Control and Performance Monitoring of a Multimedia Platform over the ATM Pilot

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ABSTRACT

This paper presents the Network Management Platform that have been deployed to control and monitor the BETEUS network. BETEUS performs multimedia application trials in a testbed based on an ATM WAN interconnection of local ATM nodes. Sophia-Antipolis (F), Lausanne (CH), Zurich (CH), and Geneva (CH) are interconnected over the European ATM Pilot. The BETEUS application platform allows geographically separated participants to actively take part in group discussions from their personal workstations equipped with audio and video facilities. BETEUS application platform is a typical example of future multimedia applications with its complexity with regard to numerous factors such as information type, distribution of users and their interactions, information flow, and stringent Quality of Service requirements. Performance may degrade at several levels: network equipment, interworking equipment, drivers, protocol stacks, etc. It is therefore necessary to develop a network management platform that is able to monitor the different parameters of interest during intensive usage of the multimedia applications. In addition to standard and proprietary MIBs provided with the networking devices, specific MIBs have been developed and integrated in the management environment. They are requested using standard protocols (CMIP/SNMP).

The management activities involve the network (local ATM devices), the systems (multimedia hosts), and the applications (audio and video). At each local site a single interface, the Mediation Device, is in charge of routing requests of the management system to the agents that are distributed in the site. It is also in charge of filtering and delivering the events sent by the agents to the management system. The Mediation Device uses CMIP to communicate with the network management centre and SNMP to communicate with the local agents of the LAN.

The Network Management Platform focuses more specifically on measurement of performance statistics of network utilisation. The result is a better understanding of the Quality of Service for end user applications in a real environment, of the use of network management to influence existing end to end application servicing, and of the answer of ATM and current equipment to the needs of end user applications.

1 INTRODUCTION

BETEUS, an acronym for Broadband Exchange for Trans European Usage, is a European project aiming to build an early real usage of tele-collaboration services with the objectives to:

- give broadband access to tele-teaching organizations,
- develop and spread out the usage of remote education facilities,
- evaluate suitable multimedia applications.

BETEUS provides experience in operating broadband systems from a user point of view. BETEUS offers to geographically distant users the tools for experimenting a real virtual community field test where they can teach, learn, discuss, edit multimedia documents, manage and design projects. BETEUS focuses on distributed classroom, informal meeting, multimedia document archival and retrieval scenarii. These multimedia applications run within five ATM LANs spread in several countries and interconnected through the European ATM Pilot.

The performance requirements of multimedia application at user and network levels are stringent and complex. ATM is promising to be the only telecommunication technology that can fulfil these requirements. This real usage of multimedia applications over an ATM Network is a good opportunity to investigate whether the early ATM Networks and the existing multimedia hosts satisfy the stringent Quality of Service (QoS) requirements of multimedia applications.

This paper addresses the QoS issues of the BETEUS multimedia applications and presents the network management platform that has been deployed for monitoring the performance at several levels (switches at local sites, workstations, applications).

The Multimedia sources of BETEUS are bursty and unpredictable, therefore performance may degrade at various time scales and several points in the ATM network. This will have an important impact on the QoS provided to the applications. Performance may depend also on other factors such as the computing power of the multimedia host (processor speed, memory, I/O architecture, etc.), the communication protocol implementation (TCP/IP suite), the load on the multimedia host and the network interface. The main objective of the Network Management Platform deployed is to gather performance statistical data at the local sites.

This paper is organized as follows: Section 2 presents the multimedia environment, Section 3 discusses the Bandwidth and QoS issues, Section 4 describes the network management platform that have been developed, Section 5 presents an example of statistics that have been measured and it is followed by the conclusion of the article.

2 BETEUS MULTIMEDIA ENVIRONMENT

2.1 The Multimedia Applications

The BETEUS applications use multimedia workstations scattered over a wide area network. Each workstation acts as a communication unit that transmits, receives and processes multiple video, audio and data streams, independently from its geographical location. The multimedia services provided by the applications include:

- interactive distance learning (distributed classroom and informal meeting),
- multimedia document retrieval and archiving.

The applications infrastructure includes the components needed for running collaborative work sessions at the end points of a virtual community. Functionalities such as audio, video, data communication, telepointer facilities, shared work space, and a session management are provided.

In the distributed classroom scenario a high quality multipoint videoconferencing and shared workspace tools are used to allow remote students to participate in lectures. The global view of each remote site is shown and every student at a remote site can ask questions to the lecturer.

The Informal meeting scenario (figure 1) permits users to participate actively in group discussions from their multimedia hosts. This scenario focuses on the functionality to dynamically join-in and drop out sessions.

Using archiving and retrieval multimedia documents functionality, lectures can be compressed and stored as multimedia documents. They can be later replayed by students through World Wide Web servers. In this scenario a large amount of information has to be transferred from servers to clients.

