The future of mobile networking

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Nokia Siemens Networks

Introduction

- Current technologies
- Some real world measurements
- LTE
- New wireless technologies
- Conclusion

The immediate future in the US

- Upgrades to existing infrastructure:

  High Speed Packet Access (HSPA)
  - Downlink (HSDPA) most deployments up to 7.2Mbit/s
  - Uplink (HSUPA) most deployments up to 1.9Mbit/s
  - Next stage:
    Evolved High Speed Packet Access
    HSPA+ up to 42Mbit/s up, 11 Mbit/s down

Comparison to DSL at random home in Finland

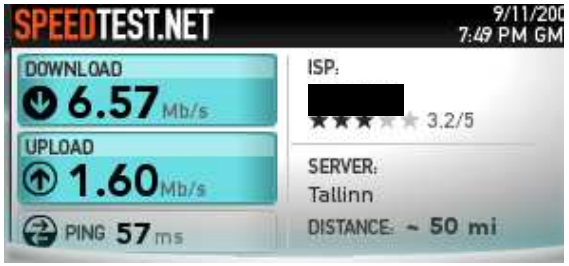
HSPA

HSPA faster in uplink

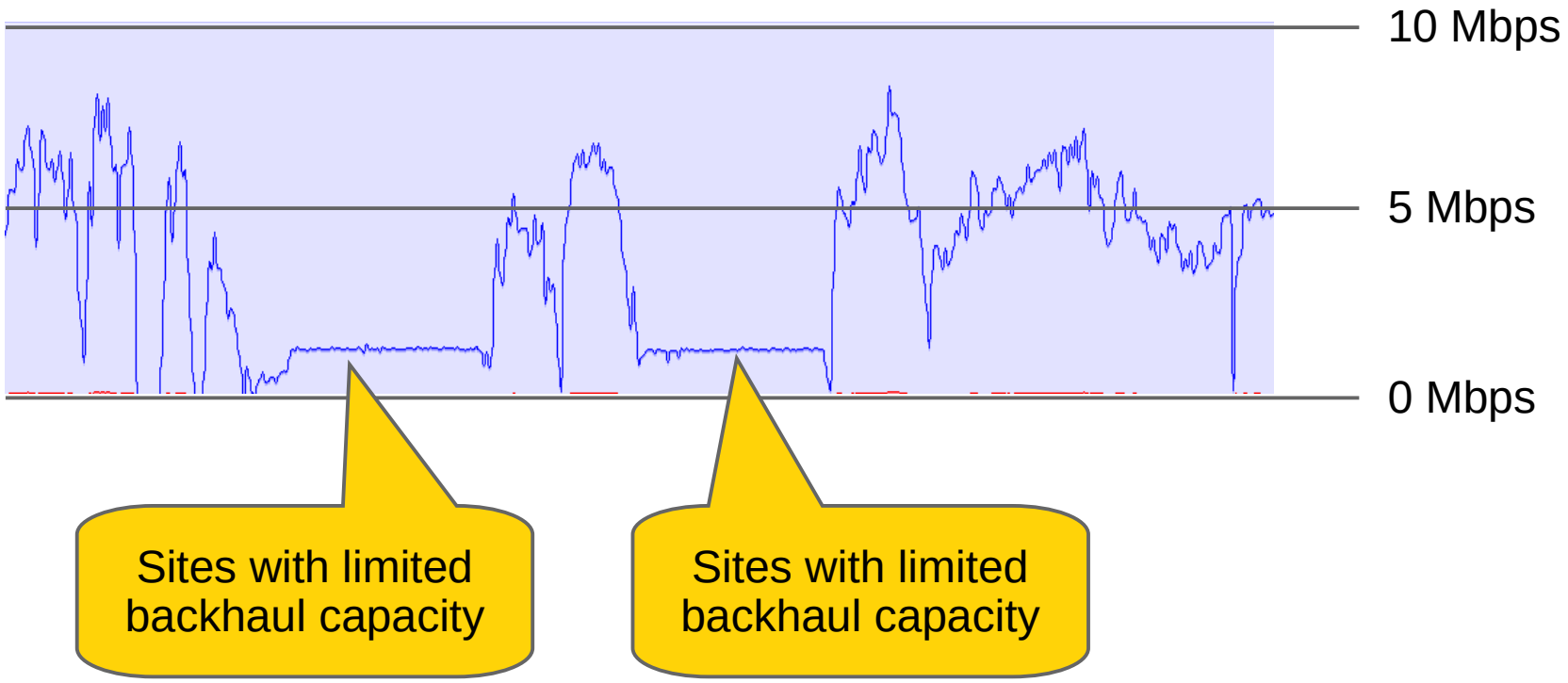
DSL

DSL faster in downlink

Another speed test for HSPA:

