Performance of DNS as Location Manager

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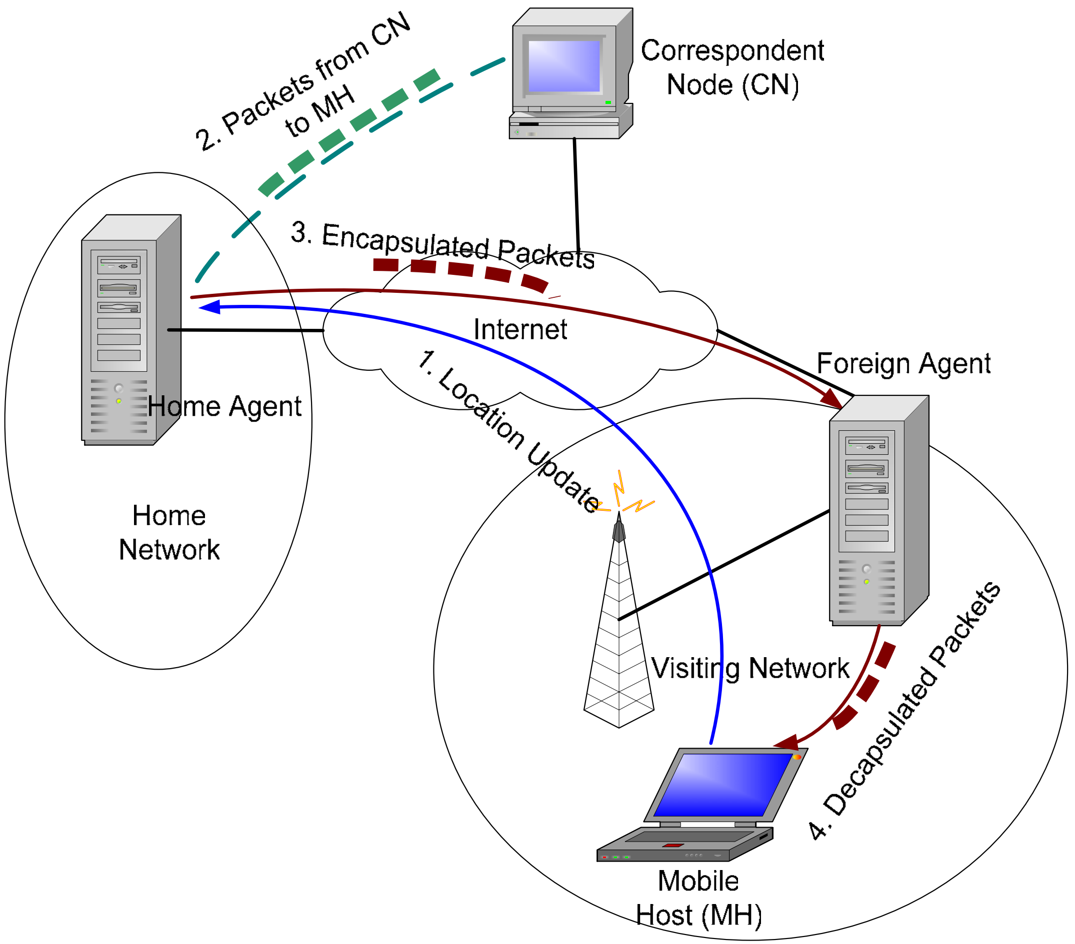
- In current Internet, IP addresses have duplex roles:
  - Identifying the end points in transport layer connections
  - Routing IP packets.
  - In wired networks, these two roles do not contradict.
- In Mobile Networks, we got a problem:
  - Internet enforces a hierarchical address structure. To maintain routing scalability of the Internet, mobile hosts (MH) have to change their IP addresses after change the point of attachment.
  - Popular transport layer protocols, like TCP, require the connection identifier unchanged during data transmission.

- Mobile IP employs a pointer mechanism similar to the one used by the postal system.
- MH registers its location with HA after every subnet change.
- Packets from CN to MH are encapsulated then decapsulated and delivered to MH.



Major Drawbacks of Base Mobile IP

- Need modification to Internet infrastructure.
- High handoff latency and packet loss rate.
- Inefficient routing path.
- Home Agent must reside in MH's home network
  - hard to duplicate HA to various locations to increase survivability and manageability.
- All data traffic for MHs in a particular network must go through one HA
  - creates scalability issues.

Research Efforts and Proposed Scheme

- Enhancements on Mobile IP:
  - Low latency Handover for MIPv4.
  - Hierarchical IP, HAWAII and Cellular IP.
  - Optimized Smooth Handoff.
  - Mobile IPv6
  - FMIPv6, HMIPv6, FHMIPv6.

