



# Solutions on HetNet Mobility Robustness and Traffic Offload

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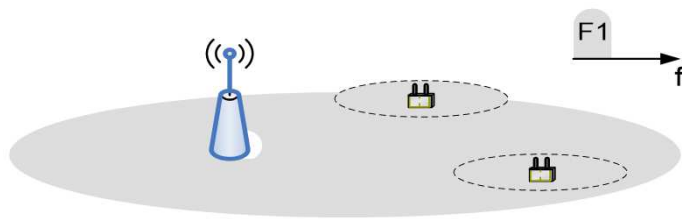
# Company Facts – NoMoR Research

- ▶ Industry: IT Telecommunication
- ▶ Headquarter: Munich, Germany
- ▶ Founded: September 2004
  
- ▶ Background
  - Spin off from Munich University of Technology
  - Global business, cutting edge technology
  
- ▶ Business areas
  - LTE/LTE-A and future 5G is our business
  - R&D projects, system simulations and early prototyping
  - Consultancy, technology training and standardisation services
  
- ▶ Service offer to operators
  - Analyse various options to introduce small cells in your specific network or to maximize macro capacity by adding advanced LTE/LTE-A features
  - First step: Kick off activities with a 2 days joint training/workshop

# Small Cell Deployments

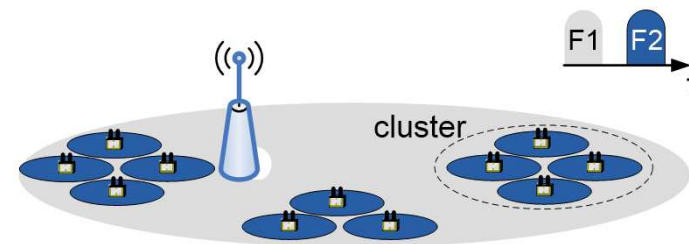
## Today's Sparse Deployment

- little inter pico interference
- no mobility between picos
- co-channel deployment macro / pico possible
- tight coordination between macro and pico essential
- Cell Range Expansion to maximize offload/better uplink



## Future (Ultra) Dense Deployment

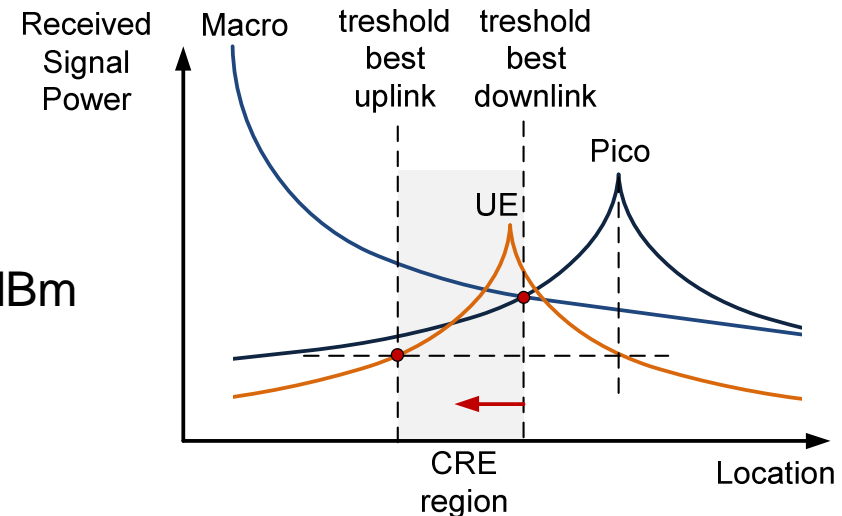
- severe inter pico interference
- mobility between picos
- different frequencies for macro / pico essential
- loose coordination between macro and pico possible
- inter-frequency handover due to lack of full coverage



