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Challenge and reality of future mobile systems

November 2, 2016

KDDI Research Inc. Chairman

Fumio Watanabe

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Three User Scenarios by ITU-R WP5D

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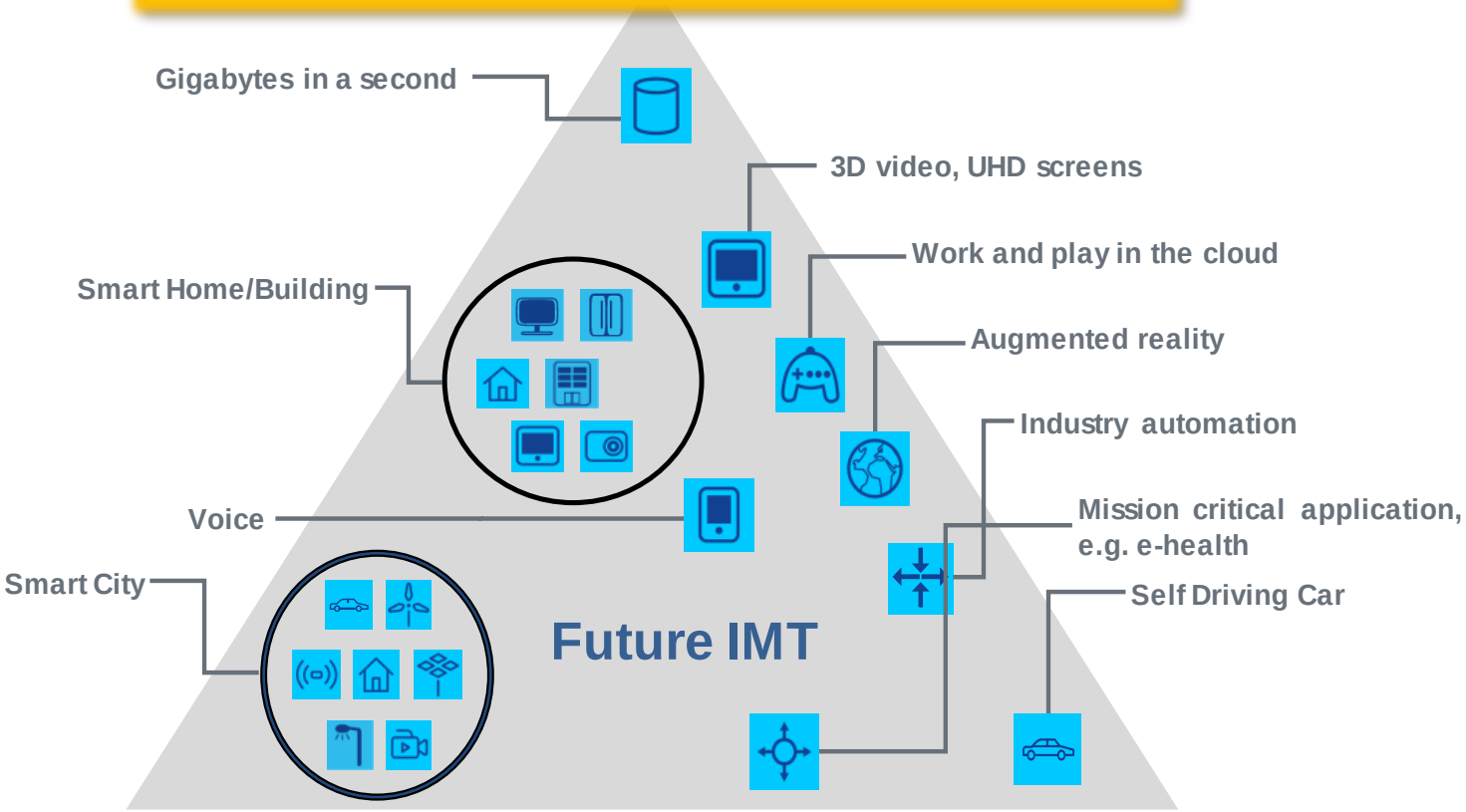
1.Enhanced Mobile Broadband



2.Massive-Machine Type Communication

3.Ultra-reliable and Low Latency Communication

Source: ITU-R Rec. M.2083-0, "Framework and overall objectives of the future development of IMT for 2020 and beyond", Sept. 2015

