

GENERALIZED MODELING FRAMEWORK FOR HANDOFF ANALYSIS

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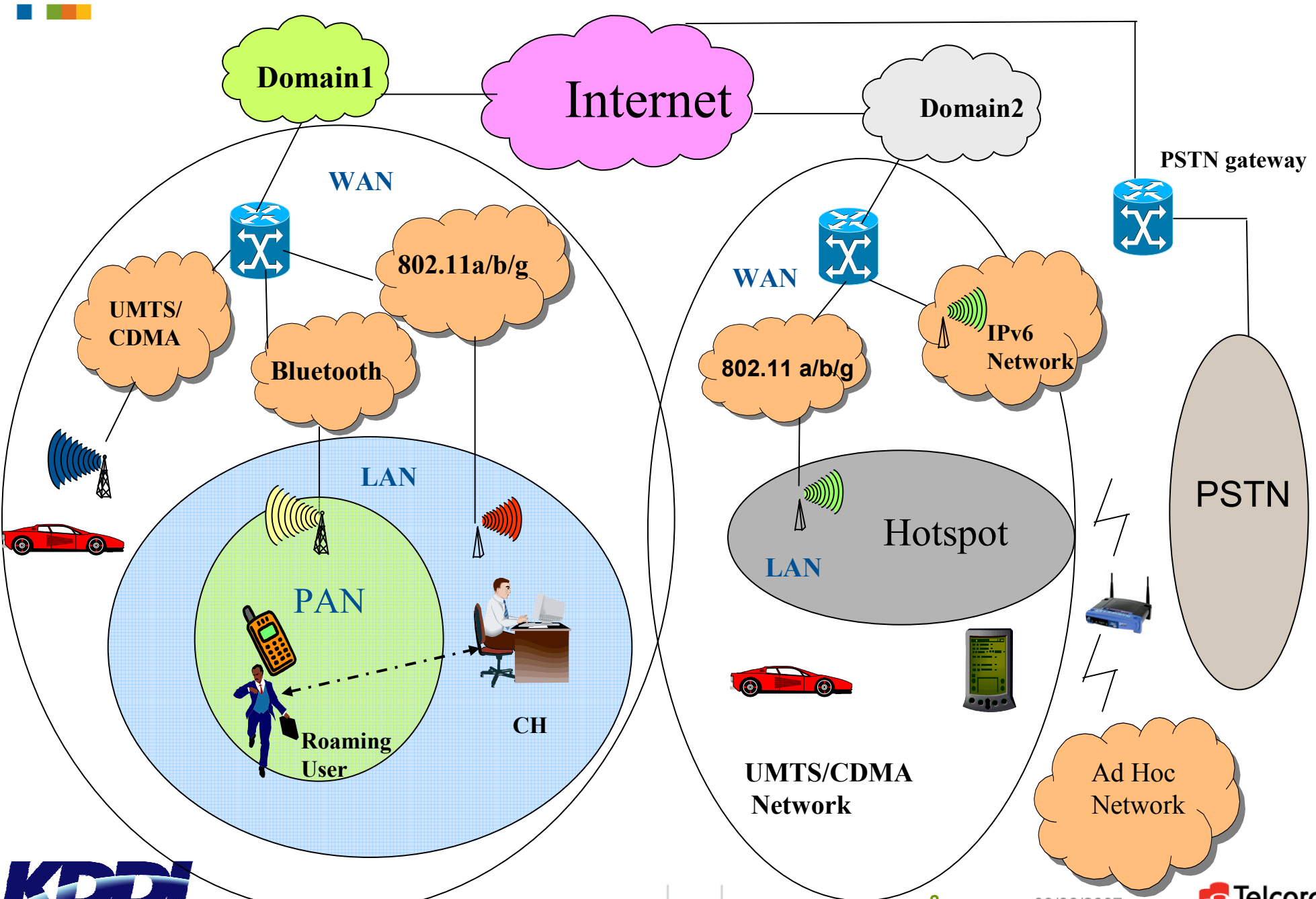
Authors:

Ashutosh Dutta, Bryan Lyles
Telcordia Applied Research

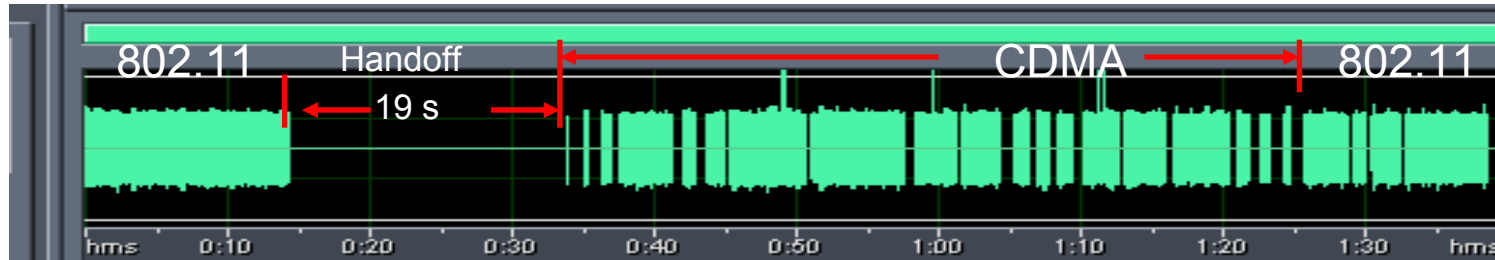
Henning Schulzrinne
Columbia University

Tsunehiko Chiba, Hidetoshi Yokota, Akira Idoue
KDDI R&D Labs

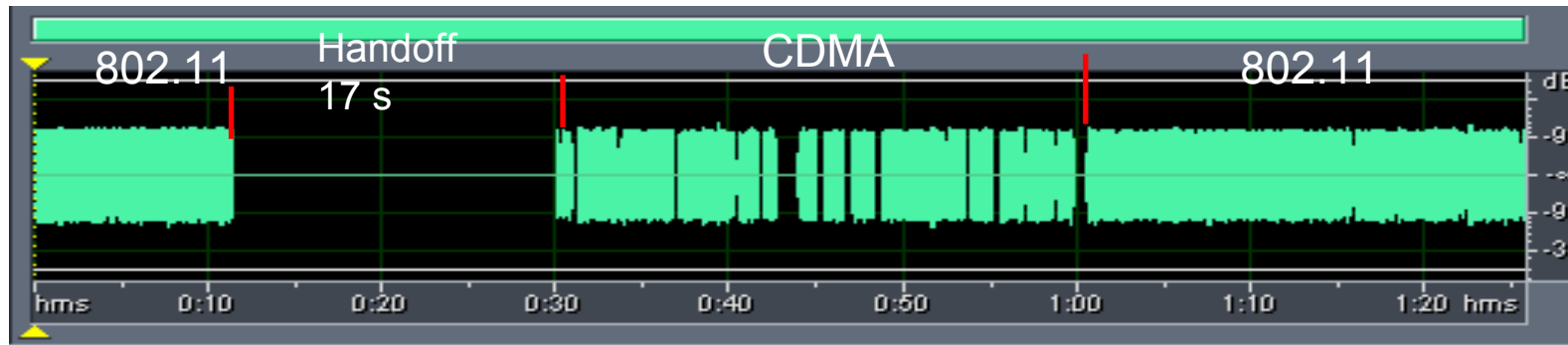
Mobile Wireless Internet: A Scenario



Effect of handoff delay during non-optimized mobility management (experimental results)



Multiple Interface Case (802.11b – CDMA1XRTT) – MIP as mobility protocol



Multiple Interface Case (802.11b – CDMA1XRTT) – SIP as mobility protocol



Single Interface Case (802.11b – 802.11b) – SIP as mobility 09/06/2007

■ Motivation

- Current mobility protocols span across multiple layers and are Ad Hoc in nature
- Optimization methodologies are tightly coupled with each of the mobility protocol
- There is no general mobility framework that can define a mobility event
- A formal analysis of handoff event helps to develop a set of systematic optimization techniques
- Model-based and Experimental validation are cited

