

► **From Media Independent Mesh Networks to Media Independent Services**

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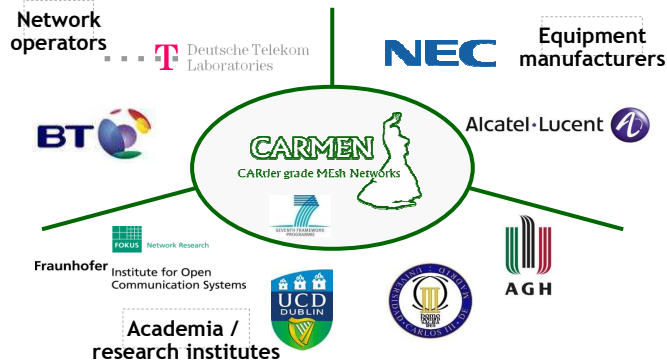
Carrier-grade Wireless Mesh Network Workshop,
 ICT Mobile Summit 2009, Santander, Spain

CARMEN Project Overview

► **CARMEN = CARrier-grade MESH Networks**

- ▷ Collaborative project within EU's 7th ICT Framework Programme
- ▷ Runtime: 3 years (Jan. 2008 – Dec. 2010)
- ▷ Budget: 6.2 M€ (3.9 M€ EU contribution)

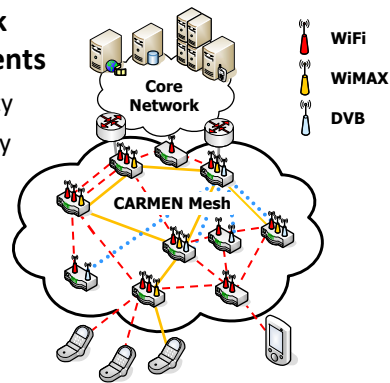
► **Consortium:**



Goals of Carmen

► Goal: Full Wireless Mesh Network architecture for carrier requirements

- ▷ triple-play service quality, high reliability
- ▷ full flexibility regarding radio technology
 - microwave, WiMAX, WiFi, LTE, DVB, ...
 - even heterogeneous deployments
 - smooth migration paths
- ▷ very low CapEx and OpEx



Use Case Scenarios

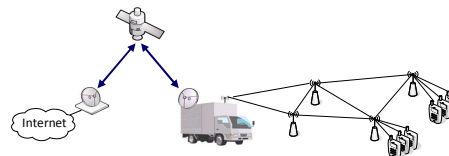
► London Olympic Games 2012

- ▷ low-cost, short-term provisioning of additional wireless access capacity
- ▷ triple-play QoS requirements

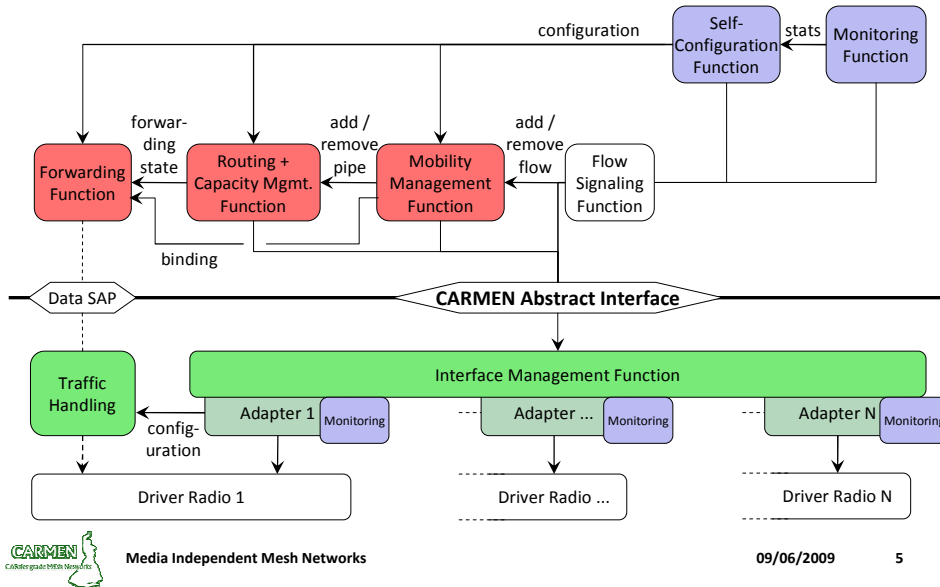


► Emergency Response Support

- ▷ severe capacity constraints
- ▷ intermitted connectivity to core
- ▷ sub-optimal node placement
- ▷ focus on group-communication



