Signalling Cost Analysis of SINEMO: End-to-End Network Mobility

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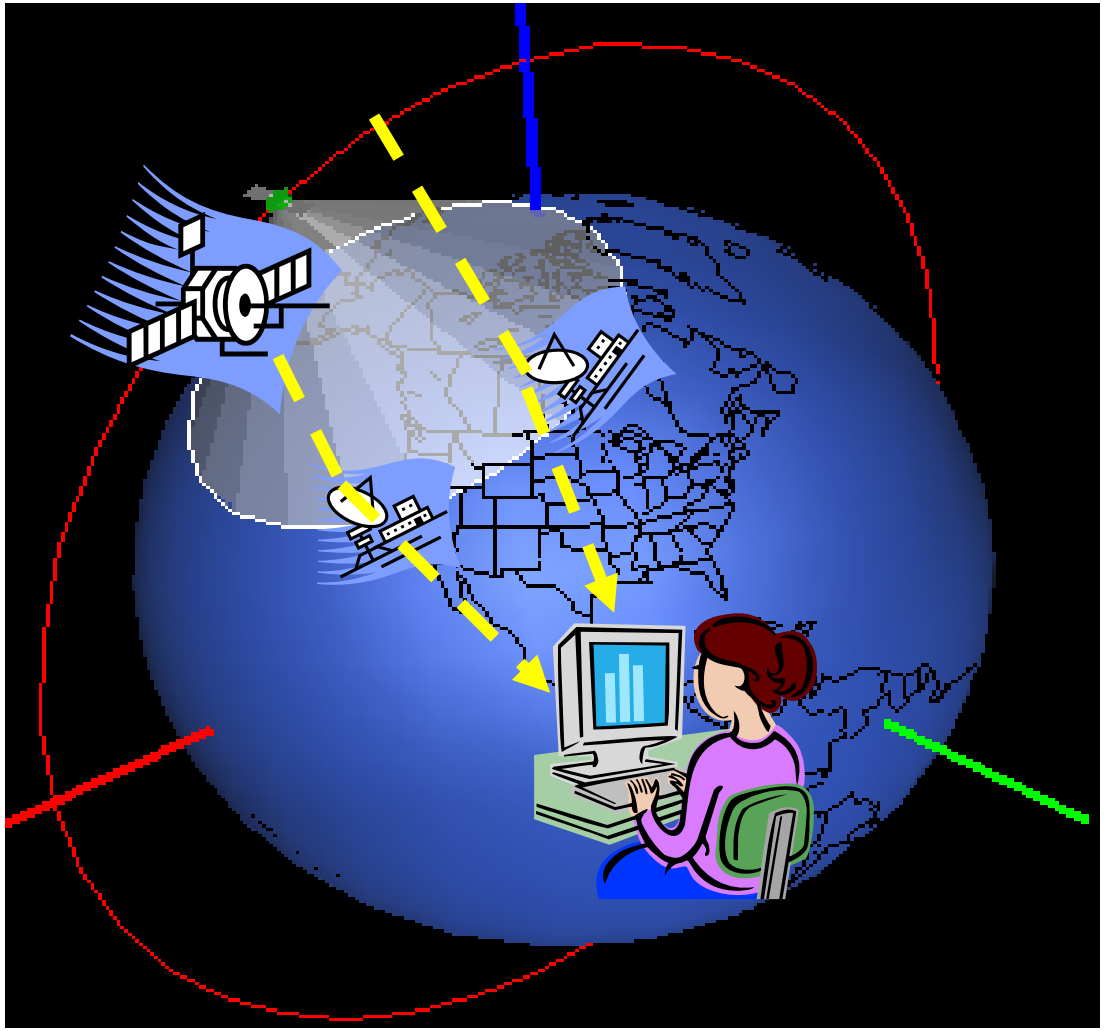
Network Layer handover: Satellite as a mobile host

- Satellite onboard equipments act as the endpoint of the communication.
- Ground stations are allocated with different IP prefix.
- Satellite need to maintain continuous connection with remote computer.



SIGMA: Basic concepts

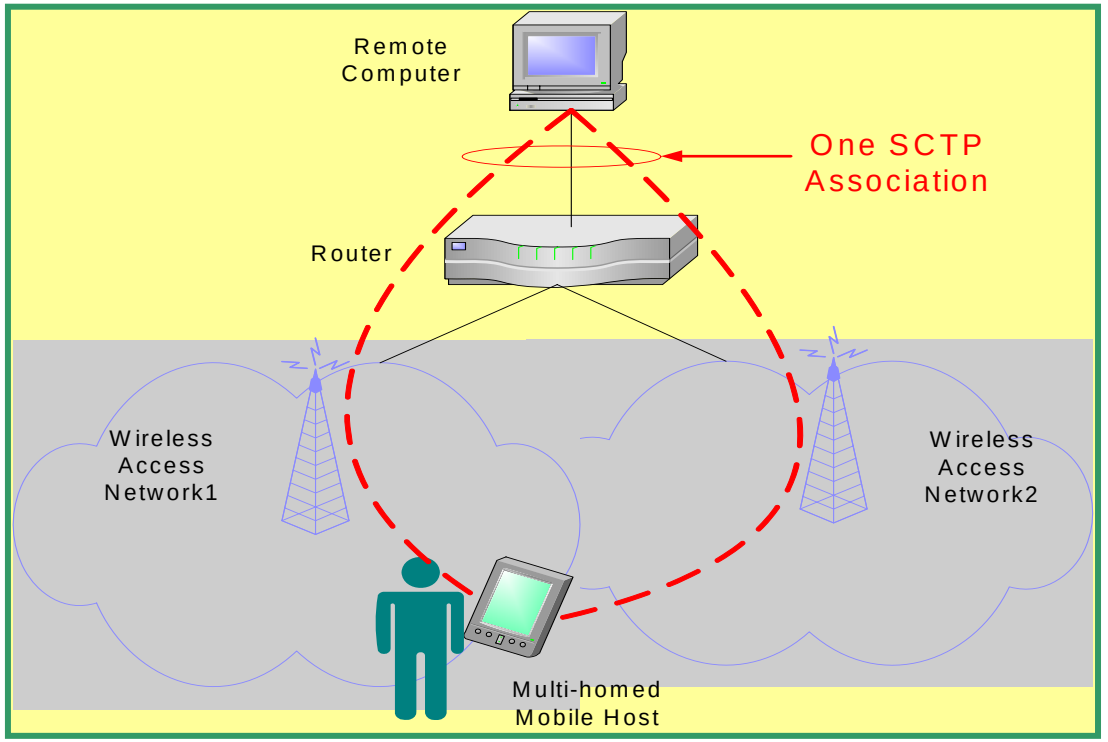
- Decouple location management from handoff
- Location management and handoff in parallel to data transmission
- Allow the layer whose performance is to be optimized to take responsibility of the handoff
- Implementation:
  - Multihoming to achieve simultaneous communication with multiple access points.

