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Shall we apply paging technologies to Proxy Mobile IPv6 ?

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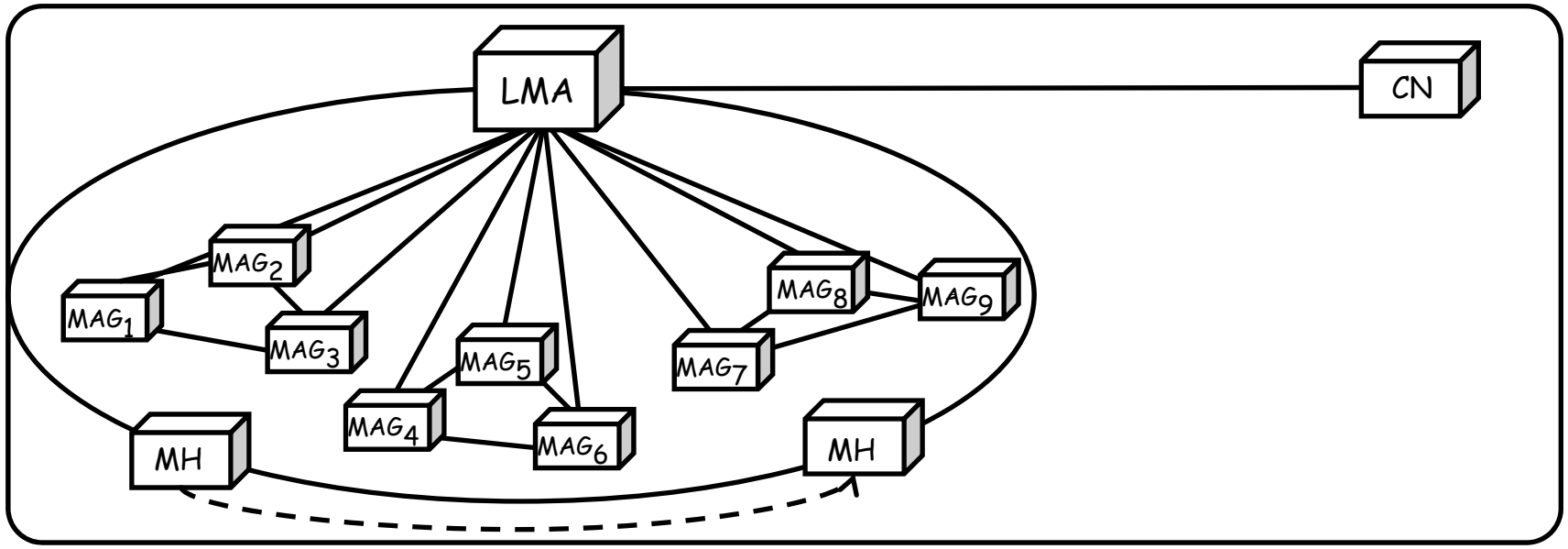
Proxy Mobile IPv6

- The general way for IPv6 based mobility
  - host-based mobility protocols
    - Mobile IPv6 (RFC 3775), Hierarchical Mobile IPv6 (RFC 4140)
  - depending on the mobility stack installed on mobile hosts
    - sending binding update messages and maintaining binding information
    - signaling concentrated to mobile hosts

- The new trend in IPv6 based mobility
  - network-based mobility protocol
    - Proxy Mobile IPv6 (PMIPv6, RFC 5213, published: August 2008)
  - no need for installing the mobility stack on mobile hosts
    - ordinary hosts can hand off between different subnets
    - sending binding update messages and maintaining binding information are done by newly introduced mobility entities

Problem statement

- The newly proposed mobility entities in PMIPv6
  - Mobile Access Gateway (MAG)
    - sending proxy binding update messages on behalf of a mobile host
  - Local Mobility Anchor (LMA)
    - maintaining all binding information for mobile hosts in its domain
    - maintaining all data traffic for mobile hosts in its domain
    - can be a performance bottleneck



Problem statement

- Scalability issues in PMIPv6
  - need to reduce binding update messages focusing to LMA
  - need to increase the number of supporting mobile hosts
  - need to optimize mobility management cost
  - Paging technologies
    - can be a candidate solution for solving scalability issues

