Hybrid Multilayer Mobility Management with AAA Context Transfer Capabilities for All-IP Networks

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- AAA Context Transfer for Seamless and Secure Handovers
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Introduction

- There are two major technological forces that drive the communication era:
  - Wireless evolutionary systems
  - The Internet
- The aim of these forces convergence is to offer seamless multimedia services to mobile/wireless IP-based hosts across a variety of heterogeneous access technologies.
  - UMTS
  - Wireless LAN
  - 4G
  - Etc.

Introduction

- Today, the communication subscribers are increasingly relying on diverse communications solutions for voice, data, and multimedia needs.
- What is missing is an overlying strategy for integration of these disparate solutions!
  - Mobility
  - Authentication
  - Subscriber administration
  - Consolidated accounting and billing

Introduction

- Next-generation networks features:
  - Transition to an all-IP network infrastructure
  - Support heterogeneous wireless access
  - Seamless handovers
  - Mobility and QoS support at or above the IP layer
  - Deployment of new protocols for services such as AAA and their inter-working with existing technologies.
  - Support service roaming
  - Etc.

Introduction

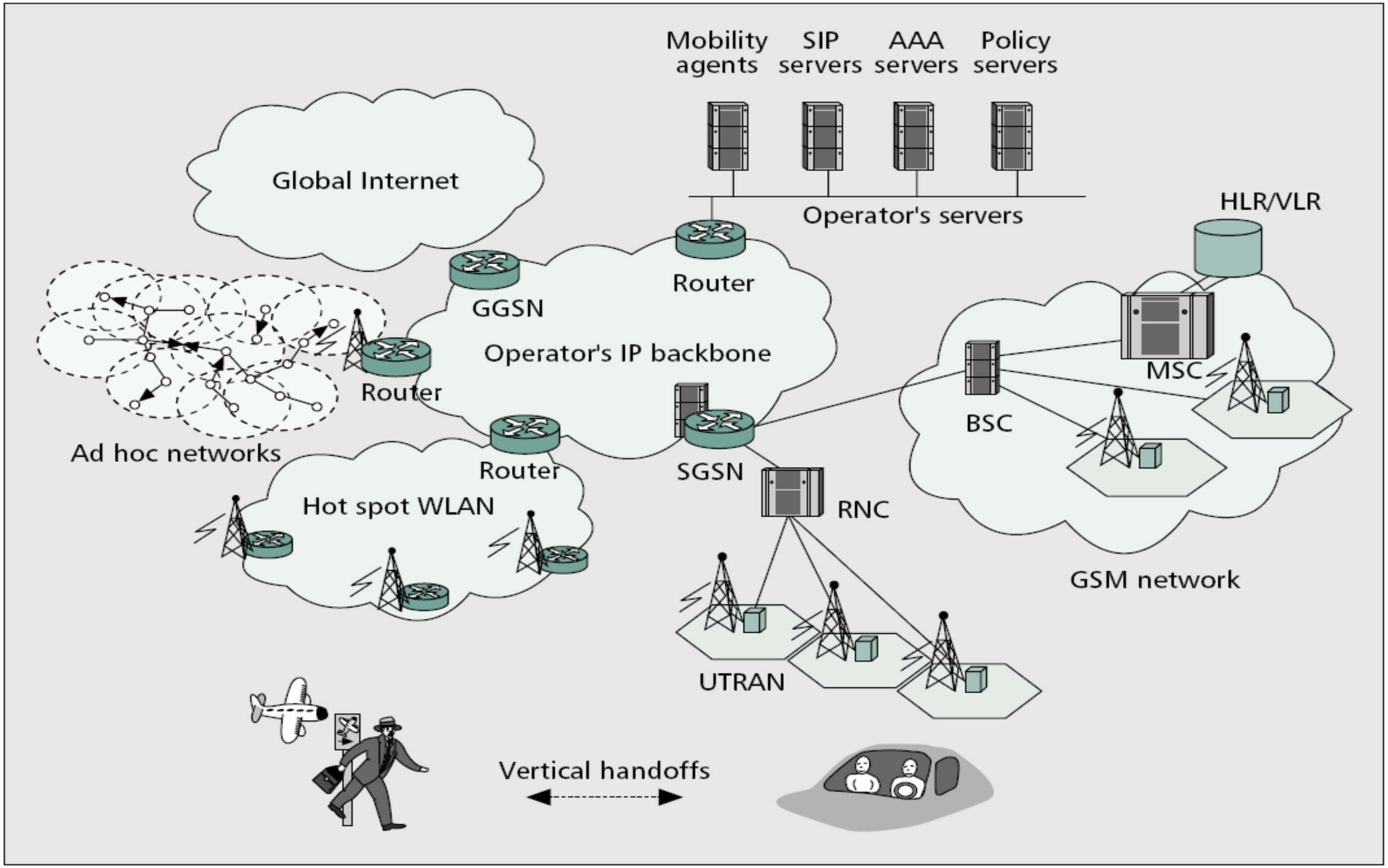


Figure 1. *All-IP network architecture.*

Introduction

- This article presents a multilayer mobility management scheme for All-IP networks.
  - Hybrid scheme for macro-mobility
  - Micro mobility protocol
- Context transfer solution for AAA
  - Enhance the multilayer mobility management scheme

Mobility Management Scheme

- Mobile IP (MIP) is the current standard for supporting the mobility of mobile users.
- The problems of MIP
  - Triangular routing
  - MIP route optimization requires modifications in the IP stack of the end hosts
  - Not acceptable for delay sensitive traffic
- Using Session Initiation Protocol (SIP) to alleviate the problems associated with MIP.

Mobility Management Scheme

- SIP is an application-layer protocol that can establish, modify and terminate multimedia sessions.
- Support basic call control and application-layer signaling for voice and multimedia sessions.
- SIP can run on top of several different transport protocols such as TCP, UDP and SCTP.

Mobility Management Scheme

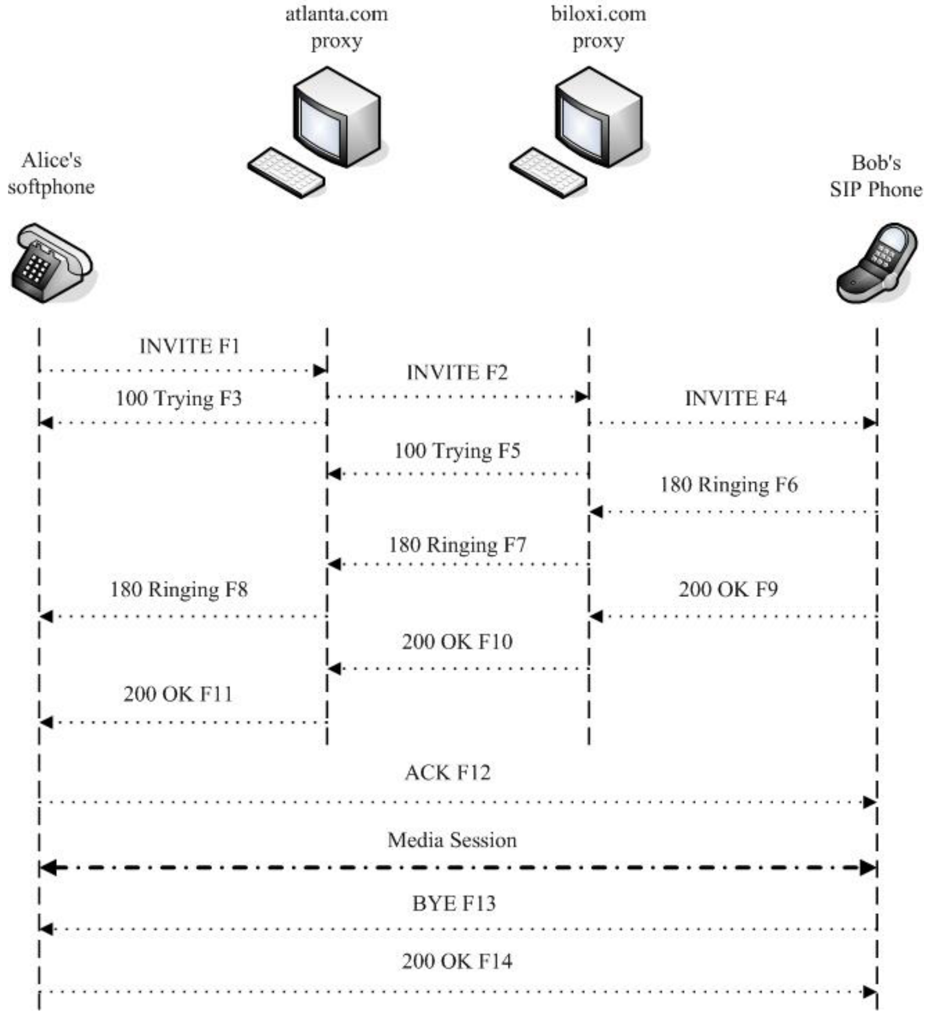
- SIP components
  - SIP user agent
    - user agent client
    - user agent server
  - SIP redirect server
  - SIP proxy server
  - SIP registrar

