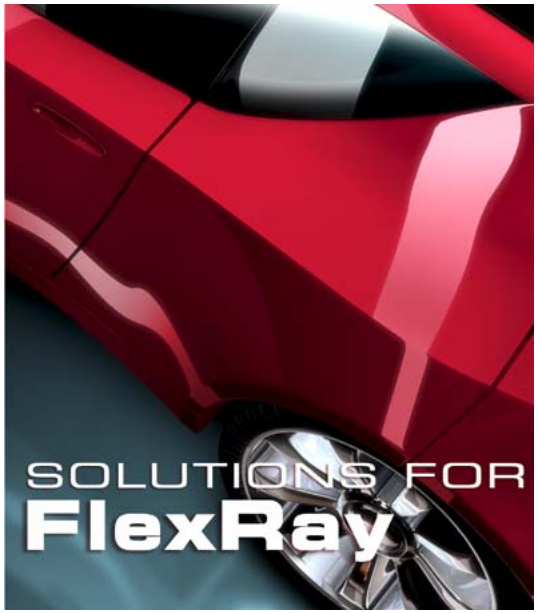

Solutions for FlexRay™

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> **FlexRay Solutions**

Design of Distributed Systems

ECU Test, Simulation, and Analysis

ECU Calibration

ECU Software

Network Interfaces

Summary

FlexRay Main Characteristics

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Startup

FIBEX Explorer

PDU Support

Analysis

Stimulation

FlexRay Solutions

Overview

Design of Distributed Systems	ECU Test, Simulation, Analysis	ECU Calibration	ECU Software	Network Interfaces
Network Designer FlexRay FIBEX Explorer pro	CANoe.FlexRay CANalyzer.FlexRay FRstress	CANape Embedded Module XCP-on-FlexRay	MICROSAR FlexRay: FR Interface FR State Manager FR TP / FR ISOTP FR NM FR XCP MICROSAR CAL: FR Driver MICROSAR COM: COM Manager PDU Router osCAN, MICROSAR OS XCP-on-FlexRay Flash Bootloader	VN3300 VN3600 VN7600 FlexCard Cyclone II SE

Application and Integration Services, Training

Agenda

FlexRay Solutions

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Network Designer FlexRay

- **Easy designing of a FlexRay communication network**
  - Define a cluster with one or two channels and the ECU topology
  - Define the signal database
  - Define FlexRay specific frames and their properties
  - Define Tx/Rx Frame relations per ECU
  - Define static and dynamic schedule
  - Specify global and local FlexRay configuration parameters (e.g. cycle length, number of slots, slot duration, …)
  - Minor changes to the architecture and communication schedule are possible without the need to completely reschedule
- **Support of FIBEX version 1.1.5, 1.2, and 2.0**
  - Consistency check for FIBEX format and FlexRay settings
- **Configuration management** based on Vector eASEE or other configuration management systems

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FlexRay Solutions

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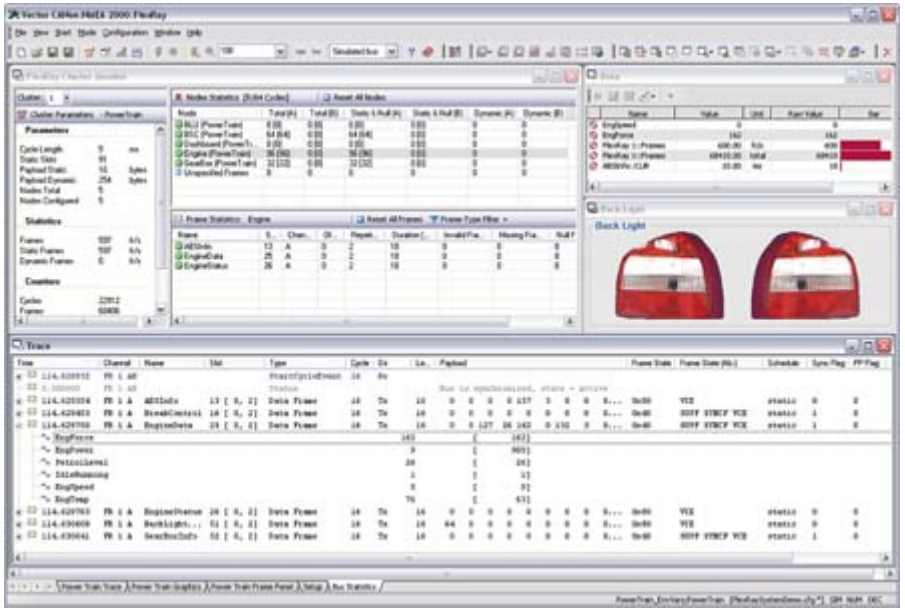
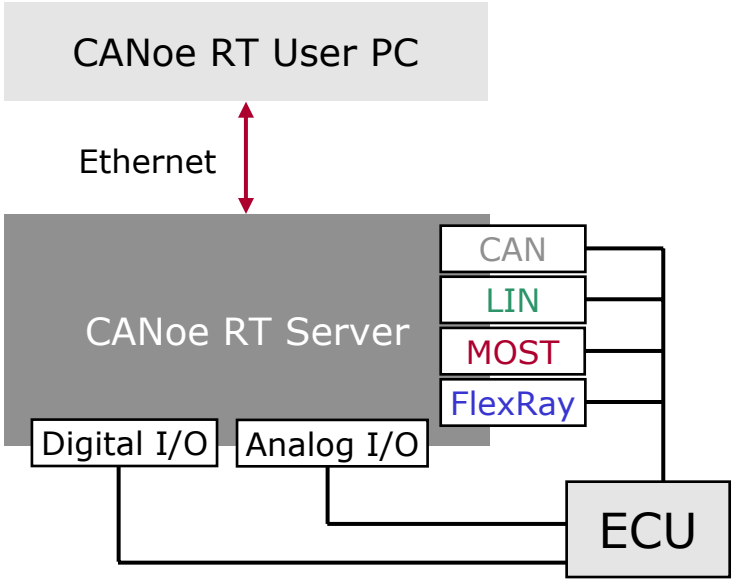
CANoe.FlexRay

- **Measurement and analysis**
  - Trace window for messages and bus events
  - Data window
  - Graphic window for plotting of signals
  - Message statistic and bus statistic window
  - Logging with triggers
  - Filter
  - Offline mode (replay of a log)
  - GUI extensions for user friendly input and output using panel windows
  - Import of network data definitions and network interface controller configuration from the FIBEX database
- **Simulation, stimulation, and test**
  - CAPL modeling language
  - Total bus simulation
  - Remaining bus simulation
  - Gateway functionality with CAN, LIN, MOST, FlexRay, J1587, etc.



CANoe RT System

- CANoe RT User PC
  - Front end for CANoe GUI
  - Host for logging data and test results
- CANoe RT Server
  - Real-time execution server for:
    - remaining-bus and environment simulation
    - test script execution



CANoe RT Server Platforms

Compact
Real-Time Box

Real-Time Rack

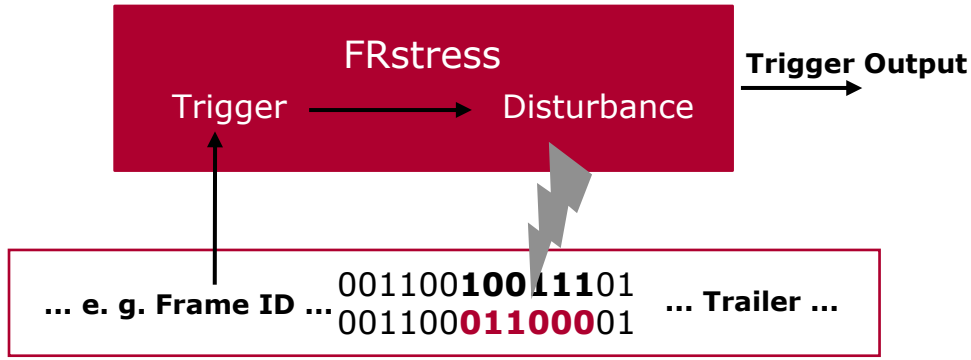
FRstress

Objectives:

- Identify network/ECU behavior caused by physical bus failures
- Identify network/ECU behavior caused by disturbing and manipulating FlexRay frames

Features:

- Triggering by specific values of frame fields or external trigger input and output
- Configuration of bit stream disturbances or manipulations
- Operation as: Normal node, star coupler, trigger engine



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> **ECU Calibration**

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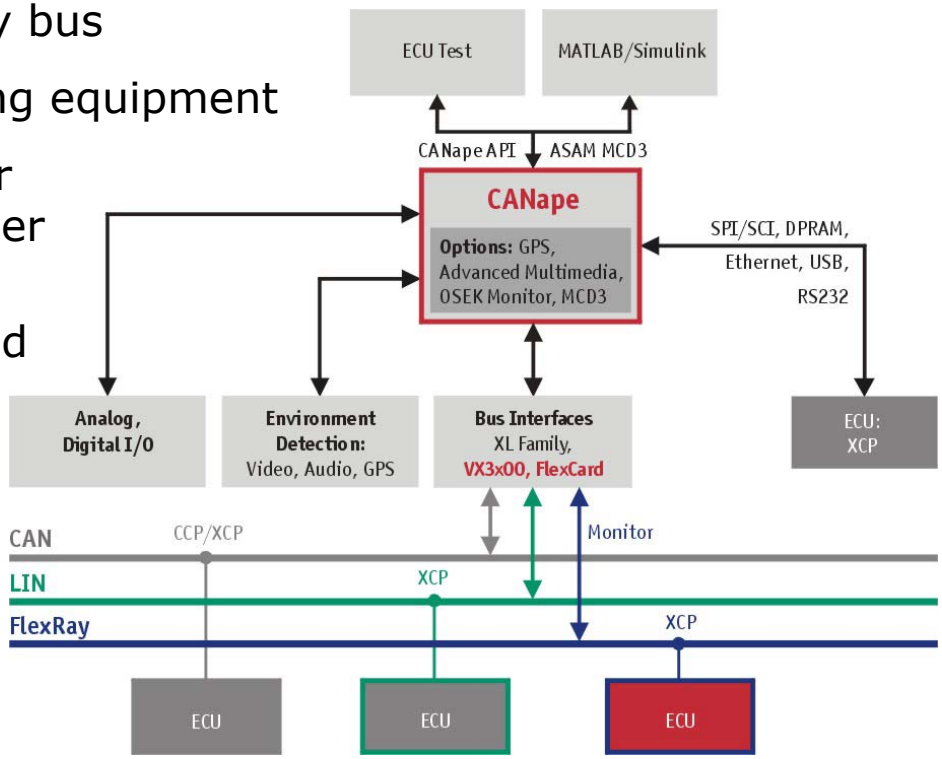
ECU Calibration

CANape

- Measurement and Calibration of ECU parameters
- Time-synchronous data acquisition and visualization of:
  - Internal ECU data
  - Signals from CAN, LIN, FlexRay bus
  - Signals from external measuring equipment
- Video and Audio measurement for verification of HMI devices or driver assistant systems
- Online calibration via CCP/XCP and real-time stimulation via XCP
- Offline calibration
- Seamlessly integrated diagnostics via KWP2000 and UDS



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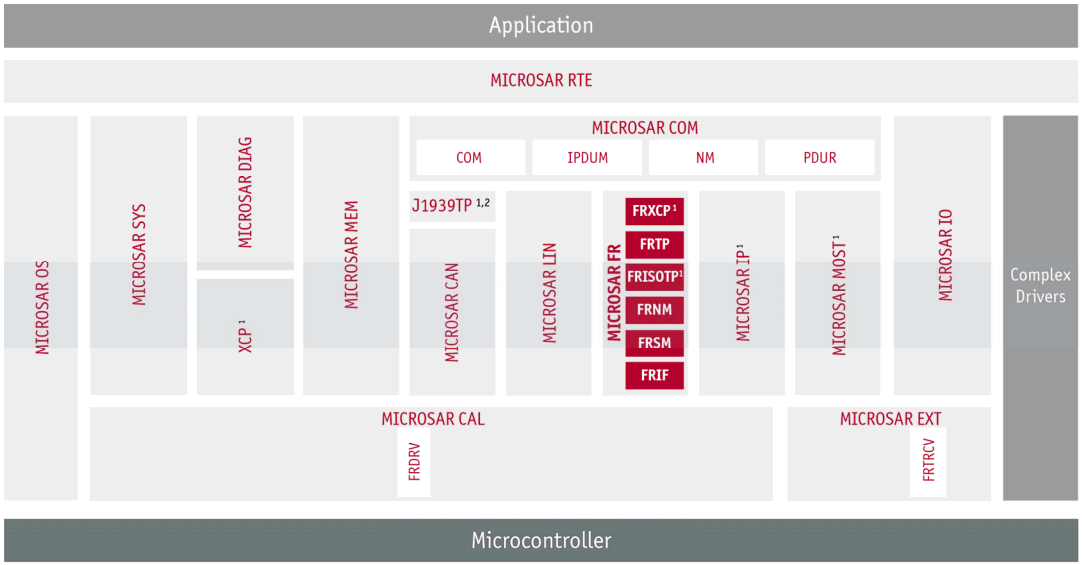
FlexRay Embedded Software Components

