GENERAL MOTORS

REQUIREMENTS AND USE CASES FOR BASE AND EXTENDED TSN CAPABILITIES

SOHEIL SAMII

802.1DG INTERIM
SEPTEMBER 23, 2019

BASE TSN CATEGORY

- Commonly used 802.1 TSN (AVB) standards:
  - Time synchronization (802.1AS-2011), no BMCA
  - Credit-based shaping (802.1Q-2014 and later)
  - (Per-stream) Ingress filtering and policing (802.1Q-2018)

- We have multiple use cases with high existing or planned production volume for the above:
  - Infotainment: time synchronization and credit-based shaping are used for synchronized audio playback
  - Active Safety / ADAS (e.g., Cadillac's Super Cruise):
    - time synchronization is required by sensor fusion
    - ingress policing prevents network congestion due to failures causing traffic flooding)
    - credit-based shaping allows high priority for sensor data while guaranteeing a minimum amount of bandwidth to less critical data (e.g., HD maps).
  - Cybersecurity: per-stream ingress policing is one layer of defense to prevent Denial-of-Service attacks

- Conclusion: Define a Base TSN capability in 802.1DG:
  - All Ethernet switches shall support the above three standards
  - Rationale: The above use cases represent large enough volume to keep other TSN standards out of the Base capability

WHAT OTHER TSN STANDARDS MAY BE NEEDED?

In addition to the base capability, define another category “extended capability” to support more advanced automotive Ethernet use cases:

Thoughts around Extended TSN capability:

- *802.1AS-REV – use 2 identical time domains to implement fault-tolerant time synchronization*
  - Sensor fusion relies on availability of time synchronization. Sensor fusion is required to remain operational even in case of failures (e.g., connector or wire issues). Examples can be found in Level 3 and Level 4 driving automation systems.

- Frame replication and elimination (redundancy) (with proxy mode of operation – optional in 802.1CB-2017)
  - Similar rationale as above for 802.1AS-REV. Proxy mode allows us to provide fault tolerance in a transparent manner to the application layer (no involvement of end station)

- Scheduled (time-triggered) traffic
- Cyclic queuing and forwarding
- Frame preemption
- Asynchronous traffic shaping (ATS)

These are different approaches to achieve low, deterministic latencies (the first 2 requiring change of communication paradigm). Not required to realize L3/L4/L5 AVs with today’s mixed CAN/LIN/Ethernet-based E/E architectures.

When automotive E/E architectures evolve towards pervasive deployment of Ethernet, then some of these may be needed to meet temporal requirements. We believe that such requirements are addressed by ATS and the ongoing developments within 802.3 for higher bandwidth.

SUMMARY – SPECIFY 2 DIFFERENT CATEGORIES IN 802.1DG

Base TSN Capability

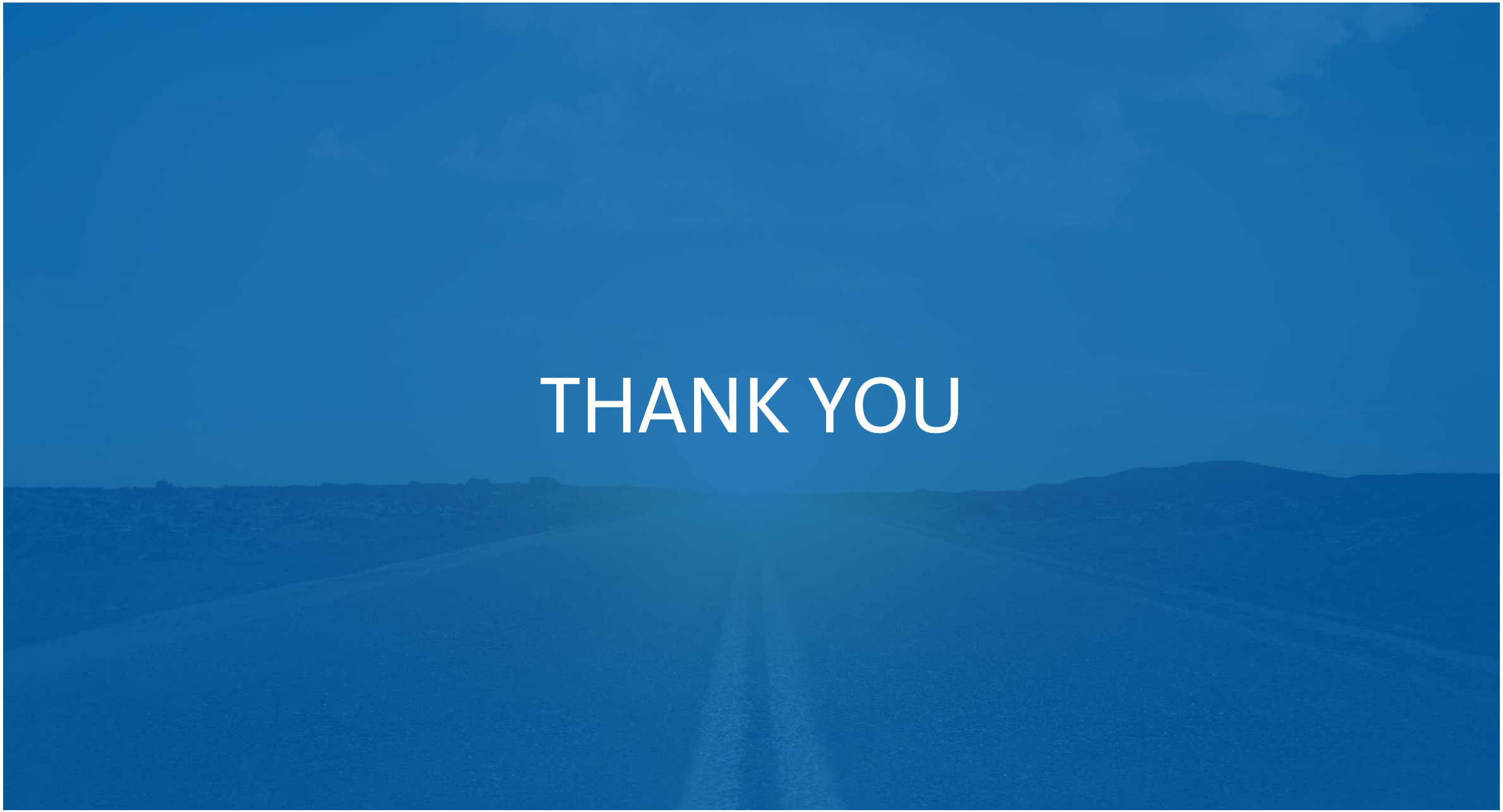
- Time synchronization (802.1AS-2011, no BMCA)
- Credit-based shaping
- Per-stream ingress filtering and policing

Already implemented by multiple vendors
Meets requirements of a large number of use cases

Extended TSN Capability

- Base TSN Capability, plus
- Fault-tolerant time synchronization (2 identical time domains with 802.1AS-REV, plus application layer to handle failures)
- Frame replication and elimination, with support of proxy mode of operation (802.1CB-2017)
- ATS to replace credit-based shaper (when available)

Higher levels of driving automation
Ethernet-centric next-generation E/E architectures


THANK YOU