Mobility is an issue in both cases, but different problems

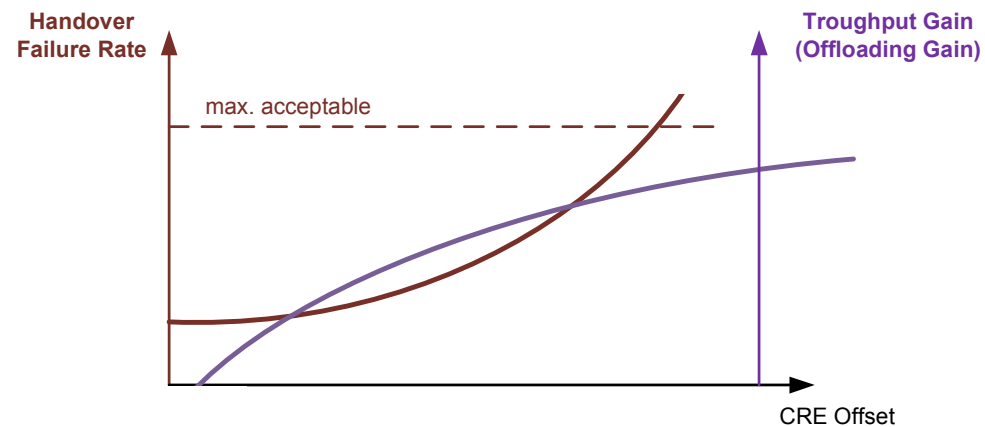
# Problem of Power Imbalance

- ▶ Cell selection/handover thresholds
  - usually based on best receive signal (best downlink)
  - ..., but best uplink would be based on lowest pathloss
- ▶ Cell Range Expansion (CRE) is when offset is added
  - to improve uplink
  - to increase cell size
    - ➔ maximize offloading
- ▶ CRE region
  - equal to UL/DL imbalance
  - e.g. macro 46dBm - pico 30dBm = 16 dB CRE region
  - adaptive per cell CRE algorithm possible
- ▶ CRE and offloading is limited by mobility issues
  - strong interference in downlink causes PDCCH failures



# Tradeoff: Handover Failures - Offload Gain

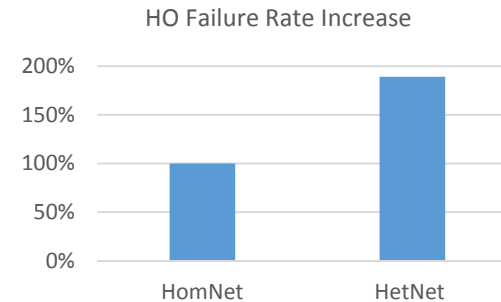
- ▶ With CRE offset, macro interference gets critical
- ▶ CRE offset might be limited due to HO failure rate
  - trade-off between offloading effect and mobility problems



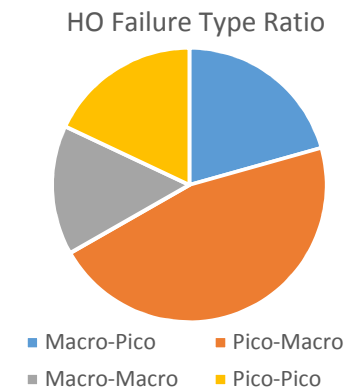
- ▶ New LTE-A technologies improve HetNet operation
  - Enhanced ICIC (Rel.10) using Almost Blank Subframes
  - FDM based ICIC using HetNet Carrier Aggregation (Rel.10)
  - UE Inter-cell Interference Canceller and FeICIC (Rel.11)
  - Enhanced PDCCH Control Channel (Rel.11)

# HetNet Mobility Performance

- ▶ HetNet performs worse compared to HomNet
  - more cell borders
  - smaller handover regions
- ▶ Most critical failure is pico to macro handover
  - signal strength changing rapidly within a pico cell
  - macro interference strong at the cell edge, particularly when using CRE
- ▶ SON Mobility Robustness Optimization is essential
  - simulations prove feasibility and improved robustness