- Configuration by AUTOSAR ECU Configuration Description or FIBEX with GENy (included in DaVinci Configurator Pro)
- Operating system independent (OSEK, AUTOSAR SC1-4, or TT OS)
- All modules are available based on AUTOSAR 3.x
- Support of Development Error Tracer
- Support of Diagnostic Event Manager
- FlexRay Timer Services
- Cycle Multiplexing
- In-Cycle Repetition
- Rx and Tx Interrupt Mode
- Rx indication and timeouts, Tx confirmation
- Small and runtime efficient implementation
- Gateway function to CAN, LIN, FR realized through MICROSAR COM (PDUR, COM)



[1] Available extensions for AUTOSAR 3.0
[2] BAM and CMDT Option available

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> **Network Interfaces**

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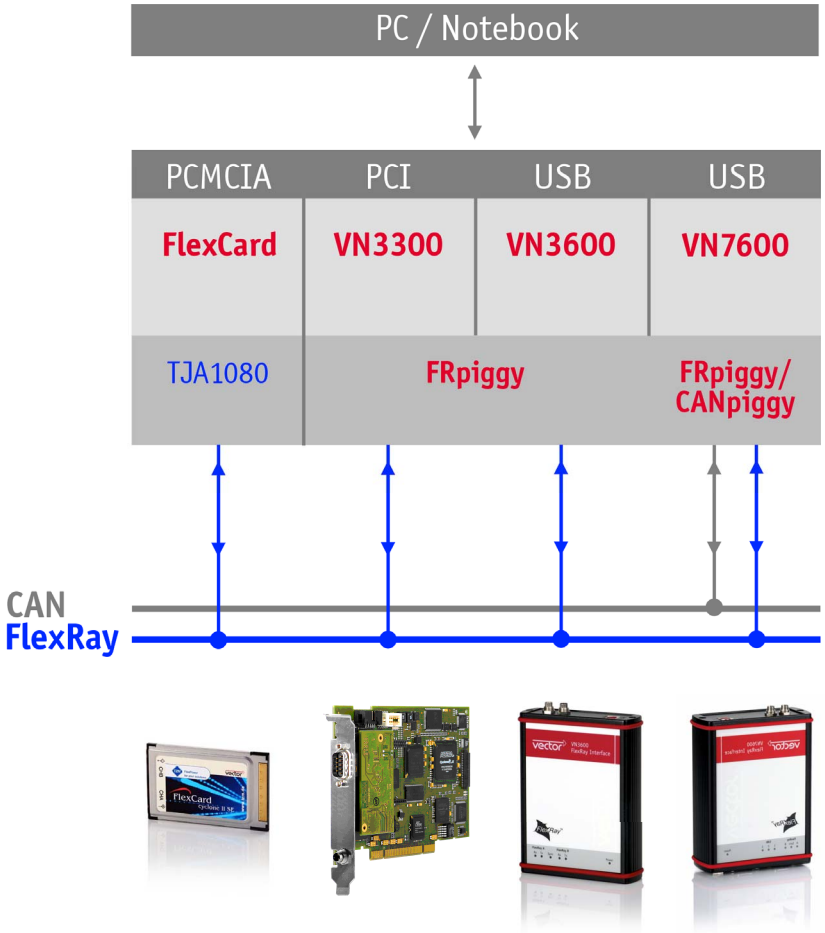
VN-Family and FlexCard

- FlexRay Controller: Bosch E-Ray
- Physical Layer Transceivers: NXP TJA1080
- Transmit and receive data and null frames
- Detect invalid frames
- Support cycle multiplexing, In-cycle response
- Support 254 byte maximum payload
- Autonomous network start
- Startup and asynchronous monitoring
- Time synchronization with Vector interfaces
- Configurable trigger output
- Driver library for own applications



RT Server Platform as Extended CANoe Interface

- Typical use case:
  CAN, LIN and FlexRay simulation with high real-time requirements
- Recommended for FlexRay simulations
- Dedicated interface for remaining bus and mid-size HIL simulations
- Deterministic execution platform for simulations
- Very small jitters
- Fast boot-up time (10 seconds)
- Ethernet connection to host PC running CANoe
- Competitive pricing due to the use of standard products
- Can be ordered as fully pre-configured system from Vector (including operating system)

Network Interfaces

VN8900 as Real Time Execution Platform

USB

VN8900

CANoe/CANalyzer GUI

USB

VN8900

Intel Atom CPU-Board

- Test Execution
- Network Simulation
- CAPL Execution
- Logging

I/O
Digital
Analog

4 Network Interfaces
CAN1 … CAN4
LIN 1 … LIN 4

USB Master
Ethernet

ECU

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Summary

- FlexRay solutions are available for:
  - Network design
  - Analysis, simulation, stimulation, and test
  - Bus stress
  - Measurement and calibration
  - Embedded software
  - Network interfaces

- CANoe.FlexRay provides a comprehensive FlexRay development and analysis solution
- Support of the FIBEX format offers a scalable solution for interfacing different development tools

Vector – Your competent FlexRay partner!

FlexRay

Short Introduction

vector

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FlexRay Solutions

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> **FlexRay Main Characteristics**

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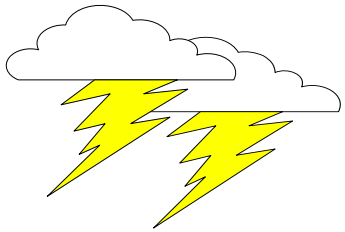
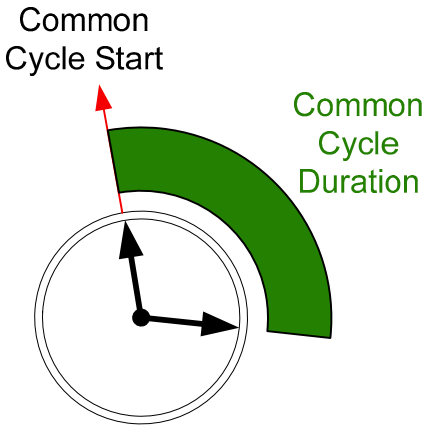
FlexRay Main Characteristics

Activation

- Event driven
  - System services are activated in response to events
  - Serial bus system:
    - Bus access based on incoming events
    - Bus access if signal changes



- Time driven
  - System services are activated at predefined times based on a (real-time) clock
  - Serial bus system:
    - Bus access is periodic based on the schedule
    - No signal change := “Nullframe”



FlexRay Main Characteristics

Example: Personal transportation

- Event driven
  - Individualized departure time
  - Departure time and therefore trip duration unknown
  - Trip might not even be completed
- Time driven
  - Periodic departure time
  - Departure time and trip duration known
  - Reliable

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> **FlexRay Communication Structure**

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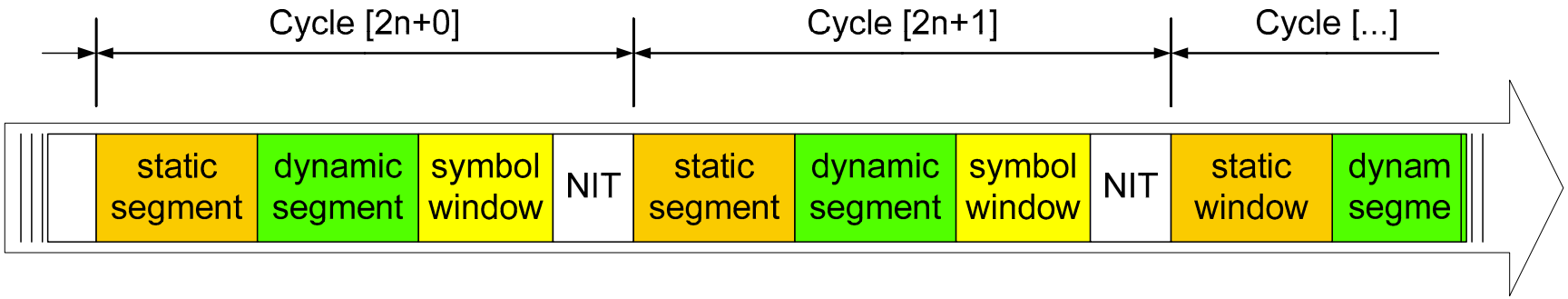
FlexRay Communication Structure

Communication Cycle

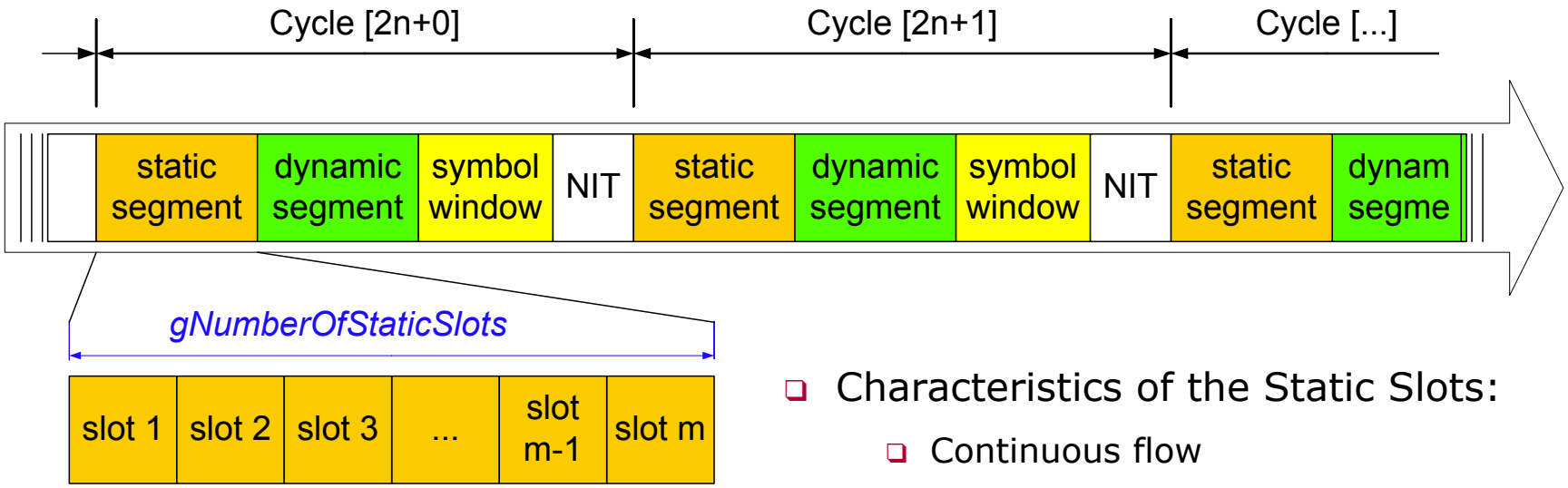


- Data transmission with FlexRay:
  - Time-driven, organized in cycles
  - Cycle time is constant – Global clock
  - Cycles are subdivided into segments
  - Segments repeat themselves at equidistant time intervals
- Communication Cycle consists of:
  - Static Segment
  - Dynamic Segment (optional)
  - Symbol Window (optional)
  - NIT: Network Idle Time

PS 2.1: cCycleCountMax := 63

FlexRay Communication Structure

Static Slots



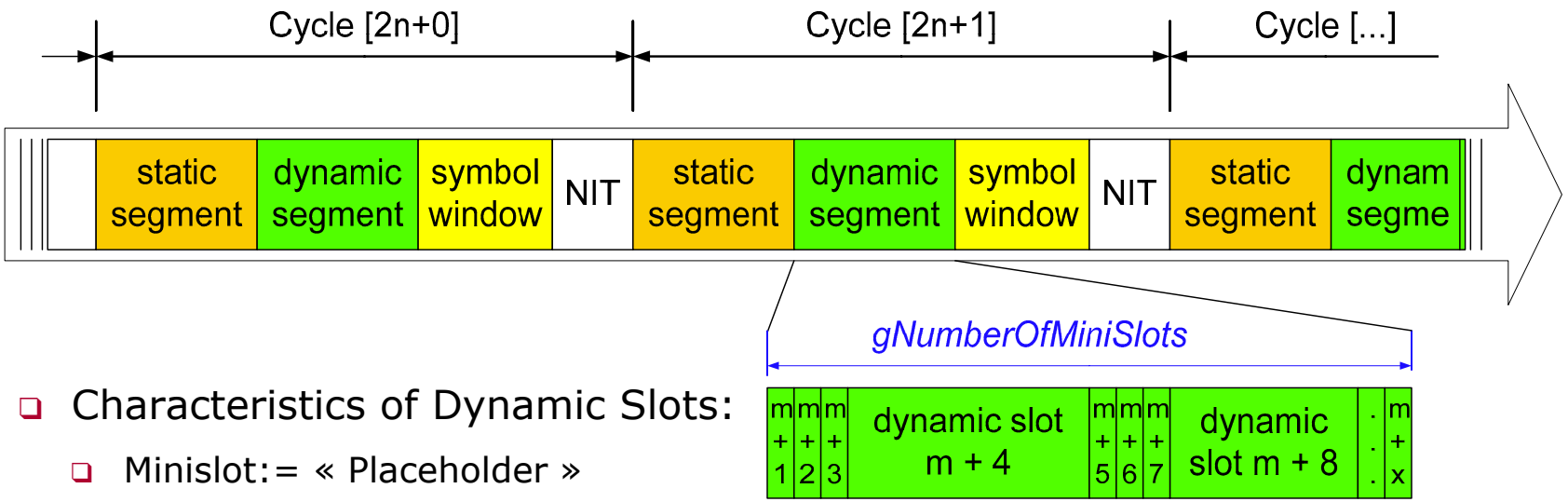
- Static Segment:
  - TDMA bus access
  - Deterministic time behavior
  - Time window for real-time applications & safety-critical applications

