

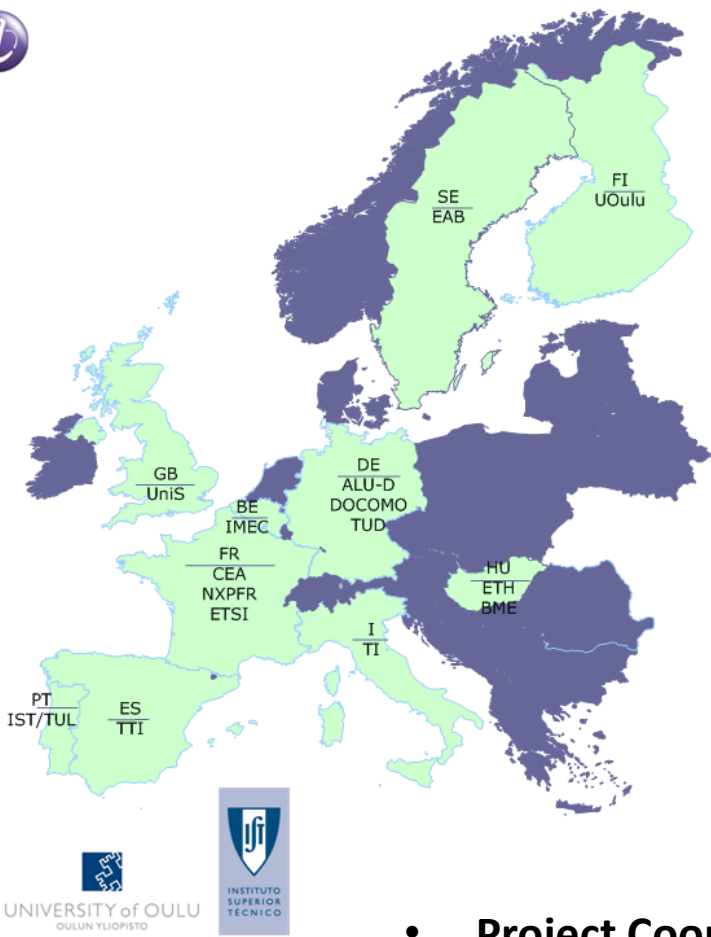
EARTH Project Overview and First Technical Results

GreenTouch Open Forum
Seoul April 8, 2011

Ulrich BARTH, Alcatel Lucent



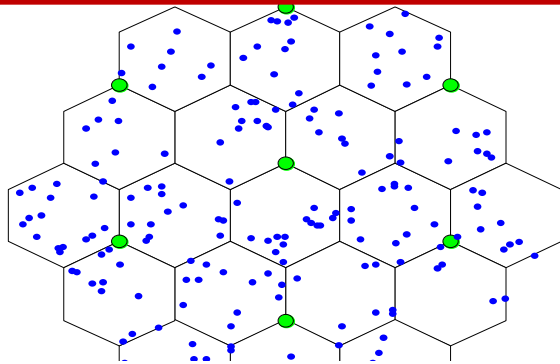
EARTH Consortium



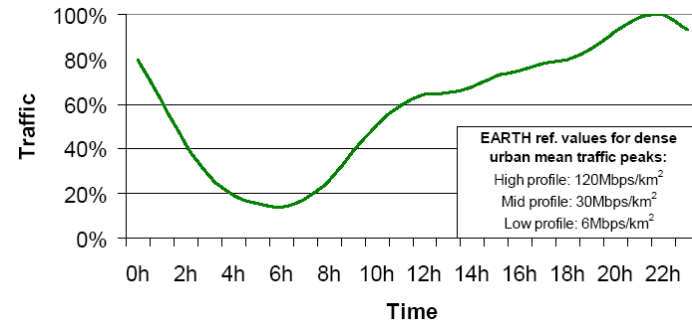
- **Project duration**
 - January 2010 – June 2012
- **Consortium**
 - 15 partners from 10 countries
- **Project budget**
 - Total 14.8 M€
 - EU part 9.48 M€
- **Resources**
 - 1219 PM
 - ➔ 40 fulltime persons 2,5 yrs
- **Project Coordinator: Dietrich Zeller, Alcatel-Lucent**
- **Technical Manager: Ylva Jading, Ericsson**