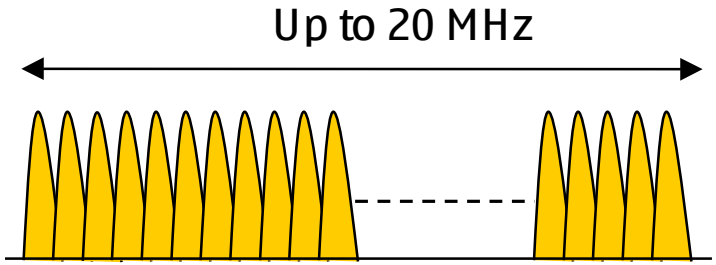


Driving Around in Suburban Area 40 km/h



LTE: Air Interface Technology

- OFDM-based DL air interface
  - Frequency bandwidth options are 1.4 MHz, 3.0 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz
  - Also used in WiMax, WLAN (IEEE)



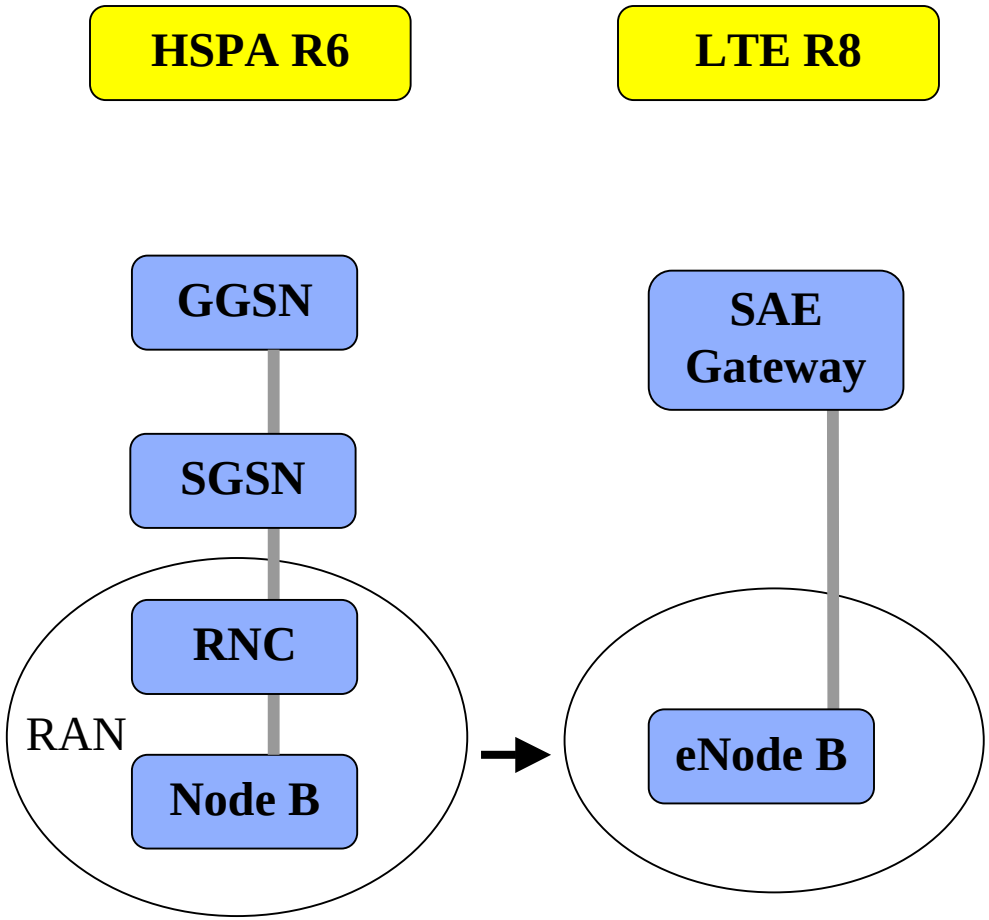
- SC-FDMA in LTE Uplink
  - More power efficient
  - User multiplexing in frequency domain
  - Smallest uplink bandwidth 180 kHz.
  - Largest 20 MHz (terminal are required to able to receive & transmit up to 20 MHz, depending on the frequency band though.)

