Servizi Applicativi su Internet

NEMO: Network Mobility

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Problem of IP mobility

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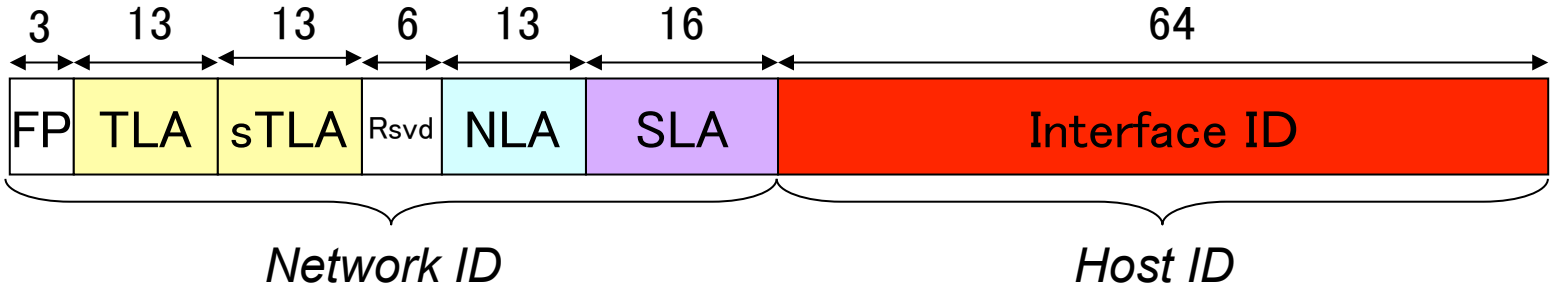
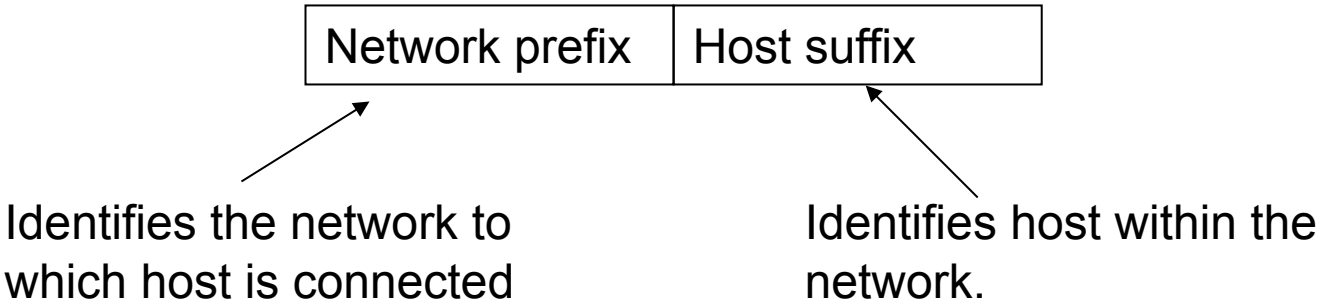
- A node is identified by IP address.
- Routing is done by IP address too.
  - IP address has two parts: Network ID and Host ID
  - Network ID is used for Routing.
  - Structure of IPv6 Address is as follow.



- When a node moves, IP address must be changed.
  - Because Network ID is depend on the attached network.

IPv6 addressing and mobility

- IPv6 addresses consist of two parts: a 64-bit network prefix and a 64-bit host suffix.



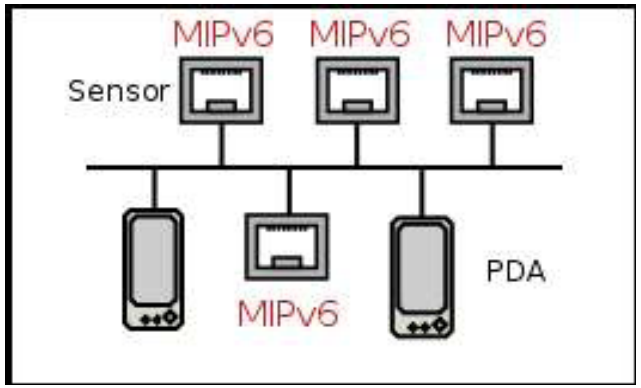
- Network prefix of address depends on location.
- When a host moves from one IP network to another, it needs to change the network part of its address.
  - Issues with reachability, session continuity.

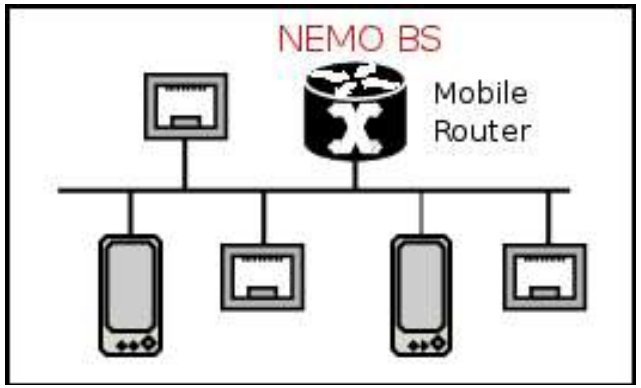
Network Mobility

- Until now all we have considered is host mobility
  - I.e. Managing the mobility of Individual devices
- However, many scenarios exist where entire networks of mobile devices move together
  - Access networks on trains, buses or planes
  - Personal Area Networks
  - Network of In-car devices