- **Extending component research to new RAN research area**
 - Radio access network energy efficiency today driven by component development; cost and technology rationalization in products
 - EARTH provides base for mobile-network energy-efficiency research
- **Analyse the situation and formulate “the problem”**
 - Life Cycle Assessment of current and future mobile networks
 - Future scenario predictions based on documented trends
- **Evaluation methodology for energy consumption**
 - The EARTH Energy Efficiency Evaluation Framework (E³F)
 - Compatible with existing 3GPP and ITU evaluation methodology
 - Develop suitable energy consumption metrics

EARTH Energy Efficiency Evaluation Framework (E³F)

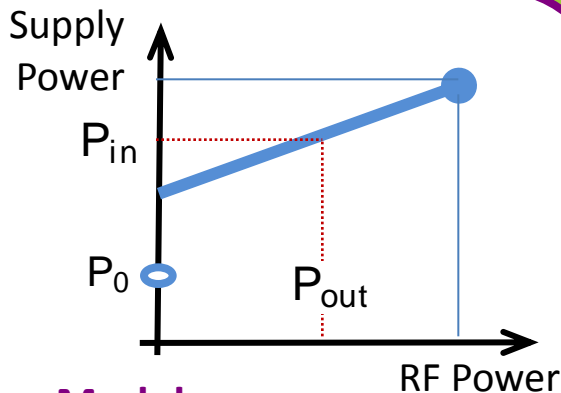


Reference System & Scenarios

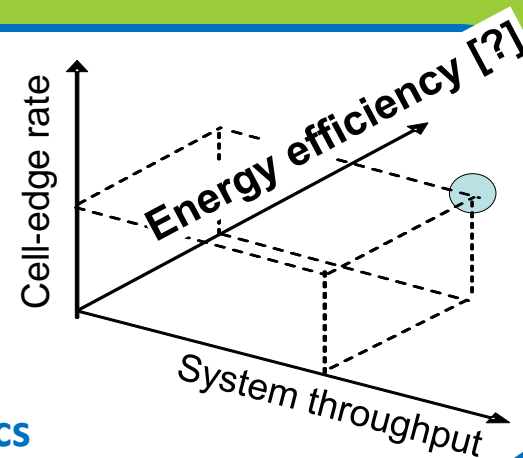


Aggregation to Global Scale

