Effect of SCTP Multistreaming over Satellite Links

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Introduction

- TCP is the main transport protocol in the Internet protocol suite
- Original TCP did not perform very well in satellite networks because of errors and long delay.
- Many schemes have been proposed to enhance TCP performance over satellite networks.
  - Window scale option
  - Byte counting
- IETF is developing the Stream Control Transmission Protocol (RFC 2960) for carrying PSTN signaling messages over IP.

Open question: Does SCTP offer any advantage in wireless and satellite networks?

Objectives

Determine suitability and advantages of SCTP's multistreaming in

- Wireless and satellite networks
- Wireless handheld devices

Outline

- Introduction to SCTP
- Multistreaming
- Multihoming
- Simulation model of multistreaming over satellite links
- Results

Introduction to SCTP

Stream Control Transmission Protocol

- SCTP (RFC 2960) is being developed by IETF as a transport protocol for carrying PSTN signaling.
  - Reliable: retransmission of lost packets, ack of packets.
  - Non-duplicated service: uses sequence numbers.
  - In-order delivery: re-sequencing at the destination.
- Transport layer protocol which operates on top of an unreliable connectionless network layer such as IP.
  - Transparent to IPv4 or IPv6
- Key features:
  - Multistreaming – multiple streams per association
  - Multihoming – multiple IP addresses per host

SCTP in the protocol stack

Upper layer applications

TCP, UDP, SCTP

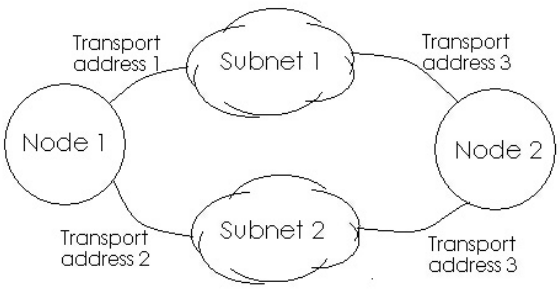
IP

Link Layer

Physical Layer

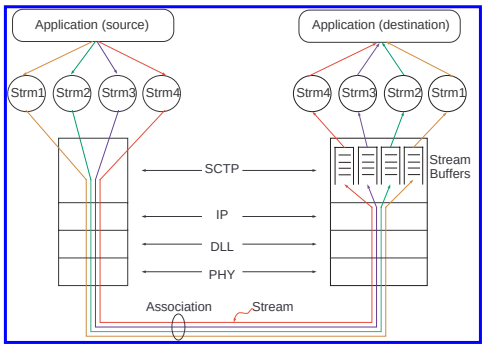
Multihoming

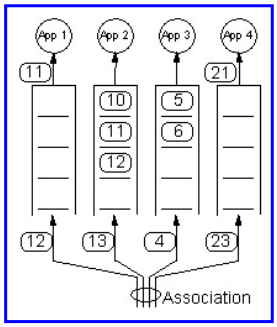
- Supports multiple IP addresses in an *association.*
- Requires multiple Network Interface Cards – already quite common in laptops !!
  - Can also be accomplished by one NIC using software radio



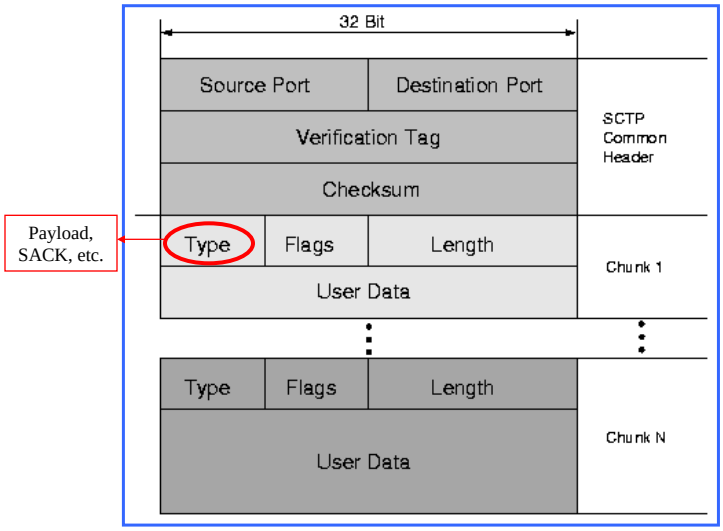
Multistreaming

- SCTP accomplishes multistreaming by creating independence between
  - data transmission (uses Transport Sequence Number)
  - data delivery (uses Stream Sequence Number)

