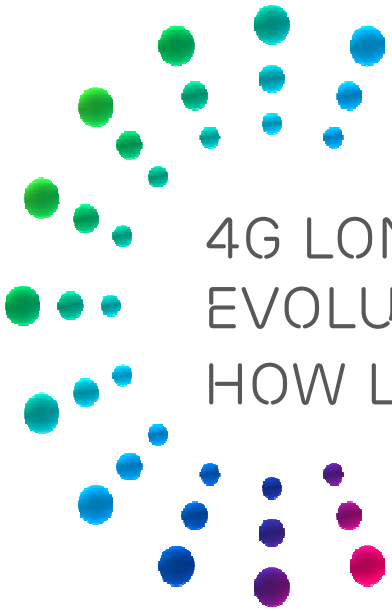


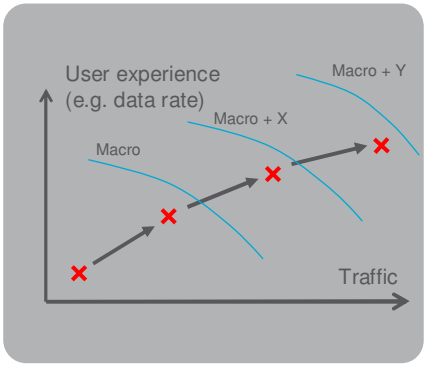
4G LONG TERM EVOLUTION (LTE) – HOW LONG CAN IT BE?

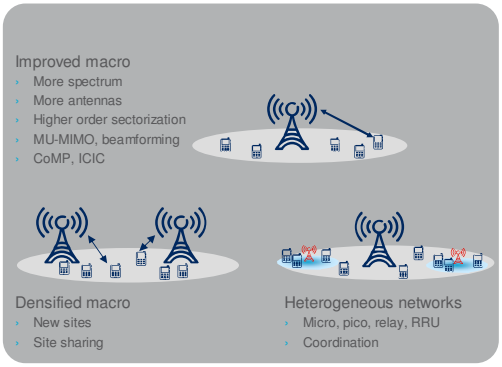
DR GUNNAR BARK
ERICSSON RESEARCH

MOBILE ULTRABROADBAND FOR ANYONE:
THE REAL CHALLENGE OF MOBILE BROADBAND

MEETING TRAFFIC AND USER DATA RATES

- Traffic growth and increased data rate expectations
- Several ways to handle – which way to go?



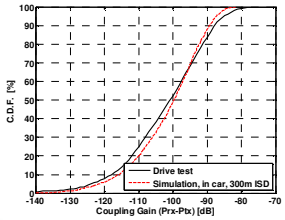


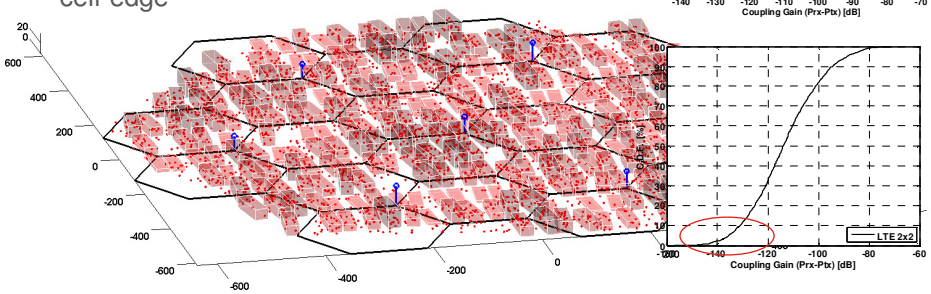
MODELS AND ASSUMPTIONS

- User behavior and traffic
  - Population density 20 000/km², market share 30%, penetration 90%
  - 80% indoor, uniformly distributed over floors
  - Traffic per user based on Ericsson strategic forecasts
- Environment and deployment
  - Building data base, ISD 425m, BS height ~ 2.5m above roof, 6 deg tilt
- Propagation
  - Winner Urban Macro Cell and (C1) Urban Micro Cell (B1)
    - "As good as it gets without being site specific"
  - Explicit LoS (and buildings) – add some site specifics
  - Angle (10-30dB) and height dependent penetration loss
  - COST231 indoor propagation
  - 3D antennas
    - Non-LoS vertical angle combined above roof-top and along streets

