wireless@kth

Friday seminar
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Challenges and Scenarios of the fifth Generation (5G) Wireless Communications System

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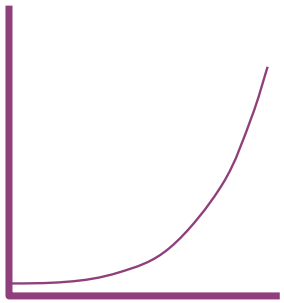
CONTENT

- About METIS
- 5G scenarios
- Examples of 5G Technical Components

5G WIRELESS ACCESS: CHALLENGES

Avalanche of
Traffic Volume



“1000x in ten years”

Massive growth in
Connected Devices

“50 billion devices in 2020”

Wide range of
Use cases & Requirements

Device-to-Device Communications

Car-to-Car Comm.

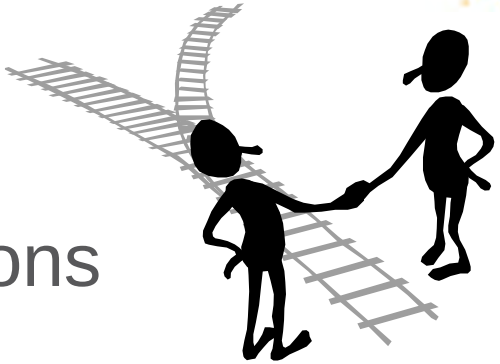
New requirements and characteristics due to communicating machines

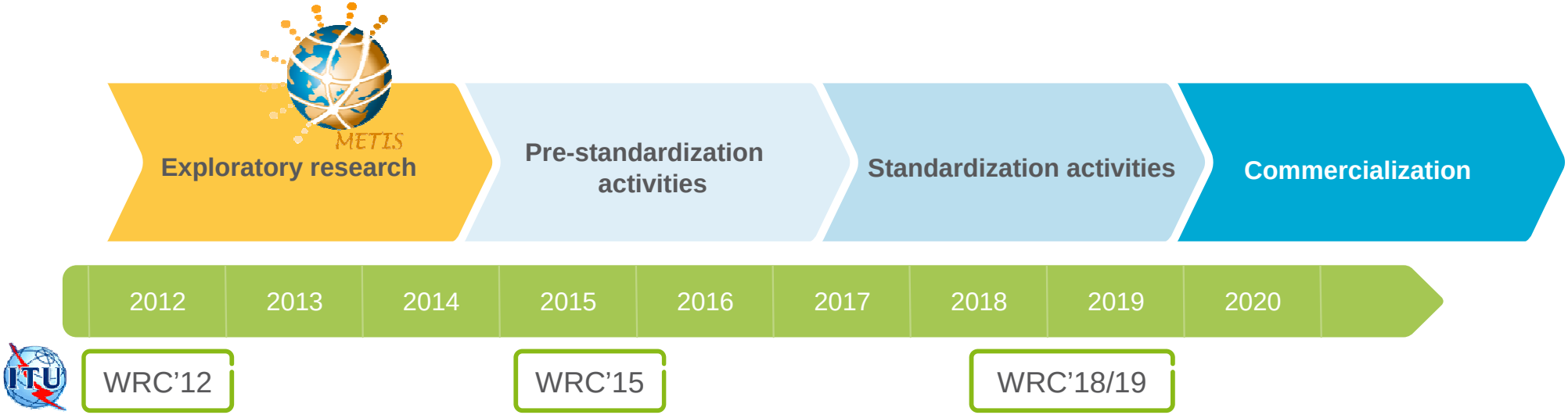
Affordable and sustainable

METIS OBJECTIVES

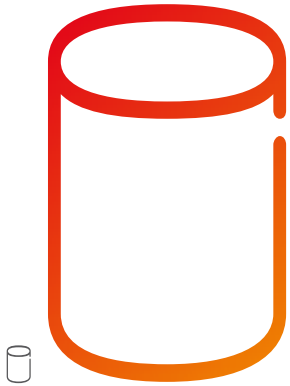
- **Lay** the foundation for
- **Ensure** a global forum for
- **Build** an early global consensus for

