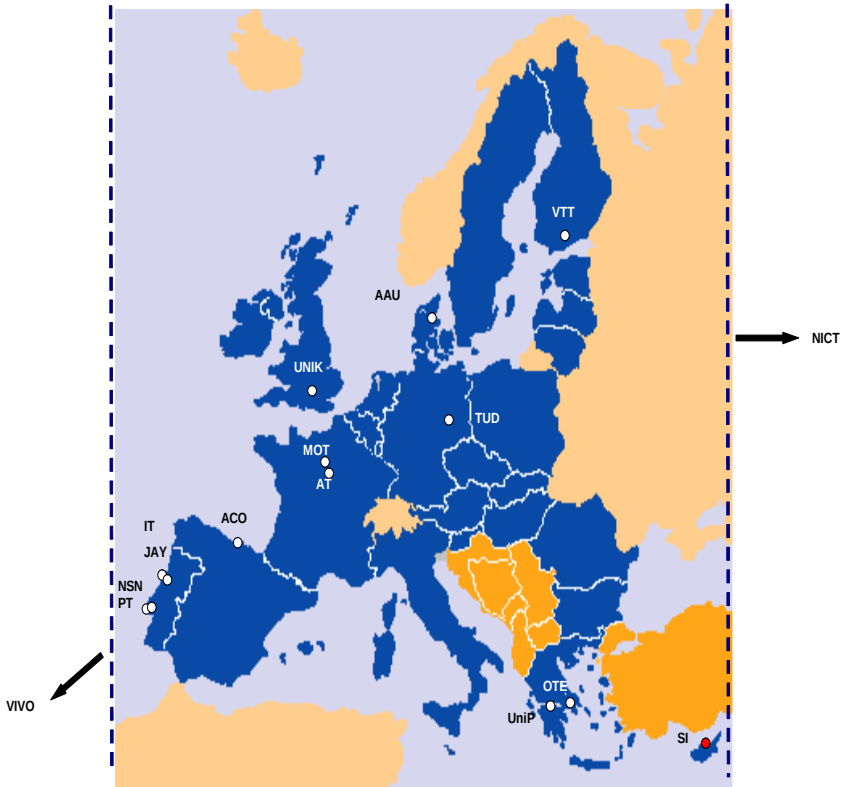
Introduction to the FUTON project

Fibre Optic Networks for Distributed, Extendible Heterogeneous Radio Architectures and Service Provisioning

Nokia Siemens Networks

FUTON in a Nutshell
Partners and calendar

✓ **FUTON consortium balanced between academy / research institutes, manufacturers and operators**



Duration: January 2008 – June 2010

Consortium

Large Industrial
- Nokia Siemens Networks
- Motorola (F)
- Alcatel-Thales III-V Labs (F)

Operators
- Portugal Telecom (P)
- Hellenic Telecommunications (Gr)
- VIVO (Br)

Small and Medium Enterprises
- Jaytech (P)
- Acorde (E)
- Sigint (Cy)

Research Centres
- Instituto de Telecomunicações (P)
- VTT (Fi)
- **NICT (Jp)**

Universities
- Technical University of Dresden (D)
- University of Aalborg (Dn)
- University of Kent (UK)
- University of Patras (Gr)

FUTON in a Nutshell
Key facts

Effort: 920.5 PM

Budget Total: 9.85 M€

EU Contribution: 6.58 M€

Budget Distribution

- Per category
  - RTD related activities: 91.4 %
  - Management related activities: 4.1 %
  - Other (Dissemination and training): 4.5 %
- Per type of organization:
  - Large industry: 35.2 %
  - SMEs: 14.3 %
  - Universities: 24.2 %
  - Research Centres: 26.3 %

Some Wireless Trends

Growing demand for wireless services

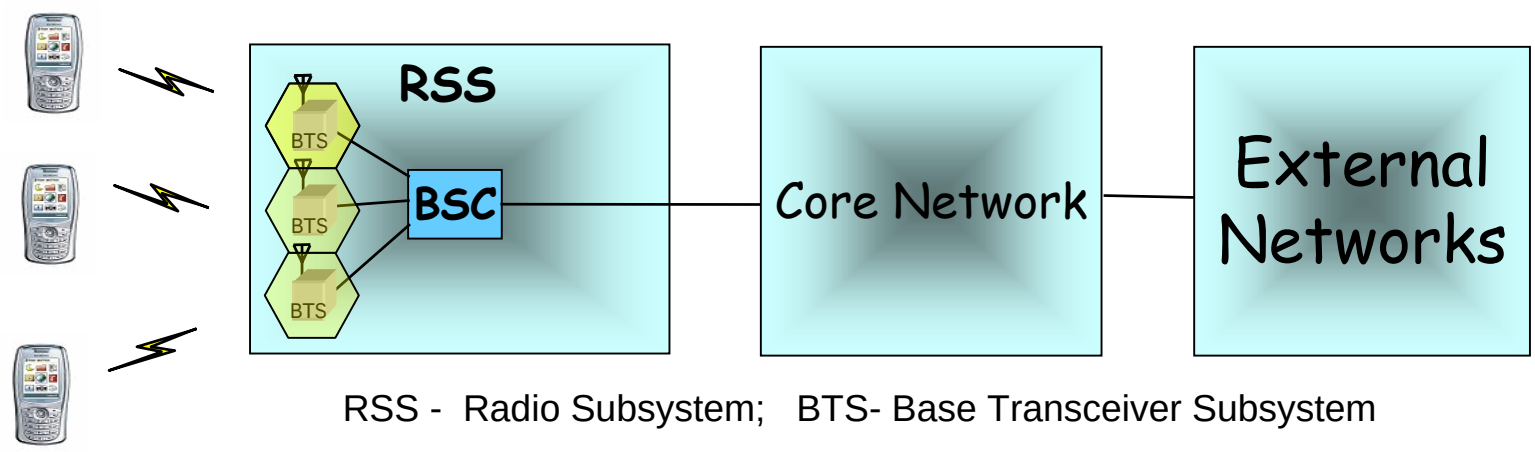
- Solution
  - Reduce the cell size, for cellular planning

