5G RADIO ACCESS AND THE ROLE OF mmWAVES – VISION AND RESEARCH

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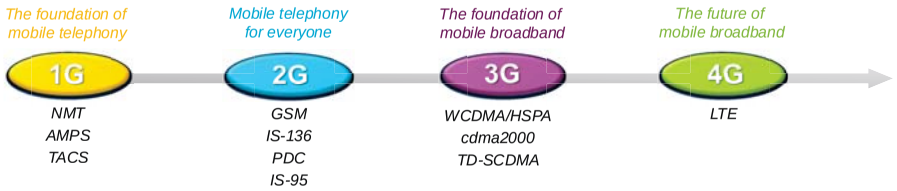
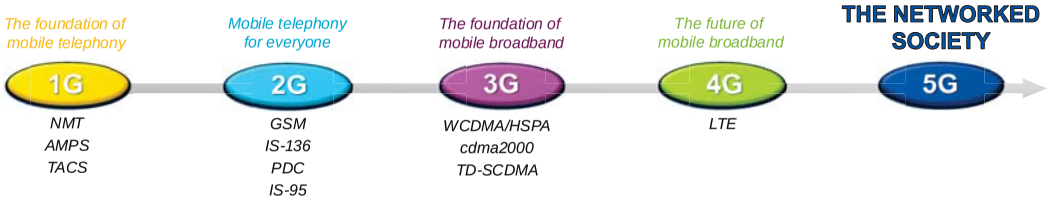
WIRELESS ACCESS TECHNOLOGY

TODAY …



WIRELESS ACCESS TECHNOLOGY

TODAY … AND IN THE FUTURE



Unlimiting *access to information* and *sharing of data* *anywhere* and *anytime* for *anyone* and *anything*

THE NETWORKED SOCIETY

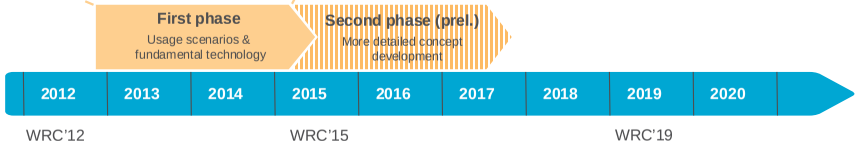
- A **connected society**
  - Devices and humans connect/interact intuitively, seamlessly
    - **"Anything that benefits from a connection will be connected"**
  - Radio performance is not an issue
- Examples
  - A connected car that adapts its driving to the conditions (traffic, weather, …)
  - Intelligent city transport and service management supported by communication
  - Moisture sensors spread on crop fields to help optimize water usage
  - A network that gives a feeling of unlimited wireless performance
  - …
- **Ericsson research vision for future radio access / 5G connectivity**
  - Unlimiting access to information and sharing of data anywhere and anytime for anyone and anything

METIS PROJECT

Mobile and wireless communications Enablers
for the Twenty-twenty Information Society

EU-funded research project on
future wireless communication

29 partners / ≈2500 man-months / 29 M€

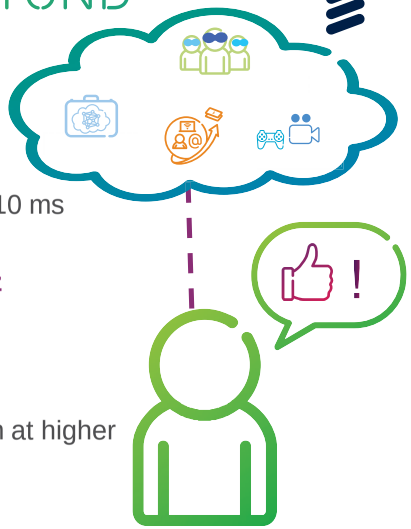


SOME 5G USE CASES

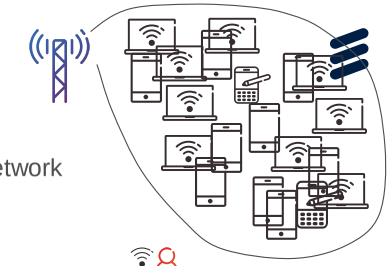
WHY DO WE NEED 5G?

