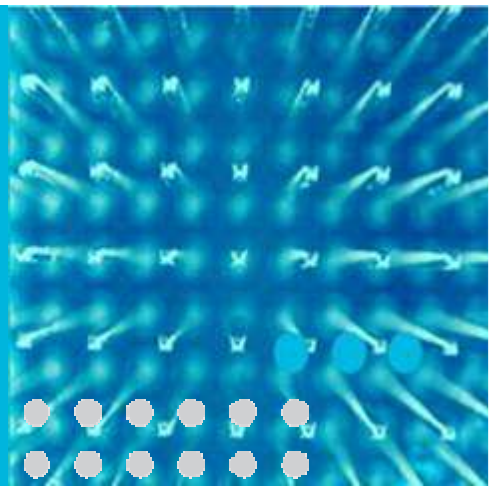
LTE-Advanced Field Trial
Coordinated Multipoint Reception



Uwe Dötsch, Bell Labs

July-2010

Motivation

Coordinated multipoint transmission / reception (CoMP)

- Candidate technology for LTE-Advanced (a.k.a. network MIMO)
- Enhance cell edge spectral efficiency
  - More consistent QoS throughout the network
  - Enhanced user experience

CoMP particularly promising in UL

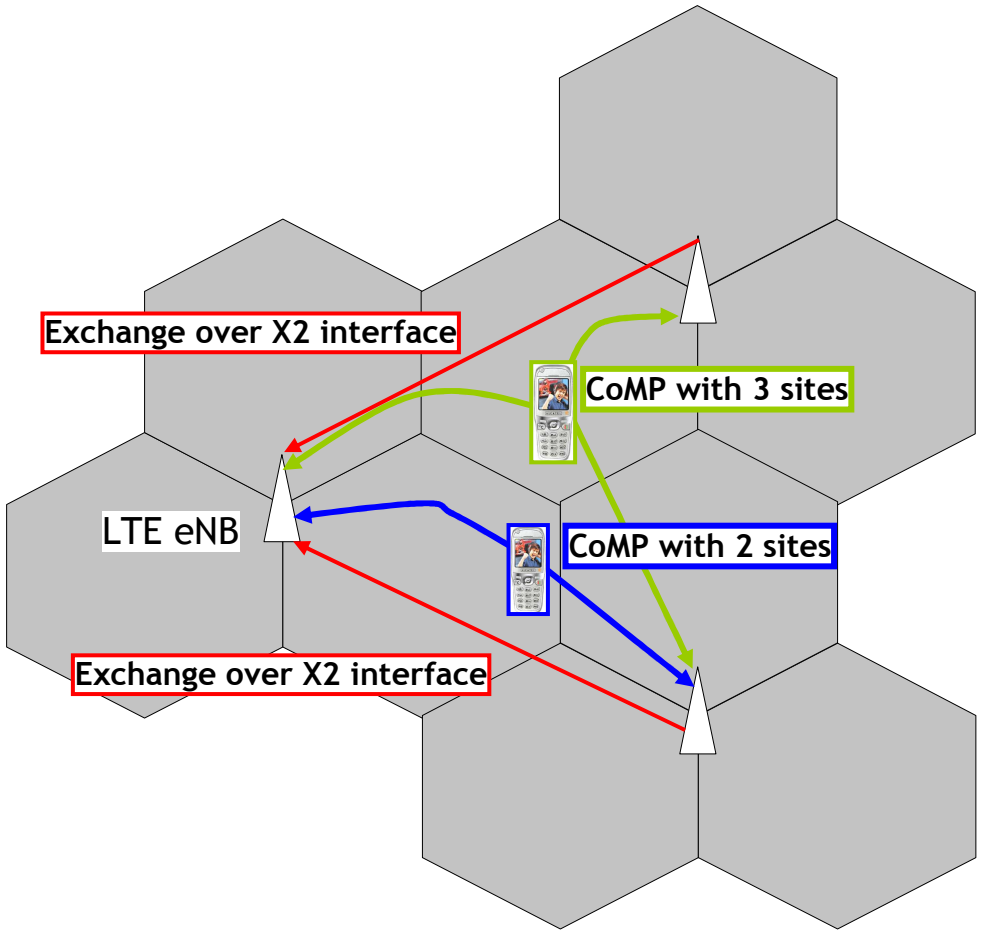
- UE transmit power limitation at cell edge
- Coherent combining can be realized w/o changes of LTE air interface and w/o changing the total number of antennas in the network
- Significant UL throughput gains observed in simulations

Objectives:

- Prove feasibility of UL CoMP in realistic LTE environment
- Quantify macro-diversity gains of UL CoMP in the field

UL CoMP basic principle

- UL signal from one user is received in multiple cells
- Radio resources allocated multiple times, i.e. multi-user MIMO over multiple cells
- Coherent combining of UL signals in a central unit
- Transfer of I/Q samples or soft bits to the central unit
- Over X2 interface or using a distributed RF architecture



Framework

Field trials within EASY-C research project

- UL CoMP drive test conducted in Berlin testbed

Partners in Berlin trial:

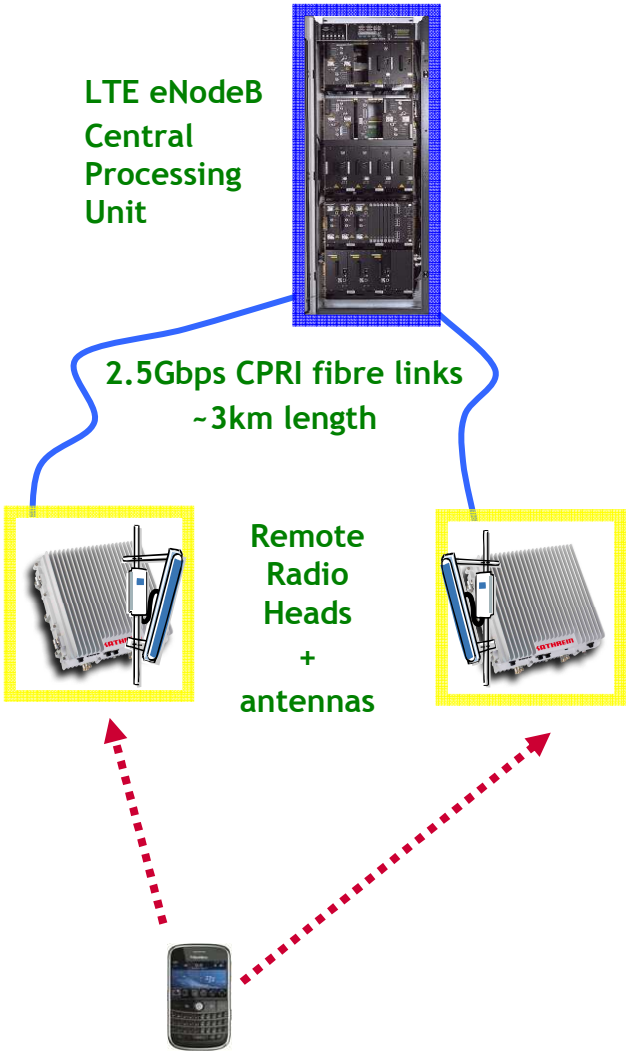
- Alcatel-Lucent Bell Labs: LTE eNB central processing
- Deutsche Telekom Laboratories (T-Labs): antenna sites, fiber links, van
- Fraunhofer Heinrich Hertz Institute (HHI): Berlin testbed
- Kathrein: remote radio heads

EASY-C research project:

- Key technologies for next generation cellular networks
- Funded by German government
- Partners from academia and industry
- Mobile network operators: T-Mobile and Vodafone
- Two testbeds in Berlin and Dresden

www.easy-c.com

LTE UL CoMP setup (4Rx)



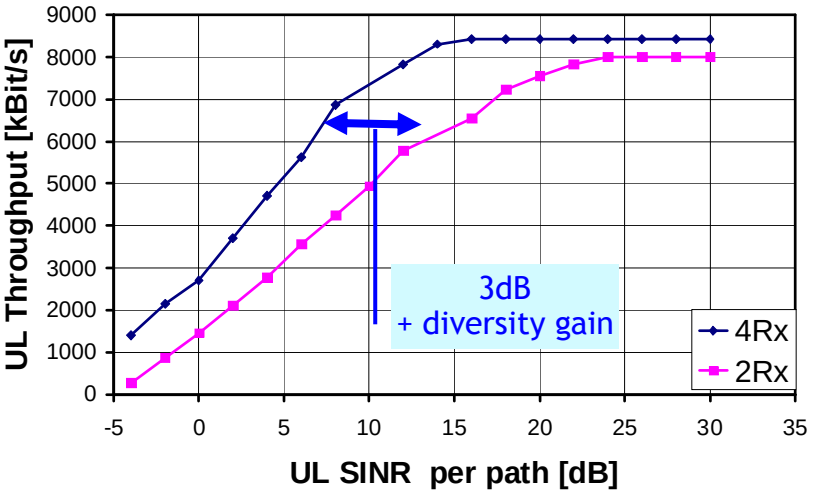
Architecture:

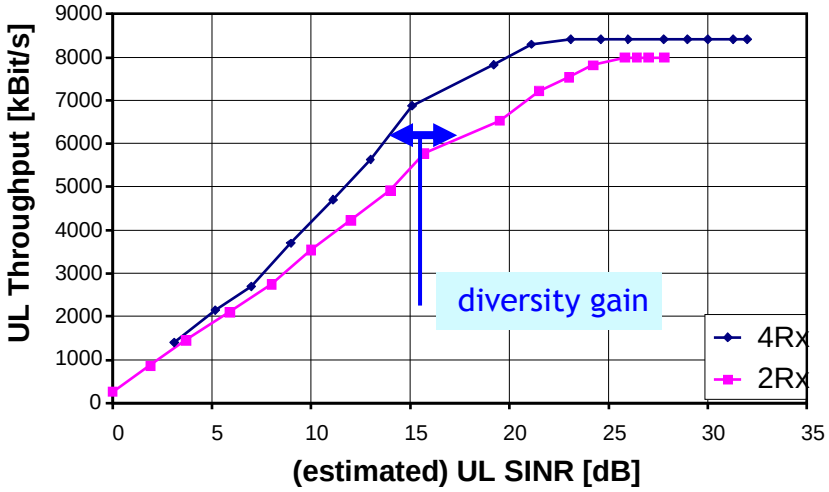
- Central processing unit + two distributed remote radio heads (RRH) with two cross polarized antennas each
- 1st RRH on T-Labs building
- 2nd RRH on Technical University Berlin
- About 570m distance between RRH sites
- RRHs connected via CPRI optical fibre links
- Length of fibre links ~3km

