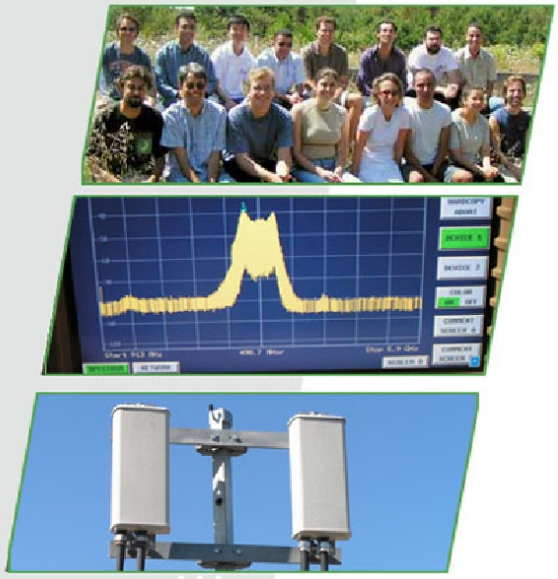
EURECOM
Sophia Antipolis

OPEN AIR INTERFACE



OpenAirMesh

A Platform for Cooperative Mesh Networks

H. Anouar, C. Bonnet,
F. Kaltenberger, R. Knopp

GDR ISIS Meeting

Paris, 12.6.2008

CHORIST

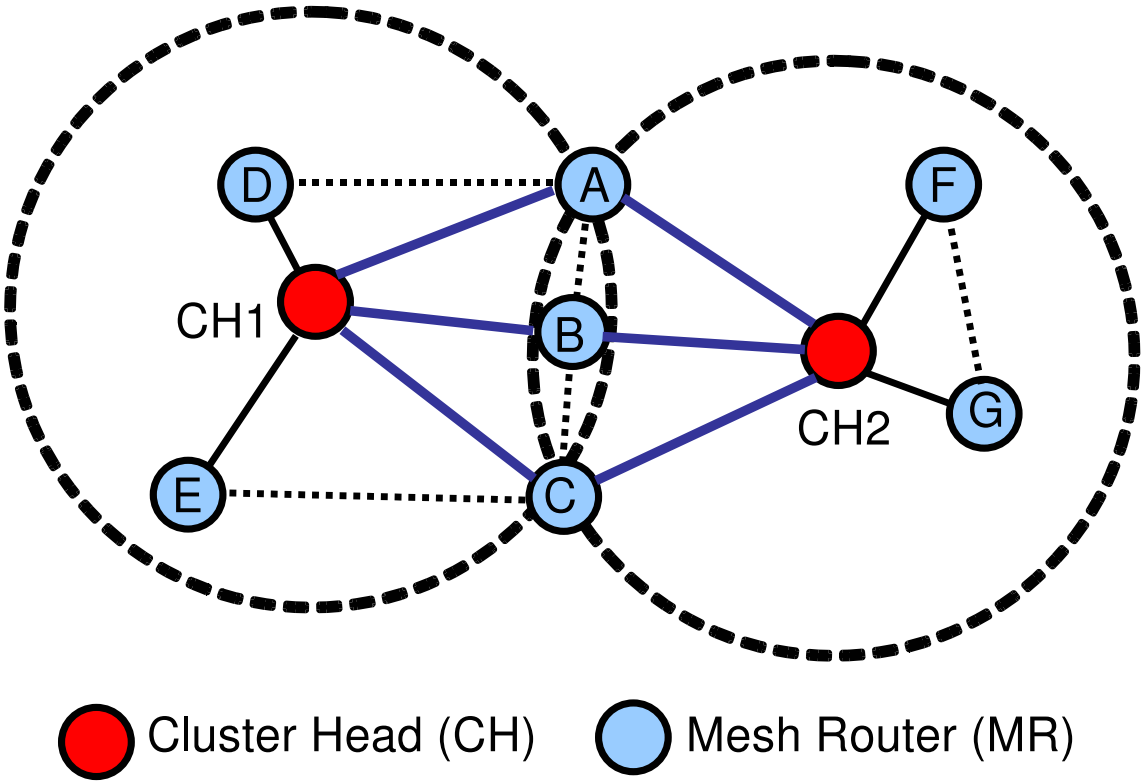
SEnsor Network for Dynamic and cOgnitive Radio Access
Sendora

