Chapter 4

L2 Handoff Scheme in IEEE 802.11 Wireless Networks

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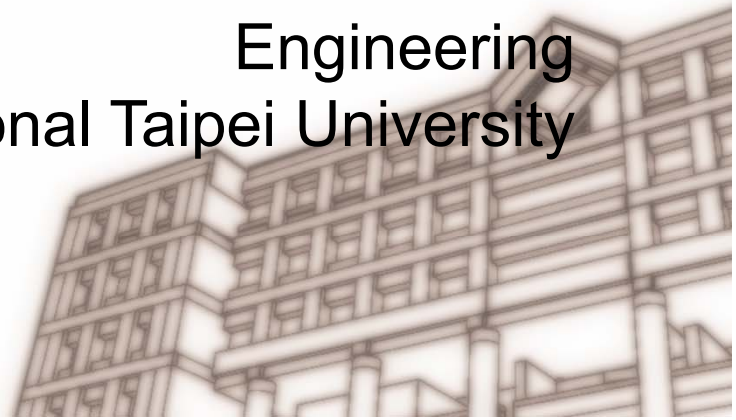
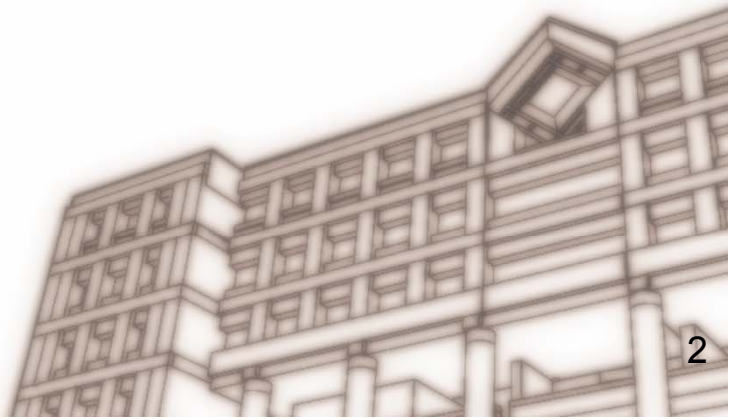


Outline

- Introduction
- Related work
- DeuceScan: Deuce-based fast handoff scheme
- Performance analysis
- Conclusions

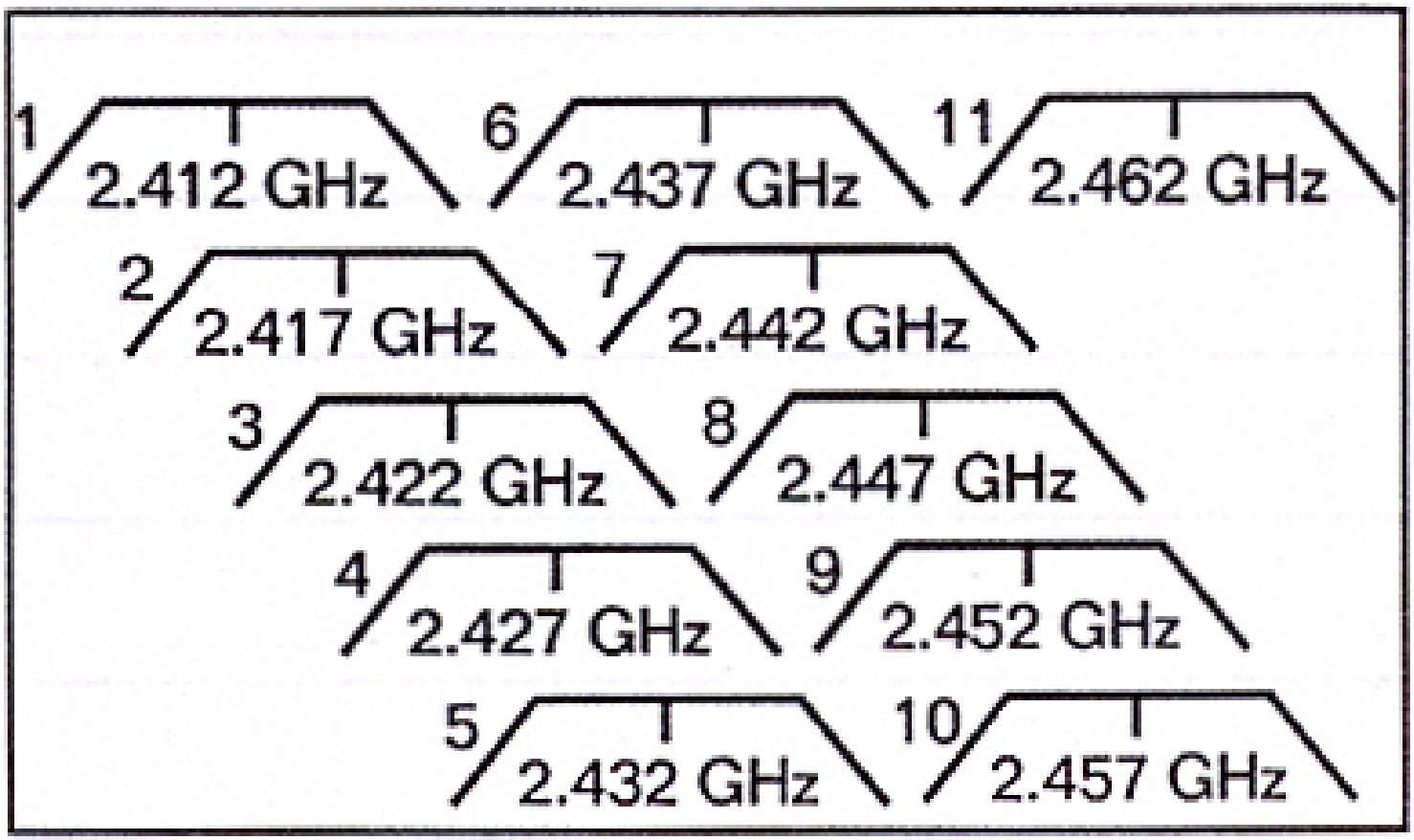


Introduction

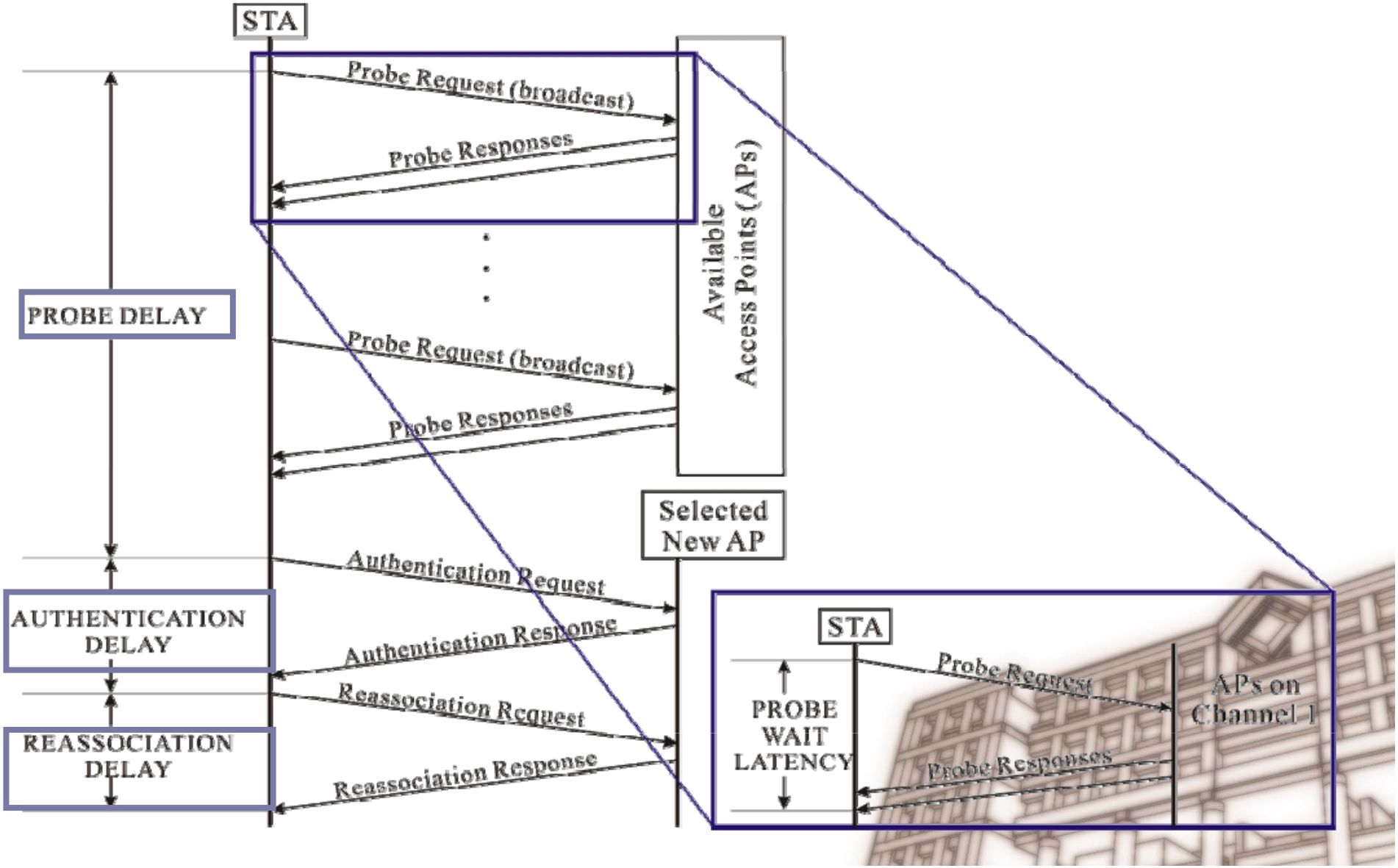
- In IEEE 802.11 Std., an mobile host (MH) needs to perform a full scan (11 channels) operation during a handoff procedure, and it wastes much time.

- The entire handoff delay time is divided into probe, authentication, and reassociation delay time. The probe delay occupies the most handoff delay time.

11 channels in 2.4 GHz



Layer 2 Handoff Process



Introduction

- This work proposed a fast handoff scheme, called DeuceScan, to reduce the probe delay for 802.11-based WLANs.
  - DeuceScan scheme utilizes spatiotemporal graph to provide the spatiotemporal information for making better handoff decisions to exactly search for the next AP.
  - DeuceScan scheme is a pre-scan approach, partial-scan approach, and two factors of signal strength and variation of signal strength are both considered in our DeuceScan scheme.

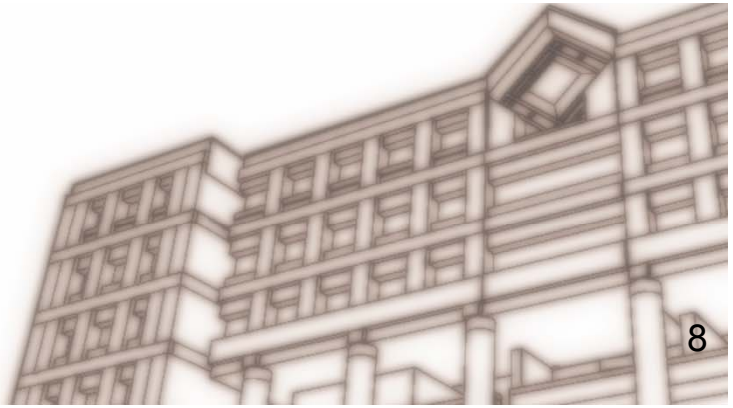
Related Work

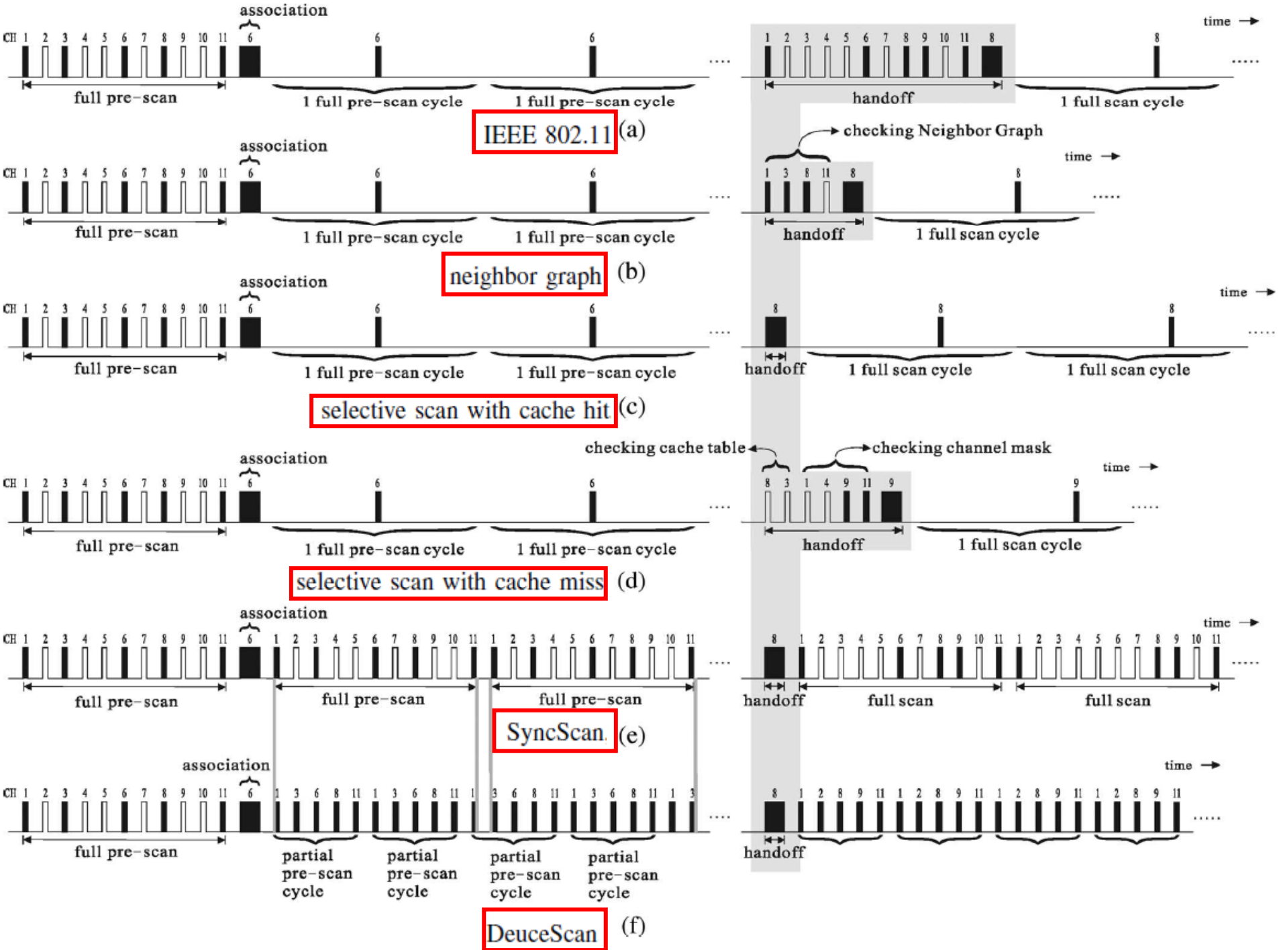
- For reducing the probe delay time
  - Partial scan
    - M. Shin *et al.,* ”Improving the Latency of 802.11 Hand-offs using Neighbor Graphs,” **ACM MobiSys**, Jun. 2004.
    - S. Shin *et al.,* ”Reducing MAC Layer Handoff Latency in IEEE 802.11 Wireless LANs,” **ACM MobiWac**, Sep. 2004.
  - Pre-scan
    - I. Ramani *et al.*, ”SyncScan: Practical Fast Handoff for 802.11 Infrastructure Networks,” **IEEE INFOCOM**, Mar. 2005.
  - Location-based
    - C. C. Tseng *et al.*, ” Location-based Fast Handoff for 802.11 Networks,” **IEEE Communication Letters**, Apr. 2005.

Comparisons of the existing fast handoff protocols

TABLE I
COMPARISON OF THE EXISTING FAST HANDOFF PROTOCOLS

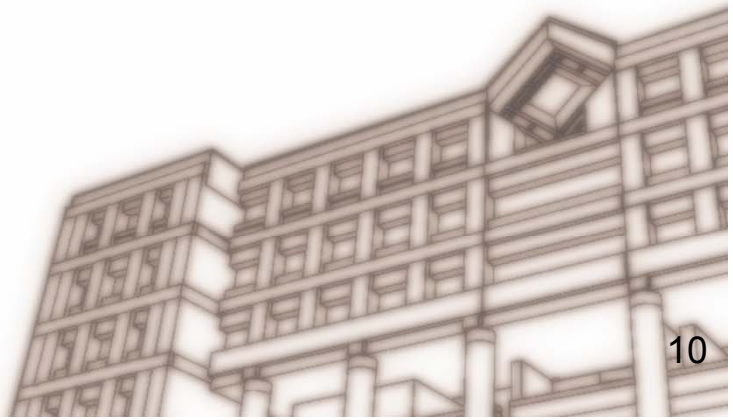
Methods / Properties	IEEE 802.11 standard [3]	neighbor graph [17]	selective scan [18]		SyncScan [16]	location-based approach [20]	DueceScan
			cache hit	cache miss			
pre-scan	no	no	no		yes	no	yes
probe action	full scan	partial scan	no	partial scan	no	no	no
handoff time	slow	medium	fast	medium	fast	fast	fast
direction	no	implicitly	no		no	yes	implicitly
location device	no	no	no		no	yes	no
memory usage	1	$O(n \times M)$	$O(n)$		$O(N)$	$O(N \times M)$	$O(n \times M)$




association
CH 1 2 3 4 5 6 7 8 9 10 11
full pre-scan
1 full pre-scan cycle
1 full pre-scan cycle
time
handoff
1 full scan cycle
IEEE 802.11 (a)
checking Neighbor Graph
neighbor graph (b)
selective scan with cache hit (c)
checking cache table
checking channel mask
selective scan with cache miss (d)
full pre-scan
full pre-scan
full pre-scan
handoff
full scan
full scan
SyncScan (e)
partial pre-scan cycle
partial pre-scan cycle
partial pre-scan cycle
partial pre-scan cycle
DeuceScan (f)

DeuceScan: Deuce-based fast handoff scheme

- Spatiotemporal graphs
- The DeuceScan fast handoff scheme
  - Deuce procedure with signal strength
  - Deuce procedure with variation of signal strength



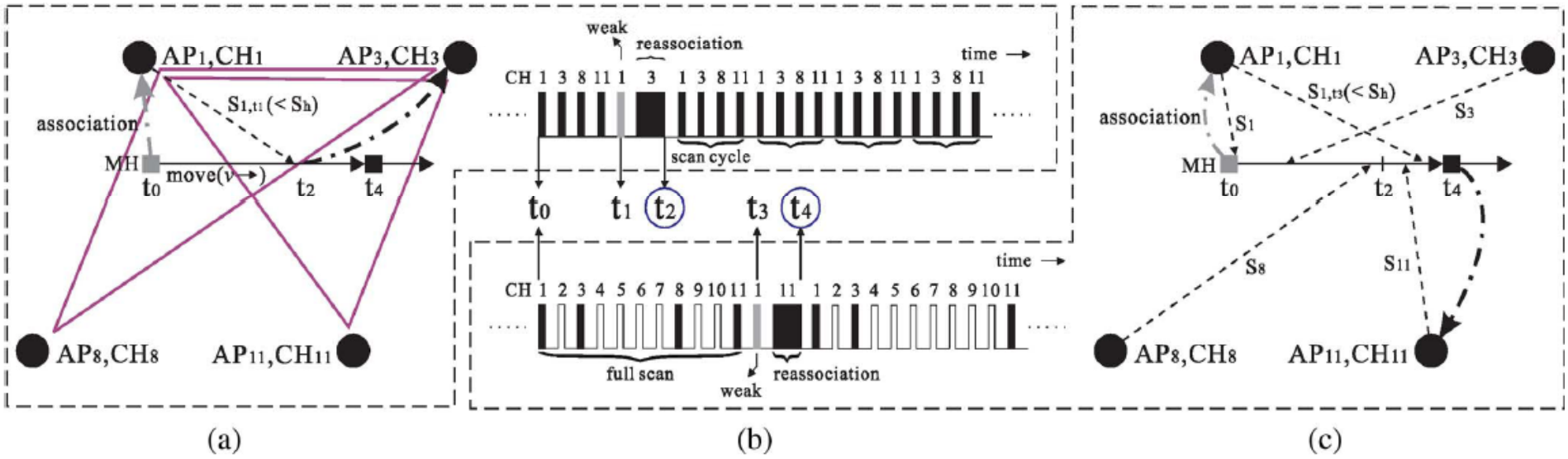
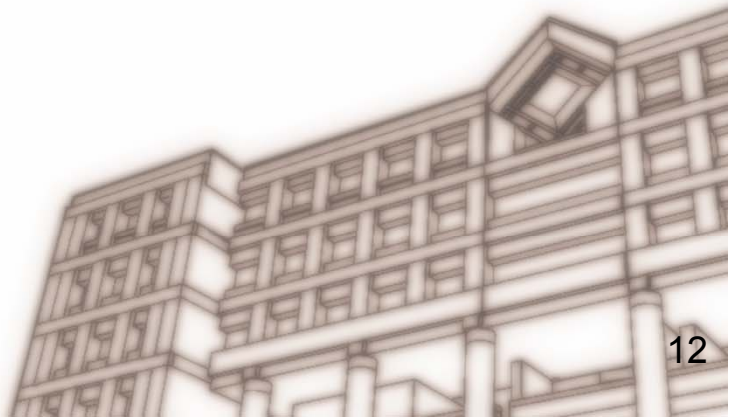


Fig. 2. DeuceScan versus SyncScan. (a) DeuceScan ($\alpha = 1, \beta = 2$). (b) Time slot sequences. (c) SyncScan.