Network Mobility Advantages

- Consider Train-Based Access network
  - If 100's of MIPv6 devices on train
    - When the train roams, all devices must update their repective HAs (A lot of control traffic sent at once)
  - With Network Mobility, a Mobile Router (MR) manages the mobility of all the devices



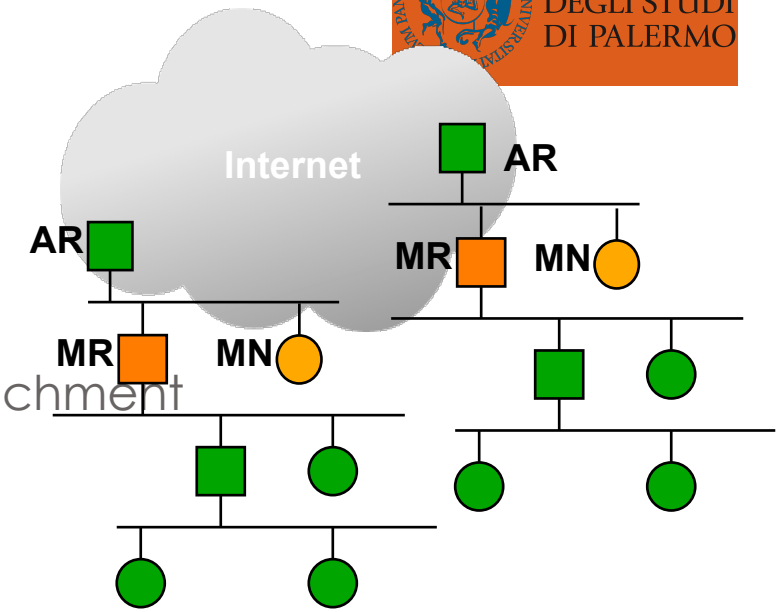


NEMO Basic Support Protocol

- IETF's Solution to supporting Network Mobility
  - MIPv6 Extension (NEMO BS is now RFC)
  - HA intercepts packets for an entire IPv6 network prefix
    - i.e. 2001:630:80:10::/64
  - MR maintains Bi-directional tunnel, forwarding packets to Nodes on its Mobile Network
  - Nodes needn't be aware of their mobility
    - COTS devices need no new code

Mobile Network

- Mobile Network vs Mobile Host



- Host Mobility:
  - a single node changes its point of attachment (mobile node MN)
- Network Mobility:
  - a bulk of nodes mobile as a unit
  - one or more IP-subnets
  - connected to the Internet via 1 or more mobile routers (MR)
  - only MR changes its point of attachment

Mobile Network

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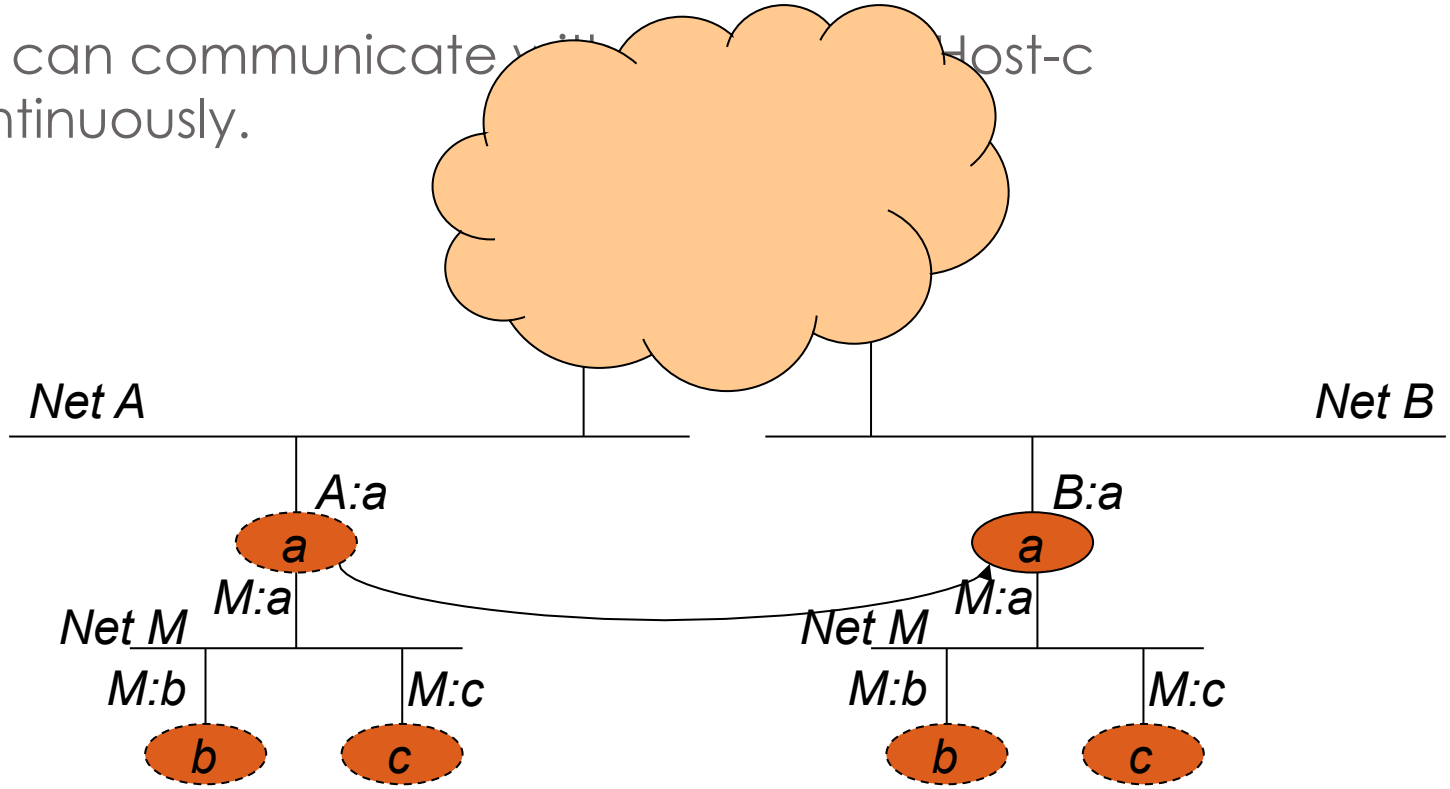
- BU can include Mobile Network Prefix (MNP).
  - NEMO has Explicit mode and Implicit mode.
- CN can communicate with Host-c continuously.



