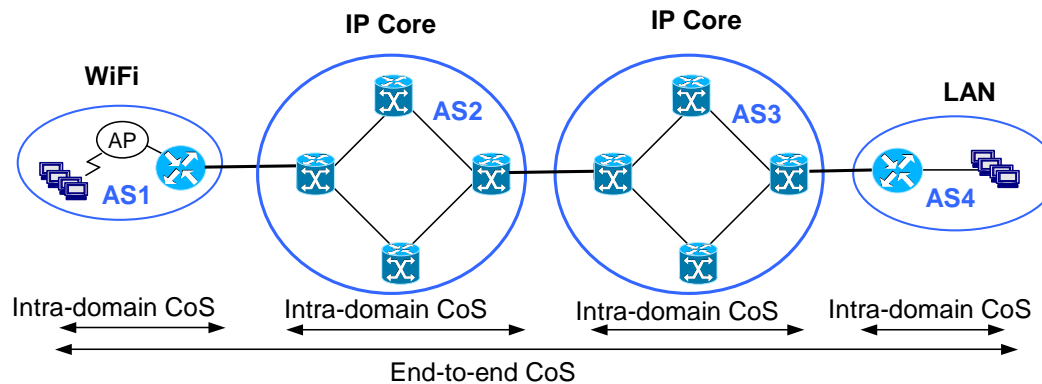# EuQoS and measurements

Marek Dabrowski (WUT), Andrzej Beben (WUT), Philippe Owezarski (LAAS), Xavi Masip (UPC), Rene Serral Gracia (UPC), Gerardo Garcia de Blas (TID)

EEQoS Workshop, Paris, 22 June 2005

Outline

- Introduction

- EuQoS Monitoring and Measurement System (MMS)

- Measurement tools for EuQoS trials

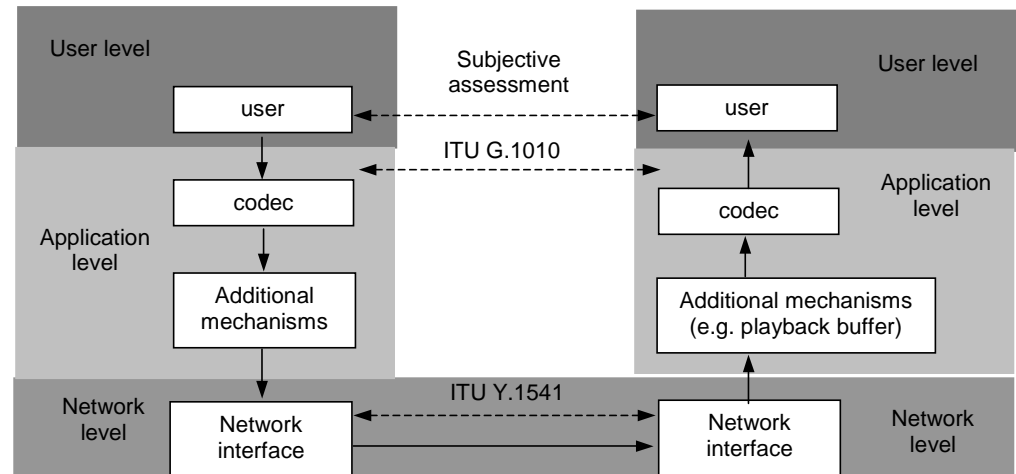- Measurement tools for supporting EuQoS system

- Summary

Introduction: the EuQoS network

- **Multiple domains based on different technologies, like xDSL, UMTS, WiFi, LAN, IP DiffServ, ...**

- **Provides QoS guarantees by offering a set of Classes of Service (CoS) with different QoS objectives**

The role of monitoring and measurements in EuQoS

- Validate the EuQoS architecture in trials by measurements of QoS level offered by EuQoS CoSs

- Support operation of EuQoS system functions, like admission control and traffic engineering

Assumed approach

- To take into account the state of the art and available tools
  - Build on tools developed by project partners and upgrade them to the needs of EuQoS
  - Integrate different tools to create Monitoring and Measurement System (MMS) for EuQoS

- Focus on measurements on network level, but take into account QoS requirements on application and user level

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- Measurement tools for EuQoS trials

- Measurement tools for supporting EuQoS system

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EuQoS Measurement and Monitoring System (MMS)

- **Measurement Points (MP)**
  - Places in a network where we perform measurements

- **Measurement tools**
  - Several tools for different types of measurements

- **Measurement controller**
  - Starting and stopping the tools
  - Collecting results

The Measurement Points (MP)

- Take into account EuQoS network architecture
  - Measurements on IP layer
 - MPs in the places where particular CoS (intra- or inter-domian) begins or ends to operate

Reference location of MPs
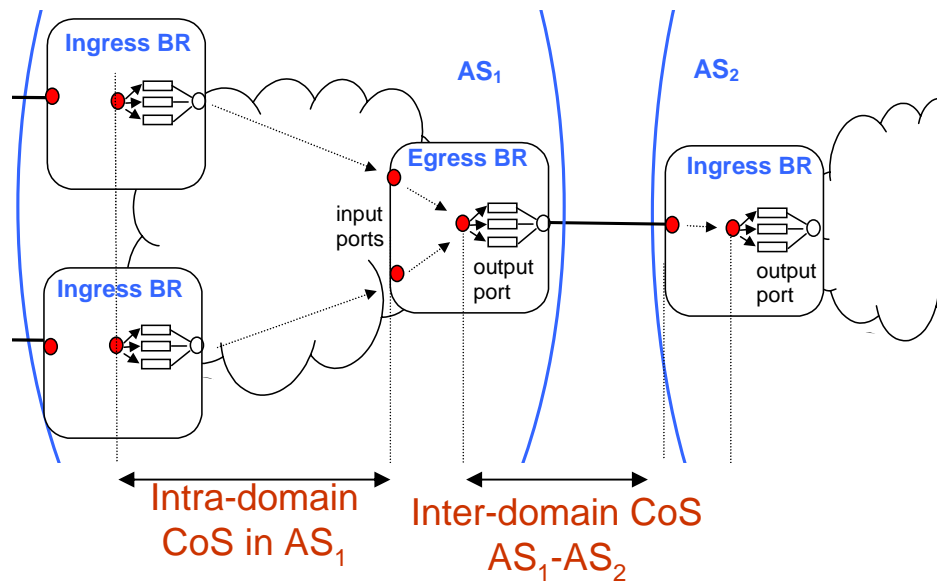
- **For core network:**
  - MP^X_a – input interface of the ingress border router
  - MP^X_b – entrance to the queue of output interface of the ingress border router
  - MP^X_c – input interface of the egress border router.
 - MP^X_d – entrance to the queue on the output interface of the egress border router

