



## Specifics of Embedded Software for FlexRay

AUTOSAR Roadshow 2008

# Agenda

## > FlexRay

FlexRay BasicSoftWare (BSW)

Calibration and Measurement (XCP)

Flashbootloader FlexRay

# FlexRay

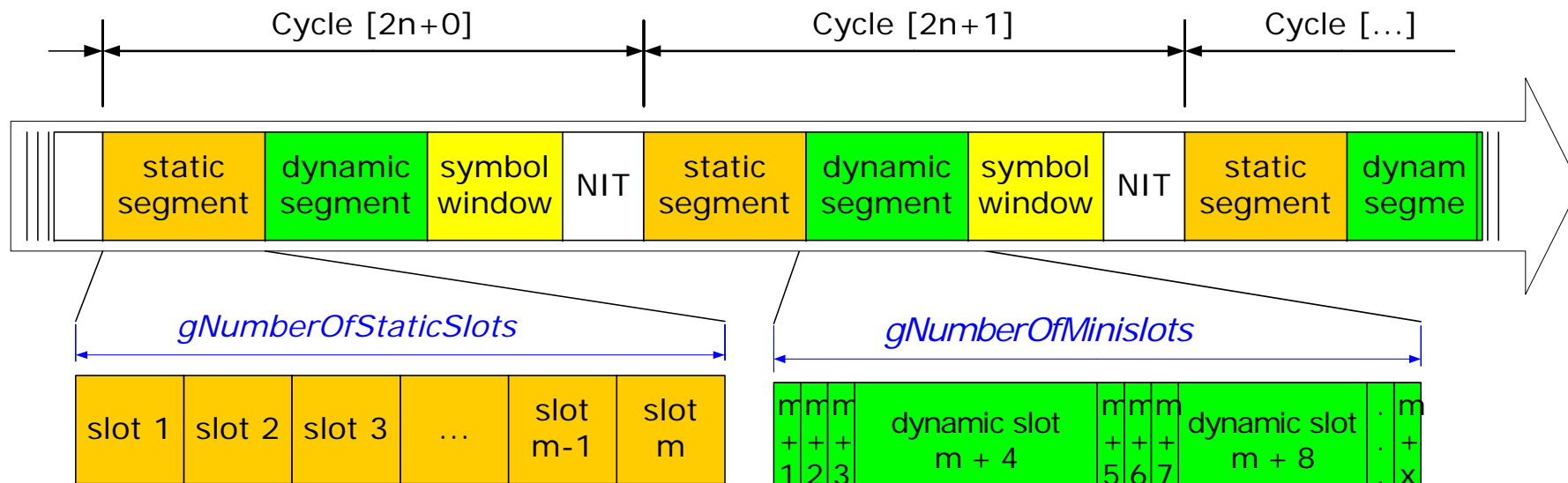
## Overview

- ❑ FlexRay Consortium was founded in September 2000 by BMW, DC, Philips and Motorola
- ❑ Data rate 10 Mbit/sec per channel
- ❑ Two channels (A & B)
- ❑ Fault tolerant synchronized global time base
- ❑ TDMA in the static segment, dynamic bandwidth allocation in the dynamic segment
- ❑ Supports bus and star topology



# FlexRay

## Communication Structure



### Static slots:

- All static slots have the same length:  $gdStaticSlot$
- Slot IDs are allocated uniquely to send nodes
- Local slot counter of each individual node begins at 1
- At least 2 and a maximum of 1023 static slots can be present

### Dynamic minislots:

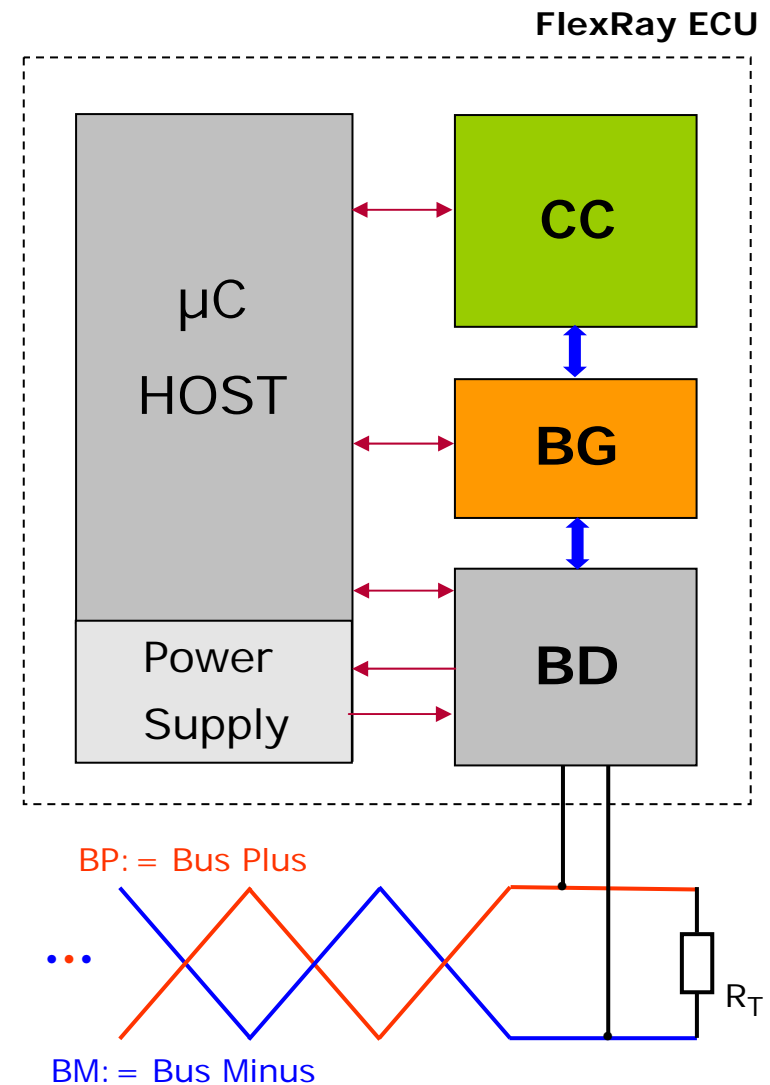
- Are placeholders that are replaced by dynamic slots if there is a need to send
- Local Minislot counter of each individual node begins at 1
- Between 0 and 7986 Minislots may exist

