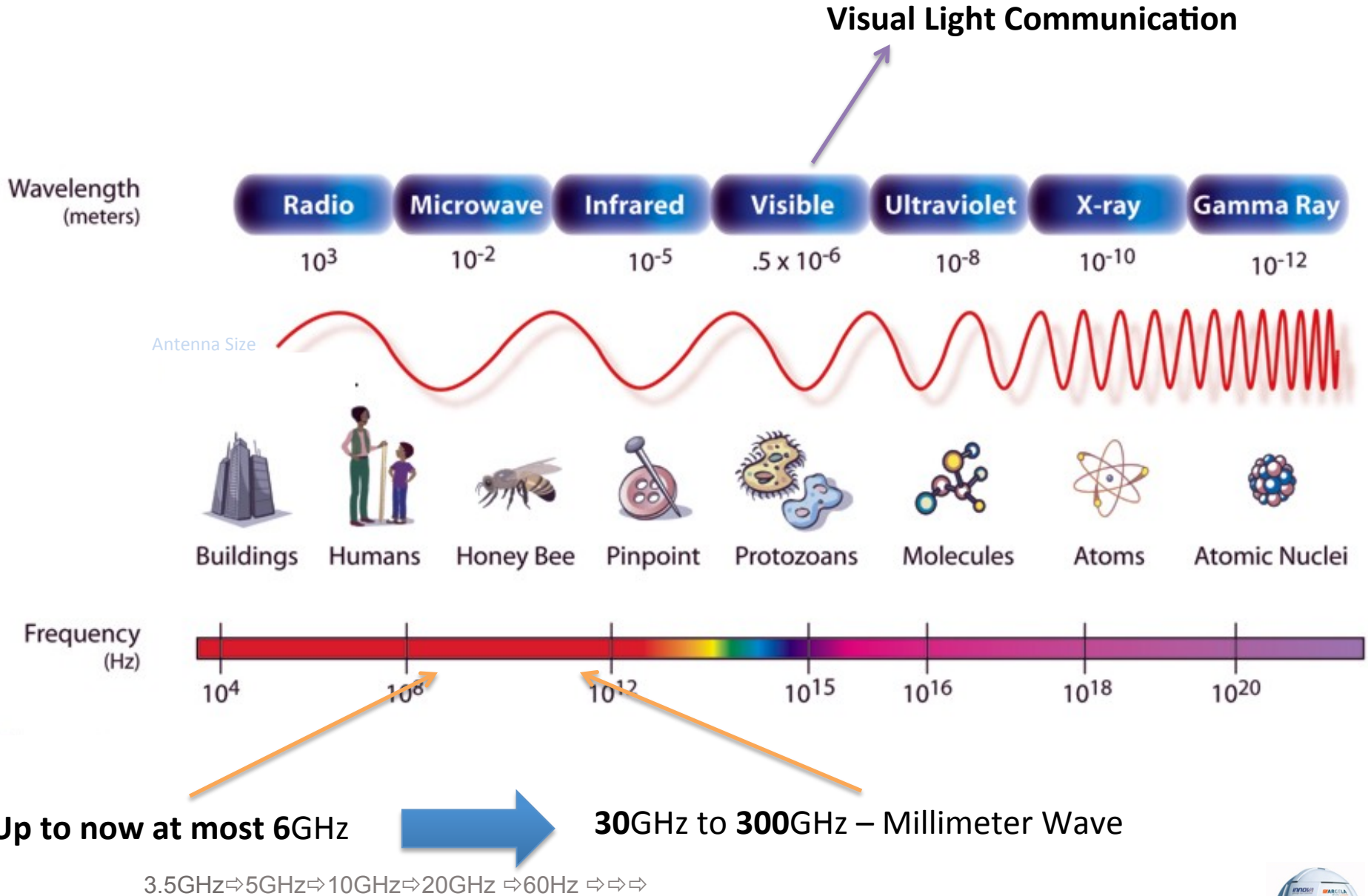


# Coverage and Capacity



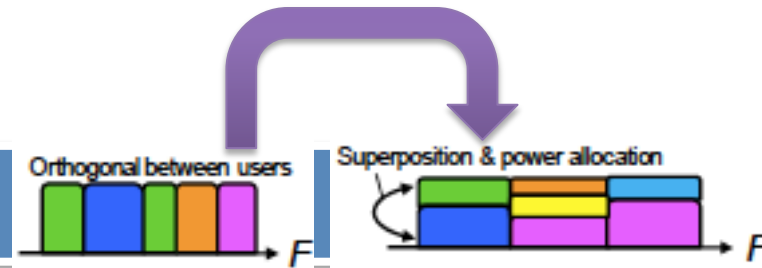


# Where is 5G?

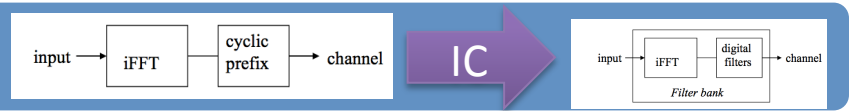


# Next steps after OFDMA

Non-Orthogonal Multiple Access (NOMA)

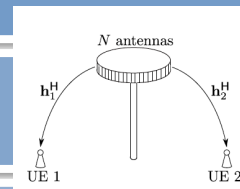