- Characteristics of the Static Slots:
  - Continuous flow
  - All static slots have same length
  - Same number of slots in each cycle: *gNumberOfStaticSlots*
  - Only one node may send per slot
  - Slot IDs have unique assignments to TX nodes
  - At least 2 static slots necessary for synchronization

PS 2.1: cStaticSlotIDMax := 1023

FlexRay Communication Structure

Dynamic Slots



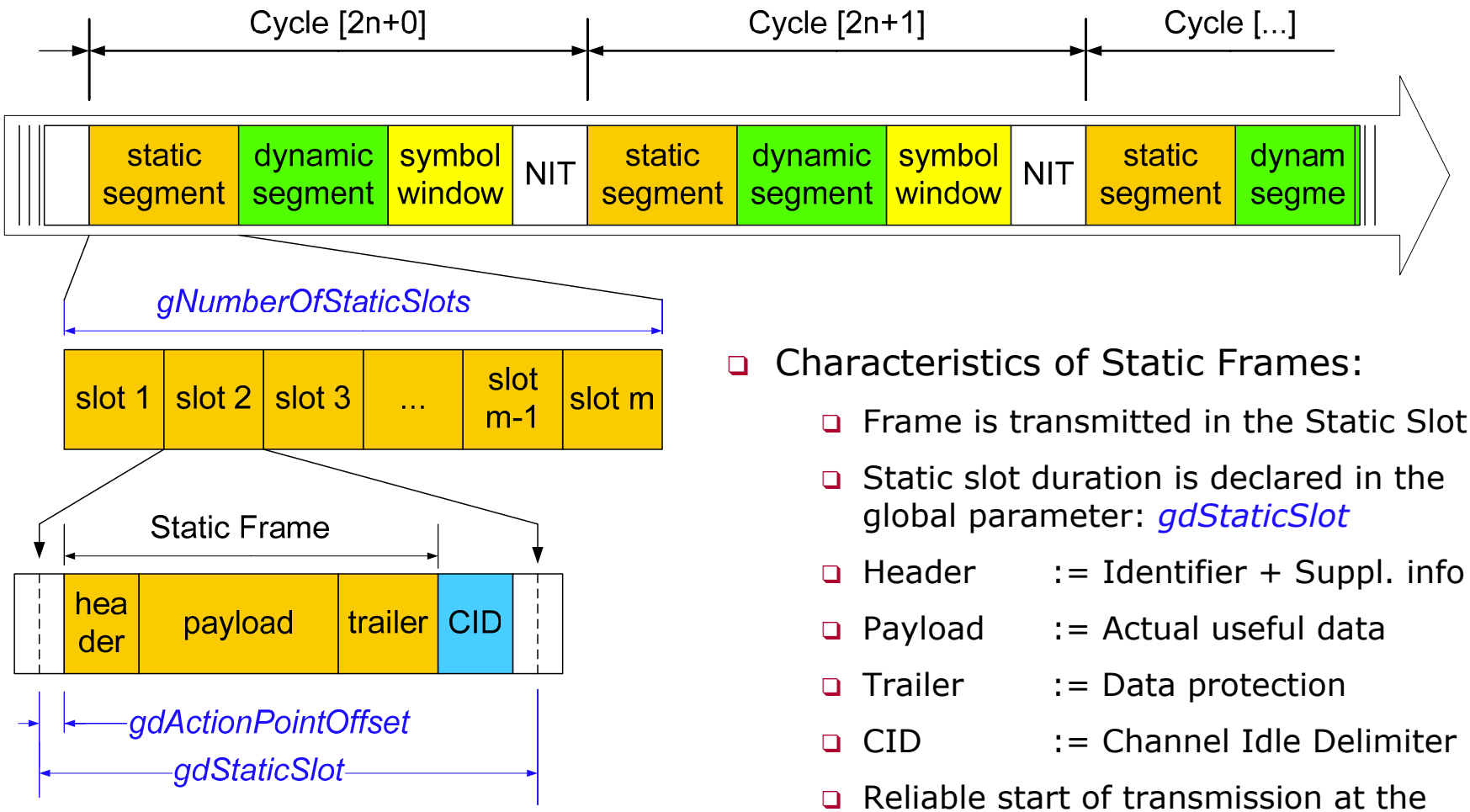
- Characteristics of Dynamic Slots:
  - Minislot:= « Placeholder »
  - Dynamic Slot IDs are allocated to TX nodes
  - Same number of MiniSlots in each cycle: *gNumberOfMiniSlots*
  - Transmission as needed, then Minislot becomes a dynamic slot
  - Dynamic slots can have different lengths

- Dynamic Segment:
  - FTDMA bus access
  - « Arbitration » based on the Minislot ID
  - Time window for event-driven data transfer

PS 2.1: cSlotIDMax := 2047

FlexRay Communication Structure

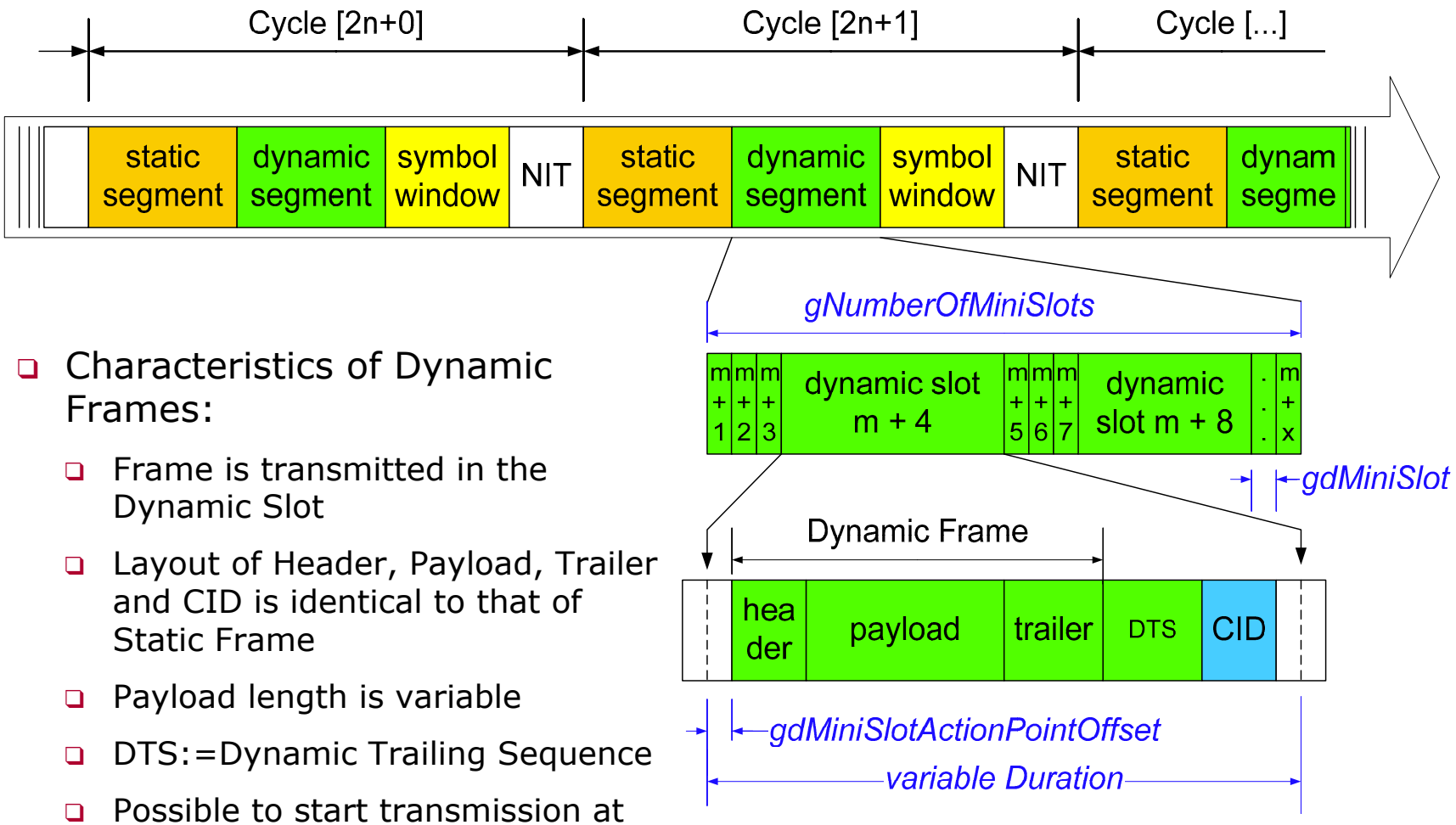
Static Frames



- Characteristics of Static Frames:
  - Frame is transmitted in the Static Slot
  - Static slot duration is declared in the global parameter: *gdStaticSlot*
  - Header := Identifier + Suppl. info
  - Payload := Actual useful data
  - Trailer := Data protection
  - CID := Channel Idle Delimiter
  - Reliable start of transmission at the Action Point, global parameter *gdActionPointOffset*

FlexRay Communication Structure

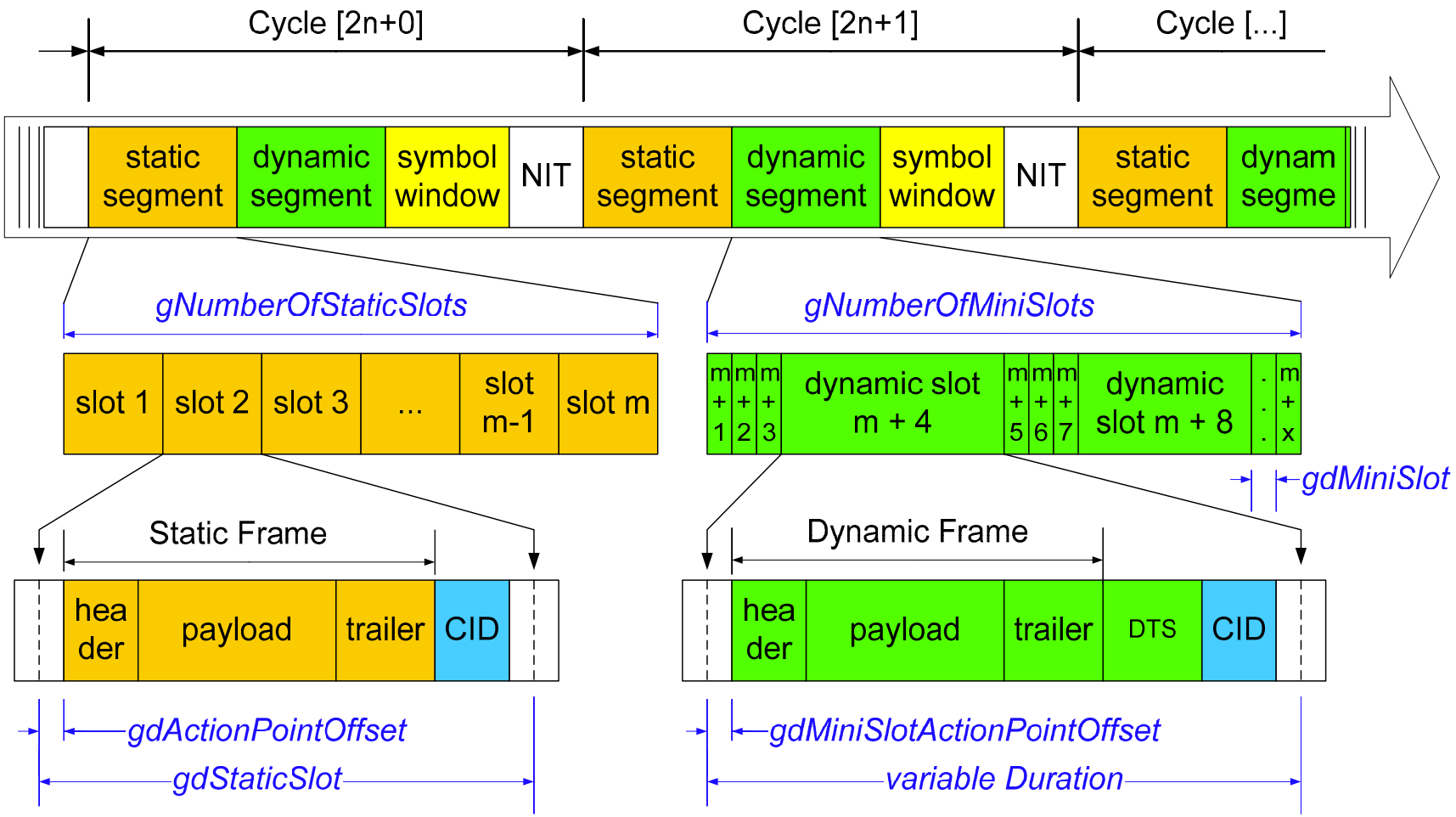
Dynamic Frames



- Characteristics of Dynamic Frames:
  - Frame is transmitted in the Dynamic Slot
  - Layout of Header, Payload, Trailer and CID is identical to that of Static Frame
  - Payload length is variable
  - DTS:=Dynamic Trailing Sequence
  - Possible to start transmission at MiniSlot Action Point, parameter *gdMiniSlotActionPointOffset*