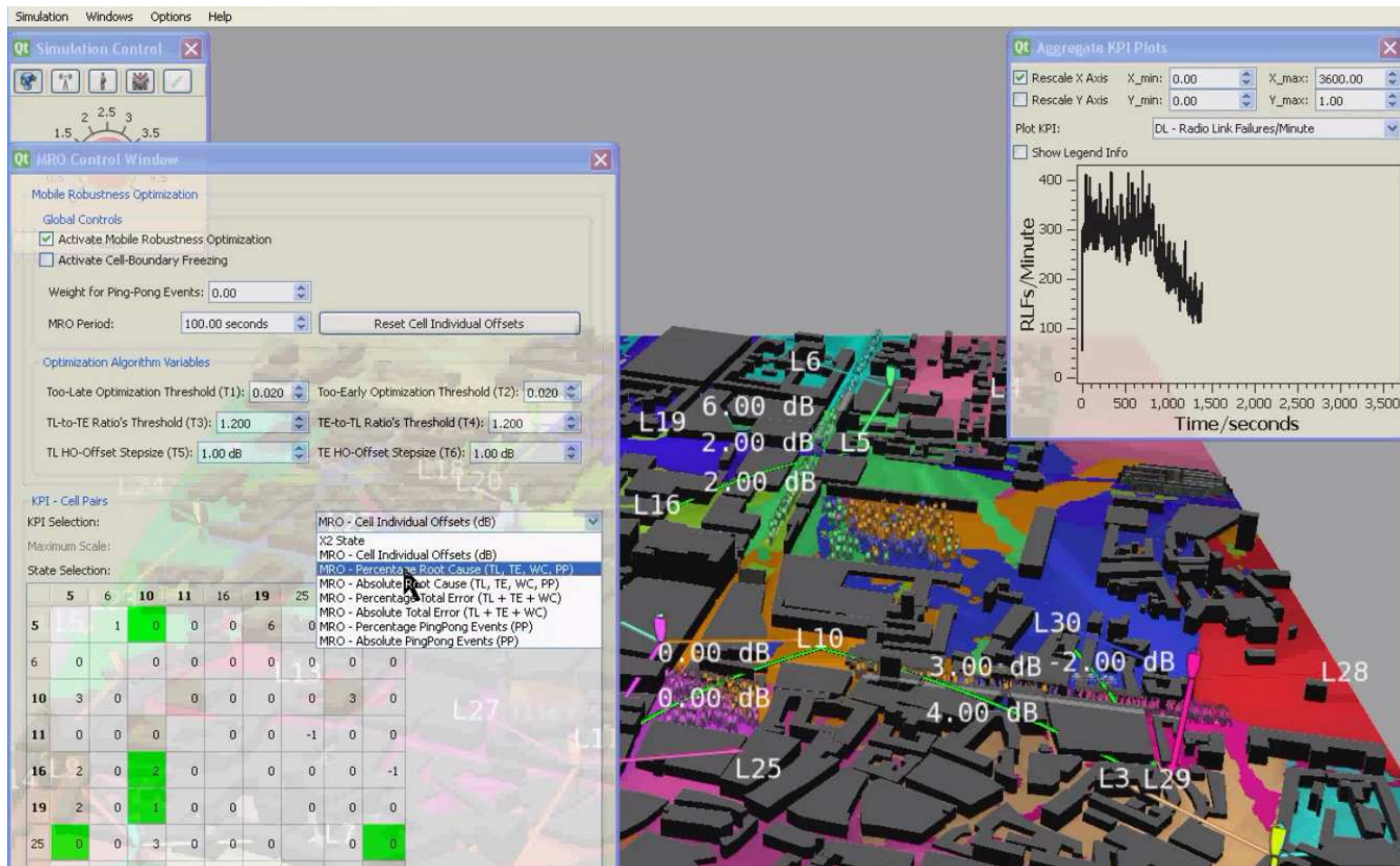


3GPP TR36.839



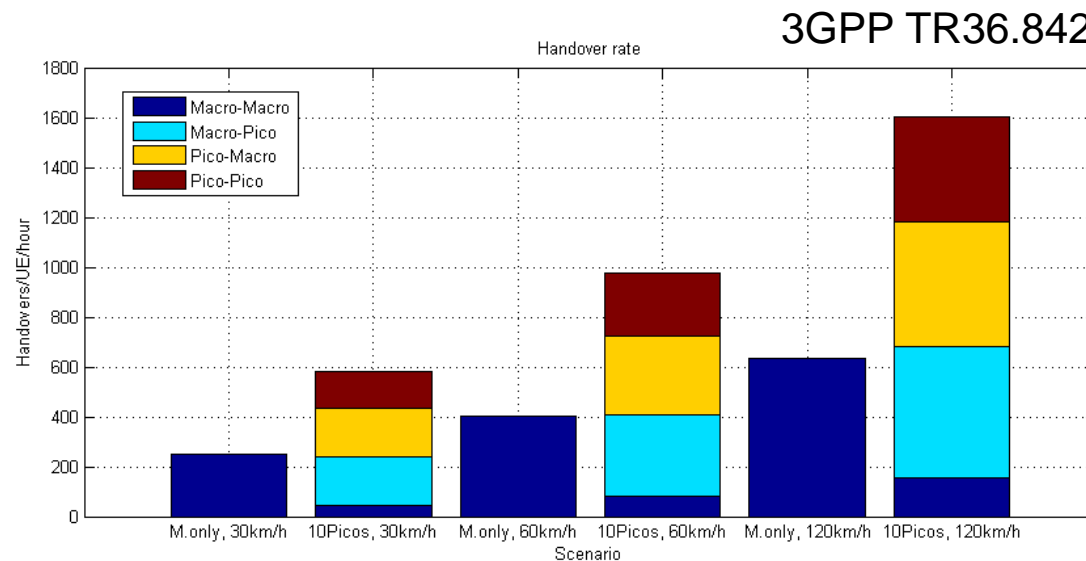
# SON Simulation Example

- dynamic system simulator, SON MRO optimization, Munich city centre
- adaptation of Cell Individual Offset to minimize HO failures and Ping Pongs



