5G & IoT
Accelerating Digital & Transforming Life

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5G & IoT - Accelerating Digital & Transforming Life

Agenda

- COSMOTE Network Mobile Broadband Facts
- Global Mobile Broadband Facts
- 5G Evolution
- 5G Basic Requirements
- 5G Air Interface
- 5G Layers
- Licensing & EMF challenges for 5G
- Case Study in Municipality City of Drama
- 5G Campus Network at UoA
- Cellular IoT market outlook
- IoT re-shaping effect on society
- Cellular IoT technologies
- IoT hot apps
- Conclusions
COSMOTE Network Mobile Broadband Facts
With the highest coverage of MBB Services

Cosmote Mobile Network is constantly expanding in order to provide Fast Mobile Internet @ more points than any other network!!

99% Population Coverage 4G
93% Geographical Coverage 4G
97% Sea Coverage 4G
98% Population Coverage IOT
50% Population Coverage 5G
>2 bn Investments in new generation networks since 2012
COSMOTE Network Mobile Broadband Facts
Ready for 2026 MBB Challenge

COSMOTE 5G already providing a 50% population coverage

Umlaut Best in Test for 7 consecutive years

COSMOTE Best MBB Network (OOKLA & P3)

source: ERICSSON mobility report - November 2020
Global Mobile Broadband Facts
Subscribers and Technology Outlook

By 2023 there will be globally:
- **8.8 billion** mobile subscriptions,
- **8.0 billion** MBB subscriptions
- **7.5 billion** smartphone subscriptions

Subscriptions/ lines, subscribers (bl)

Fast-growing 5G adoption

57% LTE Subscriptions footprint

Mobile subscriptions by technology (billion)

source: ERICSSON mobility report - November 2020
Global Mobile Broadband Facts
Mobile Traffic Outlook & Data Rates Evolution

54% mobile data traffic growth from Q3’19 to Q3’20

Traffic growth year-on-year

source: ERICSSON mobility report - November 2020
5G Evolution
or revolution?

- 2G: Digital communication and mobility
- 3G: Multimedia and basic mobile broadband
- 4G: High performance mobile broadband
- 5G: Business Enabler
  - Virtual networks & Gigabit networked society
  - Capacity & reliability
  - New business models
  - New revenue streams
  - Energy efficiency
  - Security

New business models
New revenue streams
5G Basic Requirements

5G, mobile operators would create a blend of pre-existing technologies covering 2G, 3G, 4G, Wi-fi to allow higher coverage and availability, with greater connectivity enabling Machine-to-Machine (M2M) services and the Internet of Things (IoT). This vision include a new radio technology to enable low power, low throughput field devices with long duty cycles of ten years or more.

Next Generation Technology vision:

This is more of the traditional ‘generation-defining’ view, with specific targets for data rates and latency being identified, such that new radio interfaces can be assessed against such criteria. This in turn makes for a clear demarcation between a technology that meets the criteria for 5G, and another which does not.

(source: NGMN)
5G Air Interface
Massive channels, massive MIMO

- Evolution of existing technology adding new RAN technology
- LTE+ and New Air Interface combined allows rapid switching based on radio conditions
- New Air Interface initially applied at new spectrum (up to millimeter waves) with super channels, massive MIMO & beam forming
- Gradual migration of New Air Interface into existing spectrum
5G Layers
Macro / Micro / Small / Indoor

5G Actual Deployment mainly uses the existing Site grid (macro/micro/indoor). Small cell layer deployment has started, but will be enhanced gradually.