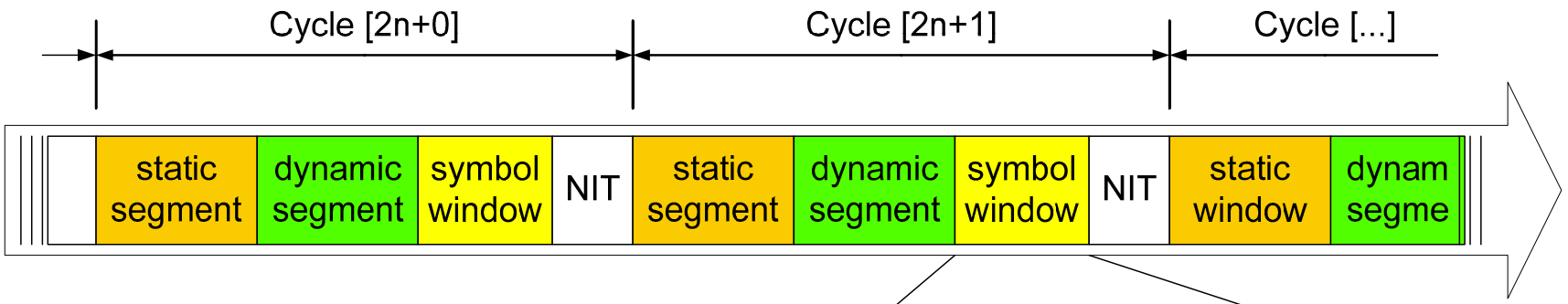
FlexRay Communication Structure

Overview: Static - Dynamic

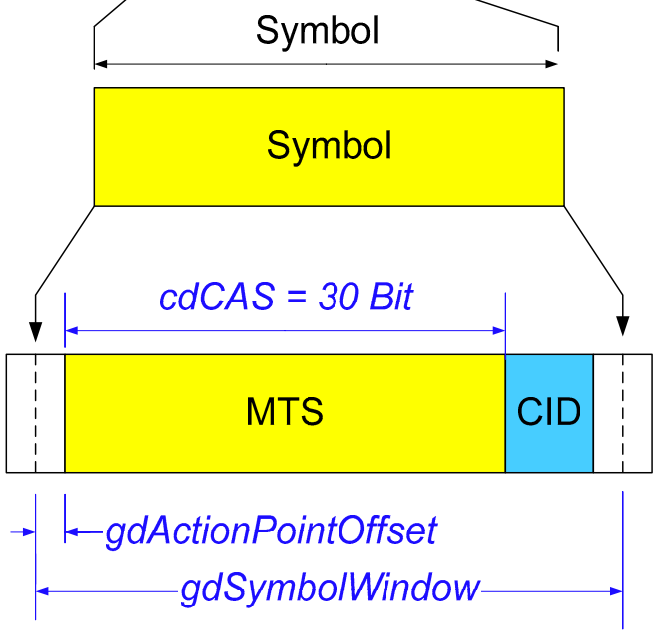


FlexRay Communication Structure

Symbol Window

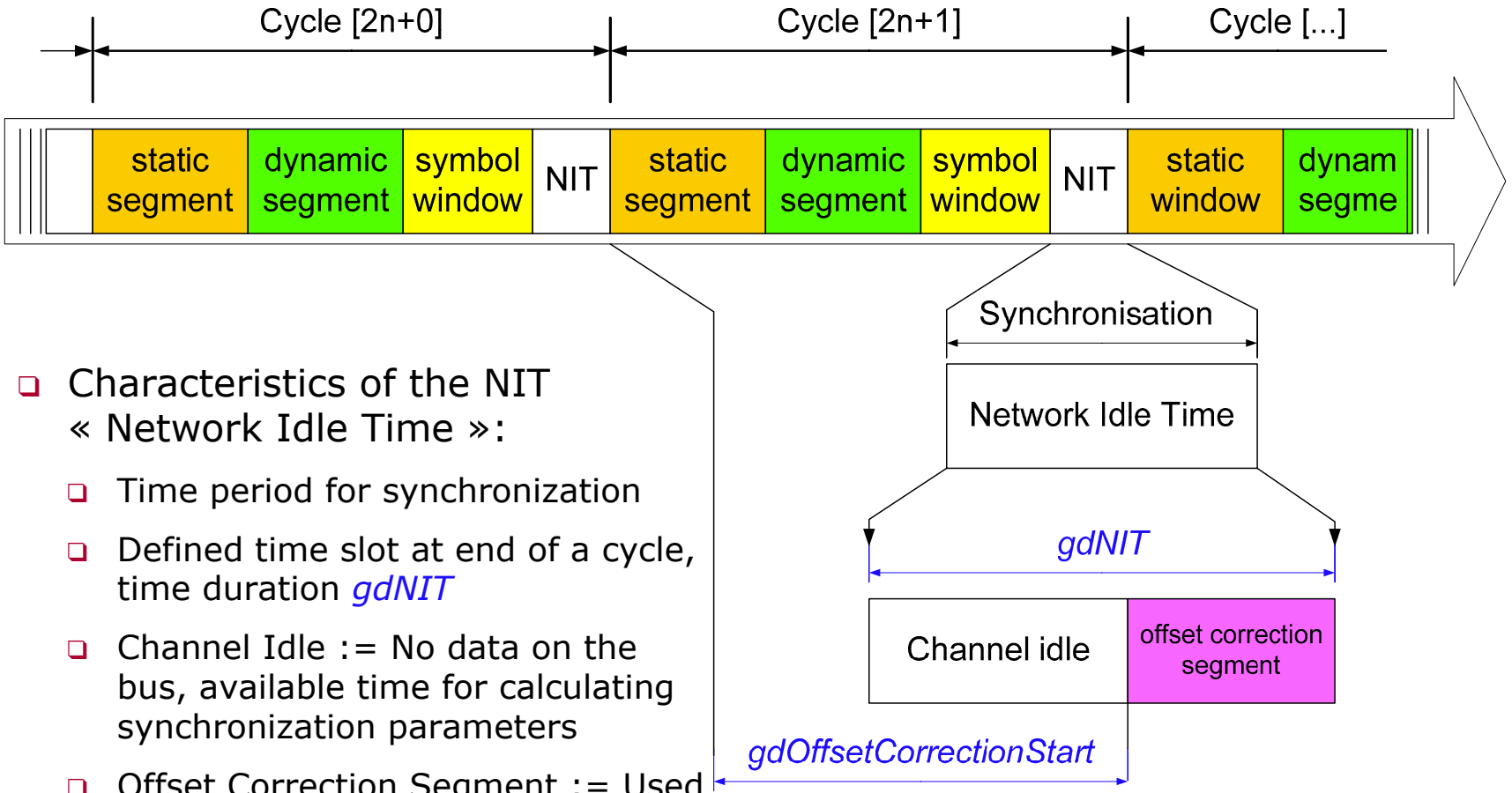


- Characteristics of the Symbol Window:
  - Optional
  - MTS := Media Access Test Symbol
    - Length is defined by *cdCAS := 30*
    - Test of the Bus Guardian
  - Only one symbol per cycle, therefore no arbitration
  - Possible to start transmission at Action Point, parameter *gdActionPointOffset*



FlexRay Communication Structure

NIT – Network Idle Time



- Characteristics of the NIT « Network Idle Time »:
  - Time period for synchronization
  - Defined time slot at end of a cycle, time duration *gdNIT*
  - Channel Idle := No data on the bus, available time for calculating synchronization parameters
  - Offset Correction Segment := Used for synchronization.

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> **Startup**

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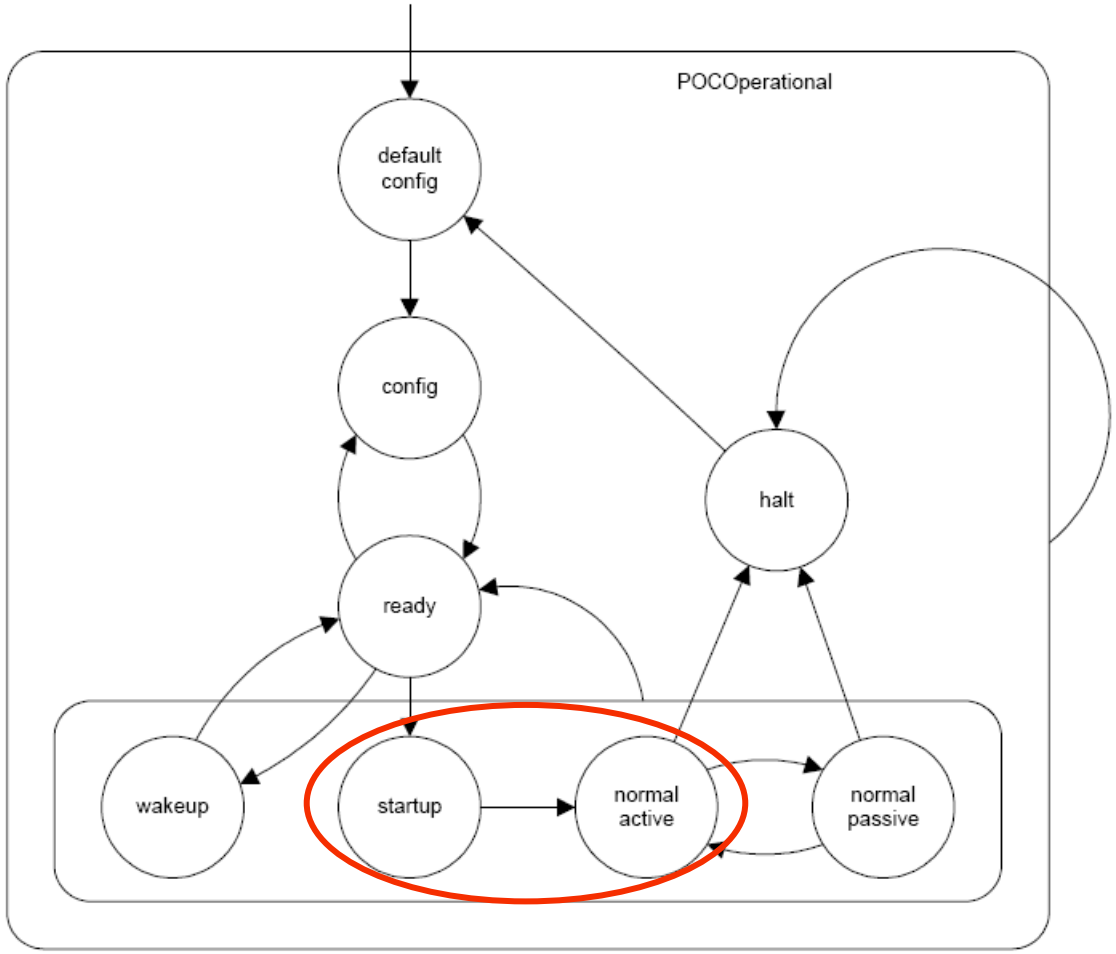
Tasks

- State change:
  - State before startup: All nodes are in Power-On and in Ready State (awake)
  - State after startup: All nodes are Power-On and in Normal Active State
  - « Creation of the common time base » for all nodes utilizing at least two Sync nodes
- Characteristics of the Startup:
  - At least two coldstart nodes are necessary
    - « Leading Coldstart Node » : Initiates setup, prescribes schedule
    - « Following Coldstart Node » : Synchronizes itself to Leading CSN
  - Startup is simultaneously on both channels
  - Leading Coldstart Node sends « CAS » Collision Avoidance Symbol
  - After a specified time the Leading Coldstart Node sends its first Startup Frame (SyncFrame) -> Start of Cycle
  - After a minimum of 4 cycles the Following Coldstart Node may also send its Sync Frames

