

LTE-Advanced

– The solution for IMT-Advanced

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Definitions

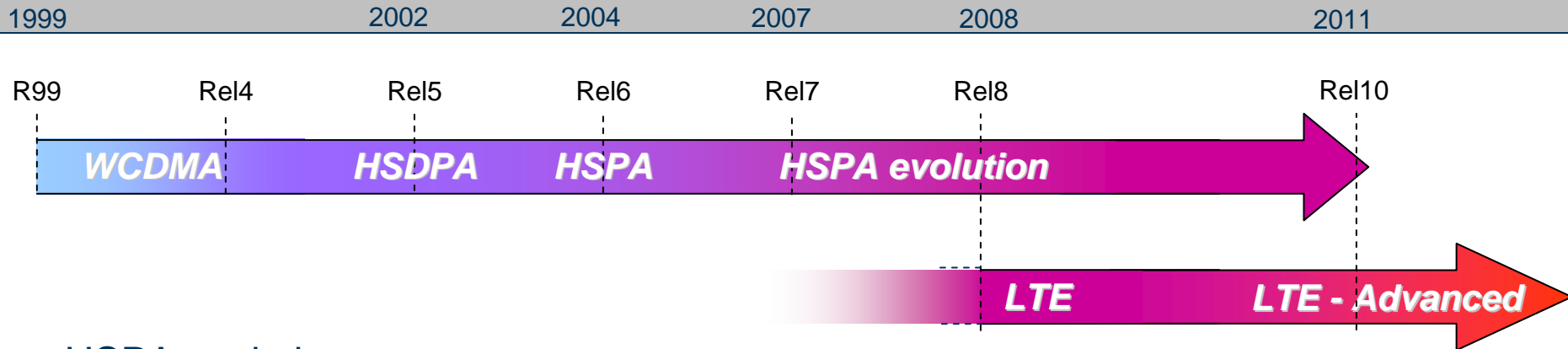
- **IMT-Advanced**

- A family of radio-access technologies fulfilling IMT-Advanced requirements
- Relates to 4G as IMT-2000 relates to 3G
- IMT spectrum will be available to both IMT-2000 and IMT-Advanced

- **LTE-Advanced**

- 3GPPs concept for IMT-Advanced and shall at least fulfill the IMT-Advanced requirements
- Natural evolution of LTE
 - LTE Release 10 (first LTE release is Release 8)

3G Evolution – Towards IMT-Advanced



- HSPA evolution
 - gradually improved performance at a low additional cost *in 5MHz spectrum allocation*
 - *Next Step: Dual-carrier (10 MHz)*
- LTE
 - *LTE is a new Radio Access Network (RAN)*
 - significantly improved performance *in a wide range of spectrum allocations up to 20 MHz*
 - Peak data-rates up to 300 Mbps
- LTE - Advanced
 - Natural evolution of LTE, next major step
 - Based on LTE and should fulfill at least, but not limited to, IMT- Advanced requirements
 - Support of spectrum aggregation up to 100MHz and peak data-rates up to 1Gbps

LTE-Advanced

Backwards compatibility & Migration

■ **Spectrum**

- Possibility for LTE/LTE-Advanced co-existence
LTE Rel-8 UE should be able to access an LTE-Advanced-capable carrier
- ***Smooth/low-cost network upgrade to LTE-Advanced capabilities***