# FlexRay

## Design of a FlexRay ECU

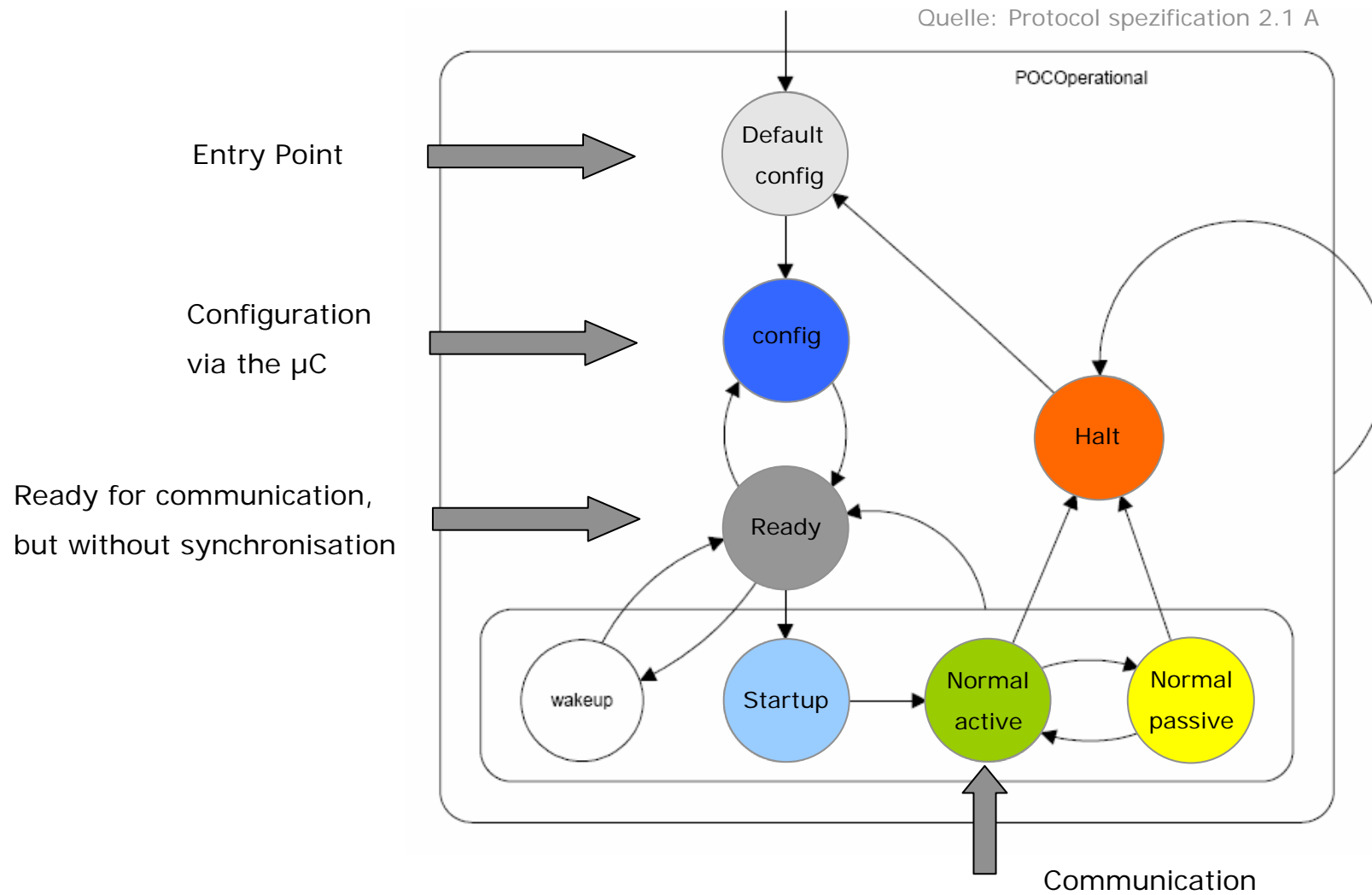
### Elements of a FlexRay ECU

- ❑ **μC** := HOST  
Execution of the program/code specifically for a certain microcontroller.
- ❑ **CC** := Communication Controller  
Serves as interface for sending and receiving of the FlexRay frames.
- ❑ **BG** := Bus Guardian  
Optionally supervises the timely correct bus access.
- ❑ **DB** := Bus Driver  
Level Converter between ECU and FlexRay Bus. At the same time serves as amplifier for the FlexRay signals.



# FlexRay

## Conditions of the Communication Controllers



### Goals IP (Intellectual Property)

- ❑ Implementation of the FlexRay Protocol was not realized directly as an integrated circuit but only as an HDL-File.
- ❑ HDL := Hardware Description Language. This language serves as a description of the functionality of an integrated circuit, independent of the manufacturing technology.

### Variants

- ❑ BOSCH / VHDL Format: → E-Ray
- ❑ Freescale / Verilog Format: → MFR4xxx
- ❑ XILINX

### Implementation

- ❑ Various silicon manufactures are offering their own FlexRay devices based on these e.g. stand-alone, on-chip or as FPGA solution.