⇒ **5G** mobile communications





METIS OBJECTIVES

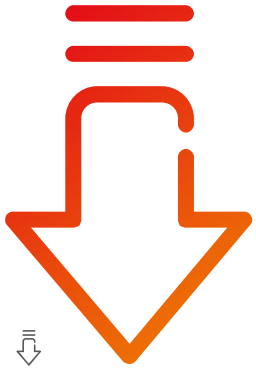


1000x
higher mobile data volumes

50/500 B devices

10-100x
higher number of connected devices

Up to 10Gbps



10-100x
typical end-user data rates

Few ms E2E

5x
lower latency

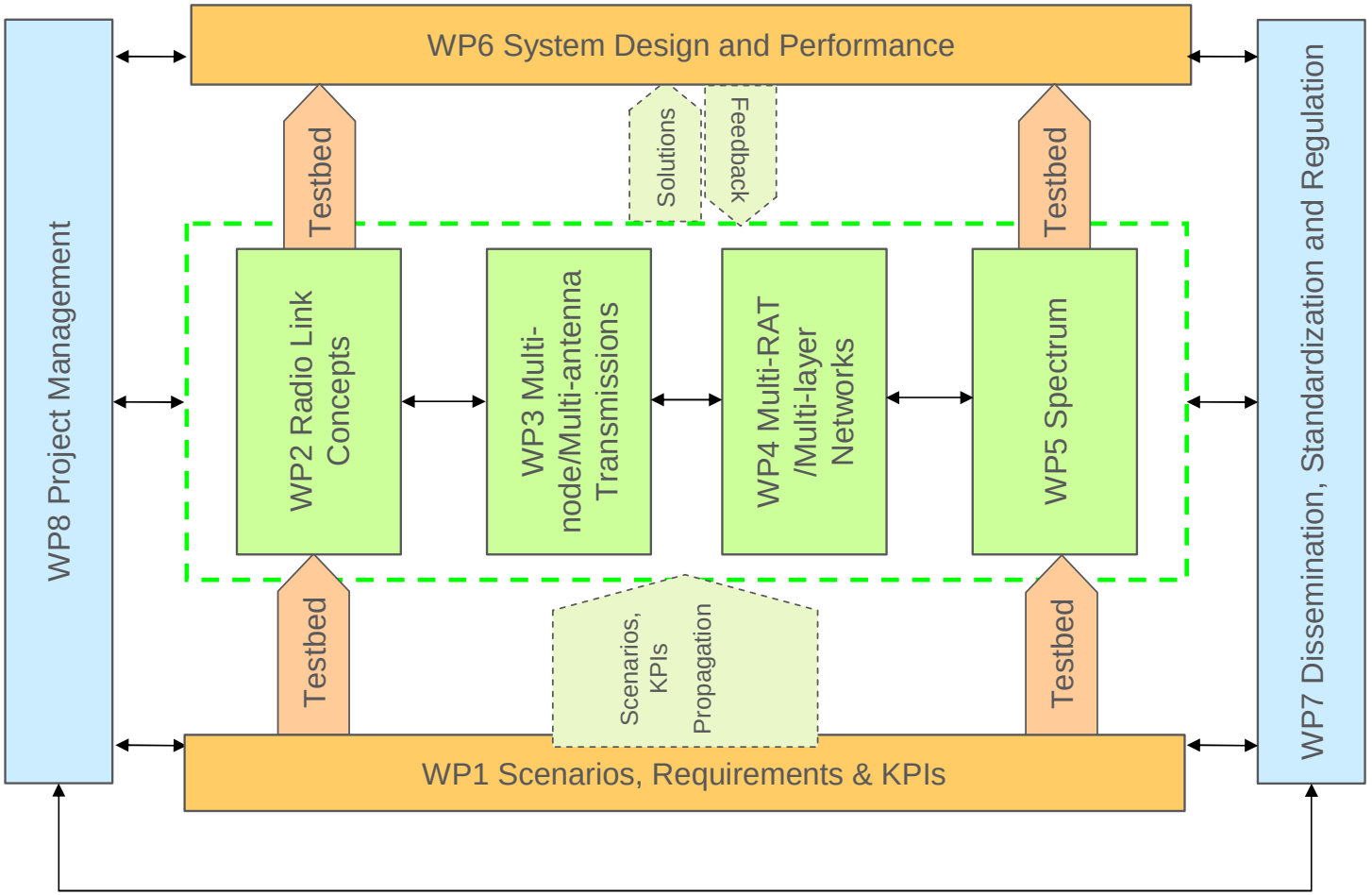
10 years

10x
longer battery life for low-power devices

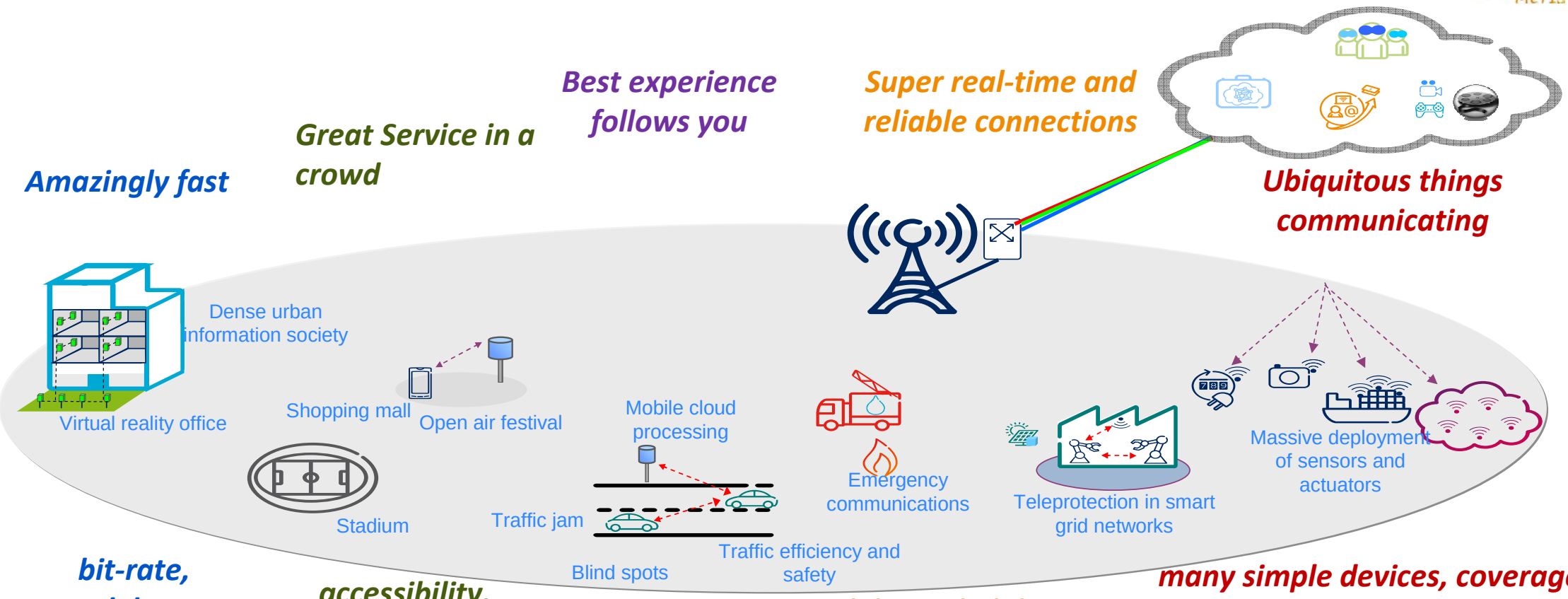
Develop a concept for future mobile and wireless communications system that supports the connected information society