SIGMA: Seamless IP-diversity based mobility architecture.

Decouple location management from handoff and
IP-diversity for seamless handoff

SIGMA: Basic concepts (2)

- Mobile IP assumes the upper layer protocol use only one IP address to identify a logical connection. Some buffering or re-routing should be done at the router for seamless handover.
- SIGMA supports multiple IP addresses at transport layer naturally via multi-homing feature. When mobile host moving between cells, it can setup a new path to communicate with the remote computer while still maintaining the old path.



Advantages of SIGMA:

- Reduced packet loss and handover latency
- Increased throughput
- No special requirement on Router and Access networks.

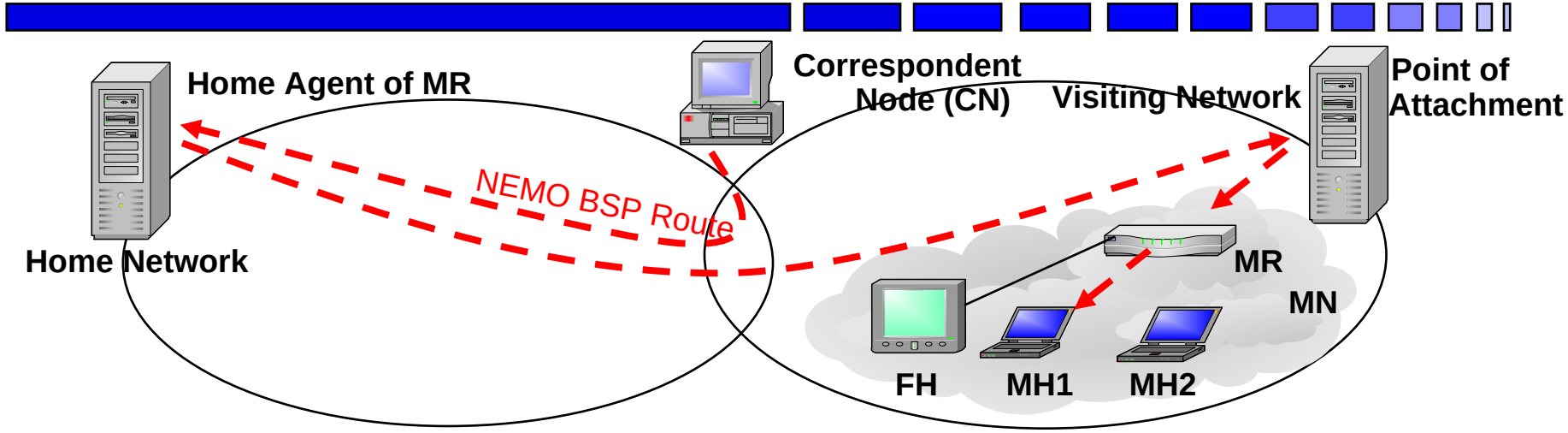
NEtwork MObility

- Mobility of a Host – Mobile IP (IETF standard), SIGMA.
- New Trend – Mobile Network (MN).
- NEtwork MObility (NEMO) – a collection of Internet nodes moving as a unit.
- IETF has developed NEMO Basic Support Protocol (BSP).
- Here, we propose a new NEMO protocol named SINEMO.

Network Mobility Protocol Design Characteristics

- Nodes inside the mobile network should not be aware of mobility.
- Minimum signaling over the wireless links.
- Low handover latency and packet loss during handover between subnets.
- Deployment should not be complex.
- Suitable for space networks.

NEMO BSP Architecture



- Double tunnel setup:
  - One between Home Agent and Point of Attachment (PA) in the visiting network
  - The other between MR and PA
- Inefficient routing path.
- Extra overheads in data packets due to encapsulation.
- High handover latency and packet loss rate.
- Needs modification in Internet infrastructure.
- Creates scalability issues.