■ **Infra-structure**

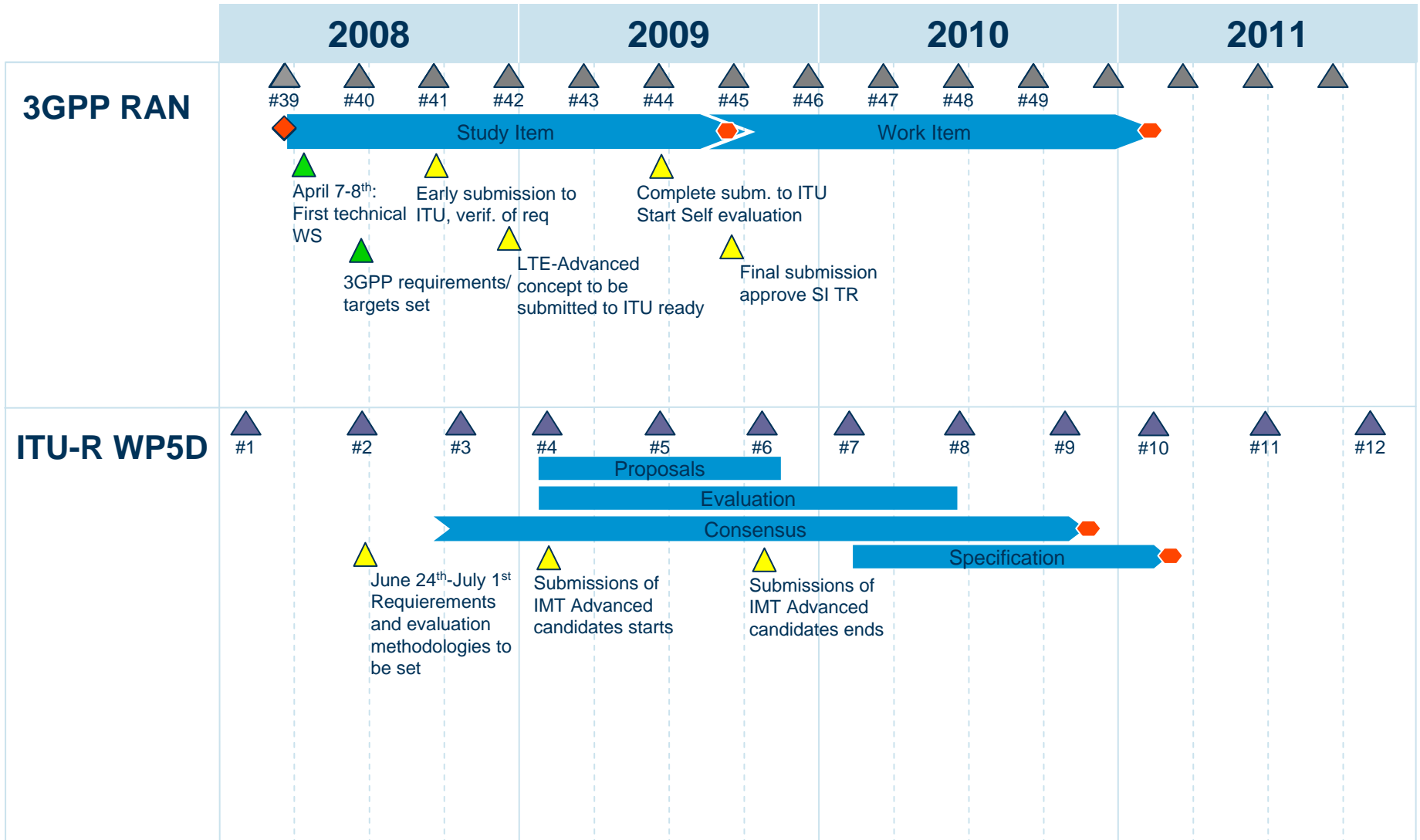
- Easy upgrade to support LTE-Advanced features
- ***Smooth/low-cost network upgrade to LTE-Advanced capabilities***

■ **Terminals**

- Low incremental complexity to include LTE-Advanced functionality
- ***Fast adoption of LTE-Advanced terminal capability***

