Realizing Automated Driving Systems using Ethernet TSN and Adaptive AUTOSAR

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GENERAL MOTORS

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Agenda

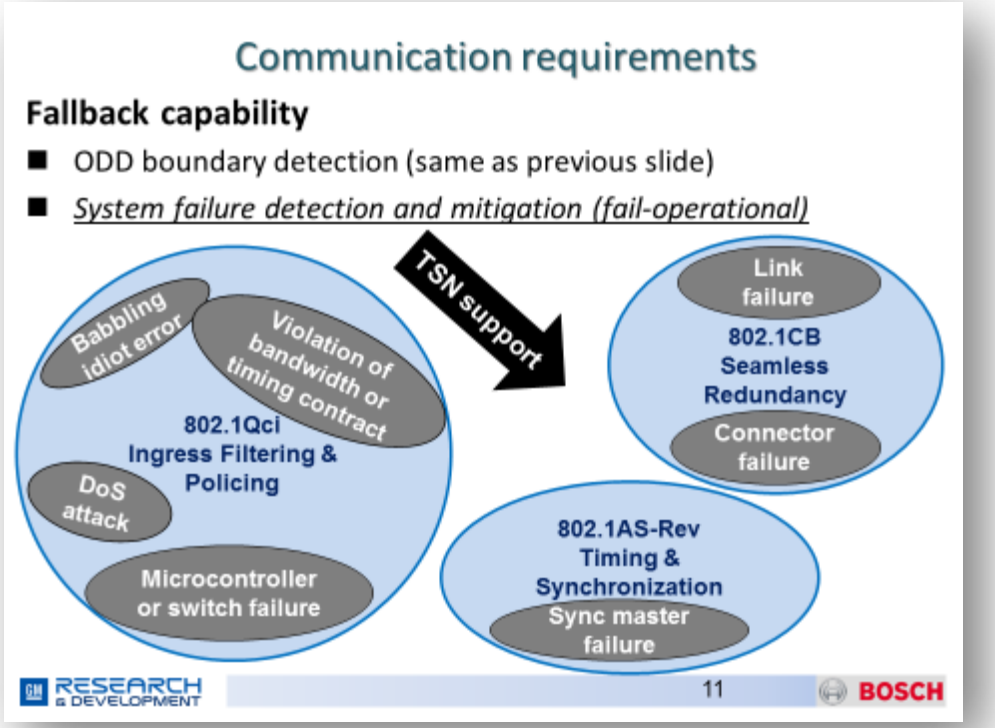
- Automated driving communication needs
- Ethernet TSN standard
- Introduction to Adaptive AUTOSAR
- Proposal on realizing them together
- Bench results so far
- Concluding remarks

ADAS & Automated driving Communication needs

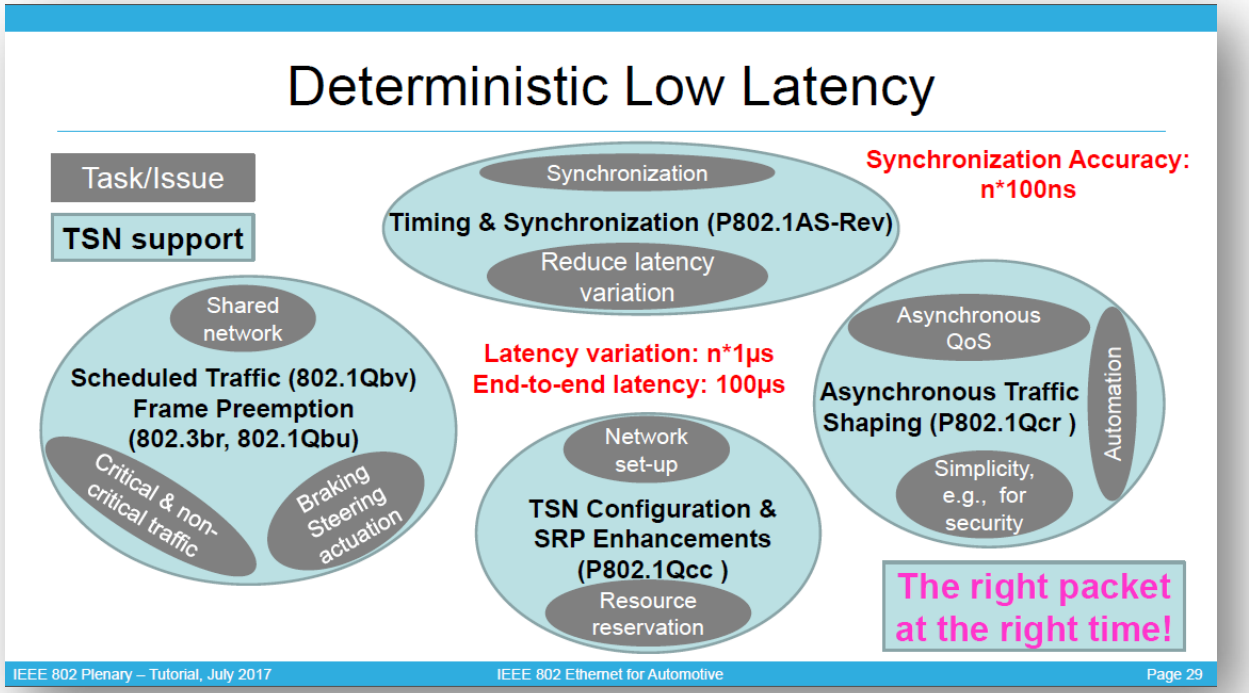
- Guaranteed, low end to end latency
- Fault tolerance to communication link/node failures
- Time awareness and Synchronization to global clock
- Prevent network nodes to flood the media
- Secured data exchange

Standardized implementations are preferred!