Possible use of higher frequency bands

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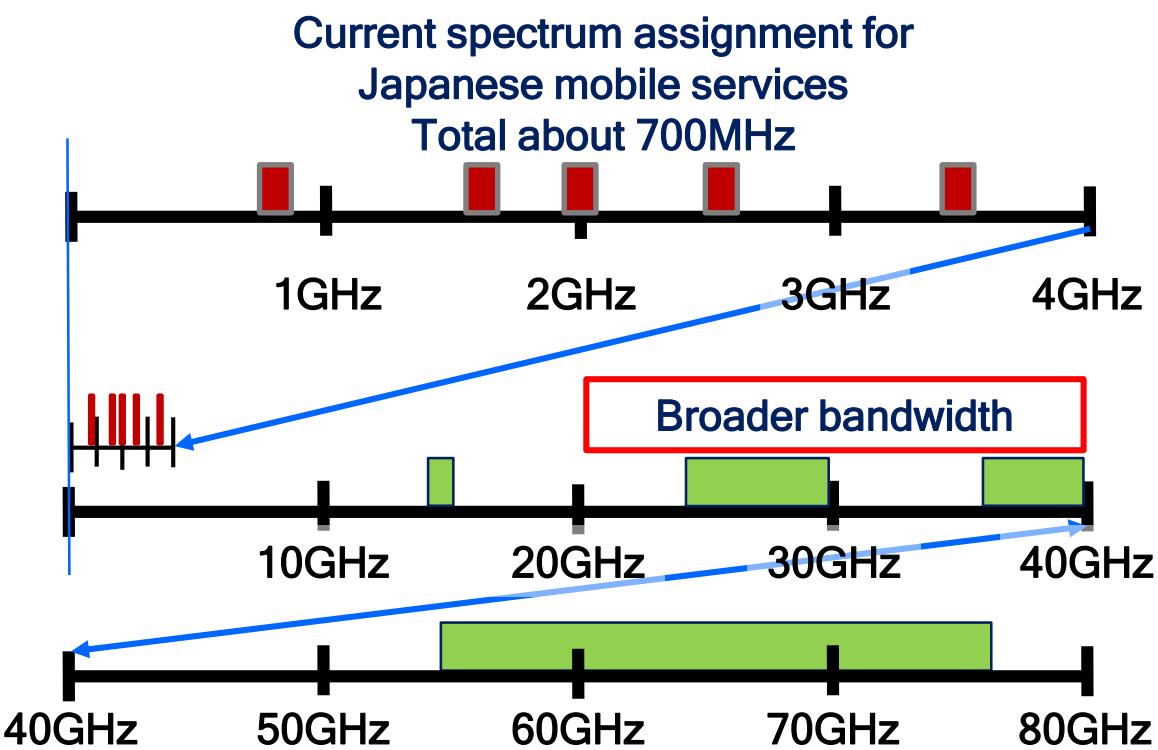
5G provides higher data speed & higher capacity

- ➢ Broader spectrum bandwidth in higher frequency bands
- ❑ WRC-2019 will discuss “5G spectrum” above 6GHz
- ❑ R&D activities for 5G radio systems in the 28GHz, etc.



Ericsson at MWC 2016

http://www.telecomtv.com/articles/5g/ericsson-previews-its-mwc-activities-with-gigabit-lte-13244/

How to use higher frequency bands?

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Higher frequency bands, e.g. sub-mm wave and mm-wave, for mobile communications:

A Typical Story

- Higher propagation loss
- Smaller coverage
- Many antenna sites
- Not suited to area coverage, huge CAPEX & OPEX

Scenario 1

Short range, Spots & Gates, Indoor

Scenario 2

Reuse existing sites with high gain antennas & CoMP

How can “5G” utilize high speed spots?

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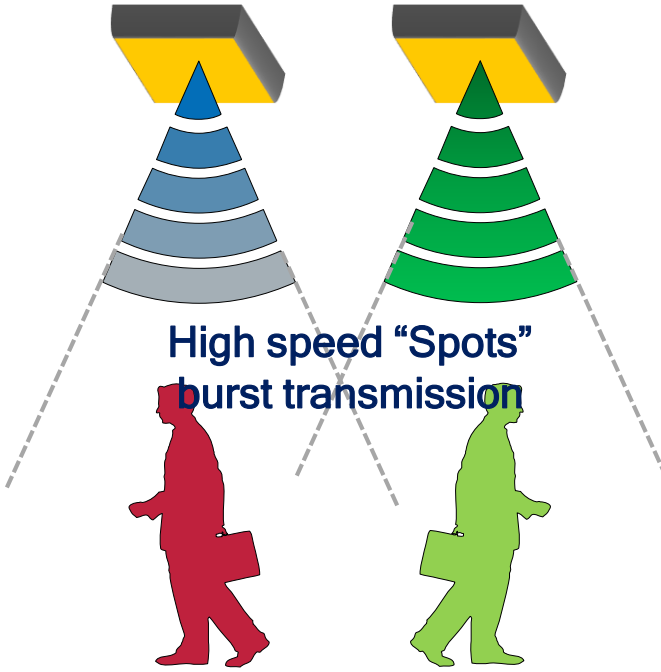
Background

- WRC-19 will identify 5G spectrum above 6GHz, e.g. mm-wave.
- To provide higher throughput, e.g. 10Gbps, higher frequency bands, e.g. mm-wave, will be used
- Cell size will be smaller like a “spot”
- UE would stay at a spot for a very short time, e.g. < 1s

Can we fully utilize high speed radio “spots” by existing 3GPP network architecture and protocols?



