



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

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Project Field „Intelligent Wireless Technologies & Networks“



# Mobile Networks – enabler for connected life & work.

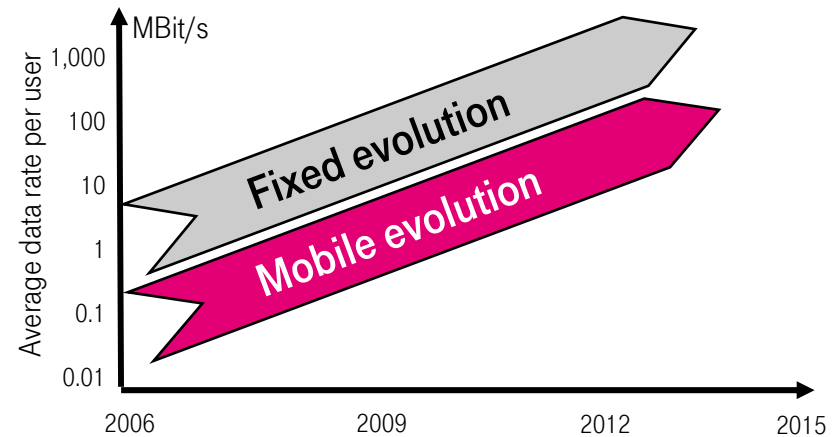
## Customer demands

- 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.
- Data rate capabilities double about every 18 months.
- Data rates of mobile technologies are about a factor 10 ... 25 below fixed technologies\*.

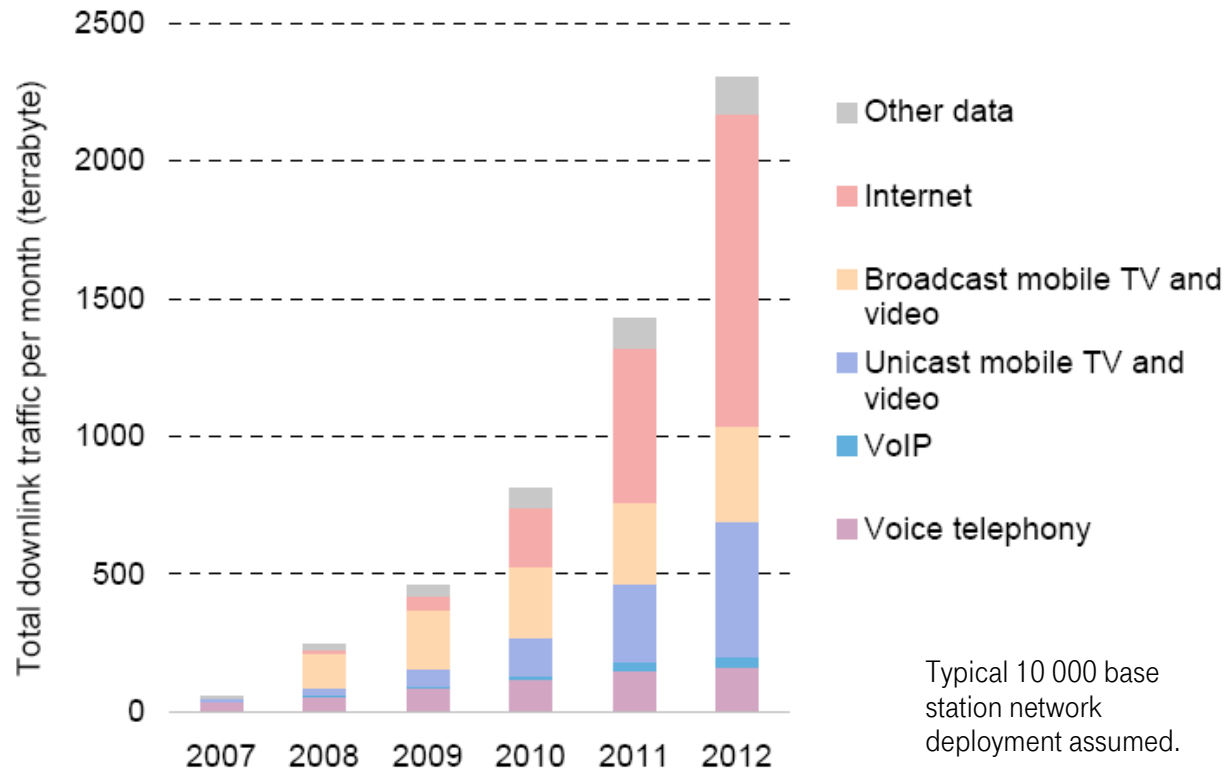


\*) WLAN (Wireless Local Area Networks) support similar data rates than fixed access).



