18º Seminário da RTCM, Coimbra, 21/02/2014

Optimização da arquitectura de rede para o transporte eficiente de video móvel

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instituto de telecomunicações

creating and sharing knowledge for telecommunications

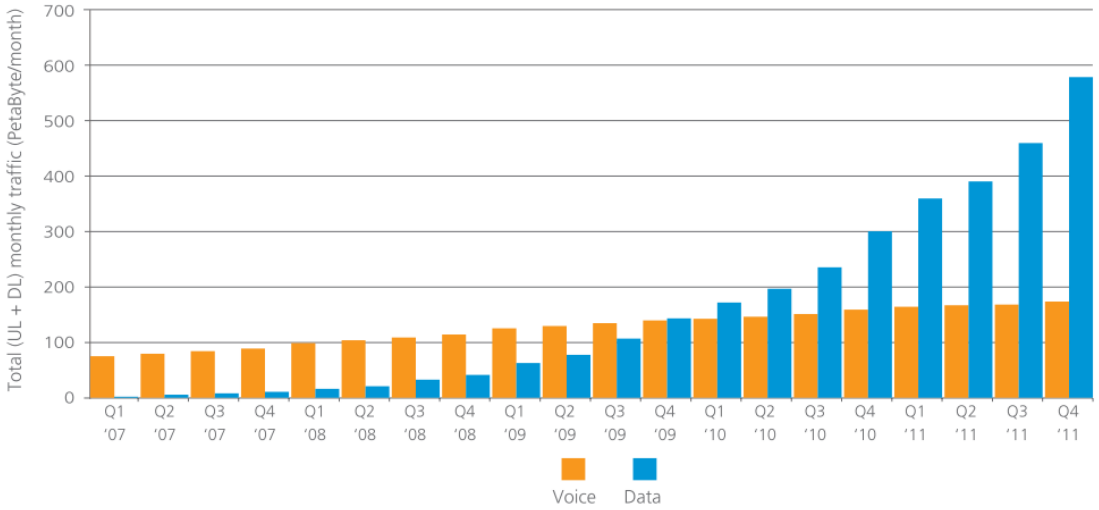
Outline

- Motivation
- Design Guidelines
- IP multicast mobility for seamless vídeo support
- Contributions
- Conclusions

Motivation

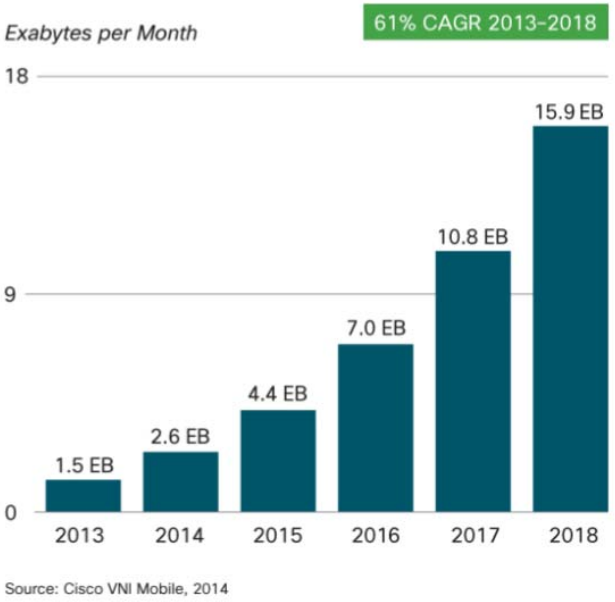
- Key facts:
  - Accessability to powerful, **IP-enabled** devices
  - Faster networks and cheaper mobile **data**

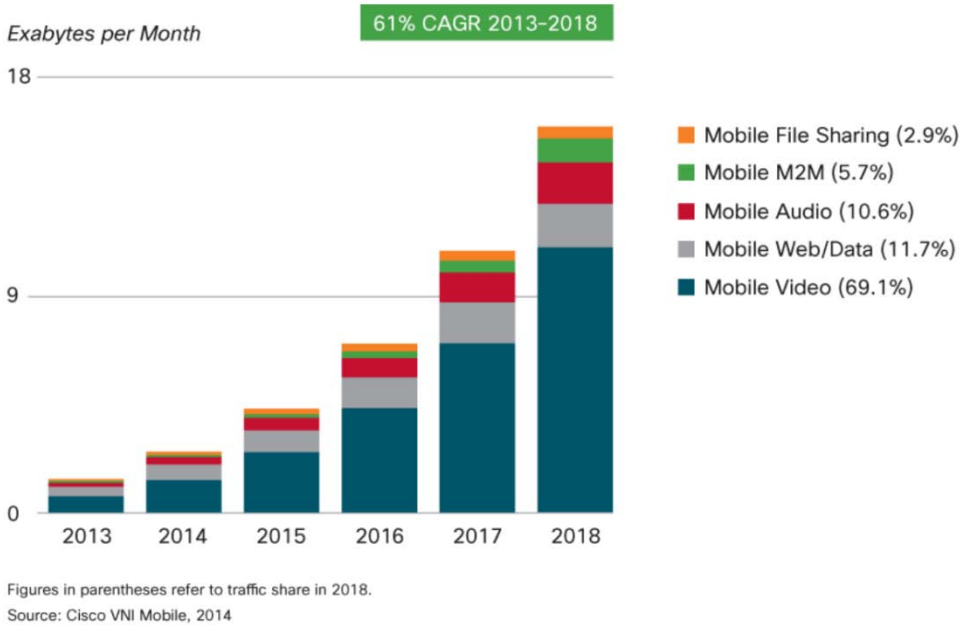
  ➔ Easy access to **video!**



Akamai's "The State of the Internet, 4th Quarter, 2011 Report"