- **For access network:**
  - MP^X_t – at IP interface of the user terminal

AS: Autonomous System
AN: Access Network

BR: Border Router
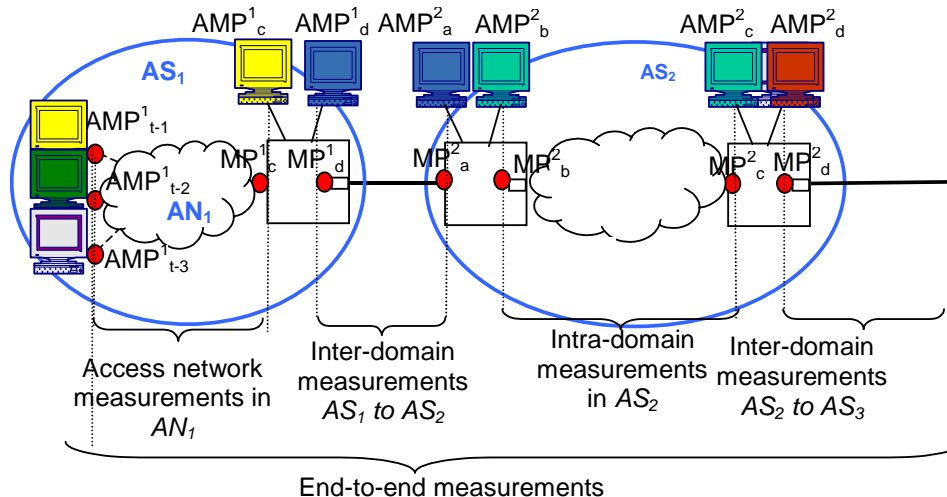MP: Measurement Point (reference location)
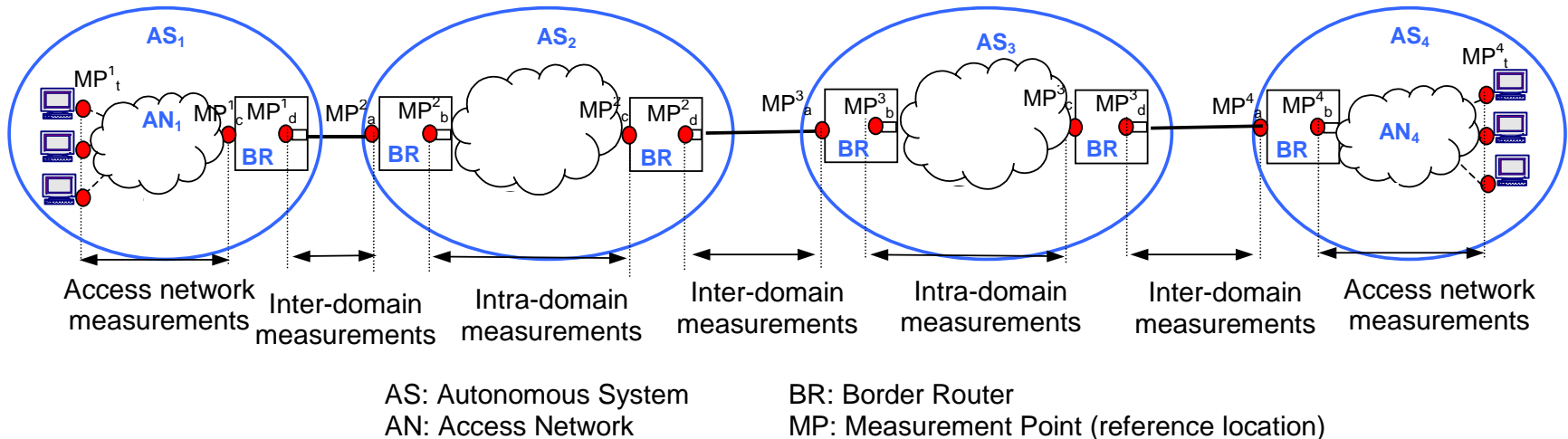
Deployment of measurement equipment