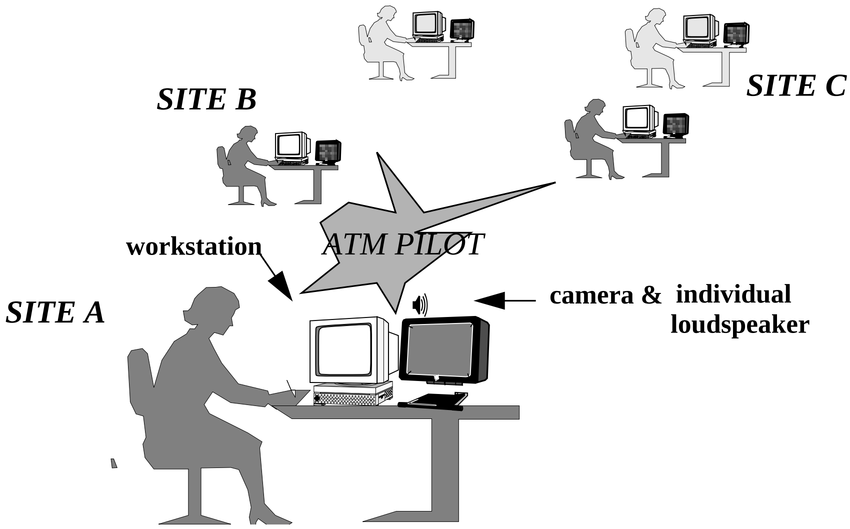

Figure 1: Informal meeting scenario

2.2 Data Network

The European ATM Pilot is an early WAN ATM Network that spans most of western Europe and includes 18 Public Network operators. The objectives of the ATM Pilot are:

- confirm the interoperability in a multi-vendor and multi operator environment,
- evaluate the capacity of ATM as a technology to support broadband services,
- test applications in conjunction with pilot users.

The ATM Pilot is not a service but an experimental network and its users include:

- Europe wide advanced research projects such as BETEUS,
- the European public research community,
- PNO's research labs,
- multinational companies.

The sites running BETEUS applications (figure 2) that are interconnected over the European ATM Pilot include: EPFL (Lausanne), ETHZ (Zurich), and CERN (Geneva) in Switzerland, TUB (Berlin) in Germany, and Eurecom (Sophia-Antipolis) in France.

The service provided to the BETEUS partners by the ATM Pilot is Semi-Permanent Virtual Path (VP). The physical bit rate at the access is defined by the existing interfaces. Two kinds of interfaces are used to access the ATM Pilot: 34 Mbps (E3 interface) and 155 Mbps (STM-1 interface). The BETEUS sites are interconnected through a full-meshed set of bidirectional VPs. The peak bandwidth allocated for each VP is 3 Mbps, except for the connection between EPFL and ETHZ which uses 4 Mbps. To offer such topology, these 10 bi-directional VPs are provisionned on a periodic basis (half a day per week) by the European ATM Pilot for BETEUS. Within each VP, three VCs are created for the video traffic, the audio traffic, and the data traffic. This latter includes also the network management traffic.

The ATM configuration at each local site consists of a single or two interconnected private ATM switches (FORE ASX 200). The FORE ASX 200 switch brings connectivity to LAN workgroup, LAN backbone, and LAN/WAN internetworking applications. This switch can establish Permanent and Switched Virtual Circuits. The multimedia applications run on Sun Sparc 10 Workstation(s) directly attached to the switch through an adapter card (FORE SBA 200).

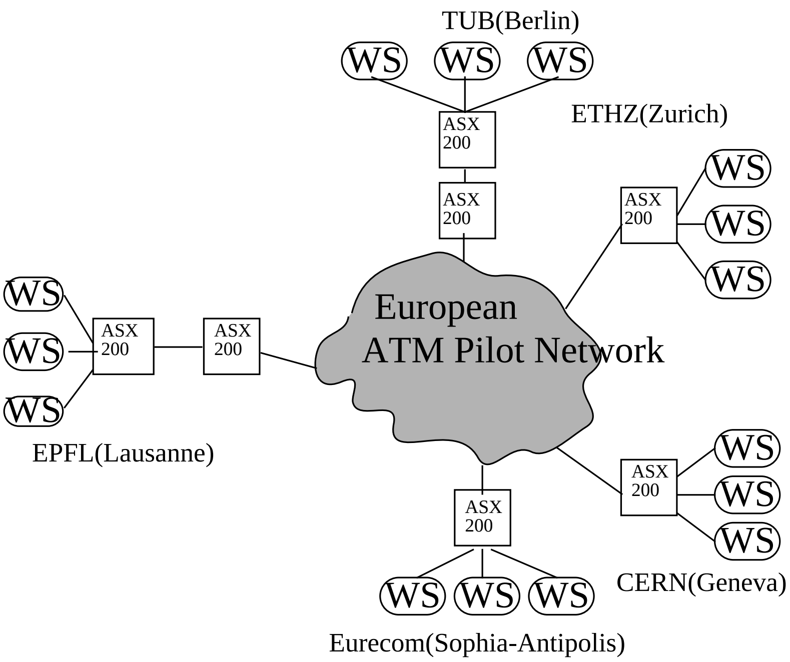

Figure 2: BETEUS Data Network

2.2.1 Protocols Architecture

Several network protocol stacks are used for communication among BETEUS applications. UDP/IP over AAL5 is used by video and audio applications. TCP/IP over AAL5 is used by the session manager application (control). The end-to-end QoS may be influenced by these protocol designs and implementations and their performance should therefore be monitored.

