The Moby Dick Architecture

Jürgen Jähnert

On behalf of Moby Dick

Content

- ✍Objectives of Moby Dick
- ✍Moby Dick Architecture
- ✍Interfaces
- ✍W- CDMA
- ✍Summary

Objectives of Moby Dick

- Real All-**IPv6** architecture integrating **Mobility, QoS** and **AAAC**

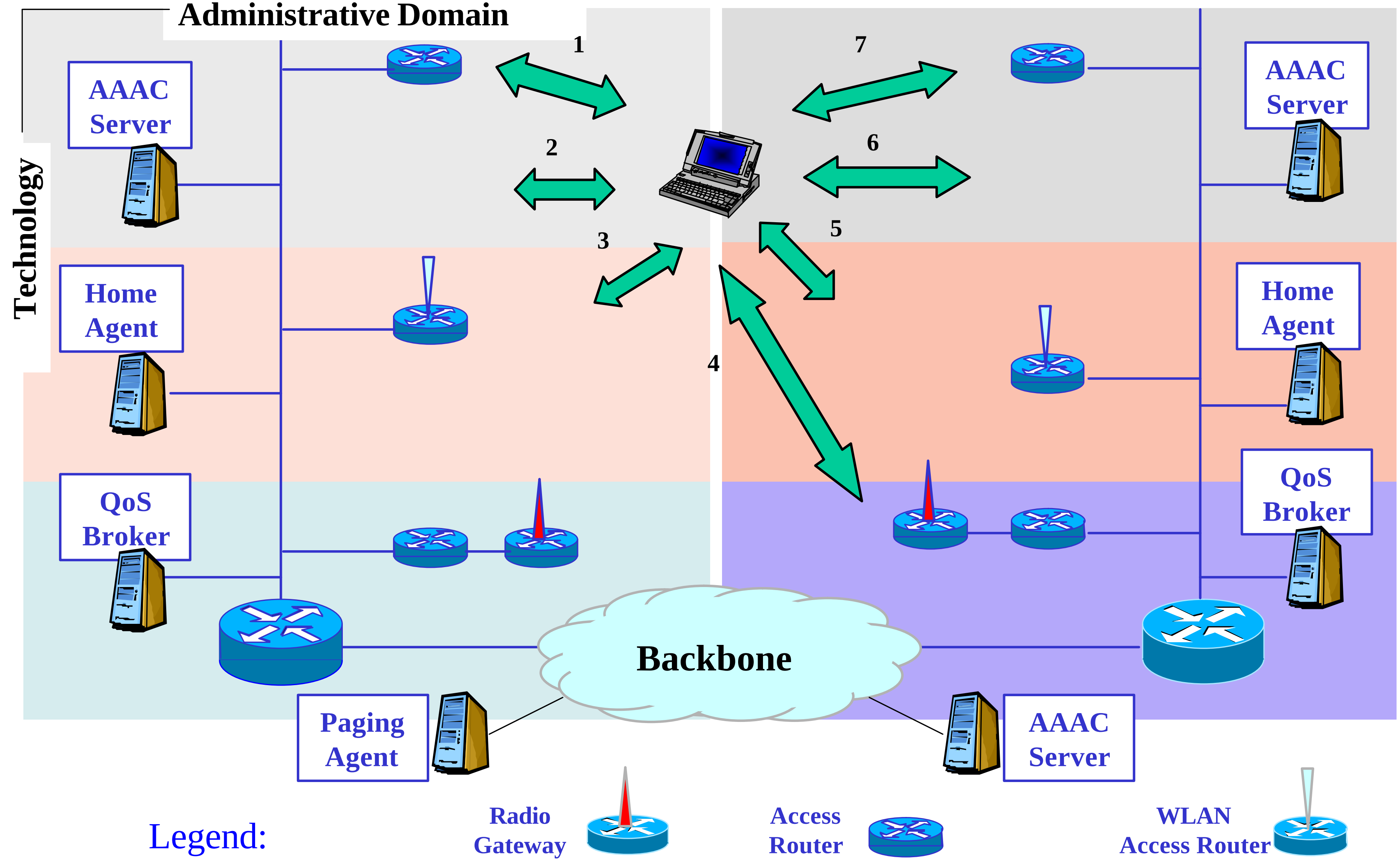
- Support of **seamless handover** mechanisms across heterogeneous access networks (W-CDMA, wireless LAN, Ethernet, etc.).

- Definition of mobility-enabled end-to-end QoS architecture.

- AAA mechanisms enriched with Auditing and Charging (AAAC).

→ Integrated Approach: Mobility AAA and QoS towards 4G

Moby Dick Approach



Initial Decisions

- Our solution to support W-CDMA in Moby Dick:
  - W-CDMA base station directly attached to IP network.

- Institut EURECOM has an open platform which supports W-CDMA-TDD mode and gives us the opportunity to deploy a solution with a radio access router (RAR).

- Mobility: FAST Handover, Paging
- QoS: DiffServ + QoS Broker
- AAAC: IRTF Architecture + Charging

The Moby Dick Challenge

AAAC

- Auditing
- Authentication
- Authorisation
- Accounting
- Charging
- Security

QoS

- Differentiated Services
- Signalling
- L2 / L3 mapping
- Policing

Mobility

- Handover (seamless, fast)
- Mobile IP
- Paging
- Context Transfer

Key achievements

- ✍ Definition of interfaces almost completed
  - Interfaces between physical components
  - Interfaces within physical components
- ✍ Concept for centralised profile
- ✍ Supporting both, legacy applications and QoS-aware applications
- ✍ Definition, development and implementation of a 3GPP W-CDMA to IP network interconnection using a proprietary RTLinux driver
  - Real Time implementation of 3GPP Radio Interface Protocol
  - Definition of the modifications needed to support IP-Mobility

Interfaces (1)

Interface between components (MT, AR …)

- ✍ Signalling Flow specification
- ✍ MAQ (**M**obility-**A**AA-**Q**oS) scenario for Registration
- ✍ Session Setup
- ✍ Fast Handover for intra-domain scenarios - across technologies
- ✍ Re-Registration for inter-domain scenarios – across technologies

Interfaces (2)

Mobile Terminal (MT), Access Router (AR), AAAC Server, centralised profile

- Interfaces on Mobile Terminal:
- Interfaces on Access Router:
  - Context transfer
- Radio Gateway: IP to W-CDMA
- QoS Broker
- AAAC Server
- Centralised profile

W- CDMA

- Real Time implementation of W-CDMA
- Layer 1 and 2 compliant with 3GPP specifications
- RRC signalling functionality supports IP-based management functions in terms of mobility and QoS, based on the 3GPP standards
- Initial version of a configuration tool to determine the L1/L2 radio resource parameters according to the requested QoS
- Connection to the standard Linux IPv6 driver.

Summary

✍ Integration between AAAC, QoS, and Mobility

- Architectural alternatives converged
- Big step towards IP dominated 4G network architecture

✍ Architecture specified, W-CDMA radio integrated with IPv6 stack

✍ Specification of interfaces

Moby Dick Mobility Design and Implementation

Amardeo Sarma

On behalf of MobyDick

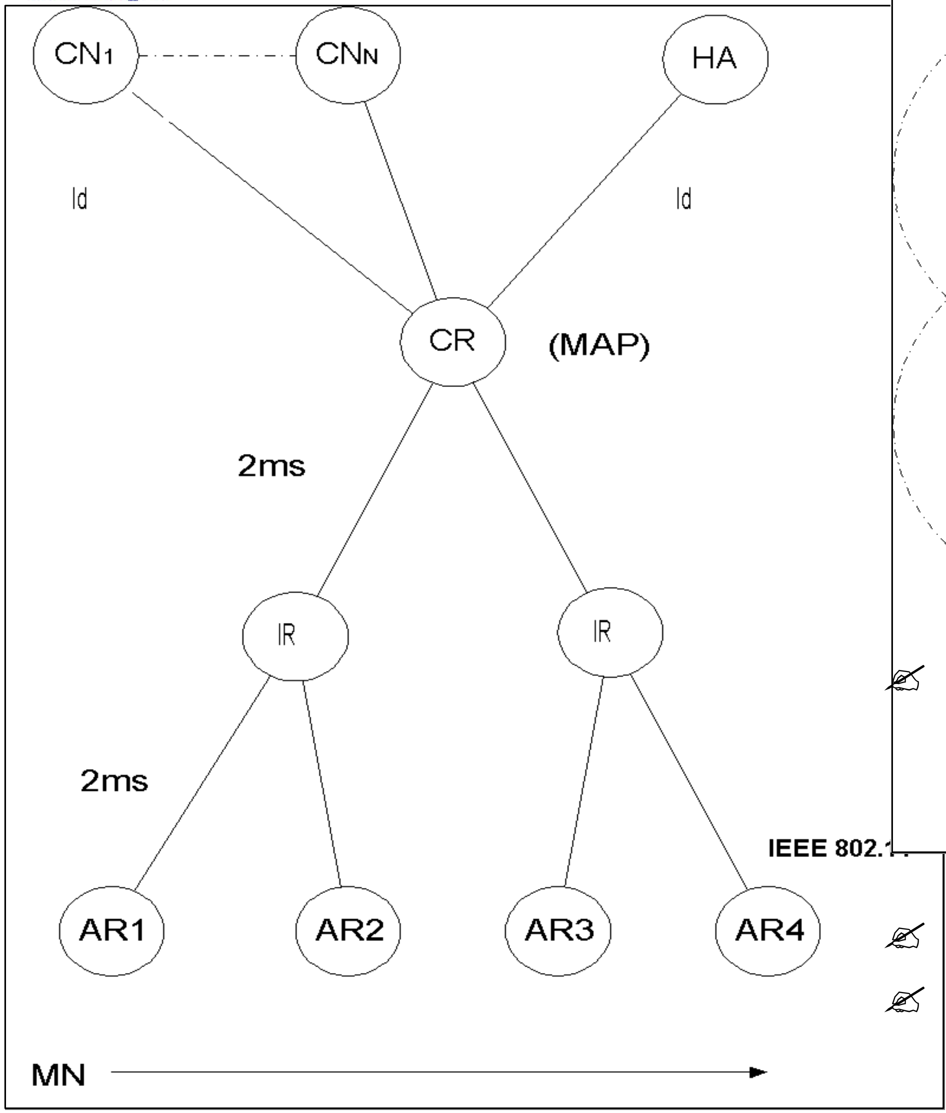
Content

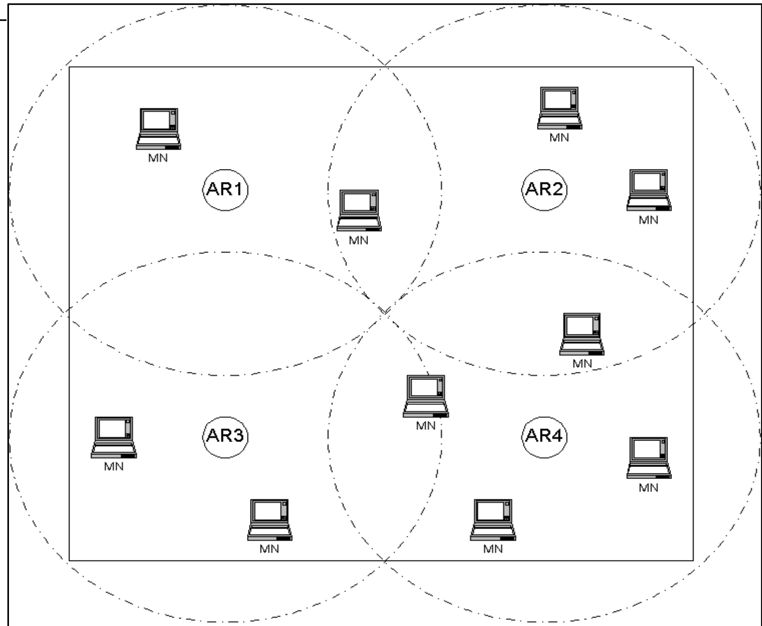
- ✍Handover
- ✍Paging
- ✍Implementation status
- ✍Summary

Moby Dick Handover Approach

- Achieve Seamless Handover *despite* AAAC and QoS
- MIPv6 is a tool for roaming and handover
- Improving handover (e.g. make before break)
  - Fast Handover FMIPv6
  - Hierarchical approaches, e.g. HMIPv6
- Simulations to aid decision
- Implement selected version
- Use approach to support AAAC

