

Mobile IP Simulation

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Mobile IP – Features



- Support host mobility
- No geographical limitations
- No modifications to other routers and hosts
- No modifications to the current IP address and IP address format
- Supports security
- Operate seamlessly to end user

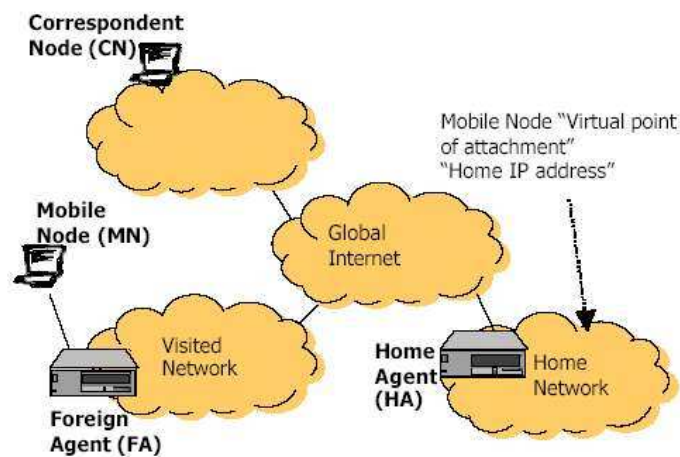


Mobile IP – Entities

- Mobile Node (MN)
- Home Agent (HA)
- Foreign Agent (FA)
- Correspondent Node (CN)
- Other terms:
 - Home address
 - Care-of-address
 - Binding list
 - Visitor list
 - Pending list

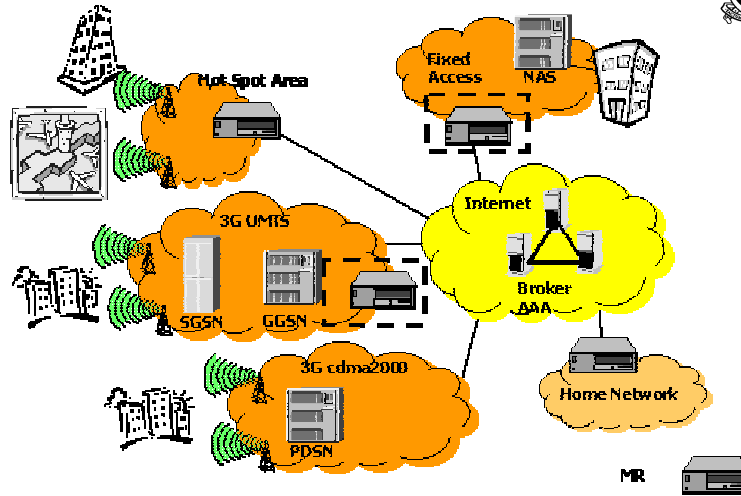


Mobile IP – Network structure



Source: <http://www.ipunplugged.com/pdf/MobileIPIntro.pdf>

Mobile IP – Network structure

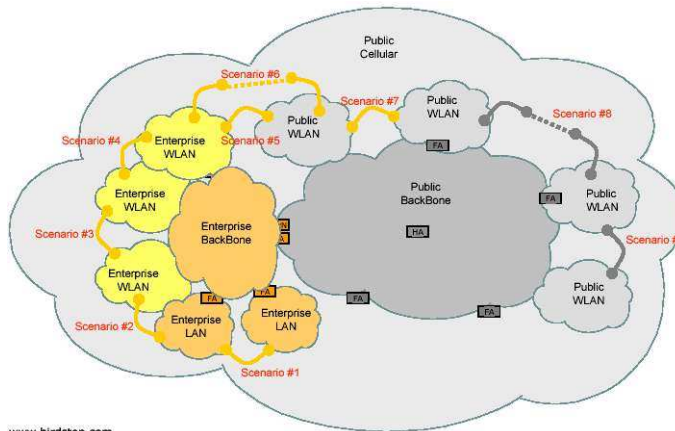


Source: http://www.isoc.org/isoc/conferences/inet/01/CD_proceedings/T40/inet_T40.htm#_Toc512923044