Macro
Active 5G
Macro
Passive 5G
Micro
Passive 5G
Indoor
Passive 5G
EMF challenges for 5G

- Massive MIMO and beamforming
  - More complex EMF compliance assessments
  - Potentially higher EIRP and larger EMF compliance boundaries (exclusion zones) than for conventional antennas
  - Site design of increasing importance

- Frequency bands above 10 GHz
  - Test methodology and standards available but need to be further refined and accepted by regulators
  - EMF limits more conservative in the nearfield which leads to larger compliance distances for small cell base stations and which may affect maximum UE power
Licensing challenges for 5G
(Small Cell Implementation in Cities)

Typical Micro Layer
- Common Transport
- Modem or MW
- Indoor Equipment Deployment
- Feeder/Combiner Usage

Small Cell
Street furniture sites
Vault site
Case Study in Municipality City of Drama
(Small Cell Implementation in Cities)

5 new Small Cells positions in the down town:

1. Eleftherias Sqr.
2. Oniroupoli Sqr.
3. Ipirou Str. (cafes)
4. Alpha Bank
Case Study in Municipality City of Drama
(Small Cell Implementation in Cities)

Small Cells Solutions:

1. Flower Pot
2. Lighting Pole
3. Smart KVs with smart lighting & meteo data
Case Study in Municipality City of Drama
(Small Cell Implementation in Cities)

Small Cells Implementations

1. Eleftherias Sqr.
2. Oniroupoli Sqr
3. Ipirou Str. (cafes)
4. Alpha Bank
Challenges for 5G

**LICENSING**

Quick, simple, hassle – free network deployment is critical. Therefore:

- Network implementation must be supported with fast and simple site permission process promoting the deployment of Macro and Small Cells.

**EMF**

- EMF limits to align with ICNIRP (EU recommended levels) in order to introduce new technologies (5G)
- Introduction of the realistic maximum transmitted power to EMF calculation models. Based on reasonable assumptions, the realistic maximum transmitted power was found to be around of 25% of the theoretical maximum power which translates to a reduction in EMF compliance boundary with a factor of about 2.
- Massive MIMO spread the beams to different directions and has a result of antenna Gain reduction.

**Street Furniture sites, vault sites! Need to educate both the Authorities and the public.**

EMF compliance for 5G networks is a challenge considering

i) Existing networks (2G, 3G, 4G)
ii) New MIMO antennas,
iii) Existing Standard for EMF calculations
iv) Stricter EMF limits in Greece
5G Campus Network at UoA

The Vision

• Close Co-operation between UoA and COSMOTE
• COSMOTE builds a full 5G Campus Network
• UoA uses the 5G to promote educational and scientific goals (new apps, research projects, etc)

What we have done so far

• 5G Indoor Network in Dept. of Informatics & Telecommunications LABs, at 3.5 GHz

• 5G Indoor Network in Dept. of Informatics & Telecommunications Auditorium, at 3.5/26 GHz (mmWave)

What are the next steps

• Extend the existing 5G Campus Network, indoors & outdoors
• Provide Network Slicing Functionality
• Start developing use cases, i.e. Augmented Lectures, Campus Self Driving Vehicle
Cellular IoT market outlook

5.9 billion cellular IoT @ 2023

Cellular IoT 2020-2026 CAGR of 23%

NB-IoT & Cat-M will make up 45% of cellular IoT connections in 2026

Cosmote within the first twenty networks commercially deployed by Eo2017

NB-IoT already supported by 110 networks and Cat-M by 50 networks

source: ERICSSON mobility report - November 2017
IoT re-shaping effect on society
Transformational impact in all industries, value chains & entire business configurations

IoT transforms the way we:
- Work
- Commute
- Interact
- Entertain

source: Nokia
Cellular IoT Technologies
LTE is already sufficient - 5G advantage is on critical side

### NB-IoT
- Very low complexity & cost UE
- Very high device volumes
- Very small data packages
- Very tough static radio conditions

### CAT-M
- Low complexity & cost UE
- High device volumes
- Low size data packages
- Mobility
- Voice Support

#### NB-IoT Deployment Schemes
- Standalone
- Guard Band
- In Band

- Mass market IoT already took off over LTE with R13 SW/HW
- Critical IoT coming over 5G NR