# Exponential growth of data traffic in mobile networks.

Demand for future mobile communications markets and services in Europe - example.



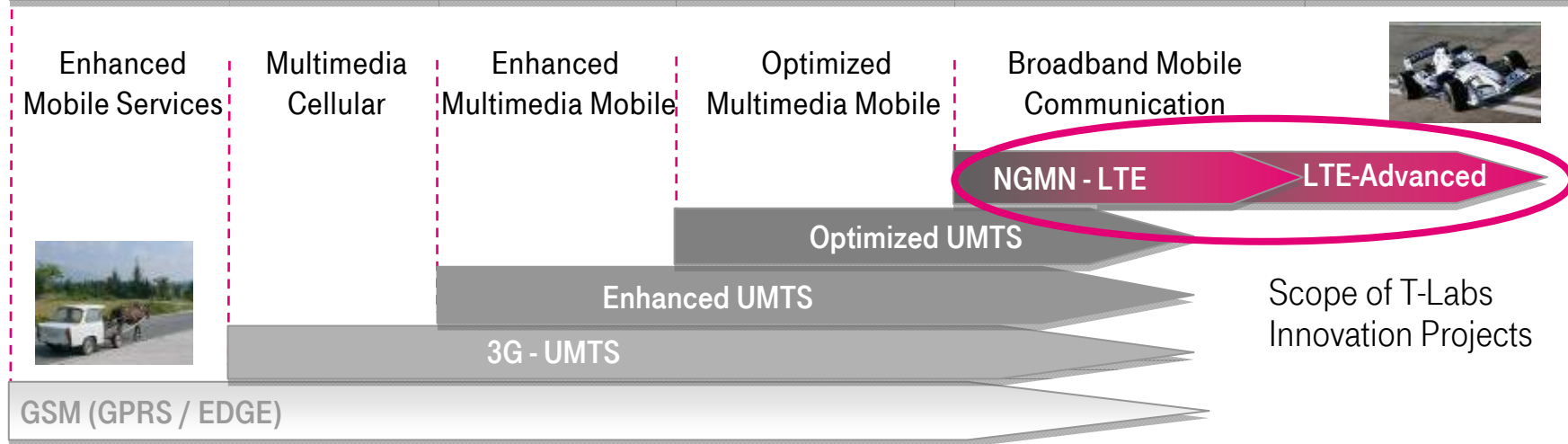
Source: Analysys Research, 2008.



