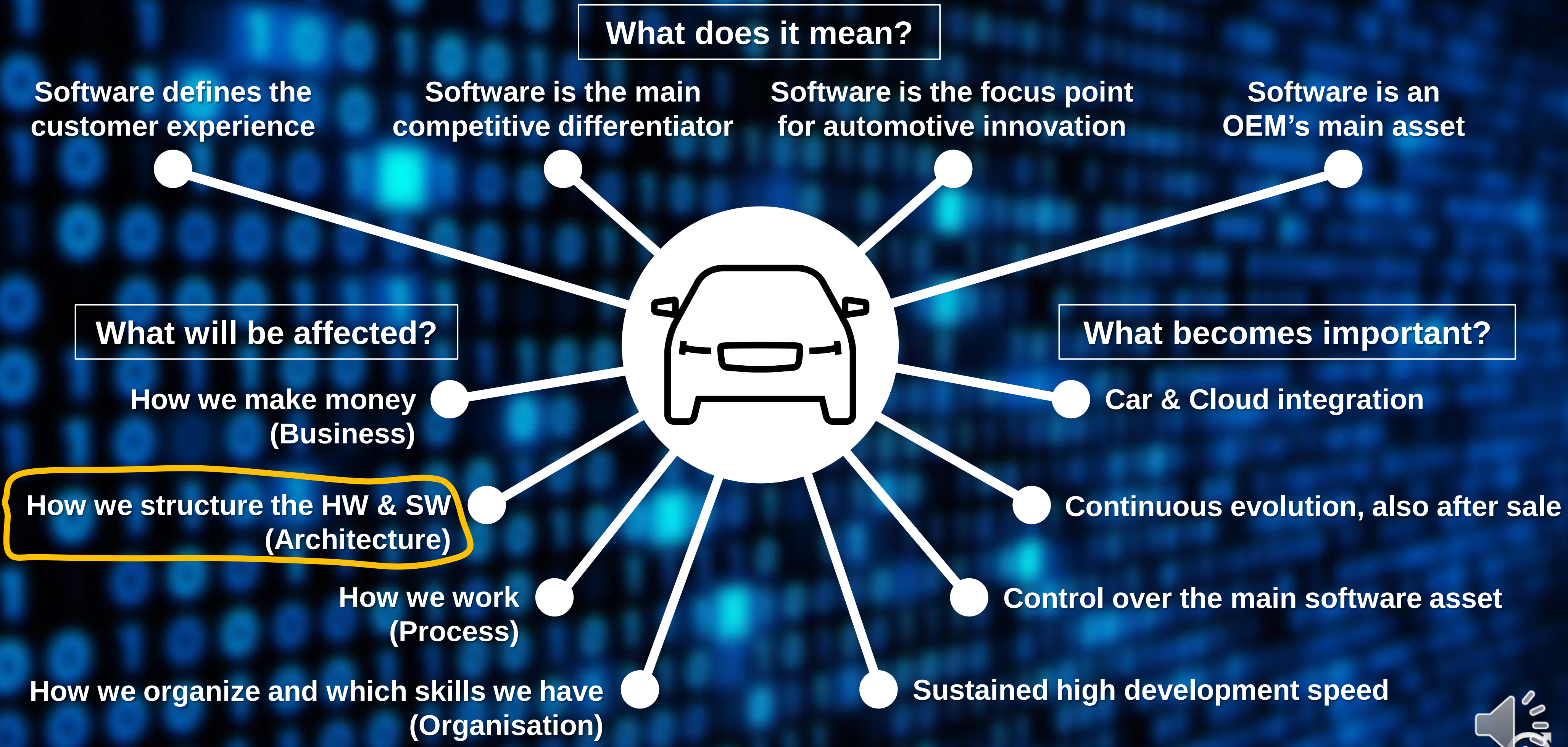
Time Synchronisation in Automotive E/E Centralized Architecture

International Time Synchronisation Forum (ITSF 2020)

Hoai Hoang Bengtsson (System Architect) and Martin Hiller (Solution Architect), Volvo Car Corporation, Sweden

THE SOFTWARE DEFINED CAR



What does it mean?

- Software defines the customer experience
- Software is the main competitive differentiator
- Software is the focus point for automotive innovation
- Software is an OEM's main asset

What will be affected?

