Flow Aggregation in TSN

Tongtong Wang , Huawei
Norman Finn , Huawei
IEEE 802.1 TSN, November 2017, Orlando

HUAWEI TECHNOLOGIES CO., LTD.

Motivation

- After discussion of “stream aggregation for bridges” in Filling Detnet Needs in last meeting, this presentation provides more thoughts about TSN flow aggregation.

Motivation - Aggregation Scenario in Core Nodes

- Currently, core nodes need to keep all flow status in TSN network, and this will cause
  - Huge amount of flow table entries
  - More and more flow status refresh messages
- Flow aggregation can help simplify this problem, e.g. setup tunnels or dedicate paths etc., thus reduce queue number and scheduling cost.

- However, several issues come with aggregation
  - Multiple flows interfere each other in aggregation scenario.
  - Same latency for larger flows and smaller flows.

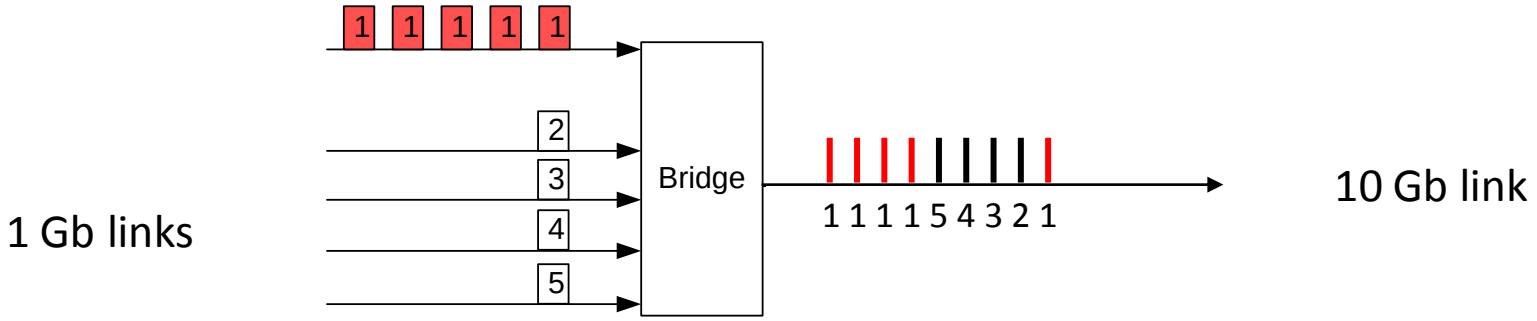
Motivation - Aggregation Scenario in Core Nodes

- Currently, core nodes need to keep all flow status in TSN network, and this will cause
  - Huge amount of flow table entries
  - More and more flow status refresh messages
- Flow aggregation can help simplify this problem, e.g. setup tunnels or dedicate paths etc., thus reduce queue number and scheduling cost.

- However, several issues come with aggregation
  - Multiple flows interfere each other in aggregation scenario.
  - Same latency for larger flows and smaller flows.

Aggregation Mode - 1

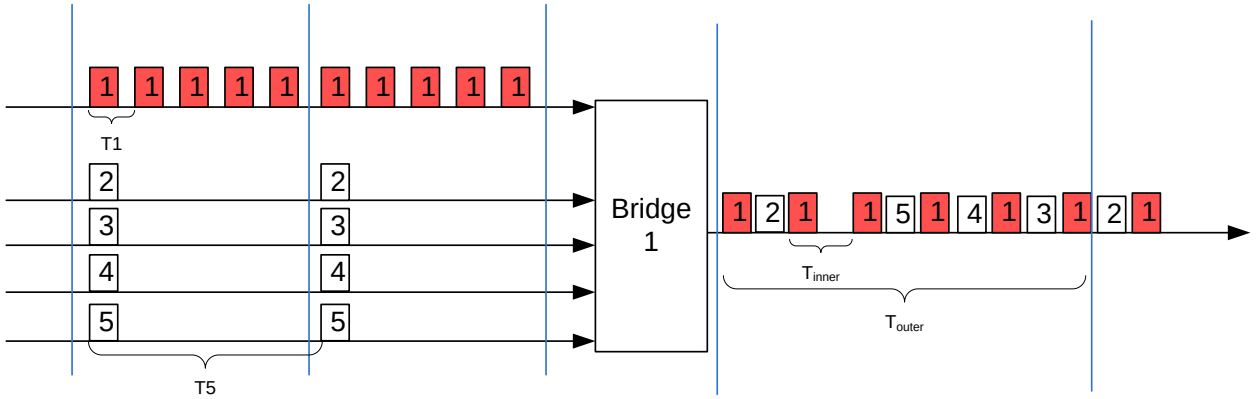
- Coarse-grained aggregation
  - Simply map a group of flows into one reservation (a set of queue and shaper)



