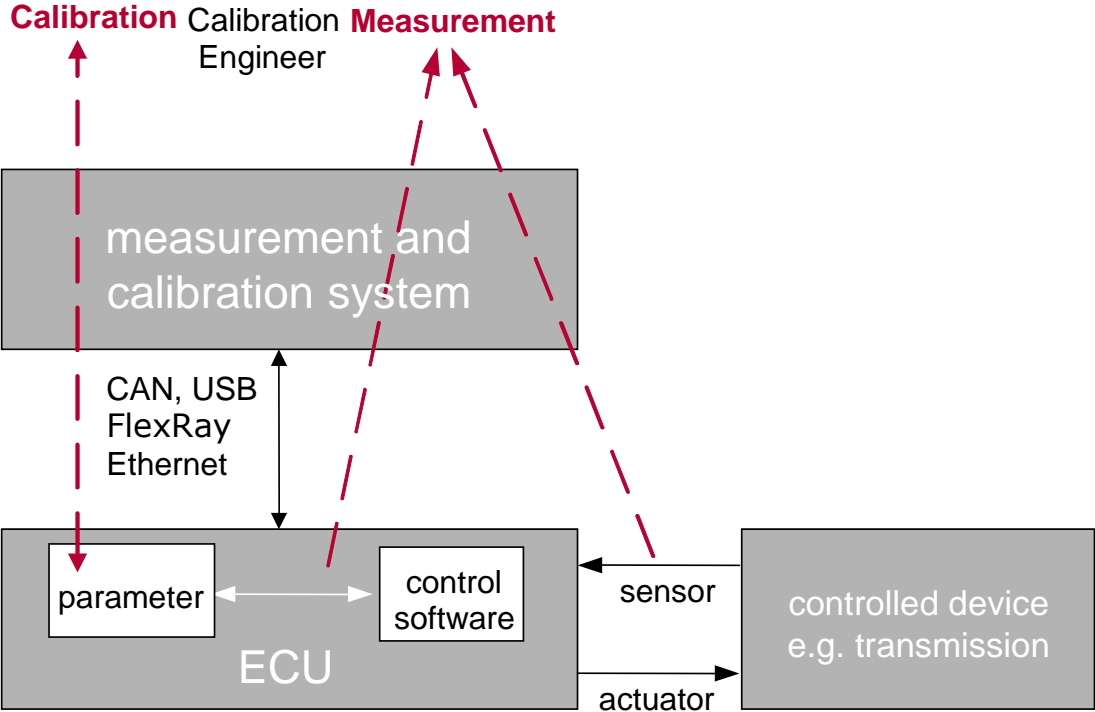




## Calibrating ECUs via XCP on FlexRay

# Calibration Basics



# Calibration Basics

## Motivation

Calibration is an iteration of

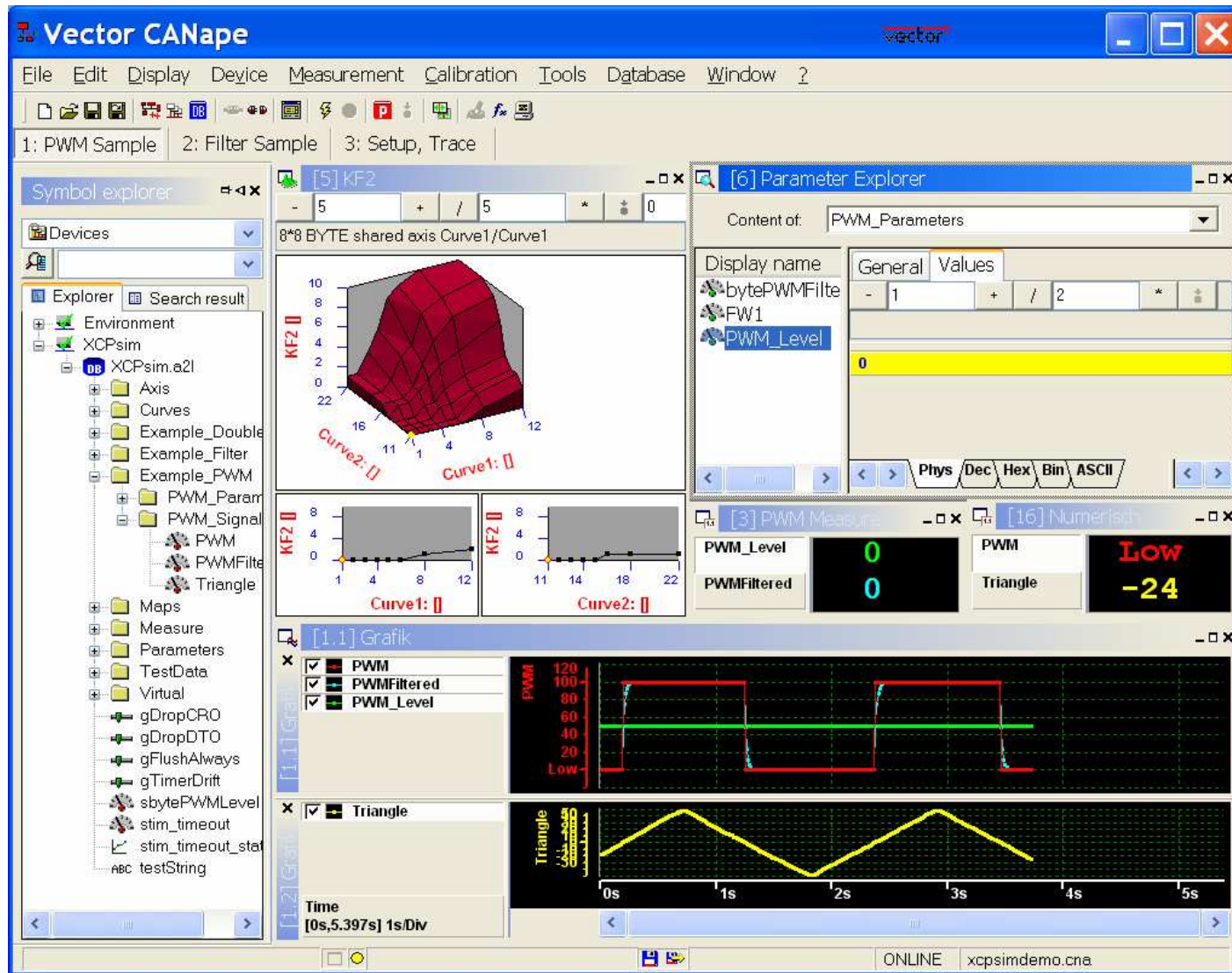
- ❑ Modifying parameters
- ❑ Measuring the reaction of the system

There may be multiple ECUs requiring calibration sharing the same network. Calibration can be performed either subsequentially or simultaneously.

Consequence: The network is a shared resource.

# Calibration Basics

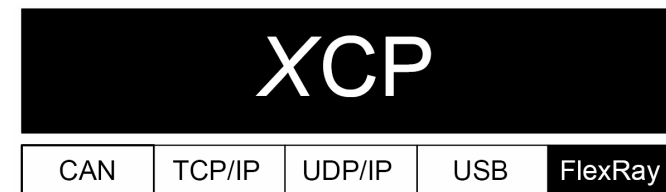
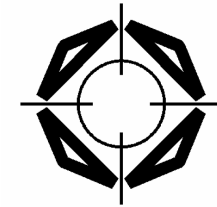
How it can look like



# XCP

## Overview

- ❑ ASAM Standard
- ❑ Address oriented access to ECU parameters
- ❑ Reading and writing ECU memory
- ❑ ECU event driven measurement data sampling
- ❑ Bypassing via XCP stimulation
- ❑ Memory page switching
- ❑ Flashing