- Guidelines for deployment of MMS in EuQoS testbeds
  - Limited access to the routers
  - Active and passive measurements
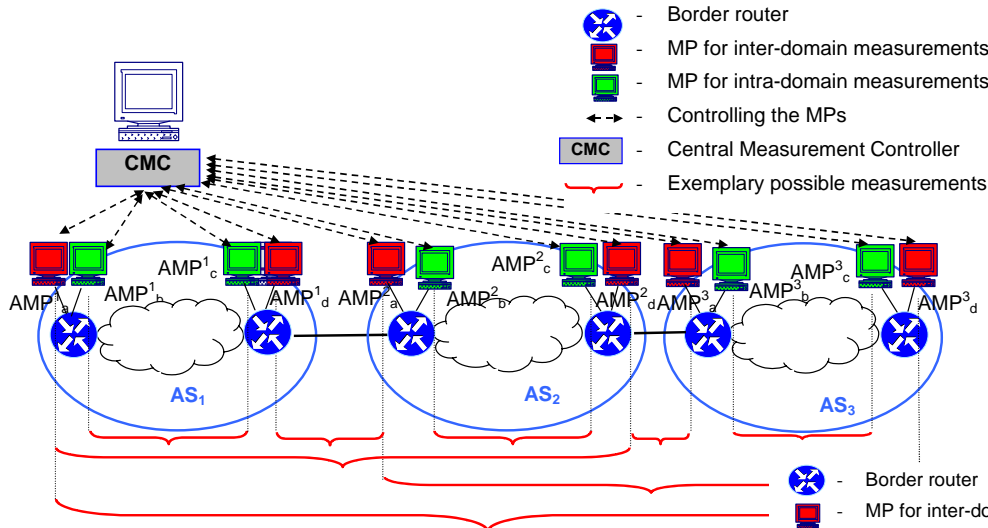 - Internal architecture of access network
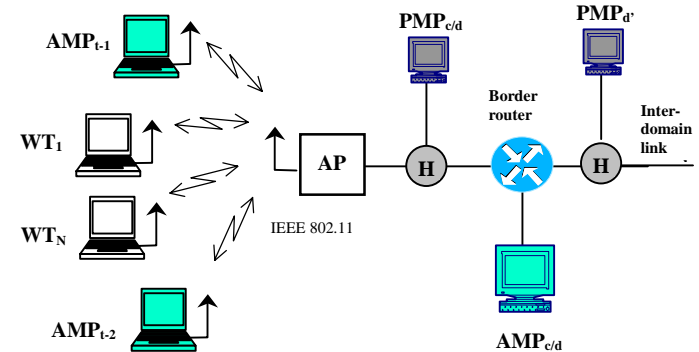
WT$_i$: Wireless Terminal i=1,..N
AMP: Active Measurement Point
PMP: Passive Measurement Point
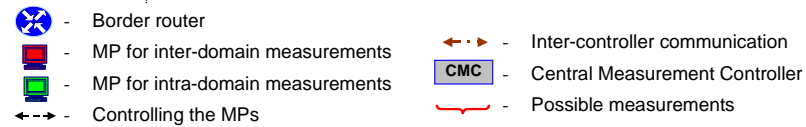
AP: Wireless Access Point
H: Passive hub
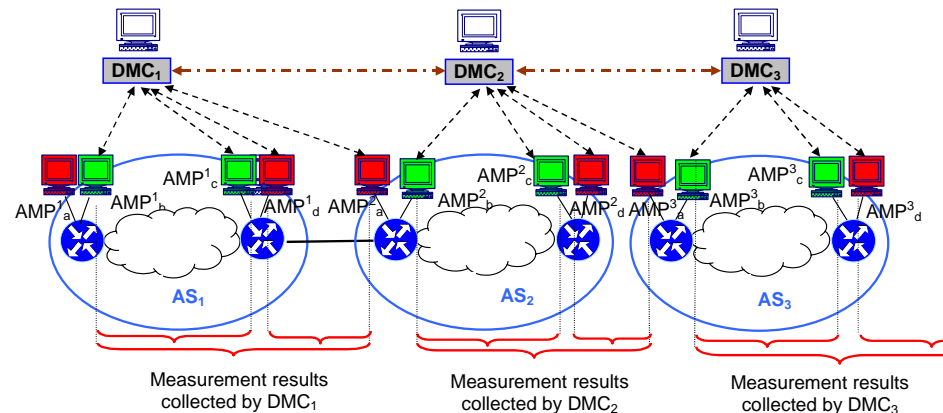

Access network measurements in AN_1

Inter-domain measurements AS_1 to AS_2

Intra-domain measurements in AS_2

Inter-domain measurements AS_2 to AS_3

End-to-end measurements

Controlling the measurements in inter-domain environment

Current MMS architecture

Border router
- MP for inter-domain measurements
- MP for intra-domain measurements
- Controlling the MPs
- CMC - Central Measurement Controller
- Exemplary possible measurements

All measurement results are collected by the Central Measurement Cor

Border router
- MP for inter-domain measurements
- MP for intra-domain measurements
- Controlling the MPs
- Inter-controller communication
- CMC - Central Measurement Controller
- Possible measurements

Planned MMS architecture

Measurement results collected by DMC_1

Measurement results collected by DMC_2

Measurement results collected by DMC_3

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Measurement tools for EuQoS trials