MOBILE BROADBAND BEYOND 2020

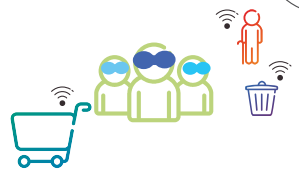
- Capacity ("1000x"), data rates, latency
- Up to ~10 Gbps for local access, RTT latencies <10 ms
- Indoor, dense urban outdoor
- Solution: **Ultra-dense networks** operating at **GHz bandwidths** at higher frequencies ("**MMW**")
- 100s of Mbps essentially everywhere
- Solution: Denser deployments and more spectrum at higher frequencies, coordination, antennas, …



PROXIMAL COMMUNICATION



- **Massive traffic requirements**, under-dimensioned network
  - traffic jams, special events, festivals, trains, airplanes, etc
  - Data sharing, "local Internet"
- **Proximity and interaction**
  - Continuous interaction between proximal devices
    - Proximal Internet
  - Tracking, "wireless sense", MTC, "offloading", …
- **NSPS** (National security public safety)
  - Communicate reliably with limited infrastructure
- Solution component: **D2D communication**

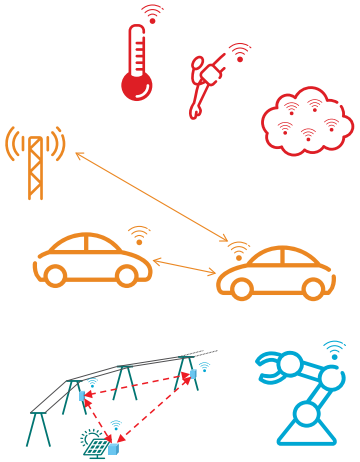


MACHINE TYPE COMMUNICATION

› **Massive machine communication**
- Sensors, actuators, …: everyday objects getting connected
- **Solution**: Low overhead communication, integration of capillary networks

› **Vehicular communication**
- Traffic safety, self driving vehicles, …
- **Solution**: Network assisted D2D, low latency high reliability

› **Ultra-low latency, ultra-high reliability**
- Smart grid, wireless factories / “industry 4.0”, …
- **Solution**: New technologies or special modes



COMMUNICATING MACHINES

Wide range of requirements and characteristics

› *Very* small payload *... in some cases*

› *Very* low device cost *... in some cases*

› *Very* long battery life *... in some cases*

› *Very* high reliability *... in some cases*

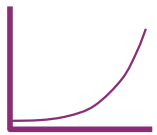
› *Very* low latency *... in some cases*

› *Very* good coverage *... in some case*

Very large number of devices!

5G WIRELESS ACCESS
KEY CHALLENGES FOR THE NETWORKED SOCIETY

Massive growth in
Traffic Volume



“1000x and beyond”

Massive growth in
Connected Devices

“50 billion devices”

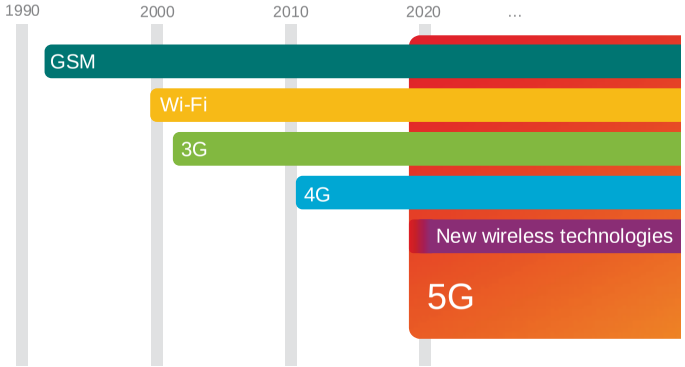
Wide range of
Requirements & Characteristics

- **Data rates**
- **Latency**
- **Reliability/availability**
- **Security**
- **Device energy consumption**
- **Device cost**
- **.....**