What to expect in the near future:

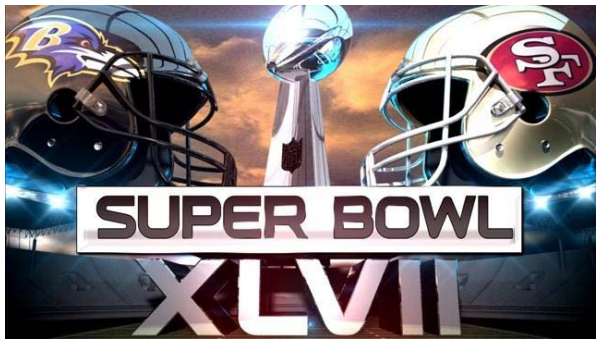




Motivation (2)

- IP video Broadcasting will (finally) emerge
  - Both Operators (e.g. Vodafone) and Industry (Ericsson, Qualcomm) companies are pushing eMBMS
  - Finally business cases seem to align with technology availability:

    E.g: Exciting conferences, popular sports or great concerts



A bright future awaits mobile Operators and clients...

Or is it a Tsunami, threatening networks operation?

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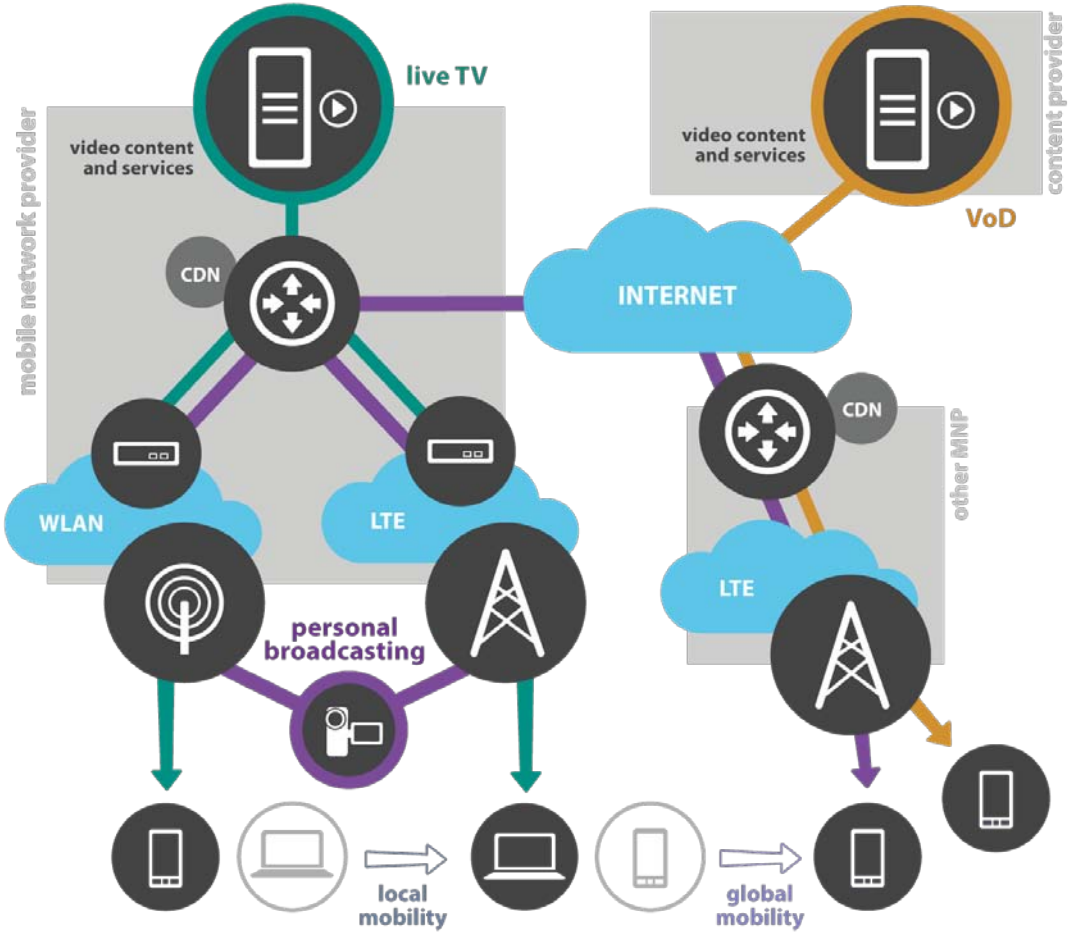
Motivation (3)

- Distinct attempts to alleviate the problem
  - IP offloading (LIPA, SIPTO)
  - Micro & femto-cells
  - Deployment of additional capacity
- Most solutions don't assure network core efficiency
  - They address access network offloading / congestion-control
  - Centralized mobility management (e.g. MIPv6, PMIPv6, GTP & PGW) "force" bottlenecking
- Problem expected to be magnified with:
  - Increase in video resolution: 4K, 8K video and other rich (e.g. biometric) data
  - More and more connected devices (M2M, IoT, IoE, the list goes on…)