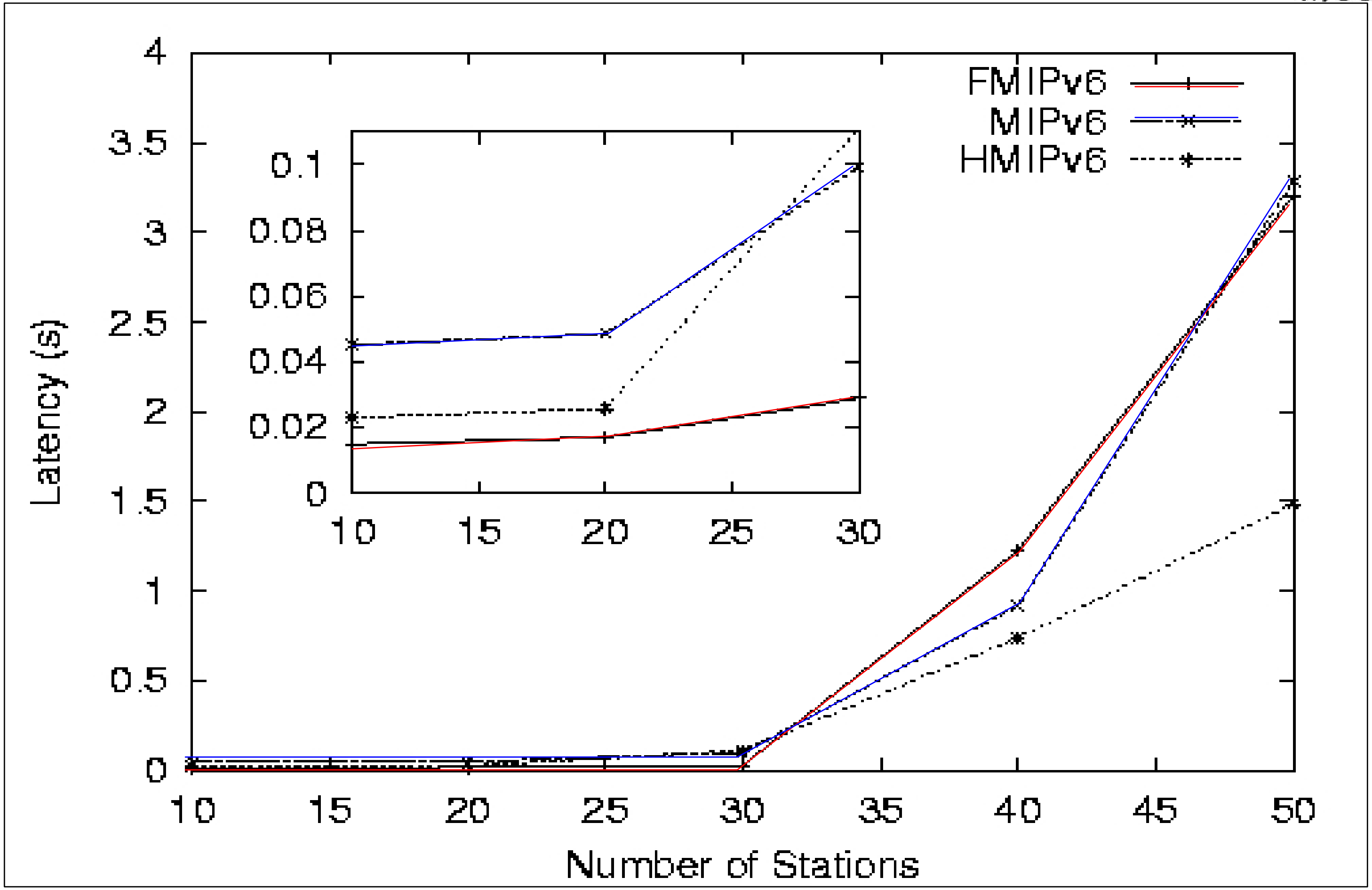
Simulation of MIPv6 Handover



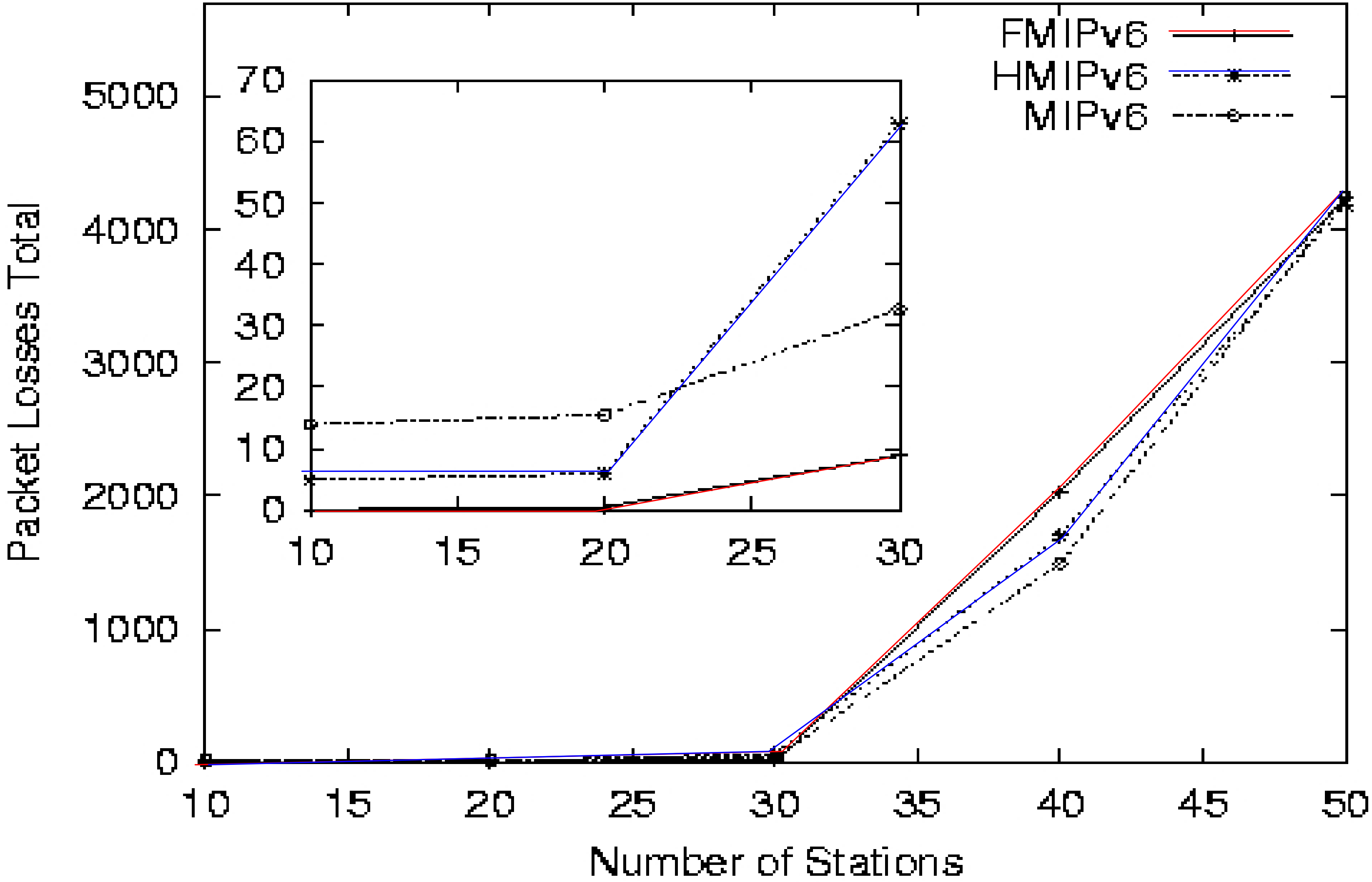


- Compares:
  - Standard Mobile IPv6 (MIPv6)
  - Fast Handovers for Mobile IPv6 (FMIPv6)
  - Hierarchical Mobile IPv6 (HMIPv6)
- Variable number of background mobile nodes.
- Results represent the average values for 1000 simulations

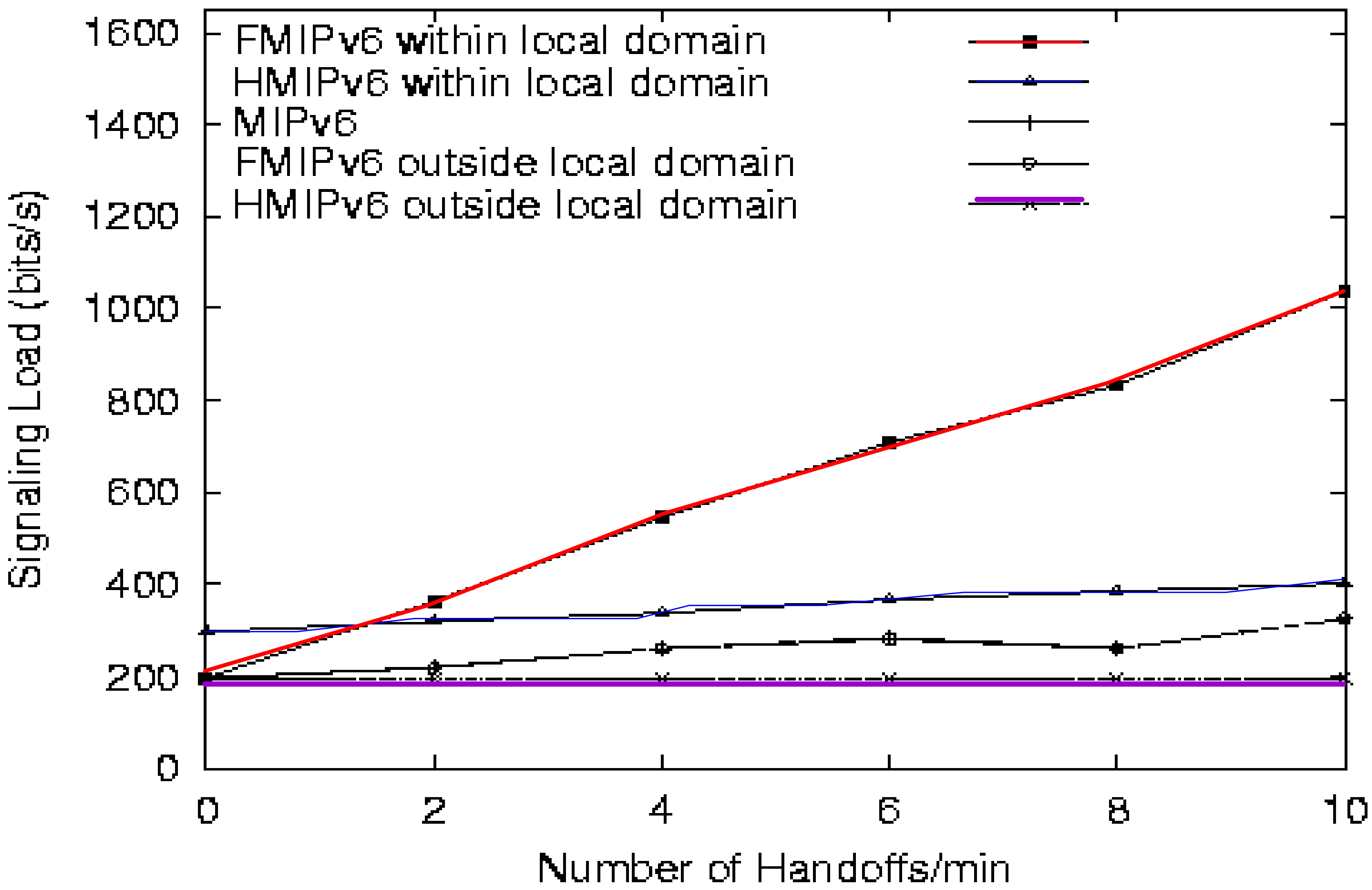
FMIPv6 versus HMIPv6 saturation conditions



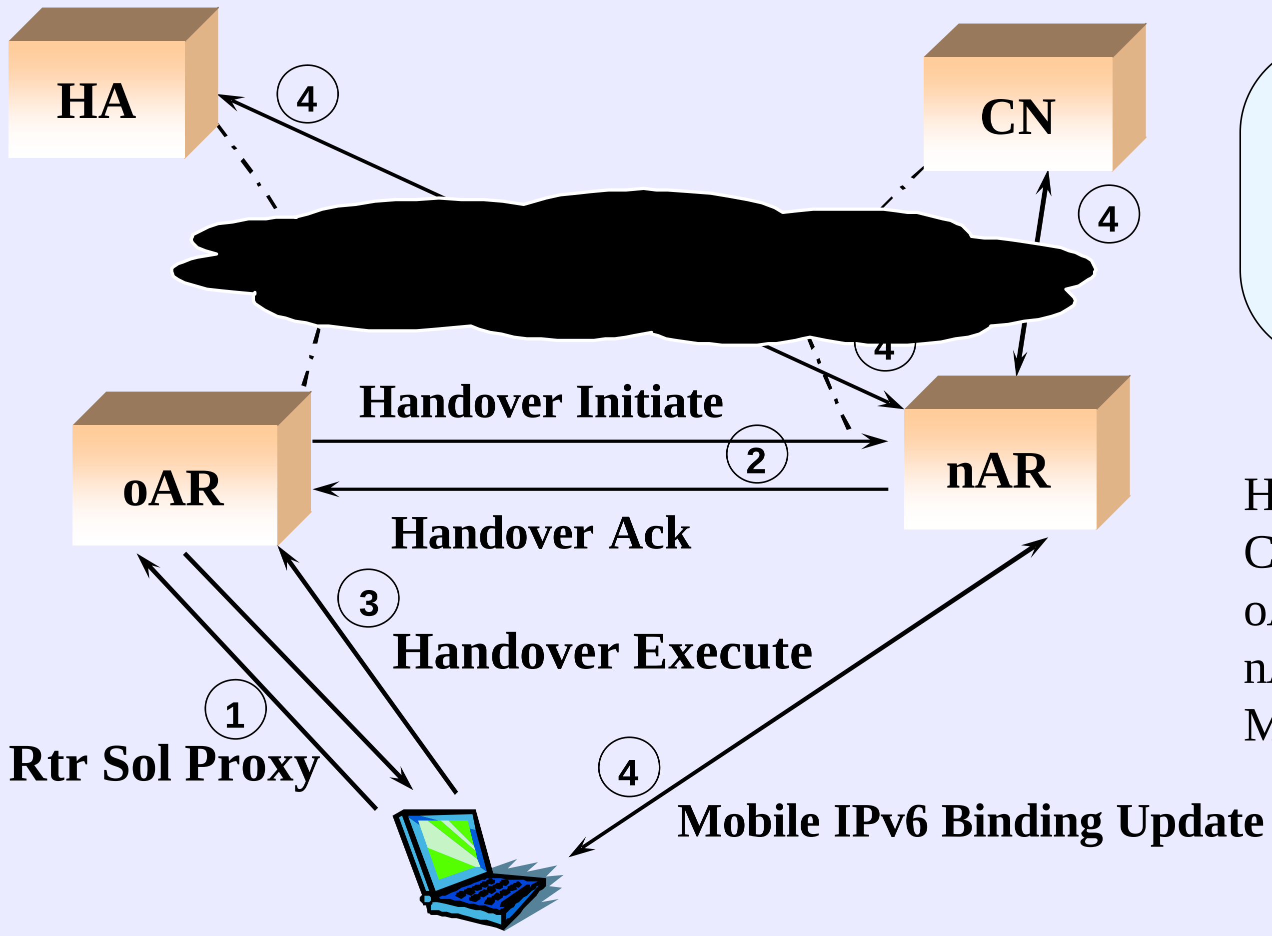
FMIPv6 versus HMIPv6 saturation conditions



FMIPv6 versus HMIPv6: signalling load



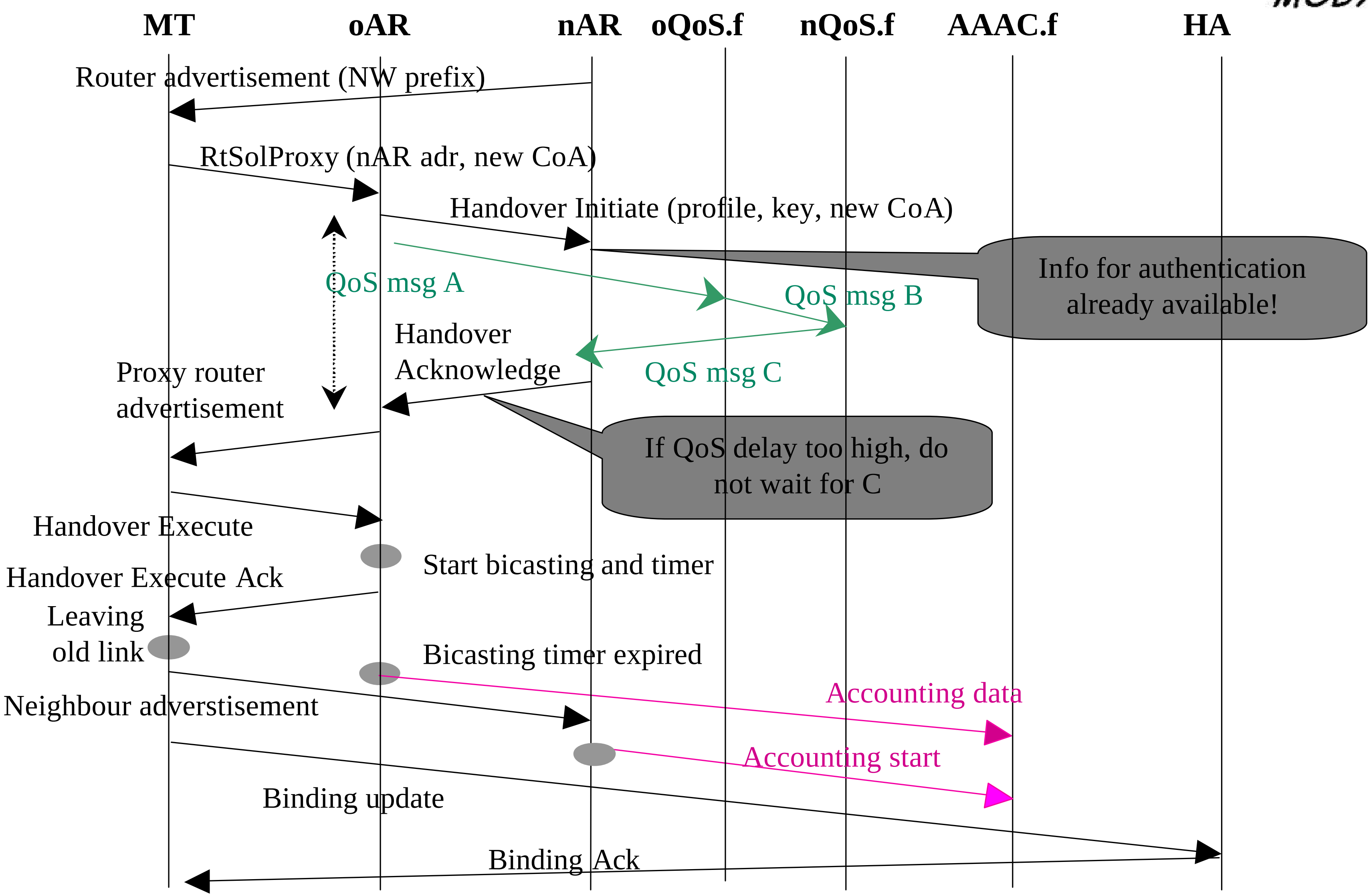
Fast handover (overview)



FHO messages will carry AAAC information

HA	Mobile IPv6 Home Agent
CN	Correspondent Node
oAR	Old Access Router
nAR	New Access Router
MT	Mobile Terminal