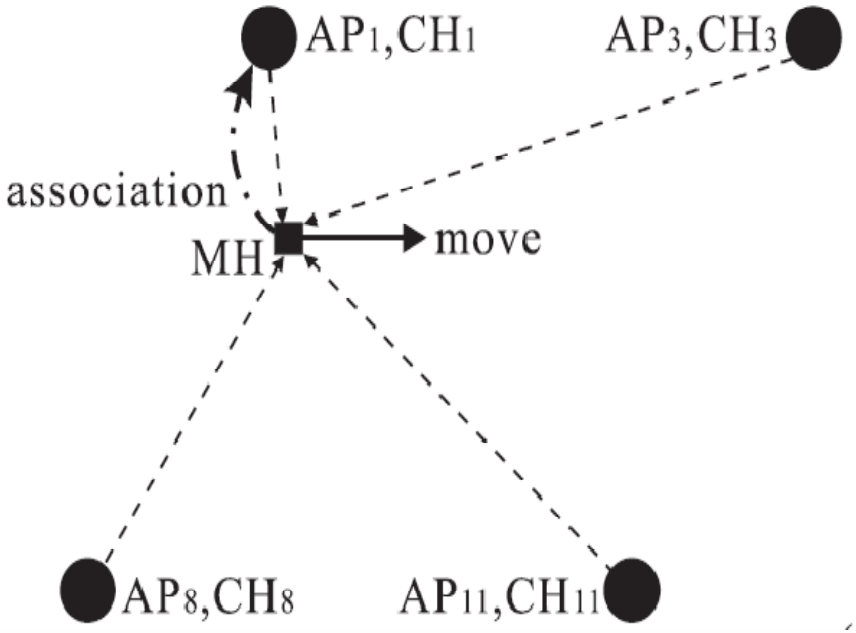
Spatiotemporal graphs

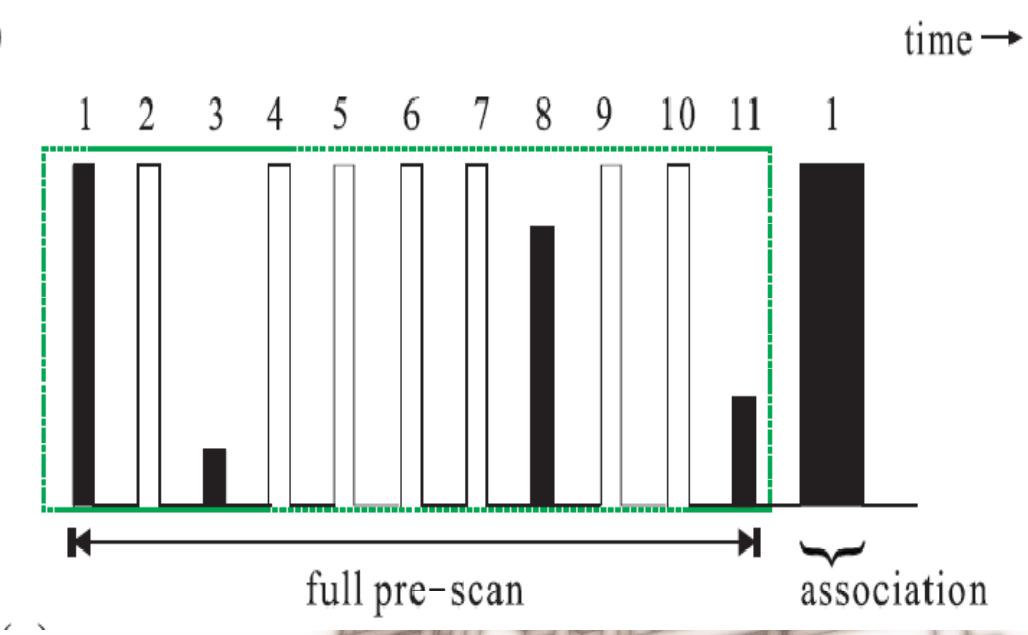
- Composed of a lot of spatiotemporal triangles which are established at distinct time and places.
  - The current triangle presents the first three closest APs near an MH. (largest RSS)
- Each MH will possess its own individual spatiotemporal graph.



An example of construction of spatiotemporal graphs (1/3)

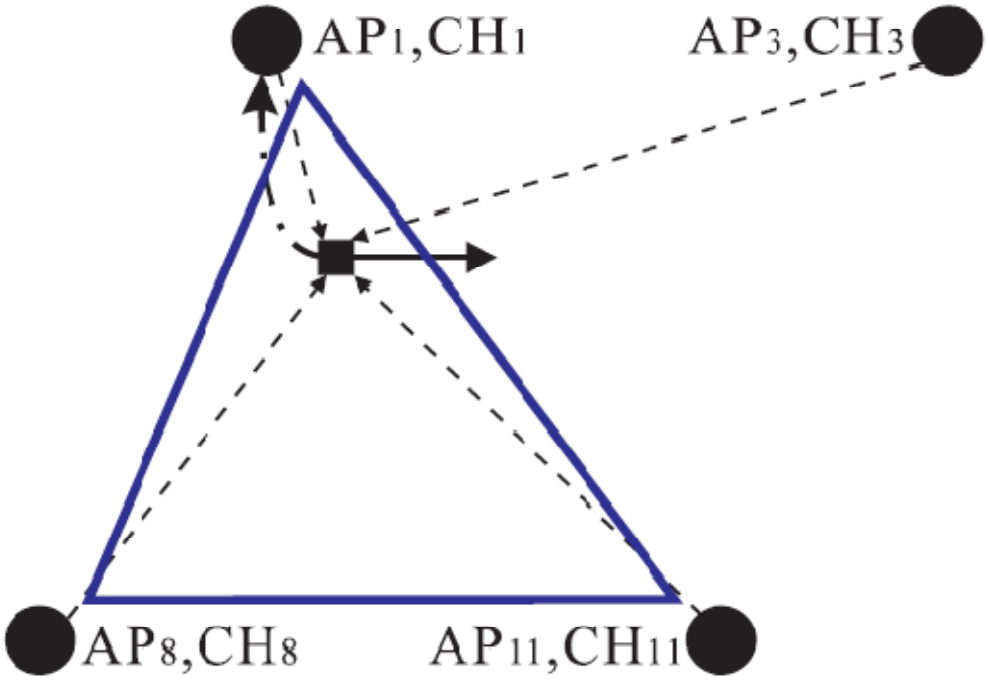
- The full pre-scanning operation needs to be performed if an MH enters a new location.





An example of construction of spatiotemporal graphs (2/3)

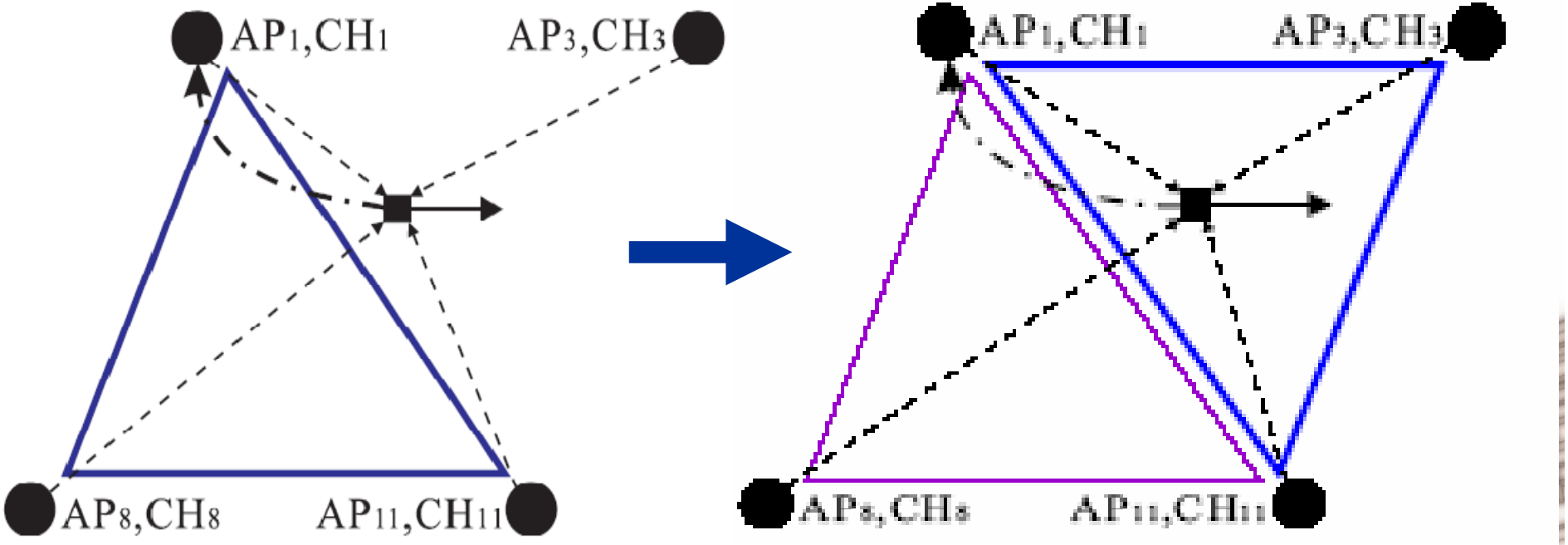
- A triangle is constructed by three APs, AP_1, AP_8, and AP_{11}.



An example of construction of spatiotemporal graphs (3/3)

- Construct a new spatiotemporal graphs

A spatiotemporal triangle list = $\{\nabla_{t_1}, \nabla_{t_2}\}$



$\{\nabla_{t_1}, \nabla_{t_2}, \ldots, \nabla_{t_i}, \nabla_{t_{i+1}}, \ldots, \nabla_{t_j}\}$ at time t_j

The DeuceScan fast handoff scheme

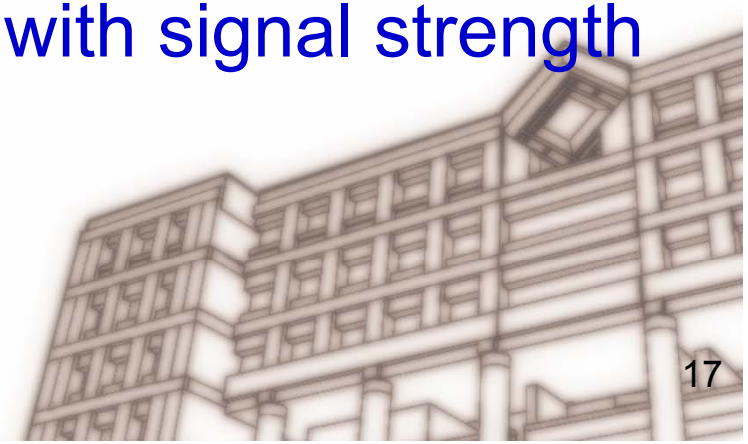
- For reducing the layer-2 handoff latency which utilizes spatiotemporal graphs to provide spatiotemporal information for making better handoff decisions to exactly search for the next AP.

- Adopting two factors of received signal strength and variation of received signal strength.

Deuce procedure with signal strength

- The deuce procedure is used for confirming whether the RSS received from an MH at some place are stable by continuously probing nearby APs and judges if it needs to change the current spatiotemporal triangle.

- We denote a deuce procedure with signal strength as $D_S(\alpha, \beta)$.

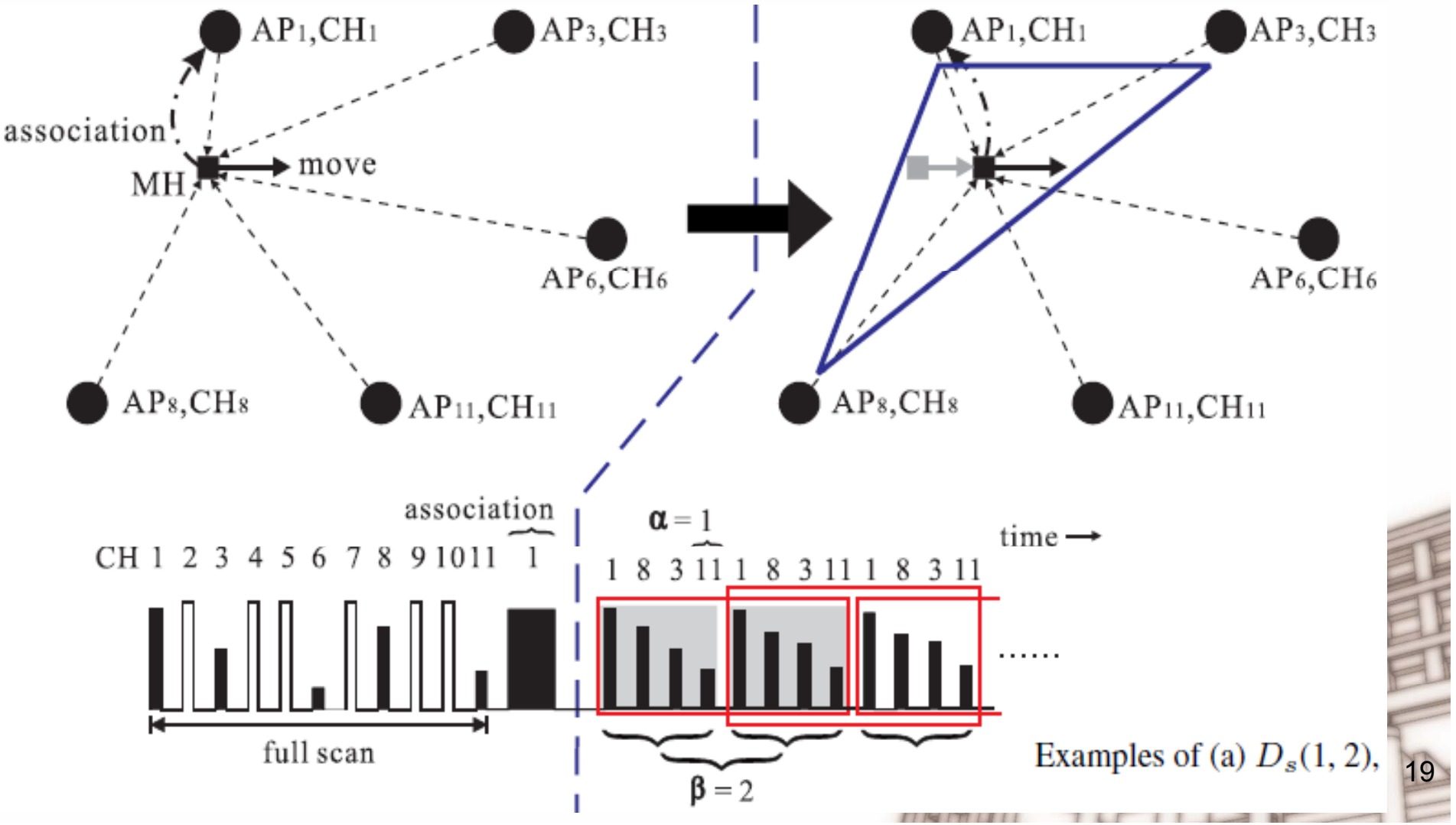


Deuce procedure $D_S(\alpha, \beta)$

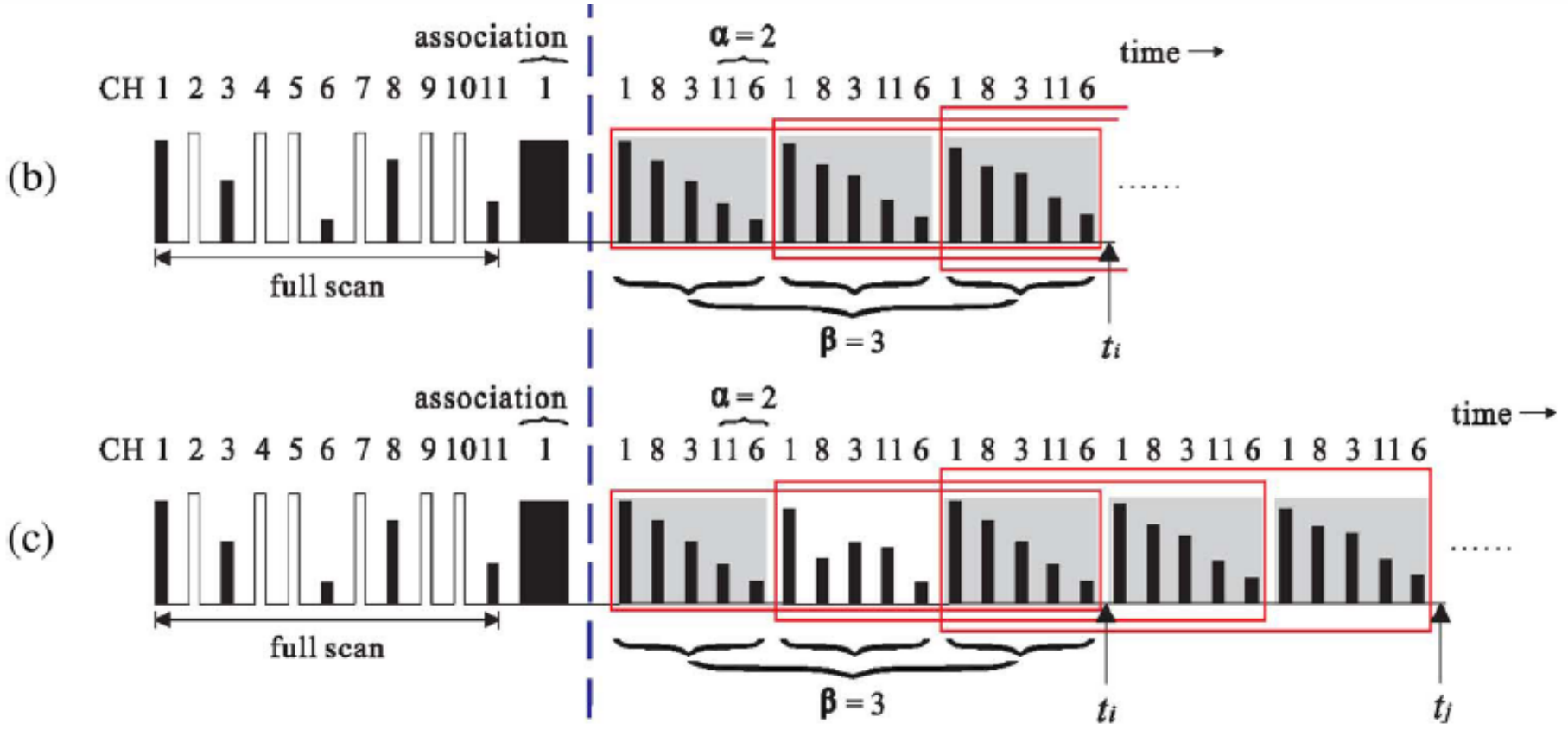
- After initial full scan we select the APs which have the first α +3 strong RSS receiving from the MH to form a scan cycle, and this presents that there are still α APs for selecting if the full scan has a mistake.

- Successive **β** scan cycles form a deuce window.
  - It is stable means that the RSS magnitude order in each scan cycle of a deuce window are the same.

An example of $D_S(\alpha, \beta)$



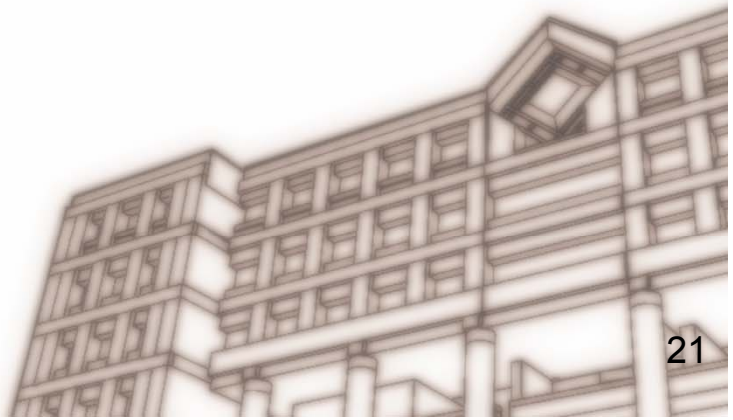
Examples of (a) $D_s(1, 2)$,



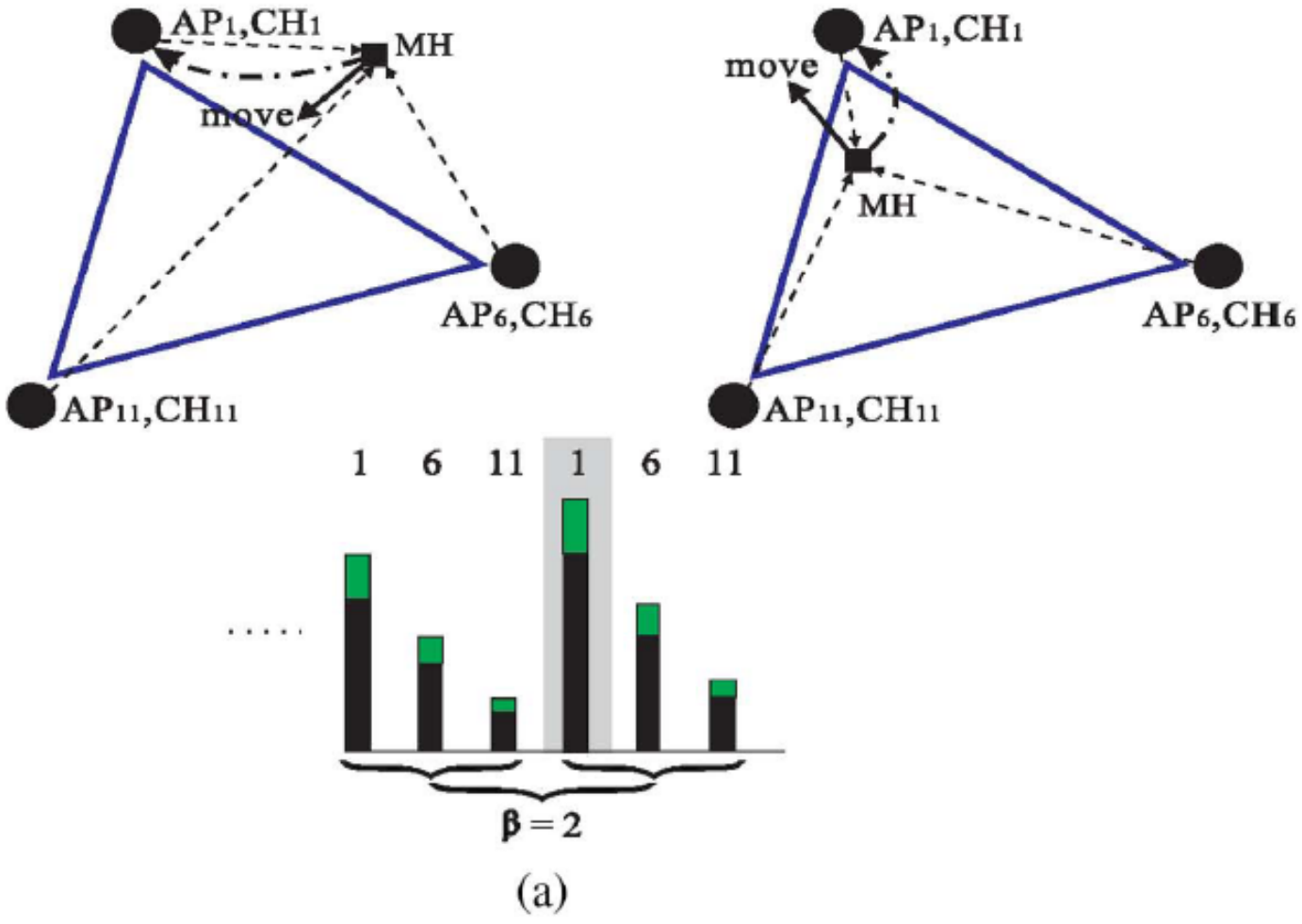
(b) $D_s(2, 3)$, and (c) $D_s(2, 3)$.