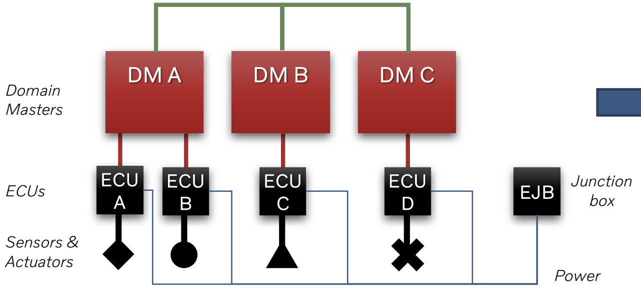
- How we make money (Business)
- How we structure the HW & SW (Architecture)
- How we work (Process)
- How we organize and which skills we have (Organisation)

What becomes important?

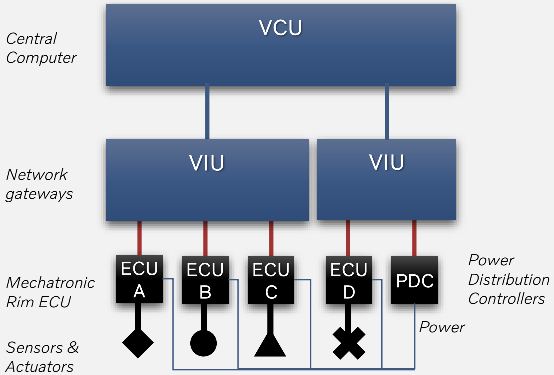
- Car & Cloud integration
- Continuous evolution, also after sale
- Control over the main software asset
- Sustained high development speed

E/E evolution – Electronics & Hardware

Domain Architecture

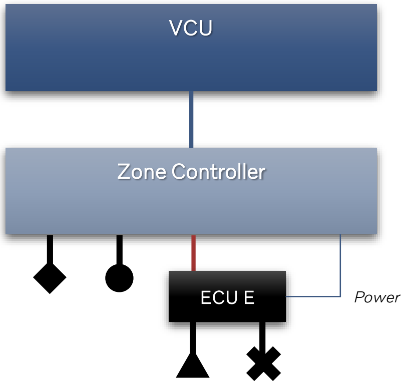


Centralized Architecture



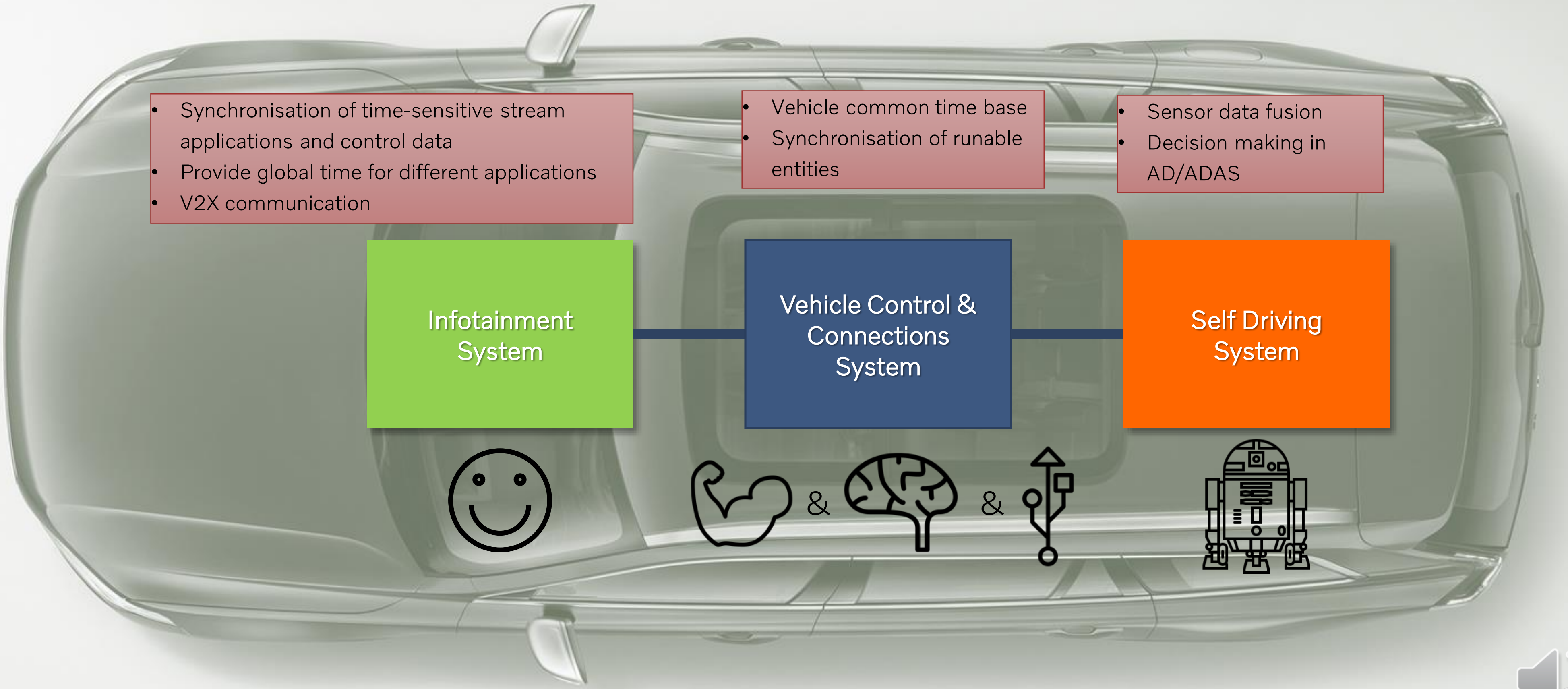
Integrating domain masters and other compute heavy ECUs into one central computer

