

The AMoRE Demonstrator for Real-Time System Level Simulation of LTE-Advanced Radio Networks

ITG Workshop on Simulation and Prototyping Environments for Mobile/Wireless Research

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Presentation Outline

- **Introduction to the AMoRE Simulator**

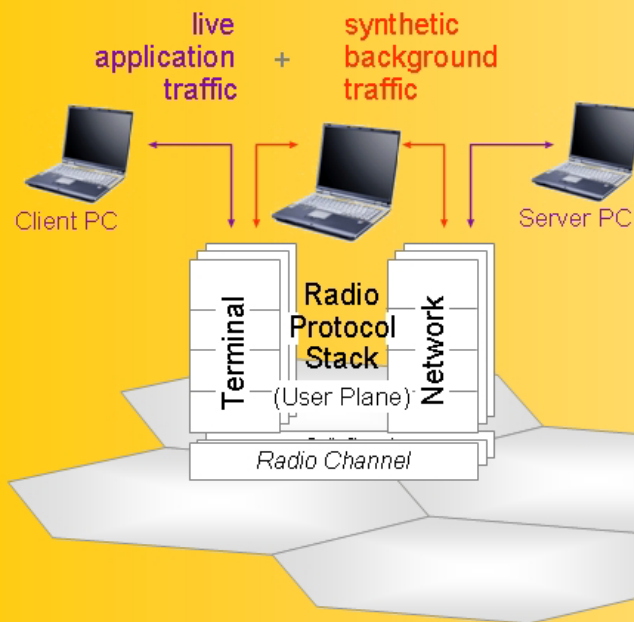
- ☞ Tool overview
- ☞ Objectives and distinctive features
- ☞ History and feature overview

- **Use Cases**

- ☞ QoS-aware scheduling and downtilt-based ICIC as offline example by screenshot
- ☞ Multi-layer co-channel HetNet with TDM eICIC as live demo → *visit demo area in next coffee break*

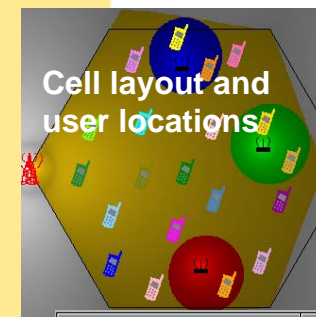
What is AMoRE ?

Advanced Mobile Radio Realtime Experience



Observe user perception and impacts on Quality of Experience

- Live applications over simulated radio network
- e.g. video, gaming, web browsing, ftp

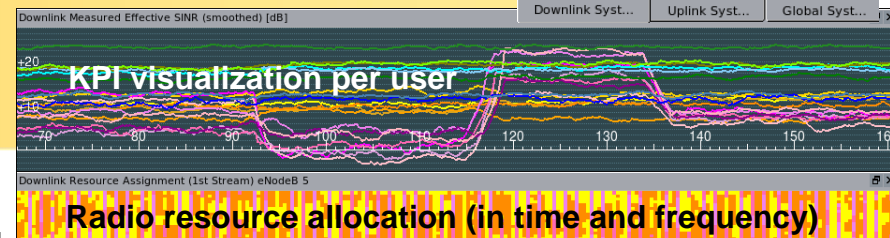


Observe system behaviour in different operating conditions

- Visualization of system operation and performance
- Interactive changes of configuration and conditions

Gain insight in future radio technology

- System level radio simulation in realtime
- Focus on PHY and MAC layers
- Multi-cell, multi-user, bidirectional



Particularities of the AMoRE Simulator

Realtime capability is paramount

- Soft criterion: responsiveness in interactive use
- Hard criterion: allow live application traffic in simulated network

System level simulation with some specialties for fast execution

- Small simulated area with „feedback model“ for interference from surrounding cells
- Simplified LL2SL interface: precomputed fading files for equivalent channel gains and time-correlated orthogonality fluctuations
- Originally: only single target cell fully modelled
new generation: use of GPGPU for multi-cell, multi-user channel computations

Interactive use for demonstration, education - and for experimental research

- GUI for condition and configuration changes at runtime
- Intuitive visualization of immediate allocation and performance impacts
- Focus on MAC layer RRM: scheduling, resource allocation, link adaptation
- Research aspect: observation of unexpected effects that might go undetected in statistical analysis

AMoRE History and Feature Set

Tool History since 2005

- HSDPA, HSUPA up to Rel-9
- LTE: Rel-8, new platform for LTE-A
- SW development by external partner (Nomor Research) exclusively for NSN

Execution Platform

- HSPA and LTE Rel-8 on conventional laptop PC under Linux



- LTE-A with multicell capability (AMoRE NG) on high-performance (laptop) PC with high-end graphics card (GPU-accelerated simulation)

