4G Mobil-szélessáv: Hogyan jutunk 4-ről az 5-re

Novák Csaba
Ericsson Magyarország

LTE Subscriptions
1H 2014 298 012 134
Wireless-access generations

1980
The foundation of mobile telephony
3G
2 Mbps

1990
Mobile telephony for everyone
HSPA
14 Mbps

2000
The foundation of mobile broadband
LTE
100 Mbps

2010
Bigger and better mobile broadband
IMT/LTE Advanced
1 Gbps

2020

In the future

› More than 10 Gbps in specific scenarios
› 100s of Mbps generally available in urban/suburban scenarios
› Multi-Mbps connectivity essentially everywhere
LTE Evolution - Today

- **OFDM transmission**
- **Multi-antenna support**
- **Channel-dependent scheduling**
- **Bandwidth flexibility**
- **ICIC**
- **Hybrid ARQ**
- **FDD and TDD**
- **VoLTE**
- **Voice over LTE**
- **Dual-layer beamforming**
- **Positioning**
- **MBMS**

**Basic LTE functionality**

**Enhancements & extensions**
LTE Evolution

Carrier Aggregation

MIMO enhancements
(Paradigm shift, CRS→DM-RS)

Relaying
(Backhaul using LTE spectrum)

Heterogeneous Deployments
(Range expansion for co-channel)

Improved UE requirements
(IRC receivers)

CoMP
(Multi-point CSI feedback, QCL)

Device-to-Device Communication

Local-Area Access
(Dual Connectivity, WiFi Intergration, ...)

Multi-antenna Enhancements
(3D beamforming, massive MIMO, ...)

FDD+TDD aggregation

Carrier Aggregation Enhancements

Latency Reductions

License-Assisted Access
(Exploiting unlicensed spectrum)

Multi-antenna Enhancements
(3D beamforming, massive MIMO, ...)

Licensed Shared Access

Rel-10
Finalized 2010

Rel-11
Finalized 2012

Rel-12
Finalized 2014

Rel-13
To be started
Macro cell capacity

- Add Spectrum
- Sectorization
- 4-Way Receive
- 4x2 MIMO
- 4x4 MIMO
Carrier Aggregation

3GPP defined combinations (Relevant for European bands):
› 800 + 1800 → 10+20 MHz max
› 800 + 2600 → 10+20 MHz max
› 1800 + 2600 → 20+20 MHz max
› 1800 + 1800 → 20+20 MHz max
› 2600 + 2600 → 20+20 MHz max

Throughput ~x2
Ericsson leads in LTE advanced - CA

› Commercial service powered by Ericsson

› Live demos and trials

World’s first 450Mbps live demo with Telstra

Supported by Ericsson’s commercial hardware and software
Future Wireless Access – “5G”

Evolution of existing technology + new radio-access technology
Traffic capacity

- More dense networks – adding more infra-structure
- More spectrum – extending into higher frequency bands
- Enhanced technology
What does 5G bring?

› Enhancing current Mobile Broadband Services
  – Massive capacity, very high end-user data rates, low latency, improved energy performance, …

› New use cases – “Machine-Type Communication”
  – Massive MTC, Mission-critical MTC, …
5G Technology areas

Extension to higher frequencies
Complementing lower frequencies for extreme capacity and data rates in dense areas

<table>
<thead>
<tr>
<th>Flexible duplex</th>
<th>Spectrum sharing</th>
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</thead>
<tbody>
<tr>
<td>FDD and TDD</td>
<td>Unlicensed</td>
</tr>
<tr>
<td>Dynamic TDD</td>
<td>Shared licensed</td>
</tr>
<tr>
<td>Full Duplex</td>
<td>Network sharing</td>
</tr>
<tr>
<td></td>
<td>Complementing</td>
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<tr>
<td></td>
<td>dedicated</td>
</tr>
<tr>
<td></td>
<td>licensed spectrum</td>
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</tbody>
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Multi-antenna technologies
For higher as well as lower frequencies