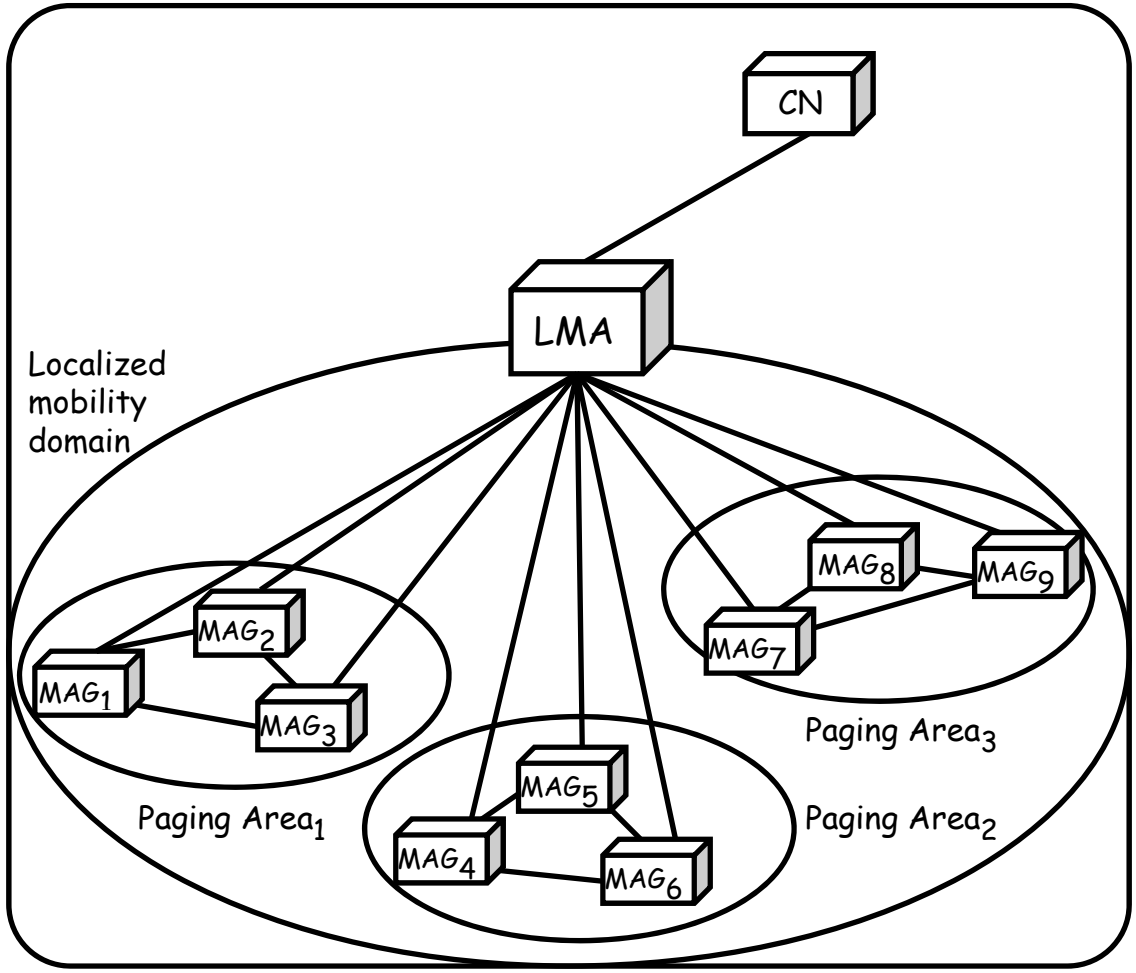
Paging extension for PMIPv6

- Design considerations
  - support for unmodified mobile hosts
  - reduction in mobility signaling cost
  - avoidance of paging processing at a single point

- Paging algorithm
  - fixed algorithm
  - hierarchical algorithm
  - last-location algorithm
  - dynamic algorithm