- **Available tools developed by project partners**

  NetMeter (UPC)
  Evaluating offered QoS

  E2ETT (Datamat)
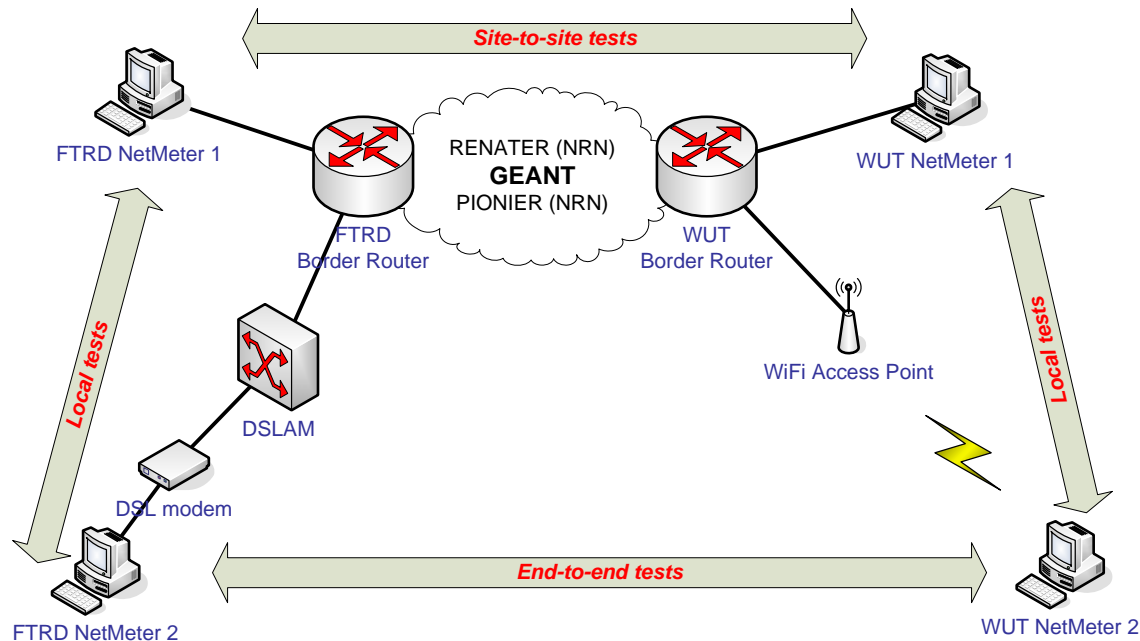 Analysing QoS experienced by UMTS users

  Zoo (LAAS)
  Analysing the traffic characteristics

- **Commercial tool**

  Chariot
  Evaluating offered QoS
  Validating the NetMeter measurements

First connectivity tests (1)

- **NetMeter** deployed in all EuQoS testbeds
- Evaluation of EuQoS testbed networks
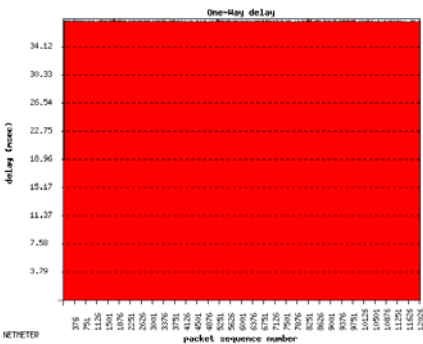- Examplary scenario with xDSL in FTRD and WiFi in WUT

First connectivity tests (2)
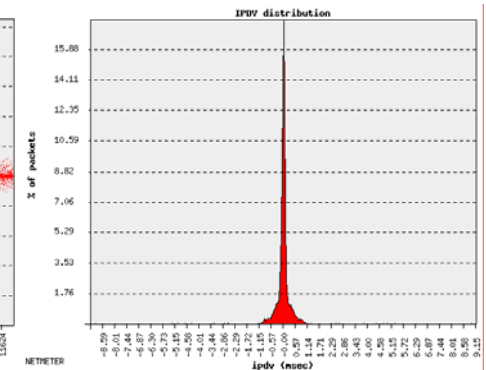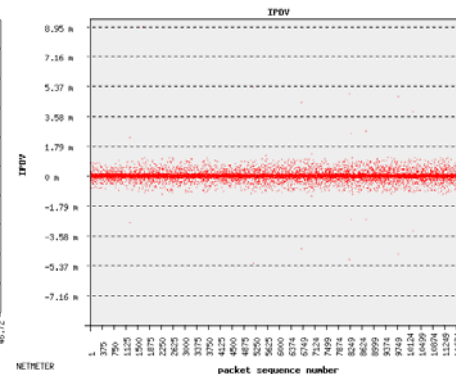
- Methodology
  - Artificial traffic
  - Four pre-defined traffic patterns: *VoIP*, *UDP1*, *UDP2*, *TCP*
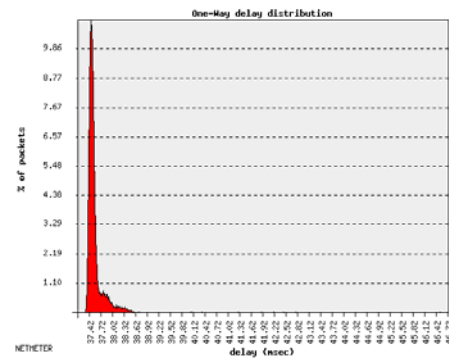
OWD: One Way Delay   IPDV: IP Packet Delay Variation (IETF IPPM)

Received packets	Packets dropped	Average delay [ms]	Max delay [ms]	Min delay [ms]	Delay variation [ms]
12000	0	38	47	37	9