Motivation of SIGMA

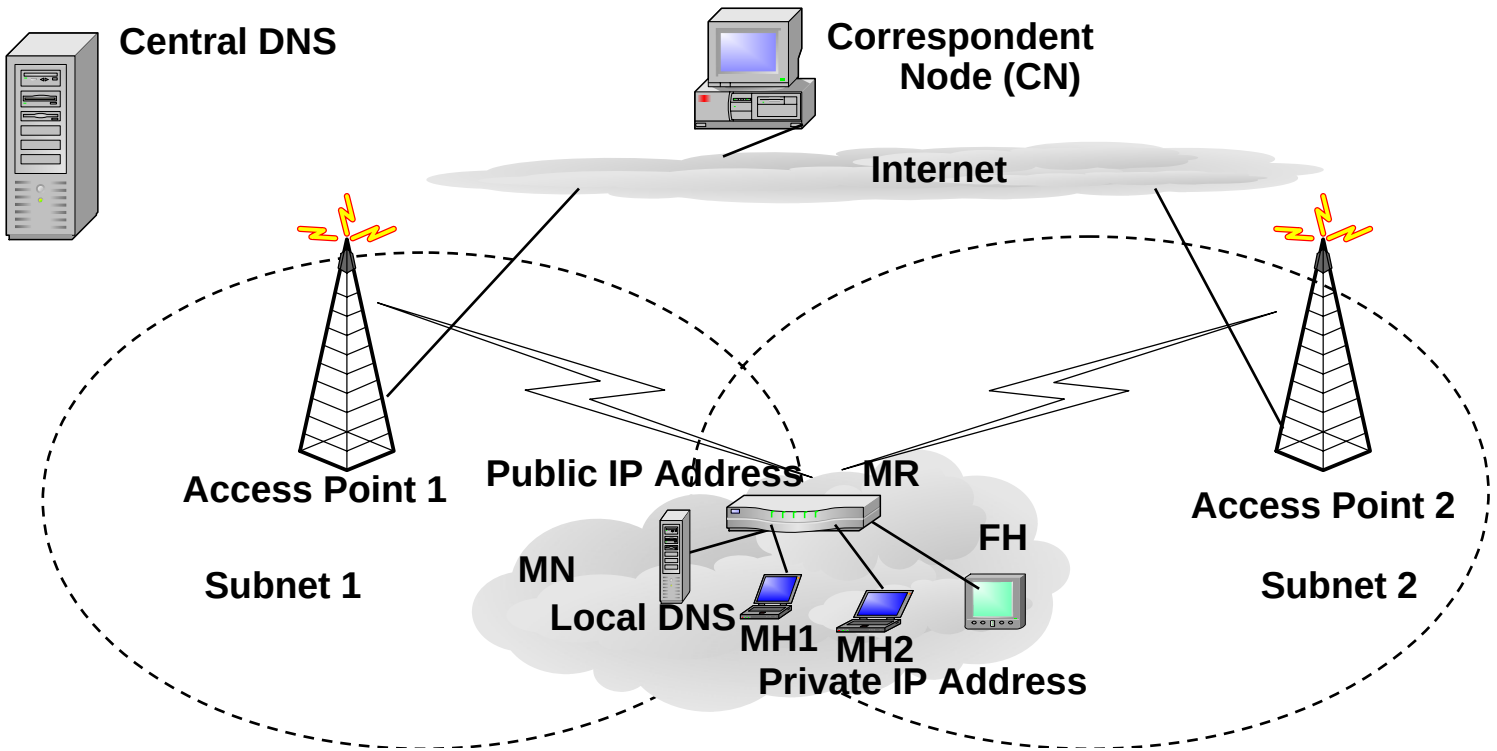
- Real-time traffic requires low-latency, low-loss rate mobility protocol support.
- Various *diversity* techniques used extensively at physical layer of wireless networks
  - space (or antenna) diversity, polarization diversity, frequency diversity, time diversity, and code diversity.
- Many mobile hosts equipped with multiple interfaces - enabled by the improvements in wireless networking device.
  - Development of Software Radio technology will eventually integrate all interfaces into one card.
- Advances in transport layer protocols:
  - built-in support for multihoming by Stream Controlled Transmission Protocol (SCTP).

- **A new kind of diversity is possible: *IP diversity*.**

SINEMO

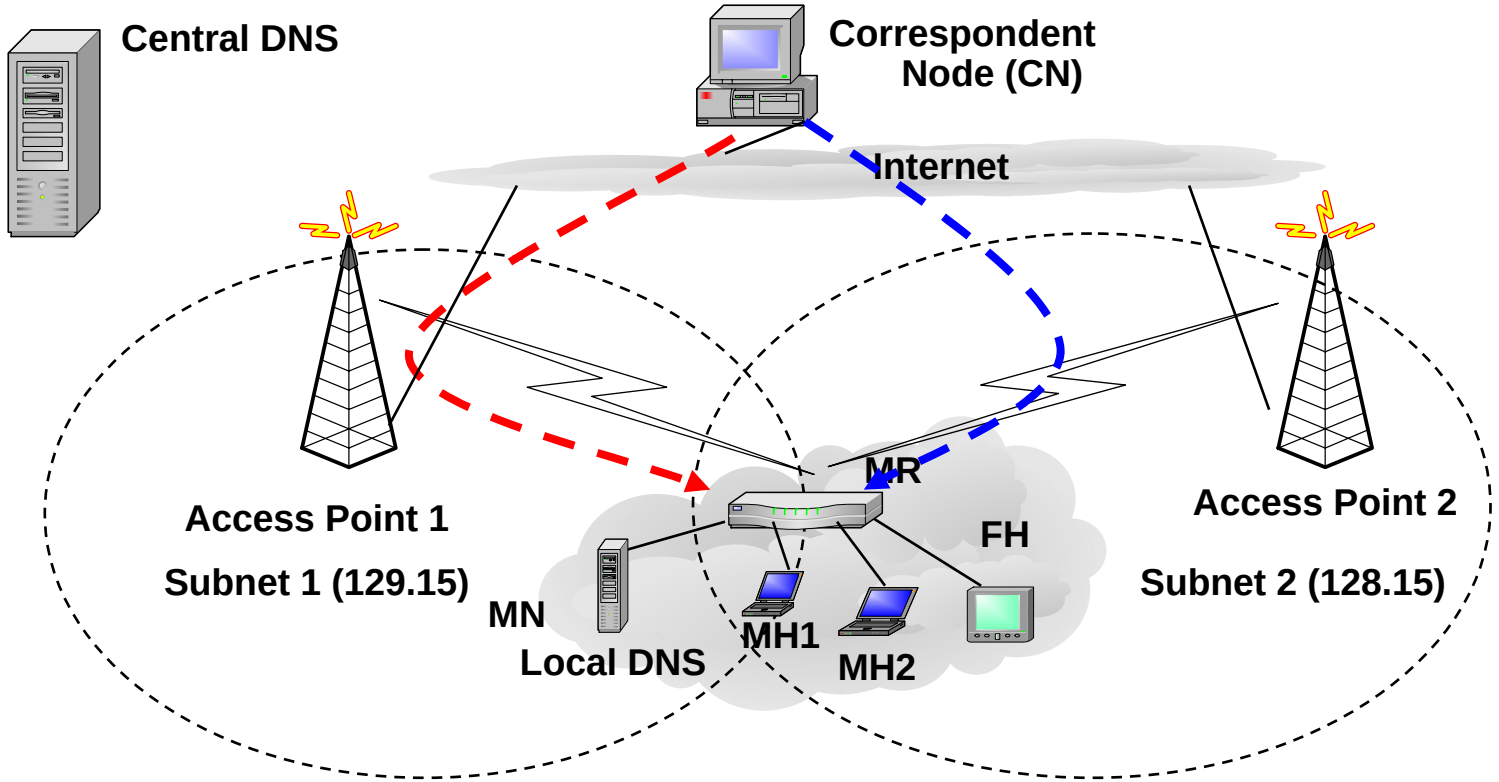
- Seamless IP-diversity based NEtwork MObility.
- Uses IP-diversity to hand over between subnets.
- IP-diversity refers to having multiple IP addresses in a single host.
- SINEMO is an extension of SIGMA (Seamless IP-diversity based Generalized Mobility Architecture).
- Underlying transport protocol has to support IP diversity.