Affordable and sustainable

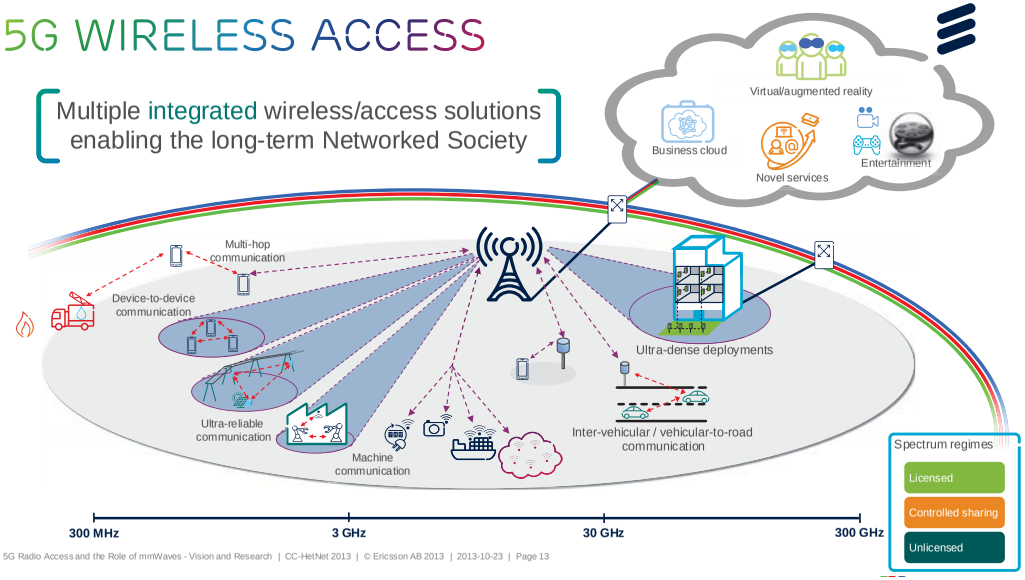
OUR 5G WIRELESS ACCESS VISION
5G == WHAT IS NEEDED TO ENABLE THE LONG-TERM NWS

5G
=
evolution of existing standards
+
complementary new technologies



5G WIRELESS ACCESS

Multiple integrated wireless/access solutions enabling the long-term Networked Society



SPECTRUM

SPECTRUM

Massive traffic

Ultra-high data rates

- *Large amounts of spectrum*
- *GHz transmission bandwidths*

Spectrum regimes

- Licensed
- Controlled sharing
- Unlicensed

› Much more spectrum will be needed for 5G
- Ability to operate in different spectrum regimes
  - › Enables access to more spectrum
- Dedicated licensed spectrum still key
  - › Controlled sharing and unlicensed can complement
- GHz transmission bandwidths available at mmWave frequencies

Global harmonization key to industry scale and roaming

SPECTRUM

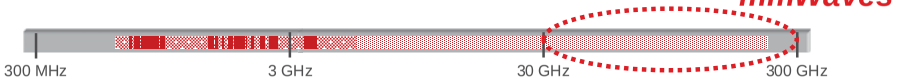
Today – *Spectrum up to 3.5 GHz*

SPECTRUM

2020 – *Extended spectrum availability up to 10 GHz*

SPECTRUM

Beyond 2020 – *Extension beyond 10 GHz*



- Large amount of spectrum available ⇨ *Further massive increase in traffic capacity*
- Potential for very large contiguous bandwidths ⇨ *Enabler of extreme data rates*
- Small wave length ⇨ *Enabler for massive antenna solutions*

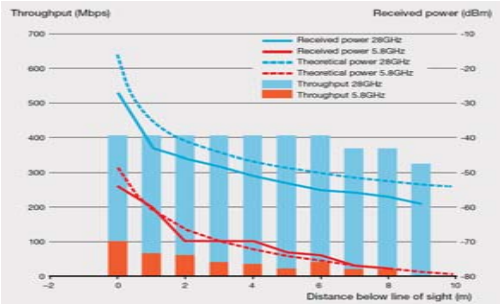
Many opportunities but also many challenges

mmWAVE PROPAGATION

mmWAVE NLOS PROPAGATION

- Diffractions
  - A ➡ B: LOS propagation with high gain antennas → link budget can be made very good
  - B ➡ C: diffraction at last diffraction edge dominates the overall loss
- Reflections
  - Make use of strong reflections but antenna alignment becomes critical
- Outdoor-to-indoor penetration loss (C ➡ D)
  - Loss increases with increasing frequency