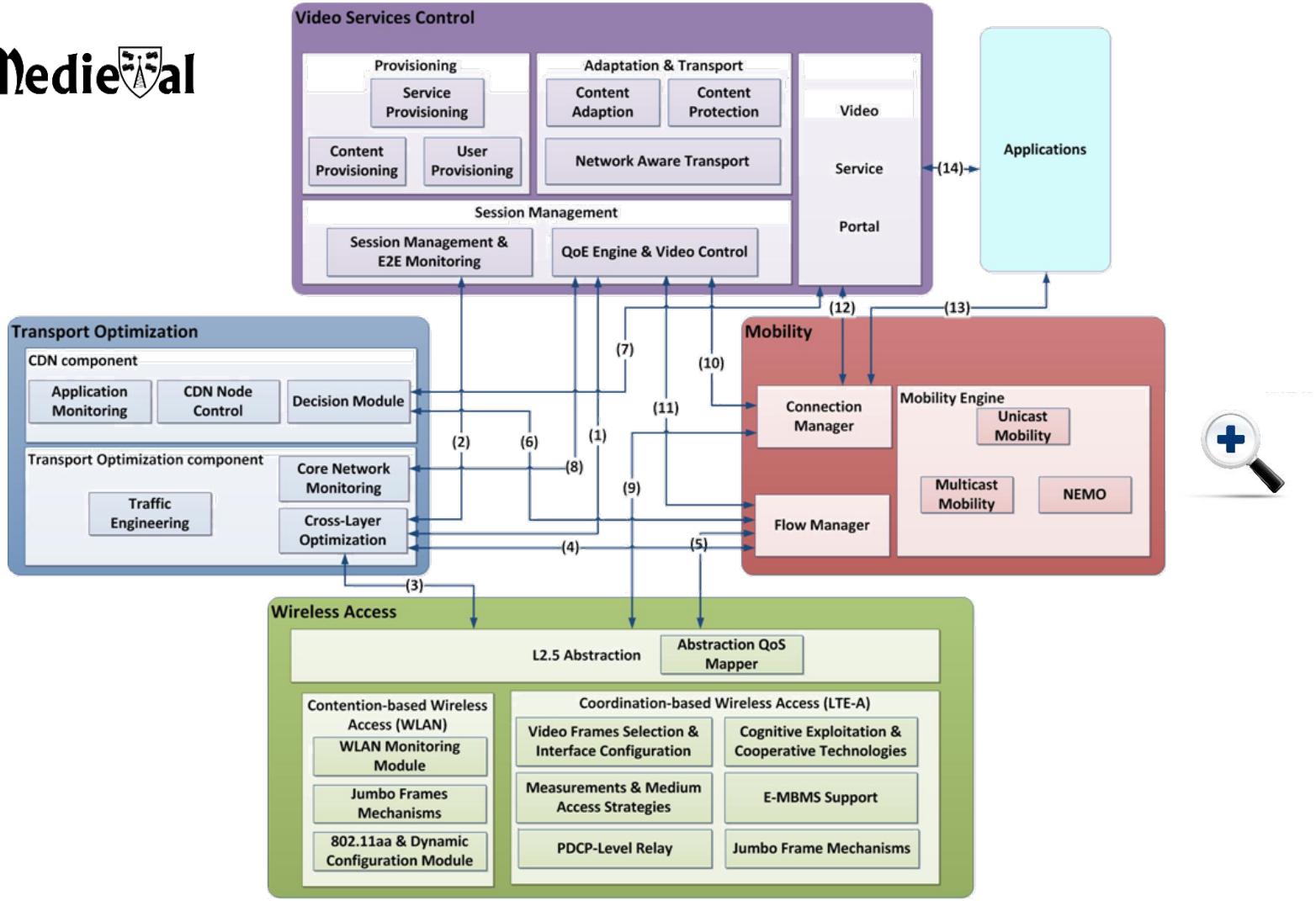
Motivation (4)

- Envisioned scenarios



Design guidelines

- Transport architectures featuring video specific enhancements at the different layers of the protocol stack and suitable for commercial deployment by mobile network operators



Zooming into Mobility Management

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Zooming into Mobility Management

- Distributed and Dynamic Mobility Management (DDMM)
  - Distributed: positioning anchors at the edge of the network
  - Dynamic: activating mobility on-demand, not by default

ADVANTAGES:

- DMM is a paradigm for flat architectures, enabling unified management of 3GPP and non-3GPP access networks (FMC)
- Optimal routing in a per-flow basis
- Minimizes potential for Single Point of Failure / core link bottlenecking

Zooming into Mobility Management (2)

- IP Multicast support in DDMM
  - **Receiver mobility**: Priority is to transfer multicast context to new network, and to synchronize frame by means of buffering, etc
  - **Source mobility**: Anchor flows close to the host, prevent any disruption to assure seamless service for all receivers
  - **Both**: Provide intelligence to multicast hosts for coping with mobility within heterogeneous scenarios

ADVANTAGES:

- IP multicast efficiency is not compromised by IP mobility management

IP multicast mobility for seamless vídeo support

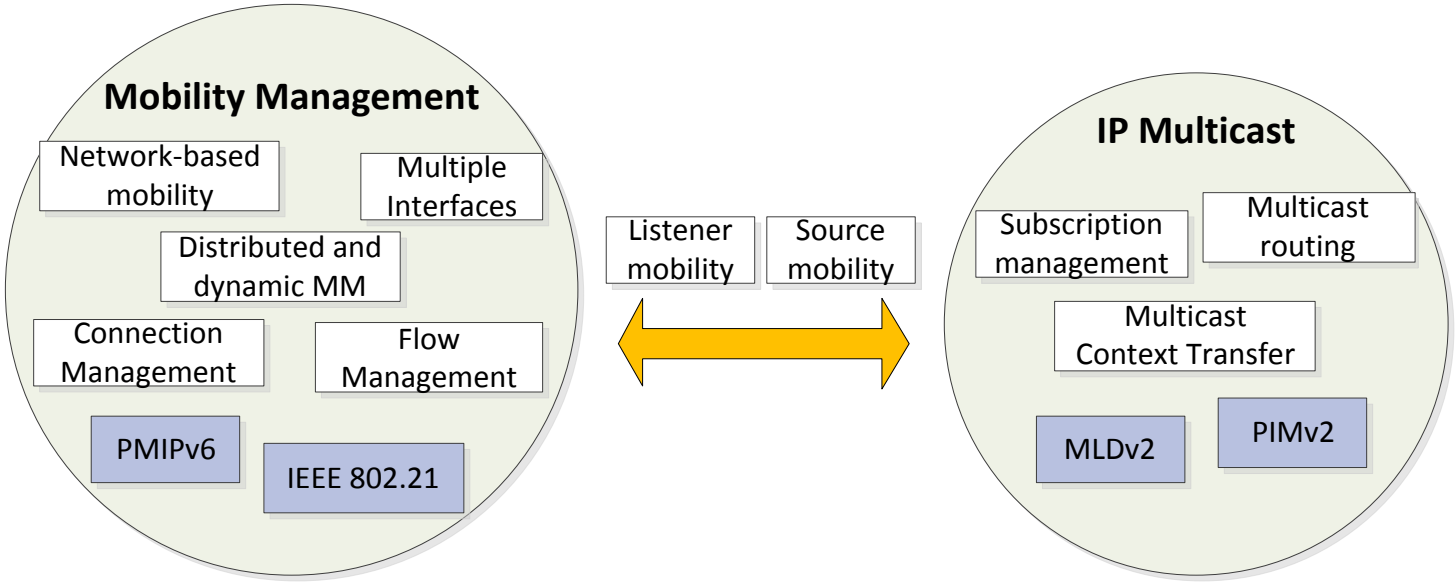
1. MIH-enhanced multicast mobility in PMIPv6

2. IP multicast in DMM
   - MLD Proxy @ Mobility entity
   - Multicast Router @ Mobility entity

3. Cross-layer multicast mobility for vídeo

IP multicast mobility for seamless vídeo support

- The core of this work has been the **enhancement and integration / orchestration** of mechanisms towards the deployment of **group-based video** services



MIH-enhanced multicast mobility in PMIPv6

- Multicast listener mobility enabled for vertical handovers
  - Extending context transfer protocol with multicast information
  - Adding a new TLV to IEEE 802.21 messages

MIH_MN_HO_Candidate_Query.request

MIH Header Fields (SID = 3, Opcode = 1, AID = 5)
Source MIHF ID TLV
Destination MIHF ID TLV
Link identifier TLV
List of link PoA list TLV
Handover resource query list TLV
IP address configuration methods TLV
DHCP server address TLV
FA address TLV
Access router address TLV
Subscribed multicast groups TLV

MIH_N2N_HO_Query_Resources.request

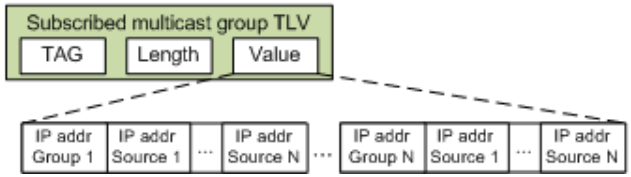
MIH Header Fields (SID = 3, Opcode = 1, AID = 5)
Source MIHF ID TLV
Destination MIHF ID TLV
Handover resource query list TLV
IP address configuration methods TLV
DHCP server address TLV
FA address TLV
Access router address TLV
Link identifier list TLV
Subscribed multicast groups TLV

Used open-source tools:

- *MRD6*

open dot twenty one ODTONE

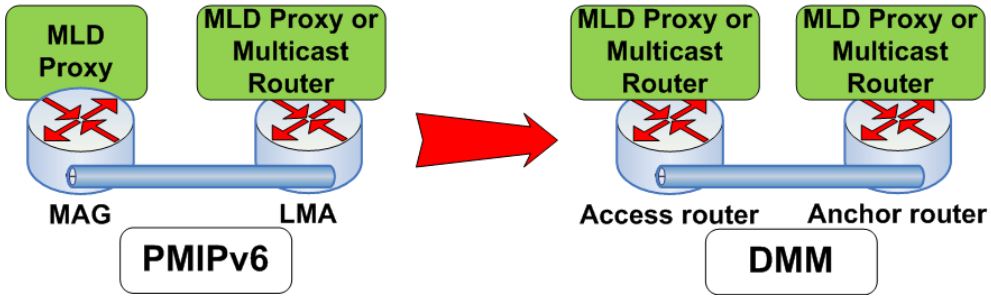
OPEN PROXY MOBILE IP



- Multicast source mobility (ASM or SSM)
  - Rely on Multicast Mobility Decision entity for “virtual anchoring”
    - I.e. Updating SPT up to MAG

IP multicast in DMM – the problem with CMM

- In PMIPv6, either MLD Proxy (RFC6224, Base Solution) or Multicast Router @ MAG can be considered
- PMIPv6 Multicast Base Solution (RFC6224) limitations:
  - Tunnel convergence problem
  - Non-optimal routing

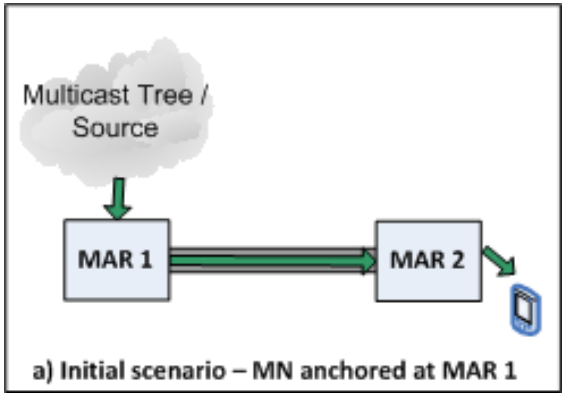


- **Initial step**: identify and analyze different possibilities for multicast support in future network-based DMM protocols