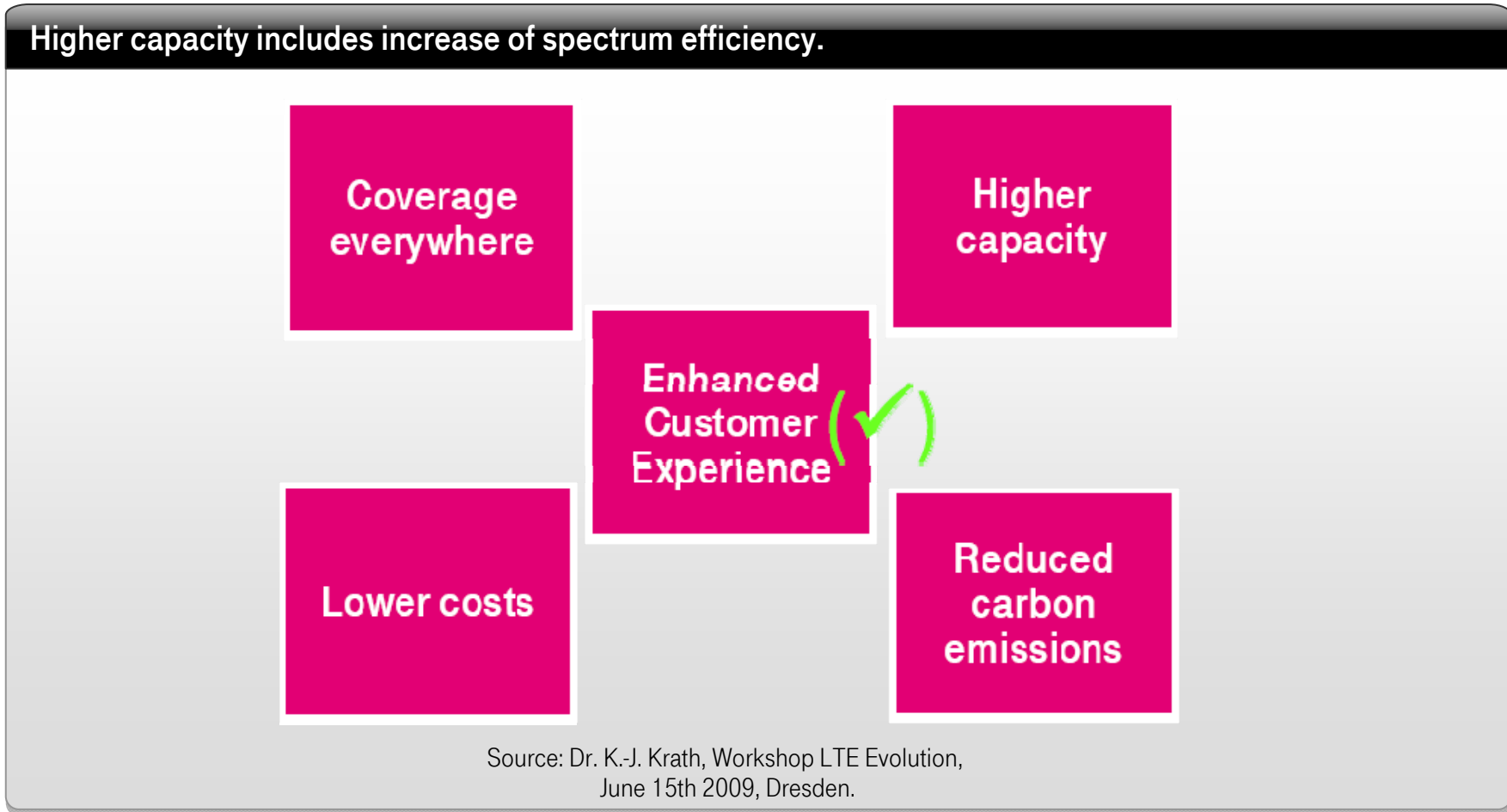
# Expected roadmap of mobile network technologies.

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

<b>GSM</b> GPRS/ EDGE	<b>UMTS</b> R99, 1st version of 3G	<b>HSDPA</b> Downlink Enhanced 3G	<b>HSPA / HSPA+</b> Downlink / Uplink Enhanced 3G	<b>NGMN - LTE</b> Broadband radio, IP based architecture Future Wireless Cellular	<b>LTE-Advanced</b> Enhanced LTE with new radio concepts
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# Future challenges for mobile network operators.



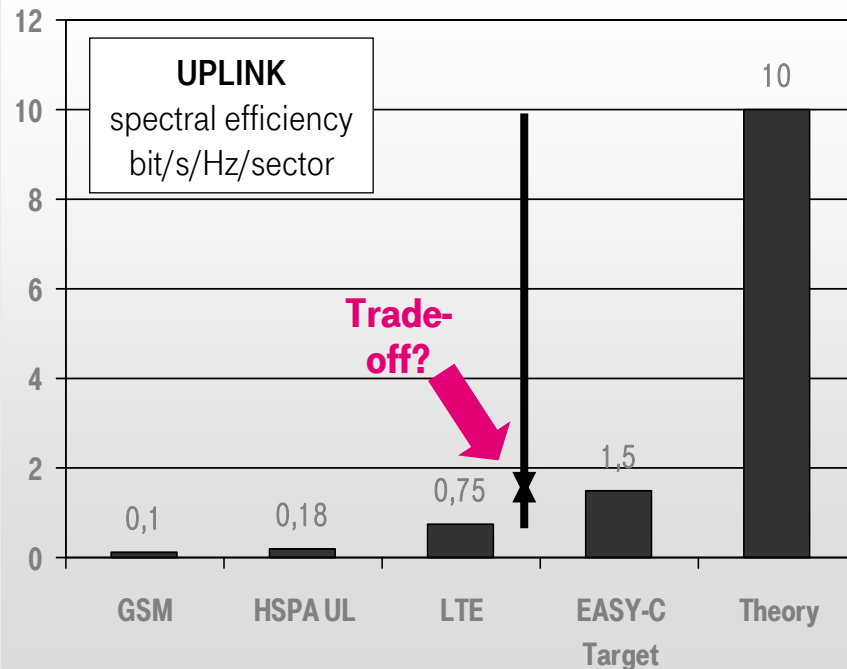
Source: Dr. K.-J. Krath, Workshop LTE Evolution, June 15th 2009, Dresden.