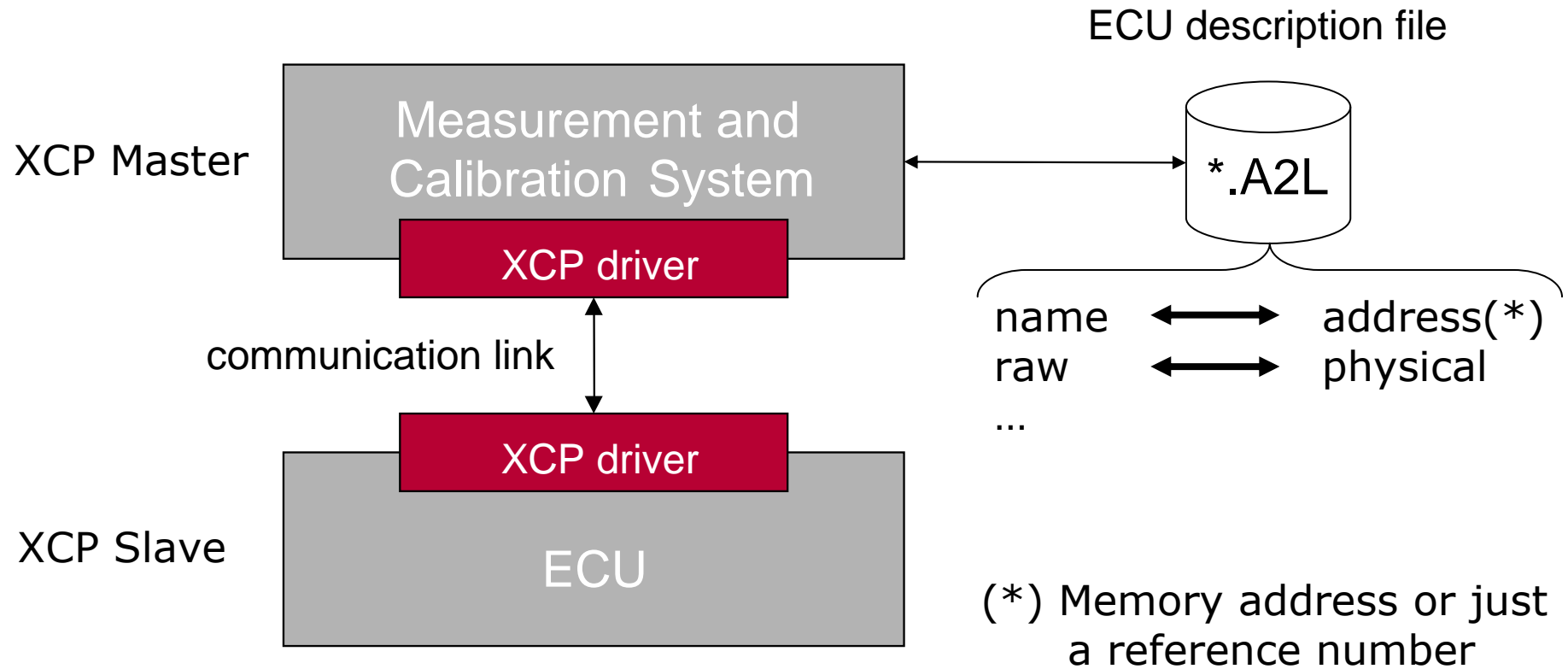


### Layers of the Protocol Stack

- ❑ XCP Protocol Layer defining the commands
- ❑ XCP transport layer describing the implementation for a specific network / bus type (CAN, UDP, FlexRay etc)

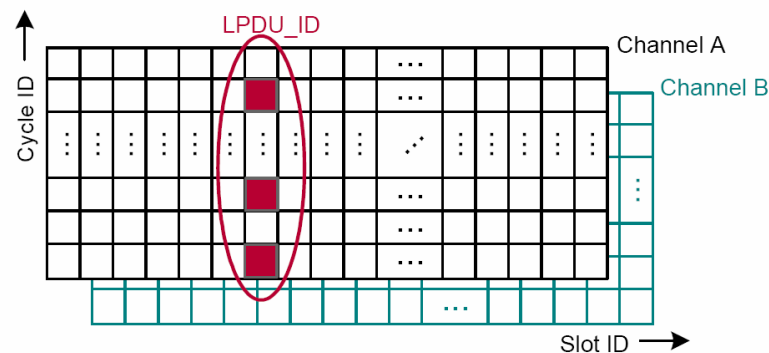
# XCP

## Master-Slave Relation



# FlexRay

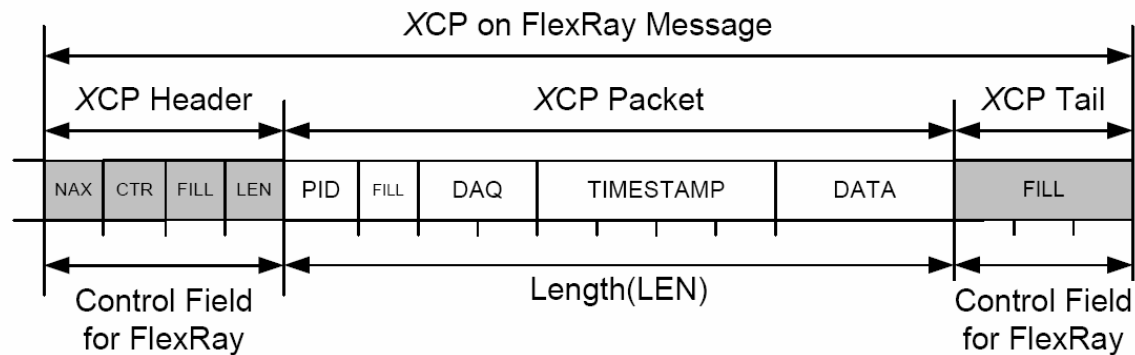
- ❑ Periodical Cycle
- ❑ Cycle structure defined at network definition time
- ❑ Cycle consists of static and dynamic segment
- ❑ Static segment is fixed at network definition time
- ❑ Dynamic segment
  - ❑ Supports event based data transmission
  - ❑ Normally used for flashing, diagnostics, calibration, inter ECU communication during integration phase (see V-Process)
  - ❑ Bandwidth constraints and FlexRay minislot architecture lead to slots being a limited resource