These protocols are located as shown on the following figure:

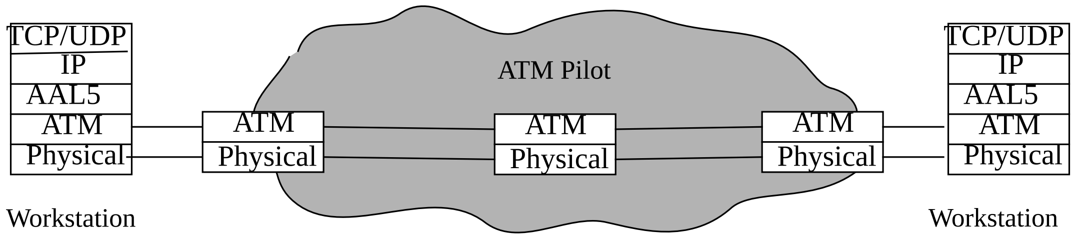

Figure 3: Protocols Architecture

3 BANDWIDTH AND QOS ISSUE

3.1 Bandwidth requirements

ATM Networks allocate to the application an amount of bandwidth which should be sufficient to satisfy the QoS they request. This amount of bandwidth for Variable Bit Rate (VBR) sources, such as BETEUS applications, is less than the Peak Bit Rate of the sources in order to take advantage of the multiplexing capability of ATM (statistical multiplexing) and to save resources. The bandwidth allocated however is greater than the average Bit Rate of the sources in order to guarantee an acceptable QoS. The raw average bandwidth requirements of BETEUS video and audio applications is calculated as follows:

3.1.1 Video

The raw video bandwidth requirement depends on the colour, spatial and motion resolution. A full colour image generally uses 24 bits/pixel in order to reproduce the full range of video colour on the workstation, 1/4 screen in high resolution requires 128*240 pixels, and 25 frames/s give an good quality. In BETEUS an acceptable quality has been obtained using a higher resolution (200x200) but with only 8.33 frames/s. Therefore the raw bandwidth used by the video applications of BETEUS has been calculated as follows:

Video-bandwidth=(bits/pixel)x(pixels/frame)x(frames/s)=(24)x(200x200)x(8.33)= 7,996,800 bits/s

This is a quite large amount of information to be transferred since only 3 Mbps bidirectional VPs have been allocated from one node towards the other BETEUS nodes. A video CODEC has been used for compressing the video information before sending it to the network. One of the important characteristics of a CODEC is the compression ratio. For compressed video, the output rate is function of the amount of spatial detail and activity in the scene. A Parallax board is used to perform the compression in JPEG. It can send 1/4 PAL resolution at a rate of 25 frames per second. The compression ratios achieved vary from 20:1 to 100:1. Motion-JPEG is used by the Parallax board for compression and decompression, capture, storage, playback and networking of digital video. Recall that JPEG has been designed for the compression of still-images. Motion-JPEG works independently from frame to frame and therefore it does not minimize the redundancies between consecutive frames. This is also why, JPEG is not very tolerant to cell losses since a single ATM cell loss may result in the lost of an entire frame and why it is also considered as bandwidth-intensive compared to MPEG standards.

3.1.2 Audio

CCITT recommends 64 Kbps for CBR voice [2]. This means that the analog signal is sampled every 125 µs and the signal amplitude is quantized into 256 steps, resulting in a PCM primary frame length of 8 bits. The audio bandwidth requirement is function of the sample rate and the sample resolution.

Audio bandwidth = (bits/sample)*(samples/s)

64 Kbps (8 bits/sample*8000 samples/s) has been specified for the BETEUS audio application using a µ-law coding scheme.

3.2 QoS related to applications

The Quality of Service (QoS) is, according to CCITT [1], “the collective effect of service performances which determines the degree of satisfaction of a user of the service”. From the user’s perspective, QoS should be expressed by parameters which are related to user-perceivable effects. The contractual QoS should be objective in the sense that it can be specified, measured and verified. Therefore the “degree of satisfaction” mentioned in the CCITT definition should be used on objective QoS parameter values. The common QoS metrics considered by multimedia application designers are the *packet/cell loss*, the *latency (delay)*, the *jitter (cell delay variation)* and the *skew.*

- *Packet/Cell loss*es: The requirements for uncompensated Cell Loss Ratio for still-images are in the order of 10^{-7}~10^{-11} [3] in order to maintain a good image quality. As noted before, a single cell loss of JPEG image may results in an entire image loss and retransmission is not possible because of the time constraints. Audio is also sensitive to losses. Important loss or distortion can be easily detected by ear. The Loss Rate of audio varies in function of the applications [11].
- *Latency (delay)*: An image quality of 25 frames per second is equivalent to an end-to-end delay of 40 ms for video traffic. Sound is also sensitive to latency periods. The maximum one-way delay for telephony is 400 ms but the main problem is echo. A speaker expects to hear his own voice in a delay less than 100 ms [11]. The more the end to end delay increase, the more echo is noticed. The end to end delay for echo-free conversation is estimated at 25 ms according to CCITT [12]. For greater delay echo compensation measurements are necessary.
- The *jitter* is the instantaneous variation in object presenting time. At the network level the jitter is illustrated by the CDV. The *jitter* objective of a 1.5 Mbps MPEG NTSC video is 6.5 ms [4].
- The *skew* is the difference in presentation times between two related objects. For example in order to synchronize voice with the speaker’s lip motion the audio advance of video should be less than 40 milliseconds, and the video advance of audio should be less than 120 ms [4].

