A Network-Assisted Inter-RAT Handover Scheme

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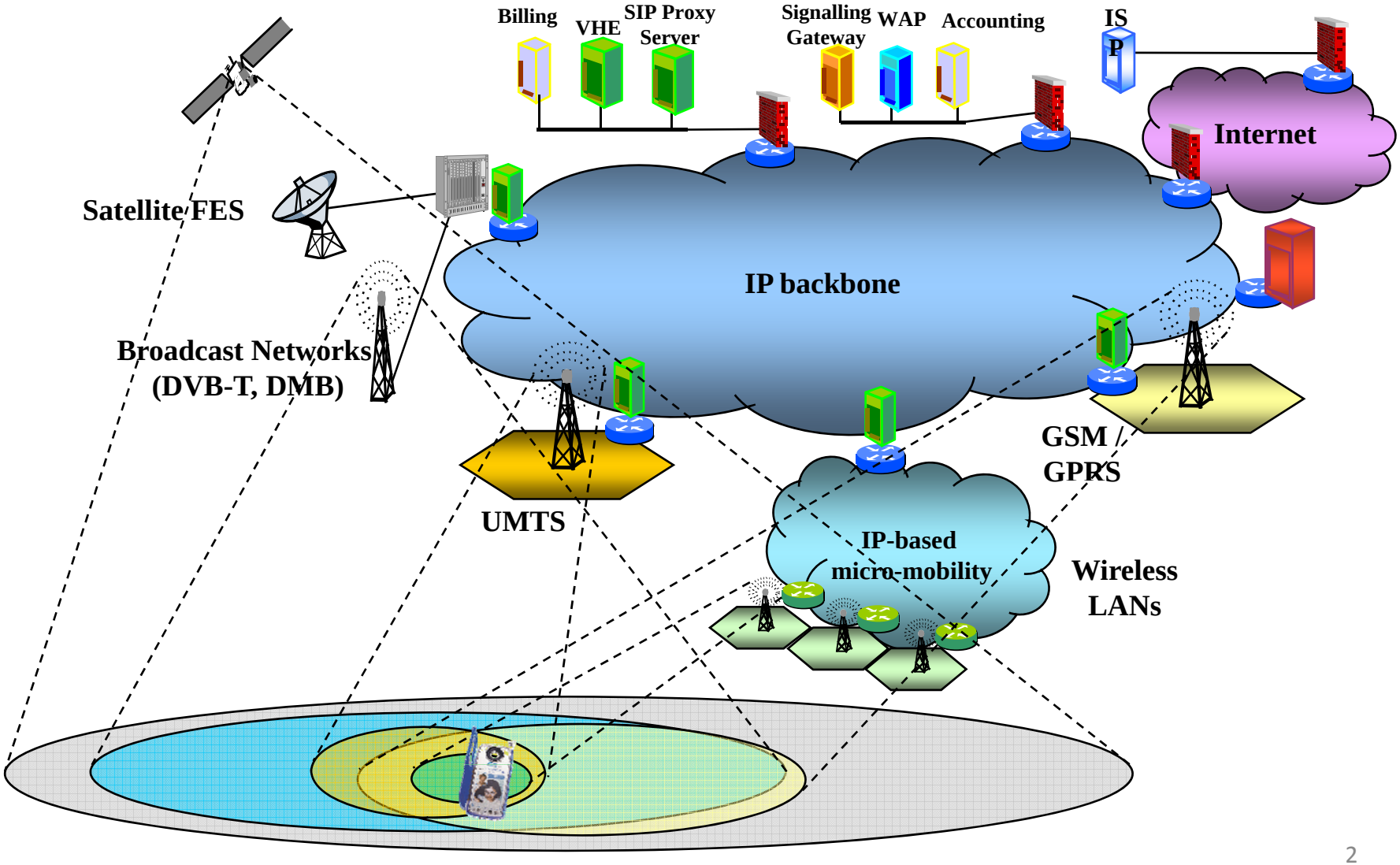
Heterogeneous Wireless Networks



Case Study: 3G-WLAN VHO (1/2)

- WLAN
  - Low cost, high data rate, small coverage
  - Designed for low terminal velocity (non-contiguous spots)
  - Office, Stations, Department store, Subway etc.
- 3G Cellular Network
  - High cost, medium data rate, large coverage
  - Even a fast moving vehicle can use on-line browser

Case Study: 3G-WLAN VHO (2/2)

	3G	WLAN
Data rate	< 2Mbps	< 11Mbps
Range	3-5 Km	50-60 m
Handover	Yes	Limited
Security	High	Low (being improved)
Coverage	Wide area (continuous)	Hot spots (non continuous)
Mobility	High speed	Stationary, Nomadic
Service	Voice and data	Primarily data

Related Works (1/2)

- Numerous works on network discovery, handover decision/execution
  - [1] Wengui Zhang, "Handover Decision Using Fuzzy MADM in Heterogeneous Networks," in Proc. IEEE WCNC 2004.
  - [2] A. Hasswa et al. "Generic Vertical Handoff Decision Function for Heterogeneous Wireless Networks," in Proc. IEEE WOCN 2005.
  - [3] R. Tawil, O. Salazar and G. Pujolle, "Vertical Handoff Decision Scheme Using MAMD for Wireless Networks," in Proc. IEEE WCNC 2008.
  - [4] W. Ying et al., "Vertical Handover Decision in an Enhanced Media Independent Handover Framework," in Proc. IEEE WCNC 2008.
  - [5] E. Stevens et al., "An MDP-Based Vertical Handoff Decision Algorithm for Heterogeneous Wireless Networks," IEEE Trans. Vehicular, March 2008.
  - [6] F. Zhu and J. McNair, "Optimizations for Vertical Handoff Decision Algorithms," in Proc. IEEE WCNC 2004.

