Session Summary: QoS over IP

Rapporteur: Thomas Nolte

1 Introduction

The objective of this session was to discuss different aspects related to Quality of Service (QoS) over IP. In recent years, QoS over IP has been a topic of growing interest, especially since multimedia applications have become a part of every day life. Today several domains of applications require good QoS, not only multimedia applications. Hence, there is a growing demand for QoS models and mechanisms. In this session there were 4 presentations talking about

- different issues affecting real-time performance in IP-based home networks,
- the usage of routers for IP-based real-time communication,
- distributed soft real-time communication,
- and reliability issues for regional scale distributed control systems or communication subsystems.

In the following sections the presentations are summarised together with their related session discussions. Finally, the whole session is concluded.

2 Robust Real-Time IP-based Multimedia Communication

The first presentation of the session was given by Michael van Hartskamp from Philips Research. The focus of his presentation was to identify sources that might violate real-time behaviour in an IP-based local area network. This violation is caused mainly by the protocols included in the IP-stack.

A home network is defined as a real-time network where several multimedia devices are connected. However, due to the nature of an IP-based network, the real-time behaviour is disturbed caused by, e.g., IP address leasing. This disturbance is not tolerated since audio and video streaming is considered as hard real-time traffic. Hence, glitches are not tolerated by the end-users. Several issues affecting the real-time performance of home networks are identified. These issues are often originating from the dynamic behaviour of home networks, which calls for dynamic protocols, e.g., DHCP, DNS, and Zeroconf. Typical scenarios that can cause temporal unavailability are

- adding of devices, e.g., a laptop is connected at home when its owner returns home after work,
- removing of devices, e.g., switching off a device, and
- merging of networks, e.g., connect a car network with the home network.

Most identified scenarios that violate the real-time behaviour are connected to the reconfiguration activities of the IP-stack, often directly related to the behaviour of the DHCP protocol, e.g., the DHCP-server might go away, or a new one might pop up so several DHCP-servers are available in the network. When a device needs to refresh its IP, which DHCP-server should the device use? These scenarios cause temporal unavailability in the order of seconds, violating possible real-time streams.

Possible solutions discussed in the presentation were the usage of IPv6, and/or the usage of link-local IP addresses, reduce wait-times in IPv4 link-local protocols, send suggestions to DHCP protocols, maintaining of connections with invalid addresses, and to provide a table with local name to hardware address (IPv6 address).

During the discussions following the presentations in this session, Michael stated that the choice of network, IP, is due to its popularity. Moreover, the paper is not presenting any QoS model, so there is no good way of assuring the desired QoS. Furthermore, Michael has no plans in developing any own technology for measuring QoS. The solution should be to use standards that have QoS support built in. However, not many standards have QoS management today, although some standards provide QoS management. To conclude, the focus of this presentation is mainly to

address and clarify the issues violating real-time behaviour in IP-based home networks rather than presenting a new model of QoS as a solution to the problems. Searching for a possible solution, looking at the following two presentations, they are both router based, and therefore not directly suitable for the needs of a home network as described in Michaels presentation. Hence, a possible solution is still an open issue.

3 Avoid LAN Switches - IP Routers Provide a Better Alternative for a Real-Time Communication System

The second presentation of the session was given by E. Simon from CNAM-Laboratorie Cedric. The message of this presentation was that in order to achieve good QoS for real-time communication in IP-based factory communication systems, routers are a better choice to manage QoS compared to LAN switches. Traditionally switches are proposed or used, but in the presentation by E. Simon, it is shown how to use simplified routers for the QoS management.

The aim of the presentation was to clarify that many difficulties in Industrial Ethernet (to achieve real-time communication) are mainly due to the usage of switches as the communication backbone instead of (as proposed) routers to do the QoS management.

The current functions encountered in a QoS enabled router are the following: classifier, scheduler, traffic conditioning in queues (metering, marking, shaping, dropping and queuing disciplines). However, for real-time traffic not many of these functions are needed. Instead, it is possible to make the router simpler by removing unused functionality.

In the work presented, a Linux-based router is used to evaluate queuing discipline management. Queue configuration for Linux is done by using scripts. However, this work is still not completely finished since some desired behaviour is not yet achieved. The goal is to use Linux-based routers to achieve good QoS management in IP-based factory communication systems.