Network Mobility

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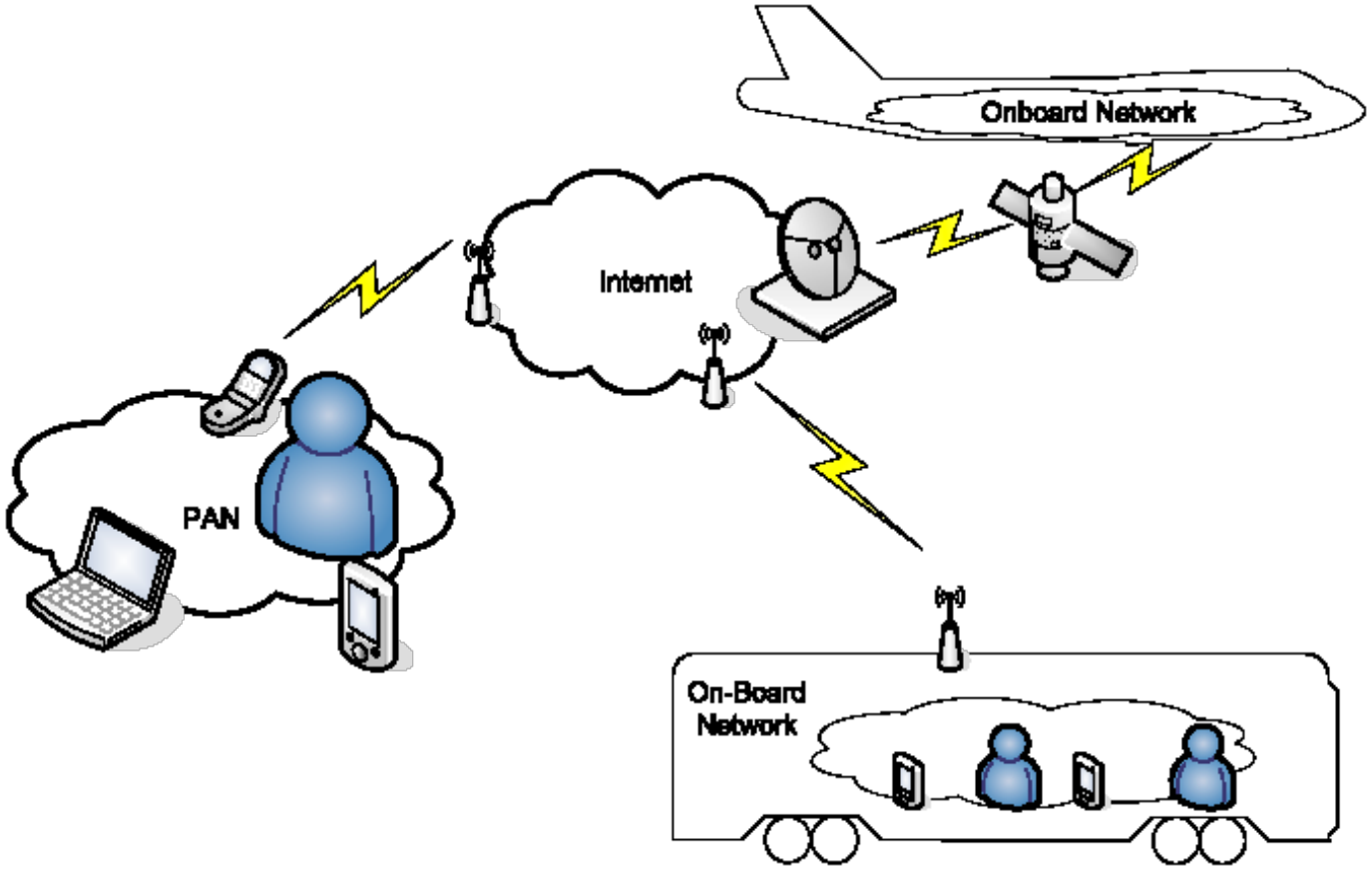