SINEMO Architecture



- MR acts a gateway, acquires IP prefix from the access points.
- Each host inside the MN has both public and private IP addresses. MR keeps a mapping between public and private IPs.
- Network Address Translation (NAT) at MR.
- Hierarchical Location Manager is used.

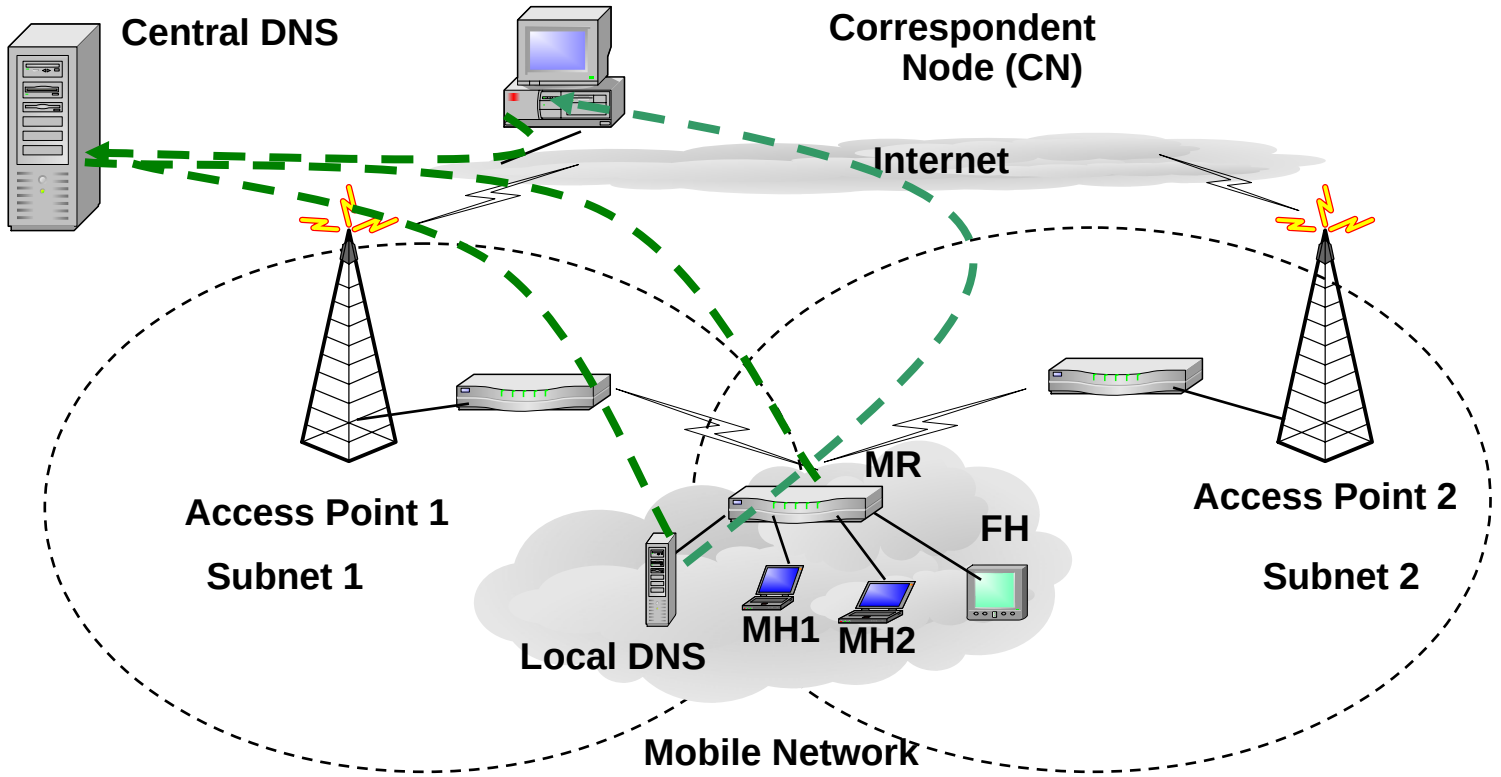
SINEMO Data Path



In Subnet 1		
Private IP	Public IP	Public Port
192.168.A	129.15.A	5000
192.168.B	129.15.B	6000

In Subnet 2 (after subnet change)		
Private IP	Public IP	Public Port
192.168.A	128.15.A	5000
192.168.B	128.15.B	6000

