



# WP3/6: Monitoring System

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# Outline



- ***Introduction***

- ***E2E Monitoring and QoS Peering Models***

- ***Monitoring System Architecture***

- ***Service level Monitoring***

- ***Experimental Results***

- ***Conclusion***

# Introduction



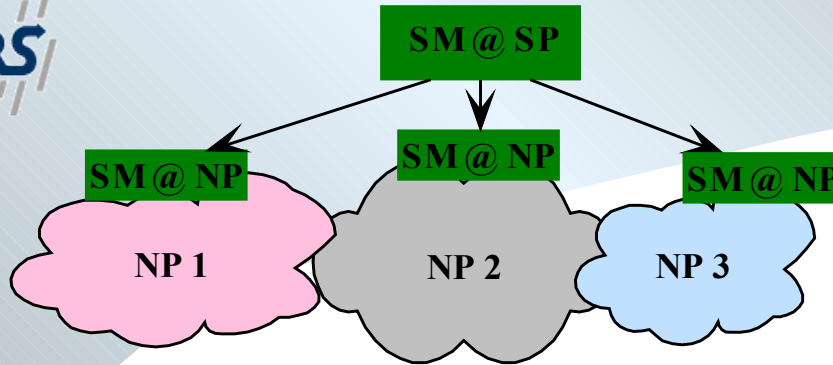
- Monitoring System for use in multi-domain heterogeneous networks in order to support cross-network audiovisual service offering for:
- ***Assisting service/network providers***
  - to verify the QoS performance guarantees of service agreements
  - to provide inputs for a E2E adaptation in case of service degradation
- ***Assisting network providers***
  - in making provisioning decisions for optimizing the usage of network resources according to short and medium term changes
  - providing measurement information for long-term planning in order to avoid undesirable conditions

# Multi-domain Monitoring Requirements



- E2E QoS monitoring is not simply the concatenation of single domain QoS measurements but it has some multi-dimensional aspects
- ***Cooperation of providers in the service delivery chain is essential***
- Providers should cooperate based on an agreed framework formulating:
  - the configuration of monitoring elements and service,
  - the execution of measurements,
  - the composition of results in an appropriate way,
  - and the exchange of measurement data between providers.

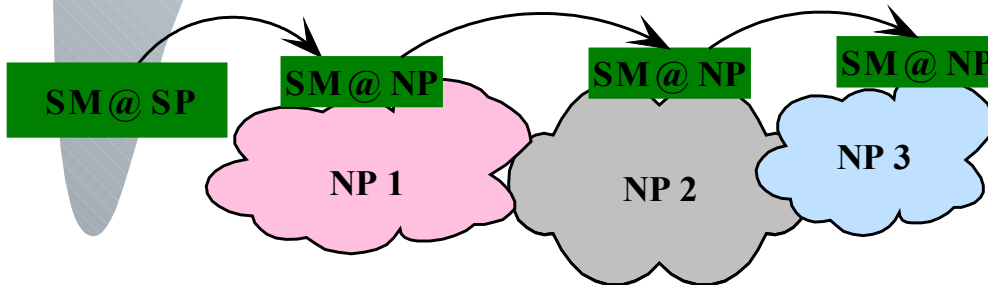
# QoS Peering Models : hub, cascaded/bilateral



Hub QoS Peering

The order of magnitude of the number of pSLSs needed for an NP to reach every other domain is  $O(N^2)$  per QoS class, where  $N$  is the number of domains

=> Knowledge of inter-domain topology, Can be useful for the SP



Cascaded/Bilateral QoS Peering

Each NP has at most  $(N-1)$  pSLS contracts to establish, with its neighbors in order to reach to  $(N-1)$  destination domains

=> More scalable, Possible relationship for monitoring only:

- No need to have/maintain inter-domain topology knowledge,
- Less signaling messages between NPs

SM@ NP : Service Management at Network Provider  
SM@ SP : Service Management at Service Provider  
NP : Network Provider