# Agenda

FlexRay

> **FlexRay BasicSoftWare (BSW)**

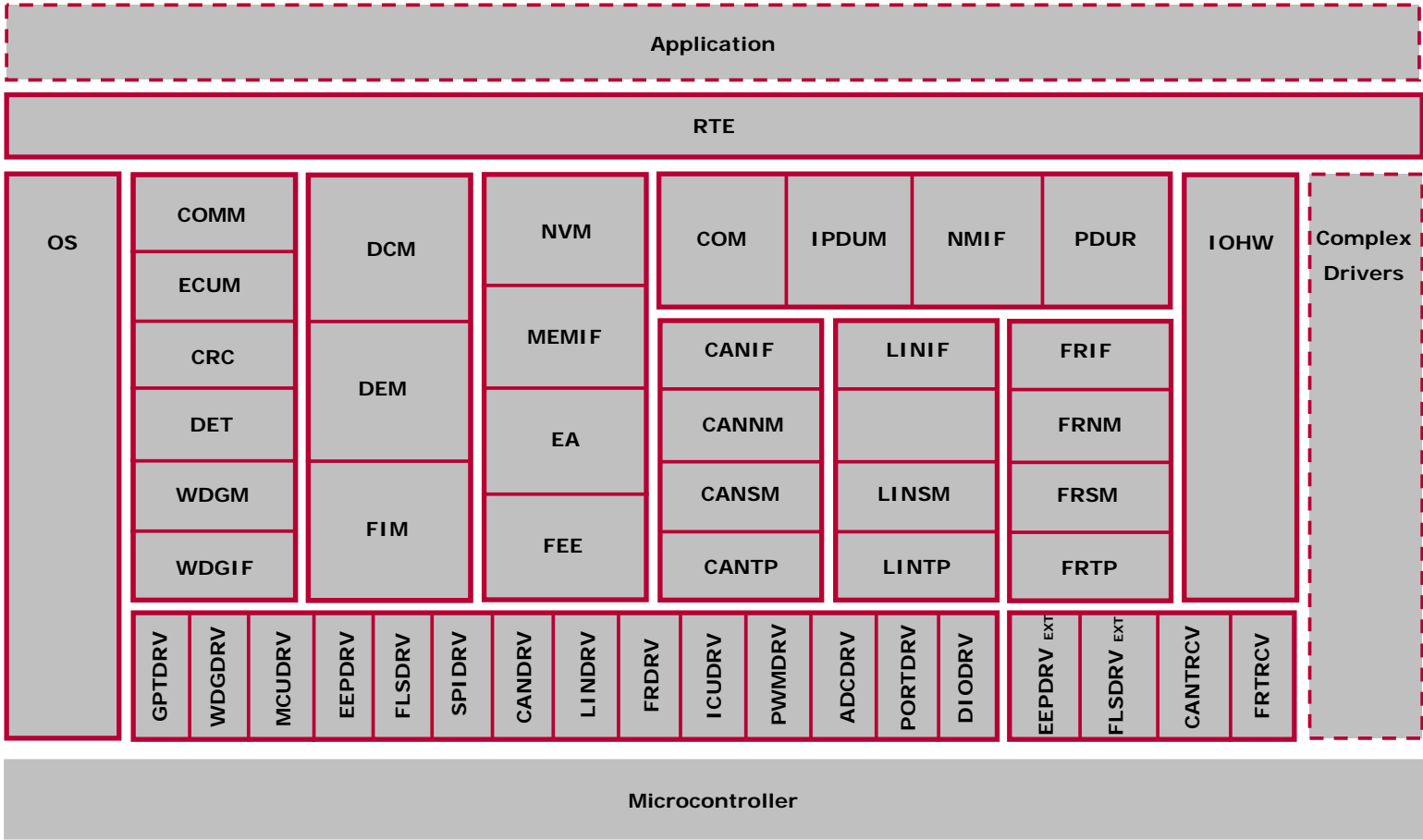
Calibration and Measurement (XCP)

