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The communication system for advanced automotive control applications

FlexRay

Enabler for Future

Automotive System Architectures

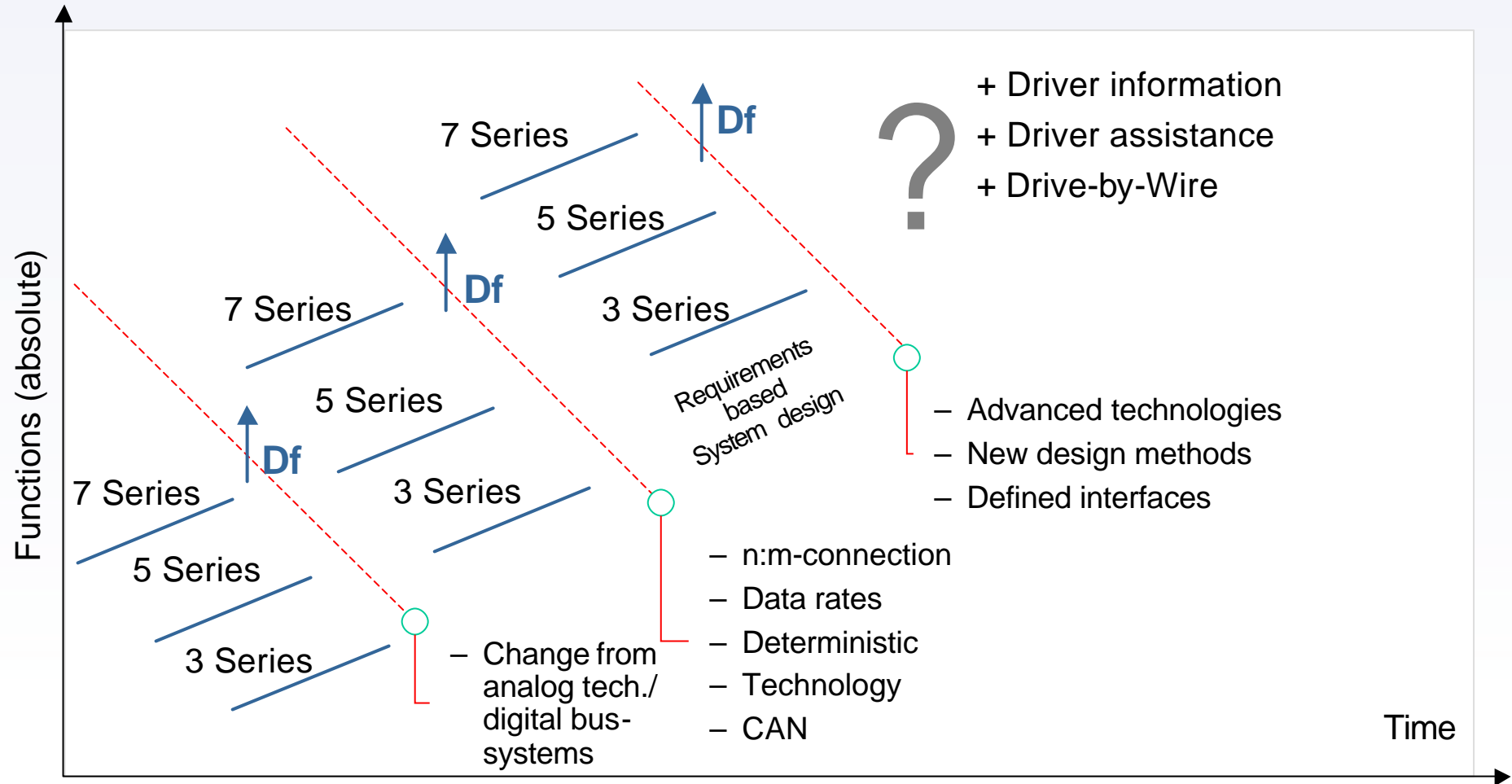
3rd March 2005

Genf

Dr. Günter Reichart - BMW Group



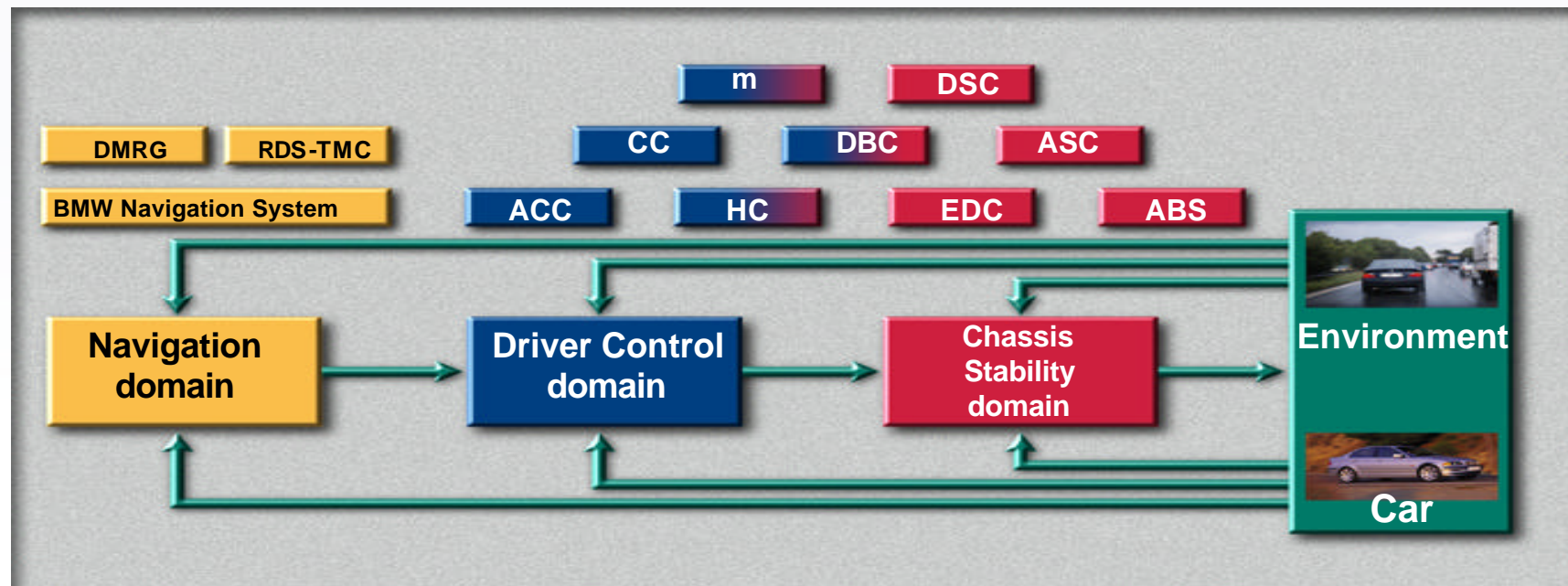
Requirements driven evolution of functions and systems - mapped on BMW car series





