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# TCP in the Trans-Pacific High Definition Video Satellite Communications Experiment - the Next Test

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## Abstract

This paper describes a future Transmission Control Protocol (TCP) test which was planned as a part of the Transs-Pacific High Definition Video Satellite Communications Experiment. The TCP test *portion* of the Trans-Pacific High Definition Video Satellite Communications Experiment intends to examine the correlation between the underlying assumptions of some TCP algorithms and the performance shortfalls observed when the algorithms are used in a satellite-based environment, and to make experimental changes to existing TCP variants to study the effects of the modifications.

The emergence of a global information infrastructure (GII) using broadband satellites brings with it many opportunities and challenges. Broadband satellites serve as a key link in establishing a worldwide network of networks, while imposing upon us the particular characteristics of propagation delay, bandwidth, and error rates which differ from those of terrestrial networks. The use of existing TCP protocol variants over a satellite link can result in low throughput, particularly with the higher error rates and the effects of a large multiplicative product of propagation delay and bandwidth for broadband geostationary-Earth-orbit (GEO) satellites.

Slow-start, congestion avoidance, fast recovery and fast retransmission are algorithms that can be found in modem TCP implementations. There are underlying assumptions in these algorithms which help control congestion while at the same time help maintain a satisfactory transmission efficiency. When applied to an environment with satellite links, the assumptions in the algorithms may no longer apply.

For instance, the TCP congestion avoidance algorithm assumes that on most network paths the packet losses are due to congestion in the network. The response of the algorithm to the losses is therefore a decrease in link utilization. However, this would have a negative impact if the TCP path traverses over a satellite link, in which case the losses are more likely caused by link errors. To counter the misinterpretation of the signal, a TCP variant will need to be able to distinguish between losses due to

error and losses due to congestion. Allowing the congestion avoidance algorithm to differentiate between error loss and congestion loss will permit it to perform better in a satellite-based environment.

As another example, in an environment where bandwidth reservation is used (either by user agreement or protocols such as RSVP) for each individual flow of data between a source and a destination, the probing by the TCP slow-start algorithm contributes to a long ramp-up delay before the flow reaches an equilibrium and utilizes the available bandwidth. The impact is more significant on smaller files over satellite links because the transfers will be limited to a small fraction of the available bandwidth while the window is opening up. In most cases, the file transfer would have completed before the window opens up fully. The effect may also lengthen the transfer of large files, such as high definition video master clips and remote astronomy images. Allowing the slow-start algorithm to be assigned initially a window size equivalent to the reserved bandwidth would help in reducing the ramp-up time. Whether or not the window size remains static or is permitted to change dynamically is one of the topics for investigation regarding the granularity in a reserved bandwidth environment.

Issues of interoperability with existing TCP variants will be examined, and measurements of the effectiveness of the modifications will be made. The TCP test is expected to provide some additional insight into the use of broadband satellites as a component in the global information infrastructure.