



## - Systems Beyond 3G

Matthias Lott

Siemens AG, Communications, Munich, Germany

ICC,

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# Systems B3G

## - Cooperation Architecture

### Inter-working of different RANs:

- Legacy RANs (GSM, UMTS, 802.16, 802.11x)
- IST WINNER air-IF
- Support for future RANs

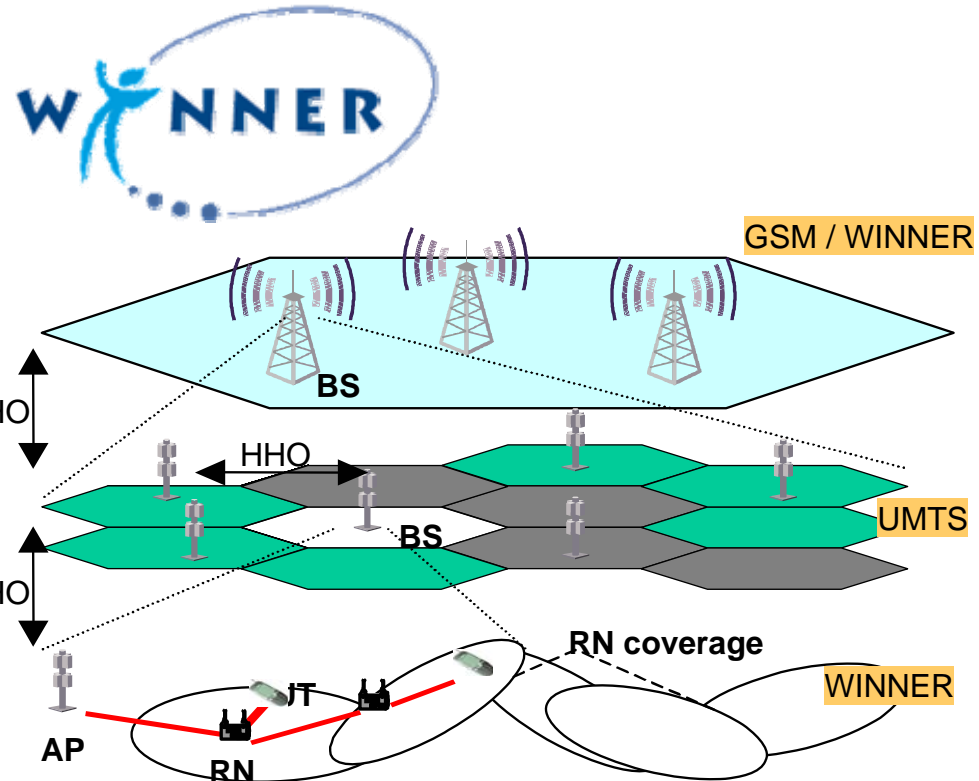
### Coordination of different RAN RRM resources (Cooperative RRM concept)

- Support complete set of inter-RAN cooperation mechanisms, e.g. inter-RAN handover (VHO)

### Must provide to upper layers an unified interface (e.g. by means of the Generic Link Layer concept)

- Hiding the intrinsic complexity of underlying layers and RANs
- GLL provides an application programming interface to higher layers