Overview of the Carmen Architecture



CARMEN in IEEE 802.21

Motivation

- **Mesh networks are being deployed and there are already many commercial products**
 - Motorola (MotoMesh), Cisco(Cisco Aironet 1520 Series), InfiNet (InfiMesh), Winncom (SyncMesh), BelAir, NEC, Others...
- **Products are designed for homogenous media, but the flexibility of mesh makes it attractive to combine heterogeneous technologies**
 - Hence heterogeneous access is required by network operators
 - ▶ 802.11, 802.16, 802.15.4, DVB, 3GPP...
- **Need standardized support at data link layer for mesh optimization**
 - to provide support for carrier grade services

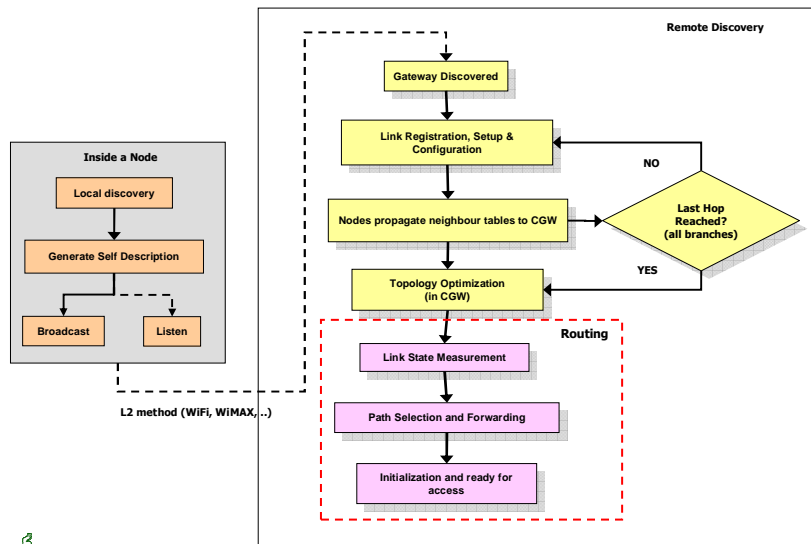


Goal and Approach

- **Enable optimization of heterogeneous carrier grade mesh networks through an abstraction layer**
 - Build and manage heterogeneous mesh networks
 - Enable media independent configuration of PHY and MAC layers with respect to higher layer requirements
 - Support higher layers by link layer triggers
- **IEEE 802.21 was designed for enabling media independent handovers**
 - Most of the primitives are generic enough to use for other purposes
 - Current direction of IEEE 802.21: Media Independent Services instead of Media Independent Handovers
 - Hence, use IEEE 802.21 where possible and extend it for enabling media independent mesh systems



Common Behavior in Mesh Networks



Local Discovery Primitives

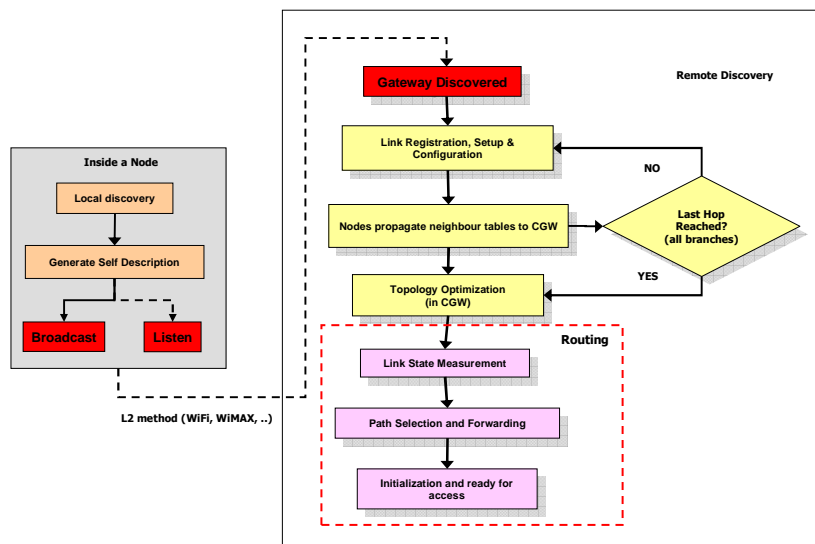
- AI_Radio_Get_Radios (RadioInterfaceID, Technology)
- AI_Radio_Get_Properties

```
LIST(
    SEQUENCE(
        RadioInterfaceID,
        Technology,
        Directionality,
        listOfSupportedChannels,
        TxPowerRange,
        SensitivityRange,
        MCSList,
        AntennaProperties
    )
)
```