Filter Bank Multicarrier (FBMC)



Millimetre frequencies/waves

3D Massive MIMO



Cognitive radio spectrum sensing

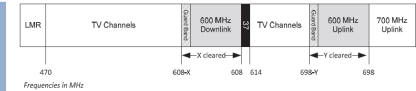


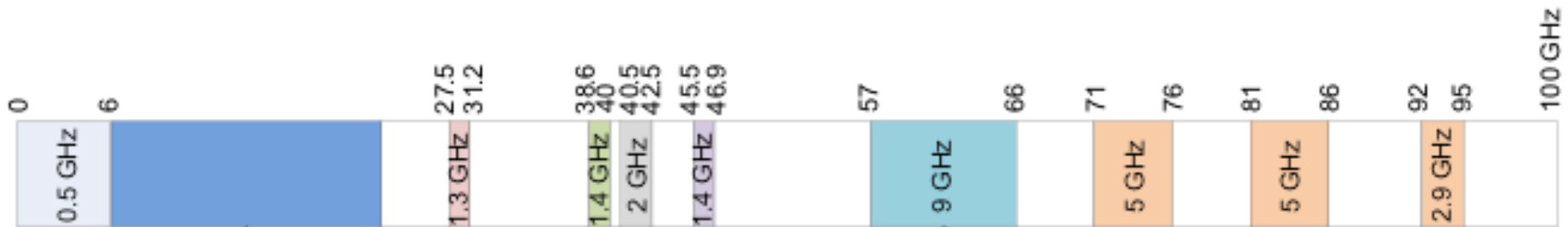
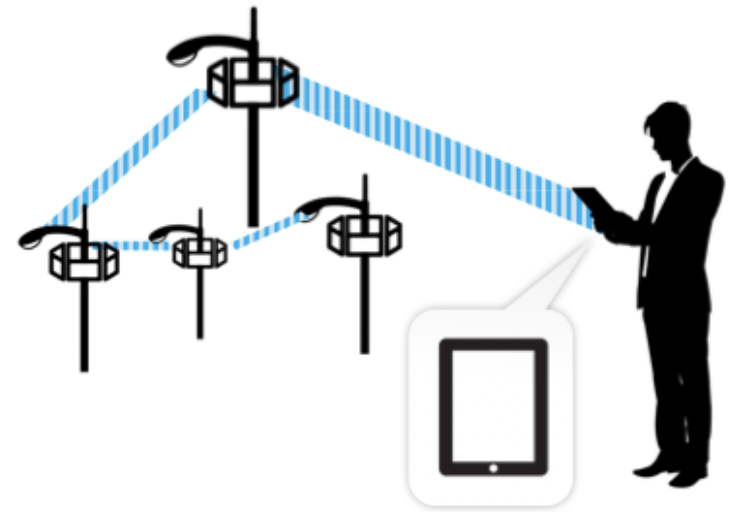
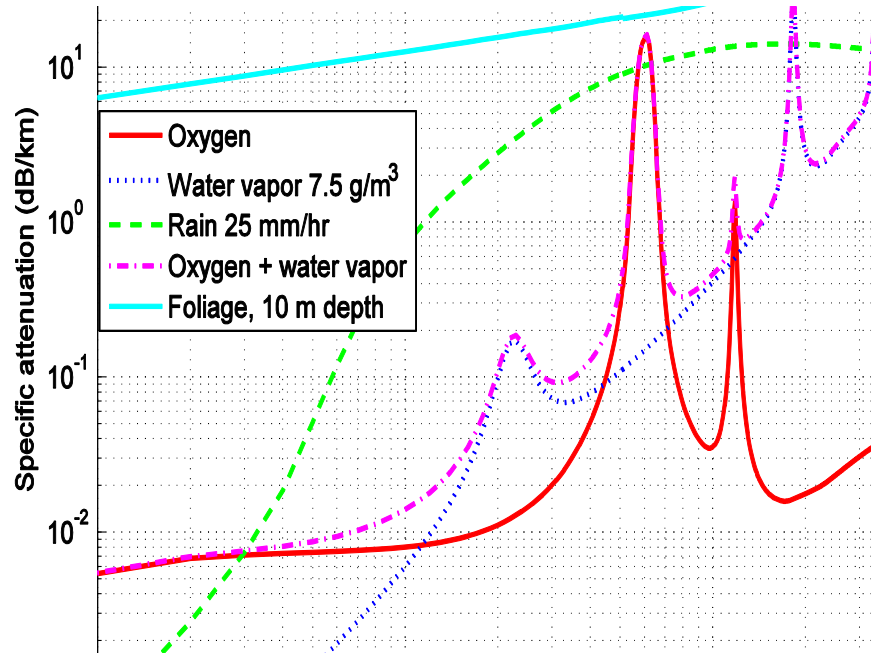
Figure 4. 600 MHz Band Plan