- Transport Layer Mobility:
  - MSOCKS
  - TCP Connection Migration

Our proposed scheme: Seamless IP diversity based Generalized Mobility Architecture (SIGMA)

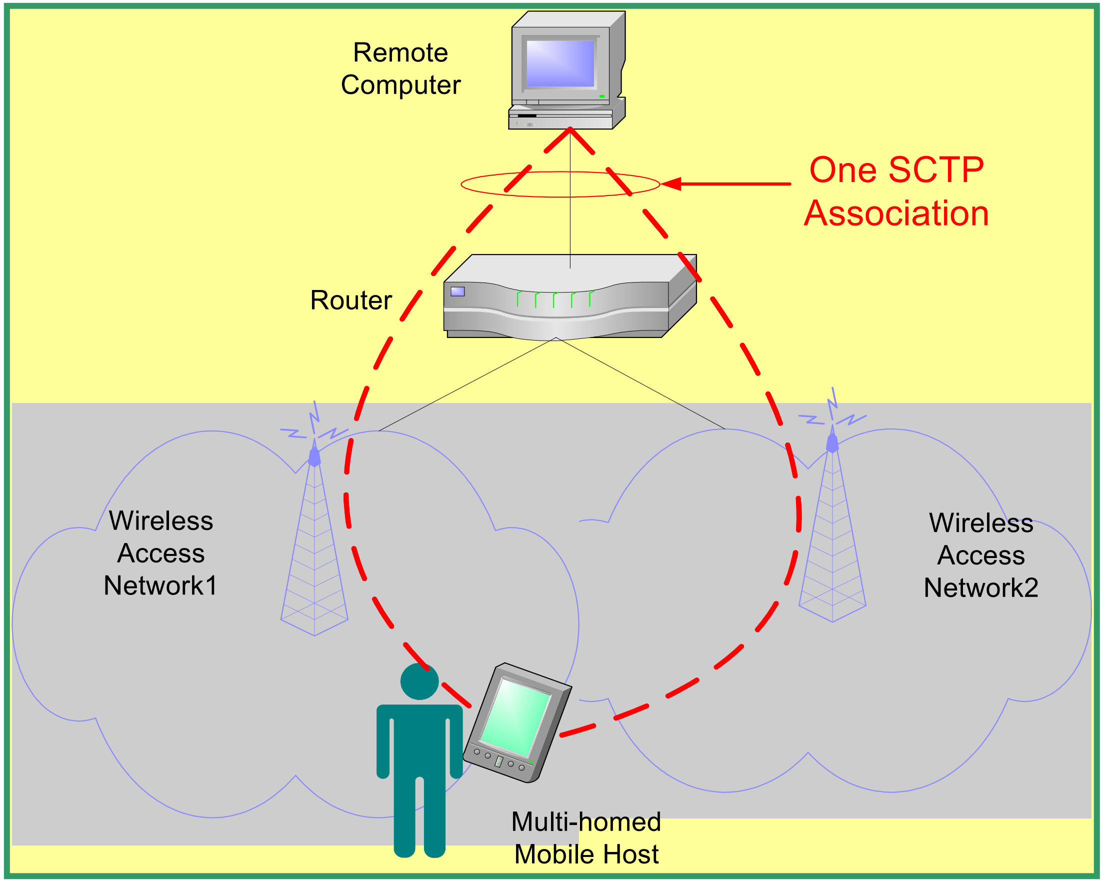
Problem Statement

- Mobility
  - Handoff: change of IP address with change of subnet
  - Location Management: identification of the mobile host (MH) with continuously changing IP addresses
- DNS as Location Manager (LM)
  - DNS - almost ubiquitous connection originator
