

Technical Consideration for T4SAT

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Motivation

- The performance of transport protocols will be impacted by the unique characteristics such as networks-highly dynamic topologies, long and variable propagation delays and time-varying channel errors. The optimization of transport layer technologies in LEO satellite networks should consider:
 - the congestion control algorithms should be optimized to adapt the increasing bursty packet loss and significant delay variability.
 - the congestion notification should decouple channel errors from congestion signals while adapting to rapid topology changes.
 - the ACK mechanism should adapt the transport layer to reduce spurious retransmissions.

Optimization of Congestion Control Algorithms

- Challenges:
 - In LEO satellite networks, frequent handovers and connection switching will increase packet loss ratio (e.g. over 60%).
 - In LEO satellite networks, the dynamic topology could add significant delay variability beyond the inherent propagation latency and it also consumes valuable satellite capacity.
- Technical Considerations:
 - congestion control algorithms should be selected and optimized to tolerate the high packet loss ratio and predict bandwidth to control the congestion before the queues overflow.
 - congestion control algorithms should be optimized to adapt seamlessly to latency variations and RTT fluctuation based on precise RTT measurements.

Enhancement of Congestion Notification

- Challengings:
 - In LEO satellite networks, the packet loss will be divided into channel-error loss and congestion-based loss and random packet loss will lead to the failure of congestion control mechanisms.
- Technical Considerations:
 - The congestion notification should distinguish channel-error loss and congestion-based loss such as setting the 1-bit flag in ECN.
 - It needs to retransmit the lost packets without reducing congestion window for channel-error loss.

Adaptations of Transport Protocols

- Challenges:
 - In LEO satellite networks, the propagation delays (e.g. 20-150ms RTT) are higher exceeding the terrestrial networks. The Retransmission Timeout (RTO) mechanism will frequently misinterpret propagation delay as congestion leading to unnecessary congestion window reduction and packet retransmissions.
 - In LEO satellite networks, asymmetric uplink and downlink capacities cause ACK congestion and buffer overflows.
- Technical Considerations:
 - The ACK mechanism in LEO satellite networks should adapt the transport layer to guarantee ACK delivery such as setting ACKs to higher priority during handovers.
 - Especially during orbital transitions, it needs to reduce spurious retransmissions caused by orbital motion.

Next Steps

- Comments and Questions are very appreciated!