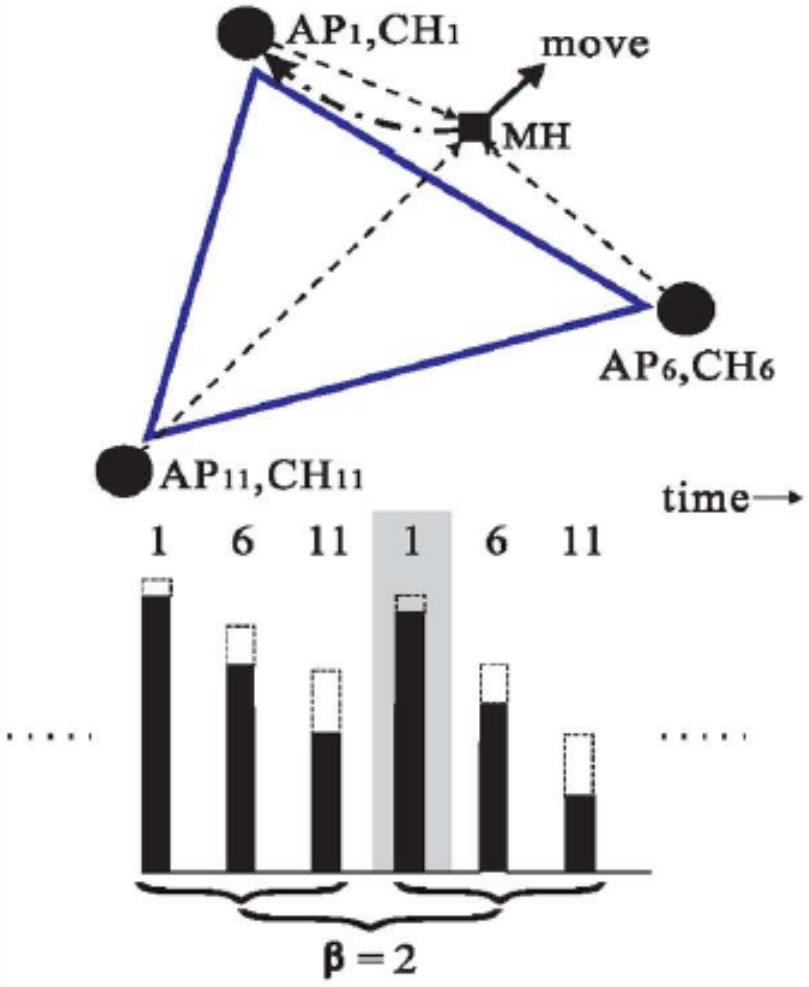
Deuce procedure with variation of signal strength

- When the variation of successive two RSS of an AP is positive, the MH moves away from this AP.
- An MH can be aware of its moving direction (to be close to or to be distant from some APs) and determine which is the next AP when handoff.
- We denote a deuce procedure with variation of RSS as $D_V(\alpha,\beta)$.



An example of $D_V(\alpha,\beta)$





(b)

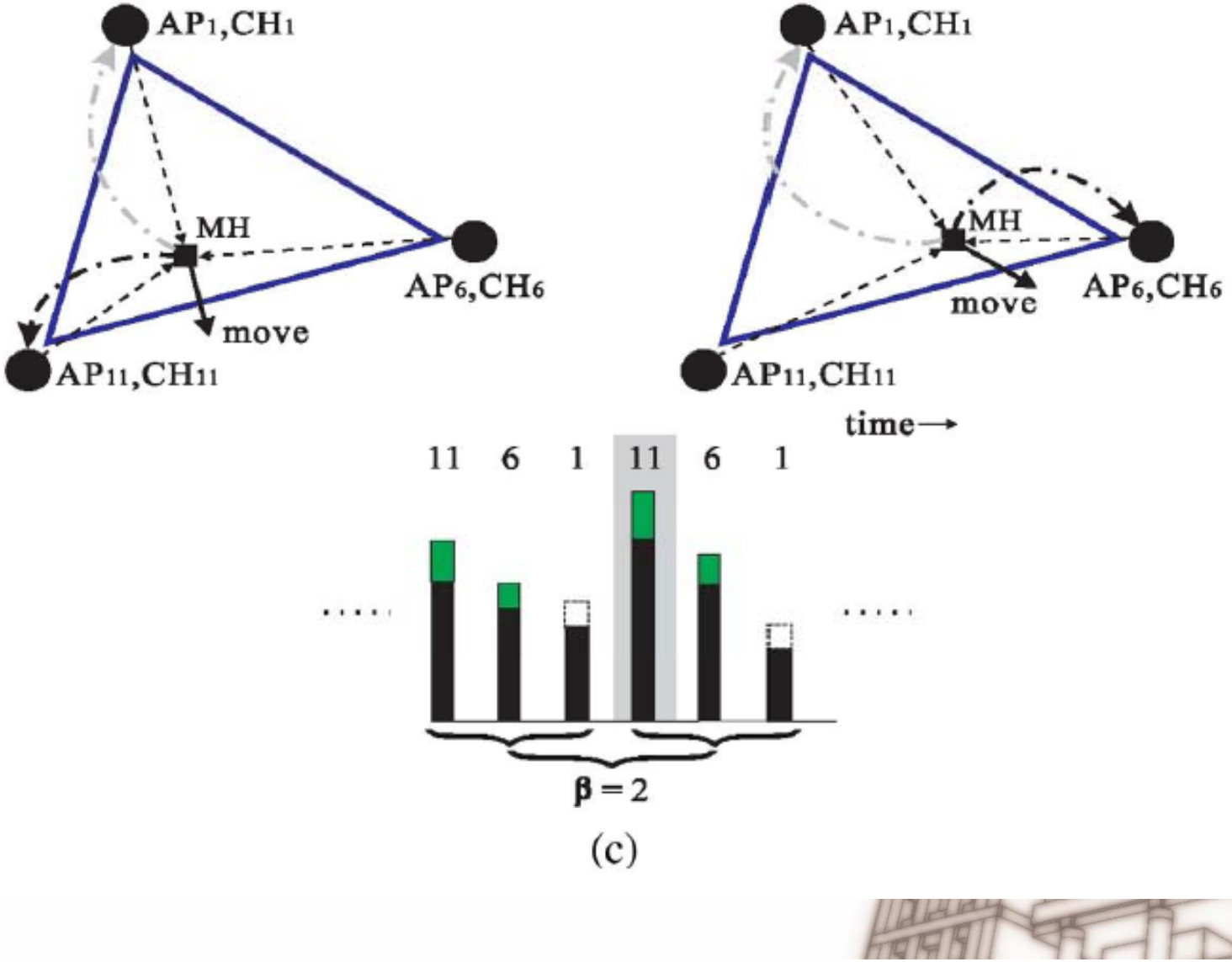

AP1,CH1
MH
AP6,CH6
move
AP11,CH11
AP1,CH1
MH
move
AP6,CH6
AP11,CH11
time
11
6
1
11
6
1
β = 2
(c)

Fig. 6. Construction of spatiotemporal graphs.

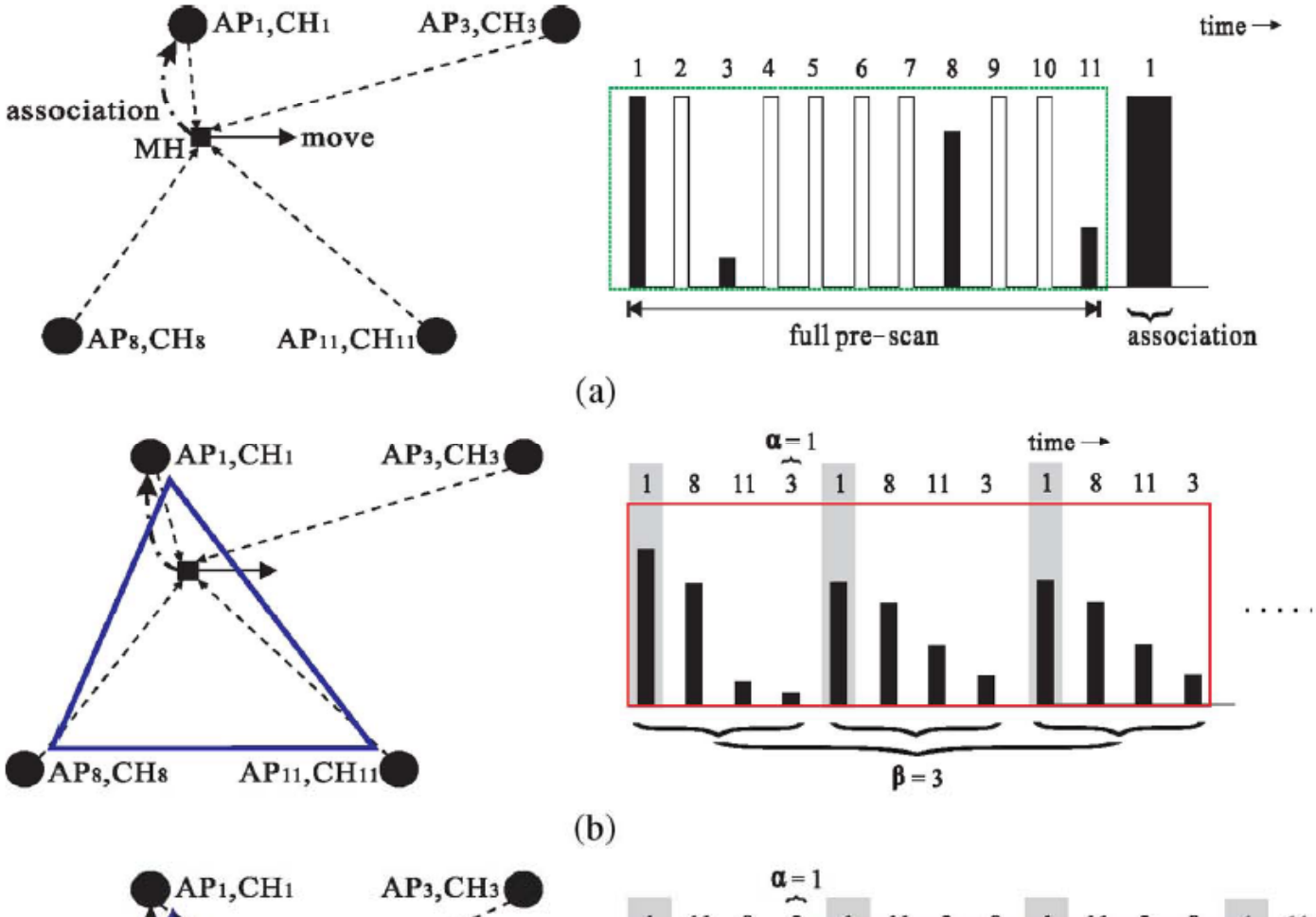
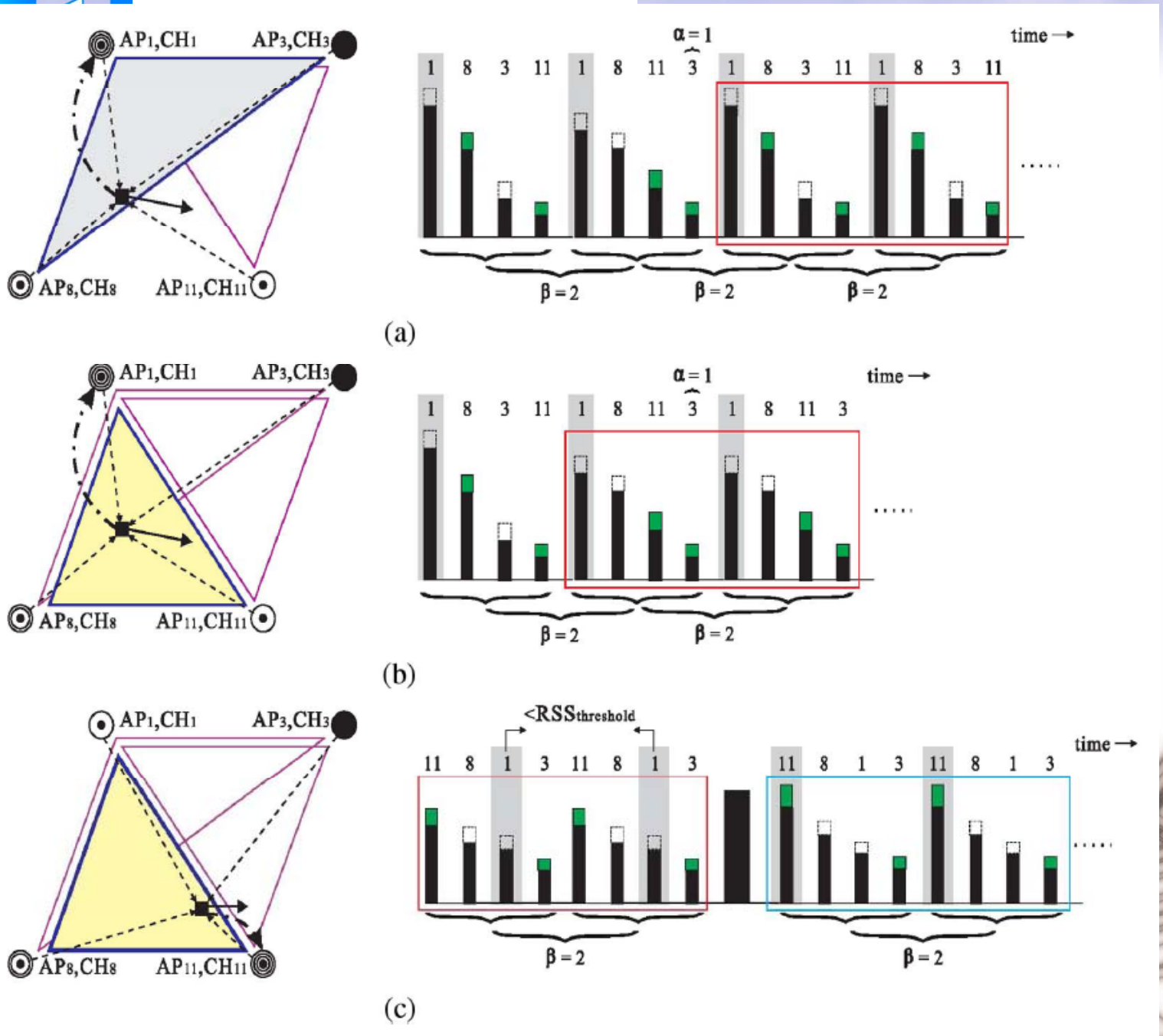


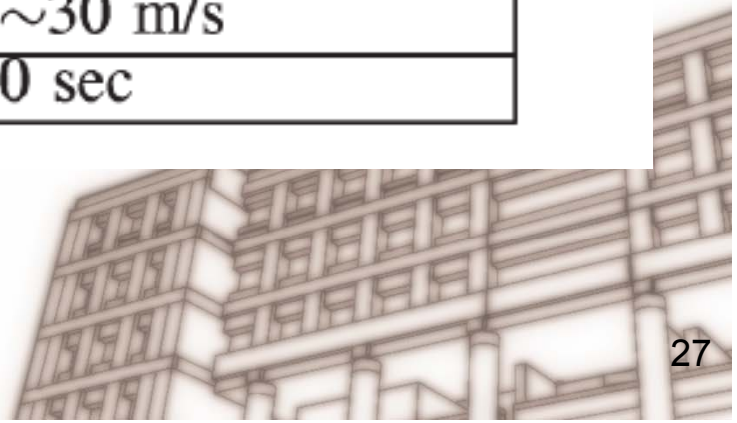
Fig. 7. Applying the DeuceScan scheme.



Simulation results

- Simulator: NCTU-NS simulator
  - Simulation parameters

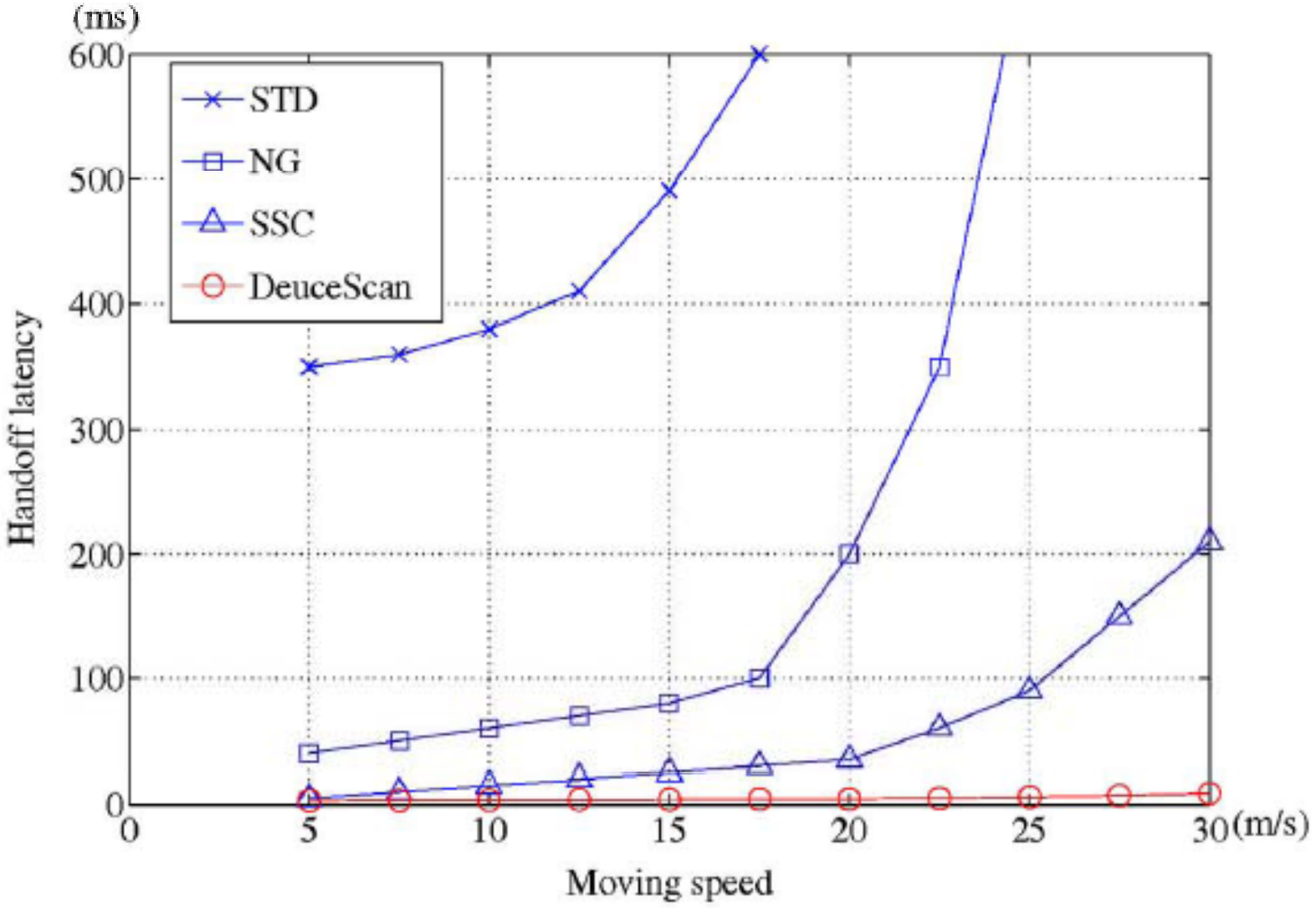
Parameter	Value
Number of mobile hosts	500
Number of access points	100~200
Network region	1000 m ×1000 m
Radio propagation range	100 m
Mobility of mobile hosts	5~30 m/s
Pause time of mobile hosts	10 sec



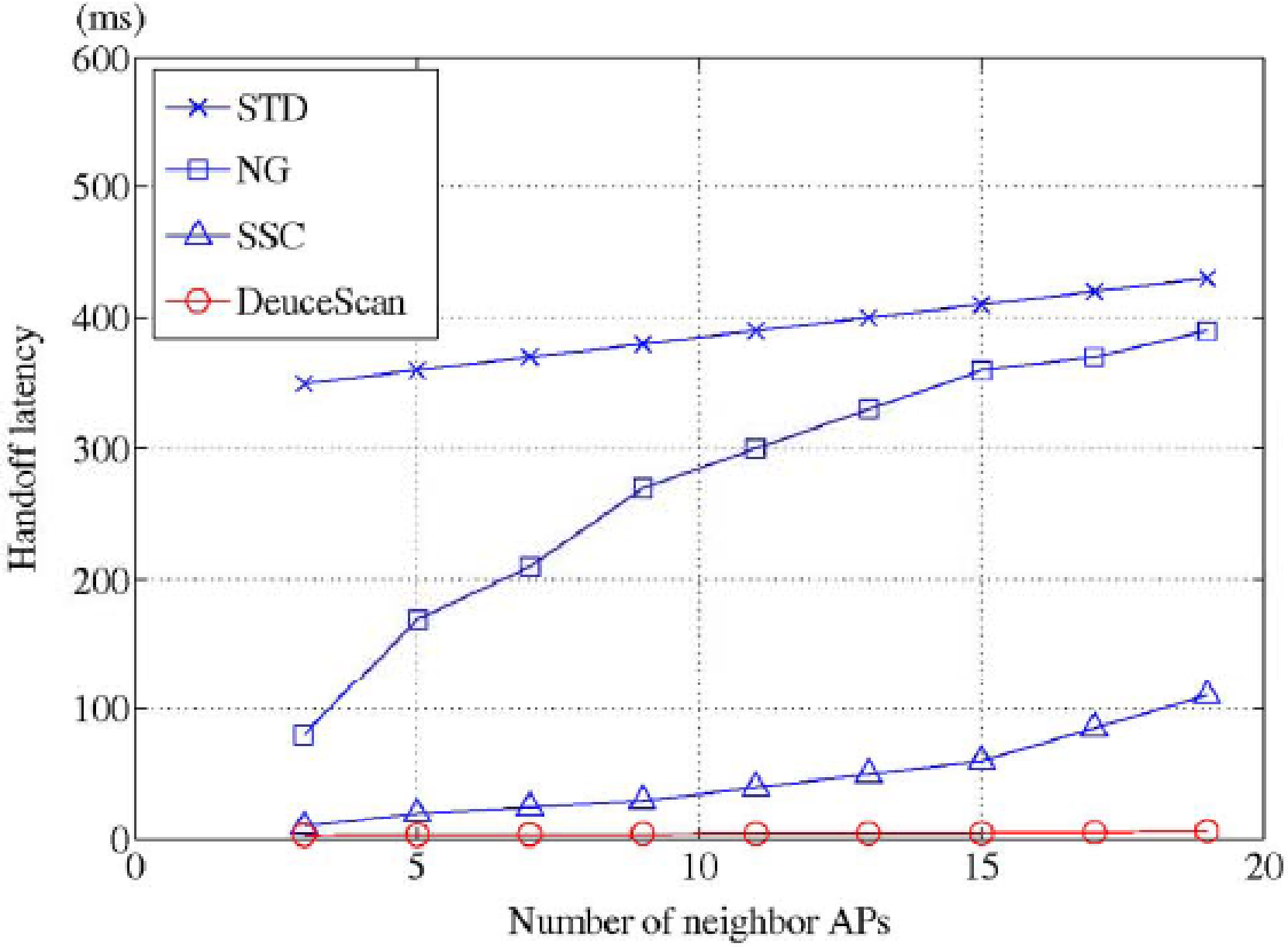
Performance metrics

- *Handoff latency*
  - A delay time between an MH moving its association from one AP to another.
- *Packet loss*
  - The number of all lost packets during handoff of an MH.
- *Link quality*
  - The average received signal strength of an MH during a period of time.