METIS STRUCTURE: WORK PACKAGES

- WP1 (DOCOMO)
- WP2 (Huawei)
- WP3 (Alcatel-Lucent)
- WP4 (NSN)
- WP5 (Nokia)
- WP6 (Ericsson)
- WP7 (Ericsson)
- WP8 (Ericsson)



METIS 5G SCENARIOS



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AALBORG UNIVERSITY
DENMARK

Aalto University

BMW GROUP
Forschung und Technik

Alcatel·Lucent

CHALMERS
UNIVERSITY OF TECHNOLOGY

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Anite

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Heinrich Hertz Institute

HUAWEI

KTH
VETENSKAP OCH KONST

National and Kapodistrian
UNIVERSITY OF ATHENS

NOKIA
Connecting People

nsn

UNIVERSITY of OULU

POLITECHNIKA POZNAŃSKA

RWTH AACHEN UNIVERSITY

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TELECOM ITALIA

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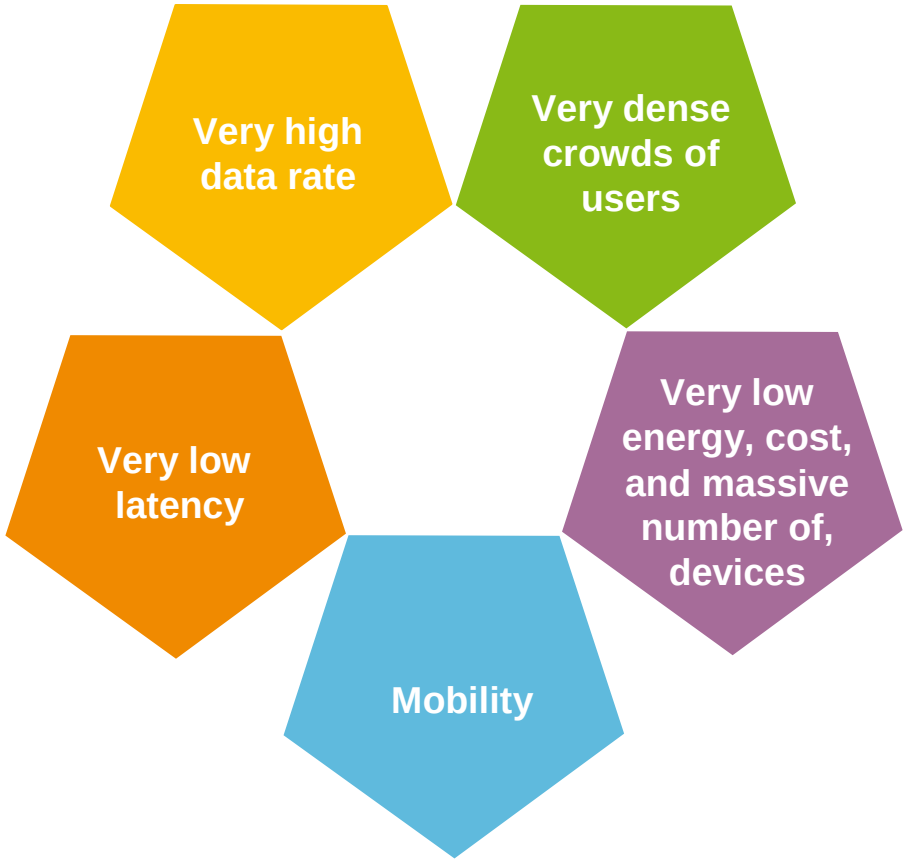
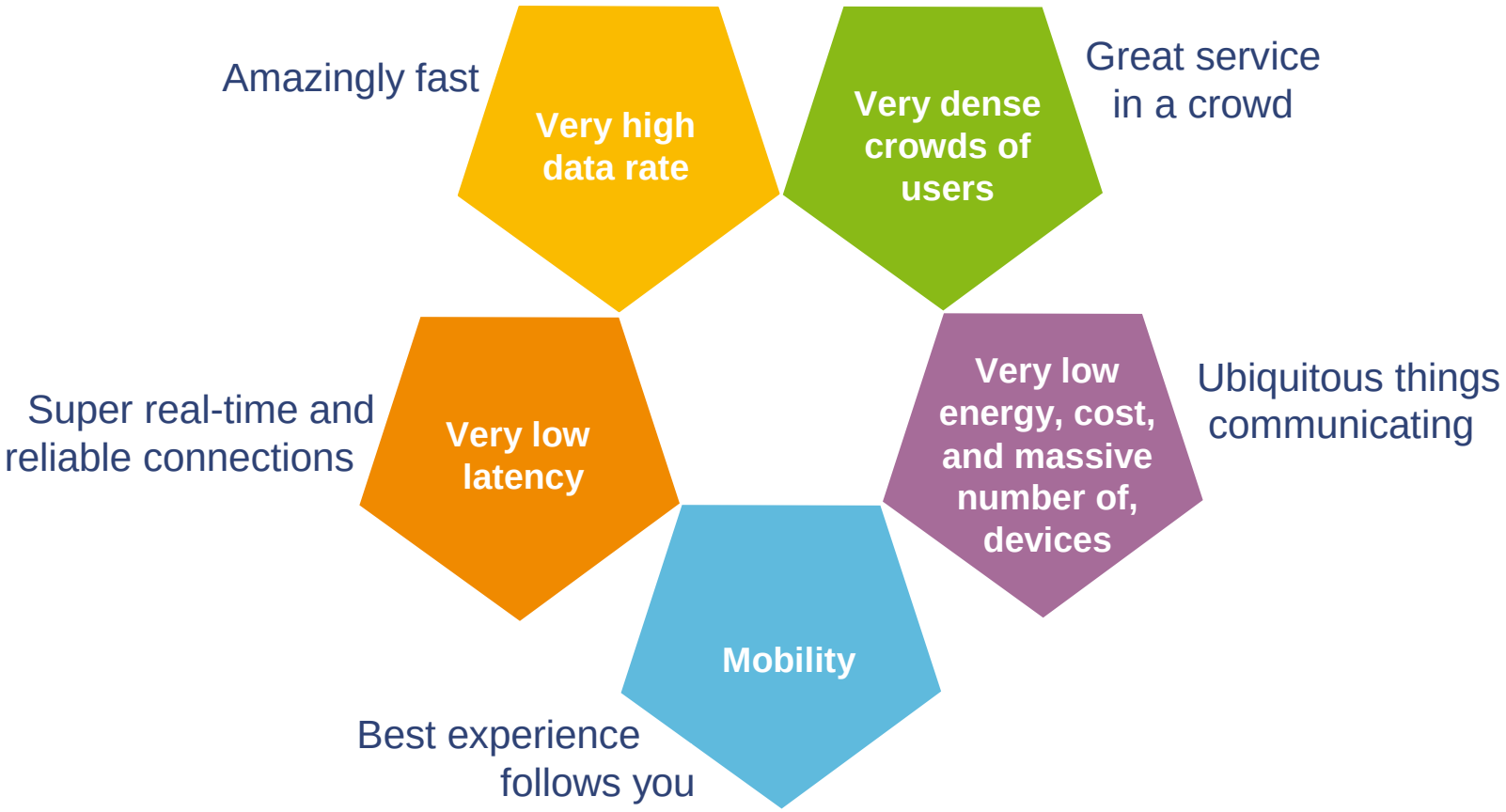
METIS 5G SCENARIOS