# XCP on FlexRay

## Basics

Transport layer specification, describes the protocol implementation on a specific network layer (bus)



- ❑ FlexRay is schedule based, i.e. periodical and deterministic
- ❑ Static segment can be used for XCP Bypassing → deterministic latency
- ❑ Dynamic segment is normally used for calibration and related measurement having no need for deterministic latency

### Constraints when using the dynamic segment

- ❑ Limited number of slots (FlexRay minislot architecture)
- ❑ Limited bandwidth

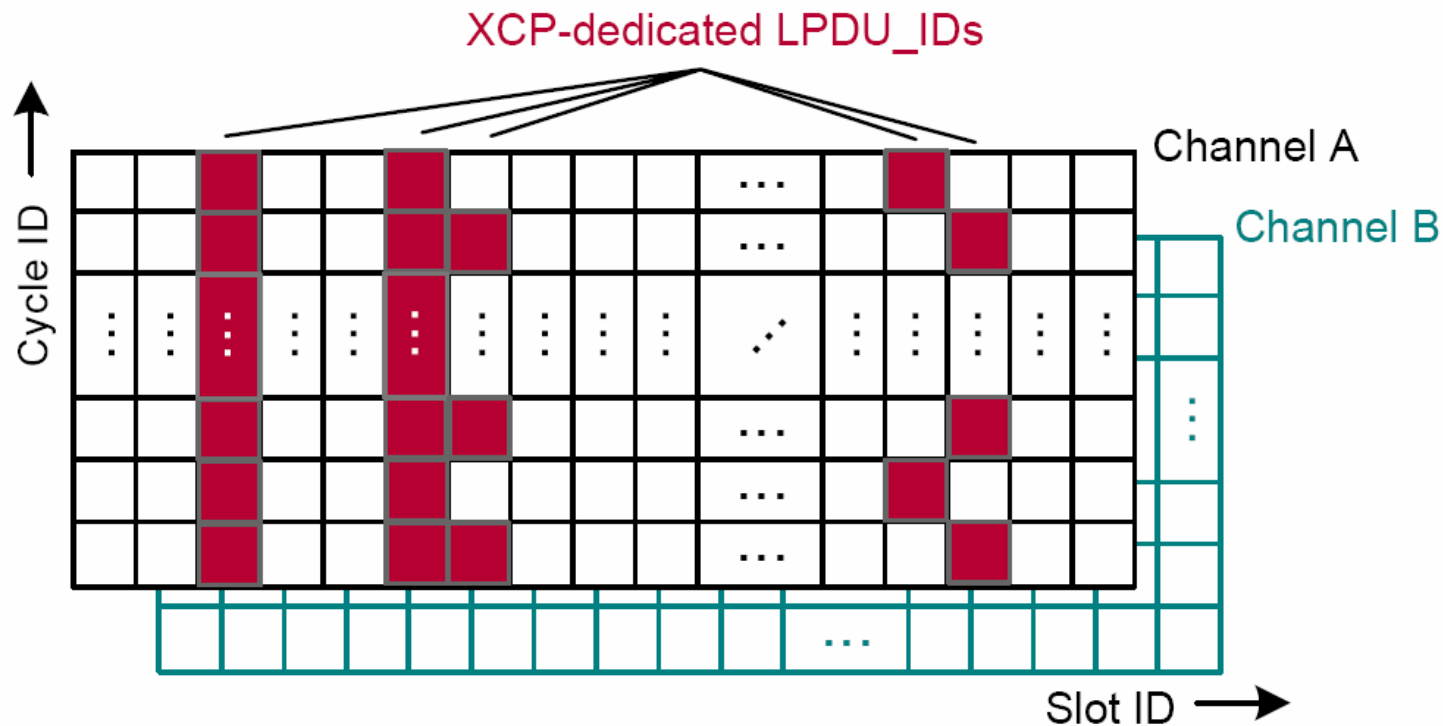
### Dynamic management for the XCP slots