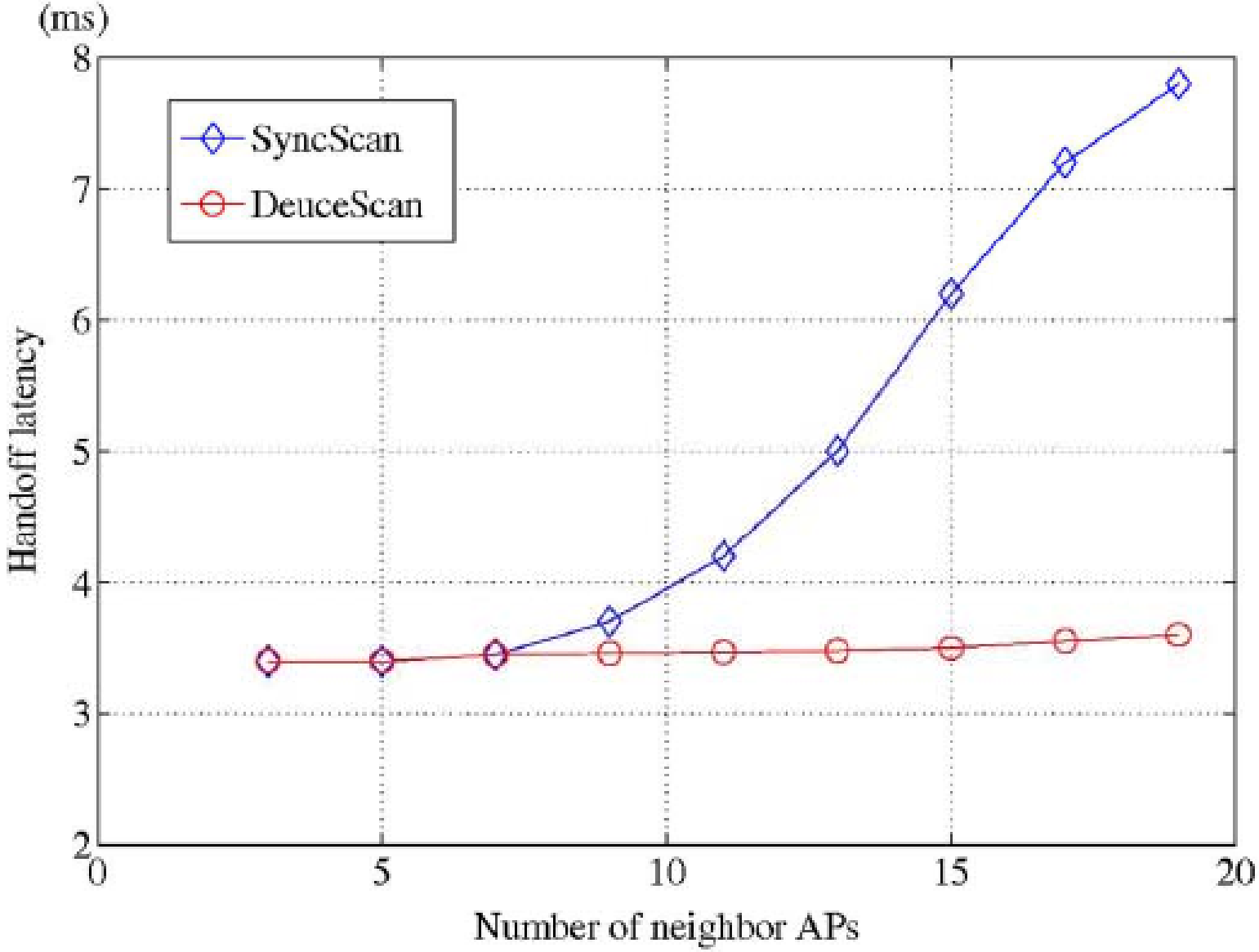
Handoff Latency vs. Speed



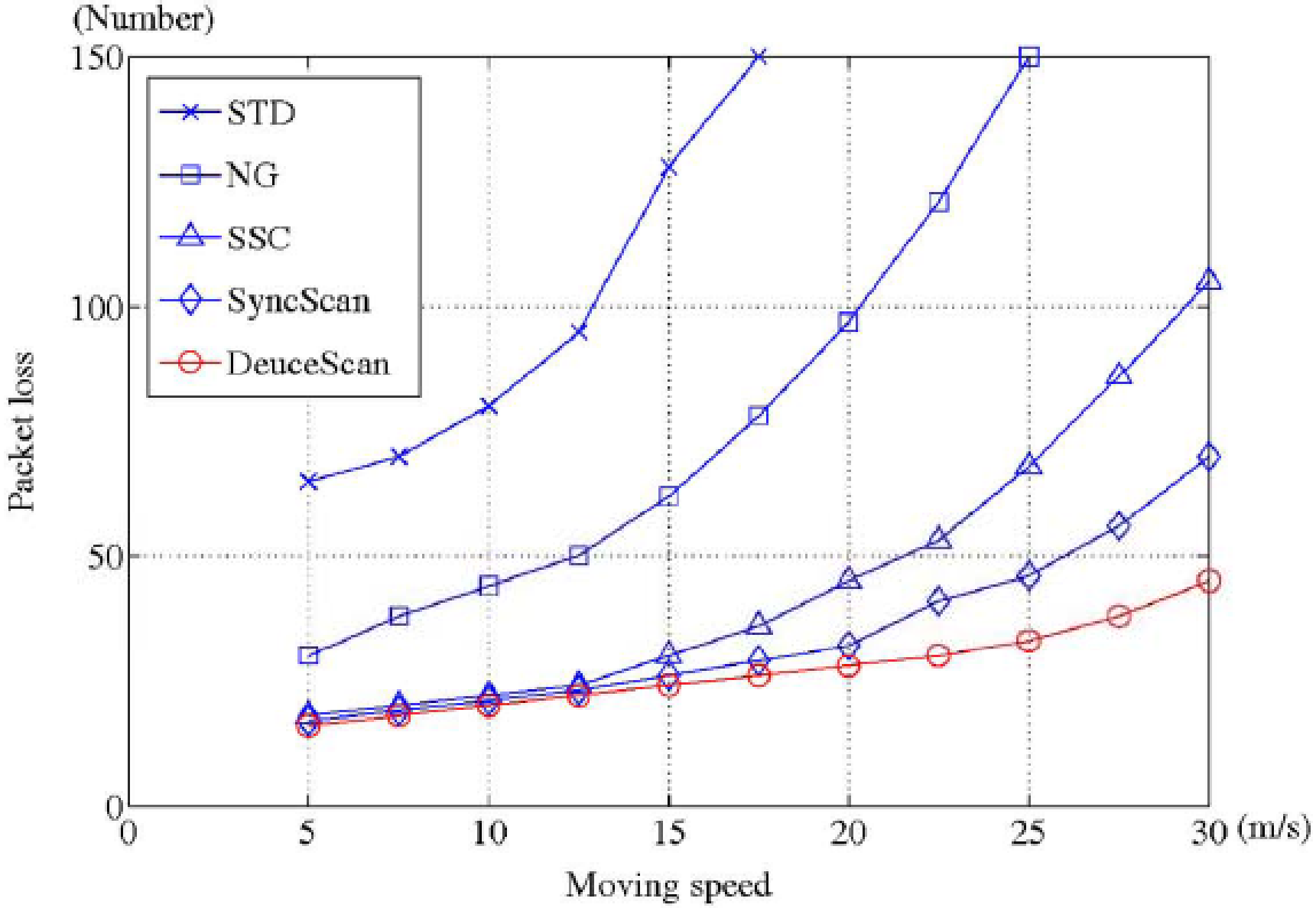
Handoff Latency vs. # of APs



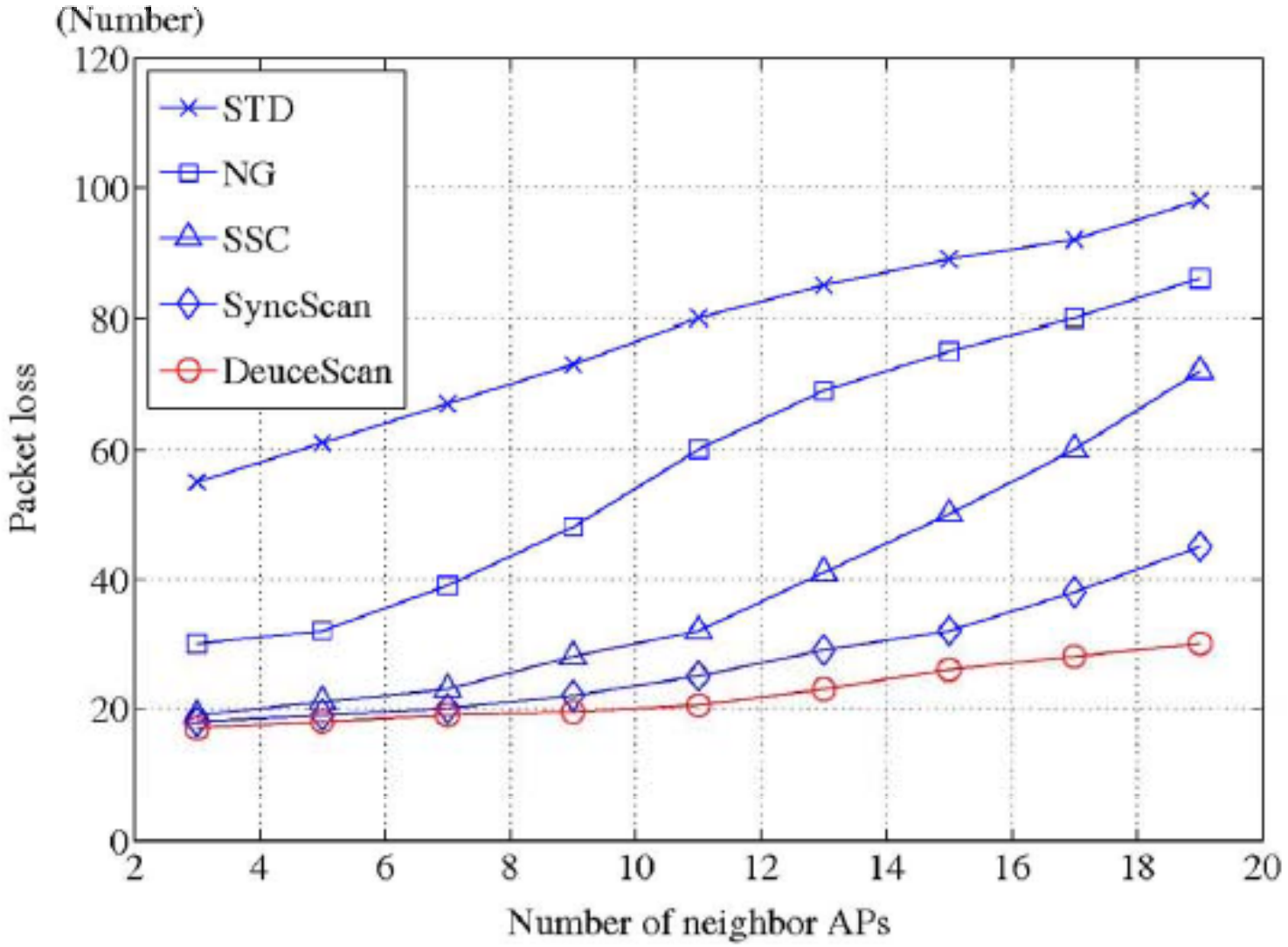
Handoff Latency vs. Speed



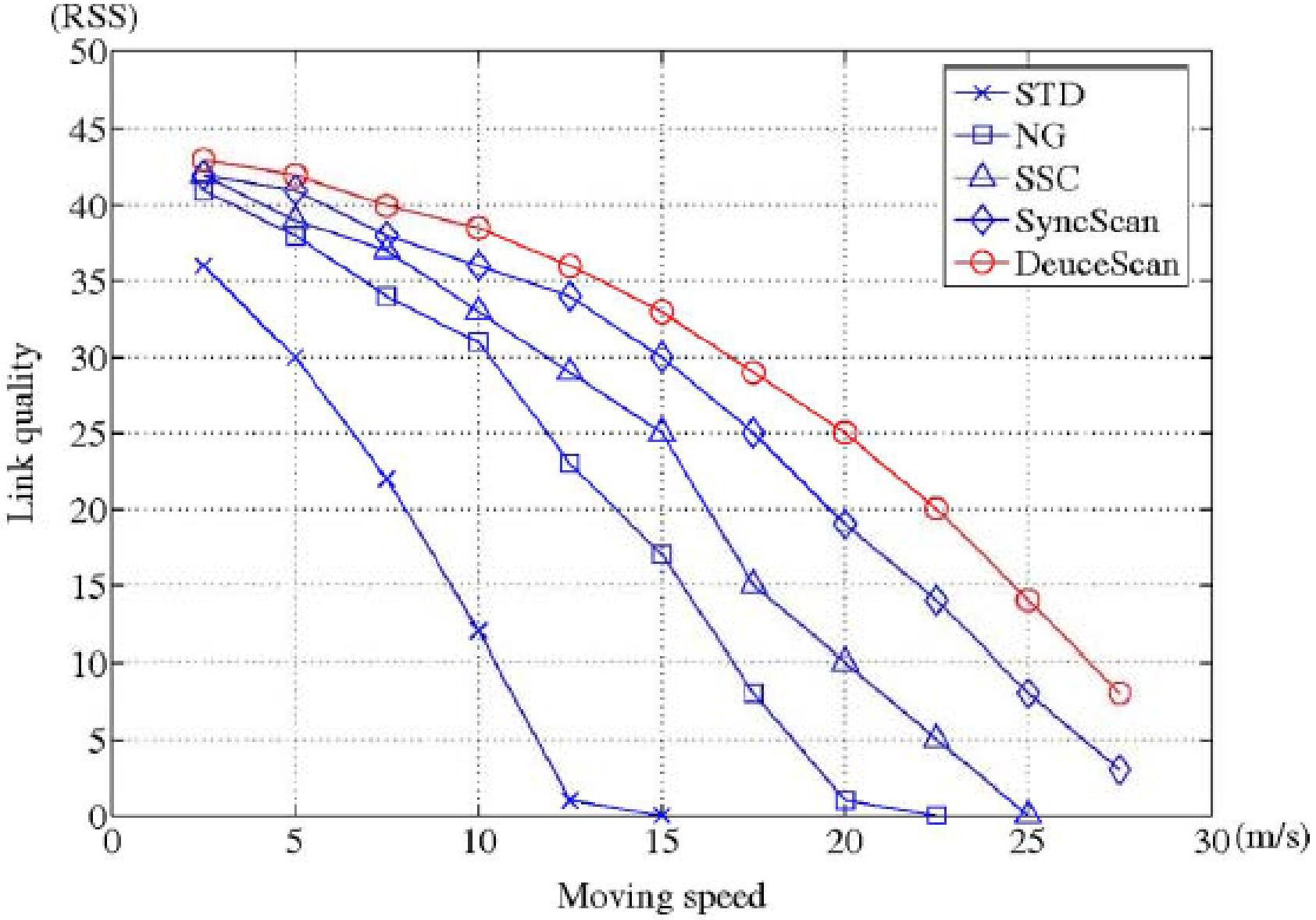
Packet Loss vs. Speed



Packet Loss vs. Number Neighbor of APs



Link Quality vs. Speed



Conclusions

- This paper presents a new fast handoff scheme, called DeuceScan, to reduce the probe delay for 802.11-based WLANs.

- A spatiotemporal approach is developed in DeuceScan scheme to utilize spatiotemporal graph to provide the spatiotemporal information for making better handoff decisions to exactly search for the next AP.

Layer-2/3 Fast Handoff Mechanism for VoWi-Fi

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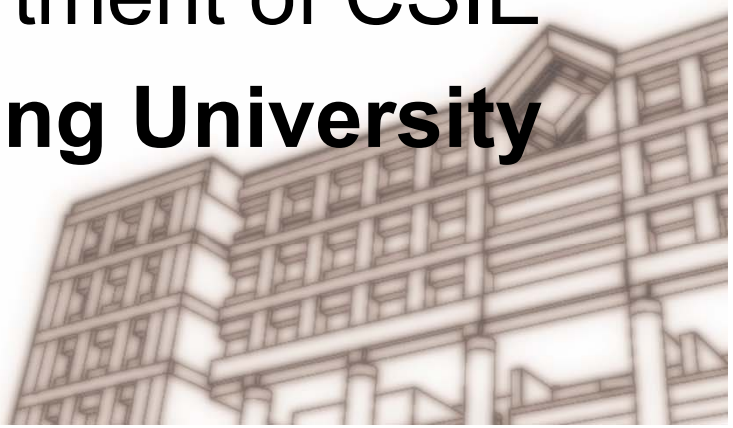
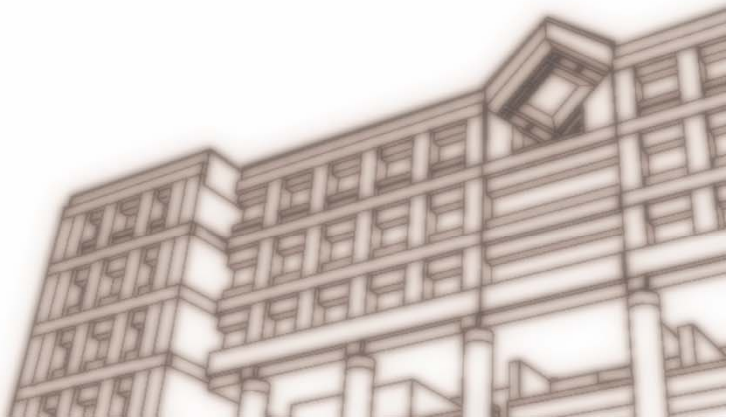


Outline

- Introduction
- Our Layer-2 Solution: **DeuceScan**
- Our Layer-3 Solution:
  P2P Mechanism based on HMIPv6
- Cross-Layer Design
- Experiment Results
- Demonstration
- Conclusion



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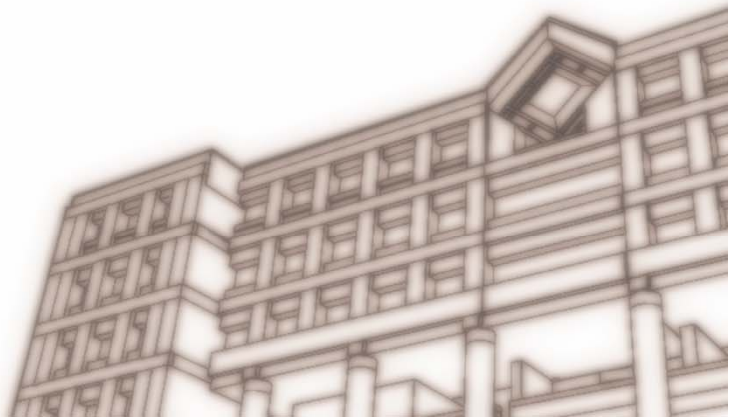
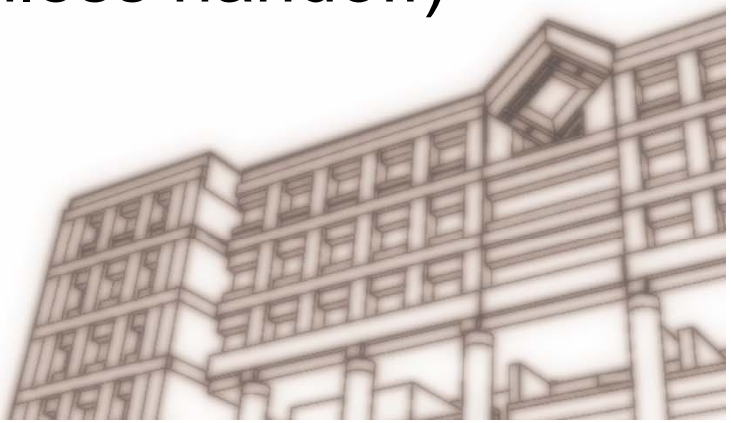