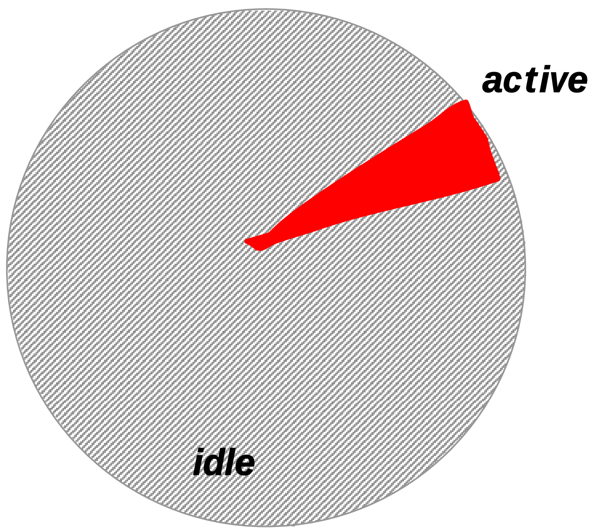
Handover signal flow



Paging in IP based Networks

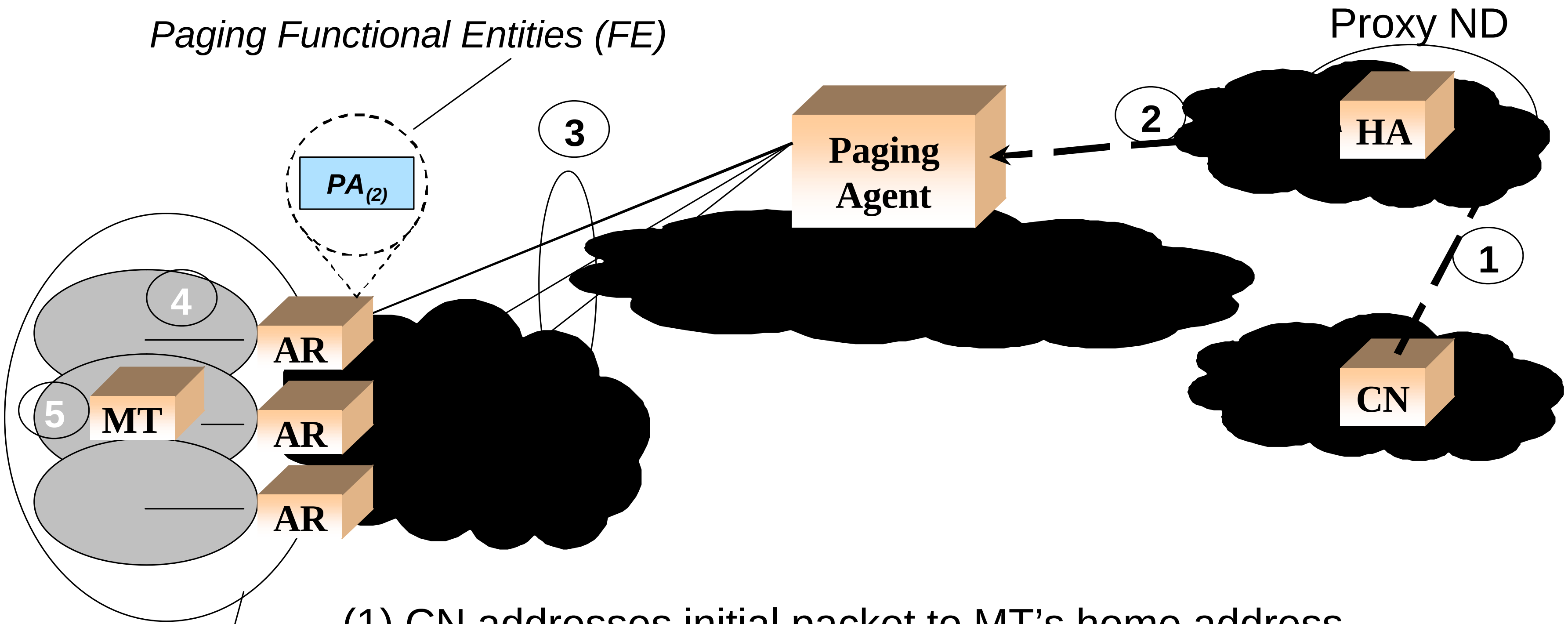
- Mobile Terminals are idle most of the time
- Objective: Add paging to cut signalling and support power savings
- Our Concept is IP based paging

Total population of mobiles[1]



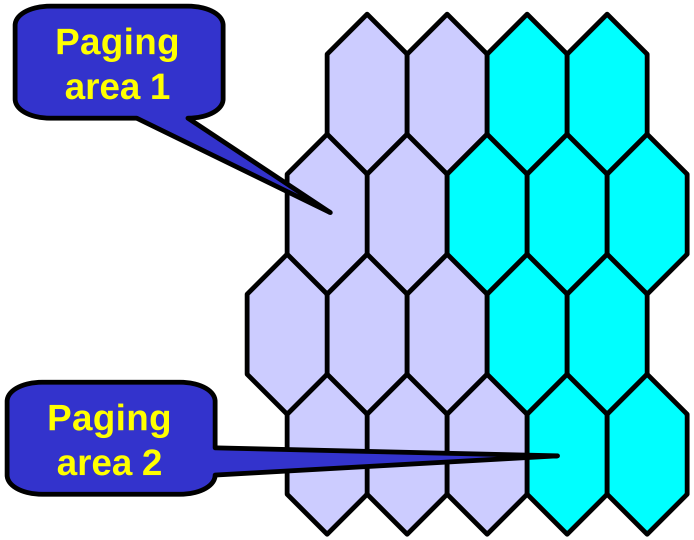
[1] *'Minimal Paging Extension for Mobile IP', Columbia University*

Integration of IP Paging in MIPv6

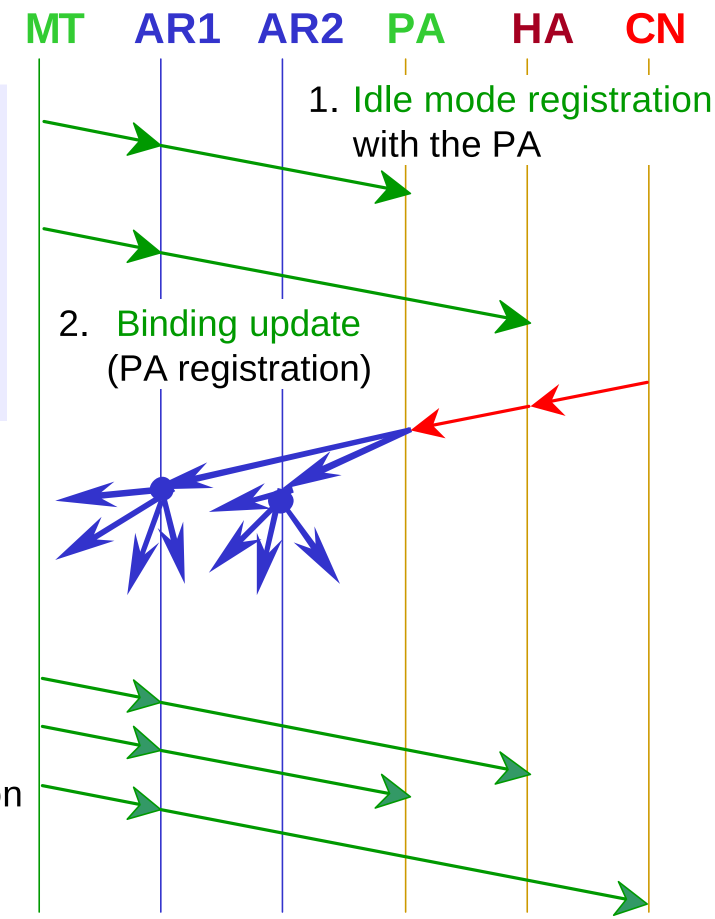


(1) CN addresses initial packet to MT's home address
(2) HA intercepts packet and forwards them to the PA
(3) PA buffers initial packet(s) and initiates paging the MT
(4) ARs search for the MT within the respective area
(5) MT receives the Paging Request and initiates entering active state

Specification of paging



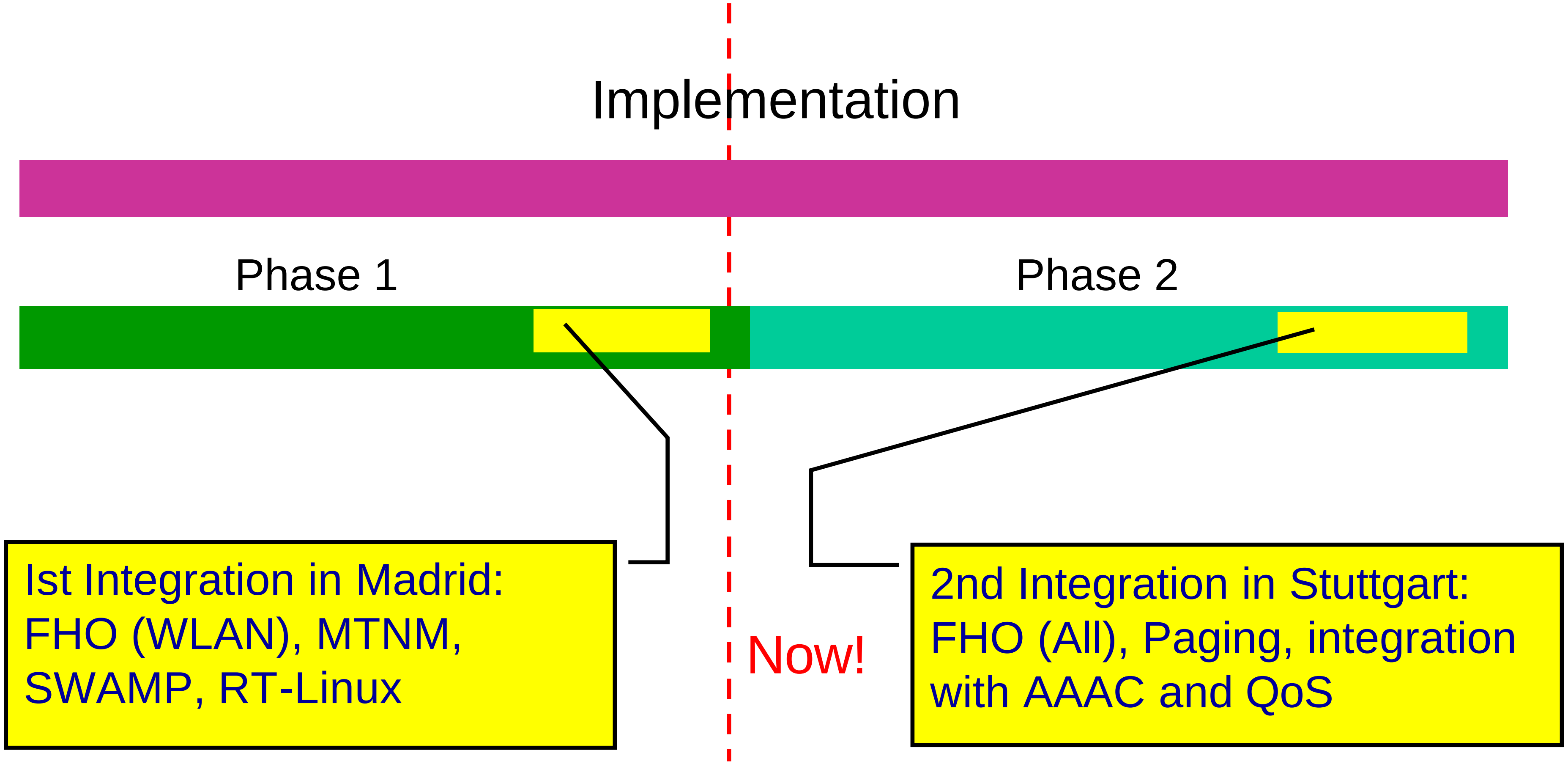
PA: Paging Agent
CoA: IPv6 Care-of Address
CN: Correspondent Node
HA: MIPv6 Home Agent
AR: Access Router
MT: Mobile Terminal



3. PA buffers data packets and initiates paging the Mobile Terminal

4. Connection establishment
   Binding Update (CoA registration)
   Terminal active notification to PA
   Binding update for route optimisation

Mobility Status



Summary

- Handover and Paging are important issues to be solved for IPv6-based mobility solutions
- Moby Dick has chosen the Fast Handover approach based on simulations
- Fast Handover integrates transfer of AAAC information in the FHO messages
- Moby Dick will have an IP Paging solution for the project
- IETF drafts (paging, CoA acquisition) have provided visibility to Moby Dick

QoS Architectures
for
Mobile Service Provisioning

Hong Yon Lach
On behalf of MobyDick

Content

- ✍Moby Dick QoS Objectives
- ✍Moby Dick QoS Architecture
- ✍Implementation
- ✍Simulation
- ✍Future Steps

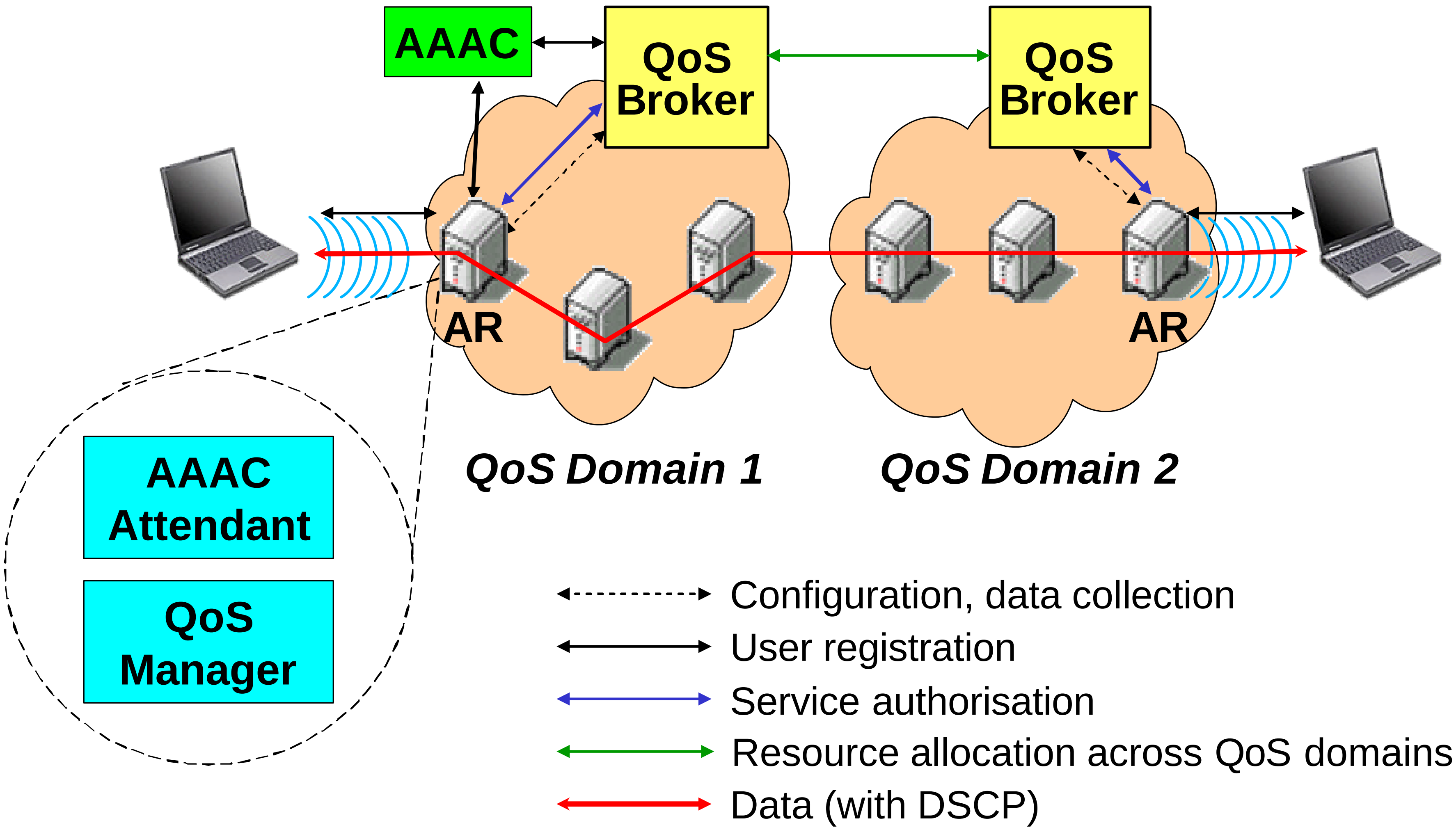
IETF QoS Architectures

- IntServ (Integrated Services)
  - Per-flow resource reservation, RSVP signalling
  - Problems in scalability, complexity, and mobility
- DiffServ (Differentiated Services)
  - flow aggregation per Class of Service, based on priorities
  - No end-to-end guarantee, but scalable
- IntServ over DiffServ
  - IntServ at the network boundaries, DiffServ in the core
- NSIS (Next Step in Signalling)
  - Will only define exchange of QoS signalling information