FIVE CHALLENGES

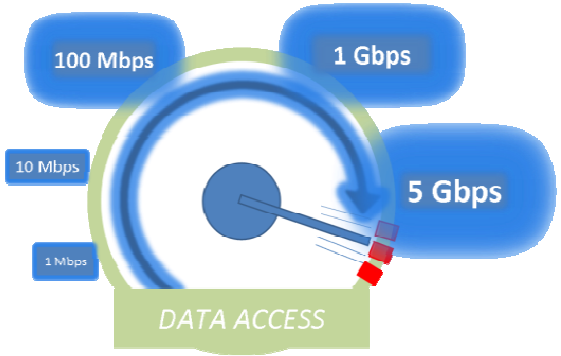


FIVE SCENARIOS



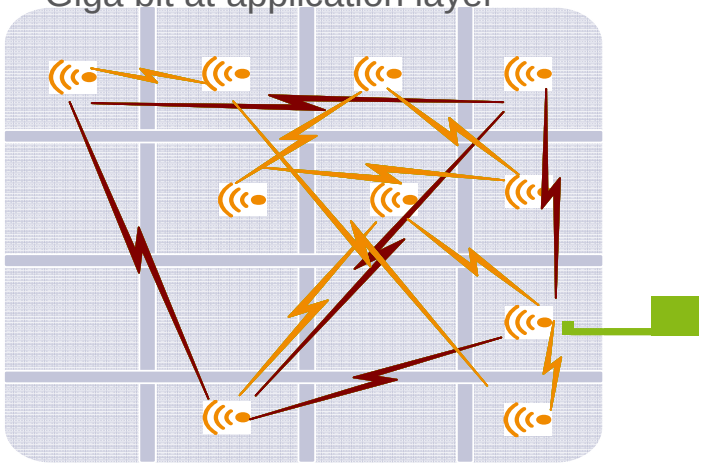
SCENARIO: *Amazingly fast*

- Work and infotainment unhindered by delays
- Amazing end-user experience provided by very high data-rates



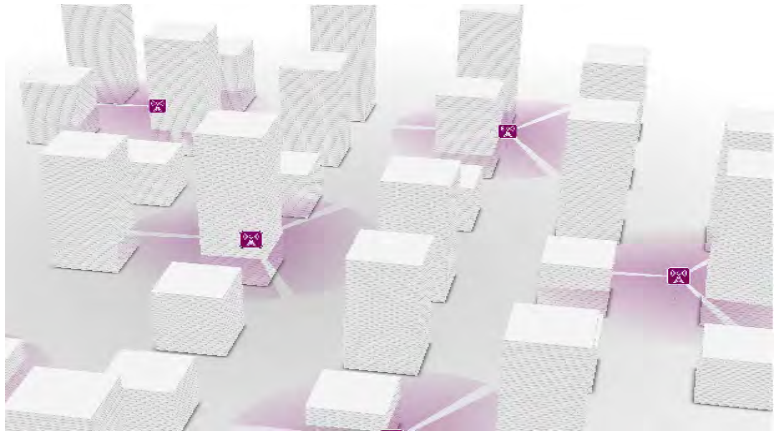
Virtual reality office

Giga bit at application layer



Dense urban information society

- Ubiquitous dense urban coverage
- Large and dynamic user crowds



SCENARIO: *Works in a crowd*

- Great user experience even in extremely crowded situation
- Extreme traffic densities, dynamic in time and space

Shopping mall, Stadium
extreme user densities

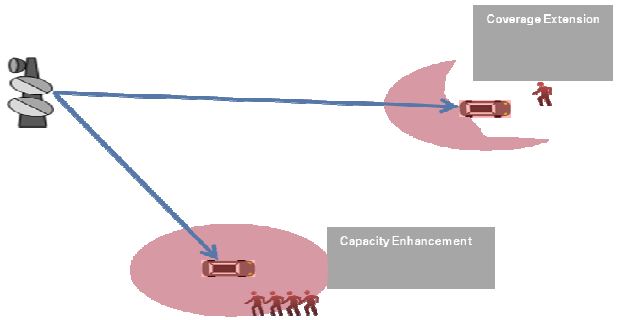
Open air festival
little fixed infrastructure for temporary events