TSN is a key enabler for automated driving



http://standards.ieee.org/events/automotive/2015/05_Ethernet_TSN_as_enabling_technology_for_ADAS.pdf



http://www.ieee802.org/802_tutorials/2017-07/tutorial-Automotive-Ethernet-0717-v02.pdf

Realizing Ethernet TSN in a network

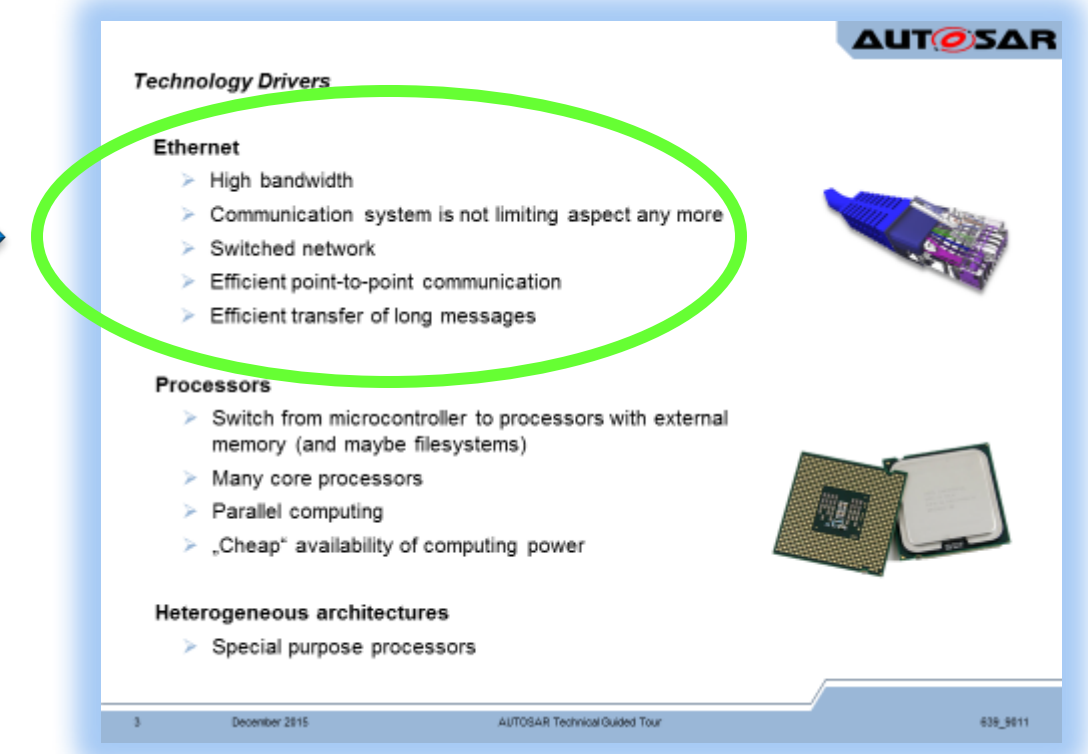
IEEE standard	What does it do	Who will implement
P802.1AS-Rev – Network Time synchronization	Synchronized Time base for all nodes	Switch and End stations (its firmware/host CPU)
802.1Qci – Ingress policing	Eliminate the babbling streams	Switch or MAC for end stations
802.1CB – Seamless Redundancy	Filtering redundant traffic	Switch, (proxy mode)
P802.1Qcr – Asynchronous Traffic Shaping	Asynchronous traffic scheduling	Switch + Host controller
802.1Qbu/802.3br – Frame Preemption	Better bus utilization	Switch + Host controller
802.1Qch – Cyclic queuing and forwarding	Reduce latency by Synchronized data transmission	Switch + Host controller

Switch manufacturers are onboard, how about standardized software?