# ENTHRONE E2E Monitoring Solution



- Monitoring based on cooperation of several actors (**CPs, SPs, NPs, CCs**)
- E2E monitoring is tackled using an overlay network of components communicating in **cascaded fashion** using the **Cascaded Peering model**
- Service monitoring at both QoS performance and perceived quality levels
- Resource monitoring at traffic class, node, path, and network levels
- Measurements are collected and translated to network-independent format using XML-based MPEG-21 data models (**UED**)
- a set of protocols for exchanging the monitoring results (**EMon, EQoS-ResMon, MPEG-21 Event Reporting**)

# Monitoring System Architecture (1/2)

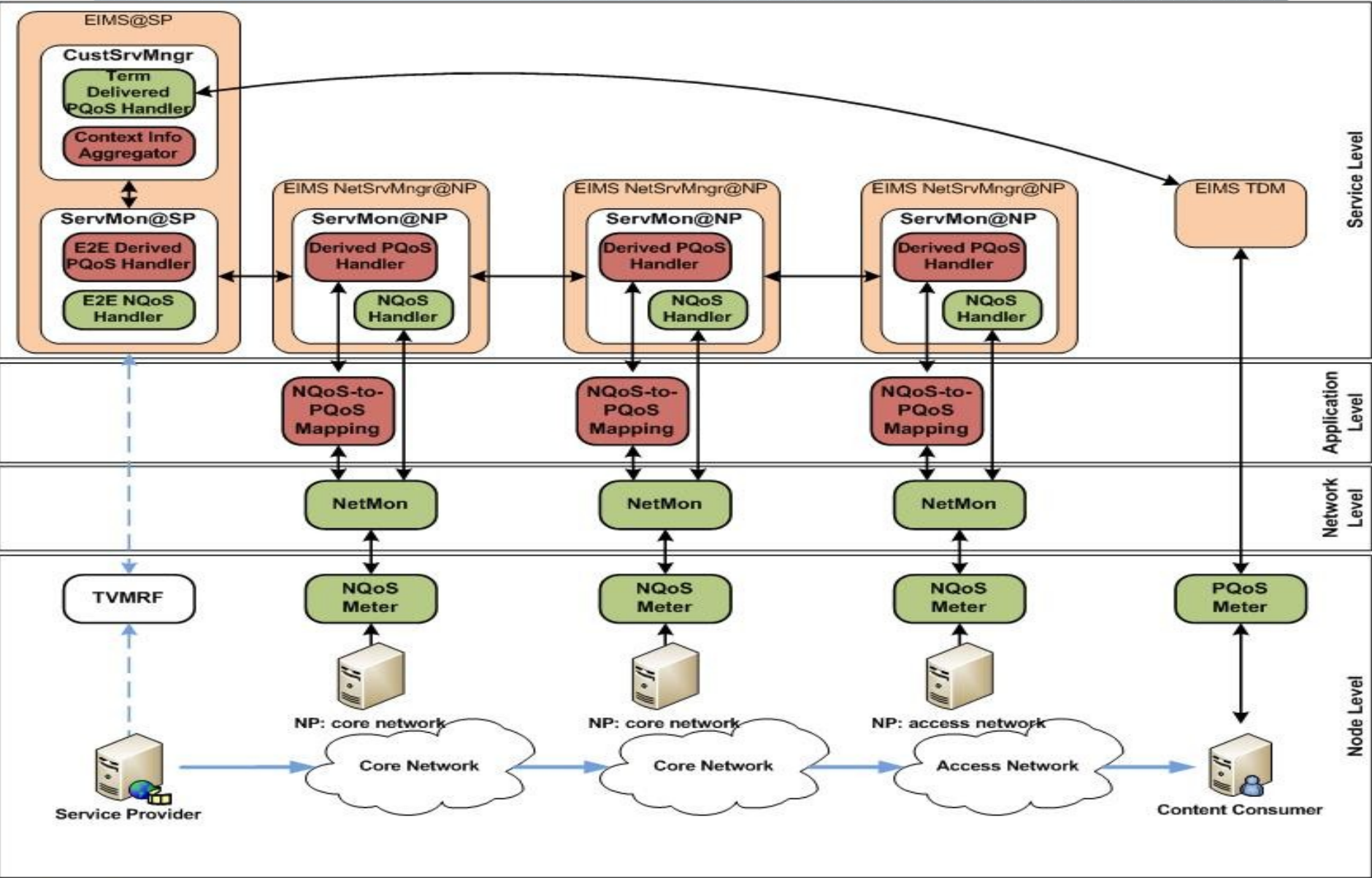


The Monitoring System utilises the network-wide performance and traffic measurements collected by all the network elements, in order to inform Managmnt & adaptation engines on QoS degradation cause and location