SCENARIO: *Best experience follows you*

- Same experience at home, in the office or on the move
- Robust communication in remote areas, disaster areas and unforeseen local traffic demands

Blind spots

Accessibility in places with potential poor coverage



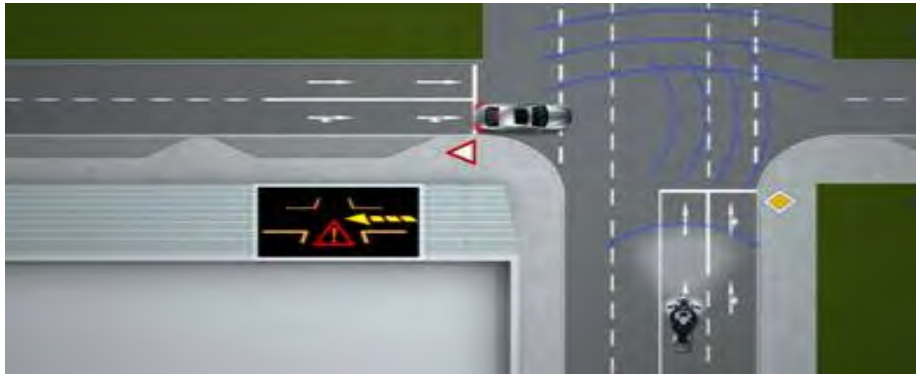
SCENARIO:
Super real-time and reliable connections

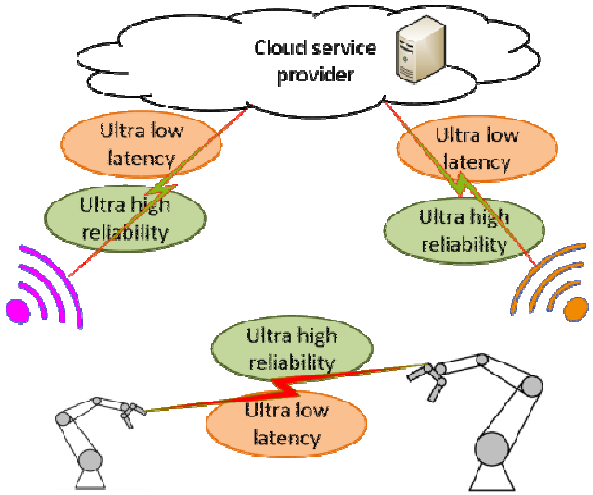
- Low E2E latency delay and reliable communication enabling critical machine-type applications
- Empowering industries to embrace new technologies in their processes

Traffic efficiency and safety

• More efficient use of road infrastructure

• Reduce risk for traffic incidents



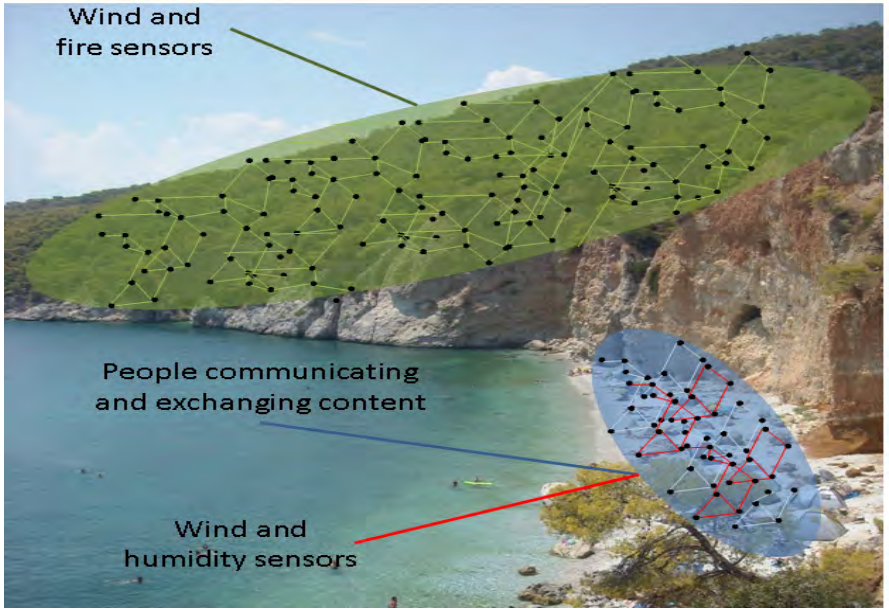


SCENARIO: *Ubiquitous things communicating*

- Very large number of small, simple, and inexpensive devices
- Requirement for long battery lifetime, scalability, and adaptability
  - Inexpensive = small battery, simple device

Massive deployment of sensors and actuators

- Handle a massive number of devices
- Very low cost devices with long battery lifetime
- Provide protocol scalability and coverage