Startup

Procedure

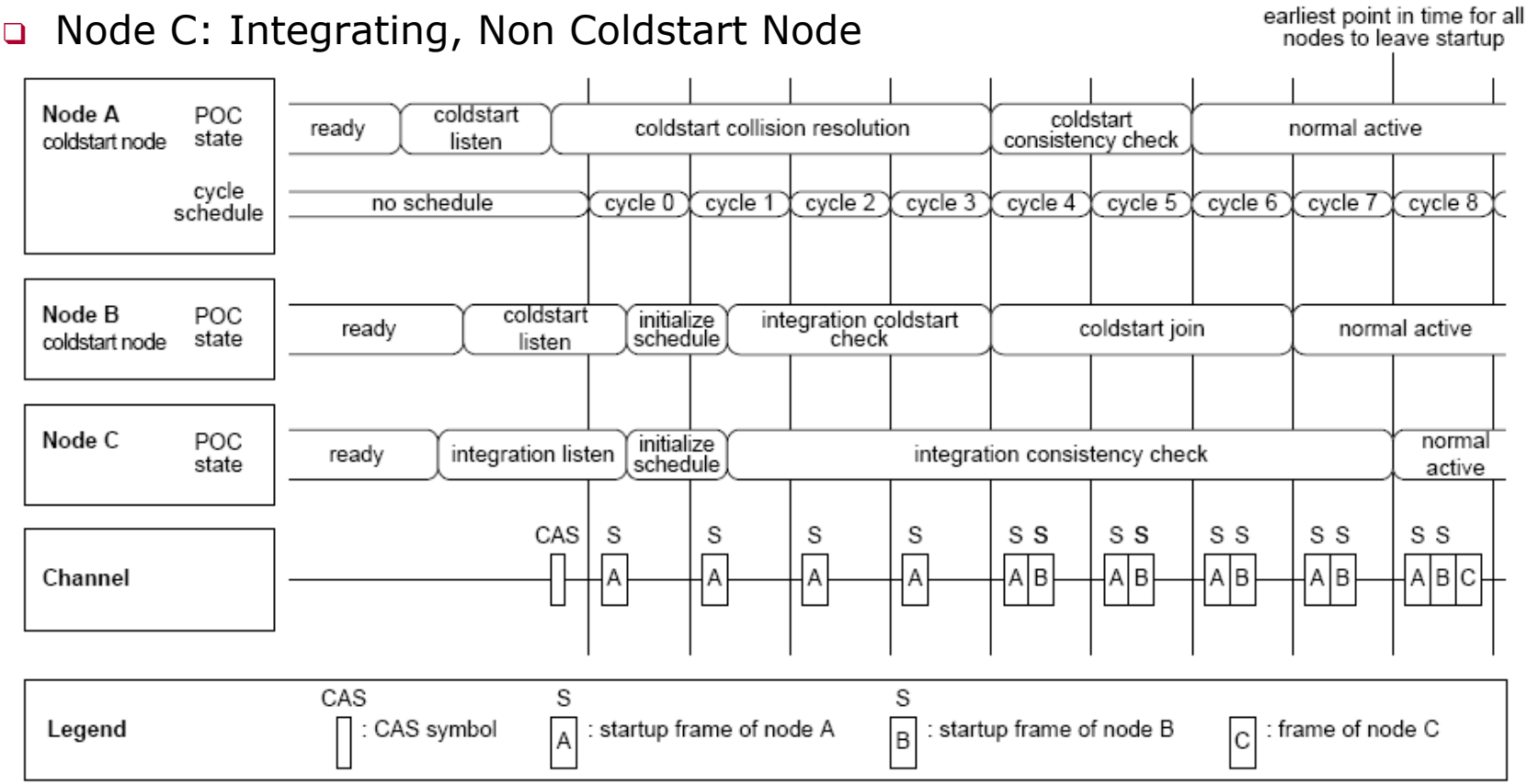
- Leading ColdStart Node:
  - Host puts CC in Startup
  - POC goes to Coldstart Listen State
  - CC sends CAS Symbol
  - CC sends its Sync frames over 4 cycles
- Following ColdStart Node :
  - CCs detect Sync frames
  - Attempt to synchronize during the 4 cycles
  - Send their own Sync frames for 5-7 cycles



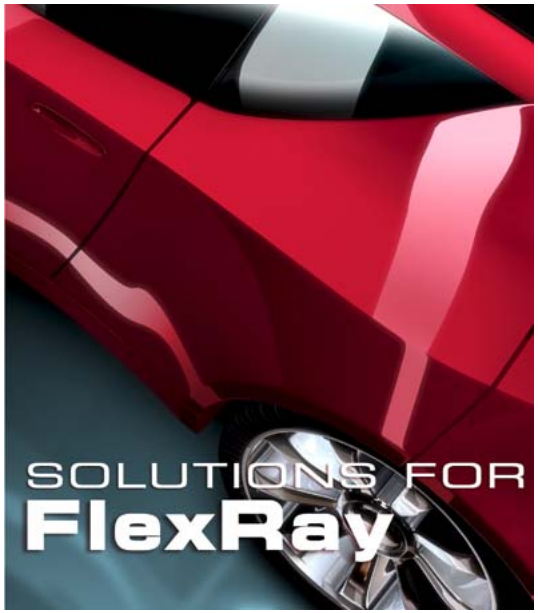
Source: FlexRay PS2.1

Startup Example

- Node A: Leading Coldstart Node
- Node B: Following Coldstart Node
- Node C: Integrating, Non Coldstart Node



Source: FlexRay PS2.1



CANoe & CANalyzer.FlexRay

Features

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> **FIBEX Explorer**

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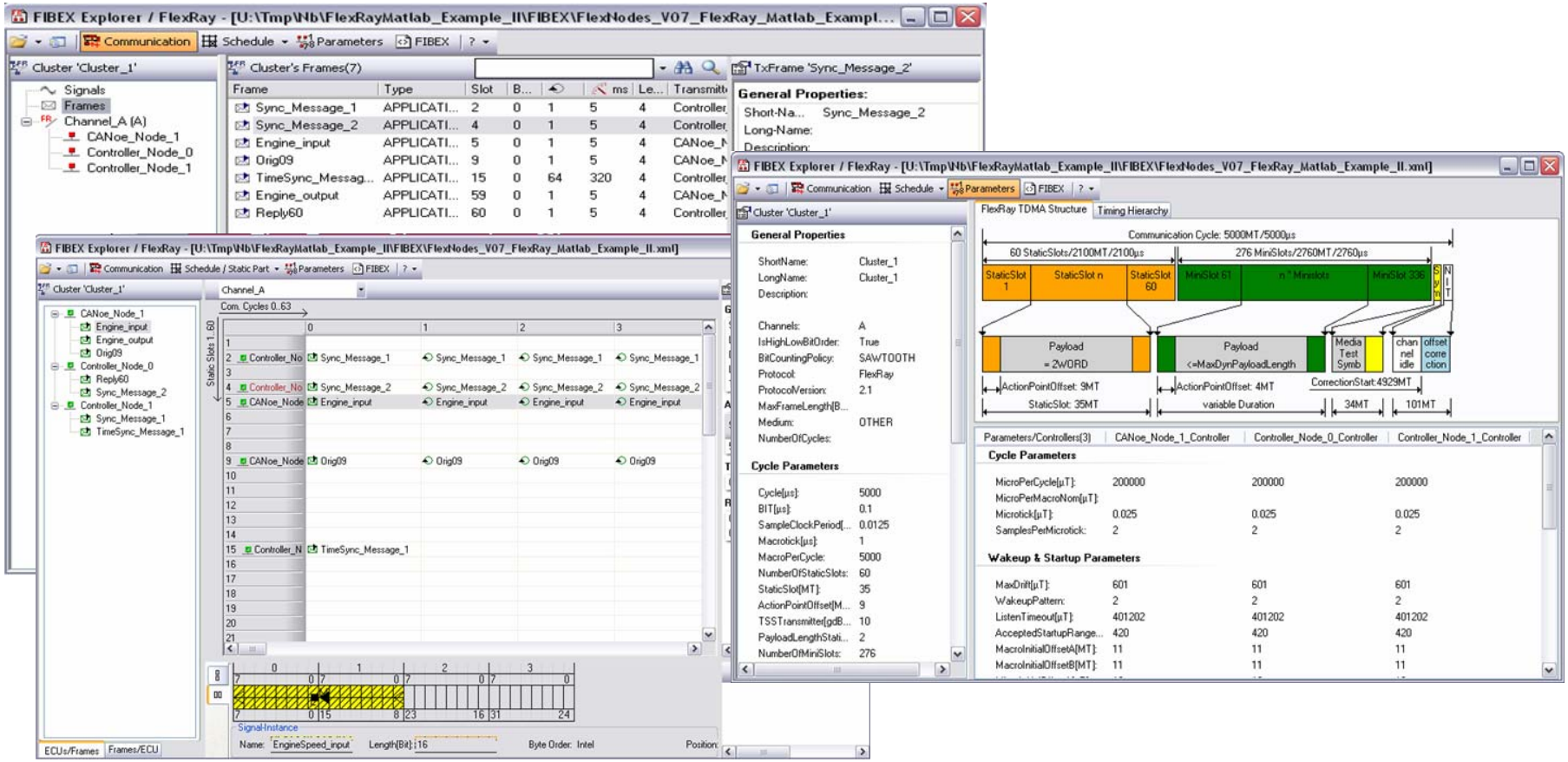
FIBEX Explorer

NEW 7.0

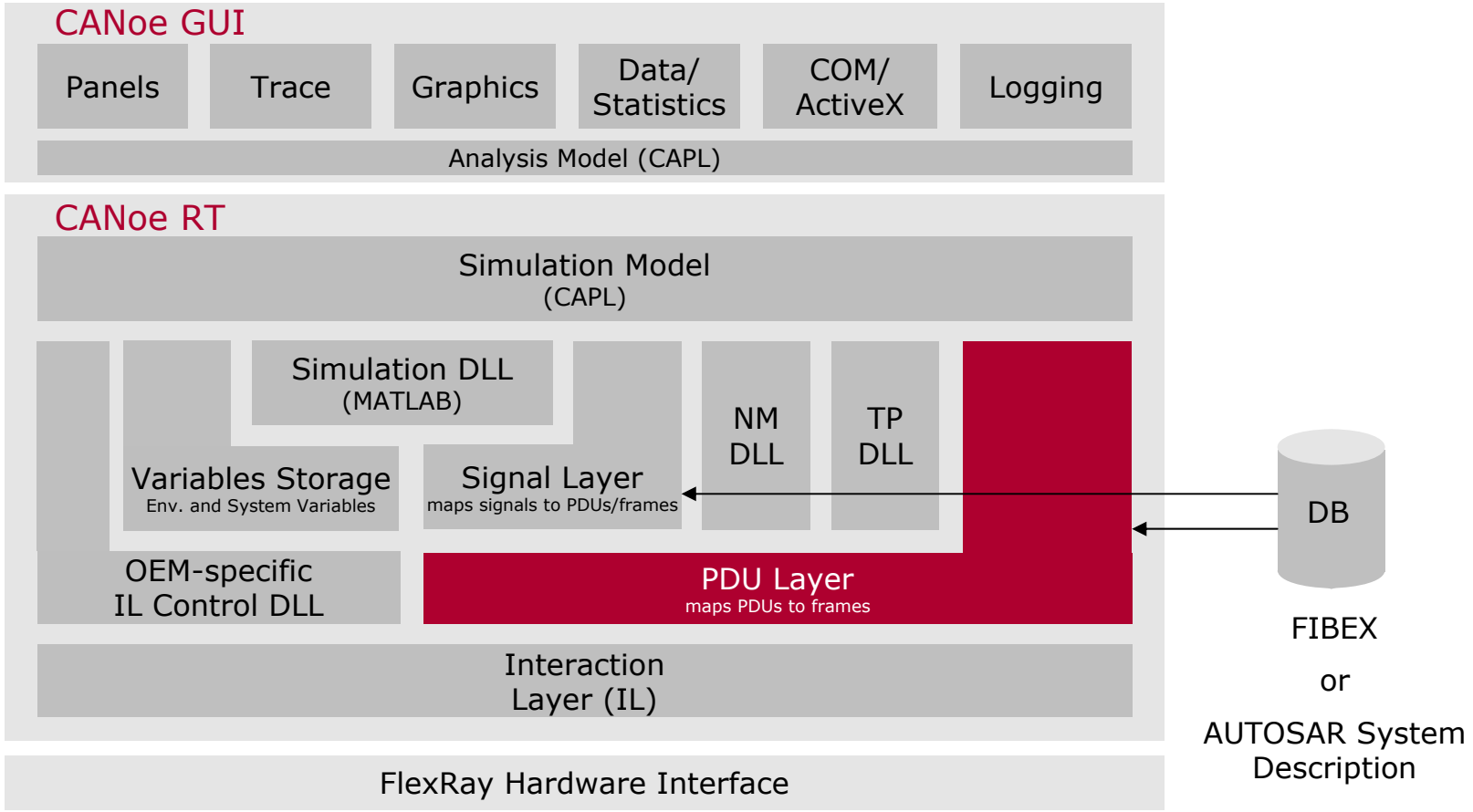
- User friendly visualization of FIBEX and FIBEX+ databases
- Detailed views for communication (Frames/PDUs, RX/TX relations, Signals, and ECUs), scheduling, and network parameters



