EU FP7 Call 8 Project iJOIN

iJOIN: **I**nterworking and **JOIN**t Design of an Open Access and Backhaul Network Architecture for Small Cells based on Cloud Networks

iJOIN vision towards 2020 radio access technologies

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The iJOIN Project

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- Funding scheme: STREP
- Objective 1.1
- Duration: 30 months
- Begin: 01 November 2012

- Industry partners
  1. NEC (UK)
  2. Telecom Italia (IT)
  3. Telefonica (ES)
  4. Sagemcom (FR)
  5. Intel Mobile Communications (FR)
  6. HP Italy Innovation Center (IT)
- Research institutes
  7. IMDEA (ES)
  8. CEA (FR)
- Universities
  9. University of Bremen (DE)
  10. University of Surrey (UK)
  11. University of Dresden (DE)
  12. Universidad III Carlos de Madrid (ES)

Outline

- Motivation and Background
- Key Concepts
  - RAN as a Service
  - Joint RAN and backhaul operation and design
- Results
- Summary

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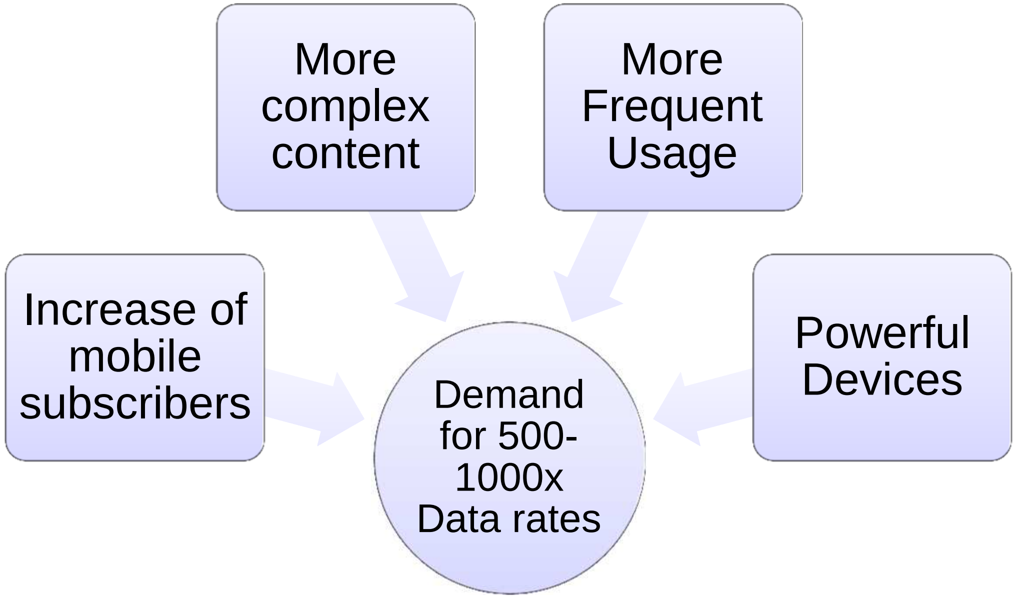
MOTIVATION AND BACKGROUND

Motivation

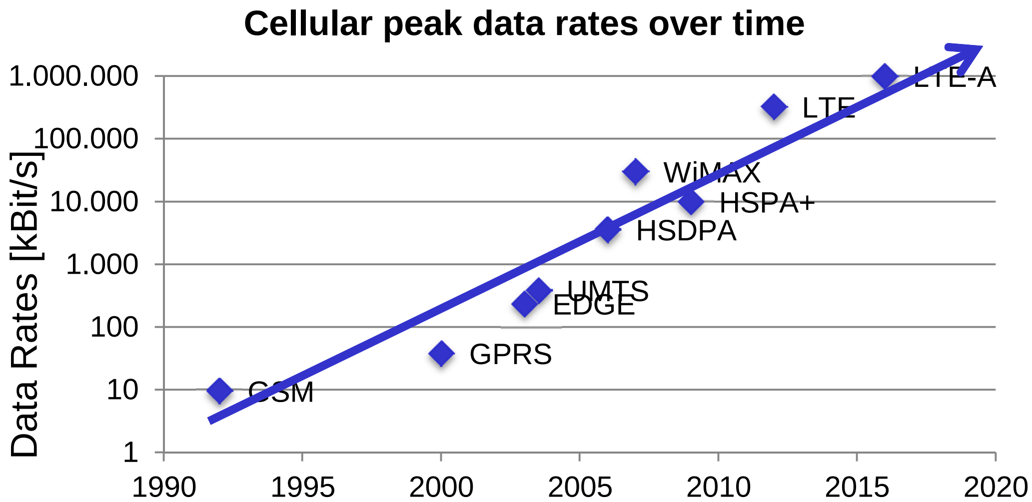


500 – 1000x Increase in overall traffic demand …

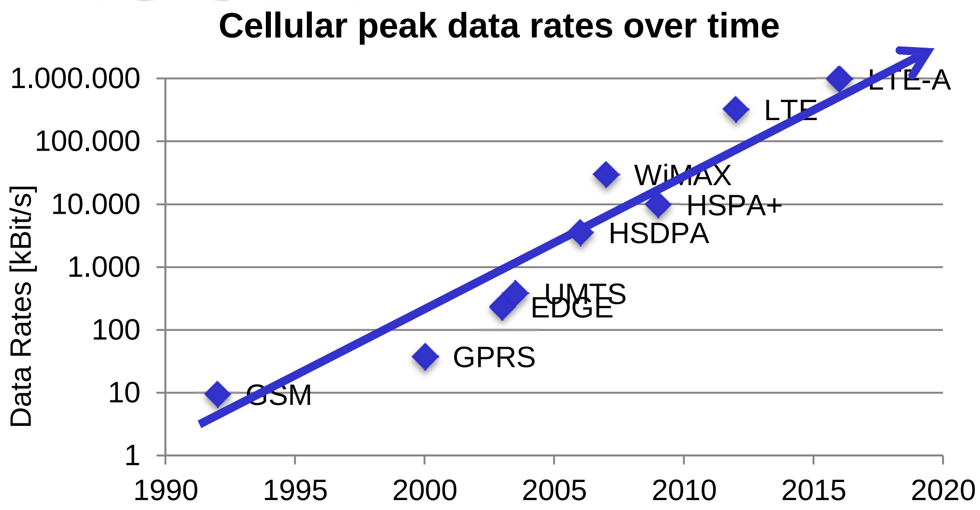
- Exponential increase of mobile data subscribes (4x 2006-10 in EU)
- Internet content more complex (Avg. website 3x size in 5y, 90% of all www are multi-media)
- Mobile devices are used more frequently (iTunes has 500k apps, adding 10k each day)
- Devices become more powerful (Increase by 100% in 2007-10 of wireless users)