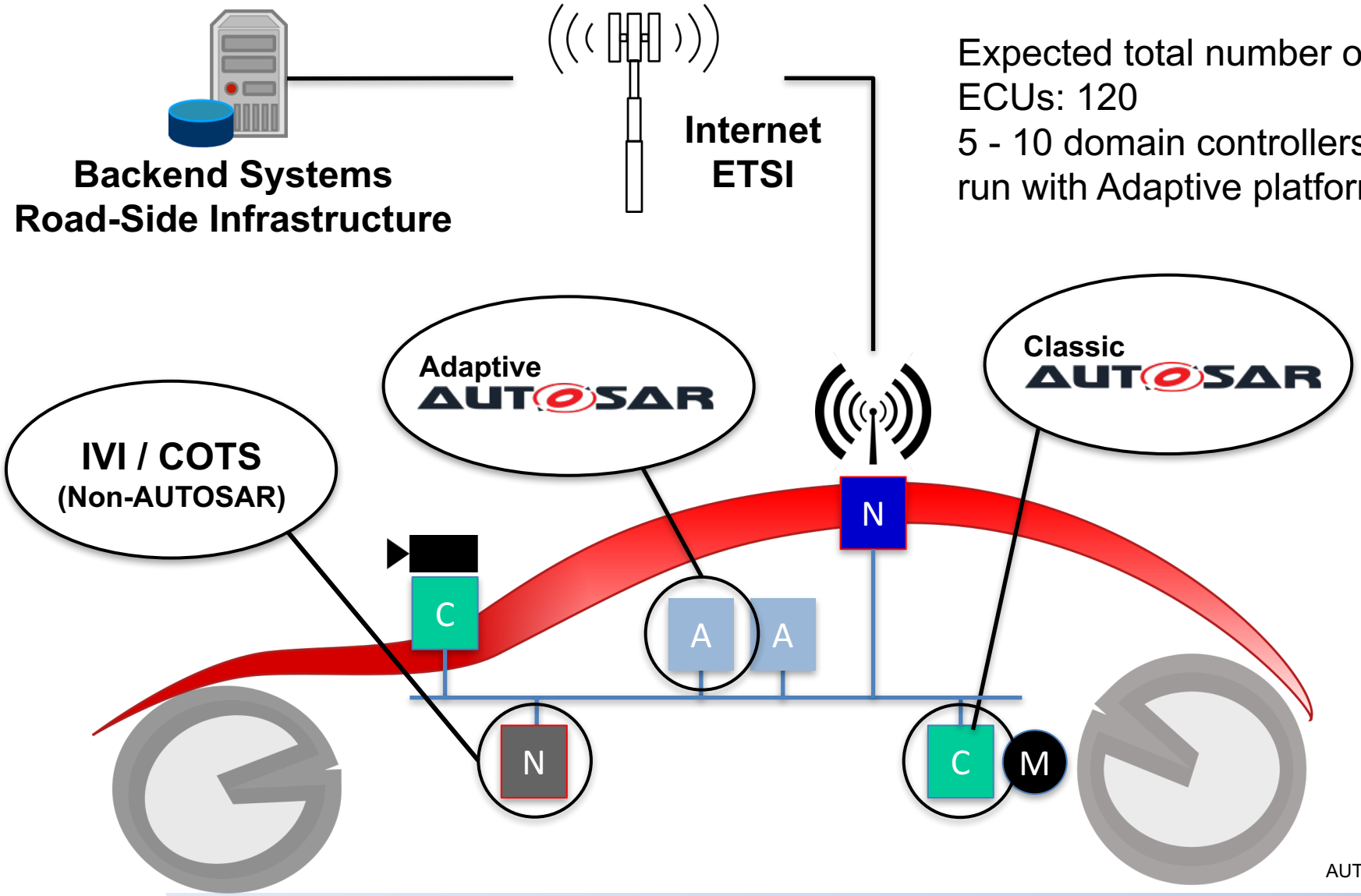
Technological Alignment

AUTOSAR Classic already supports Ethernet!!

ETHERNET is one of the KEY Technology drivers for Adaptive AUTOSAR!!!



