SR-TSN

draft-stein-srtsn-00

DetNet

IETF-110

Yaakov (J) Stein

RAD

What is the problem I am solving?

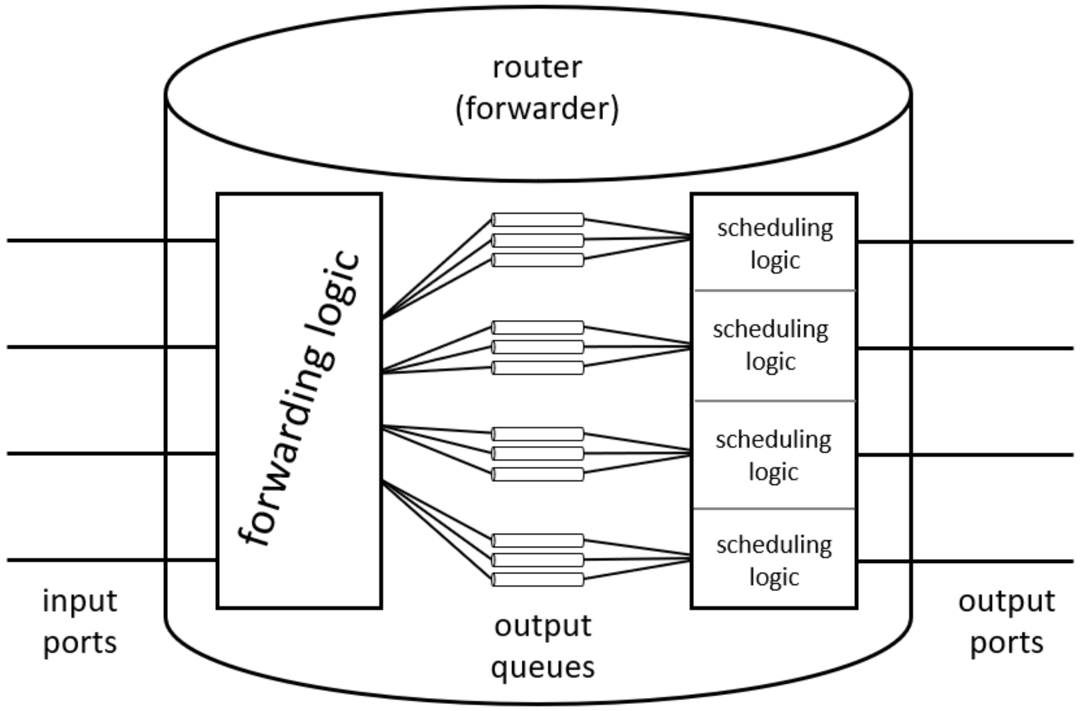
SRTSN is a new mechanism for **T**ime **S**ensitive packet flows

There two good reasons *not* to use time scheduled gating (Qbv) :

1. Qbv assigns packet flows to TDM-like timeslots
   negating much of the statmux advantage of PSNs
2. Qbv requires complex optimization and distribution
   which is a challenging exercise **at scale**
   (when not accomplished optimally
   efficiency is abysmal and/or
   delay requirements are not met)

Note that low latency is critical for URLLC xHauling
yet, the TSN folks are not mandating their own mechanism
for this kind of TS flow (802.1CM only includes
preemption)
leaving only the alternative of physical traffic

What forwarder architecture is assumed?



Note: I wrote output **queues** but conventional FIFO queues are not optimal data structures for SRTSN

Routers (forwarders) perform 2 distinct per-packet **and** per-router* functions:

- forwarding
  - to which output port
  - *where* to send

with Segment Routing

- scheduling
  - which packet to transmit
  - *when* to send

with TSN/DetNet

* They may also perform per-flow **or** per-router functions, which are already handled well enough

What am I proposing?

There is an alternative to time scheduled gating
that does not suffer from these drawbacks

- it can be optimized even for relatively large networks
- its configuration can be easily and rapidly distributed
- time sensitive flows can be dynamically added or removed
- it lowers average latency as compared to standard queueing
- ratio of missed deadlines can be tuned

The approach requires adding a new extension header
containing a *stack* (or equivalent) data structure

One implementation of the proposal
is merged with source routing or Segment Routing
implementing a more complete form of *network programming*

What else can be done?

There are several known ways
to reduce end-to-end propagation delay, for example :

- **L**ongest **I**n **S**ystem
  - insert the packet's birth time into the header
  - prioritize packets with earlier birth times

    this is suboptimal since a LIS packet
    with a loose delay budget
    will be sent before a younger packet with a tight budget
- **E**arliest **D**eadline **F**irst
  - insert packet’s deadline into the header
  - prioritize packets with earlier deadlines

    this is suboptimal since an EDF packet
    already be close to its destination
    will be sent before a later packet far from

So, what's the stack-based approach?

The stack-based approach inserts into the packet *local* deadlines
for each router along the path
and each router prioritizes according to its own local deadline

The router *may* perform EDF on local deadlines
or maybe **J**ust **I**n **T**ime, or any other method
to ensure that the packet exits before its local deadline

In fact, one particularly convoluted method reproduces Qbv
but without having to configure all the routers

Notes:

- the router needs something more complex than a FIFO queue
  but less complex than time scheduled gates
- there are several ways to compute the local deadlines
  (more on that later)

What is SRTSN?

If we are already using a stack
why not reuse Segment Routing's stack too?