LTE-Advanced

Time-schedule

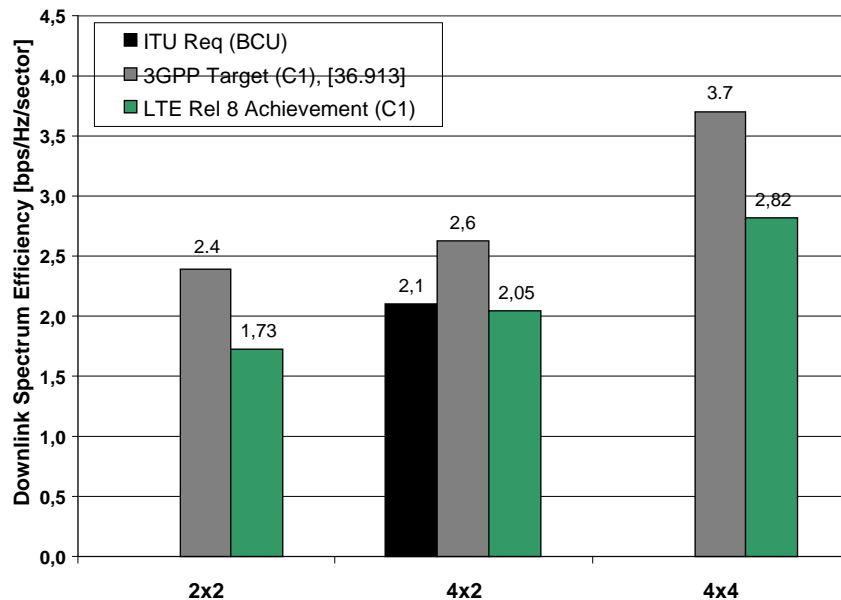


Requirements and targets

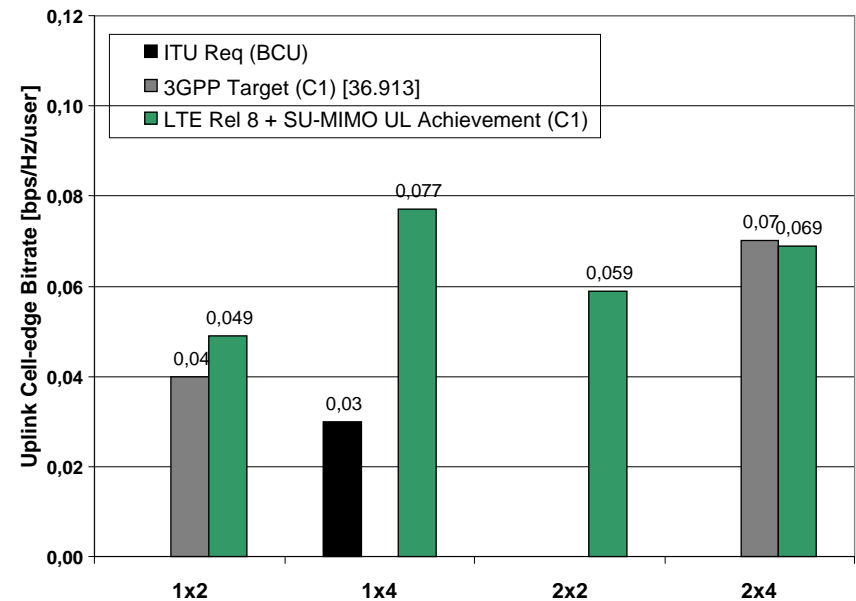
- Requirements of IMT Advanced to be set by ITU in June/July 2008
- Targets for LTE-Advanced set by 3GPP in May/June 2008
 - Reference: 36.913

	ITU Requierements	3GPP Targets
Peak data-rates		1Gbps in DL 500Mbps in UL
Bandwidth	[60] MHz	[100] MHz
User plane latency	10 ms	10 ms
Control plane latency	100 ms	50 ms
Peak spectrum efficenvy	[15] bps/Hz in DL [7.5] bps/Hz in UL	30 bps/Hz in DL 15 bps/Hz in UL
Average spectrum efficiency	To be set for four scenarios and several antenna configurations. See next slide for examples for Case 1.	
Cell edge spectrum efficiency		
VoIP capacity	[200] UEs per 5MHz	Improved compared to Rel 8

