# Requirements-oriented Path Selection for Multipath Transmission


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## I. Introduction

In today's networks, the Internet Protocol IP is used as ISO/OSI layer 3 implementation and provides packet-oriented transport of any user data independent from the considered application. IP is responsible for transferring data from the source to the destination host. Packet forwarding is processed very close to the routing in a hop-by-hop manner. Unfortunately, IP does not support any kind of transmission requirements-oriented routing. In general, IP processes each packet according to the best effort paradigm.

Current research in ISO/OSI layer 4 focuses on the "Stream Control Transmission Protocol" (SCTP) [1] as a state of the art end-to-end unicast transport protocol. It is able to operate in both connection and message oriented mode. An SCTP based transmission, also denoted as association, supports single path based transfers by default. In addition to it, SCTP allows both communication endpoints to listen on multiple addresses. This feature is called multi-homing.

The CMT-SCTP [2] protocol extends SCTP by enabling the use of multiple paths for each transmission of message-oriented data. CMT-SCTP is able to combine different network interfaces for one transmission and therefore allows an application to communicate with increased bandwidth. Moreover, CMT-SCTP allows using multiple interfaces simultaneously in order to transmit data in a redundant manner, which enhances end-to-end robustness. However, current networks base on the IP protocol and therefore are not able to provide multiple disjunctive routes (or parts of the route) towards the same physical host. Classical routing protocols, e.g. OSPF and BGP, allow defining different metrics per route, only, in order to assign each route its special priority. However, this lacks the support of a defined packet scheduling in order to process packets according to round robin scheduling (to increase bandwidth) or packet duplication (to increase robustness).

In general, setting up a good performing end to end multi-path transfer shows a lot of unsolved issues related with the drawbacks of the current layered based protocol stack, where each layer is not aware of the service needs. As demonstrated in [3], using CMT-SCTP in a multi-path scenario is a hot research topic, where multiple issues have to be solved. Especially the utilization of dissimilar transport paths is a big challenge [4]. Even scenarios with similar paths show a fairness problem when going through bottlenecks. Another current problem is how to schedule the data over multiple paths. Due to the lack of exact information about the QoS characteristics of the used paths, it is difficult to avoid bad scenarios such as, for example, transferring important data over a weak path while other better paths are available.

In order to gain optimal benefit from the features introduced by CMT-SCTP, a network should support a requirements-oriented routing and should be able to react on transmission requirements in a dynamic manner along the entire route.

The goal of this work is to show how the Future Internet architecture "Forwarding on Gates" (FoG) [5, 6] can be used to support the state-of-the-art transport protocol CMT-SCTP by providing an enhanced routing in order to improve the transmission of a video stream and define which data is more important for the current scenario.

## II. Scenario

Our demo scenario consists of four basic components: a file processing application, our video processing application "Homer" [7], CMT-SCTP as transport layer and FoG as data transferring network architecture. The overall scenario is depicted in Figure 1. For transferring transmission requirements from applications towards the network stack we use the G-Lab API (GAPI) [8].

CMT-SCTP is enabled to use the extended routing capabilities of FoG. In contrast to today's IP, CMT-SCTP, here, can request routes from FoG satisfying special requirements. Especially, CMT-SCTP is enabled to request disjunctive routes from FoG for its multipath transmissions. If the network topology provides disjunctive paths, FoG will provide as many disjunctive routes as possible. In contrast to this, in IP based networks CMT-SCTP has to operate with the assumption that different destination addresses for the same physical host automatically lead to dissimilar routes in the network. In FoG networks, CMT-SCTP can benefit from explicitly given physically disjunctive paths. Moreover, FoG allows CMT-SCTP to define the importance of different transmissions, e.g. to implement traffic prioritization of path combinations.

## III. Demonstration Setup

Our demo shows a use-case with concurrent video and file transmissions as depicted in Figure 1.

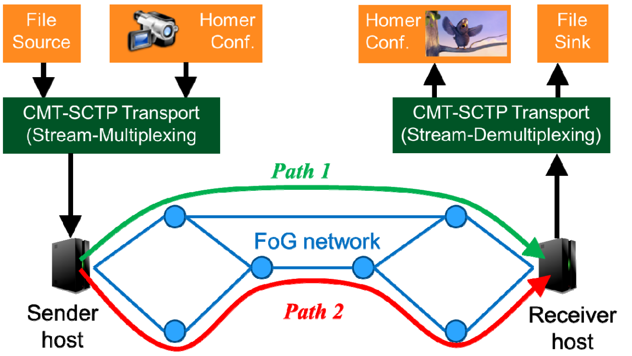


**Figure 1: demonstration scenario**

The user is able to start and stop different file and video transmissions with the help of our GUI. For each transmission, the user can set different requirement profiles, which define the transmission priority. Furthermore, the user can choose between the SCTP transmission with disjoint paths and the IP behavior with a single path. That allows an easy comparison of the behavior of the current and the Future Internet. In case the current Internet has to be simulated, the SCTP's requirements will be ignored and all data packets will be delivered according to the best effort paradigm. This leads to artifacts in the video presentation caused by the concurring streams. If the user selects the Future Internet alternative, SCTP can use the features of the FoG architecture and state explicitly its requirements for a route. Consequently, the transmissions can be performed either with high or low priority. Depending on the requirements defined for the video transmission, the video playback will show artifacts and indicate if the transmission is worse during a file transfer is running in parallel.

To allow an easy observation of the differences in terms of routing, every stream within the illustrated network topology is shown in a different color. Figure 1 shows a Future Internet example with two routes: path 1 is used for high-priority video transmission and provides high bandwidth. Path 2 is used for low-priority file transmissions and offers only an unpredictable delay with low end-to-end bandwidth. The current data rates per stream are depicted, too.

Figure 2 shows a screen shot of our GUI. On the left hand side, a part of the network and a marked transmission path is shown. On the right hand side, a graph showing the used bandwidth for the link between node C and B is depicted.

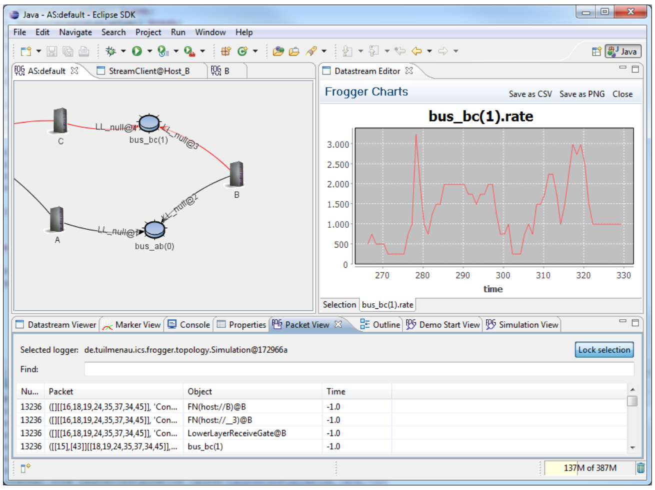


**Figure 2: screen shot showing network, marked path, and used data rate for one link**

## IV. Summary and Conclusions

Our demonstration software shows a new kind of communication between the FoG architecture and the CMT-SCTP protocol. By using different settings we are able to demonstrate how the architecture manages different types of traffic and guarantees an artifact-free video transmission.

## V. References


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