Related Works (2/2)

- Handover decision: depending on VHO criteria
  - Channel condition is a key criteria for VHO

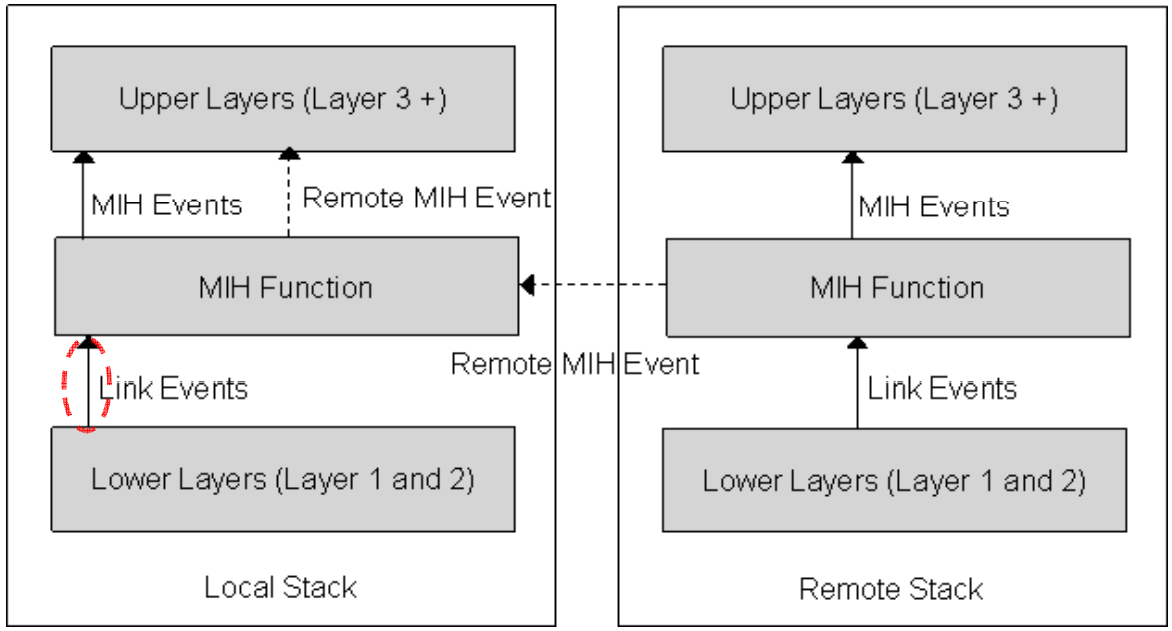
	Price	Bandwidth	Channel condition	Sojourn time	Power	Security	User preference
[1]	O	O	O	O	O	X	X
[2]	O	O	O	X	O	O	O
[3,4]	O	O	O	X	X	X	X
[5,6]	X	O	O	X	X	X	X

Motivation

- Channel scanning is indispensible to obtain channel conditions; However, channel scanning leads to significant latency!
  - In WLANs, scanning latency is about 200-300 msec!
- How to reduce channel scanning latency in VHO?
  - IEEE 802.21 MIH provides useful information via Information Server (IS)
  - *Exploit temporal and spatial locality* in IS!

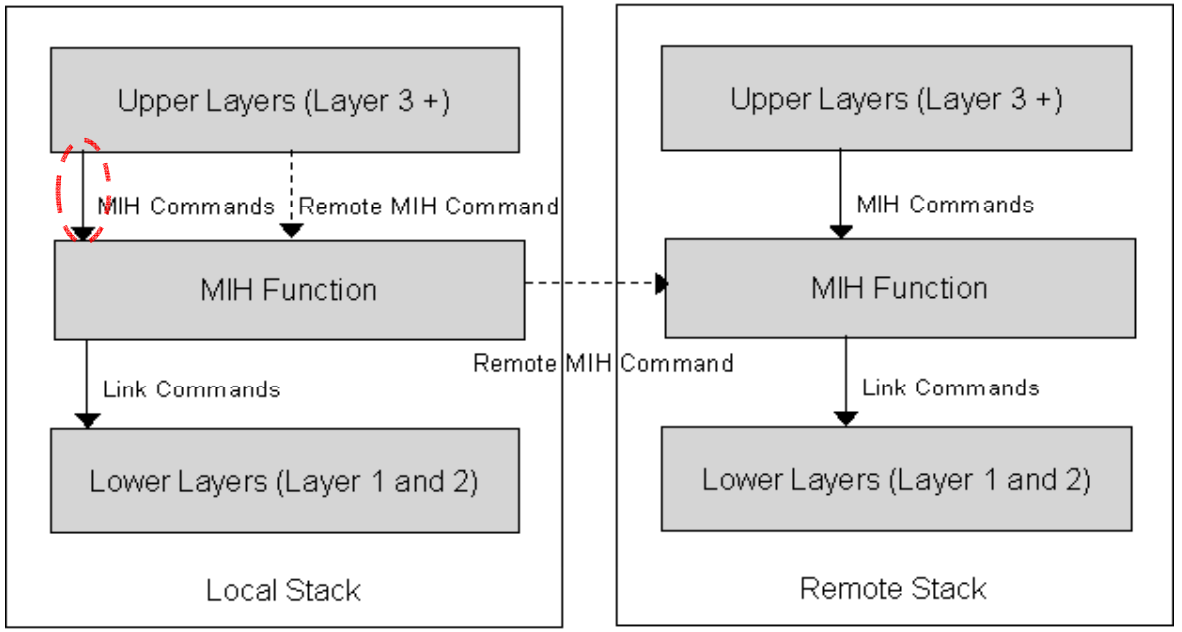
MIH Services (1/3)

- MIES (Media Independant Event Service)
  - Link up/down, link parameters change,
  - link going down, link event rollback



MIH Services (2/3)