Flashbootloader FlexRay

# FlexRay BasicSoftWare (BSW)

## MICROSAR – Basic Software for AUTOSAR 3.0

Full range of basic software modules offered by Vector



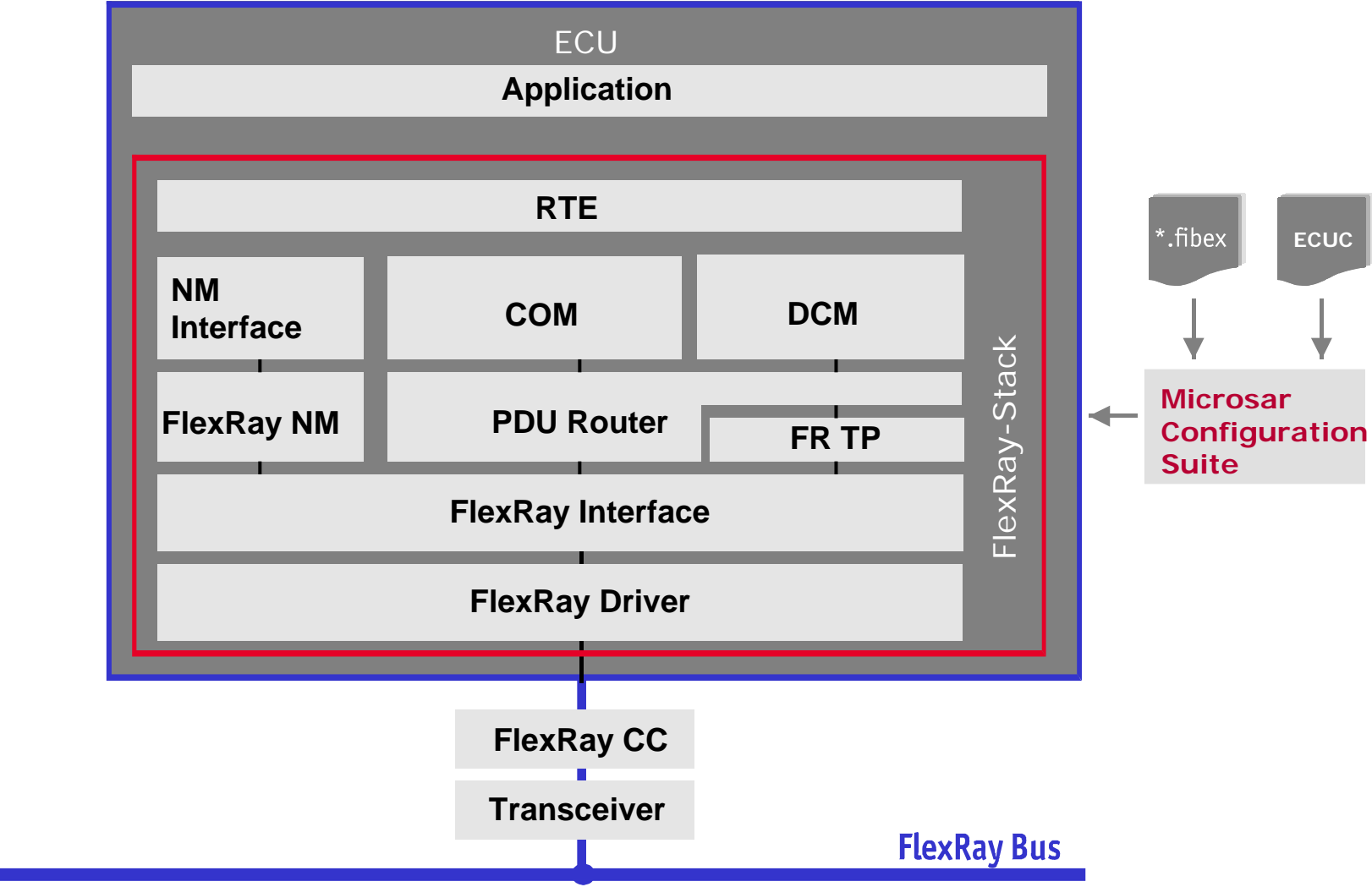
Vector MICROSAR product

Service by Vector



# FlexRay BasicSoftware (BSW)

## Overview



# FlexRay BasicSoftware (BSW)

## Duties

- ❑ FlexRay Driver:
  - ❑ Initialize the FR Controller
  - ❑ Send and Receive Frames
  - ❑ Detection of FR Controller Errors
  
- ❑ FlexRay Interface
  - ❑ Assemble PDUs to Frames and vice versa
  - ❑ Handling of PDU Update Bits
  - ❑ Indication/Confirmation
  
- ❑ FlexRay TP
  - ❑ Handling of segmented and (un)segmented PDUs
    - ❑ ISO Format
    - ❑ Extended Formats

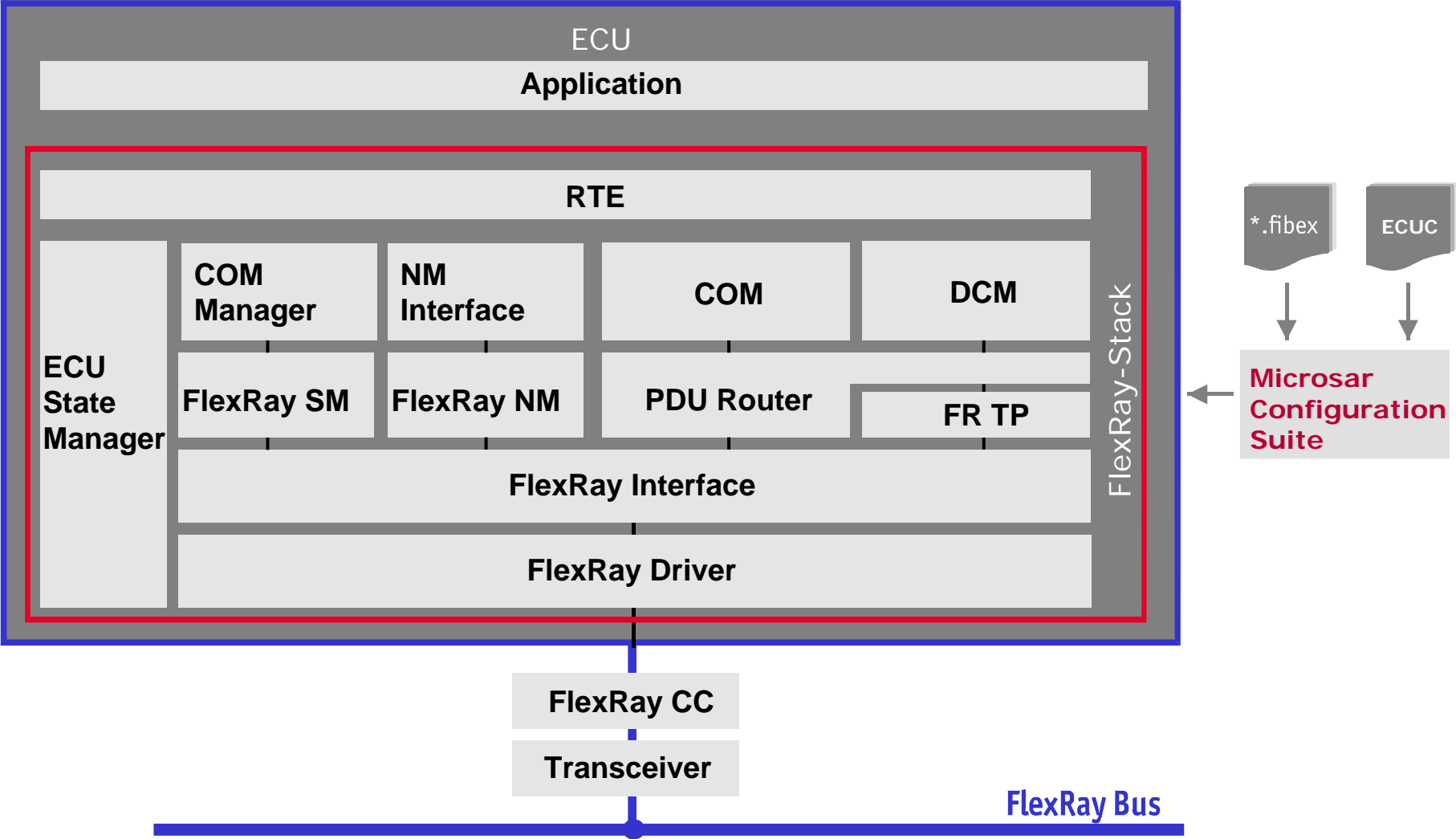
# FlexRay BasicSoftware (BSW)

## Duties

- ❑ Network Management:
  - ❑ Indication of the local communication needs to others
  
- ❑ PDU Router
  - ❑ Dispatching PDUs to COM and DCM
  - ❑ Might contain PDU-Gateway
  
- ❑ COM
  - ❑ Extraction of signals out of PDUs
  - ❑ Endianness handling
  - ❑ Various trigger conditions
  - ❑ Might contain Signal-Gateway