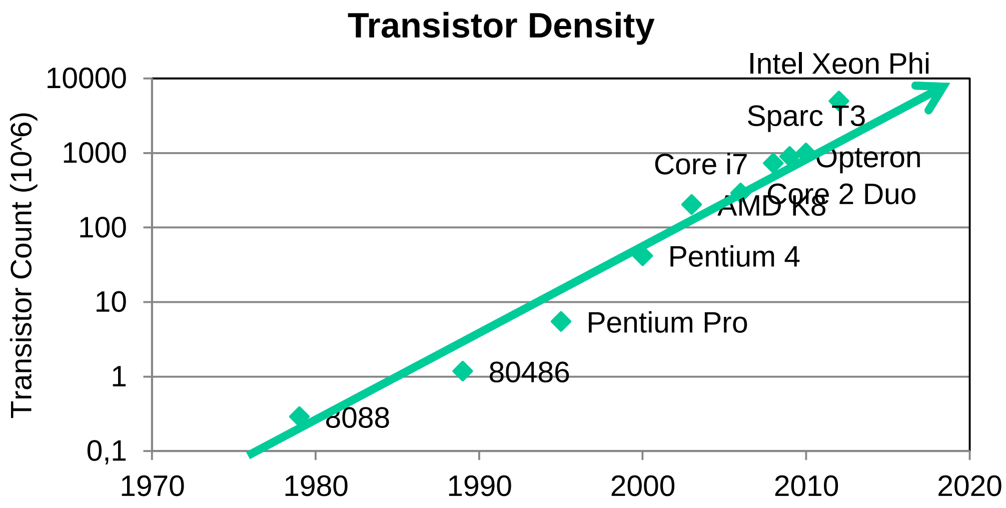
Development of cellular data rates…

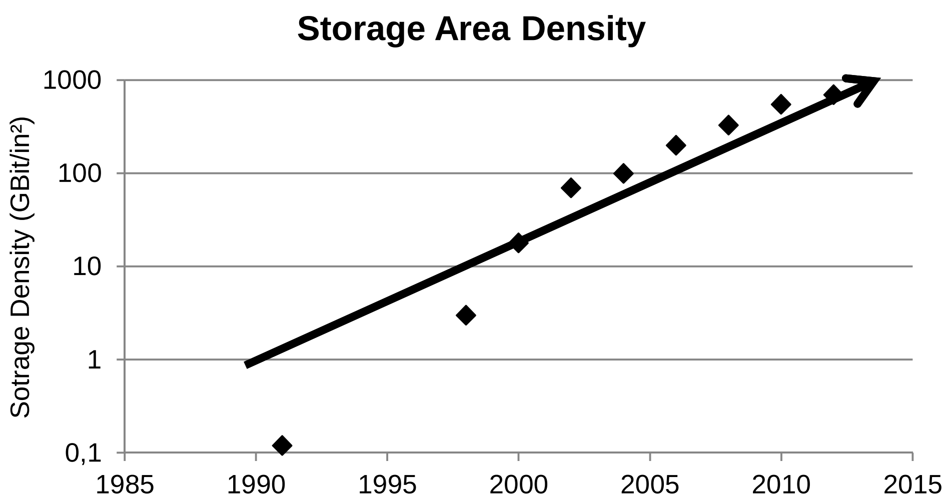
- Cellular peak data rate increase every 10y by factor 100
- Services evolve → design today for services of tomorrow
- Digital agenda requires this development

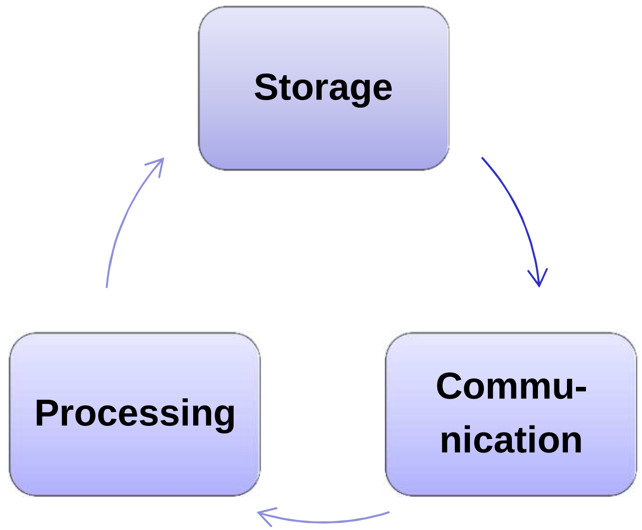


Introduction









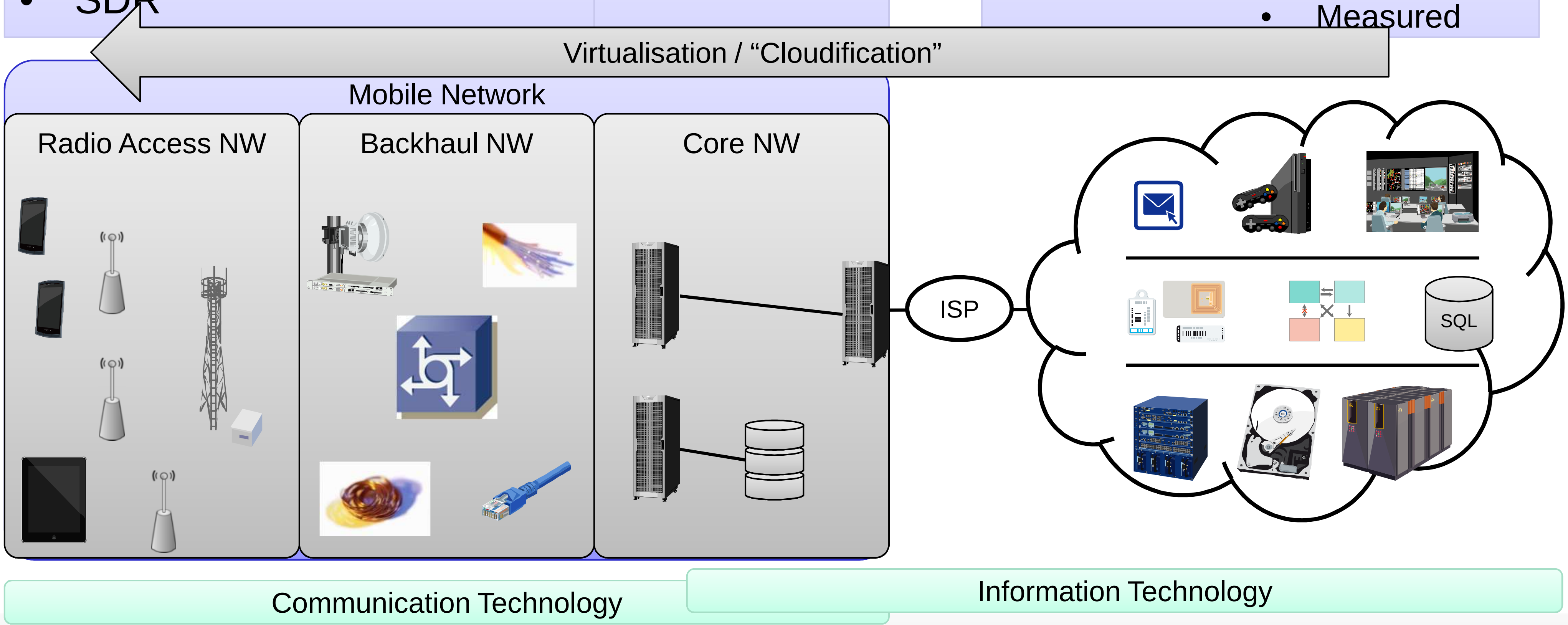
How the "Cloud" changes the picture …

- C-RAN
- RAN-Sharing
- SDN
- SDR

- NFV
- Soft-EPC
- SDN

- SaaS
- PaaS
- IaaS

- On-demand
- Broad access
- Pooling
- Elasticity
- Measured



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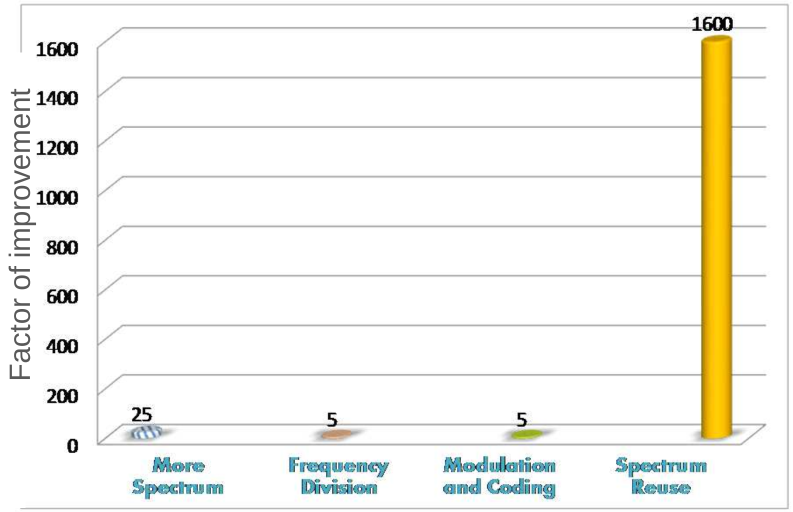
KEY CONCEPTS