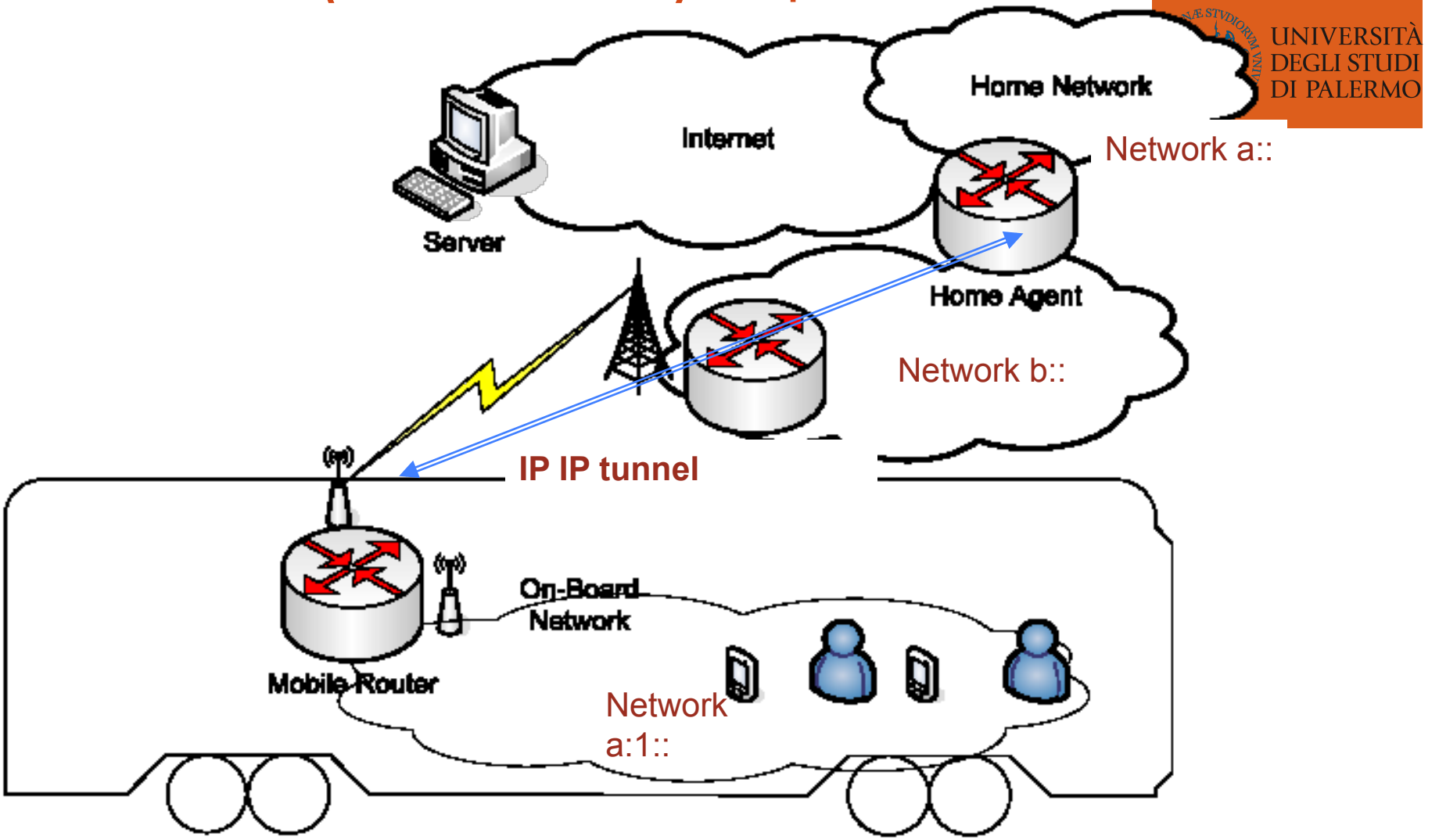
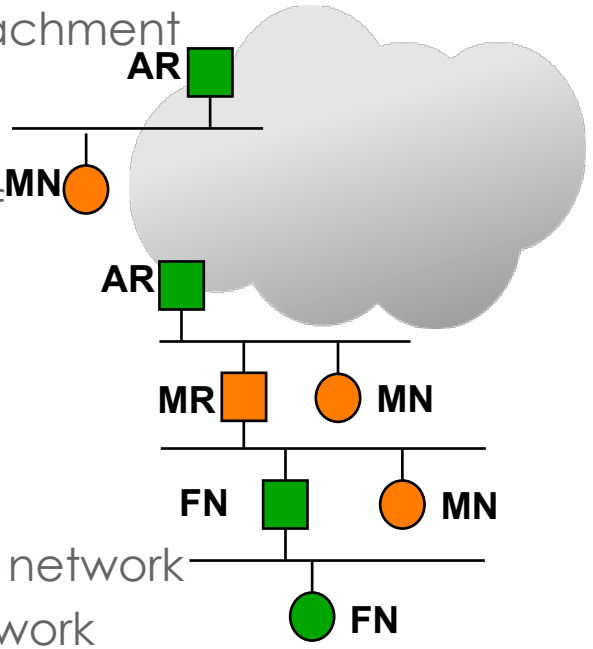