Need new architecture and protocols

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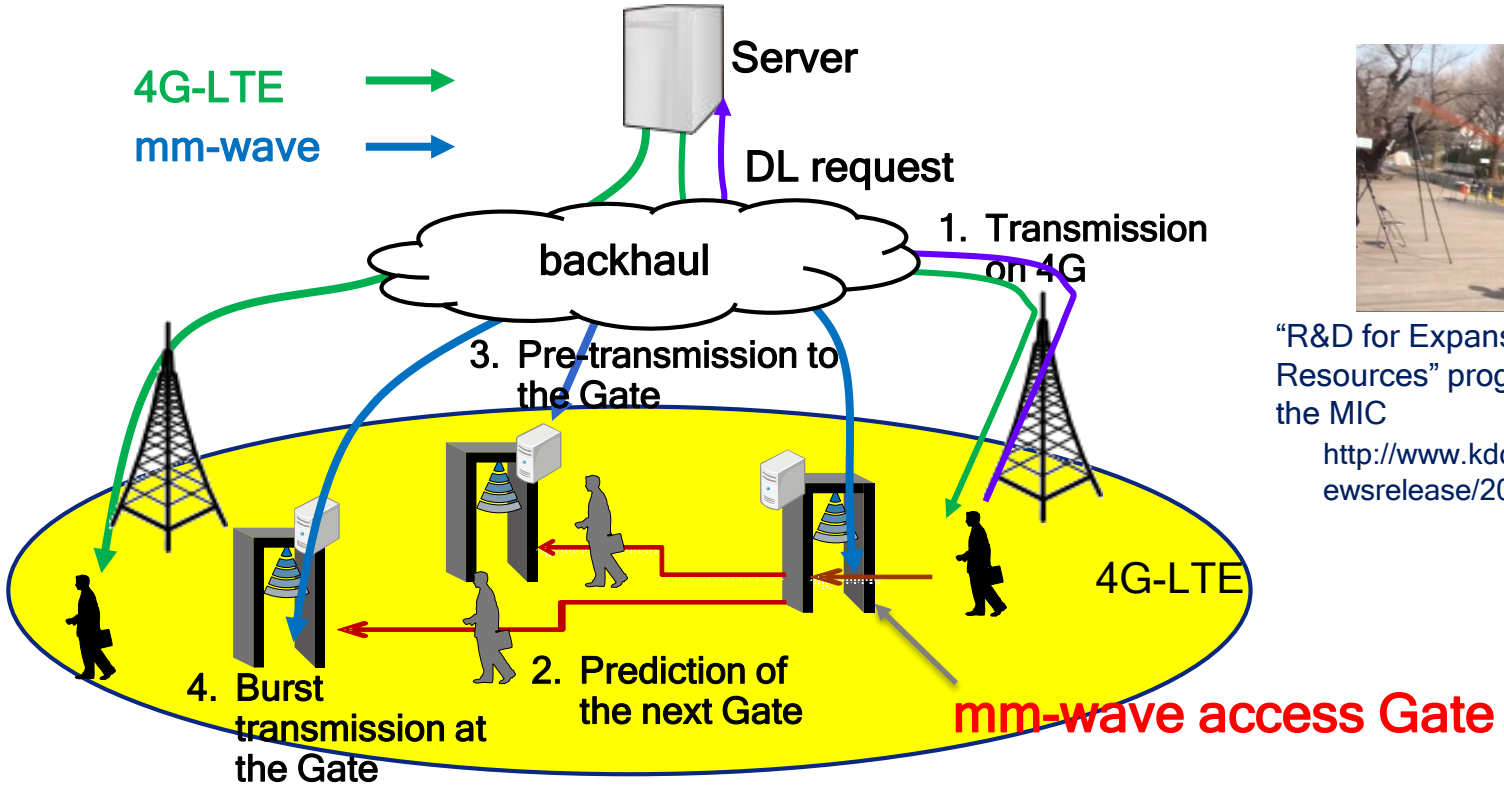
- ✓ Inter-band CA and Dual Connectivity are sufficient?
- ✓ Need switching-free by session-less communication?
- ✓ Need **CCN & ICN?**
- ✓ Need **Mobile Edge Computing?**

CCN (Content-centric Network)
ICN (Information Centric Networking)