- **A four levels monitoring Architecture : *ServMon, NQoS/PQoS mapping, NetMon and NodeMon***
  - Service monitoring for both service connectivity and user (PQoS) levels
  - Network monitoring for network-wide dynamic resource management
  - Node monitoring for node level resource management (NQoS & PQoS)
- **A tree phases monitoring procedure :**
  - **Setup/configuration**: monitoring jobs instantiation/configuration
  - **Continuous monitoring** (periodic NQoS status and PQoS evaluation)
  - **On-Demand monitoring** for actual network conditions information retrieving



# Monitoring System Architecture (2/2)





# Service Level Monitoring (1/3)



- **Two types of Monitoring**

- Core and access networks on aggregated streams by the ServMons
- EIMS level on a particular customer stream by the CustSrvMgr

- **NQoS ⇒ PQoS Mapping**

- Measure current network conditions (NQoS)
- Mapping to PQoS resulting in an approx. of PQoS delivered to a number of app streams

- **ServMons:**

- NQoS monitoring
- NQoS/PQoS mapping (*Derived PQoS*) support for cSLs monitoring

- **CustSrvMgr:**

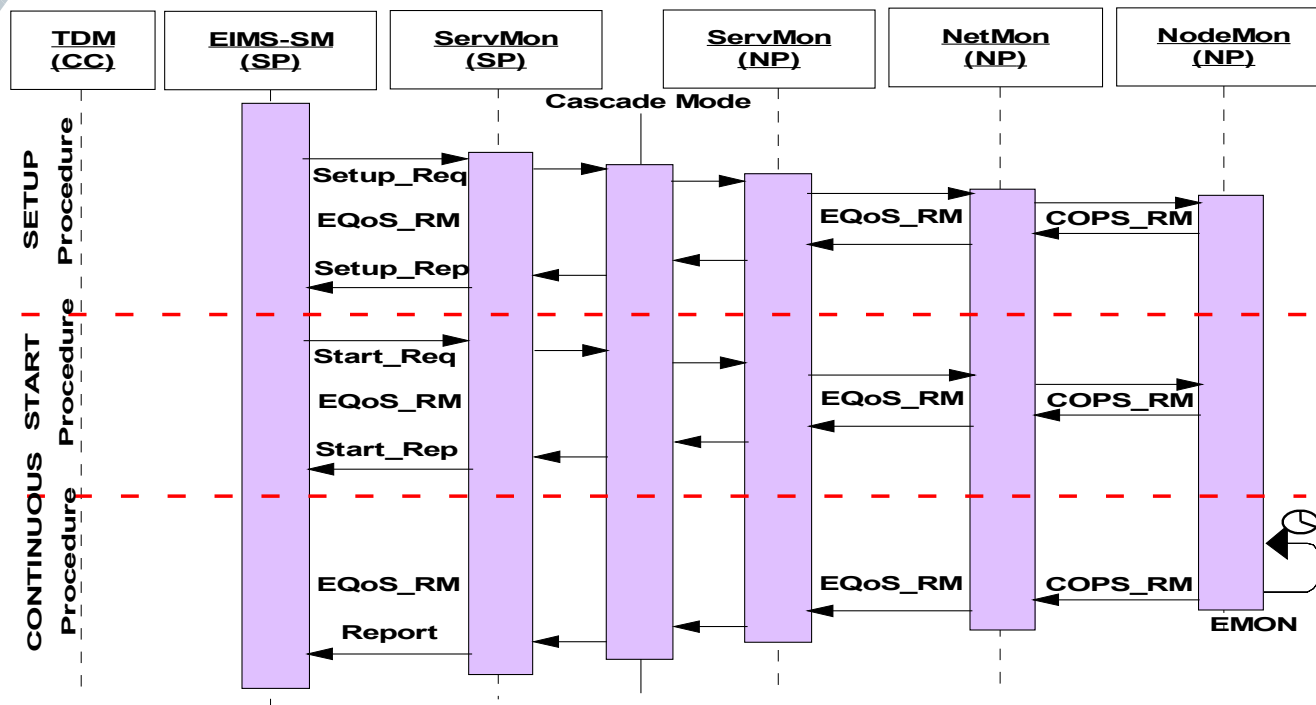
- PQoS monitoring at terminal and related *Delivered PQoS* handling

