

Virtual Radio Networks

A Framework for Configurable Radio Networks on Shared Infrastructure



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Innovation Cycles in Radio Networks

- Constant innovation in wireless transmission
 - MIMO, cooperative transmission, relaying, ...
 - routing, mobility management, multicast, ...
 - ➔ ... but it takes long time before real deployment (if at all)
- Why ?
 - Long development cycles
 - complexity (large scale distributed systems)
 - backwards compatibility
 - consensus-building and standardisation
 - Economic barriers
 - Large up-front investment for network build-out

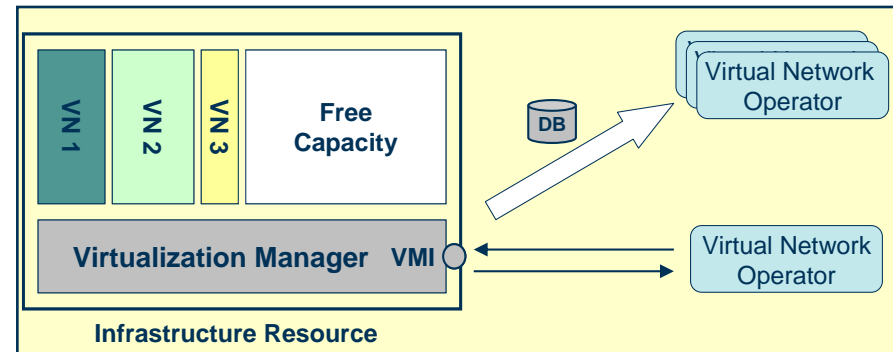
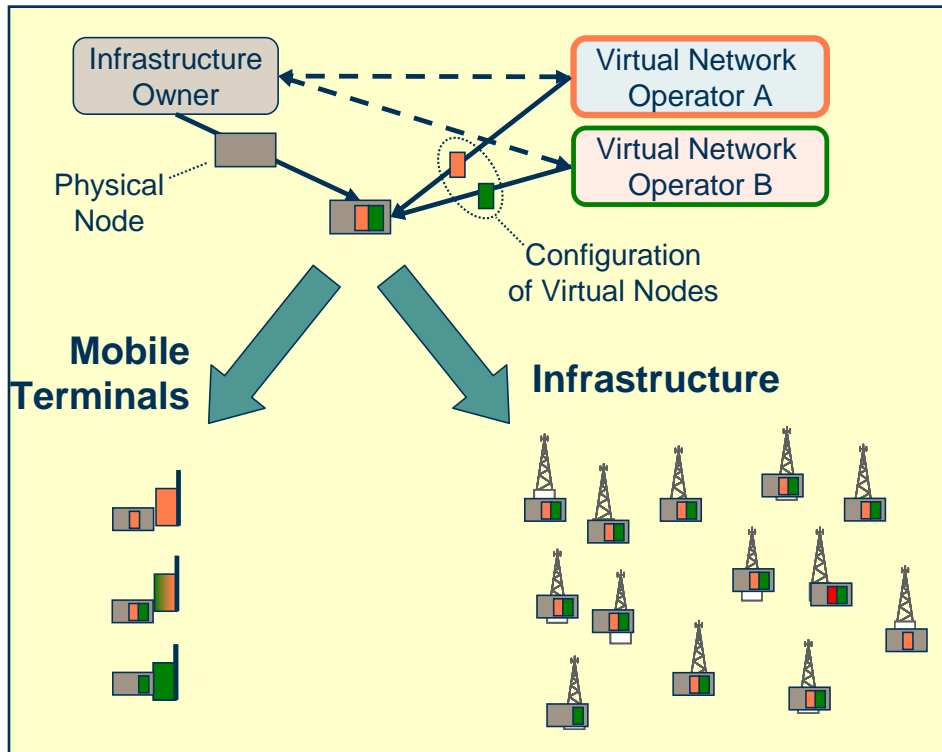
Related Work

- **Virtualisation** (mainly fixed networks)
 - separation, resources sharing
 - considered as design principle for Future Internet
- **Reconfigurable Networks**
 - for wireless mainly focused on *software defined radio*
 - role-based protocol design, active networking, router virtualization

- ➔ **Combine Network Virtualization with Reconfigurability**
 - ➔ Concurrent existence of different radio network solutions
 - ➔ Avoid problems *of evolution by parallelism*
 - ➔ Migration as transition from one virtual network to another one
 - ➔ Wireless edge network for *end-to-end virtual networks*