PDU Support

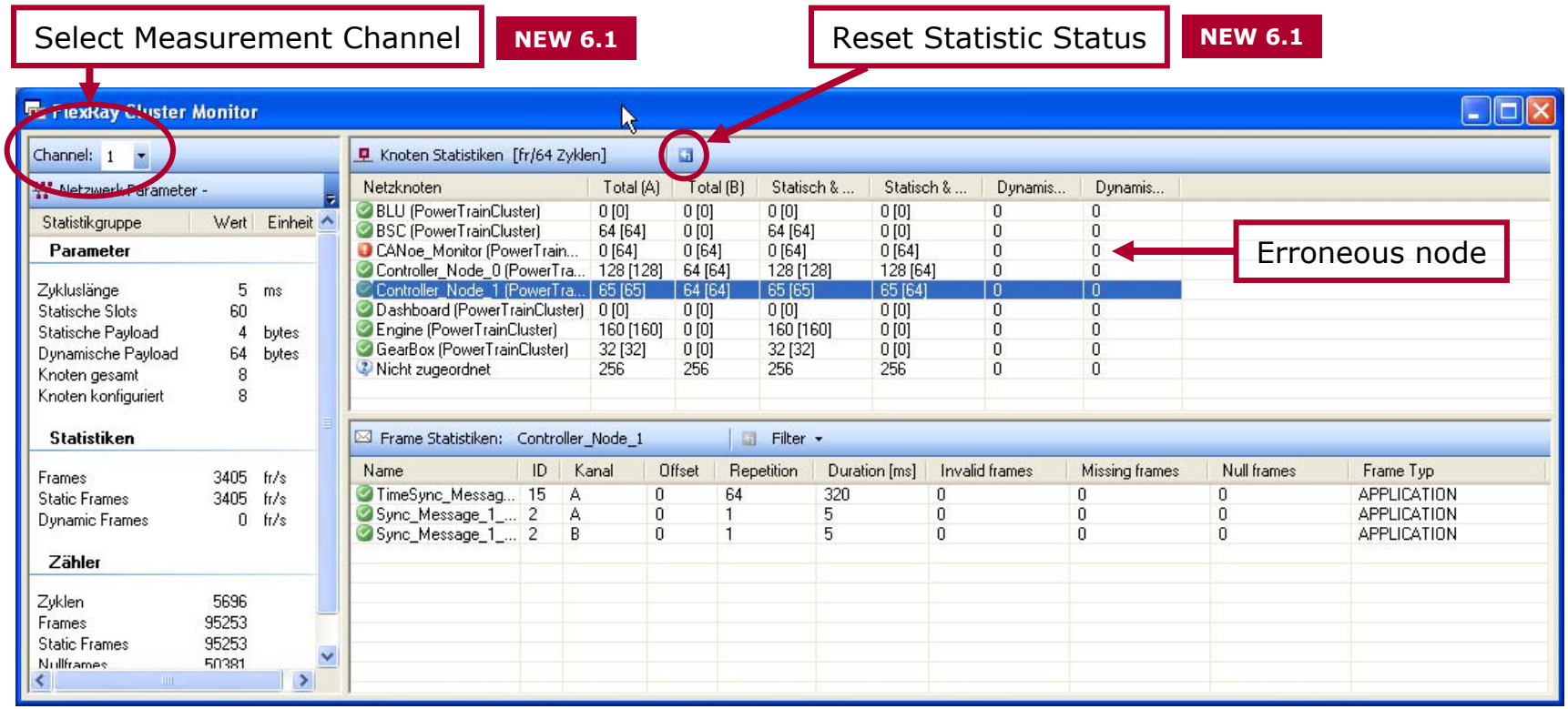
CANoe's AUTOSAR Stack

- Semantic interpretation controlled by PDU Layer
- FIBEX or AUTOSAR System Description used as database



Cluster Monitor

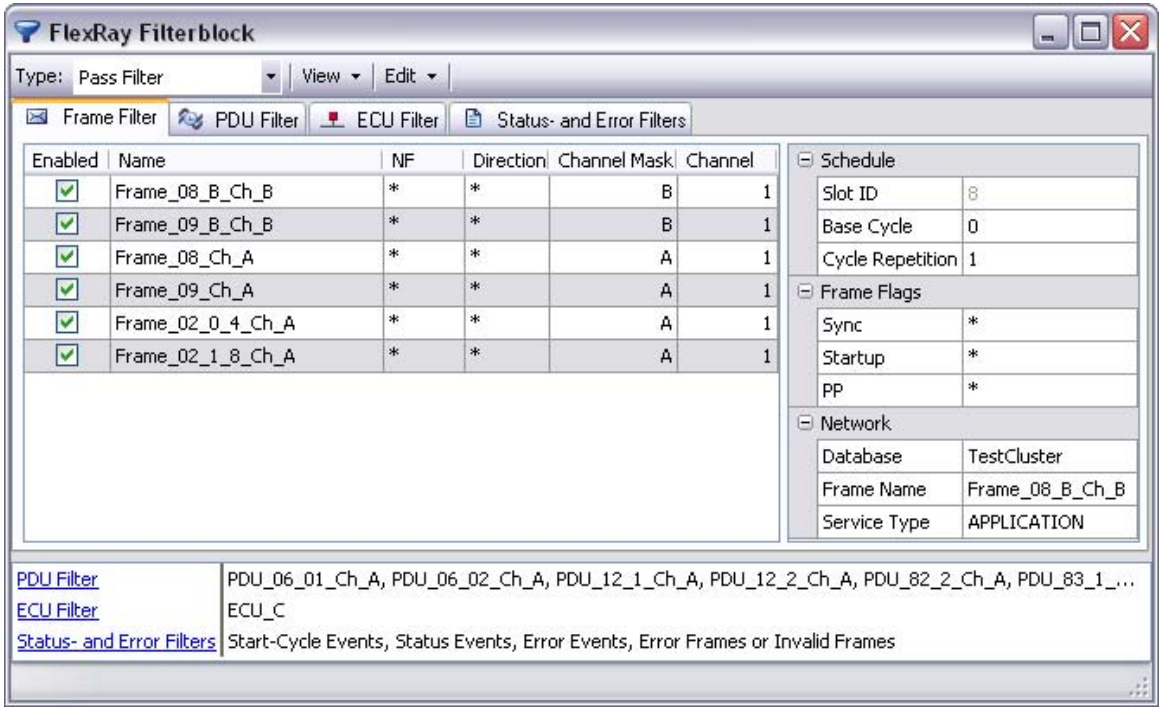
- Detailed analysis of the communication on network, node and frame level
- Automatic check based on the expected communication defined in the database
  Example: The ECU CANoe_Monitor does not send the expected number of frames.



FlexRay Filter Block

NEW 7.2

- Filter functions for Frames, PDUs, ECUs, Status and Error Events
- Overview section
- Comfortable grouping possibility of its filter rules

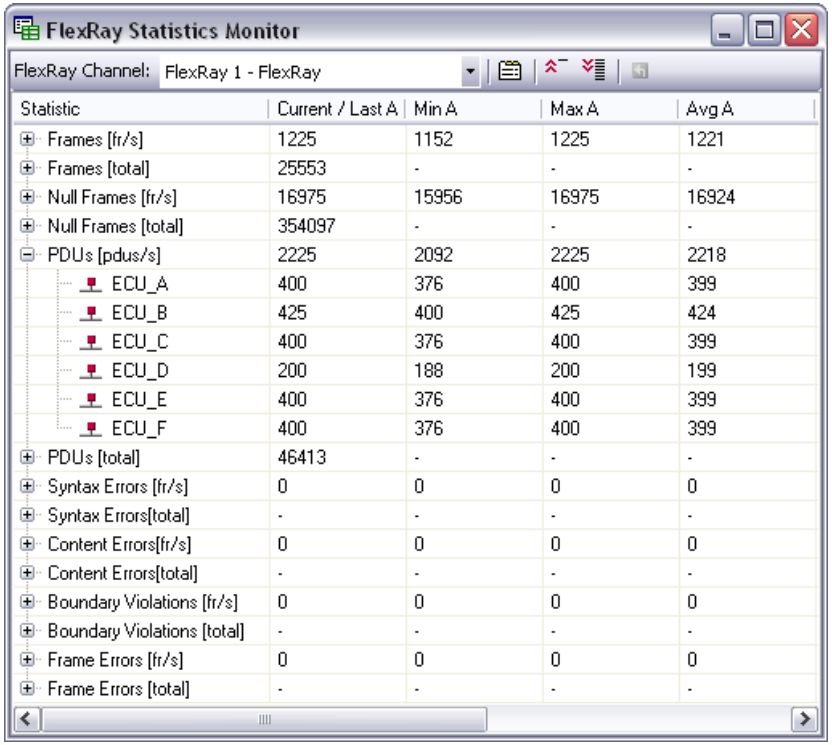


Analysis

FlexRay Statistics Monitor

NEW 7.2

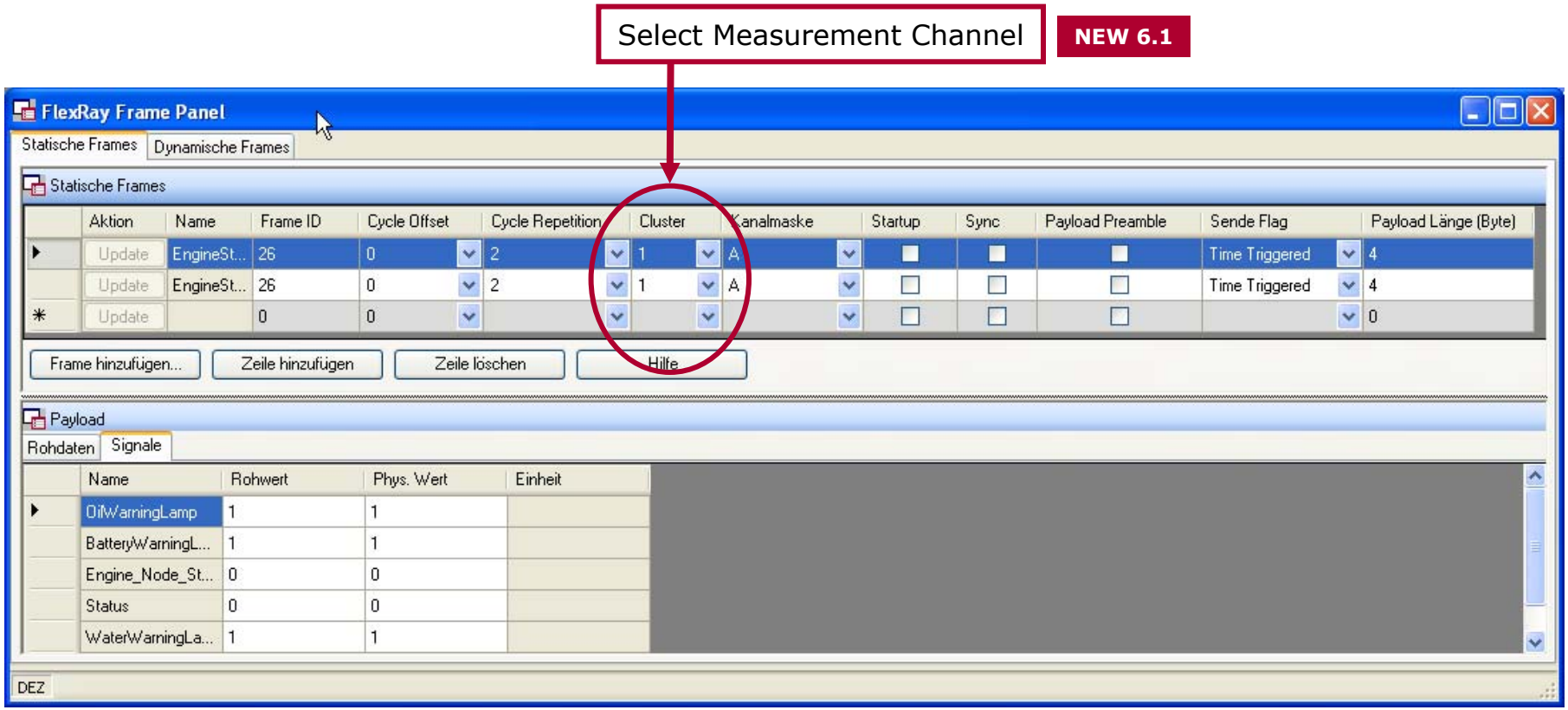
- Displays FlexRay-specific statistics on network and node level
- Statistics for Frames and PDUs
- Detailed statistics for protocol errors