Moby Dick QoS Objectives

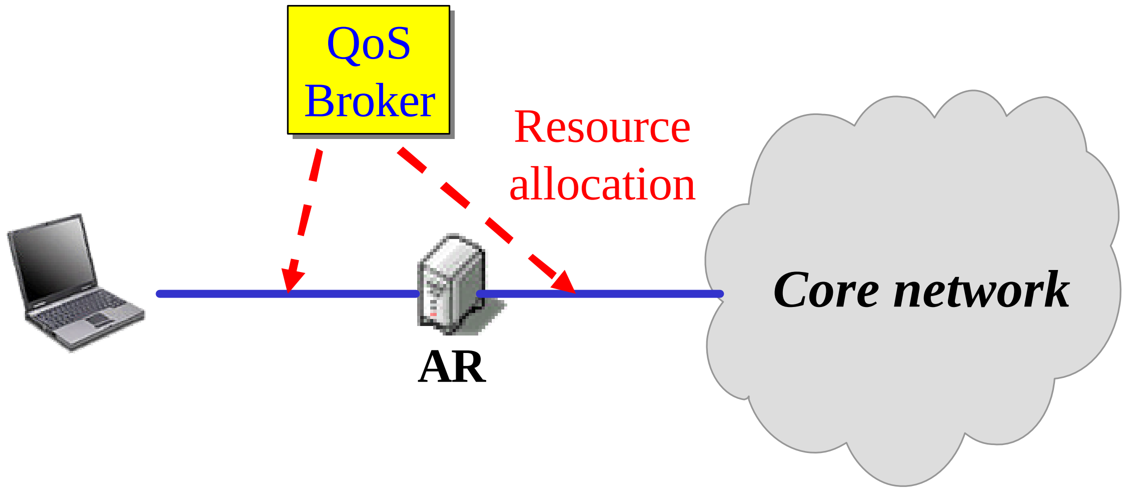
- Goals
  - End-to-end IP QoS management in Moby Dick
- Challenges and Requirements
  - Allocating resources in the access networks
  - Offering end-to-end QoS
  - Maintaining user connectivity and QoS while moving
  - Making security, mobility and QoS systems work together

Moby Dick QoS Architecture



QoS Brokers Functionalities

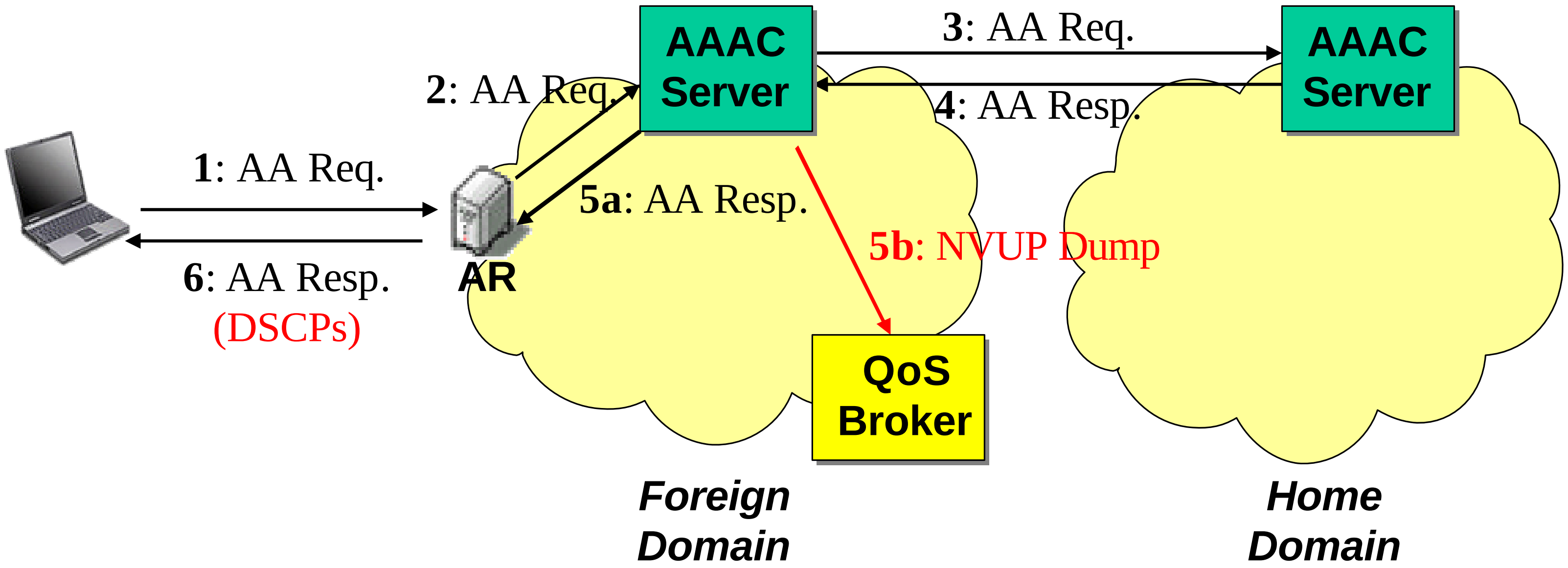
- Resources allocated only in the access network (over-provisioning in the core)
- Resources allocated per user+CoS (QoS parameters = Bandwidth + Priority)
- Interactions with AAAC for user registration
- Interactions with the AR for QoS configuration and service authorisation
- No explicit resource reservation and release by users



Selected Classes of Services

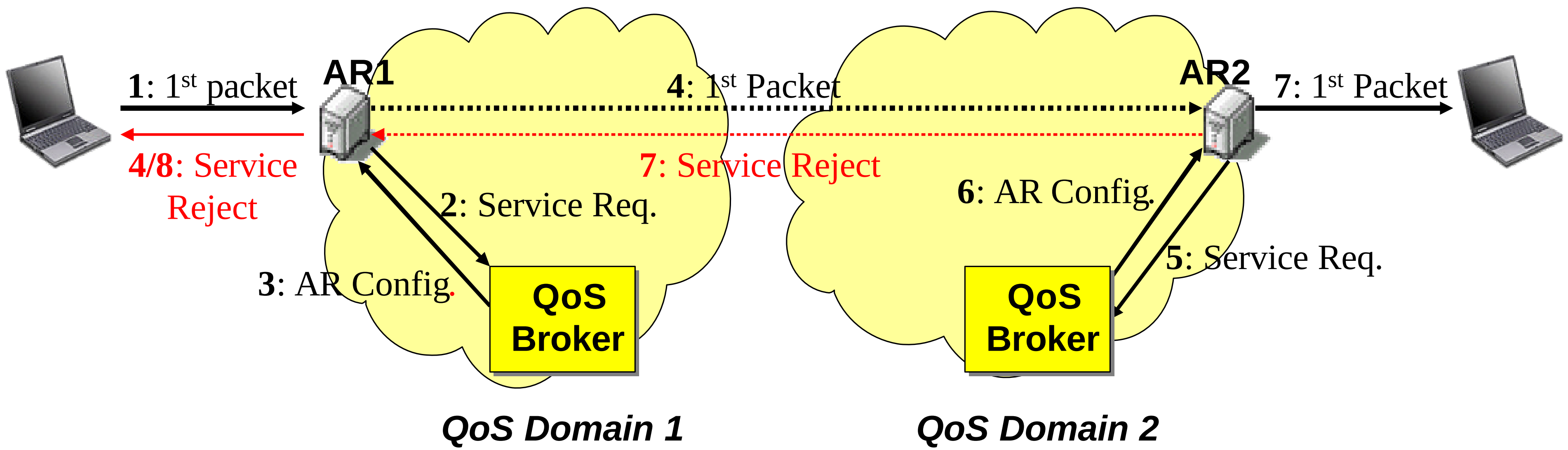
Service		Relative Priority	Service parameters	Service Description
Name	Class			
S1	EF	1	Peak BW: 32 kbps	Real time services
S2	AF41	2	Unspecified	IP signaling only
S3	AF21	3	CIR: 256 kbps	Priority (urgent) data transfer
S4	AF1*	4	3 drop precedences (kbps): AF11 – 64 AF12 – 128 AF13 – 256	Better than BE: streaming, ftp, etc
S5	BE	5	Peak bit rate: 32 kbps	Best effort
S6	BE	5	Peak bit rate: 64 kbps	Best effort
S7	BE	5	Peak bit rate: 256 kbps	Best effort

