BMW Car IT GmbH.

AUTOSAR - First Experiences and the Migration Strategy of the BMW Group

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BMW Group

AUTOSAR - First Experiences.
Overview.

1. **Focus of this talk:** Model based development under AUTOSAR – the Virtual Function Bus (VFB) and its implementation, the Runtime Environment (RTE)

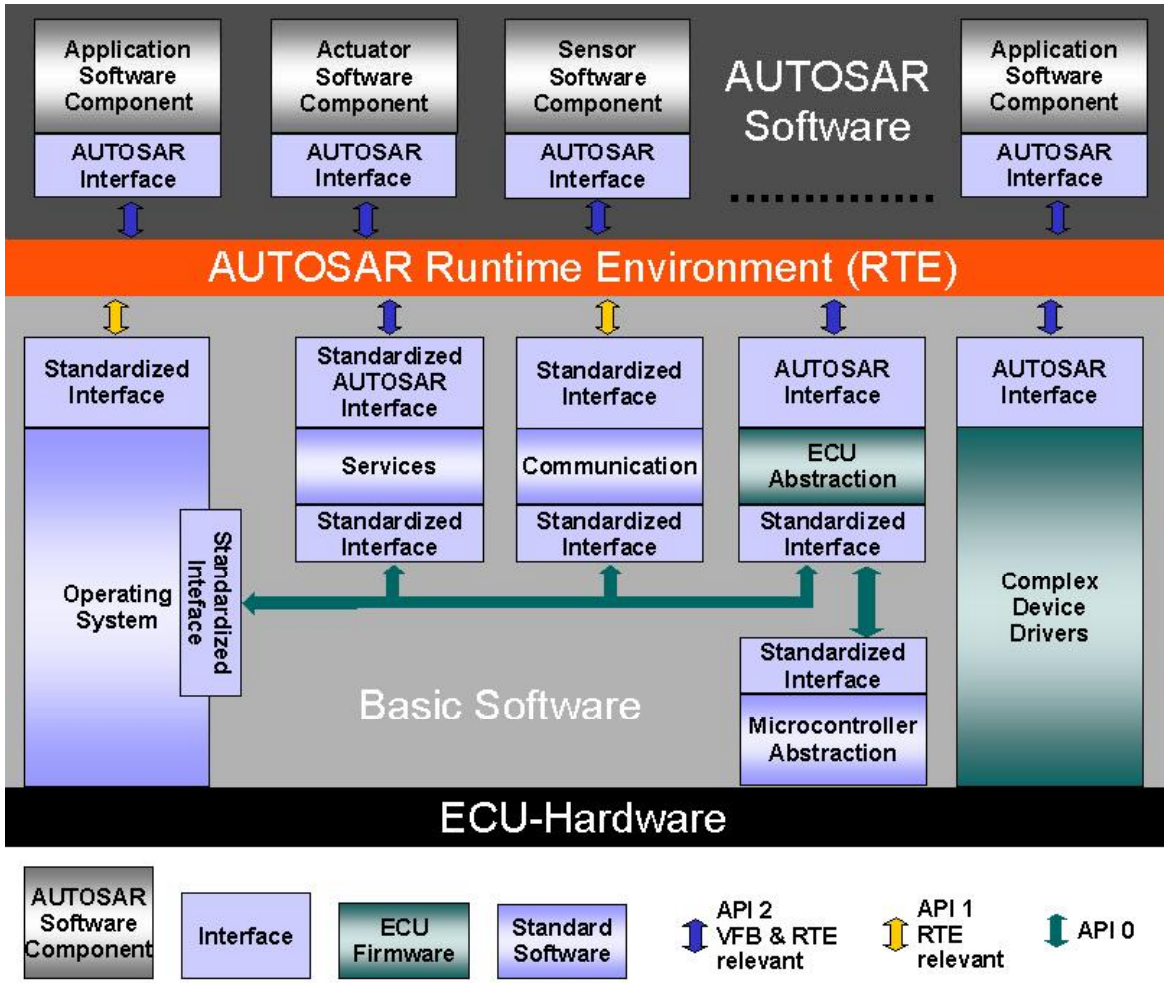
2. **History and Lessons learned**

3. **The AUTOSAR Strategy of the BMW Group**: Migration into the AUTOSAR world.

4. **Future Steps**: „Beyond AUTOSAR“

Standardization

AUTOSAR – ECU Software Architecture



Automotive Open System Architecture (AUTOSAR):

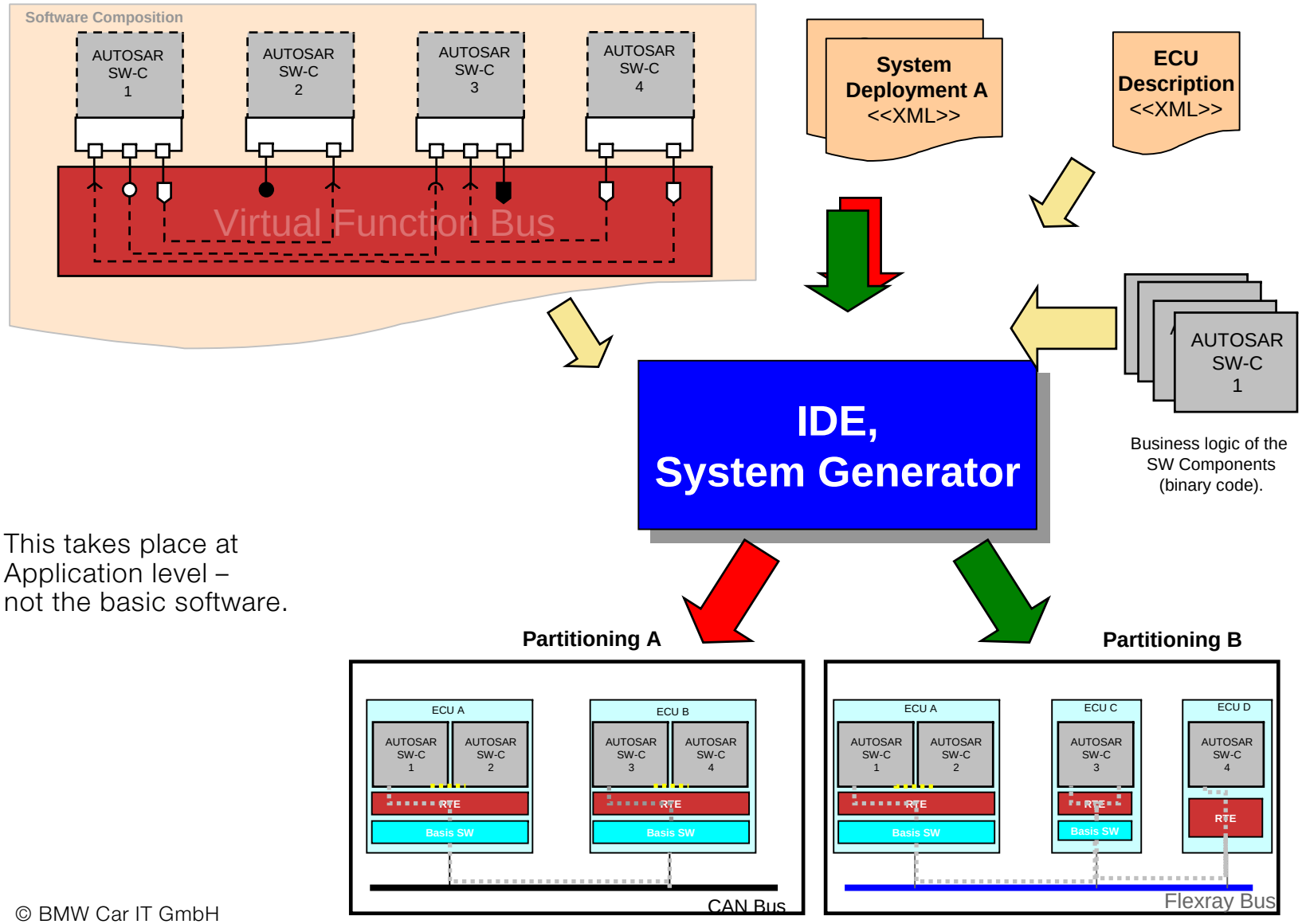
- Standardized, openly disclosed interfaces
- HW independent SW layer
- Transferability of functions
- Redundancy activation