  - Can provide IP address
  - Can be deployed without any change in infrastructure
- DNS query fails when location manager provides obsolete IP address.
  - The fraction of time LM gives correct location is the success rate
- Identifying the query failure probability determines performance of DNS as LM.

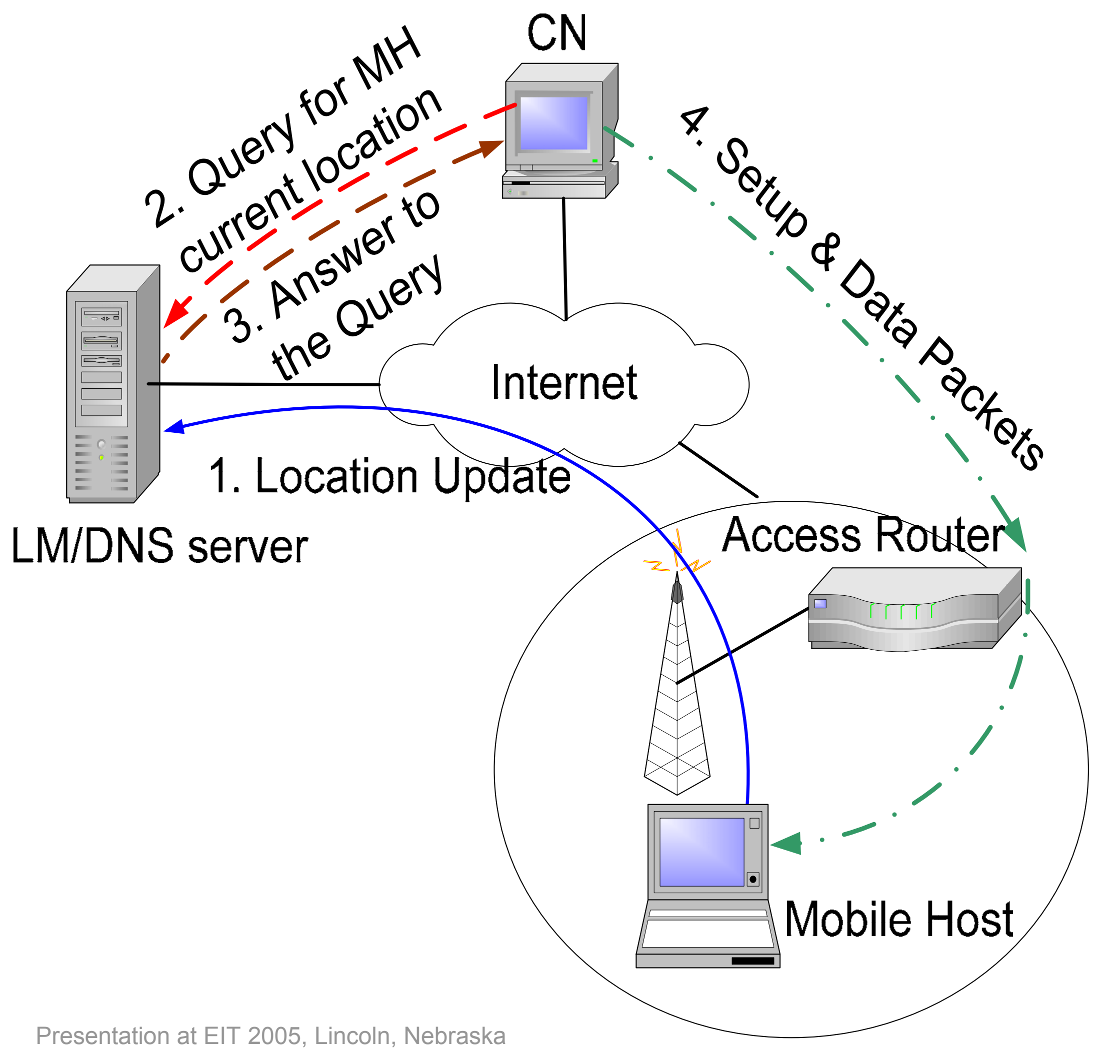
Basic idea: setup a new path to communicate with CN while maintaining the old path.