NEMO (RFC 3963) Operation



Terminology: Architecture Components

- MNNs: Mobile Network Nodes
  - MR: a router which changes its point of attachment to the Internet
  - nodes behind the MR:
    - Fixed node: unable to change its point of attachment
      - Belong to the mobile network
      - E.g. sensors, light, GPS
    - Mobile Node: able to change its point of attachment
      - Don't necessarily belong to the mobile network
      - Get Internet access via the mobile network
      - E.g. mobile phone, PDA



Terminology: Architecture Components

- Fixed Node (FN)
  - A node, either a host or a router, unable to change its point of attachment and its IP address without breaking open sessions.
    - FNs are standard IPv6 nodes as defined in [draft-ipv6-node-requirements] which do not support the MN functionality defined in [MIPv6] section 8.5 nor any other form of mobility support.
- Mobile Node (MN)
  - A node, either a host or a router, which is able to change its point of attachment and maintain continuous sessions.
- Mobile Router (MR)
  - A router which changes its point of attachment to the Internet. It:
    - has one or more egress interface(s) and one or more ingress interface(s) and acts as a gateway between the mobile network and the rest of the Internet.
    - maintains the Internet connectivity for the entire mobile network.

Terminology: Functional Terms

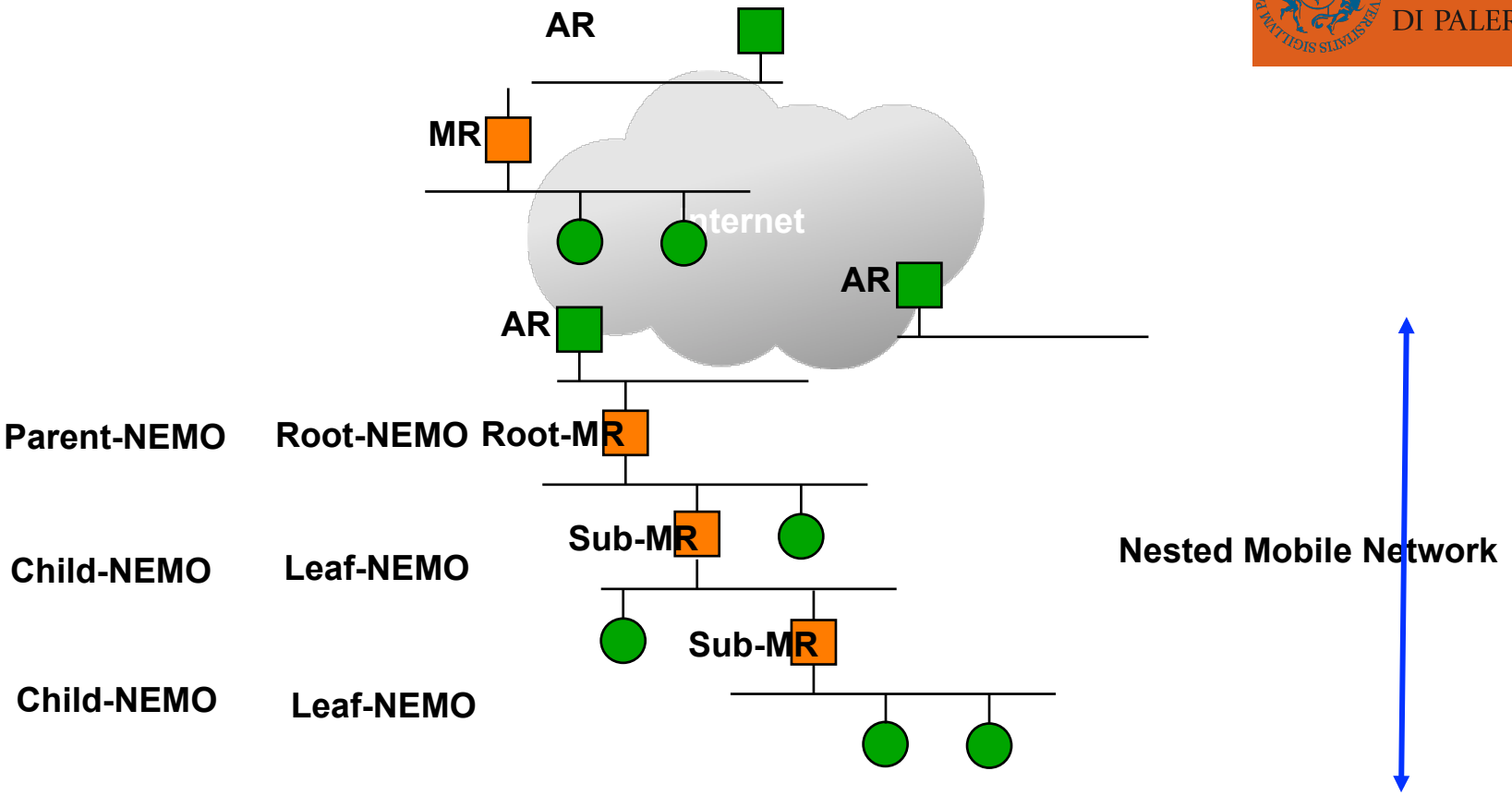
- MIPv6-enabled node:
  - A mobile node (MN) which is able to change its point of attachment and maintains continuous sessions thanks to the MN functionality as defined in [MIPv6] section 8.5.

- NEMO-enabled (NEMO-node)
  - A node that has been extended with network mobility support capabilities and that may take special actions based on that. (details of the capabilities are not known yet, but it may be implementing some sort of Route Optimization).