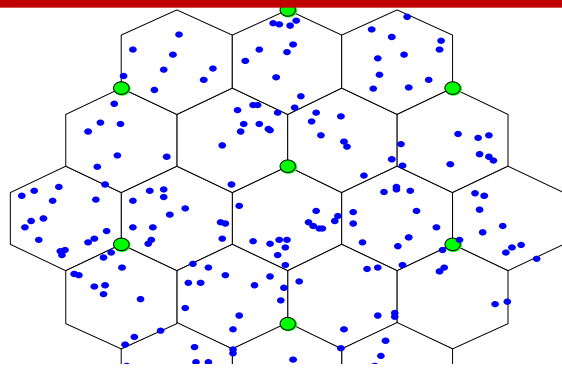
E³F



Power Model



Metrics



Reference System & Scenarios

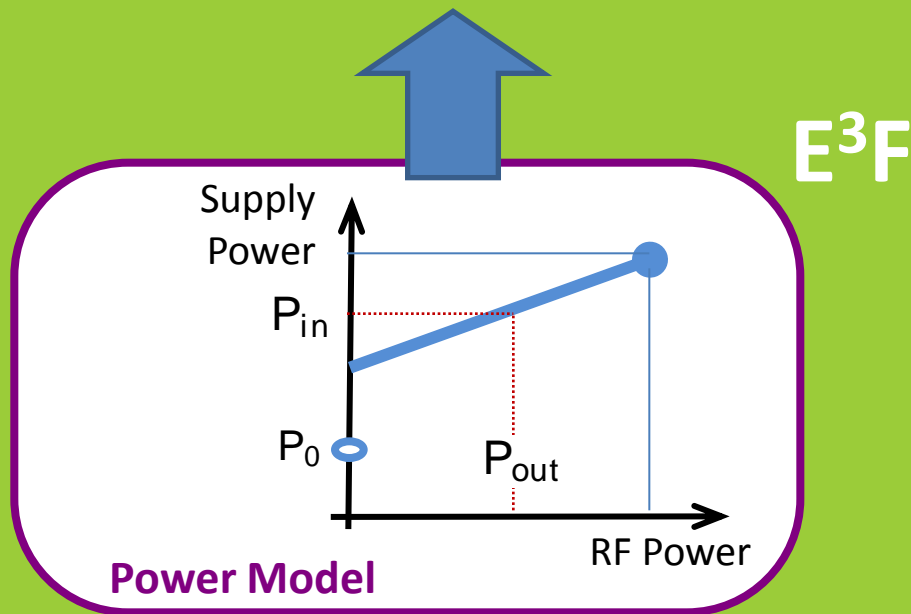


Traditional (small-scale, short-term) **System Level Simulations**

E³F

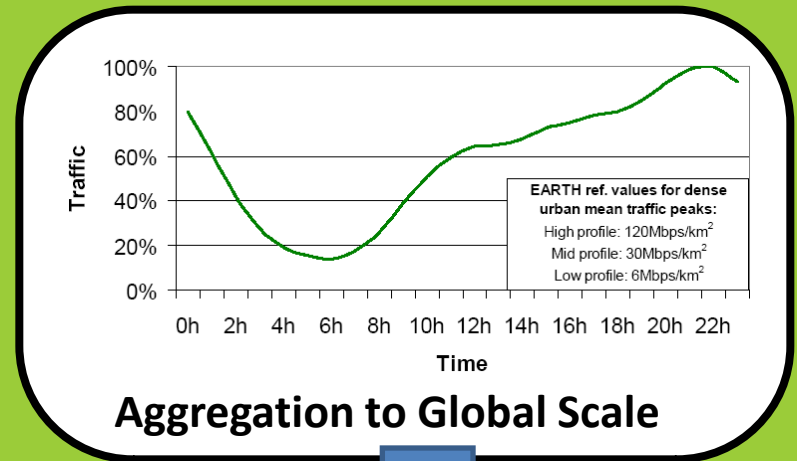
- 3GPP and ITU compliant evaluation methods
- Dynamic system simulations for different scenarios
 - Dense urban, urban, suburban and rural
- System simulations carried out for a range of average load levels

Realistic Power Model



- Detailed power model for node and components
- Power models for various base station types
 - Macro, micro, pico and femto nodes
- Dynamic load dependence on OFDM symbol scale

- Based on network traffic data; geographical and population data
- ➔ Models average traffic aggregation to 24 hours
- ➔ Maps reference scenarios to country and European scale