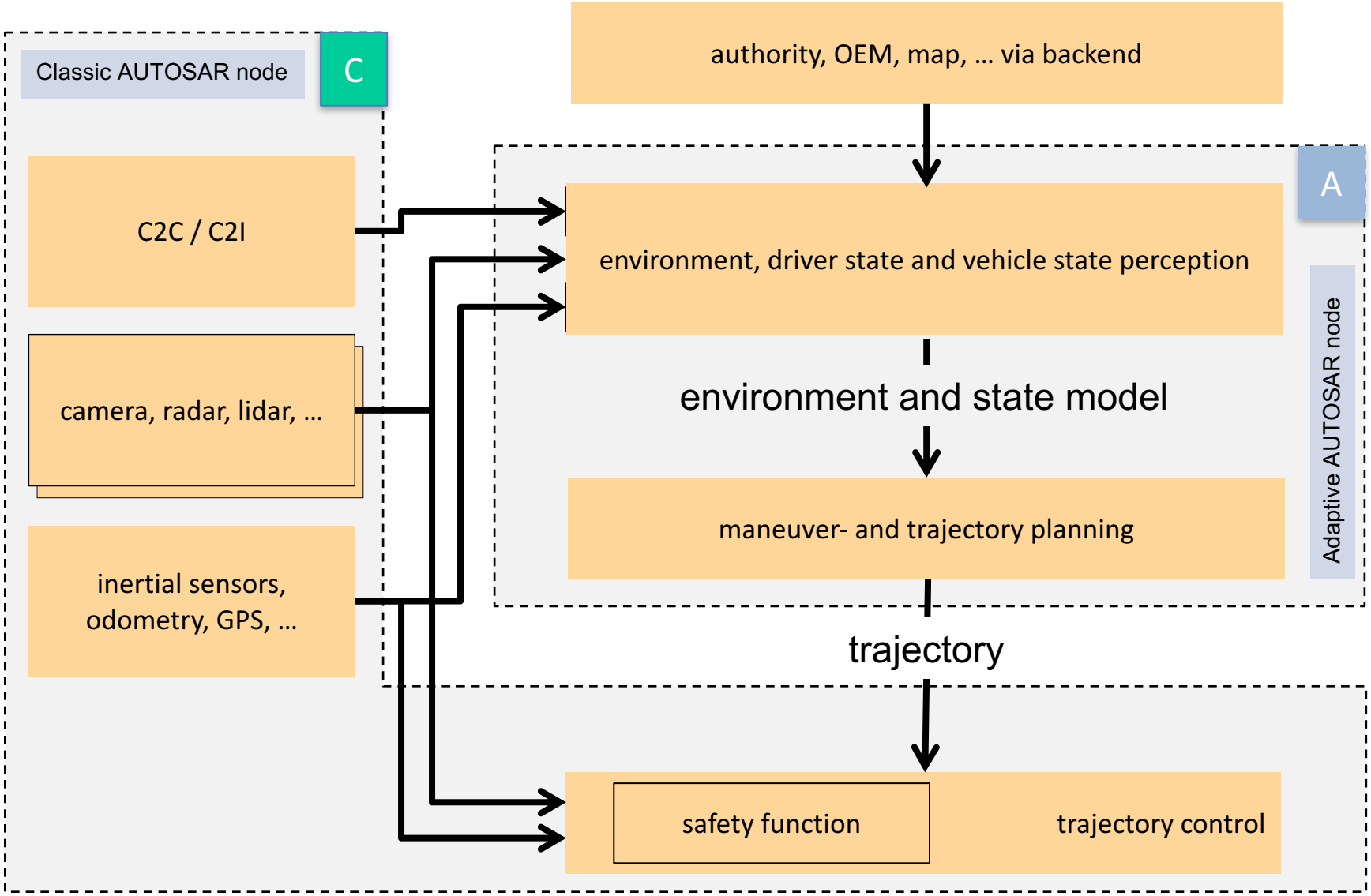
What's new in Adaptive AUTOSAR?



Expected total number of ECUs: 120
5 - 10 domain controllers will run with Adaptive platform