LTE data rates and UE Categories

- All categories support 20 MHz (L1 data rates can be higher)
- 64QAM mandatory in downlink, but not in uplink (except Class 5)
- 2x2 MIMO mandatory in other classes except Class 1
- Class 3 expected initially

	Class 1	Class 2	Class 3	Class 4	Class 5
Peak rate DL/UL	10/5 Mbps	50/25 Mbps	100/50 Mbps	150/50 Mbps	300/75 Mbps
RF bandwidth	20 MHz	20 MHz	20 MHz	20 MHz	20 MHz
Modulation DL	64QAM	64QAM	64QAM	64QAM	64QAM
Modulation UL	16QAM	16QAM	16QAM	16QAM	64QAM
Rx diversity	Yes	Yes	Yes	Yes	Yes
BTS tx diversity	1-4 tx	1-4 tx	1-4 tx	1-4 tx	1-4 tx
MIMO DL	Optional	2x2	2x2	2x2	4x4

LTE Architecture Evolution

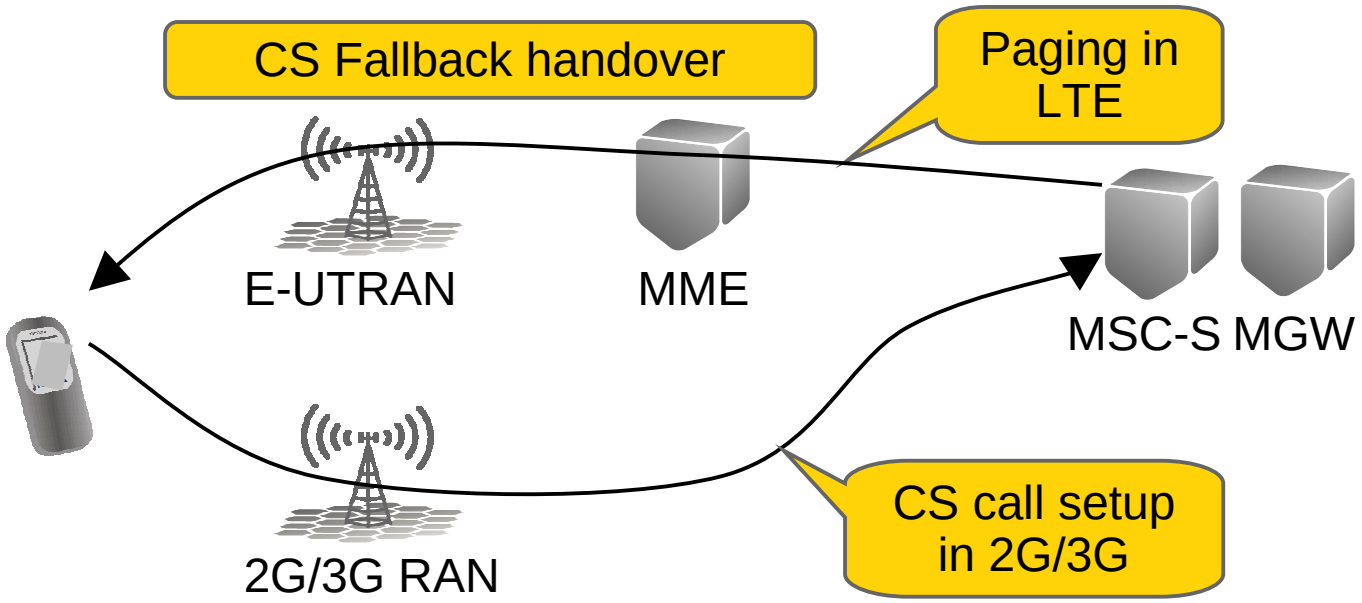


The LTE architecture is flat, only two nodes for the user data

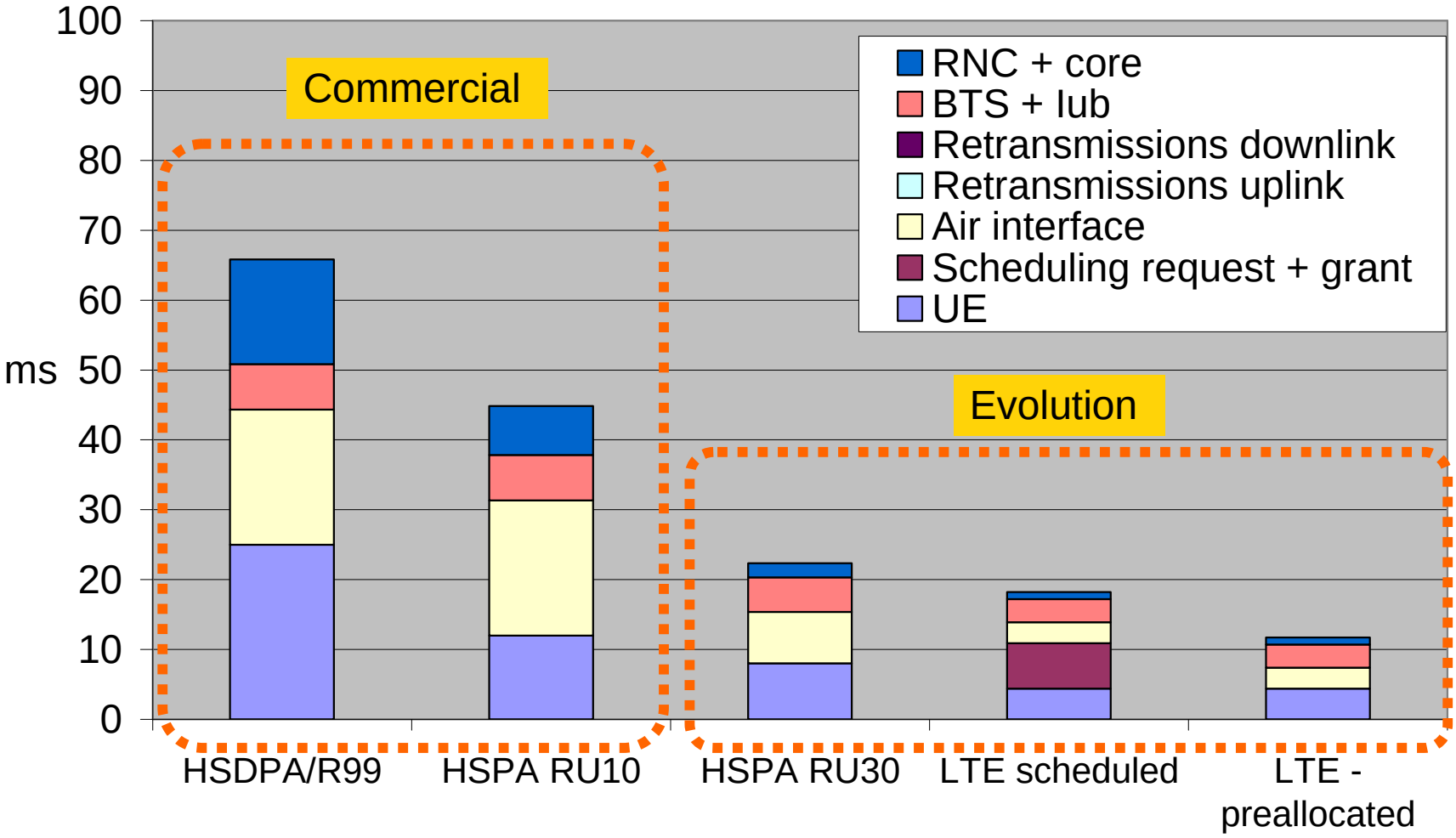
- No RNC!

LTE: Voice

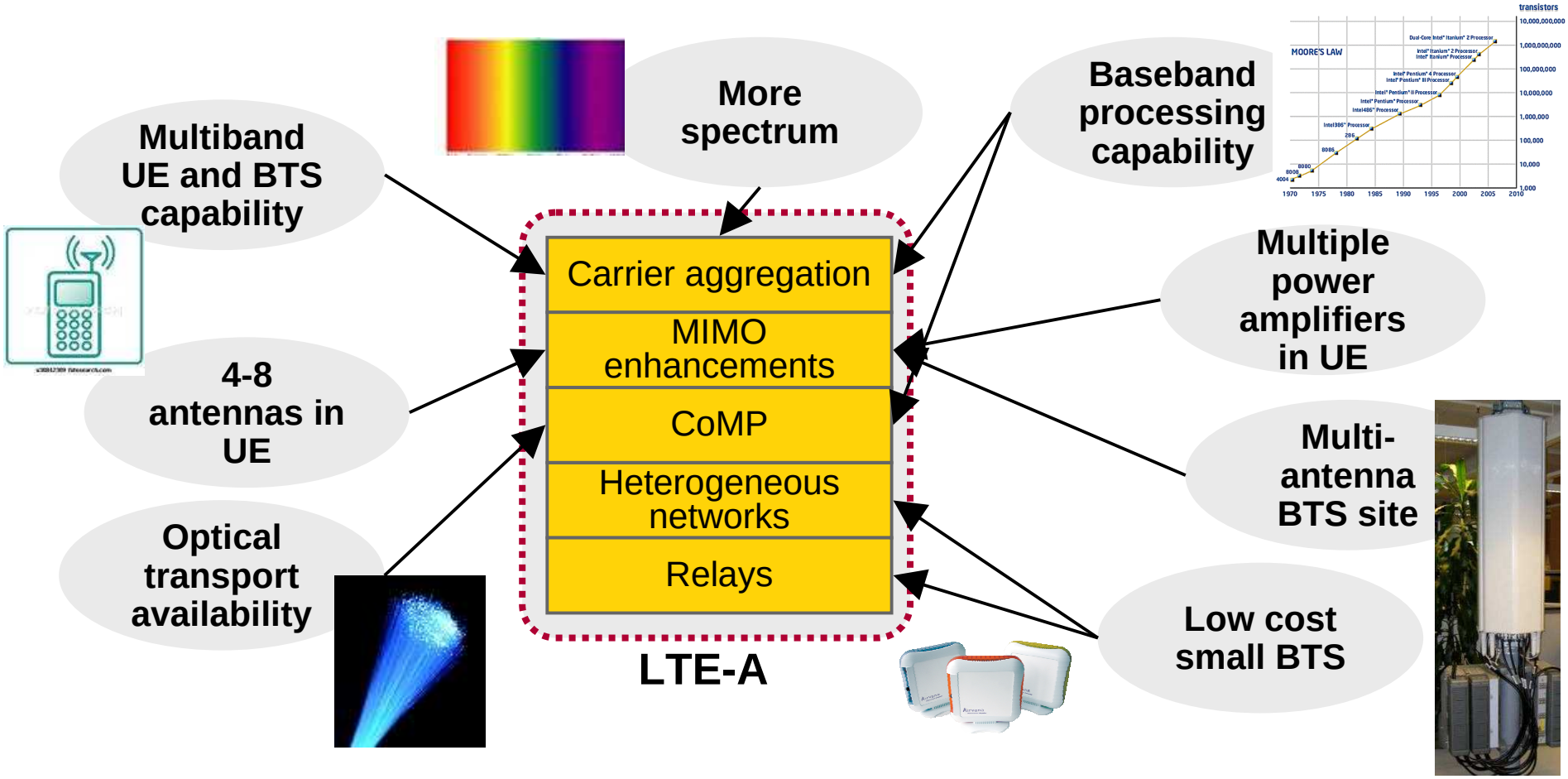
- The ultimate LTE voice solution will be VoIP + IMS
  - Circuit Switched (CS) voice will not be possible in LTE since there is no CS core interface
- LTE can rely on CS fallback handover where LTE terminal will be moved to 2G/3G to make CS call



