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Analysis of the combination of different IP mobility schemes

78th IETF, IRTF MOBOPTS WG

Maastricht, 29th July

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*** Research leading to these results partiy funded from the Spanish MICINN, through the I-MOVING project (TEC2010-18907)**

Introduction

Ubiquitous mobility

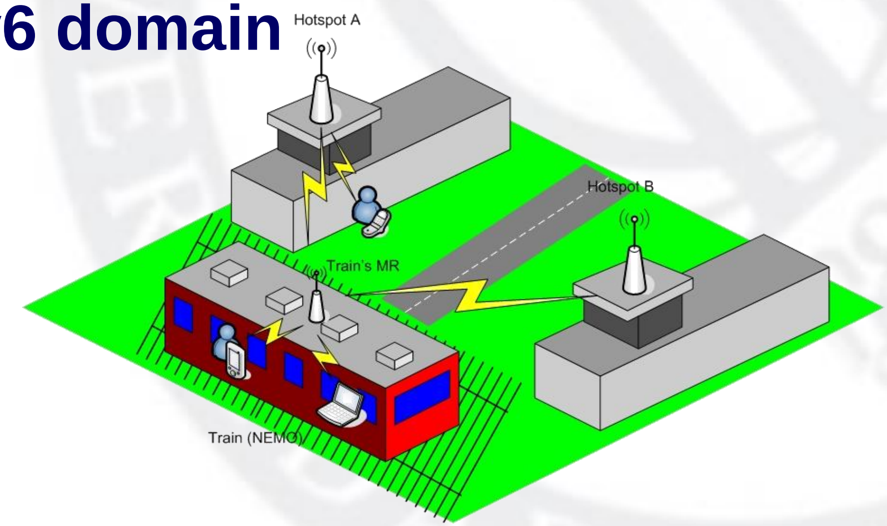
- **The necessity of mobility support is obvious**
  - **Users are mobile, and demand Internet access anywhere, anytime**

- **IP not designed for mobile users**
  - Many solutions/protocols
  - Host/network based
- **This, we already know...**
- **Question this "exercise" addresses**
  - **tradeoffs of combining different solutions?**

Mobility protocols considered

- **Mobile IPv6**
- **NEMO Basic Support protocol**
- **Proxy Mobile IPv6**
- **N-PMIPv6**
  - ♦ **Extensions to PMIPv6 to support mobile MAGs in a Proxy Mobile IPv6 domain**

“NEMO-Enabled Localized Mobility Support for Internet Access in Automotive Scenarios”, I. Soto, C. J. Bernardos, M. Calderon, A. Banchs, A. Azcorra, IEEE Communications Magazine, Automotive Networking - Technology, Design, and Applications series, Vol.47, No.5, May 2009