3.3 QoS related to Network

QoS includes the different network management functional areas such as Configuration Management, Performance Management, and Fault Management. However it should be mentioned that it has a very close relationship to the Network Performance. In fact the main difference is that QoS is a user-oriented performance concern while Network Performance is more Network Operator oriented. The main generic QoS parameters defined by CCITT

[1] are: Accuracy, Speed, and Dependability. At the Bearer Network, ATM Forum has mapped these generic parameters to the ATM performance parameters as follows [10]:

- Accuracy: Cell Error Ratio, Cell Misinsertion Rate,
- Dependability: Cell Loss Ratio,
- Speed: Mean Cell Transfer Delay, Cell Delay Variation.

In the network the source of QoS degradation are: propagation delay, media error statistics, switch architecture, buffer capacity, traffic load, number of nodes in the communication path, resource allocation, failures (port, switch, link, etc.).

The different Performance Parameters are influenced as follows:

- Cell Error Ratio and Severely-Errored Cell Block Ratio: media error statistics, number of nodes in the communication path,
- Cell Loss Ratio: media error statistics, switch architecture, buffer capacity, number of nodes in the communication path, traffic load, resource allocation, failures,
- Cell Misinsertion Rate: media error statistics, number of nodes in the communication path, traffic load,
- Mean Cell Transfer Delay: propagation, switch architecture, buffer capacity, number of nodes in the communication path, traffic load, resource allocation,
- Cell Delay Variation: switch architecture, buffer capacity, number of nodes in the communication path, traffic load, resource allocation.

4 THE NETWORK MANAGEMENT PLATFORM

The Network Management Platform of BETEUS includes the following components:

- A Presentation Service implements the Graphical User Interface (GUI) organized in maps and symbols representing the network devices in a topological view,
- A Data Management Service permits the storage of the incoming events,
- A Notification Management Service specifies the reception of specific events by registering Event Forwarding Discriminators,
- Communication Protocols (CMIP and SNMP).

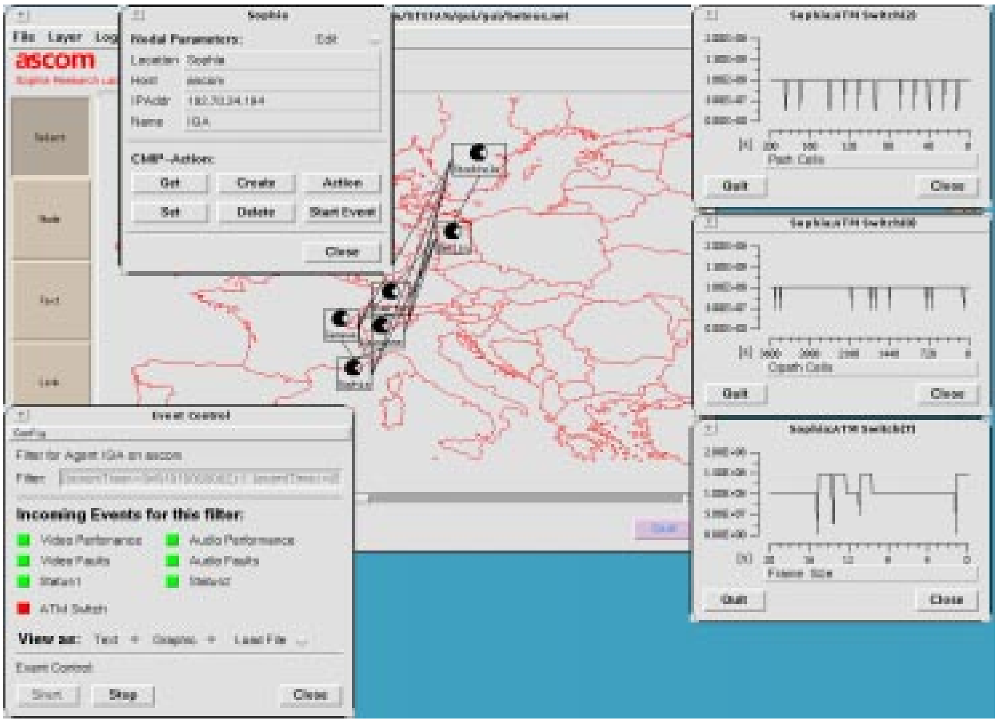

Figure 4: The BETEUS NMC

The network management station (figure 4) called the Network Management Centre (NMC) integrates the Presentation Service, the Data Management Service and the Notification Management Service. Through the Presentation Service, users can edit symbols representing the nodes on a geographical view of the network. A notification reporting interface permits to be notified of the type of the incoming events (video performance events, audio performance events, etc.). These current raw events can be examined in a text window. It is also possible to show a graphic display of the statistics recovered from the event report (figure 5).