User Registration

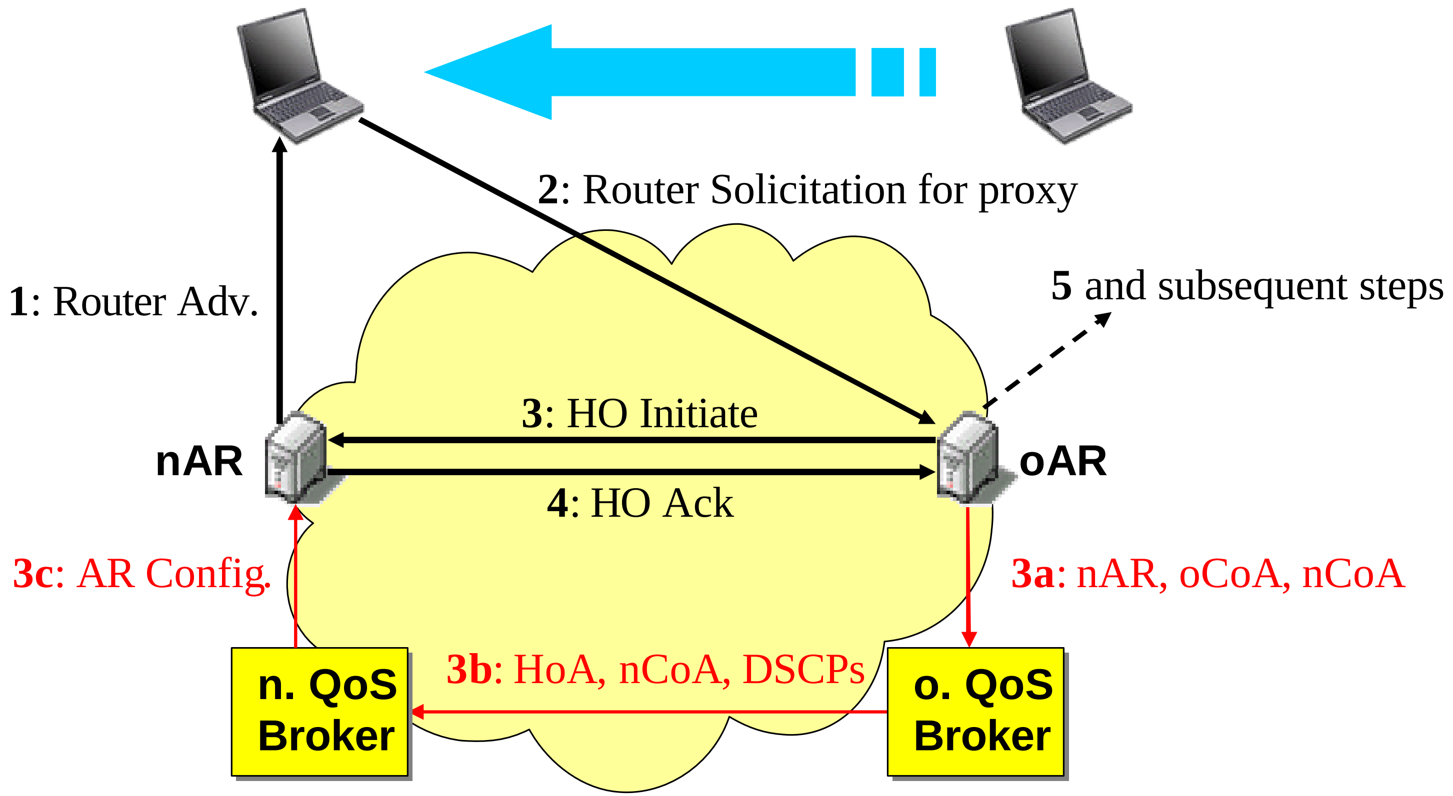


NVUP (Network View of the User Profile) = CoS, Bandwidth, Priority, Timeout

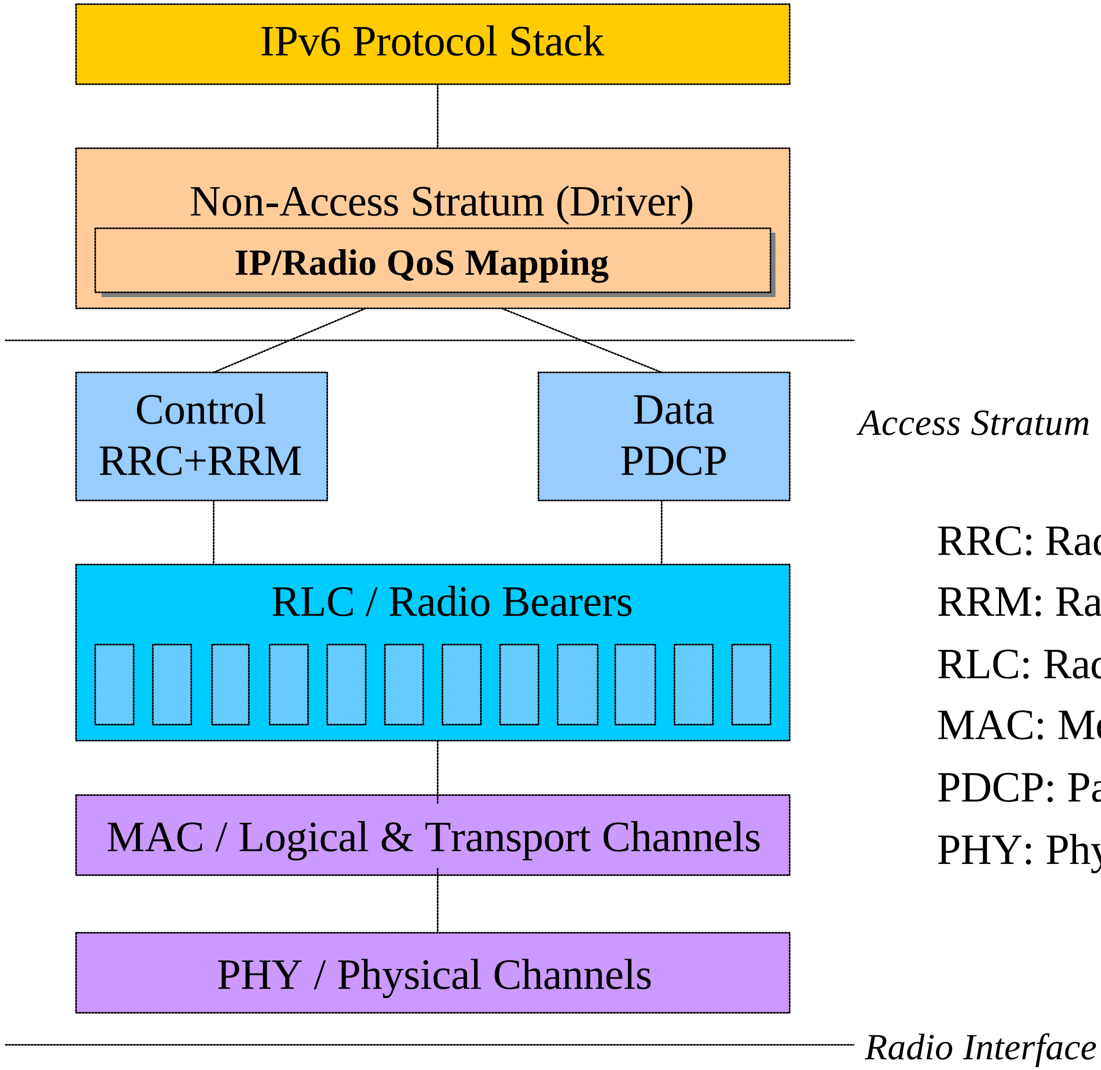
Service Authorisation



QoS during Fast Handover

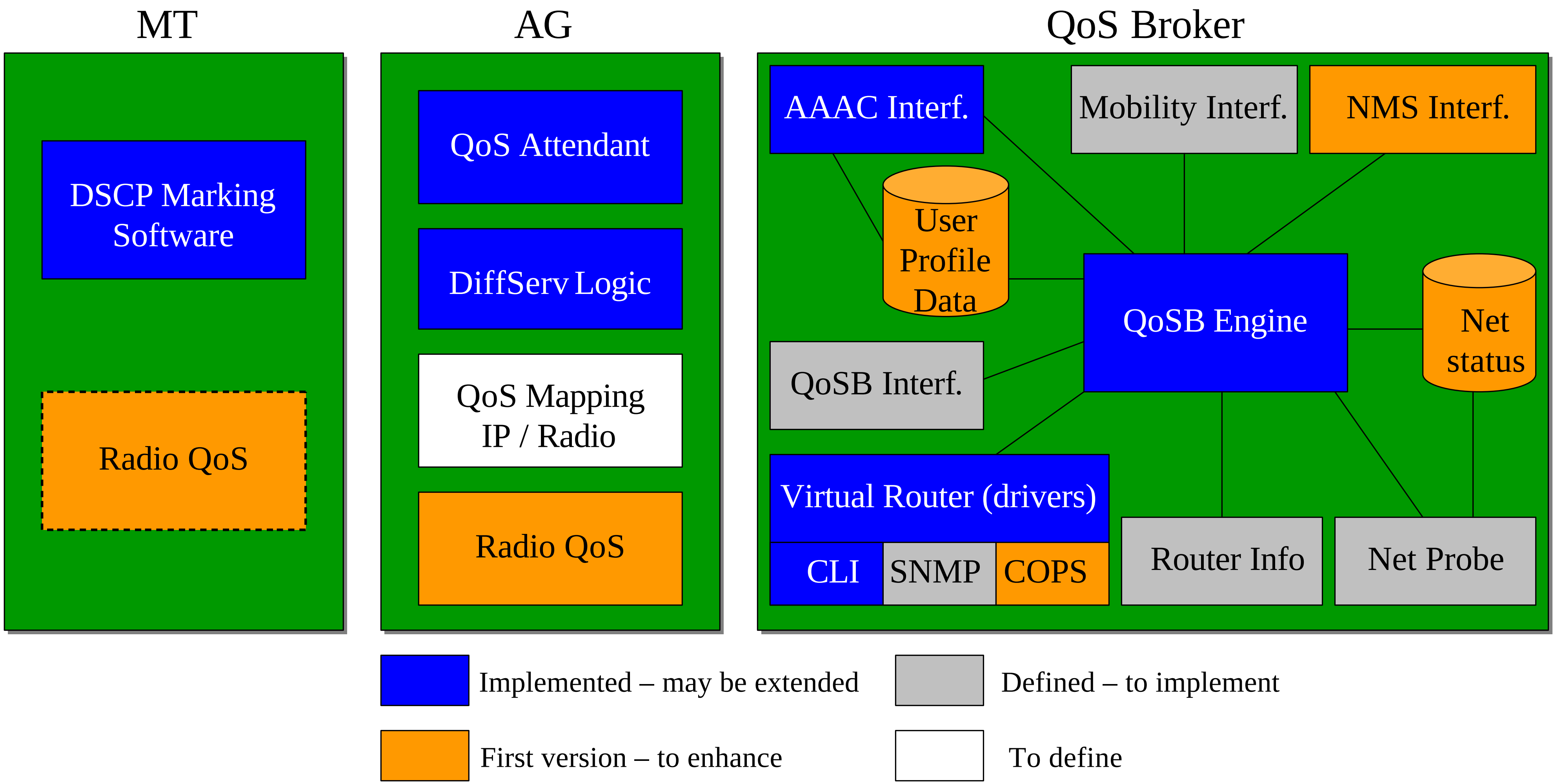


Radio QoS in Radio Gateway



RRC: Radio Resource Control
RRM: Radio Resource Management
RLC: Radio Link Control
MAC: Medium Access Control
PDCP: Packet Data Convergence Protocol
PHY: Physical Layer

Implementation (Done)



Implementation (To Do)

- QoS Brokers
  - Mobility management
  - Radio parameters management
  - Communications between QoS Brokers
- DSCP Marking Software enhancement
- QoS validation
  - How to measure the QoS offered?
  - How to verify resources are correctly allocated and released?

Simulation

- Influence of packet size on delay and jitter in a same CoS (EF) with heterogeneous traffic in PHB
  - Per-hop delay and jitter do not depend on traffic mix
  - But they depend on packet size distribution and load
- Choice of queuing techniques in PDB
  - Comparison of different schedulers (Strict Priority, SFQ, WFQ)
  - First results: Strict Priority with rate limitation may be effective for Moby Dick scenarios
    - Lower jitter
    - Lower maximum delay
- Study of 802.11e EDCF
  - 802.11e EDCF provides distinguishable delay differentiation for different traffic types

Next Steps in QoS Research

- QoS architecture
  - Efficient resource management in the QoS Broker: over-allocation, dynamic management
  - QoS negotiation and renegotiation with the handover management
  - Bi-directional resource allocation
  - Most effective queuing techniques and configuration for Moby Dick
  - Which flows can be and which flows must not be aggregated in same CoS
- Investigate QoS measurements
- Improve TCP performance based on results of our simulations and tests

Mechanisms for Service Provisioning in a Heterogeneous Mobile Environment

Burkhard Stiller
on behalf of MobyDick

Content

- Motivation and Introduction
- Requirements
- AAAC System
  - User Profile
  - User Registration Protocol
  - Metering, Accounting, and Charging
  - AAAC Server and Client
  - AAAC-Mobility Interaction
  - AAAC-QoS Broker Interaction
  - Auditing and Logging
  - IPSec
- Summary

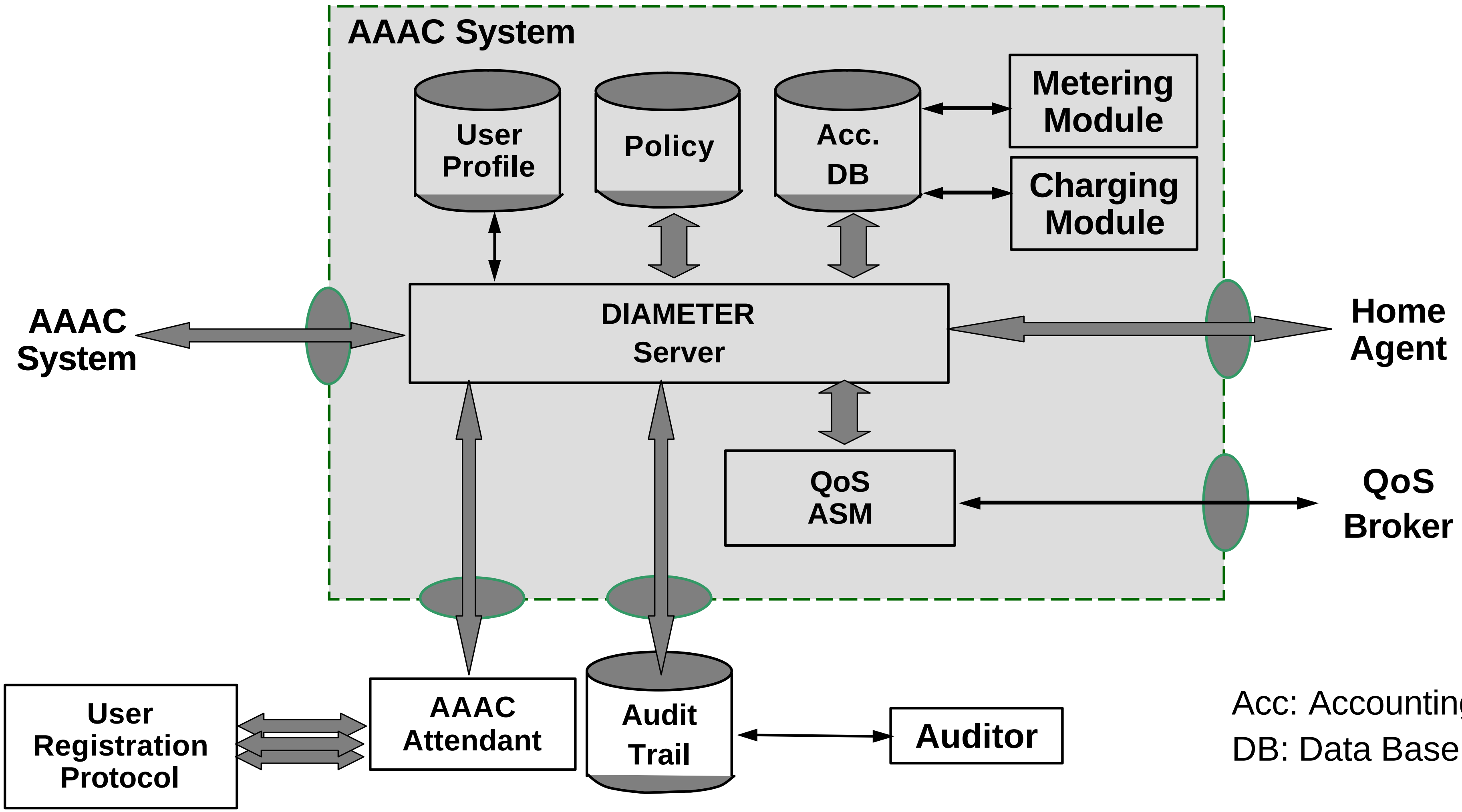
AAAC Motivation and Introduction

- Fact 1: Variety of existing wireless networking technology.
- Fact 2: Variety of Internet services to be offered seamlessly in wireless and wired networks under commercial constraints.
- Technical and economic prerequisite mechanisms are Authentication, Authorization, Accounting, and Charging (AAAC):
  - Functional evaluation of appropriate/existing components for a new AAAC entity, termed AAAC System.
  - Definition of AAAC Client and core AAAC Server.
  - Refinements of interaction schemes (Mobility and QoS Broker) by message sequence charts.

AAAC Requirements

- AAAC for charging, pricing, and auditing:
  - Meeting business requirements and
  - Security issues.
- AAAC for mobility support:
  - Inter- as well as intra-domain and
  - Intra-technology.
- AAAC for QoS support:
  - Multi-provider and Service Level Agreements (SLA) and
  - Profiles.
- Scalability considerations.

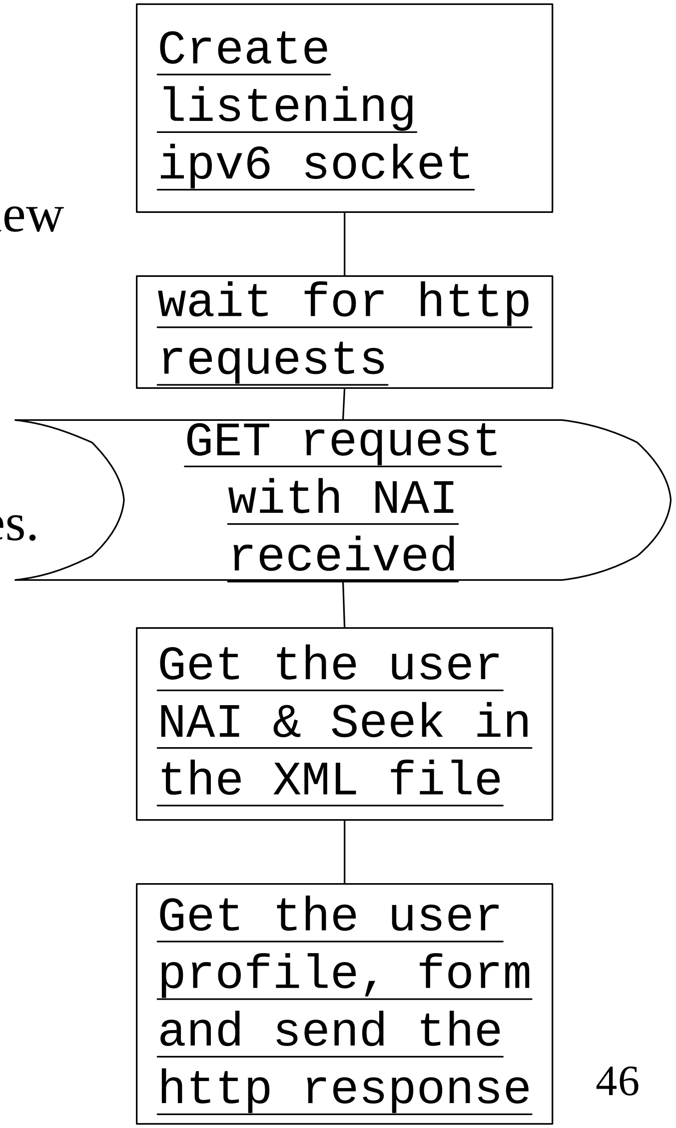
The AAAC System
— Design Overview —



Acc: Accounting
DB: Data Base

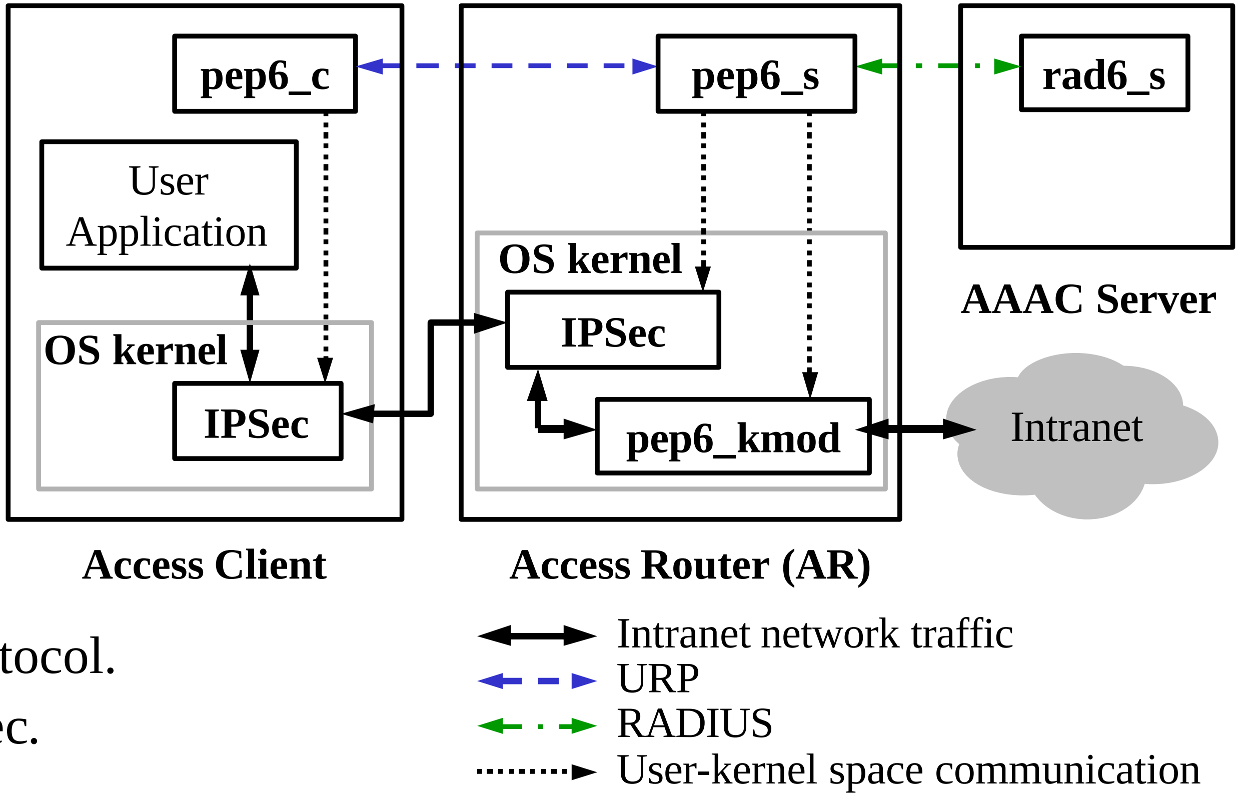
User Profile

- Design of content of user profile:
  - User-specific data records: user name, e-mail address.
  - Service-specific data: authentication data, Network View of User Profile, SLA.
  - Charging/Tariff-specific data: tariff plan, policies.
- User profile handling (XML data base):
  - Standard http server (over IPv6) reading flat XML files.
  - Allows for retrieval of a part of the XML file.
  - Client Application Programming Interface (API) developed.
- Advantages of user profiles in XML:
  - Flexibility to update content.
  - Flexibility to change the description.