# FlexRay BasicSoftware (BSW)

## Overview



# FlexRay BasicSoftWare (BSW)

## Duties

- ❑ ECU State Manager:
  - ❑ Handling of ECU States (OFF, RUN, SLEEP, STARTUP and SHUTDOWN)
  - ❑ Initializing of OS and all BSW modules
  
- ❑ COM Manager:
  - ❑ Initializing of communication stack (IFs, NMs, TPs, PDU, ...)
  - ❑ Switch on/off requested bus communication
  - ❑ Bus error management
  
- ❑ FR State Manager: New for AUTOSAR 3.0
  - ❑ Wakeup and Startup handling for FlexRay

# Agenda

FlexRay

FlexRay BasicSoftWare (BSW)

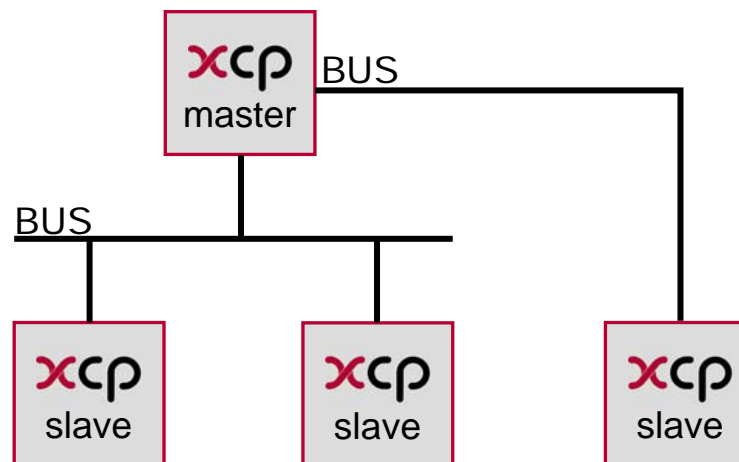
**> Calibration and Measurement (XCP)**

Flashbootloader FlexRay

# Calibration and Measurement (XCP)

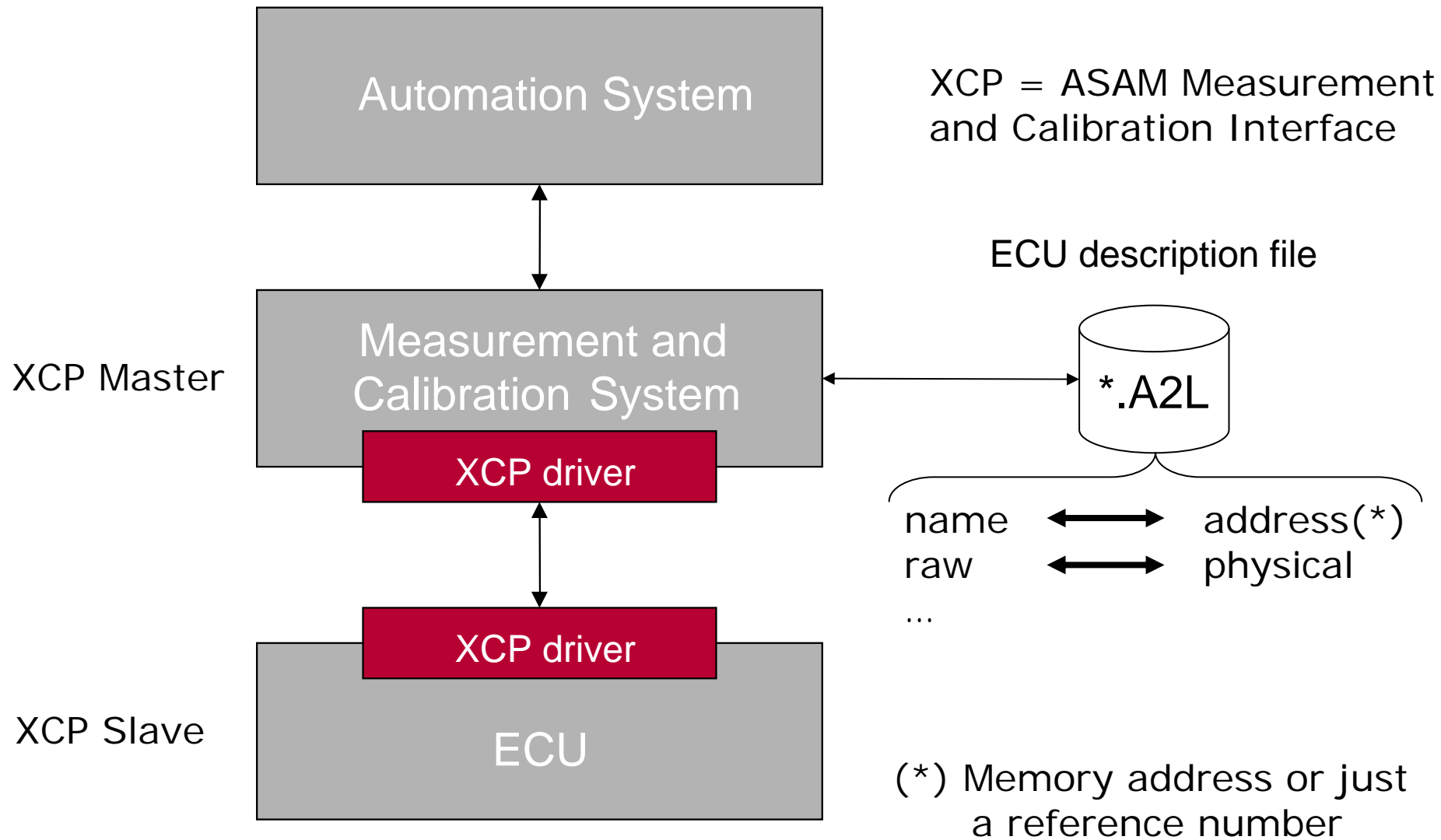
## Overview

- ❑ XCP is the successor of CCP (CAN Calibration Protocol)
- ❑ XCP stands for Universal Calibration Protocol
- ❑ The “**X**” generalizes the “various” transportation layers used by the members of the protocol family e.g. “XCP on CAN”, “XCP on Ethernet”, “XCP on UART/SPI”, “XCP on LIN”, etc.
- ❑ ASAM Measurement and Calibration Interface, standard since 2003
- ❑ Single Master, Multi Slave concept