# Increase of Signalling Load in HetNets

- ▶ Besides mobility issues, each handover also adds signalling load to the core and backhaul traffic



- ▶ Impact on user experience and network complexity
  - increases with of number of small cells
  - increases with the user mobility

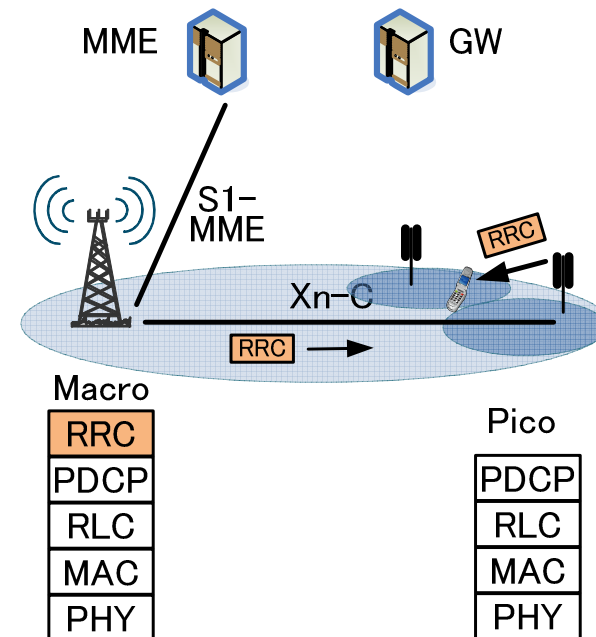
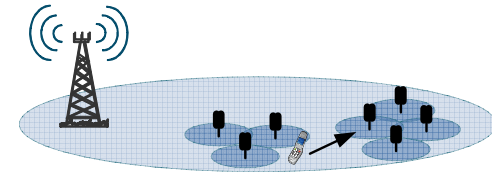