Handover process:

- STEP 1: Layer 2 handover and obtain new IP address
- STEP 2: Add IP addresses into the association
- STEP 3: Redirect data packets to new IP address
- STEP 4: Update location manager (LM)
- STEP 5: Delete or deactivate obsolete IP address



Advantages:
- Transparency to existing network applications.
- Decoupling of location management from data forwarding functions.
- Significant reduction in system complexity and operating cost.
- Enhanced system survivability and manageability.



- **Objective**
  - Analyze performance of DNS as a LM. Determining factors:
    - overlapping distance between subnets
    - network latency
    - subnet radius
    - residence time

- **Contribution**
  - Analytical model for performance of DNS as LM
  - Identify the impact of the following on query failure
    - subnet radius
    - MH velocity
    - network delay.

Location Manager (LM)

- For data network, location is synonymous to IP Address
- The entity of the network that provides location of an MH is the location manager
- MH continuously changes its location (IP address), so each time LM has to update itself

Location Queries

- Location Update
  - updating the LM when MH acquires/releases an IP address
- Location Search
  - querying the LM for the current IP address of MH;
- Location Confirmation
  - updating and confirming the information of the MH at the CN

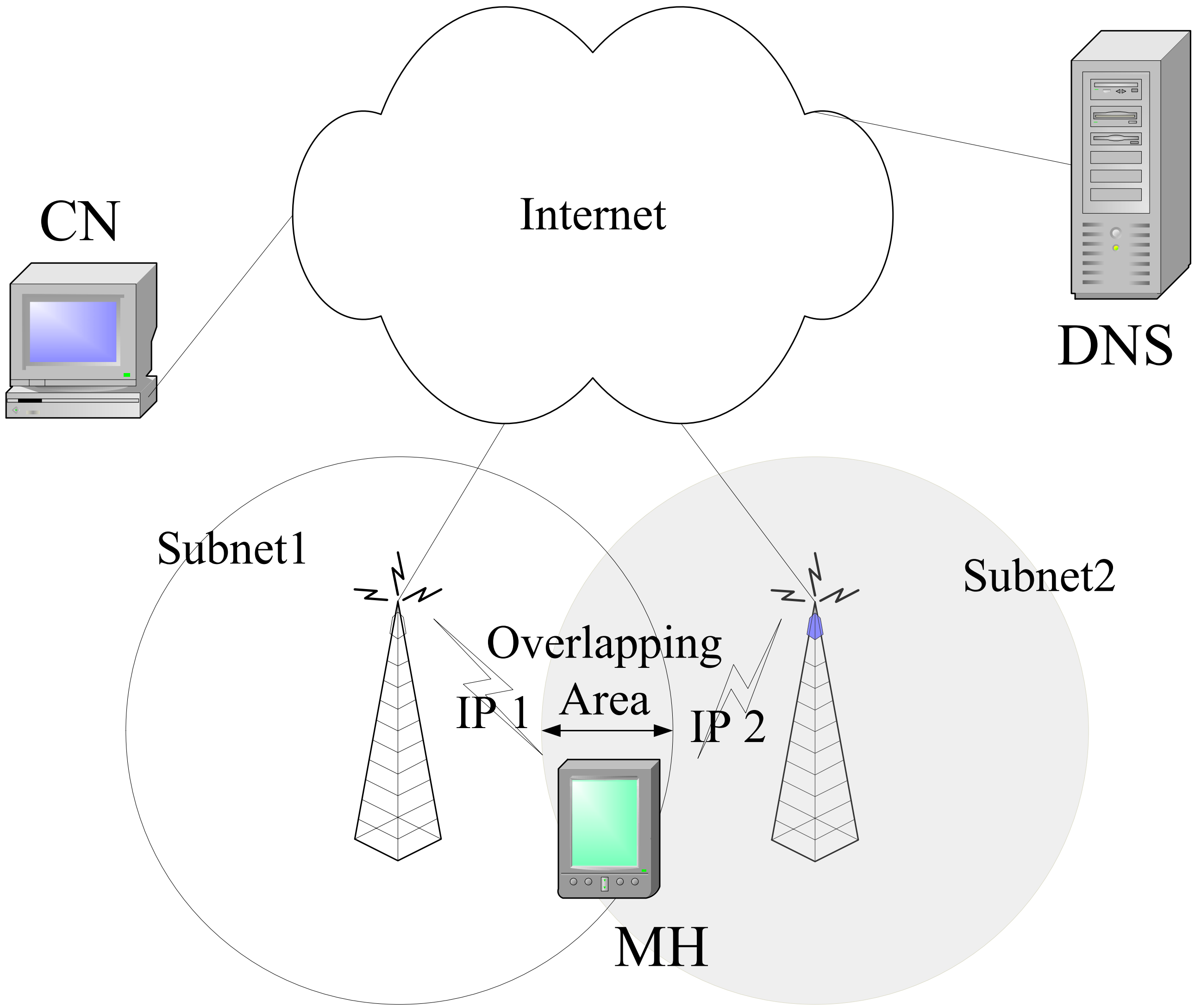
DNS

- Domain Names mapped to IP address
- Authoritative Name Server (ANS) has name-to-address mapping
- ISPs maintain Local Name Server (LNS)
  - caches Domain Name to IP Address mapping
- Duration of caching in LNS → defined by Time to Leave (TTL)

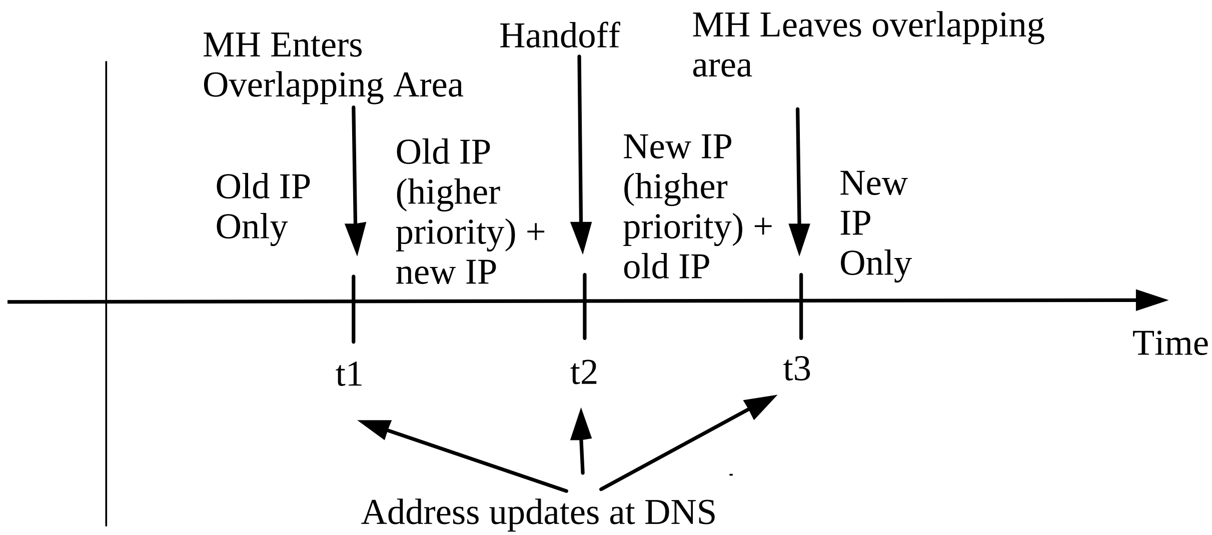
DNS as LM

- Domain names mapped to IP address for easier retrieval
- ANS is updated with new address when MH moves