User Registration Protocol

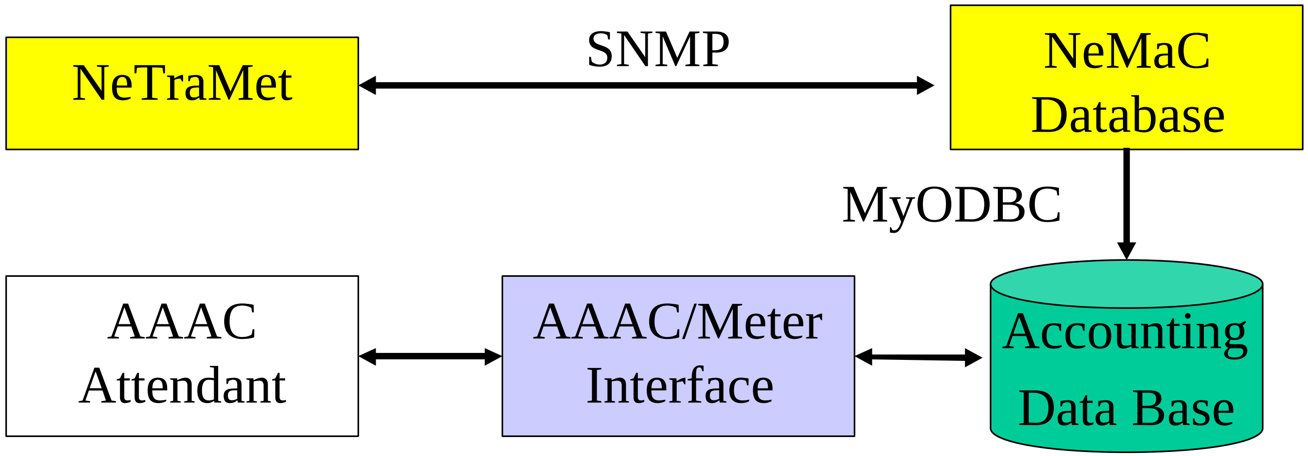
- Design and implementation of a User Registration Protocol (URP):
  - Supports Local Security Association Temporary Shared Keys.
  - Supports CHAP.
  - Independent of access technology.
  - Establishes a secure connection between the access client and an AR.



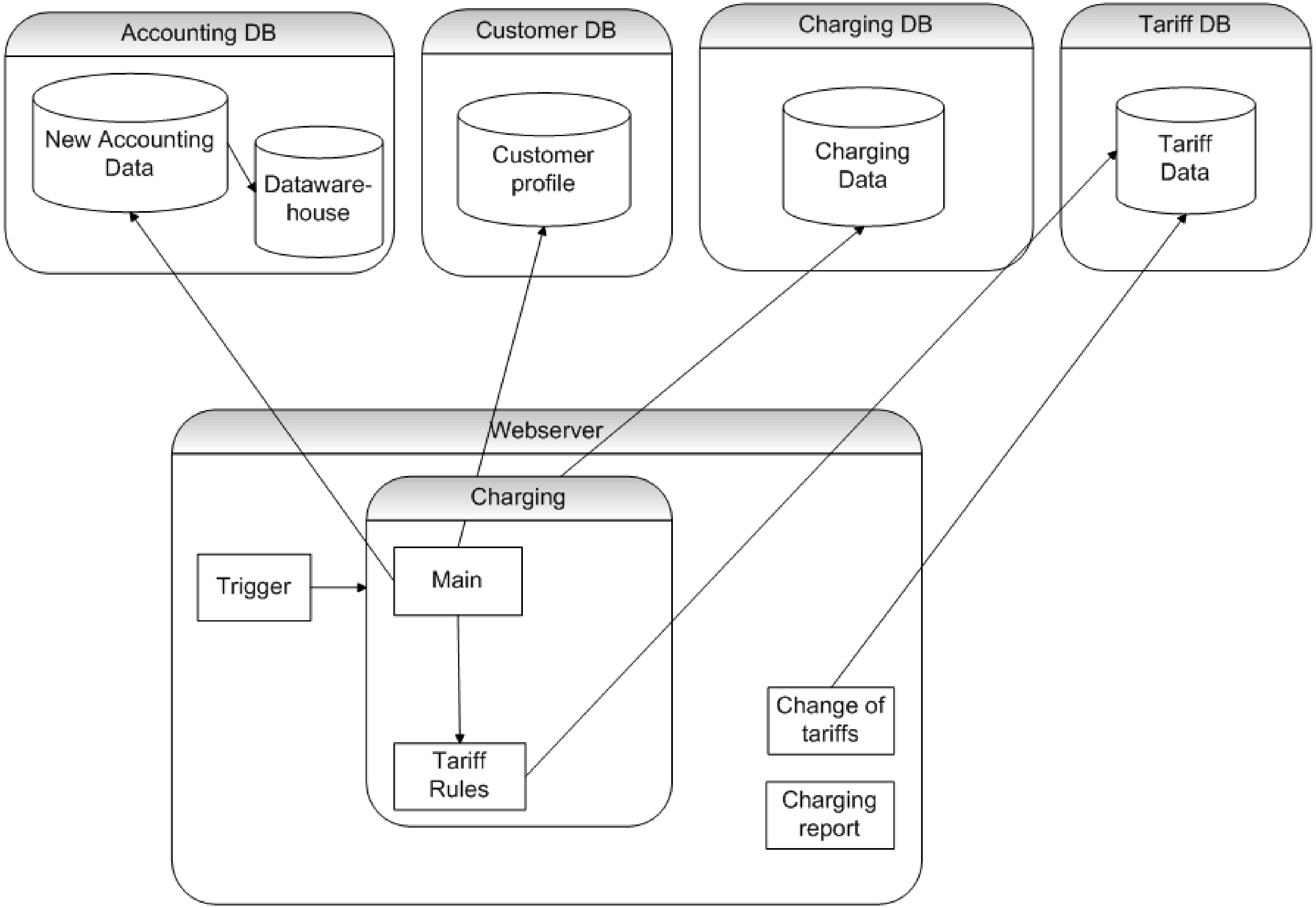
- Advantages:
  - Application layer protocol.
  - Compatible with IPsec.

Metering in AAAC

- Design and implementation of a metering framework:
  - Port of IETF meter NeTraMet to an IPv6-aware meter.
  - Modification of IETF Meter reader NeMaC for MySQL capabilities.
  - Integration with MobyDick-compliant databases.
  - Design and implementation of an interface to the AAAC Attendant.

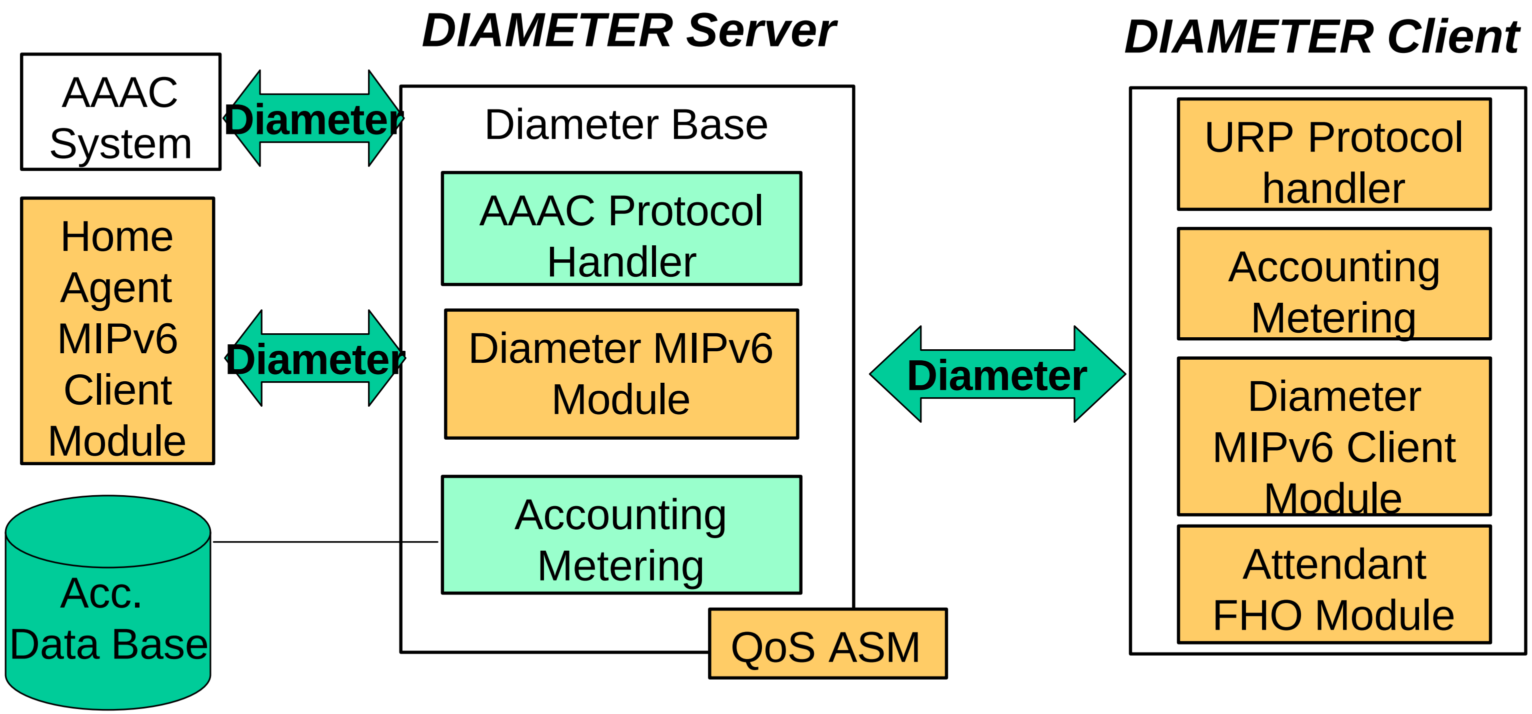


Charging in AAAC



AAAC Server and Client

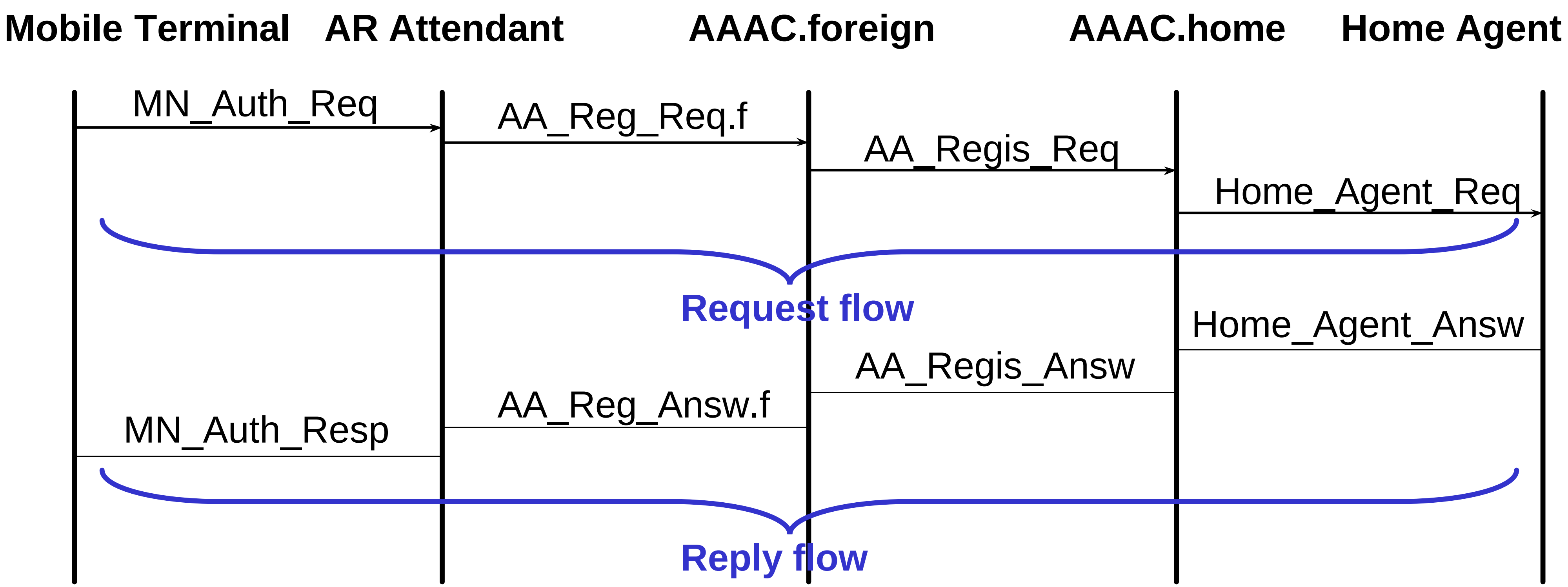
- DIAMETER Server/Client development:
  - Evaluation of an DIAMETER implementation.
  - MobileIPv6 module and QoS ASM implementation for DIAMETER Server.
  - Implementation of DIAMETER Client for Access Router Attendant.



Acc: Accounting
ASM: Application Specific Module
FHO: Fast Handover

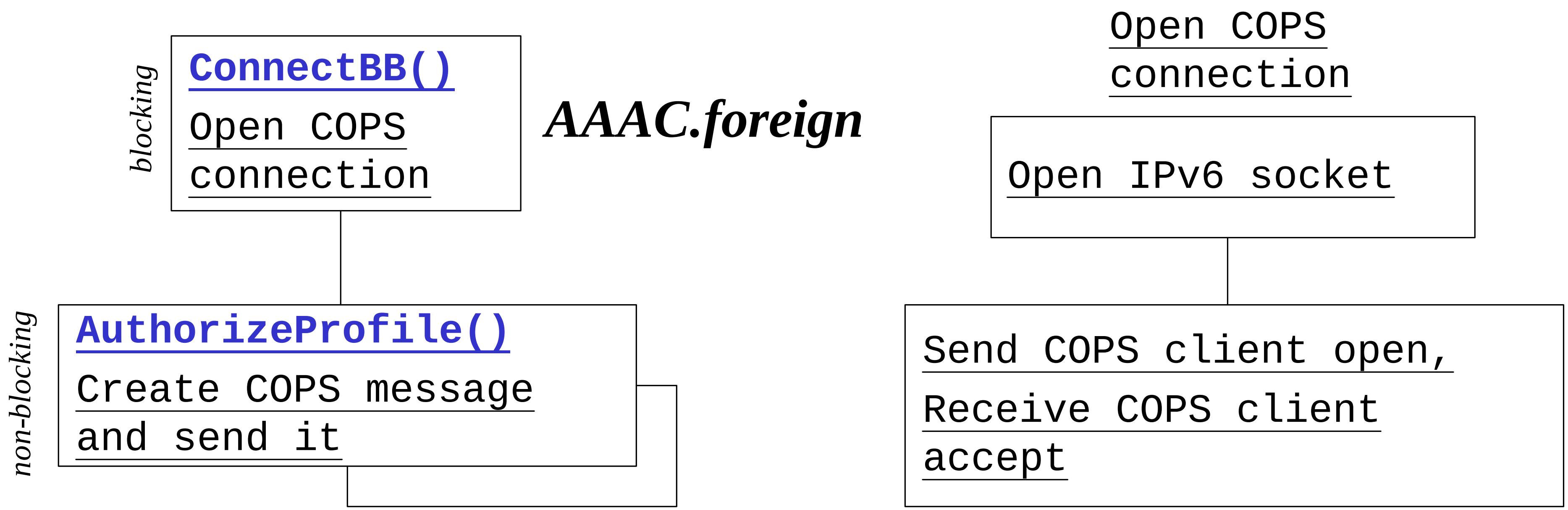
AAAC — Mobility Interaction

- Design of interaction scheme:
  - Based on draft-le-aaa-diameter-mobileipv6-01 and draft-ietf-aaa-diameter-10.