AUTOSAR RTE:
by specifying interfaces and their communication mechanisms, the applications are decoupled from the underlying HW and Basic SW, enabling the realization of Standard Library Functions.

source: www.autosar.org

AUTOSAR - First Experiences.

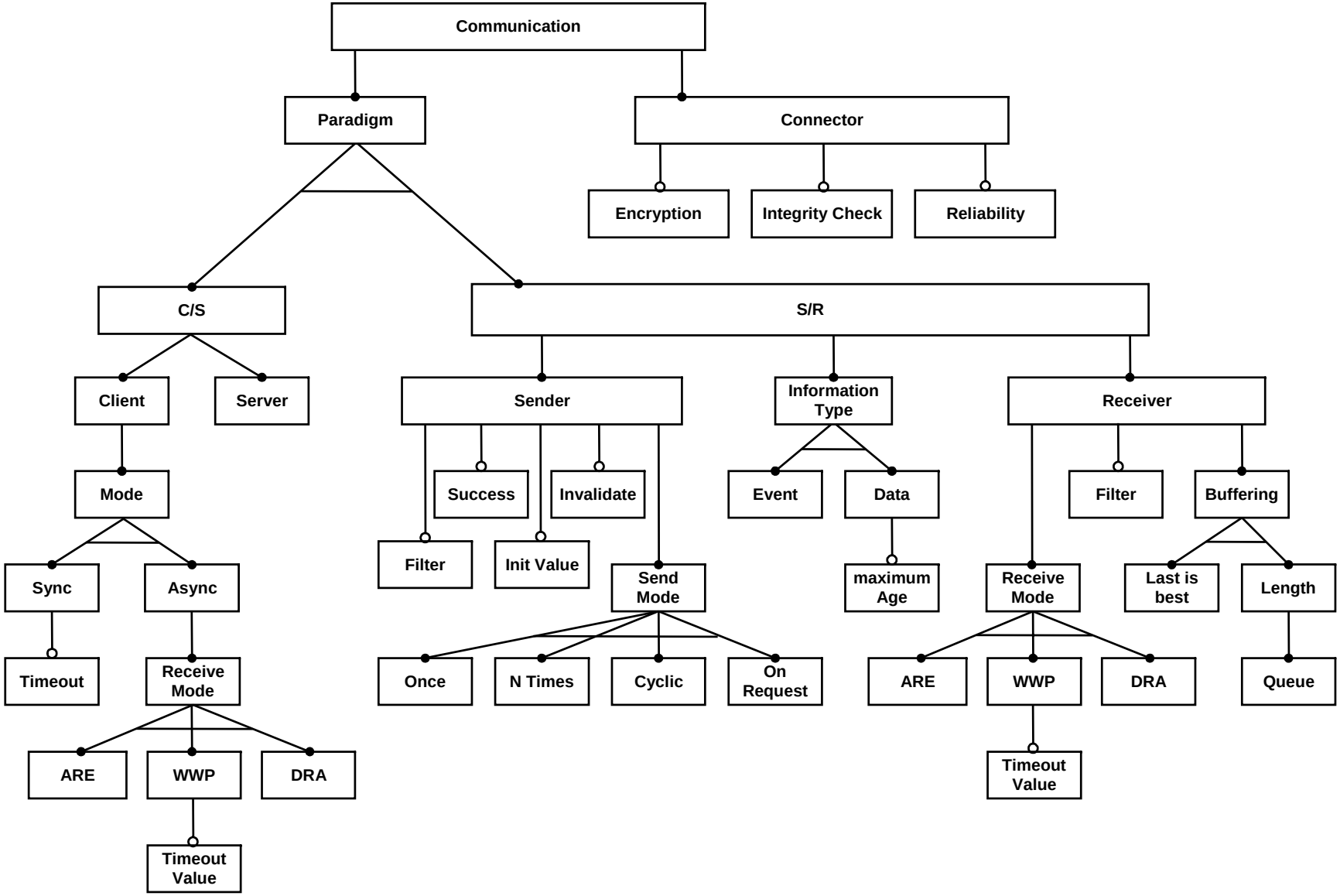
Model based development under AUTOSAR.



This takes place at Application level – not the basic software.

AUTOSAR - First Experiences.

A subset of the Virtual Function Bus.



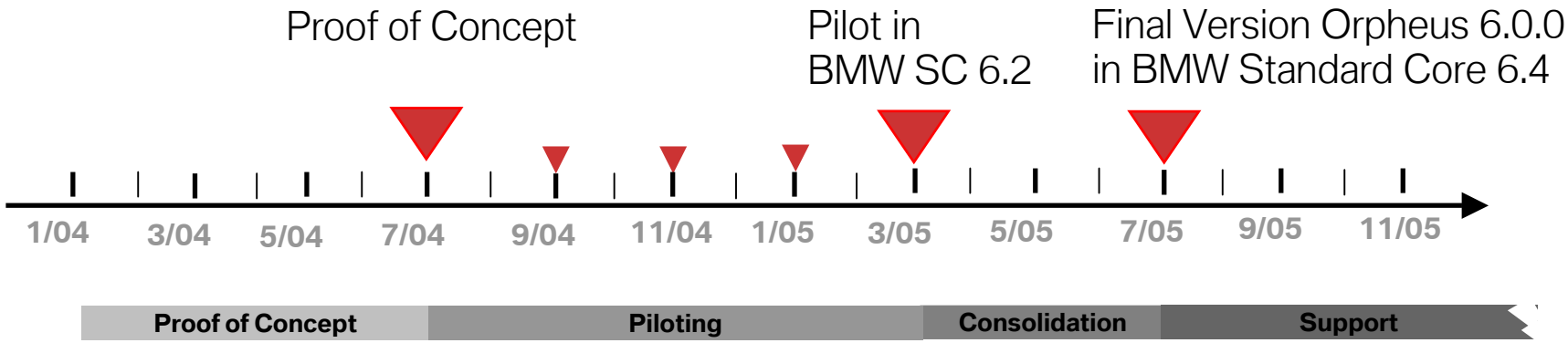
AUTOSAR - First Experiences.
History.

Experiences gained of three phases:

1. „**Proof of Concept**“: technical feasibility and feedback from the developer’s perspective.