Situation snapshot of in-car E/E systems and architectures

- Increasing requirements (legal, functional and safety) demand for further electric/electronic systems
- Mechatronic will replace mechanic (e.g. Drive-by-Wire)
- New functions (e.g. driver assistance) need higher data exchange between functional domains

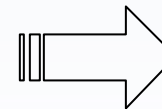
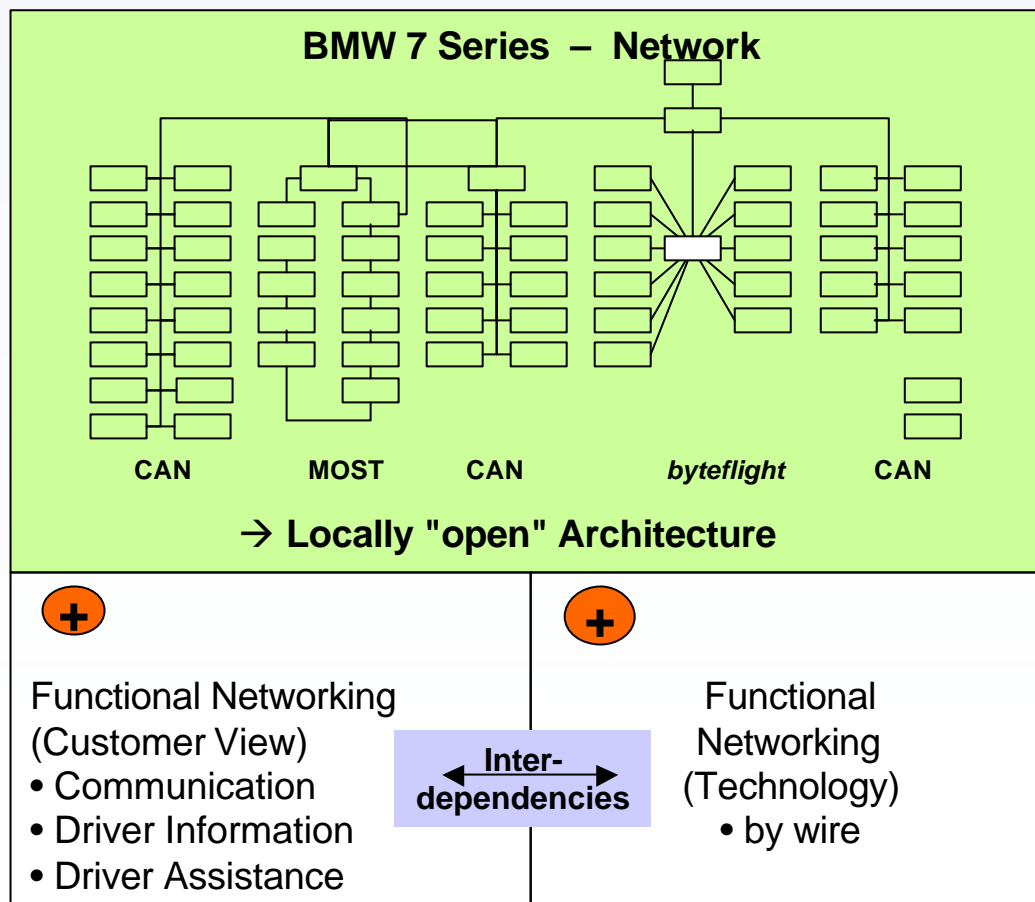




System Architecture - Complexity Management

Lessons learned ...

→ Complexity by introducing many communication systems in a single car platform



Goal:

**Reduction of variants in
specific communication
systems**

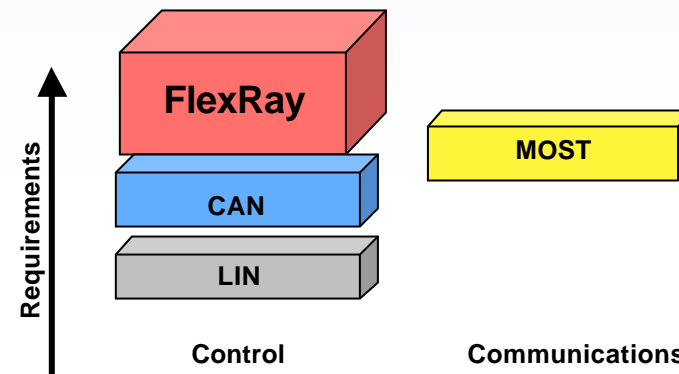
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**Common
Open System
Architecture Forward
Standardization**



Requirements for a common communication system mapped to the automotive application domains

- X-by-wire systems → Dependability and fault containment
- Chassis systems → Determinism
- Powertrain systems → High bandwidth
- Future backbone for open systems architectures → Flexibility and high bandwidth