IP multicast in DMM w/ MLD Proxy

- Analogously to PMIPv6's Multicast Mobility Base Solution (RFC6224)
  - MLD Proxy @ MAR
  - Upstream link configured towards anchor MAR (same as LMA in PMIPv6)

MAR = Mobility Access Router

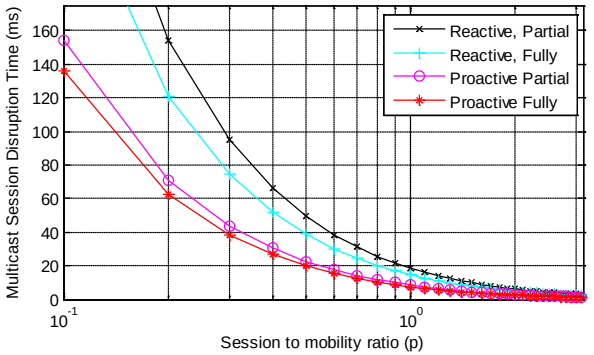


- Schemes are differentiated based on:
  - Distribution degree:
    - Partially or Fully distributed
  - Proactiveness:
    - Reactive or Proactive

Sergio Figueiredo, Seil Jeon, Rui L. Aguiar, **"Use-cases Analysis for Multicast Listener Support in Network-based Distributed Mobility Management"**, Proc. 23rd IEEE PIMRC, Sydney, Australia, Sep 2012

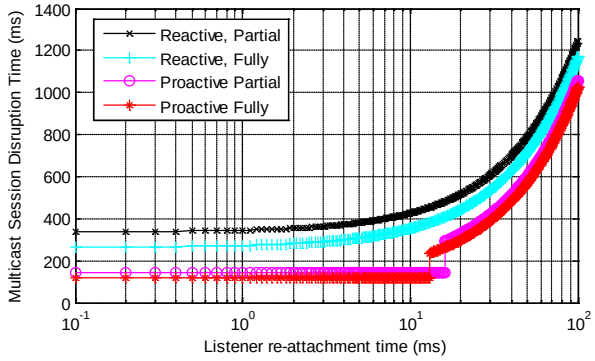
IP multicast in DMM w/ MLD Proxy (2)

1) Service disruption time as function of **SMR (Session to Mobility Ratio)**

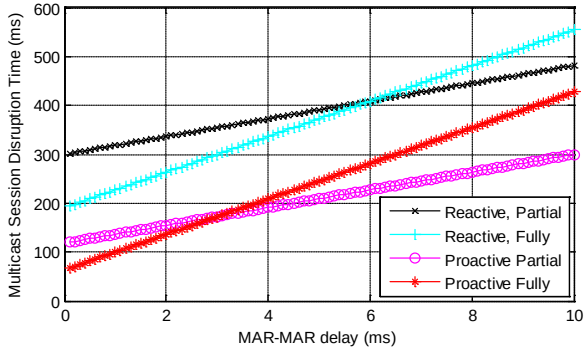


High Mobility **Low Mobility**

2) Service disruption time as function of **re-attachment time**



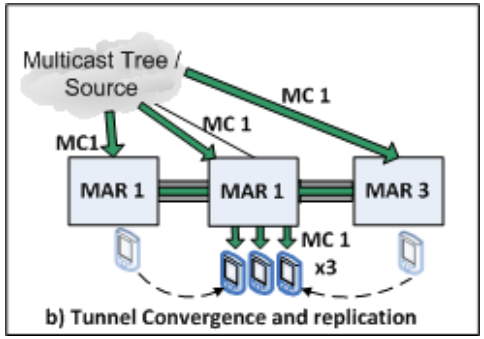
3) Service disruption time as function of **tunnel traversal time**

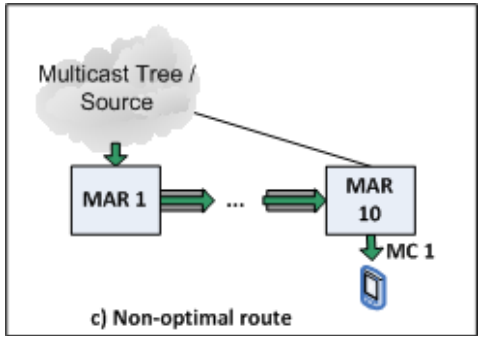


IP multicast in DMM – issues with MLD Proxy

- Issues with MLD Proxy:

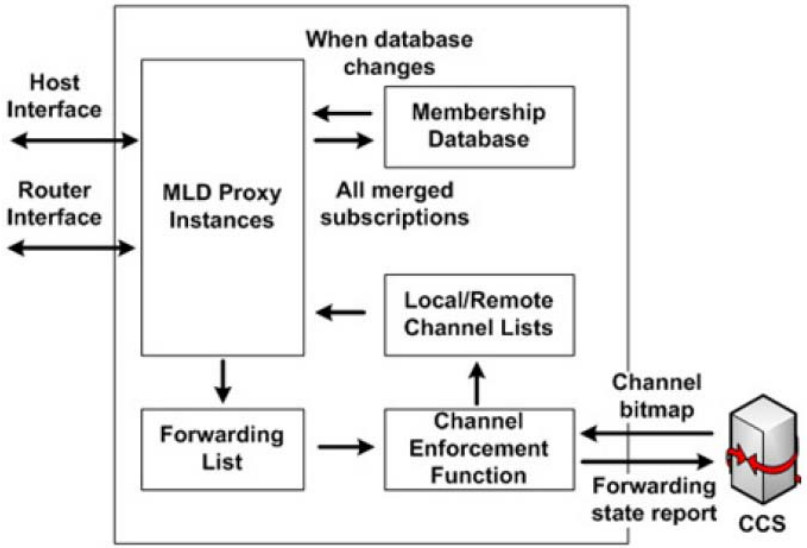
1. Duplication & Tunnel convergence problem
2. Non-optimal routing