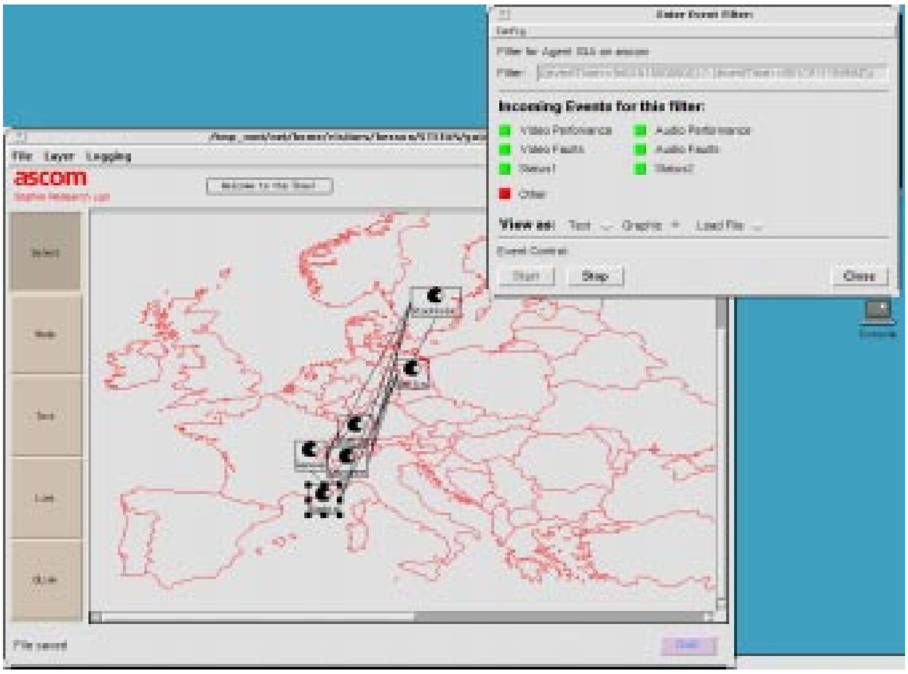

Figure 5: NMC Graphical Monitoring

The Data Management Service allows to store the incoming events in event types dependant files. It is possible to read these files from the NMC. The NMC also enables through the Notification Management Service to indicate the events of interest using a filtering mechanism.

The managed resources are:

- the ATM switches at the local sites,
- the network interfaces (adapter cards),
- the multimedia workstations,
- the multimedia applications.

Fore System ATM Switch provides an SNMP agent running on the switch controller, and that supports a proprietary MIB. This MIB contains information on the following elements on the switch board, the buffers, the hardware ports and the VPs and VCs.

The Fore Adapter card can also be managed via an SNMP agent implementing a proprietary MIB. For its main part this MIB maintains information about VPs and VCs by aggregating it in function of the different layers of the ATM protocol (Physical, ATM, AAL).

System management is performed through an SNMP agent that has been developed for the monitoring of the performance of multimedia host systems (UNIX Workstation). This agent reports on the system activity. System activities that are monitored include the CPU utilization, the I/O activity, the context switching, the paging, the free memory and swap space. Recall that UNIX which is not a real time system may experience bad performance. There is a possibility to reduce or remove the bottleneck by reconfiguring the kernel or distributing the multimedia applications on different workstations.

An SNMP agent is in charge of reporting performance statistics at the multimedia applications level. This provides the closest QoS measurements to end users. The multimedia applications send statistic reports to the agent regularly instead of being requested by the agent. The information reported are related to the image and audio packets statistics.

The NMC requests, using CMIP, the agents at a local site through a unique interface (figure 6), called the Mediation Device (MD). The MD is an application level gateway that is used for providing the Q-Adapter functions that enable internetworking between CMIP and SNMP. It dispatches the incoming requests to the local agents and can preprocess and filter the responses and forward the SNMP traps destinated to the NMC. The MD uses SNMP protocol to communicate with the local agents.