- AI_Radio_Get_Parameters



Common Behavior in Mesh Networks



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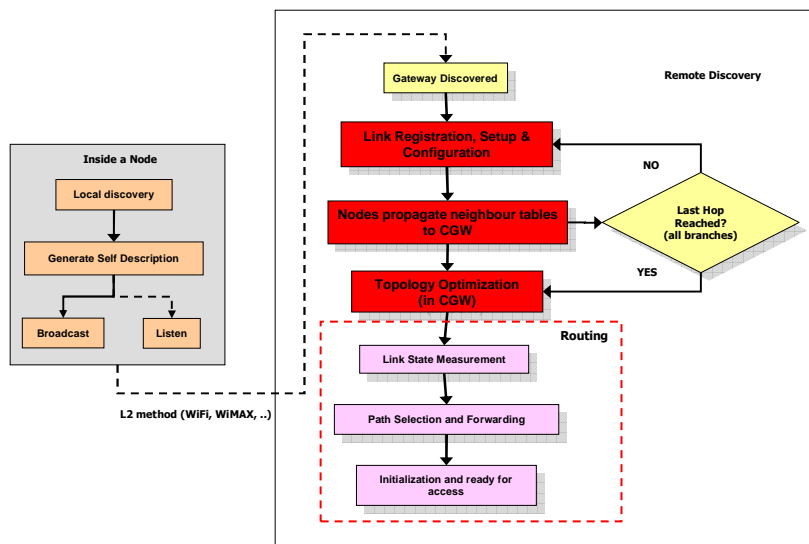
Gateway Discovery Primitives

- **AI_Mesh_Link_Info_Broadcast** (in Carmen Gateway)
 - IEEE 802.11 allows beaconing (with limited information)
 - IEEE 802.11 ad hoc allows any unauthenticated messages
 - IEEE 802.11u enables any MIH message to be sent as management frames (Class 1 Frames) prior to authentication
 - IEEE 802.16 has different options
 - MOB_NBR-ADV (Neighbor Advertisement Message) or MR_NBR-INFO and Simultaneously use DCD for end-to-end metrics
 - Include mesh capability in SBC-REQ (SS basic capability request – MIH Capability)
 - Also 802.15.4 has similar broadcast messages
- **AI_Mesh_Link_Discovered.reg** (in Carmen Mesh Point)



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Common Behavior in Mesh Networks



Link Activation Primitives

- **AI_Link_Power Up** (in Carmen Mesh Point "CMP")
- **SCF_SCF_Neighbour_Report()** (between CMP and Carmen Gateway "CGW")
 - RS_NBR_MEAS-REP for 802.16
- **SCF_SCF_Reconfiguration()** (between CMP and CGW)
 - **AI_Radio_Set_Parameters ()** (CGW's SC to CMP's AI)
 - **AI_Link_Set_Link_Group () -> AI_Link_Assign_Link_GroupID ()**
 - RS_Config-CMD for 802.16

Contributions to IEEE 802.21

➤ **An ad hoc group for extension discussions is approved by the working group**

- Architectural changes
 - o Proxy Mode
- Structural changes
 - o New Primitives
- Minor changes
 - o LINK_TUPLE_ID instead of LINK_ID
 - o Switch_Interface_Mode (ad hoc - relay – infrastructure – base station)
 - o LINK_DETECTED on both link endpoints



Next Steps

➤ **Next Meeting July San Francisco**

- Media Independent Services
- Intersecting points with IEEE 1904.4.1
- Study Group for Mesh Amendment to IEEE 802.21



Conclusions

- **Carrier grade mesh networks**
 - Business demand (operators, vendors: DT, BT, ALU, NEC, Redline, StrixSystems)
 - Successful deployments already (Portland, Stockholm, UK wireless cities)
- **In case of heterogeneity carrier grade mesh networks require an abstraction layer for optimal functioning**
- **IEEE 802.21 provides the best basis for this purpose**
- **Extensions to the current baseline are necessary**
- **Mesh Ad Hoc Group for an amendment to IEEE 802.21 is already working on the topic**