- Source of the problem:
  - Upstream interface configured towards anchor (as PMIPv6 Base solution)

- Alternative:
  - Configuration towards multicast infrastructure



- MNs will subscribe different channels at different times (thus different MARs):

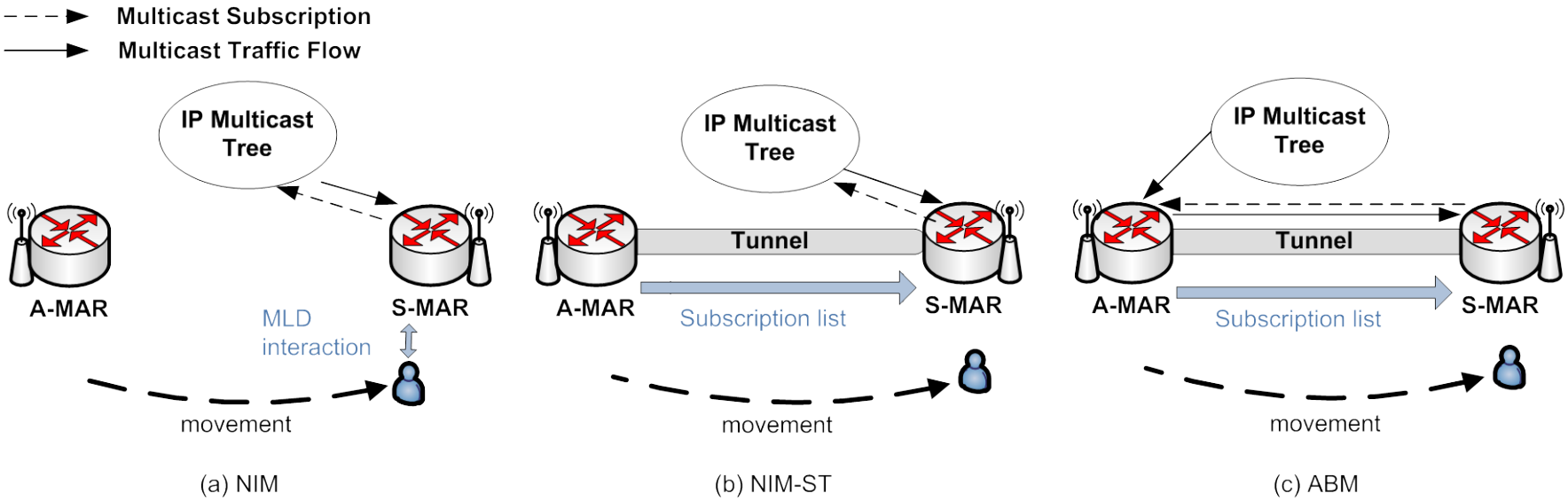
- Solution: per-channel upstream configuration

Seil Jeon, Sergio Figueiredo, Rui L. Aguiar, **"A Channel-Manageable IP Multicast Support Framework for Distributed Mobility Management"**, Proc. IFIP Wireless Days 2012, Dublin, Ireland, Nov 2012