<table>
<thead>
<tr>
<th>Beam-forming for coverage</th>
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<tbody>
<tr>
<td>Multi-user MIMO for capacity</td>
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Inter-site cooperation
Multi-site transmission/reception

<table>
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<tr>
<th>Multi-layer connectivity</th>
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Ultra-lean design
Minimize transmissions not related to user data
Separate delivery of user data and system information

Higher data rates and enhanced energy efficiency

Access/backhaul integration
Same technology for access and backhaul
Same spectrum for access and backhaul

Device-to-device communication
Direct communication
Device-based relaying
Cooperative devices
Extension to Higher frequencies

**cm-band:** BW \(~500\ \text{MHz to 1 GHz}\)

- 10 GHz
- 30 GHz
- 100 GHz

**mm-band:** At least \(~1\ \text{GHz and above}\)

- ~1 GHz

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### Propagation

- **Diffraction**
- **Outdoor/indoor penetration**
- **Rain/atmospheric attenuation**
- **Body loss**

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### Regulation

- Additional Tx power limitations above 6 GHz
Licensed-Assisted Access

› Unlicensed spectrum used as *performance booster* in *operator-deployed small cells*
  – Always accompanied by a licensed carrier – no focus on stand-alone operation

› Primary carrier uses *licensed* spectrum (FDD or TDD)
  – Control signaling, mobility, user data

› Secondary carrier(s) use *unlicensed* spectrum
  – Best-effort user data (DL and potentially UL)
Multi-Antenna
3D and CoMP (RAN1, RAN3)

› Coordinated multipoint (CoMP) enhancements
  – CoMP also for non-ideal backhaul

› 3D channel modeling
  – Include elevation domain, for studies of 3D MIMO

› 3D MIMO
  – Elevation beam forming
  – Massive MIMO (up to 64 basestation antenna ports)


Not part of Rel-12 → Rel-13
Device-to-Device Communication and Discovery (RAN1)

› New RAN Work Item for
  – Broadcast communication targeting NSPS use case
  – Discovery targeting commercial use case

› NSPS
  – Direct communication important
  – Focus on "out of NW coverage"
  – Relaying from D2D towards LTE EPC

› Commercial
  – Proximity detection important
  – Focus on "In network coverage"
  – Operators request authentication and authorization

Proximity enabled communication
Proximity based social networking
5G time schedule

- Exploratory research
- Pre-standardization activities & Technology development
- Standardization activities
- Commercialization

- Propagation measurements, testbeds, prototyping
- Trials
- Live 5G systems

- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

WRC ‘12
WRC ‘15
WRC ’18/19

5G introduction expected around 2020
Supersonic LTE
Taking LTE to new heights

› Video streaming at supersonic speed
  - Device travelling@1634 km/h (Mach 1.33)
    Max altitude reached: 5522 m
  - Live video stream transmitted from rocket via standard LTE smartphone

› Ericsson Commercial LTE network
  - Síminn - Iceland
  - Rocket launch: Thursday May 15th, 2014

› The “Mjölnir” project was carried out by Reykjavík University in 2014

Link to recorded video stream: https://www.youtube.com/watch?v=zJ3UW8y1Sp&feature=youtu.be
ERICSSON 5G DELIVERS 5 GBPS SPEEDS

- Live, over-the-air demonstration of Ericsson pre-standard 5G technology achieves 5 Gbps throughput in the 15 GHz frequency band
- NTT DOCOMO and SK Telecom senior management witness Ericsson’s achievement that employs innovative radio interface and advanced MIMO technology
- 5G performance will enable new machine-to-machine applications that benefit both consumers and enterprises

5G implementation in commercial mobile networks is expected in 2020, but Ericsson (NASDAQ ERIC) has already achieved speeds of 5 Gbps in live, over-the-air demonstrations of the company's pre-standard 5G network technology. This proven performance will be critical to addressing both the relentless growth in mobile data demand and enabling the next-generation machine-to-machine applications. NTT DOCOMO and SK Telecom senior management witnessed Ericsson's achievement at Ericsson lab in Kista, Sweden.