Statistic	Current / Last A	Min A	Max A	Avg A
Frames [fr/s]	1225	1152	1225	1221
Frames [total]	25553	-	-	-
Null Frames [fr/s]	16975	15956	16975	16924
Null Frames [total]	354097	-	-	-
PDUs [pdus/s]	2225	2092	2225	2218
ECU_A	400	376	400	399
ECU_B	425	400	425	424
ECU_C	400	376	400	399
ECU_D	200	188	200	199
ECU_E	400	376	400	399
ECU_F	400	376	400	399
PDUs [total]	46413	-	-	-
Syntax Errors [fr/s]	0	0	0	0
Syntax Errors[total]	-	-	-	-
Content Errors[fr/s]	0	0	0	0
Content Errors[total]	-	-	-	-
Boundary Violations [fr/s]	0	0	0	0
Boundary Violations [total]	-	-	-	-
Frame Errors [fr/s]	0	0	0	0
Frame Errors [total]	-	-	-	-

Frame Panel

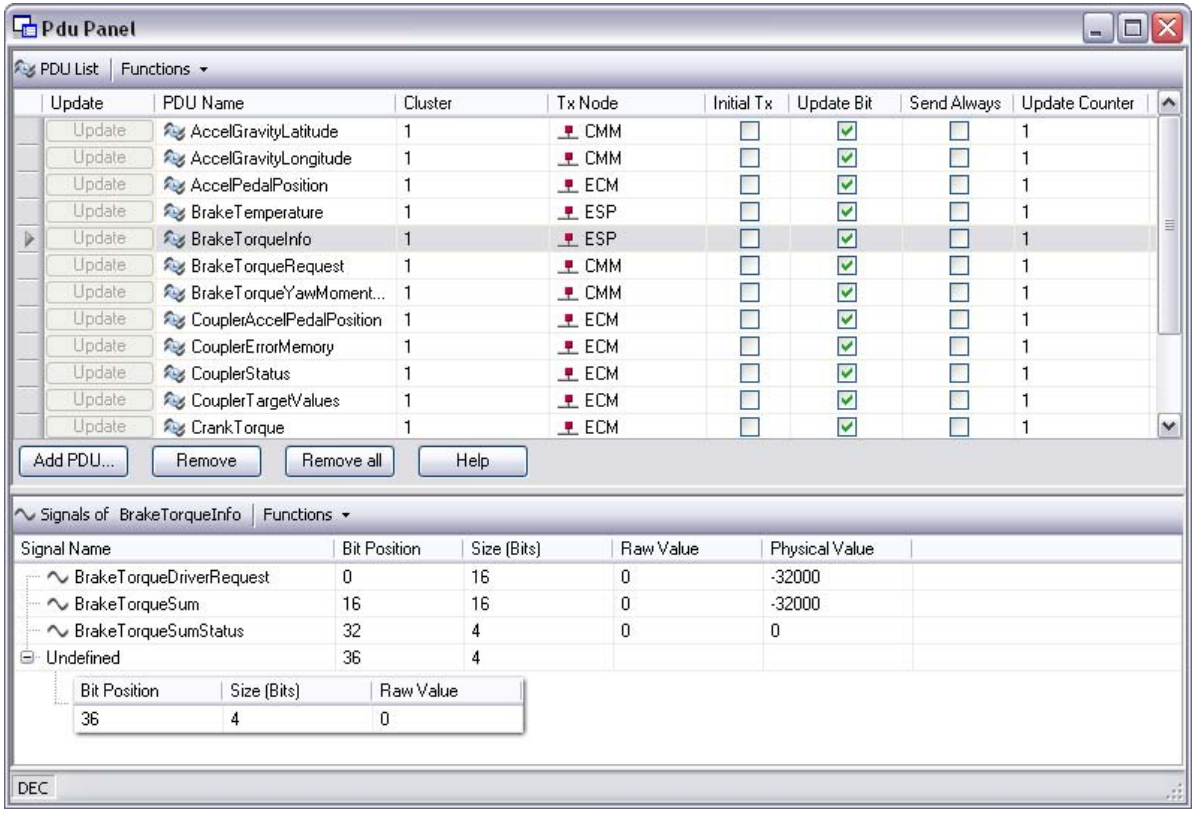
- Easy configuration of Tx frames considering all FlexRay specific elements
- Simplified data update without any CAPL program code



PDU Panel

NEW 7.1

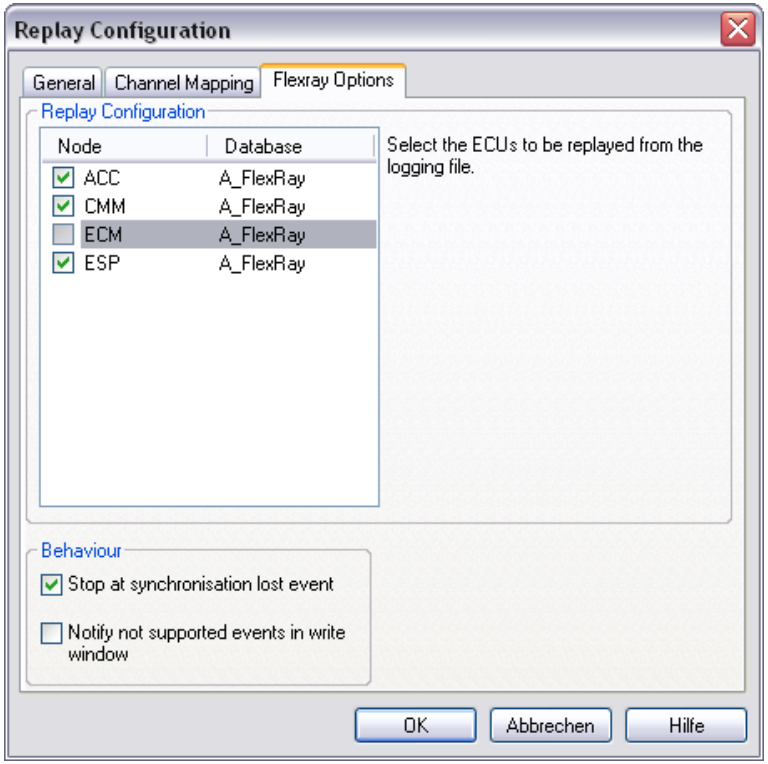
- Easy configuration of Tx PDUs considering all FlexRay PDU specific elements (Update Bit, Update Counter,…) using FIBEX 3.0 or FIBEX+
- Simplifies data update without any CAPL program code



Replay Block

NEW 7.1

- FlexRay Replay Block
  - Insertion of certain data sequence
  - Provides the counter part of a real ECU
  - Support of PDUs and Frames

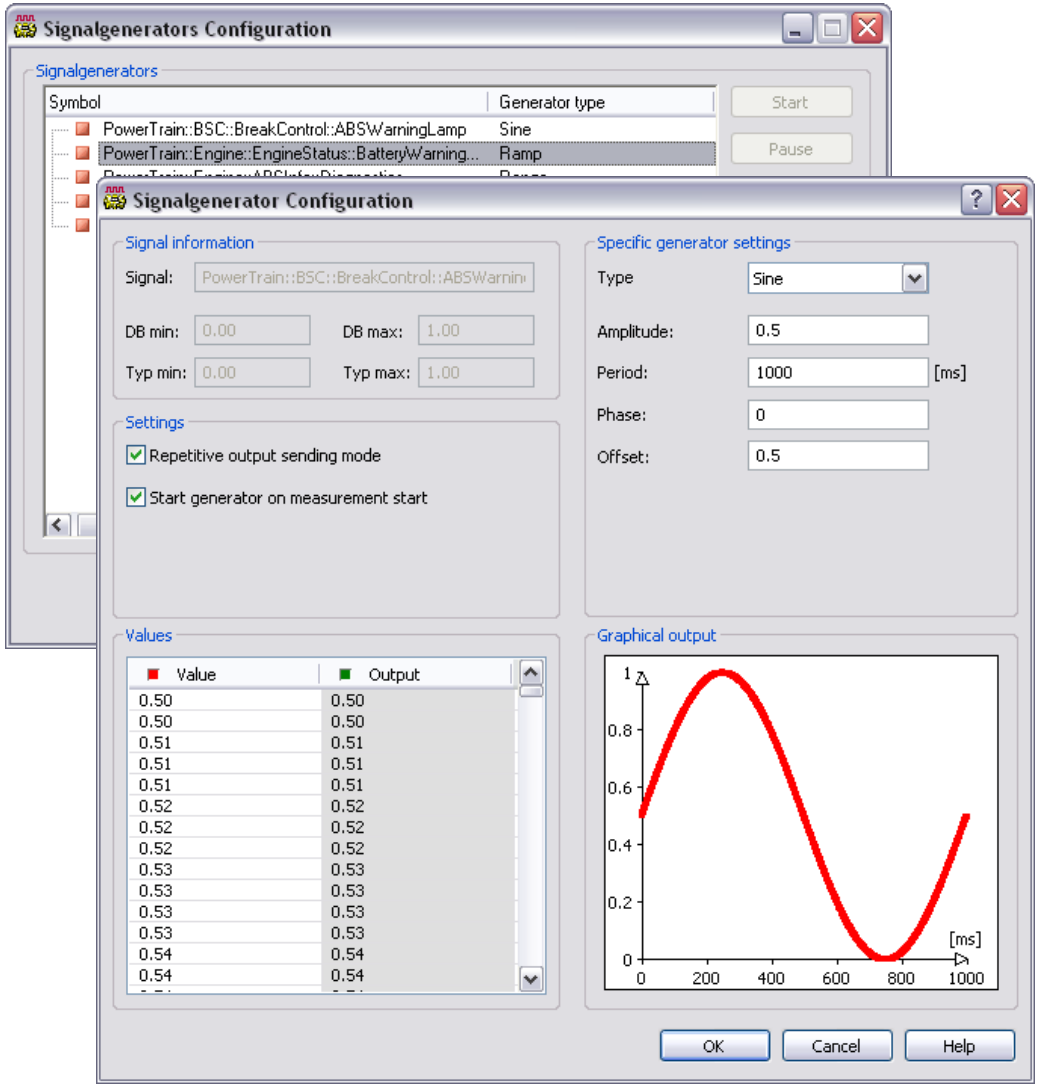


Stimulation

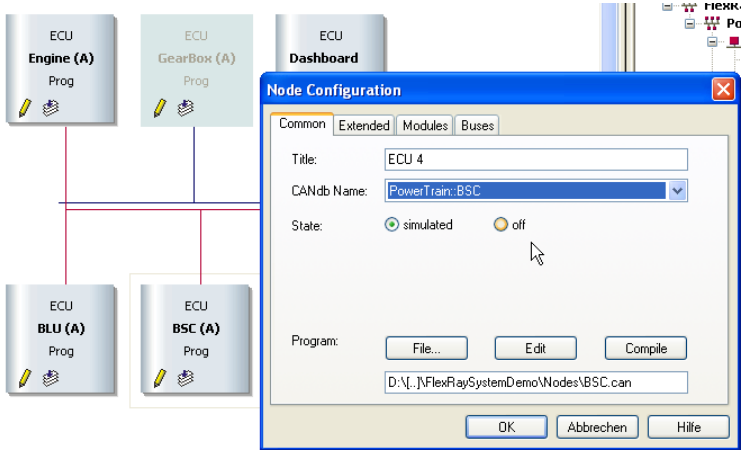
Signal Generators

NEW 7.0

- Signal generator for FlexRay signals
  - Simple generation of signal courses (ramp, sine, …)
  - Synchronized to the FlexRay schedule



- Automatic registration of TX frames of simulated nodes



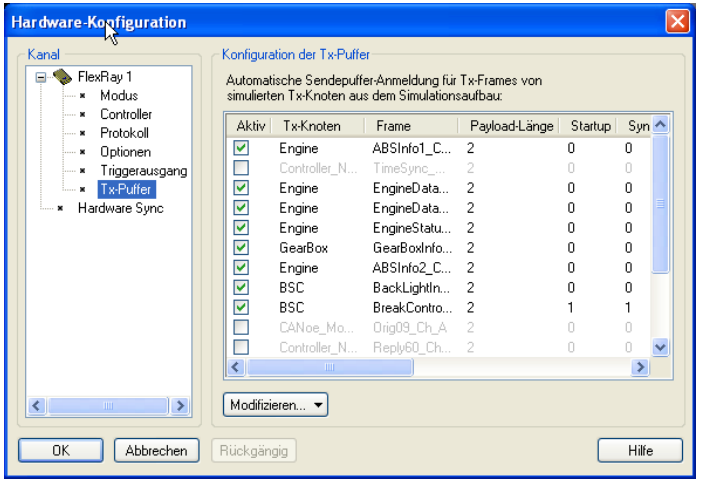
  - Activation via ECU assignment in the simulation setup

  - Check and modification of the automatic registered TX frames
    - > Additional manual deactivation of not needed TX frames to save TX buffers in the CC

NEW 6.1

    - > One click modify of Startup/Sync flag for all frames

    ➔ Simply simulate complete load of static segment when using database import wizard with creation of simulation nodes!