Introduction to OpenAirInterface

EURECOM
Sophia Antipolis

- Development platform for digital radio communications
- Open-source hardware and software solution
- Innovation through experimentation
- Cellular and **Mesh** configuration
- **PHY layer** targets WiMax and UMTS LTE (MIMO-OFDM)
- **MAC layer** supports collaboration

Wireless Mesh Network Architecture



- Nodes can take the role of a CH or MR
- Dynamical self-organization and self-configuration

Cooperation in Wireless Mesh Networks

EURECOM
Sophia Antipolis

Types of Cooperation

- Collaborative ressource allocation (spatial re-use)
- Relaying
- Distributed signal processing

Benefits

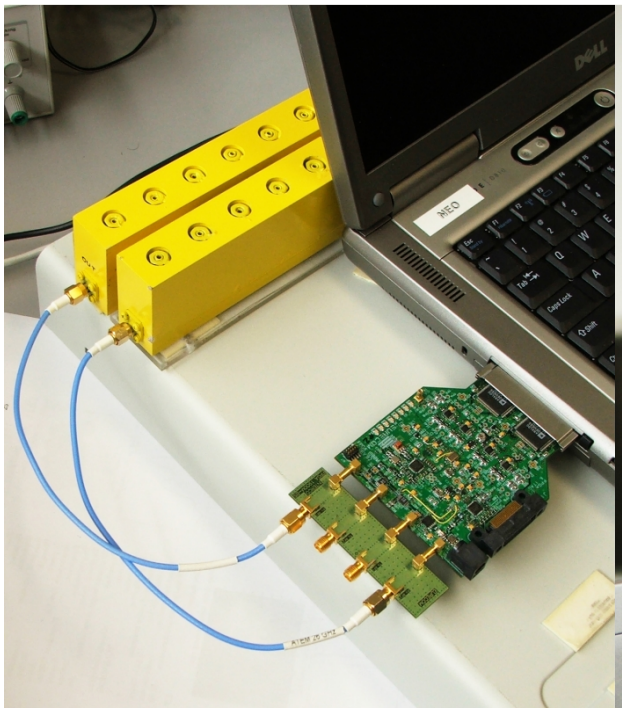
- Increased network throughput
- Increased coverage and reliability

Enabling Technologies

- Distributed synchronization
- Interference-aware scheduling
- Multiple antennas (MIMO)
- Interference cancellation receivers

Hardware Architecture

EURECOM
Sophia Antipolis



CBMIMO1 card

UE antennas

BS antennas

Hardware Characteristics

EURECOM
Sophia Antipolis

	Currently	Next Year
Carrier Freq.	1.90 - 1.92 GHz	200 MHz - 7.5 GHz
Bandwidth	5 MHz	20 MHz
Channels	2	4
Duplex	TDD	TDD and FDD