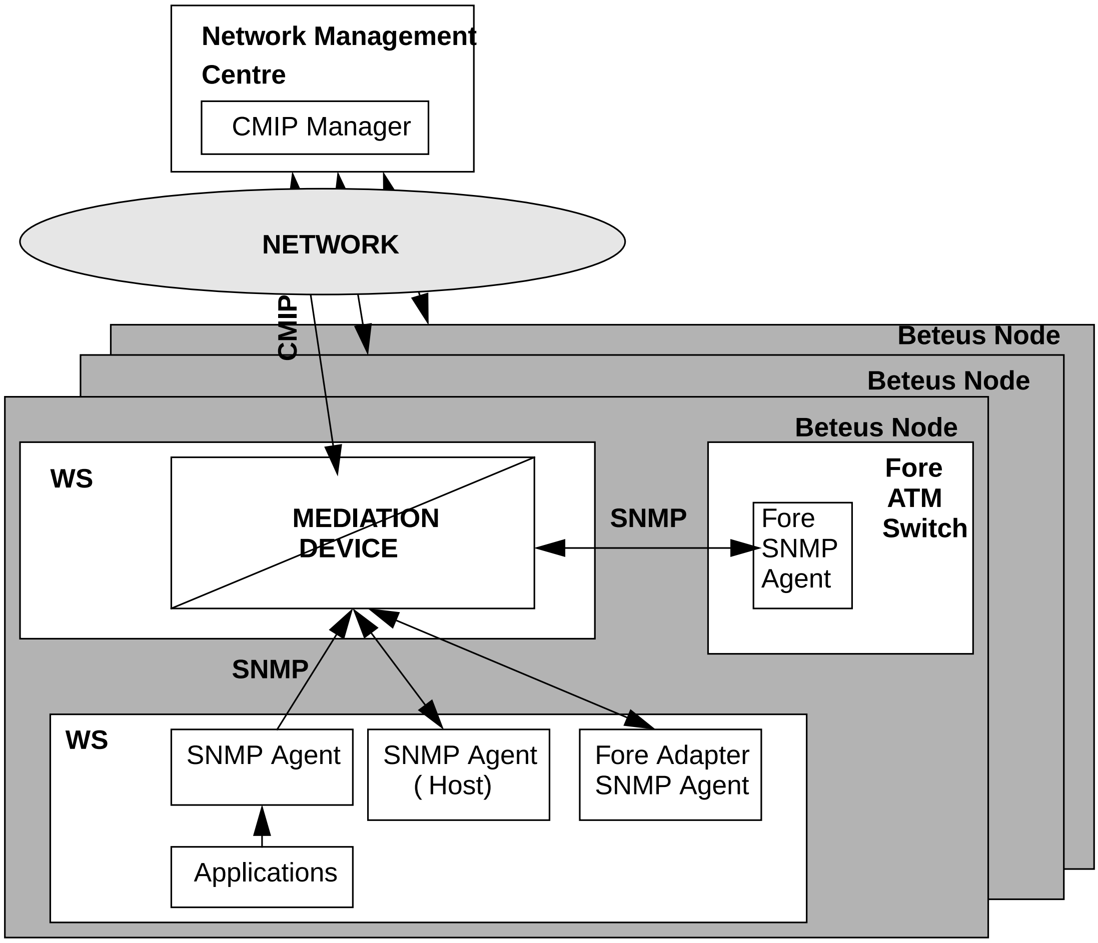

Figure 6: The Local Network Management Configuration

CMIP between the NMC and the local sites gives an appreciable WAN bandwidth saving by taking advantage of the powerful event reporting scheme of OSI. The event report of OSI permits to specify the conditions under which event reports are sent. The unavoidable SNMP polling is confined within the local sites. An additional reason for keeping polling locally is that the polling period should be very short in the high speed networks in order to be efficient. Recall that with SNMP the main way for the management station to receive information is polling the resources. The agent initiates an operation only when it wants to report an extraordinary event (i.e. link failure). For doing this, it issues a trap message and the management station may poll the agent in order to identify the source of the problem (trap directed polling). Only a few standard traps have been defined although proprietary traps can be implemented.

The implementation of the OSI Metric Monitor (X738) and Summarization (X739) SMFs within the MD permits to perform locally polling, threshold checking, data summarization and statistical analysis functions. Recall that Metric Monitor Objects are used for periodically observing the attribute (of type Counter or Gauge) of another managed object. Internal thresholds can be used for determining whether a Quality of Service alarm notification should be issued. The basic processes provided by the Metric monitoring function include data capture, data conversion, data enhancement, and data analysis. The Summarization function aims to extract information from managed objects representing underlying resources or metric objects, and places it in summarization objects. Algorithms (i.e. means, standard deviation) are used in order to calculate summary information from the observed attributes.

5 EXAMPLE OF MEASUREMENT RESULT

It is out of the scope of this paper to provide the performance analysis of the data that have been monitored. However this section presents a sample of performance statistics (incoming traffic) that have been collected during one of BETEUS multimedia session at the ATM adapter card of the workstations dedicated to video applications.

AAL5 layer reception performance analysis session time values:

- Start: `09:00:24` hrs.
- End: `13:00:27` hrs.
- Session duration: `14401` seconds
- Average time interval between two SNMP agent queries: `15 seconds`

The absolute values obtained for the time duration of the session are the following:

AAL5 type ATM cells statistics

- Total received AAL5 ATM cells: `28662673 cells`
- Average AAL5 ATM reception cell rate: `1990.32 cells/sec.`
- Minimum effective AAL5 ATM reception cell rate: `0.0055 cells/sec.`
- Maximum effective AAL5 ATM reception cell rate: `3745.5 cells/sec.`

AAL5 PDUs statistics

- Total received AAL5 PDUs: `394 413 AAL5 PDUs`
- Average AAL5 PDU reception rate: `27.38 AAL5 PDUs/sec.`
- Minimum effective ALL5 PDU reception rate: `0.0027 AAL5 PDUs/sec.`
- Maximum effective AAL5 PDU reception rate: `65.6 AAL5 PDUs/sec.`

ATM layer and AAL5 reception layer statistics

- Globally the number of AAL5 received cells equals the total ATM cells received by the SBA200 atm adapter.
- Both the ATM layer and the AAL5 layer effective reception cell rates follow the same dynamic variations over the session period. No significant mismatches between these layers were detected. This leads to a minimum overhead introduced by the SAR sub-layer and by the ATM layer in the process of adapting `53 bytes` ATM cells into `48 bytes` AAL5-SAR SDUs. ATM cells are passed from the ATM layer to the AAL5 SAR sub-layer with almost no queueing time that could modify the traffic dynamic variation between these two layers.
- AAL5 reception cell rate variations over smaller time periods and the multimedia data flow evolution correspond to the same variations as described in the ATM layer reception performance analysis section.
-

AAL5 reception PDU Size statistics

The AAL5 cell rate and AAL5 PDU rate variations allow us to consider that in average, the number of cells per AAL5 PDU correspond to a simple calculation of the number of received AAL5 cells divided by the number of received AAL5 PDUs over a determined period of time. This consideration is made because traffic variations between AAL5 PDUs and AAL5 cells are almost similar in fixed periods of time.