Service Specialized System - SSS



BS: Base Station  
AP: Access Point

UT: User Terminal  
RN: Relay Node

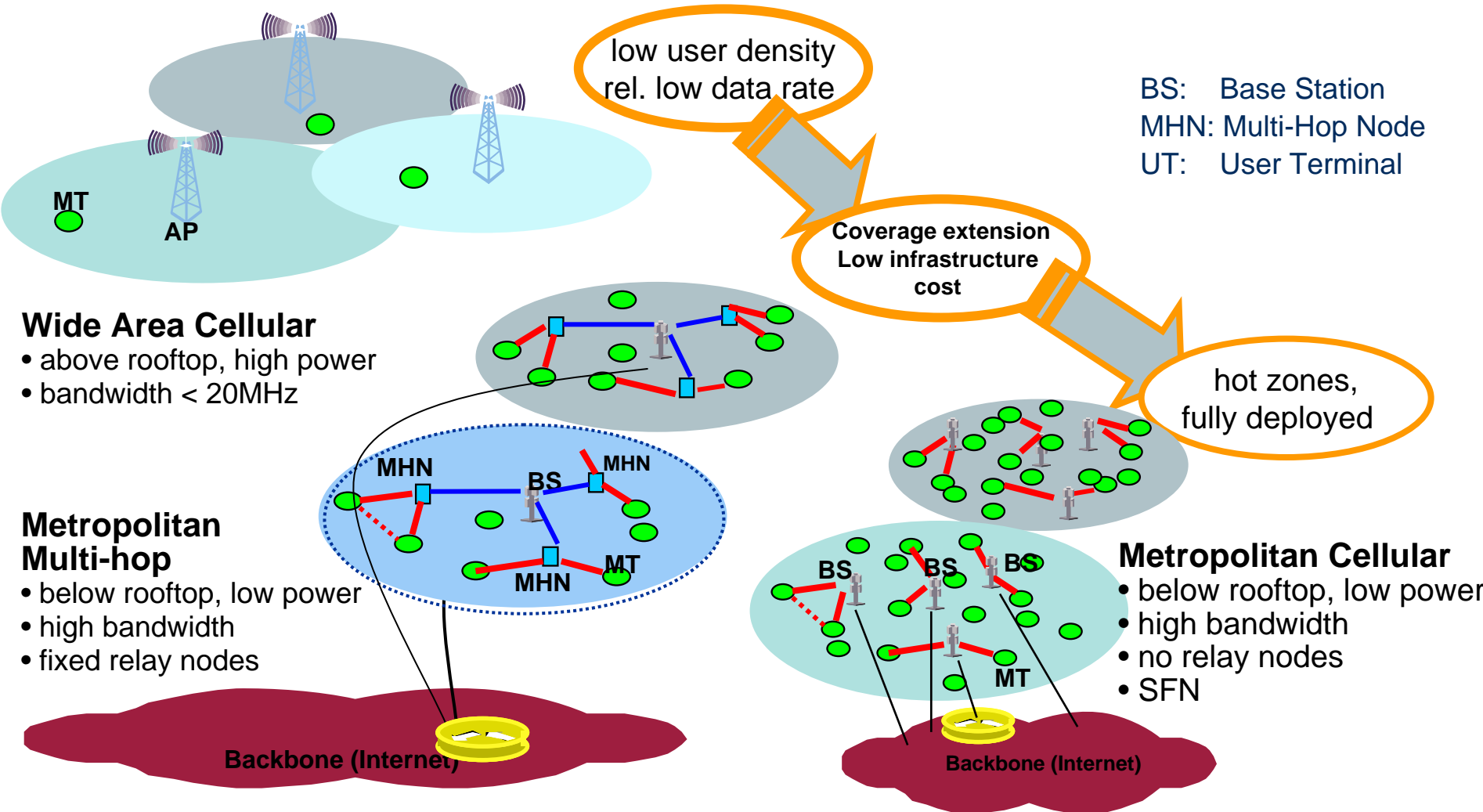
HHO: Horizontal HO  
VHO: Vertical HO



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# Systems B3G