With SRTSN each TS packet carries a stack with both
- forwarding (segment routing) instructions and
- scheduling (local deadline) instructions

in each stack entry

Like in SR, the stack is inserted by the ingress router
which has its clock sync'ed to all the other routers
so that the deadlines are directly comparable

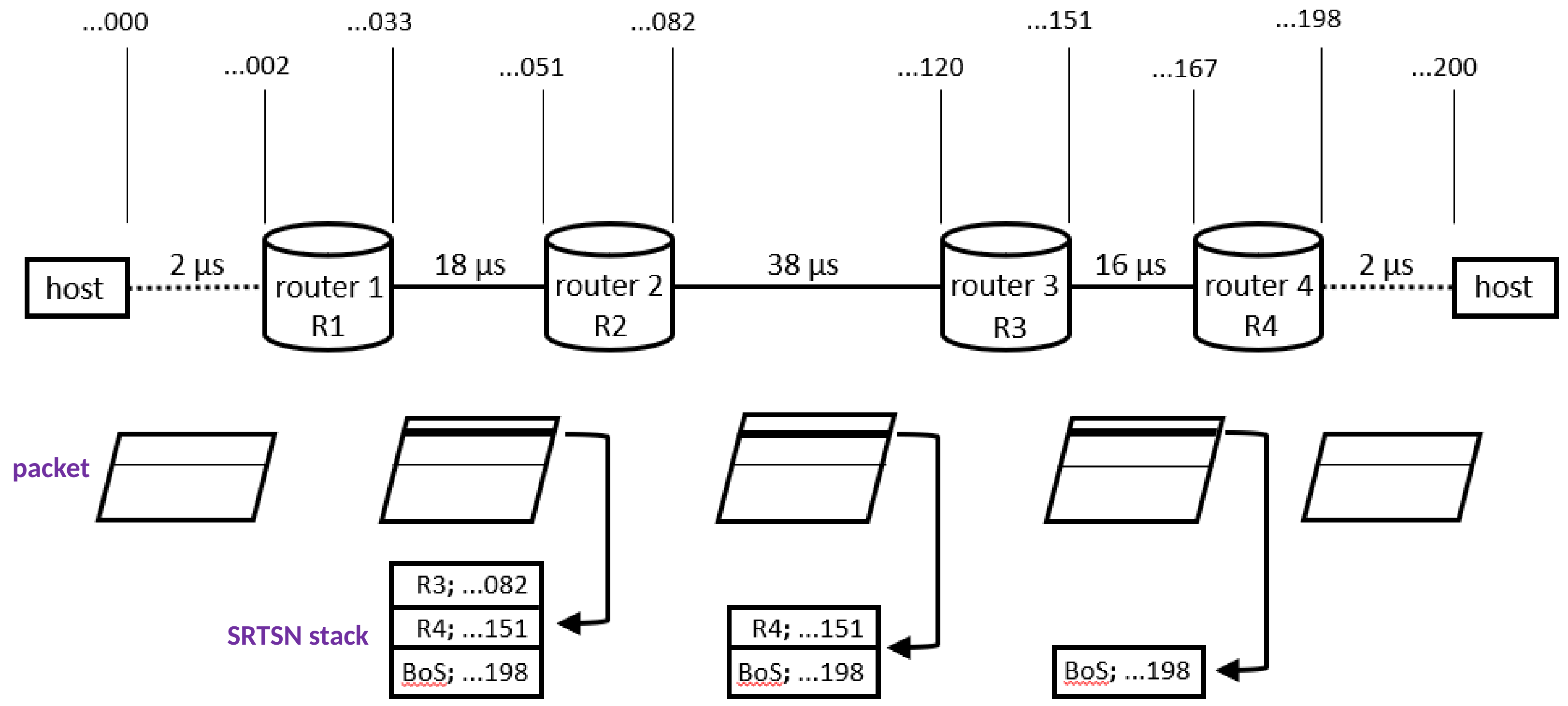
There may additionally be non-TS packets with lower priority
and there may be several priority levels of TS packets

Simple Example *

Total delay budget = 200 μsec

Minimal delay = link latencies + minimal residence times = 100 μsec

Fairly divide spare 100 μsec queueing time between forwarders



* This is just one way to set local deadlines

Won’t that take a lot of room?

If each SRTSN stack consists of

- a 128-bit IPv6 address
- a 64-bit timestamp

then each stack entry would consume 24 bytes!

But we needn’t be so wasteful !

Our deadline wraparound requirements are minimal

(they are unambiguous if wraparound is twice the maximum time path time)

and in a single network we need only specify router suffixes

(or even router indexes)

In fact, each entry need only be

$$\mathrm{ceil}(\log_2(N_{\mathrm{routers}})) + \mathrm{ceil}(\log_2(2\ \text{max-path-time} / \text{resolution})) + 1\ \text{bits}$$

For small networks this is about 16 and for medium ones 32 bits

So, 4-8 hops only require about as much as a single IPv6 address!

What am I asking this WG?

Being a solution for Time Sensitive flows

this work seems to naturally fit the DetNet charter

- addresses bounds on latency
- focuses on the data plane aspects
- applicable to both L2 and L3 networks
  (no physical layer mechanism needed)
- mostly for networks under single administrative control

Is there interest here ?

I request the DetNet and Spring chairs to coordinate

as to where this work should progress

Thanks for listening !

comments appreciated

Yaakov_S@rad.com