<table>
<thead>
<tr>
<th></th>
<th>NB-IoT</th>
<th>CAT-M1</th>
<th>LTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uplink Peak Throughput/ UE</td>
<td>~105 kbps</td>
<td>~1,119 Mbps</td>
<td>Inherited from LTE (UE category dependent)</td>
</tr>
<tr>
<td>Downlink Peak Throughput/ UE</td>
<td>~80 kbps</td>
<td>~533 kbps</td>
<td>Inherited from LTE (UE category dependent)</td>
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<td>Bearer</td>
<td>FDD (1 Anchor PRB)</td>
<td>FDD (Single Narrowband)</td>
<td>FDD &amp; TDD</td>
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<tr>
<td>Cell Range</td>
<td>Up to 120 km</td>
<td>Up to 100 km</td>
<td>Up to 100 km</td>
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<tr>
<td>Coverage extensions</td>
<td>CE Level 0,1,2</td>
<td>Coverage Enhancement Mode A</td>
<td></td>
</tr>
<tr>
<td>Battery Life</td>
<td>Up to 10 Years</td>
<td>Up to 10 years</td>
<td>Use case dependent</td>
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<tr>
<td>Energy Efficiency</td>
<td>Power Saving Mode, extended DRX</td>
<td>Power Saving Mode, extended DRX</td>
<td>Power Saving Mode, extended DRX</td>
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<tr>
<td>Mobility</td>
<td>Idle Mode Mobility</td>
<td>Connected &amp; Idle Mode mobility</td>
<td>Connected &amp; Idle Mode mobility</td>
</tr>
<tr>
<td>Voice</td>
<td>Not supported</td>
<td>VoLTE</td>
<td>VoLTE</td>
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<tr>
<td>Positioning</td>
<td>CID</td>
<td>OTDOA (3GPP R9), ECID</td>
<td>ECID, OTDOA, A-GPS</td>
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<tr>
<td>Baseband Unit support</td>
<td>Baseband 52/66 – Full</td>
<td>Baseband 52/66 – Full</td>
<td>Baseband 52/66 – Full</td>
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<tr>
<td>Capacity (#cells, #users etc.)</td>
<td>See latest “Ericsson RAN Compute Capacity Roadmap”</td>
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IoT hot apps
smart city – smart environment – smart industry – smart agriculture – smart business

source: Libelium
IoT hot apps - Public
Typical applications & use cases

- Smart metering
  - Gas
  - Electricity
  - Water

- Smart waste management
  - Unoptimized route to garbage collection

- Smart parking
  - 95% unoccupied slots
  - 28% occupied slots
  - 40% available slots
  - 96% smart parking

Alarms & Event Detectors (safety)

- Fire water tank
- Gas leakage detection panel
- Fire alarm control panel
- Elevator
- Building management system
- Fire fighting pump
- Fire stations

Help with finding a parking space

Source: Huawei, DT
IoT hot apps - Industry
Typical applications & use cases

source: Huawei
IoT hot apps - Personal
Typical applications & use cases

- Smart cycling
  - Position Reporting & Security
  - Motion Monitoring
  - Shifting control

- Wearables

- Kids monitoring

source: Huawei
Conclusions

Key messages

• Starting as a mobile evolution, 5G will become a revolutionary enabler

• 5G will enable new functionality for people, societies, business & industries

• 5G will facilitate the deployment of huge numbers, applications of M2M and IOTs

• By imposing new hard technical requirements, 5G will eventually drive to new network structures & architectures (centralized functions together with decentralized, virtual networks, real-time processing, etc)

• Network implementation must be supported with fast and simple site permission process promoting the deployment of Macro and Small Cells. EMF limits to align with ICNIRP (EU recommended levels) in order to introduce new technologies (5G)

• But as long as 5G standardization progresses, 4G makes the necessary convergence steps, preparing the smooth adaptation of the new ecosystems:
  • Preparing the Gigabit Society > 1Gbps will be available with LTE advanced technology (trials FE2016)
  • Initiating the IoT market by launching the new NB-IoT standard

The new era is starting just now!
Thank You!