  - Next bridge in path can forward multiple flows using single aggregation ID.
  - Need more jitter tolerance due to random arrangement in aggregation.

Aggregation Mode – 2

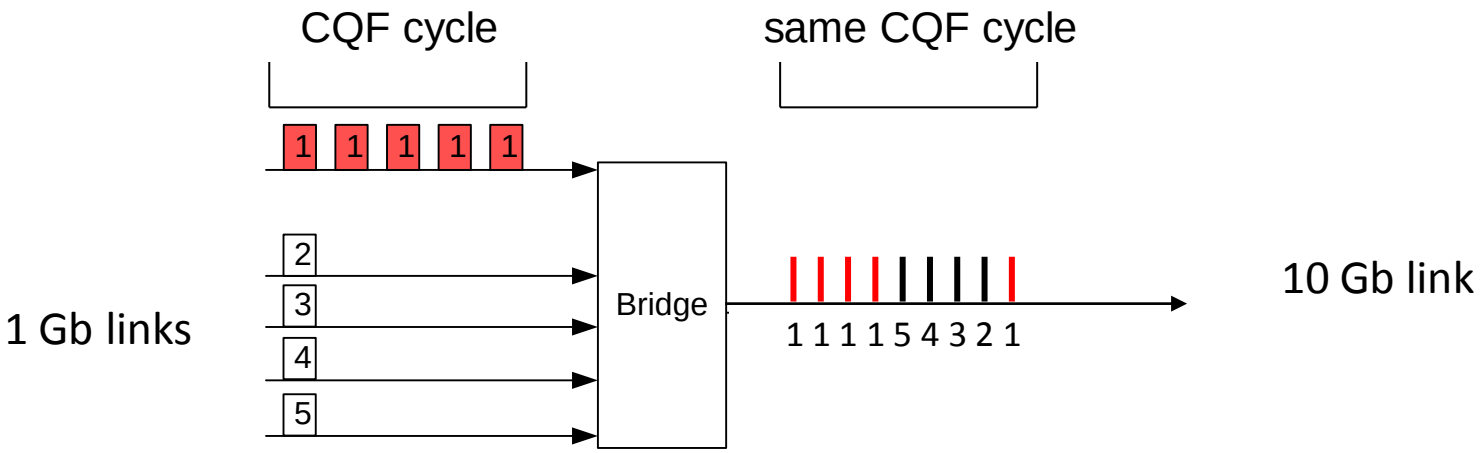
- Fine-grained aggregation / Hierarchy scheduling
  - Hierarchy mapping a group of flows onto the port, by precisely arrange its time window and sequence.



  - Small flows may have larger repeating interval(T_{outer}), while big flow uses smaller interval(T_{inner}). This is a very simple aggregation example, flows with other arbitrary measurableIntervals may result in irregular aggregation pattern.
  - Latency for different flows depends on its own scheduling interval, that means larger flows can have smaller delay than smaller flows. This is the essential advantage over CQF.
  - This kind of aggregation is hard in time slice computation, but easier for data path. I.e. either TAS or ATS can support this feature.

