

# Technical and economical assessment of selected LTE-A schemes.

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#### Mobile Networks - enabler for connected life & work.

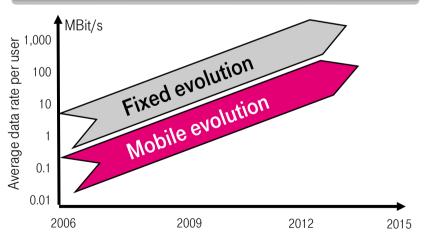
#### **Customer demands**

- Mobility, flexibility and convenience are key user requirements for access to Internet-based services on the move, at work and at home
   → can only be provided by wireless access.
- Data rate requirements for mobile and wireless access are rapidly increasing in future.



#### **Technology evolution**

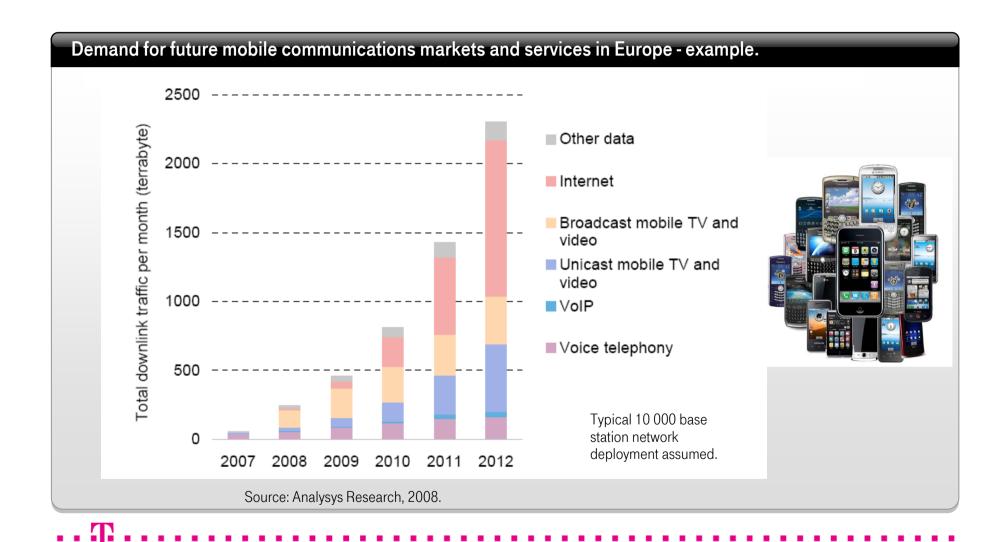
- Fixed and wireless access technologies are constantly evolving.
- Date rate capabilities double about every 18 months.
- Data rates of mobile technologies are about a factor 10 ... 25 below fixed technologies\*.



\*) WLAN (Wireless Local Area Networks) support similar data rates than fixed access).