"R&D for Expansion of Radio Wave Resources" program sponsored by the MIC

http://www.kddilabs.jp/english/newsrelease/2016/030101.html

Session and Service Continuity (SSC) Mode

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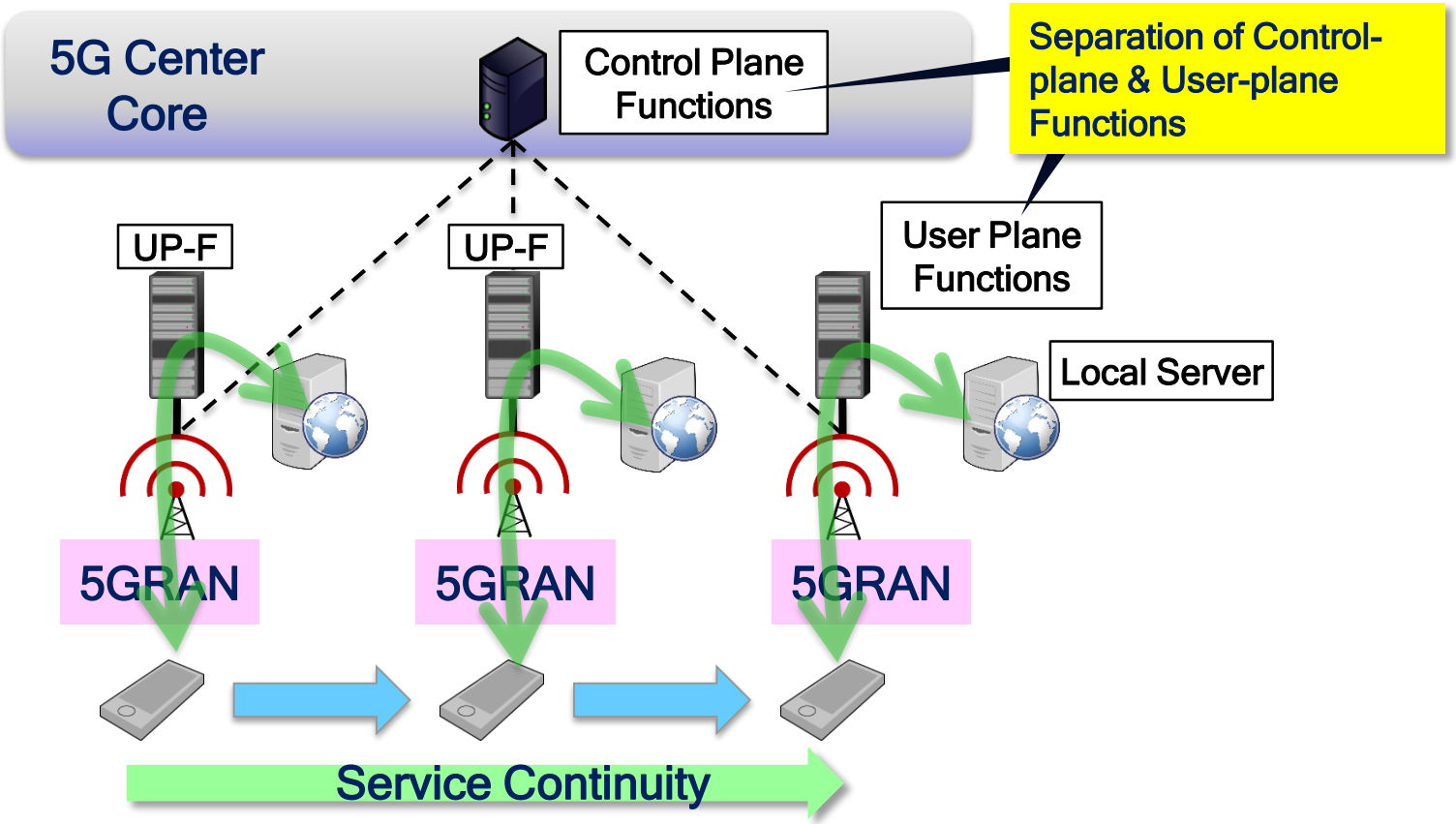
❑ Service Continuity through different Servers with different IP address

- Separation of Control-plane functions at Center Core & User-plane functions at Edge Core
- For low latency required applications
- For very short sojourn time situation, e.g. small spots