Cycle Size Problem

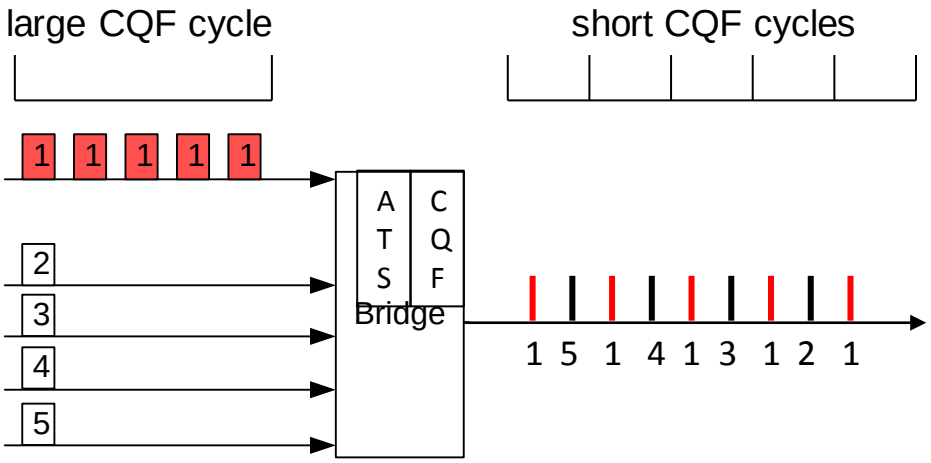
- Coarse aggregation : lower speed links to higher speed links
  - If links have the same CQF cycle time, the data is packed OK, but the cycle requires more buffers on the high speed link, and has larger latency than necessary.



  - Bridging device needs to store all packets for one cycle , quite large for output port if it is x10/x100 times higher speed than input port.

Cycle Size Problem

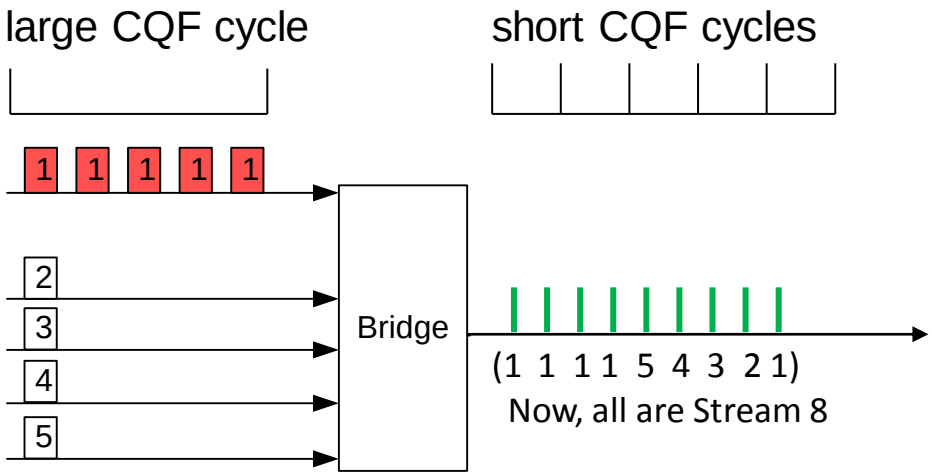
- Fine aggregation: lower speed links to higher speed links
  - Hierarchy mapping a group of Streams onto the port, using (say) Asynchronous Traffic Shaping on top of shorter CQF cycles.



  - Buffer size in bridged is saved for shorter output cycle time;
  - ATS (only one example) makes Streams very even.
  - Note that Streams 2-5 share the same bandwidth in different (small) cycles.
  - This may be difficult and complex, but can be made to work.

Coarse aggregation with shorter cycle?