Introduction

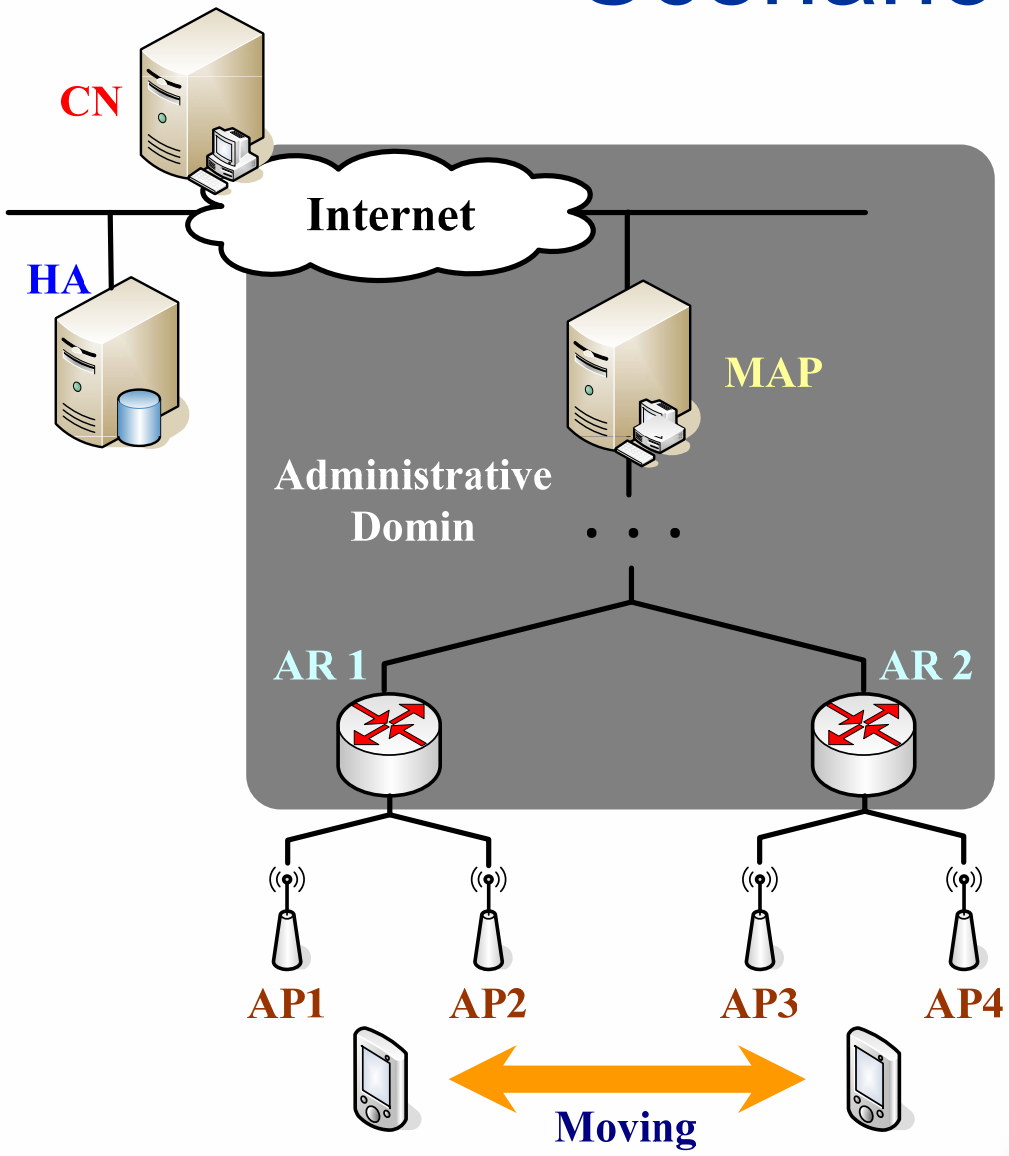
- To support VoIP (SIP service) over Wi-Fi wireless networks
- To develop a new Layer-2/3 Fast Handoff Mechanism for VoWi-Fi with
  - A cross-layer design (layer-2/layer-3)
  - Low handoff latency (seamless handoff)
  - Keeping session



Our New Achievements

- Layer-2/3 Fast Handoff Mechanism for VoWi-Fi to improve the handoff latency
  - Layer-2 handoff: DeuceScan scheme
  - Layer-3 handoff: Peer-to-Peer fast handoff scheme
  - Low overhead and low handoff latency

Scenario



MAP: Mobility Anchor Point
AR: Access Router
HA: Home agent
CN: Corresponding Node

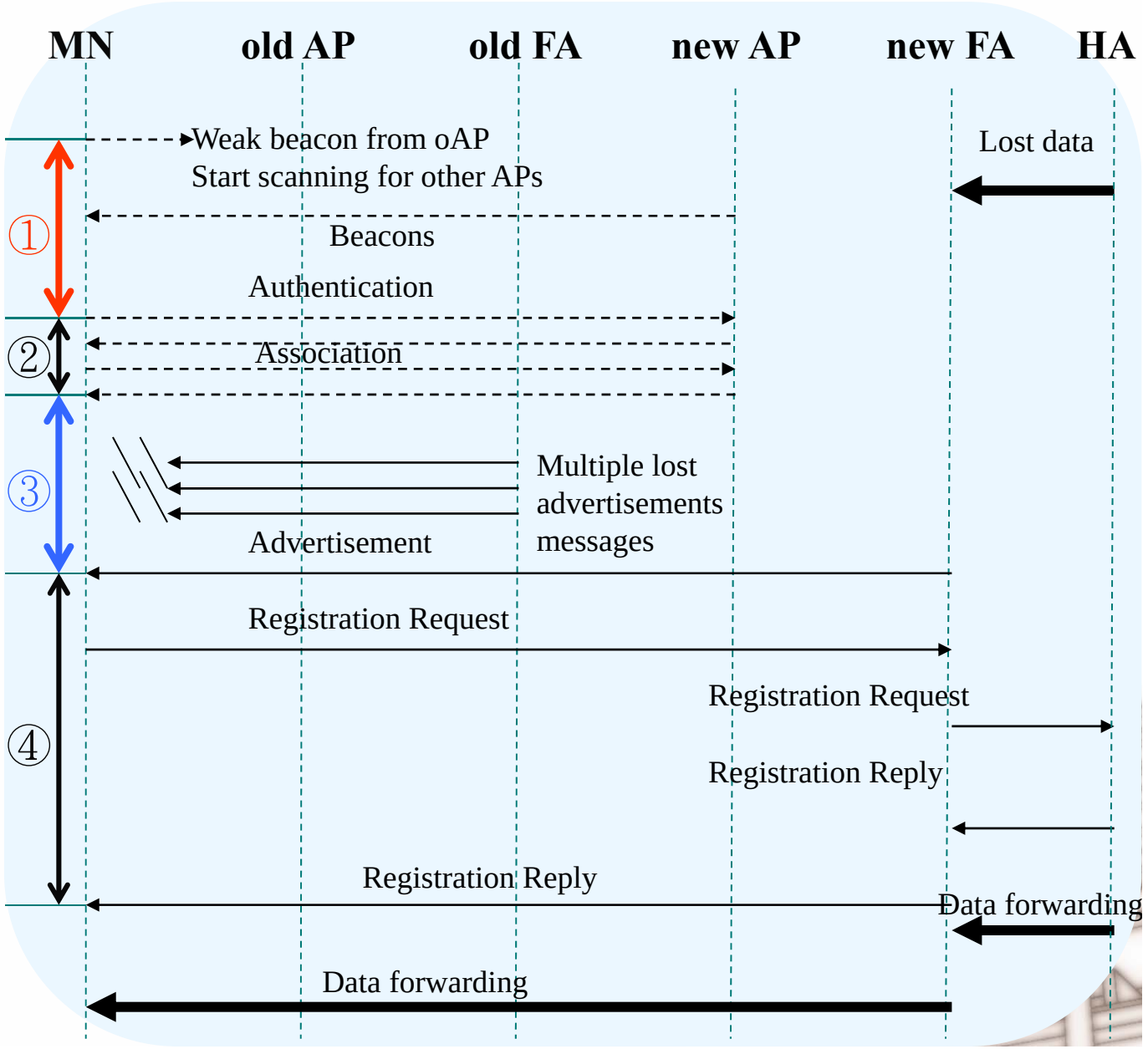
Layer-2/3 Handoff Latency over WLAN

① Delay due to 802.11 channel scanning for new APs

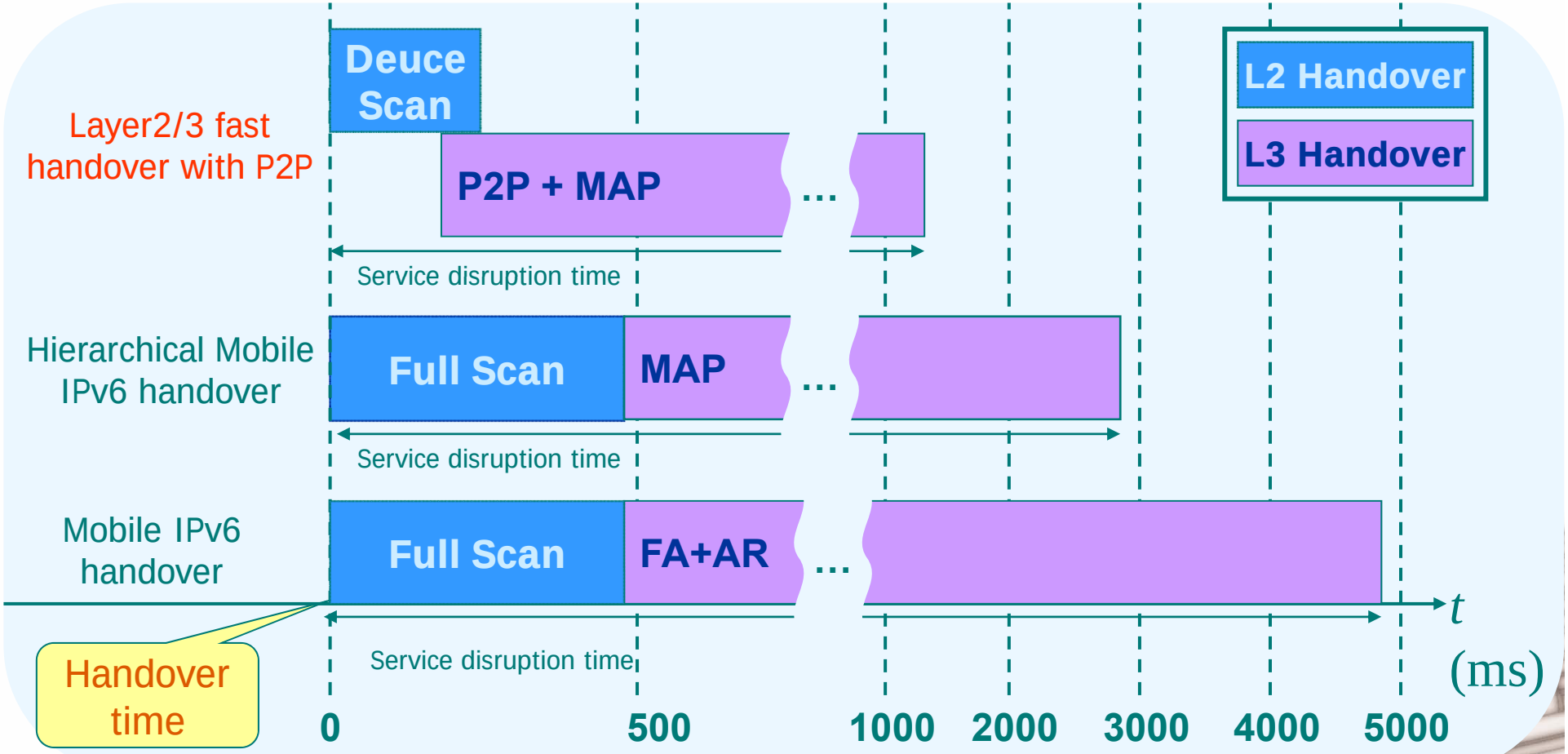
② Delay due to the 802.11 authentication / association procedure

③ Delay due to IP layer movement detection

④ Delay due to the Mobile IP registration procedure



Objectives


Layer2/3 fast handover with P2P
Deuce Scan
P2P + MAP
Service disruption time
Hierarchical Mobile IPv6 handover
Full Scan
MAP
Service disruption time
Mobile IPv6 handover
Full Scan
FA+AR
Service disruption time
Handover time
L2 Handover
L3 Handover
t
(ms)
0
500
1000
2000
3000
4000
5000

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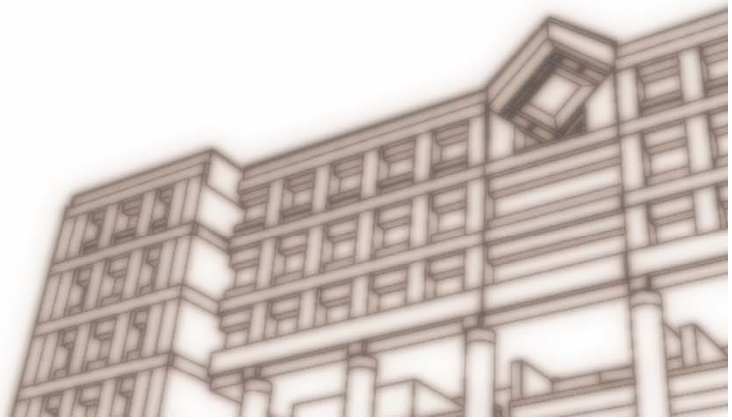
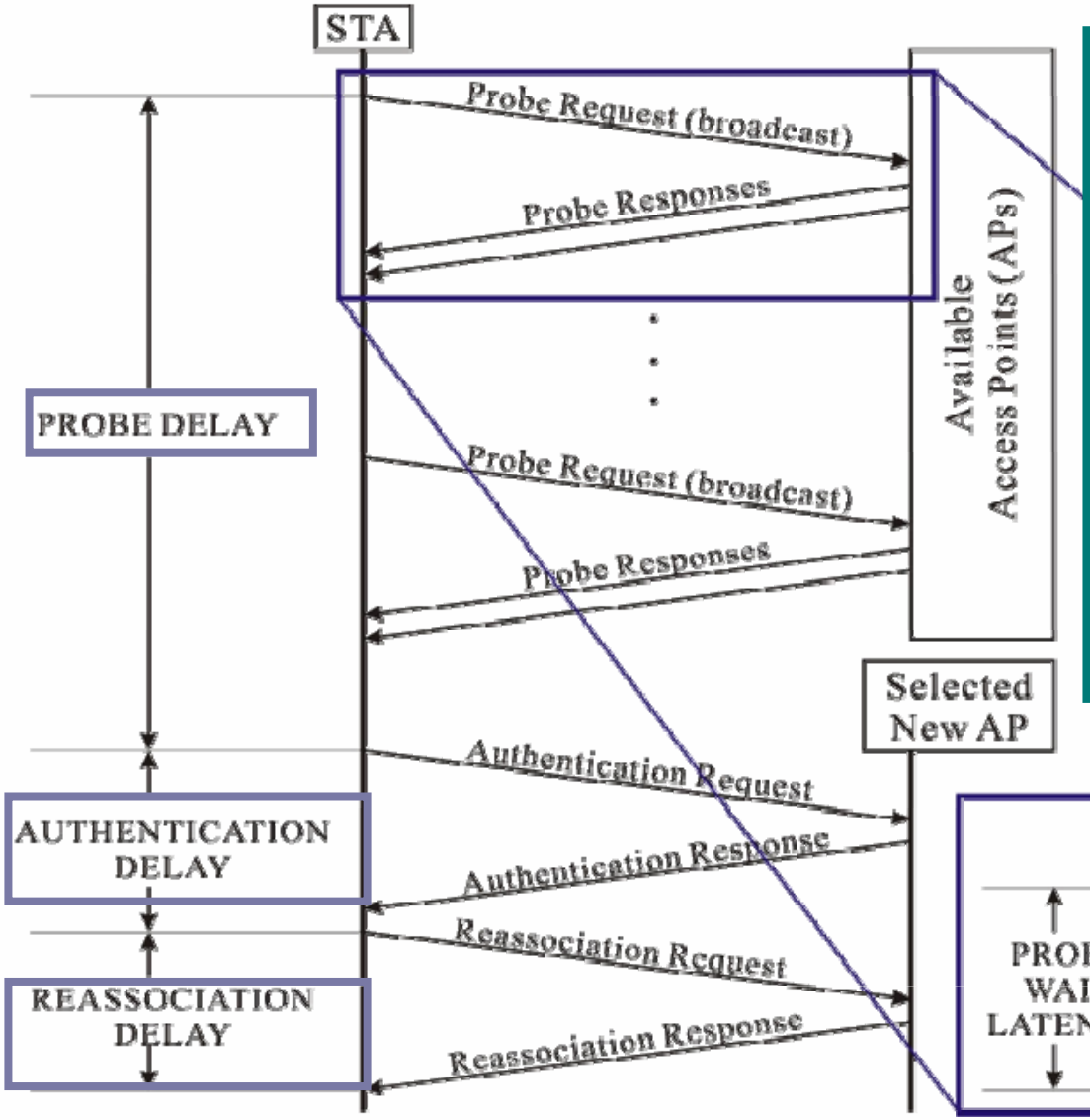
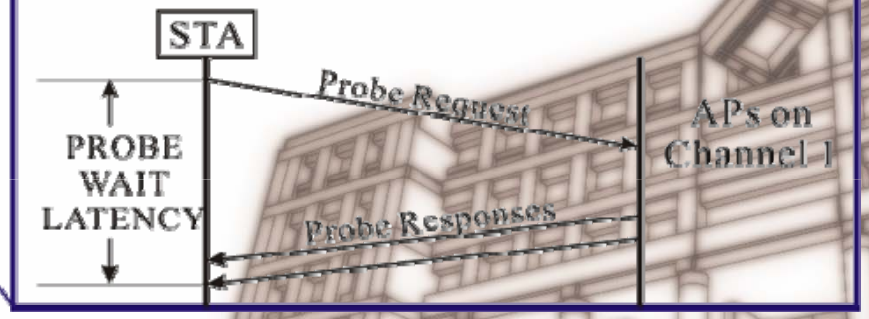


Candidate-AP Detection Function

- To provide useful information to cross layer-2/3 handoff scheme
  - DeuceScan
  - HMIPv6 + P2P
- To identify possible candidate APs
  - To utilize signal strength (variation) and moving history

Two Basic Solution - Layer 2 Handoff Process

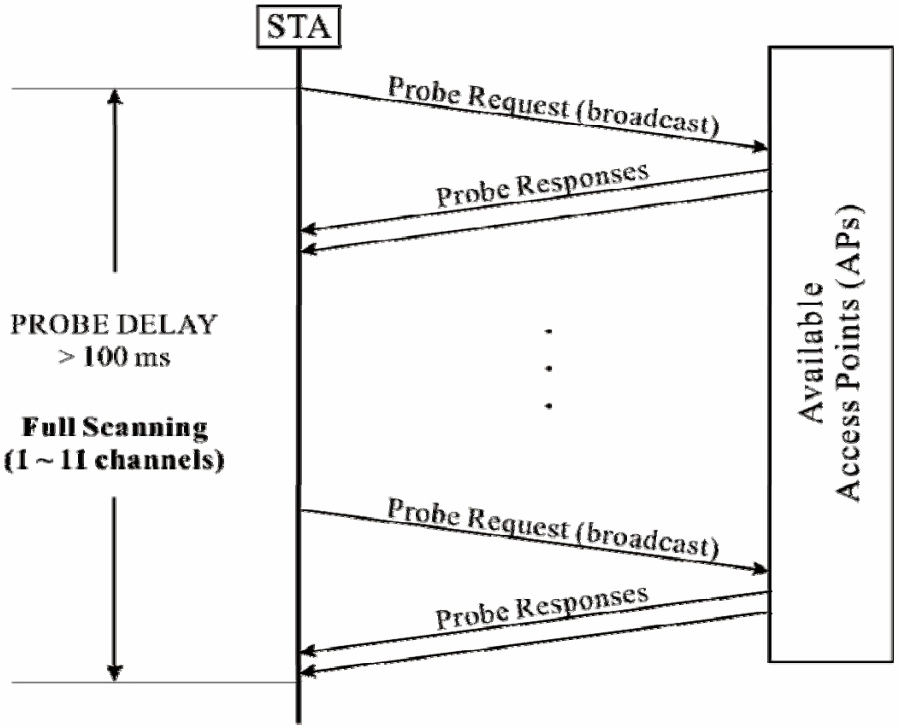




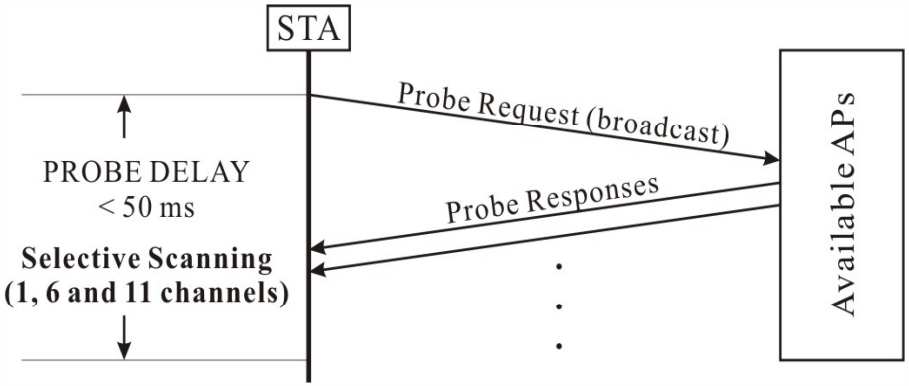
- Probe delay ≈ 300ms ~ 600ms
- Authentication ≈ <40ms
- Reassociation ≈ <20ms
- **Goal：Probe delay < 50 ms**