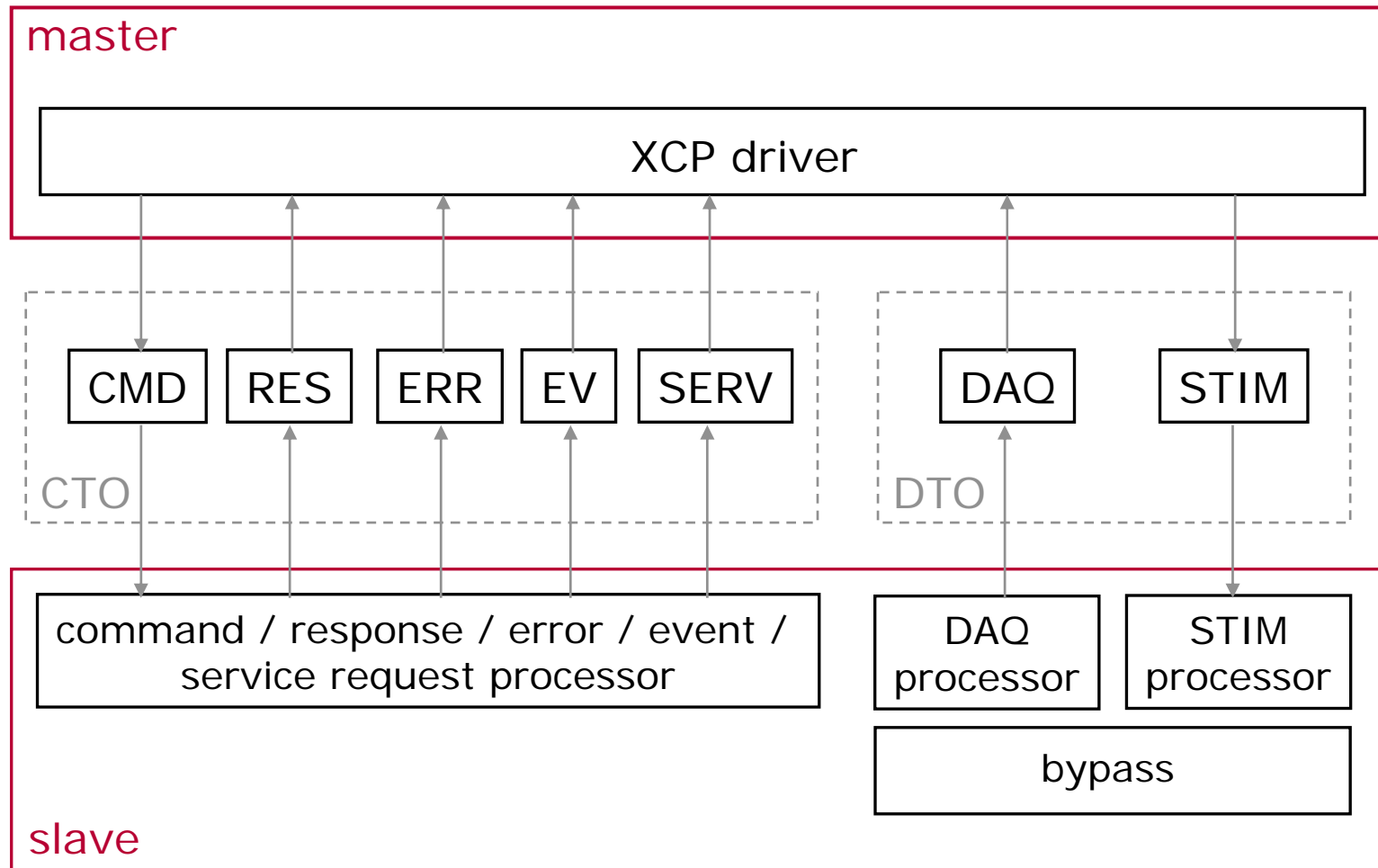
# Calibration and Measurement (XCP)