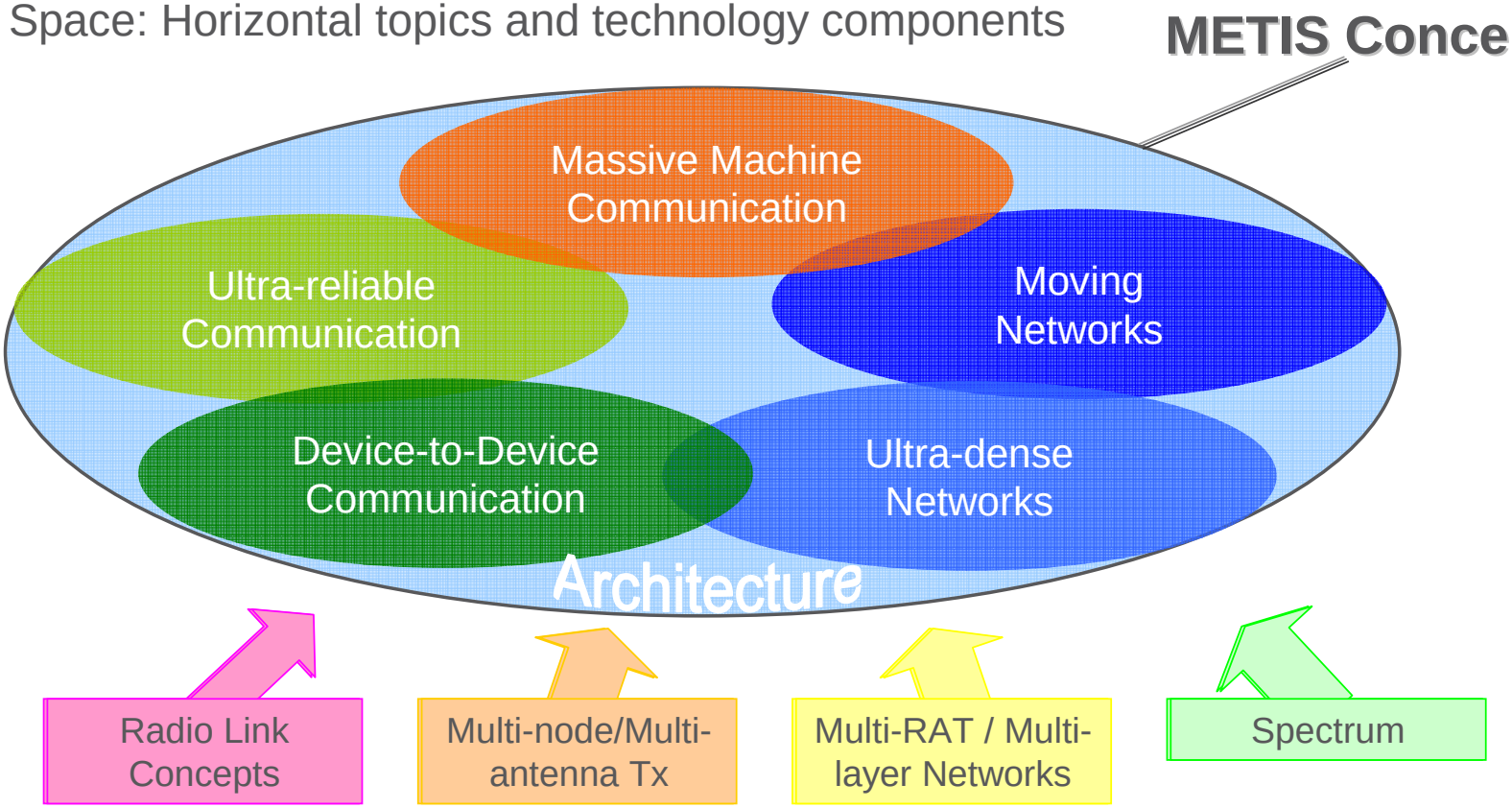


ROAD TO 5G TECHNICAL COMPONENTS

PROBLEM TO SOLUTION SPACE

Problem space: Scenarios from end-user perspective

Solution Space: Horizontal topics and technology components



MASSIVE MIMO: CSI ERROR

Example of contribution:

30 Gbps simulation using 11 GHz band measured 24x24 MIMO channel

Transmission scheme	24x24 MIMO-OFDM eigenmode
Signal bandwidth	400 MHz
Subcarrier spacing	195 kHz
Modulation scheme	AMC (QPSK, 16QAM, 64QAM)
Channel coding	Turbo code, Coding rates of 1/2-3/4
Maximum bit rate	35.3 Gbps (64QAM, 3/4)

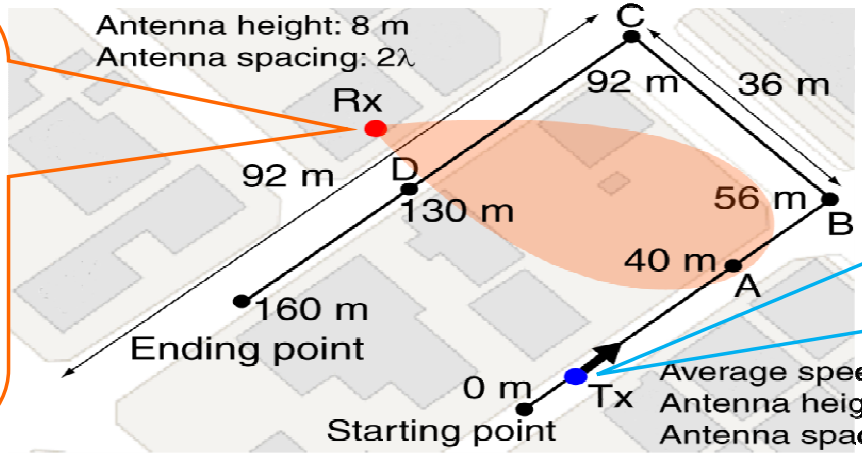
Investigation points:

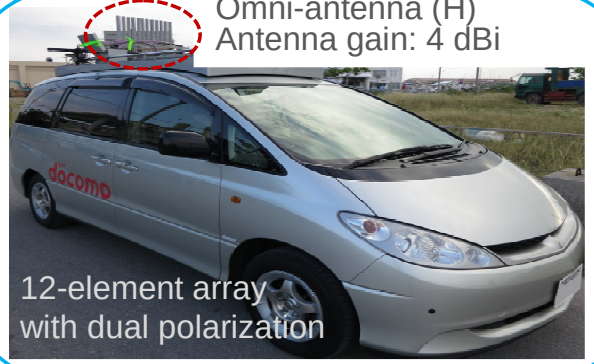
- Performance analysis of massive MIMO in higher frequency bands
- Clarification of requirements of CSI error and hardware impairments for high-performance massive MIMO