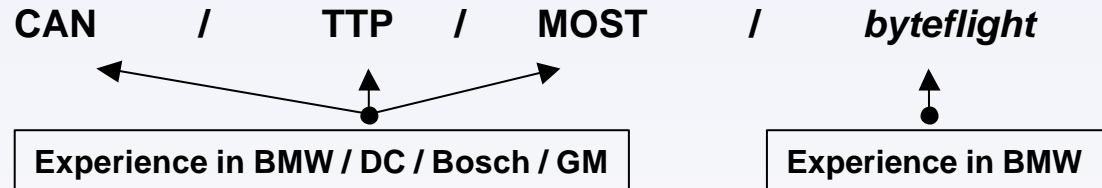
Requirements for Open System Architecture

- Displacement of functional modules beyond domain boundaries
- Strategy for reduction in technology variety is mandatory and it requires new feature integration
- Flexibility of hardware
- Approach must be based on future standards
- Standardized interfaces
- Support by development methods and tools



FlexRay History

1998 Analysis:



Start of communication between BMW and DaimlerChrysler

1999 *Realization: Future requirements are not fulfilled by existing protocols*

Since 1999 Consequences: Start of cooperation

2000 FlexRay Consortium founded by BMW, DaimlerChrysler, Motorola, Philips

Since 2000 Realization of FlexRay System together with semiconductor industry

10/2000 Bosch joins FlexRay Consortium

09/2001 General Motors joins FlexRay Consortium

04/2002 - 10/2002 Ford Motor Company, Mazda and Fiat join as Premium Associate Members

Q3/2003 Volkswagen joins the FlexRay Consortium

Q4/2003 Toyota, Honda, Nissan join the FlexRay Consortium as PAMs

06/2004 Release of FlexRay Specifications, SW & tools available to the general public

Q3/2004 PSA, Renault join the FlexRay Consortium as Premium Associate Members



Scope of the Consortium

The scope of the Consortium is to develop jointly an innovative communications network of very high quality which consists of the complete communication infrastructure and includes inter alia the specifications for the serial communications protocol, the transceiver, the hardware and software interfaces and conformance/certification procedures. This will serve as the basis for the development, production and implementation of certain communications networks for automotive applications.

The ultimate objective of the Consortium is the factual industry-wide recognition of a new standard for a deterministic automotive network which shall be open to use and development by third parties.



De-facto Automotive Standard

Core Members

BMW Group

Bosch

DaimlerChrysler

General Motors

Freescale

(Motorola)