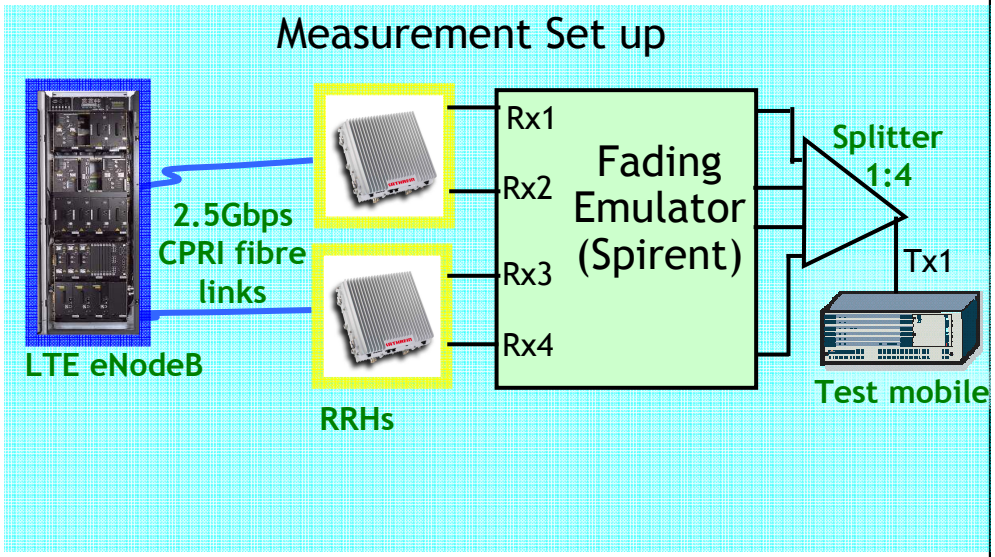
System parameters:

- 2.6GHz carrier
- 5 MHz bandwidth
- UL peak data rate = 8.5 Mbps (16QAM SIMO)

UL COMP Lab measurements with 2Rx and 4 Rx for fading profile





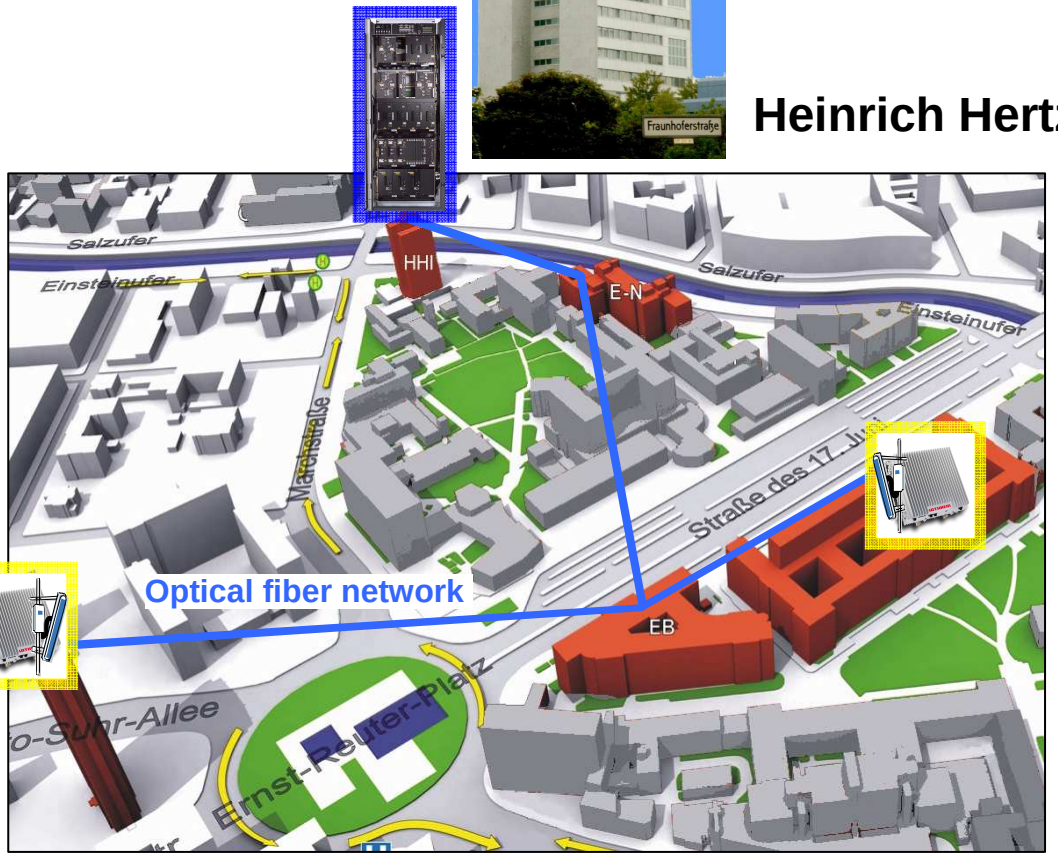


Main results:

- Gains confirmed
  - increased received energy for 4RX vs. 2RX → 3dB
  - plus diversity gain depending from fading channel