# Service Level Monitoring (2/3)



**Continuous Monitoring** : ServMons provide network conditions info to EIMS-SM/AM. This supports adaptation calculation and dynamic SM :

- MPEG-21 based cross layer Digital item adaptation
- better behaviour of AC algorithm for better utilisation of the network resources

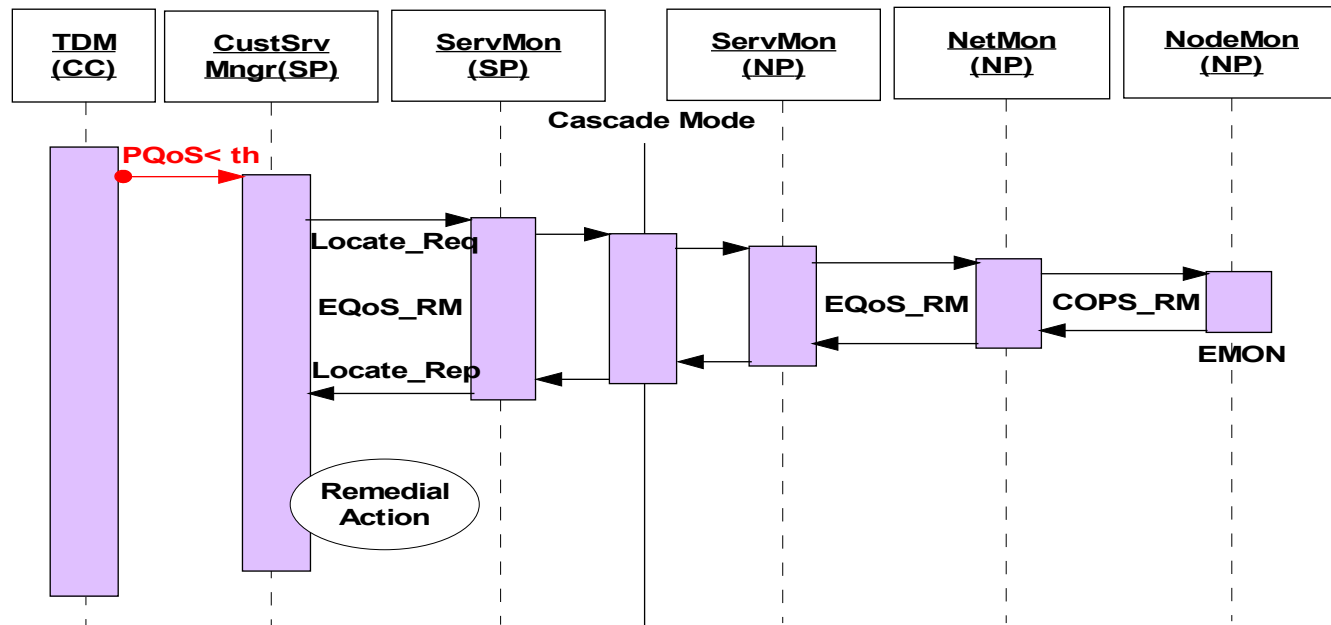


# Service Level Monitoring (3/3)



- **On-demand Monitoring** : triggered by the CustSrvMngr on PQoS alert

- ServMon@SP provides input (net. UED) to CustSrvMngr for building context information to be delivered to AM for appropriate adaptation



# NQoS to PQoS mapping (1/2)



- Some approaches have already proposed in the literature:
  - very analytical statistical model of the packet-loss visual impact on the decoding video quality for MPEG-2 video sequences
  - transmission/distortion modelling for real-time video streaming over error-prone wireless networks, where a modelling of the impulse transmission distortion is performed
- These models are very codec and content specific, while they do not also provide any end-to-end video quality estimation, namely the degradation during the encoding process and the transmission/streaming procedure
- ENTHRONE approach is a **generic model for e2e video quality degradation prediction which estimates the worst case degradation of the initial encoded quality**,
  - regardless of the used video codec and the dynamics (i.e. content) of the transmitted encoded sequence.