Latency Evolution for HSPA and LTE

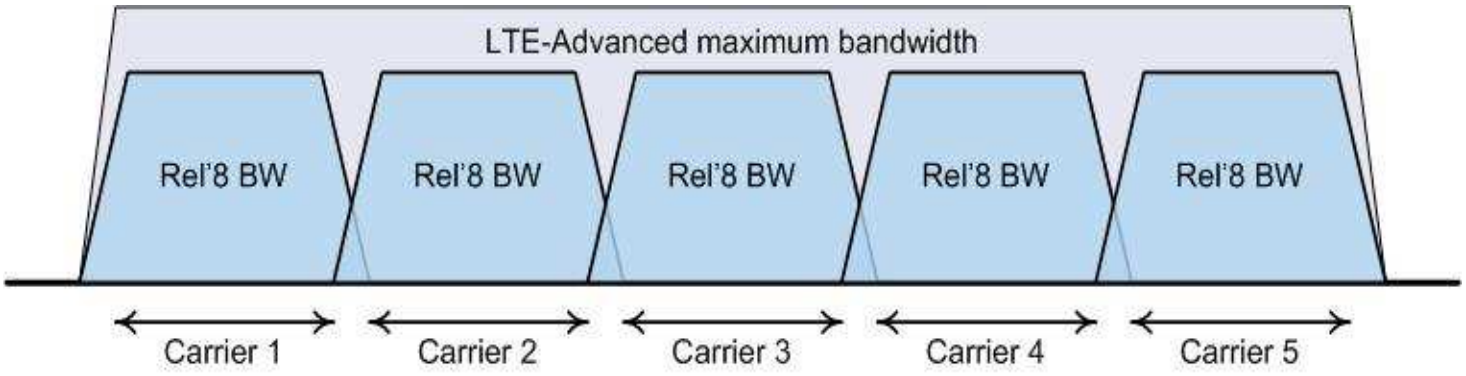


LTE technology evolution (LTE-A)



