World Beyond 2020: How 5G Will Play a Major Role in Supporting Socio-Technical Evolution

Agnieszka Szufarska, Patrick Marsch, Preben Mogensen, Ossi Pöllänen, Nokia Solutions and Networks

Introduction

5G

What will trigger it?

What will the world beyond 2020 look like?

What will it be?

How should mobile industry assist society development?

Introduction

Socio-technical evolution in the last decades driven by ICT

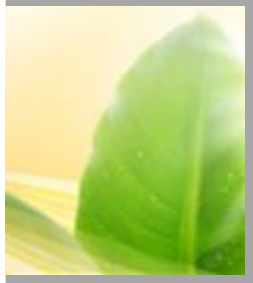
Next main driver: **mobile broadband connectivity**

Next generation mobile communications systems: **‘5G’**

- This paper and presentation:
  - Vision of socio-technical evolution beyond 2020, driving factors and triggers for 5G
  - Key requirements towards 5G mobile communications systems
  - Technical building blocks already identified for 5G systems

Socio-technical evolution beyond 2020

Broadband Internet connectivity widely available

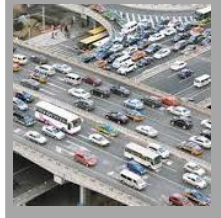


need for strong limit on energy dissipation and CO_2 footprint per capita

More context-related information (e.g. augmented reality).

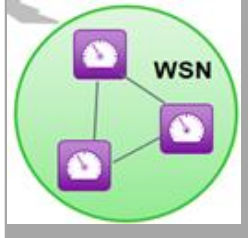
Increased extent of remote virtual collaboration

Increasing average age and higher importance of health care



Need for more efficient and safer transportation means

Personal data stored in the cloud and transmitted over wireless channels



'Internet of things'

NSN's View on 5G

5G is stretching far beyond 2020 and will enable a more scalable service experience on demand. People and machines will enjoy a virtual zero latency gigabit experience when and where it matters.

5G will not be a completely new wide area radio technology, but an integration of both novel and existing access technologies such as LTE-A and Wi-Fi

10,000 times more traffic

Virtually zero latency

5G = Omnipresent connectivity for communication and control beyond 2020

1,000 times more traffic

Reduce latency to milliseconds

10-100 times more devices

Up to 10 Gbit/s

More diverse applications (e.g. tactile Internet)

Flattened total energy consumption

Teach networks to be self-aware

Reinvent telcos for the cloud

Personalize network experience

Flattened energy consumption, self-awareness, and personalized network experience will continue to be key design principles of any future generation

nsn Technology Vision 2020 → Beyond 2020 / 5G

nsn

More detailed view on 5G requirements

10,000 times more traffic and 10-100 times more devices

Virtually zero latency

Up to 10 Gbit/s.

- Typical user data rates greater than **100 Mbps**

Increased cost and energy efficiency

Support for diverse application needs

Fundamental 5G building blocks

5G = evolution + revolution

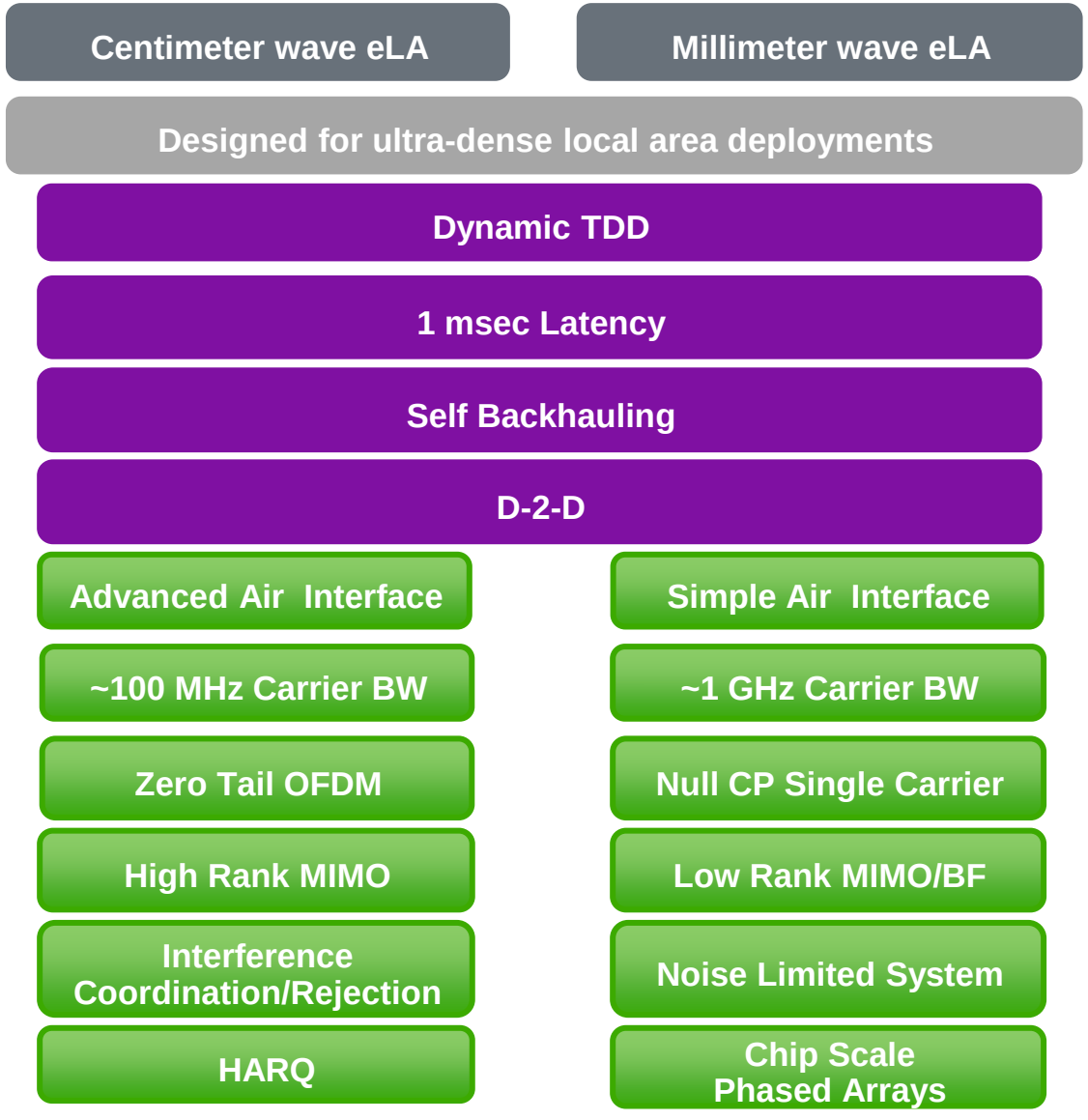
Ultra dense deployments with high traffic demand and low latency requirements will be the environment in which new revolutionary technologies will emerge