- ❑ FIBEX database describes the dedicated slots for XCP
- ❑ ECU's A2L file describes how many slots are necessary for XCP communication (mandatory: cmd/res)
- ❑ Calibration tool assigns the FlexRay slots dynamically to the ECU each time the measurement signals are reconfigured (when starting a new measurement)

# XCP on FlexRay

## XCP dedicated slots

- ❑ Generalization of a slot (FlexRay data frame) is a LPDU, described by a LPDU-ID (4-tuple vector)
- ❑ A set of LPDUs have to be reserved for XCP communication in network design



# XCP on FlexRay

## ECU Buffer Assignment

- ❑ ECU sends and receives data using FlexRay communication controller (CC) buffers
- ❑ Some of the CC buffers must be assigned to XCP communication
- ❑ Depending on the CC capabilities the buffers may be reassigned during ECU runtime (buffer attribute *fixed* or *variable*)

For this case XCP on FlexRay defines transport layer commands for dynamical assignment of LPDU-IDs to CC buffers.

Example

Buffer	FLX_LPDU_ID				MAX_FLX_LEN _BUF_x
	FLX_SLOT_ID	OFFSET	CYCLE _REPETITION	CHANNEL	
Buffer_1	123	0	1	A	32
Buffer_2	124	1	2	A	32
Buffer_3	(125)	0	2	A	32
Buffer_4	126	(*)	(*)	A	(64)
Buffer_5	(*)	(*)	(*)	(*)	(64)

123, A initial value ( ) configurable  
\* uninitialised parameter

# XCP on FlexRay

## Required Transport Layer Commands

- ❑ Dynamic Buffer-to-Slot Assignment: FLX\_ASSIGN
- ❑ Activation for slot competition: FLX\_ACTIVATE / FLX\_DEACTIVATE

# Multiple XCP ECUs on Network

## Scenarios

- ❑ Exclusive slots for each ECU: XCP Master (i.e. the calibration tool ) checks the compatibility of network and ECU parameters
- ❑ ECUs have fixed buffer assignments to slots and one slot is used by multiple ECUs
  - ❑ XCP packet type CMD/RES: ECU's Node Address for XCP (NAX) is used to distinguish the ECUs
  - ❑ XCP packet type EV and SERV: XCP master uses TL commands to activate or deactivate the usage of the buffer
- ❑ ECUs have reconfigurable CC buffers: XCP master assigns the CC buffers to XCP dedicated slots each time the measurement is reconfigured

For each scenario the user may have configured measurement signals which are in conflict with the available network XCP slots. In this case the XCP master must inform the user and reject to start the measurement.

Q: Can I measure data for an 2.5ms ECU event when the FlexRay cycle is 5 ms?

A: Yes, you have to use XCP DAQ timestamps for this purpose.

Q: Is there a relation between MAX\_DTO (XCP parameter) and MAX\_FLX\_LEN\_BUF\_x (CC buffer parameter)?

A: Yes,  $\text{MAX\_FLX\_LEN\_BUF\_x} \geq \text{sizeof(XCP-Header)} + \text{MAX\_DTO} + \text{sizeof(XCP-Tail)}$

Q: Is dynamic bandwidth management possible for static slots?

A: No, for two reasons:

- ❑ The static segment is fixed at network definition time, but the bandwidth management occurs at runtime, during XCP communication.
- ❑ Each static slot must be assigned exclusively to one single ECU.

## Links to other information sources

- ❑ FlexRay:

<http://www.flexray.com/>

[http://www.vector-informatik.com/vi\\_flexray\\_solutions\\_de,,2816.html](http://www.vector-informatik.com/vi_flexray_solutions_de,,2816.html)

- ❑ XCP specification:

[www.asam.net](http://www.asam.net)

- ❑ XCP source code:

[https://www.vector-worldwide.com/vi\\_downloadcenter\\_de.html](https://www.vector-worldwide.com/vi_downloadcenter_de.html)

- ❑ XCP master CANape

[http://www.vector-informatik.com/vi\\_ecu\\_measurement\\_de.html](http://www.vector-informatik.com/vi_ecu_measurement_de.html)



Thank you for your attention.

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