## - Scalable Deployment with Multi-hop



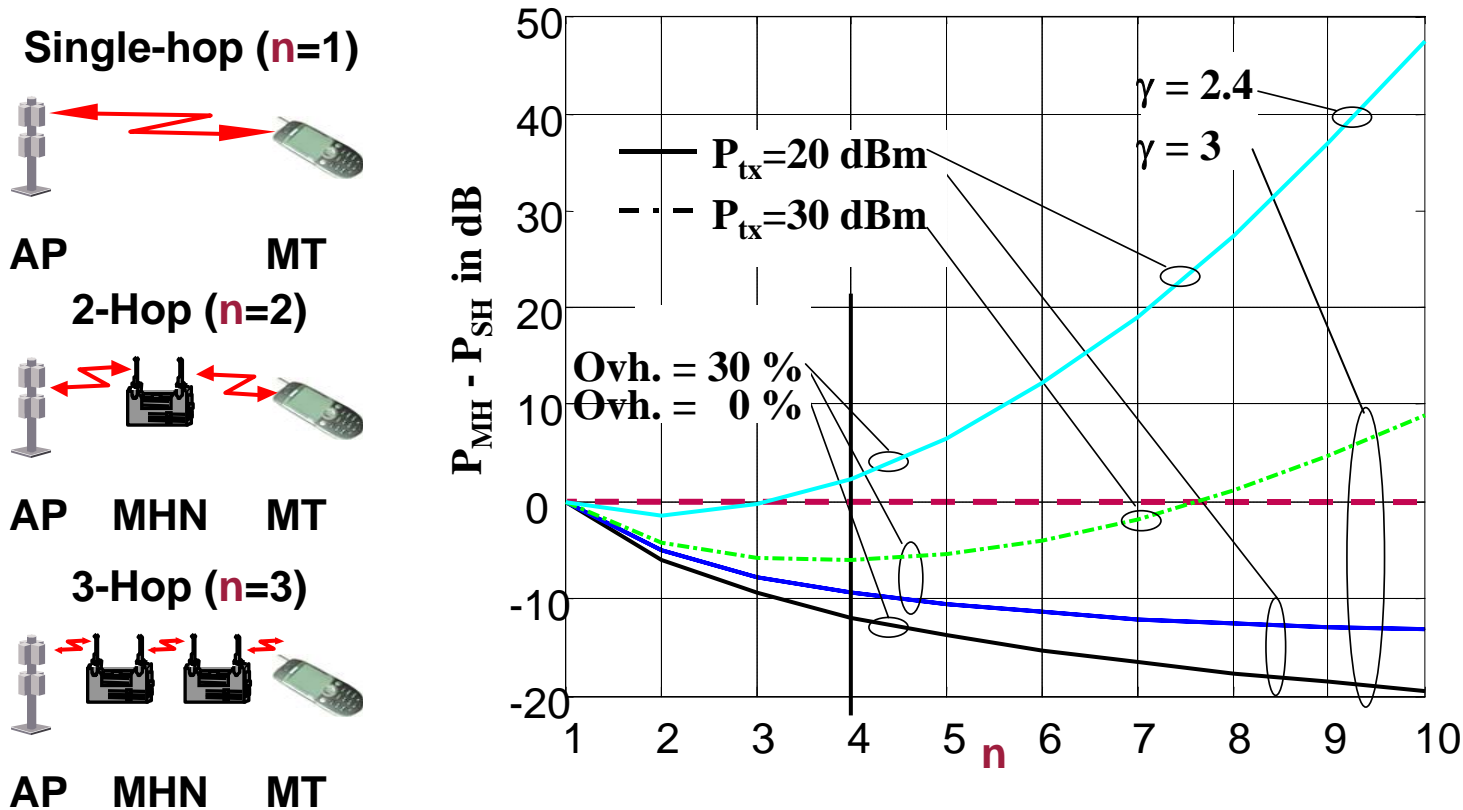
# Cooperation on Air-Interface

## - Reason for Oligohop Communication

Introducing Multi-Hop Nodes (MHNs)