SINEMO Location Management

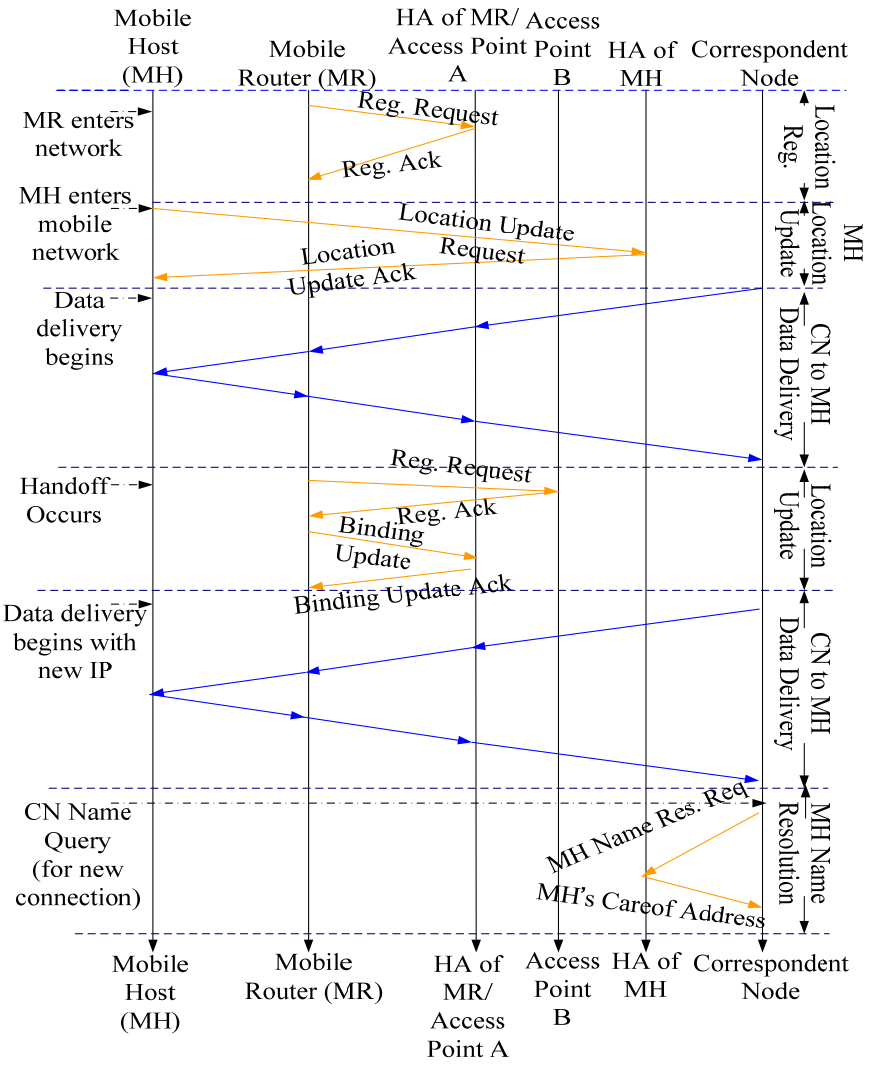


- MR only updates the Central DNS when subnet is changed.
- CN queries Central DNS to get the IP address of MH.
- Central DNS redirects the query to Local DNS and local DNS replies with the IP address of MH.

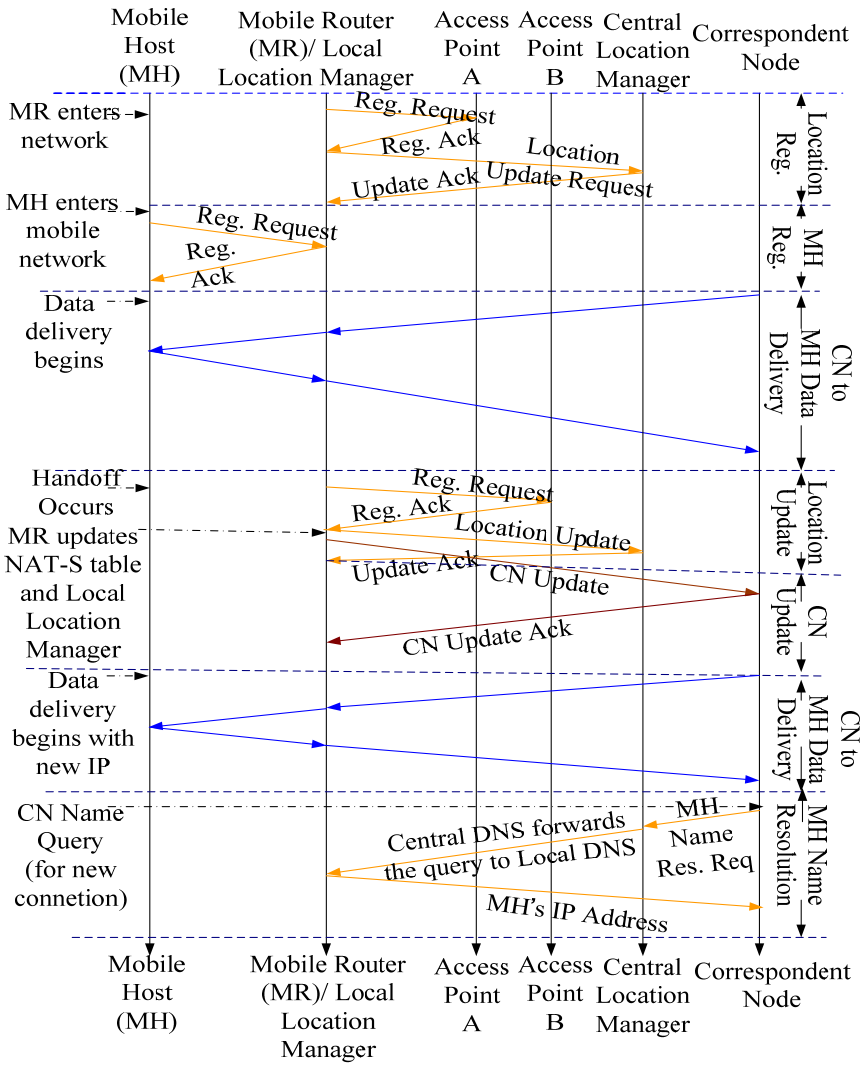
Comparison between NEMO BSP and SINEMO

Features	NEMO BSP	SINEMO
Signaling	Low	Slightly higher than NEMO BSP
Routing	Not very efficient	Efficient
Handover Packet Loss	Higher	Lower
Deployment	Needs modification in Internet Infrastructure	Less modification is needed
Space Network Suitability	Suitable	Suitable