Key enablers to satisfy data demands

Small Cells

- 50% Total cost of ownership (TCO) savings
- Four-fold increase in density until 2014
- Worth about 6.1bln USD until 2014

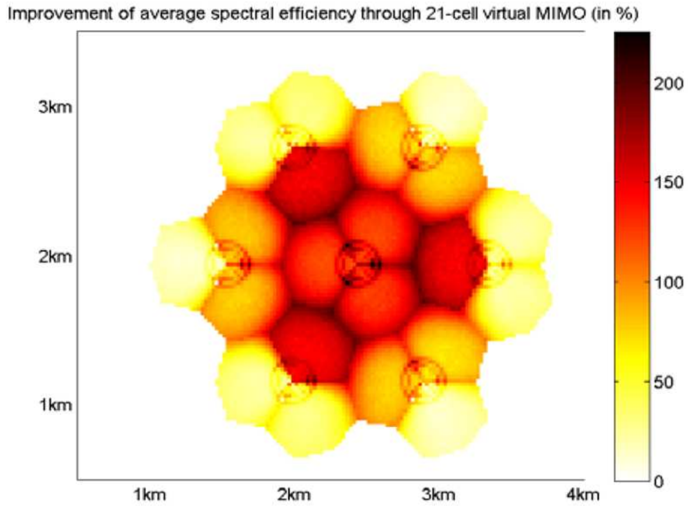
➔ Small-cells are *the* option to handle higher rates and to improve energy/cost-efficiency



Centralised Processing

- C-RAN handles inter-cell interference, allows for higher utilisation and to avoid peak-provisioning
- Up to 50% energy-saving
- 20%-50% OPEX reduction, 15% CAPEX reduction
- Requires high capacity and low delay backhaul

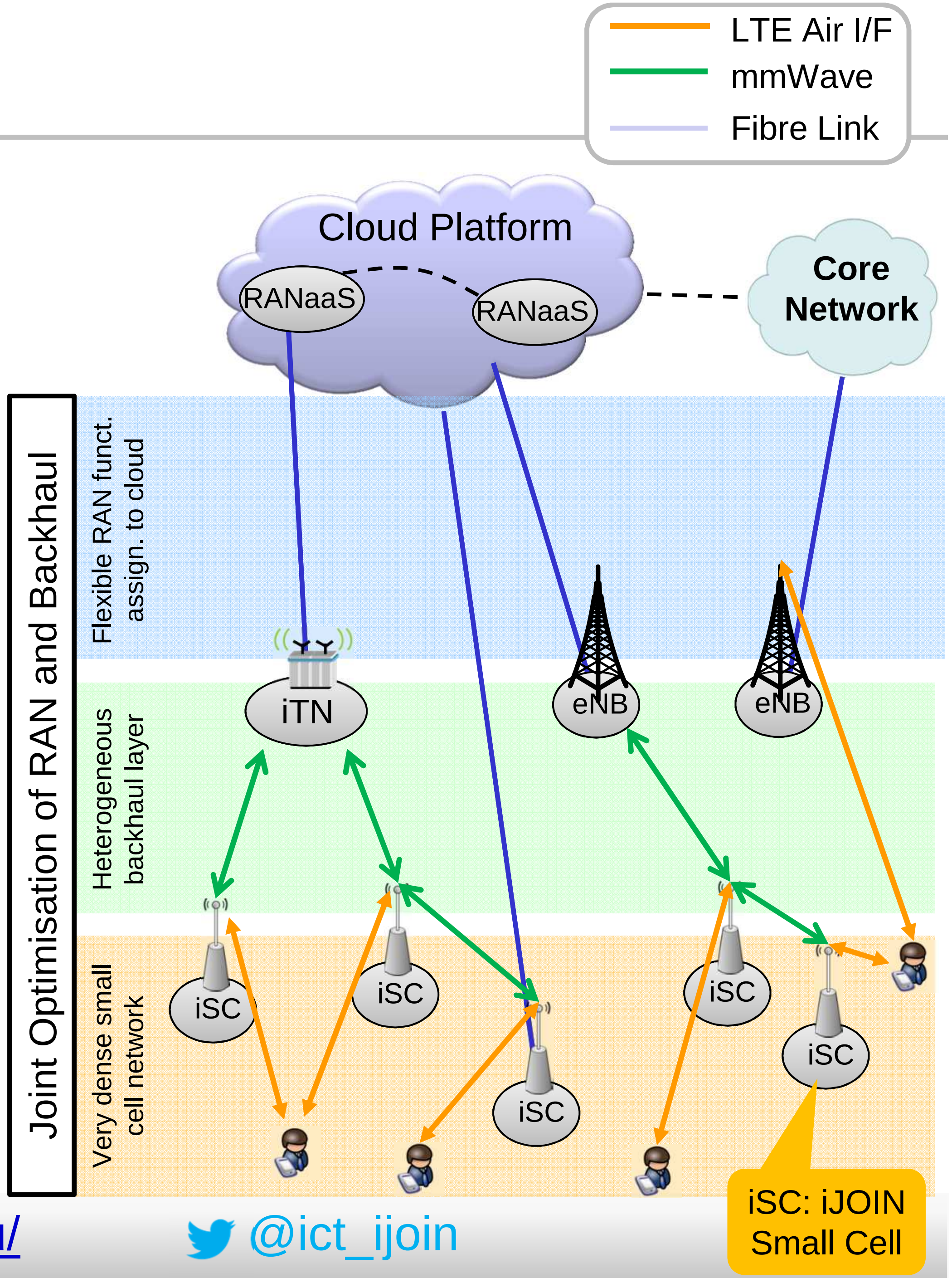
➔ Centralisation is an option to implement the network but requires more flexibility than today



Key Concepts

- **<u>Flexible centralisation through RANaaS (RAN-as-a-Service)</u>**
  - Offer RAN functionality as cloud-service
  - Simplified RAN management and flexible small-cell solutions
  - Allow to flexibly shift functions from RAN to cloud
  - Reduce complexity & cost through elastic & flexible function assignment
  - Higher energy-efficiency through computational diversity and higher utilisation

- **<u>Joint design and optimisation of RAN and backhaul</u>**
  - Interworking of access and backhaul network
  - Optimise for flexible centralisation
  - Optimise backhaul for small cells
  - Consider heterogeneous backhaul network (fibre and wireless)
  - Relax backhaul requirements through dynamic provisioning ("on-demand")



