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PIPVIC - Piloting IP Videoconferencing

Deliverable D0

Title: Collection and Analysis of Mbone Traffic Statistics, V1

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Document Reference: PIPVIC D0

Date: February 1998

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1. Introduction

This document is a proposal as to the most appropriate way of collecting and analysing traffic statistics in the PIPVIC (Piloting IP Videonconferencing) Project.

The aim of the PIPVIC project is to understand potential issues involved in running a large-scale IP mulkticast videoconferencing service. To this end, a series of structured activities (teaching, research and administration) are conducted, using IP multicast videoconferencing tools, with users at 6 sites in the UK academic community:

- University College London (Leading Partner)
- University of Exeter
- University of Essex
- Unversity of Wales at Aberystwyth
- University of Westminster
- School of Slavonic and East European Studies (SSEES).

The audio, video and shared workspace tools used for conferencing between the sites were provided by a separate project, SHRIMP.

The detailed aims of the project, as described in the proposal, are:
- To pilot and assess IP multicast videoconferencing with a cross-section of users with differing requirements (other IP based videoconferencing tools will be tested as part of large scale piloting activities).
- To assess the effectiveness of IP videoconferencing tools in a collaborative working environment.
- To identify further requirements for a large-scale deployment and use of wide-area IP videoconferencing service on JANET.
- To begin to test what happens when congestion occurs within a service network environment and to evaluate the effects of congestion on videoconferencing applications within a service network environment (this aspect will be fully tested as part of the large scale piloting activities).
- To begin to determine the scalability of IP videoconferencing on JANET (this aspect will be fully tested as part of the large scale piloting activities).

To address the last 3 aims, the project is to carry out monitoring and analysis of the network conditions and performance during the videoconferencing sessions.

This report – PIPVIC Deliverable D0 – is a proposal for collecting and analysing traffic statistics during the project. It provides a rationale for the approach chosen, based on best current knowledge, and explain how data collection and analysis methods chosen will provide good indication of level or performance and cause of any problems observed. It is based on the advice of Mbone experts at UCL and in the international research community.

This deliverable is submitted for agreement with UKERNA. The intended audience of this document is therefore PIPVIC partners and staff coordinating the PIPVIC project at UKERNA.

The collection and analysis of data should be documented and constantly reviewed throughout the project. At the end of the project, conclusions as to which data collection and analysis methods provide meaningful feedback about network performance will be provided in a separate deliverable (D4).

2 Mbone monitoring

The protocol stack used for IP multicast conferencing on the Mbone is relatively shallow [5]; there are only a few layers at which is it sensible to take measurements: *application level* (RTP/RTCP), *IP level* (routing and packet loss rates) and *link level*. In the following sections, these are discussed in turn.

2.1 Monitoring at the application level

An Mbone multimedia conference comprises a set of packet flows, one for each media, carried by a transport protocol known as the Real-time Transport Protocol (RTP) [9]. The RTP control protocol (RTCP) is an integral part of RTP and provides for participant identification and Quality of Service (QoS) feedback. Despite its name, RTCP is not a control protocol in the usual sense: it provides information on the progress of a session only, but cannot be used to influence that session. Information conveyed in RTCP includes user details, together with loss rate statistics and summary transmission rate data. The user details provided are sufficient to identify participants in a conference, and the QoS information is useful for debugging network problems.

There are a number of ways in which RTCP data can be analysed. The most common means are:

1) **Loss statistics from Mbone tools**: Audio/video conferencing tools such as rat [7] and vic [6] maintain internal statistics on packets received, from which they derive buffering parameters, adapt to network conditions, etc. It is possible to access some of this information from within the tools, and hence obtain some diagnosis of network problems. There are three major drawbacks with using this method:
    (a) the format in which the loss statistics are reported is complex, and requires in-depth knowledge of multicast to interpret;
    (b) since the data can only be accessed in real-time, post-session analysis is not possible; and
    (c) the loss statistics cover packets lost for reasons other than network problems (i.e. processor overload in the workstation).

