SOS: Sender Oriented Signaling for a Simplified Guaranteed Service

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Outline

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2. Background
3. Basic operations
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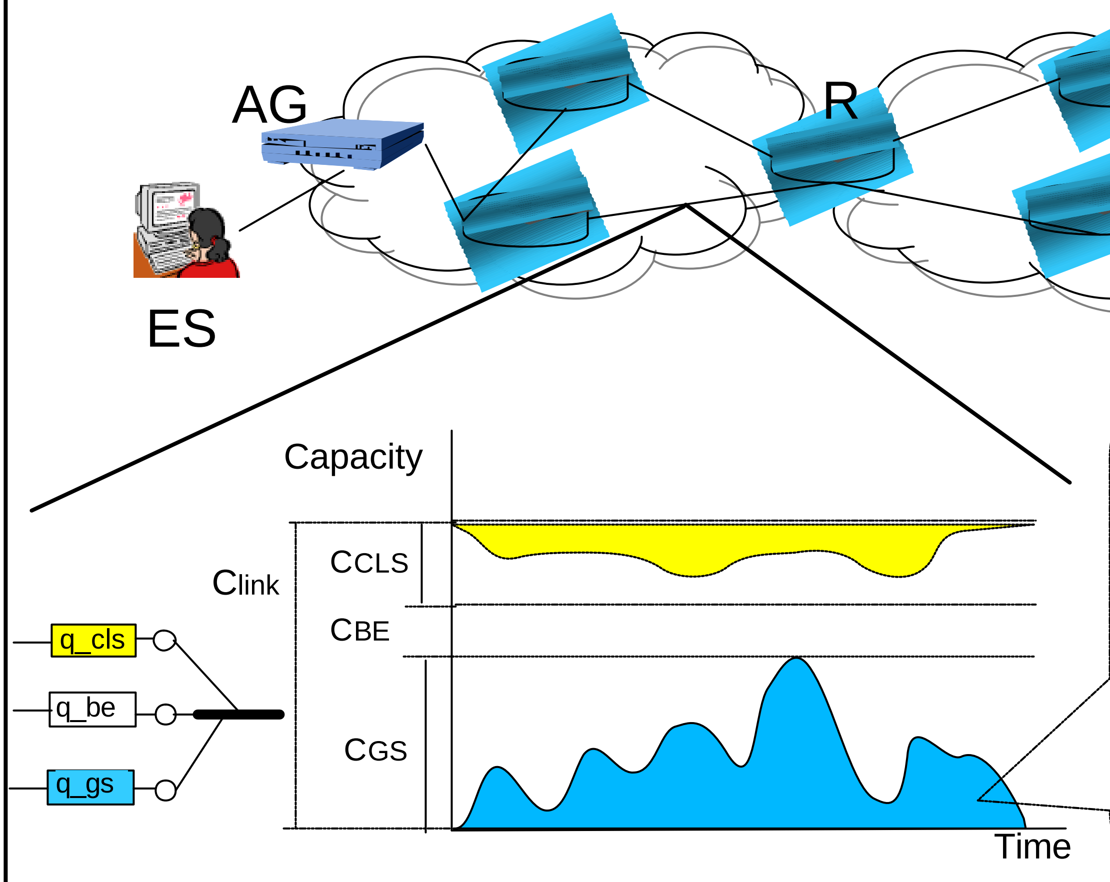
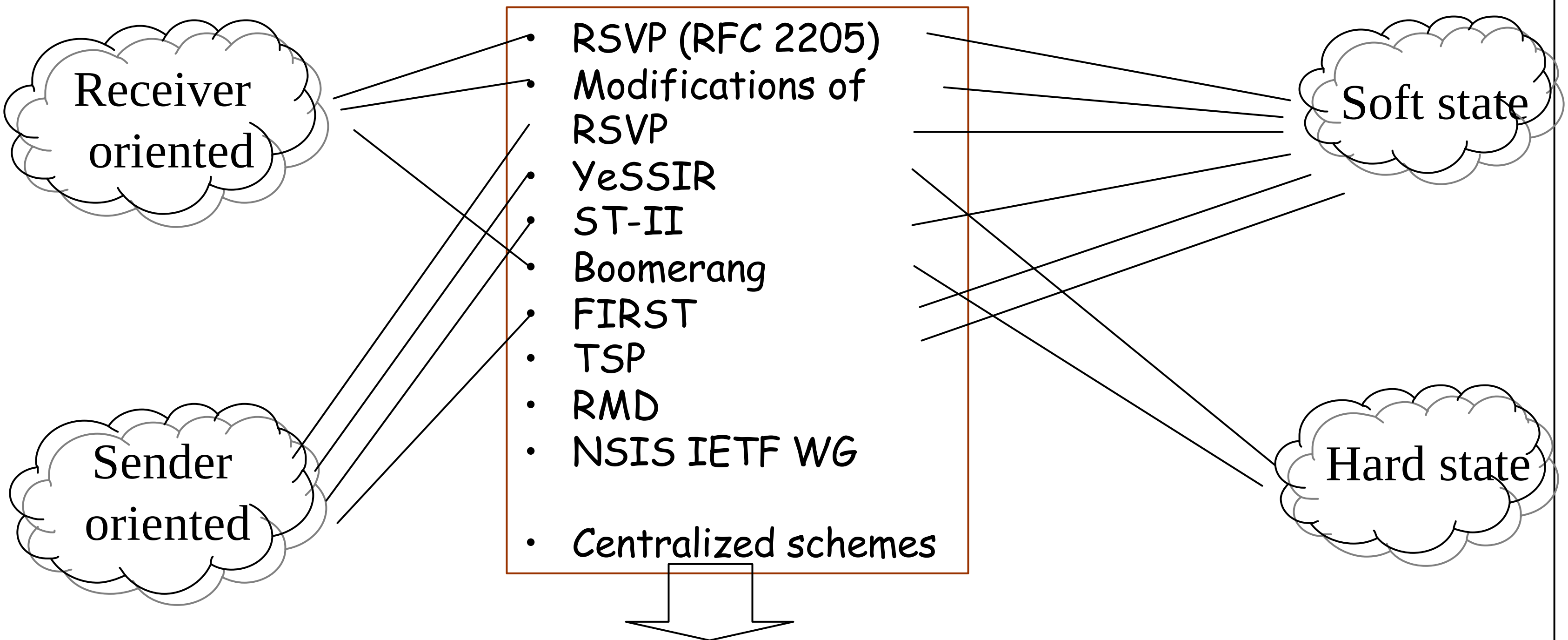
Network and service architectures