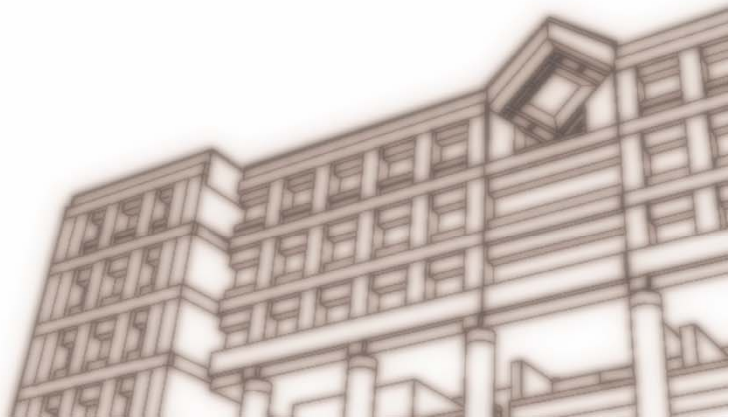
Selective Scanning

Full scanning (1~11 channels)
Probe delay > 200 ms



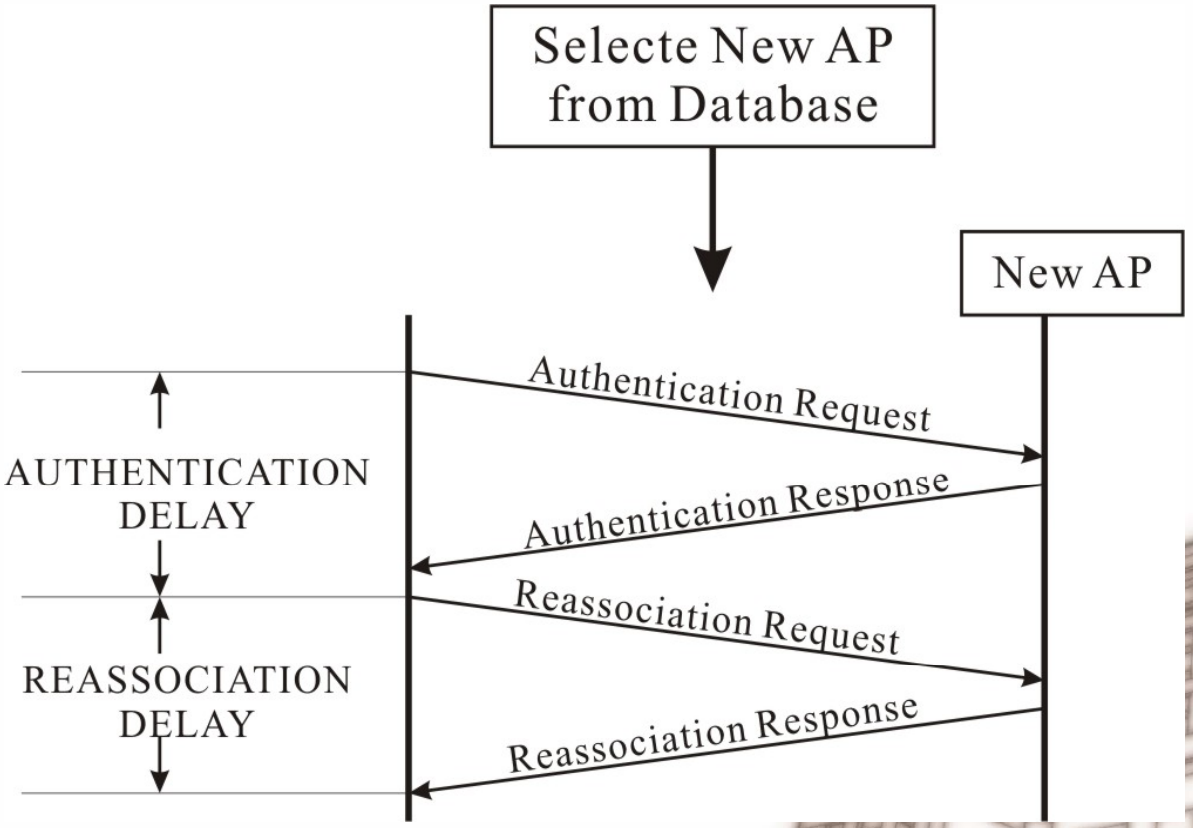
Selective scanning (1, 6 and11 channels)
Probe delay < 100 ms



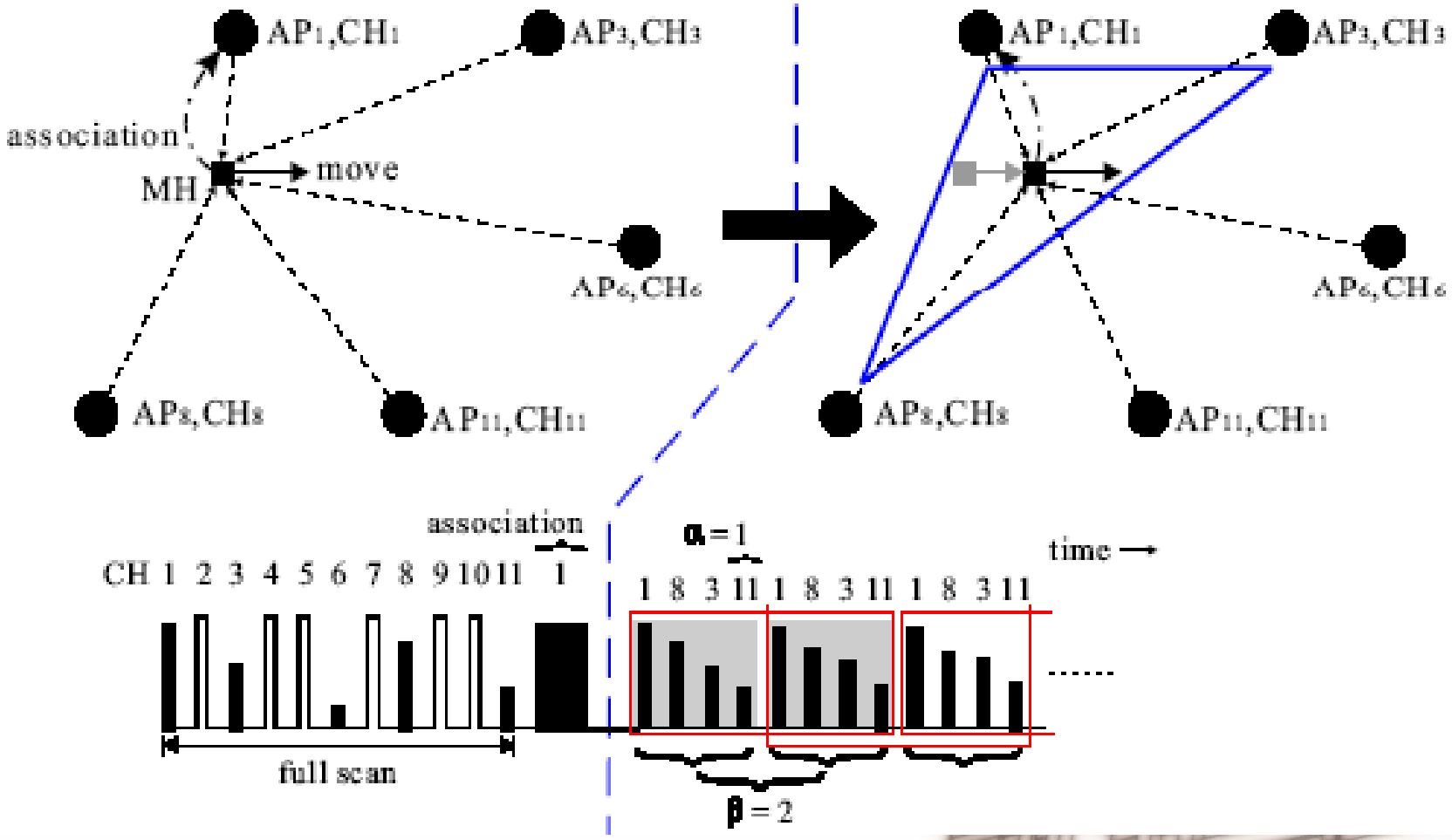


Skip Probe Phase

To monitor the status of APs beforehand



Our Layer 2 Solution: **DeuceScan**



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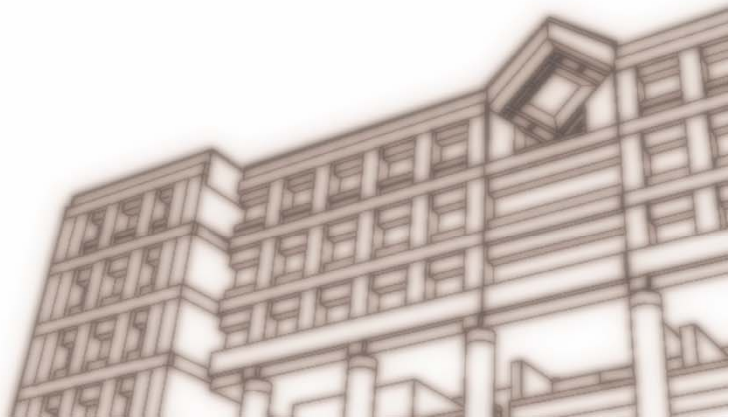
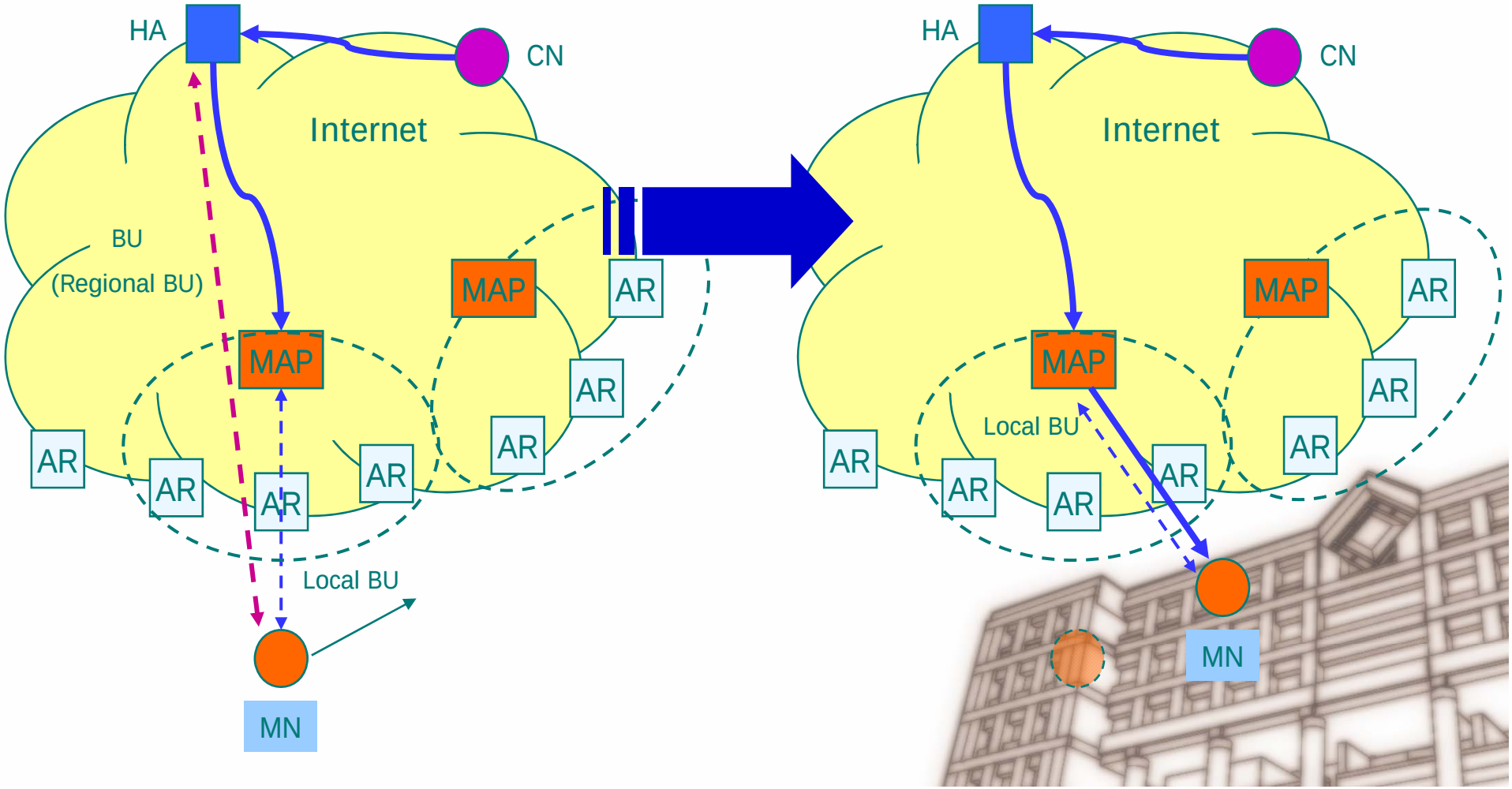
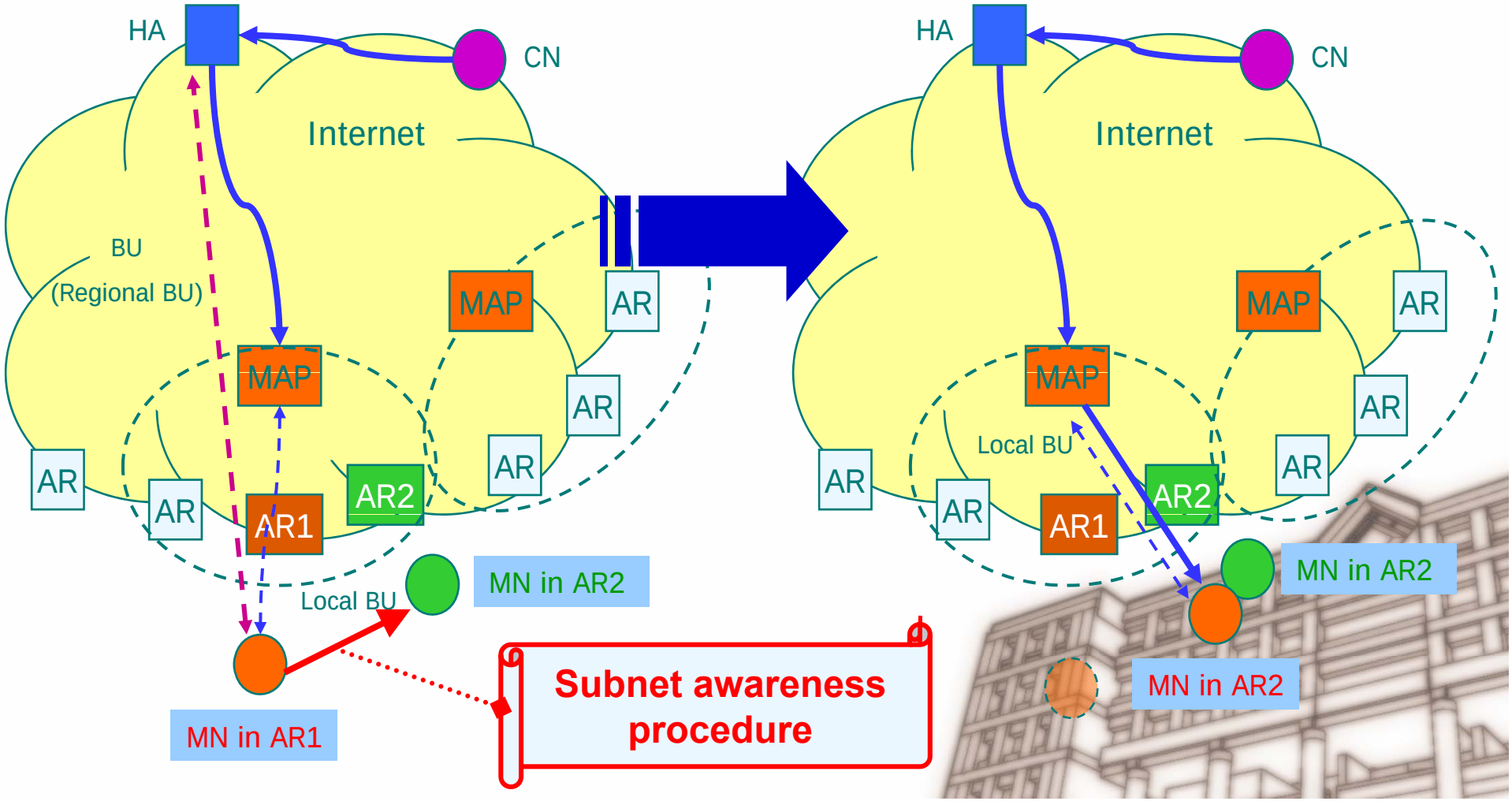


Layer 3: Original HMIPv6 Scheme



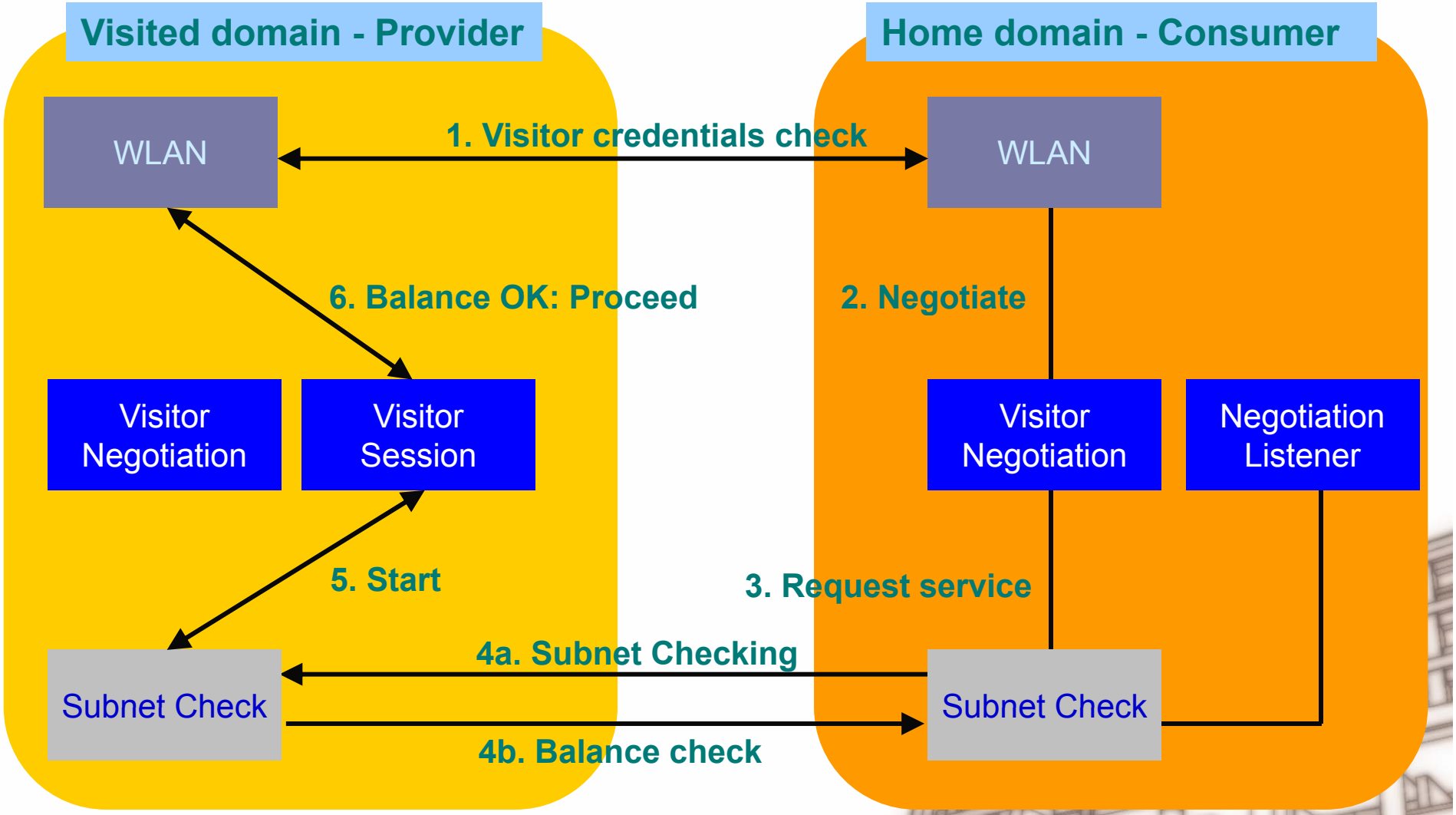
Our Layer 3 Solution:
P2P Mechanism based on HMIPv6