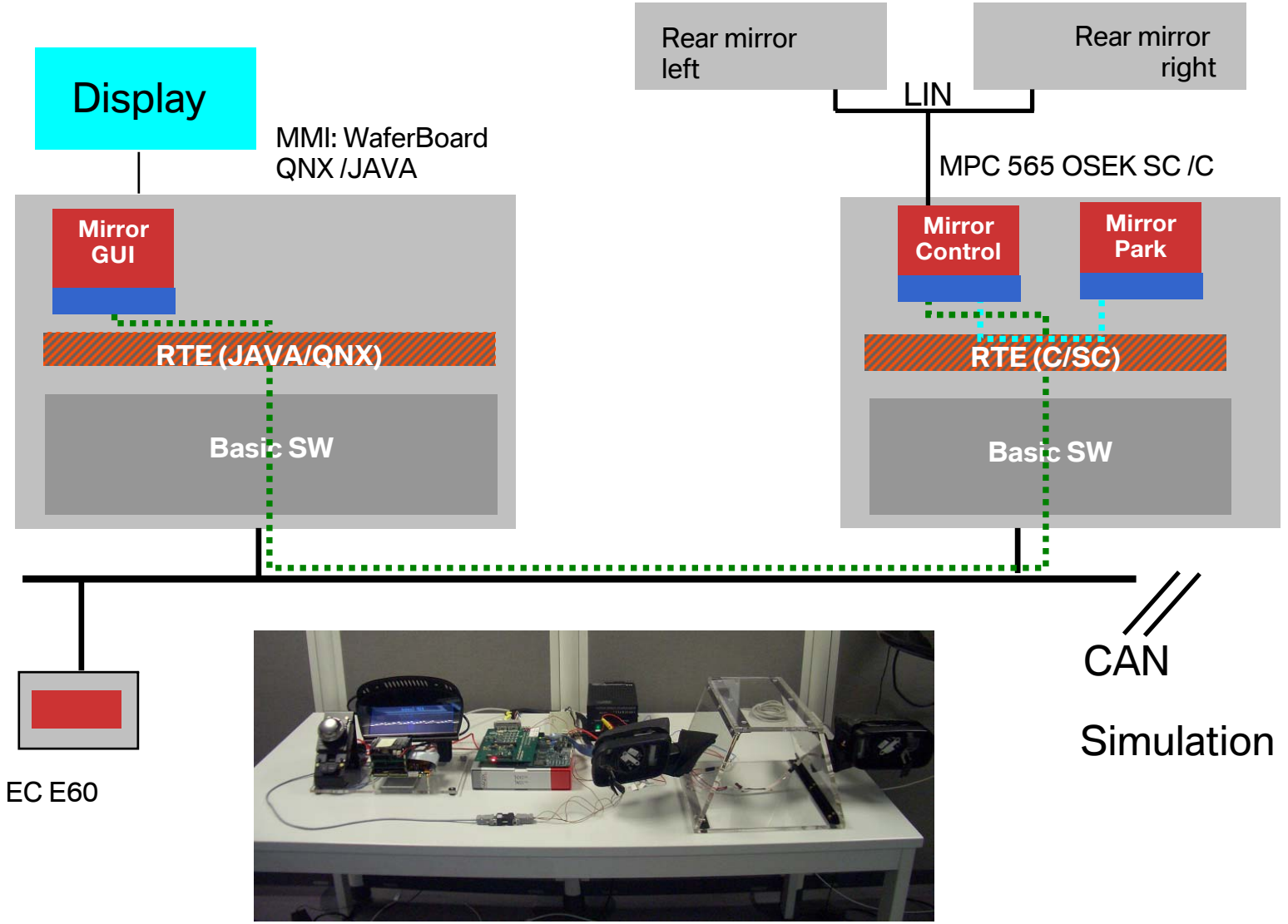
2. „**Piloting**“: Confirming the applicability in the automotive domains by piloting existing functions and ECUs in the domains.

3. „**Consolidation Phase**“: Integration of resulting software and tools into the BMW Standard Core 6.



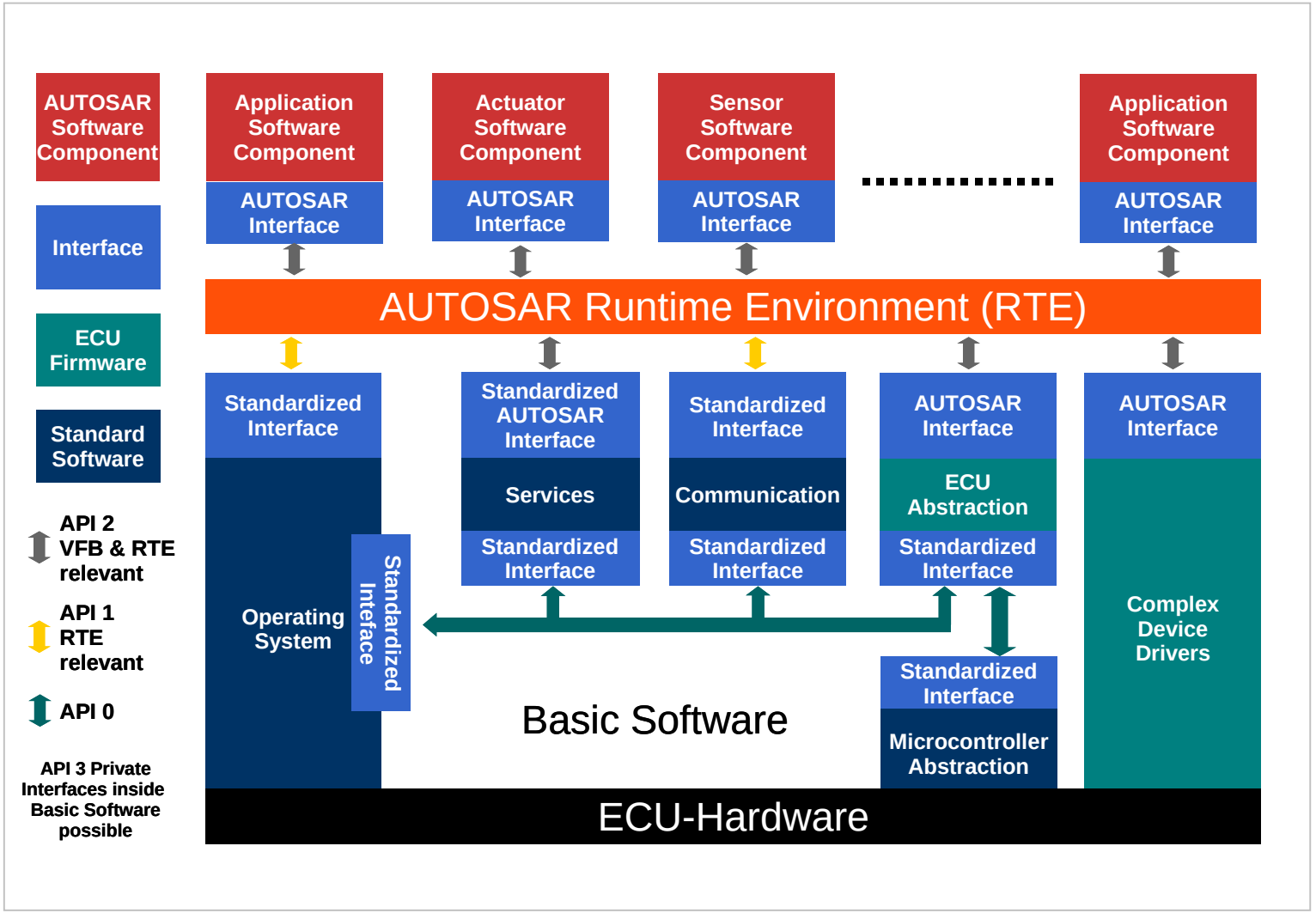
AUTOSAR - First Experiences.