Mobility Management Scheme

- SIP message format:

Start-line	INVITE sip:bob@biloxi.com SIP/2.0
Header Field(s)	Via: SIP/2.0/UDP pc33.atlanta.com;branch=z9hG4bK776asdhds Max-Forwards: 70
	To: Bob <sip:bob@biloxi.com>
	From: Alice <sip:alice@atlanta.com>;tag=1928301774
	Call-ID: a84b4c76e66710@pc33.atlanta.com
	CSeq: 314159 INVITE
	Contact: <sip:alice@pc33.atlanta.com>
	Content-Type: application/sdp
	Content-Length: 142
Empty Line	
Message Body	v=0
	t=2873397496 2873404696
	m=audio 49170 RTP/AVP 0

Mobility Management Scheme



Mobility Management Scheme

- SIP handoff during a session

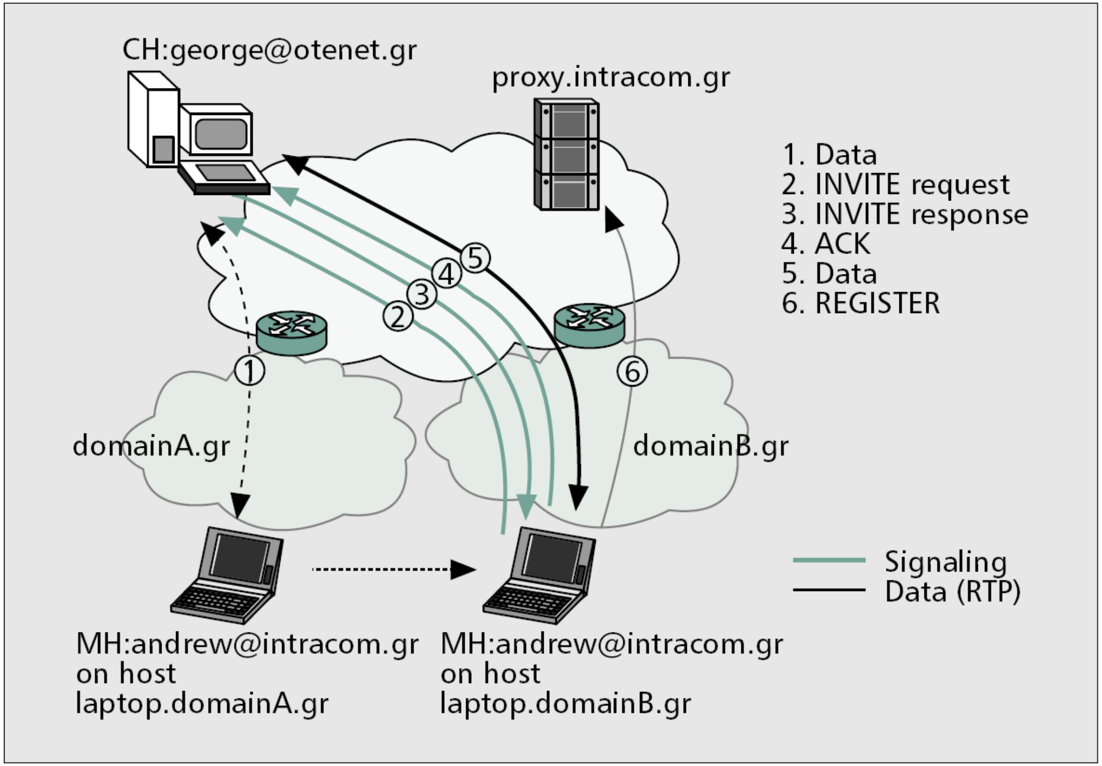


Figure 2. *SIP terminal mobility.*

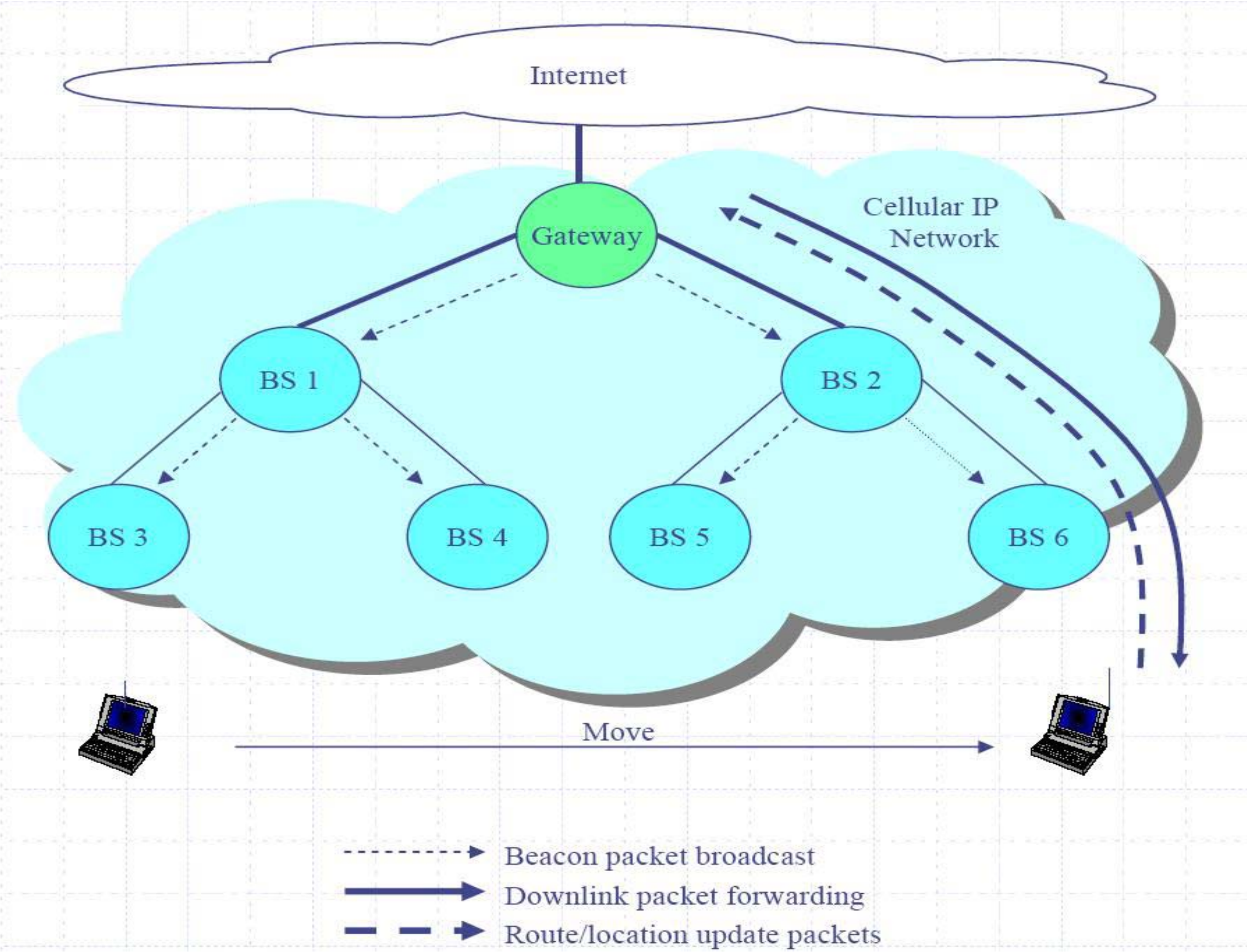
Mobility Management Scheme

- In the proposed scheme, SIP signaling is used to support inter-domain mobility for real-time traffic, while MIP applies to non-real-time traffic.