SCENARIO AND CALIBRATION

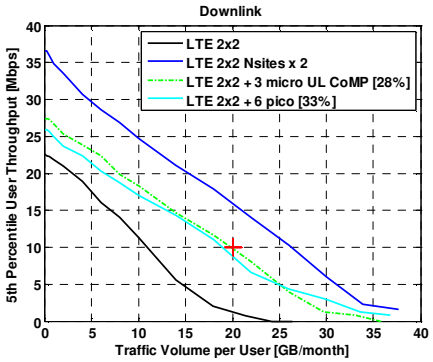
- Environment and propagation first calibrated to drive tests in Stockholm (300m ISD, 10dB in car loss) – a very dense network
- Selected 'generic' scenario has 425m ISD and 80% indoor users – more typical
- Still quite OK coverage ~ 138dB coupling loss at cell-edge

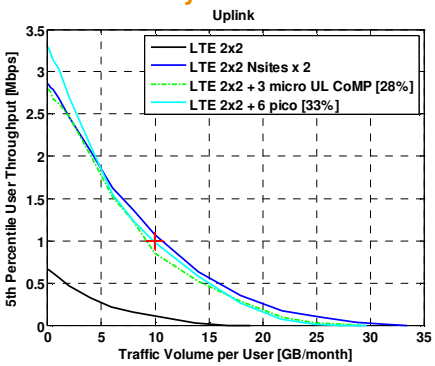




APPROACHES TO REACH TARGET

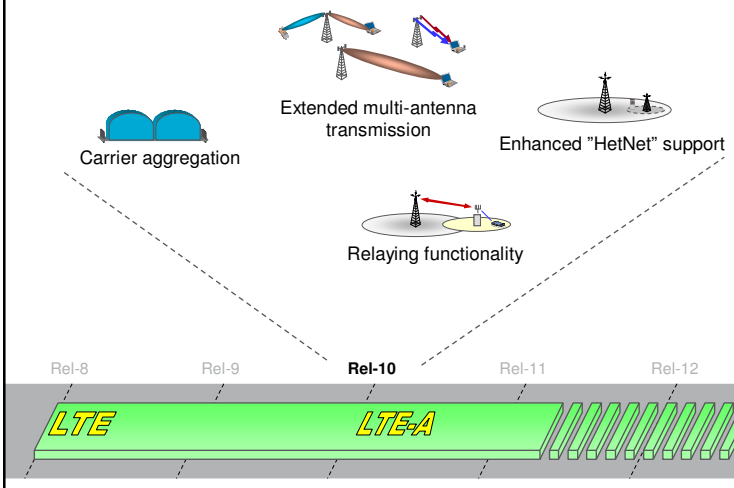
- Similar performance with
  - Macro densification x2
  - Adding three 10W micros with UL CoMP
  - Adding six 2W picos
  - Adding >15 indoor picos
- **Operators choose way to go**
  - **We reach very far with macro**
  - **Site acquisition, rentals and backhaul capabilities might decide way to choose**





LTE ADVANCED = 3GPP REL 10 HOW DOES IT PERFORM?

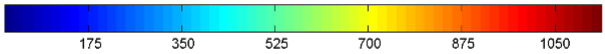
LTE RELEASE 10 – "LTE-ADVANCED"



OUTDOOR MACRO IN STOCKHOLM

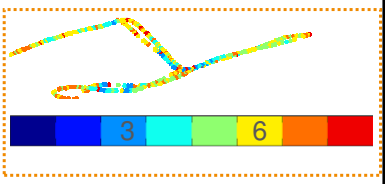
THROUGHPUT WITH LTE REL 10

Throughput



Mbps @ 60MHz

Rank choice

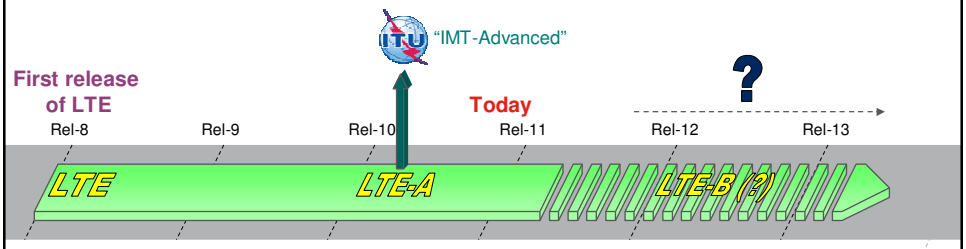


- Reaching over 1 Gbps in good condition
- Seldom below 400Mbps
- Proving that: **LTE technology is not limiting the bit-rate performance**