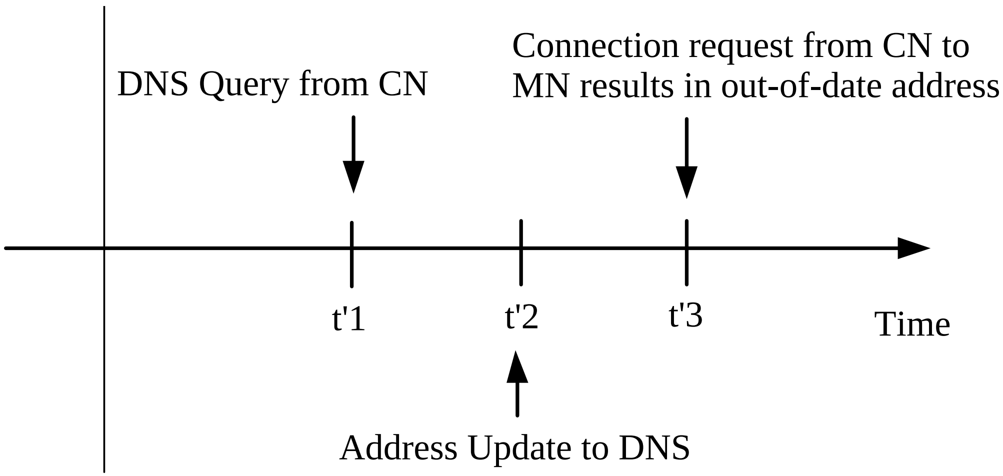
DNS as LM



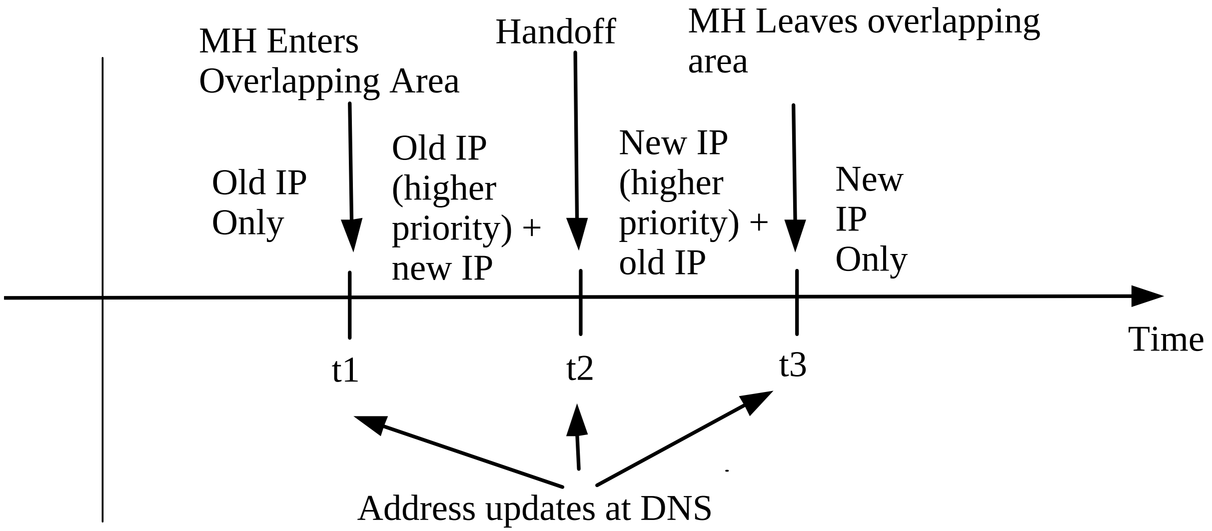
Internet
CN
DNS
Subnet1
Subnet2
Overlapping
Area
IP 1
IP 2
MH



- **DNS updates with SIGMA**
  - MH communicates with CN with old IP address, DNS has entry for that address
  - At time t1, MH enters the overlapping area, get new IP address, DNS has both the addresses with higher priority to old one
  - At time t2, relative signal strength of new subnet is stronger and hence handoff takes place, DNS has both the addresses with higher priority to new one
  - At time t3, MH moves into new subnet leaving the overlapping area, releases the old IP address, DNS has only the new address



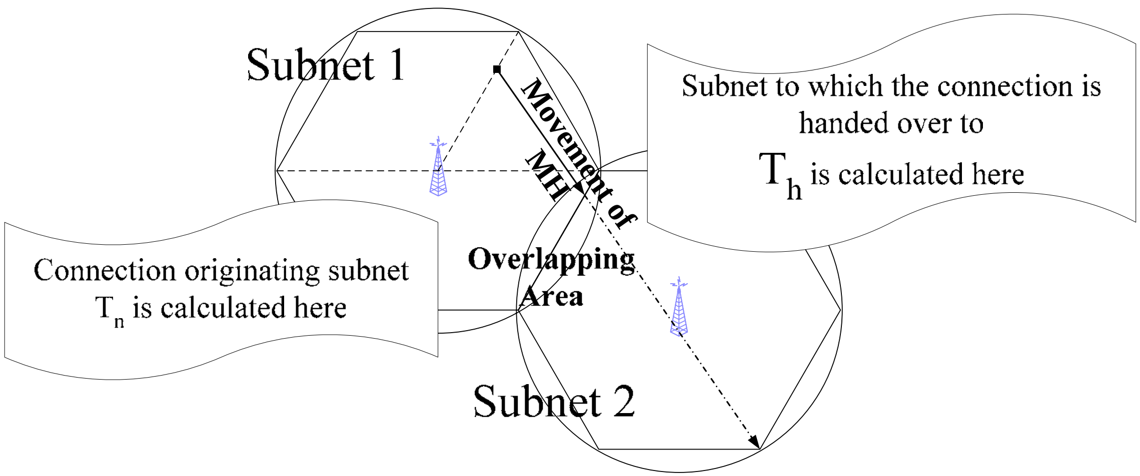
- Request Sequence
  - DNS query comes from Correspondent Node (CN) at time t'1
  - Handoff takes place and DNS is updated at time t'2
  - Connection request is made at time t'3 from CN with obsolete IP address retrieved at time t'1
  - LM has served an invalid address → query failure



Mitigating Query Failure

- Query failure
  - DNS query before t1 and connection request after t3
- No query failure in overlapping region
  - DNS serves both addresses
- Query failure depends on
  - network and DNS service delay,
  - overlapping area and ***subnet residence time***