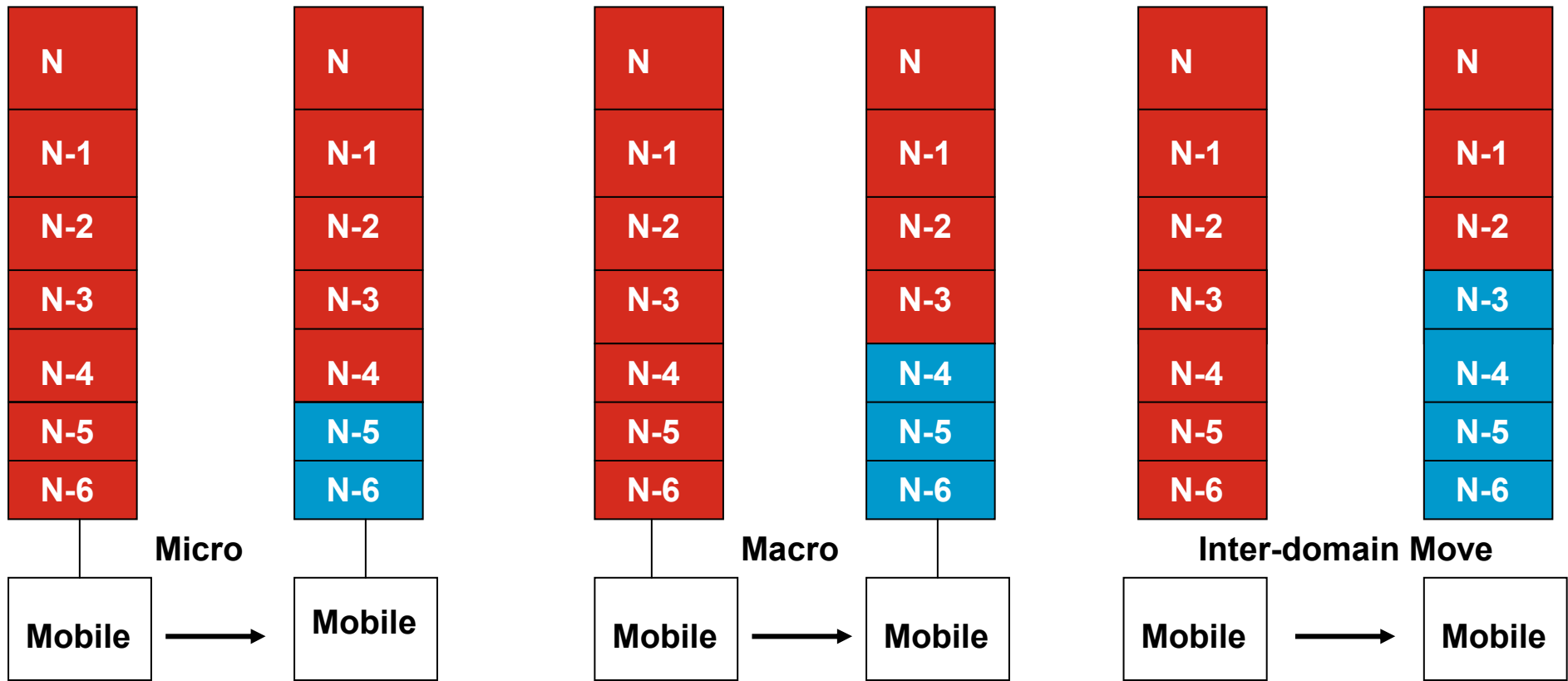
Primitive Properties of a Mobility Event

- **Triggering Event**
 - Handoff Decision to switch access networks
- **Network Discovery**
 - Discover the new networks around the current network
- **Resource discovery in the new network**
 - New frequency, QoS parameters
- **Detection of new point of attachment**
- **Configuration of network identifier**
 - Obtain new connection temporary Identifier (e.g. new IP address,)
- **Authentication**
 - Authentication of identity
- **Encryption**
 - Protection of signaling and data
- **Registration**
 - Establish the mapping between permanent identifier and temporary identifier for proper location management
- **Binding Update**
 - Associate new network identifier for rerouting of data
- **Media redirection**
 - Rerouting of data from CN
 - Encapsulation/decapsulation (Tunneling)
 - Buffering