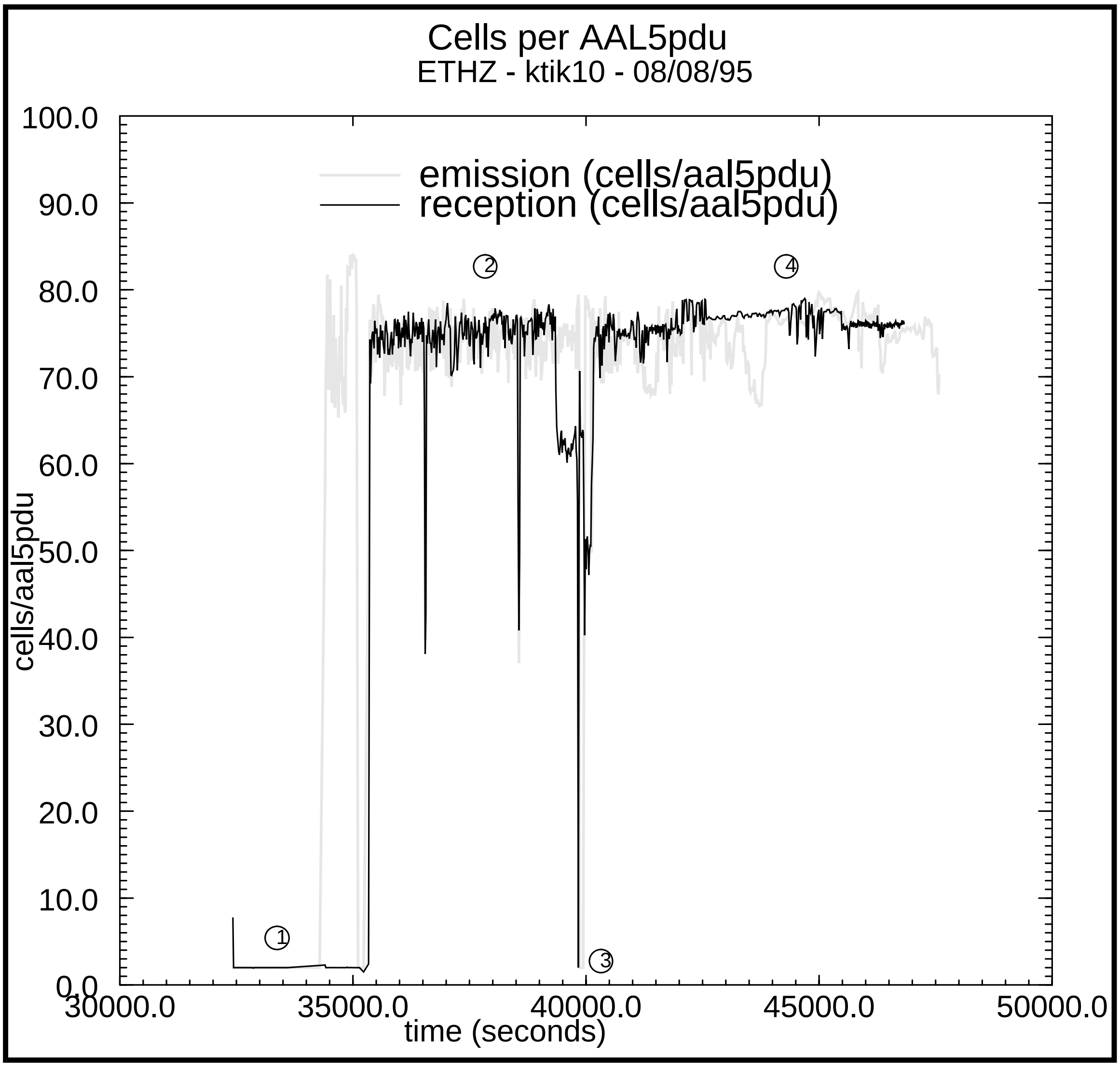

Figure 7: Number of Cells per AAL5 PDU

At the beginning of the session (figure 7), `2 ATM cells` generate `1 AAL5 PDU` on the average (period 1 in the figure 7). The application data represents only a `54.%` of the avaible data in the payload field of two ATM cells. As with the emission starting period of the session, the throughput is very low.

In the activity periods, an average value of `73 ATM cells` generated one AAL5 PDU (period 2 and 4 in the figure 7). The average AAL5 PDU size is then equal to `73 x 48 bytes = 3504 bytes`. The `3504 bytes` include the AAL5 PDU trailer and its payload data (LLC/SNAP header + IP header + UDP header + Application data). The application data represents `98.74%` of the total payload data of the `73 ATM cells` (only `1.26%` is due to the AAL5 trailer, the LLC/SNAP, the IP and UDP headers).

Fore systems adapter card allows an IP MTU size up to `9180 bytes`. The performance throughput can be improved if IP datagrams are set to their maximum size of 9180 bytes (as described by the RFC 1626). User data represents `99.6%` of the AAL5 PDU maximum size.

The emitting and receiving applications have a stable behavior generating AAL5 PDUs with similar performance characteristics. The variable size compressed JPEG images induce the AAL5 size variations but it keeps their values near the average value (the standard deviation for the number of cells per AAL5 emitted PDU is `16.46 cells/AAL5 PDU` and the standard deviation for the number of cells per received AAL5PDU is `22.14` `cells/AAL5 PDU`). It should be noted that the application perform a kind of traffic shaping by maintaining a near constant throughput as much as possible.