Requirements and targets for spectrum efficiency – some examples



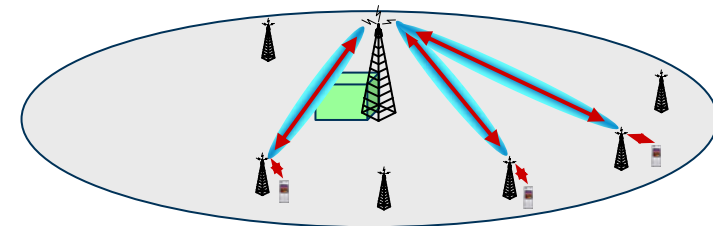
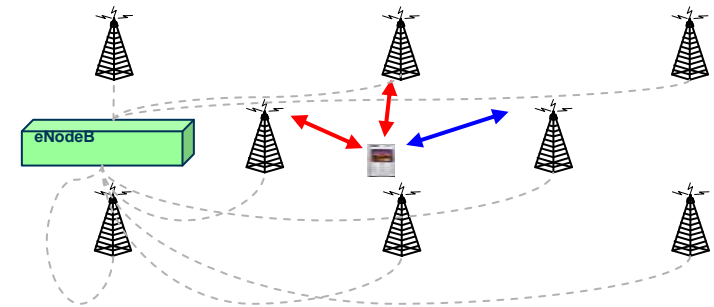
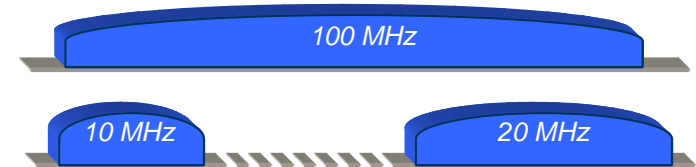
- LTE rel 8 is 15-38% below 3GPP target, on par with ITU requirement



- LTE rel 8 on par with 3GPP targets, far above ITU requirement

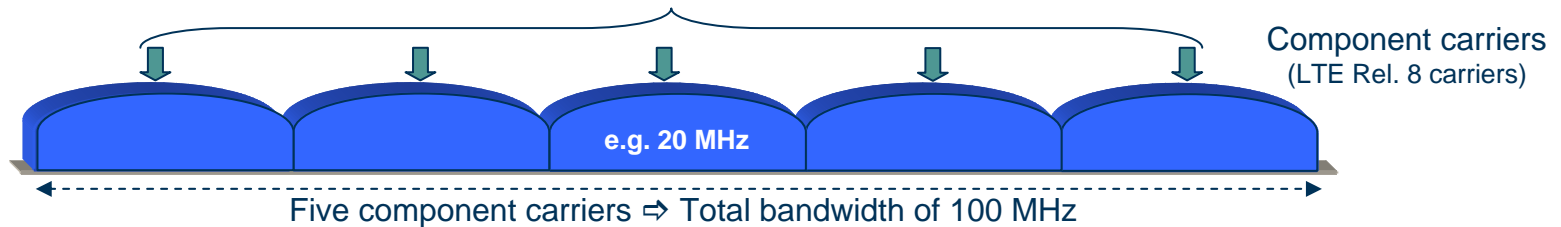
LTE-Advanced – Key Components

- Improved spectrum flexibility
 - Wider bandwidth (up to 100MHz)
 - Spectrum & carrier aggregation
- Multi-antenna solutions
 - Spatial multiplexing in uplink
 - Spatial multiplexing + beamforming in downlink
 - Higher order MIMO in downlink
 - Coordinated multipoint transmission
- Multihop communications
 - L1 repeaters for coverage extension
 - L3 relays for self-backhauling