„Proof of Concept“ (June 2004).



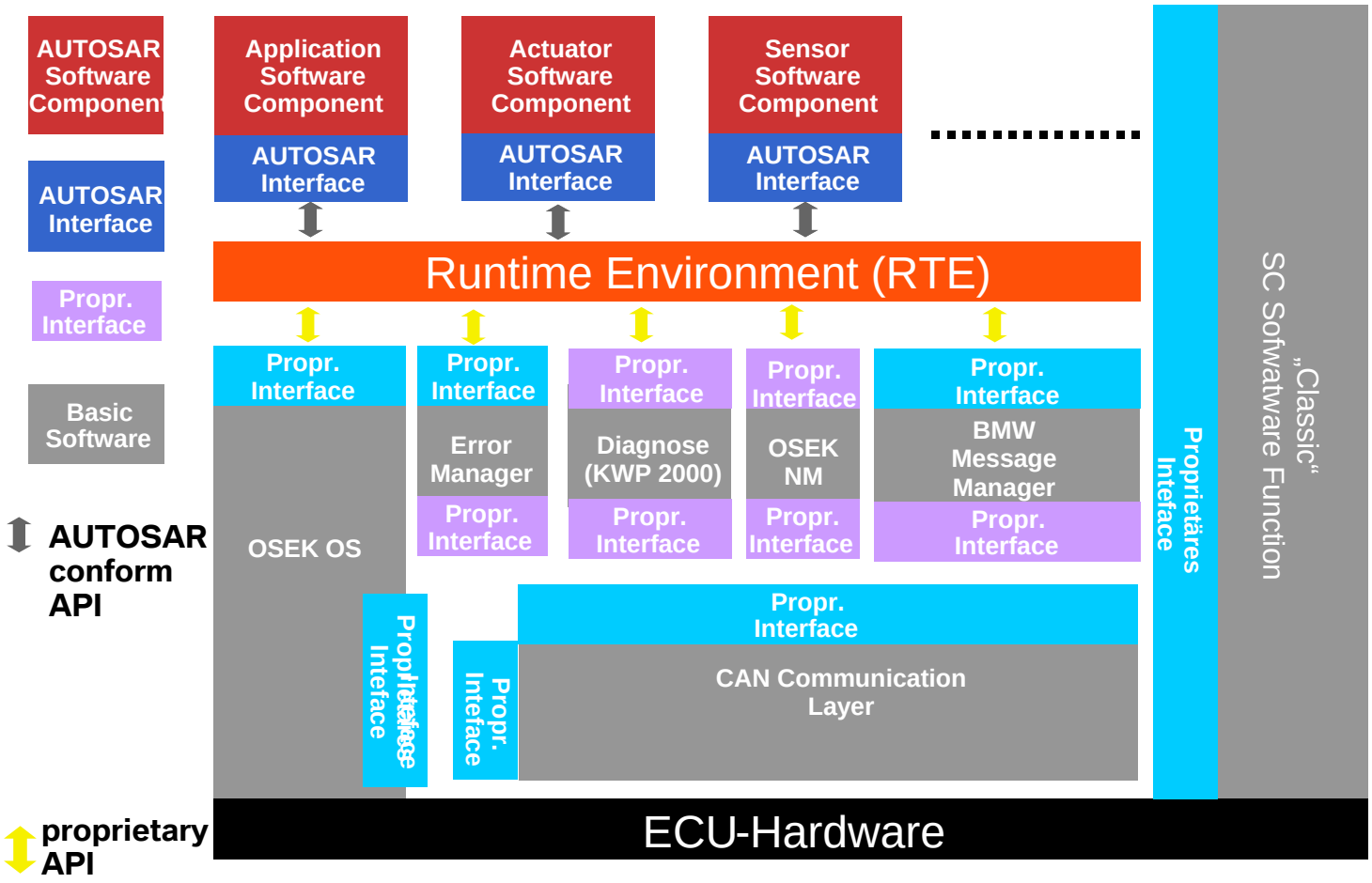
AUTOSAR - First Experiences.

AUTOSAR Architecture.



source: www.autosar.org

AUTOSAR - First Experiences.
Architecture of the BMW SC/RTE.



AUTOSAR - First Experiences.
Pilots (07/04 – 03/05).

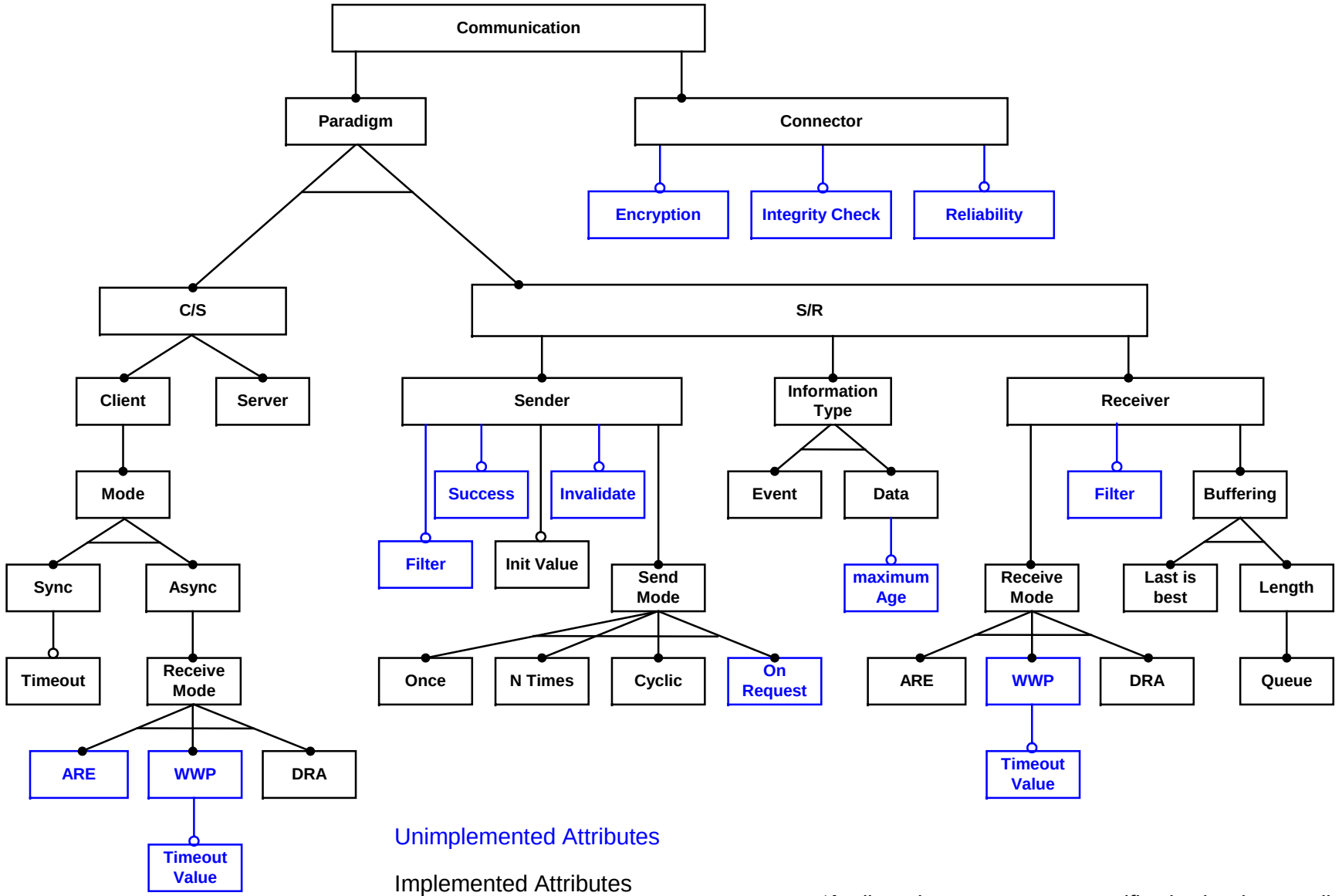
■ Body	sun roof	(finished)
■ Body	fuel gauge	(finished)
■ Body	climate control	finished)
■ Chassis	chassis management	(finished)
■ Powertrain	Driver Request	(finished)