2) ***The rtpmon tool***: *Rtpmon* [1] can be used to monitor an ongoing session and identify network problems. It displays a matrix of sources and receivers, with the packet loss rate (as reported by RTCP) displayed in the cells of the matrix. The presence of high loss rates is an indicator of network problems, which should be investigated further. The manner in which loss statistics are displayed by *rtpmon* is less complex than those presented by the media tools, but is still difficult to read and interpret. Like the statistics from the media tools, it must be used during a session, and cannot provide post-session analysis.

3) **The *rtpdump* tool**: *rtpdump* [8] can be used to save RTP packet headers for later analysis. It is not suitable for interactive monitoring, or for use by non-technical users. The information stored comprises all RTP packet headers received at a site,

together with all RTCP packet information. This set of data can thus be used to obtain an exact analysis of the conference as seen at a single site, and to obtain approximate information, as provided by RTCP, for other sites. Trace data may be taken at multiple sites, and it should be possible to combine this to provide a detailed view of the conference. The major drawback of this methods is that there is currently no software tool to analyse such traces; therefore, datafiles (which reach approximately 10Mb per hour per site) would have to be analysed by hand.

Since RTCP gives a global view of the quality of a conference, the reports are multicast, so monitoring need not be performed at each site (although if logging can be conducted at multiple sites, the more detailed RTP packet loss information can be combined with the summary RTCP data).

We need to understand the credence that can be placed on the session information (RTP/RTCP) transmitted by the tools; although the RTP information is reliable, since the operation of the tools relies upon it, there are suspicions that the information from the RTCP packets is less reliable.

2.2 Monitoring at IP level

The application level monitoring described in the previous section provides an indication of whether problems exist, but gives little information about where the cause of the problem might be. The only tool which can give information on IP multicast packet loss is multicast traceroute (*mtrace)* [3]. *mtrace* determines the multicast route between two sites, and reports on packet loss characteristics along that route. If problems are noted during the application level monitoring of a session, it is possible to trace the multicast routing between those sites seeing problems, and to determine where bottlenecks occur. To date, this has typically been a manual process, and interpreting the output of *mtrace* requires an in-depth understanding of multicast. There is some hope that more advanced monitoring software may be developed [4], but this is not expected to be available in the short to medium term.

mtrace depends on the ability to send a special IGMP packet to all routers in the path between two hosts. Therefore, it may fail if:

1. network packet loss rates are high (since the traceroute packets may be lost),
2. firewalls are configured to block such packets, or
3. routers are configured to ignore such requests.

In our experience, the last two occur rarely within SuperJANET, but the first is a common problem.

2.3 Monitoring network conditions at the link level

The cause of IP level problems described in the previous section can be identified by studying the link-level packet loss characteristics. Link-level monitoring requires low-level access to the network links. If IP level problems persist, such link level monitoring should be conducted by the SuperJANET operations staff to determine the cause of the problem.

3 Tracing Mbone problems

There are two approaches to monitoring and analysing network performance in the context of the PIPVIC project: *real-time* or *post-session analysis*. Both are discussed in this section.

3.1 Real-time analysis

The ability to detect a network problem and locate its source during an ongoing session is clearly useful, since immediate action can be taken to remove the cause of the problem. The simplest means of detecting network problems is through analysis of *application level statistics*, as were discussed in section 2.1. From study of RTCP reception report data (for example, as provided by *rtpmon*), it is possible to determine packet loss rates. If applications are seeing high packet-loss rates, this is a signal that IP level monitoring should be employed to determine the location of any problem.

High loss rates, as reported in RTCP, are not necessarily indicative of a network problem. A loaded workstation, for example, can cause scheduling anomalies which result in an application missing packets, even though the network is functioning correctly (this will probably show up as increased jitter in the RTCP reports). Furthermore, the statistics provided by some versions of the media tools have turned out to be inaccurate.

If network problems are suspected, it is necessary to employ IP level monitoring to determine the location of the problem. This is done by running *mtrace* between those sites seeing the problem, and interpreting the results. This should lead to the bottleneck or failed link to be identified and fixed.