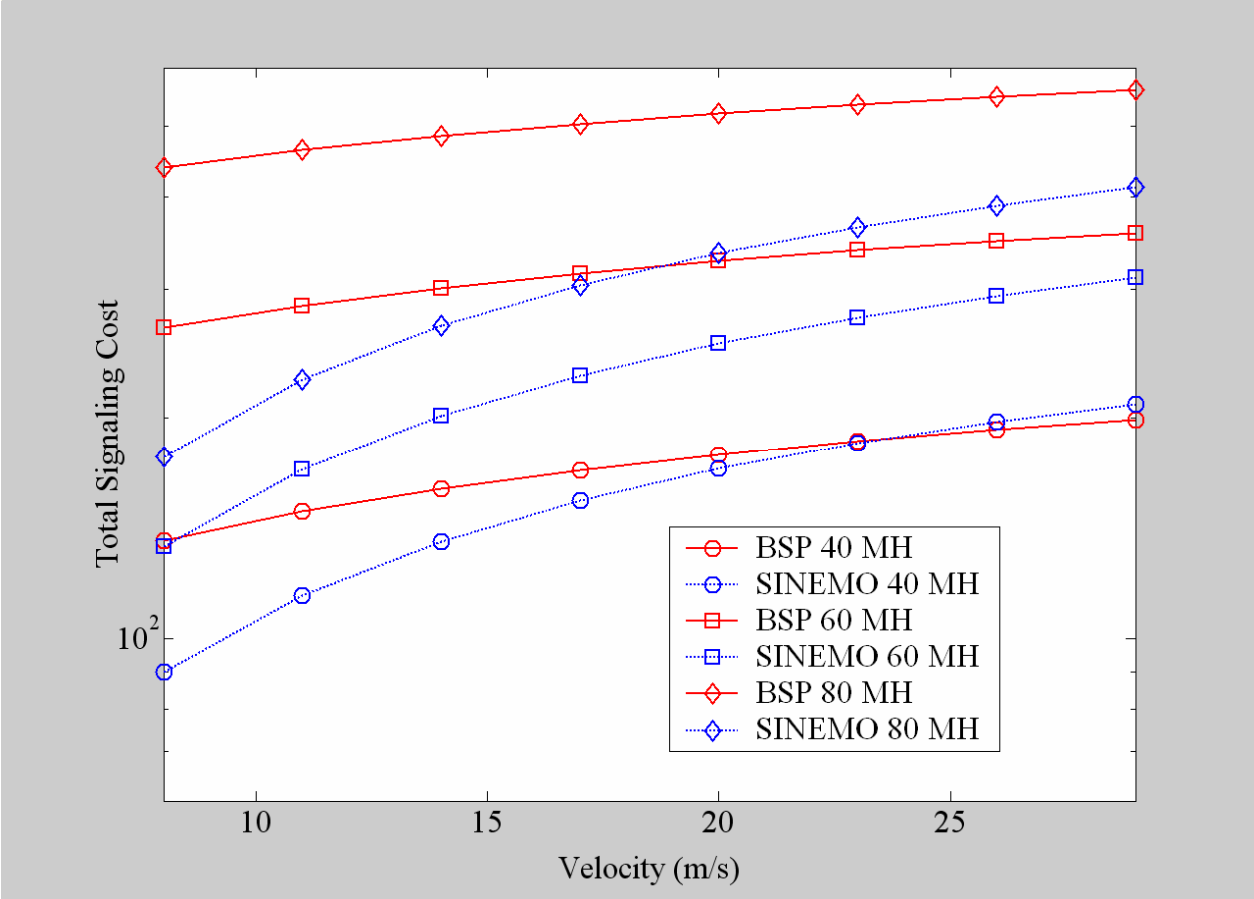
Signaling of NEMO BSP



Signaling of SINEMO



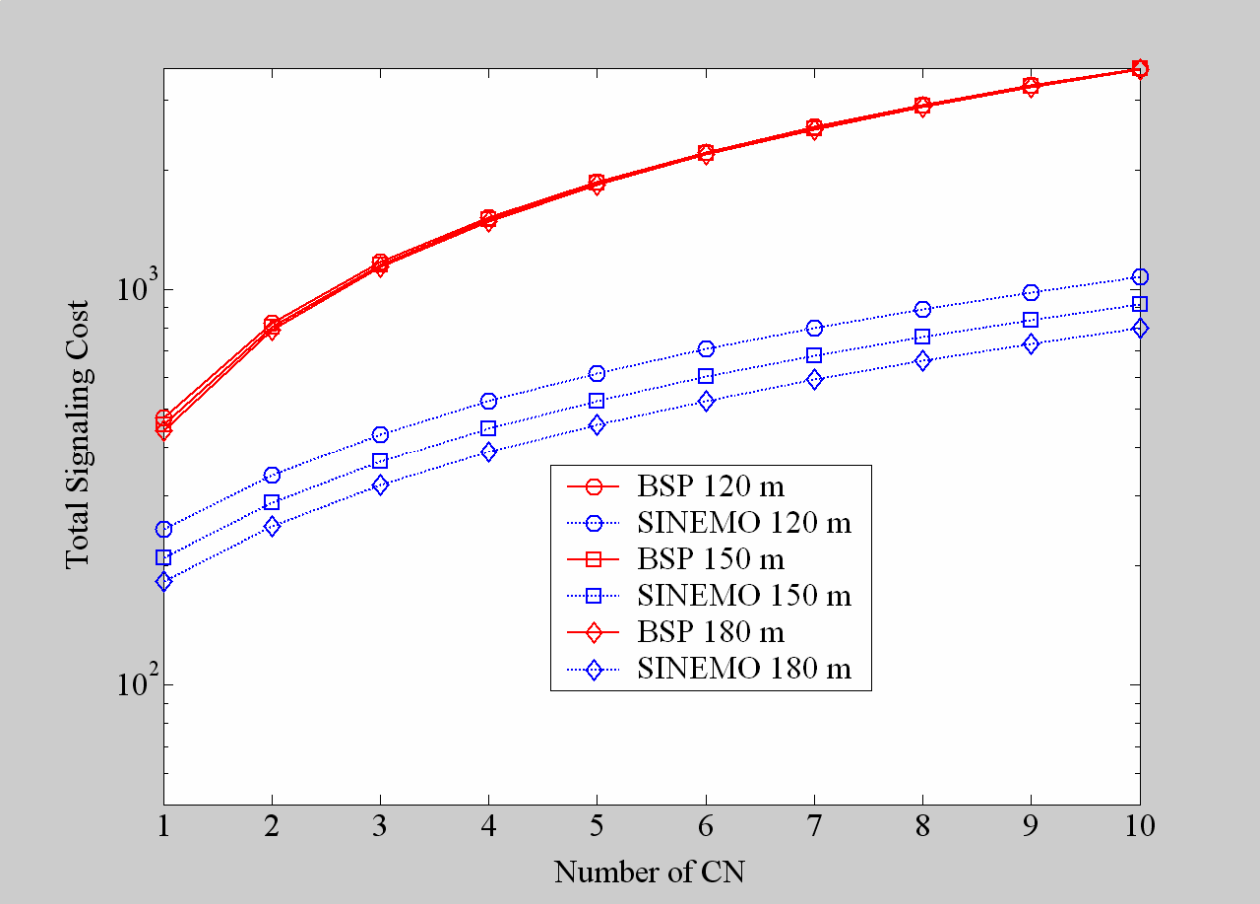
Results



Signaling cost vs. MR velocity for number of MH.