Terminology: Functional Terms

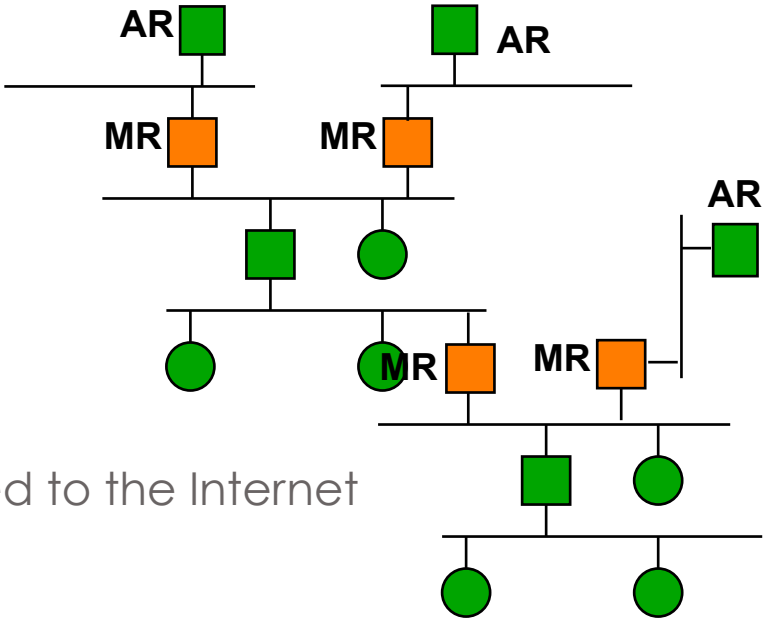
- Basic Support:
  - HAs and MRs are the only NEMO-enabled nodes
  - Nodes behind the MR
    - Fixed nodes and mobile nodes
    - Are NOT NEMO-enabled nodes
    - May be MIPv6-enabled or not
      - MIPv6-enabled to manage their own mobility (VMNs / LMNs)

Terminology: Nested Mobile Network



Terminology: Multihomed Nested Mobile Networks

- Multihomed Configurations
  - Multiple MRs
  - MR with multiple interfaces



- Multihomed & Nested
  - Case 1
    - Child-NEMO has one MR
    - Root-NEMO is multihomed
    - Child-NEMO remains single-homed to the Internet
  - Case 2
    - Child-NEMO has 2 MRs
    - Child-NEMO is multihomed to the parent-NEMO and the Internet

Nested Mobile Networks

- NEMO BS introduces new scenarios (and therefore problems) not possible with MIPv6
  - Nested Mobile Networks (Nested NEMO)
- What happens if a NEMO-enabled PAN attaches to a NEMO-enabled train network?
  - Devices connected to the PAN are 2 levels deep in the Nested NEMO
  - Multiple HAs to visit
    - Produces Pinball Routing (AKA Multi-Angular Routing)
    - Latency & header size increases with every level of nesting
- Nested NEMO can be many levels deep (1 - 36)

Route Optimisation

- MIPv6-Style RO cannot be applied to NEMO
  - In NEMO, Nodes behind the MR are unaware they are connected to a Mobile Network
  - Many Nodes behind the MR will be communicating with many different CNs
- MR could record packet transfers and perform RO on behalf of Nodes on the Mobile Network
  - But this solution would be unacceptable!
    - Large amount of state held in the MR
    - When MR roams: Influx of protocol data & big increase in processing
    - Still wouldn't optimise route in Nested NEMO

Route Optimisation

- MIPv6 Nodes can join a NEMO network and perform RO to prevent packets travelling via the MIPv6 Node's HA
  - However, packets will still be sent via the NEMO MR-HA tunnel
- NEMO RO has therefore been focussed on reducing the sub-optimality of the MR-HA tunnel in the Nested NEMO case
  - So packets only travel via one HA, regardless of the depth of the Nested NEMO
- Many solutions have been proposed within the IETF NEMO WG, but as of yet non have been standardised.

MANEMO

- The MANEMO (MANET-NEMO) concept has developed from the requirement to optimise local packet delivery paths within a Nested NEMO structure.

NEMO WG status

- NEMO Basic support is published as RFC (RFC3963).
- NEMO WG must consider next step.
  - Route optimization
    - Lengthy route
    - Nested mobility
    - Multiple tunnels
  - Multi-homing
    - Multiple interfaces
    - Multiple routers
    - Multiple MNPs
    - Multiple HAs
  - Fast-handover
  - Scalability

Mobile IPv6 Implementations

- Windows
  - MS Research implementation MN, CN, HA
  - MS CN implementation for Win XP
  - Elmic software: embedded MN
- BSD
  - KAME (Wide project): MN/CN/HA
  - INRIA: MN/CN/HA
  - NEC
- Linux
  - MIPL (Helsinki University of Technology): MN/CN/HA
  - Elmic software: embedded MN
- Symbian: MN
- HP-UX 11.11, 11.23 : HA/CN
- Cisco: HA
- Nokia: HA

Mobile IPv6 extensions

- Localized mobility management
  - Hierarchical Mobile IPv6
  - Fast Mobile IPv6
- Context transfer to new router: Context transfer protocol
- Early discovery of new router: Candidate access router discovery protocol