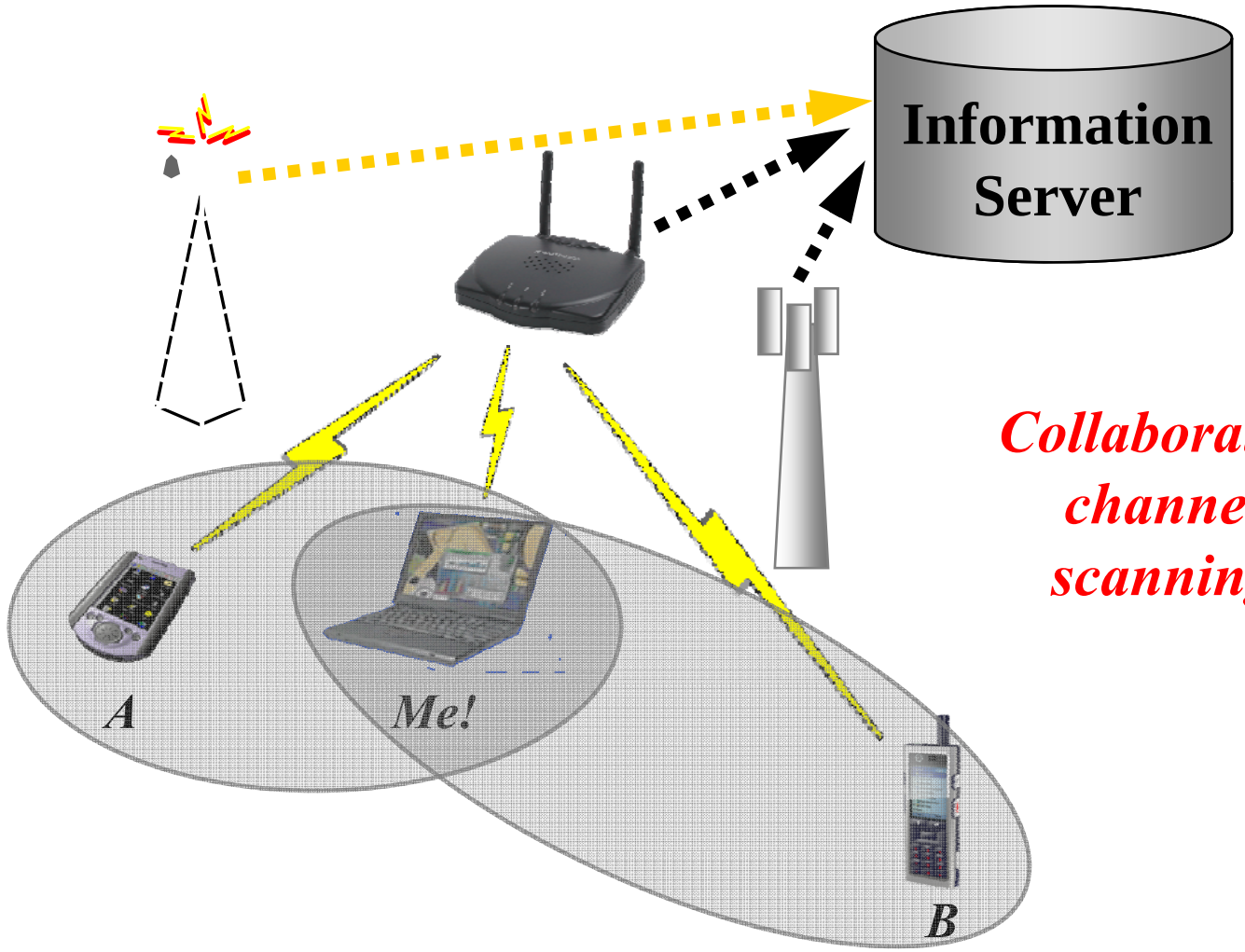
- MICS (Media Independant Command Service)
  - MIH Scan, MIH Configure



MIH Services (3/3)

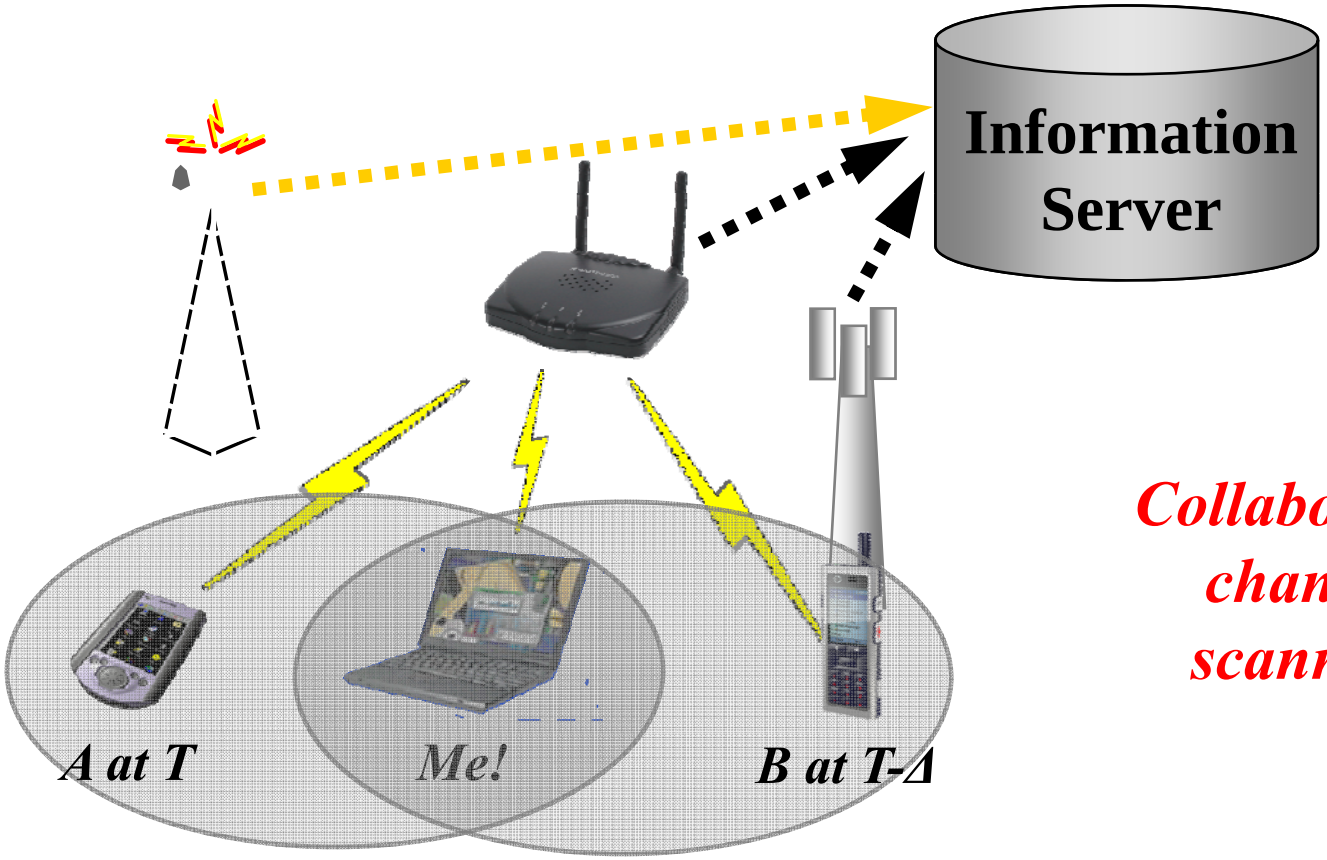
- MIIS (Media Independant Information Service)
  - Discover and obtain neighboring network information within a geographic region
  - Communicate with neighboring network elements
  - Query/response mechanism: neighboring network names, providers and cost, MAC addresses of neighboring network elements, channel information, security, QoS, ...