Field Test Berlin

Heinrich Hertz Institute



User equipment carried in van

~570m distance

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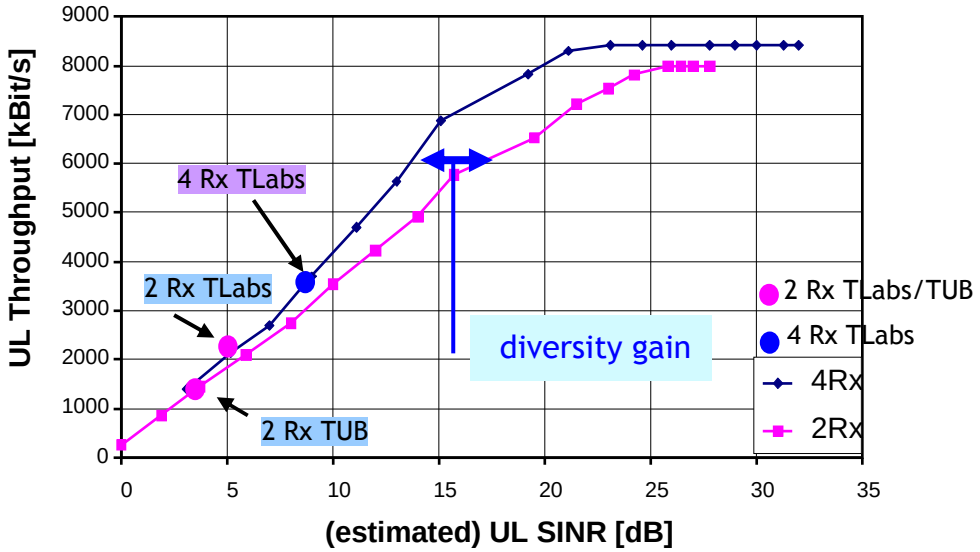
Consistency Check : Static user @ cell edge

Simulated a cell edge situation:

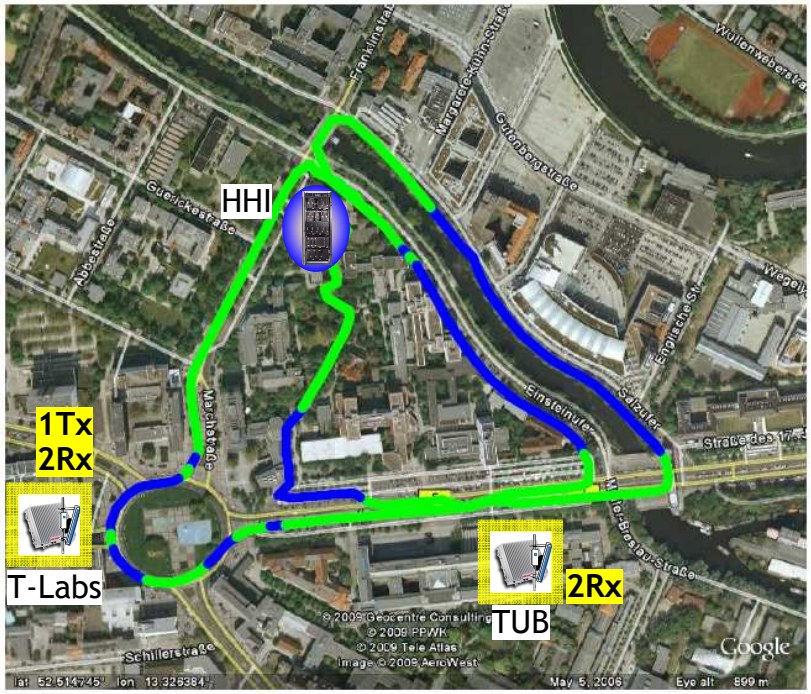
- Static UE was positioned outside HHI (cell edge position, no velocity)
- Lab measurements for comparison



- static field measurement matches lab data
- approximately 4 dB gain in SINR
- 80 % throughput gain

Determination of serving cell

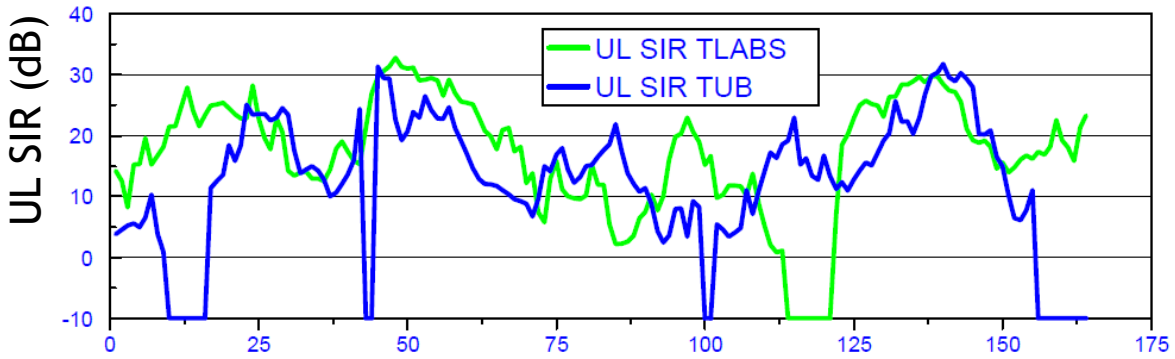
Mapping of strongest Cell for drive route