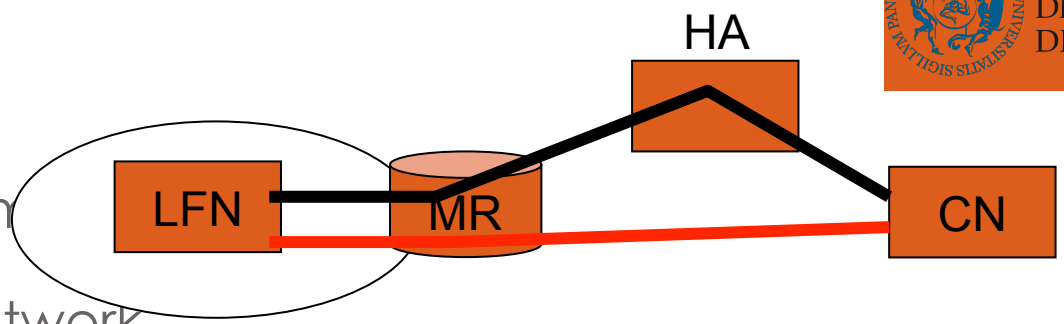
Outline

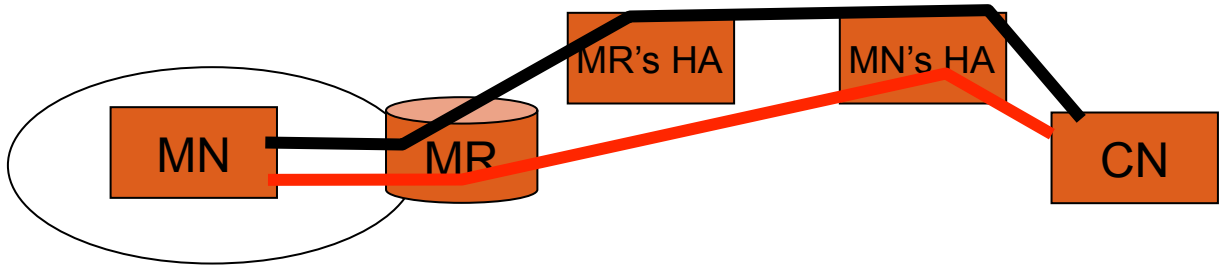
- Types of route optimization
- Nested Nemo RO and Local Mobility Management
- RO & Multihoming
- Shades of transparency
- AR selection

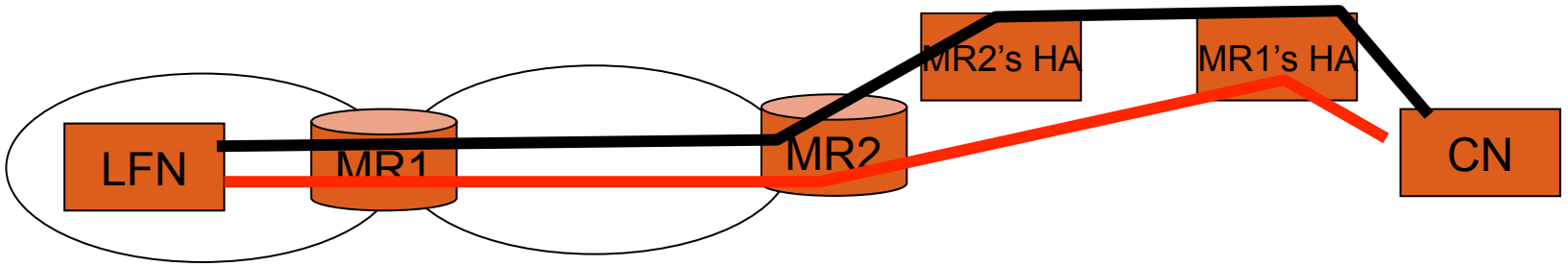
Types of route optimizations

LFN = Local Fixed Node

- MR-to-CN
- MIPv6 Route Optim
- Nested Mobile Network







RO and LMM (Routing Optimization and Local Mobility Management)

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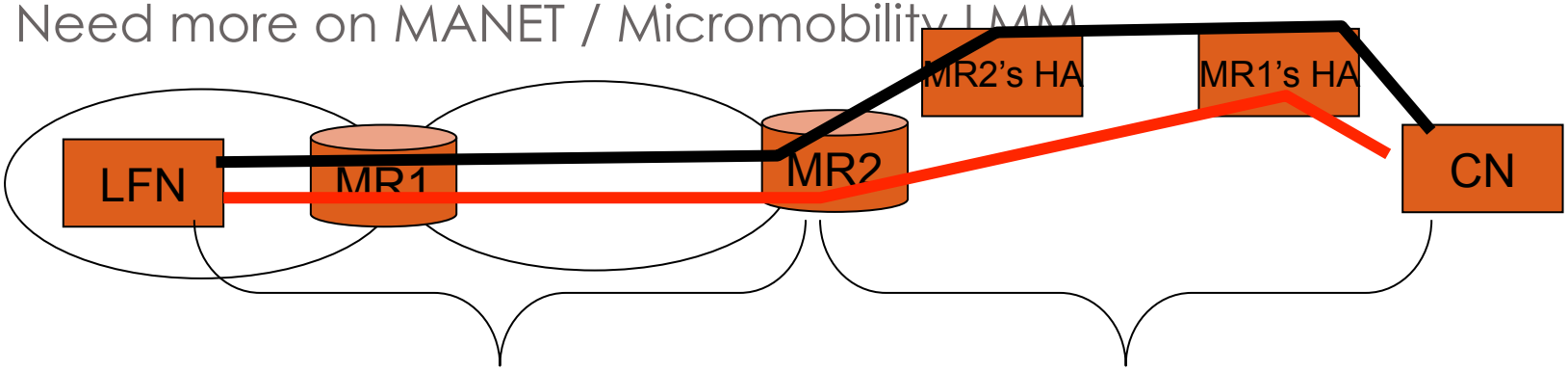
- Model: Nested Nemo attached to an AR
- AR (or root-MR) owns all the CareOfs of the MNs (from the infrastructure standpoint)
- AR (or root-MR) handles the local mobility to the MNs (using ad-hoc or MIP)
- HMIP and DHCP-PD based approaches
- Need more on MANET / Micromobility LMM