- Reducing interference + increasing data rate

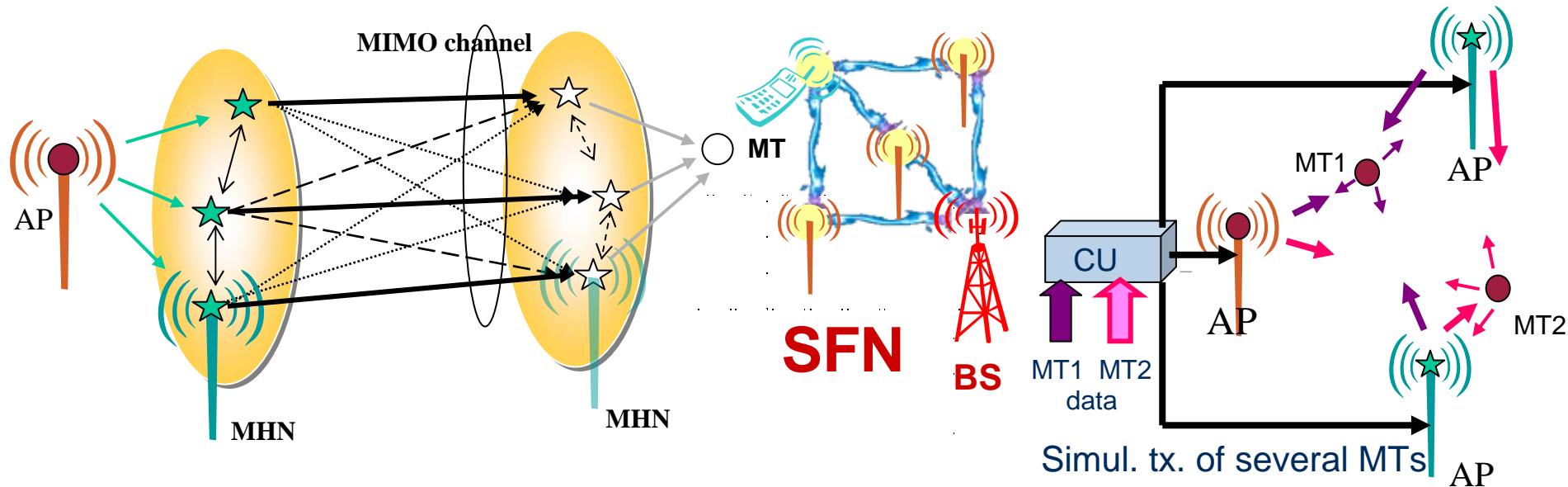
**Tx-power of Multihop ( $P_{MH}$ ) – Tx-power of Single-hop ( $P_{SH}$ ) based on Shannon**



**A number of 4 hops = oligohop should not be exceeded!**

# Cooperation on Air-Interface

## - Cooperative Distributed Antenna Concepts



### Co-operative antenna system:

- High outdoor performance for MIMO
- Simple MTs w/o complex antennas

**VAA:**  
**Virtual Antenna Array**

### Joint Transmission / Detection

- Increased capacity
- Minimized Inter-Cell Interference

### Performance:

- more than 30 bps/Hz at 10 dB SNR

# Cooperation between Networks

## - UMTS / WLAN / WiMAX Inter-working

- WLAN in hot-spots (e.g. high-speed file downloads)
- WiMAX for DSL replacement
- Smooth handover from/to UMTS

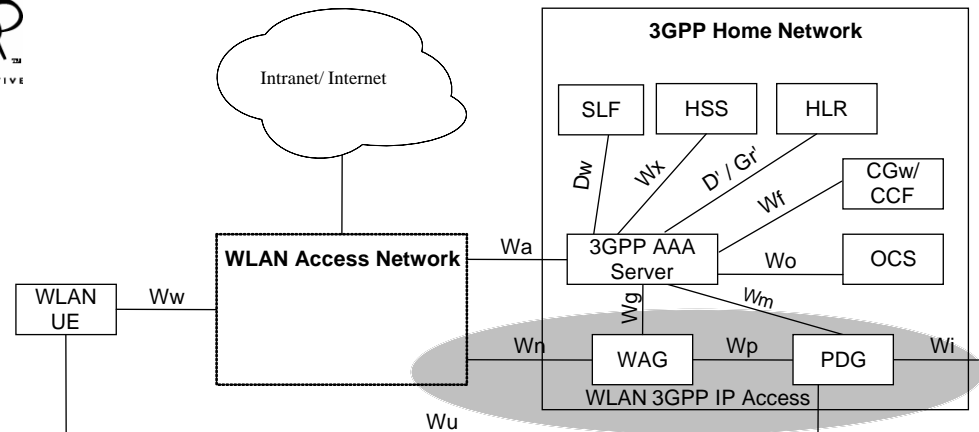
- 3GPP SAE/LTE



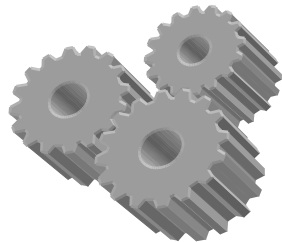
- IEEE



- IETF



➔ Not only technical cooperation is needed,



also “cooperation” between different standardization bodies is required!