AMoRE LTE Feature Set

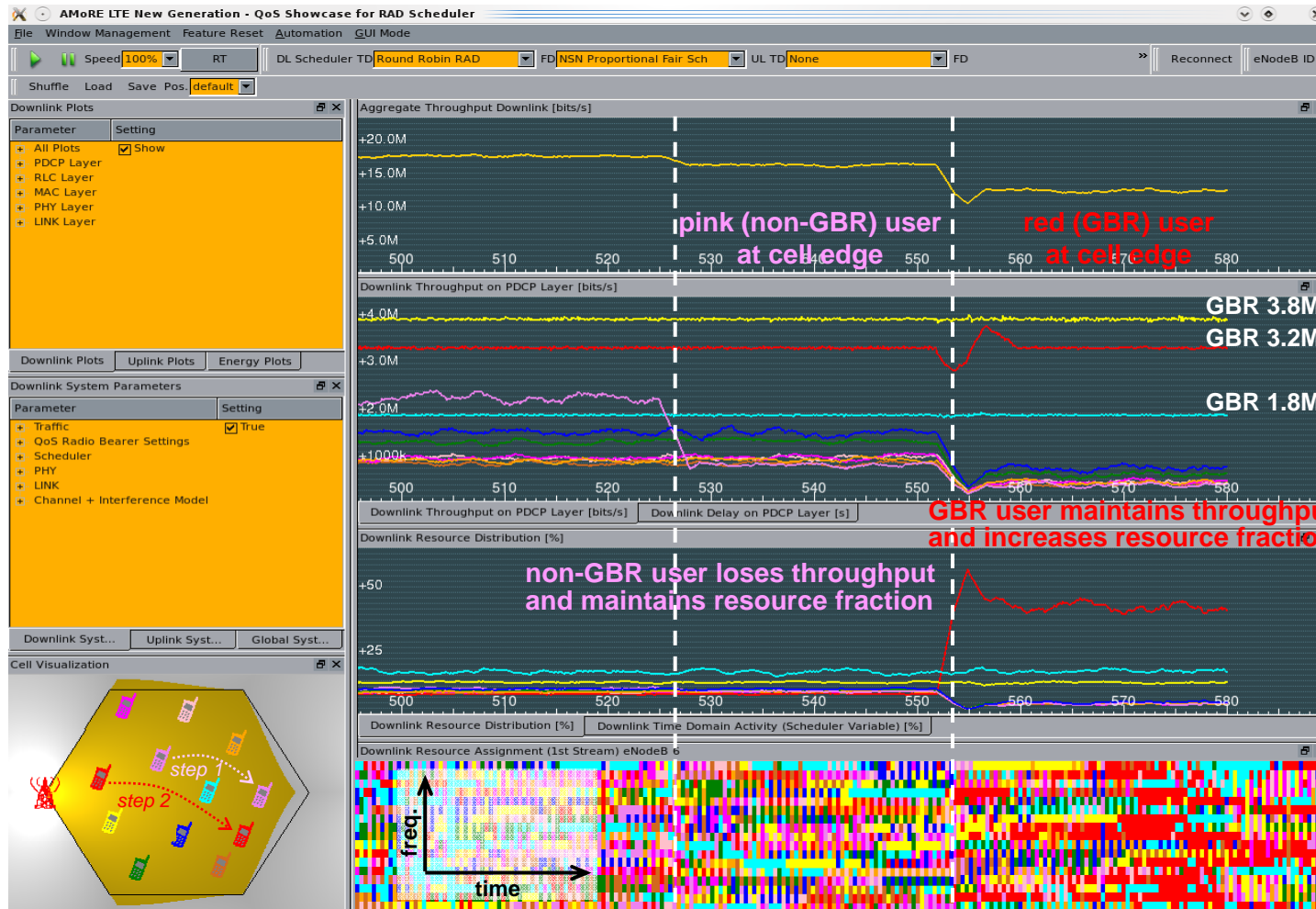
- regular hexagonal cell layout with 3-sector sites
- 2D or 3D antenna patterns
- FDD and TDD modes
- configurable bandwidth (single carrier)
- channel-aware scheduling and fast link adaptation in TD and FD
- QoS-aware scheduling on DL
- MIMO up to 4x4 antenna
- FTB or ATB and fractional PC on UL
- Beamforming (DoA) and MU-MIMO on UL and DL

Extended capabilities on AMoRE NG

- multicell configurations with UE mobility between cells
- multi-layer HetNet, new ICIC schemes
- in preparation: CoMP Joint Tx (and CS)



