



Workshop NEMO 2007

# **Multihoming in Nested Mobile Networks with Route Optimization**

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# Multihoming in Nested Mobile Networks with Route Optimization

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## **I. The ONEMO protocol**

1. NEMO and nested configurations
2. Optimized NEMO

## **II. A case study: Passenger in a train**

## **III. Multihoming issues in nested nemo**

1. Problem in our scenario
2. Previous work on multihomed nested NEMO
3. Issues when using ONEMO

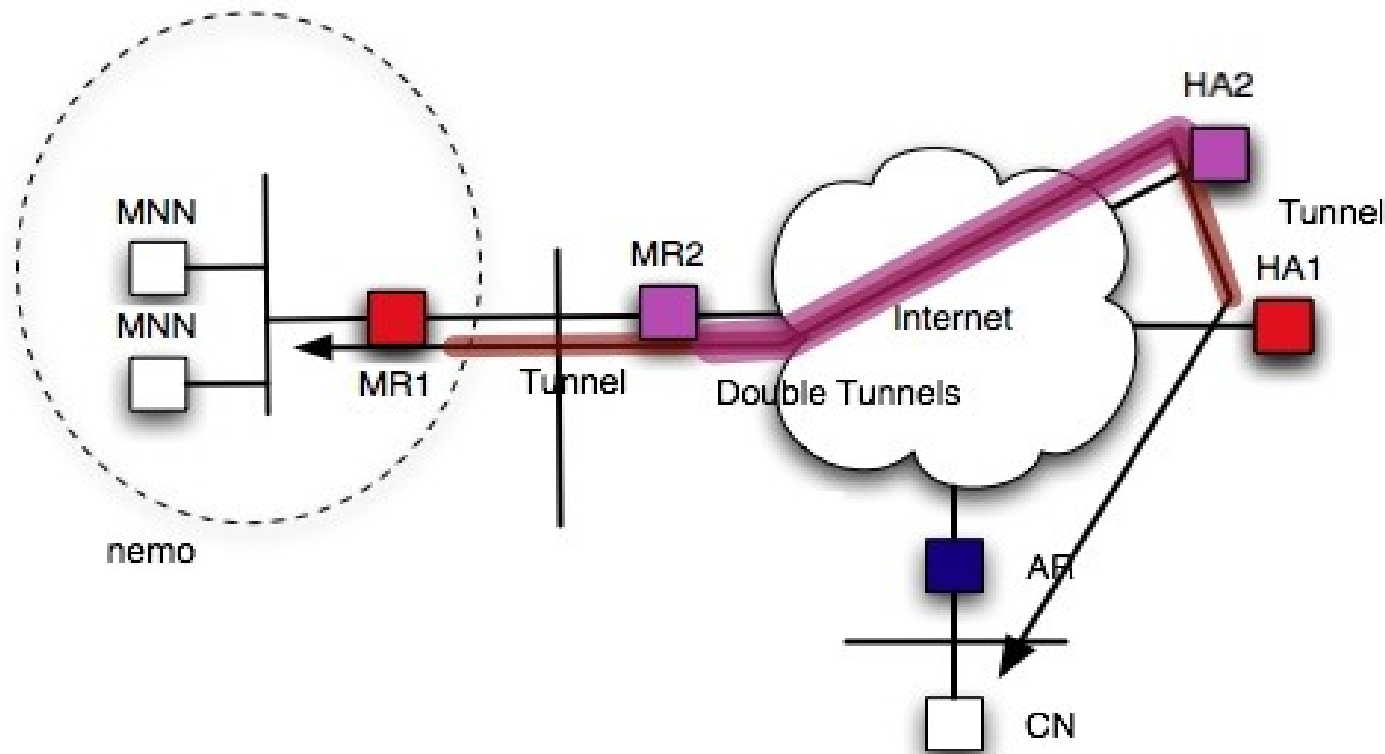
## **IV. How to choose the best path**

1. Information needed to select the default router
2. Our contribution: Extension of the hierarchical MR option
3. Complexity of nested configurations