Resulting steps:

1. The RTE is the appropriate interface for migration.
2. An optimized RTE Code Generator is needed.
3. Integrated tool support for modeling, configuration that fits into the BMW design process.

AUTOSAR – Migration Strategy.

A stable subset of the VFB for migration.



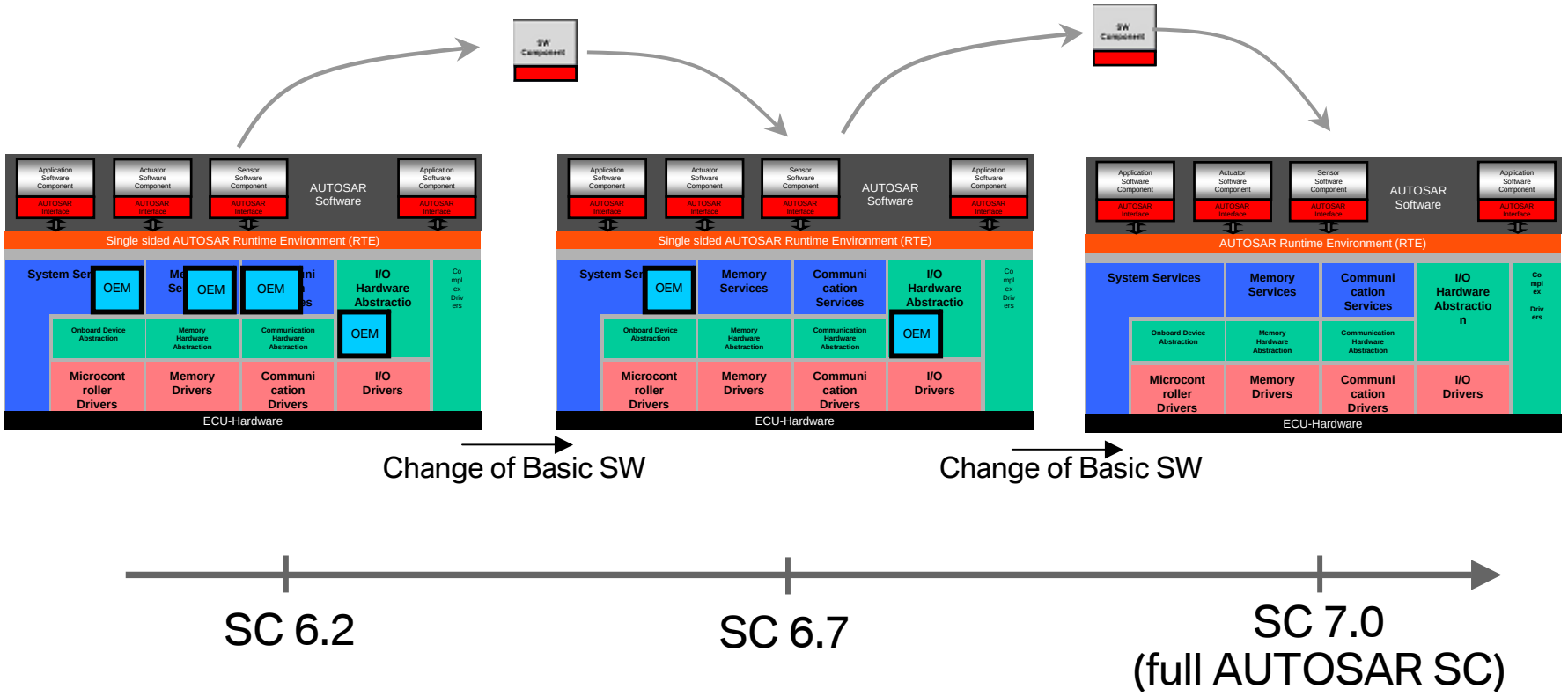
Unimplemented Attributes

Implemented Attributes

(Attributed not on a mature specification level are not listed)

AUTOSAR – Migration Strategy.
Migration at SW-component level.

RTE based SW Components are migratable with an calculable amount of adaption.



An application, coded against the RTE interface, can be migrated up to the fully compliant AUTOSAR standard core.

„Stepwise Migration of Software Level

AUTOSAR – Migration Strategy.
RTE against an existing COM Matrix.