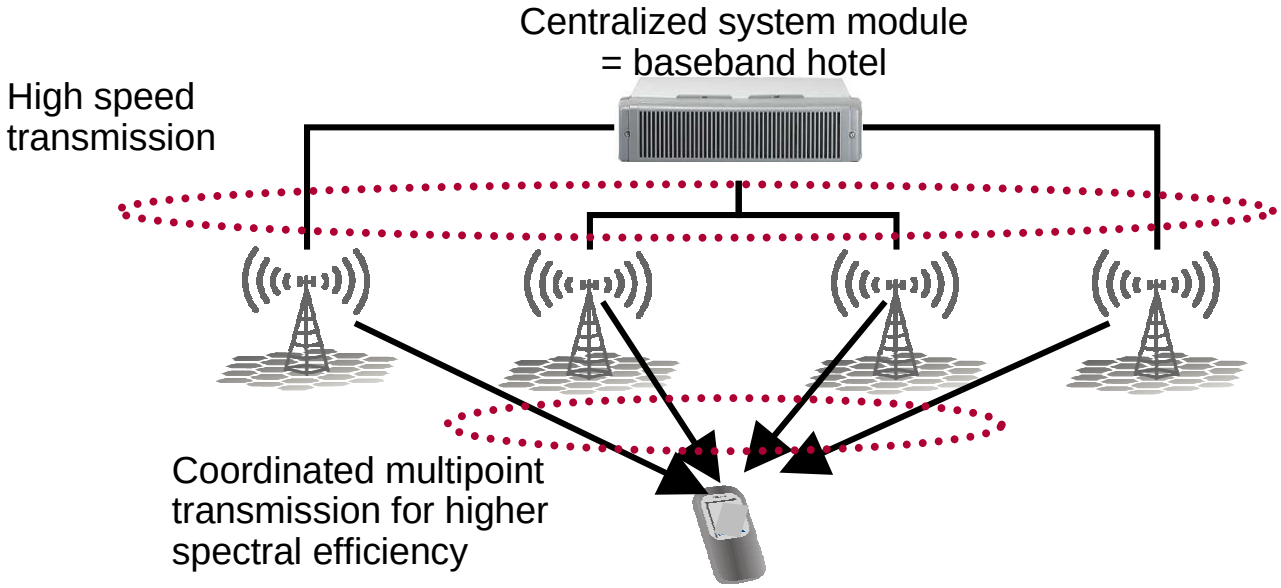
Bandwidth Extension

- High peak data rate of 1 Gbps in downlink and 500 Mbps in uplink can be achieved with bandwidth extension from 20 MHz **up to 100 MHz.**
- We combine N Release 8 component carriers, together to form N x LTE bandwidth, for example 5 x 20 MHz = 100 MHz etc.



Coordinated Multiple Point Transmission and Reception

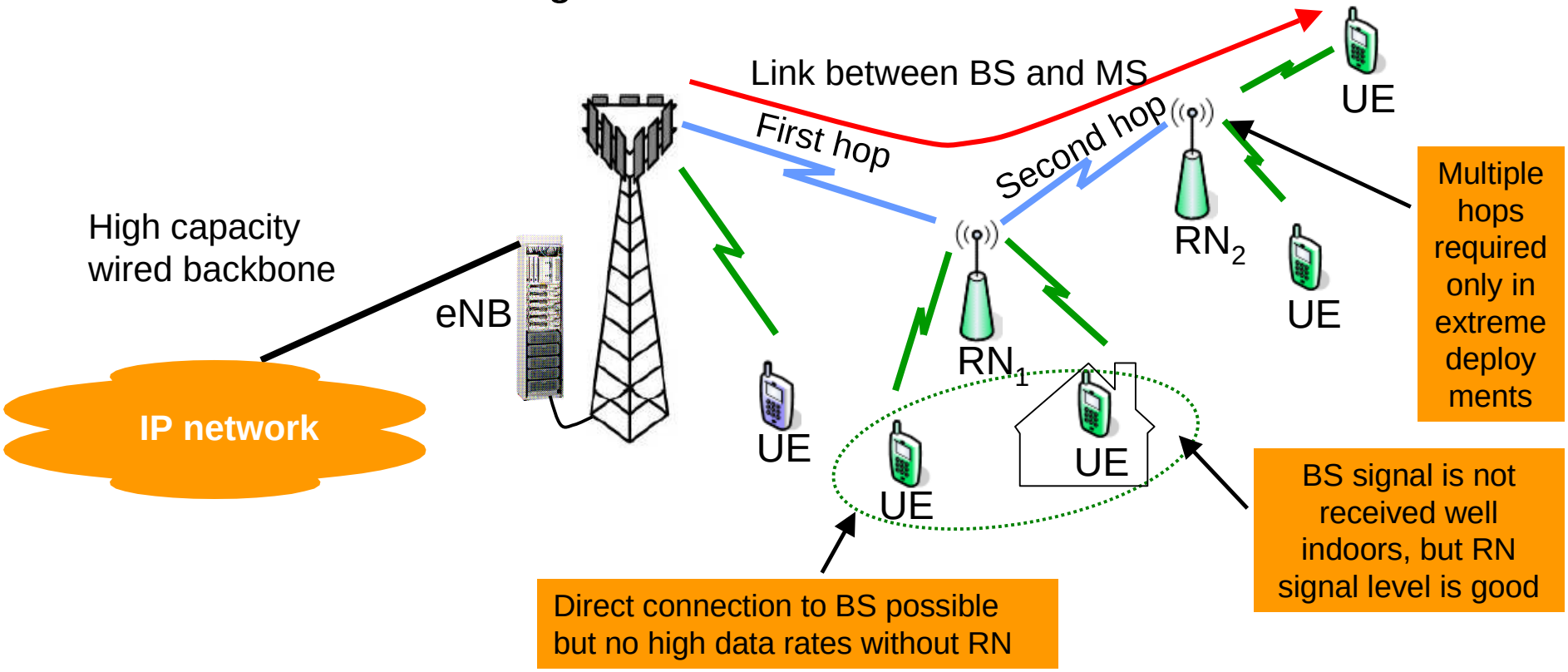
- In case fast inter BS connections are available (e.g. optical) fast coordination is no fairy tale anymore