Guaranteed service (GS):

- No packet loss due to buffer overflows
- Tightly bounded delays
- Fixed amount of capacity reserved
- Single-rate reservation
  - Upper bound on source's bitrate

Background



- Standardized protocols are quite complex
- Simplified schemes are not standardized
- New generation protocol is still under development

Background summary: design goals for our protocol

- No per-connection soft-states in the routers, aggregated soft-states will be used instead
- Low number of signaling messages per connection
- Small processing time for signaling messages
- Robust and tolerant to losses of all message types

SOS: Background (cont)

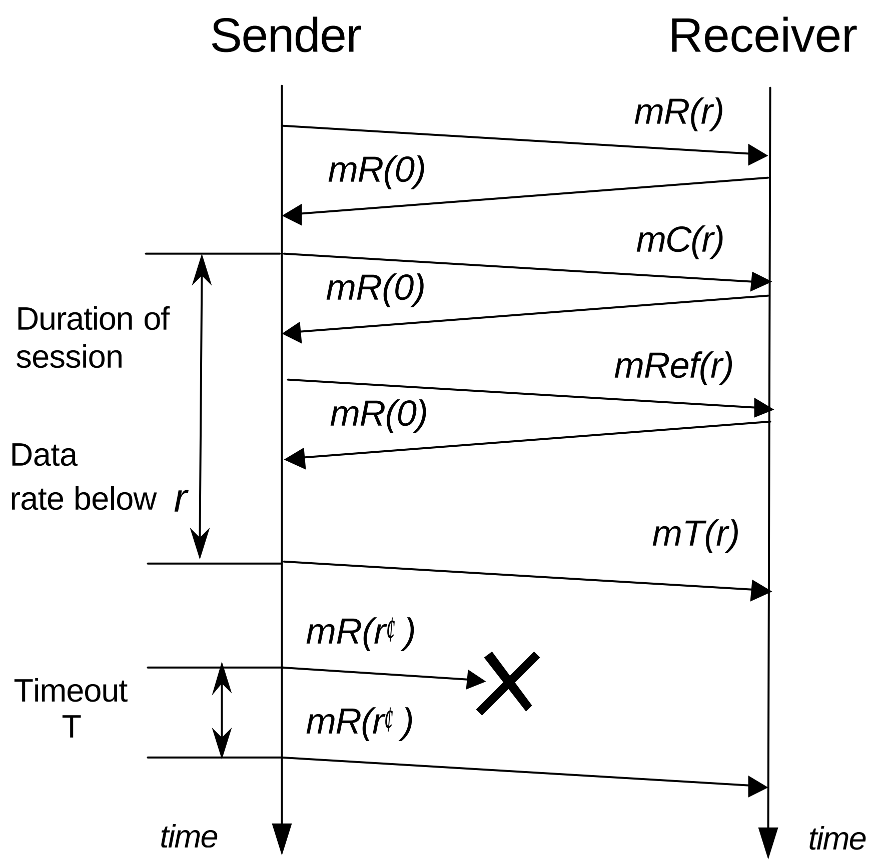
Assumptions for this presentation

- Rerouting does not occur in the network (studied in ongoing work)
- Only unicast communication
- Wireless links are not considered
- Each GS connection is described solely by a peak rate
- Reservation state is purely additive
  - The reserved rate of an outgoing link of a router equal to the s um of the incoming rates for the link (enforced by scheduling)

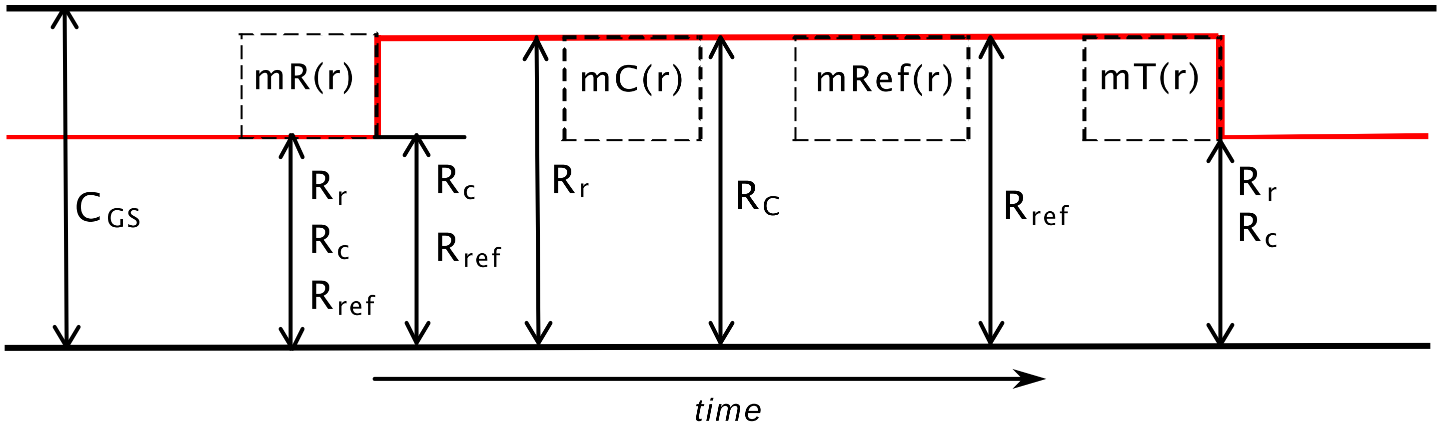
Basic operations of SOS

- Reservation message for the amount of capacity *r* , *mR(r)*
  - The requested rate *r* is a multiple of Δ, where Δ bits per second is a minimum value (quantum) of reservation
  - Messages of this kind may be discarded by the routers
- Confirmation message for the reserved capacity *r*, *mC(r)*
  - Messages of this type may be discarded by the routers
- Refresh message for the reserved capacity *r*, *mRef(r)*
  - Messages of this type may be discarded by the routers
- Tear down message to release the reserved capacity *r*, *mT(r)*
  - Messages of this type may be discarded by the routers