✓ Service continuity in LTE = Handover



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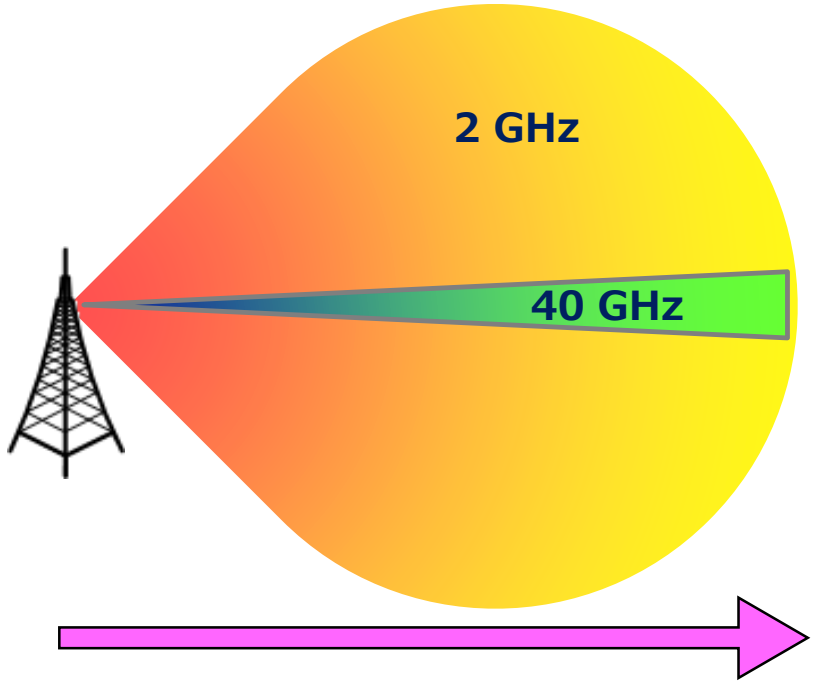
Reuse existing sites with high gain antennas & CoMP

Coverage expansion by high gain antennas

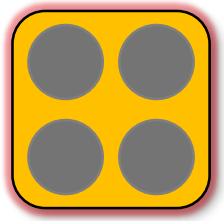
- ❑ Higher propagation loss
- ❑ Higher antenna gain for same size antenna