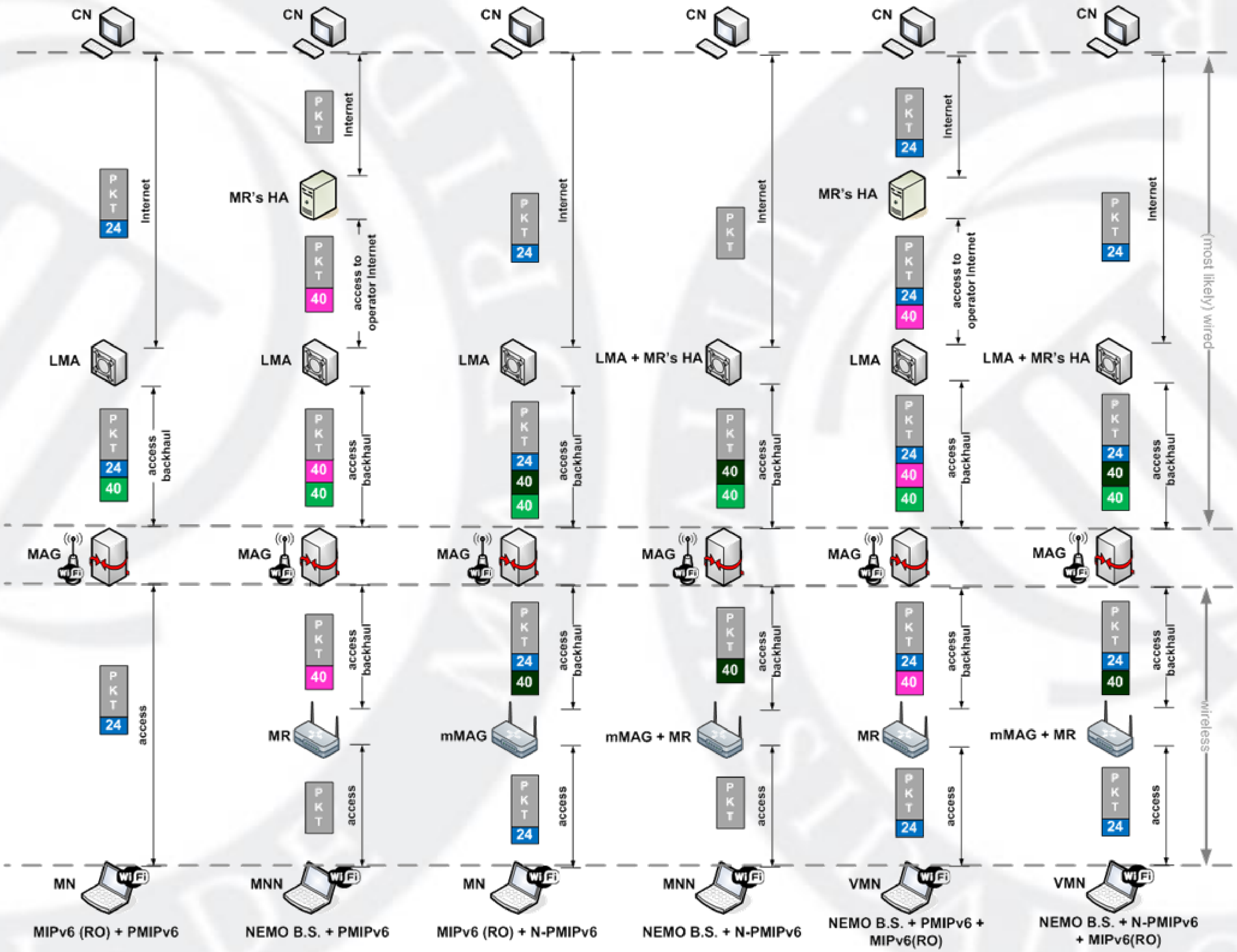
Combinations considered (I)

- **MIPv6 + PMIPv6**
  - **PMIPv6 support offered by the access network operator**
  - **MIPv6 used to obtain global mobility support**
    - **E.g., to roam across different domains**
- **NEMO B.S. + PMIPv6**
  - **Mobile Router attached to a PMIPv6 domain**
  - **Nodes attached to the NEMO cannot move – without breaking connection – unless provided with MIPv6 support**
- **NEMO B.S. + PMIPv6 + MIPv6**

Combinations considered (II)

- **MIPv6 + N-PMIPv6**
  - **Similar to MIPv6 + PMIPv6 combination**
  - **Use of N-PMIPv6 allows mobile nodes to roam between fixed and mobile access infrastructure within the PMIPv6 domain**
- **NEMO B.S. + N-PMIPv6**
  - **Moving MAGs have also RFC3963 MR capabilities**
  - **From deployment viewpoint, it makes sense to co-locate MR’s HA and the LMA of the MR’s N-PMIPv6 domain**
- **NEMO B.S. + N-PMIPv6 + MIPv6**