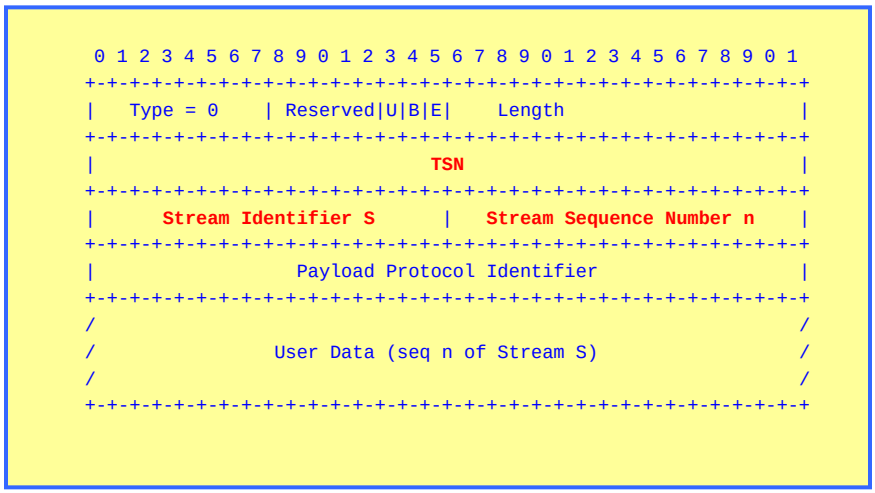




SCTP Packets



Chunk Type: Payload



SCTP Congestion Control

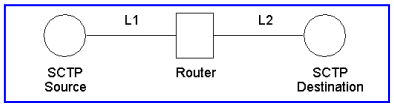
- SCTP congestion control assures that the traffic behaves in the network in the same way as TCP traffic.
- Enables a seamless introduction of SCTP services into existing IP networks.
- SCTP is rate adaptive similar to TCP.
  - Slow Start, Congestion Avoidance, Fast Retransmit
  - Fast Recovery is implemented, but in a slightly different way than TCP.
- Differences with TCP
  - Number of bytes acknowledged to increase *cwnd.*
  - SACK is mandatory
  - No explicit fast recovery phase
  - Unlimited number of Gap Ack Blocks in SACK

Simulation Setup

ns-2 Simulation Setup

Assumptions

- *Ftp* traffic between source and destination.
- Packets are of *fixed length* of one MTU.
- Upper layer at destination is always ready to accept data.
- Association consists of a number of streams.
- Receiver buffer size = *B*



Link delay (L1+L2) = 260 msec

Results

Performance Metrics

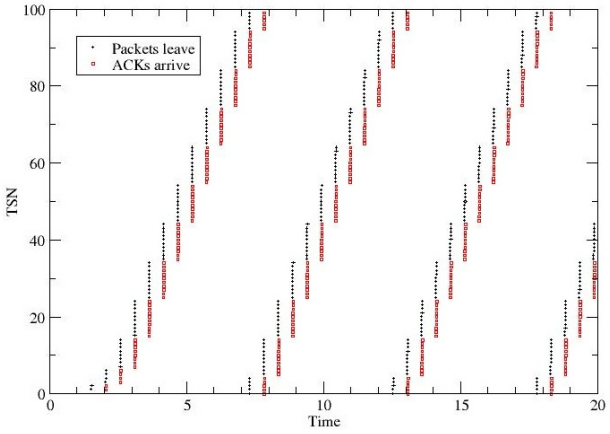
- Goodput: Number of good packets received at the receiver.
- Optimal receiver buffer size

as a function of

Error probability (e) = Prob. that a packet is lost in the network.

Packets Plot: No loss

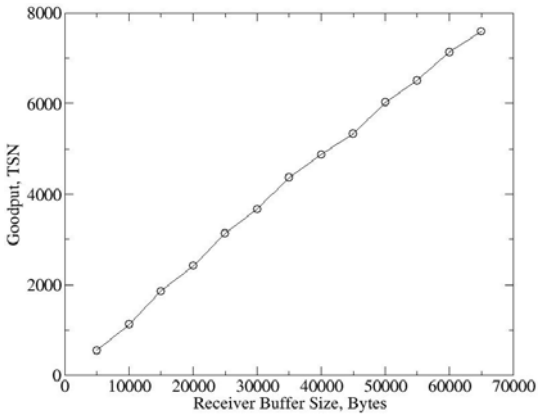
- No packet loss means no blocking at the receiver.
- *cwnd* initially increases until it reaches *B*.
- Goodput is limited to *B/MTU* packets every RTT; Goodput therefore increases linearly with *B*.



s = 4, e = 0, B = 15K

Goodput: No loss

- Since goodput is limited to *B/MTU* packets every RTT; it increases linearly with *B*.