Spatial Locality



Collaborative channel scanning

Temporal Locality

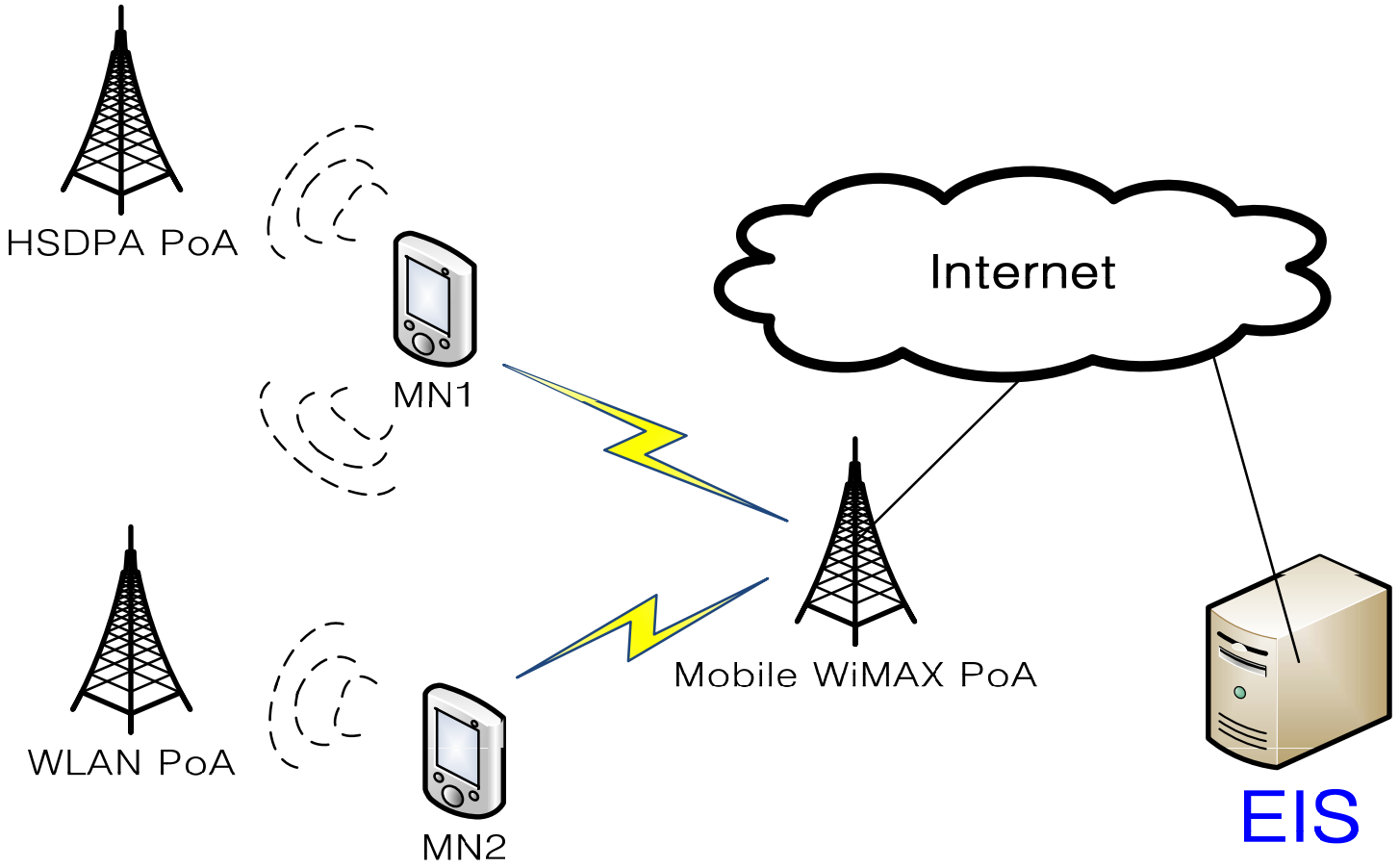


Collaborative channel scanning

System Model (1/2)

- DB Schema in enhanced IS (EIS)
  - *Extended channel state information (ECSI)*
    - $(id,\ t,\ (x, y),\ \delta)$
  - Access point identification, id
  - Measurement time, t
  - Measurement location, (x, y)
  - Signal-to-noise ratio (SNR), δ

System Model (2/2)



- Each MN should notify the ECSI to EIS

Estimating the SNR (1/2)