Signaling cost increases with velocity because higher velocity results in lower residence time and thus frequent handoffs

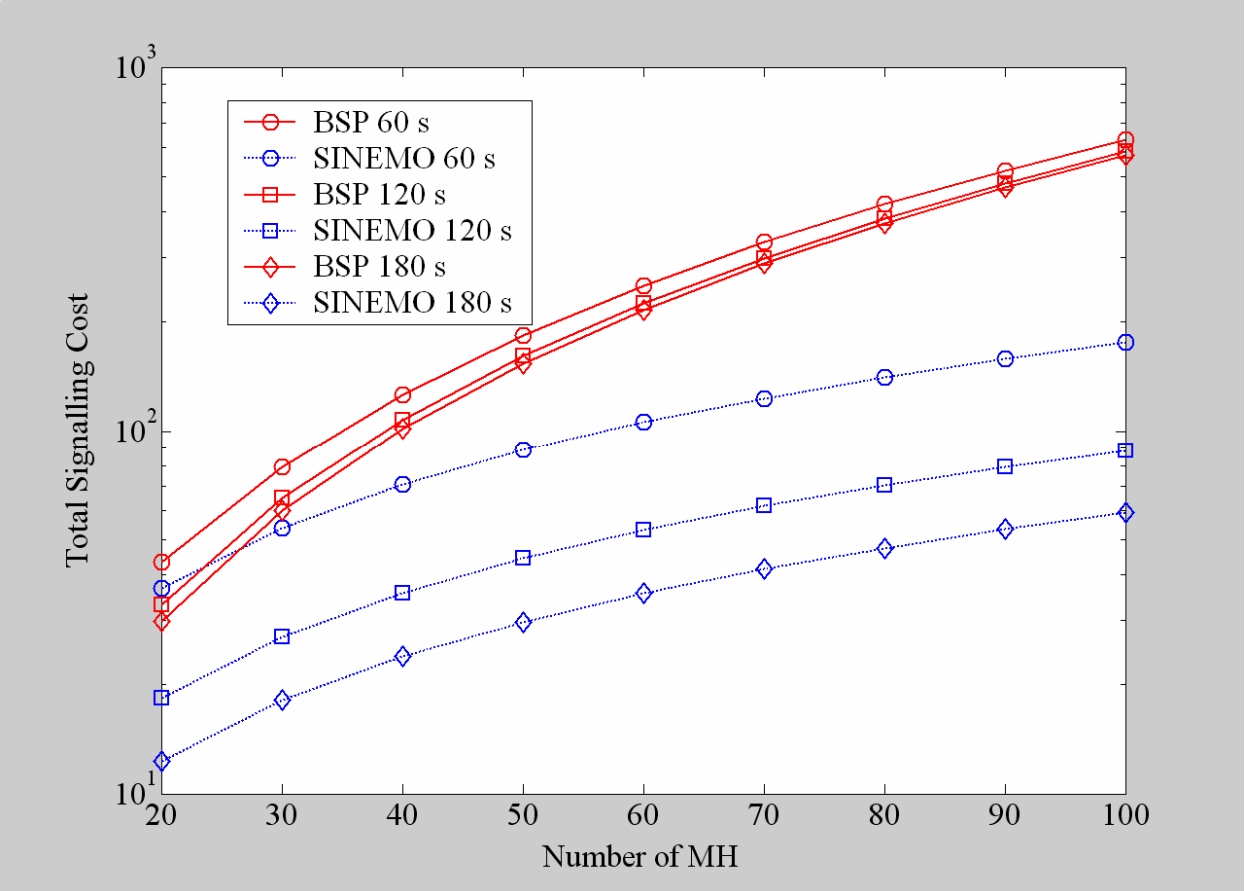
Results



Signaling cost vs. number of CN for different epoch lengths.

Longer epoch time means higher residence time and thus less frequent handoffs and fewer signaling messages