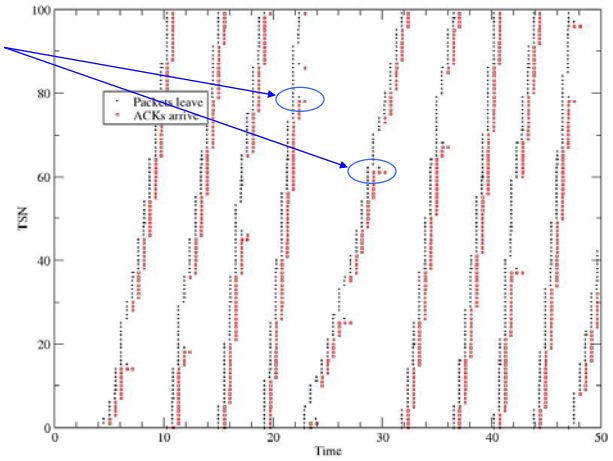
s = 4, e = 0

Packet plot: Congestion Control limited

- Long delays in Retx of lost packets while waiting for DupAcks

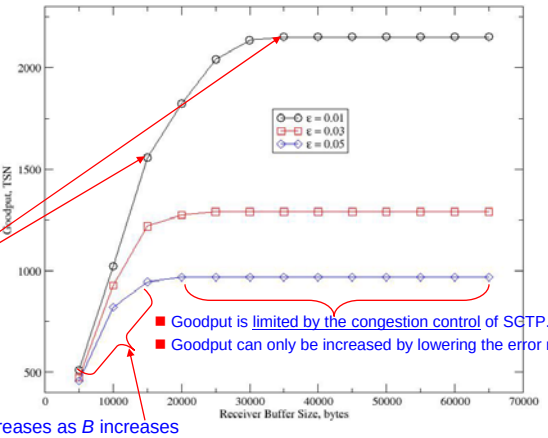
  +

  drop in *cwnd* due to Retx results in poor goodput when receiver buffer is not a constraint.



s = 4, e = 0.01, B = 35K

Goodput with errors



See *a_rwnd* and *cwnd* in the next two figures

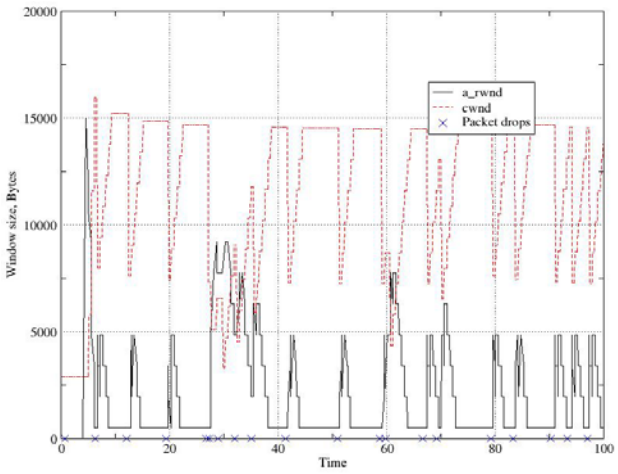
- Goodput is limited by the congestion control of SCTP.
- Goodput can only be increased by lowering the error rate

Goodput initially increases as *B* increases when the goodput is constrained by B (*a_rwnd* frequently drops below 1 MTU)

s = 4, e > 0

cwnd and *a_rwnd* with errors: Receiver buffer limited

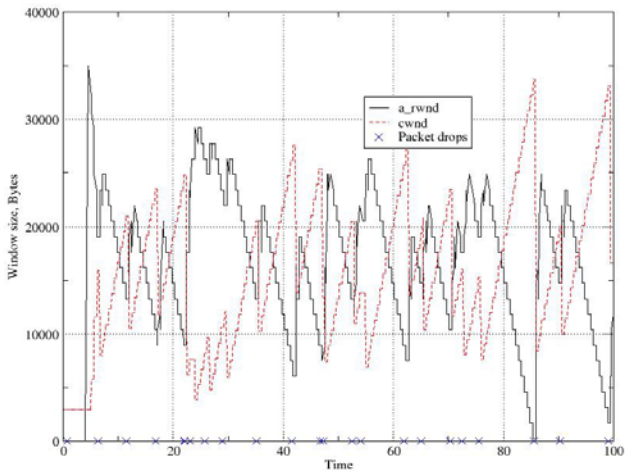
- *B*=15K results in the throughput being constrained by the receiver buffer size
- *a_rwnd* frequently drops below 1 MTU, and *cwnd* is restricted to 15K.