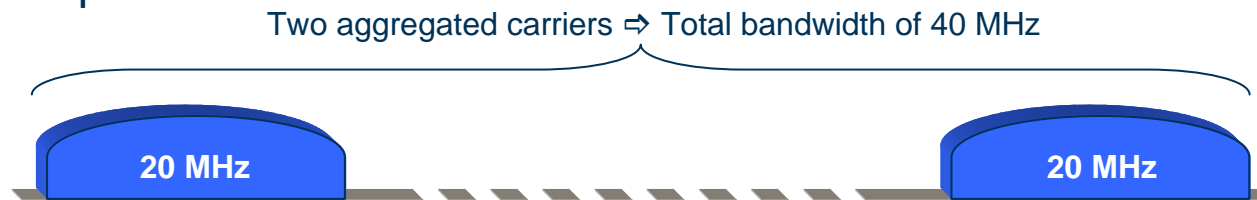


Spectrum and carrier aggregation

- LTE-Advanced should extend LTE to even wider bandwidth
 - Up 100 MHz
- Spectrum compatibility \Rightarrow *Carrier aggregation preferred*
 - Aggregation of multiple component carriers into overall wider bandwidth
 - Each component carrier can appear as LTE carrier to LTE UE

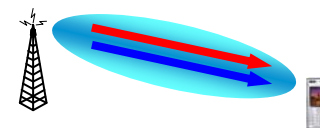
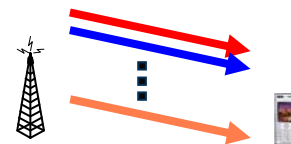
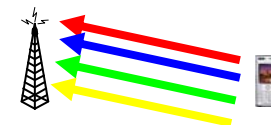


- Spectrum flexibility - Carrier aggregation with carriers in different frequency bands.
 - Possibility for wider total bandwidth without correspondingly wider contiguous spectrum



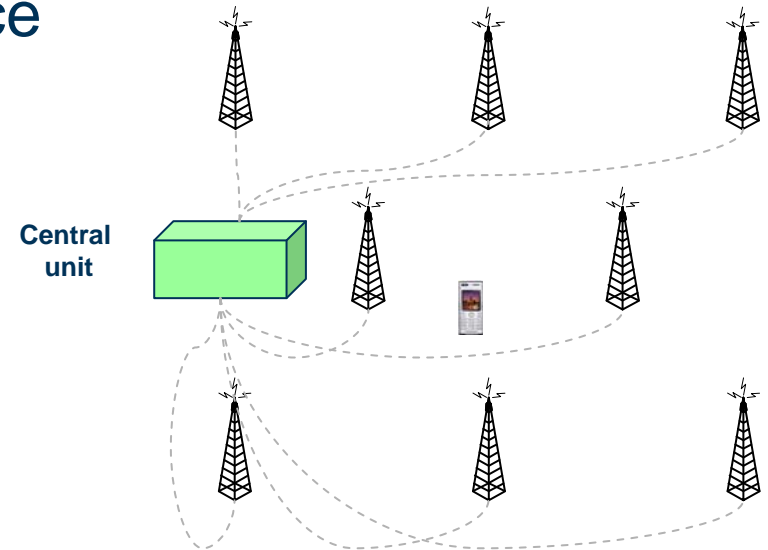
Multi antenna features

- Spatial multiplexing in uplink
 - Up to 4x4 MIMO
- Increased spatial multiplexing in downlink
 - e.g. 8x8 MIMO
- Non codebook based beamformed spatial multiplexing in downlink
 - Classical beamforming via dedicated reference signals

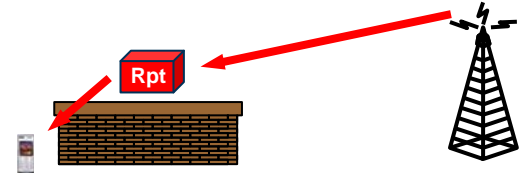


Coordinated multipoint Tx/Rx (COMP)

- Coordinate the transmission and reception of signal from/to one UE in several geografically separated points.
- Improves SNR and/or interference
- High Performance Potential
 - Straightforward in uplink
 - Feedback of channel status information challenging