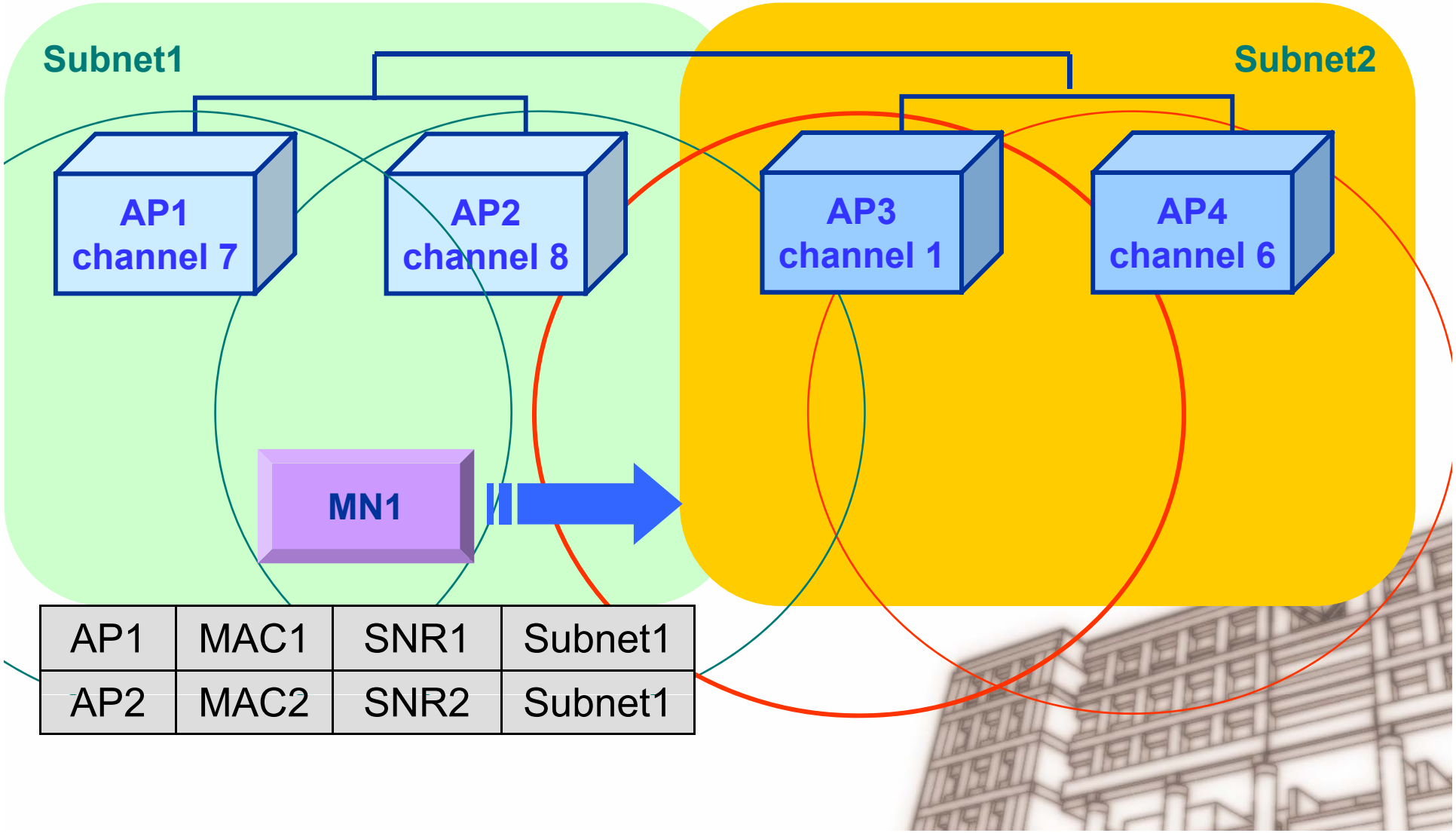
The Handoff Latency of our Scheme

- Current IP and CN IP
- Subnet awareness table
  - Channel
  - MAC
  - SNR
  - Subnet
- Continuously pinging CN
  - Record RTT per 300ms

The Flowchart of P2P Solution

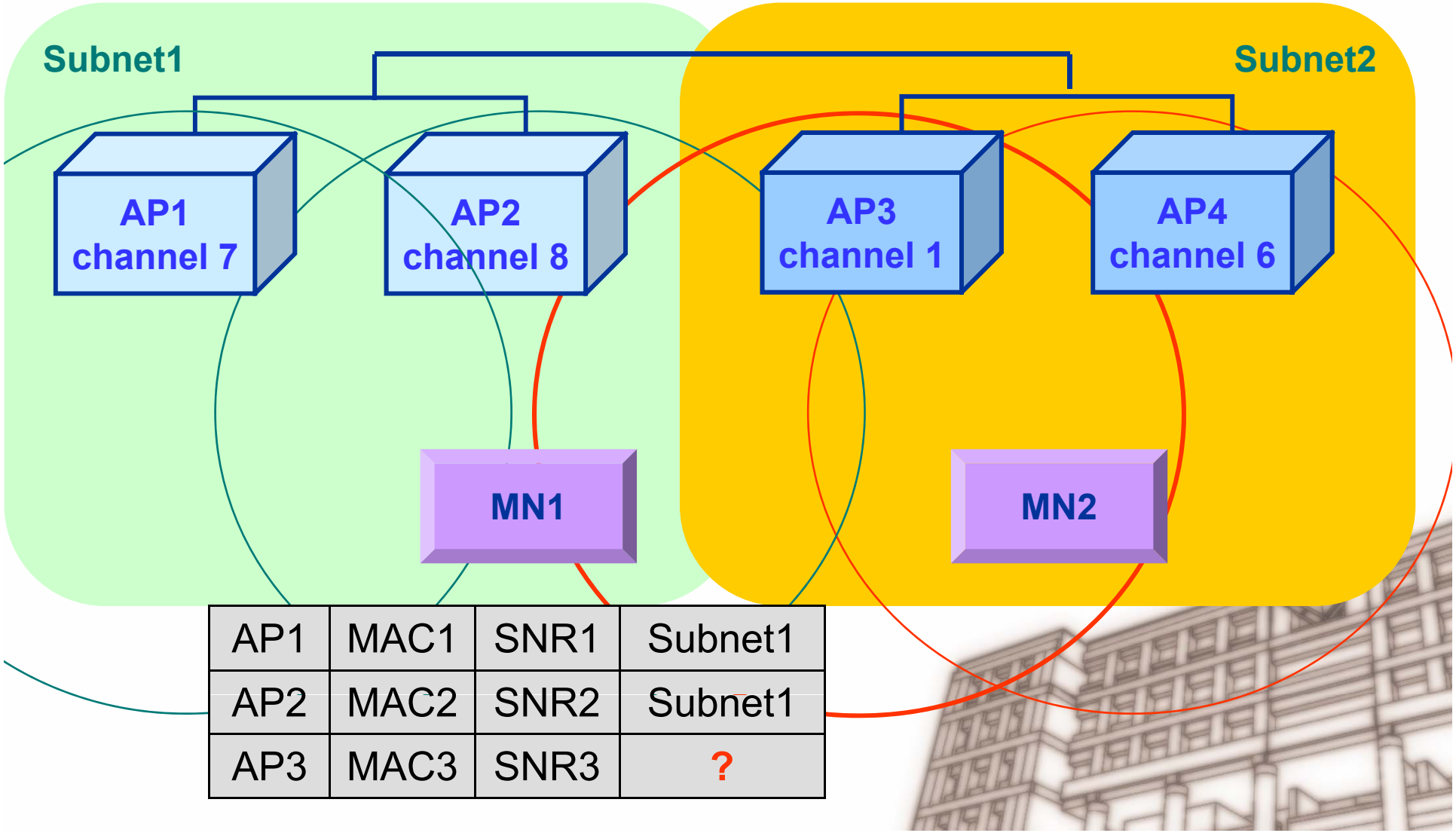


Peer-to-Peer Fast Handoff -
Subnet Awareness Table



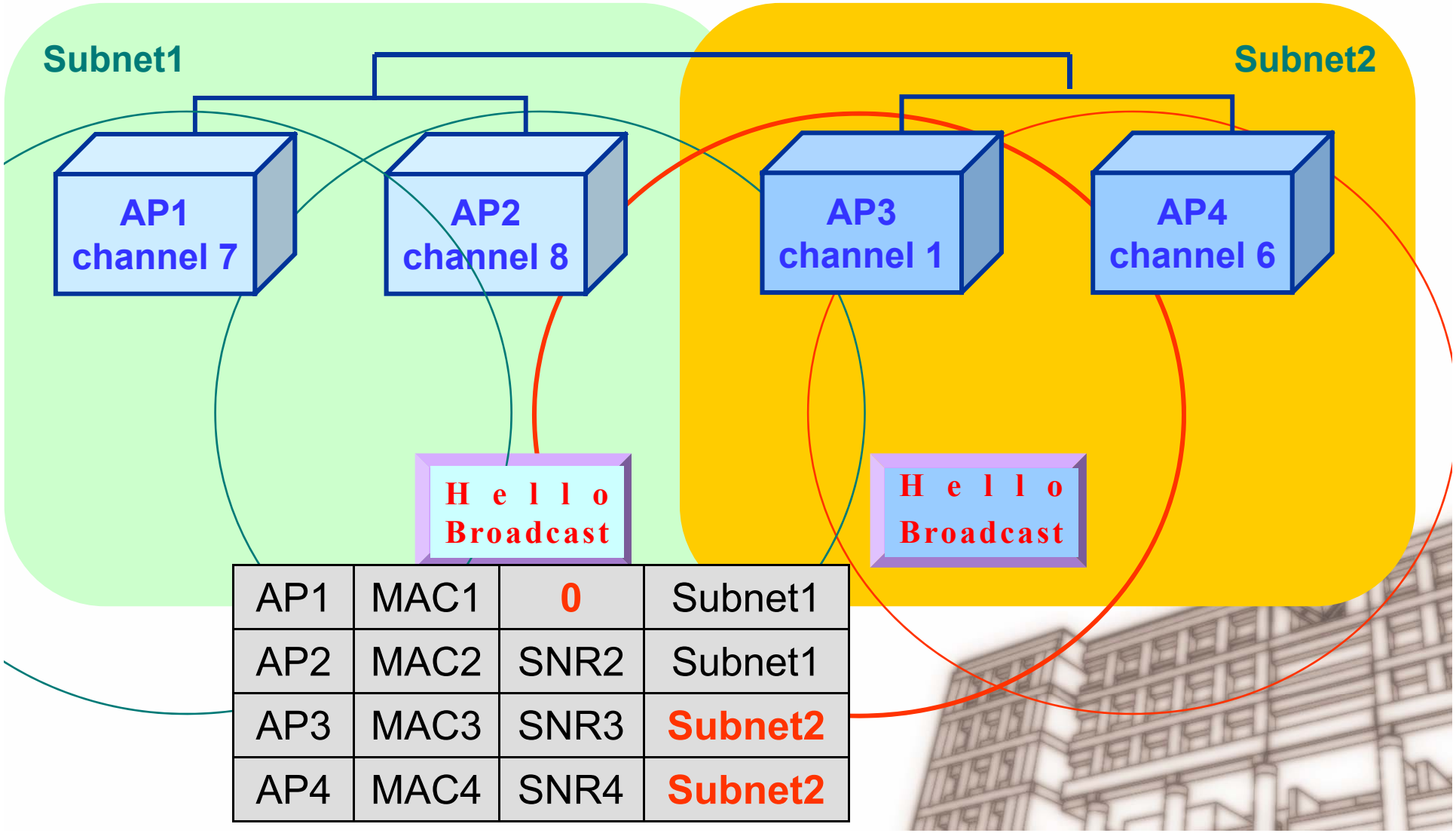
AP1	MAC1	SNR1	Subnet1
AP2	MAC2	SNR2	Subnet1

Peer-to-Peer Fast Handoff -
Subnet Awareness Table



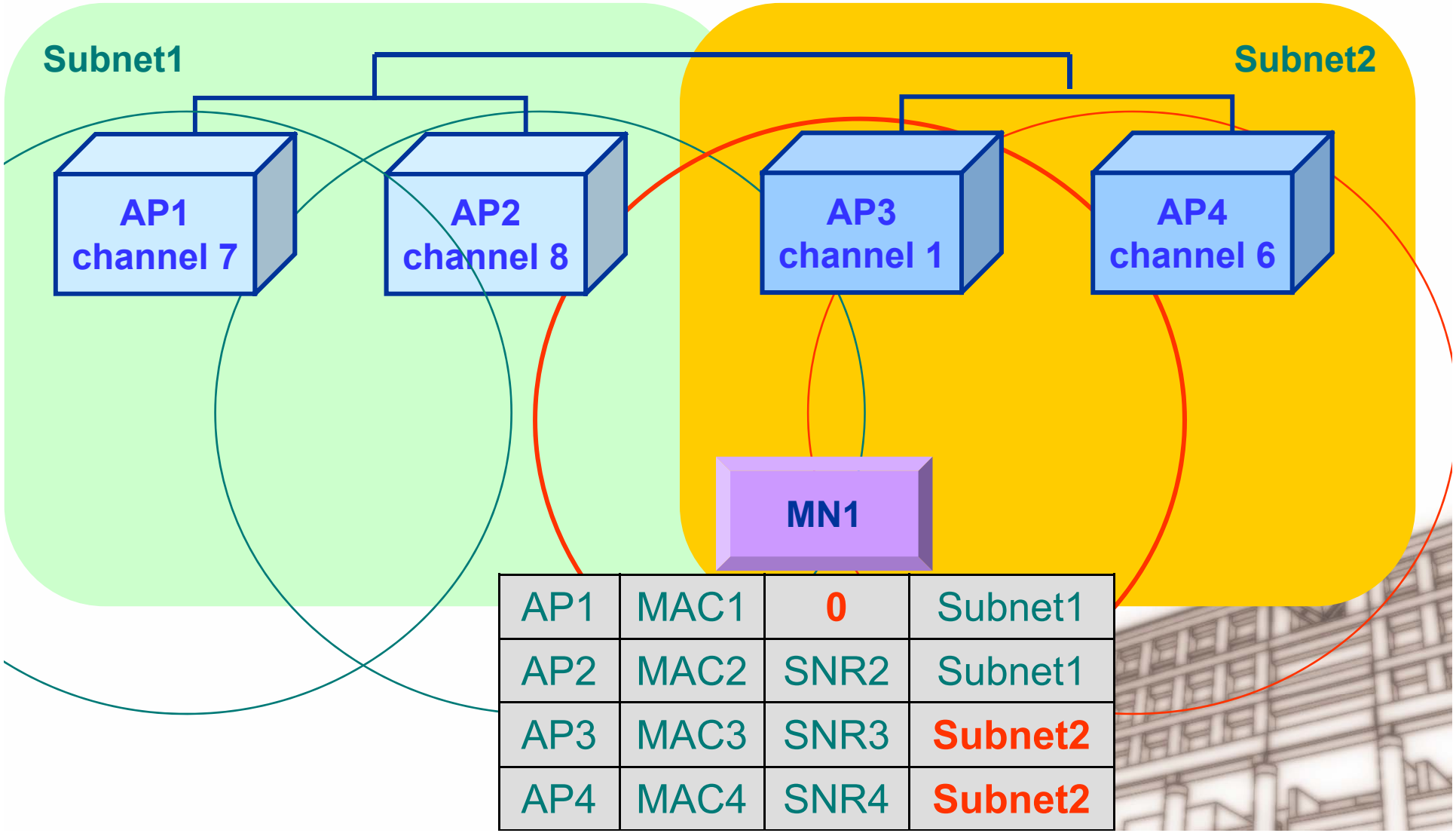
AP1	MAC1	SNR1	Subnet1
AP2	MAC2	SNR2	Subnet1
AP3	MAC3	SNR3	?

Peer-to-Peer Fast Handoff -
Subnet Awareness Table



AP1	MAC1	0	Subnet1
AP2	MAC2	SNR2	Subnet1
AP3	MAC3	SNR3	Subnet2
AP4	MAC4	SNR4	Subnet2

Peer-to-Peer Fast Handoff -
Subnet-Awareness Table



AP1	MAC1	**0**	Subnet1
AP2	MAC2	SNR2	Subnet1
AP3	MAC3	SNR3	**Subnet2**
AP4	MAC4	SNR4	**Subnet2**

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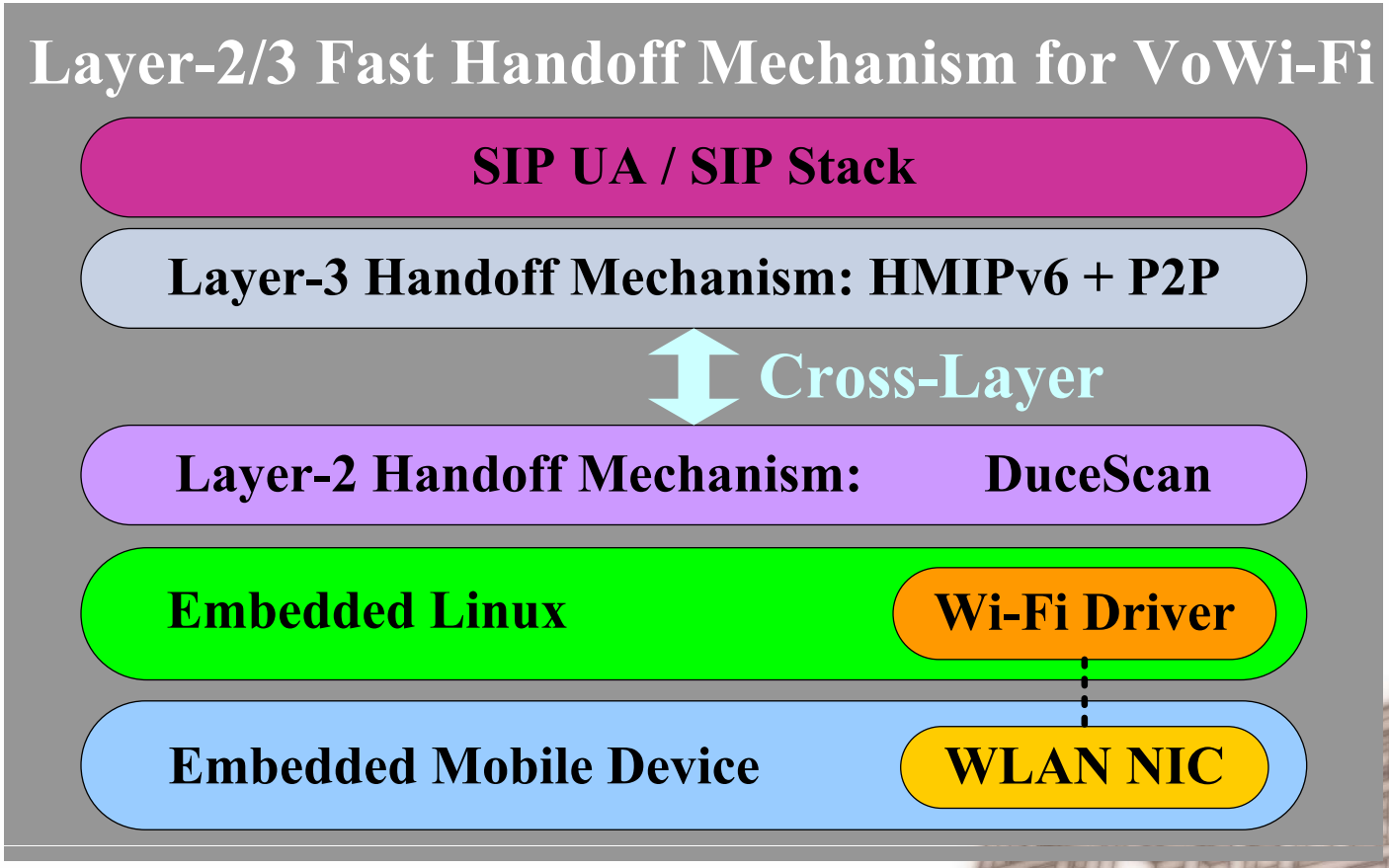
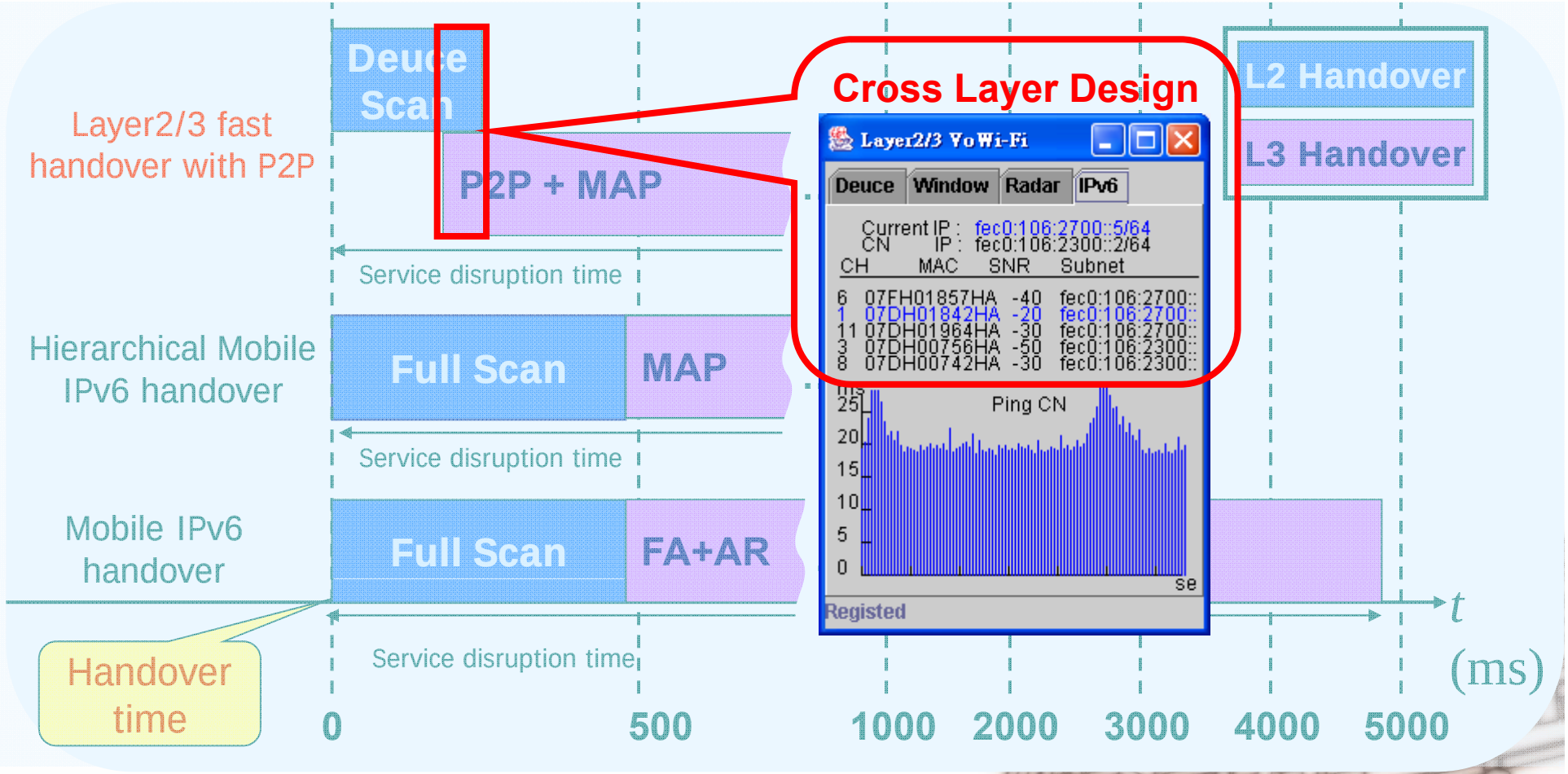
Cross-Layer Design