Planned trials of EuQoS CoSs

- Measurements of QoS in „worst–case" traffic conditions
  - Maximum load allowed by admission control
- Validation of QoS offered by EuQoS CoSs
  - Intra–, inter– domain and end–to–end
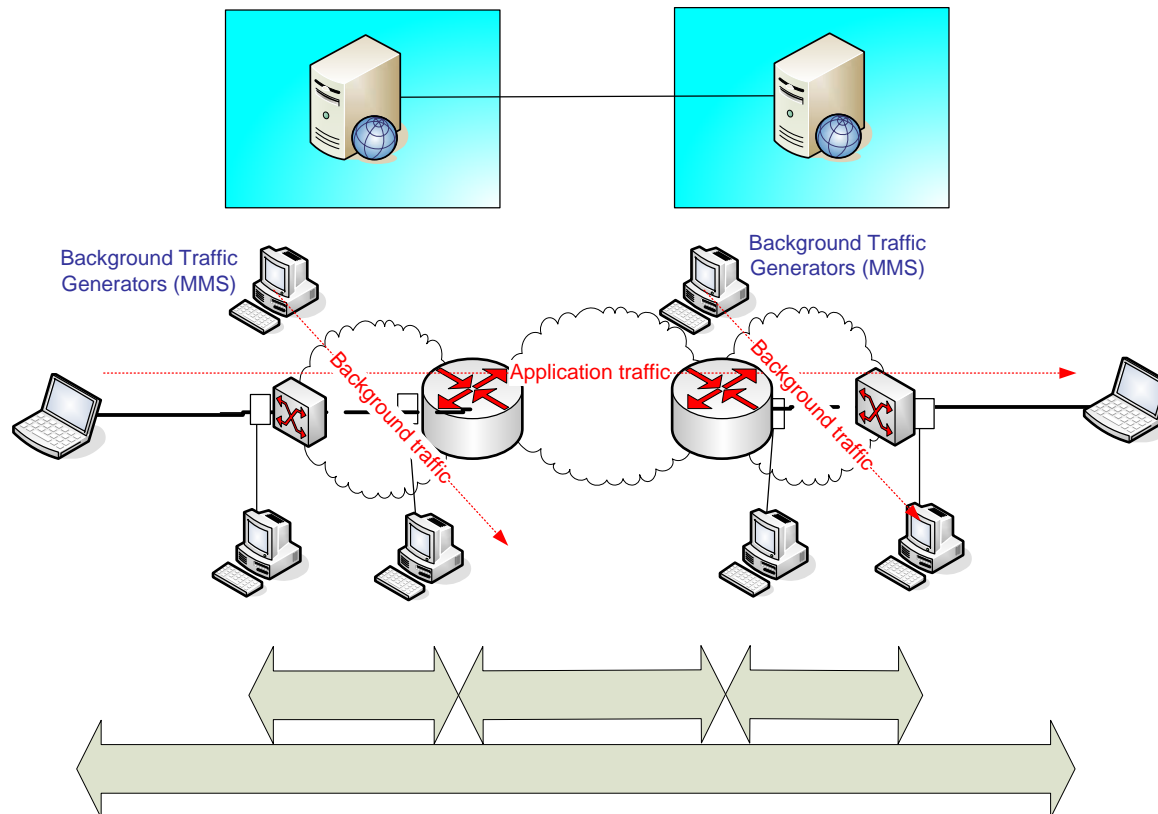
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- **Measurement tools for supporting EuQoS system**

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Measurements for supporting operation of EuQoS system

- **Information about current state of the network**

  - QoS level, for monitoring services offered to customers

  - Carried traffic, for improving effectiveness of Connection Admission Control (CAC) and Traffic Engineering (TERO)

  - Inter-domain routing paths, for TERO and inter-domain CAC
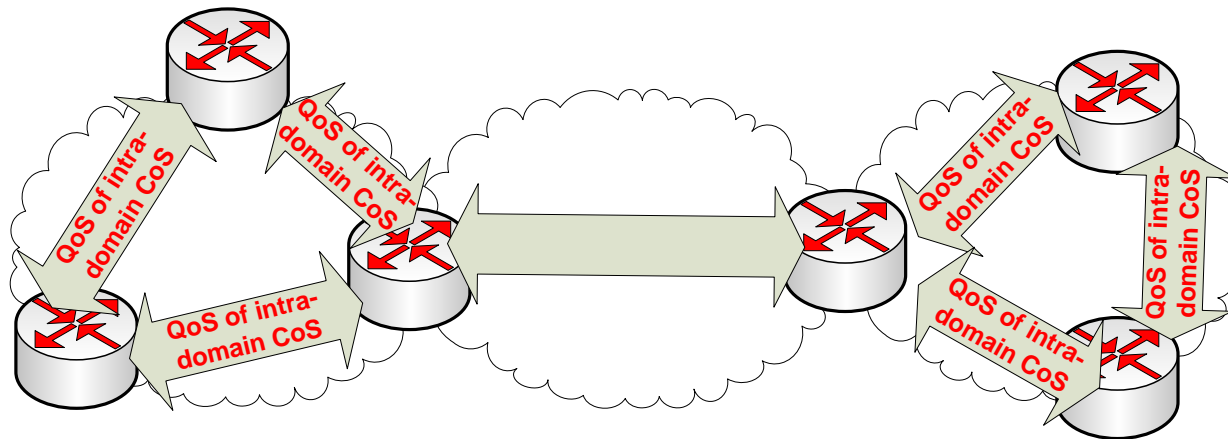
The architecture of MMS for supporting EuQoS system