Measurement Environment/Data

12-element array with dual polarization

Sector antenna
3 dB beamwidth:
H: 65 deg. V: 8 deg.
Antenna gain: 15 dBi

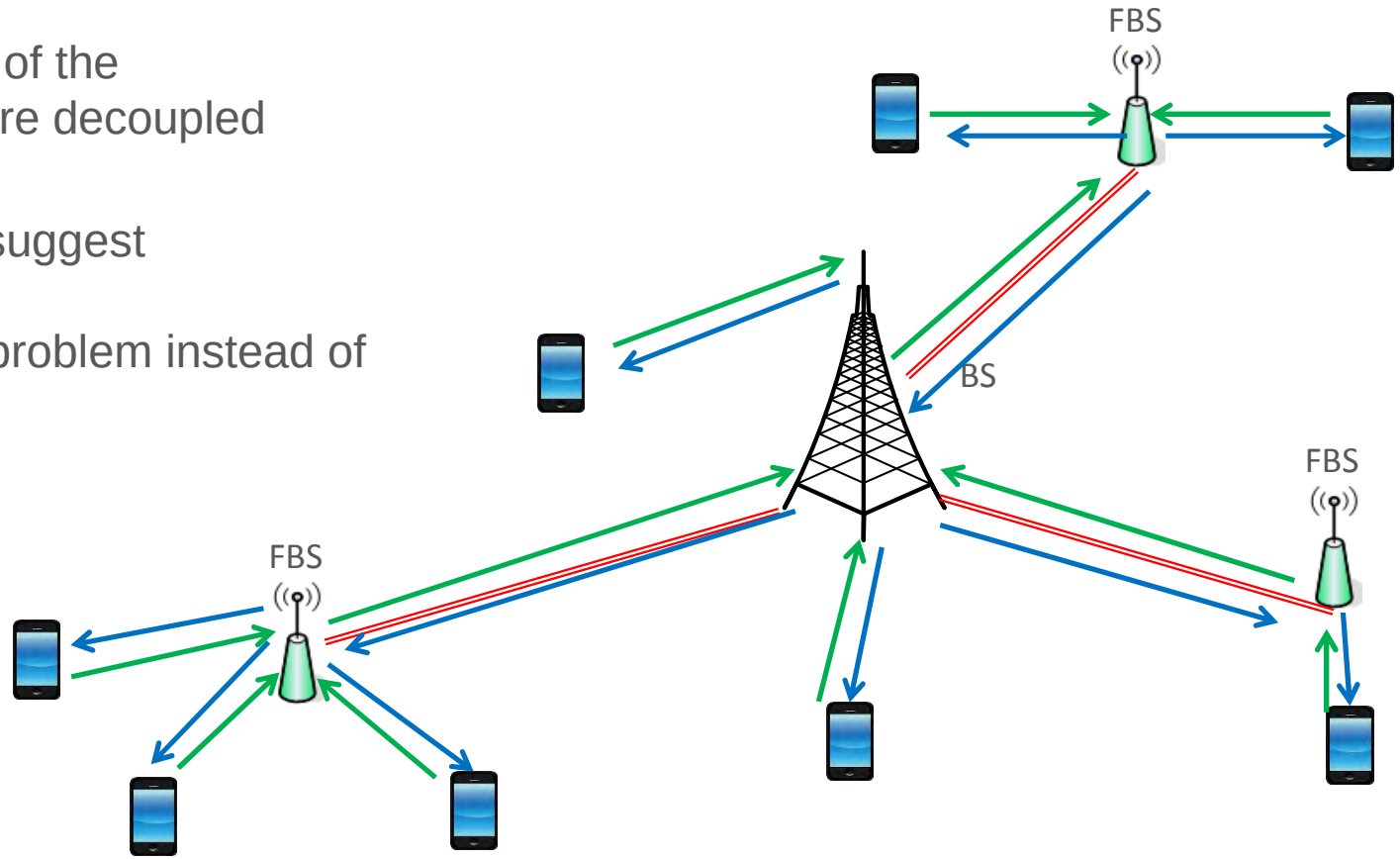




** This channel measurement was conducted in Ishigaki City in partnership with Tokyo Inst. of Tech. in Japanese national project*