# I. The ONEMO protocol

## 1. NEMO and nested configurations

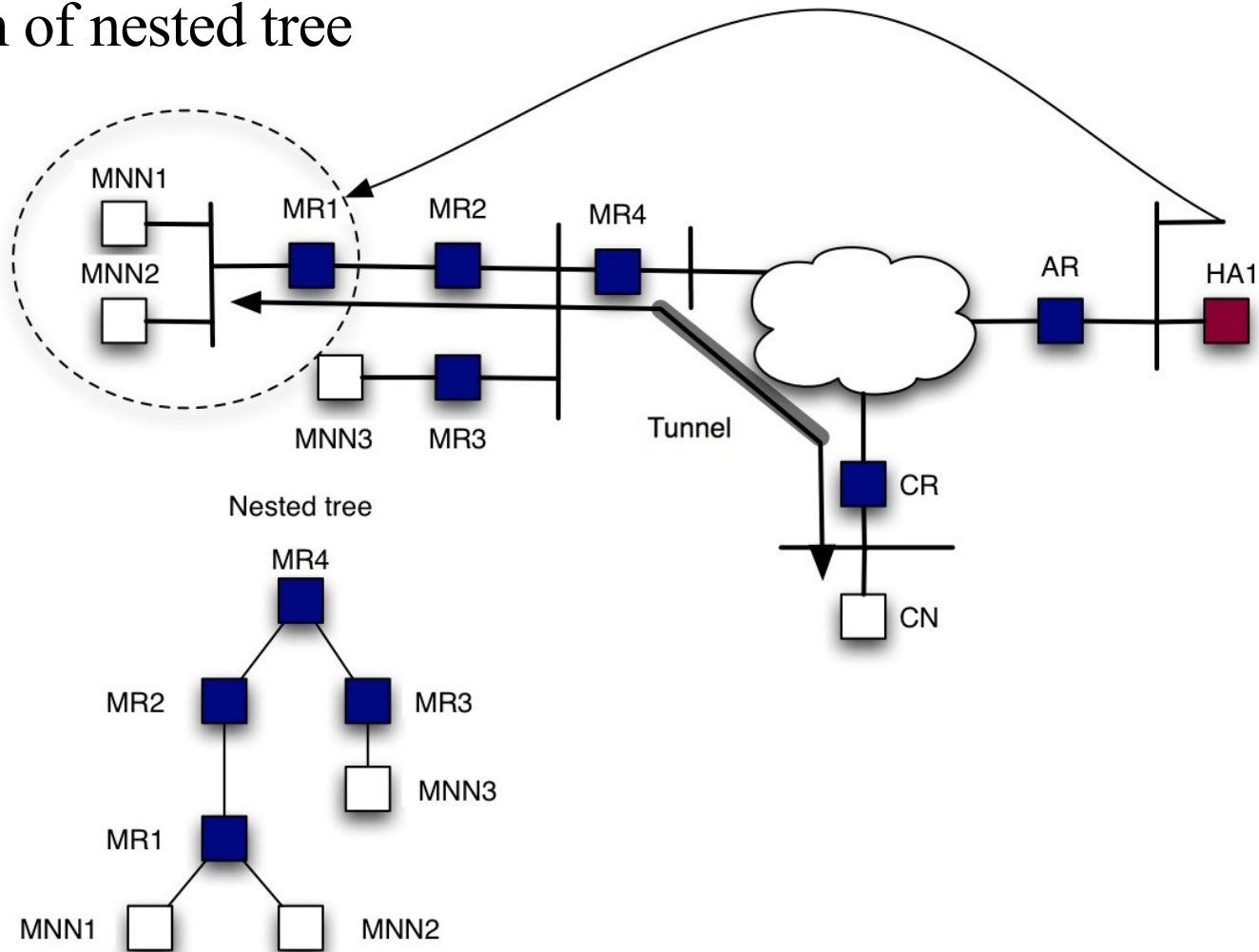
- In nested cases, a bi-directional tunnel is established between each pair of MR\HA. Packets are routed through several HAs and they will be encapsulated several times.
- Ex with 2 pairs of HA/MR:



# I. The ONEMO Protocol

## 2. Presentation of ONEMO

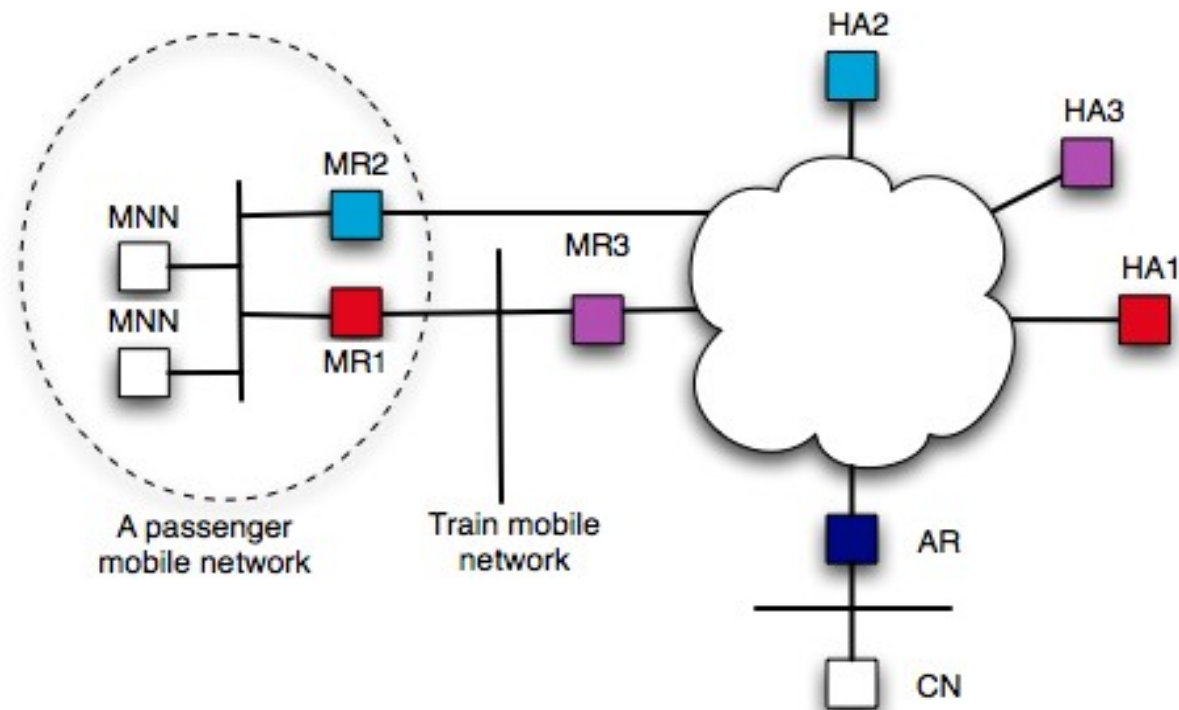
- Goal of ONEMO: to establish a bi-directional tunnel between the root-MR and the CR
- Definition of nested tree



## II. A case study: Passenger in a train

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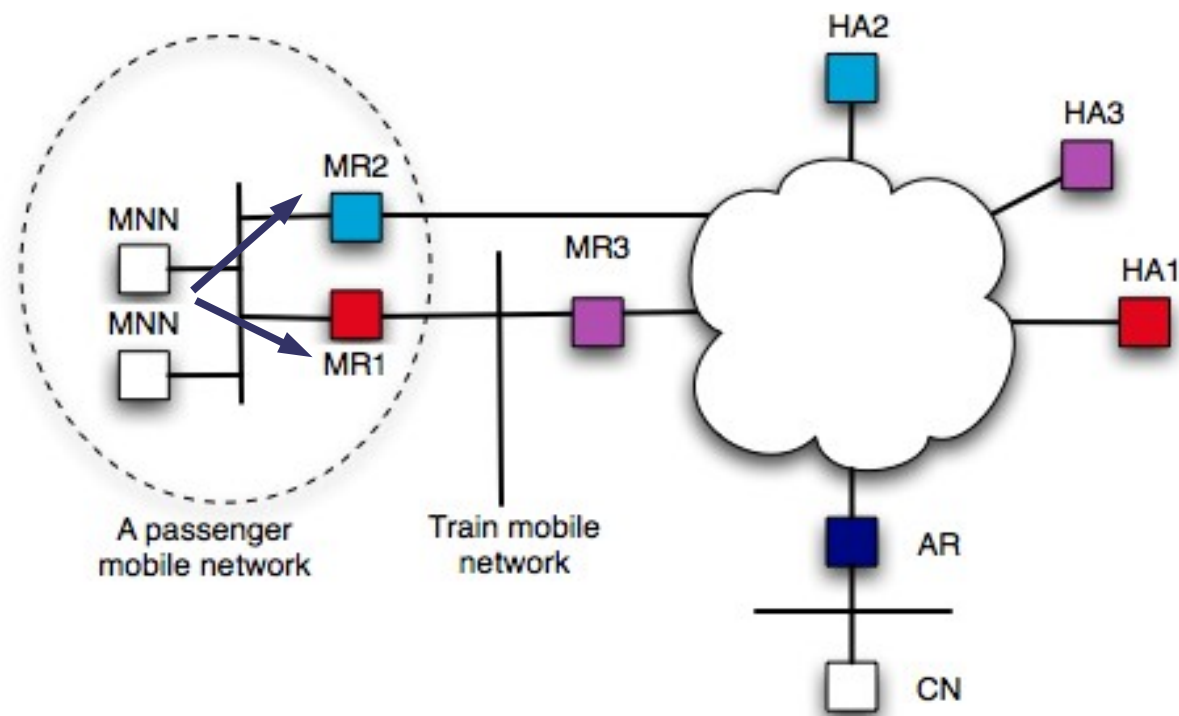
- A train provide a Wifi network to the passengers with MR3
- The passenger could connect to MR3 with MR1 (for example his laptop)
- The passenger could also connect directly to Internet with MR2 (his phone with its GPRS connectivity)
- The train is connected to Internet with a Wimax connectivity.
- The MNNs can be a PDA and some sensors...