mmWAVE NLOS BACKHAUL TRIALS
DIFFRACTION

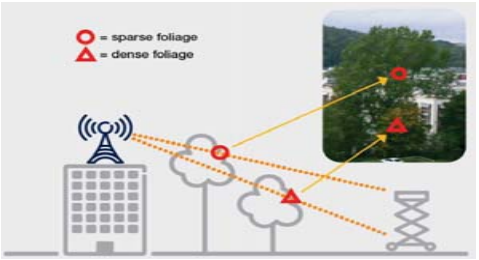


› Comparison with similar antenna sizes at both ends
- 5.8GHz: 1x40MHz TDD, 19dBm, 17dBi antennas
- 28GHz: 2x56MHz FDD, 19dBm, 38dBi antennas

mmWAVE NLOS BACKHAUL TRIALS
REFLECTION

› Reflections may be used
- 5-25dB additional loss as compared to LOS expected in trial area
- Multiple reflections may also be used

mmWAVE NLOS BACKHAUL TRIALS
FOLIAGE PENETRATION



› Large signal power variations observed for dense foliage

› Communication through penetration through sparse foliage possible

See further http://www.ericsson.com/news/130222-non-line-of-sight-microwave-backhaul-for-small-cells_244129229_c

mmWAVE NLOS BACKHAUL TRIALS
SUMMARY

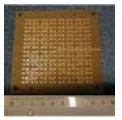
- Line of sight
- Single reflection
- Double reflection (not always possible)
- Diffraction

Distance	LOS	Single Reflection	Diffraction	Double Reflection
0-100m	400Mbps	400Mbps	400Mbps	280Mbps
100-250m	400Mbps	400Mbps	400Mbps	185Mbps
250-500m	400Mbps	400Mbps	280Mbps	185Mbps

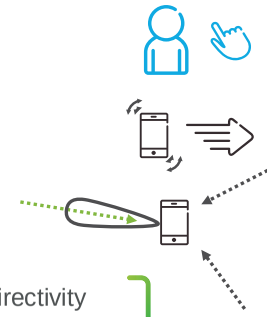
Directive high gain antennas key enabler for NLOS at 28GHz wireless backhaul

CONCLUDING REMARKS

mmWAVE FOR RADIO ACCESS
BEYOND WIRELESS BACKHAUL



- mmWaves works for fixed access
  - Wireless backhaul-like, highly directive antennas, no mobility!
- mmWaves for mobile access – additional research is needed
  - Mobility?
  - Adaptive antenna systems?
  - Propagation
    - Outdoor to indoor?
    - Path loss impact of users? Signal blockage in general and coverage?
    - Channel models?
  - Hardware aspects?
  - Energy efficiency?
  - Massive MIMO?
  - …



[Access is different from fixed backhaul, need adaptive directivity possibly also multiple antenna arrays in terminal and macro diversity]

SUMMARY / WRAP-UP

- **5G is more than just higher data rates and capacity for mobile internet access**
- **"Everything connected" means diverse requirements**
  - 5G is the set of technologies that fulfill the NWS vision; *not* a technology replacing 4G/3G
  - 5G includes evolution of existing technologies (3G, 4G, wifi, …) and new technologies for use cases not best addressed by (evolution of) existing technologies
- **5G is in a research phase**
  - Important to exchange views
  - mmWave in wireless backhaul or fixed access works!
  - mmWave in mobile access is a great opportunity but has many research challenges to solve!
  - Do not forget the backhaul challenge in future (ultra) dense heterogeneous network deployments!

THANK YOU FOR YOUR ATTENTION!

- Some references
  - Ericsson:
    - "*5G Radio Access – Research and Vision*", Ericsson white paper
      - http://www.ericsson.com/news/130625-5g-radio-access-research-and-vision_244129228_c
    - "*Evolving Wireless Communications*", IEEE Vehicular Technology Magazine
      - http://dx.doi.org/10.1109/MVT.2012.2234051
    - "*Non-line-of-sight small cell backhauling using microwave technology*", IEEE Communications Magazine
      - http://dx.doi.org/10.1109/MCOM.2013.6588654
    - "*Non-line-of-sight microwave backhaul for small cells*", Ericsson Review
      - http://www.ericsson.com/news/130222-non-line-of-sight-microwave-backhaul-for-small-cells_244129229_c?categoryFilter=ericsson_review_1270673222_c
  - METIS: www.metis2020.com
    - "*D1.1: Scenarios, requirements and KPIs for 5G mobile and wireless system*"
    - …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