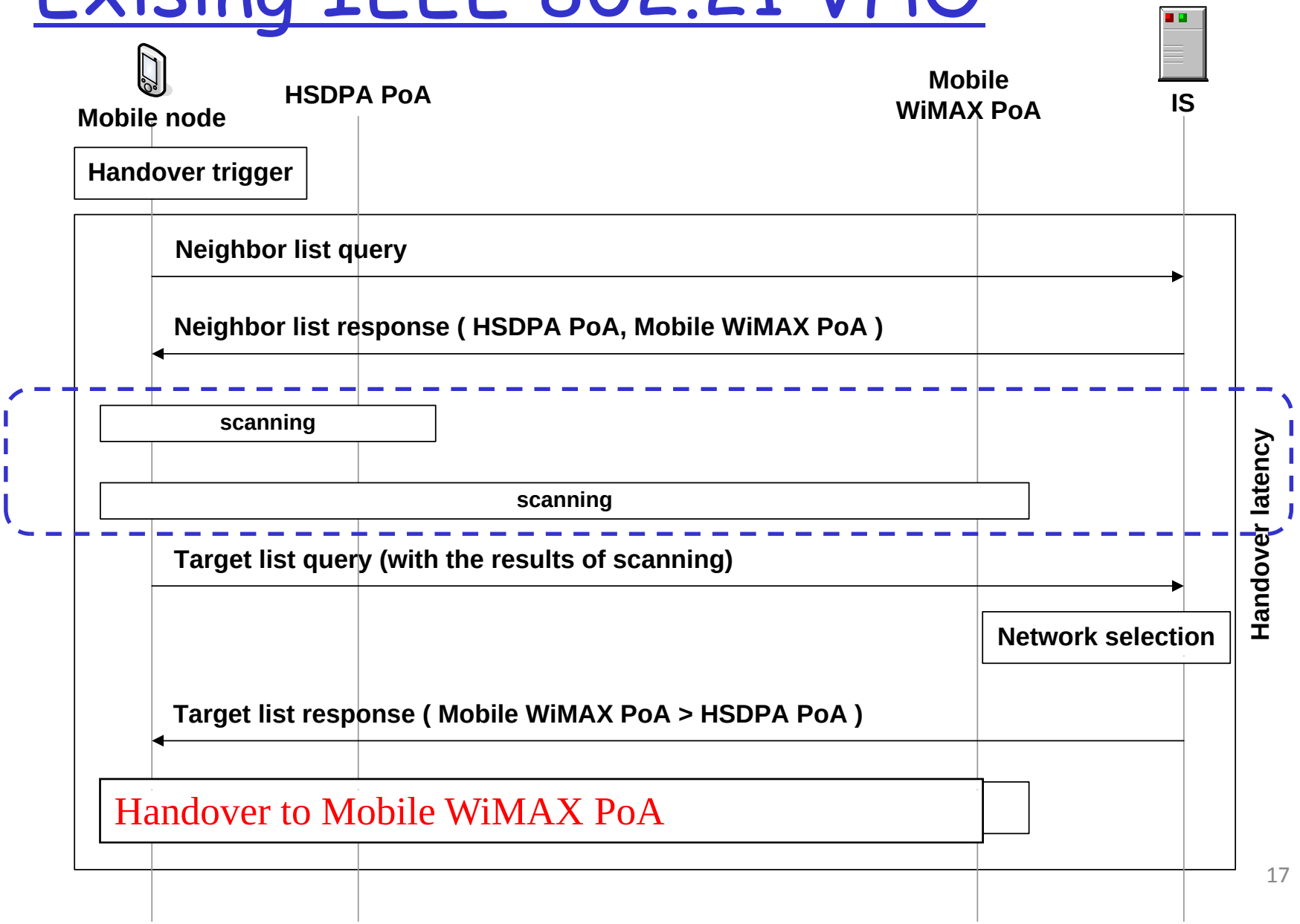
Algorithm 1 SNR estimation

1: initiate R_M, W, N;
2: $i \leftarrow 0$;
3: **while** $i < N$ **do**
4: $j \leftarrow 0$;
5: $m \leftarrow 0$;
6: **while** $j < n_i$ **do** *Temporal Locality*
7: **if** $t_0 - ESCI_i(j).t < W$ && $\sqrt{(x_0 - ECSI_i(j).x)^2 + (y_0 - ECSI_i(j).y)^2} < R_M$ **then** *Spatial Locality*
8: $\theta(m) \leftarrow ESCI_i(j)$
9: $m++$;
10: **end if**
11: $j++$;
12: **end while**

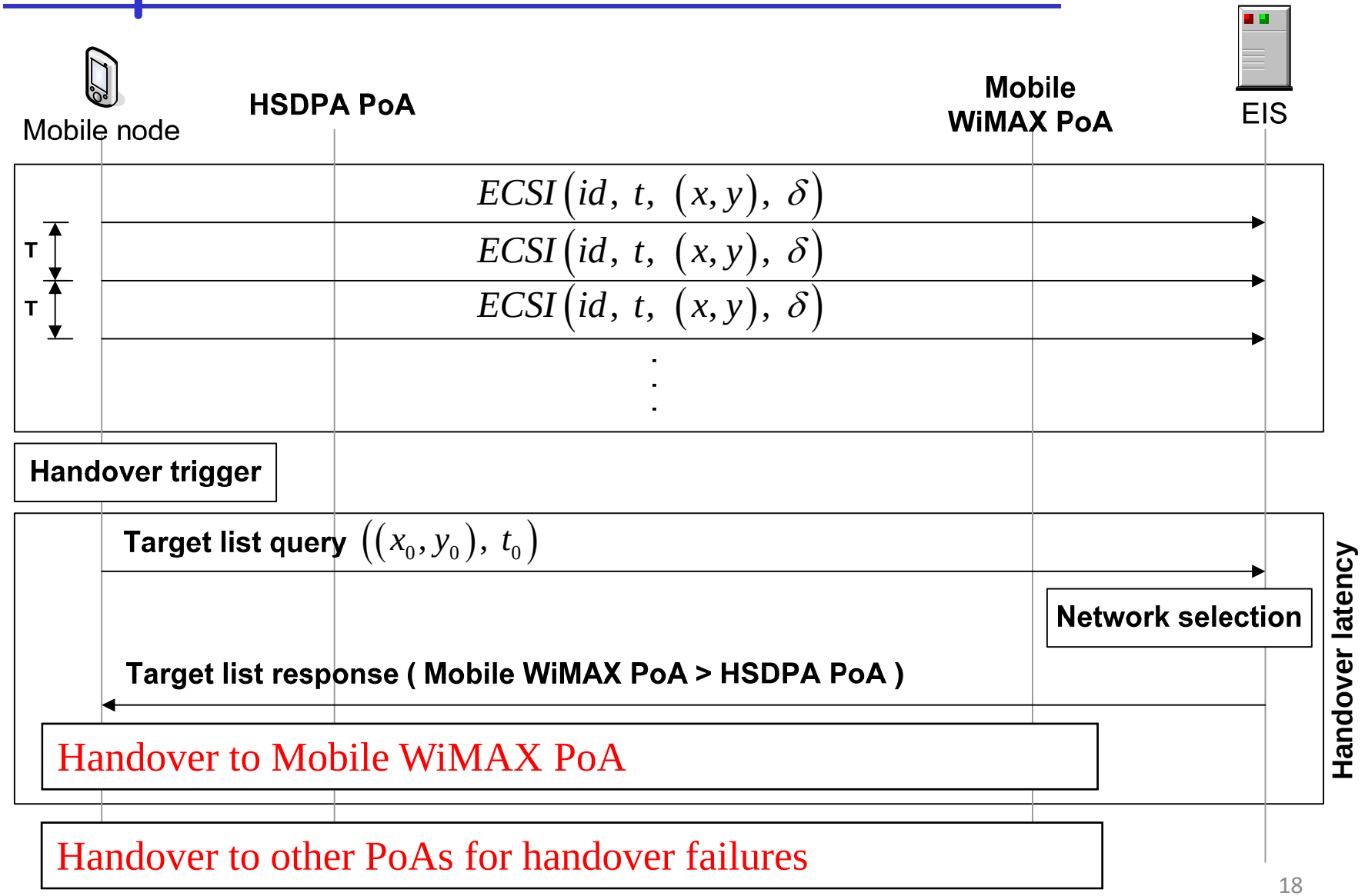
Estimating the SNR (2/2)