➢ **"Propagation loss – Antenna gain" is constant for LOS condition**

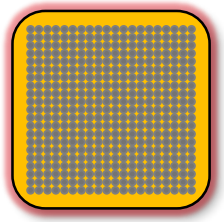


Coverage range for LOS condition with same antenna size

Example 20×20 cm array antenna



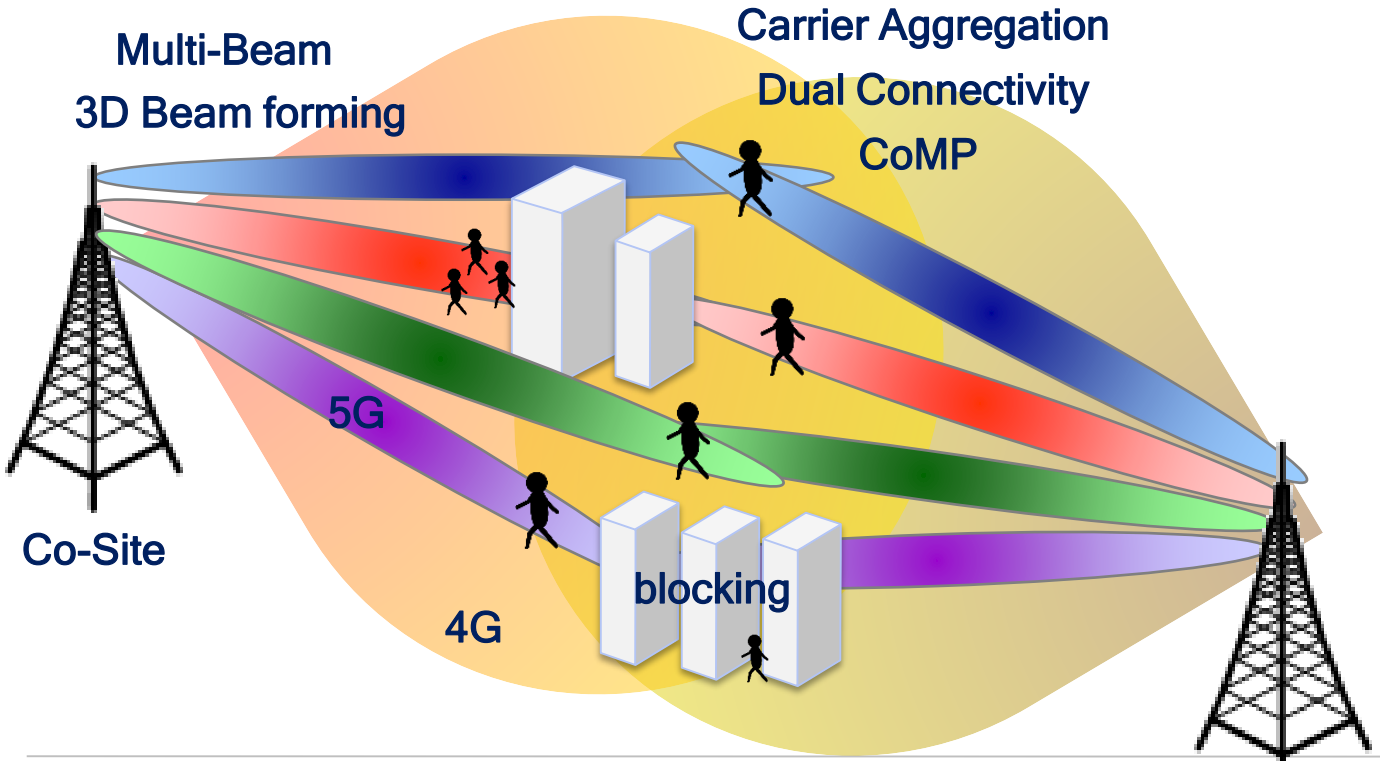
2 GHz
4 antennas
about 12dB gain



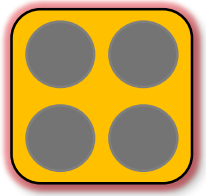
40 GHz
1600 antennas
about 38dB gain

Use case of higher frequency bands

- Difficult to service for NLOS condition
- Using high gain/narrow beam antenna to compensate propagation loss in LOS
- Multi-beam & 3D beam forming are essential
- Beam tracking will be the one of the difficult subjects
- CA and Dual-connectivity with low frequency bands are keys to stable operation



Example 20×20 cm array antenna



2 GHz
4 antennas
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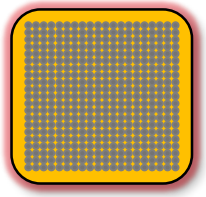

40 GHz
1600 antennas
about 38dB gain

Performance improvement by Multi-site

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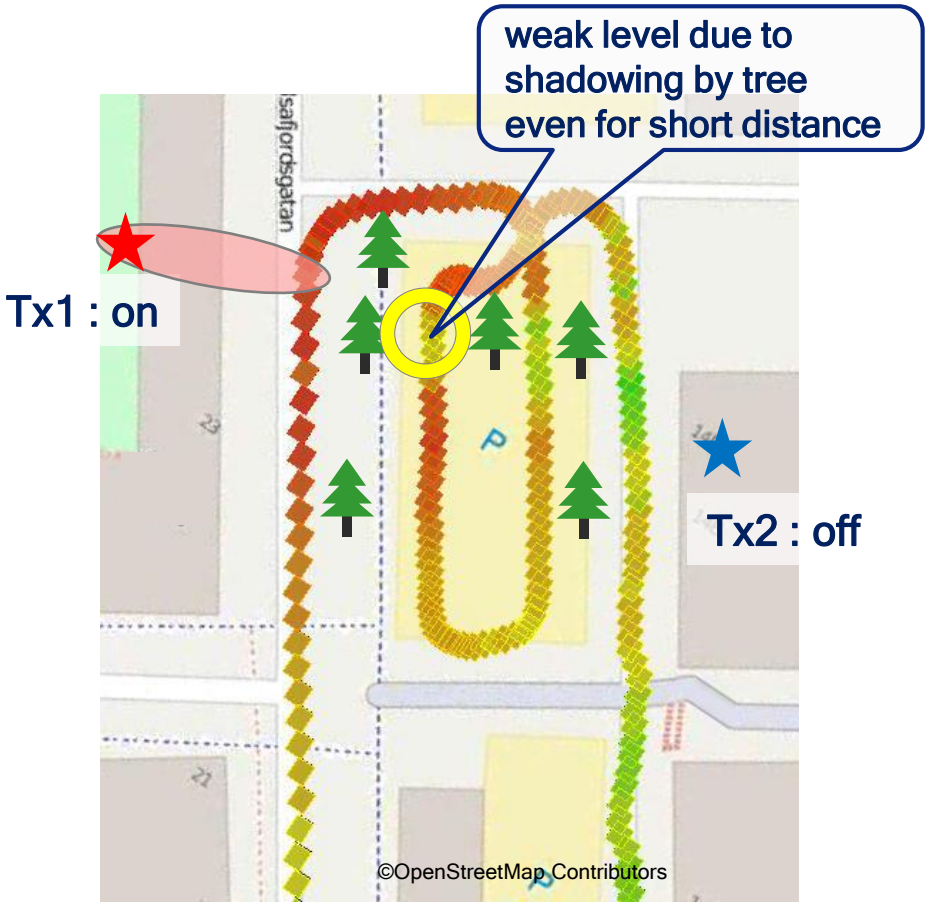
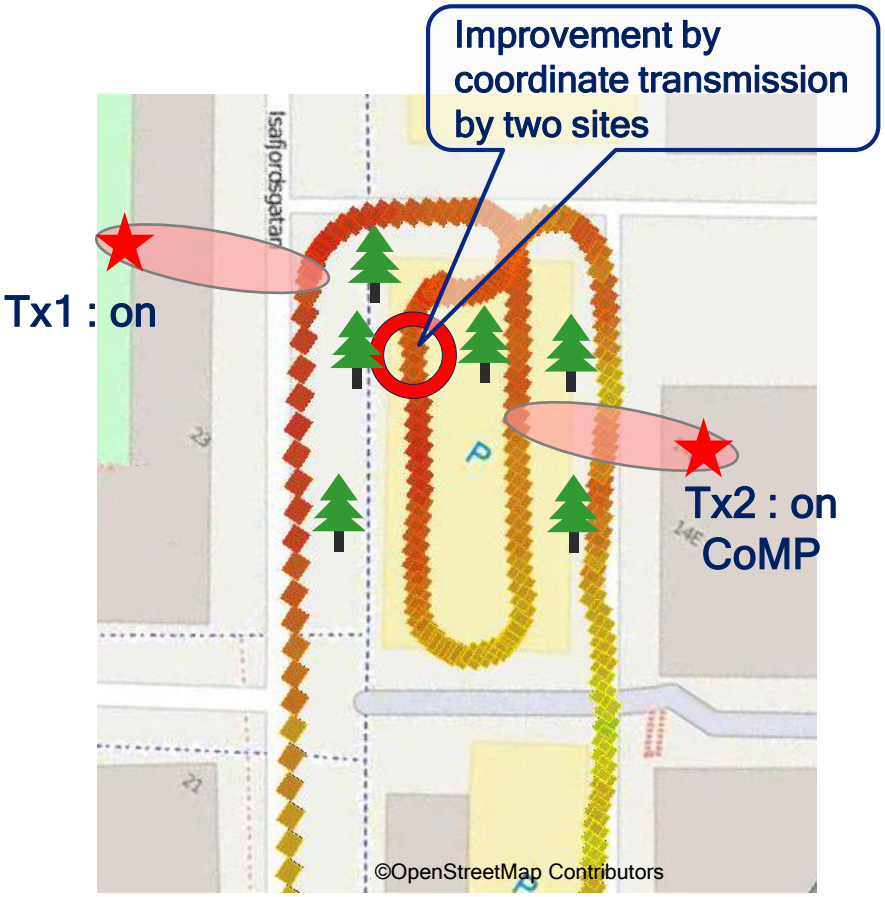
Single BS Transmission