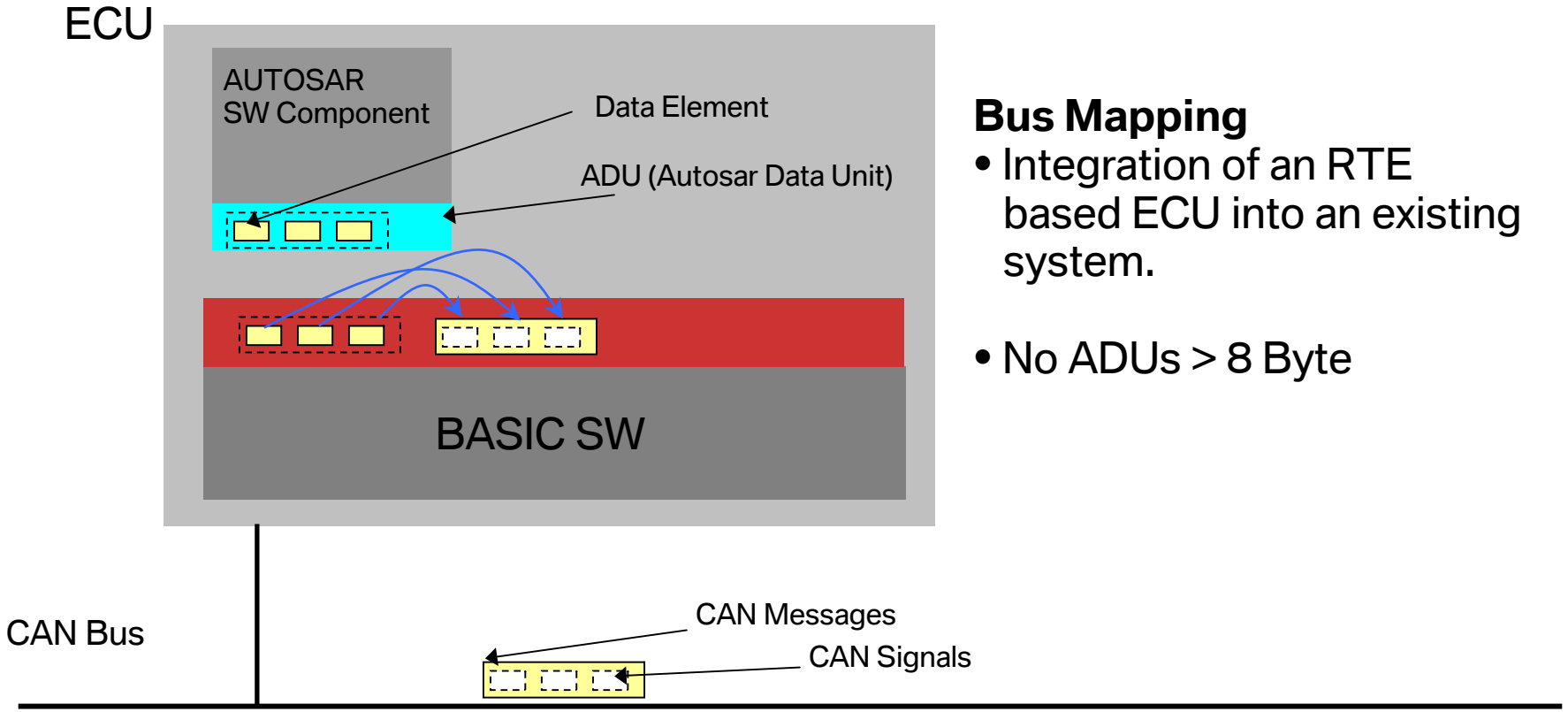
AUTOSAR Vision:
From the partitioning to the COM matrix.

Status Quo:
From the COM Matrix to the ECU interface

Ergo: „AUTOSAR brings up a new reuirement for migration: generating an RTE against an existing COM matrix “

AUTOSAR – Migration Strategy.

Migration into an existing board network.



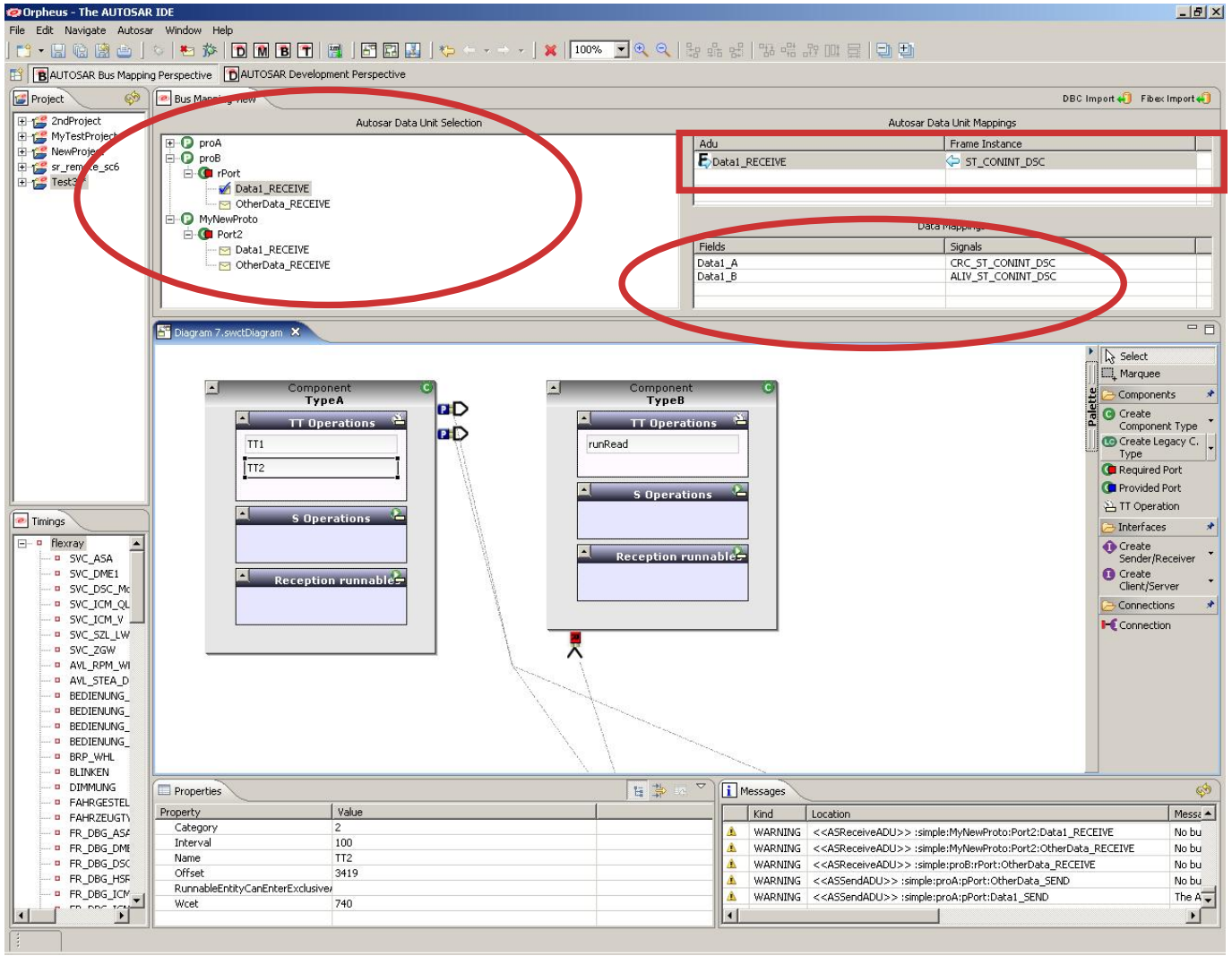
Bus Mapping

- Integration of an RTE based ECU into an existing system.
- No ADUs > 8 Byte

AUTOSAR – Migration Strategy.