Philips

Volkswagen

Premium Associate Members

ContiTeves

Delphi

Denso

Fiat

Ford Motor

Honda

Mazda

Nissan

Peugeot Citroen

Renault

Toyota

Tyco Electronics

Volvo

Associate Members

AMS

ATMEL

Avidyne

Berata

EADS

Elmos

ESG

Esterel

Fujitsu

Hella

Hitachi

Hyundai

Infineon

Mitsubishi

NEC

Nidec

Pacifica

Porsche

Renesas

RWTÜV

SiemensVDO

SP

ST Micro

Subaru

Sumitomo

Texas Instruments

ThyssenKrupp Automotive

TRW

Visteon

Yazaki

Development Members

Cadence

CANway

CapeWare

Cardec

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DECOMSYS

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IXXAT

MicroSys

National Instruments

NSI

3SOFT

Softing

SystemA

TecWings

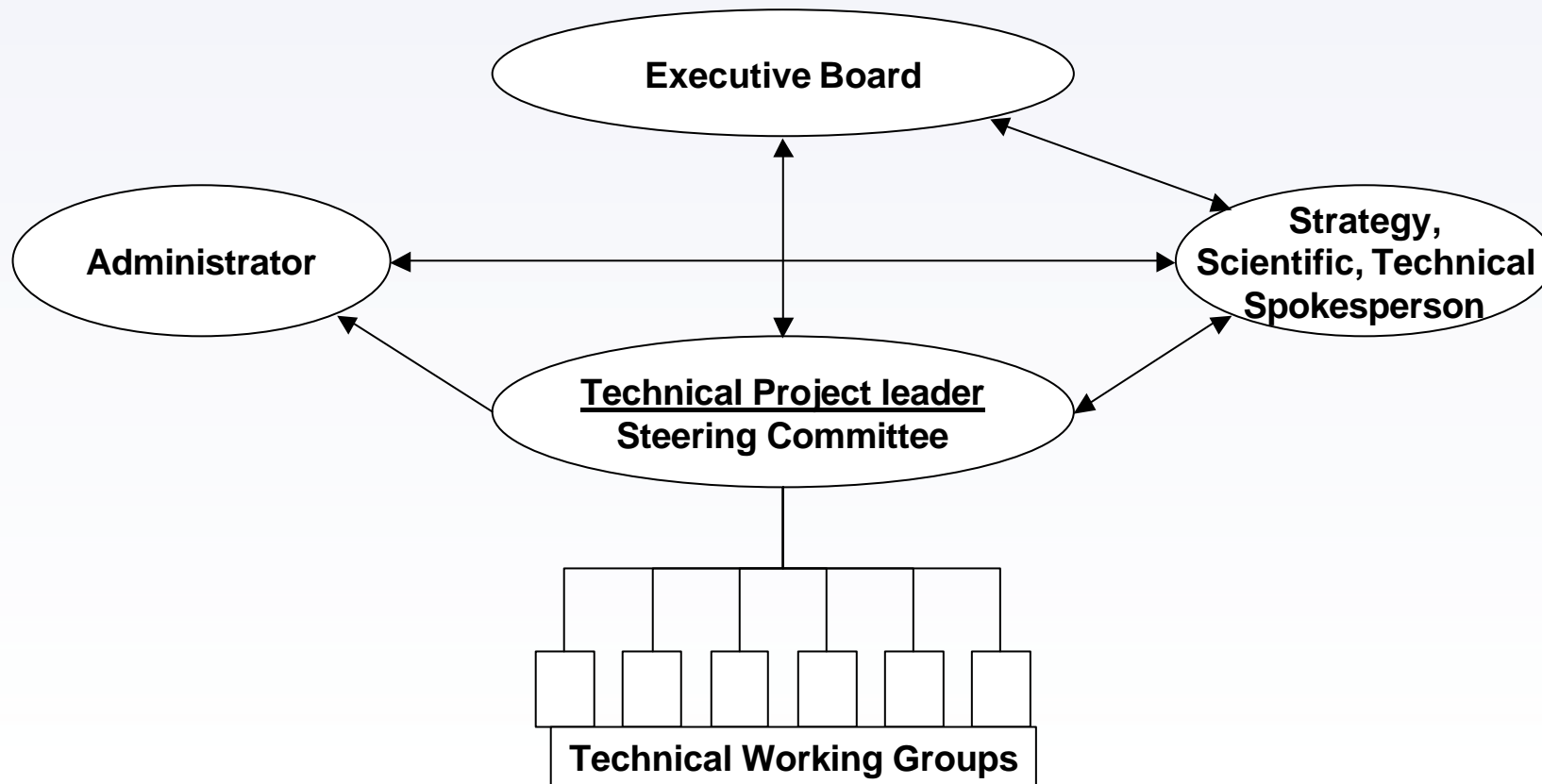
TZM

Vector Informatik