Two BSs Coordinate Transmission



Signal strength

-40 dBm — -90 dBm

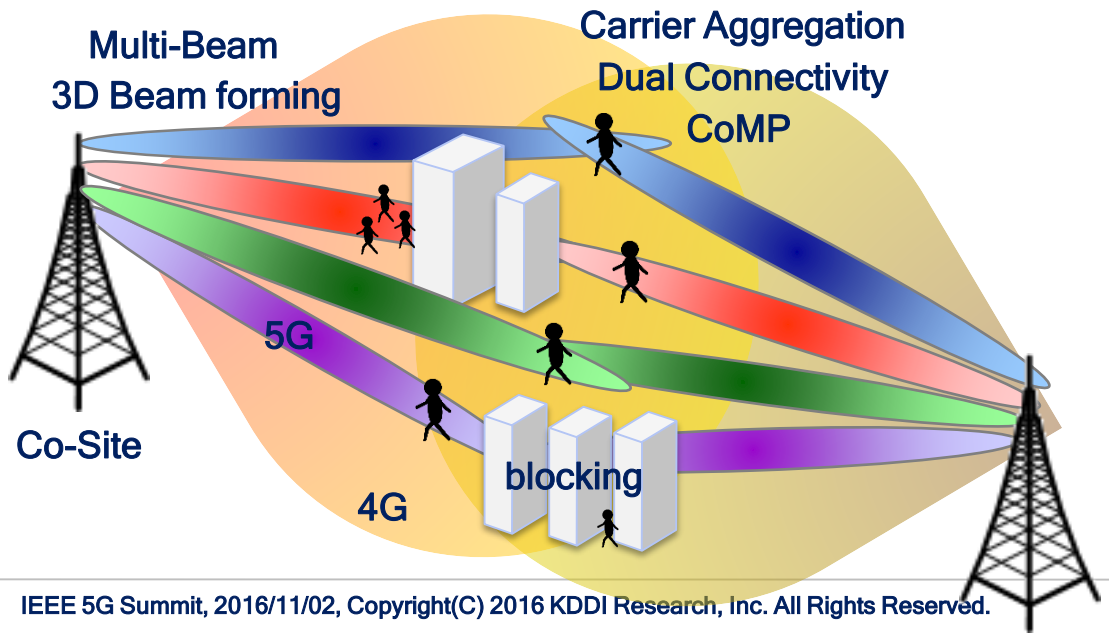
CP-OFDM	Tx1 ant. H=8.5m
15 GHz	Tx2 ant. H=14m
eirp = 42 dBm	Rx ant. H=2.8m

Ericsson test environment is used for the measurements.