Functional Matrix of Mobility Event

Mobility/Function	Access Type	Network Discovery	Resource Discovery	Triggering Technique	Detection Technique	Configuration	Key exchange/Authentication	Encryption	Binding Update	Media Rerouting
GSM	TDMA	BCCH	FCCH	Channel Strength	SCH	TMSI	SRES/A3	DES	MSC Contld.	Anchor
WCDMA	CDMA	PILOT	SYNC Channel	Channel Strength	Frequency	TMSI	SRES/A3	AES	Network Control	Anchor
IS-95	CDMA	PILOT	SYNC channel	Channel Strength	RTC	TMSI	Diffie-Hellman AKA	Kasumi	MSC Contld.	Anchor MSC
CDMA 1X-EVDO	EVDO	PILOT Channel	SYNC Channel	Channel Strength	RTC	TMSI	Diffie-Hellman/CAVE	AES	MSC	PDSN/MSC
802.11	CSMA/CA	Beacon 11R	11R 802.21	SNR at Mobile	Scanning, Channel Number, SSID	SSID, Channel number	Layer 2 authenticate 802.1X EAP	WEP/WPA 802.11i	Associate	IAPP
Cell IP	Any	Gateway beacon	Mobile msmt.	AP beacon ID	GW Beacon	MAC Address AP address	IPSec	IPSec	Route Update	Intermediatey Router
MIPv4	Any	ICMP Router adv. FA adv.	ICMP Router Adv.	FA adv. L2 triggering	FA adv	FA-CoA Co-CoA	IKE/PANA AAA	IPSec	MIP Registration	FA RFA HA
MIPv6	Any	Stateless Proactive	CARD 802.21 11R	Router Adv.	Router Prefix	CoA	IKE/PANA AAA	IPSEC	MIP update MIP RO	CH MAP HA
SIPM	Any	Stateless ICMP Router	802.21 11R	L3 Router Adv.	Router Prefix, ICMP	CoA AOR Re-Register	INVITE exchange/AAA	IPSEC/SRTP/S/MIME	Re-INVITE	B2BUA CH RTPtrans

A layered approach to mobility optimization



Layers on the mobile Not Affected due to mobility



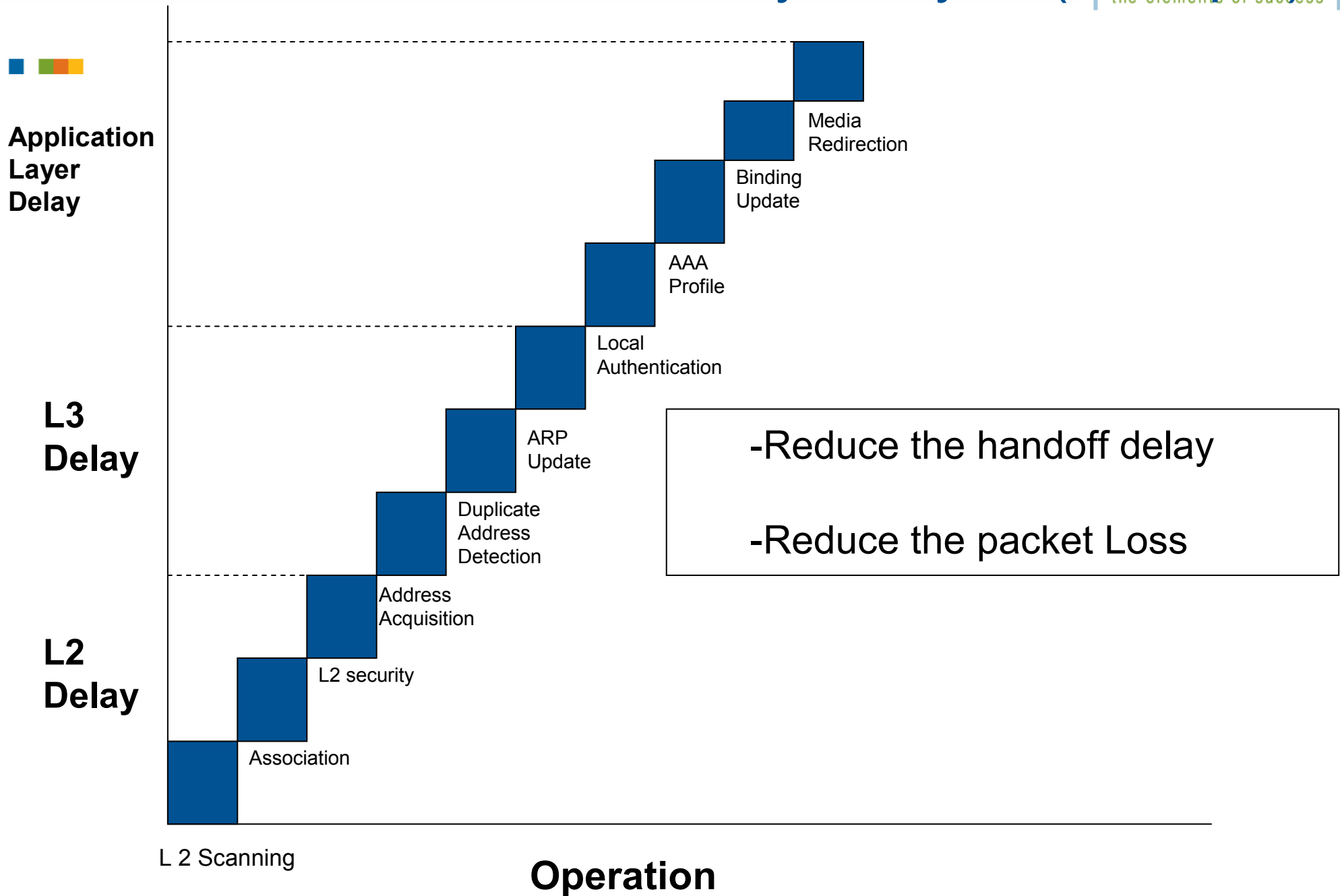
Layers on the mobile Affected due to mobility