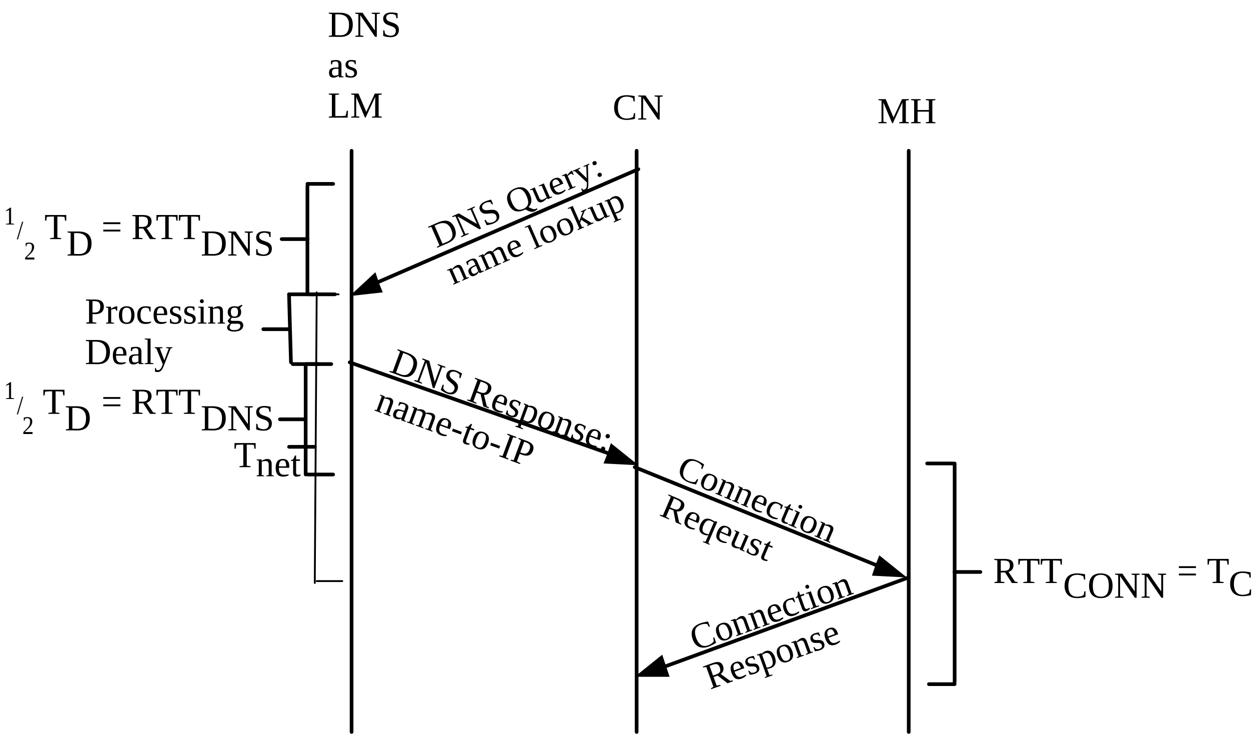
- Subnet Residence Time (time MH spends in a subnet)
  - Connection originating subnet
  - Handoff subnet



- Total Time = $E[T_n] + nE[T_h]$ where
  - $T_n =$ Residence time in connection originating subnet
  - $T_h =$ Residence time in Handoff subnet
  - n = number of handoffs

Network and Server Processing Dealy

- T_{net} = *time taken for a DNS response to go to CN*
  + time taken for a connection request to go to MH
  + time taken to process the name lookup



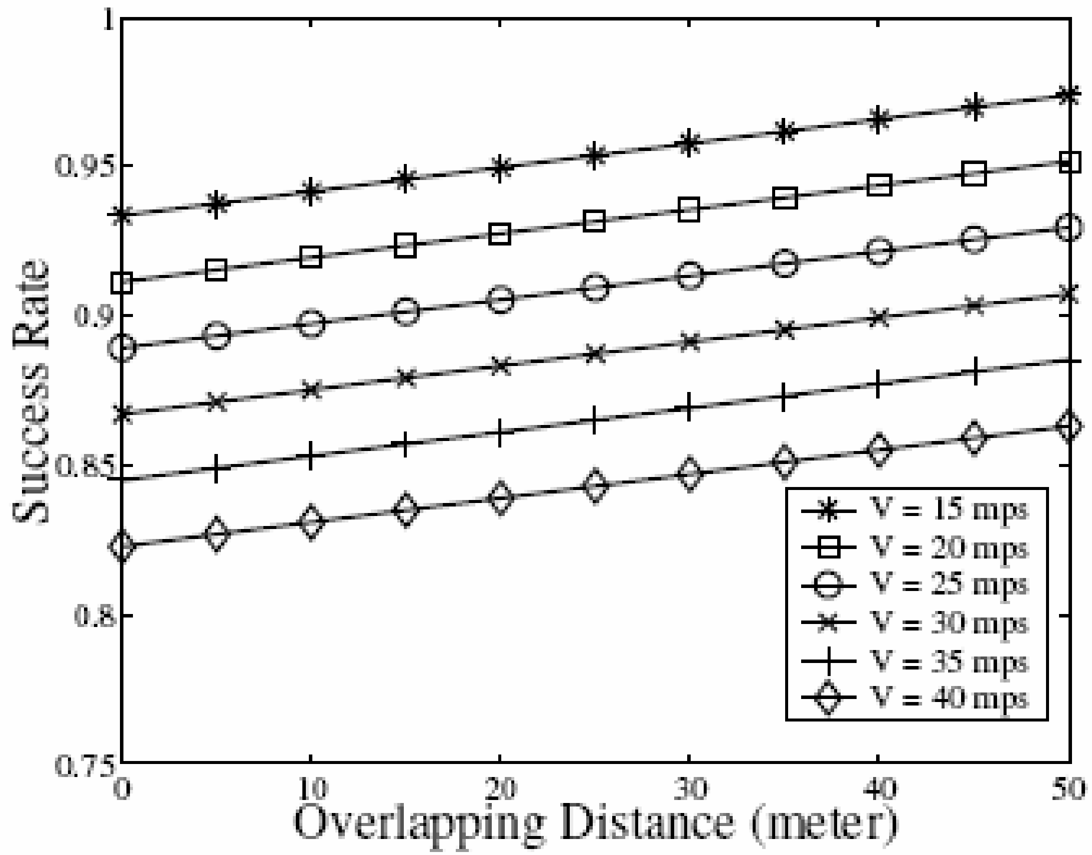
- Critical Time: when query failure might occur
  - Δt_{1+2} = t2 - t1 and Δt_{2+1} = t3 - t2
  - $\Delta t_{1+2} + \Delta t_{2+1}$ gives the residence time of MH in overlapping area and depends on overlapping distance and the velocity of MH
  - Query failure would occur if $T_{net} > (\Delta t_{1+2} + \Delta t_{2+1})$
  - *So critical time,* $T_{cr} = (T_{net} - (\Delta t_{1+2} + \Delta t_{2+1}))$