- Mobility within a subnet area can be supported by a candidate micro-mobility protocol.
  - Cellular IP,
  - HAWAII
  - Hierarchical Mobile IP
  - Etc.

Mobility Management Scheme

- Cellular IP was designed to support fast handoff in a wireless network of limited size.
  - Eliminate the need for a mobile to change its IP address while moving inside a CIP network.
  - Use host-specific routing
  - Support paging

Mobility Management Scheme



Mobility Management Scheme

- The integration between macro-mobility protocols (SIP and MIP) and micro-mobility protocols is accomplished through the Enhanced Mobility Gateway (EMG).
  - FA
  - NAT
  - STUN servers
  - Others

Mobility Management Scheme

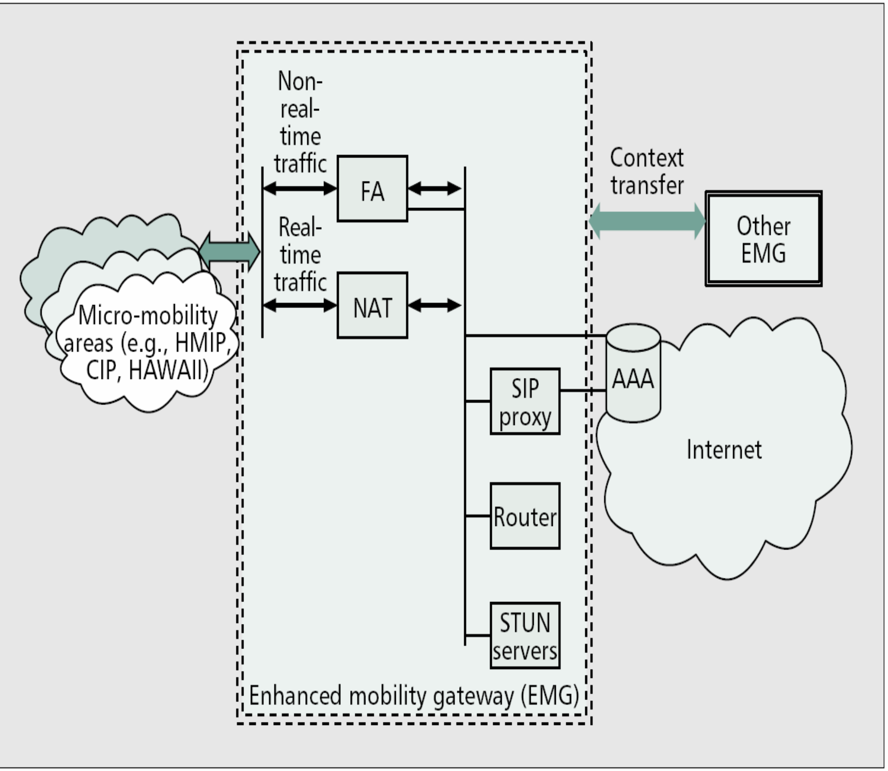


Figure 3. *The enhanced mobility gateway separating micro-mobility from hybrid macro-mobility protocols.*