Layers on the correspondent host

Inter-domain Handoff Delay Analysis (example)

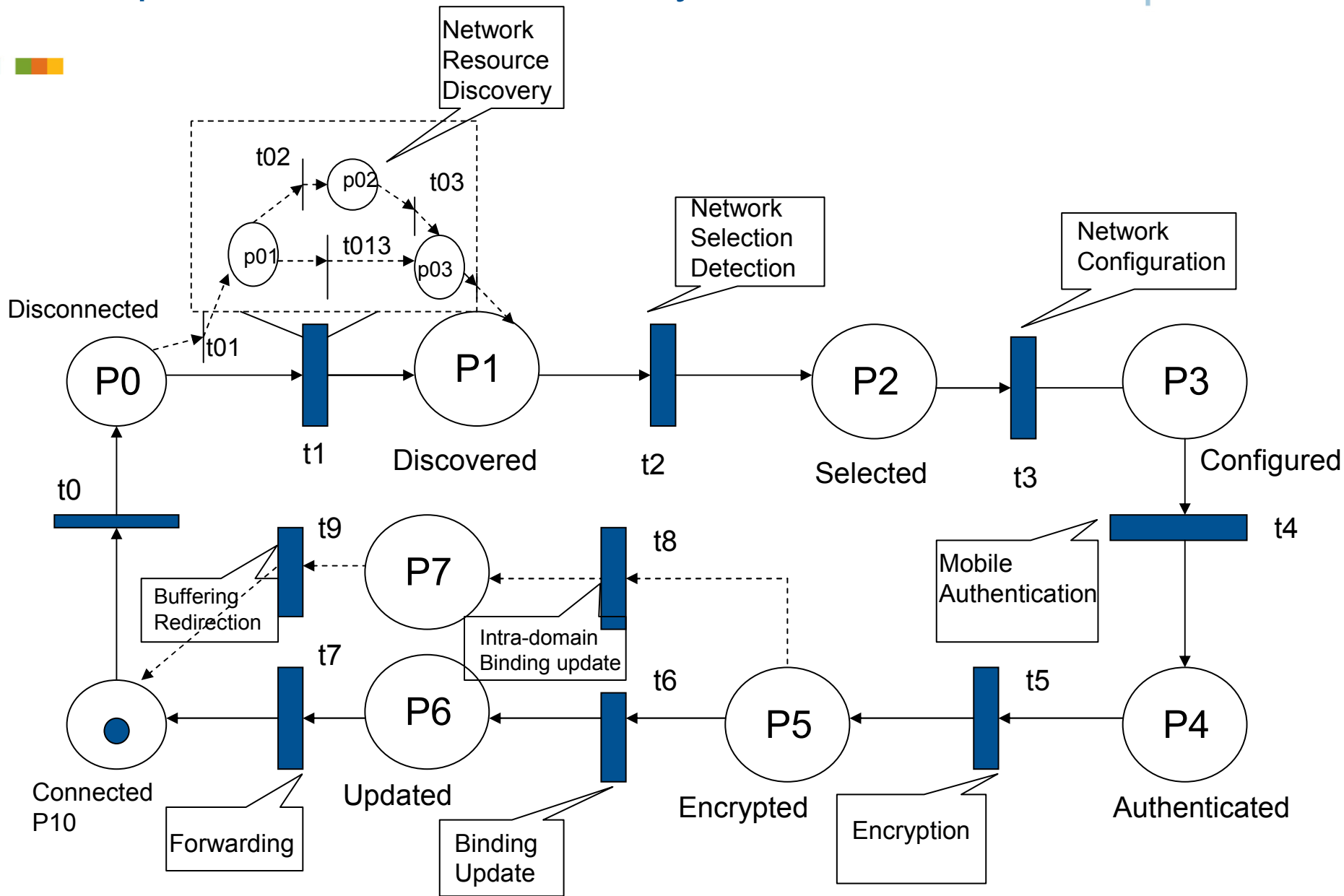