Need for a broadband component

- Solution
  - Exploit the rich scattering properties of the wireless channel using multiple Tx/Rx antennas (MIMO concepts)

The Conventional Cellular Architecture

Wireless Cellular Networks: Architecture



RSS - Radio Subsystem; BTS- Base Transceiver Subsystem

- BTS (GSM) or Node B(UMTS)
  - L1 Processing & basic Radio Resource Management (RRM)
- BTS is connected to the BSC (RNC) through cable or microwave links
  - In either case the data is regenerated at the BTS (Node B)

Space multiplexing by treating radio signals from other cells as unknown interference

The Conventional Cellular Architecture
Network capacity

What is the scaling problem with such an architecture?

When the cell size gets smaller and smaller

- Path loss exponent reduces
- Interference from other cells increases
- Capacity per cell decreases
- Capacity (users/km^2) does not scale linearly as the cell size reduces

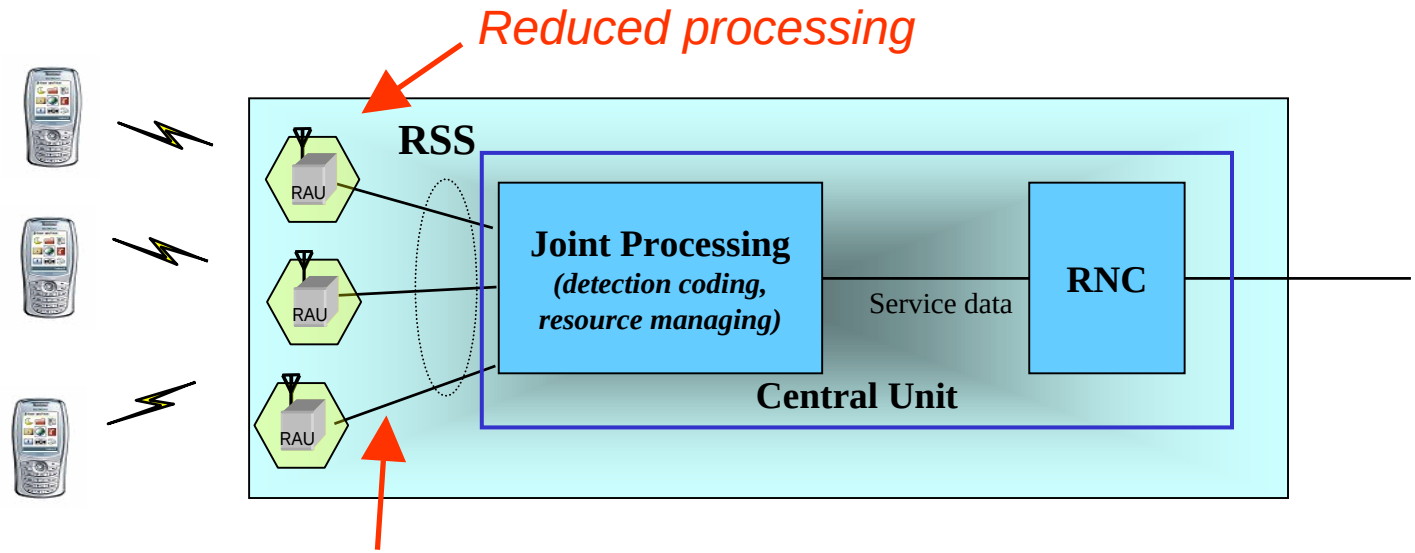
Solution

- To modify the architecture so that the signals from other cells are not seen as interference

The Conventional Cellular Architecture
Network capacity

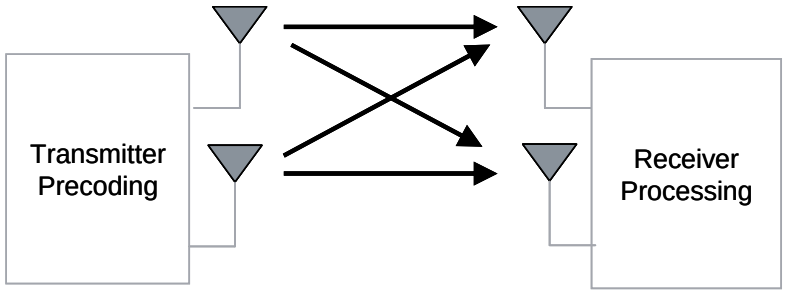
What would be an obvious solution to increase the system capacity?