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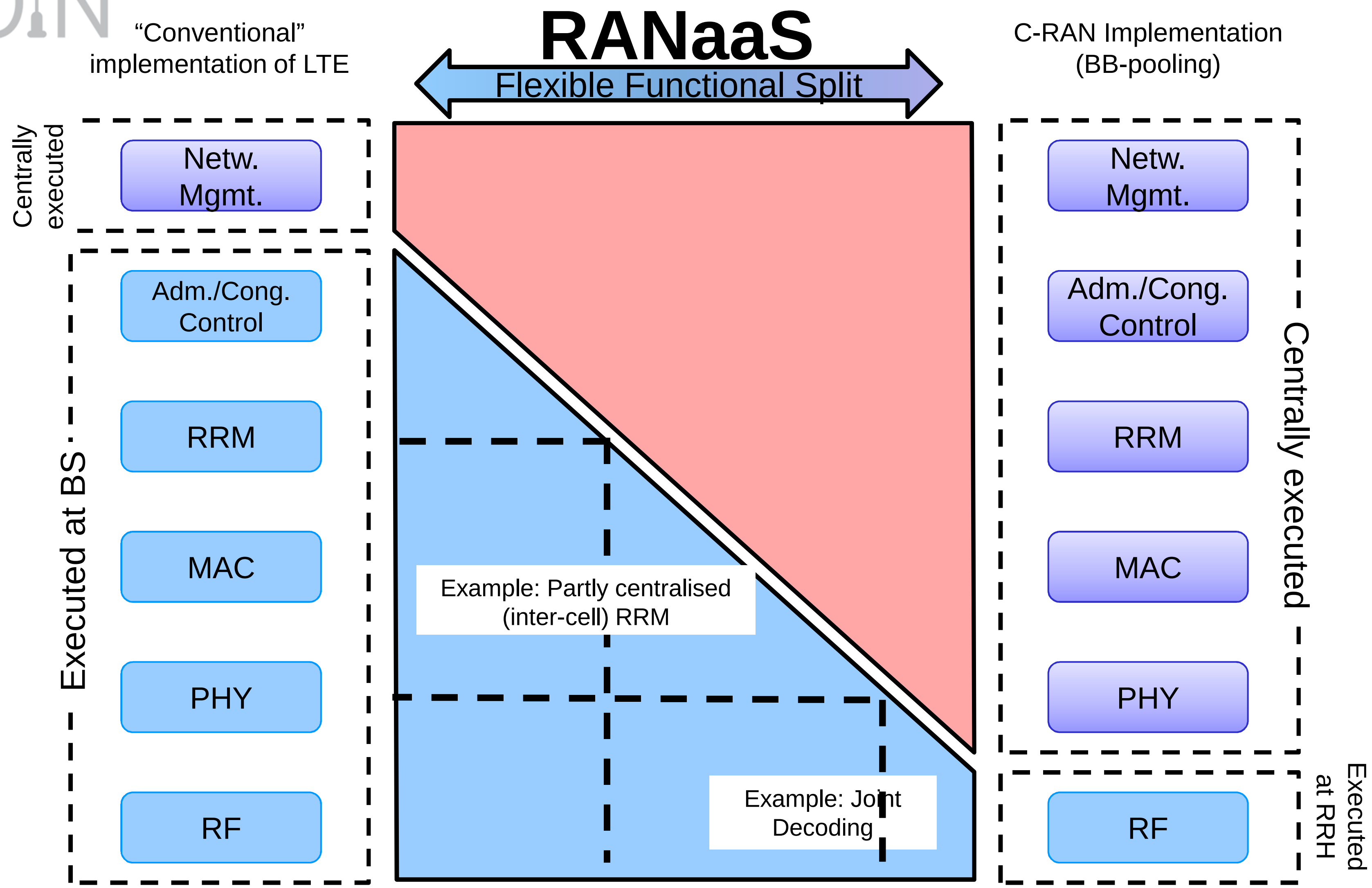
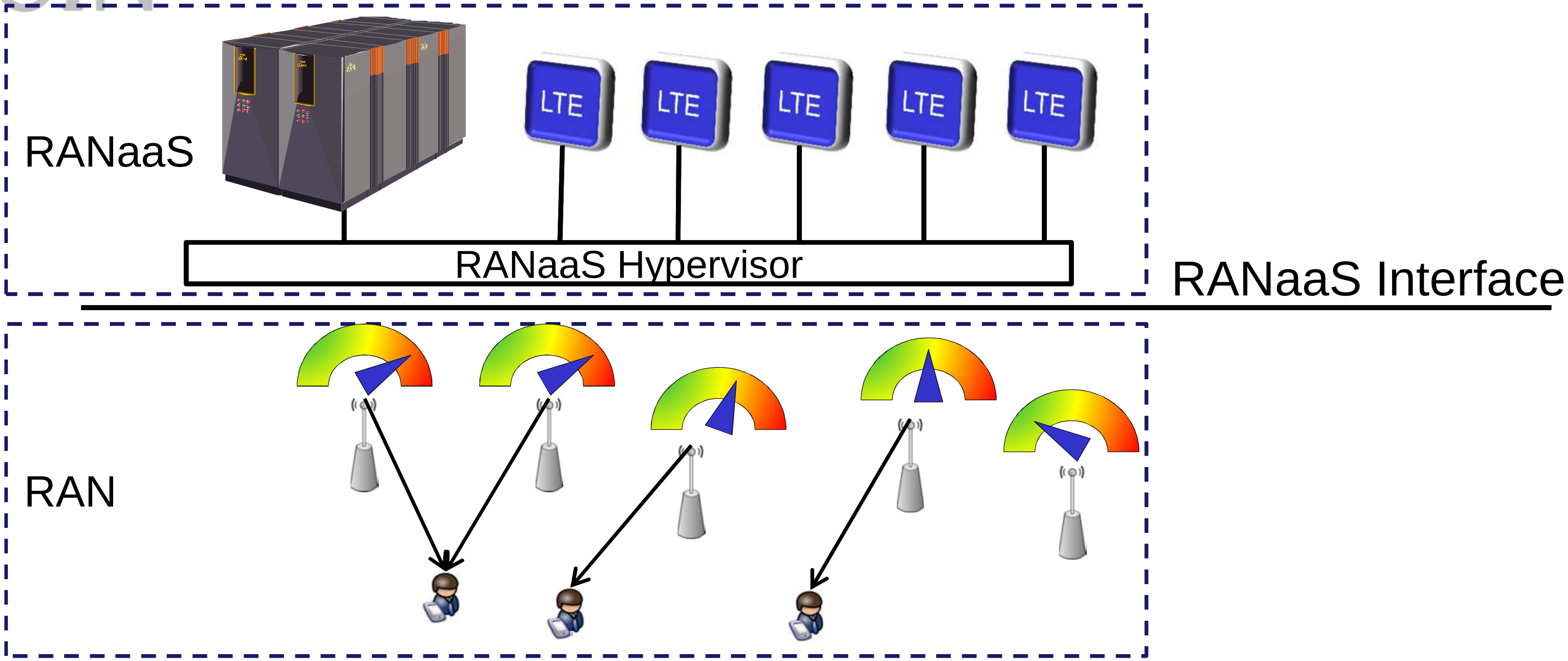
RAN AS A SERVICE