Performance analisys: overhead



Performance analysis: handover latency

- **4 different components considered (simplification)**
  - **Layer-2 handover time ($T_{L2\text{-}HO}$)**
    - **Modeled with a Beta probability distribution function (mean 50ms, variance 13.4ms^2)**
  - **Movement detection time (T_{MD})**
    - **We assume it is based on ND (reception of unsolicited RAs)**
    - **Modeled with the following probability densitiy function (RM=7ms, Rm=3ms, mean 26ms, variance 0.27ms^2):**

$$f_{T_{RA}^{unsol}}(t) = \begin{cases} \dfrac{2}{R_M + R_m}, & t \leq R_m \\ \dfrac{2(R_M - t)}{R_M{}^2 - R_m{}^2}, & R_m < t < R_M \\ 0, & \text{otherwise} \end{cases}$$

Performance analysis: handover latency

- **Signalling delay**
  - **Depends of the RTT between the different involved entities**
  - **We consider 3 different delays (PingER project):**
    - “local”: 5.37ms
    - “regional”: 18.32ms
    - “continental”: 138.79ms
  - **Modeled with a Weibul distribution, variance provided by Hurst parameters of 0.8, 0.65 and 0.5**
- **Authentication delay (T_{auth})**
  - **Same for all, so we do not consider it in the final computation for the comparison**

Performance analysis: Handover delay

- **MIPv6/NEMO B.S.**
  - **T(MIPv6/NEMO)** $= T_{L2\text{-}HO} + T_{MD} + T_{auth} +$ **+ RTT(MN/MR,HA)**
  - **T(MIPv6 RO)** **= T(MIPv6) + RTT(CN,HA)**
- **PMIPv6**
  - **T(PMIPv6)** $= T_{L2\text{-}HO} + T_{MD} + T_{auth} +$ **+ RTT(MAG, LMA)**
- **N-PMIPv6**
  - **Same than for PMIPv6**

Performance analysis: Handover delay

- **MIPv6 + PMIPv6**
  - **MN moves, within LMD: T(PMIPv6)**
  - **MN moves, to LMD:**
    - **T(MIPv6+PMIPv6)** $= T_{L2\text{-}HO} + T_{MD} + T_{auth} + RTT(MAG,LMA) + RTT(MN,HA)$
- **NEMO B.S. + PMIPv6**
  - **MR moves, within LMD: T(PMIPv6)**
  - **MR moves, to LMD:**
    - **T(NEMO+PMIPv6)** $+ T_{L2\text{-}HO} + T_{MD} + T_{auth} + RTT(MAG,LMA) + RTT(MR,HA)$