Super wideband spectrum

Multi-technology carrier aggregation

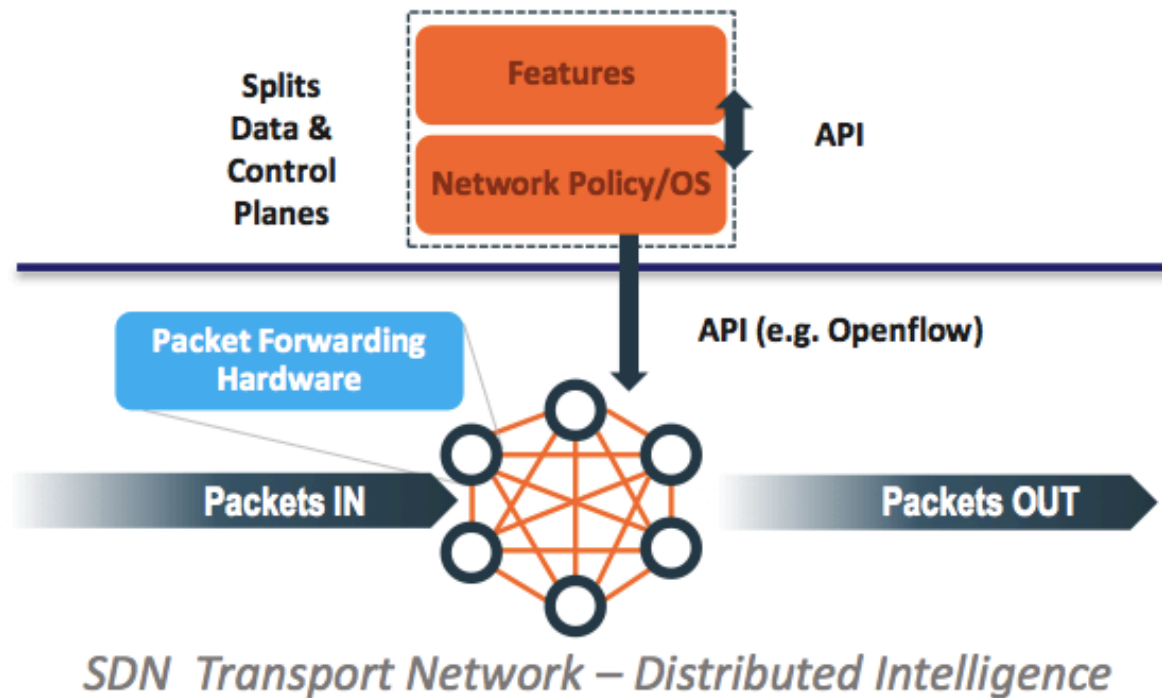


# Millimeter Wave



## Internet will be redefined....

- Routing, Multicasting, Naming, Addressing, TCP over Wireless, Mobility, Multi-homing, Flaws in Security



# Visual Light Communication

## 1. PHY

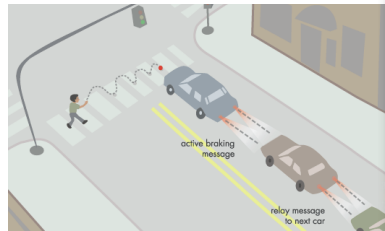
- Data rate granularity
- Complexity / Power efficiency / performance trade-off