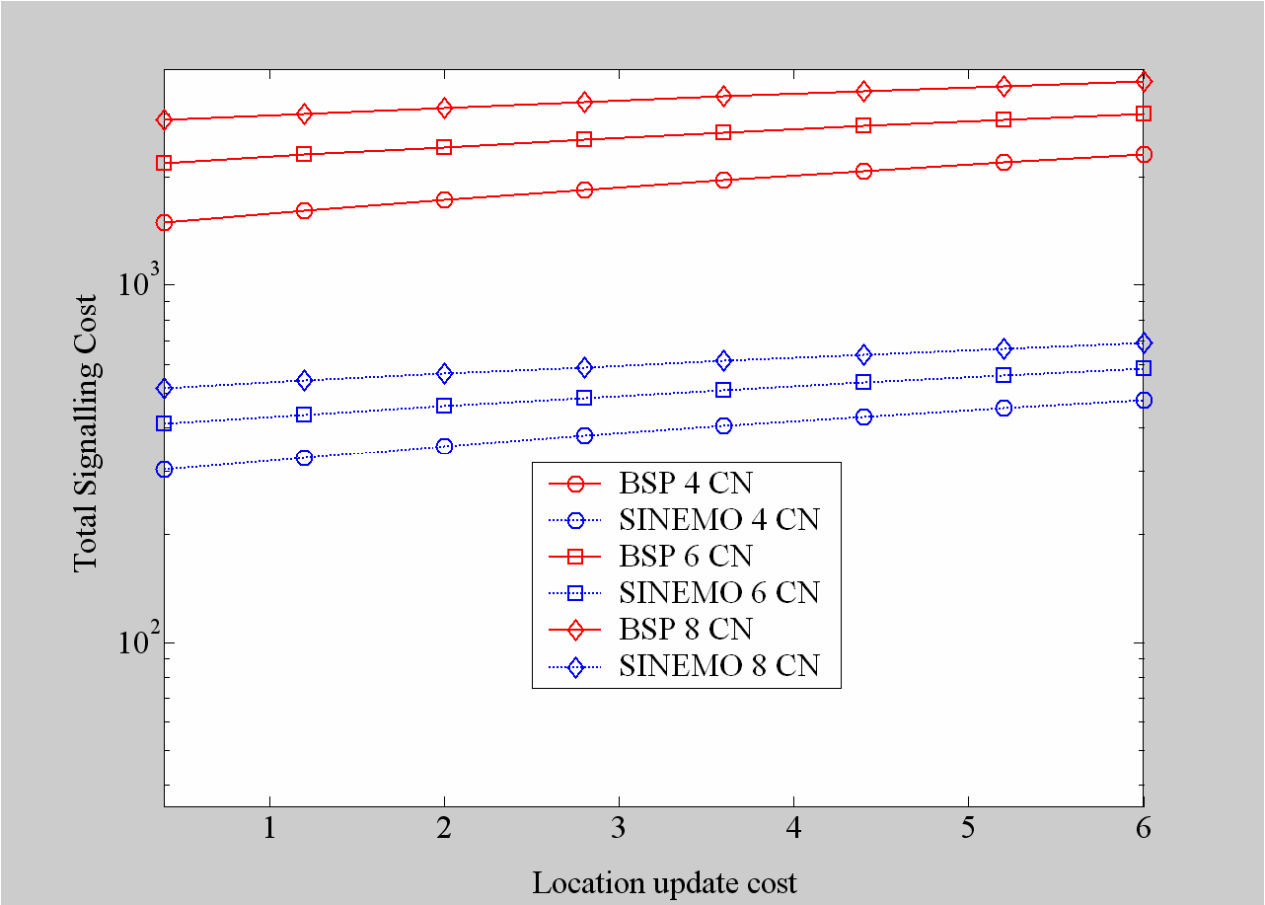
Results



Signaling cost vs. number of MH for different residence time.

Signaling cost of SINEMO is lower than BSP due to the fact that the LLM update does not incur any data transmission cost

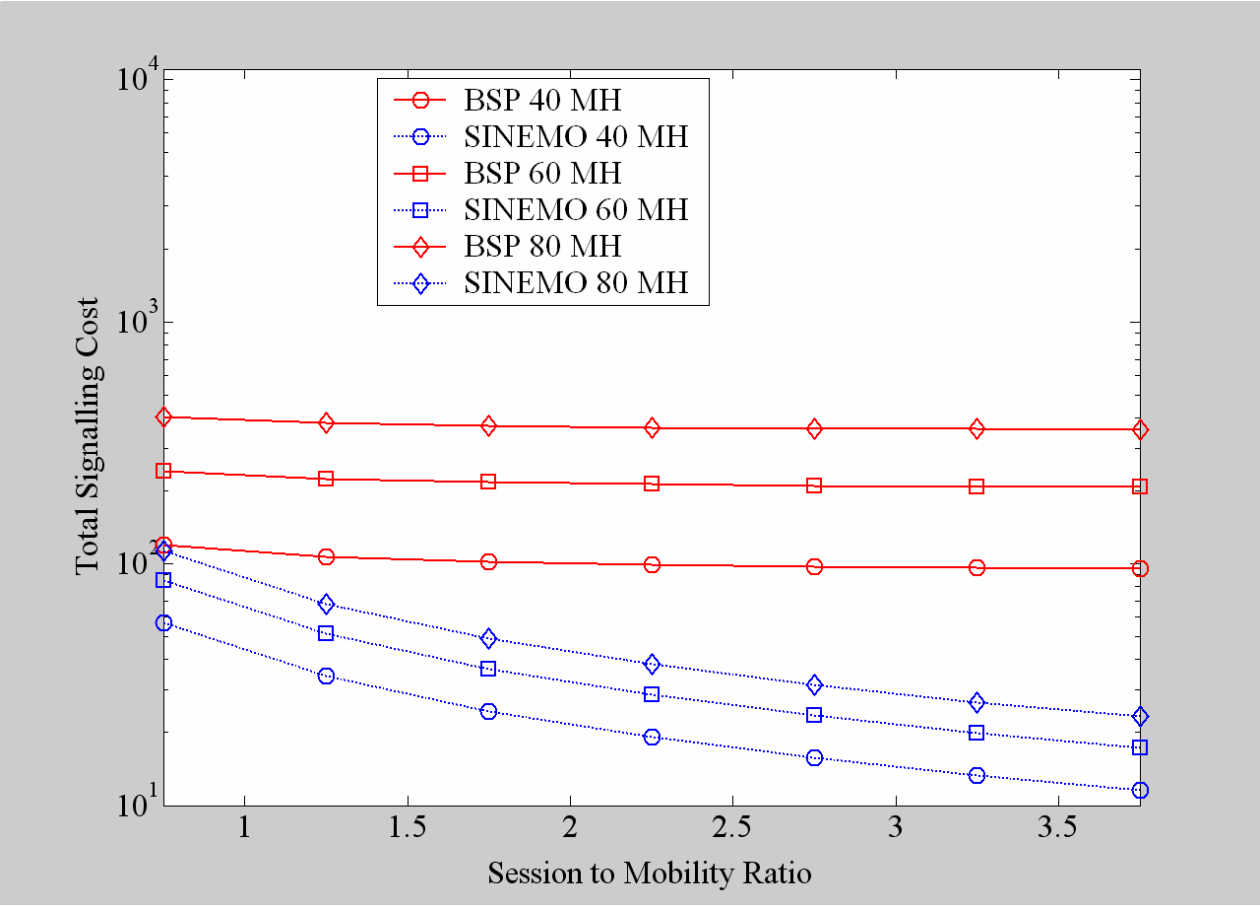
Results



Signaling cost of SINEMO is lower than BSP because SINEMO does not update the CLM for MR handoffs

Signaling cost vs. number location update cost for different CN.

Results



Higher value for *SMR* indicates low mobility, thus fewer number of updates and lower signaling cost

Signaling cost vs. session to mobility ratio for different number of MH

Conclusion

- NEMO BSP → Lot of signaling for nested mobility
- SINEMO → IP diversity based end to end mobility management with local location management
- SINEMO avoids packet encapsulation and uses optimal route
- Signaling cost of SINEMO is lower than NEMO BSP

Acknowledgements

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