In the discussions following the presentations, the question of why not to use the resource reservation protocol (RSVP) was asked. This since most factory networks are limited in size. There were some discussions regarding weather or not RSVP is obsolete. However, the discussion ended in that this belongs to the work that E. Simon will look into in the near future.

4 QoS Support for Real-Time Flows in Internet Routers

The third presentation of the session was given by Orazio Mirabella from the University of Catania. The topic of his presentation was about providing QoS for soft real-time streams of messages generated by applications distributed over the Internet. By separating real-time streams from non real-time streams in two queues, the real-time queue can be scheduled using deadline-based scheduling, e.g., Earliest Deadline First (EDF). The non real-time queue is a simple FIFO queue. Deadlines are assigned to messages based on an end-to-end basis. Since a message typically passes over several routers before it reaches its destination, the end-to-end deadline is divided into hop-deadlines, based on the number of routers/hops that a message passes before reaching its destination. The scheduling is performed at each router/hop. If a hop-deadline is violated, the message can be discarded, causing less congestion in the network. Also, a dynamic approach that is using feedback is presented, the Adaptive Earliest Deadline First (AEDF).

The implementation of the proposed mechanism is evaluated using FIFO, EDF, and AEDF in a smaller IPv6 network. Linux was used together with the Click[1] router software. The results show that AEDF and EDF outperform plain FIFO. However, in the discussions at the end of the session, it was pointed out that a comparison to Weighted Fair Queuing Scheduling (WFQS) would be a more realistic evaluation. Both because WFQS is more frequently used in the Internet, and, compared to EDF, WFQS can easily be implemented in hardware. This comparison could be done according to Orazio, although the focus of this presentation is to show the performance of the dynamic feedback-based scheduling, and how it can improve the behaviour when the routers in the system have different load. Orazio plans to compare AEDF with WFQS in the future. Another important issue with this proposal is related to the infrastructure already existing in the Internet. It is not easy to convince people to change the routers of the Internet in the way as proposed in the presentation.

5 Towards Reliable Integrated Services for Dependable Systems

The fourth and last presentation of the session was given by Henrik Schiøler from Aalborg University. The presentation discusses several issues relating to

[1] http://www.pdos.lcs.mit.edu/click

reliability for regional scale distributed control systems. The communication subsystem is especially in focus. Resource allocation is done in advance, based on the route resources. This route allocation is done rather rarely. Reliability Resource Reservation Protocol (RRSVP) is proposed for reliability management, as a counterpart of the Resource Reservation Protocol (RSVP) for time and bandwidth resource management. Reliability is defined as an attribute of the route. They use optimal route discovery and utility functions that take cost into consideration. Alternative routing is also taken into consideration. By using the RRSVP in IP-based networks, reliability management is achieved in communication systems or subsystems. Several reliability measures are presented, e.g., reliability, availability, and failure rate. Availability is suggested as a common measure for various types of systems. They are planning on doing some prototype implementations in the near future.

In the discussions following the presentations of this session a probabilistic upper bound on availability was asked for. However, so far, according to Henrik, none seems to make use of probabilistic upper bounds today, although probabilistic methods exist and their calculus could be applied. The reason for why probabilistic upper bounds are not used today is due to that integrated services are not implemented in commercially available routers and switches. The reason for why integrated services are not implemented should be that integrated services are believed not to be scalable enough.

6 Concluding Remarks

To conclude this session, the first presentation was identifying issues disturbing the real-time performance of IP-based home networks. What we need for home networks are good mechanisms to provide/guarantee QoS to the users of the network. In the second presentation, routers are proposed to be the backbone of an IP-based real-time Ethernet instead of switches, which are more commonly proposed today. This because they are QoS enabled while switches are not, and one can strip down the functionality of a router quite easily to make it suitable for QoS management in a real-time network. In the third presentation routers were used to schedule streams of soft real-time messages. This was done by modifying the router software, so real-time traffic could be scheduled according to a deadline based scheduling. The fourth and last presentation was about a reliability resource reservation protocol for regional scale distributed control systems. The new protocol allows for management of communication systems in terms of reliability. A common measure for various communication systems was proposed to be availability.

Although all four presentations are quite different, we can see that they are all addressing QoS at different levels in a system. Hence, an interesting future work, other than the future work proposed in the individual presentations, would be to combine some of the work presented in this session.