Example Case 1: QoS-aware Scheduling



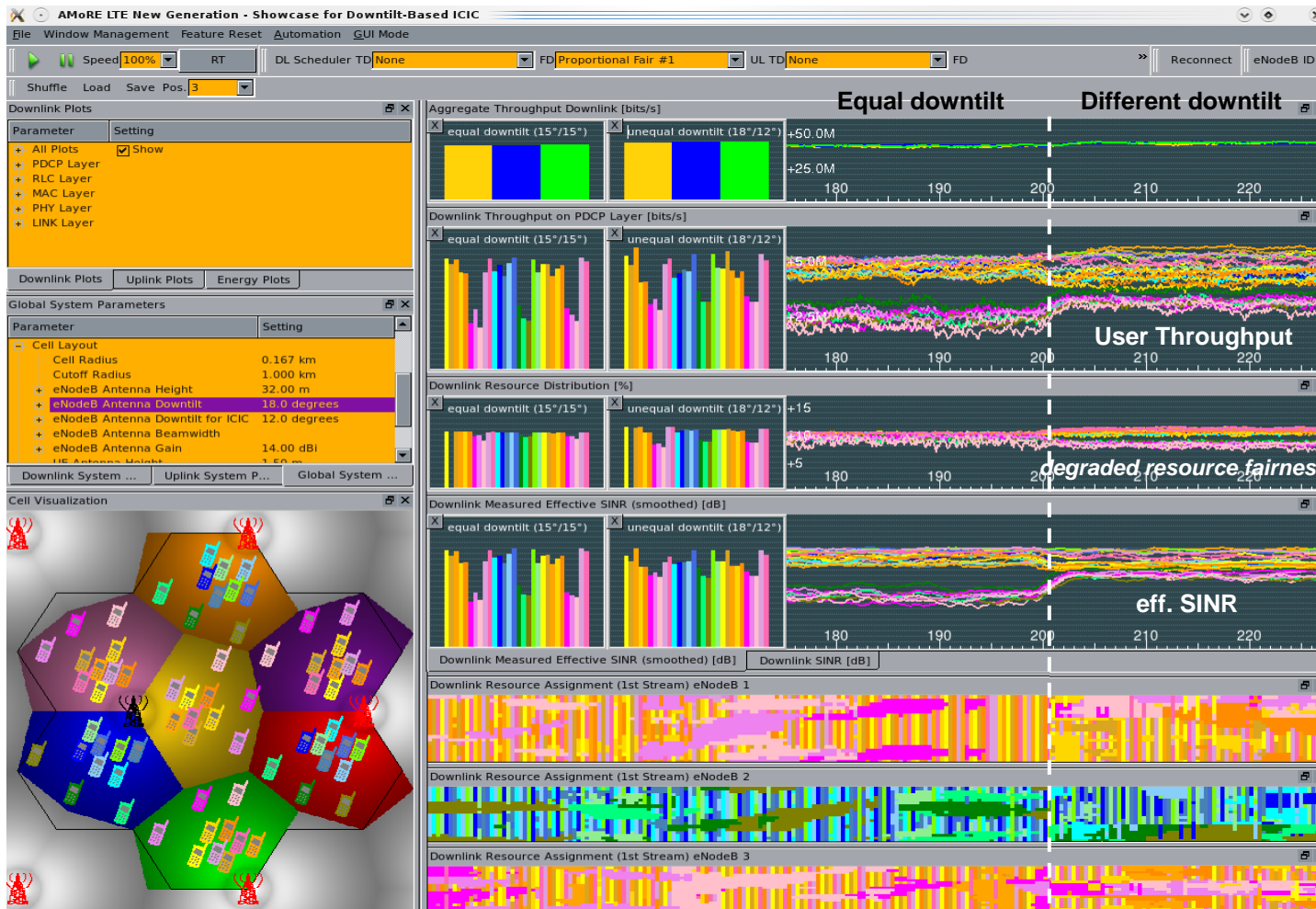
QoS differentiation:
GBR vs non-GBR
services

GBR services:
adjust resource
assignment to
varying needs

Non-GBR services:
(weighted) fair
assignment of
remaining
resources

*More red assignments
required in cell edge
conditions*

Example Case 2: Downtilt-based ICIC



Bandwidth divided in 3 subbands

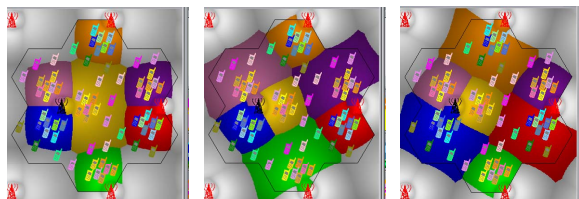
Smaller downtilt, higher range on one subband (in reuse 3 pattern)

Channel-aware scheduling across all subbands

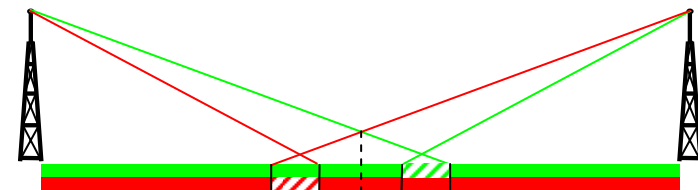
SINR and TP gain for cell edge users

Resource assignment

- ← yellow cell
- ← blue cell
- ← green cell



Areas of strongest RSRP in upper/medium/lower subband, when unequal downtilt is applied



Thanks for your attention, questions are welcome

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