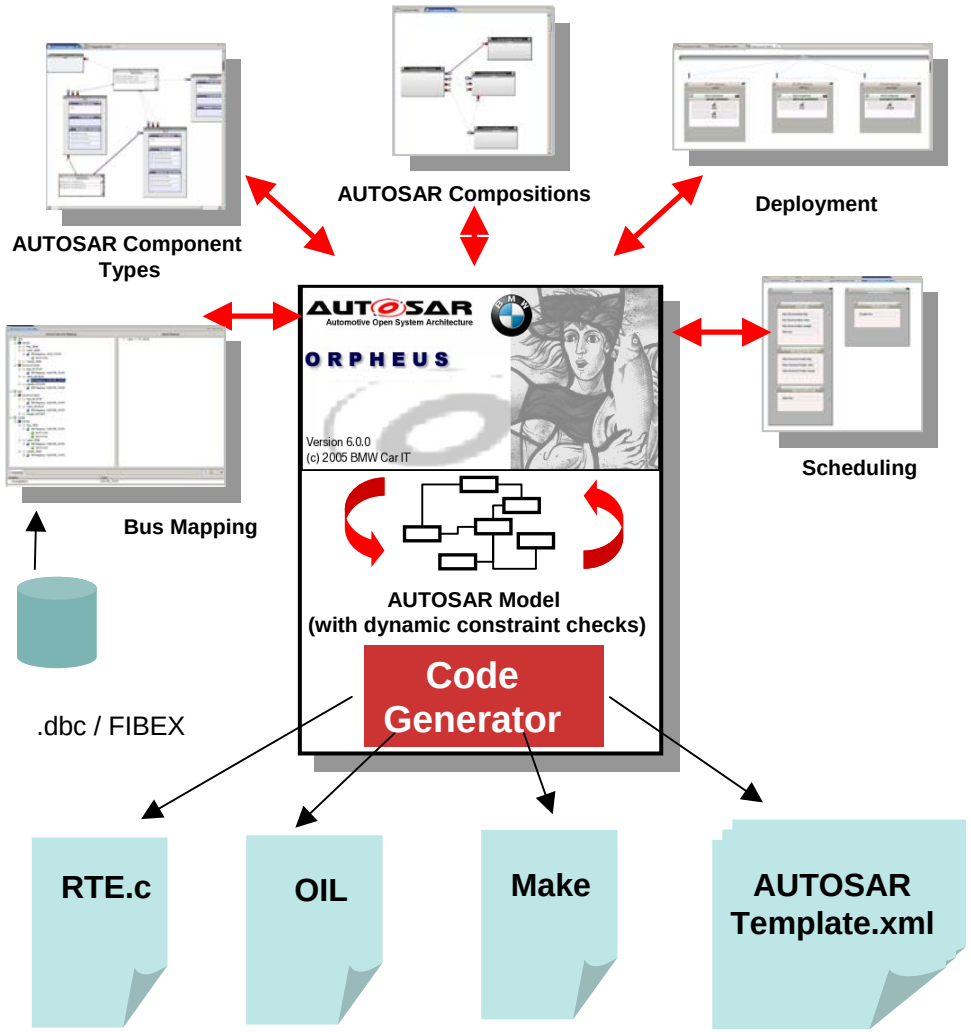
Migration into a board net.

The RTE based ECU behaves towards the bus exactly like a „classical“ ECU



„stepwise migration of ECU level

AUTOSAR – Migration Strategy.
ORPHEUS.



ORPHEUS = modeling tools + code generator

- **Enabler for migration**
  Integrated in BMW SC6,
  Import DBC/FIBEX

- **Graphical Modeling** of
  - AUTOSAR Application Components
  - Mapping to CAN and Flexray Bus
  - Scheduling
  - Partitioning of Software

- **Optimized Codegeneration** of RTE (incl. autom. Unit Tests)

- **Open**
  (Adation to ASCET, AUTOSAR Templates)

AUTOSAR – Migration Strategy.
The Powertrain Pilot.

Voices outside AUTOSAR back in 2002:

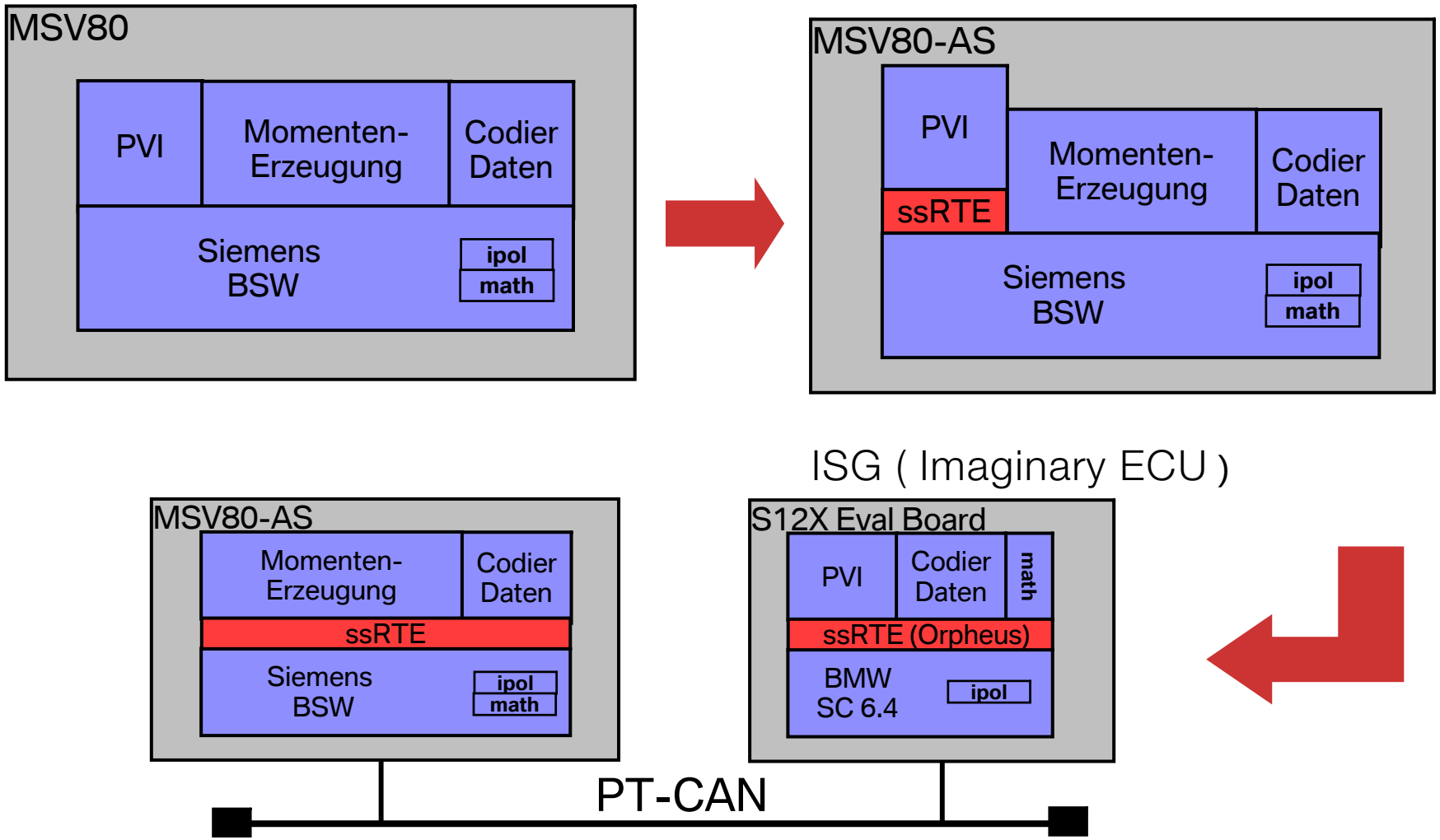
„AUTOSAR will never work!“

„AUTOSAR is not feasible“

„The runtime environment will double the RAM/ROM allocations!“

AUTOSAR – Migration Strategy.
The Powertrain Pilot.