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Mobile IP – Solution in public networks



www.birdstep.com

Source: www.mobileinfo.com/Presentations/download/Birdstep_Mobil%20IP.pdf



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Scalability and Performance



- Normal IP network:
 - Max users \Rightarrow Throughput
- Mobile IP:
 - Max users \Rightarrow Throughput, registration rate, memory
- Simple calculation:
 - 1 million users reregistering every 2 hours is \sim 140 registrations per second.
 - Every registration requires a Security Association lookup \Rightarrow 140 queries per second per million users

Simulation Model



- Aims
 - Simulate Mobile IP operation
 - Capable to investigate in large-scale (large number of users and networks)
- Features
 - Experiencing Mobile IP operation behaviours
 - Set of Mobile IP's parameters
 - Quantify workload and control message overhead
 - Trace based
 - Flexible configuration of different scenarios
 - Set of Network's parameters
 - Set of Mobility's parameters

Continuous Time Markov chains



- State Space (S)
- Key quantities are the transition rates q_{ij} defined by transition rate matrix Q
- Holding time is exponentially distributed with mean $v_i = \sum_{j \in S} q_{ij}$
- Probability of going from state i to state j equals to q_{ij}/v_i which defines probability matrix P

Applied Model



- Set of states = Set of networks
- Initial matrix = Mobile Node appearance rate matrix
 - Specify the rate at which MNs belonging to one network may appear (not handoff) in other networks
- Pre-define transition rate matrix
 - Specify the mobility characters of each network e.g. holding time, handover probability

Mobile IP operation in Simulated mode



1. MN - attaches to a new foreign network.
2. MN - solicits an agent advertisement
3. FA - sends advertisement.
4. MN - requests registration from FA.
5. FA - forwards registration request to HA.
 - FA stores MN record in its Pending list
6. HA - sends registration reply to FA.
 - HA stores MN record in its Binding list

Mobile IP operation in Simulated mode

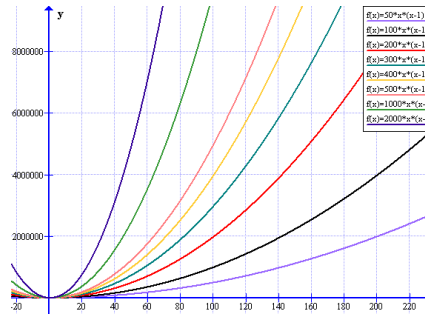


7. FA - forwards registration reply to MN.
 - FA removes record from Pending list and creates a record in its Visitor list
8. MN re-registers before its record lifetime is expired
9. When holding time expires MN handoff to other FA or return home or turned off

Validation experiments



- Using Symmetrical parameters
- $M = \lambda.T.N.(N-1)$



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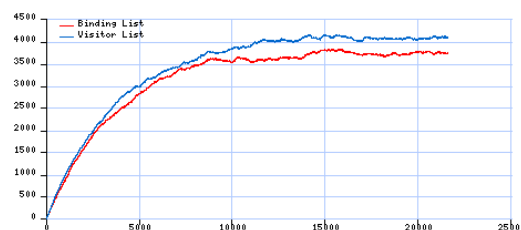
x = number of networks
y = maximum number of users

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Validation experiments



- Using Symmetrical parameters
 - 2 networks
 - Lifetime = 180 sec
 - Appearance rate = 1 per sec
 - Holding time = 2000 sec
 - 50% off
 - Estimated load at steady state = 4000 concurrent connected MNs



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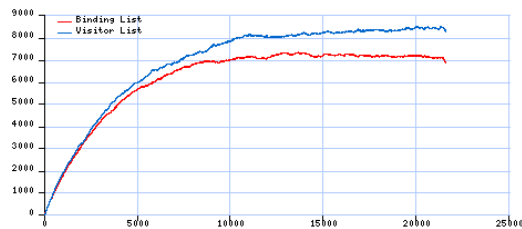
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Validation experiments



■ Using Symmetrical parameters

- 3 networks
- Lifetime = 180 sec
- Appearance rate = 1 per sec
- Holding time = 1333 sec
- 33% off
- Estimated load at steady state = 8000 concurrent connected MNs