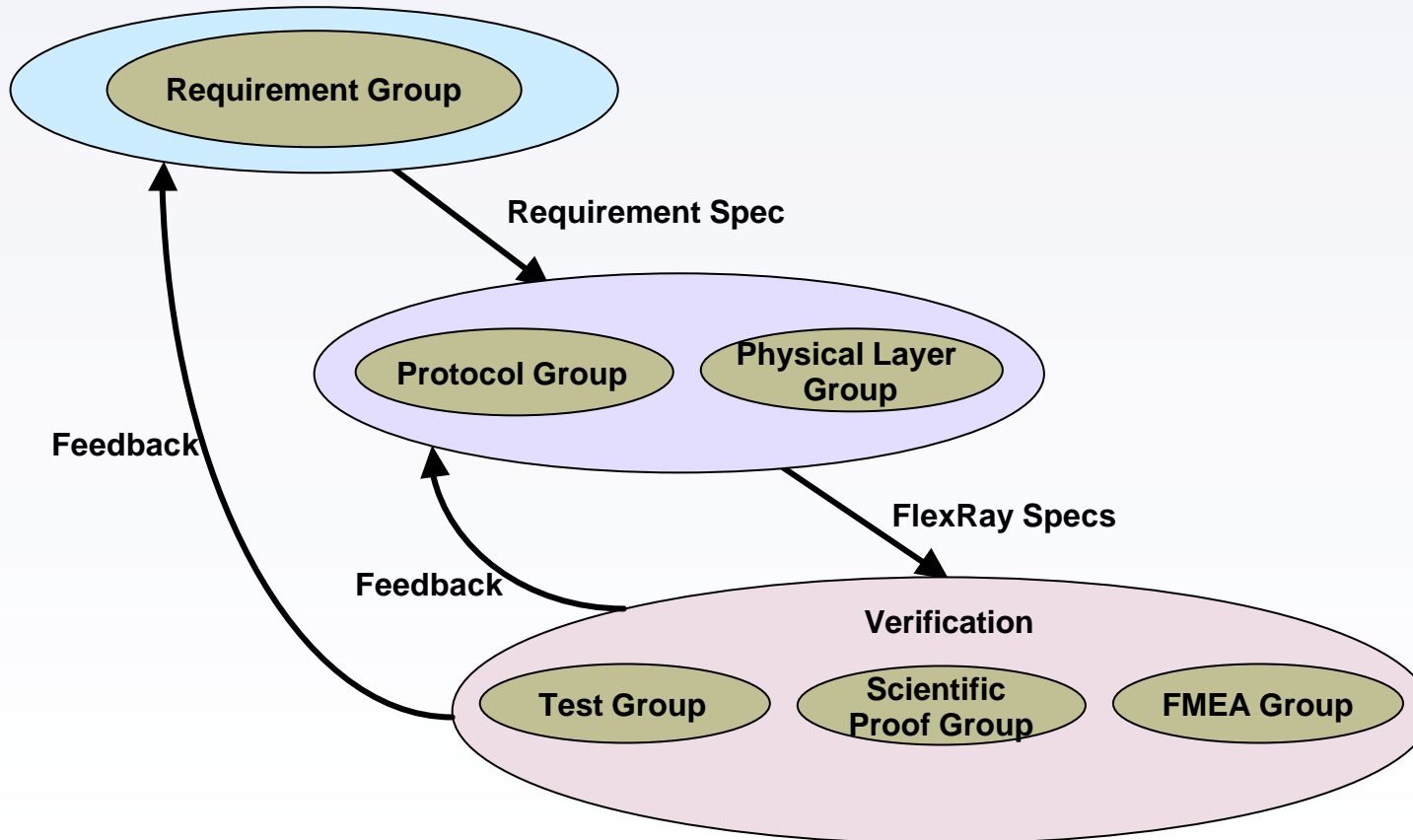
Volcano

Weise GmbH

Structure of the Consortium - Mechanisms



Working Group Structure

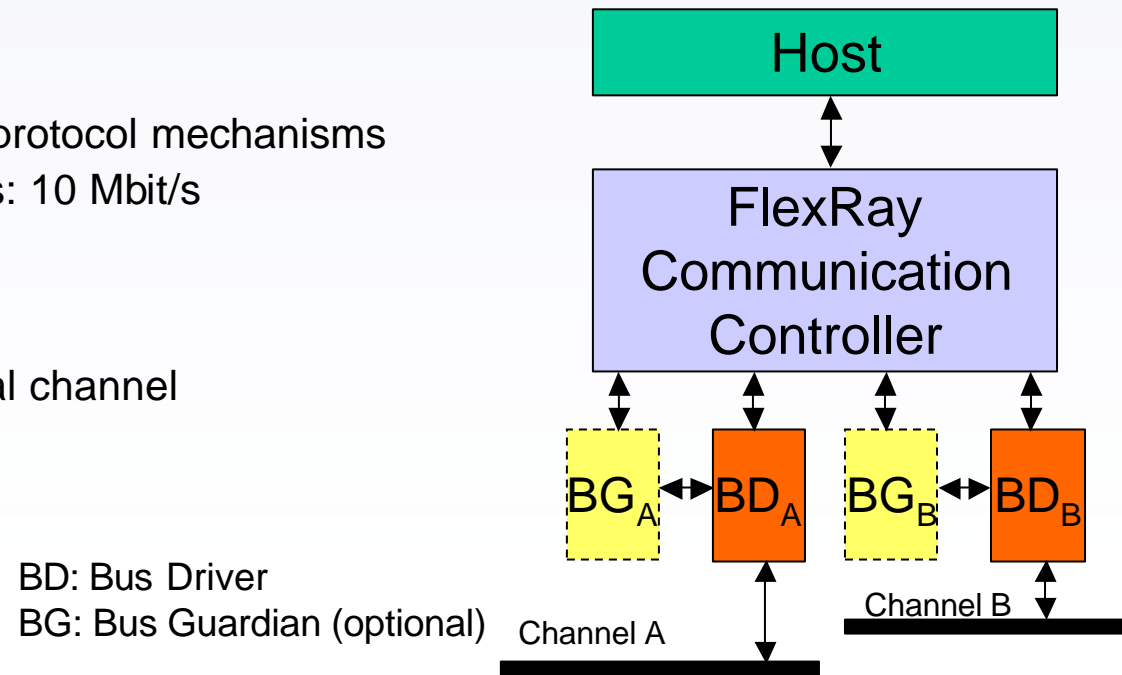




FlexRay - the communication system (1/3)

Features

- Forward-standardization – an objective from the beginning
 - OEMs, TIER1s and semiconductor vendors are represented in the FlexRay consortium
- Bandwidth
 - No limitation due to protocol mechanisms
 - Current design focus: 10 Mbit/s
- Scalability
 - Single channel / Dual channel
 - Mixed configuration





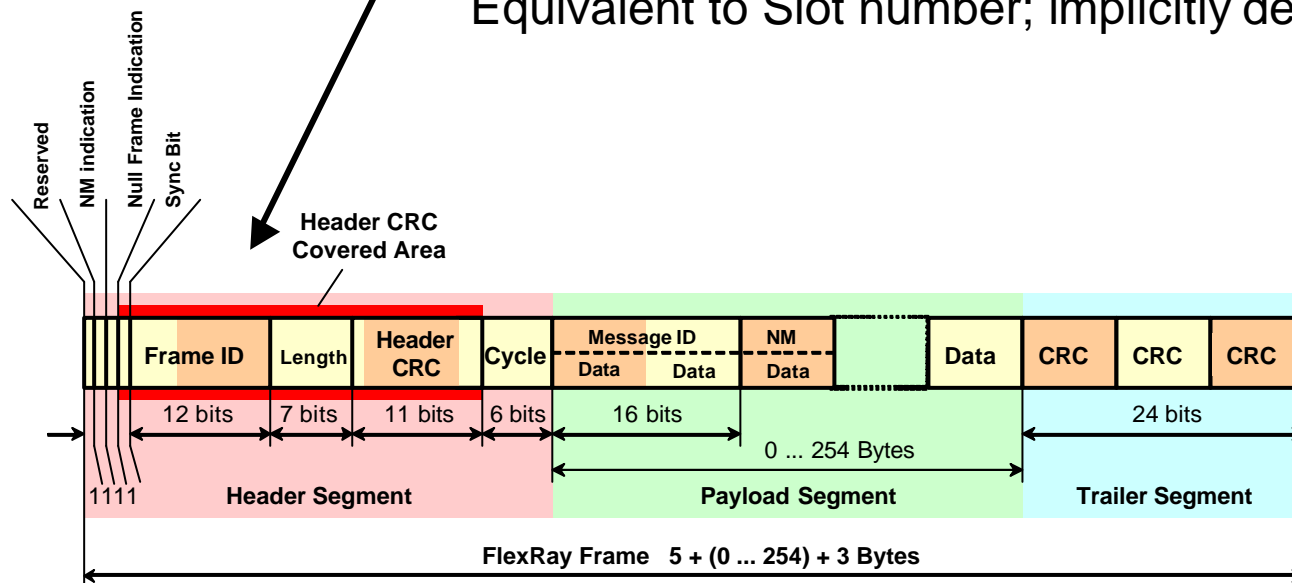
FlexRay - the communication system (2/3)

- Flexibility

- Open to many network topologies
- Electrical and optical Physical Layer
- Dynamic and static segments in communication cycle
- Frame ID

Frame ID:

Equivalent to Slot number; implicitly denotes the sender



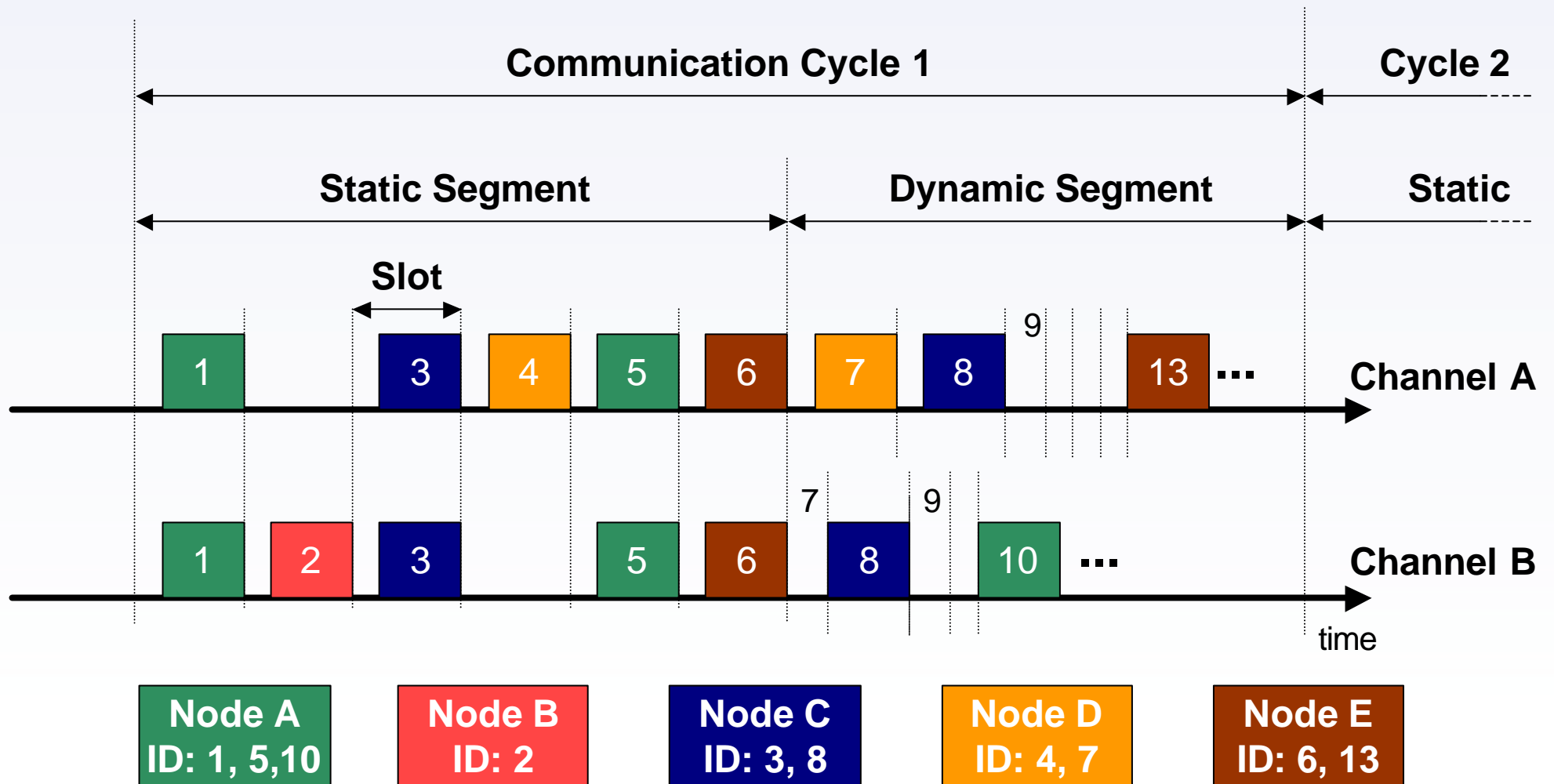


FlexRay - the communication system (3/3)

- Deterministic
 - Stringent deterministic by TDMA media access (Time Division Multiple Access) in static segment
 - Limited deterministic by FTDMA media access (Flexible Time Division Multiple Access) in dynamic segment
- Safety
 - Distributed Clock Synchronization
 - Offset and Rate Correction
 - Bus Guardian
 - CRC
 - Header CRC
 - Frame CRC
 - Hamming Distance of 6