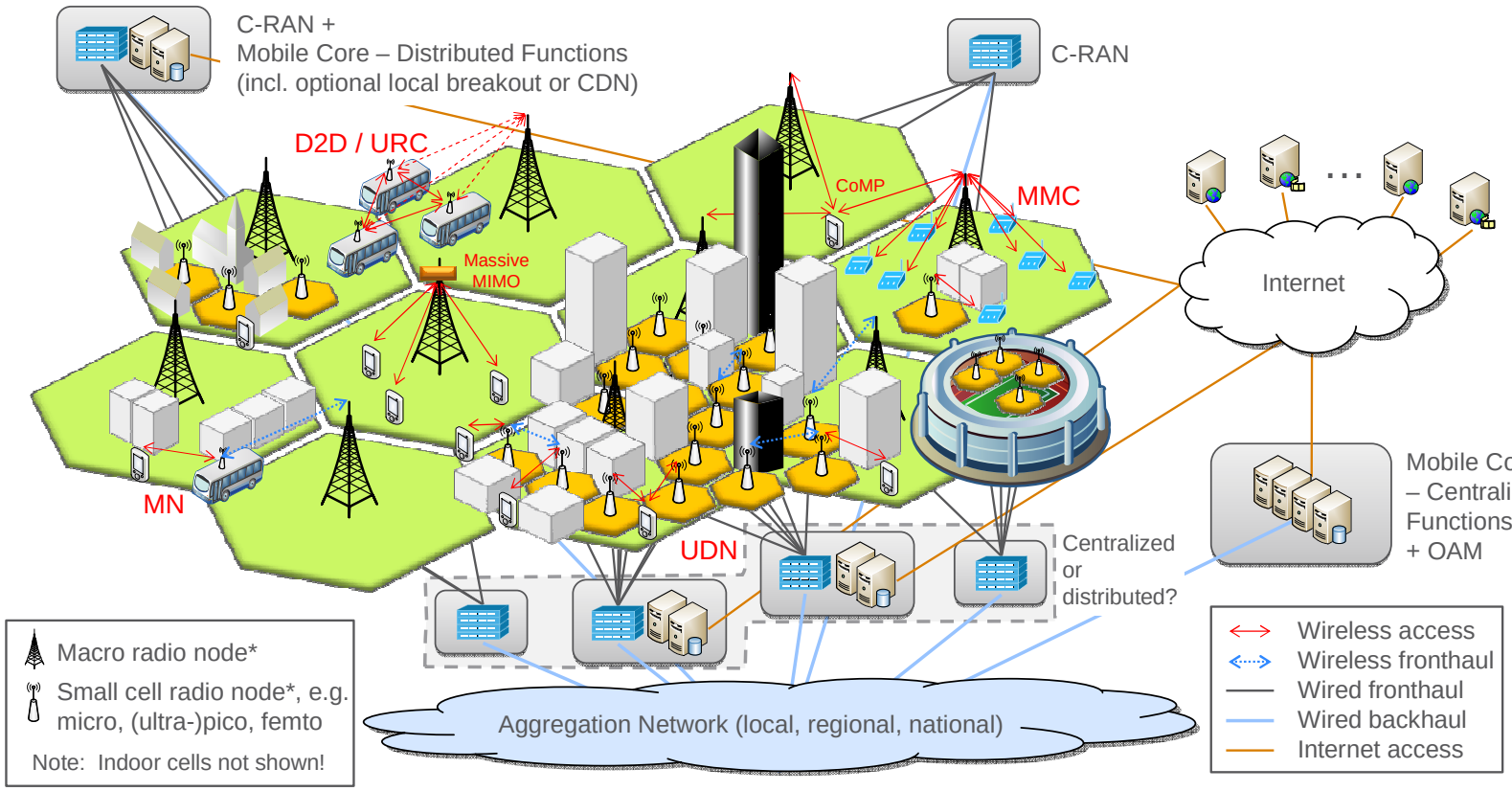
BEYOND UPLINK & DOWNLINK: TWO-WAY COMM.

- Traditionally, the designs of the uplink and the downlink are decoupled
- The ideas related to wireless network coding suggest optimization of the two-way communication problem instead of decoupling



5G ARCHITECTURE

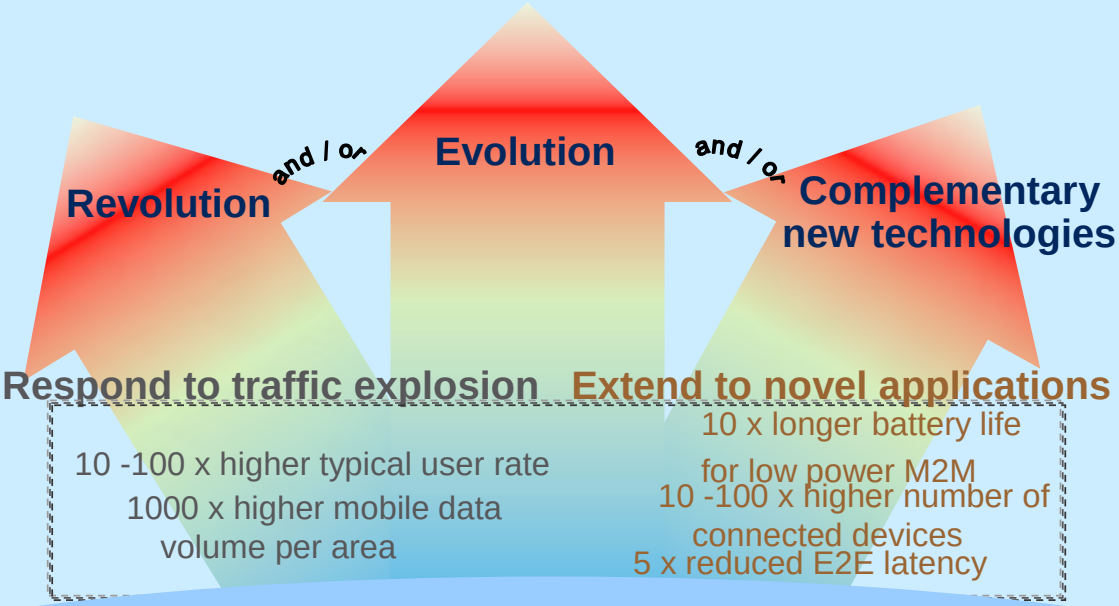
- Amazingly Fast scenario
  - high data rates
  - high network capacities
- UDN
  - ISD down to about 10 m outdoors
  - 1>= radio nodes per room
- Local break out
- Accelerated content delivery
- Distributed mobile core functions



* Only Remote Radio Units (RRUs) assumed.

5G Future

Integration
of access technologies
into one seamless experience



- Massive MIMO
- Ultra-Dense Networks
- Moving Networks
- Higher Frequencies

- D2D Communications
- Ultra-Reliable Communications
- Massive Machine Communications

Existing technologies in 2012

3G | 4G | Wifi

USEFUL LINKS

- A. Osseiran et al, The foundation of the Mobile and Wireless Communications System for 2020 and beyond Challenges, Enablers and Technology Solutions, VTC Spring 2013, June 2-5, 2013, https://www.metis2020.com/documents/publications/
- **Deliverable D1.1**, “Scenarios, requirements and KPIs for 5G mobile and wireless system”, June 2013, https://www.metis2020.com/documents/deliverables/
- **Deliverable D2.1**, “Requirements and general design principles for new air interface”, Sept. 2013, https://www.metis2020.com/documents/deliverables/
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- **Deliverable D5.1**,“Intermediate description of the spectrum needs and usage principles”, Sep. 2013, https://www.metis2020.com/documents/deliverables/
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