# NQoS to PQoS mapping (2/2)



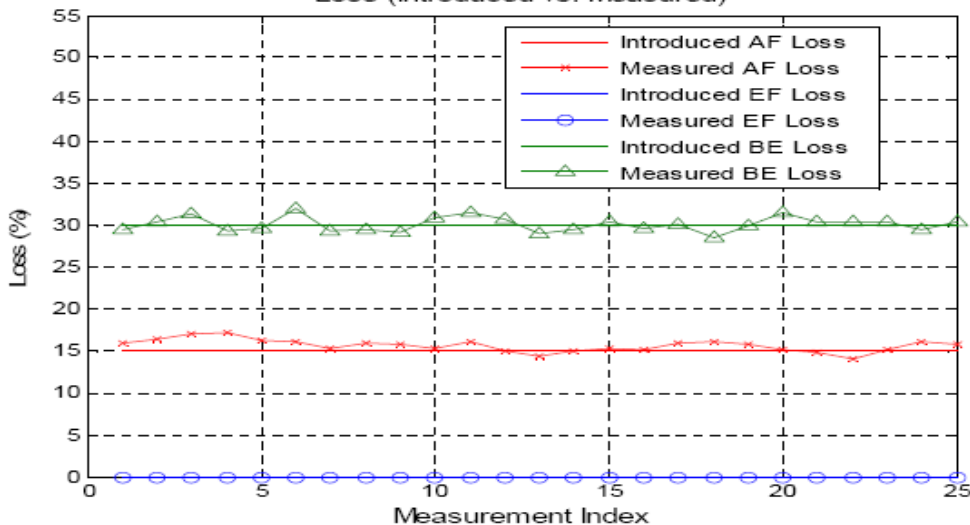
- At application level, are achieved the **translations between network packet loss ratio and Decodable Frame Rate (Q)**, as well as **packet size and Decodable Frame Rate**
- Q is an application-level metric, with values ranging from 0 to 1.0. The larger the value of Q, the higher the successful decoding rate at the CC
- Q is the fraction of decodable frame rate, which is the number of decodable frames over the total number of frames sent by a video source

$$Q = \frac{N_{dec}}{(N_{total} - I + N_{total} - P + N_{total} - B)}$$

- Where Ndec is the sum of number of successfully decoded I, P, B frames i.e., Ndec-I, Ndec-P, and Ndec-B
- At service level, the **Main Opinion Scores (MOS, perceived quality metric)** are deduced from Q with values ranging from 0 to 100

# Some Experimental Results

Loss (Introduced vs. Measured)



## Packet loss ratio Accuracy

	One-way-loss-rate (%)	Flow identification (DSCP)
EF services	0	0xB8
AF services	15	0x28
BE services	30	0x00

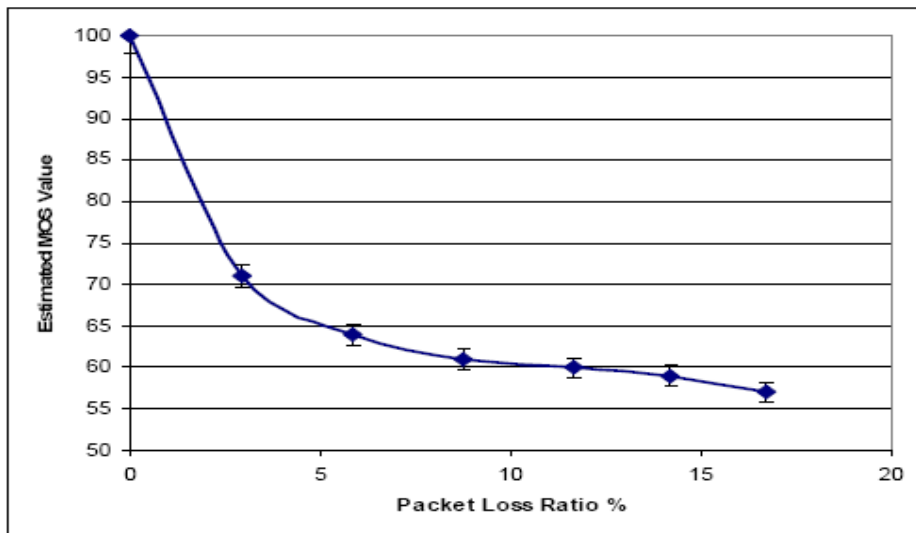
**Note: The E2E One Way packet Loss ratio (EOWL) is multiplicative:**