#### Exponential growth of data traffic in mobile networks.

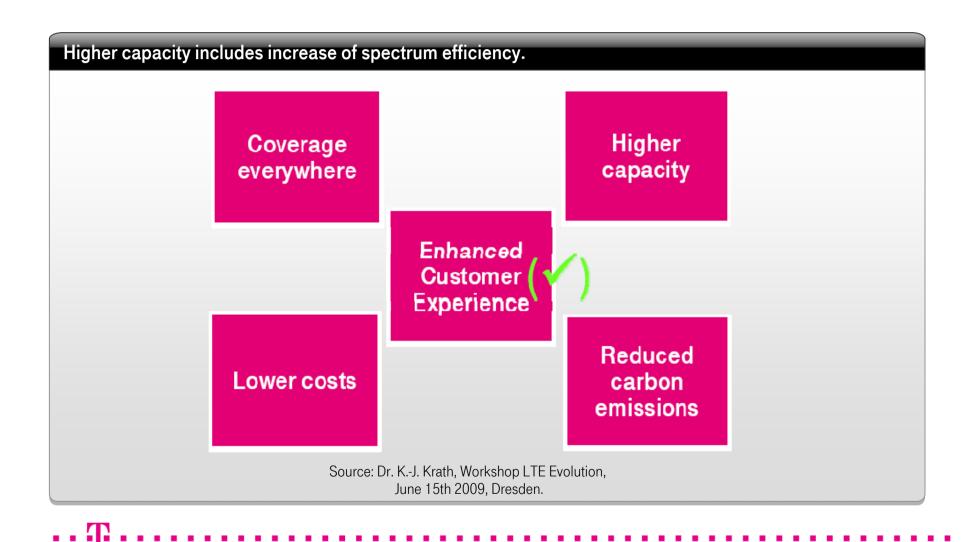


## Expected roadmap of mobile network technologies.

2000 - 2003	2003 - 2004	2005 - 2006	2007 - 2010	2011+	2015+
32 - 128 kbps	64 - 384 kbps	0.384 - 4 Mbps	0.384 - 7 Mbps	up to 170 Mbps (peak)	up to 1 Gbps
GSM	UMTS	HSDPA	HSPA / HSPA+	NGMN - LTE	LTE-Advanced
GPRS/ EDGE	R99, 1st version of 3G	Downlink Enhanced 3G	Downlink / Uplink Enhanced 3G	Broadband radio, IP based architecture	Enhanced LTE with
EDGE	0130	Ermanced 3G	Ellianced 3G	Future Wireless Cellular	new radio concepts
Enhanced Mobile Services	Multimedia Cellular	Enhanced Multimedia Mobile	Optimized Multimedia Mobile	Broadband Mobile Communication	
	 		 	NGMN - LTE	LTE-Advanced
		Optimized UMTS			
The state of the	Enhanced UMTS				Scope of T-Labs
Latte	3G - UMTS				Innovation Projects
GSM (GPRS / ED	GF)				

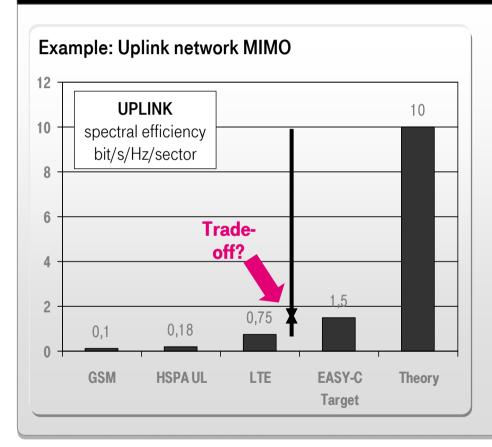


## Future challenges for mobile network operators.



## Spectral efficiency can be increased – but what are the costs?

#### Arrange trade-off between technical performance & economic feasibility

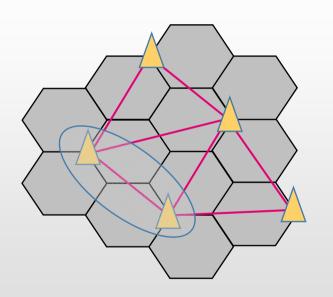


- Vision & theory: If channel conditions of all mobiles were available in the whole network simultaneously, transmission capability could be increased enormously.
- Practical constraints: If at all (from a current perspective), this can only be achieved using very expensive high-performance networking between base station sites.
- EASY-C economic assessment will help find a reasonable trade-off between affordable network components / implementation and feasible performance gain.

## Key technologies for LTE-Advanced.

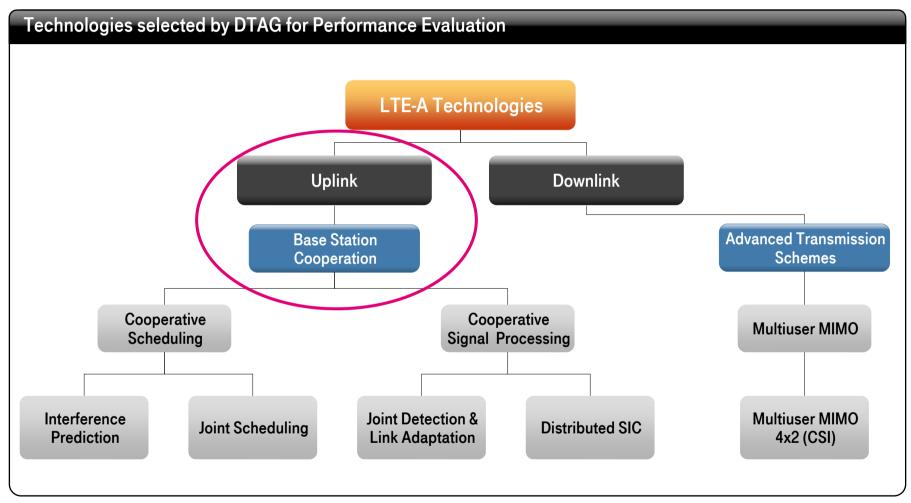
#### Coordinated Multi-Point (CoMP): Principles and implications