13: **if** $m == 0$ **then**
14: $exit;$
15: **end if**
16: $sort(\theta, \sqrt{(x_0 - \theta(k).x)^2 + (y_0 - \theta(k).y)^2}),$
$\text{for } 0 \leq k \leq m-1 \ ;$
17: $\delta_i^E = \theta(0).\delta;$
18: $j \leftarrow 1;$
19: **while** $j < m$ **do**
20: $\delta_i^E = \alpha \cdot \delta_i^E + (1-\alpha) \cdot \theta(j).\delta;$
21: $j++;$
22: **end while**
23: $i++;$
24: **end while**

Exising IEEE 802.21 VHO



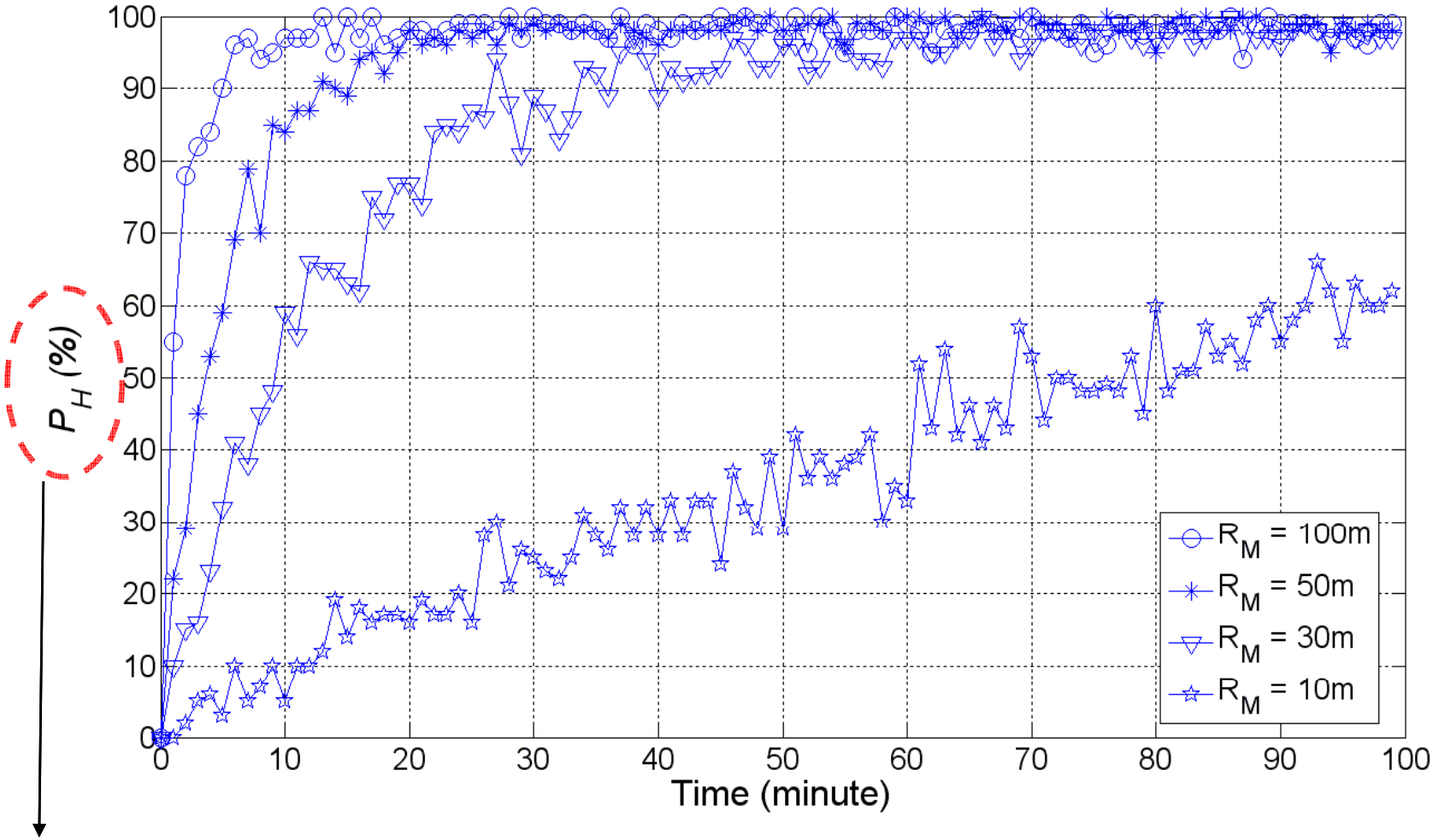
Proposed IEEE 802.21 VHO



Simulation Environment

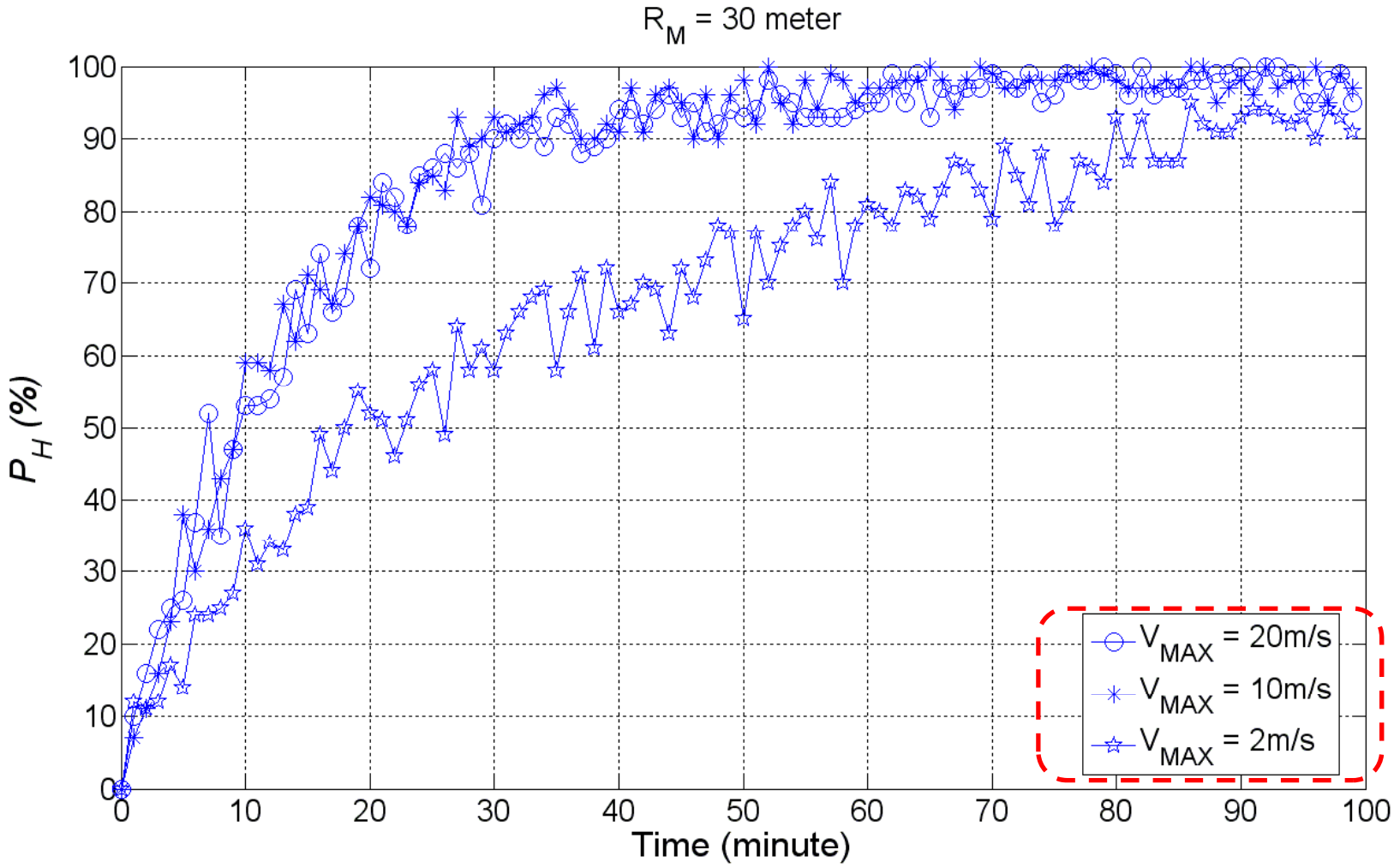
- Wireless channel model
  - COST-231 Hata model
- Mobility model
  - Random way-point mobility model
- Heterogeneous network model
  - HSDPA + Mobile WiMAX + WiFi

Simulation Results (1/4)