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

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

### Example: Uplink network MIMO



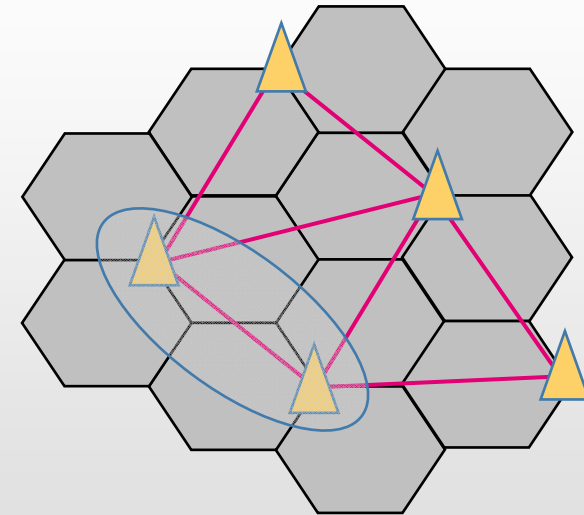
- **Vision & theory:** If channel conditions of all mobiles were available in the whole network simultaneously, transmission capability could be increased enormously.
- **Practical constraints:** If at all (from a current perspective), this can only be achieved using very expensive high-performance networking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



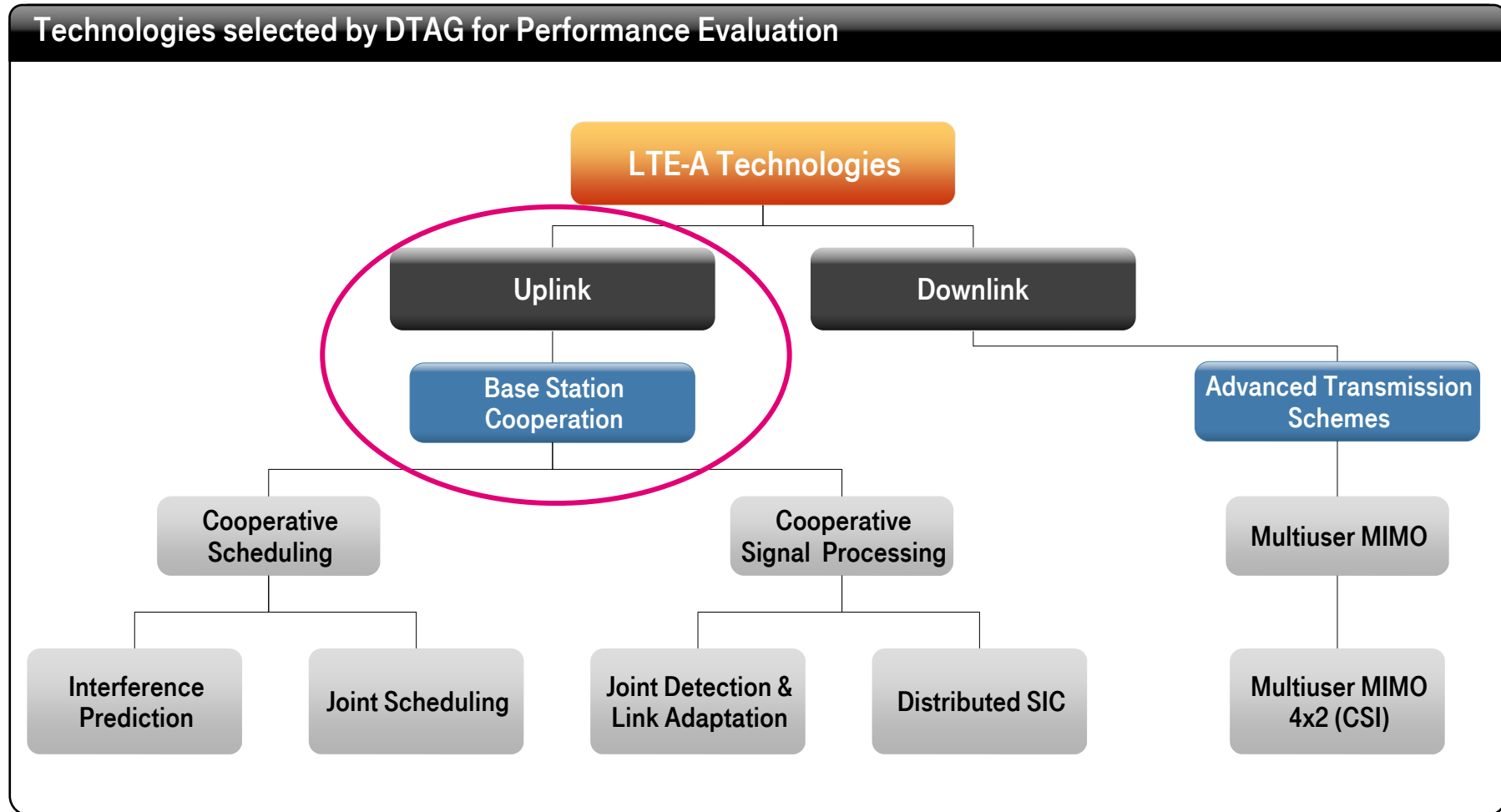
# Key technologies for LTE-Advanced.