## 2. Optical Circuits

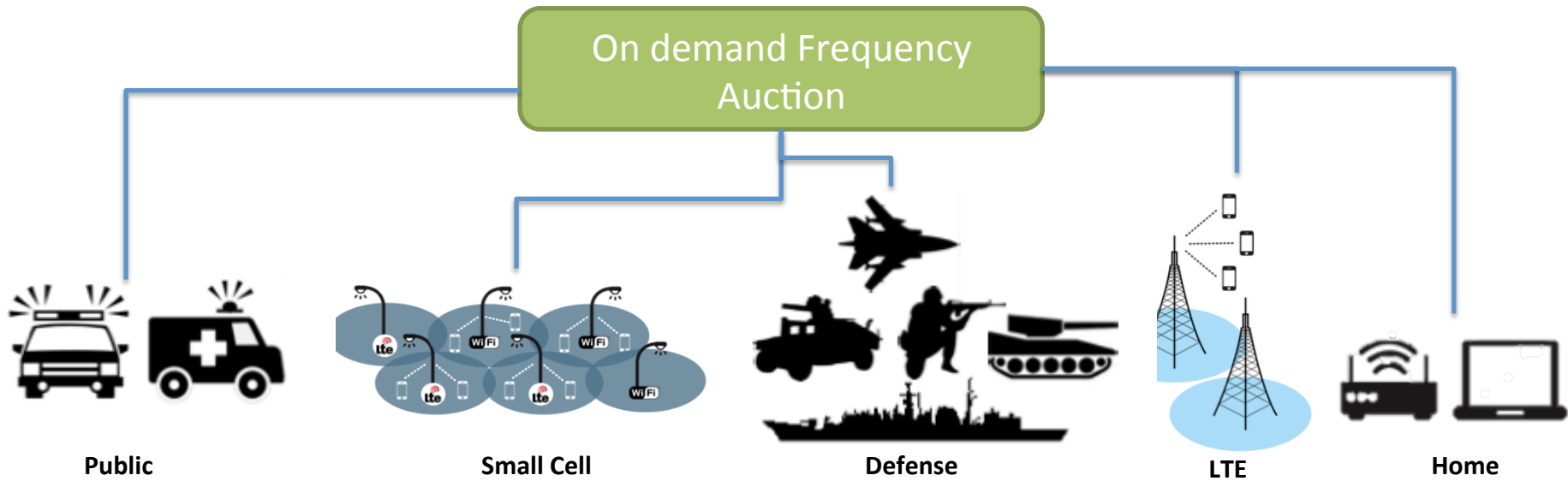
- Optical subsystems
- Analogue LED driver electronics
- ADC/DAC solutions
- Automatic gain control

## 3. MAC

- Duplexing
- Diversity / link blockage
- MIMO / beamforming
- Interference mitigation
- Mobility support
- Relaying



# Dynamic Frequency Auction



**THANK YOU!**

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