Key Concepts: RAN as a Service

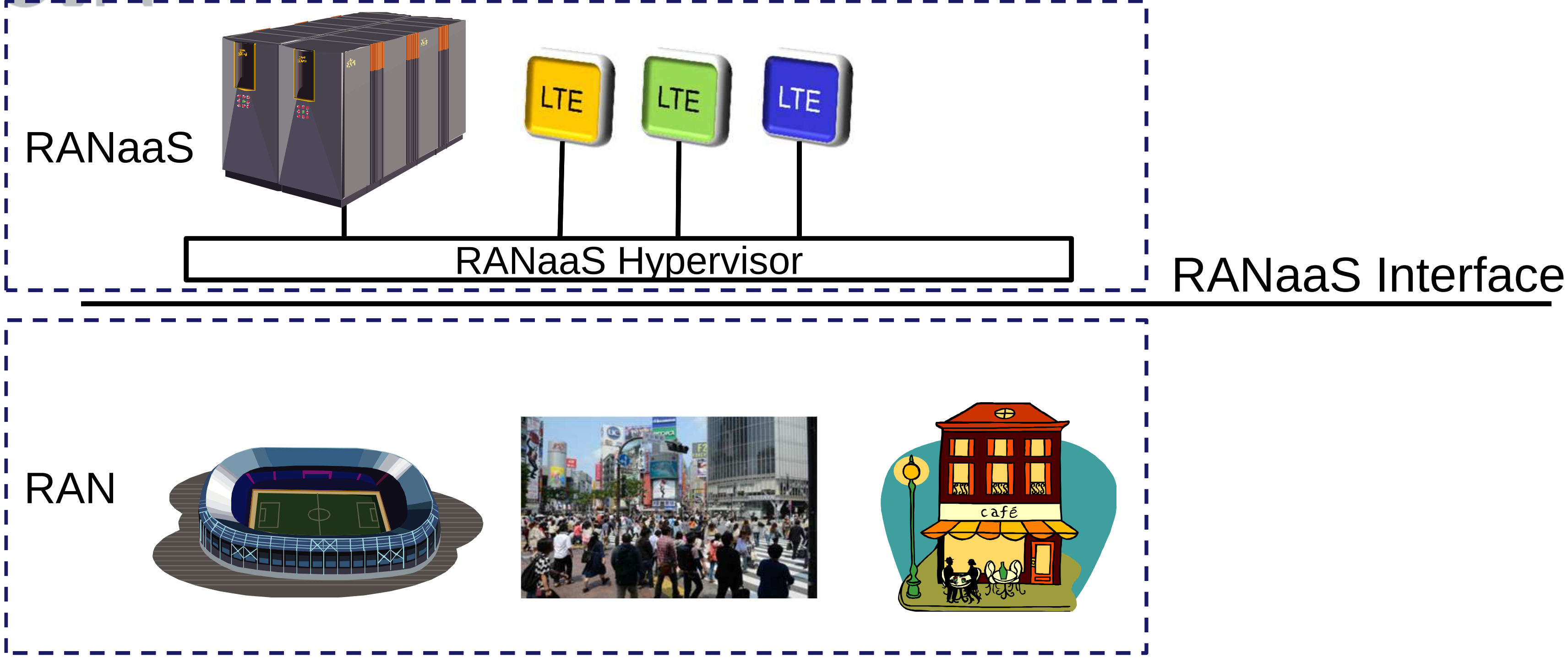


Key Concepts: RANaaS Benefits



- Computational diversity
  - Exploitation of temporal and spatial traffic fluctuations
  - Efficiently use available resources, scale resource according to needs (resource pooling, elasticity)

Key Concepts: RANaaS Benefits



- Localized optimisation
  - Optimisation based on purpose, deployment, …
  - Using software implementation rather than configuration (SON)
  - Flexible software assignment over time and space

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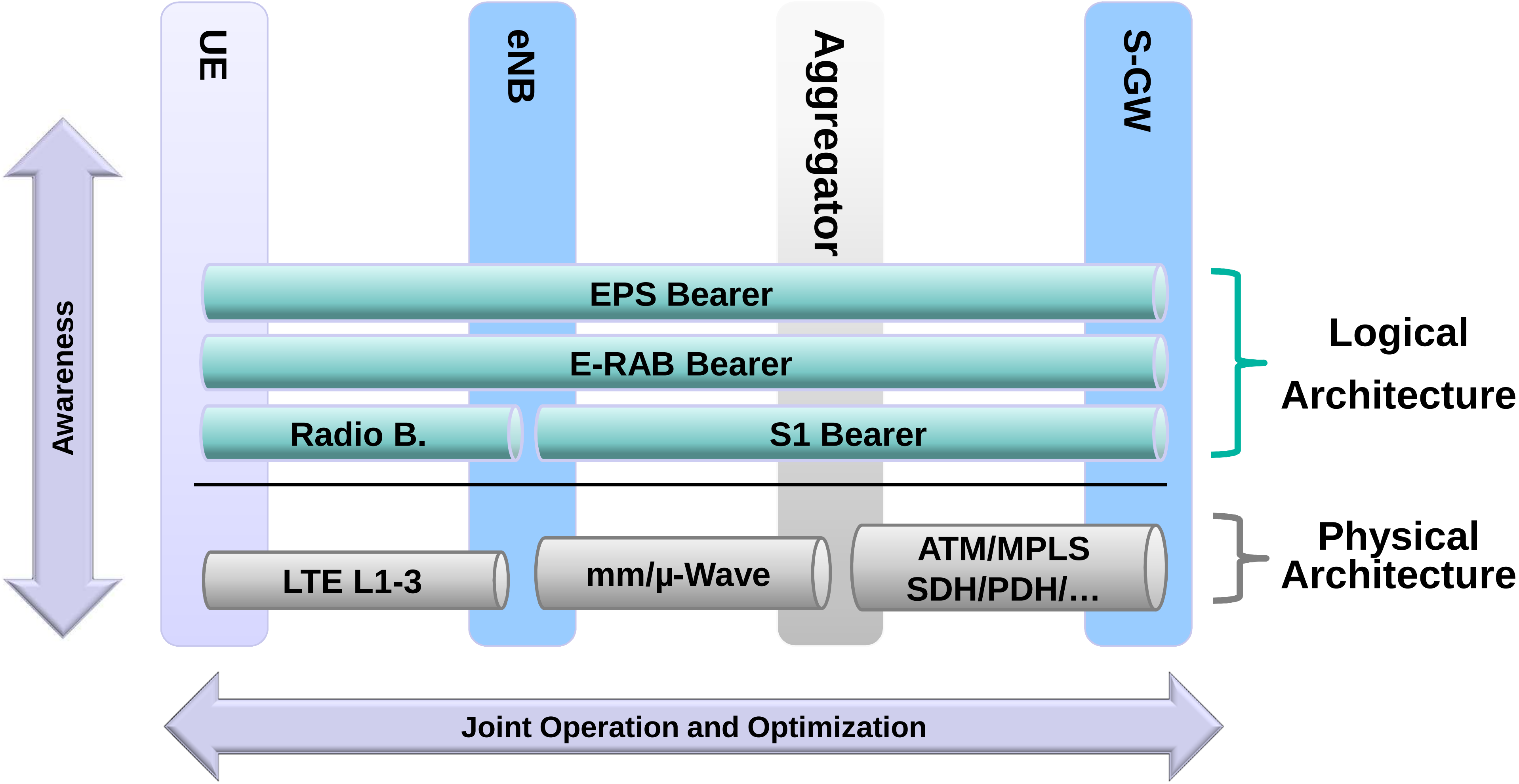
JOINT RAN AND BACKHAUL OPERATION AND DESIGN