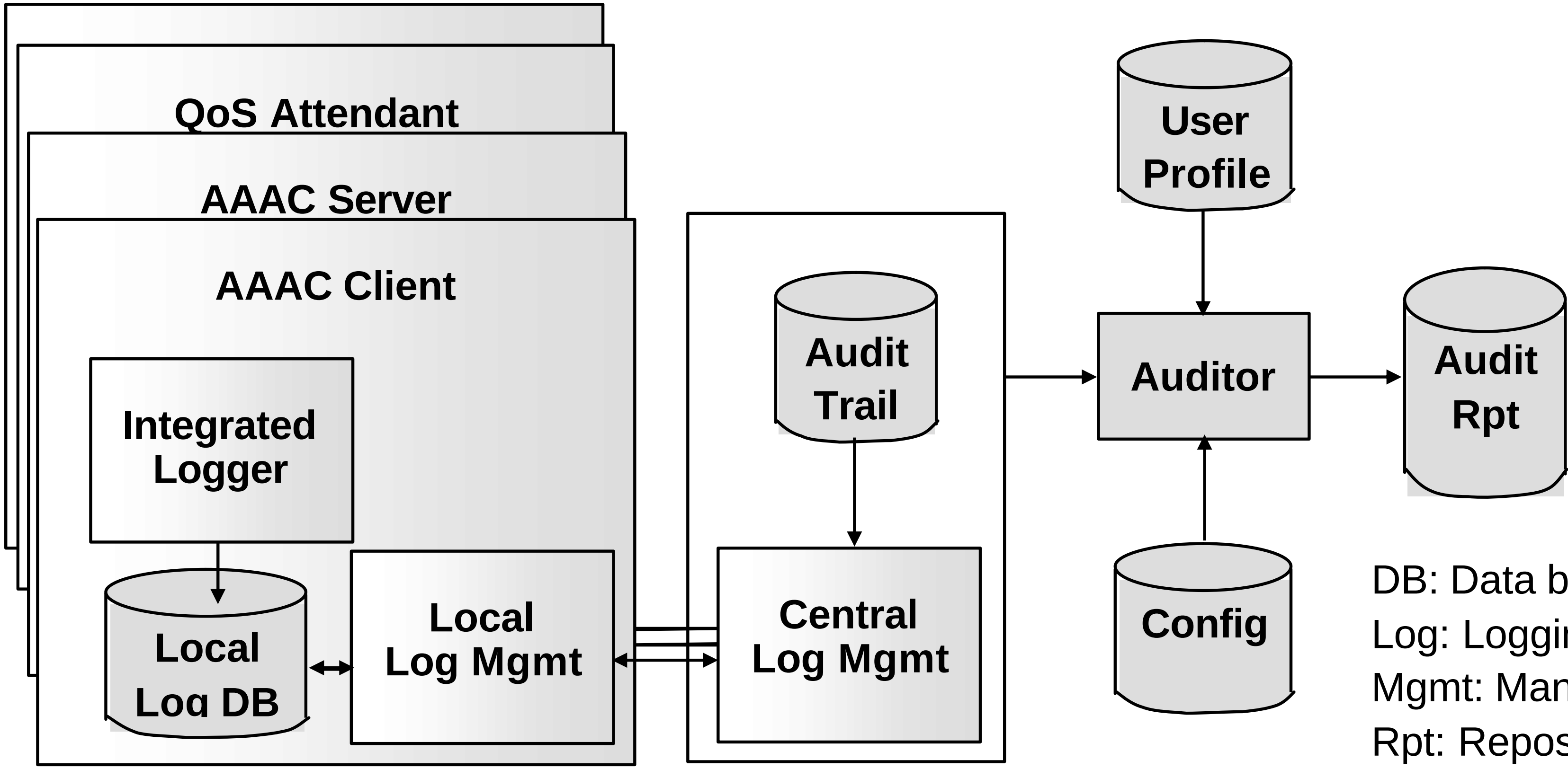
AAAC — QoS Broker Interaction

- Design of an API to allow AAAC.foreign and QoS Broker interaction:
  - ConnectBB() called on AAAC.f initialization:
    Opens IPv6 socket and opens COPS connection to the QoS Broker.
  - AuthorizeProfile() forms a COPS message including, a.o. Care-of-Address, Time-to-Live, Bandwidth.



Auditing and Logging

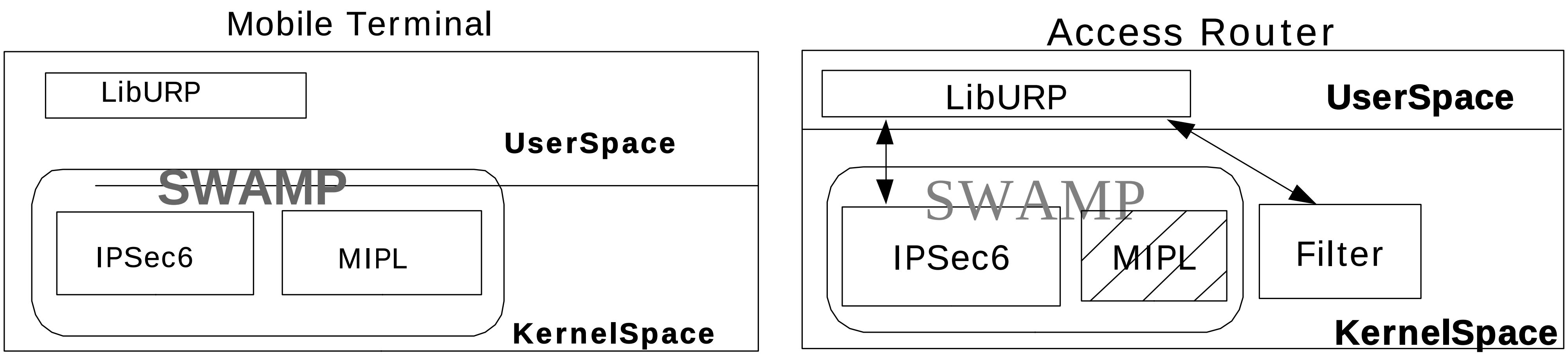
- Design of auditing and logging for MobyDick services:
  - Specification of service level guarantees.
  - Specification of violation conditions.



DB: Data base
Log: Logging
Mgmt: Management
Rpt: Repository

IPSec Support in MobyDick

- Development of IPSec-enhanced Linux kernel for MobyDick:
  - MIPL does not co-exist with IPSec6.
  - Created a software package (SWAMP) merging MIPL and IPSec6.
  - Developed a library to use IPSec6 functionality:
    - o Using Linux kernel version 2.4.16.
    - o Using MIPL version 0.9.1.



Summary

- The AAAC work of MobyDick achieved:
  - Handling of user profiles.
  - User Registration Protocol.
  - IPv6-enabled meter.
  - Accounting, charging, and user profile data bases.
  - Generic AAAC System.
  - Auditing.
  - Creation of integrated MIPL and IPSec6 library.

- Applying IETF/IRTF RFC/drafts in major areas:
  - DIAMETER, Mobile IPv6, CHAP, Local Security Associations, NeTraMet, NeMaC, Policy-based Accounting.

Moby Dick
Demonstration Overview

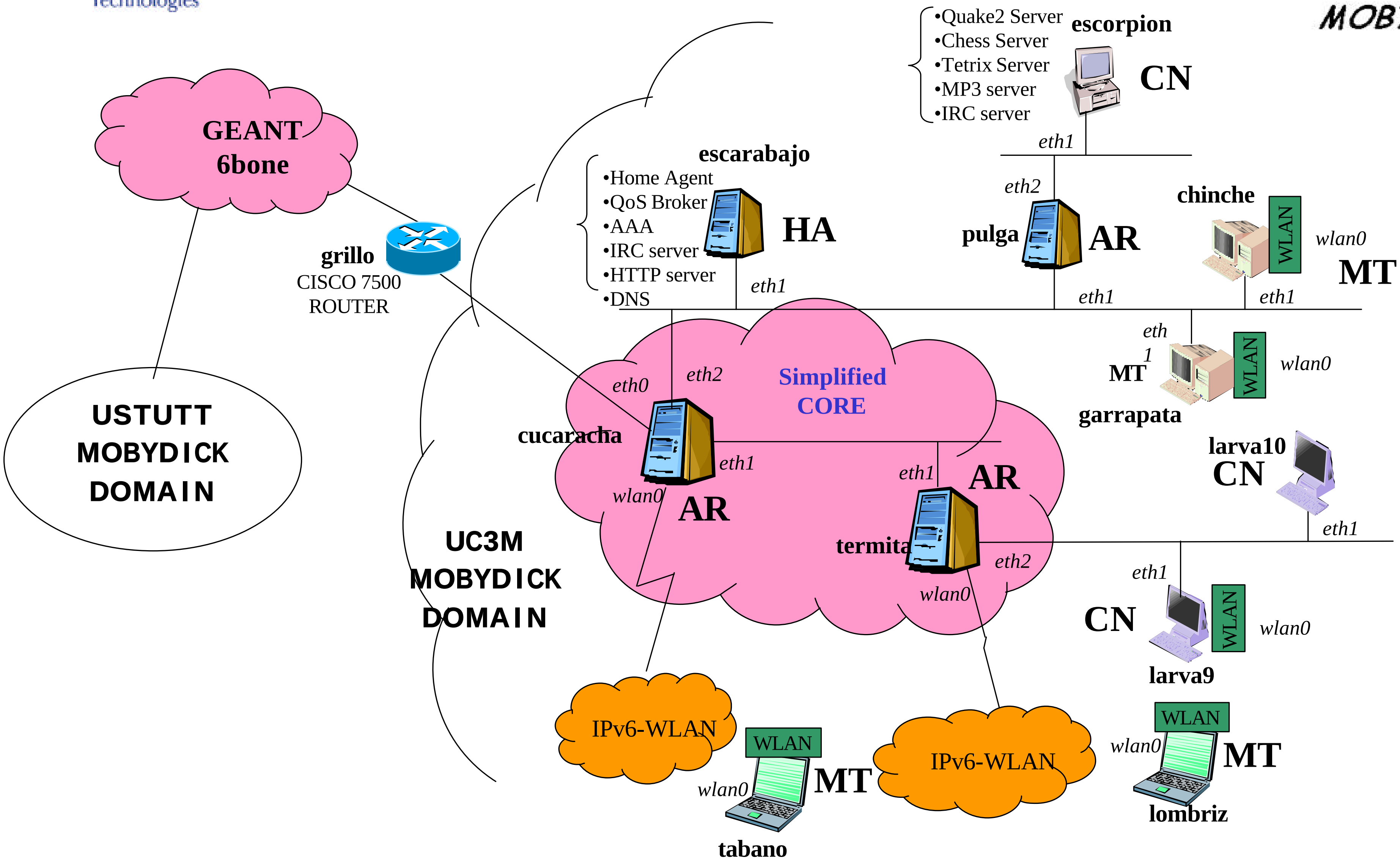
Jose Ignacio Moreno

On behalf of Moby Dick

Content

- Presentation of the testbed
- Presentations of Demos
  - AAAC
  - QoS
  - Mobility
  - W-CDMA
- Conclusion

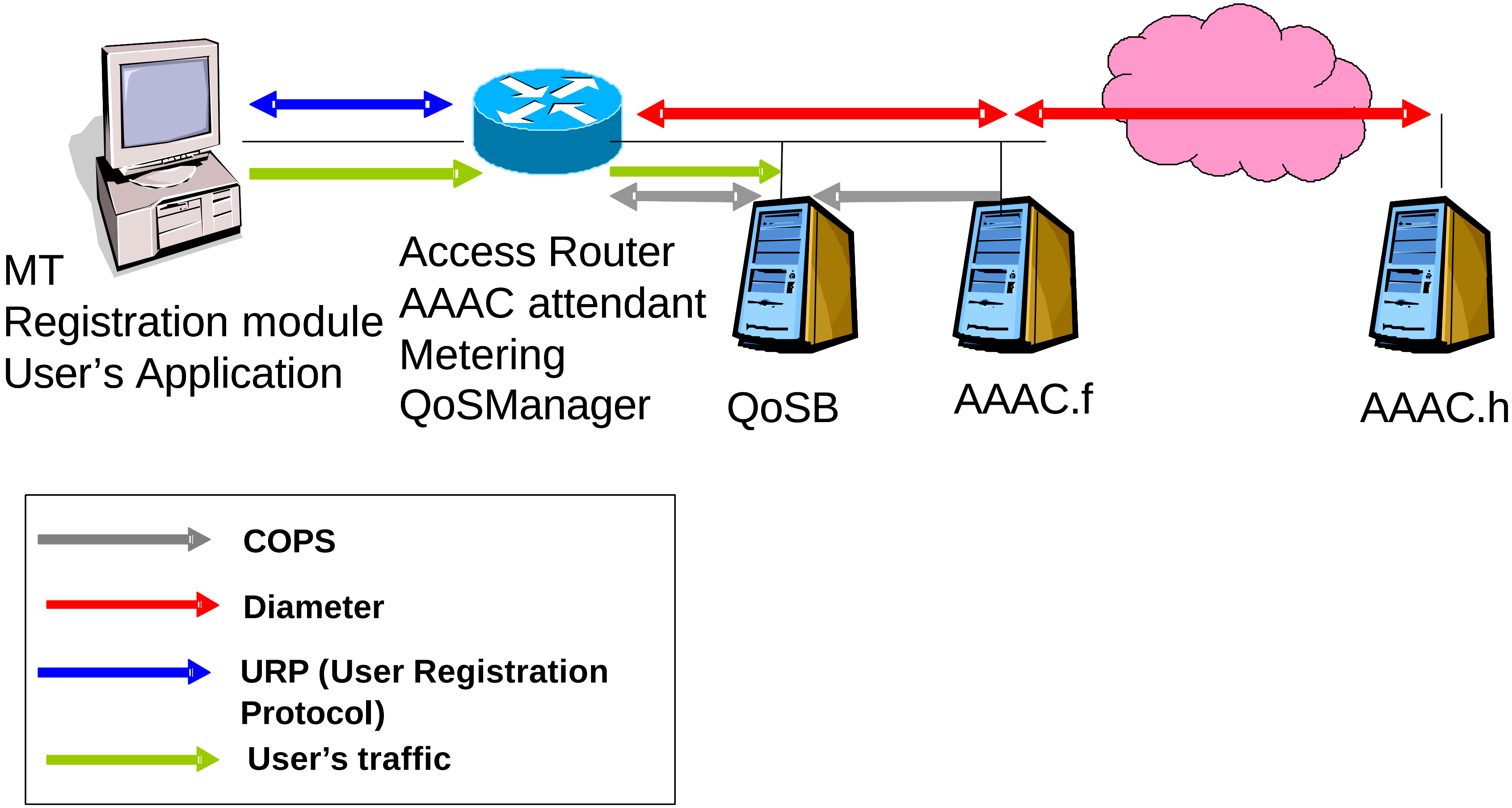
Moby Dick testbed



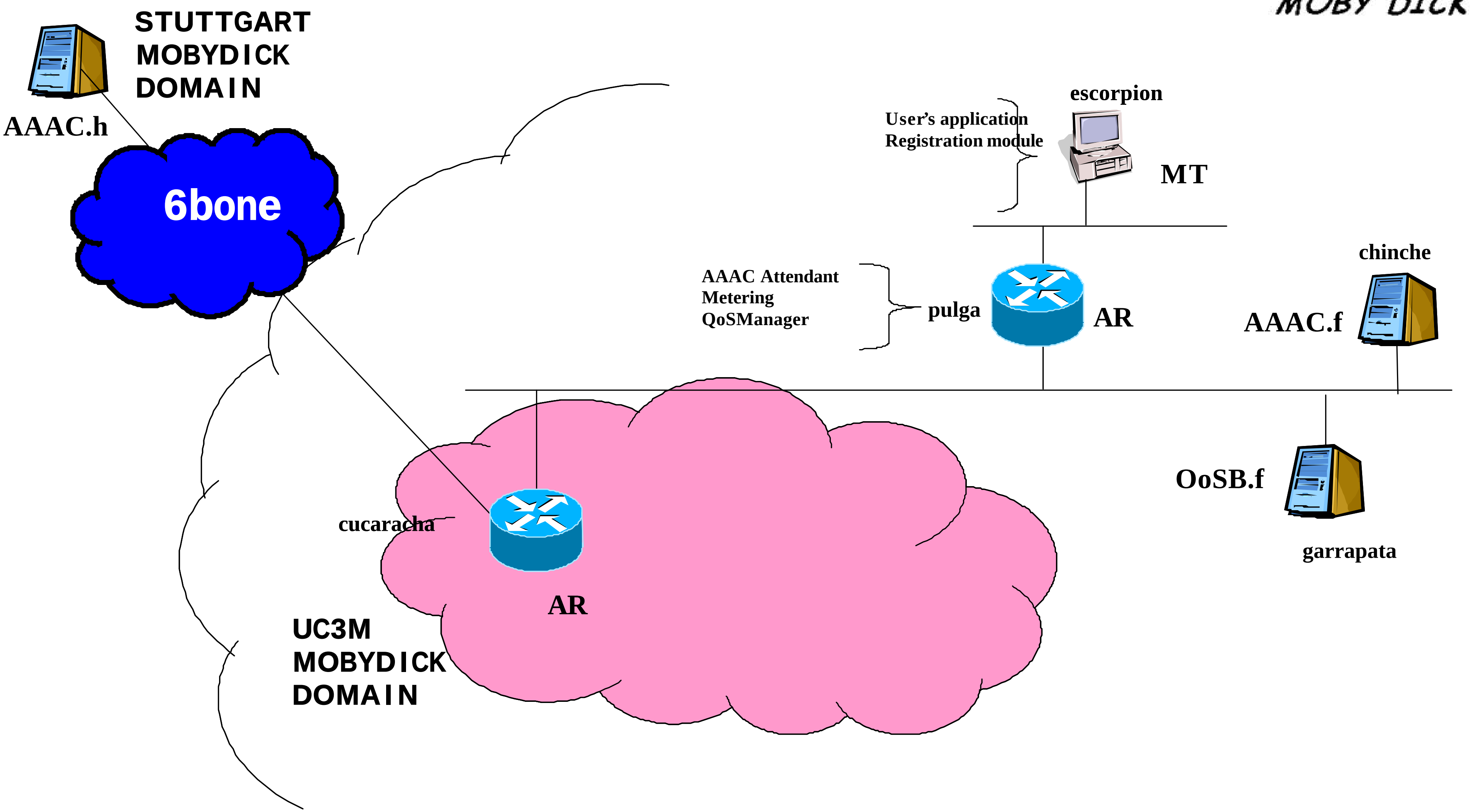
AAAC Demonstration

- **Goals**
  - Registration process and its effect in user's traffic
- **Test Specification**
  - MT registers using URP
  - AAAC attendant translates URP messages to Diameter
  - AAAC.f communicates with the QoSB
- **Results**
  - User profile is transferred to all the entities
  - User packets can reach the core network.