- T-labs site dominates
- Handovers would not be too frequent

2Rx UL SIR T-Labs > UL SIR TUB

2Rx UL SIR TUB > UL SIR T-Labs



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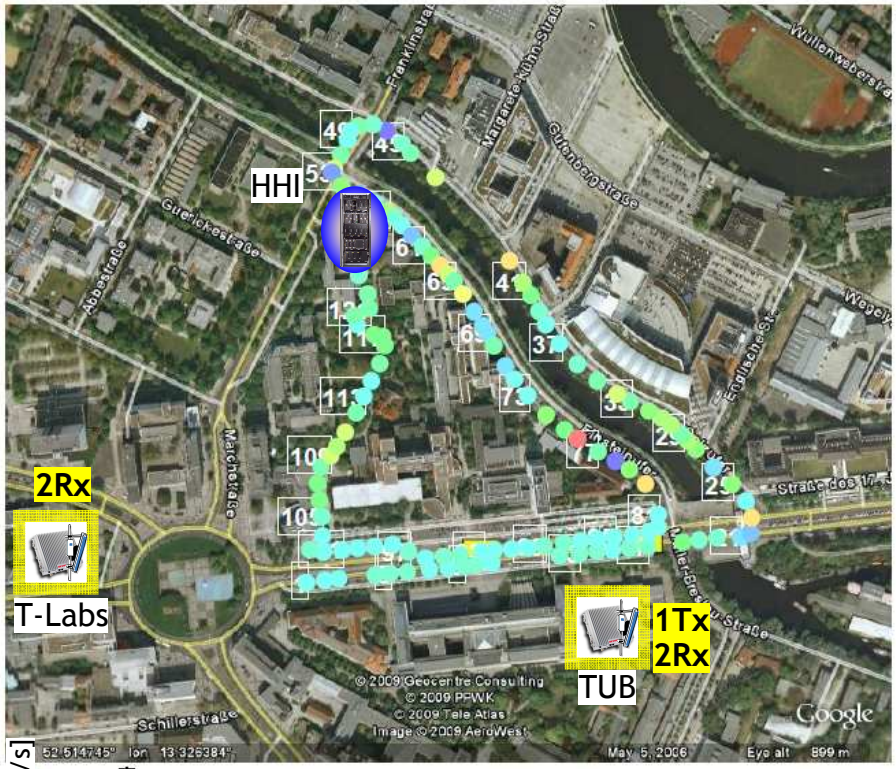
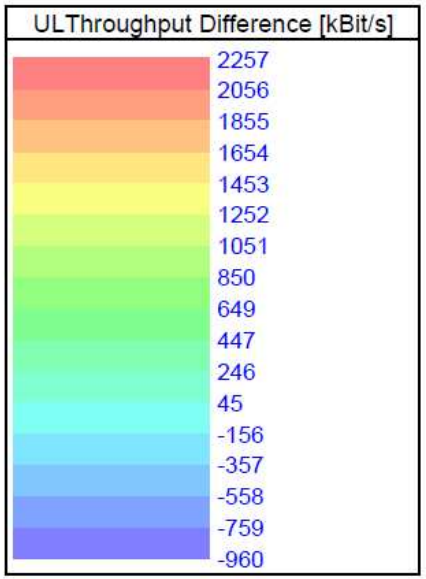
UL Throughput gain of Macro Diversity compared to 2Rx Handover

Serving Cell TUB

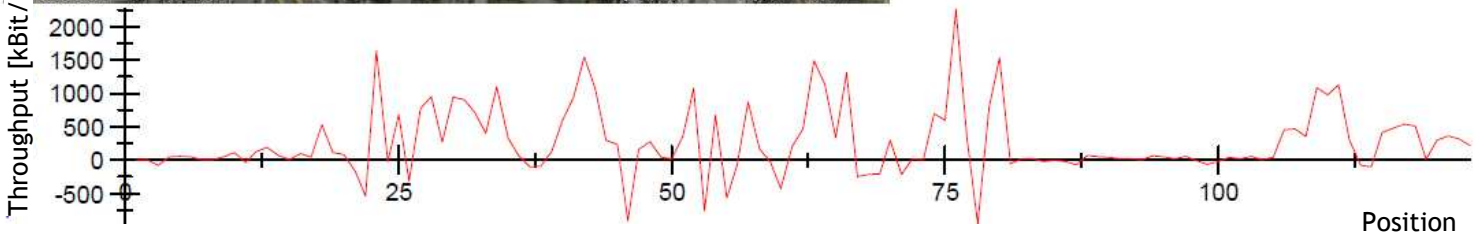


Difference UL Throughput
Macro Diversity (2Rx x 2Rx) - Rx Diversity (2Rx)
(HO criterion SIR threshold 0 dB)



Serving Cell TUB

Significant Macro Diversity gain compared to Handover Scenario with 2 Rx for SIR threshold 0 dB