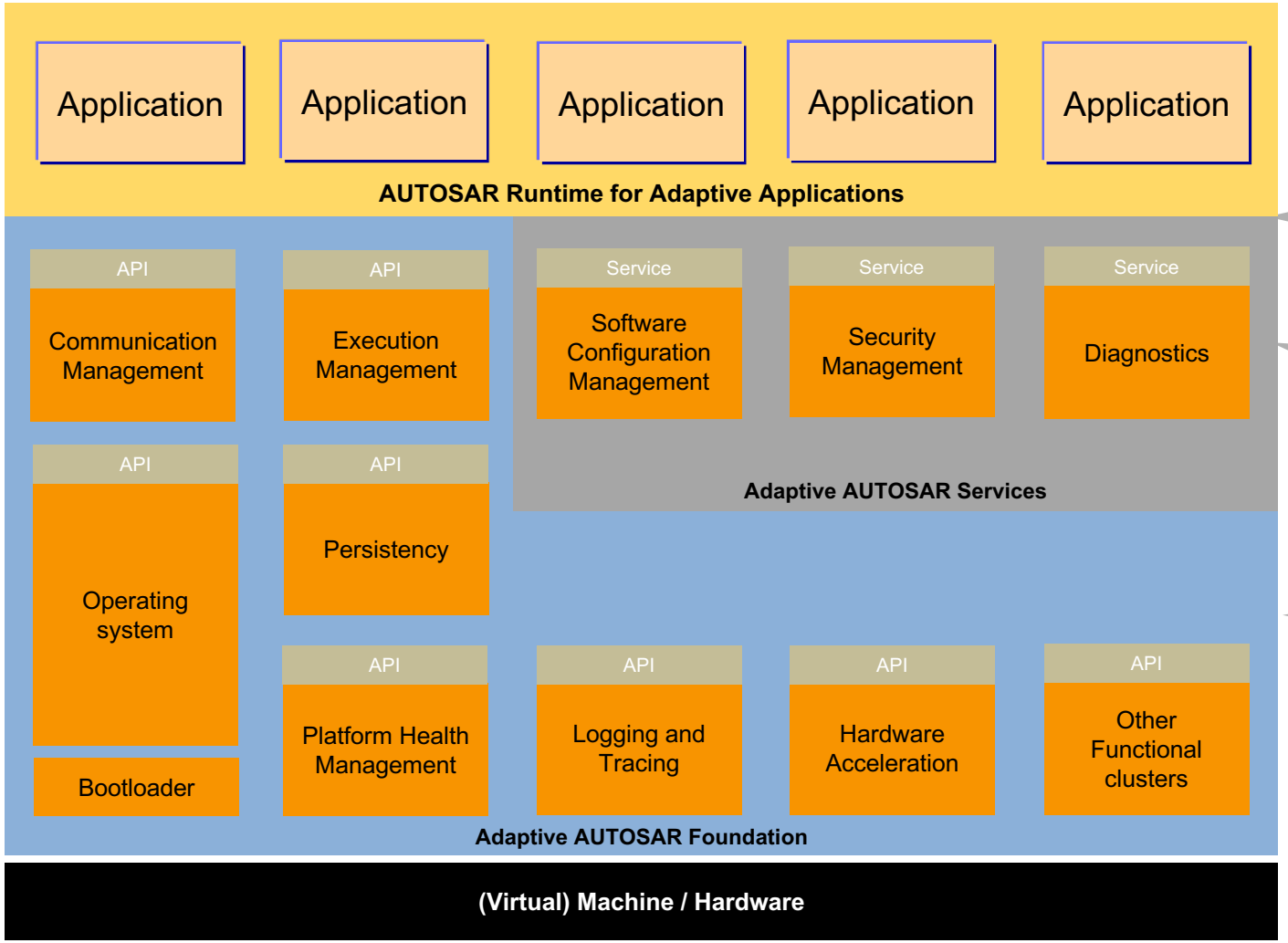
AUTOSAR_EXP_PlatformDesign.pdf

Sample Automated Vehicle System Architecture



AUTOSAR_EXP_PlatformDesign.pdf

AUTOSAR Runtime for Adaptive Applications - Functional Clusters



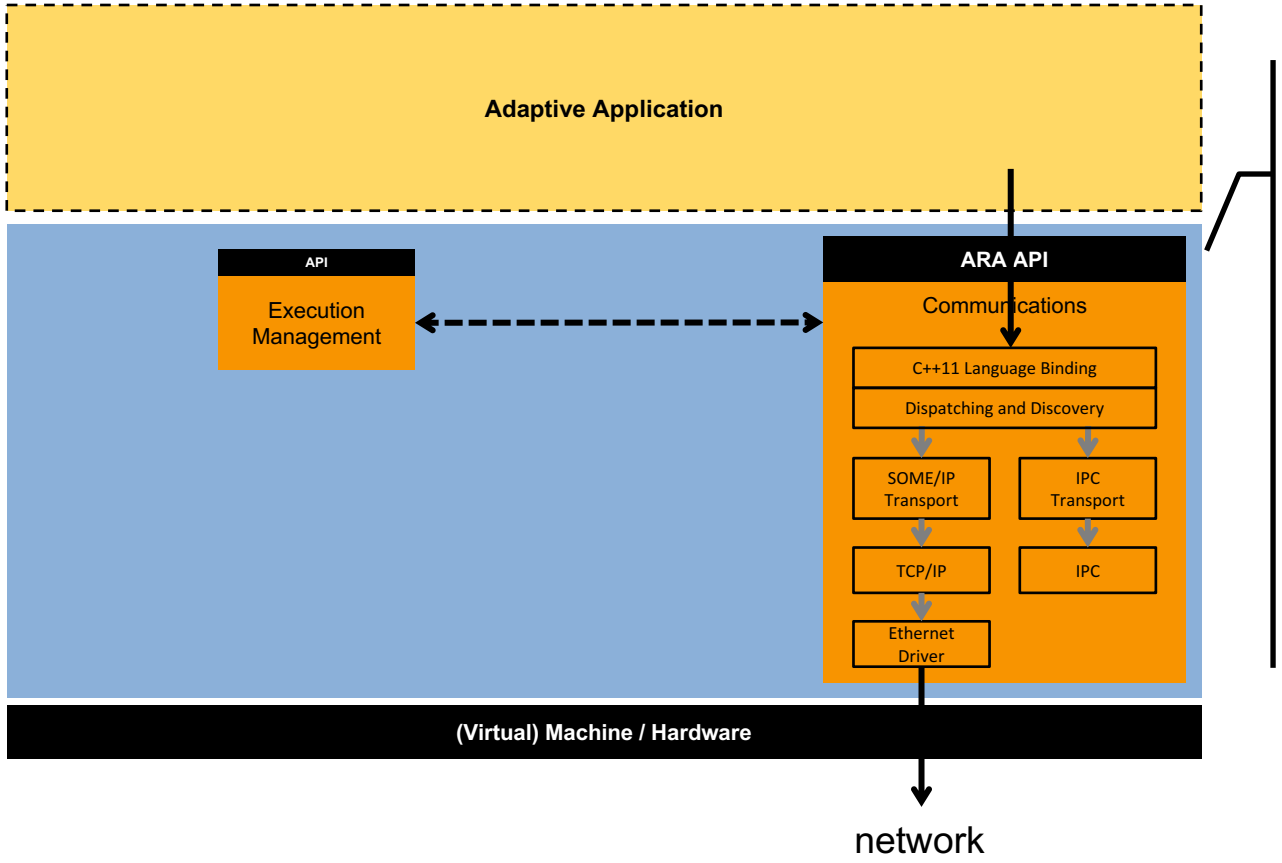
APIs and services exposed to applications by functional clusters