Success Rate

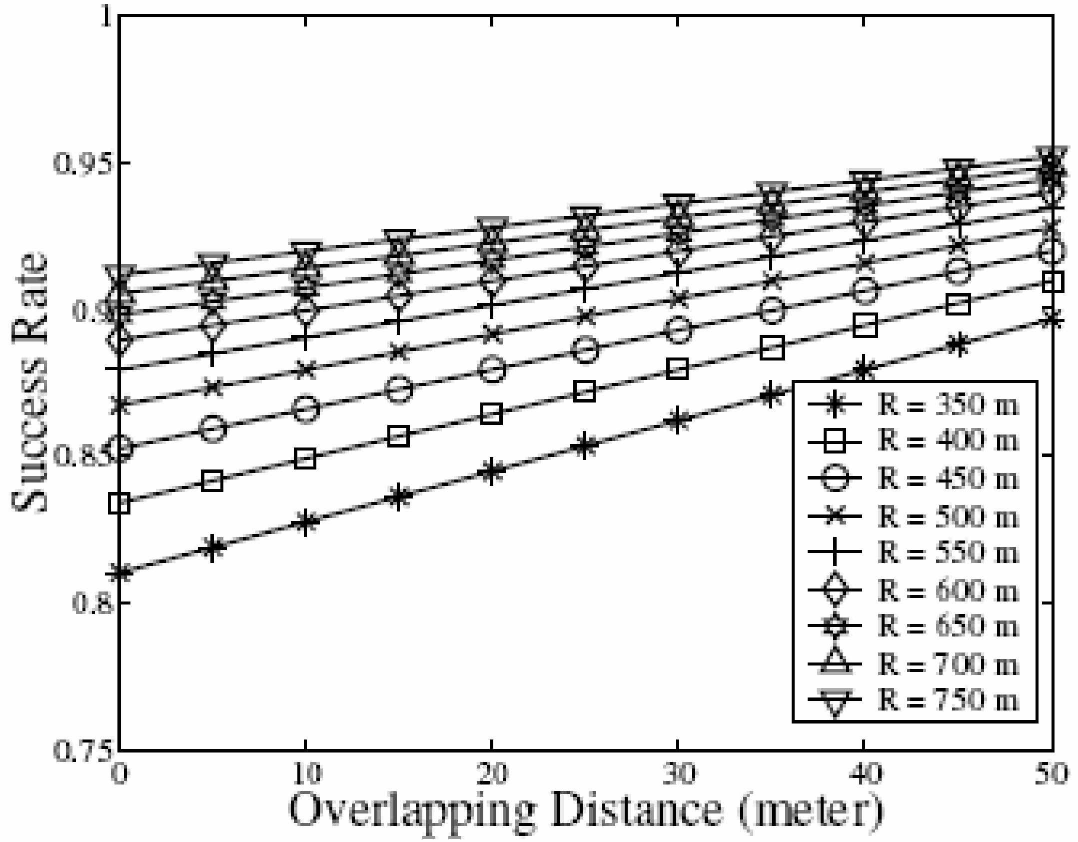
- Critical time is a fraction of total connection time
- This fraction determines the upper bound of failur
- Lower bound of success =