- Inter-cell interference mitigation due to cooperation of adjacent base station (→ distributed MIMO system).
- Basic CoMP types:
  - Joint processing ("Network MIMO"): Coherent joint transmission/reception from/to geographically separated antennas.
  - Coordinated scheduling and/or beamforming:
     Decisions for scheduling/selection of beams considers interference situation in neighboring cells.
- CoMP has high potential for big improvement of spectral efficiency.
- (Fully) meshed broadband backbone necessary with tight latency and synchronization requirements.
- Backbone capacity and/or latency may impact achievable gains.



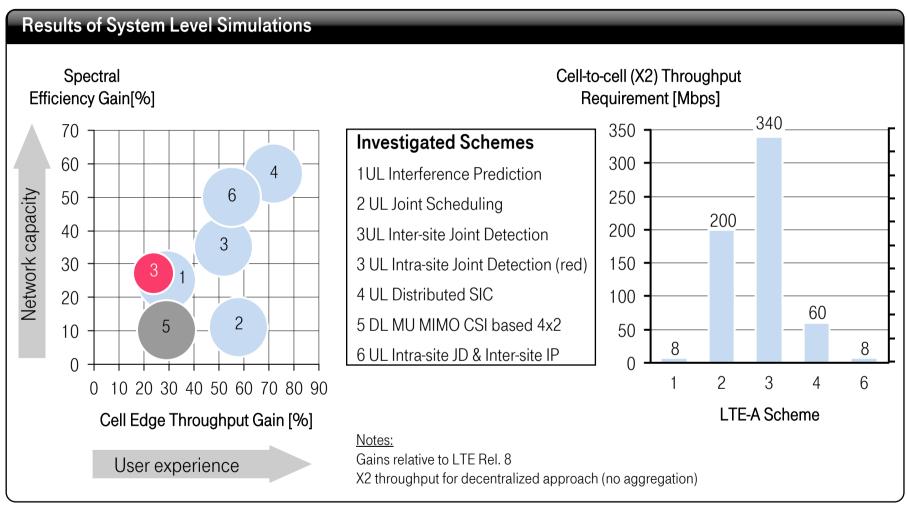


## Key technologies for LTE-Advanced.



SIC = Successive Interference Cancellation; CSI = Channel State Information

## Performance improvements and backhaul requirements.



SIC = Successive Interference Cancellation; CSI = Channel State Information; JD = Joint Detection; IP = Interference Prediction

## Approach for Economic Assessment of LTE-A key technologies.

# Baseline Deployment

- Economical Scenario Definition
- Backhaul modeling
- Deployment simulation

## Baseline Performance

- Technical Scenario Definition
- System level simulations based on 3GPP simulation conditions

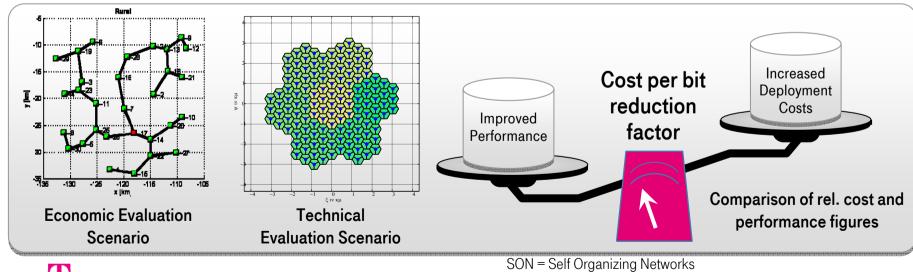
#### **SON Applicability**

#### LTE-A Deployment

- Definition of cost factors for all elements except for backhaul
- S1&X2 backhaul modeling

#### LTE-A Performance

 System level simulation results for spectral efficiency and cell edge user throughput



SON = Sell Organizing New

## Economic Assessment of LTE-A key technologies.

#### Cost are estimated by "Deployment Simulations"

Real World Scenarios

- Deployment scenarios should allow for detection of all significant topics in context with deployment.
- Mean inter-site distances is chosen as the most significant selection parameter.