End to end setup and tear down of reservation



Setup, confirmation, refresh and tear down in a router



mR(r):
  if ($r > C_{GS} - R_r$) drop *mR(r)*
  else R_r += r
mC(r):
  R_c += r

mRef(r):
  R_{ref} +=r
mT(r):
  R_r -=r
  R_c -=r

Garbage collection

A garbage collection is needed to

- Re-establish reservation levels, which may be inconsistent due to losses of signaling messages

A garbage collection is needed when

- mR() are discarded due to admission control
- mC() and mT() are lost due to a link failure or bit errors

Observations on frequency of losses due to different reasons:

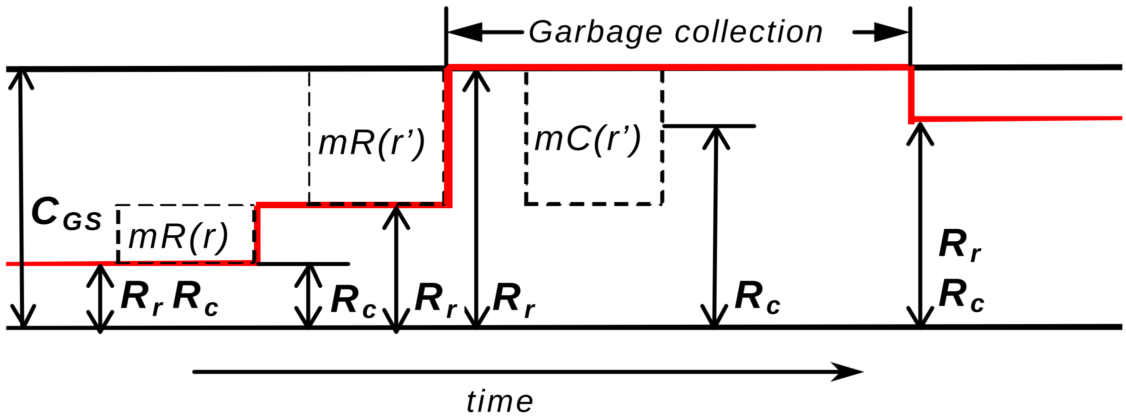
- The reasons for losses of mR() on one hand and mC() and mT() on other are unrelated
- Losses due to link or bit errors are more rare events than those due to admission control

We develop two independent garbage collection processes

- The short-term scheme to handle losses of mR()
- The long-term scheme to handle losses of other types of messages

SOS: Garbage collection (cont)

The short-term garbage collection

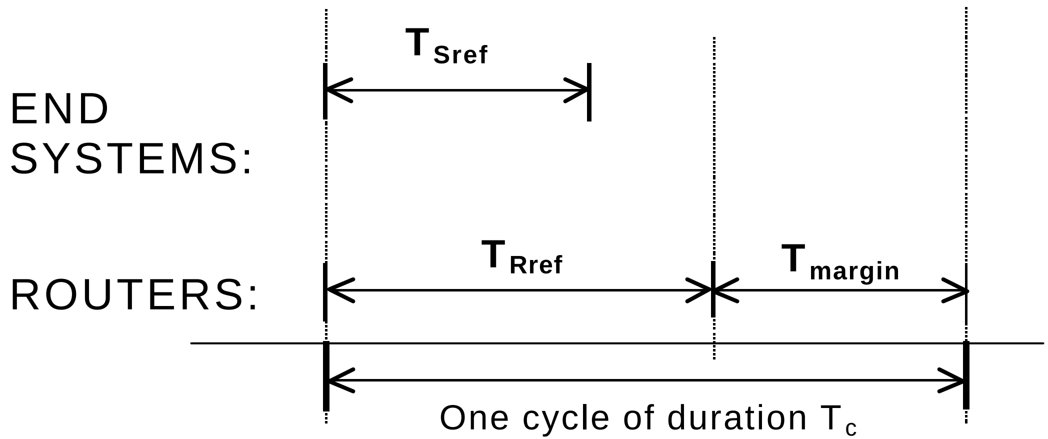


Started when $r + R_r \geq C_{GS}$, *that is*

- When next coming message reserves leftover capacity
- Or when one or more reservations are dropped

SOS: Garbage collection (cont)