Services provided via Communication ARA API

Language specific APIs as part of ARA

AUTOSAR_EXP_PlatformDesign.pdf

Adaptive Platform – Technical Architecture (Communication)



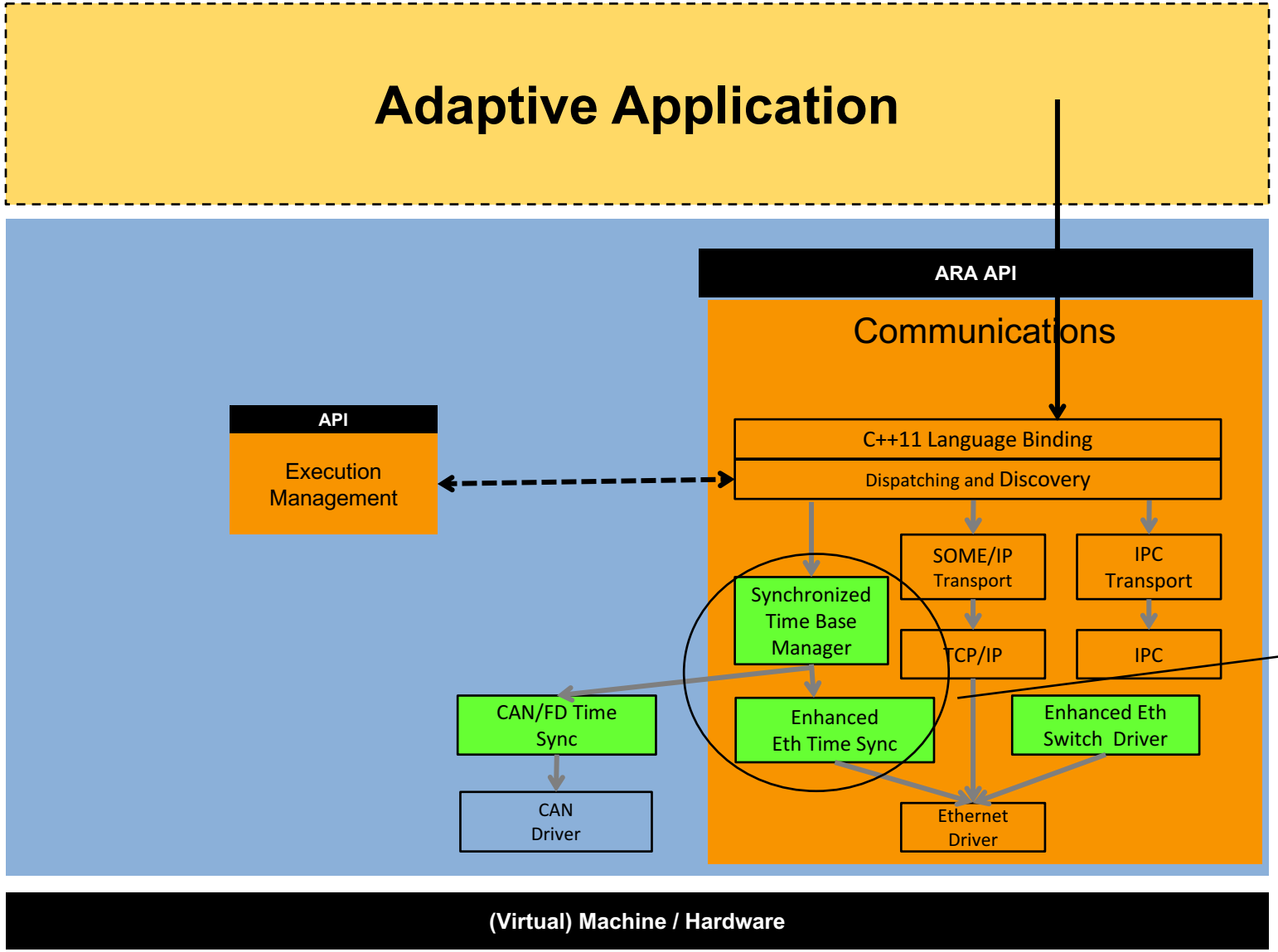
Public Interface
Part of the adaptive AUTOSAR API and specified in the SWS.

Protected Interface
Interaction between functional clusters. Not normative, intended to make specification more readable and to support integration of SW into demonstrator.

Private Interface
Interaction between elements within a functional cluster. Not used in specifications, but maybe for

AVB/TSN for Traffic management and 802.1AS Time Sync are preferred

Realizing TSN in Adaptive AUTOSAR – a Proposal



Extensions to adaptive AUTOSAR R17-03

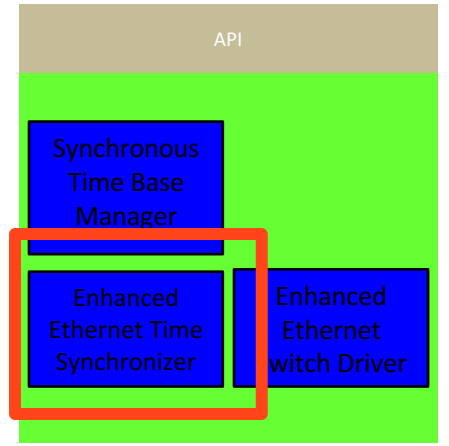
Stbm might be required when CAN/CAN-FD support included in Adaptive AUTOSAR R17-10