**Backhaul Models** 

- Backhaul models should allow for estimation of the cost impact of LTE-A throughput and latency requirements.
- Due to big differences of real world scenarios abstractions are required.

**Cost Models** 

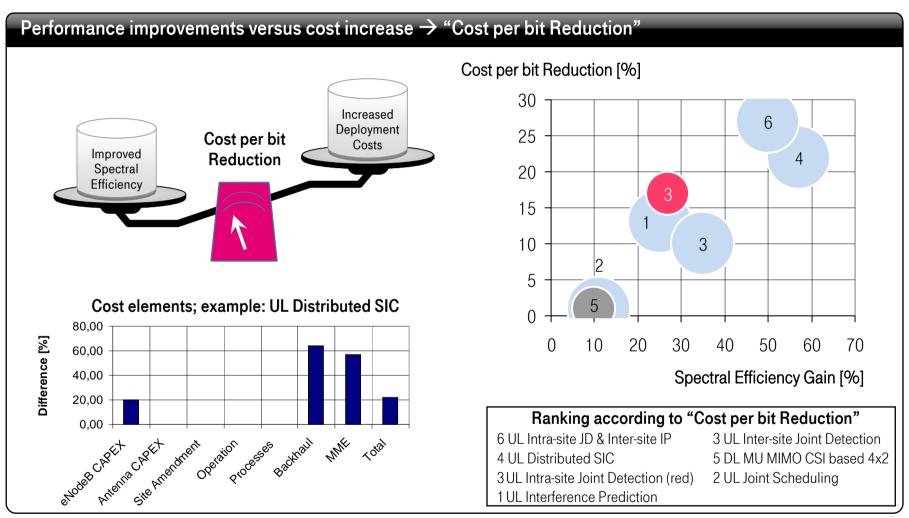
- Assessment is oriented towards relative cost figures.
- The relationships between the different cost elements shall be as realistic as possible.

**Clustering Rules** 

- Assumptions on rules for building of CoMP cooperation clusters must be aligned between performance evaluation and deployment scenarios.
- Cluster building is based on received power levels as well as on signal arriving times at the receiver (guard interval violation not allowed).

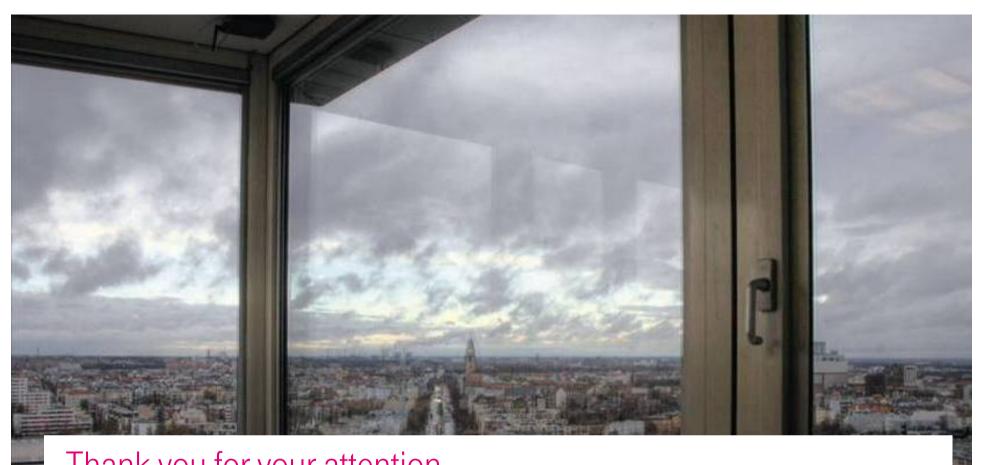


## Economic Assessment of LTE-A key technologies.



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Thank you for your attention.