- **MMS Measurement Tools**
  - **ORENETA**: QoS monitoring tool
  - **LLMT**: Link Load Measurement Tool
  - **TMT**: Topology Measurement Tool
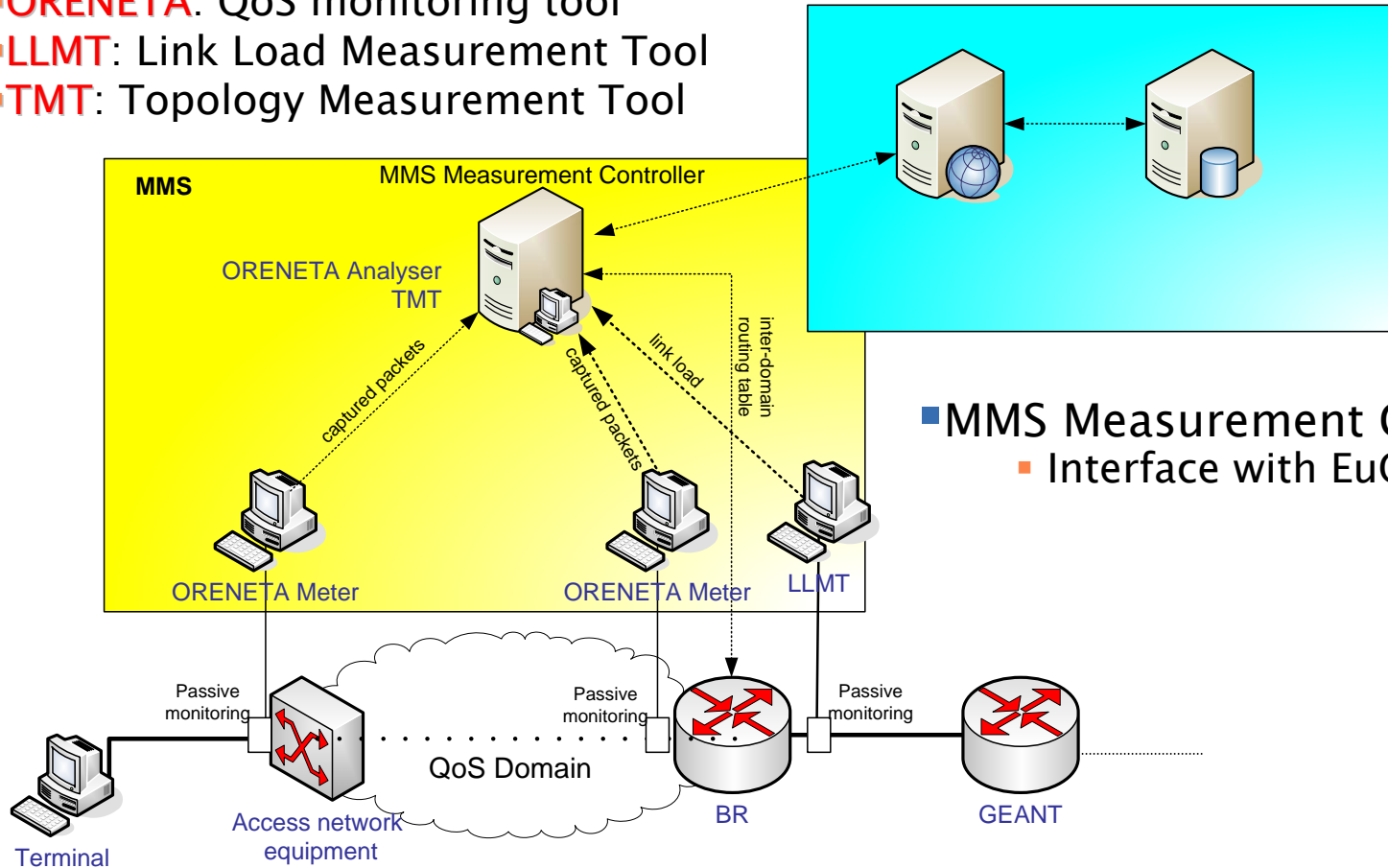
- **MMS Measurement Controller**
  - Interface with EuQoS MMFM

- **QoS monitoring**
  - Intra-domain CoSs
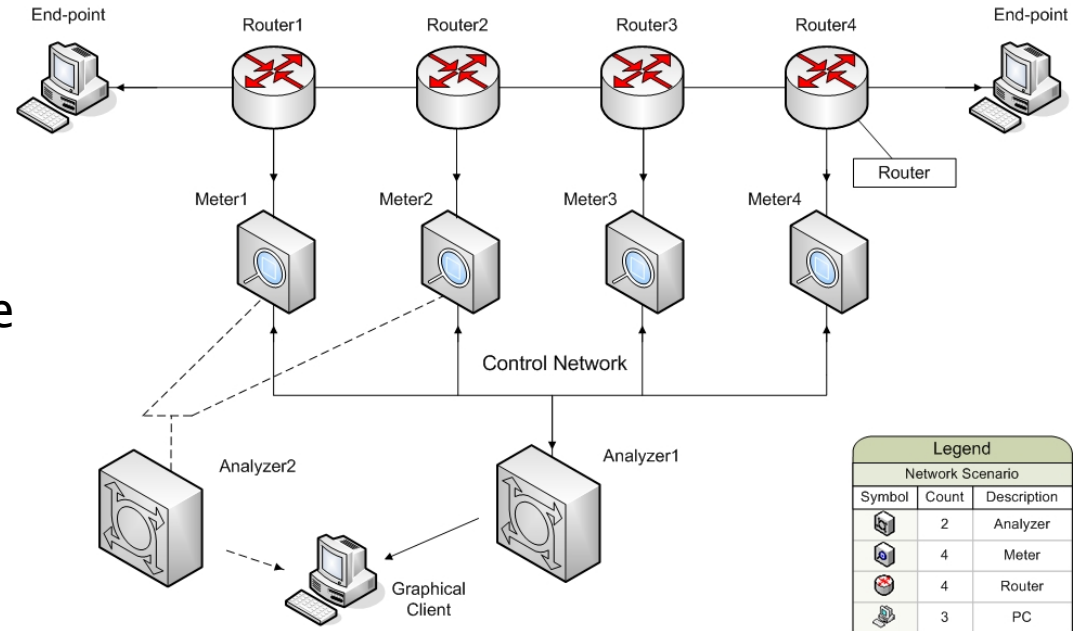 - Inter-domain CoSs (including GEANT connection)

ORENETA: QoS monitoring tool (2)