## 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.

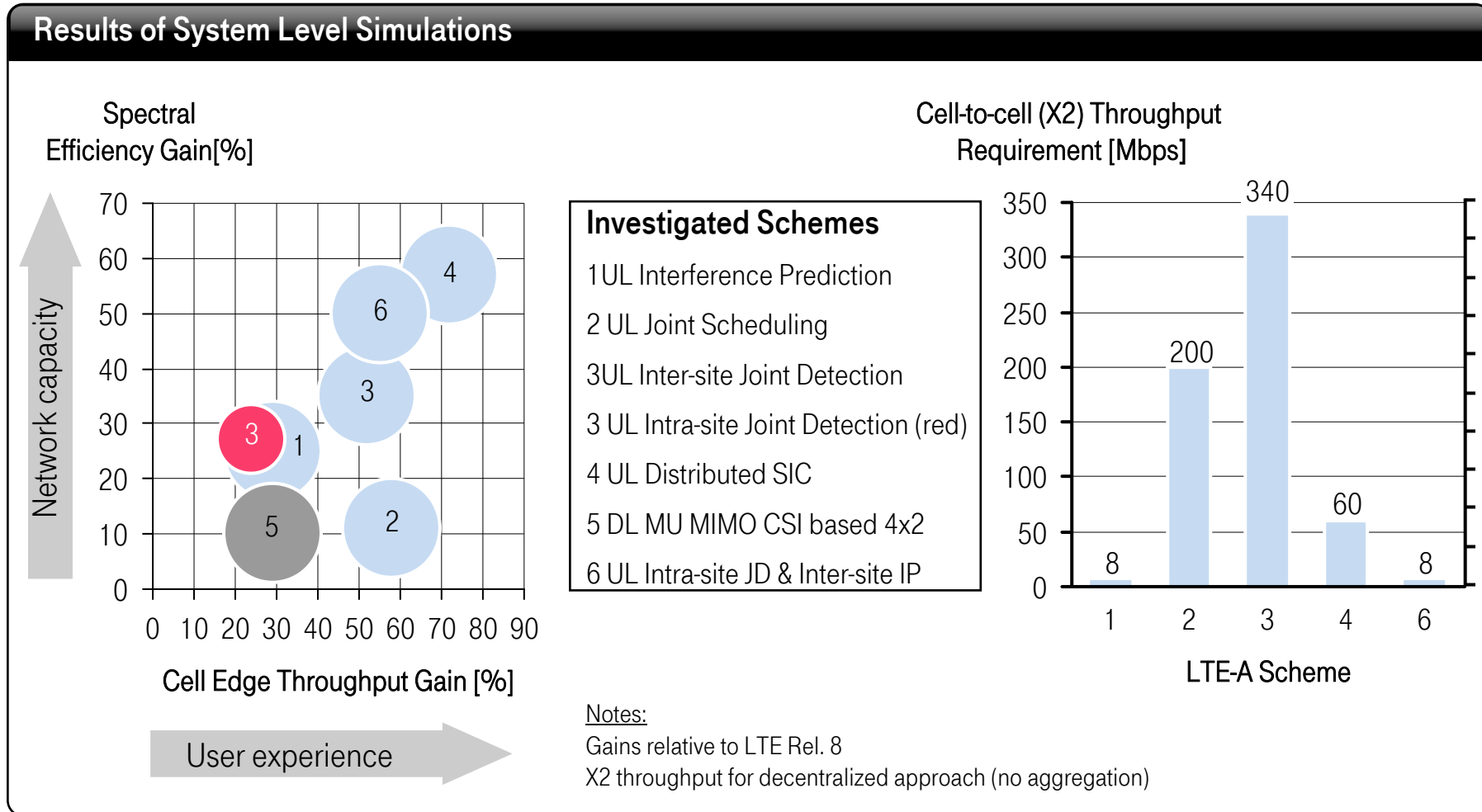


SIC = Successive Interference Cancellation; CSI = Channel State Information