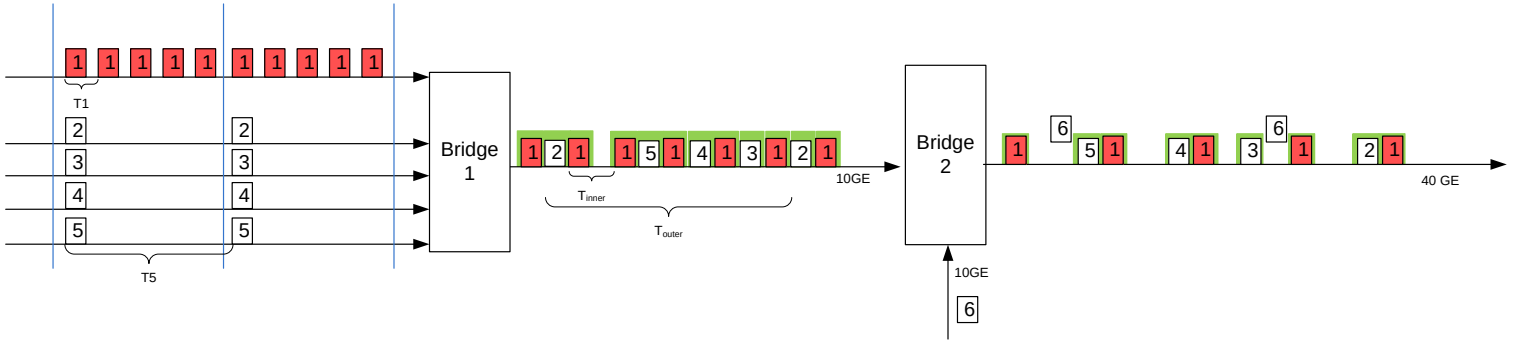
- Coarse aggregation
  - Encapsulate a group of Streams into one Stream with one reservation.



  - The packing that was a problem is OK, now, because all are the same Stream (Stream 8).
  - Simple coarse aggregation solves the buffer size consumption problem, with some increasing gaps and bursts in merging flows.

Compatibility with Regular Bridge

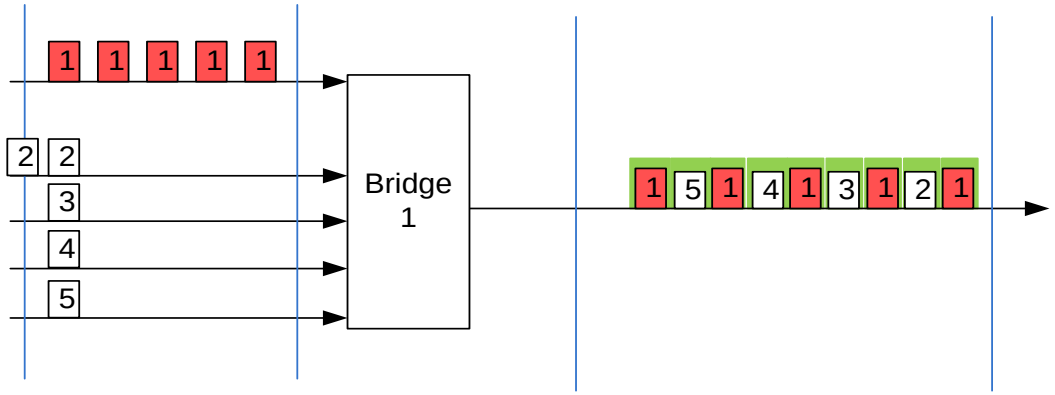
- Core node (bridge 2 in this example) process all TSN flows just as a regular bridge defined in current TSN standard.
  - No knowledge of flow 1~5 is required.
  - Green flow and flow 6 are scheduled to same egress port.



- Detailed aggregation information is only required on bridges that modify/separate aggregation configuration, e.g. add or remove flows to the aggregated channel.

Deal with Packet Gaps and Bursts

- Coarse-gained aggregation does not care about gaps and bursts in flows.
- Fine-grained aggregation like to maintain characteristic for each individual flow in aggregating.
  - Need buffering to remove jitter



Aggregation Configuration

- Either centralized or distributed computation and configuration is possible, as long as it is all consistent .

- Packet encapsulation for aggregating
  - Add label on each packet in aggregation flow.
  - or use global sync-ed time line to setup aggregation. E.g. in TAS approach, aggregated flow are put into a certain time window.

Summary

- Aggregation :
  - Aggregation is definitely usefully in large scale TSN network with huge amount TSN flows.
  - May need to define control plane protocols to setup/remove aggregation? Aggregation is network level mechanism, not a decision for individual bridge.

- But coarse or fine aggregation is a choice to make
  - Timing performance will degrade within coarse grained aggregation channel, using fine-grained aggregation can help avoid interference at expense of hierarchy computation.
  - Maybe suitable for different scenarios?

Thank you