IP multicast in DMM w/ Multicast Router

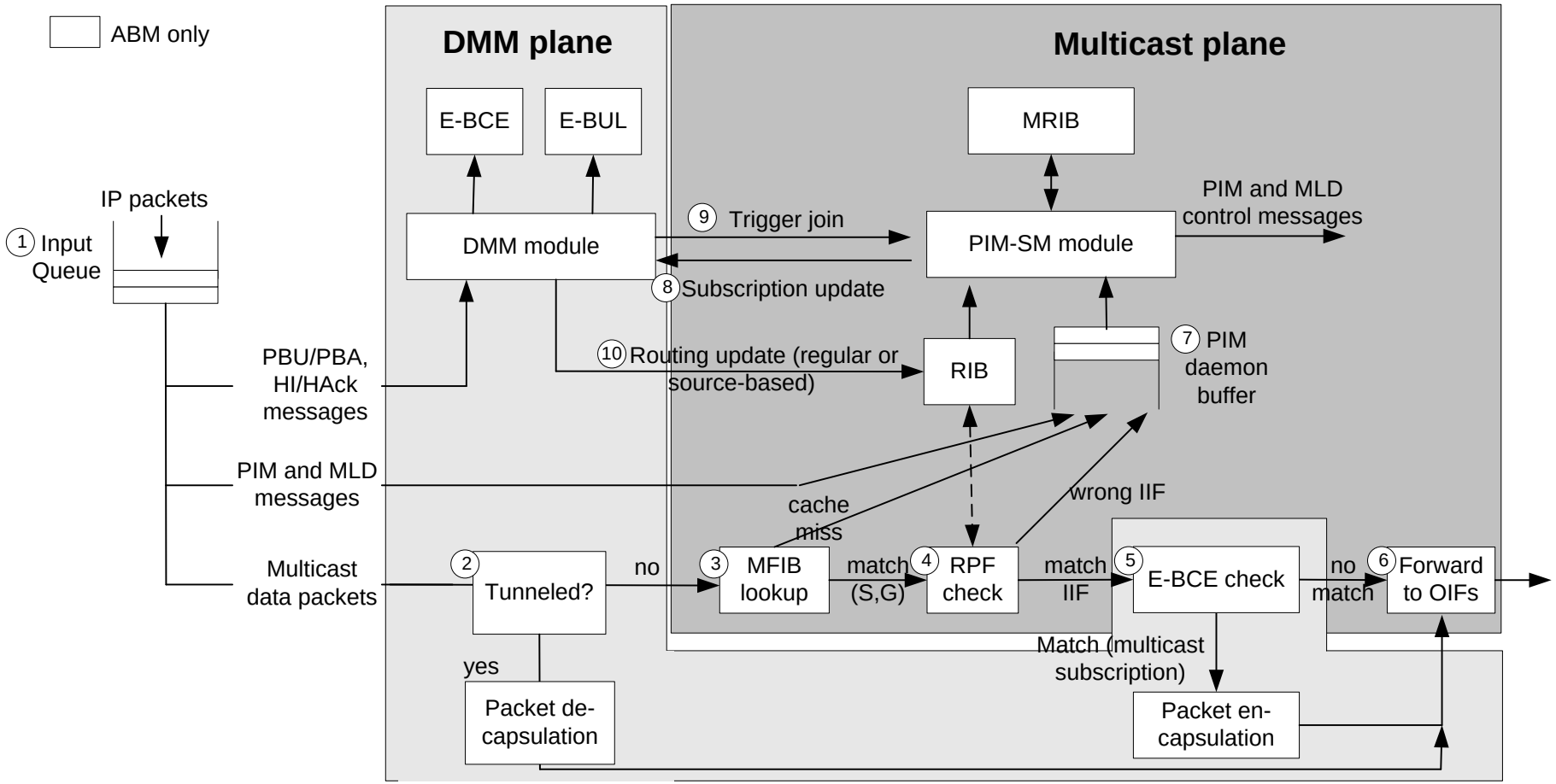
- Architecture preventing the occurrence of tunnel replication cost, and consisting of 3 schemes

1. Native IP Multicasting (NIM)
2. Native IP multicasting with subscription transfer (NIM-ST)
3. Anchor-based multicast transport (ABM)



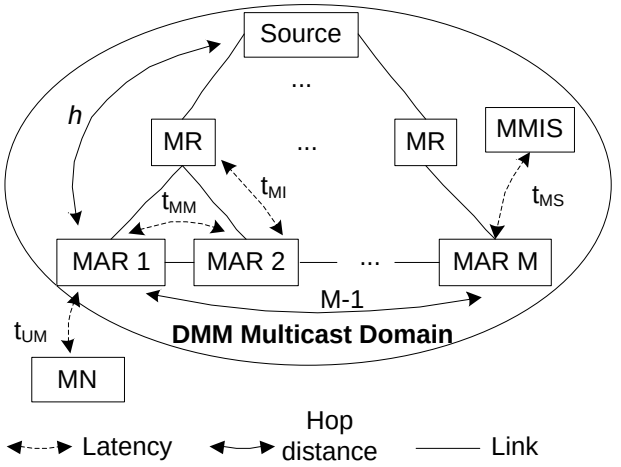
IP multicast in DMM w/ Multicast Router (2)

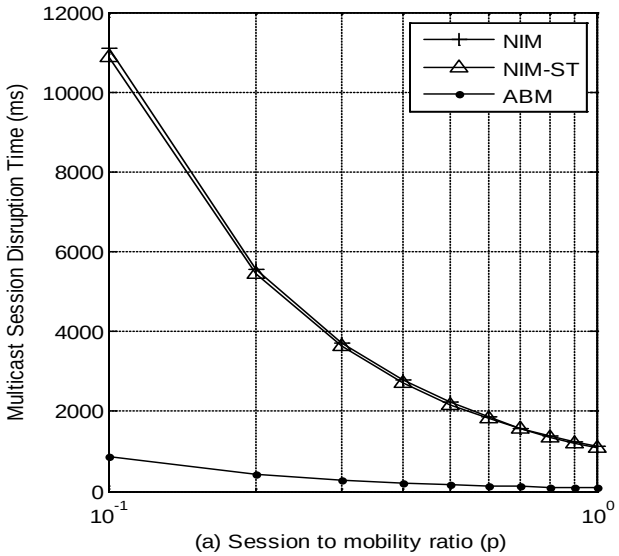
- Integration between mobility and IP multicast routing planes