Paging extension for PMIPv6

❖ Paging architecture



- router based paging

: paging state is distributed among MAGs

- multicast group

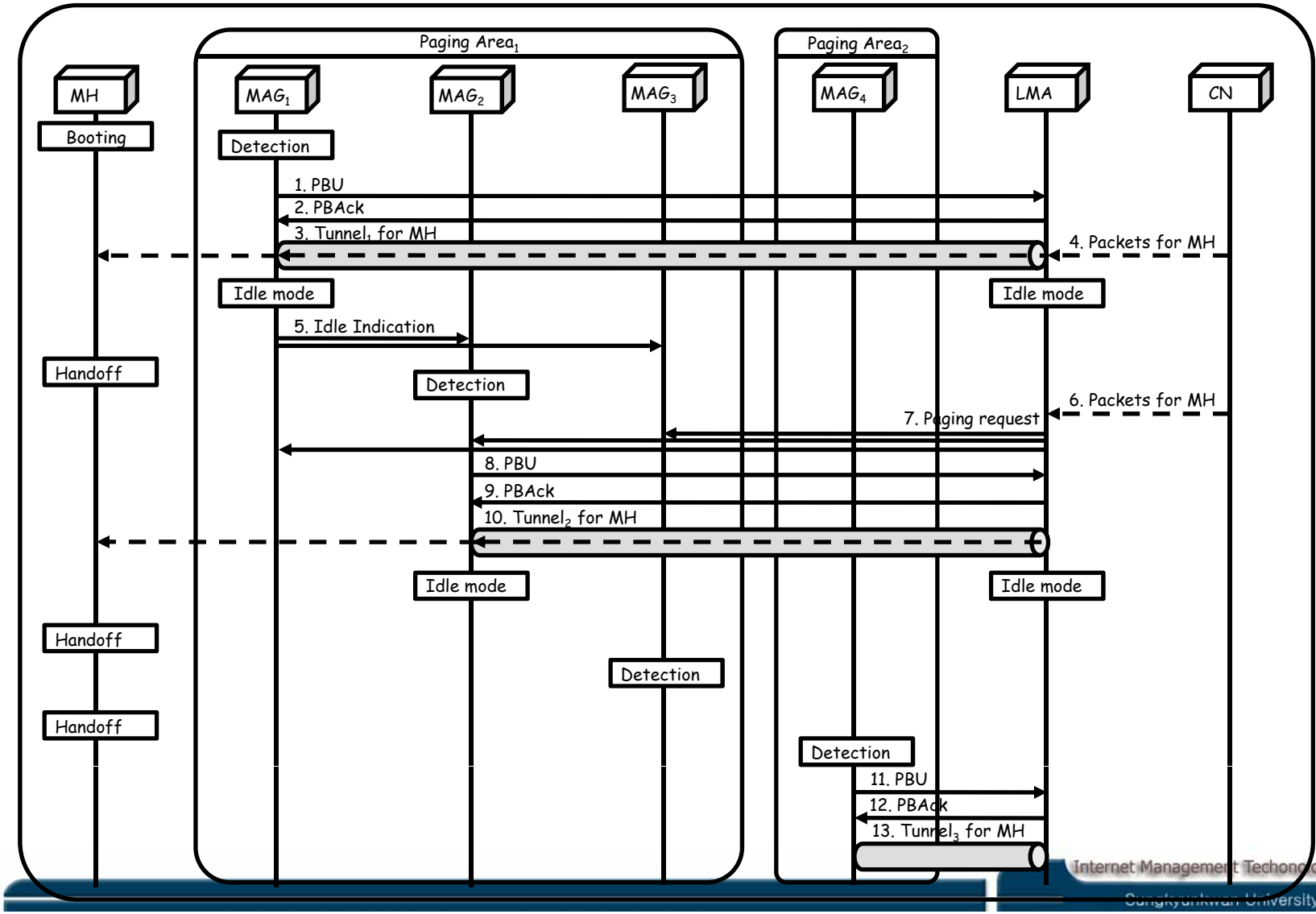
: MAGs have the same multicast group

- time-based state

: paging state changes based on binding

Paging extension for PMIPv6

- Paging message sequence



Performance evaluation

- System model
  - layered hexagonal network model
    - L-level paging area is consisted of 3L(L+1) + 1
  - fluid-flow mobility model
    - for calculating cell (subnet) crossing and paging area crossing rates
- Signaling Costs

• PMIPv6 without paging

$$C_{ba} = (t_\alpha + t_\gamma + p_\alpha) \times \left(R_c \cdot N_c + \rho \left(\frac{L_c}{4} \right)^2 \cdot N_c \cdot r \right)$$