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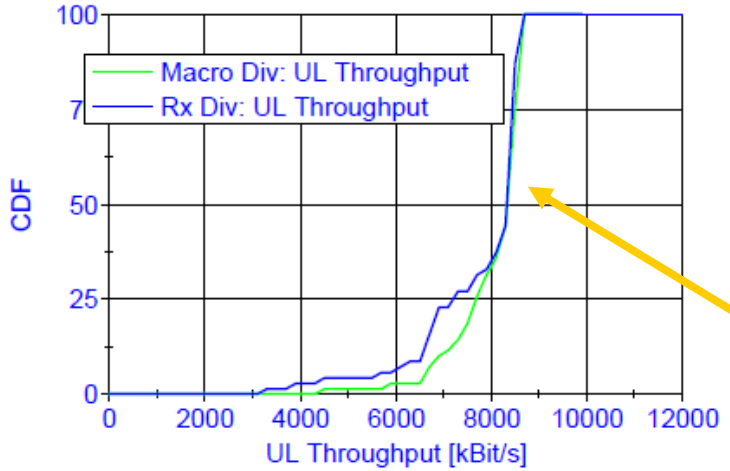
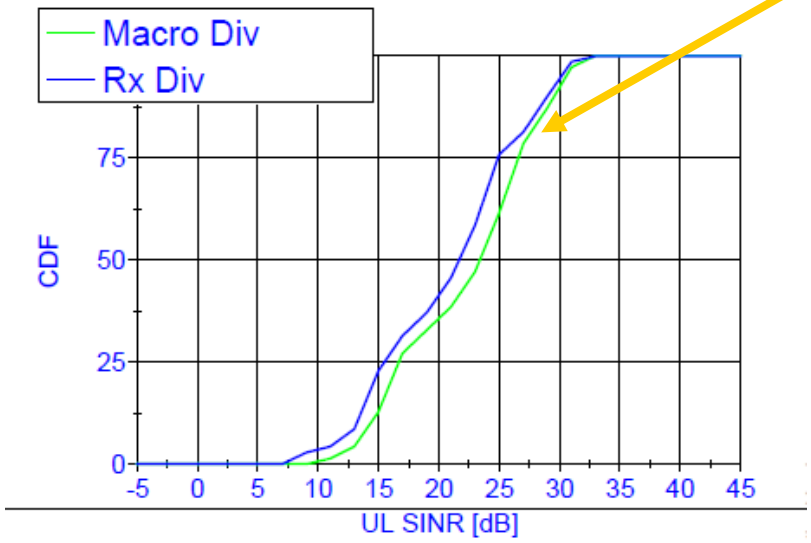
TLabs Site: Macro Diversity compared to 2Rx Handover



Serving Cell: TLabs

Significant throughput improvement with Macro Diversity compared to Handover Scenario with 2 Rx for SIR threshold 0 dB

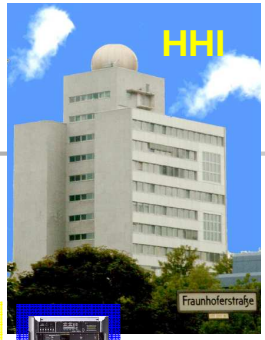
SINR gains, but throughput limited by modulation
→ 64 QAM would help here



Serving Cell: TLabs

Significant improvement of UL SINR for the Macro Diversity Case

Field Test Berlin



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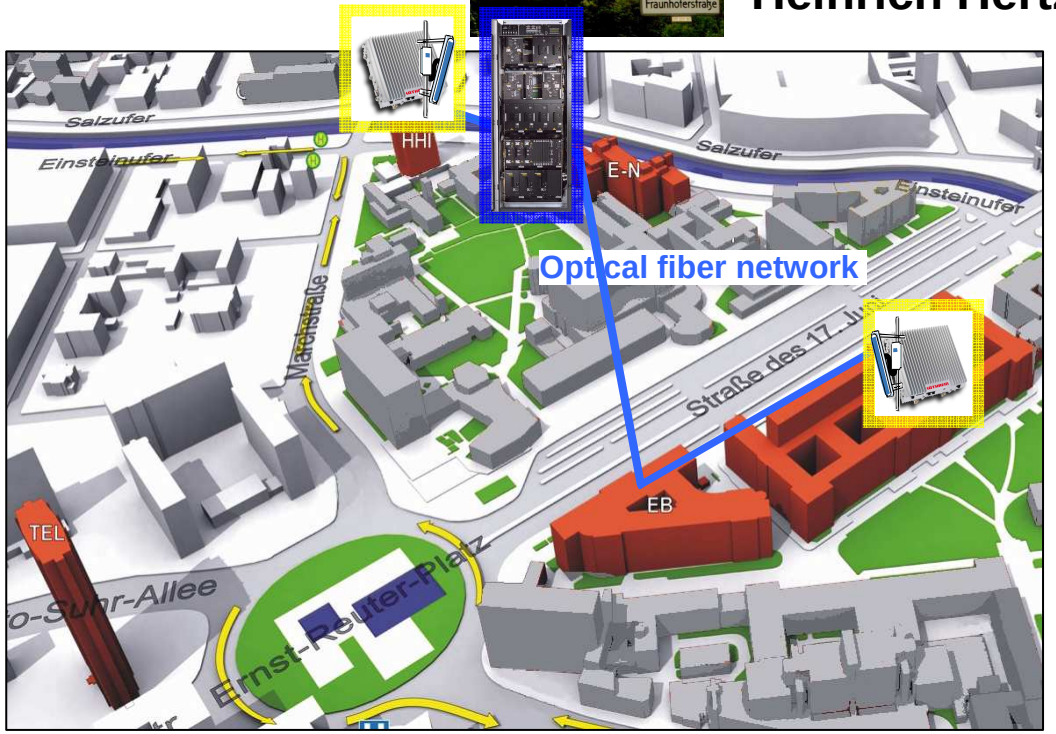