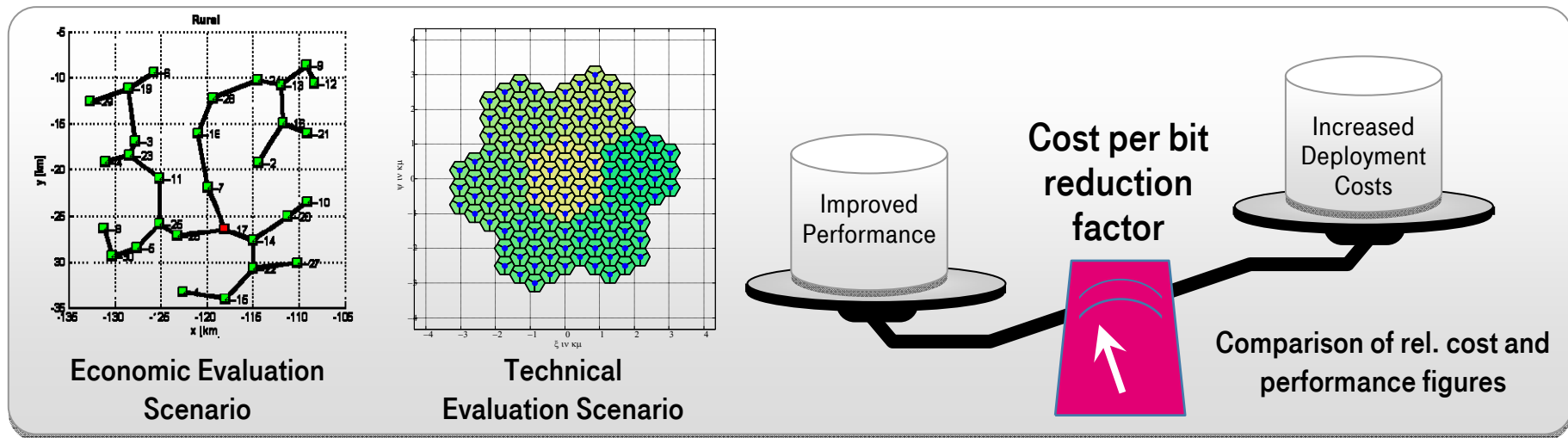
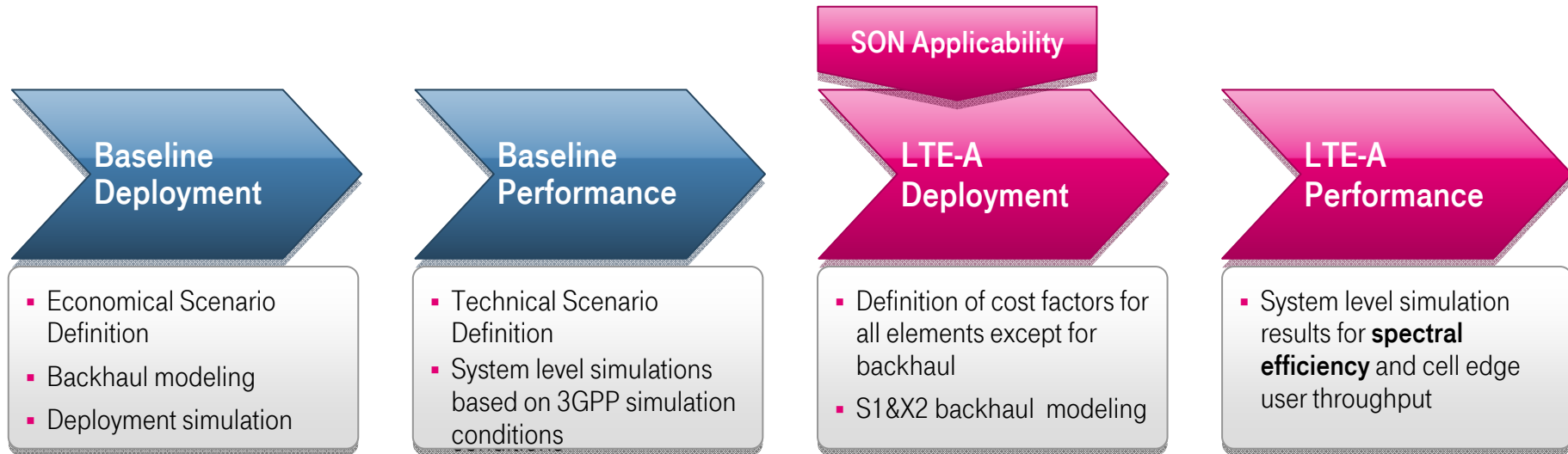
# Performance improvements and backhaul requirements.