Signals from the different cells not treated as unknown interference



➔ Allows soft combination / processing at the Central Unit (CU) ➔ Signals from different cells not treated as interference

The Conventional Cellular Architecture
Point-to-point capacity issue



MIMO is the trivial solution

Separate streams at the antennas → multiplexing gain ($R=\min[M_t, M_r]$)

- But achieved only if the channel is rich scattered
- But in mobile application, outdoor channel does not have too many major scatterers, resulting in strongly correlated channel

  ➔ capacity scaling not achieved
- Furthermore when more than one pair of MIMO users exist, interference to each other still exists, implying the requirement of joint processing of multiple pair of MIMO links

Solution

- Build a MIMO system with spatially disjoint antennas

Proposed solution

The network capacity (users/km^2) problem and the link capacity problem **point to the same solution**

Perform a joint processing of spatially separated radio signals

Build an infrastructure that collects / distributes the radio signals from the different antennas

The technology to build that: **optical fiber**

- Huge bandwidth

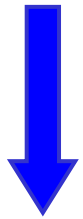
- Low losses

FUTON Architecture

But we can get much more from the infrastructure

With multiband RAU´s, the capacity of optical fiber allows:

- **The RoF infrastructure to be shared by different systems / operators**
- **If designed with the required flexibility can provide convergence wired-wireless**



Potentialities to exploit either at the technical or business levels

- **Technical level**
  - Processing of multisystems at a single location ➔ facilitate the design of efficient cross-system algorithms / protocols
  - Interoperability
- **Business level**
  - Owner of the RoF can be third party
  - Existence of an infrastructure that can be rented will facilitate the entrance of new service providers

FUTON Architecture

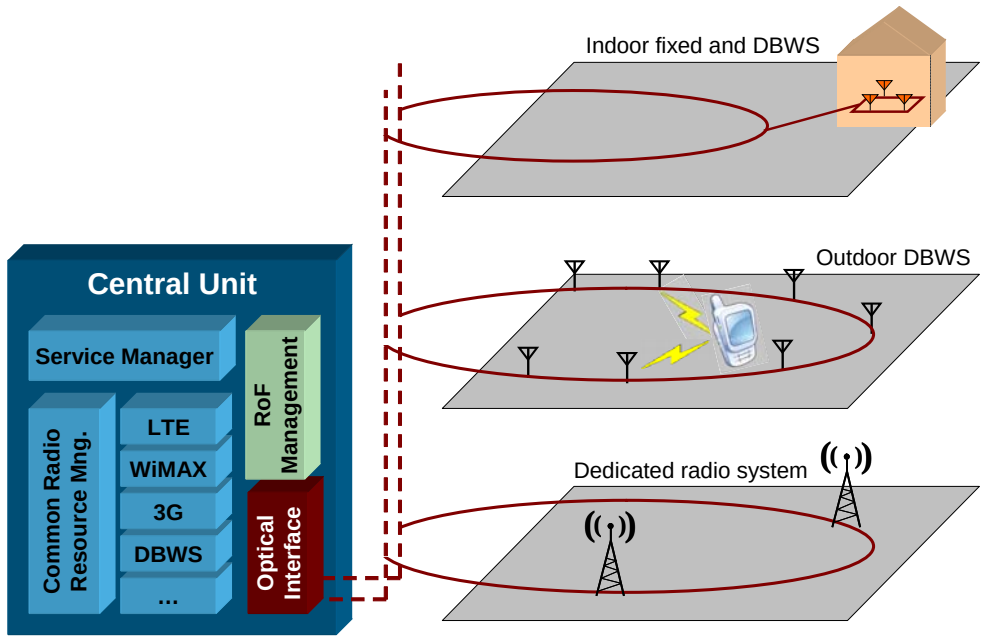
FUTON provides a fixed infrastructure that has enough flexibility to share its resources by a wide range of wired and wireless systems

The architecture comprises serving areas, where the Remote Access Units (RAUs) are located

RAUs are linked to a Central Unit (CU), using a transparent optical fibre system, and send/receive signals from different wireless systems

All processing tasks are performed at the CU

- ➡ joint processing of the signals to/from different RAUs
- ➡ virtual MIMO links



Conclusions

Distributed antenna systems one possible solution to overcome the network and link capacity problems

Optical fiber infrastructure key enabler to implement a broadband distributed network

FUTON project proposes a fiber based fixed infrastructure that may act as enabler of:

- Distributed broadband wireless systems
- Development of CRRM algorithms
- Efficient integration of fixed and wireless systems

The FUTON approach

- Fiber infrastructure not only for extension or remoting
- **But enabler for new wireless architectures and techniques**

FUTON aims at providing the long sought objective of broadband **to the user but with mobility added**

- Marriage of the optical and wireless technologies