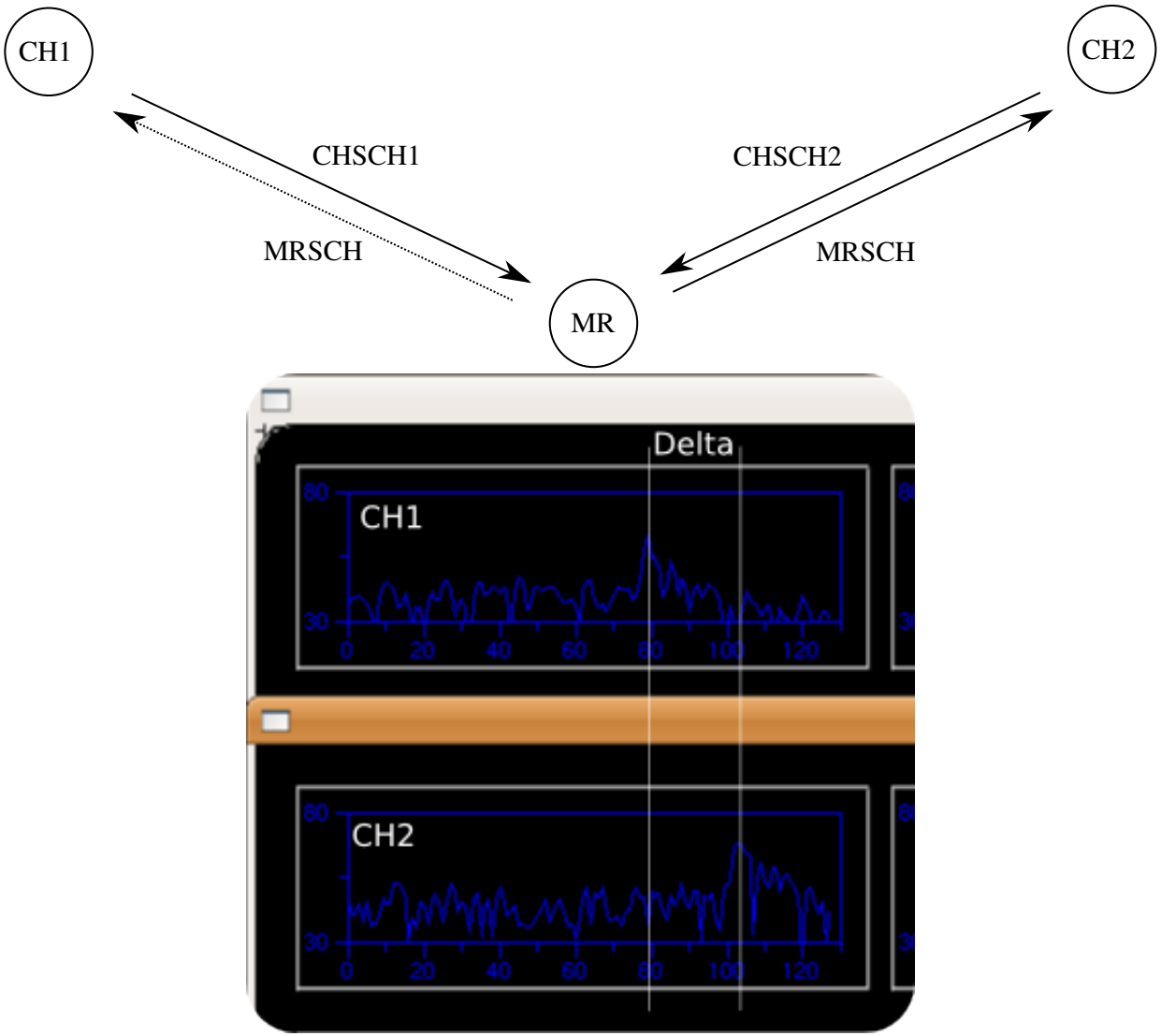
Physical Layer

EURECOM
Sophia Antipolis

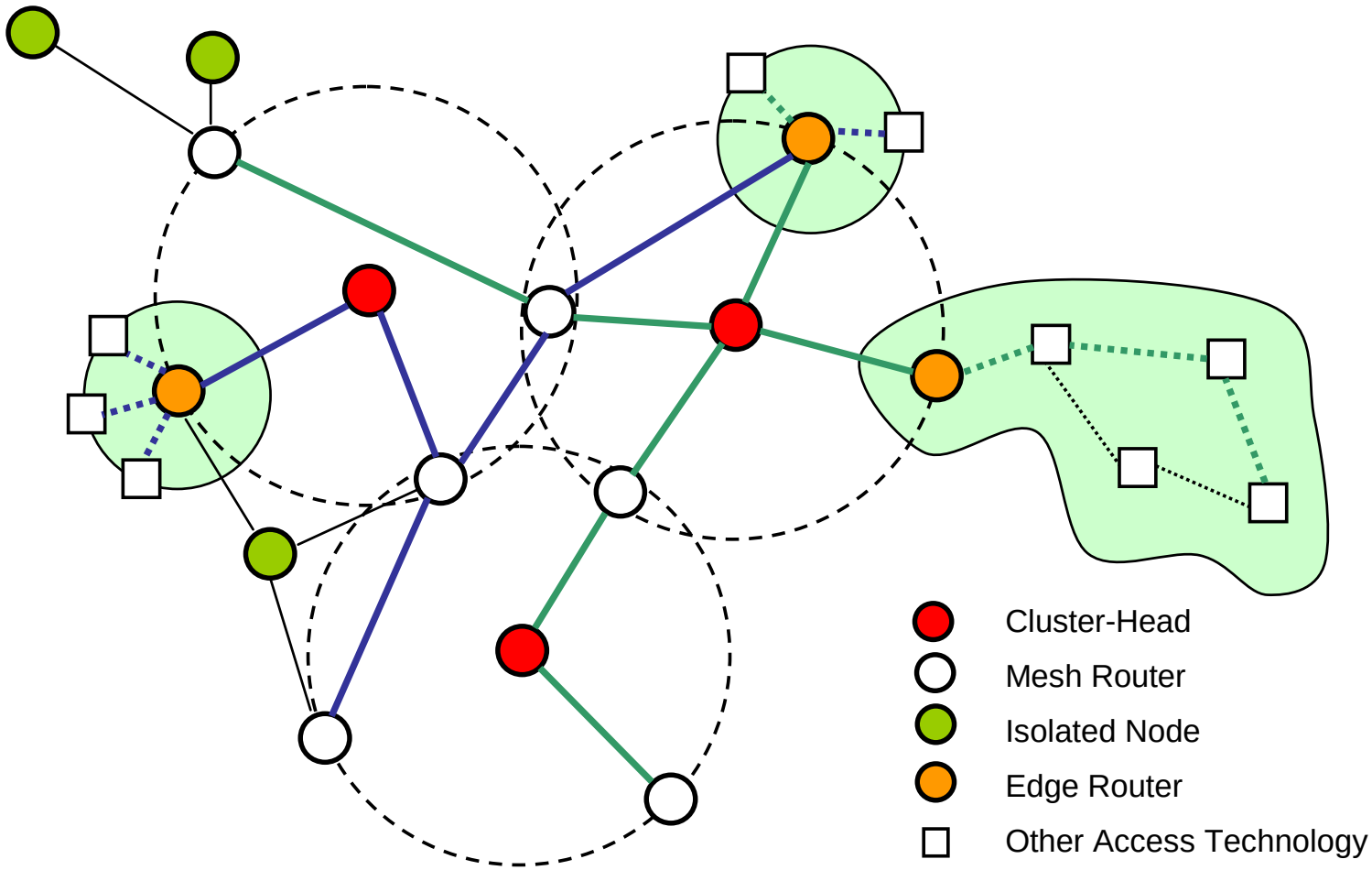
- Reconfigurable MIMO-OFDMA
- Orthogonal pilot channels
- Feedback channels
- Distributed network synchronization
- Bit interleaved coded modulation (BICM), turbo and convolutional codes, hybrid ARQ
- Spatial multiplexing (point-to-point or distributed MIMO)
- Successive interference cancellation (SIC) receiver [1]