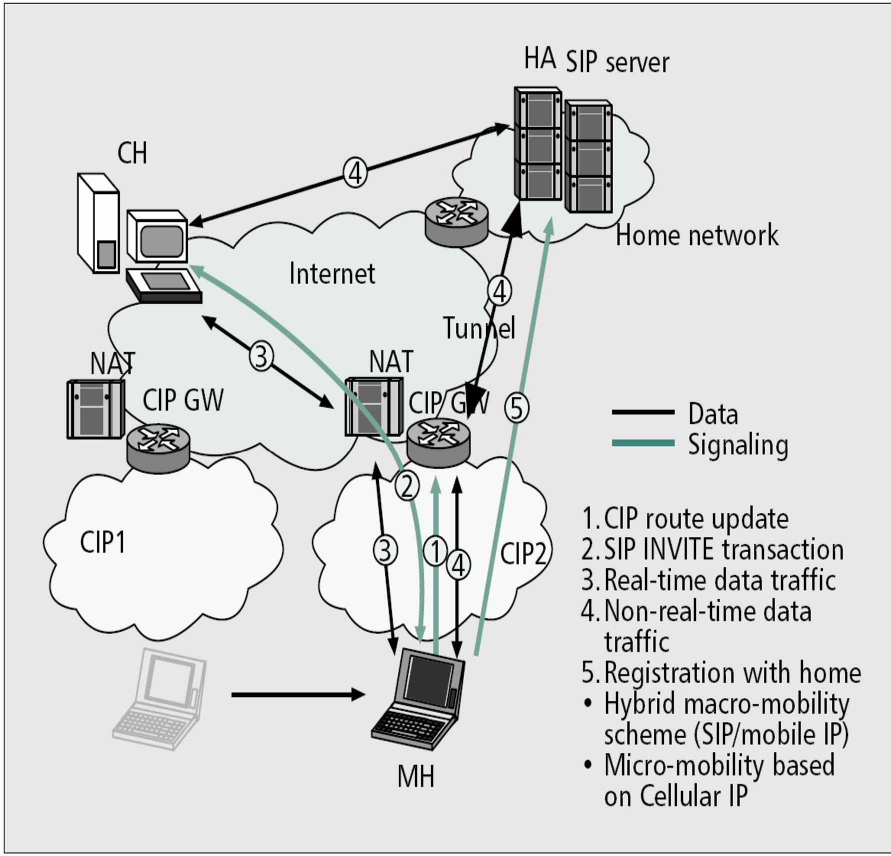


Figure 4. *The hybrid SIP/MIP approach.*

AAA Context Transfer for Seamless and Secure Handovers

- The minimization of handoff delay is a key issue in the development of the multilayer mobility management scheme.
- The introduction of AAA functionalities adds an undesired delay component.

AAA Context Transfer for Seamless and Secure Handovers

- WLANs authenticate mobile users according to the IEEE 802.1x standards
- EAP-TLS was the chosen protocol as it is 802.1x/EAP compliant
  - mutual authentication
  - Dynamic Wired Equivalent Privacy (WEP)