new local area communications concept for **centimeter waves**

- significant reduction in air interface latency
- new frame design with a flexible UL/DL pattern

utilization of higher, **millimeter wave bands** (e.g. 70-90 GHz)

- abundance of spectrum, but with very different propagation properties
- system design focused on overcoming propagation challenges instead of increasing spectral efficiency



cmWave and mmWave 5G: Common goals, different design principles

Comparison of two 5G concepts for ultra dense local area deployments

Conclusions

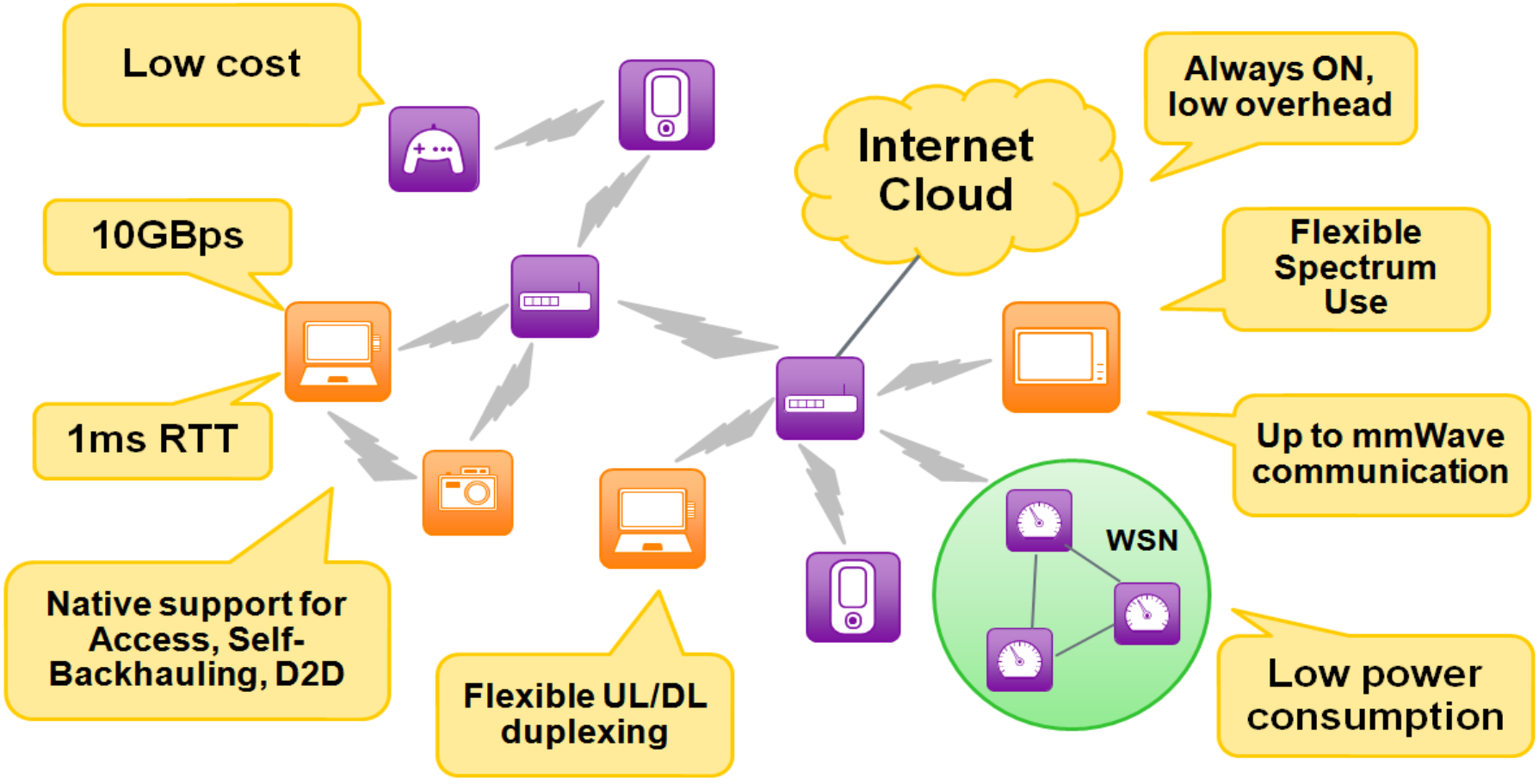
Today's world is powered by information technology, fixed broadband connectivity is widely available in many countries and the time has come for **mobile broadband** to become the driving factor