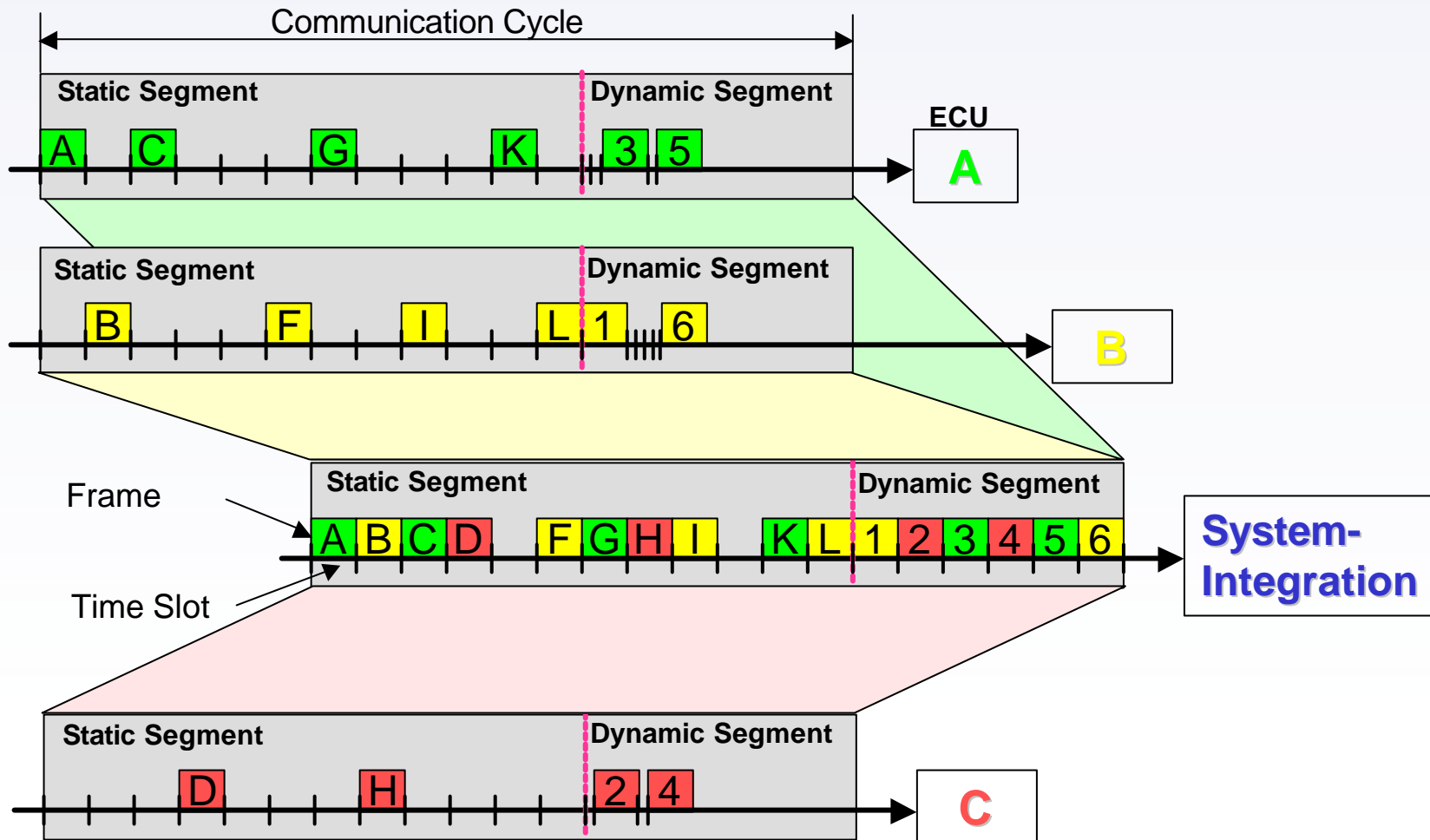


FlexRay Bus Access Method





FlexRay Time Triggered Communication Composability in the Time Domain



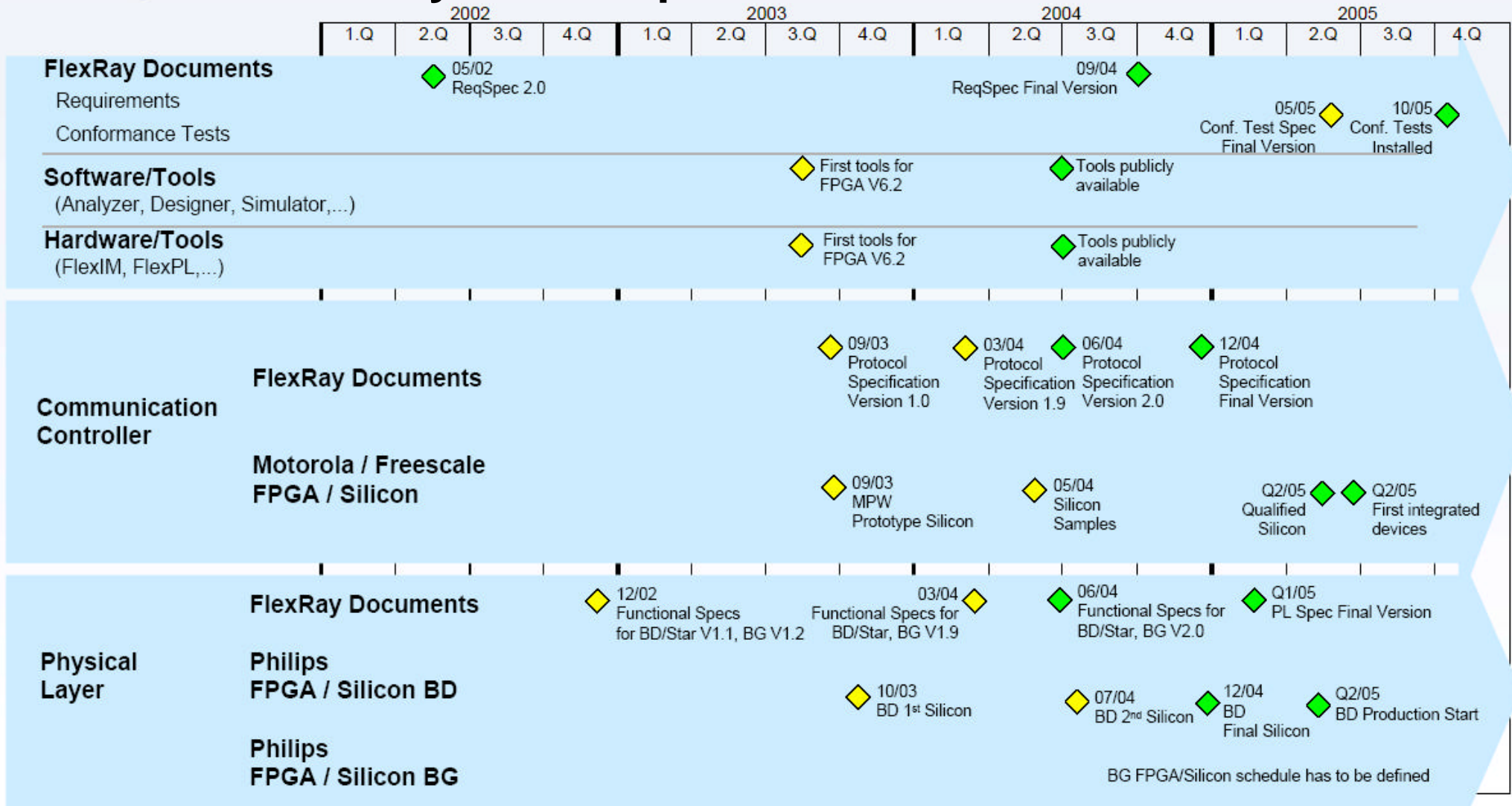


Benefits of the FlexRay Technology

- Provide a communication infrastructure for future generation high-speed control applications in vehicles such as advanced powertrain, chassis, and by-wire systems.
- High bandwidth (net data rate 5 Mbps at gross 10 Mbps), flexible use of bandwidth
- Deterministic behavior (guaranteed transmission time for frames in the static segment)
- Synchronization of tasks in distributed control systems
- Cycle times < 2 ms
- Reliable data communication
- Facilitation of system integration
- Reserves for future functional extensions
- Possibility to implement future real Drive-by-Wire functions without mechanical back-up