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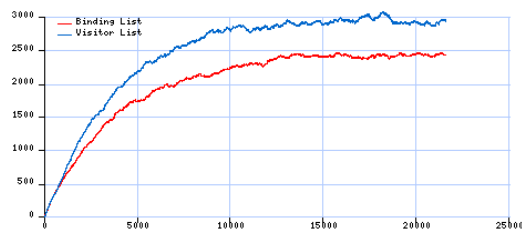
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Validation experiments



■ Using Symmetrical parameters

- 4 networks
- Lifetime = 420 sec
- Appearance rate = 5 per sec
- Holding time = 1000 sec
- 25% off
- Estimated load at steady state = 2400 concurrent connected MNs



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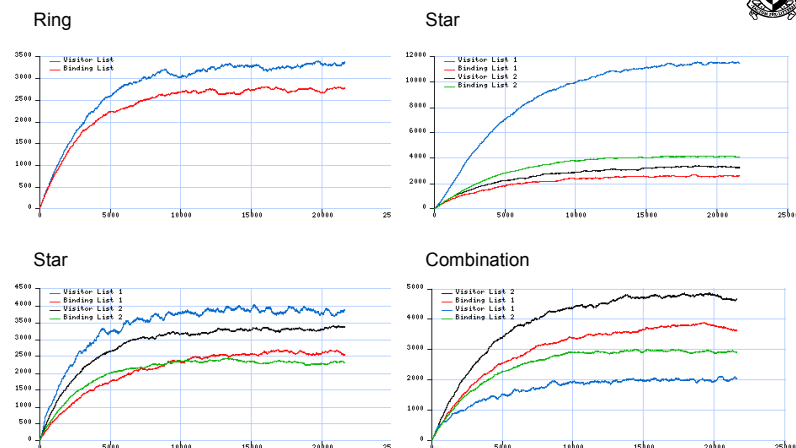
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Evaluation experiments



- Network topologies which can appear anywhere in ISP networks.
 - Ring
 - Star
 - Combination
- Something to keep in mind
 - Mobile IP network topology may not match the physical network topology.
 - The junctions between networks represent the paths where MNs can handoff

Evaluation experiments (cont)



Evaluation experiments (cont)



- Keep track of simulated operation history in several trace files

```

6957.32308277      16  0  10.1.0.1  10.3.26.222  10.1.0.1  10.3.0.1      0      0
6957.38320161      1  0  10.0.1.148 10.1.0.1  10.1.0.1  10.0.0.1     420     0
6957.40463201      1  0  10.1.0.1  10.4.0.1  10.1.0.1  10.4.0.1     420     0
6957.41945135      3  0  10.1.0.1  10.4.9.89  10.1.0.1  10.4.0.1     420     0
6957.44354696      1  0  10.3.18.131 10.1.0.1  10.1.0.1  10.3.0.1     420     0
6957.44966095      1  0  10.1.0.1  10.0.0.1  10.1.0.1  10.0.0.1     420     0
6957.47018164      1  0  10.3.26.222 10.1.0.1  10.1.0.1  10.3.0.1     420     0
6957.47922551      3  0  10.1.0.1  10.3.23.210 10.1.0.1  10.3.0.1     420     0
6957.52744453      1  0  10.3.23.185 10.1.0.1  10.1.0.1  10.3.0.1     420     0
6957.5302561       1  0  10.1.0.1  10.0.0.1  10.1.0.1  10.0.0.1     420     0
6957.58649285      1  0  10.1.0.1  10.3.0.1  10.1.0.1  10.3.0.1     420     0
6957.59420052     10  0  10.4.6.112  255.255.255.255 0.0.0.0  10.4.0.1      0      0
6957.60566105      3  0  10.1.0.1  10.4.7.26  10.1.0.1  10.4.0.1     420     0
6957.61719161     10  0  10.0.27.36  255.255.255.255 0.0.0.0  10.0.0.1      0      0
6957.64841213      1  0  10.1.0.1  10.3.0.1  10.1.0.1  10.3.0.1     420     0
6957.6510521       3  0  10.1.0.1  10.0.2.59  10.1.0.1  10.0.0.1     420     0
6957.66631309      1  0  10.1.0.1  10.3.0.1  10.1.0.1  10.3.0.1     420     0
6957.73405903      3  0  10.1.0.1  10.0.1.149 10.1.0.1  10.0.0.1     420     0
6957.73874181     16  0  10.1.0.1  10.4.6.112 10.1.0.1  10.4.0.1      0      0
6957.74471137      1  0  10.4.25.31  10.1.0.1  10.1.0.1  10.4.0.1     420     0
6957.76393536      1  0  10.2.20.70  10.1.0.1  10.1.0.1  10.2.0.1     420     0
6957.7660773      16  0  10.1.0.1  10.0.27.36 10.1.0.1  10.0.0.1      0      0
6957.7914661       3  0  10.1.0.1  10.3.18.131 10.1.0.1  10.3.0.1     420     0
6957.79844677      1  0  10.4.26.216 10.1.0.1  10.1.0.1  10.4.0.1     420     0
    
```



