End-to-end IP Service Quality and Mobility
- Lecture #8 -

Special Course in Networking Technology

S-38.215

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Planned contents & draft schedule

1.	Introduction	Jan 13th
2.	Characteristics of mobile applications	Jan 20th
3.	Service quality requirement characterizations	Jan 27th
4.	Challenges of mobile environment	Feb 3rd
5.	Mobility and QoS in GPRS	Feb 10th
6.	Mobility and QoS in 3GPP systems	Feb 17th
7.	Mobility and QoS with Mobile IP	Feb 24th
8.	**Mobile IP QoS enhancements**	Mar 3rd
9.	Edge mobility	Mar 10th
10.	Inter-system mobility	(Mar 17th)
11.	End-to-end QoS management	(Mar 31st)
12.	Summary	(Apr 7th)

Dates in parentheses to be confirmed

Agenda

- Mobile IP enhancements
  - Local Mobility Agents
  - Candidate Access Router discovery
  - Seamless Handovers
  - Bicasting
- Paging
- Summary

Goal of the lecture

- Understanding of…
  - the effect of mobility localization schemes on signalling load and handover performance.
  - Effect of seamless handover techniques on service quality.
  - Effect of bicasting.
- Paging and service quality.
- MIPv6 assumed in this lecture.
- **Note! Most the techniques described in this lecture are Internet Drafts (I-D's) at the moment and therefore more tentative than RFC's.**
  - **I-D => no standard exists at the moment, even a "proposed standard".**

Relevant IETF working groups

- IETF = Internet Engineering Task Force.
  - Organized into working groups.
  - I-D => proposed standard => draft standard => Internet standard.
- MIP-related WGs:
  - Internet area / mobileip WG:
    - IP macromobility (MIPv4, MIPv6).
  - Transport area / seamoby WG:
    - Context transfer.
    - Handover candidate router discovery.
    - Dormant mode host alerting.

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Mobility localization

- With standard MIP, HA needs to be informed of changing of CoA.
- Localized Mobility Agents (LMA): introduce “mobility proxies” closer to the edge of the network.
  - In principle multiple levels of LMAs can be used, but can be problematic in view of performance.
- Effect of LMAs:
  - Amount of signalling decreases.
    - Only LMA informed of handover.
  - Faster handover.
    - LMA closer to MN than HA.
- Compare with: GGSN, SGSN, RNC in 3GPP architecture.

[Wisely *et al.*, ch. 5]

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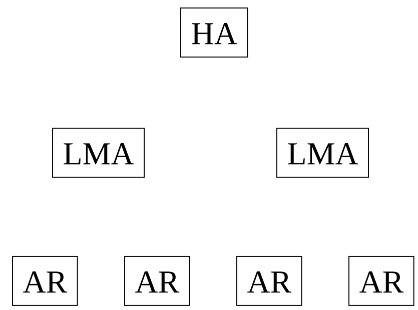
Implications of LMA schemes

- LMA knows the AR under which the mobile can be found.
- HA knows under which LMA the mobile can be found.
- Consequences:
  - Multiple levels of LMAs ⇔ performance penalty.
  - Minimization of signalling and route optimisation cannot be achieved simultaneously in general.



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HMIPv6: a LMA scheme for MIPv6

- Hierarchical Mobile IPv6 is a draft framework for LMA in MIPv6.
- Local Mobility Agent is called Mobility Anchor Point (MAP).
- MN obtains Regional CoA (RCoA) from MAP via stateless address autoconfiguration.
  - RCoA is globally routable address.
  - MN can send RCoA to HA & CNs.
- MN also has a Link CoA (LCoA) which it sends to MAP.
  - MN informs its LCoA to MAP using binding update when it changes AR.
    - Special extension needed for indicating that this is a “local” binding update.
- MAP discovery needed.