There has been some concern about the widespread use of *mtrace*, since this places a large processing load on network routers, which becomes more concentrated nearer the source. More research is needed to determine the effects this may have on the network as seen by the application.

This approach is feasible if the aim is to diagnose a particular fault, however it requires expert staff to be available when the fault is noticed, and cannot currently be automated.

3.2 Post-session analysis

Monitoring of RTP can provide two types of data for post-session analysis and debugging:

1) packet traces and RTCP reports produced by *rtpdump*, which provide an application level view including packet loss statistics, and
2) the output of *mtrace*, which gives an IP level view, showing routing and link loss rates.

Packet traces and RTCP reception report data provide an overview of the quality of a conference, giving summary data for all sites. Together with subjective quality assessment, this may help to further our understanding of the network quality required for certain tasks to be performed. The absence of software tools for automated analysis of the large amounts of data collected makes this a cumbersome and daunting task which, given the resources available in the PIPVIC project, can only be conducted by example.

Furthermore, a comprehensive collection of packet traces and summary routing information would be useful

1) to assess the performance of the network;
2) to design new transport protocols; and
3) to gauge the suitability of existing conferencing tools to the observed network conditions.

Some work has been conducted in this area [2,4, 10], but this is clearly in its early stages, and further investigation would be desirable. Detailed study in both these areas would clearly be valuable, but are outside the scope of the current PIPVIC project.

4 Proposed Monitoring and Analysis Approach for PIPVIC

It is of primary importance for the success of IP multicast conferencing that the multicast infrastructure within SuperJANET is as problem-free as possible. The situation at the start of the PIPVIC project is clearly that there are a number of problems with the network configuration, which result in large amounts of packet loss during nationwide conferences.

The major aim of the network monitoring activity to be undertaken by the PIPVIC project must therefore be to locate network problems, and to work with the SuperJANET operations staff to correct them.

To this end, it is proposed to conduct a programme of application-level network monitoring during all structured activities carried out by PIPVIC (teaching sessions, weekly seminars and project management meetings). If problems are noticed during a session, the first cause of action locally must be to monitor processor performance of the workstation, to see if the loss is caused by overload here. If this is not the case, packet loss must be investigated at network level, and a report on the likely cause and location of the problem submitted to the network operations staff. This report will take the form of sample output from *mtrace* to indicate the location of the problem, together with comments describing the duration and severity of the fault. Such monitoring and fault tracing should clearly be a distributed activity, undertaken by as many PIPVIC partners as possible, since some problems may only be apparent from a subset of the sites involved.

For each session, there should be an indication of the network performance ("no problems noticed", "problem suspected"), a summary of the problem, and of any action taken to attempt to repair that problem. This information should be collected and displayed on the PIPVIC WWW page for future inspection.

We also propose to make selective use of the SNMP tools *mconfig* and *mstat* to monitor the state of SuperJANET Mbone core routers. In particular, we will use the –*v, -D, -T* and –*C* options of *mstat* to observe whether or not Mbone tunnels are saturated in terms of their rate_limit settings. We will not methodically monitor all routers, as supplying the statistics creates additional load on the routers themselves. Instead, we will use these tools to observe suspected “Hot Spots” when packet loss is reported in tool statistics.

Clearly, large-scale collection detailed packet traces or continuous routing table metrics for post-session analysis is not feasible, since the expertise necessary to collect and analyse this data does not currently exist. Collecting statistics on this scale and analysing them would have considerable benefits for the understanding and improvement of Mbone services everywhere; however, further research must be conducted to determine the best means by which this can be undertaken, and tools developed to facilitate analysis on a large scale. We propose to collect such data for a small number of sessions, and explore them in parallel with observations and user quality reports.

Another method of post-session analysis of packet loss is via recordings using the UCL Mulitcast Conference Recorder (MMCR), which allows replay of media streams collected at a particular site. The recording will only reflect loss at the site at which it was recorded; currently, the other PIPVIC partners do not have facilities to record and store these sessions. Recordings may be able to contribute to post-session analysis, and we propose to explore this further.

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