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



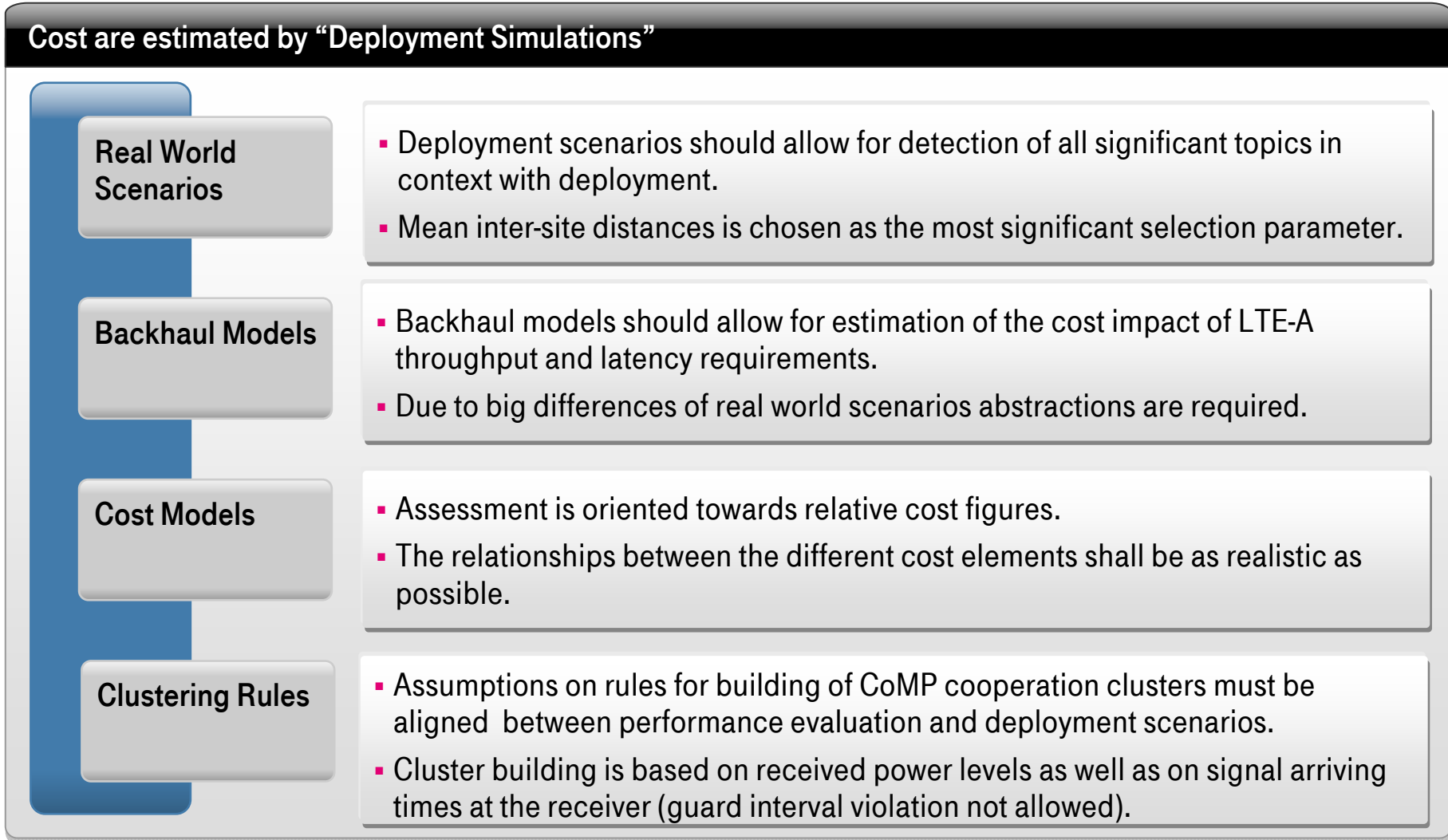
# Approach for Economic Assessment of LTE-A key technologies.