Performance analysis: Handover delay

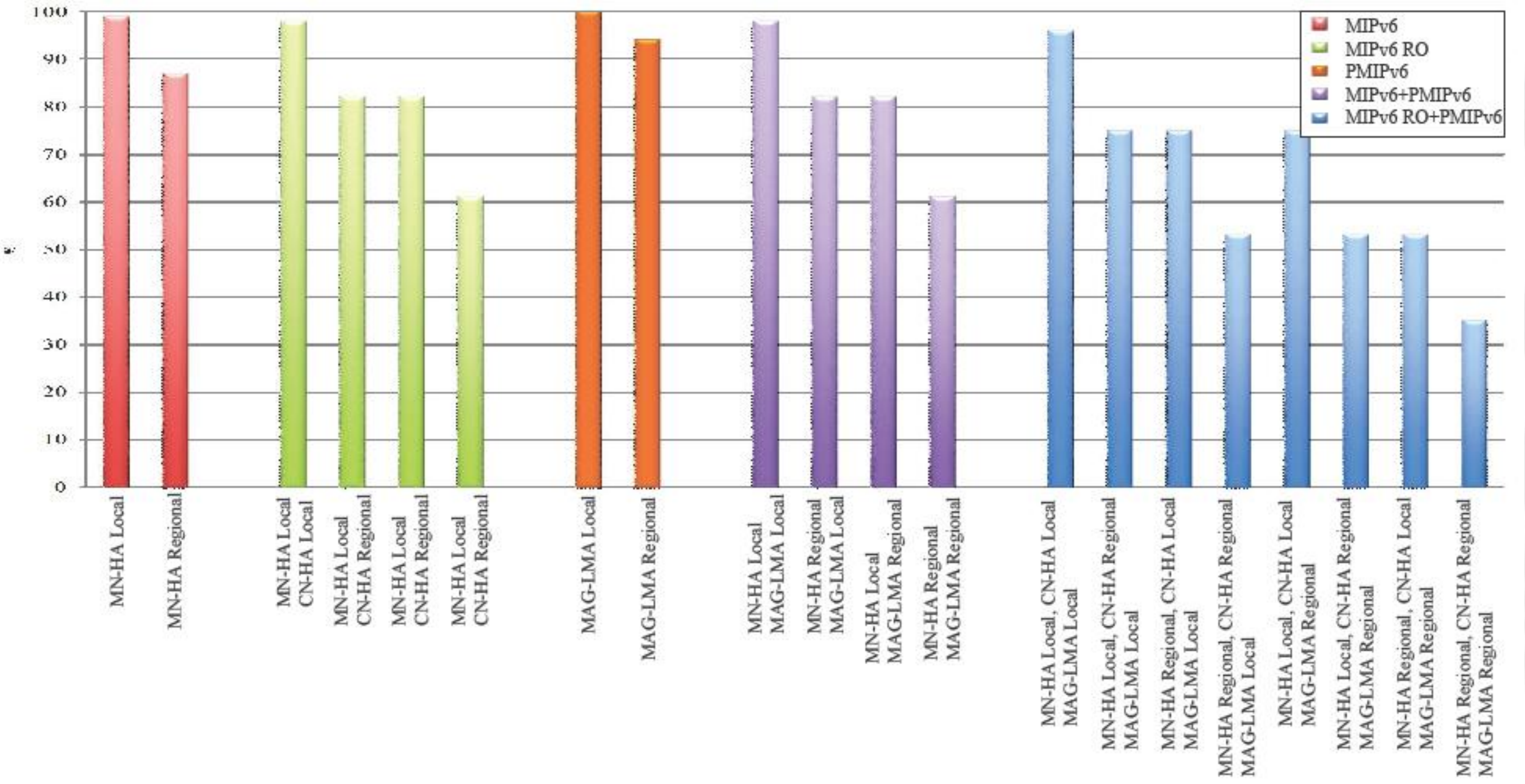
- **MIPv6 + N-PMIPv6**
  - **MN moves, within LMD: T(PMIPv6)**
  - **MN moves, to LMD: T(MIPv6+PMIPv6)**
  - **mMAG moves, within LMD: T(PMIPv6)**
- **NEMO B.S. + N-PMIPv6**
  - **MN moves, within LMD: T(PMIPv6)**
  - **mMAG moves, to LMD: T(PMIPv6)**
  - **mMAG moves, within LMD: T(PMIPv6)**

Performance analysis: Handover delay

- **NEMO B.S. + PMIPv6 + MIPv6**
  - **MN moves, within LMD**
    - **From MR to MAG: T(MIPv6+PMIPv6)**
    - **From MAG to MR: T(MIPv6)**
  - **MN moves, to LMD: T(MIPv6)**
  - **MR, within LMD: T(PMIPv6)**
  - **MR, to LMD: T(NEMO+PMIPv6)**
- **NEMO B.S. + N-PMIPv6 + MIPv6**
  - **MN moves, within LMD: T(PMIPv6)**
  - **MN moves, to LMD: T(MIPv6+PMIPv6)**
  - **MR moves: T(PMIPv6)**

Performance analysis: Handover delay

% of handovers whose delay is below 150ms



Conclusions

- **Different IP mobility protocols standardized**
- **Handovers between different access networks are going to be usual**
  - **Different mobility solutions are going to co-exist**
- **Combining solutions provide added functionality…**

- **… but also comes with a cost**
  - **Overhead: inefficient use of resources (radio!)**
  - **Longer handover latencies**

- **Need to develop solutions to alleviate these costs**
  - **E.g., Negotiation between MN and the network to activate/deactivate mobility functions as needed**

Questions?

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