the elements of success



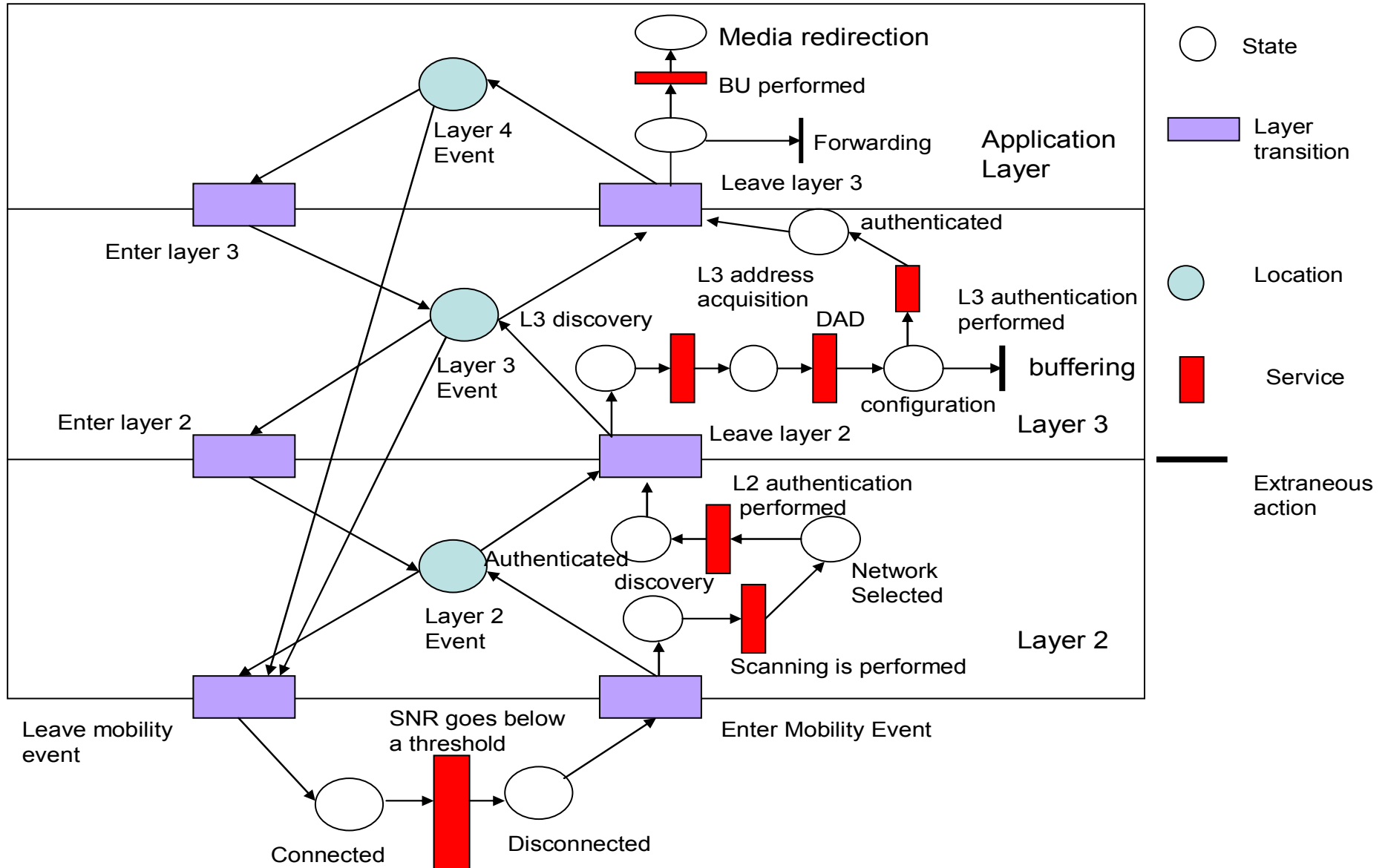
Mobility Event Distributed Tasks (Sample)