E³F

Country wide 24 hour
Traffic & Deployment
Model

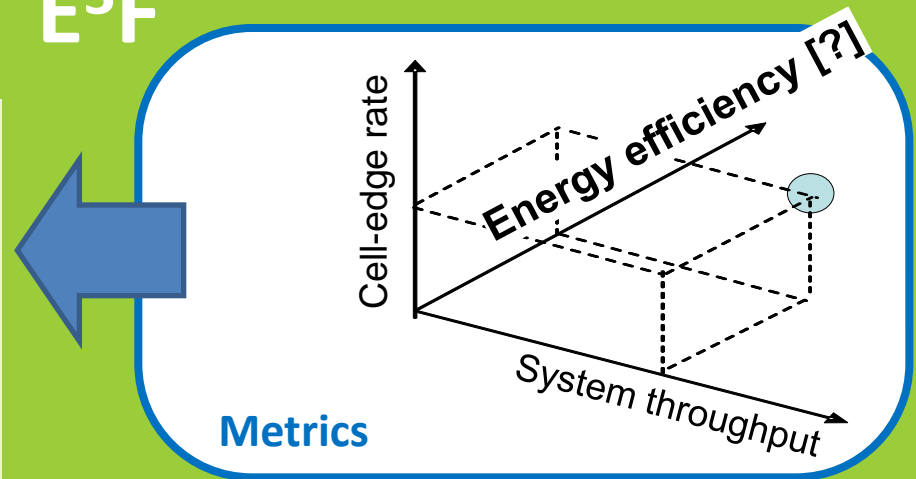
Recommended use of Energy Consumption Metrics

- [J/bit] – reflecting traditional capacity and data rate improvements
 - Increasing peak data rates quickly decreases [J/bit]
- [W/m²] – reflecting crucial coverage and service area aspects
 - High fixed cost for coverage makes [W/m²] very important
- Metric communicated to ETSI TC EE

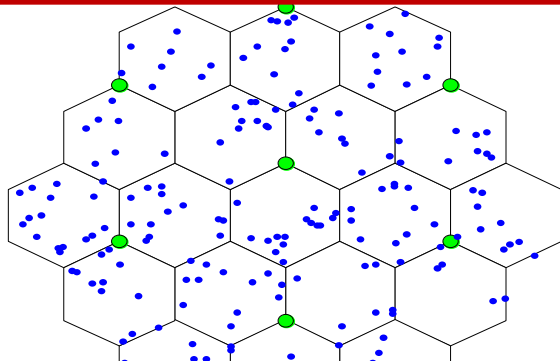
Performance Metrics for Concept Evaluations

- Served cell throughput
- Mean, 5th, 50th, and 95th percentile user throughput
- Performance metrics follow 3GPP recommendations [TR36.814]

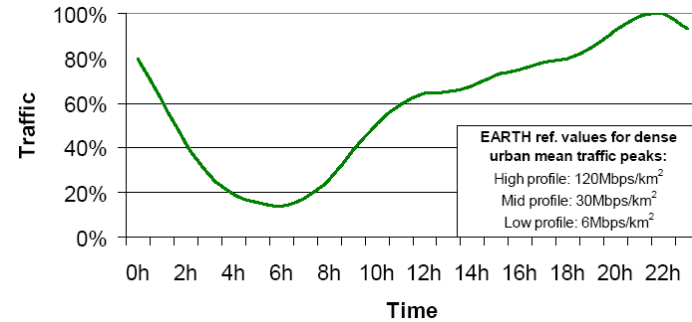
E³F



EARTH Energy Efficiency Evaluation Framework (E³F)

