Urgency Based Scheduler

comparison to other traffic classes
+ discussion on next steps

Johannes Specht	johannes.specht AT uni-due.de	**Univ. of Duisburg-Essen**
Soheil Samii	soheil.samii AT gm.com	**General Motors**

Context of this presentation

- **We presented a scalable UBS implementation at the 802.1 Interim meeting in May 2015**
  - Historically, for UBS, the main concern has been complexity in terms of number of required queues per port
  - This concern was addressed in May 2015, i.e. *the technical feasibility was demonstrated*

  (cmp. http://www.ieee802.org/1/files/public/docs2015/new-tsn-specht-ubs-queues-0521-v0.pdf*)*
- **This presentation summarizes the key properties of UBS, compares to the other traffic classes in TSN and discusses next steps**

Key Properties of UBS

Independent from clock synchronization

- Communication does not crash if clock sync fails

  Even if we would have 802.1AS Grand Master redundancy with fast fail-over, we would not want to rely on the availability of clock sync for camera, radar, and other sensor communication, especially for automated driving systems

  Cmp. Aerospace industry:
  http://www.ieee802.org/1/files/public/docs2015/TSN-Schneele-AFDX-0515-v01.pdf

- Worst case clock sync inaccuracy does not decrease link utilization, contrary to time-triggered approaches such as TAS (Qbv) and CQF (Qch)

Key Properties of UBS

Asynchronous Packet Shaping

- Oversampling is avoided, giving the highest possible link utilization for mixed traffic types:
  - Periodic flows with arbitrary periods
  - Event driven flows
  - Rate-constrained flows

- End stations applications define packet transmission times instead of the network (e.g. TAS)
  - An the practical side, harmonization of all ECU software stacks, applications, and domains is impractical

Key Properties of UBS

Low End-to-End Latency Guarantees

- TAS (Qbv) can give lower latency guarantees, **BUT** requires a lot more planning
- Latency guarantees are usually lower (faster) than those of CQF (Qch)
- Lower latency, even at high link utilizations, compared to CBS

(cmp. http://www.ieee802.org/1/files/public/docs2013/new-tsn-specht-ubs-avb1case-1213-v01.pdf)

Key Properties of UBS

Protection against babbling idiots

- Packets from different nodes are isolated in separated queues, cannot congest traffic from each other

- 100% accurate, does not require additional ingress policing for this purpose

  Note: Qci may be used to additionally protect against per-stream "babbling idiot" errors at the edges

Key Properties of UBS

Straightforward Configuration

- Setup of per flow bandwidth and maximum packet size along the path of each flow

- **[Optional]** Further reduction of end-to-end latencies by configuration of per port sub-priorities. However, this requires more queues and does not strictly need to be supported by a UBS capable bridge

Key Properties of UBS

Network Domain Isolation

- Latency analysis can be done per Hop
  (cmp. http://www.ieee802.org/1/files/public/docs2015/new-tsn-specht-ubs-queues-0521-v0.pdf)
- No agreement on cycle durations like in TAS and CQF
- No agreement on time slots (offsets in cycles) like in TAS

Key Properties of UBS

Scalability in terms of hardware

- Requires *numberOfPorts*-1 queues for each egress port

  E.g., keeping one queue for best-effort traffic, we can use the existing 7 queues for up to 8-port bridges.

- Requires more queues to implement sub-priorities (but this is **optional**)
- No (or very little) additional complexity for bridges with low port count (represents the absolute majority of automotive networks)
- Requires per flow state in the worst case, seems acceptable:
  - So does 802.1CB
  - So does 802.1Qci
  - So *may* 802.1Qbv for efficient schedules

Not needed for UBS streams (more technical: XOR)

(see e.g. http://www.ieee802.org/1/files/public/docs2012/bv-boiger-transmission-windows-0512-v02.pdf)

Key takeaway

- We need a traffic class that is not dependent on clock sync
- We need a traffic class that gives low/predictable latencies, even at high link utilizations, while avoiding the high configuration effort of TAS
- UBS provides a solution with acceptable complexity
- For bridges with low port count (which will be very common in automotive systems), there is no significant higher complexity since we can re-use the existing queues – but we need to specify configurations, so that the system engineer can decide the role of each available queue (TAS, CQF, UBS, best-effort, …)

Discussion points

In General:

We need to discuss the role of shapers/schedulers (TAS, CQF, UBS, CBS, …) and make sure we cover the intended use cases of TSN

Discussion of Next Steps:

1. Incorporate UBS in one of the existing PARs – which PAR?
    1. Qci is for policing (ingress), UBS is at egress
    2. Qch is for cyclic transport, UBS is not tied to clock sync
2. New PAR? Amendment to Q or revision of Qav?
3. Timeline?
4. Compatibility?