Comparisons of Handoff Latency



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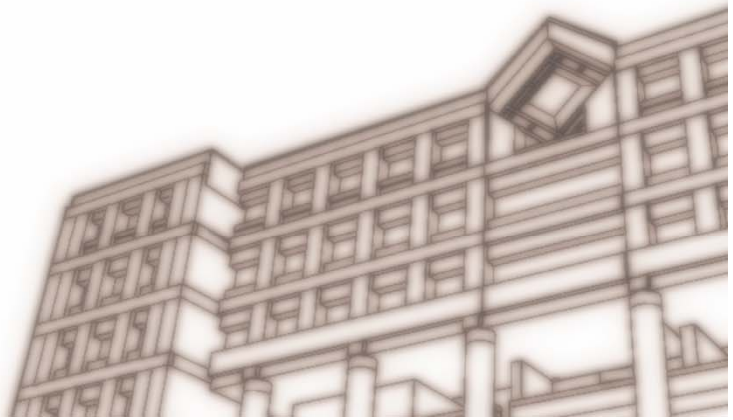
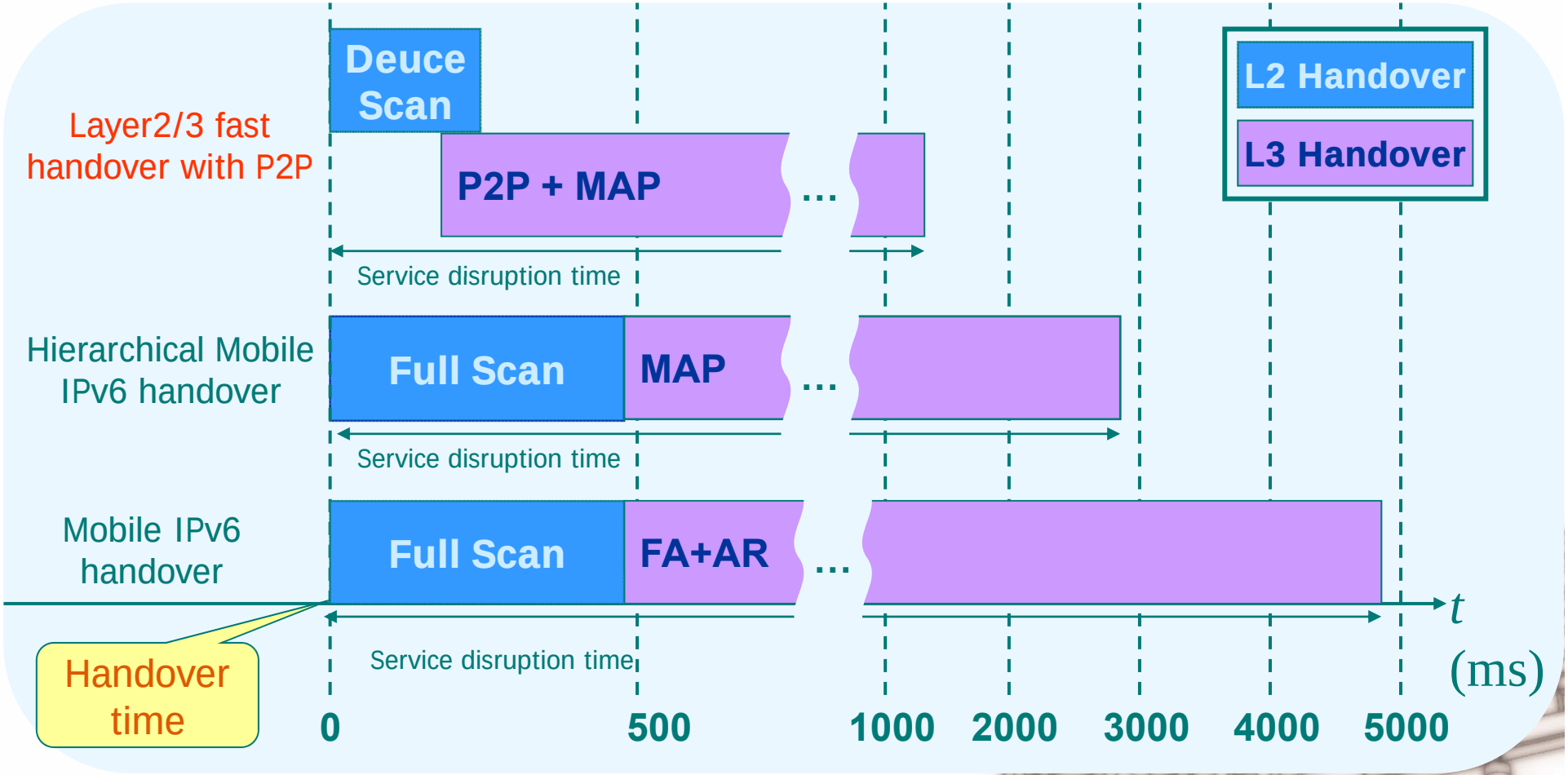
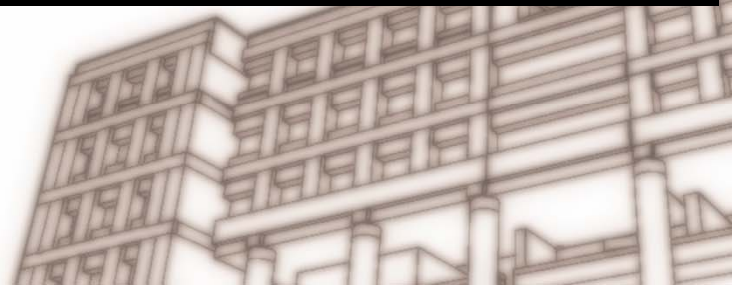


Comparisons of Handoff Latency



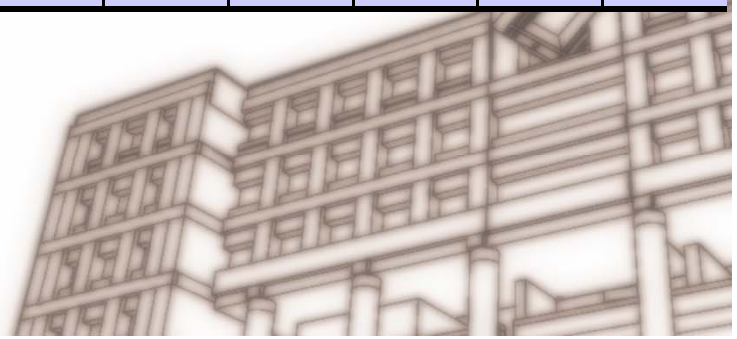
Layer-2 and Layer-3 Handover Latency

The comparison of handover delay (ms)												
	Experiment	1	2	3	4	5	6	7	8	9	10	Avg.
Layer-2	Full scan	457	236	434	317	566	321	241	364	216	274	343
	DeuceScan	**140**	**101**	**141**	**140**	**137**	**139**	**143**	**94**	**142**	**101**	**129**
Layer-3	MIPv6	4963	6606	4814	6637	5457	6021	5720	5980	6816	6606	5962
	HMIPv6	2383	2864	2498	2327	2214	2634	2901	2970	3052	2833	2668
	HMIPv6 + P2P	**1202**	**1437**	**1304**	**1463**	**1613**	**1444**	**1279**	**1748**	**1624**	**1569**	**1468**

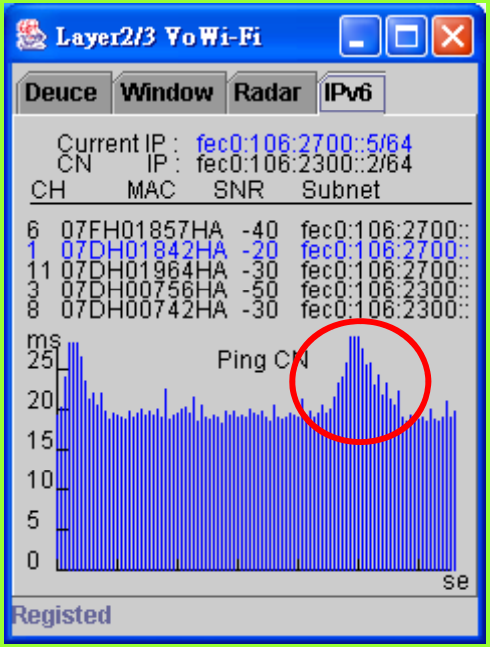


Overall Layer-2/3 Handover Latency

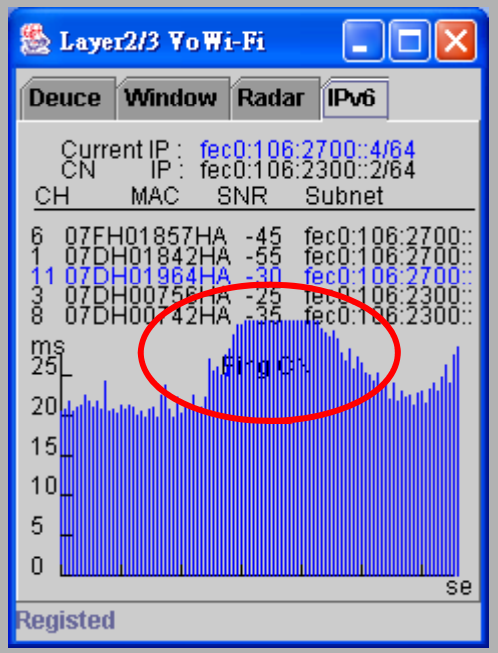
The comparison of layer-2/3 handover delay (ms)												
	Experiment	1	2	3	4	5	6	7	8	9	10	Avg.
Layer-2/3	Full scan + MIPv6	5420	6842	5248	6954	6023	6342	5961	6344	7032	6880	6305
	Full scan + HMIPv6	2840	3100	2932	2644	2780	2955	3142	3334	3268	3107	3010
	DeuceScan + HMIPv6 + P2P	**1342**	**1538**	**1445**	**1603**	**1750**	**1583**	**1422**	**1842**	**1766**	**1670**	**1596**



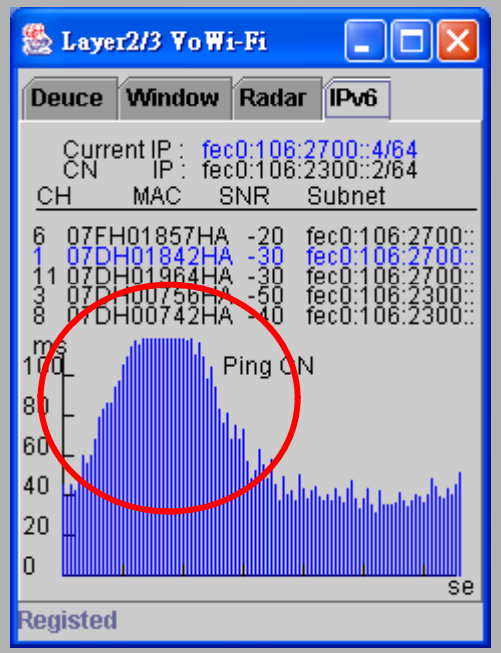
Our Results



DeuceScan + HMIPv6 + P2P



Full scan + HMIPv6



Full scan + MIPv6

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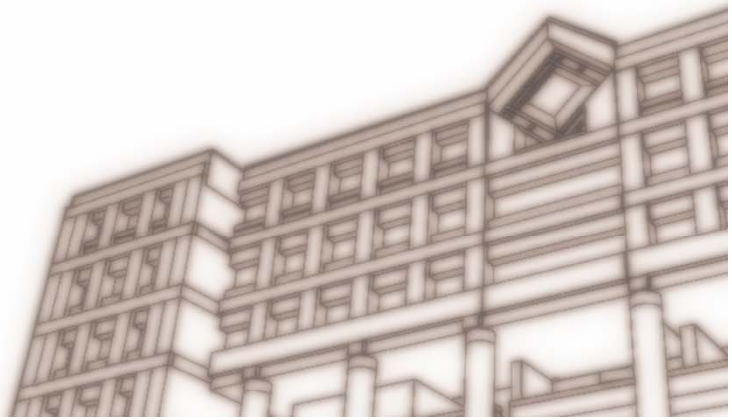
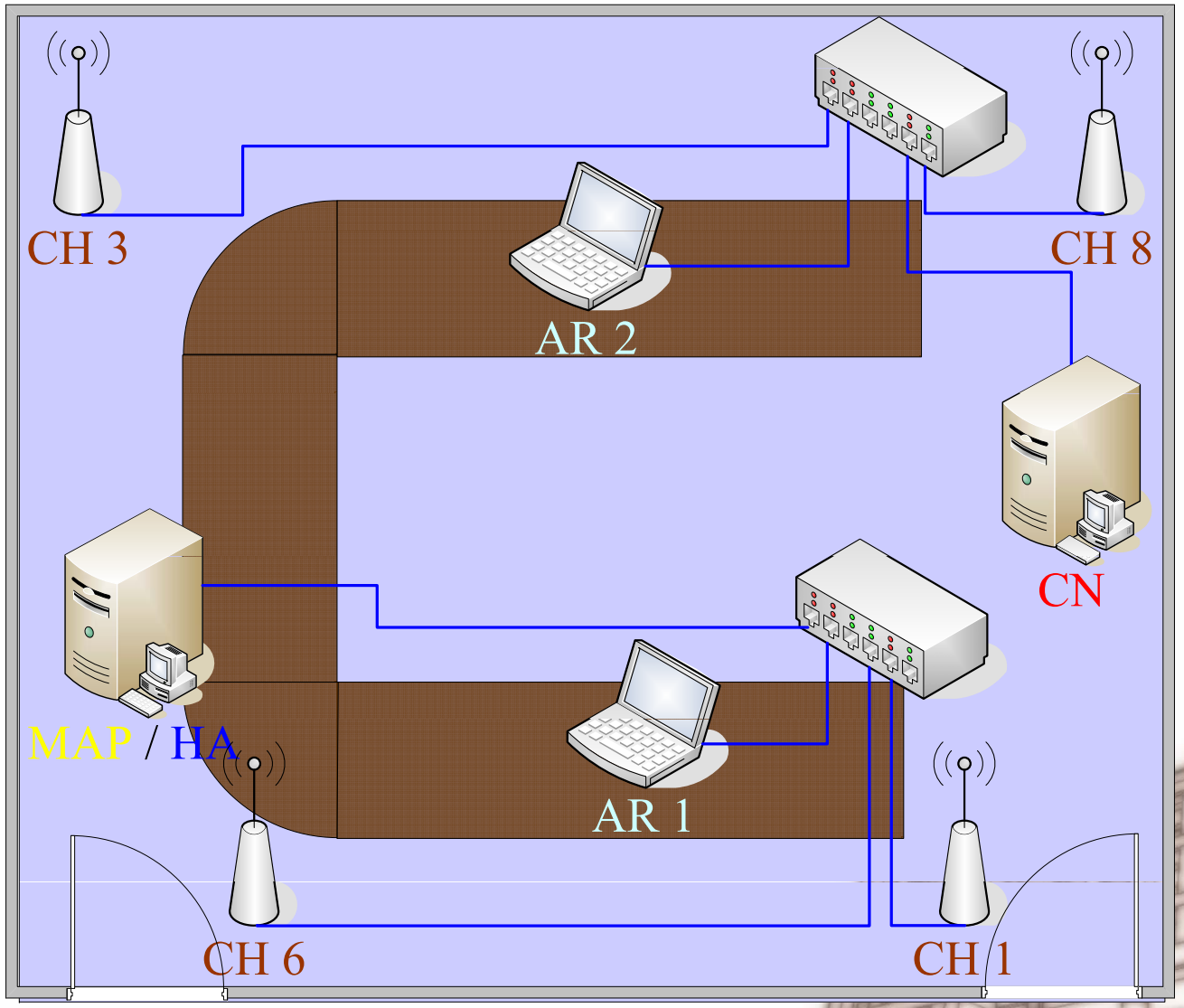


現場佈置圖



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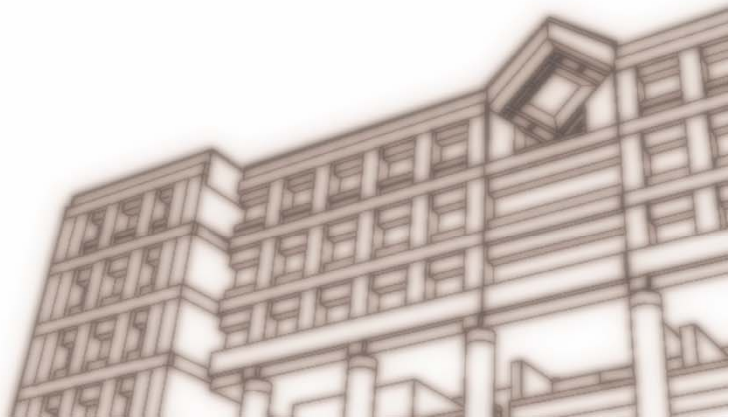
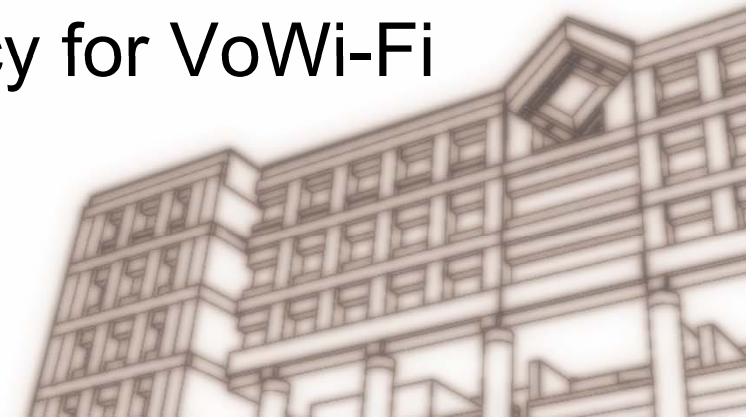


Conclusion

- We propose a new handoff strategy, Layer-2/3 Fast Handoff Mechanism for VoWi-Fi
  - Layer-2 handover using **DeuceScan**
  - Layer-3 handover using **Peer-to-Peer Fast Handoff mechanism**
  - Combining the advantages of two mechanisms to decreasing handoff latency for VoWi-Fi

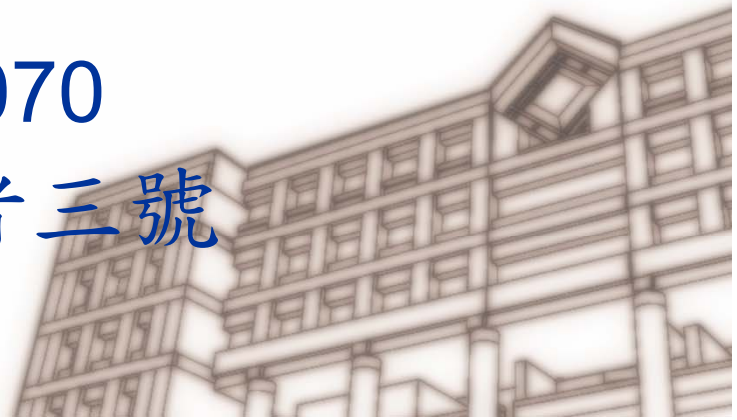


Thank you for your interest
in

Layer-2/3 Fast Handoff Mechanism for VoWi-Fi

組別: MH2005070

參賽隊伍: 行動者三號

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Play Tech
隊名 行動者3號
隊員 蕭煒翰 吳昆霖 謝博在 呂振瑋
指導老師 陳裕賢
作品名稱 Layer-2/3 Fast Handoff Mechanism for VoWi-Fi
近年來，無線網路蓬勃發展，無線網路的應用和產品也如雨後春筍般萌芽，其中最受人矚目的莫過於結合網際網路電話(Voice over IP, VoIP)應用，隨著 VoIP的需求快速增加，但聲音品質及延遲時間無法完全接受，因此在 Wi-Fi 下的 handoff 的問題一直是討論的相關議題，所以如何能在 layer-2 及 layer-3 之間快速 handoff 的又不影響原本程式連線的品質，這將是此計畫的主要目標。目前 Layer-2的handoff trigger及Layer-3的Mobile IPv6解決方法尚不完備，以IETF所提的 Fast MIPv6方法為例，仍有下列重大的缺點：若是在 current AP 無線訊號強度變弱到必須更換到new AP 時，Layer-2的trigger 所促使發出的『Router Solicitation for Proxy Advertisement』 有可能會因為訊號強度太小，而無法被current AP 收到進而轉送至 PAR，如此 fast handover 的機制就不會發生作用，加上mobile node 的移動速度不固定，current AP 的訊號品質減弱並不一定表示mobile node 要進行 handoff，因此我們提出一種全新的技術以 Peer-to-Peer (P2P)為基礎，加上cross-layer design來達到fast handoff的要求，結合現有的技術，例如HMIPv6、FMIPv6、layer-2 trigger、SIP，提供完整的 handoff 機制，以及 VoIP 服務，讓使用者無論身在何處，皆能享受高品質即時語音系統應用的樂趣。


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