RO and Multihoming

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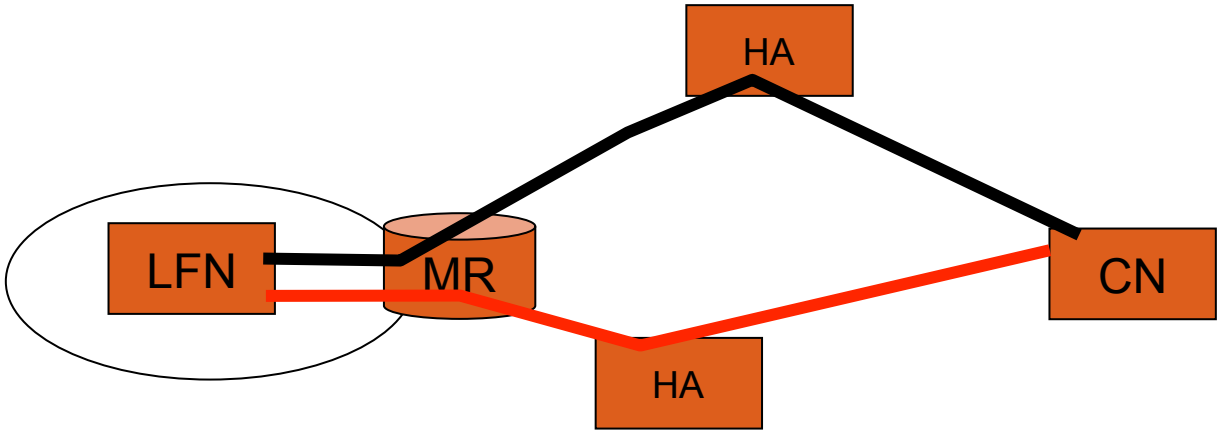
- Model: Multiple HAs (1, N, *) or Jet Set
- maybe multiple HoAs as well?
- Problem: select best HA to shorten MR/HA/CR
- Other problem?



AR selection

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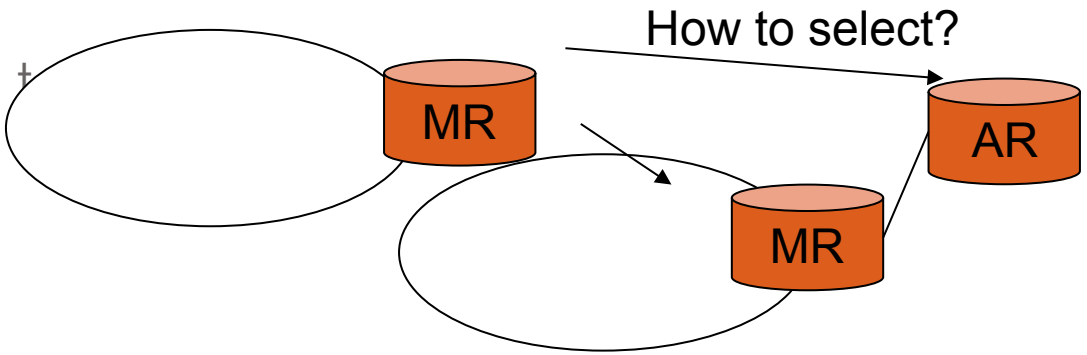
- Model: Nested Nemo attached to an AR, where
- MRs act as MAR for others MRs to attach to
- If loops are avoided, MRs form a tree
- Problem: How to select MAR?
  - Avoiding loops
  - Optimizing metrics such as hops and bandwidth
- Need a Tree Discovery mechanism
  - Quick
  - Minimal overhead on t



References

- Mobile IPv6: RFC 3775
- Securing Mobile IPv6 MN-HA signaling: RFC 3776
- Hierarchical MIPv6: RFC 4140
- Fast Mobile IPv6: RFC 4068
- Context transfer protocol: RFC 4067
- Candidate access router discovery protocol: RFC 4068
- Network Mobility (NEMO) Basic Support Protocol: RFC 3963

IETF NEMO WG

- Purpose
  - scalability
  - availability
  - backward compatibility of Correspondent Nodes
  - preserving route aggregation within the Internet
  - security
- More information
  - http://www.ietf.org/html.charters/nemo-charter.html
  - http://www.mobilenetworks.org/nemo/
  - http://www.nautilus6.org/implementation/index.php
- RFC3963: NEMO Basic Support Protocol