## Overview



# Calibration and Measurement (XCP)

## Communication between Master and Slave

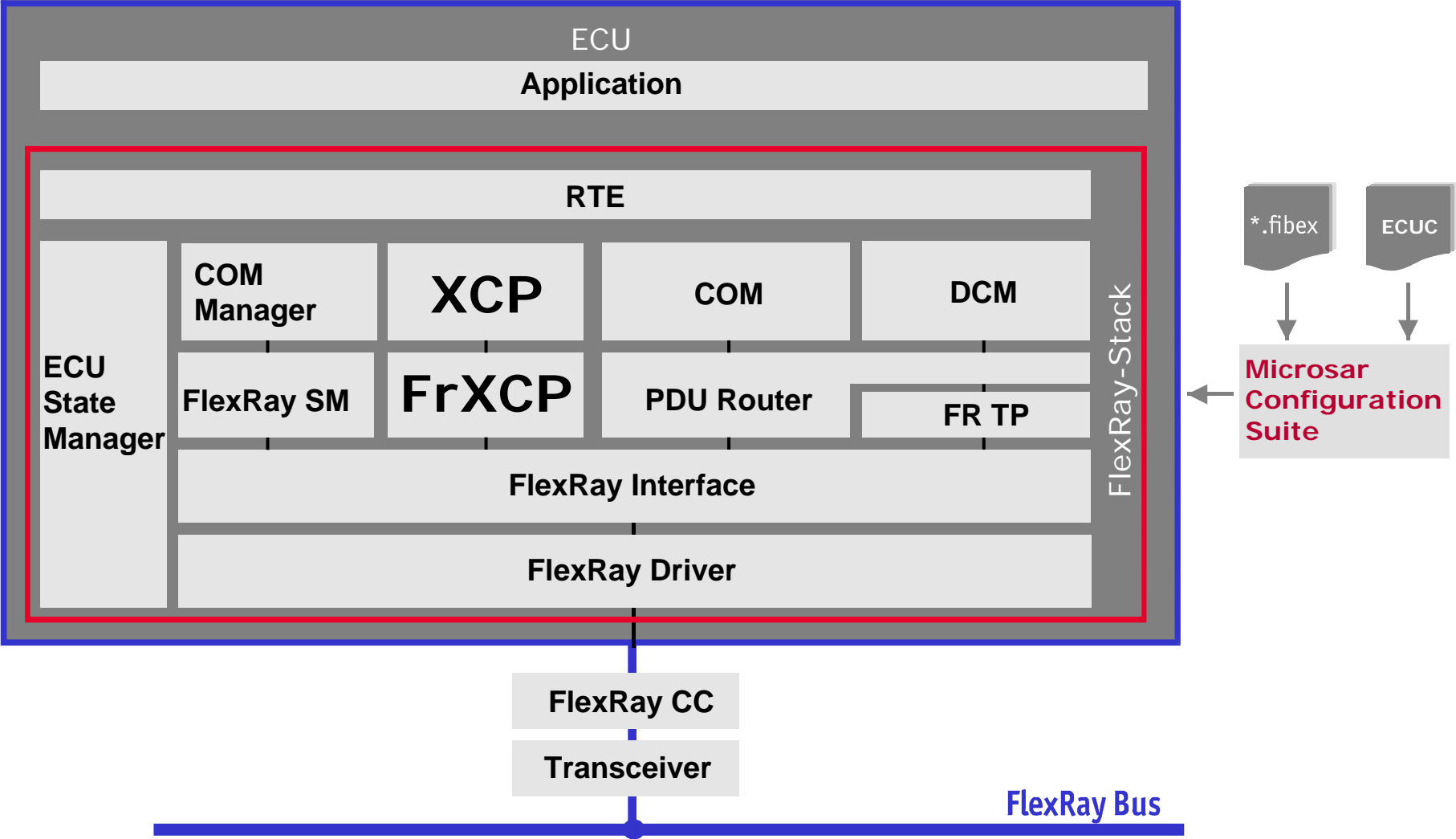


CTO: Command Transfer Object

DTO: Data Transfer Object

# Calibration and Measurement (XCP)

## XCP on FlexRay - Architecture



# Calibration and Measurement (XCP)

## XCP on FlexRay - Configuration

### ❑ Static Part

#### ❑ only XCP\_PRE\_CONFIGURED

- Exclusive L-PDUs for each Slave
- Not reconfigurable
- Unique assignment Master-Slave, no slot-multiplexing

### ❑ Dynamic Part

#### ❑ XCP\_PRE\_CONFIGURED

- Pre-configured L-PDUs
- Exclusive or per Slot-Multiplexing

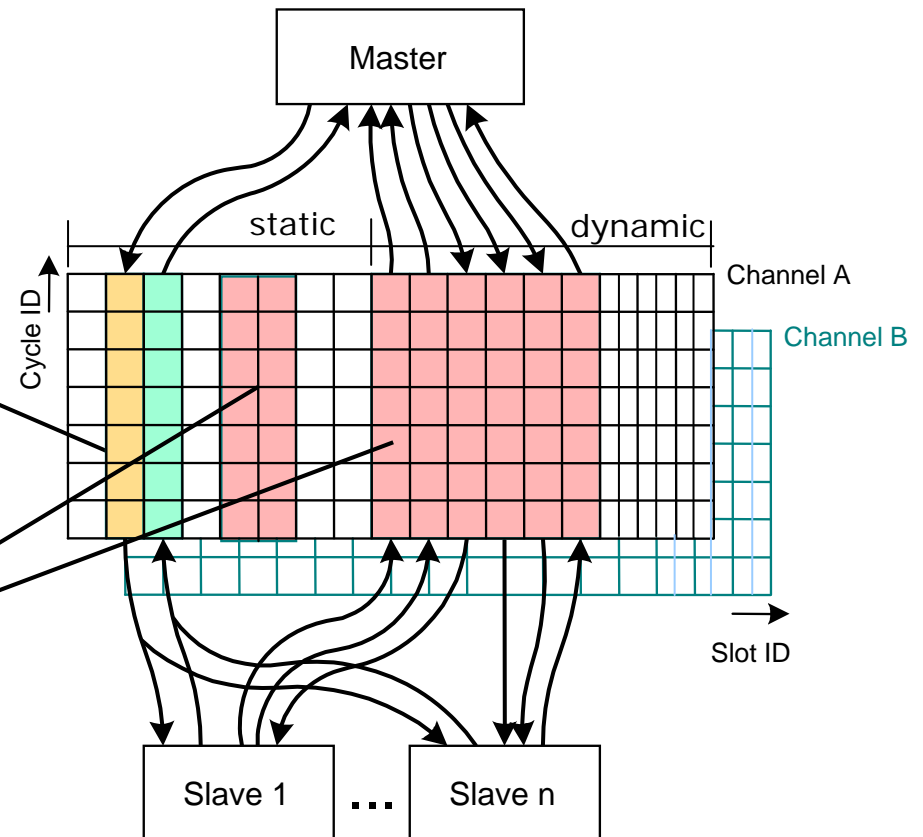
#### ❑ XCP\_RUNTIME\_CONFIGURED

- Run-time configurable L-PDUs
- Initialization by the Master

# Calibration and Measurement (XCP)

## XCP on FlexRay - Example

- ❑ Arbitration by the XCP-Master via mutually used CMD and RES channels in order to avoid collisions
- ❑ Measured values are transmitted via L-PDUs dynamically assigned at run-time



# Agenda

FlexRay

FlexRay BasicSoftWare (BSW)

Calibration and Measurement (XCP)