<u>AAL5CRC errors, Cell discards, aal5PDU discards statistics</u>

At the AAL5 reception layer, aal5 PDUs with CRC errors were discarded. The ATM cells belonging to a partially discarded PDU (in the course of being dropped) are also discarded. Is has to be noted that the `aal5ReceivedCells` and the `aal5ReceivedPDUs` counters do not take into account the number of AAL5 layer discards.

Hereafter, the time interval occurrence of AAL5 layer CRC errors, Cell discards, and AAL5 PDU discards is listed.

Event time: 09:30:26, aal5CRCErrors:0, aal5CellsDiscards: 0, aal5PDUsDiscards: 0

Event time: 09:30:41 aal5CRCErrors: 20 aal5CellsDiscards: 40 aal5PDUsDiscards: 20

Event time: 09:30:56 aal5CRCErrors: 9 aal5CellsDiscards: 18 aal5PDUsDiscards: 9

Event time: 09:50:41 aal5CRCErrors: 1 aal5CellsDiscards: 150 aal5PDUsDiscards: 1

Event time: 09:51:11 aal5CRCErrors: 1 aal5CellsDiscards: 74 aal5PDUsDiscards: 1

Event time: 09:51:42 aal5CRCErrors: 1 aal5CellsDiscards: 73 aal5PDUsDiscards: 1

Event time: 09:53:26 aal5CRCErrors: 1 aal5CellsDiscards: 66 aal5PDUsDiscards: 1

Event time: 10:20:27 aal5CRCErrors: 3 aal5CellsDiscards: 220 aal5PDUsDiscards: 3

Event time: 11:49:56 aal5CRCErrors: 1 aal5CellsDiscards: 75 aal5PDUsDiscards: 1

Every AAL5 PDU discard was caused by a CRC error. At this level, the number of discarded ATM cells and AAL5 PDUs follow the number of cells/AAL5 PDU behavior described early. The first two interval time sets confirm that at the beginning of the session period, 20 discarded AAL5 PDUs represent 40 discarded ATM cells which makes an average value of two cells dropped by a dropped AAL5 PDU. The following time periods confirm that in average, a dropped AAL5 PDU represents 73 discarded cells.

<u>AAL5 layer AAL5 PDU loss statistics</u>

During the whole session period, 37 AAL5 PDUs were discarded among a total of 394 413 received AAL5 PDUs. This leads to a total of 394 376 AAL5 PDUs passed to the IP layer.

The AAL5 loss rate over the session period time is then equal to the number of discarded AAL5 PDUs divided by the total number of received AAL5 PDUs:

AAL5 layer loss rate = $37 / 394413 = 93.81 \times 10^{-6}$

<u>ATM layer cell loss statistics</u>

We can now make an estimation of the ATM layer cell loss rate considering that the occurrence of cell loss is uniformly distributed over the time (this leads to a pessimist cell loss rate approach since errors are normally correlated). Real measured results should present better CLR values. We consider that an average of 73 ATM cells form an AAL5 PDU. This leads to the following results:

ATM layer cell loss rate = $93.81 \times 10^{-6} / 73 = 1.281 \times 10^{-6}$

This CLR should be compatible with the QOS requirement of multimedia application. Then again, if we consider that the cell loss is uniformly distributed over the time, we can estimate the Bit Loss Rate:

Bit Loss Rate = $1.281 \times 10^{-6}/424$ (bits in an ATM cell)= 3.03×10^{-9}

The estimation value obtained for the Bit Loss Rate presents a very reliable ATM network (even if cell loss is considered to be uniformly distributed over the time).

6 CONCLUSION

ATM aims to provide a flexible mean of information transfer for emerging multimedia applications, typically video, audio and data connections. New multimedia applications have stringent performance requirements. The management of hosts and networks connecting multimedia applications is complex due to the high number and diversity of devices and systems that are found on the communication path. The QoS perceived by the user may not be satisfying, and the network management activity is used to identify the performance bottlenecks. The ATM pilot does not provide performance management support or QoS guarantees. However it is important to measure the level of performance achieved at the local sites within the ATM equipment, multimedia workstation and applications. The ATM Network gives performance guarantee only at the Network boundary. The UNIX-based multimedia Workstations can violate QoS guarantees provided by the ATM network because of the processing load and the interaction of systems components. The UNIX workstations provide no performance guarantees and as may experience varying delays as high as several milli-seconds.

Several theoretical studies have tried to tackle performance issues related to ATM Networks and multimedia applications. A lot of performance models have been developed for ATM Networks and multimedia applications and remain to be validated and tuned or corrected by comparison with the measured results under realistic conditions. Performance statistics are obtained by taking measurements using a network management platform.

Several Network Management Protocols have been defined with different approaches. In practice they will have to live together since their functionalities are sometimes complementary or one of them is imposed by the device vendor where the functionality of an other is needed. In the BETEUS project we first investigate all potential performance bottlenecks and then build a Network Management Platform integrating SNMP, along with CMIP protocol and TMN concepts in order to have a fully distributed and flexible management platform. It was important for us is to use the right network management paradigm at the right place taking into account the variety of network devices and their management agents, and to integrate everything and make the different elements interoperable. We presented in this paper the QoS issues facing BETEUS applications and the network management platform that has been used to monitor the performance of the BETEUS multimedia applications.

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