Wireless communication beyond 2020 shall provide support for many new use cases and enable services scalable enough to cover diverse requirements resulting from both personalized communications and emerging 'Internet of things'

5G will be both: evolution and revolution, and revolutionary technologies we outlined target ultra dense small cell deployments – either by system design targeted for small cells or by access to new frequency bands in cm- and mmWave region

BACKUP

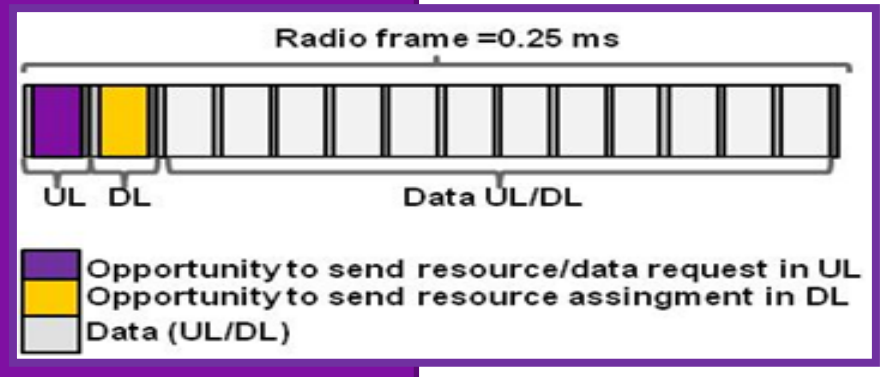
LTE evolution seems the right way to go for wide area but can we further optimize for super dense 5G local area radio?



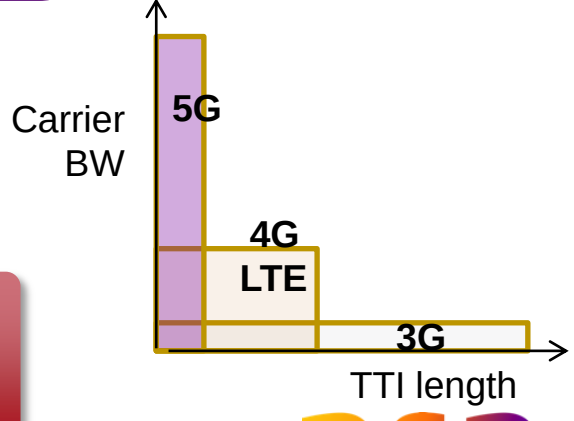
cmWave enhanced Local Area

We consider **a TDD radio frame tailored towards local area** (cell radius <100m), enabling

- robust and fast control plane
- fully flexible data plane
- low system overhead and short TTI length (~0.25ms for 3.5 GHz)
- OFDM symbol length, TTI length etc. scalable according to different carrier frequency / system bandwidth
- clean and simple HARQ, fast HARQ RTT
- quick transition from/to sleep/active mode
- inbuilt support for cross-link interference mitigation



Example numerology for f_c = 3.5 GHz



TDD:

- Flexible spectrum assignment
- Flexible UL/DL duplexing
- Ease of support: normal access, self-backhauling and D2D

Frame based system with time synchronization

- Pipe-lined control and data streams for energy saving
- Coordinate or stabilize other cell interference

OFDMA “like” multiple access for all links
Simple MIMO processing
Larger sub-carriers spacing

mmWave Backhaul and Access

Swaths of spectrum available

- V-band: 57-64 GHz (7 GHz bandwidth)
- E-band: 71-76 + 81-86 GHz (2x5 GHz bandwidth)
- W-band: 92-94 + 94.1-95 GHz (2+0.9 GHz bandwidth)

Advantages

- Can easily meet 5G peak and edge data rates
- Exploit beamforming gains using massive antenna arrays
- Access and backhaul can use same radio

Research still needed in several areas

- mmWave integrated circuits
- Antenna array architectures
- Understanding mm-wave propagation

First step is wireless backhaul

Next multi-Gbit/s mobile access and backhaul/access integration