Cooperation between BMW AG, BMW Car IT and Siemens VDO

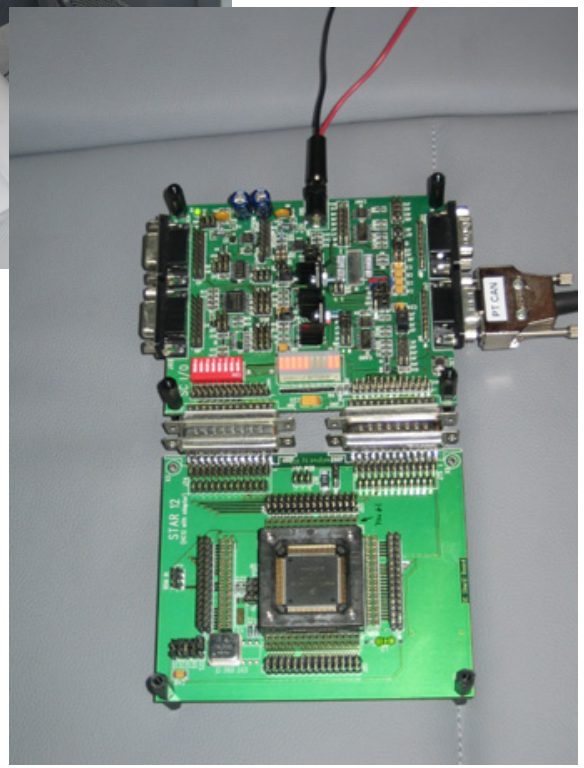


AUTOSAR – Migration Strategy.
The Powertrain Pilot.

The AUTOSAR Car at BMW CarIT

The MSV80 on and under the hood

The Imaginary ECU (ISG)



On the rear seat of the AUTOSAR car.

AUTOSAR – Migration Strategy.
Resource Allocation: RAM and ROM.

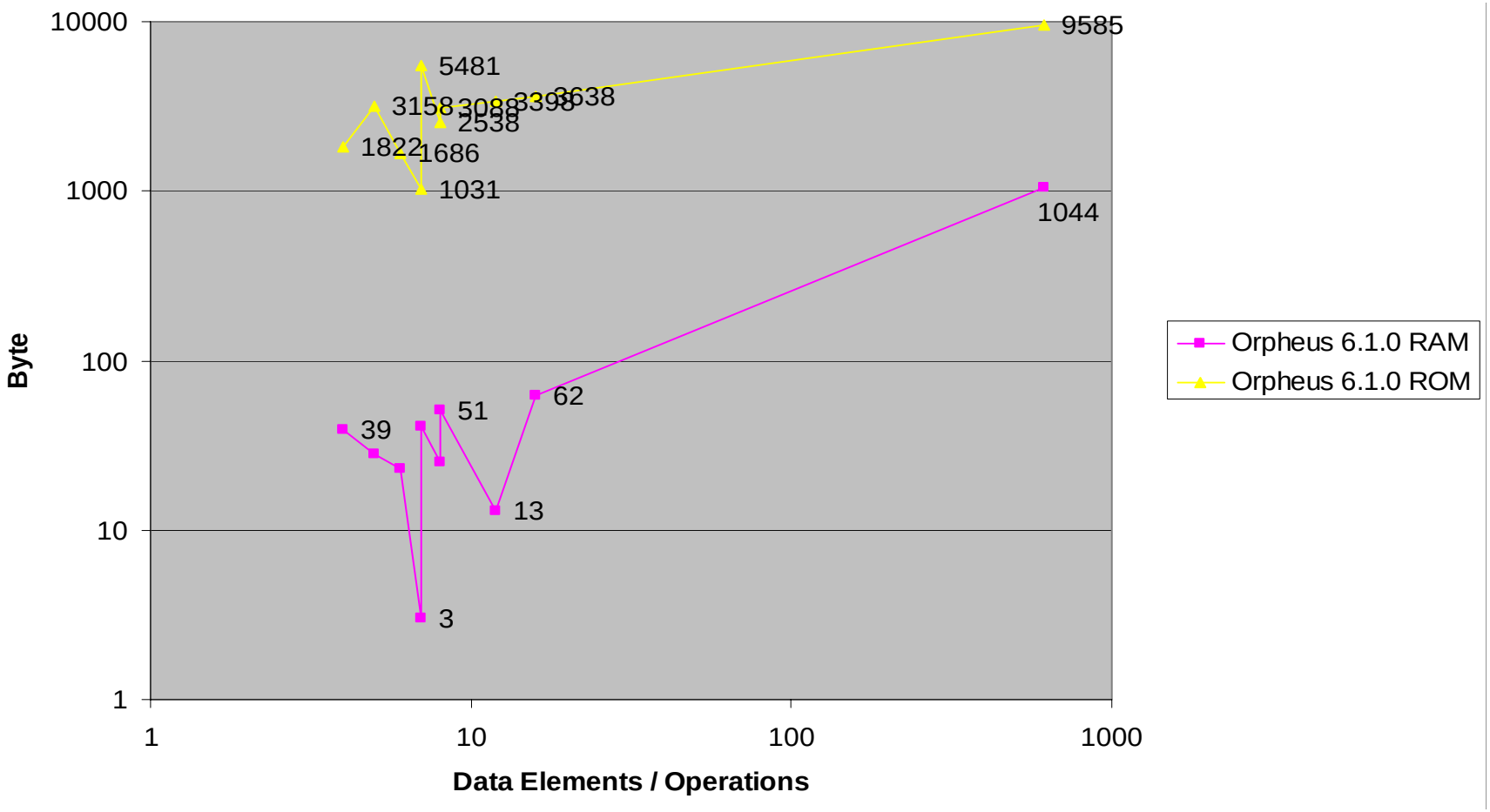
# of Software components	9	2 full compliant: PVI, TRCG9 capable: PVSV ... MTAC
# of Interfaces	12	-
# of Data Elements	15	1:3, 1:2, 10:1
# of Provided Ports	12	-
# of Required Ports	22	-
# of Connectors	22	15 RTE Write Functions 25 RTE Read Functions (26)
# of Runnables	none	Scenario II: 1 – PVI on ISG
Access Types	R, W	Data read and write access

Additional resources	Scenario I	Scenario II
ROM in bytes	390[3]+_?_[4]	428[3]+_?_[4]
RAM in bytes	23[1]	20[1]+ 9[2]

[1] – Internal RTE buffers
[2] – Temporary CAN message buffers
[3] – RTE Functions (RTE read/write, RTE PDU send/receive)
[4] – Additional code within the aggregates to call the RTE read and write functions and dealing with different resolutions of data.

AUTOSAR – Migration Strategy.

Resource Allocation: How does it scale?



AUTOSAR at BMW Group.
Future Work.

- Timing & Scheduling
- Safety aspects at model level
- Error handling at VFB level.

AUTOSAR at BMW Group.
Conclusion.

- The AUTOSAR approach is feasible
- AUTOSAR getting into series production
- Iterative prototyping is an appropriate way to boost the quality and acceptance of software innovations.
- AUTOSAR is an enabler for future innovations concerning timing, error management and safety aspects.

AUTOSAR at BMW Group.

Thank you for your attention.