Advanced repeaters



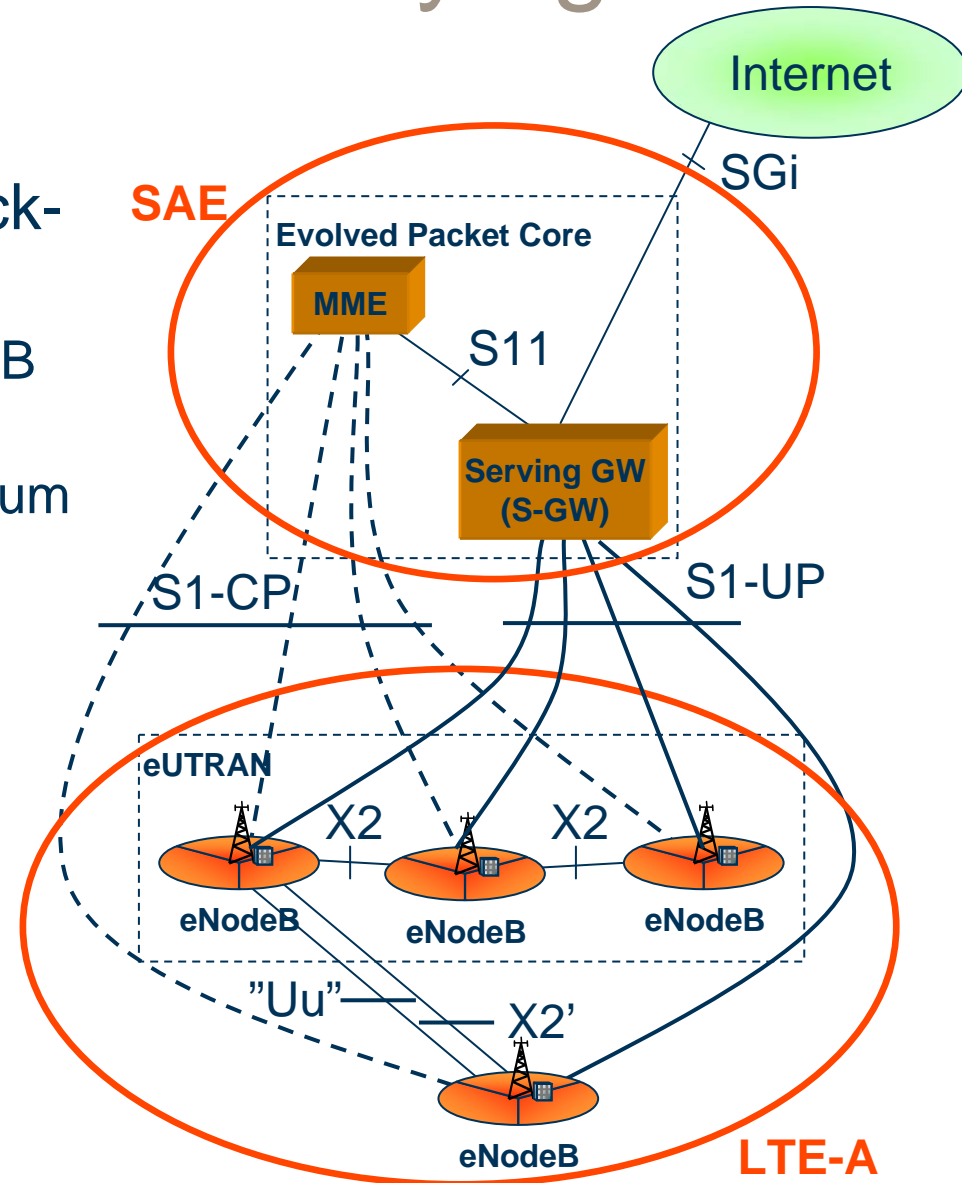
- Repeater
 - SNR at repeater input sets an upper limit on the SNR at the terminal
 - Small delay, less than the cyclic prefix
 - Terminals can exploit repeated **and** direct signal
 - Exist already today