WHAT IS THEN COMING AFTER LTE-ADVANCED?

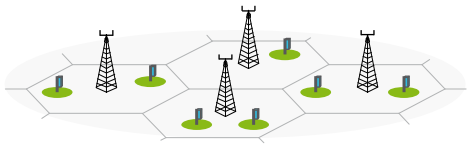
EVOLUTION OF LTE

- First major evolution step: LTE release 10 ("LTE-A")
  - Defined by ITU as "IMT-Advanced" technology
- Current 3GPP focus: Release 11
- Evolution beyond release 11?



HETEROGENEOUS NETWORK "HETNET"

Overlapping "cell layers" of different power



Lower-power "pico" nodes for capacity and high data rates

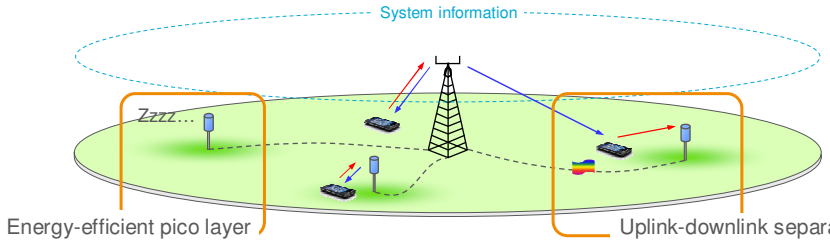
Overlaid macro layer for full-area coverage

- *"Hierarchical cell structures"* already in GSM
- The new thing: *Possibility for "same-frequency" operation*

⇨ ***More complex interference situation***

SOLUTION – "SOFT CELL"

- Pico node does not create a cell of its own but extends the macro cell
  - System information and any other cell-specific info from macro node only
  - Only user data from pico node
- Avoids macro-to-pico interference
- Possibility for separate downlink and uplink termination points
- Mobility simplified – no handovers within macro area
- High energy efficient in pico layer – *only transmission when useful transmission*



Energy-efficient pico layer
Pico node active only when transmitting data

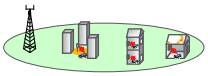
Uplink-downlink separation
In case of low-latency backhaul

FUTURE OPTIONS FOR LTE DEVELOPMENT

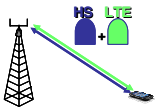
RELEASE 12 AND BEYOND

SOME AREAS UNDER CONSIDERATION

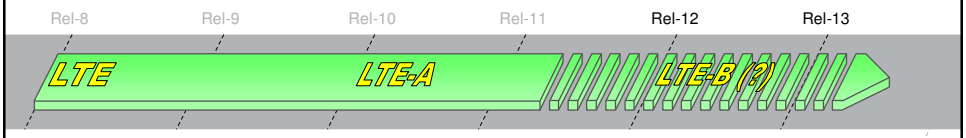
- LTE for local-area access



- Multi-RAT aggregation
  - HS + LTE
  - LTE + WiFI



- Device-to-device communication

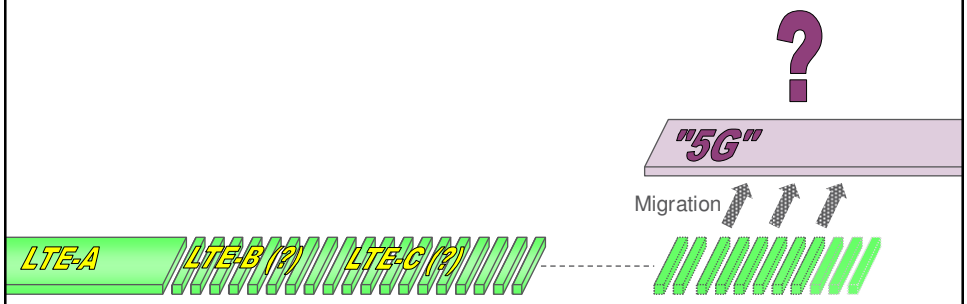


FUTURE RADIO ACCESS

What about the future?
A new radio-access technology?