# III. Multihoming issues in nested mobile networks

## 1. Problem in our scenario

- The passenger network has 2 mobile routers: MR1 (his laptop) and MR2 (his phone).
- **Problem:** Which path will take the packets sent by the passenger nemo? Via MR1 or via MR2? Which path is it better to use?



# III. Multihoming issues in nested mobile networks

## 2. Previous work on multihomed nested NEMO

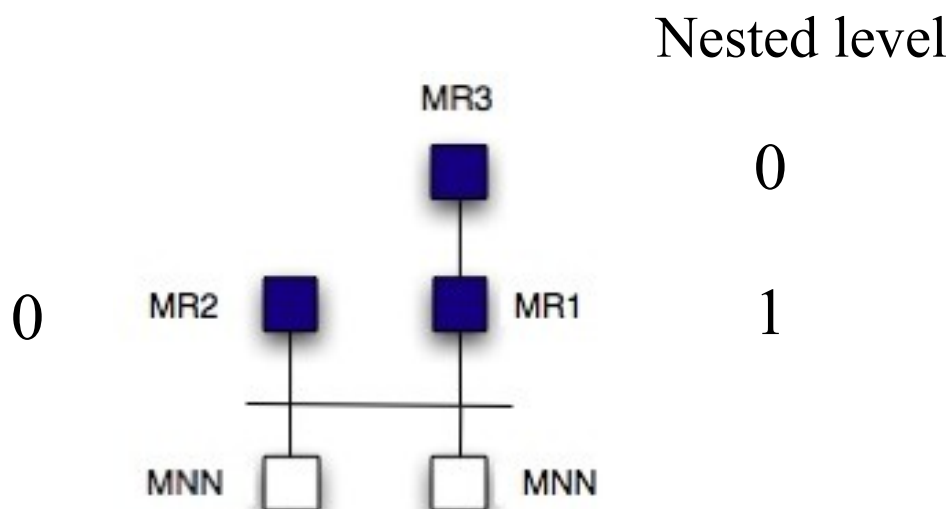
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- **Multihoming in nested cases was studied for NEMO**

### Basic Support \*

- Several Levels of tunneling: less nested path preferred
- New option for RA messages: hierarchical MR to know the nested level

- **Nested level:** the nested level of a MR directly attached to Internet = 0, it increases by 1 when a node (MR) is added in the topology.



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\* N. Montavont, T. Noel, and T. Ernst. Multihoming in nested mobile networking. In SAINT, Tokyo, Japan, January 2004

# III. Multihoming issues in nested mobile networks

## 3. Issues when using ONEMO

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- With ONEMO: only one tunnel between the root-MR and the CR.
    - No problem due to overhead and delays because of the several levels of tunnelings.
    - A higher nested level = more upper MRs in the configuration. As those MRs could change their point of attachment, the connectivity could often be lost and the nested tree could often be reorganized.
      - › **Non-nested (or less-nested) path should also be preferred.**
  - In our example:
    - less-nested path = path through the phone (GPRS connectivity).
    - “best path” = path through the laptop: higher throughput (the laptop is linked with a Wifi connectivity to the MR of the train, and this MR is connected with a Wimax connectivity).
      - › **In that case, the less nested path is not the best path.**
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# IV. How to choose the best path?