AAAC Test Scenario



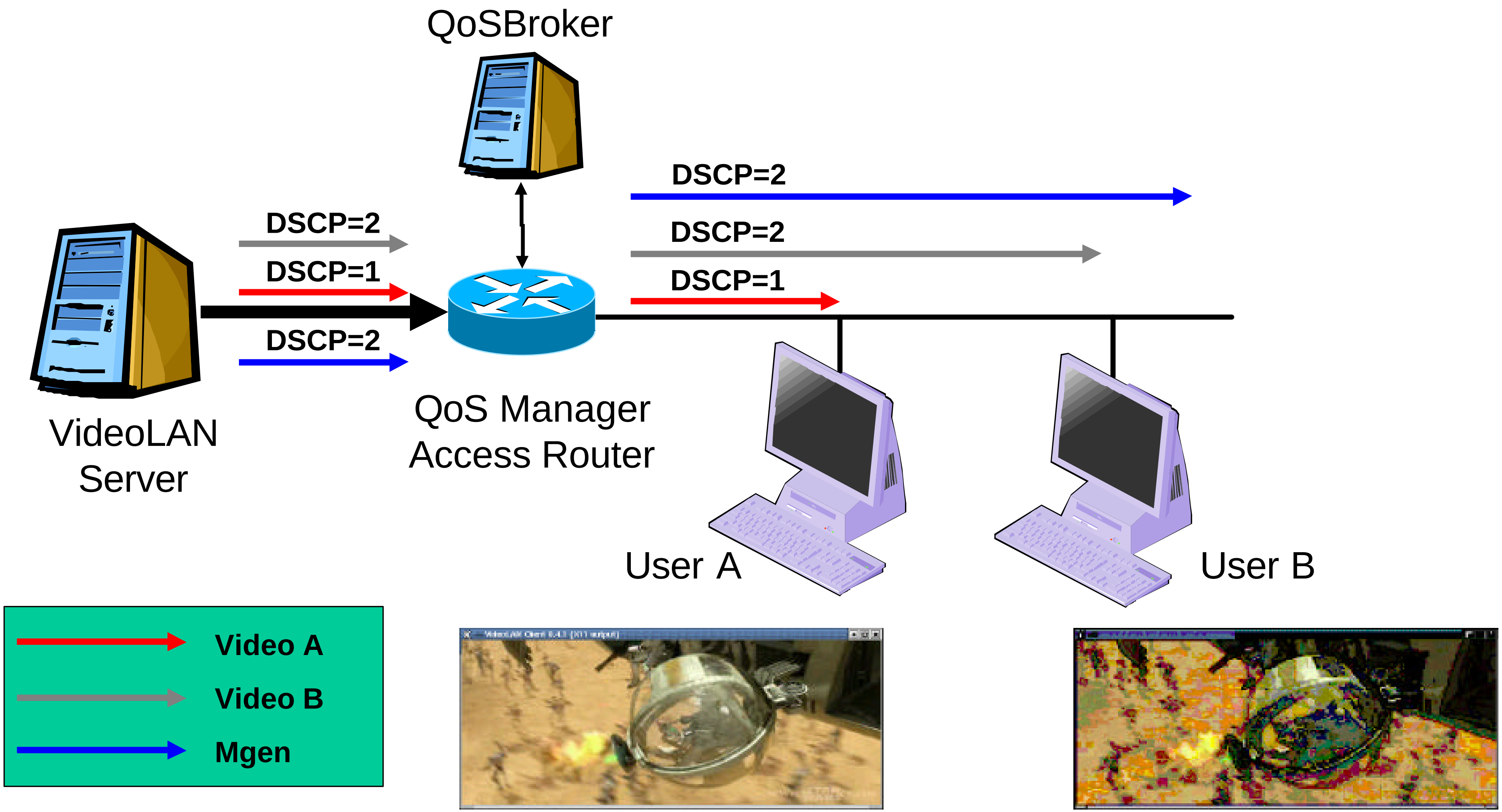
AAAC Testbed



QoS Demonstration

- **Goals**
  - Prove QoS capabilities of the network
  - Prove appropriate working of QoSBroker, QoSManager and its interaction
- **Test specification**
  - Video LAN application is serving two video streams - each one with different QoS DSCP
  - One Stream will share resources with background traffic (*mgen* application)
- **Results**
  - User A will get better quality video than User B
  - Demonstration of interaction messages

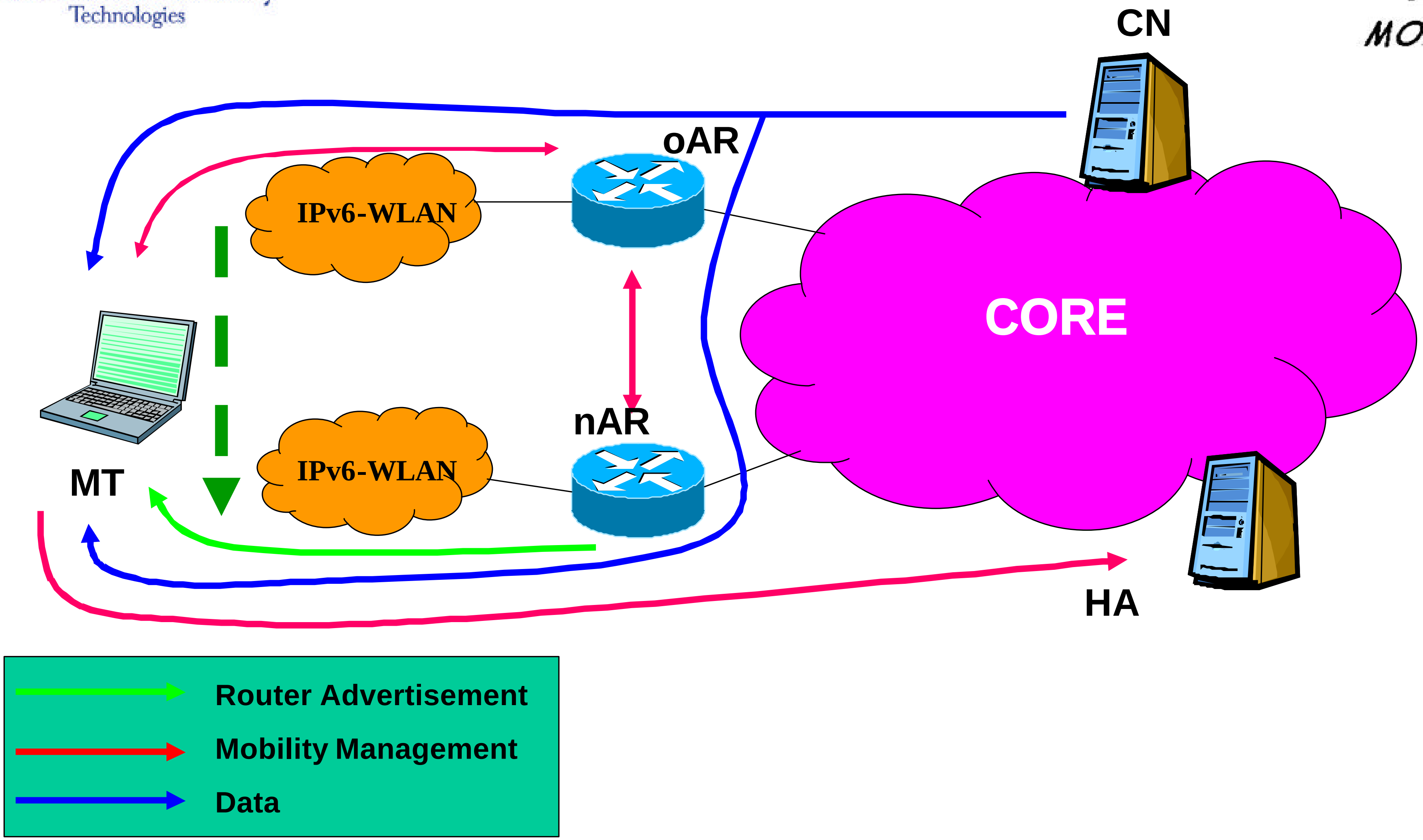
QoS Test Scenario



Mobility Demonstration

- **Goals:**
  - Seamless handover among IPv6 subnets for real-time applications
- **Test specification:**
  - A user initiates a real-time application from Mobile Terminal
  - User changes AR while communicating (seamless mobility scenario)
- **Results:**
  - Signal quality with first AR decreases,
    => Mobile Terminal performs a handover
  - No impact in application performance thanks to fast handover mechanism
    (seamless IP mobility management)

Mobility Test Scenario

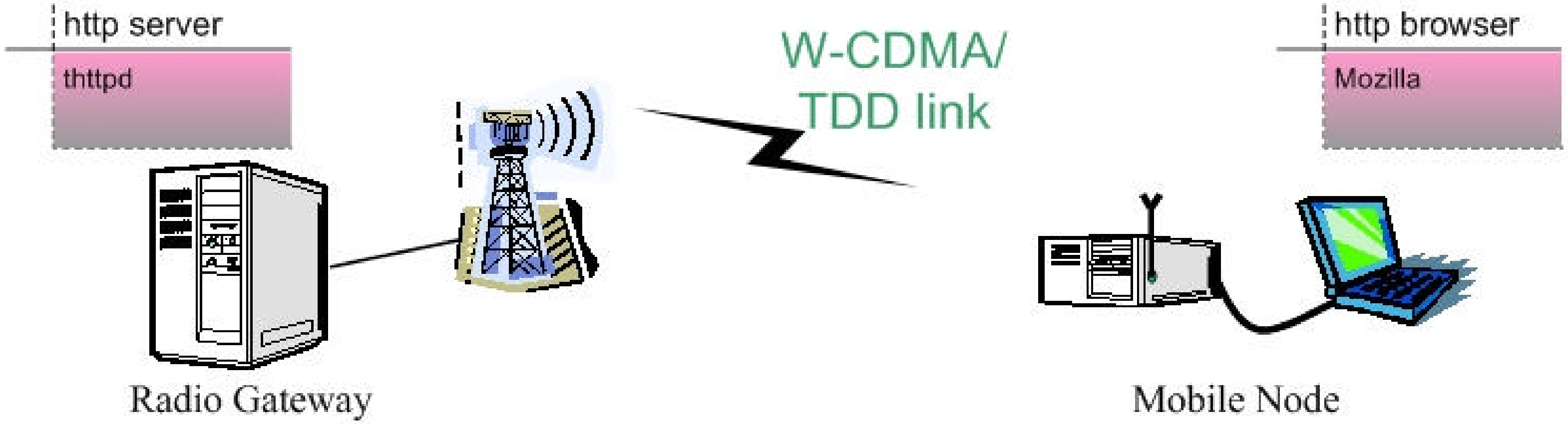


W-CDMA Demonstration

- **Goal**
  - Demonstrate Real Time W-CDMA interface in terms of a variety of constraints, behaviour, time, delay, CPU load due to RT W-CDMA processing
  - Inter-connect Access Stratum directly to IPv6 protocol stack through GRAAL (Generic Radio Access Adaptation Layer) driver.
- **Test specification**
  - Activate Transport Channels between the Mobile Terminal and Radio Gateway
  - Connect the W-CDMA Access Stratum to IPv6 protocol stack.
- **Results**
  - Data can be transferred over W-CDMA interface.

W-CDMA testbed

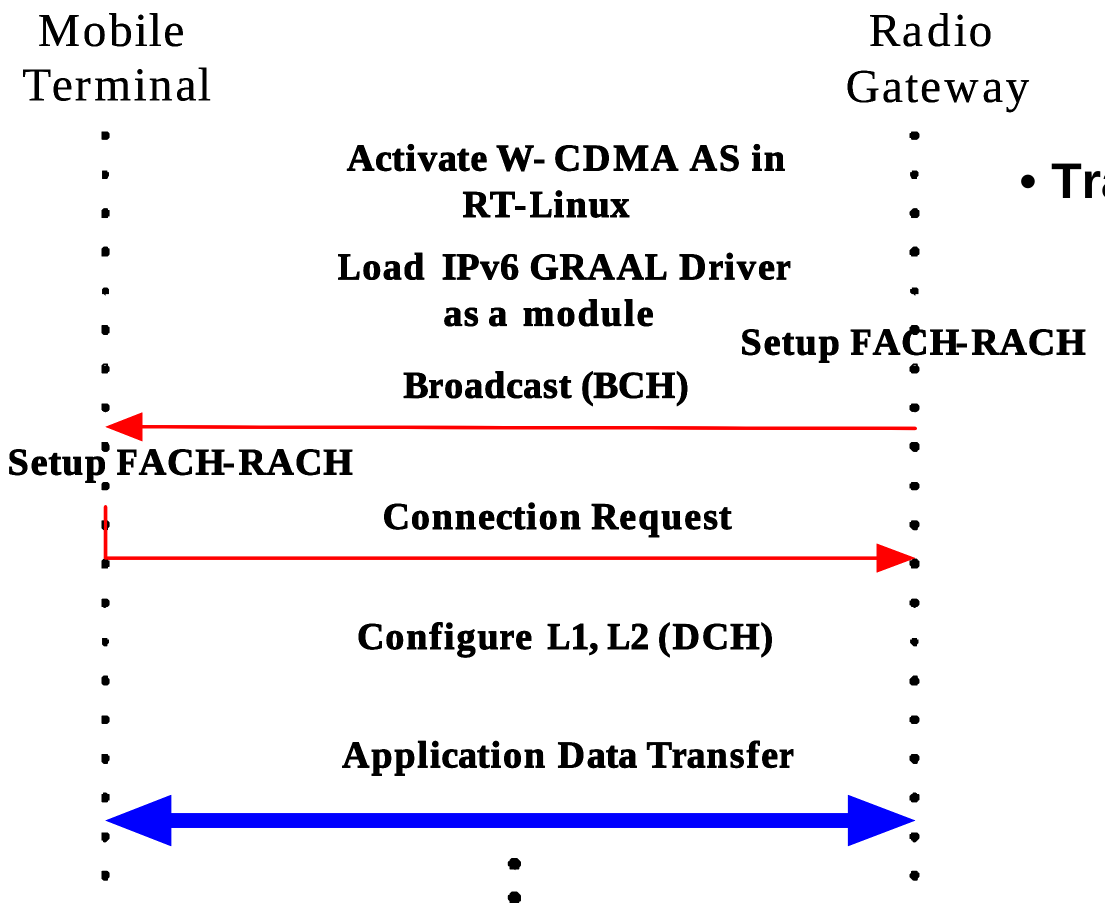
Traffic types:
- ICMP (PING, Router Advertisement)
- http



- Linux kernel 2.4.4
- RT-LINUX 3.1
- IPv6 module
- W-CDMA Access Stratum (RG)
- GRAAL driver (RG)

- Linux kernel 2.4.16
- RT-LINUX 3.1 + patch 2.4.16
- IPv6 module
- W-CDMA Access Stratum (MT)
- GRAAL driver (MT)

W-CDMA Signalling Flow



- **Transport Channels used:**
  - BCH (broadcast),
  - FACH / RACH (common channels),
  - DCH (dedicated channel, mainly for data):
    - UL (MN to RG) : 144 kbps,
    - DL (RG to UE) : 384 kbps peak rate,
    - 5 Transport Formats, convolutional code ½, TTI =10 ms, RLC AM.

Conclusions

- ✍ First Version of Moby Dick Software provide a system up and running including main functionalities of AAAC, QoS and Mobility
- ✍ A complete integrated system will be available for the trials during next year
- ✍ All modules and interfaces have been specified

Thank you and Visit us at Demo Room 4.2E03 (2nd Floor)