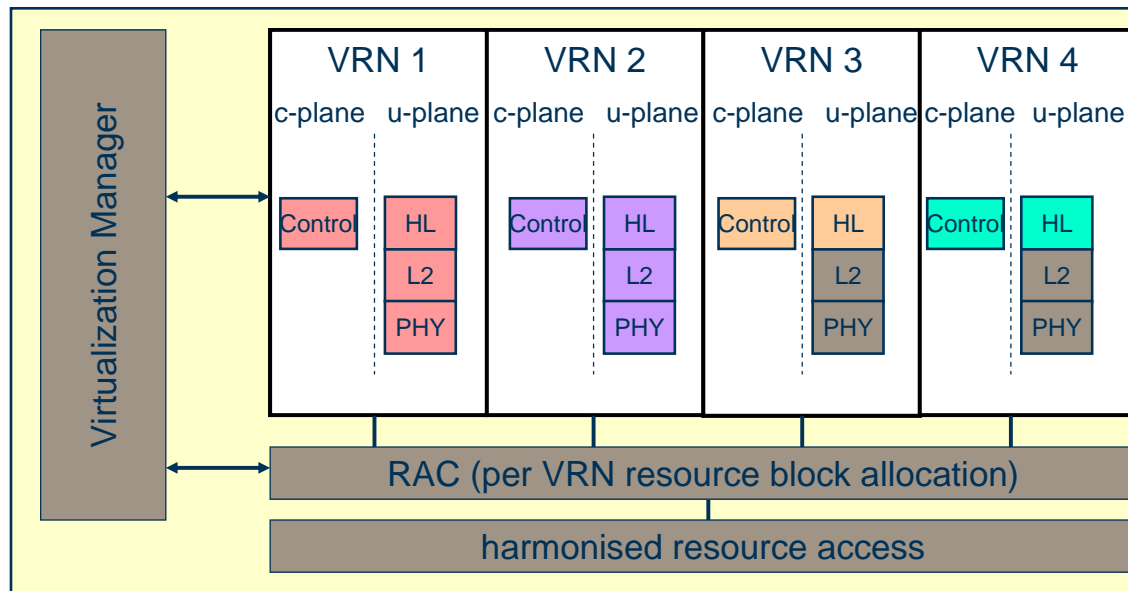
Virtual Radio Networks

- Multiple Virtual Radio Networks on a Shared Infrastructure
 - Determine required nodes
 - Configure virtual nodes
- Mobile devices
 - Can be configurable
 - Can be specific for one/few virtual radio networks (cost efficiency)



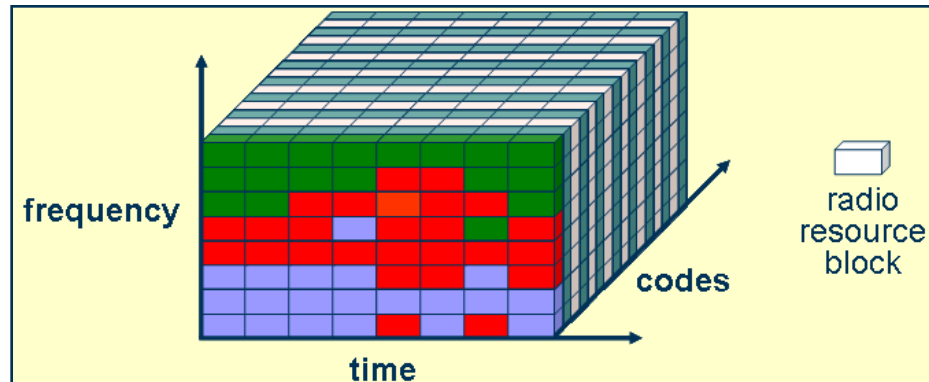
Virtual Radio Network Configuration

- Any communication method / protocol
 - Routing, mobility management, naming
 - Radio protocols, channel coding, multi-antenna transmission
 - Cross layer optimization
- Any (VRN internal) management function
- Any (VRN internal) control function
 - Multi-user management
 - Radio resource management



Radio Resource Allocation

- Different virtual radio networks share radio resources
 - harmonized *radio resource blocks*
 - some limitation on possible physical layer structures of different virtual radio networks
 - generalized form of multiple access (FDMA, TDMA, CDMA)
 - but per *virtual radio network* (not per user !)
 - coordinated via infrastructure node



- ➔ Efficient resource partitioning
- ➔ No interference between virtual radio networks