Zonal Architecture



Integrating VIUs, power distribution and mechatronic ECUs into zone controllers, and integrating mechatronic ECUs with each other

The need for high precision time synch in automotive



- Synchronisation of time-sensitive stream applications and control data
- Provide global time for different applications
- V2X communication

- Vehicle common time base
- Synchronisation of runable entities

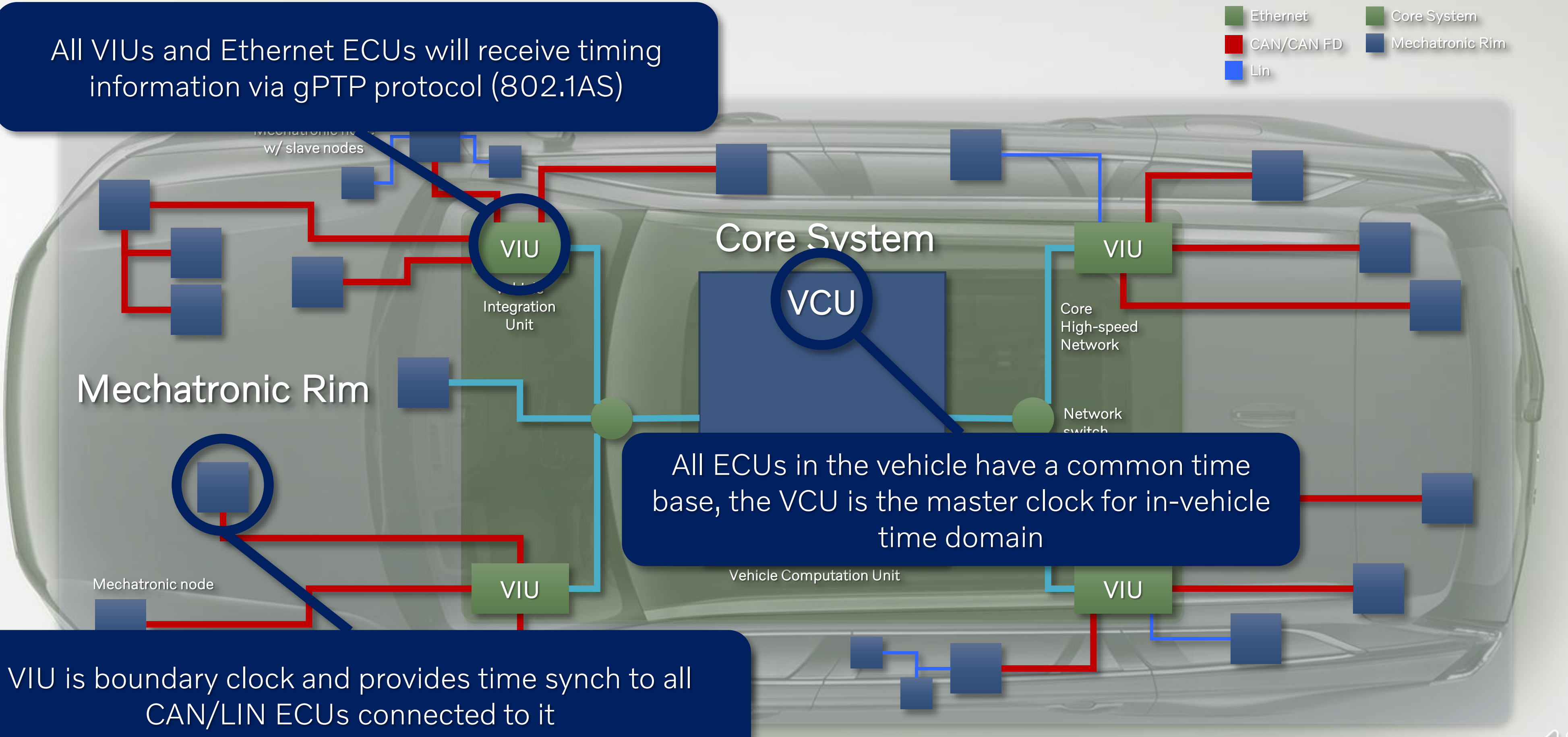
- Sensor data fusion
- Decision making in AD/ADAS