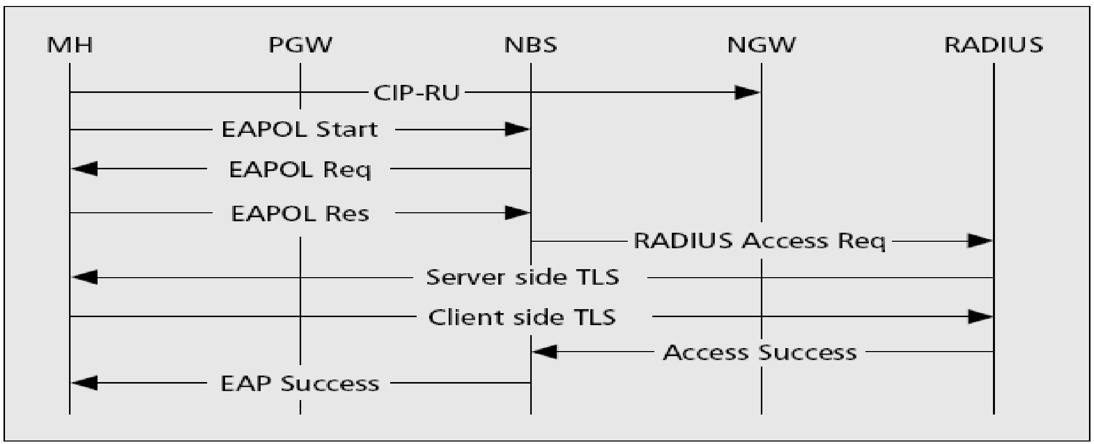


Figure 14. *The signaling flow of AAA messages.*

AAA Context Transfer for Seamless and Secure Handovers

- Context transfer could facilitate the process by transferring AAA state information from the old access router to the new access router (nAR).
- Enhance the CIP protocol
  - Introduction of a context-update (CU) packet
  - context cache at each CIP leaf node and the gateway
  - Augment the cellular-IP route-update packet with a flag to indicate handoff
  - context-update request (CUReq) packet
  - context-update reply (CURep) packet

AAA Context Transfer for Seamless and Secure Handovers

- MH transmits a RU packet to EMG.
- If the H flag is enabled, it indicate handoff occur.
- EMG request the contest
- EMG send back the CU packet to the nBS.