Table 1: System parameters

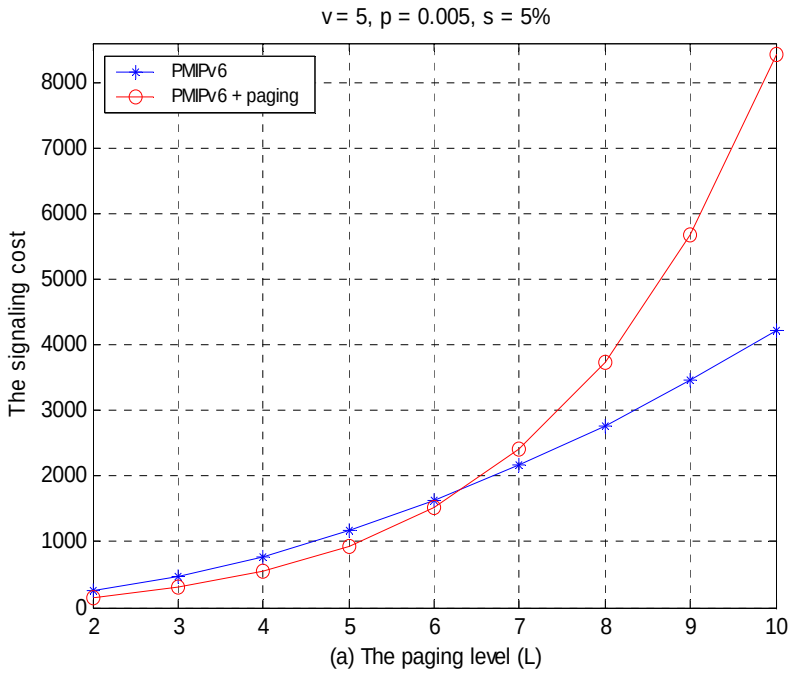
Notations	Descriptions	Values
L	The paging level	$2 \sim 10$
ρ	The density of MHs in a paging area	$0.005 \sim 0.02$
ν	The average velocity of MHs	$5 \sim 80$ (m/s)
L_c	The perimeters of a cell	100 (m)
t_α	The sig. cost between MH and MAG	1
t_β	The sig. cost between MAGs	$\sqrt{N_c}$
t_γ	The sig. cost between MAG and LMA	5
p_α	The proc. cost for tunnel	3
s	The active mode rate	$5 \sim 80$ (%)
r	The average refreshing rate	0.2
λ_i/λ_o	The incoming/outgoing session rate	$0.0008/s$

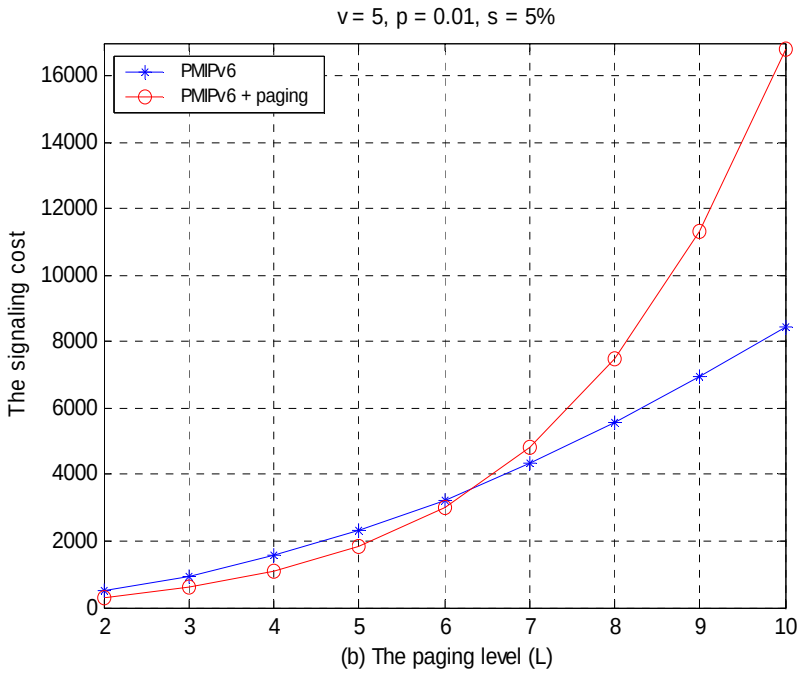
• PMIPv6 with paging

$$\begin{aligned} C_{ex} \quad = \quad & (t_\alpha + t_\gamma + p_\alpha) \times \left(R_p + (R_c \cdot N_c - R_p) \cdot s \right. \\ & + \rho \left(\frac{L_c}{4} \right)^2 \cdot N_c \cdot r \\ & \left. + \rho \left(\frac{L_c}{4} \right)^2 \cdot N_c \cdot (1-s) \cdot (\lambda_i + \lambda_o) \right) \\ & + \left((N_c - 1) \cdot (t_\alpha + t_\beta + t_\gamma) \right. \\ & \left. \cdot \rho \cdot \left(\frac{L_c}{4} \right)^2 \cdot N_c \cdot (1-s) \cdot \lambda_i \right), \end{aligned}$$