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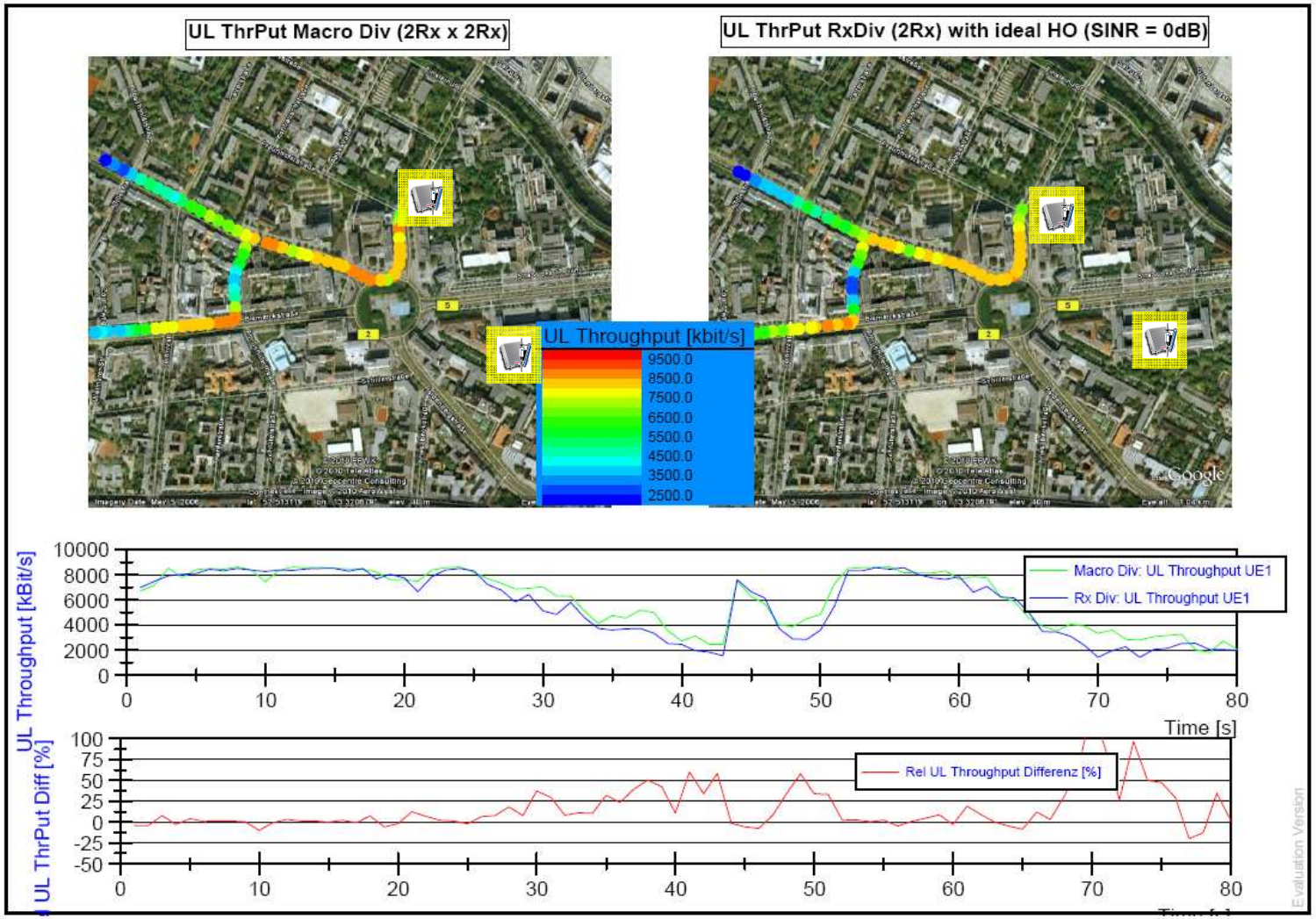
Throughput improvement



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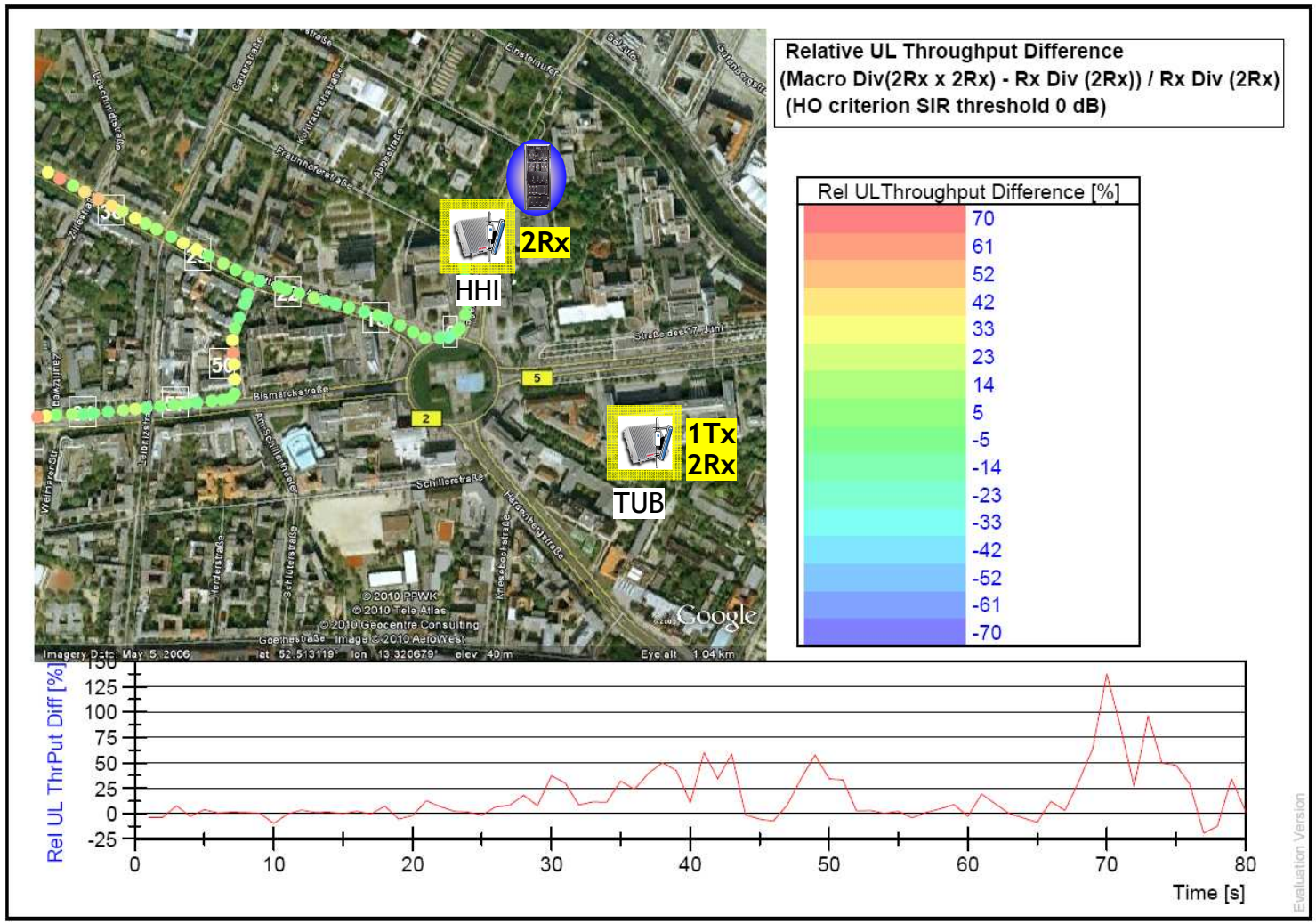
Throughput improvement