FT-Security is working on the Secure Communication concept including Authentication and encryption

802.1AS-Rev Support

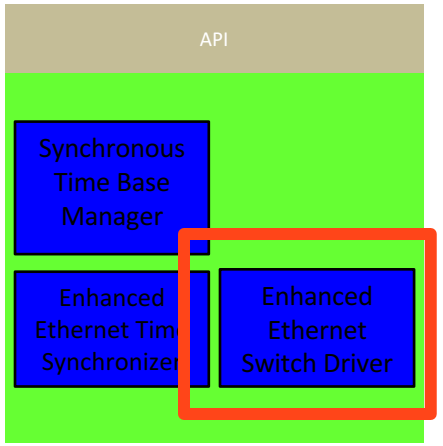
TimeSync is already a topic in FT-CM Subgroup

Enhanced Ethernet Time Synchronizer



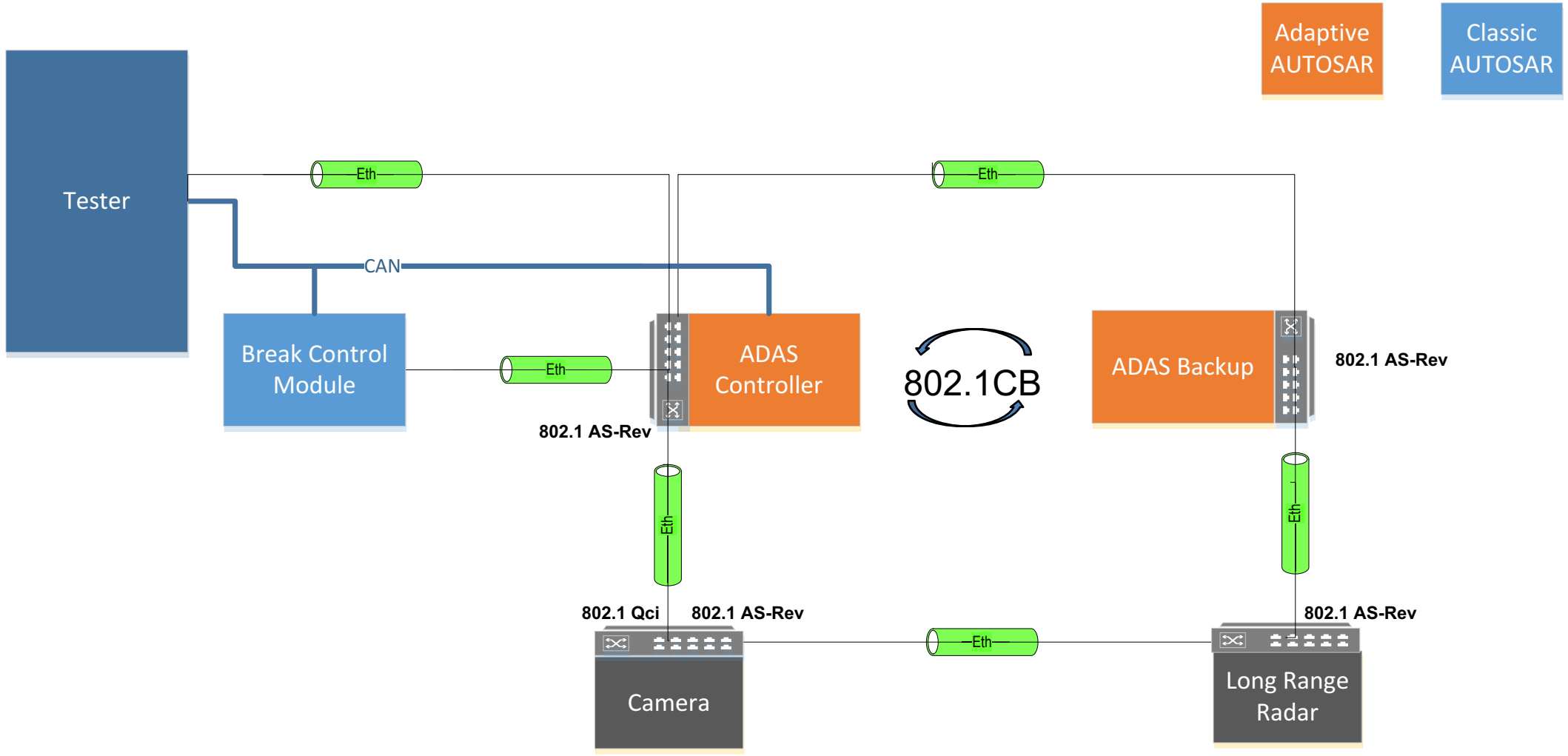
- Support Redundancy, redundant paths
- Configuration for static, redundant grandmasters
- Faster Resynchronization convergent time.
- Multi-Clock domain support (Already supported in AUTOSAR classic)
- Configuration support for Ring

Ethernet Switch Driver extension



- Host controller uses Ethernet switch driver to configure the switch
- This shall offer Configuration support for the TSN protocol features; e.g.
  - Static stream reservation, switch forwarding tables
  - Per stream ingress metering limits
  - Frame duplication path and redundancy failure action
  - And many more..