Performance evaluation

- Effect of paging level on the signaling cost

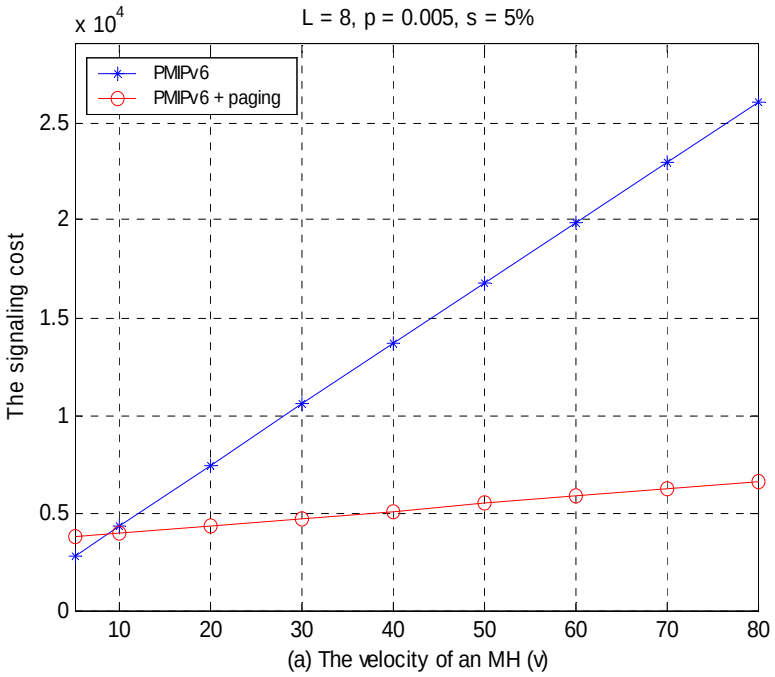


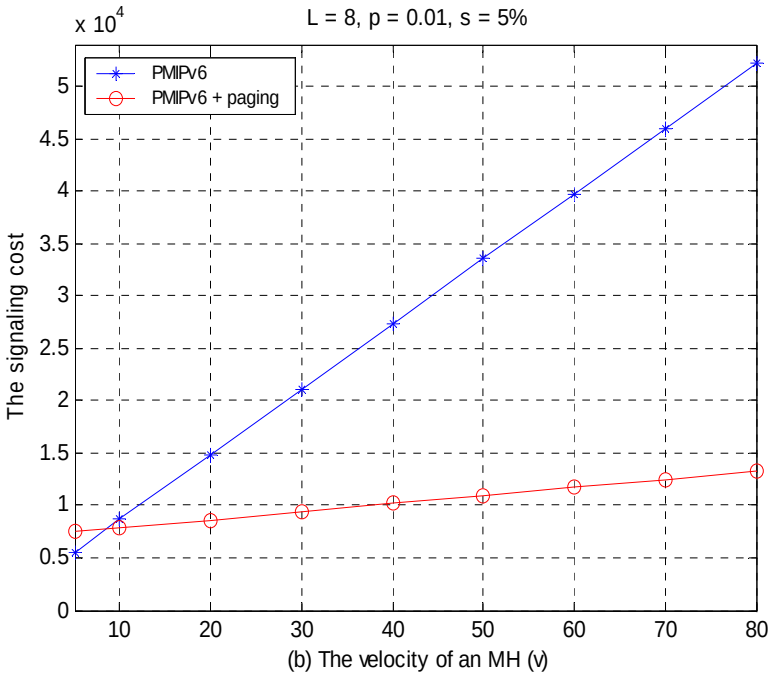


- The signaling cost for the paging extension is generally smaller than the basic PMIP6.
- However, the paging extension consumes more cost when there are low-velocity mobile hosts in the above 7 paging level.
- The size of paging areas should carefully designed.