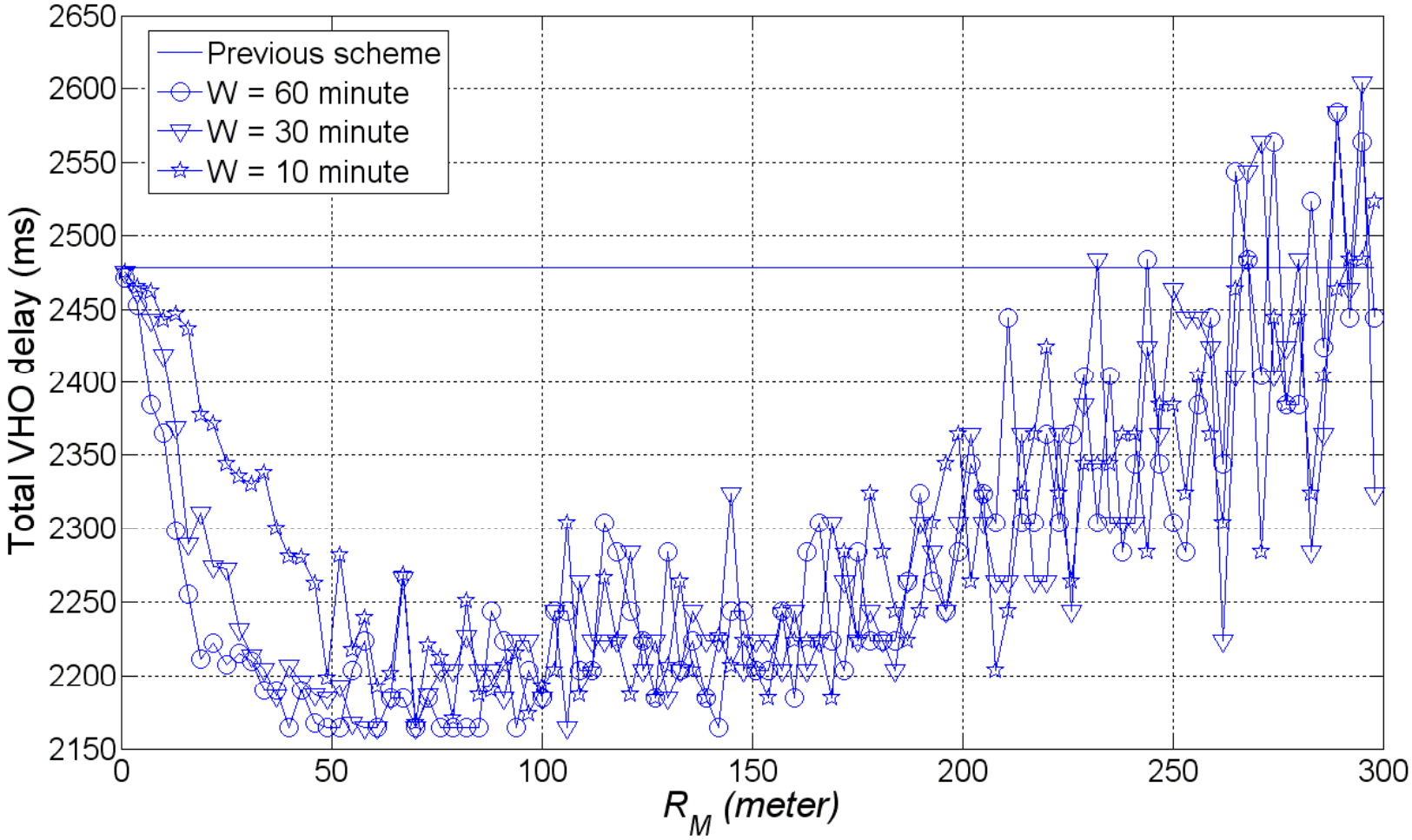


Hit: PoA by the proposed scheme = PoA by full scanning procedure

Simulation Results (2/4)

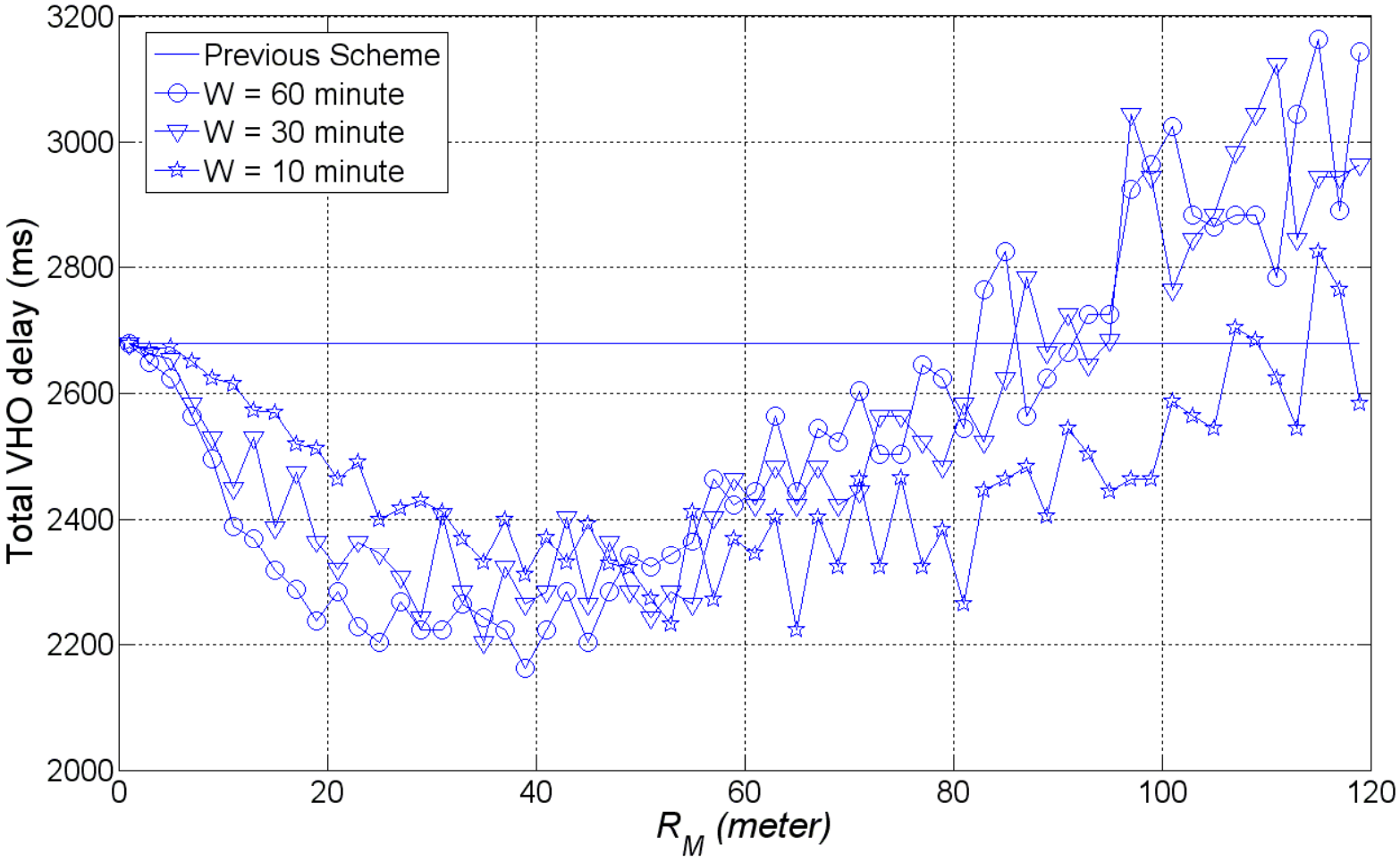


Simulation Results (3/4)



- There is optimal R_M for minimizing VHO delay

Simulation Results (4/4) (+ WiFi PoA)



- Optimal R_M is dependent on the smallest network coverage in heterogeneous networks

Conclusion

- Network assistance and collaboration are important in mobile Internet!
  - To achieve seamless inter-RAT handover
  - Optimization techniques are needed