[Wisely *et al.*/ **Soliman** *et al*., **draft-ietf-mobileip-hmipv6-07.txt]**

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HMIPv6 example (basic mode)

- MN gets LCoA from AR.
- MN discovers the RCoA from MAP advertisements.
  - If not HMIPv6 capable, just ignores them.
- MN registers its LCoA into MAP.
- MN performs binding update to HA and CNs.
  - HA is informed of the RCoA or LCoA.
  - CNs can be informed of
    - RCoA -> location privacy
    - LCoA -> optimal routing
- MAP tunnels traffic to AR

Candidate Access Router (CAR) Discovery

- Simple scheme: break-before-make, no transfer of state between access routers.
  - L2 connection to previous AR (PAR) broken
  - IP address of next AR (NAR) known to MN only after
- Scenarios that benefit from better support:
  - Load balancing between ARs.
  - Bandwidth-intensive applications.
  - Minimization of cost.
  - Inter-technology handovers.
  - Adaptability to changing topology without Ad hoc routing schemes.

[Trossen *et al.*, draft-ietf-seamoby-cardiscovery-issues-04.txt]

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CAR discovery, cont'd

- Assumption: make-before-break, or at least L2 identifier of potential AP can be acquired prior to handoff.
- Requirements of CAR solution
  - Can translate L2 address of a new access point to the IP address of the CAR (i.e., candidate NAR).
    - AP can be separate from CAR.
  - Enables obtaining of information about the relevant state of CAR.
    - E.g., loading status for traffic aggregate.

[Krishnamurti (ed.), draft-ietf-seamoby-card-requirements-02.txt]

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CAR discovery, cont'd

- Further requirements for CAR discovery:
  - Must support inter-system handovers.
  - Should avoid unnecessary transmissions to MN.
  - Must not depend on mobility management protocol.
  - Must work with variable topology
  - Should work across ADs.
- CAR discovery example: CAR state discovery alternatives.
  - Ask state from CAR prior to handover decision.
  - Periodical state reporting to neighbouring ARs.
- At the time of writing, CAR discovery just beyond requirement specification phase.

[Krishnamurti (ed.), draft-ietf-seamoby-card-requirements-02.txt]
[Liebsch *et al.*, draft-ietf-seamoby-card-protocol-00.txt]

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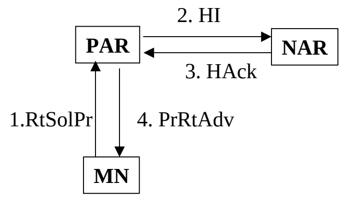
Seamless handovers

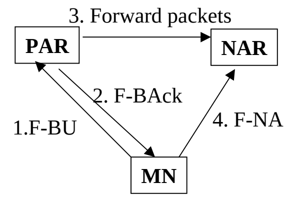
- Fast handovers: packets delivered to/from MN quickly during handover to new AP/AR.
- Smooth handovers: packet loss is minimized.
- Fast + smooth = seamless handover.
- Basic techniques:
  - Tunnelling from PAR to NAR.
    - Works in principle with break-before-make.
  - Bi-casting.
    - Requires two simultaneous CoAs.
    - Requires bicasting agent (FA, LMA, HA).

[Wisely *et al.*, ch. 5]

Tunnelling from PAR to NAR

- MN-controlled handover assumed in this slide.
- MIPv6 fast handover example:
  - Handover preparation phase.
  - Handover execution phase.
- Handover preparation phase has analogues in cellular network operation.





[Wisely *et al.*, ch. 5]

Network-controlled handover

- A second alternative, the PAR can operate without explicit control of MN.
- Handover initiated by PAR with suitable trigger event.
  - E.g. new L2 connection.
- PAR sends HI to NAR.
- NAR sends an ACK to PAR.
- Tunnel is set up between PAR and NAR for forwarding packets.
- After link layer connectivity from MN to PAR is lost, packets arriving at PAR are forwarded to MN via NAR.

Bicasting

- Basic Mobile IPv6 allows multiple CoAs to be used simultaneously.
- MN can listen to more than one APs simultaneously
  - Requires link layer that supports two or more simultaneous L2 connections.
- Same data can be transmitted via multiple paths to MN given that…
  - MN can have multiple simultaneous bindings
    - Optional feature of MIPv4
    - Proposed to MIPv6 => **bicasting**.
  - There is a mobility agent which can copy the data to be sent via multiple CoAs.