Concept evaluation bench setup

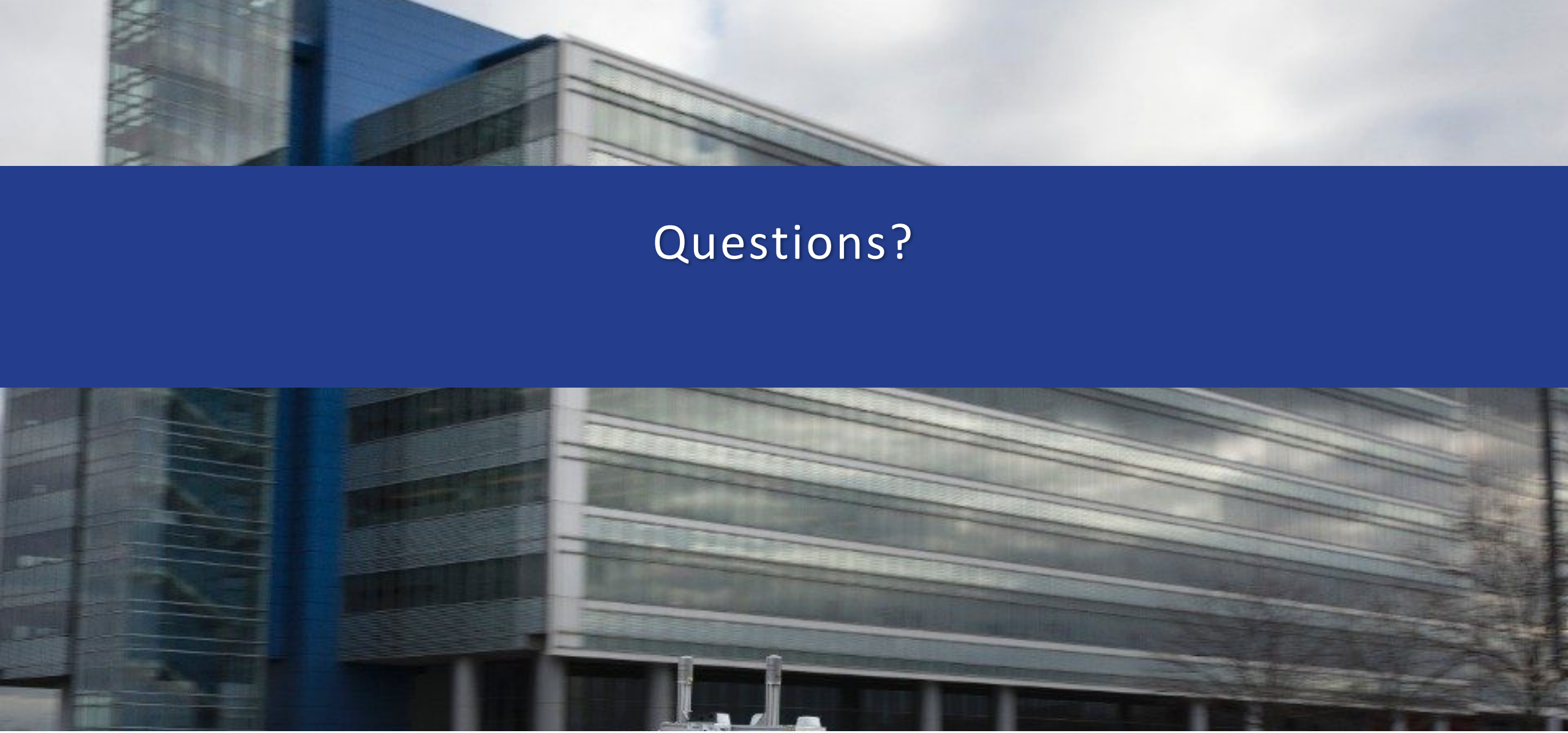


Adaptive AUTOSAR Bench results AP 17-03

- Learnings from AUTOSAR 17-03 Release (GM-ITK project demonstrator)
  - Demonstrated value of Linux / open-source ecosystem for image processing, machine learning, etc. (e.g., OpenCV)
  - Demonstrated usage of dynamic memory management
  - Demonstrated dynamic application / process update
  - SOME/IP works great for Service Discovery, but isn't sufficient for large data transfer (e.g. video streams). Workaround: TCP/IP

Conclusion

- TSN is engineered to satisfy the Automated driving systems communication requirements
- Switch vendors seems very interested in providing variants in TSN to support the Automotive market needs
- Adaptive AUTOSAR currently doesn’t specify TSN support. But we believe it is possible to adapt TSN within its functional clusters



Questions?

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Thank You!

- Acknowledgements
  - Soheil Samii, Thomas E. Fuhrman, Mike Potts, Abuzafor Rasal
  - https://www.autosar.org/standards/adaptive-platform/release-17-03/