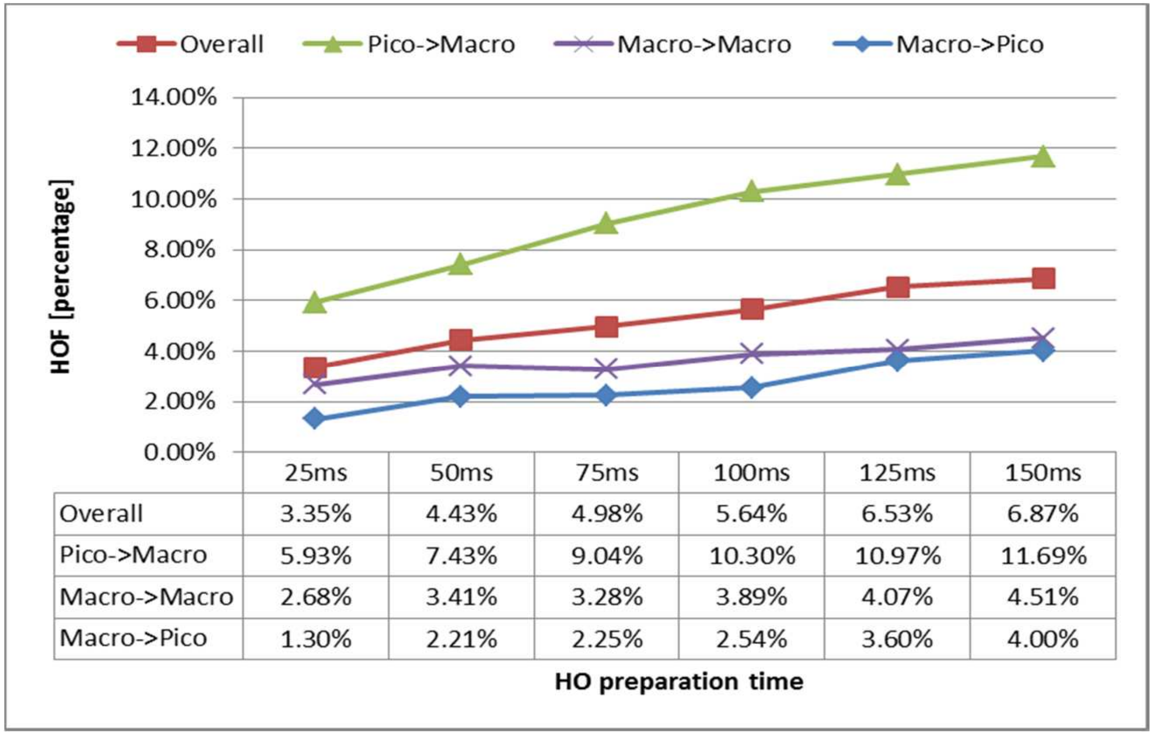
Key Concepts: Joint RAN/BH Operation



Key Concepts: RAN-BH Interworking

- SotA:
  - Separate optimisation/operation of RAN and backhaul
  - No standardised interfaces for RAN-Backhaul interaction
- But: Immediate impact of backhaul on RAN performance

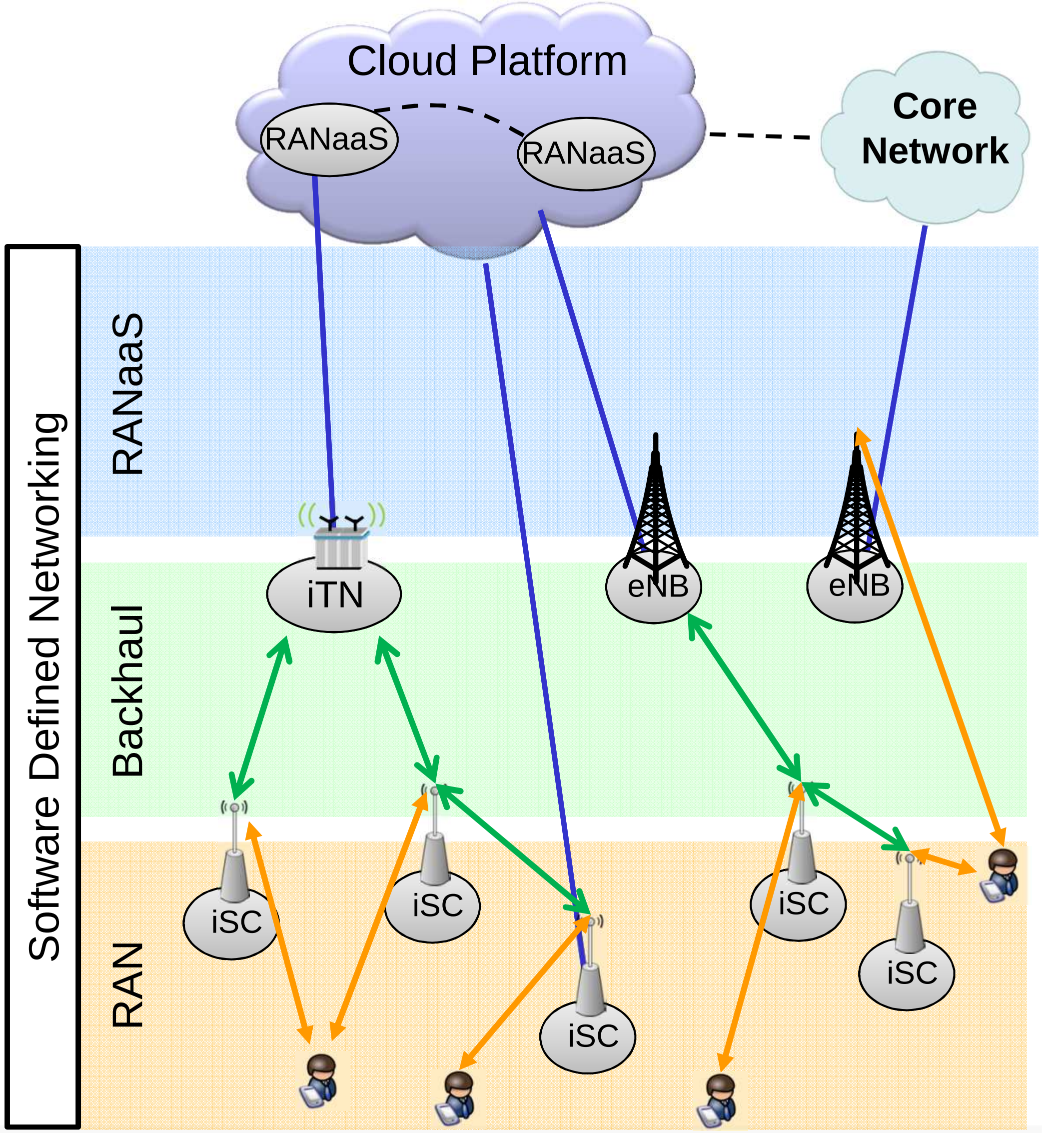
- Example: Mobility
  - Increased HO rate in dense networks
  - High backhaul latency → higher probability for RLF
  - Solutions:
    - Opportunistic handover
    - Multi-connectivity
    - Target-cell initiated HO



	25ms	50ms	75ms	100ms	125ms	150ms
Overall	3.35%	4.43%	4.98%	5.64%	6.53%	6.87%
Pico->Macro	5.93%	7.43%	9.04%	10.30%	10.97%	11.69%
Macro->Macro	2.68%	3.41%	3.28%	3.89%	4.07%	4.51%
Macro->Pico	1.30%	2.21%	2.25%	2.54%	3.60%	4.00%