Infotainment System

Vehicle Control & Connections System

Self Driving System

Using gPTP protocol for high precision time synch in Vehicle

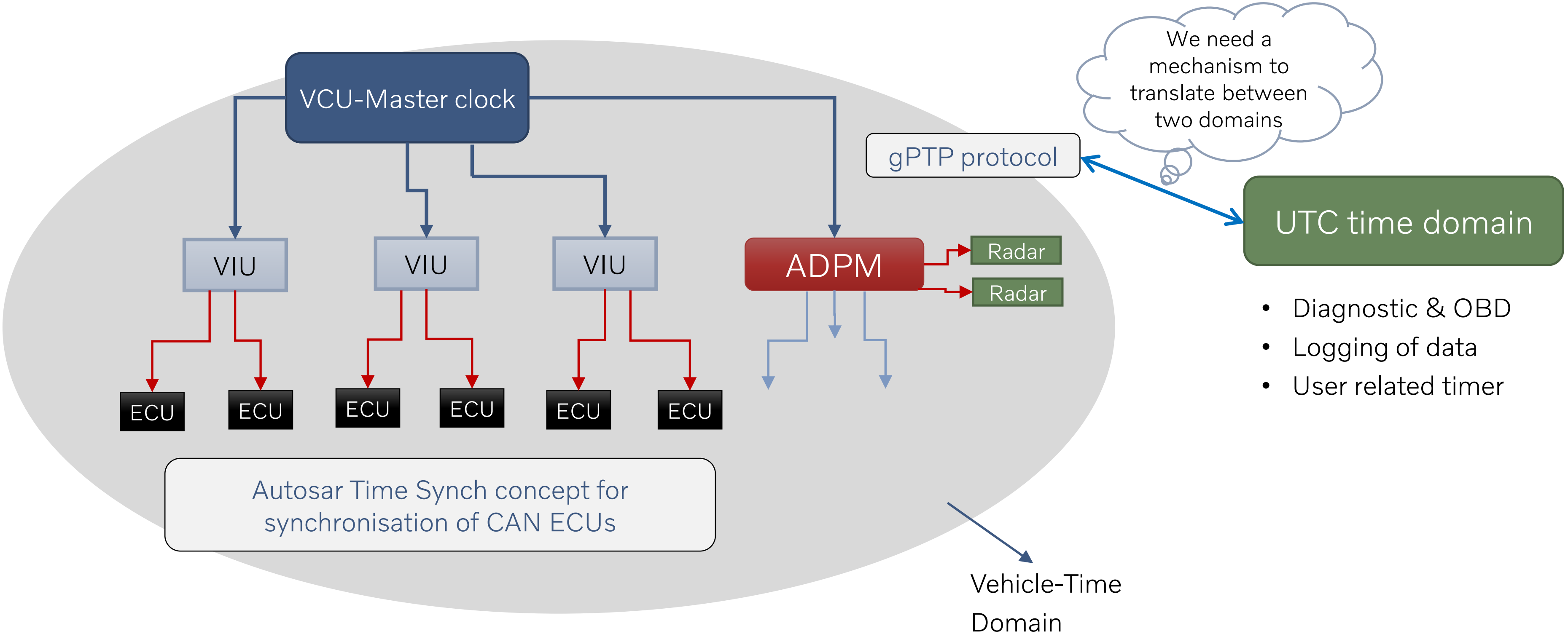


All VIUs and Ethernet ECUs will receive timing information via gPTP protocol (802.1AS)

All ECUs in the vehicle have a common time base, the VCU is the master clock for in-vehicle time domain

VIU is boundary clock and provides time synch to all CAN/LIN ECUs connected to it