New business models & relationships

Separation of

– infrastructure provider

– (virtual) network operator

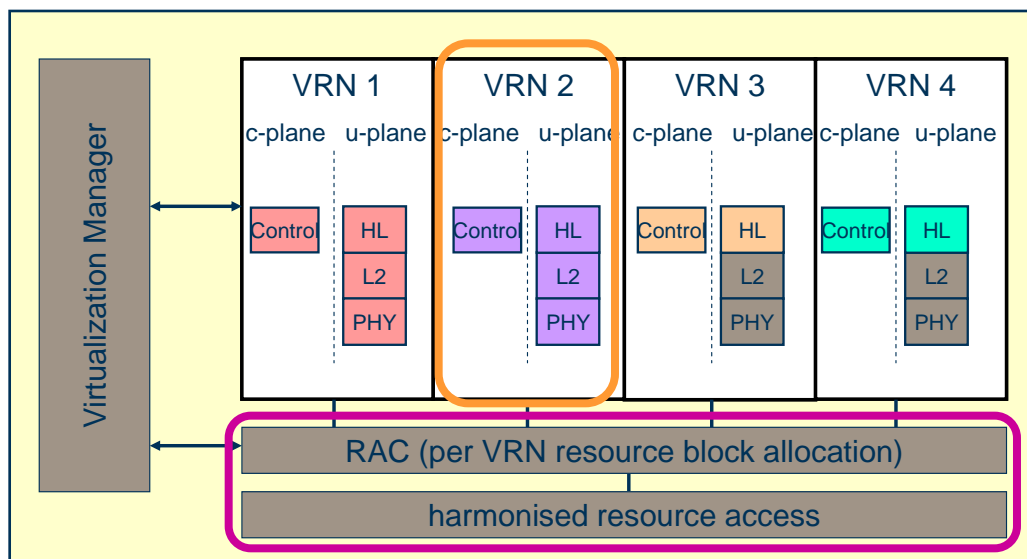
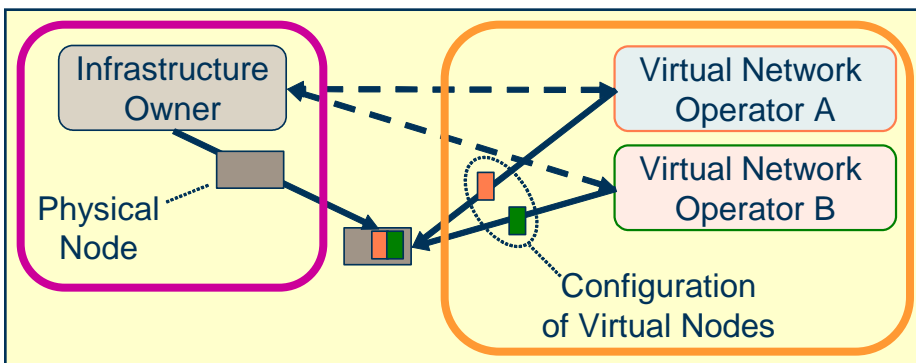
Decoupled development life cycles

– long-term

- infrastructure
- capacity

– short- / mid-term
(dynamic and flexible)

- virtual (radio) network functionality



Examples

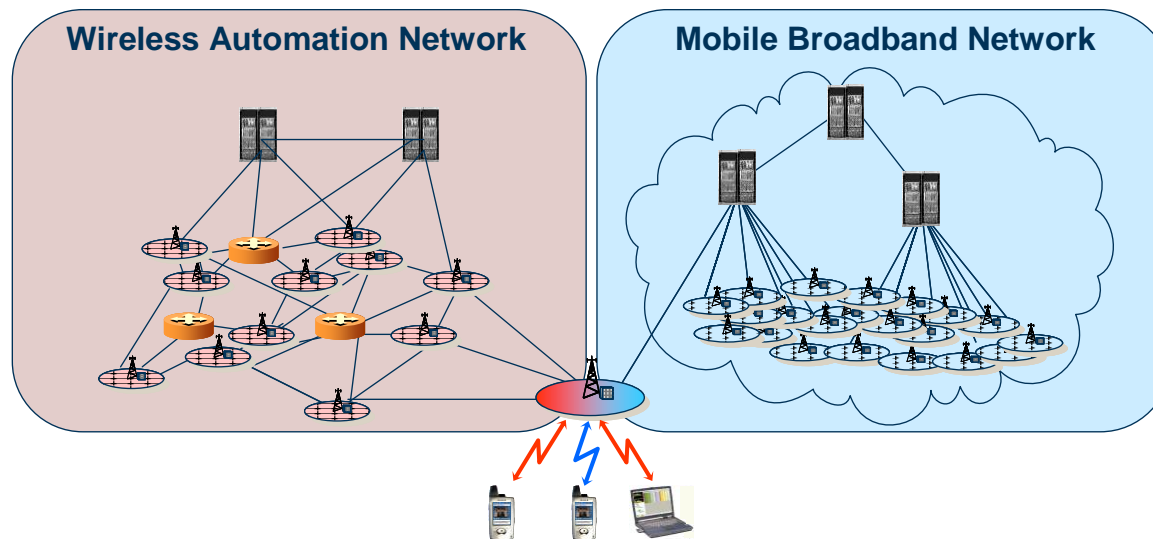
Wireless Automation Network

- Optimised for large quantity of low-rate data (machine-to-machine) services
- Multi-path mesh routing

Mobile Broadband Network

- Optimised for broadband multimedia services
- Cooperative multi-site transmission for capacity
- Cellular mobility management

Based on same infrastructure



Challenges for Virtualised Radio Networks

- Performance, scalability and cost-effectiveness of re-configurable radio nodes
- Overhead and efficiency of virtualisation
 - but aggregation of resources possible prior to virtualisation
- Fragmentation of wireless access technologies
 - economy of scale ?

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