Key Concepts: RAN-BH Interworking

- RANaaS
  - Flexibly adopt degree of centralisation
  - Apply software based on RAN/BH network information
- Backhaul
  - Differently prioritise user and control plane traffic from RAN
  - Adapt backhaul network based on load changes in RAN
- RAN
  - Optimise RAN load balancing based on backhaul information
  - Provide feedback for backhaul route setup
- Challenges
  - Avoiding oscillation
  - Defined standard interfaces (3GPP RAN3/5)



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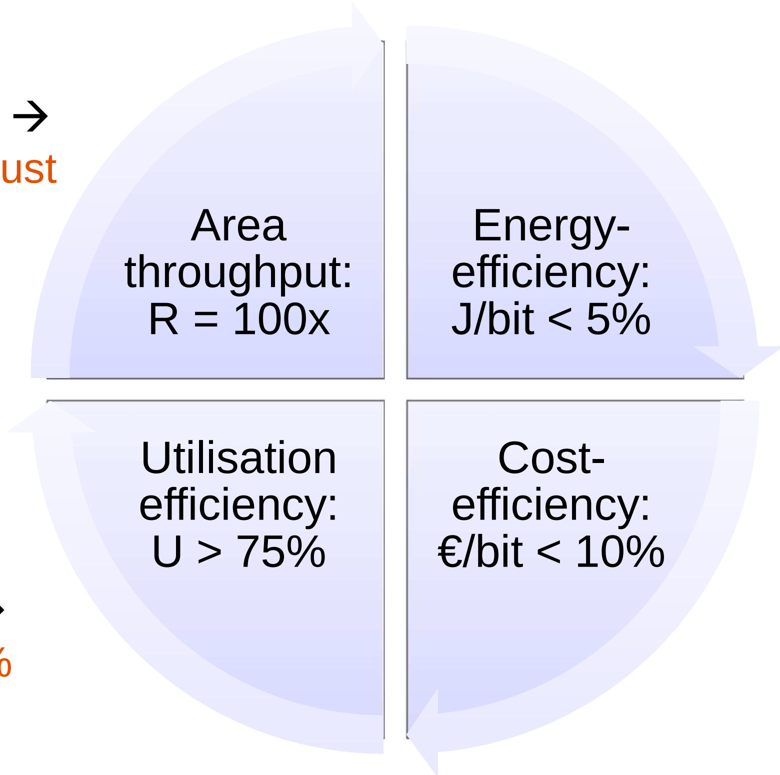
RESULTS

Main Objectives: Quantitative Measures

Demand increases by 1000x → Area throughput efficiency must increase 100x

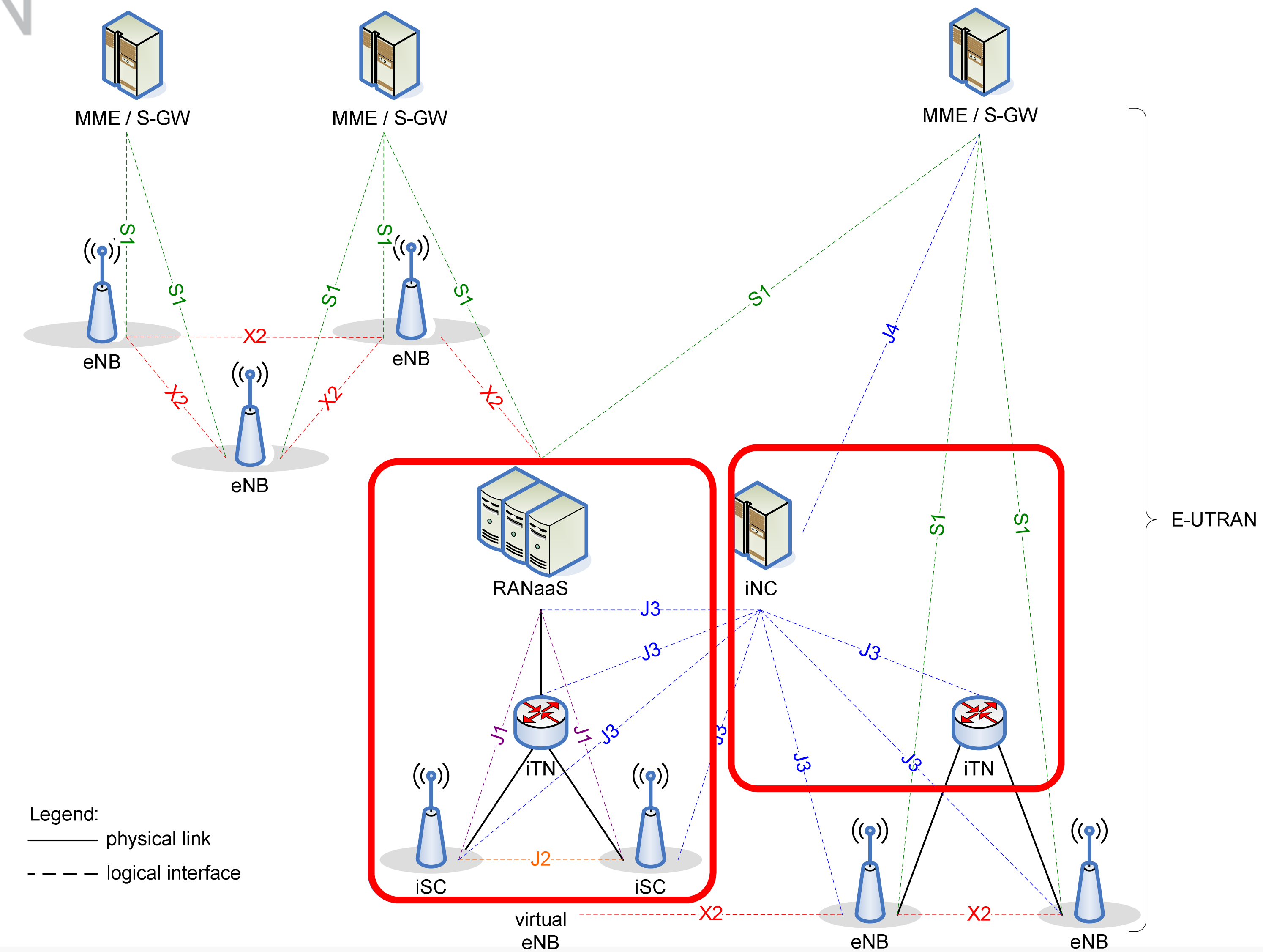
Energy demand must remain almost constant → Energy-consumption per bit 1%-5%



Combat over-provisioning → increased utilization to 75+%

Revenue per user remains constant but data per user 50-100x → Cost-per-bit 1%-5%

Results: Logical Architecture



Results: Common Scenarios (CS)