Performance evaluation

❖ Effect of velocity on the signaling cost

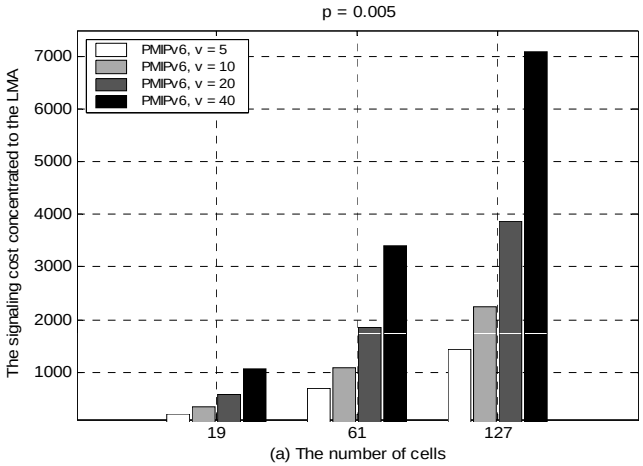


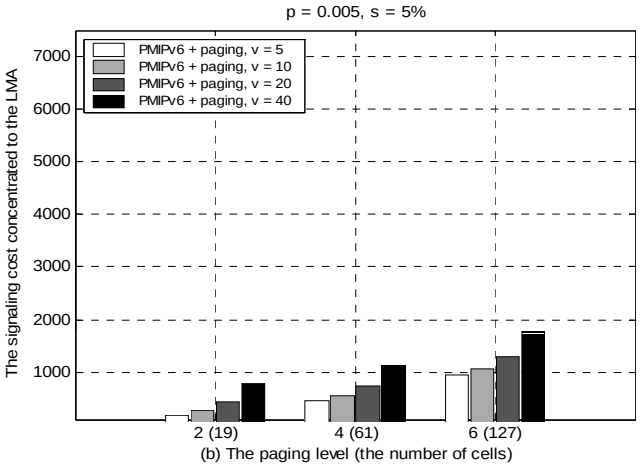


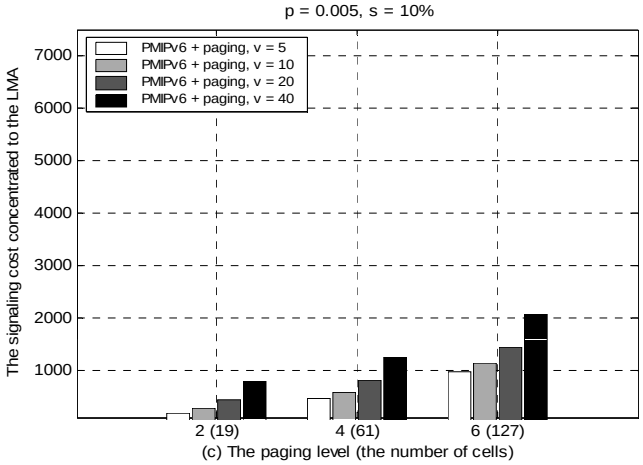
- When the velocity is lower than 10 m/s, the basic PMIP6 shows better performance.
- However, as the velocity increases, the paging extension requires lower signaling cost.

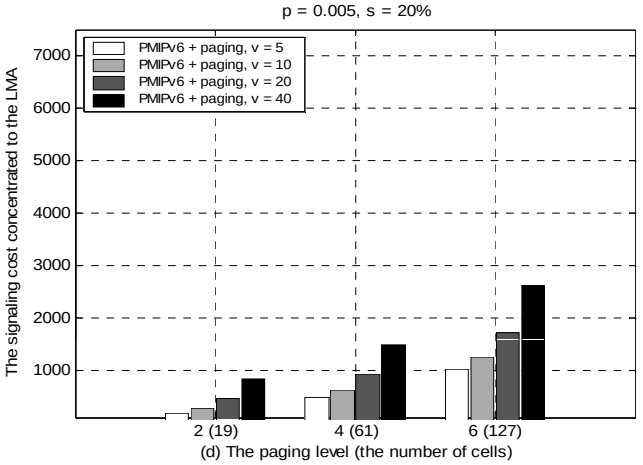
Performance evaluation

- Effect of paging level and velocity on the signaling cost concentrated to the LMA









Conclusions

- Proxy Mobile IPv6 is a centralized mobility architecture
  - posing heavy burden on the LMA
  - bring network traffic bottleneck at the LMA
- Proposed paging extension is a decentralized architecture
  - distributing processing load among the MAGs
  - solving the bottleneck problem and scalability issues

Questions ?

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