- Advanced repeater == Layer 1 relaying
 - Detectable and measurable, controllable, advanced multi-antenna capability

- L1 repeater to cover "black holes" inside cells

Self-backhauling – L3 Relaying

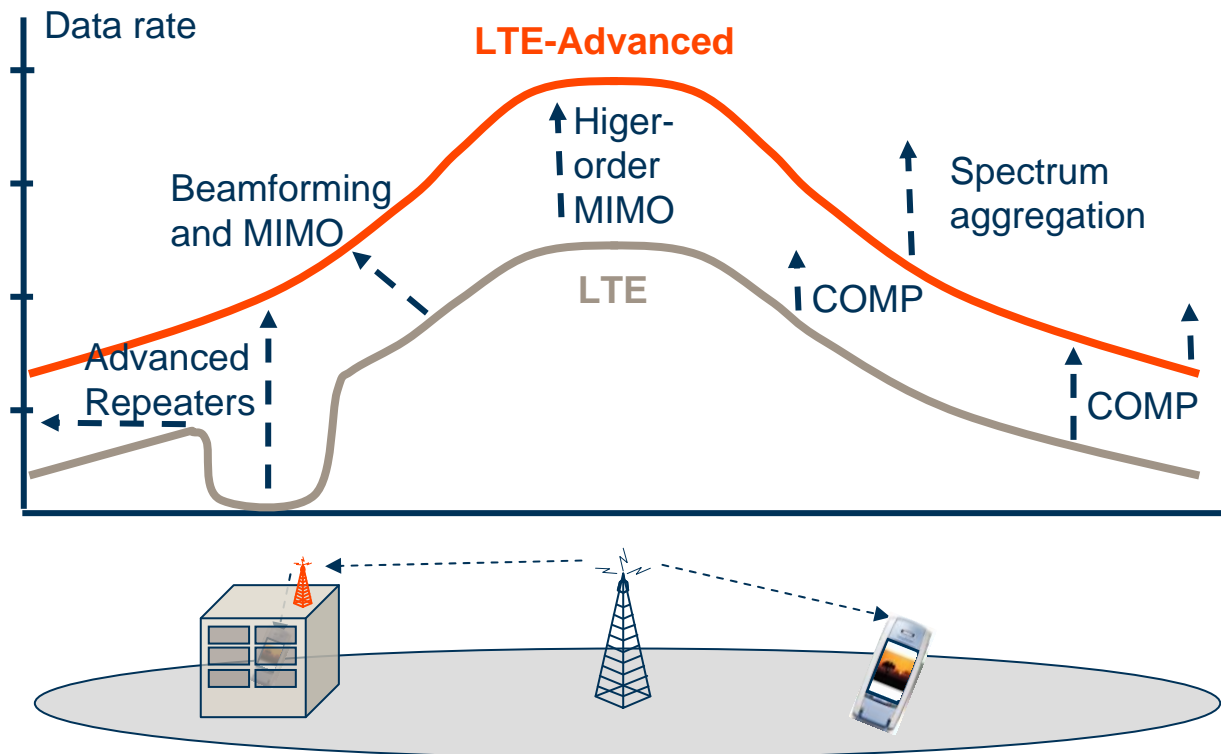
- LTE radio access in the backhaul
 - Wireless connection of eNB to central hub
 - Shared or separate spectrum
- Anchor eNB routes the packets between the wired and wireless backhaul, acting like an IP router



LTE-Advanced Improvements

The roles of the different components

- A schematic view...



Summary

- LTE-Advanced is the next major step in the evolution of LTE
- LTE-Advanced will be the 3GPP concept for IMT-Advanced
- LTE-Advanced will further boost LTE performance and capabilities
 - ... *Levaraging on already installed infra-structure base and available terminal freet*
 - ... *while retaining full backwards compatibility*
- Potential technology components:
 - Carrier/spectrum aggregatation, extended multi-antenna solutions, coordinated multi-point transmission, relaying/repeater functionality, ...

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