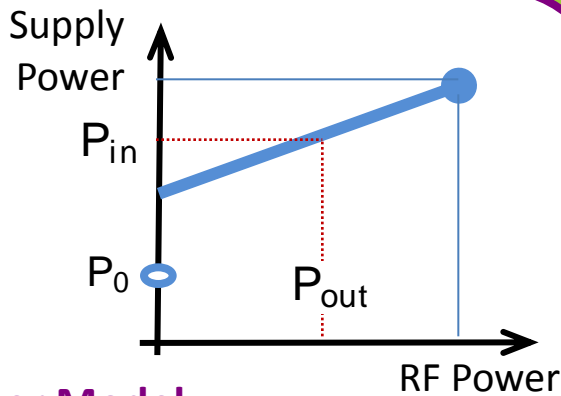


Reference System & Scenarios

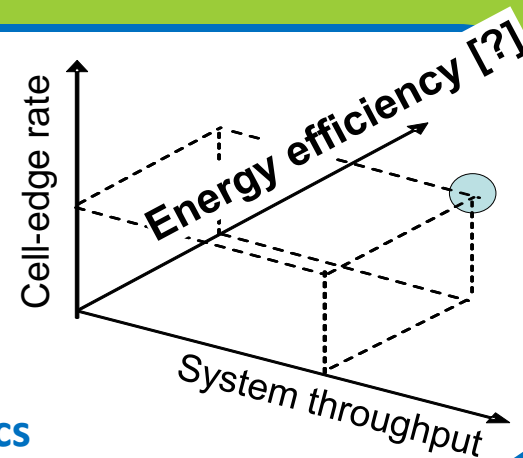


Aggregation to Global Scale

E³F

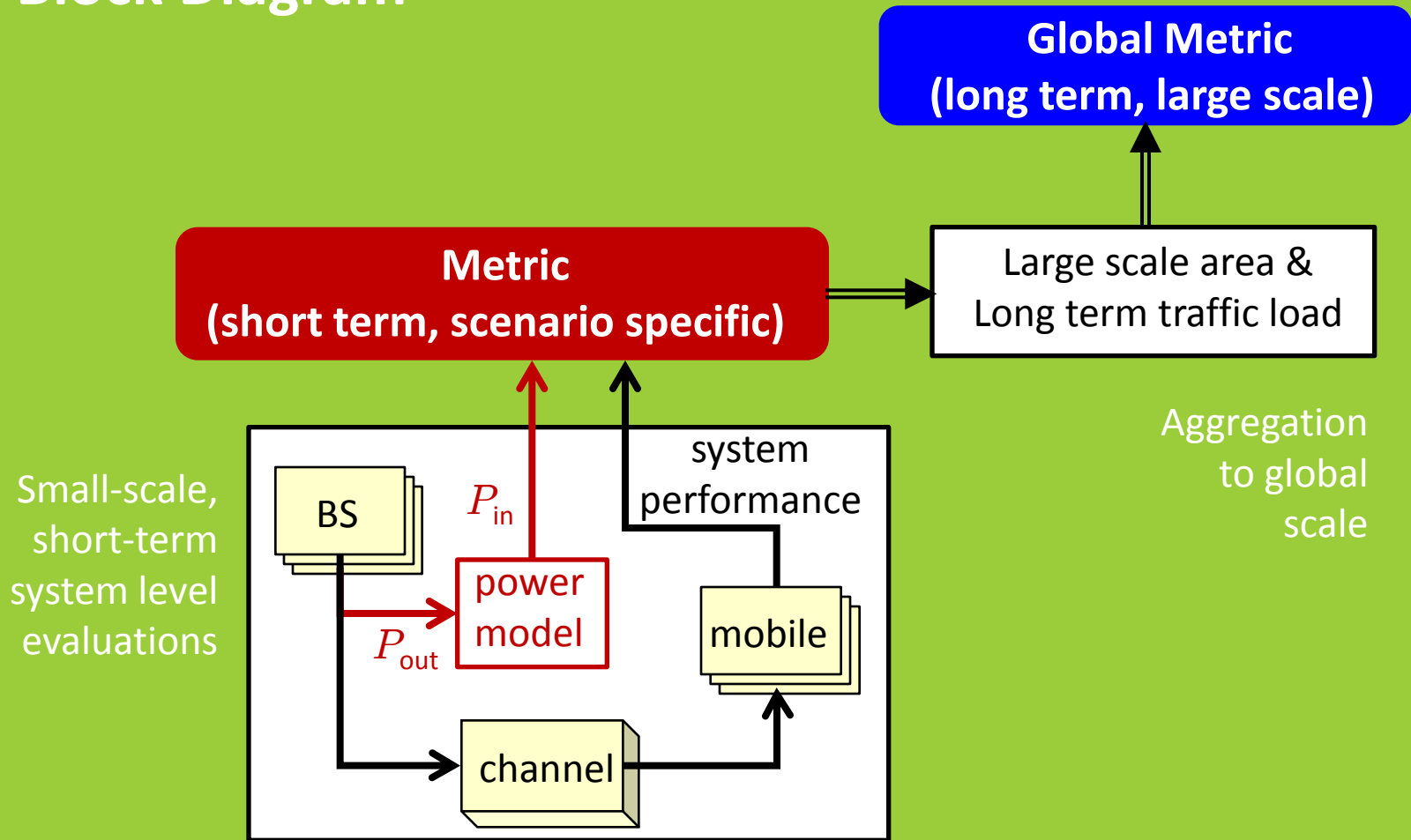


Power Model



Metrics

Block Diagram

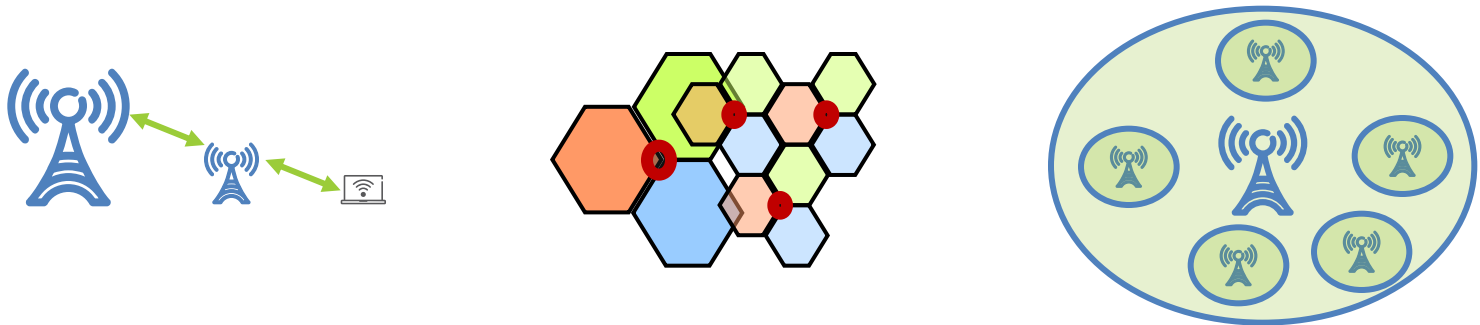


- **Drivers for cellular network energy efficiency investigations**
 - Increasing and potentially volatile electricity costs for operators
 - Controlling global CO₂ contributing from expanding cellular networks
 - ICT industry needs credibility to reduce CO₂ emission in other sectors
- **Key findings for future network energy efficiency**
 - Traffic growth has so far had little impact on NW energy consumption
 - Historic trends suggests 300 times decrease of [J/bit] – 2007 to 2020...
... but it is increasingly demanding to keep that rate of reduction
 - Huge unexplored saving potential at no and low cell load
 - Low delay is a key issue in balance between sleep modes and QoS

Evaluated Green Network Tracks (I)