SON = Self Organizing Networks

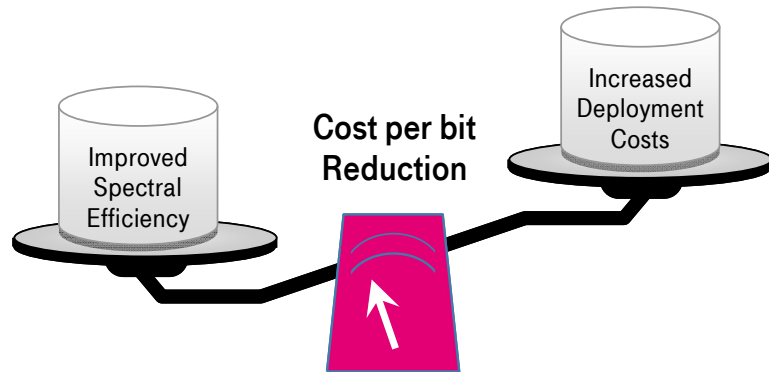


# Economic Assessment of LTE-A key technologies.

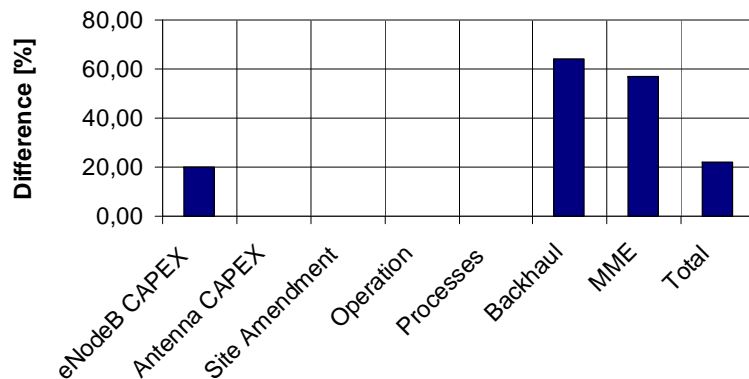


# Economic Assessment of LTE-A key technologies.

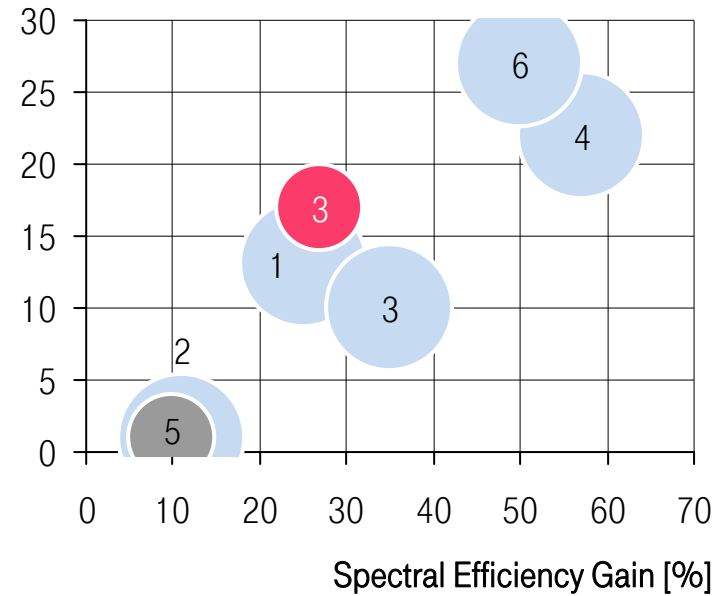
Performance improvements versus cost increase → “Cost per bit Reduction”



Cost elements; example: UL Distributed SIC



Cost per bit Reduction [%]



Ranking according to “Cost per bit Reduction”

- |                                       |                                 |
|---------------------------------------|---------------------------------|
| 6 UL Intra-site JD & Inter-site IP    | 3 UL Inter-site Joint Detection |
| 4 UL Distributed SIC                  | 5 DL MU MIMO CSI based 4x2      |
| 3 UL Intra-site Joint Detection (red) | 2 UL Joint Scheduling           |
| 1 UL Interference Prediction          |                                 |

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





Thank you for your attention.