$$\frac{\text{connection time} - \text{critical time}}{\text{connection time}}$$

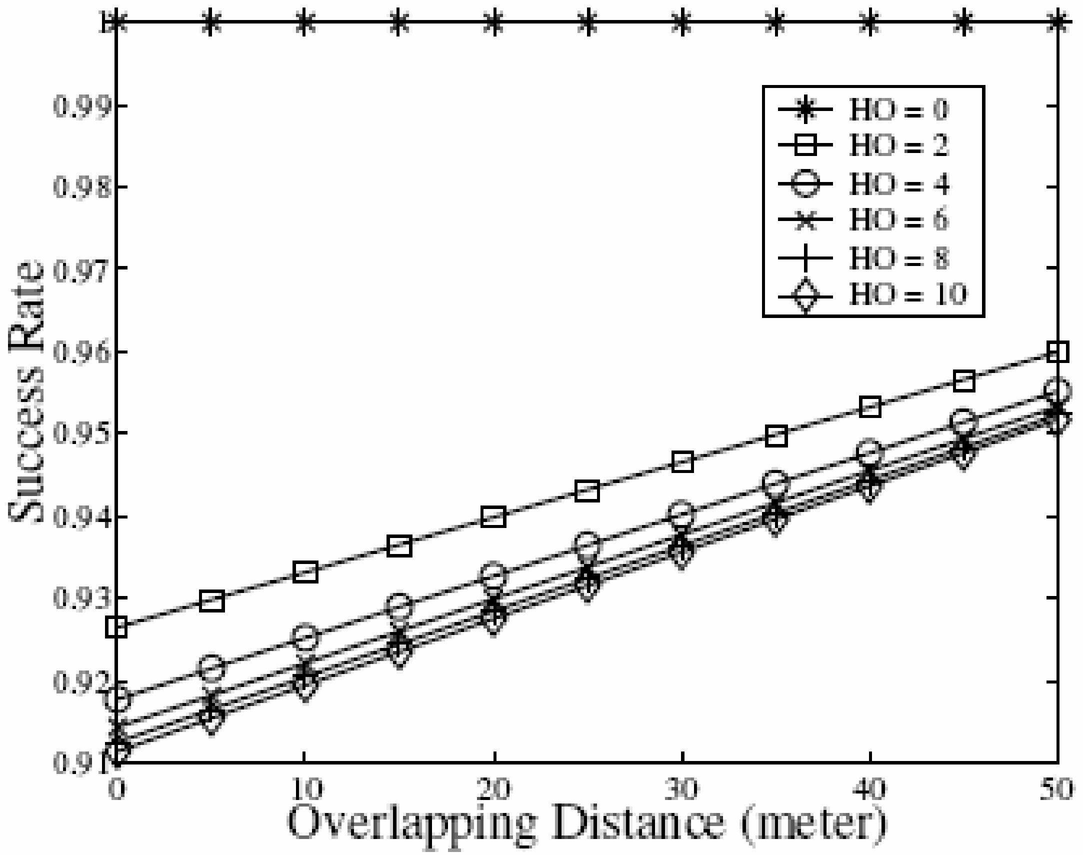
- Success rate against overlapping area for different MH velocity



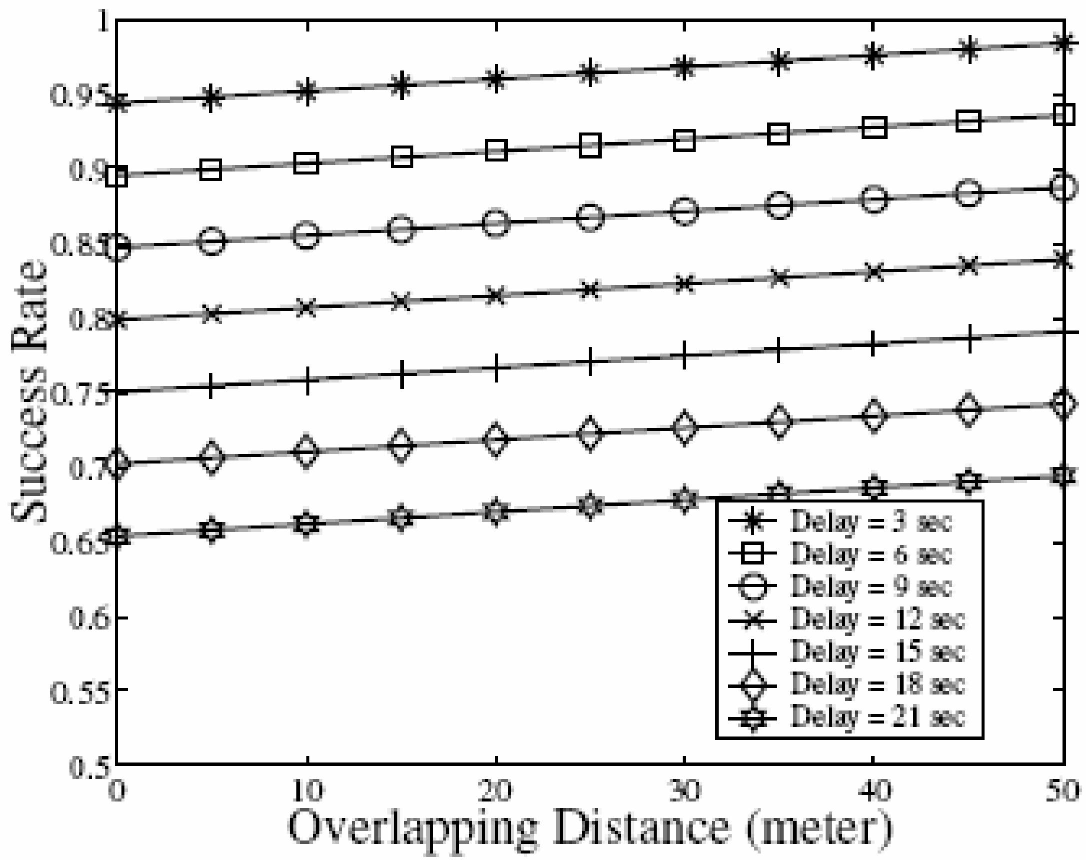
- Success rate against overlapping area for different subnet radius



- Success rate against overlapping area for different number of handoffs



- Success rate against overlapping area for different query processing time at server



Conclusion and Future Work

- Conclusions
  - Previous studies did not analyze the performance of DNS as a location manager in mobile data networks
  - We have developed an analytical model to study the performance of DNS as a location manager in terms of success rate, internet traffic load, velocity of MH and subnet radius
  - Results clearly show that DNS is a feasible solution for location management even under some tough network and mobility scenarios

- Future Works
  - Different mobility models might be used for the computations
  - Different traffic arrival pattern might be integrated

- National Aeronautics and Space Administration (NASA) for support of this project.

- More information:

http://www.cs.ou.edu/~netlab

Thank You