[1] R. Ghaffar and R. Knopp, "A MIMO broadcast strategy and interference cancellation in single frequency cellular system," in *Proc. 1st COST2100 Workshop on MIMO and Cooperative Communications*, Trondheim, Norway, Jun. 2008.

Distributed Network Synchronization

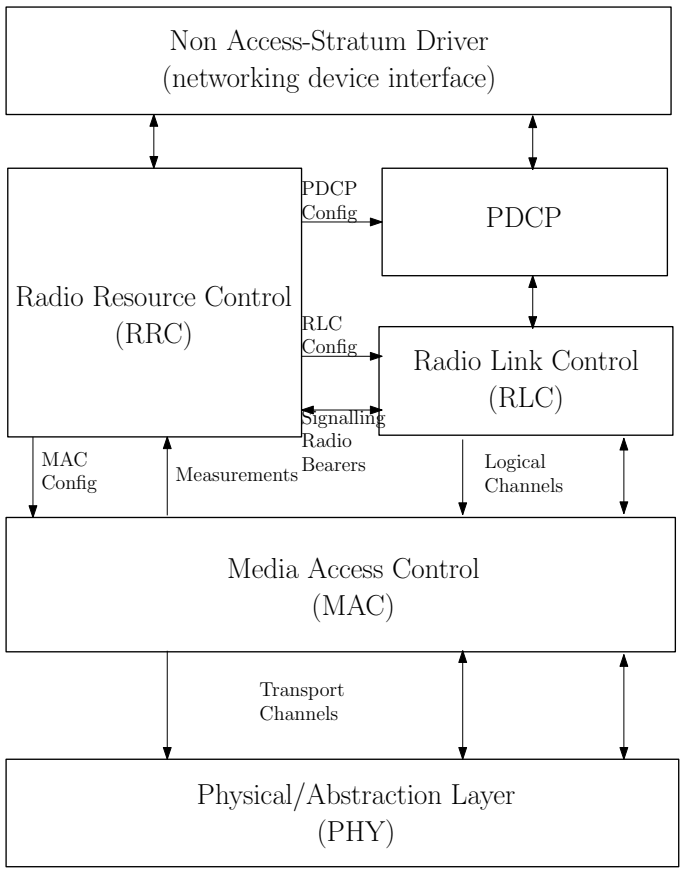


Layer 2 Protocol Stack



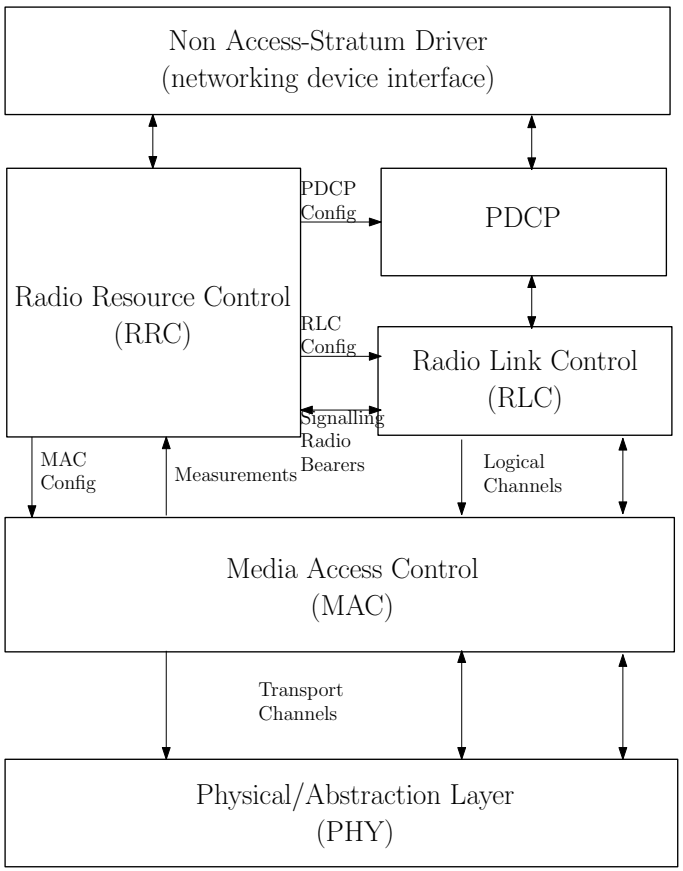
- Responsible for MAC and PHY layer resource allocation
- Interconnection of secondary air interfaces.

Layer 2 Components



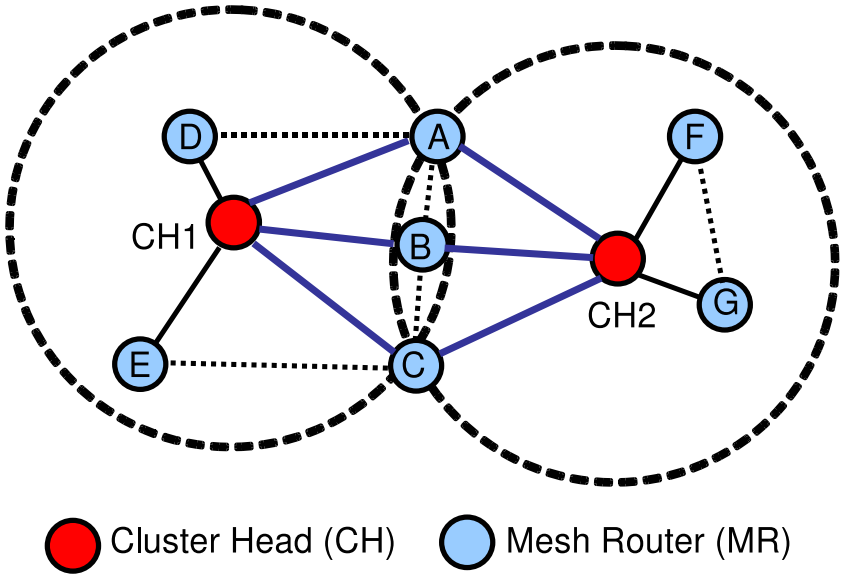
- Non-access stratum (NAS) driver
  - networking device interface
  - provides IP/MPLS layer services
  - responsible for routing/forwarding
- Radio resource controller (RRC)
  - MAC layer signalling
  - Retrieval of measurement information
- Convergence protocol (PDCP)
  - IP interface
  - header compression, ciphering