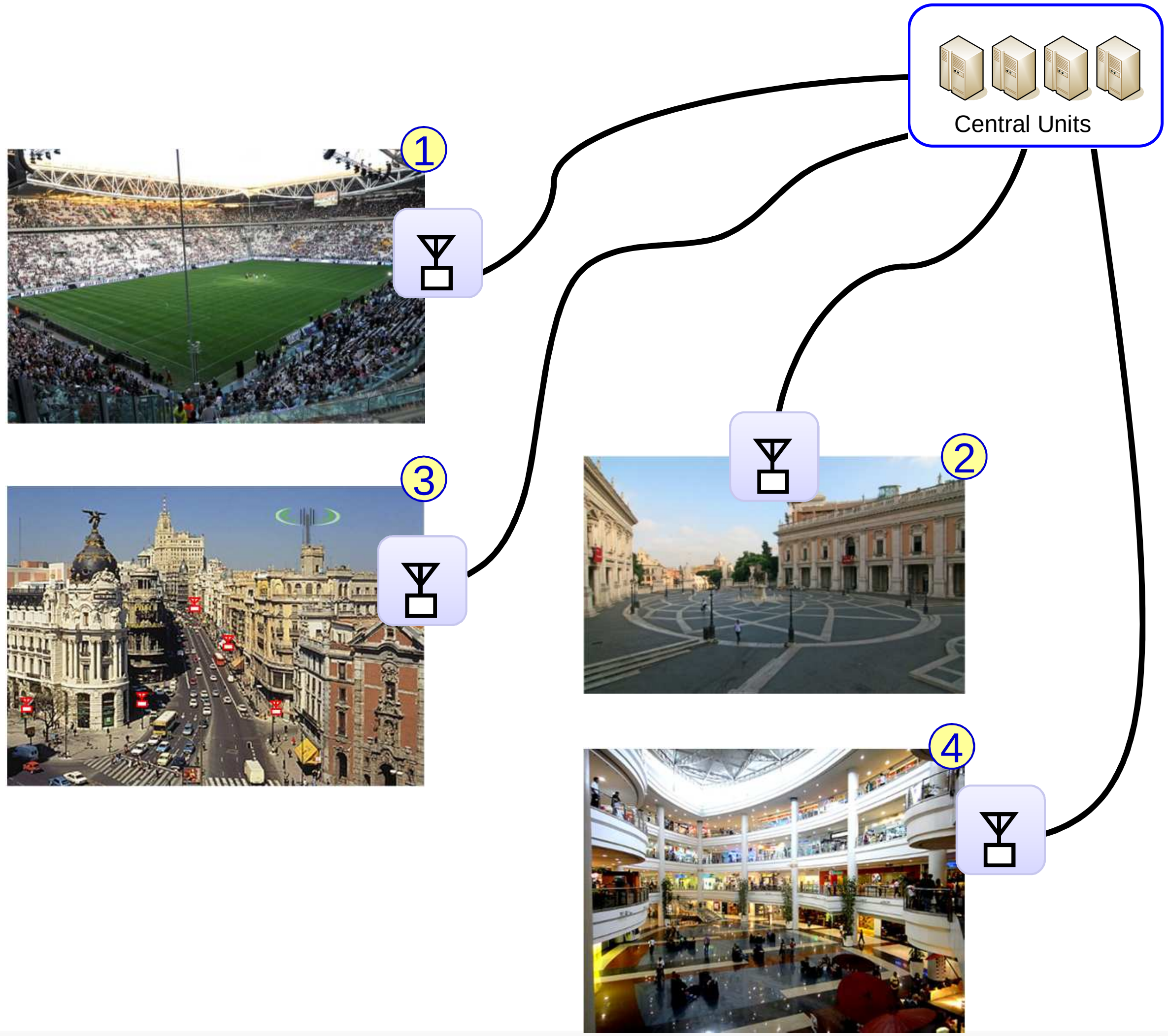
- iJOIN Common Scenarios (CS):
  - Outdoor focus:

    CS1: Dense Hotspot in a Stadium

    CS2: Dense Hotspot in a Square

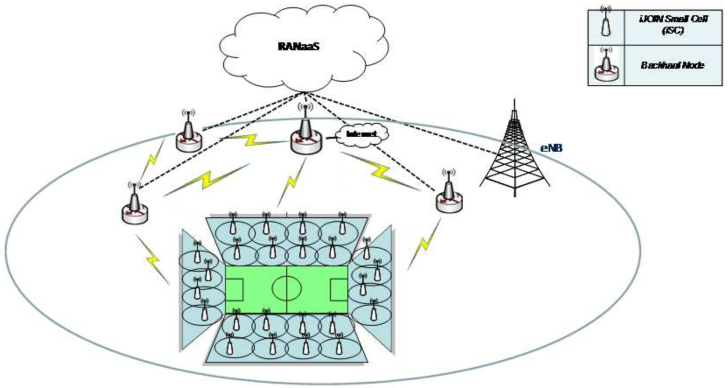
    CS3: Wide-Area continuous coverage
  - Indoor focus:

    CS4: Dense Hotspot in an Airport / Shopping Mall

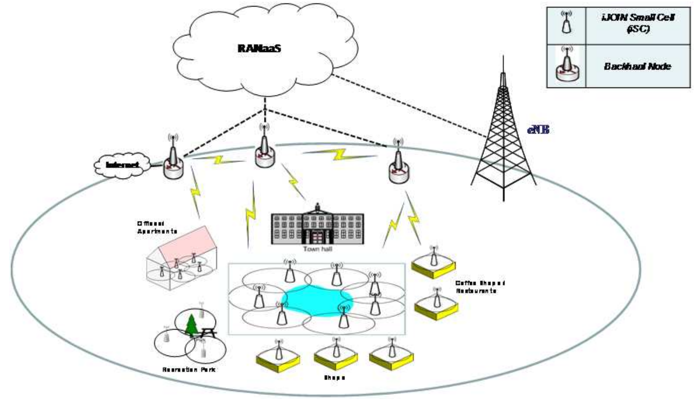


Results: Physical Architecture

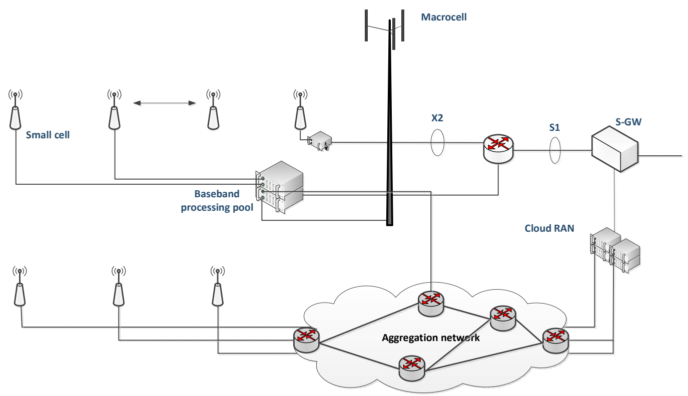
CS1: Dense Hotspot in a Stadium



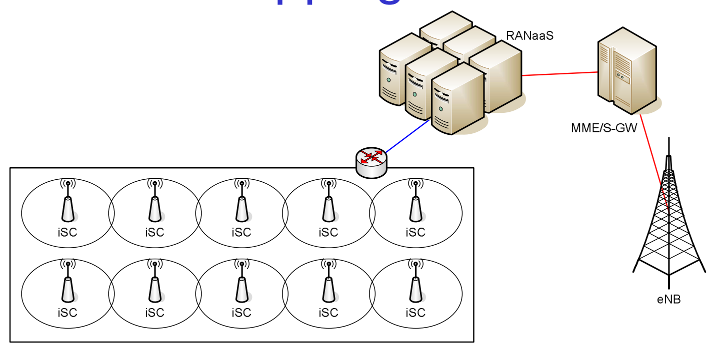
CS2: Dense Hotspot in a Square



CS3: Wide-area continuous coverage



CS4: Dense Hotspot in an Airport/ Shopping Mall



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SUMMARY

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- **New paradigms in mobile networks**
  - Ultra dense heterogeneous networks
  - Cloud computing applied to radio access and core network
  - Programmable networks, e.g. application of Software Defined Networking to mobile networks
  - System-optimization in focus

- **New opportunities**
  - Deployment of commodity hardware for RAN processing
  - Mobile communication apps
  - Dedicated purpose deployments and configurations

Thank you for your attention!