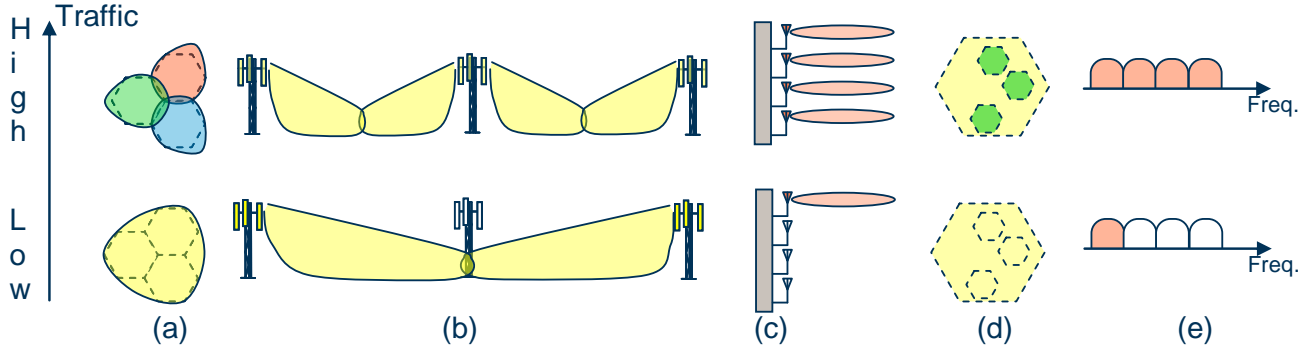
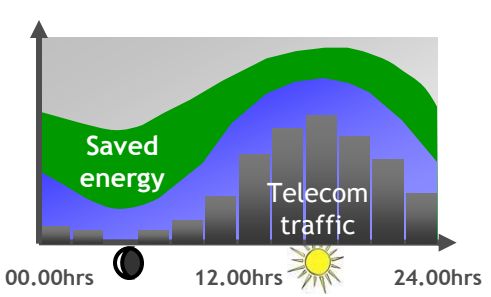
Deployment:

Relays nodes, Multi RAT, Heterogeneous Networks

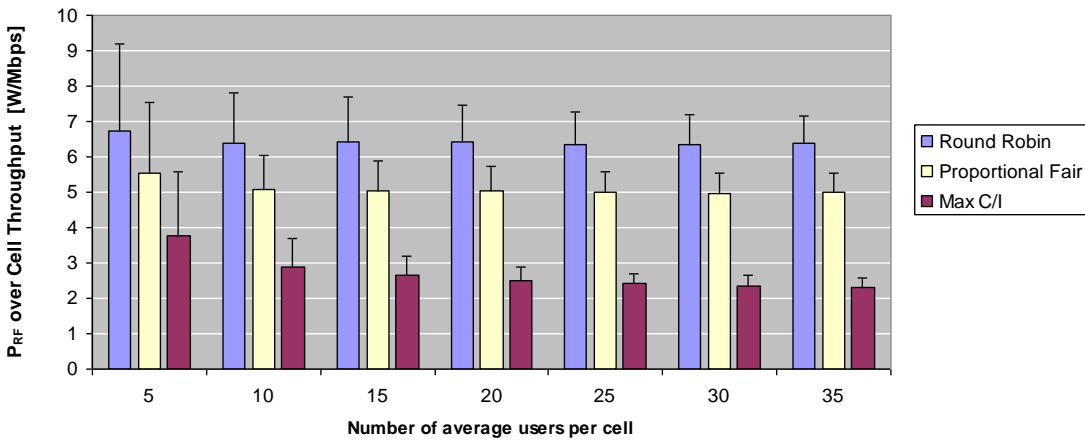


Network Management:

BS cooperation, Adaptive NW configuration

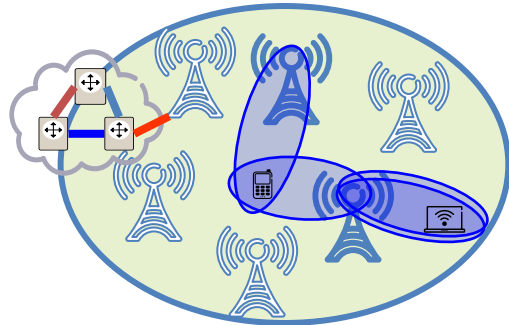


Radio Resource Management: *Energy efficient scheduling*



Future Architecture:

Designing the ultimate energy lean mobile radio system



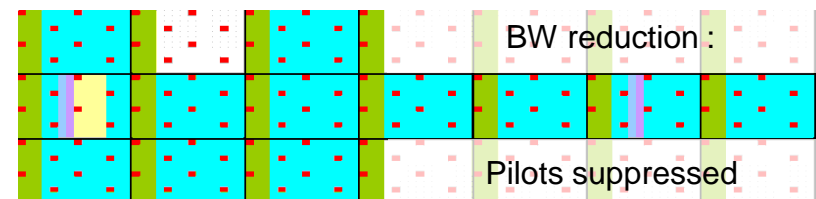
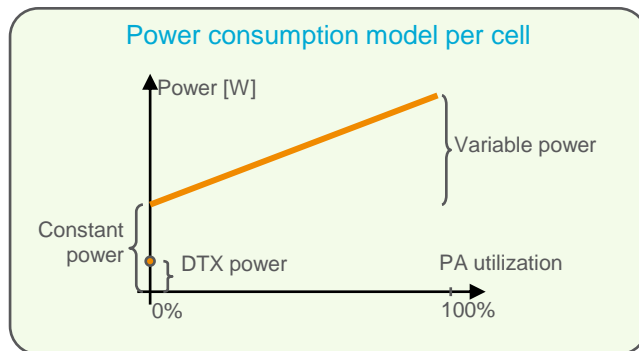
Evaluated Green Radio Tracks (I)

Multi-antenna techniques:

Reconfigurable antennas, Beam forming, Spatial multiplexing



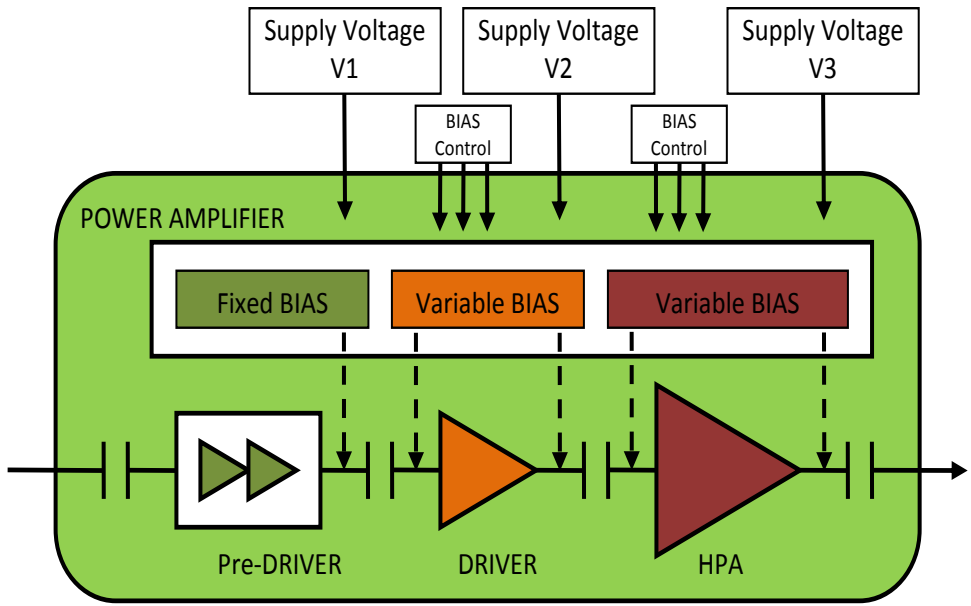
Radio interface: *DTX and sleep modes, bandwidth adaptation*



Evaluated Green Radio Tracks (II)

Macro and pico BS components:

improved and adaptable PA, transceivers etc



What happens next in EARTH?

- **Selection of most-promising technical tracks/concepts**
 - Green Network and Green Radio tracks evaluated with EARTH E³F
 - Selection of most promising tracks next week in Santander
- **Develop and evaluate integrated EARTH solution**
 - Based on most-promising concepts from areas above
 - Integrated and holistically evaluated according to EARTH E³F
 - Selected concepts to be tested in TI test plant and lab prototypes



Thank you 😊