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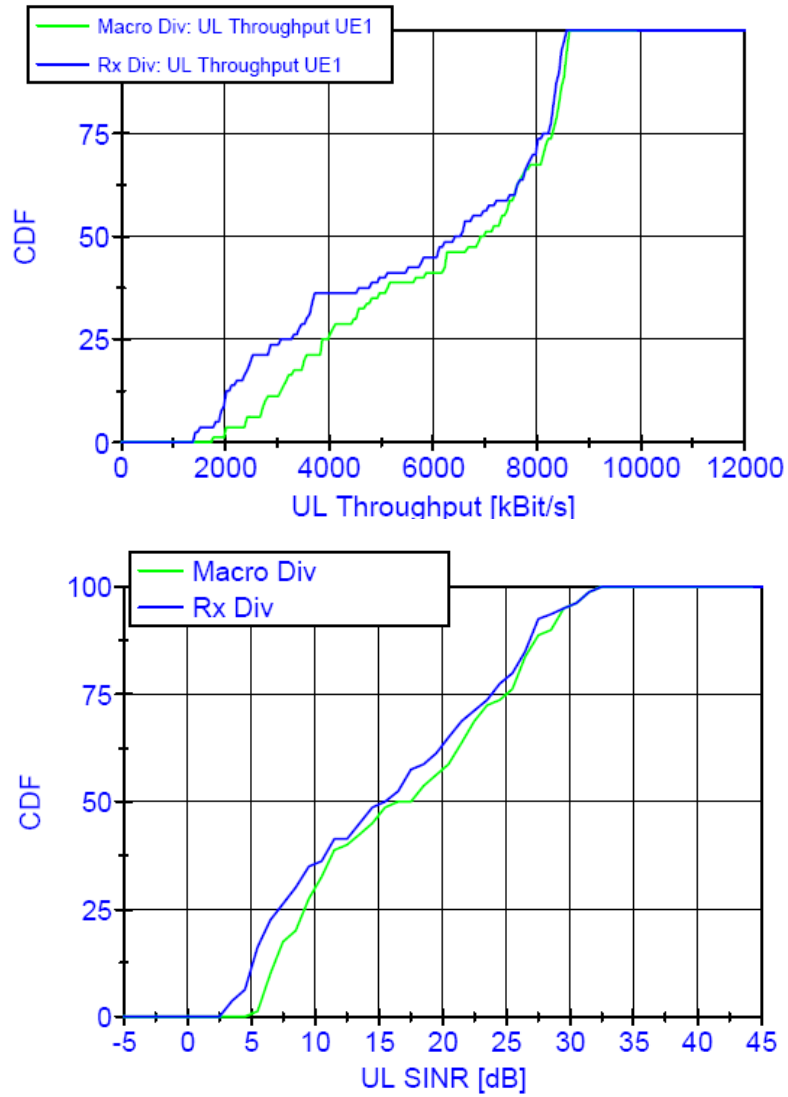
Throughput and SNR improvement



Throughput CDFs show the improvement in throughput and SINR

Summary

Industry's first live field test of CoMP in LTE network

Feasibility of UL CoMP in realistic LTE environment has been proven

- Central processing with distributed RRHs (>500m apart)
- Digital Baseband transmission over optical fibers of ~3km length
- UL coherent combining validated for MMSE receiver
- No issues with optical transmission delay
- Receiver can handle delay spread and alignment of timing advance

Quantitative results of test:

- Significant UL throughput enhancements observed for user at cell edge
- Potential improvement identified for 64 QAM modulation

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