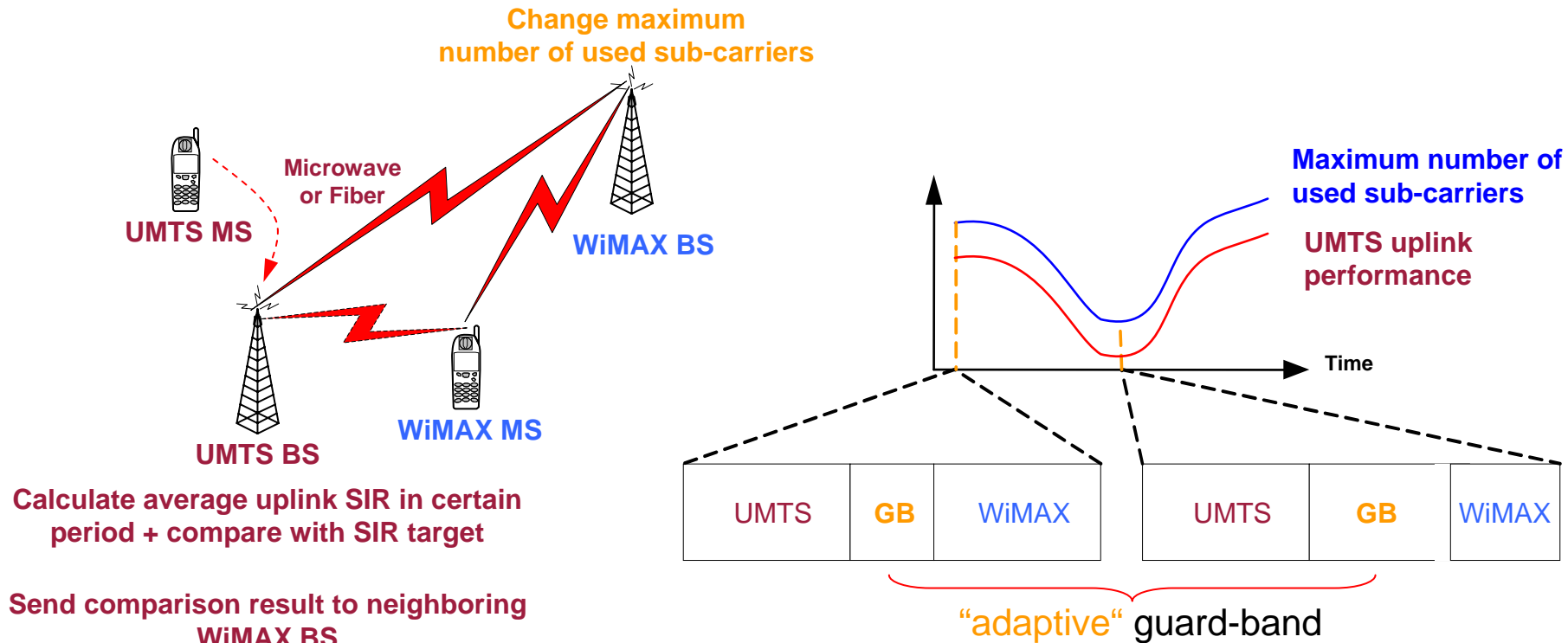
**Cooperation has many facings!**

# Cooperation between Networks

## - Example of UMTS / WiMAX Inter-working

### Network Coupling Based Inter-system Interference Reduction Schemes

- Sub-channelization of the WiMAX OFDM sub-carriers (**Adaptive Guard-band**)
- WiMAX BSs, **based on UMTS UL performance**, can **adaptively change**:
  1. Maximum downlink transmit power
  2. Maximum number of downlink used sub-carriers



# Conclusions

Different levels of Cooperation

Cooperation on the air-interface: **Cooperative Antennas**

Cooperation between networks: **Service Specialized System**  
**Adaptive Guard-band**

## Challenges

- Air-Interface: Exploitation of multi-hop gains and spatial domain
- Network: Efficient Cooperation between heterogeneous Networks (UMTS, WLAN, WiMAX, LTE/SAE, 4G)
- Support of mobility (intra-/inter-system mobility)

The future will be heterogeneous ...

***Cooperation is one key issue in Systems B3G***