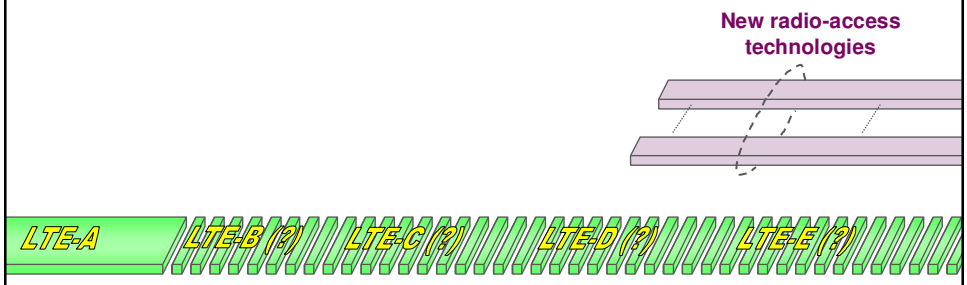
FUTURE RADIO ACCESS

A new “5G” technology for cellular communication
that can eventually replace LTE … ?



FUTURE RADIO ACCESS

… or new technologies *complementing LTE*
for specific scenarios and applications?



SUPER-DENSE DEPLOYMENTS

Order-of-magnitudes more dense than current networks

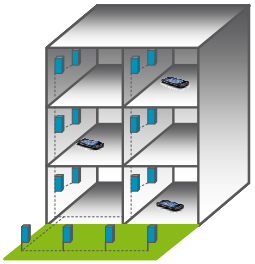
Extreme data rates and traffic capacity at very low power

Very low energy consumption

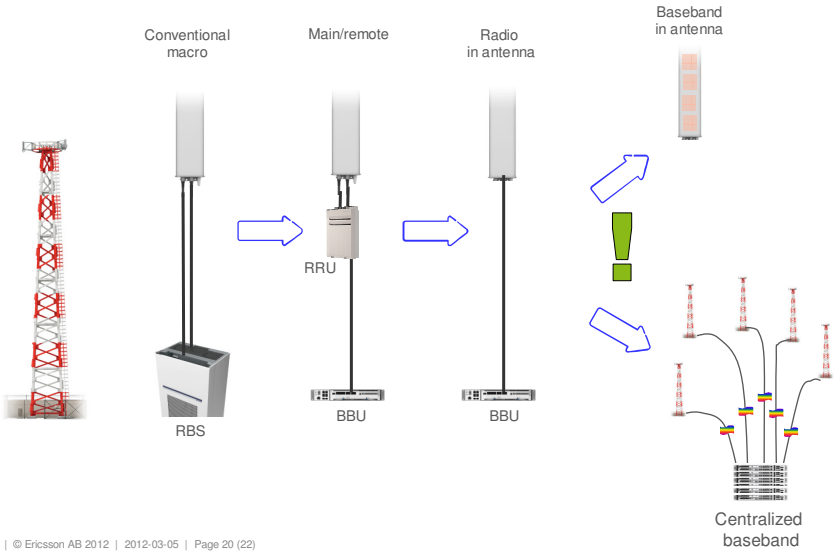
SUPER FAST and *ULTRA LEAN*

Low-cost deployment/maintenance

Availability of very dense optical backhaul



RADIO DEPLOYMENT TRENDS
BOTH DISTRIBUTED AND CENTRALIZED



LONG TERM EVOLUTION (LTE) – HOW LONG CAN IT BE?

- For currently known requirements, we see no principal limitations of LTE
- Disclaimer scenarios:
  - Device to Device not via the network
  - Extreme energy efficiency requirement

- CONCLUSION so far: LTE == the Long Term Evolution for Mobile Broadand

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