Layer 2 Components



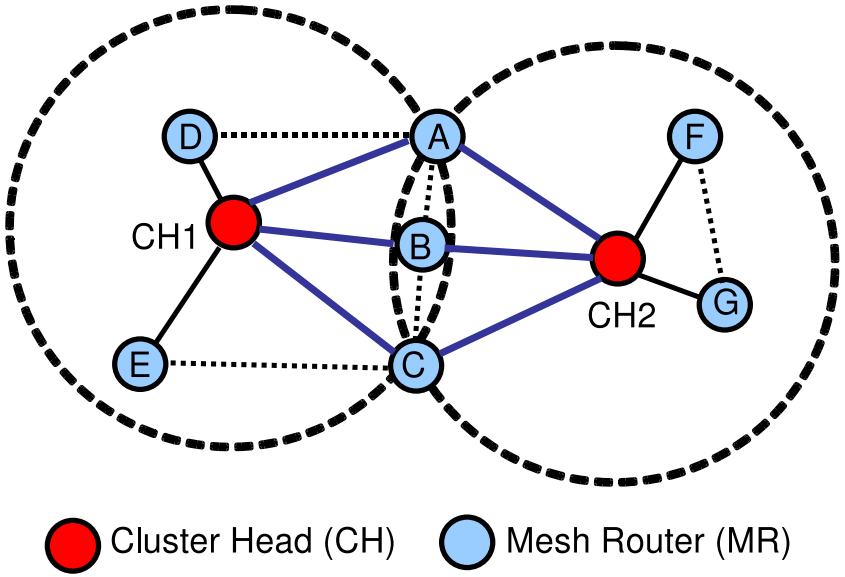
- Radio link controller (RLC)
  - automatic repeat request protocols (ARQ)
  - IP/MPLS packet segmentation
- Media access controller (MAC)
  - scheduling and multiplexing
  - mapping between logical and transport channels
- Physical/Abstraction Layer
  - PHY layer can also be emulated

Cooperative Protocols in OpenAir L2



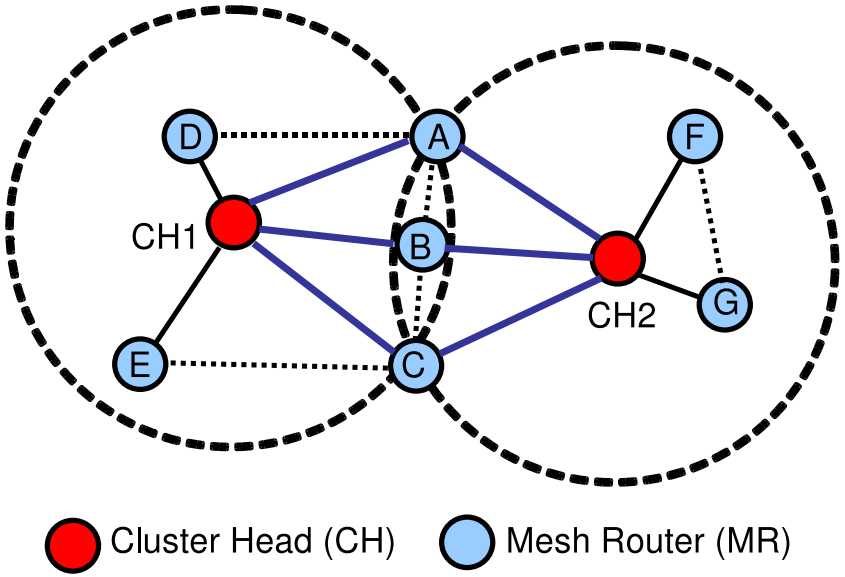
- Advanced measurement support for L3 routing protocols
  - Nodes in mesh dynamically inform L3 of wideband channel quality with their neighbors
  - L3 routing can use these measurements to adapt routing in mesh (relay selection based on QoS)

Cooperative Protocols in OpenAir L2



- Support for QoS scheduling for MR-CH and MR-MR communication within cluster
  - CH scheduler uses low-layer feedback of wideband spatial channel quality and L2 queuing information to schedule PHY/MAC resources in the cluster.
  - Measurements combined with dual-antenna interference cancellation receivers can be used to achieve spatial reuse within the cluster with scheduling

Cooperative Protocols in OpenAir L2



- Outlook: Support for L1 cooperative communications (decode-and-forward) based on distributed MIMO-HARQ
  - Main problem: How does the MAC identify flows which are routed by L1 (as opposed to L3) in a collaborative sense

Applications and Conclusions

Cooperative Wireless Mesh Networks can be used for

- Rapidly deployable networks for public safety units[2]
- Sensor networks for cognitive radio[3]

OpenAirMesh provides

- Open-source hardware and software platform
- Cooperative MAC and PHY Layer
- Distributed network synchronization

[2] www.chorist.eu

[3] www.sendora.eu