# Observations

- ▶ HetNet mobility performance is inferior to HomNet
  - Number of handovers and handover failures will increase
  - Pico to macro handover shows worst performance
- ▶ User's Quality of Experience is affected by handover and depends on backhaul realisation and characteristics
- ▶ Intelligent SON algorithms such as MRO are essential
- ▶ Impact of UE speed on mobility is significant
  - Fast moving UEs should not be kept at small cell layer
- ▶ Mobility issues, signalling and backhaul load will increase with increasing number of cells
- ▶ New architectural options are evaluated as part of 3GPP Release 12 study on small cells

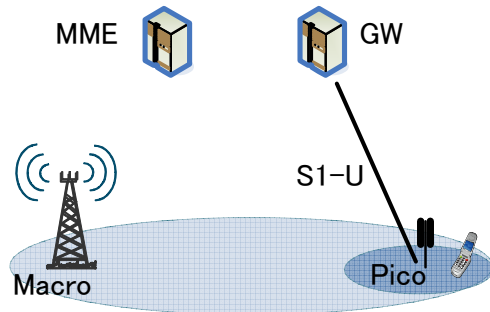
# Future HetNet Control Plane Architecture

- ▶ Can we hide pico mobility from the core?
- ▶ Yes ! S1 terminated at central site
  - ➔ no need for S1 signalling
  - ➔ no need for UE context transfers
- ▶ RRC terminated at central site
  - ➔ RRM optimized cluster
- ▶ New functional distribution
  - central site handles RRC measurements and makes optimized RRM decision
  - pico still responsible for its resources handling
- ▶ Is a new Xn interface standardized ?
  - fast backhaul preferred, not necessarily ideal



# Future HetNet User Plane Architecture

## Direct S1-U Interface to GW



Aligned with today's architecture

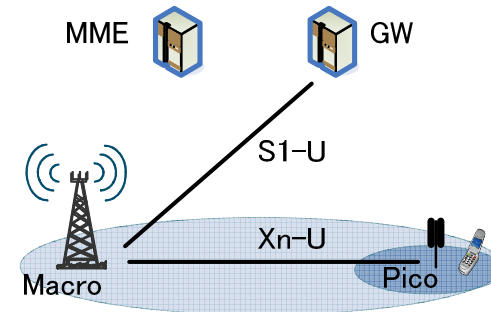
### Benefits

- minimize backhaul requirements (by local data breakout)
- improved end user latency
- distribute high rate processing complexity
- non centralized backhaul possible

### Drawbacks

- increased signalling load since mobility can not be hidden from core
- gateway must handle huge pico number

## No S1-U Interface at Pico



Fits to centralized processing architecture

### Benefits

- reduction of signalling load in core network (no path switch required within cluster area)
- RRC reconfiguration instead of handover
- allows bearer split at macro cell
- macro baseband pooling or virtualization

### Drawbacks

- burden to backhaul network routing
- macro backhaul become bottleneck
- strong impact on end to end latency

# Outlook Future HetNet's and 5G

- ▶ Larger number of small cells supported in the future
  - Deployment on different frequencies (probably in higher bands)
- ▶ Architectural options have been evaluated by 3GPP
- ▶ Control plane based on central termination point
  - Pico mobility can be hidden from core network
  - More optimized RRM decisions, no UE context transfer
  - Macro might remain anchor (no handover, but reconfiguration)
- ▶ Two user plane alternatives based on backhaul solution
  1. Ideal centralized backhaul: data routing via macro
  2. Non ideal backhaul: gateway routing, local breakout option
- ▶ Standardisation within a future release or within 5G
- ▶ Future should be considered in today's HetNet decisions

# Contact

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## Nomor 3GPP Newsletter/White Papers

- <http://www.nomor.de/home/technology/3gpp-newsletter>
- Get updates on 3GPP standardisation on quarterly basis !

## LTE Standards Discussion Forum (members > 16.000)

- <http://www.linkedin.com/groups?gid=1180727>

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