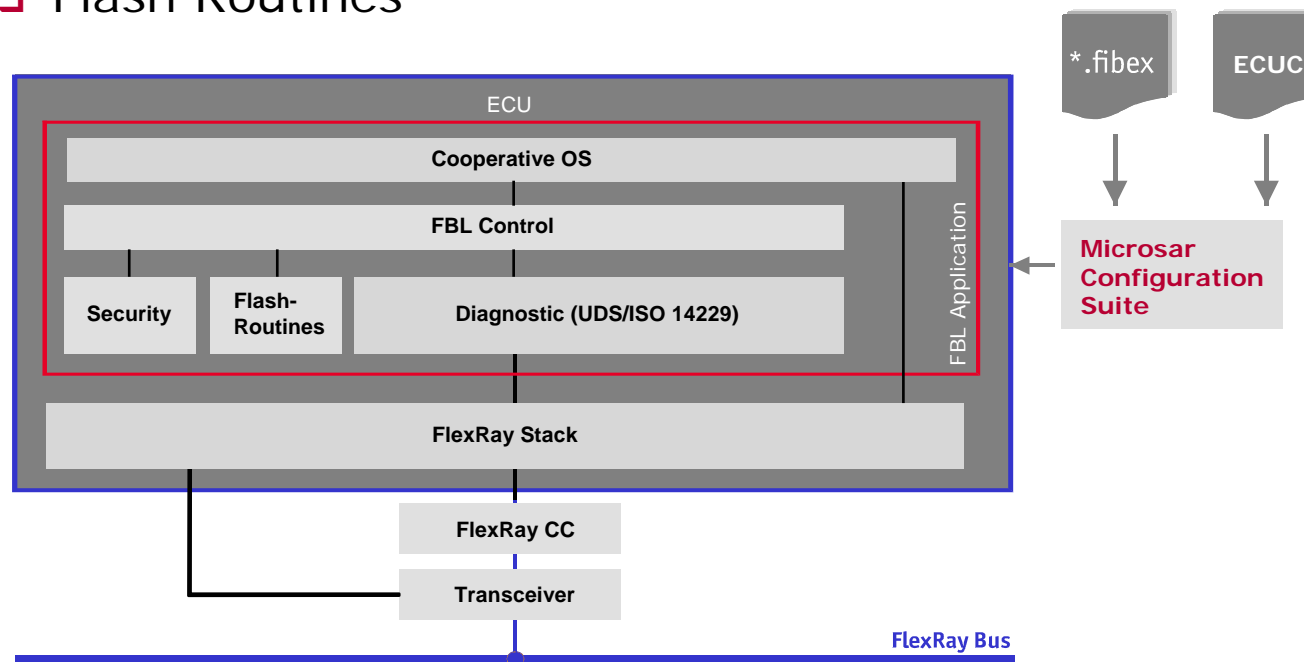
**> Flashbootloader FlexRay**

# Flashbootloader FlexRay

## Architecture

### FlashBootLoader Application

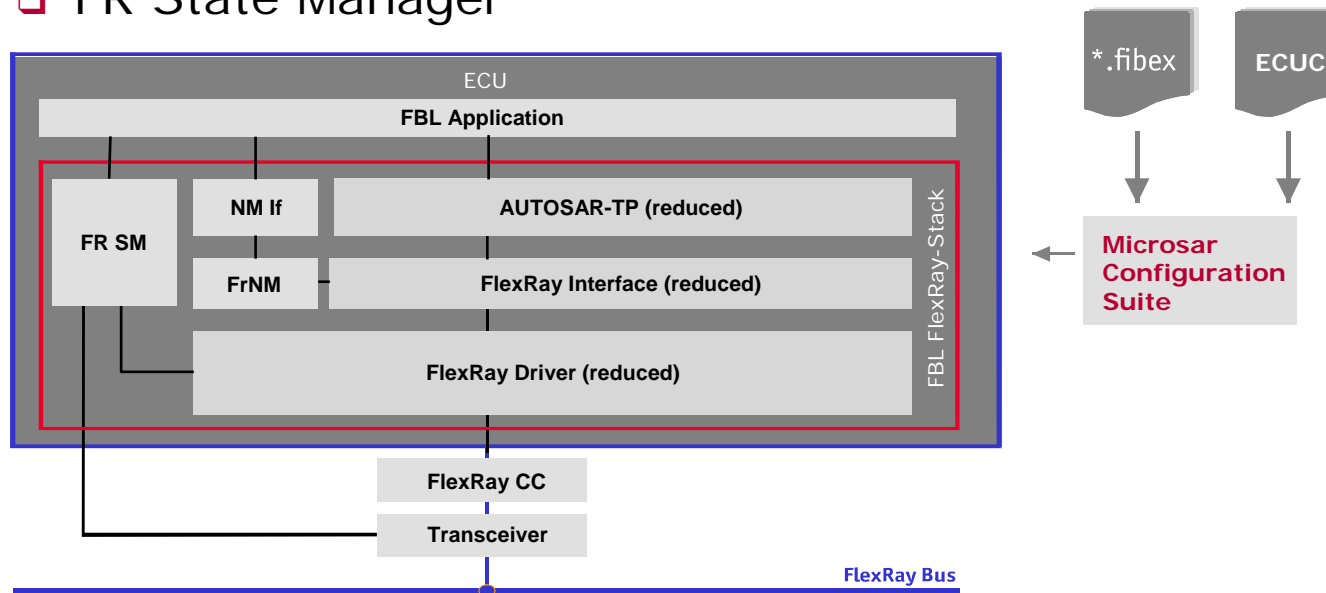
- ❑ Diagnostic (UDS/ISO 14229)
- ❑ FlashBootLoader Control
- ❑ Security
- ❑ Flash Routines



# Flashbootloader FlexRay

## Architecture

- ❑ Optimized FlexRay-Stack
  - ❑ AUTOSAR FlexRay Driver (reduced)
  - ❑ AUTOSAR FlexRay Interface (reduced)
  - ❑ AUTOSAR TP (reduced, single configuration)
  - ❑ Network Management (optional)
  - ❑ FR State Manager



# Flashbootloader FlexRay

## Example

- ❑ Data throughput depends on
  - ❑ FlexRay Schedule
    - ❑ Same schedule as for regular communication
    - ❑ Different schedule, specifically tailored for flashing
  - ❑ TP-Configuration
    - ❑ How many PDUs are assigned to the TP-channel
    - ❑ What size are these PDUs



Thank you for your attention.

For detailed information about Vector  
and our products please have a look at:

[www.vector-informatik.com](http://www.vector-informatik.com)

Author:

Dirk Großmann

Vector Informatik GmbH

Ingersheimer Str. 24

70499 Stuttgart