FlexRay Roadmap

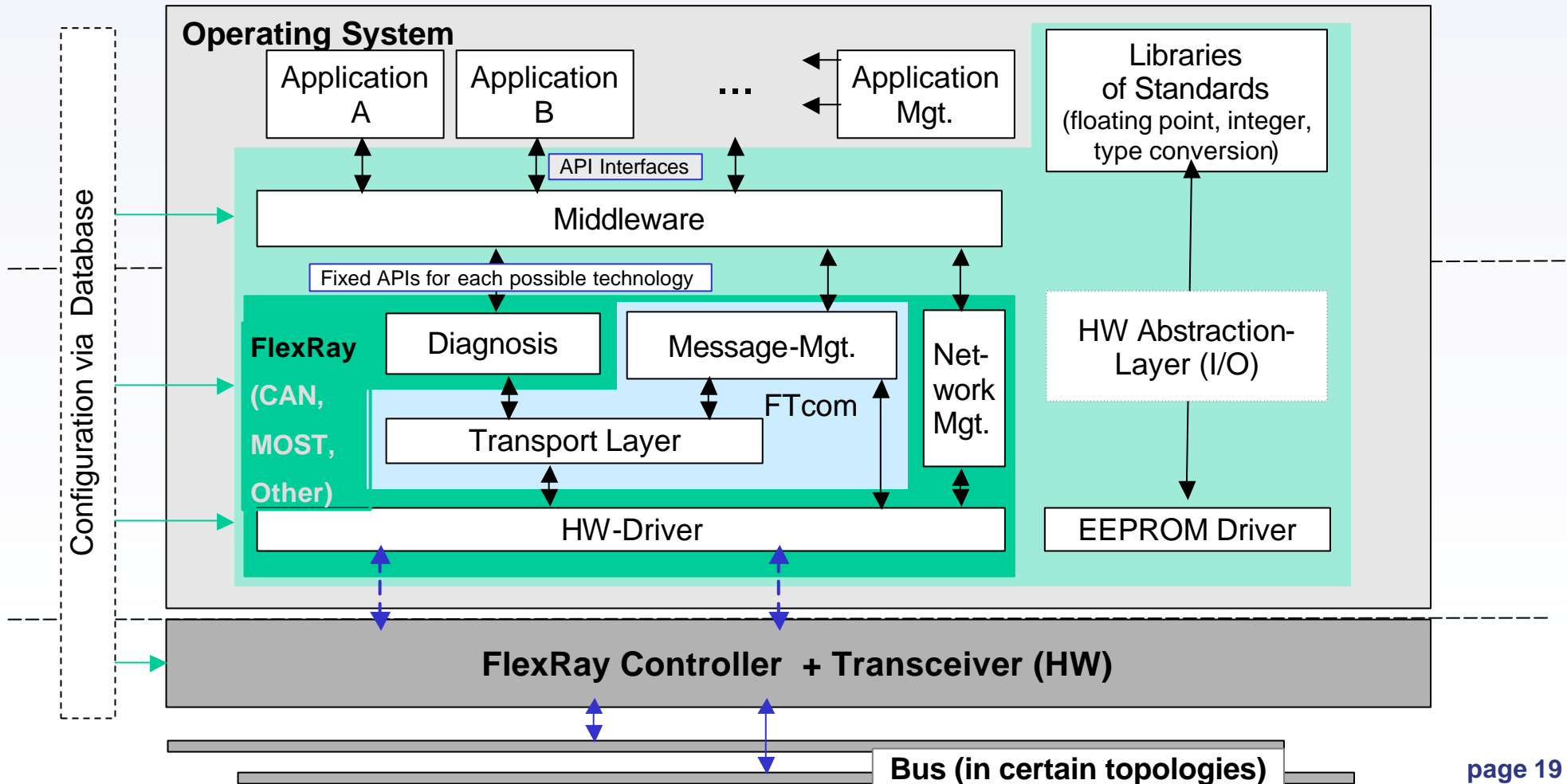


◆ FlexRay Consortium (Motorola/Freescale, Philips FPGA/silicon products subject to bilateral agreement)
 ◆ General Public (Motorola/Freescale, Philips FPGA/silicon products subject to bilateral agreement)

Date: 2004-08-04



Standard-Structure model with FlexRay as underlying Communication Layer





Activities around the FlexRay protocol

- Physical Layer development proceeding in parallel
- HW features to support future network management concepts
 - ie. Network Management Indication Bit and Network Management Vector
- OSEKtime
 - OSEK enhancement for time triggered operation
- FTcom: Fault Tolerant communication layer for OSEK architecture
 - specification and pilot-implementations available
- FIBEX (Field Bus EXchange format)
 - XML-exchange format based on a generic bus model enables interoperability between databases and development tools



Enabler for OSAR



Summary

- FlexRay is a communication system targeted at high-speed control applications in vehicles such as advanced powertrain, chassis, and by-wire systems.
- FlexRay supports these applications by providing architectural flexibility through scalability and functional alternatives.
- FlexRay is expected to be the de-facto communication standard for high-speed automotive control applications.



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Thank you for your attention!

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