- But practical challenges remain:
  - Downlink reference signal design and multi-cell channel estimation support
  - Uplink terminal feedback and required reporting schemes
  - Definition, configuration and coordination of the cell sets

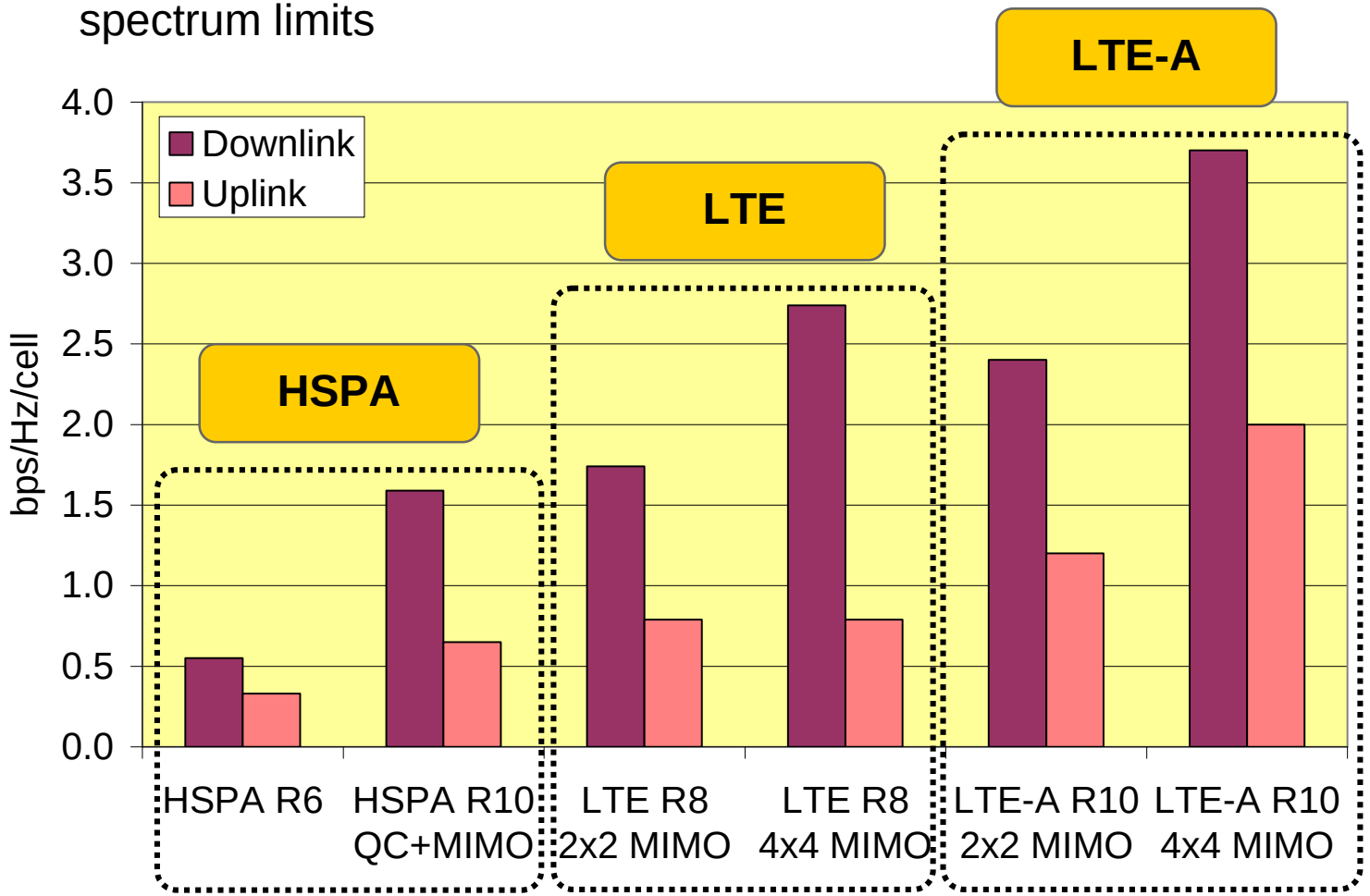
Relays (RN=Relay Node)

- Main focus is on single-hop relays.
- Main assumption self-backhauled base stations but alternatives are still being discussed.
- Each relay looks like an independent cell, backhaul provided by an in-band connection to the serving base station.