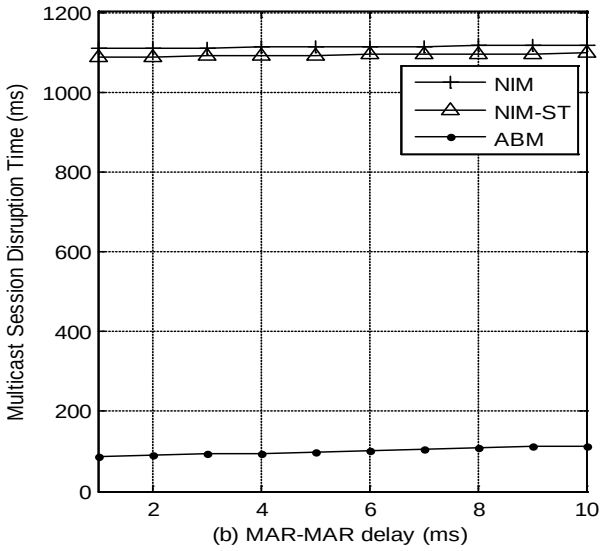


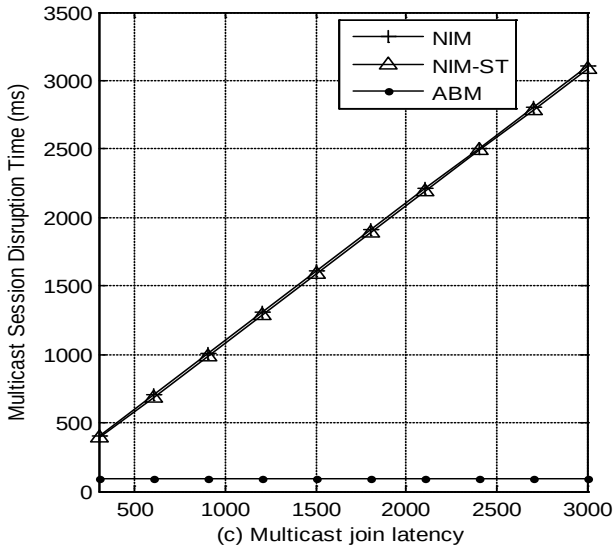
IP multicast in DMM w/ Multicast Router (3)

1. Subscription by multicast infrastructure originates an higher service disruption than using an anchored subscription
2. Leveraging on mobility tunnelling for multicast support during handover does not introduce significant overhead.



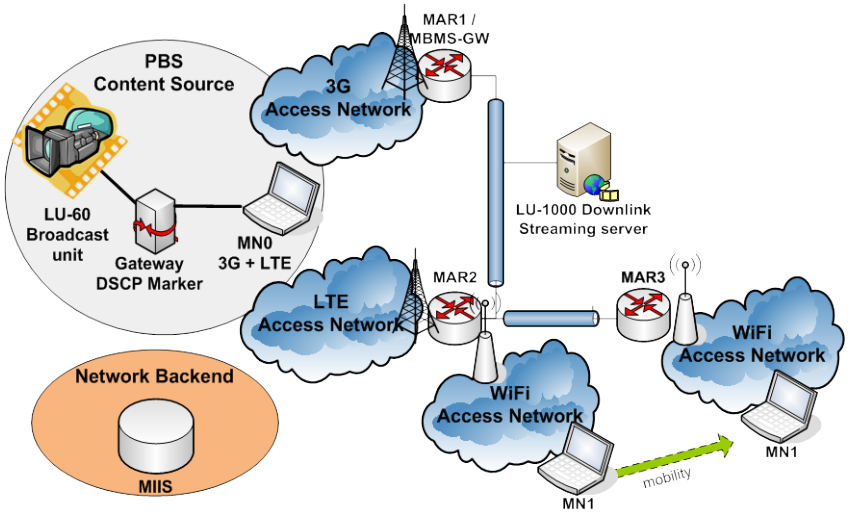


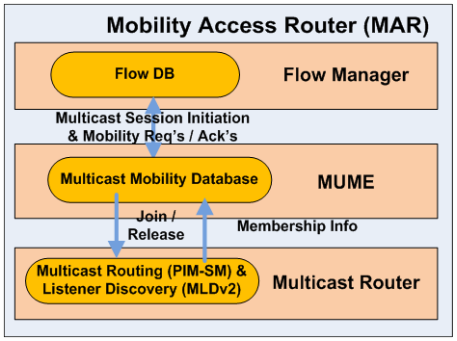


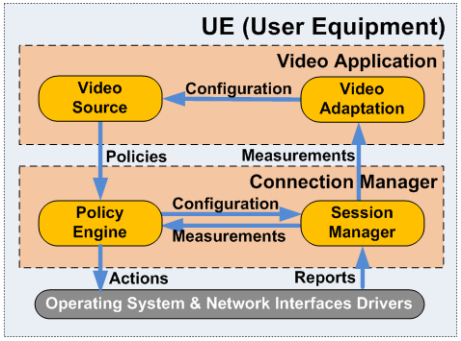


Cross-layer multicast mobility

- Implementation of cross-layer solution:







Results "snippet":

Delay factor	Measured value (ms)	Std Deviation (ms)
$T_{DISRUPTION\_CXT}$	**127.10**	2.70
$T_{DISRUPTION\_MLD}$	**553.67**	570.54

S. Figueiredo et al, **"Broadcasting User Content over Novel Mobile Networks"**, Proc. 2013 International Conference on Communications, Budapest, Jun 2013

S Figueiredo, S Jeon, Rui L. Aguiar, "**Empowering IP multicast for multimedia delivery over Heterogeneous Mobile Wireless Networks**", Prc. 2014 INFOCOM Students Poster Session (accepted)

Contributions

- Conference Proceedings:
  - 9 publications in international conferences (**ICC, PIMRC, INFOCOM student poster**)
  - 2 ongoing journals
- Standardization bodies:
  - 1 draft in IETF MULTIMOB…
  - … which led to contribution in IETF DMM's Requirements WG document
- Contribution to MediEval FP7 Project
  - Results on IP multicast mobility in DMM
  - Coordination of Demonstrator on "Personal Broadcasting Service", interleaving Connection Management, Flow Management and Session Management entities
    - Audit result: "Excellent"

Conclusions

- IP multicast will take a significant role in assuring efficient transport
  - In particular for demanding services as video

- Cross-information from the application, access network, transport and others is crucial for:
  - Seamless mobility
  - Intelligent traffic engineering

Ultimately, **Quality of Experience** preservation is achieved

Thanks for your attention!

Questions please?

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http://atnog.av.it.pt/members/sfigueiredo

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