s = 4, e = 0.01, B = 15K

cwnd and *a_rwnd* with errors: Congestion control limited

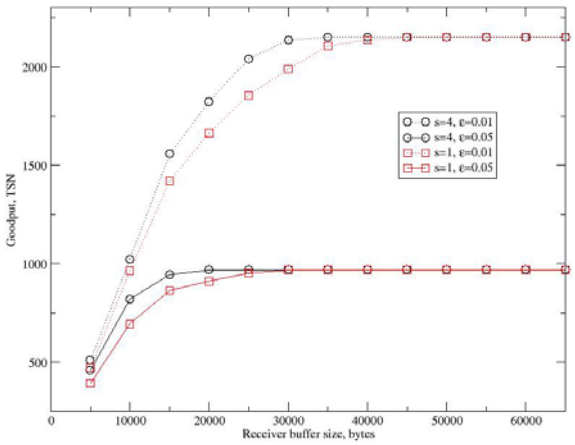
- *B*=35K makes the throughput constrained by the congestion control of SCTP.
- *a_rwnd* never drops below 1 MTU



s = 4, e = 0.01, B = 35K

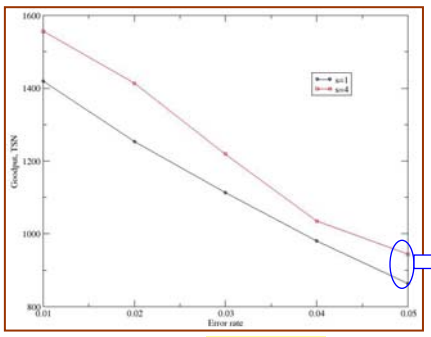
One and four streams: Goodput vs. B

- For small *B*, mutlistreaming results in less HOL blocking
  - goodput of 4-streams is higher than 1-stream.
- For large *B*, the goodput is limited by the congestion control mechanism.

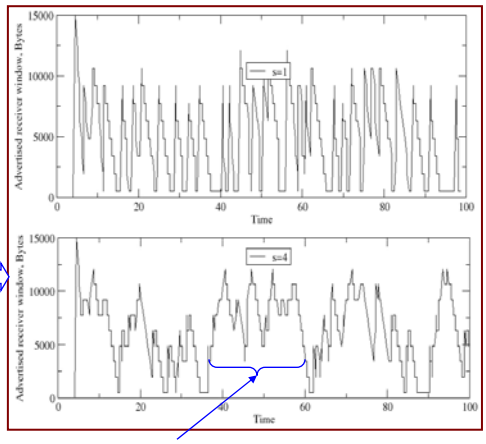


Multistreaming increases goodput for small receiver buffer sizes

Advantage of Multistreaming: High Throughput



B = 15K

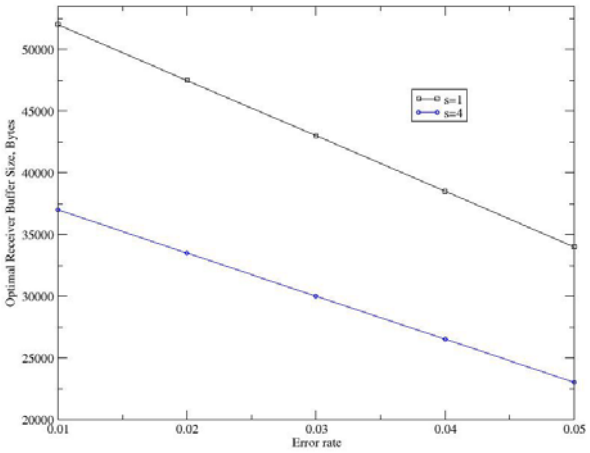


- Small Buffer size of 15K shows the advantage of multistreaming with four streams.

HOL blocking is eliminated as evidenced by the fact that *a_rwnd* is, not a limiting factor

Optimal Buffer Size

- Optimal Receiver Buffer Size: The size beyond which the *a_rwnd* never falls below 1 MTU.



Multistreaming reduces receiver buffer requirements.

Conclusions

Conclusions

- Multistreaming increases goodput for small receiver buffer sizes when compared to a single stream (for example, TCP).
- Multistreaming reduces receiver buffer requirements.

- Acknowledgements
  - NASA Glenn Research Center

- Further Information

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- These slides are available at

  www.cs.ou.edu/~atiq

Thank you