## 1. Information needed to select the default router

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- Information concerning the nested configuration needed to find the best path:
  - The nested level
  - The connectivity of the root-MR (this is the root-MR that provides the connectivity to Internet)
- To select the default router: use of policies.
- Policies that could be defined for our scenario:
  - “do not use the GPRS connection if another one is available”
  - “to select the router that is linked to the root-MR that provides the best bandwidth if its nested level is inferior to a maximum level (for example 4)”
- How to define good policies? (Future work: simulations)
- Policies needs to be exchanged with other MRs (out of scope)

# IV. How to choose the best path?

## 2. Our contribution: Extension of the hierarchical MR option

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- **The hierarchical MR option:**

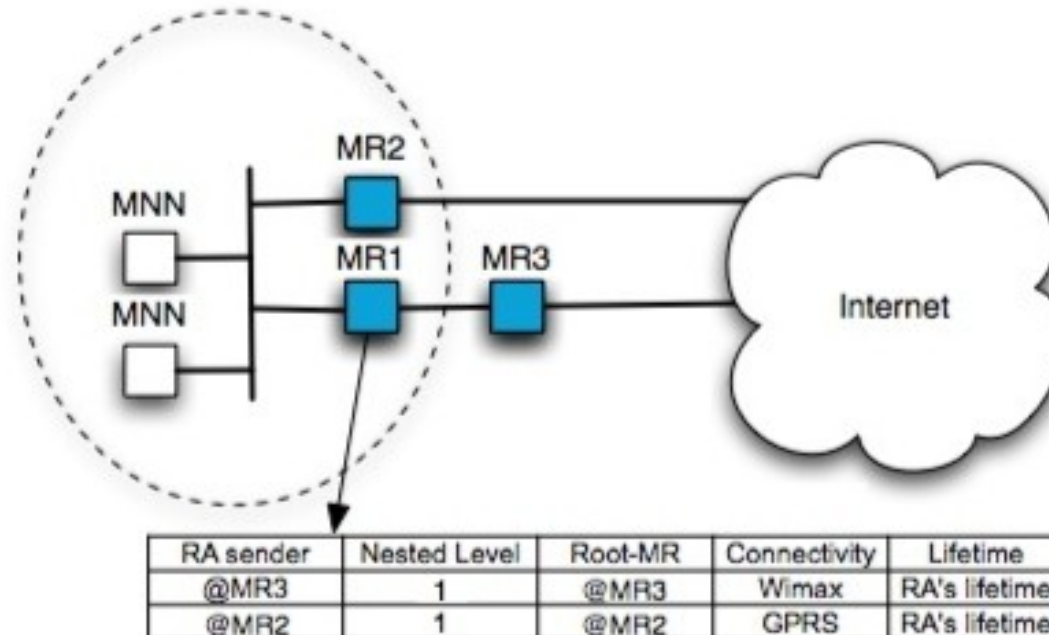
Type	Length	M	Reserved
Level		Connectivity	

Level = nested level

Connectivity = connectivity of the root-MR

- **Nested information table**

- Each MR maintains that table dynamically. MRs will change the preference option in RA to indicate the default MR.

