Demonstrating MoSaKa – A QoS System for Unstable Links With High Delay

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I. Introduction

In disaster scenarios, the ability to communicate is crucial for rescue teams. Standard communication infrastructure normally relies on widely distributed systems like base stations prone to fail in a big disaster. Independent systems like satellites can provide the necessary resources to restore communication in such cases.

Modern communication needs are no longer voice-only. More and more systems migrate towards an integrated approach offering voice, video and data communication. Packet-based data transmission schemes have proven to be a flexible tool for this kind of task, with TCP/IP being the prevailing implementation. Classical circuit-switched applications like telephony are adapted by technologies such as "Voice-over-IP" (VoIP).

Unfortunately, standard IP offers only a best-effort traffic model: packets are transported in the best possible way without guarantees. In such an environment constant-rate applications like audio and video streaming need to be protected against interference by other applications using the same resources. For this purpose, three approaches can be distinguished: overprovisioning, differentation and reservation. Overprovisioning – supplying enough link resources to satisfy all conceivable communication demands – is not a solution in a satellite environment: the link to the satellite has a comparatively low capacity and is expensive. Differentation, as performed by the "Differentiated Services" (DiffServ) architecture, offers prioritization for specific types of traffic, but is not able to guarantee transmission parameters. Thus, a reservation-based approach such as "Integrated Services" (IntServ) is required, which allows the coexistence of different kinds of simultaneous transmissions without impairing user experience.

A problem when applying IntServ to mobile satellite-based systems (or mobile scenarios in general) is its strong dependency on stable link characteristics. If a terminal is mobile and is affected by an obstacle, the channel deteriorates and the capacity of the link decreases. If the available capacity falls below the sum of all active reservations, some or all of the active reservation may no longer be served by the system. Existing approaches do no address this problem and would lead to a violation of the reserved parameters for all connections.

To avoid that, we propose a reservation-based QoS scheme [1] that is able to deal with unstable links, allowing graceful degradation if a link becomes a bottleneck, instead of affecting *all* active reservations at the same time. For this purpose, the system was designed to react to changes in the underlying link and put active reservations temporarily "On Hold", without cancelling them. If link conditions improve, reservations are resumed automatically. Applications are informed about such changes using a feedback mechanism. This relieves them (and the system) from the overhead of having to poll the path for resources. The other key contribution of the scheme is its ability to cope well with long delays (ground-to-ground time-of-flight over a geostationary satellite is $\approx 250\mathrm{ms}$). The reservation protocol reduces handshakes by aggregating multiple requests for both directions of a path into one single message.

Our demonstration shows those features by having a video chat session between two peers, consisting of multiple streams and showing the behavior of the system in the presence of unstable link conditions.

II. The MoSaKa project

The MoSaKa project [2] aims at developing a satellite ground station for highly mobile communication scenarios as found in disaster areas. The goal is to provide a full communication stack tailored towards the specifics of long-delay, low-bandwidth (compared to today's wired networks), highly-mobile communication.

The project partners develop Ka-band antennas, a tracking system, and specialized physical and MAC layers providing features such as QoS on the MAC layer and distributed resource allocation. Our part of the project is to develop a comprehensive end-to-end QoS system connecting the satellite terminals to applications on the client.

The key contributions of our proposed QoS scheme are:

Request aggregation

With the long delay introduced by the satellite link the number of round-trips necessary to complete a reservation setup is crucial to the delay introduced by using a QoS system.

This work is funded by the German Federal Ministry of Economics and Technology under the project MoSaKa (code 50 YB 0913).

The project includes further partners: Fraunhofer IIS, IABG, German Aerospace Center, and the RF and Microwave Laboratory at Ilmenau University of Technology.

MoSaKa enables an application to request an arbitrary number of paths in one single message exchange between two peers. This feature is especially useful for applications like video conferencing which typically consist of more than one data transfer path per connection. With MoSaKa QoS all necessary paths in both directions can be reserved at once.

Adaption to unstable links

One of the main challenges for QoS in an unstable environment like mobile satellite communications is the problem of path guarantees. Normally systems assume that a once-reserved path works until teared down. Mobile systems break this assumptions due to dynamic effects like shadowing and fading. MoSaKa adapts to this by introducing the "On Hold" state, temporarily suspending a path when necessary and resuming it later.

Network feedback

The active handling of link changes by MoSaKa QoS enables the system to include applications into the reaction chain. We assume that applications know best how to deal with service degradation. Therefore, the system offers applications a feedback interface informing them about changes in the network (e.g. suspension of a reserved path).

MoSaKa QoS currently relies on special functions offered by the lower layers developed in the project. The concept however is not bound to the MoSaKa environment, but can be extended to other unstable environment like Wifi (e.g. using 802.11e as a basis).

III. Demonstration

In order to show the features of the MoSaKa QoS system we set up a live demonstration as shown in figure 1. The demo scenario includes an emulated satellite link with two terminals attached. Each terminal runs the standard MoSaKa implementation with an emulated MAC layer beneath. Connected to each terminal is a client presenting a video chat application tailored to the key features of MoSaKa: complex reservation requests and active network feedback.

The satellite link will be emulated using Linux "Virtual Distributed Ethernet" (VDE) [3] which allows the user to control delay, data rate and packet loss of the link. The current link state is visualized in a control application to give the audience an impression of the situation at a glance. The control application additionally allows the reconfiguration of the satellite channel to demonstrate adaptive features of the system.

The terminals attached to the emulated link run the normal, unchanged MoSaKa QoS implementation. Visualization of the current reservation state is done based on the telemetry data exported by the software.

On the client machines we run the necessary MoSaKa software stack, as well as our video chat application [4], which implements the application side of the system. The application is able to reserve paths in the network and react to active feedback from the system. Additional software running on the client systems generates further traffic to demonstrate the QoS guarantees provided by MoSaKa in situations with competing traffic streams.

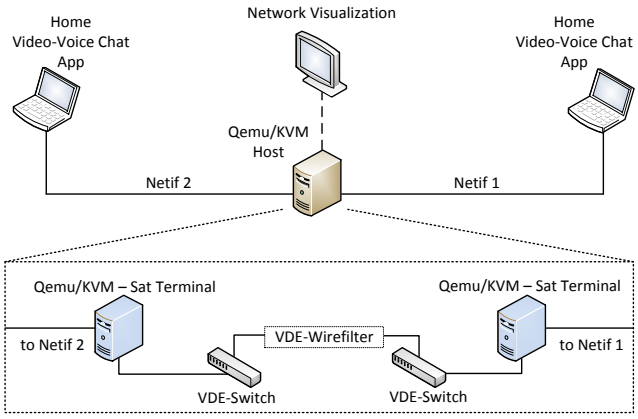

Fig. 1. Demonstration setup with Qemu/KVM host machine for the emulation of the terminals and satellite link

Users are able to trigger connection setup by initiating a video transfer from one client to another. The control application on the emulated satellite link shows the setup request passing through the different systems and causing state changes along the way. After a successful connection initialization users are able to observe a live video/audio feed.

Using the control application users can trigger a degradation of the emulated satellite link. They are able to observe the reactions of the MoSaKa terminals. The terminals optimize the resource distribution of the link, removing best-effort traffic first. Further link degradation causes the less important video stream to be suspended and feedback messages to be sent to the clients. The client applications display a message explaining the reason for the suspension. Users can now increase the capacity of the emulated link again and observe the video stream return to its normal state.

Systems without traffic control in contrast drop packets randomly, causing audio and video errors without any feedback. The user can select an unprotected connection setup to compare this to the MoSaKa world.

References

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