- **Methodology**
  - Passive method
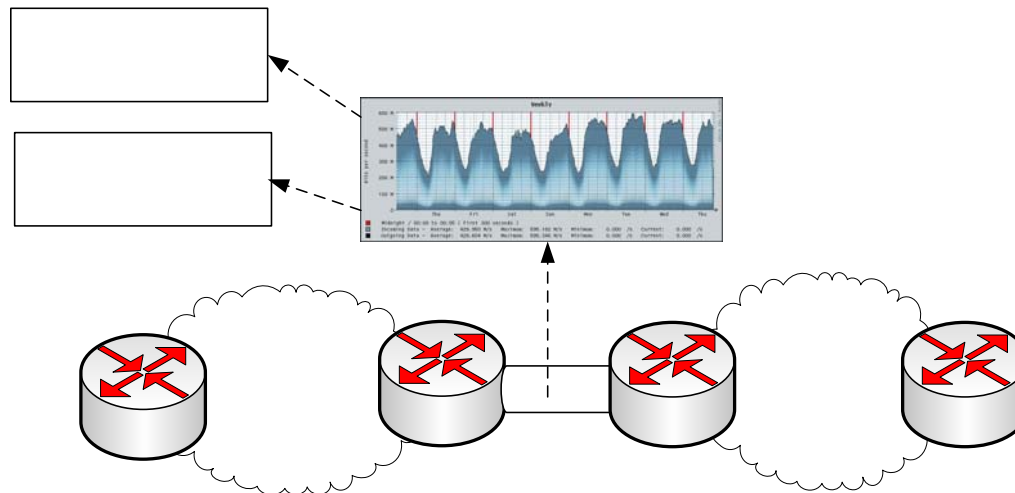 - Real Time traffic capture
  - Flow detection

- **Obtained results**
  - One-Way Delay (OWD)
  - IP Delay Variation (IPDV)
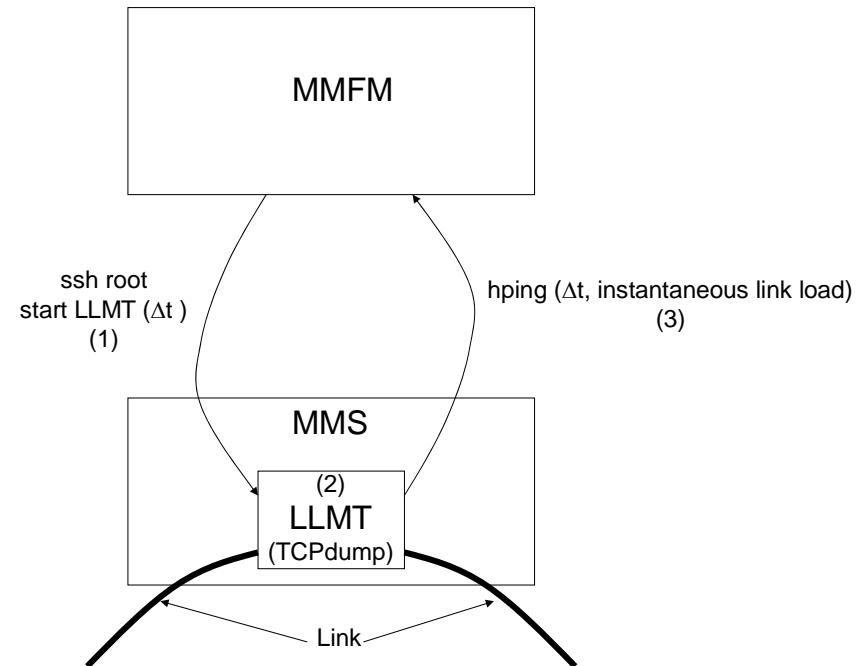 - Packet Loss Ratio (IPLR)

- Measure average bit rate of carried traffic
    - Information for TERO about carried load on inter-domain links (long-term)
    - Information for CAC about carried load (short-term, in the 2nd Phase)

LLMT: Link Load Measurement Tool (2)

- **Methodology**
  - Passive monitoring of given link
  - Capture packets with *Tcpdump*
  - Calculate average load in intervals of length Δt

- **Obtained results**
  - Average throughput in bytes/s every Δt

MMFM

ssh root
start LLMT (Δt)
(1)

hping (Δt, instantaneous link load)
(3)

MMS

(2)
LLMT
(TCPdump)

Link

TMT: Topology Measurement Tool (1)

- Discover the paths established in the network by EQ–BGP protocol
  - Information for TERO about reachable paths
  - Information for inter–domain CAC about QoS on given path
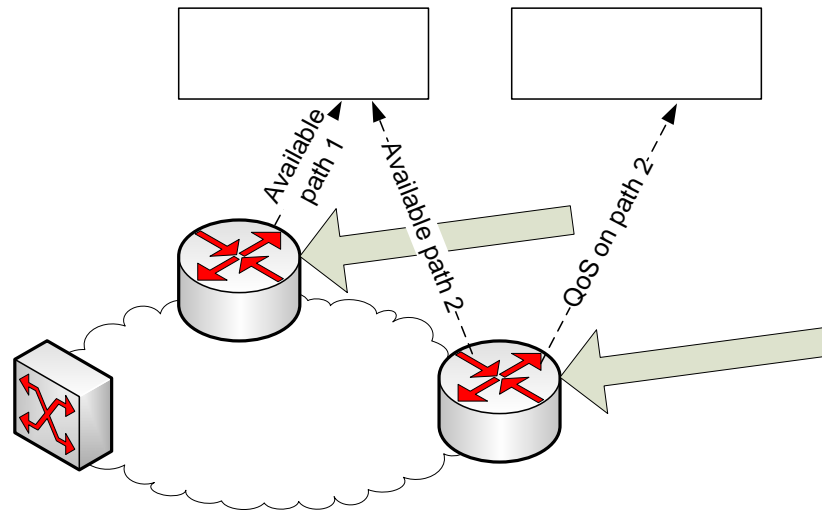
TMT: Topology Measurement Tool (2)