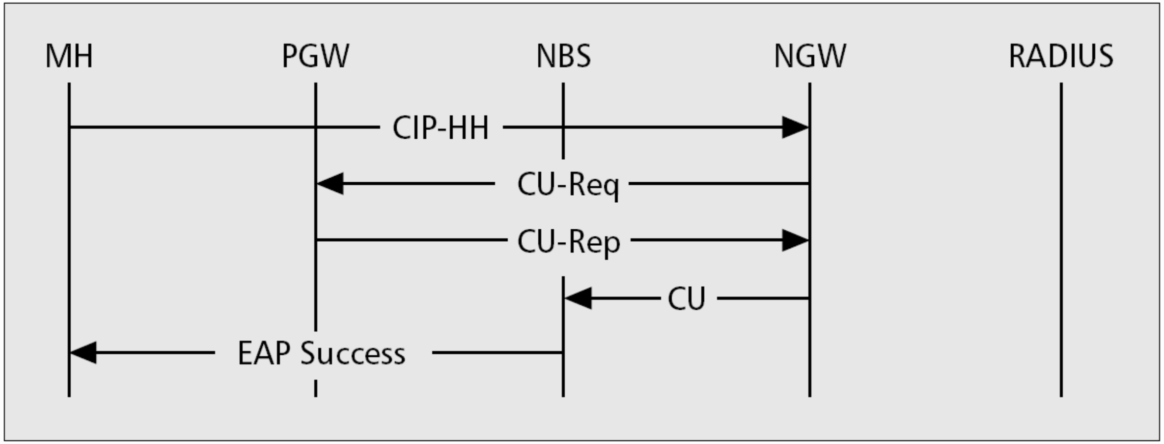


Figure 15. *Signaling flow for AAA using context transfer.*

Performance Evaluation

- Packet lost ratio for RTP session running over SIP and MIP

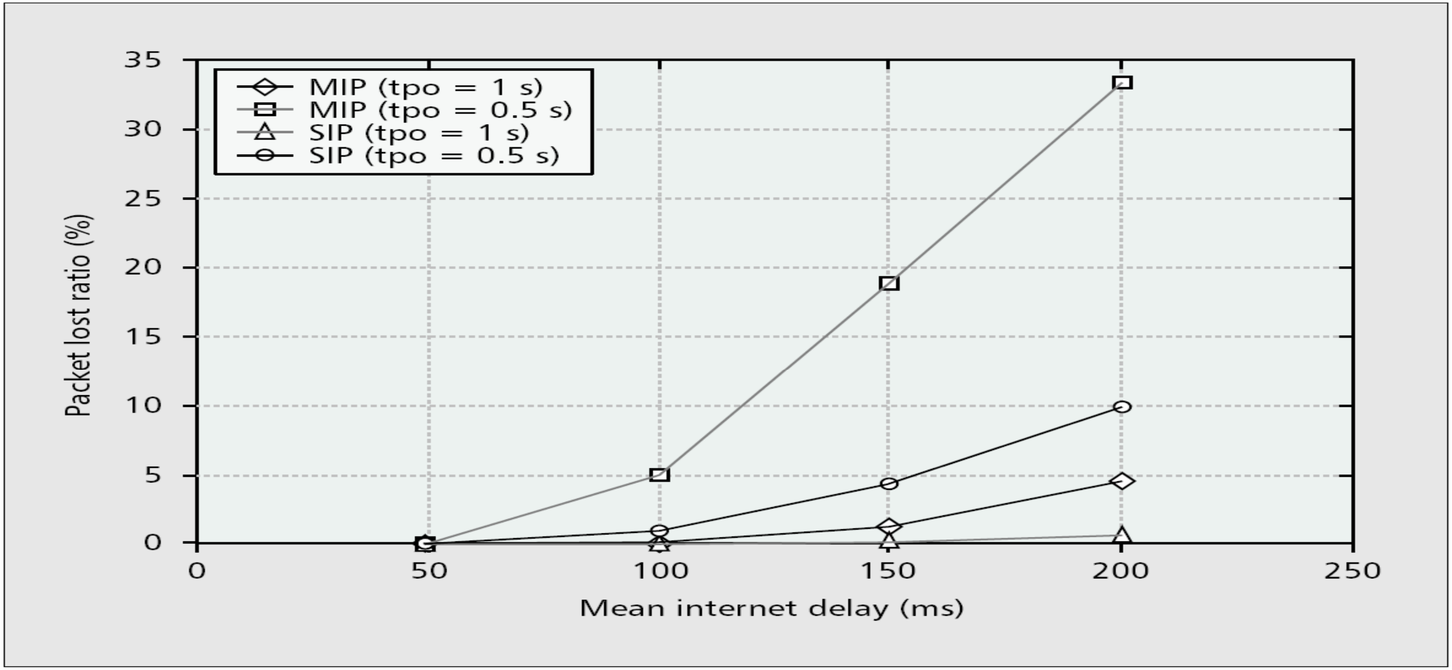


Figure 6. *PLR for RTP session running over SIP and MIP versus delay between home and visited network (MN is static).*

Performance Evaluation

Msg	Time (s)	Source	Destination	Protocol	Info
1	48.304	MH	CIP-GW	CIP	Route Update
2	50.738	MH	AP2	EAPOL	Start
3	50.74	AP2	MH	EAP	Request
4	50.748	MH	AP2	EAP	Response
5	50.753	AP2	MH	EAP	Request
6	51.538	MH	AP2	EAP	Response
7	51.739	MH	RADIUS	TLS	Client Hello
8	51.756	AP2	MH	EAP	Request
9	52.999	MH	AP2	EAP	Response
10	53.01	RADIUS	MH	TLS	Server Hello
11	54.265	MH	AP2	EAP	Response
12	54.275	AP2	MH	EAP	Request
13	55.257	MH	RADIUS	TLS	Handshake
14	55.276	RADIUS	MH	TLS	Handshake
15	56.519	MH	AP2	EAP	Response
16	56.523	AP2	MH	EAP	Success
Handoff delay = 56.523 – 48.304 = 8.219 s					

Table 4. *EAP/TLS signaling exchange (AAA context transfer disabled).*

Msg	Time (s)	Source	Destination	Protocol	Info
1	59.786	MH	CIP-GW	CIP	Route update
2	60.167	AP1	MH	EAP	Success
Handoff delay = 60.167-59.786 = 0.381 s					

Table 5. *EAP/TLS signaling exchange (AAA context transfer enabled).*

Conclusion

- This article a hybrid scheme to handle macro-mobility.
- Inter-working between micro-mobility and macro-mobility is implemented at EMG.
- A context transfer solution has been proposed to avoiding the additional delay introduced by AAA operation.

References

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- [3] A. Campbell *et al.*, “Cellular IP,” IETF Internet draft, work in progress, Jan. 2000.