Operation (Job)	Task1	Task2	Task3	Task 4
Discovery (J1)	Scanning J11	Beaconing J12	Association J13	Open Auth J14
Detection (J2)	Beaconing (L2), Router Advertisement (L3) J21	Solicitation J22	Link Switch J23	
Configuration (J3)	Identifier Acquisition J31	Duplicate Address Detection J32	Mapping Identifier J33	
Security Association (J4)	Key distribution J41	Authentication J42	Encryption J43	Decryption J44
Binding Update (J5)	Tunneling J51	Mapping IP addresses J52	Caching J53	
Media Redirection (J6)	Encapsulation J61	Decapsulation J62	Buffering J63	Forwarding J64

Simple Timed-Petri net Mobility State Transition



A layered approach in Petri Net



Sample Results from Petri Net Models

Transition, place or arc	p1	t1	p2	t2	p3	t3	p4	t4	p5	t5	p6	t6	p7	t7	p8	t8	p9	t9	p10	t10
Time delay	0	2x	0	3x	0	4x	0	3x	0	2x	0	5x	0	5x	0	2x	0	2x	0	3x

Type of Optimization	Loops in the state transition path	D_i	N_i	D_i/N_i Cycle Time
No Optimization	p0t1p1t2p2t3p3t4p4t5p5t6p6t7p10	24x	1	24x
Parallelization (Reactive)	p0t1p1t2p2t3p3t4p4t5p5t8p7t9p10	19x	1	19x
Proactive	p0t9p10	2x	1	2x
Maintain Security Binding	p0t1p1t2p2t3p5t6p6t7p10	19X	1	19X

