Challenge and reality of future mobile systems

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2. Short range & spots
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Three User Scenarios by ITU-R WP5D

1. Enhanced Mobile Broadband
   - Gigabytes in a second
   - 3D video, UHD screens
   - Work and play in the cloud
   - Augmented reality
   - Industry automation
   - Mission critical application, e.g. e-health
   - Self Driving Car

2. Massive-Machine Type Communication
   - Smart Home/Building
   - Voice
   - Smart City

3. Ultra-reliable and Low Latency Communication

Possible use of higher frequency bands

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.

Current spectrum assignment for Japanese mobile services
Total about 700MHz

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

Ericsson at MWC 2016
How to use higher frequency bands?

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?

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

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

**Diagram:***

1. Transmission on 4G
2. Prediction of the next Gate
3. Pre-transmission to the Gate
4. Burst transmission at the Gate

**Notes:**

- 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

Session and Service Continuity (SSC) Mode

- 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

5G Center Core

- Control Plane Functions
  - Separation of Control-plane & User-plane Functions

5GRAN

- User Plane Functions

5GRAN

- Local Server

Service Continuity
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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

Example 20×20 cm array antenna

- 2 GHz, 4 antennas, about 12 dB gain
- 40 GHz, 1600 antennas, about 38 dB gain

Coverage range for LOS condition with same antenna size
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
Performance improvement by Multi-site

Single BS Transmission

weak level due to shadowing by tree even for short distance

Tx1 : on
Tx2 : off

Signal strength
-40 dBm -90 dBm

Two BSs Coordinate Transmission

Improvement by coordinate transmission by two sites

Tx1 : on
Tx2 : on CoMP

Ericsson test environment is used for the measurements.

CP-OFDM
15 GHz
eirp = 42 dBm

Tx1 ant. H=8.5m
Tx2 ant. H=14m
Rx ant. H=2.8m
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

Stand alone 5G
- New 5G RAN
- New 5G Core

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

Legend:
- : 5G Data
- : 5G Control
- : LTE Data
- : LTE Control
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 and connect to EPC
- Add 5G Core interwork eLTE & 5G and connect to 5G core
- Stand alone 5G

Legend:
- 5G Data
- 5G Control
- LTE Data
- LTE Control
Key Message

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 “Interworking” is the essential for operators