Mobile IP Simulation – 19
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Evaluation experiments (cont)



1MNTrace of 5nets ring

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid connected	46253	7.8	7.8	7.8
deleted	14583	2.5	2.5	10.3
new_handoff	29100	4.9	4.9	15.3
new_popup	17156	2.9	2.9	18.2
RegReq_sent	46254	7.8	7.8	26.0
RegReq_update_sent	203848	34.6	34.6	60.6
remove	21784	3.7	3.7	64.3
remove2home	7195	1.2	1.2	65.5
updated	203564	34.5	34.5	100.0
Total	589727	100.0	100.0	

1MNTrace of 5 nets star

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid connected	47434	8.6	8.6	8.6
deleted	9173	1.7	1.7	10.2
new_handoff	30164	5.4	5.4	15.6
new_popup	17270	3.1	3.1	18.8
RegReq_sent	47434	8.6	8.6	27.3
RegReq_update_sent	183833	33.2	33.2	60.5
remove	26813	4.8	4.8	65.3
remove2home	8905	1.6	1.6	66.9
updated	183503	33.1	33.1	100.0
Total	554529	100.0	100.0	

Central MN trace of 5 nets star

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid connected	159173	8.5	8.5	8.5
deleted	30644	1.6	1.6	10.2
new_handoff	141806	7.6	7.6	17.8
new_popup	17282	.9	.9	18.7
RegReq_sent	159177	8.5	8.5	27.3
RegReq_update_sent	617794	33.2	33.2	60.5
remove	89886	4.8	4.8	65.3
remove2home	29743	1.6	1.6	66.9
updated	616713	33.1	33.1	100.0
Total	1862308	100.0	100.0	



Mobile IP Simulation – 20
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Evaluation experiments (cont)



1 Message count of 5 nets ring

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1.0	500203	58.8	58.8	58.8
3.0	249964	29.4	29.4	88.1
10.0	46256	5.4	5.4	93.6
16.0	54772	6.4	6.4	100.0
Total	851195	100.0	100.0	

1 Message count of 5 nets star

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1.0	462533	58.3	58.3	58.3
3.0	231088	29.1	29.1	87.5
10.0	47434	6.0	6.0	93.5
16.0	51775	6.5	6.5	100.0
Total	792830	100.0	100.0	

Message count of central net of 5 nets star

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1.0	1553936	58.5	58.5	58.5
3.0	776395	29.2	29.2	87.7
10.0	159178	6.0	6.0	93.7
16.0	167763	6.3	6.3	100.0
Total	2657272	100.0	100.0	

Conclusion



- Workloads are variable, depending on several factors including:
 - Mobile IP network structure
 - Number of Mobile IP users and their behaviours
 - Mobile IP parameter settings
- It is good to have an idea of what may happen in any particular Mobile IP network design ⇒ Capacity planning

Future works



- Testbed environment
 - Observe the performance and capacity of workload on current Mobile IP supported device e.g Cisco router.
- Different model approach for comparison
 - Network centric
 - User centric
 - ...

References



- Simulation web based interface
 - <http://136.186.229.246>
- Internet documents
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QUESTION?