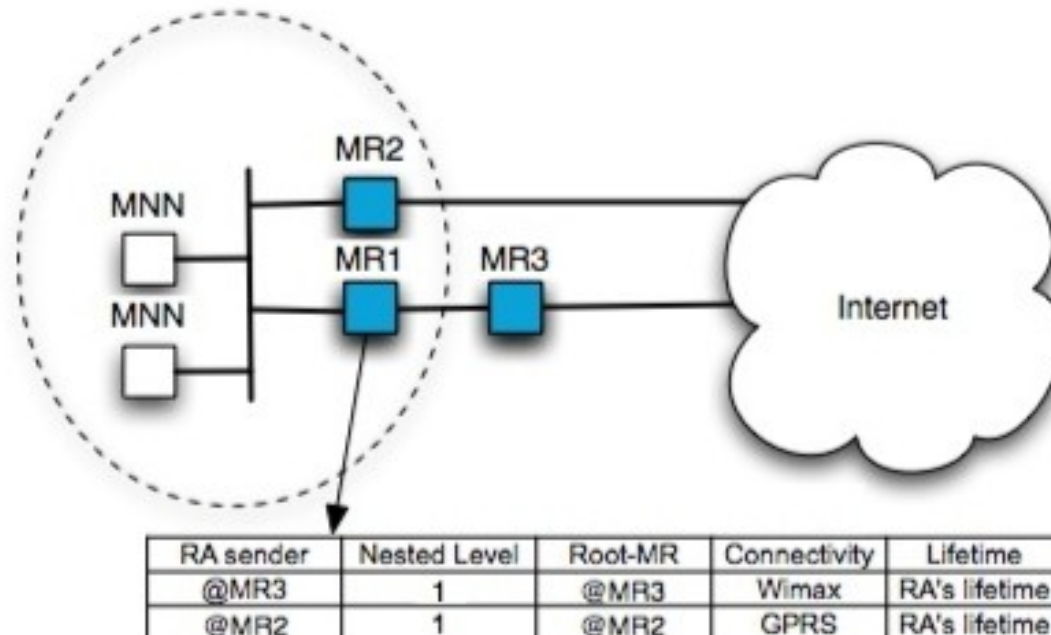


# IV. How to choose the best path?

## 2. Our contribution: Extension of the hierarchical MR option

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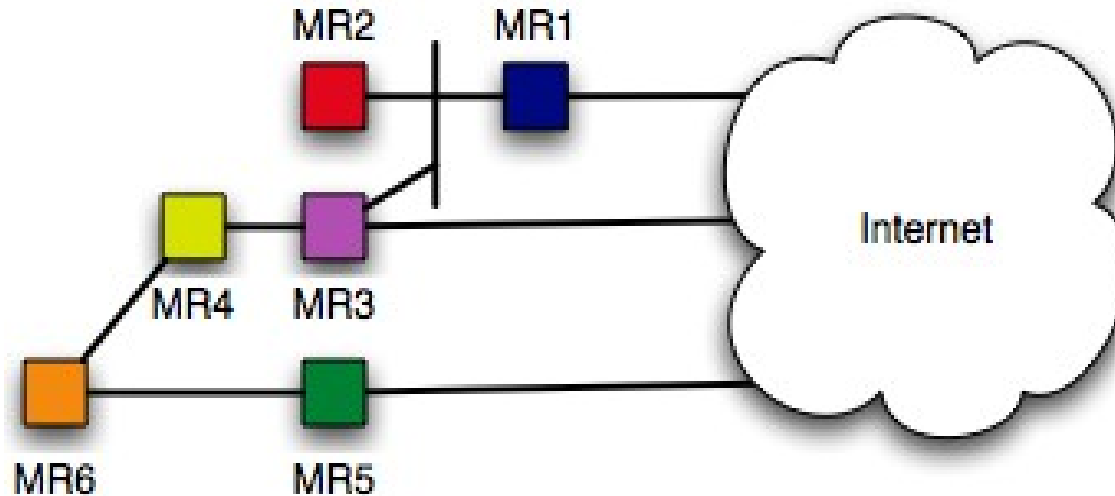
- With this example and the policy: “select the router that is linked to the root-MR that provides the best bandwidth if its nested level is inferior to 4”
  - MR1 with its nested table can see its best path is through MR3 so compare to MR2 it is a better default router.
  - MR2 can see it is not the best default router so it puts a low preference in its RA messages



# IV. How to choose the best path?

## 3. Complexity of nested configurations

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- A MR could be connected to several MRs:
  - MR3 is a root-MR but it is also connected to MR1
  - What information MR3 will send to MR4?
- One of the solution could be to send the information of its default path.
  - More research is needed to study that cases.

# Conclusion

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- We focused on Multiple MRs in nested cases
- Some information is needed to select the default router.
  - The nested level
  - The connectivity of the root-MR
- Extension of the hierarchical MR option to forward that information.
- Definition of the nested information table on the MRs.
- Future research
  - Simulations
    - to measure the time to set up RO
    - to study the dynamicity of nested configuration
    - to study the benefits of our solution depending on scenarios and policies
  - Study a mechanism to allow load sharing in nested cases

# Contact

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