2020: The Ubiquitous Heterogeneous Network - Beyond 4G

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ITU Kaleidoscope 2011 – Cape Town, South Africa
What will the world want from wireless by 2020?

Support up to 1000 times more traffic

Rock solid, ubiquitous connectivity

Apps bandwidth demand

Gbps peak speeds

Millisecond latency for true “local feel”
By 2020 – radio can reduce latency 10x

The main benefit is realized when content is close. 1 ms limits fiber length to 100 km.

Radio latency can be pushed to 1 ms by 2020 by using a shorter frame length.

Enable low-latency M2M solutions.
By 2020 - radio can improve in spectral efficiency 10x

Efficiency is not limited by Shannon law but by inter-cell interference.

Spectral efficiency can be improved by managing inter-cell interference.

Cell edge data rates improve twice as much.
By 2020 - there can be 10x more spectrum available

Evolution of available radio spectrum

- 1500 MHz
- 1000 MHz
- 500 MHz

- Unlic 5GHz
- Unlic 2.4GHz
- 3700 MHz
- 3400 MHz
- 2600 MHz
- 2300 MHz
- 2100 MHz TDD
- 2100 MHz
- 1800 MHz
- 900 MHz
- 800 MHz
- 700 MHz
- 450 MHz

10 times more spectrum can be made available if we drive for it.

Cognitive radio enables optimized spectrum usage over multiple operators.
By 2020 - there will be 10x more base stations

Global base station forecast

- By 2020, there will be 10x more base stations.
- 80% will be microcell or smaller.
- Number of cellular base stations grows to over 50 Million.
- Additionally, more than 500 M WiFi APs.

Year:
- 2010: 0 Mn
- 2015: 10 Mn
- 2020: 50 Mn

Types of base stations:
- Micro, Pico, Femto BTS
- Macro BTS
Up to 1000 times more capacity

10x Performance
10x Spectrum
10x Base stations = 1000x capacity
How about the “old” radios in 2020

GSM will still be around driven e.g. by installed M2M base and billions of legacy devices.

HSPA and LTE networks will deliver the ubiquitous mobile broadband experience.

Carrier WiFi will carry up to 50% of total traffic.

**Spectral efficiency [Bps/Hz]**

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<th>LTE</th>
<th>“B4G”</th>
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**Latency [ms]**

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How can we build this?

Switched mode power amplifier, high-voltage GaAs HBT and GaN technologies for wideband radios with multicarrier capabilities.

Radio frequency bandwidth capability of basestations:
- 1990: 2MHz
- 2000: 20MHz
- 2010: 60MHz
- 2020: 200MHz

System on Chip enables small radios, low power consumption & integration of intelligent functions. SDR is no problem for digital processing!

Laws of physics determine antenna size:
- 1990: 2MHz
- 2000: 20MHz
- 2010: 60MHz
- 2020: 200MHz

Continuous growth of computing power with Moore’s law:
- 1990: 2Mn
- 2000: 60Mn
- 2010: 2Bn
- 2020: 60Bn

For same performance, antenna size does not get smaller. Size even increases if beamforming is required.

Continuous growth of computing power with Moore’s law.

Laws of physics determine antenna size.

For same performance, antenna size does not get smaller. Size even increases if beamforming is required.
What will a macro site look like?

Bulky shelters have disappeared - base stations installed on mast tops

RF module is integrated with the antenna

Baseband processing is integrated with the antenna, or pooled at central site

New antenna form factors emerge: panels, arrays, irregular shapes
What will a small base station look like?

Pico/Micro size is dictated by required antenna performance

Femto module shrinks to finger tip size
How can we deploy, commission and maintain all the radios, frequency bands and layers?

All cells and frequency layers automatically managed by advanced SON

All spectrum under unified RRM for instant capacity and coverage optimization

Cognitive networks will reduce errors, improve quality and lower operation and energy costs

Virtually one ubiquitous connectivity
Gigabit Experience
Reliable, Efficient and Personal

Ubiquitous Connectivity
Unified Radio Resource Management
Cognitive Networks
Active Antennas
Wideband Multiradio
Liquid Radio
Multi-Carrier
Multi-Standard
Heterogenous Networks
Self Organized Networks

MOBILE BROADBAND

Multi-Standard
Heterogenous Networks
Self Organized Networks
Thank you!