[Wisely *et al.*, ch. 5]

Bicasting, cont'd

- Bicasting can be used to avoid "ping-pong" handovers between two AR's…
  - But traffic has to be sent (at least) twice in the access network.
- Bicasting draft (not official WG draft at the moment):
  - Perform bicasting in the AR, MAP, or HA.
- Analysis:
  - Simpler than fast handover.
  - Requires extension to MIPv6.
  - If bicasting done higher up than in AR level, more traffic in the fixed network.

[El-Malki *et al.*, draft-elmalki-mobileip-bicasting-v6-02.txt]

Summary: handover techniques

- **LMAs** allow for
  - Faster binding updates to proxy mobility agents.
  - Mobile can decide how to update HA and CNs.
    - Amount of signalling vs. optimality of routing.
- **CAR** discovery allows for
  - Identification of CAR from L2 ID.
  - Obtain service quality status from CAR.
- **Smooth handover**:
  - Transfer QoS & security state between PAR and NAR.
- **Bicasting**:
  - Alternative to CAR discovery + smooth handover.

MN paging

- If wireless device needs to be always in communication-ready mode, battery life is shortened.
- Simple solution: terminals not actively communication go to dormant mode and awaken periodically to check for incoming traffic.
  - Network needs to help in traffic forwarding.
- However, it is desirable to be able to communicate with terminals at all times, not only to make connections.
- Solution:
  - Terminals which are not actively sending data go into dormant mode.
  - Network pages for nodes in the dormant mode when there is incoming traffic for them.

[RFC3132]

MN paging / 2

- Paging support can be built into radio link layer.
  - Typically inform the network of crossing a “paging area” boundary.
- Link layer without paging support always knows the exact location of the MN.
  - “Periodical polling” assumed.
- Dormant mode terminal supporting paging:
  - Reduced amount of location update signalling.
  - MN is not necessarily to receive packets.
    - Radio interface may be “on” only part of the time.
  - MN can receive and respond to paging messages.

[RFC3132]

IP paging

- Analysis of the need for IP paging:
  - No L2 support for paging => IP paging does not bring any benefits.
    - Network always knows the exact location of the MN.
  - If L2 paging area update can be used for triggering MIP registrations, IP paging does not bring extra benefits.
  - If L2 paging area larger than IP subnets, triggering of MIP registrations from paging area updates is not possible.
  - If paging area update is based on heuristics, IP paging brings benefits.
  - IP paging can span multiple access technologies.

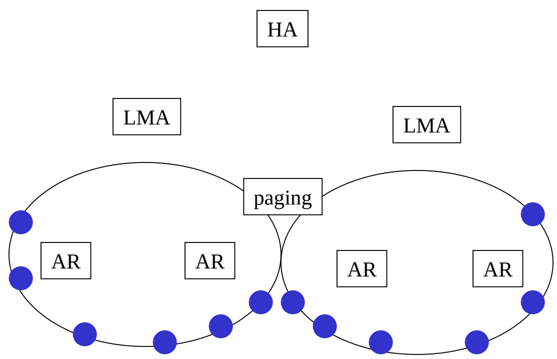
[RFC3132]

Paging and service quality

- No paging:
  - No periodic checking for incoming traffic in MN => unavailable when dormant.
  - Periodic checking => service instantiation time can be long for telephony.
- Paging supported:
  - Link layer paging: shortened service instantiation time within a L2 technology for incoming services.
  - IP layer paging:
    - Necessary if L2 paging area larger than IP subnet.
    - Helps if L2 paging based on heuristics.
    - Can be used to facilitate inter-technology paging.

Example

- Compared to basic MIP, handover optimisation support brings extra complexity into the network.
  - LMAs.
  - Inter-AR protocols.
- Paging support allows battery life & L2 capacity optimisation.



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Summary

- **Draft** technologies for enhancing service quality support in MIPv6 networks:
  - LMA.
  - CAR.
  - Smooth handover.
  - Paging.
    - L2
    - IP
- The above technologies bring cellular network-like functionality to IP layer and L3/L2 interface.

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