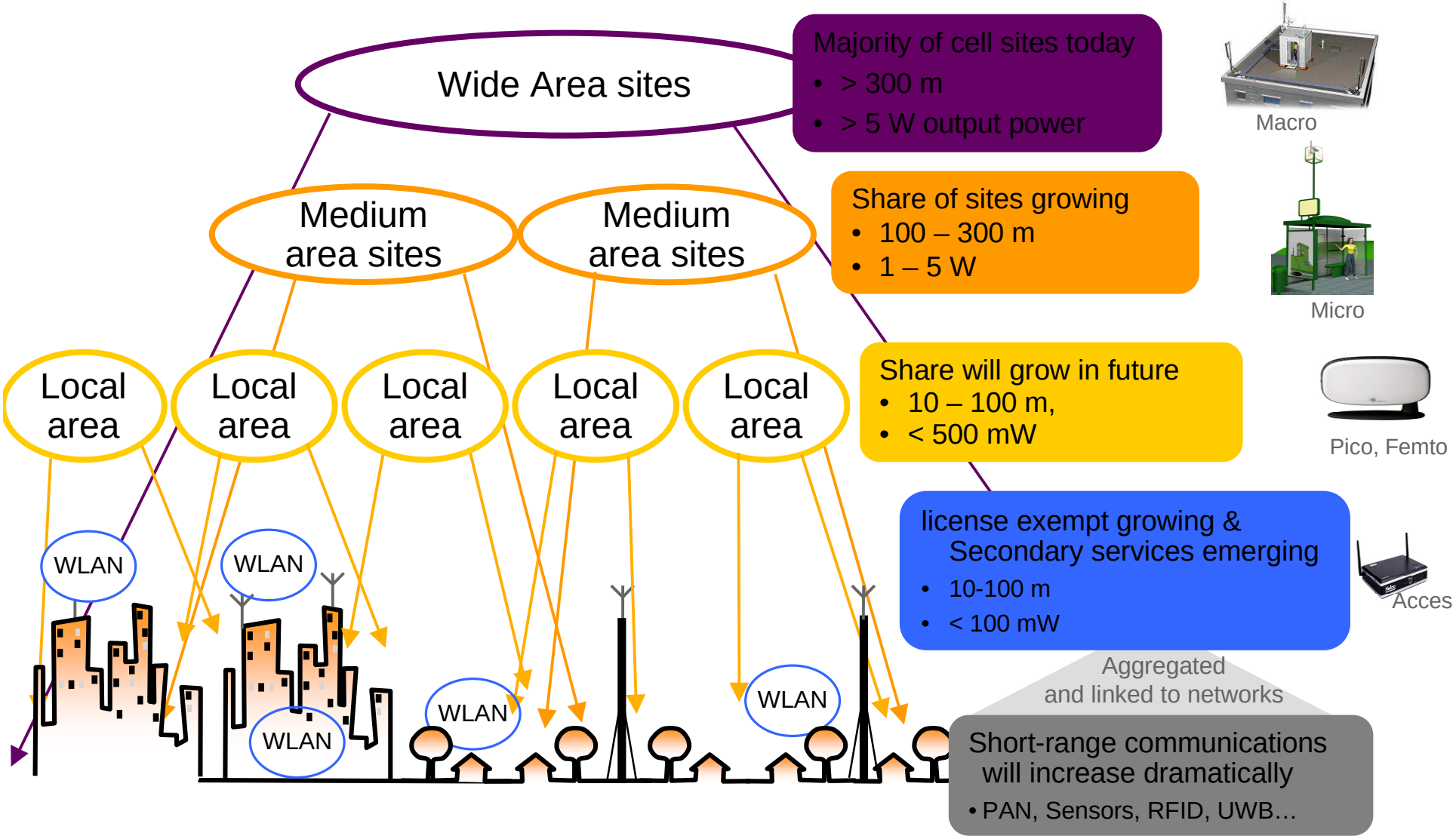


Spectral Efficiency Improves but Only Moderately

- Shannon law limits link performance improvements
- Only moderate gain in spectral efficiency
- Not possible to push more bits through macro cell channel due to spectrum limits



Heterogeneous Networks – The Combined Benefit of Wide & Local Area



Conclusion

- Mobile networks are finally being designed and optimized for TCP/IP use
- Mobile emerges as a competitor for fixed broadband
- Large cells will be pushed to the limits with increased data usage
  - Smaller cells are necessary
    - Coverage will improve
- Backhaul will often determine the actual speeds experienced by end-users
- Radio capacity will remain strained with an increased number of Internet users, each using more bandwidth