$$EE_{OWL} = (1 - \prod_{i=1}^n (1 - p_i))$$

Packet loss ratio measured for EF, AF and BE traffic classes

**NQoS to PQoS mapping results based on the described approach**

**input: the packet loss ratio**  
**output: derived PQoS level (MOS)**



The experimentally estimated MOS value derived from the proposed NQoS-to-PQoS monitoring tool

# Monitoring system output (1/2)

## ServMon's output: MPEG-21 compliant network UED



```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ns2:DIA xmlns="urn:mpeg:mpeg7:schema:2001"
xmlns:ns2="urn:mpeg:mpeg21:2003:01-DIA-NS">

  <ns2:Description
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:type="ns2:UsageEnvironmentType">
  <ns2:UsageEnvironmentProperty xsi:type="ns2:NetworksType">
    <ns2:Network id="net1_AS1">
      <ns2:NetworkCharacteristic xsi:type="ns2:NetworkConditionType">
        <ns2:AvailableBandwidth average="4166"/>
        <ns2:Delay delayVariation="5" packetOneWay="110"/>
        <ns2:Error packetLossRate="16.66261342384426"/>
      </ns2:NetworkCharacteristic>
    </ns2:Network>
  </ns2:UsageEnvironmentProperty>
</ns2:Description>
</ns2:DIA>
```



# Monitoring system output (2/2)

## Monitoring System output file



**Test condition: Packet loss ratio introduced from 0% to 50% with step of 5%**

```
Thu Feb 28 17:37:23 CET 2008: !!! CURRENT AVERAGE (WINDOW) !!! average = 2  
Loss (%) = 0.00; Derived PQoS (0-100) = 100; Description = Excellent
```

=====

```
Thu Feb 28 17:37:30 CET 2008: !!! CURRENT AVERAGE (WINDOW) !!! average = 2  
Loss (%) = 2.59; Derived PQoS (0-100) = 73; Description = Good  
(p = 0.02597; Estimated Successfully Decoded Frames = 0.76284)
```

```
Thu Feb 28 17:38:21 CET 2008: !!! CURRENT AVERAGE (WINDOW) !!! average = 2  
Loss (%) = 10.4; Derived PQoS (0-100) = 61; Description = Good  
(p = 0.10492; Estimated Successfully Decoded Frames = 0.31451)
```

=====

```
Thu Feb 28 17:38:28 CET 2008: !!! CURRENT AVERAGE (WINDOW) !!! average = 2  
Loss (%) = 13.4; Derived PQoS (0-100) = 59; Description = Fair  
(p = 0.13440; Estimated Successfully Decoded Frames = 0.23501)
```

=====

```
Thu Feb 28 17:41:30 CET 2008: !!! CURRENT AVERAGE (WINDOW) !!! average = 2  
Loss (%) = 50.3; Derived PQoS (0-100) < 40; Description = Bad
```

# Conclusion



- ENTHRONE proposes a QoS Monitoring System for keeping track of the compliance of the level of E2E service provided to the CCs by the SP
- Monitoring system provides the means for remedial actions to be taken:
  - MPEG21 cross-layer adaptation in case of service degradation
  - inputs to service management entities for better AC mechanisms

## **ENTHRONE approach differs from the previous IST projects in that:**

- E2E scope and business model encompasses CPs, SPs, NPs and CCs
- Using of XML-based MPEG-21 data models
- Quality Meters at user-side measure the PQoS of an audio-visual stream
- The PQoS is also assessed from measured network performances at NPs



# Thank you

# Questions ?

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