Testbed and Experimental Results

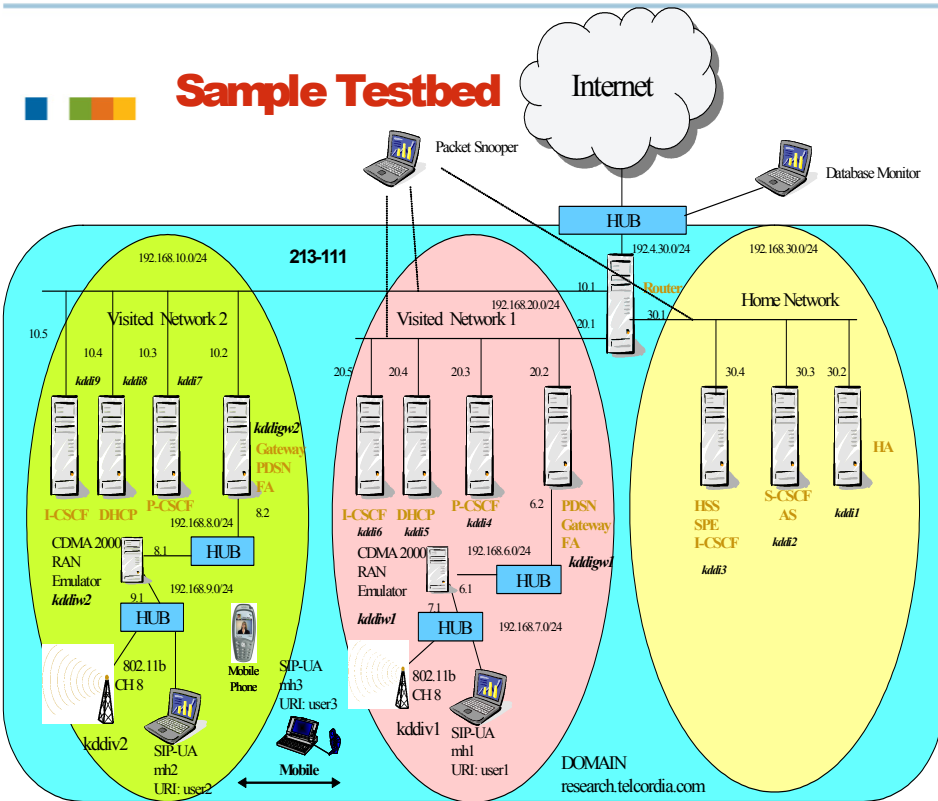


Figure 1: MMD Experimental Testbed

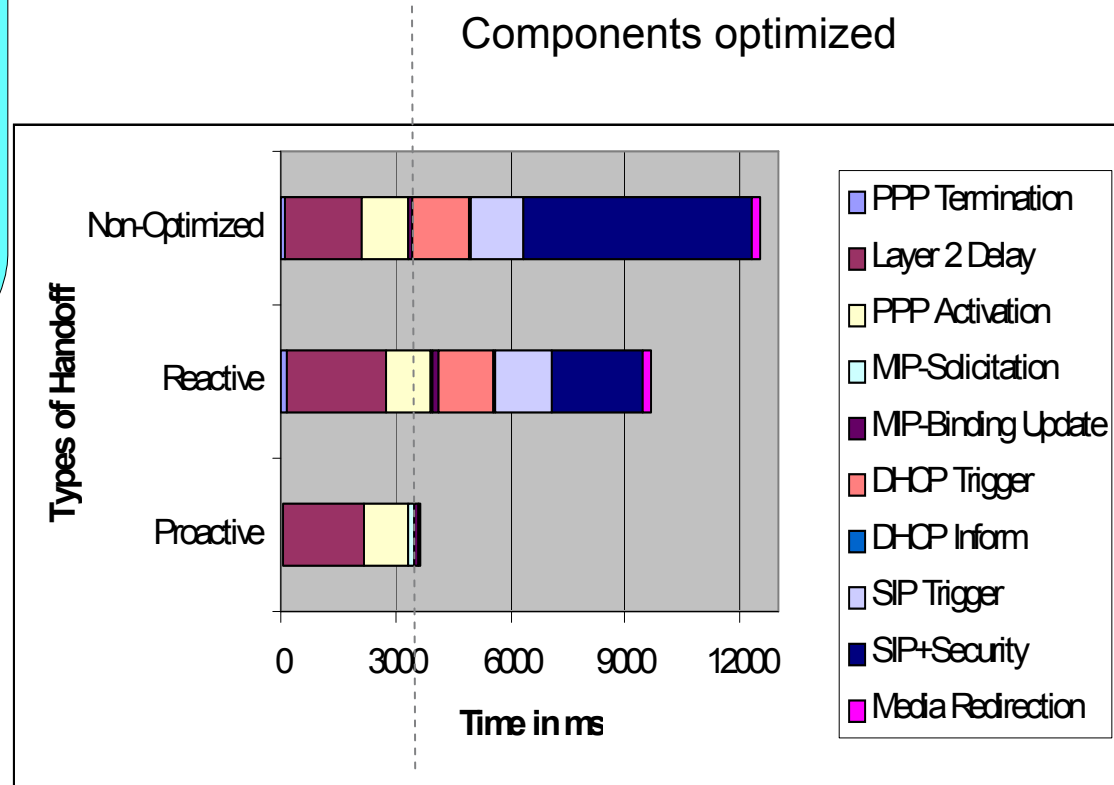


Figure 2: Handoff delay with 3 levels of optimization

Summary

- Identification and analysis of fundamental properties that are rebound during a mobility event
- Use these properties to build a systematic framework that can represent a mobility system model
- A series of optimization methodologies that could be applied to link, network and application layer
- Validation of these models by way of experiments, and Petri net model
- Introduce a set of design rules that can help optimize a mobility event to provide the desired threshold value



Backup slide



- **Handoff Delay (T4) consists of**
 - Re-Attachment Delay
 - Binding Update Delay
 - Security Association
 - Media Redirection
 - Processing delay at each end-point
- **Re-attachment delay**
 - L2 association
 - L3 association
- **Binding (signaling) update delay**
 - Network Transmission delay
 - Number of message exchange
 - Processing delay at the end point
- **Security Association**
 - Local authentication and inter-domain security association
- **Media Redirection**
 - Rebinding
 - Network transmission delay