- ## Methodology
  - Read EQ–BGP routing tables of routers in given AS

- ## Obtained results
  - Set of reachable network paths and their attributes

EuQoS MMFM

MMS Measurement Controller

TMT

BR1 (BGP)   BR2 (BGP)
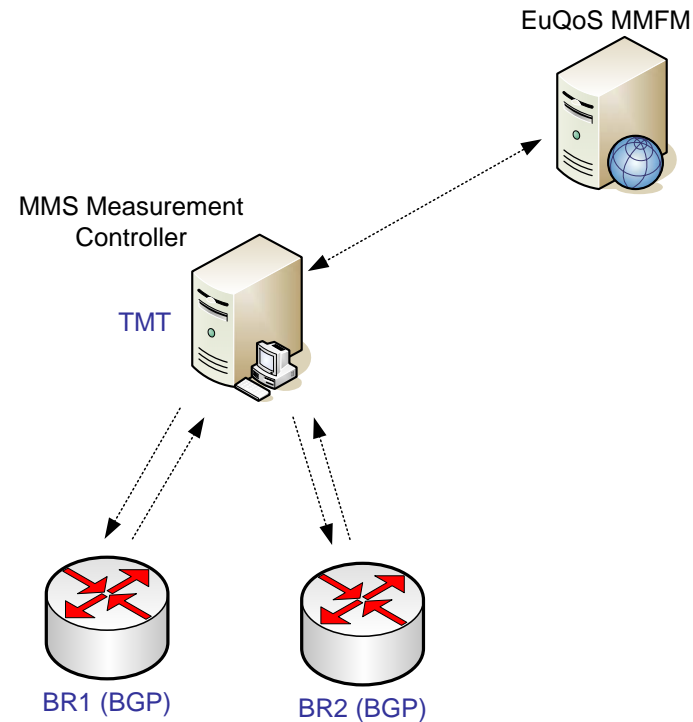
```
ROUTER_IP  |PREFIX      |MASK|COS|STATUS |NEXT_HOP   |AS_PATH      |QOS (EQ-BGP)
10.205.0.1|10.203.0.0|16  |1  |BEST   |10.203.0.1|65511        |10 32 7 N/A
10.205.0.1|10.203.0.0|16  |2  |BEST   |10.203.0.1|65511        |5 16 7 N/A
10.205.0.1|10.203.0.0|16  |2  |ALT    |10.204.0.1|65510 65509|5 16 7 N/A
```

Information Society
Technologies

Integration of MMS with the EuQoS system

- Interface with MMFM based on sockets
- RM Database, shared with other EuQoS modules

Summary
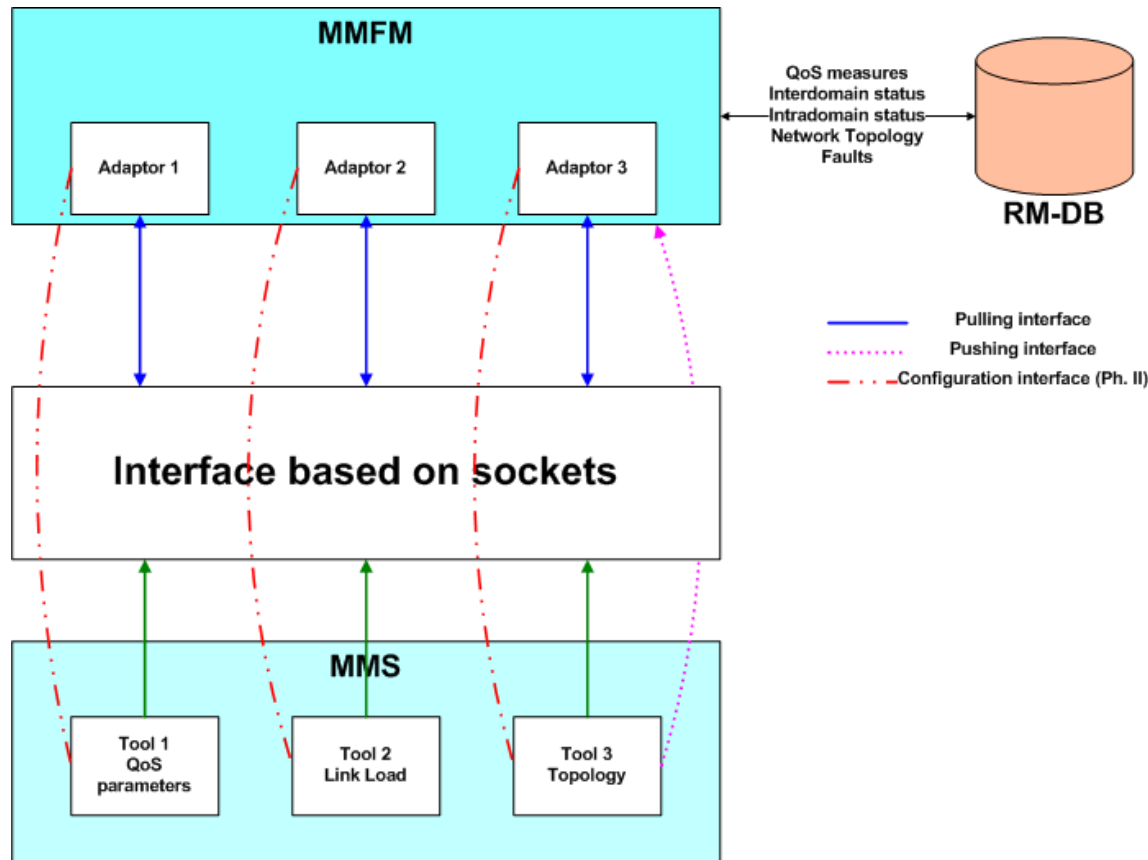
- **MMS for validating QoS in trials**
  - Generating and measuring artificial traffic

- **MMS for supporting EuQoS system functions**
  - QoS monitoring
  - Link load measurements
  - Discovering inter-domain routing paths

- **Further work**
  - Finishing development of tools and their interfaces with MMFM
  - Focus on multi-domain and end-to-end measurements