In-vehicle time hierarchy



We need a mechanism to translate between two domains

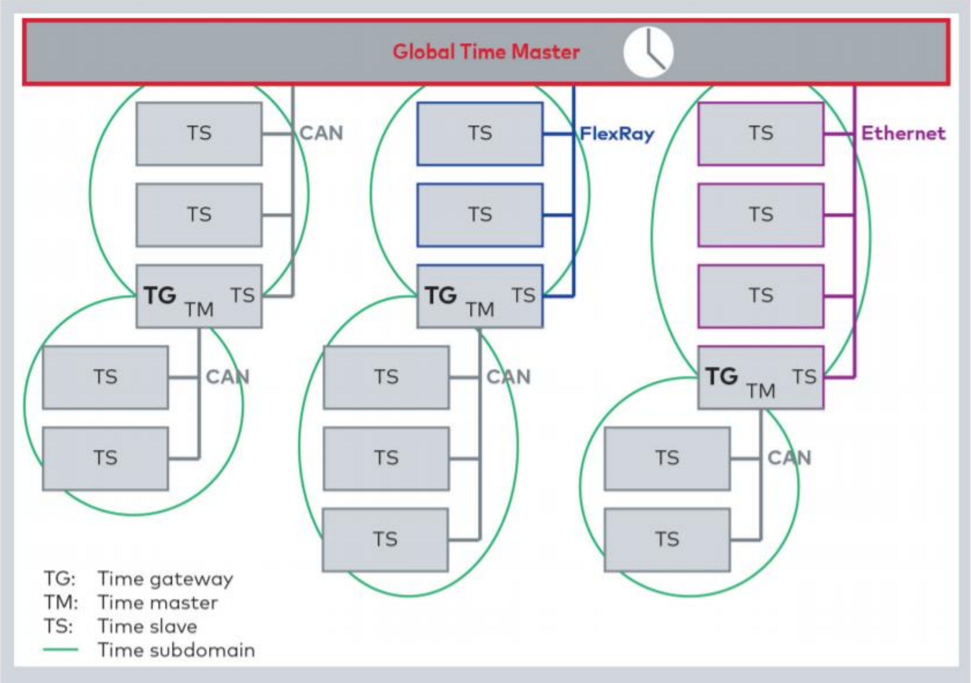
Autosar Time Synch concept for synchronisation of CAN ECUs

Vehicle-Time Domain

- Diagnostic & OBD
- Logging of data
- User related timer

Technologies used right now

- We follow the Avnu profile on Time Synchronisation for Automotive
  - No BMCA (Best Master Clock Algorithm) is used
  - Grand Master for the gPTP protocol is chosen from vehicle computational unit
  - One time domain for in-vehicle
- We use Autosar Time Synch Concept



Source: vector/ AUTOSAR

Challenges and considerations

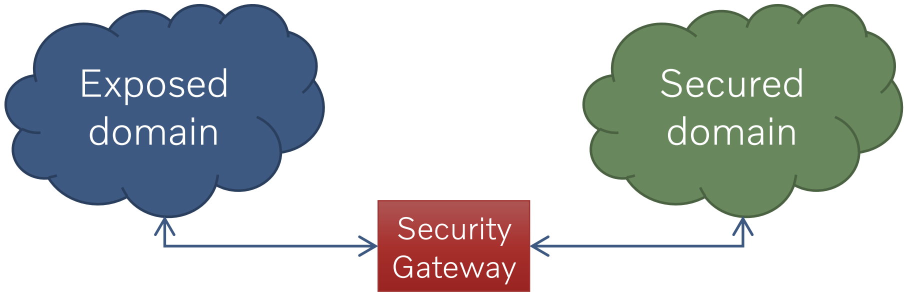
How to meet all functional safety requirements (ASIL)

- Keep data integrity high (e.g., account drifting)
- Allow E2E protection (e.g. security of time sync messages)
- Keep communication network “robust”/avoid unnecessary single points of failure
- Allow for network validation and verification

Ability to support high accuracy and precision/resolution levels

System start up time is short < 100ms

- Store (default) configurations in endpoints wherever possible to eliminate additional communication and convergence times
- If clock sync is needed during start up phase:
  - Let it startup before real-time streams are emitted without congestion by streams
  - Multiple sync messages needed at startup for consistency Fast intervals needed for startup



Considerations

Power considerations:

- Fast re-integration after standby/sleep

Validation and diagnostic considerations

Network consideration

- Command and control traffic
- Both event based and periodic
- Gatewaying traffic between CAN-Ethernet

Implementation consideration

- Simple and low cost, easy to maintain
- Tool support is important

VOLVO

Thank you and questions!