Time cycles and synchronization of network devices



- T_C – All network devices operate in cycles of fixed duration
- The beginning of each cycle is synchronized using SNTP
- T_{Rref} – Refresh messages may arrive to a router
- T_{margin} – Time to process signaling messages which arrived before T_{Rref} and are still waiting in the buffer
- T_{Sref} – Time during which a sender may send the refresh messages

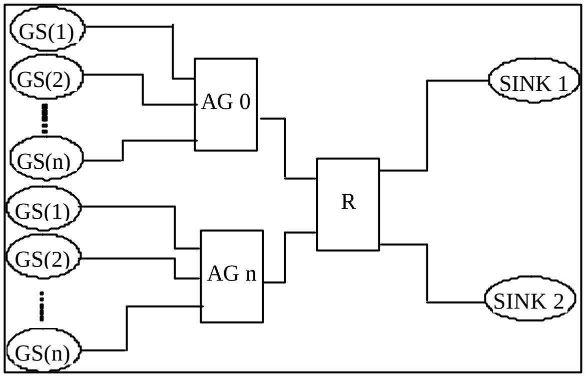
The long-term garbage collection (recovery from losses of mC() and mT())

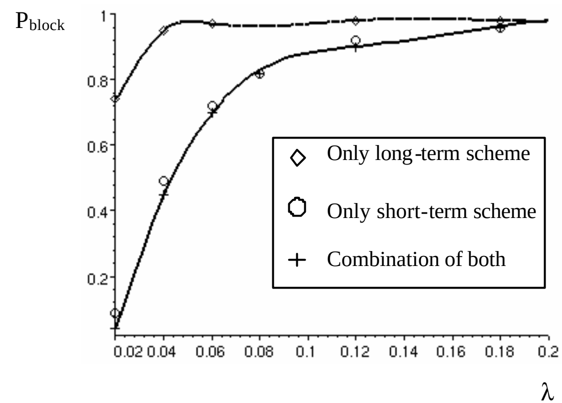
- Based on precise definition of time intervals during which the s enders can issue signaling messages
- The value of T_{Sref} ensures that mRef() will not arrive to a router after T_{Rref}
- The decision about the garbage collection is done by comparison of R_r and R_{ref}:

  if $(R_r > R_{ref})$ *then* $R_r = R_{ref}$; $R_c = R_r$

- The long-term garbage collection may recover the losses of mR() as well

Evaluation of blocking probability of the garbage collection processes





- Two-stage network
- The number of GS sources n = 5
- The capacity of all links $m \cdot \Delta$ =9Mb/s
- Δ is capacity needed for one call = 3Mb/s
- The calls from each source is a Poisson stream with intensity λ
- The duration of each call is μ^{-1}=5s
- T = 0.1s is the timeout
- T_C=2s
- The goal is to capture general behaviors of two garbage collection schemes and their influence on each other

✓Implemented alone, the long-term scheme introduces higher $\mathbf{P_{block}}$ than the short-term scheme

✓The resulting $\mathbf{P_{block}}$ of their combination is the smallest value of individual probabilities

Message processing rate and buffer dimensioning

- Implemented in NS-2
- Actual time the processor spends on processing every signaling meessage measured (*a piece of a code within one ns function was timed*):
  - One reservation meessage 2.0 microseconds
  - One teardown message 1.8 microseconds
  - One confirmation message 1.2 microseconds
  - One refresh message 1.3 microseconds

➢ The average rate of message processing 700000 messages per second

➢ If link capacity is 100 Mb/s, the reservation quantum Δ is 10 kb/s, then a buffer for 30000 messages is needed

Summary

- Sender oriented
- Four types of signaling messages *mR()*, *mC(), mRef()* and *mT()*
- No per-flow state in core routers
- Aggregated soft-state is used:
  - Three state variables R_r , R_{ref} and R_c for each outgoing link
- Simple operations allow fast message processing
  - Implementation of the protocol allows processing of 700 thousand signaling messages per second on P-III 500 MHz processor

Ongoing and future work

- We are conducting more experiments for evaluation of the blocking probability
- Encoding of signaling messages in the IP header
  - To encode 4 types of messages 2 bits are needed
  - To encode the rate value 16 bits are sufficient
- Handling of re-routing
- Multicast support
- Implementation in a Linux-based platform

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