Cost effective deployment

- CAPEX mainly depends on number of new sites
- OPEX mainly depends on total number of sites
- It is essential for cost effective deployment to reuse of existing sites even for higher frequency band

- Multi-site (CoMP) can improve low visibility (LOS) of high frequency band
- It is not necessary to cover 100% by the higher frequency band, since it is mainly for off-loading



Non stand alone 5G

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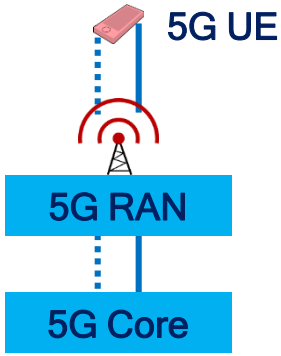
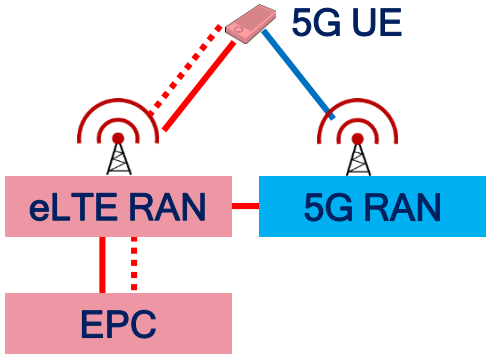
Stand alone 5G



- New 5G RAN
- New 5G Core

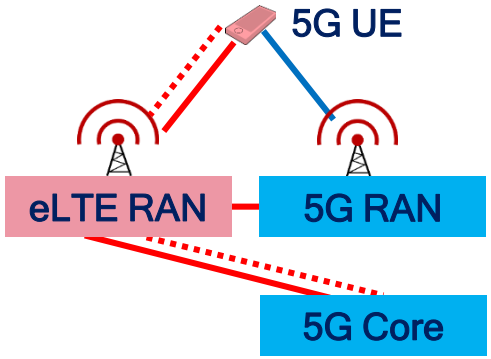
: 5G Data
: 5G Control
: LTE Data
: LTE Control

Non stand alone : EPC



- eLTE Anchor
- without 5G Core
- eLTE RAN with 5G RAN Interwork

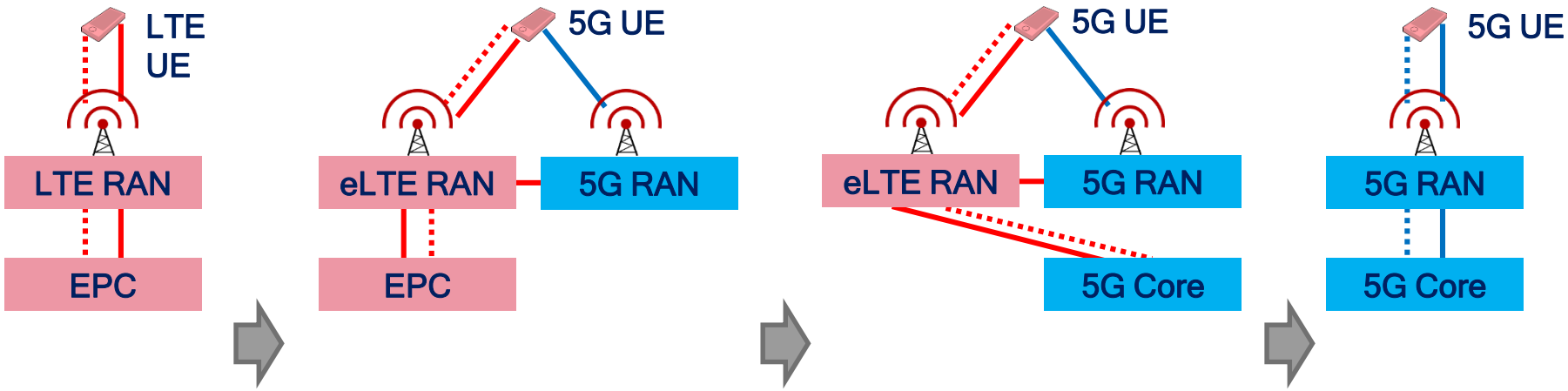
Non stand alone : 5G Core



- eLTE Anchor
- with 5G Core
- eLTE RAN with 5G Core IF

Typical Migration Scenario

- Smooth migration is the key to cost efficient deployment of new services by 5G
- Interworking of LTE and 5G is the key
- 5G will take a “user data off loading” role in the initial stage



existing LTE

add 5G RAN
interwork eLTE & 5G
connect to EPC

add 5G Core
interwork eLTE & 5G
connect to 5G core

Stand alone 5G

: 5G Data
: 5G Control
: LTE Data
: LTE Control

Key Message

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Challenge to the Next Generation Mobile

- Use case of higher frequency bands will not be limited small spots services by use of multi-beam, 3D beam forming, CoMP and beam tracking
- Session and Service Continuity (SSC) Mode be a key for small spots configuration, and further new architecture, e.g. CCN & ICN, might be necessary
- Reuse existing sites with high gain antennas & CoMP be essential to cost effective deployment of 5G even for higher frequency bands
- 4G and 5G "Interwarking" is the essential for operators

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