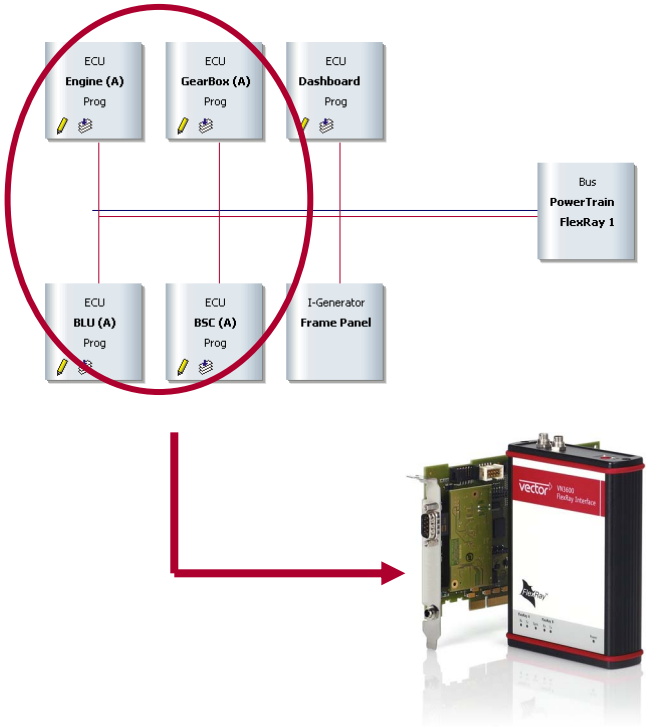


CAPL on Board for CANoe

General Features

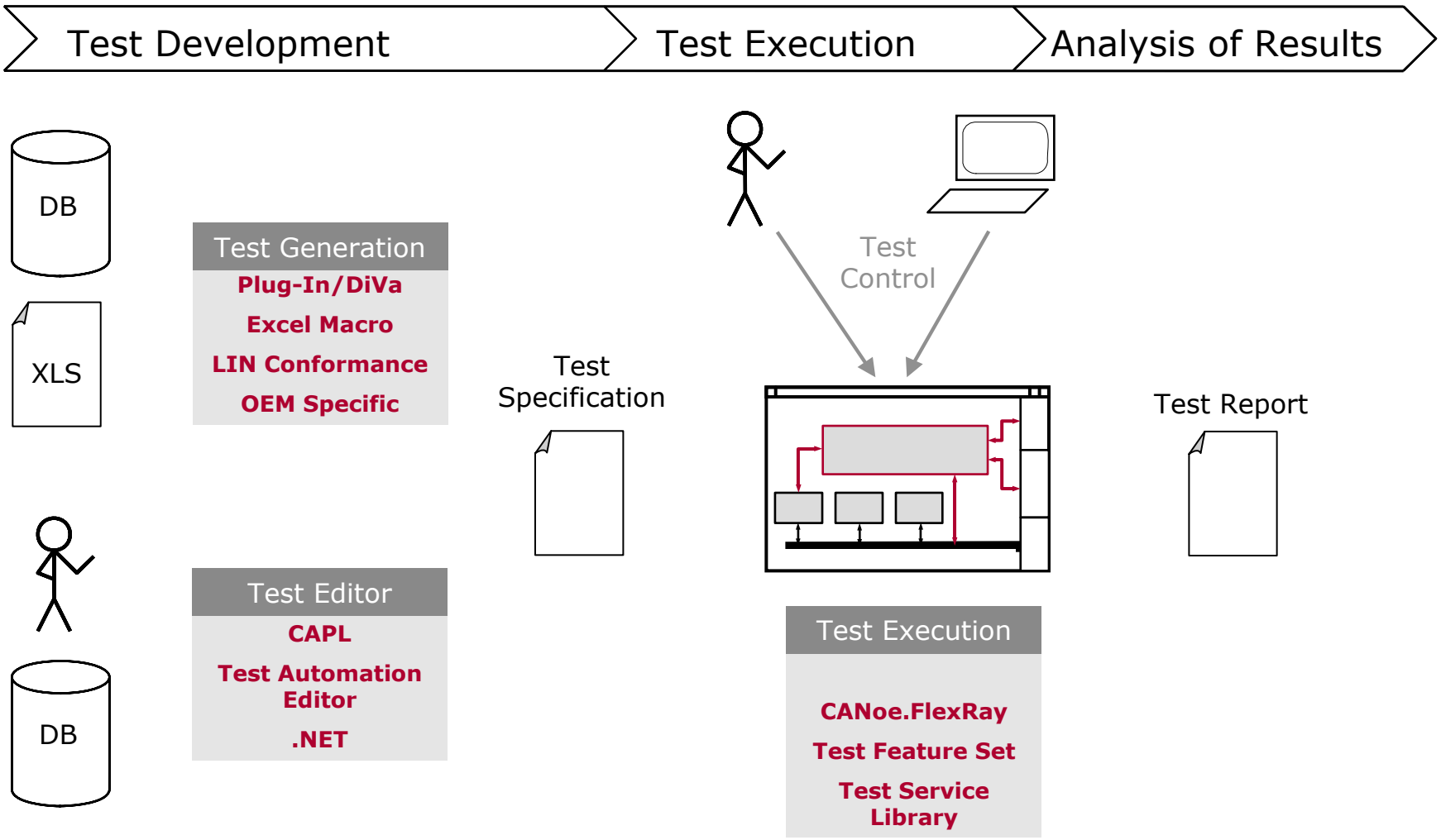
NEW 7.1

- Execution of CAPL programs on the VN3x00 & VN7600 network interfaces
- The CAPL code of the selected nodes will be transferred to the network interface during measurement preparation and executed on the modules
- Use case:
  - Simulation of time critical tasks
- Goal:
  - Deterministic execution of the CAPL programs
  - Reduced latency for fast responses

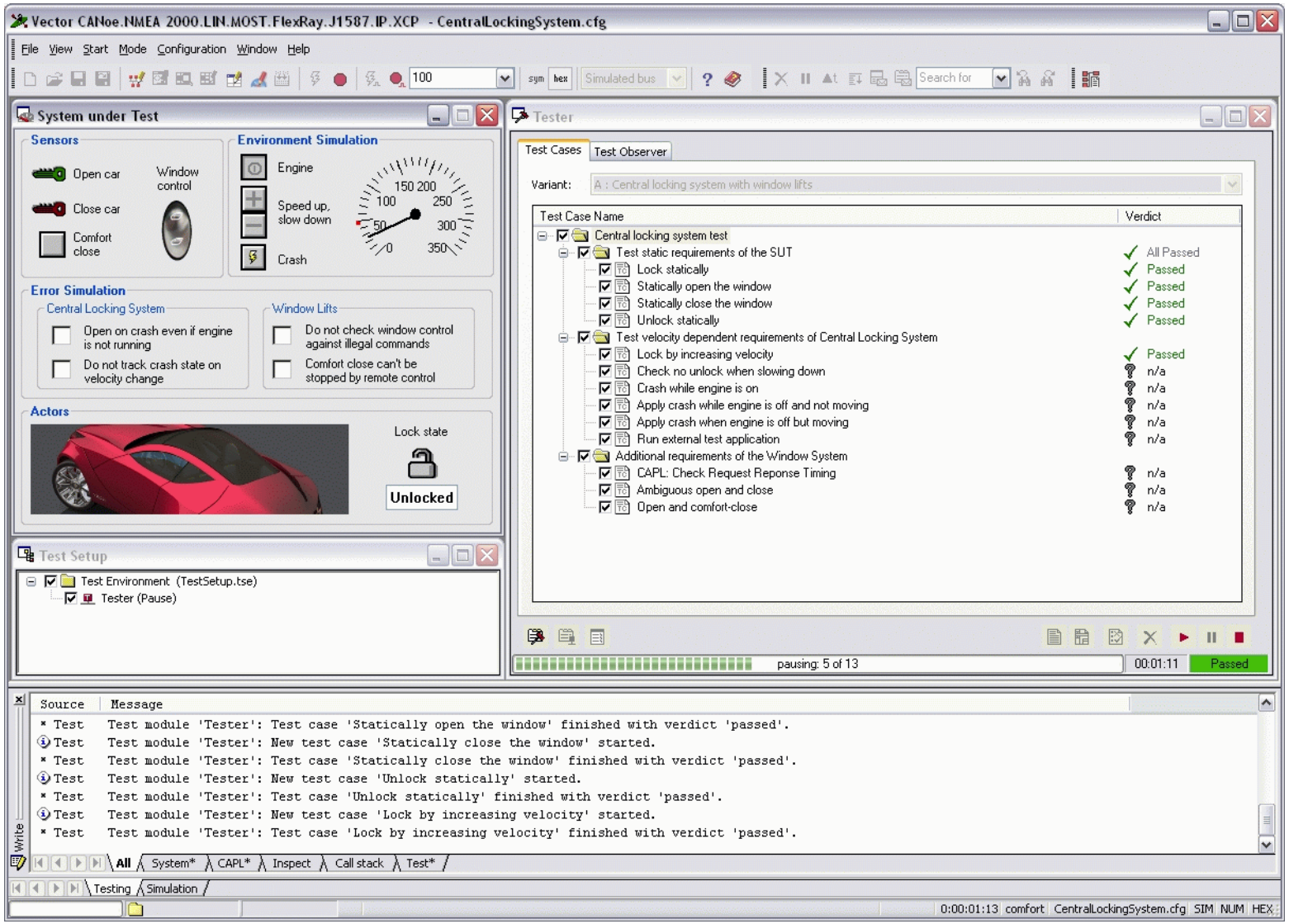


Test

Solutions

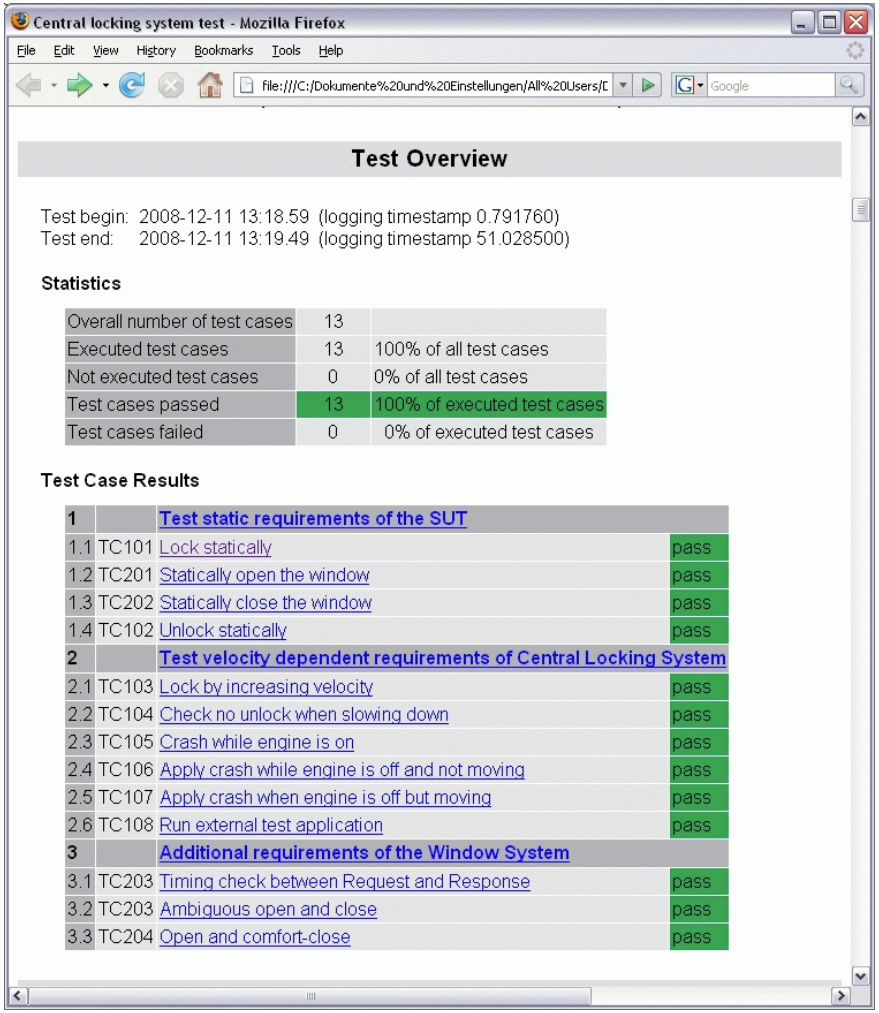


Test



Test

Report



Test Overview

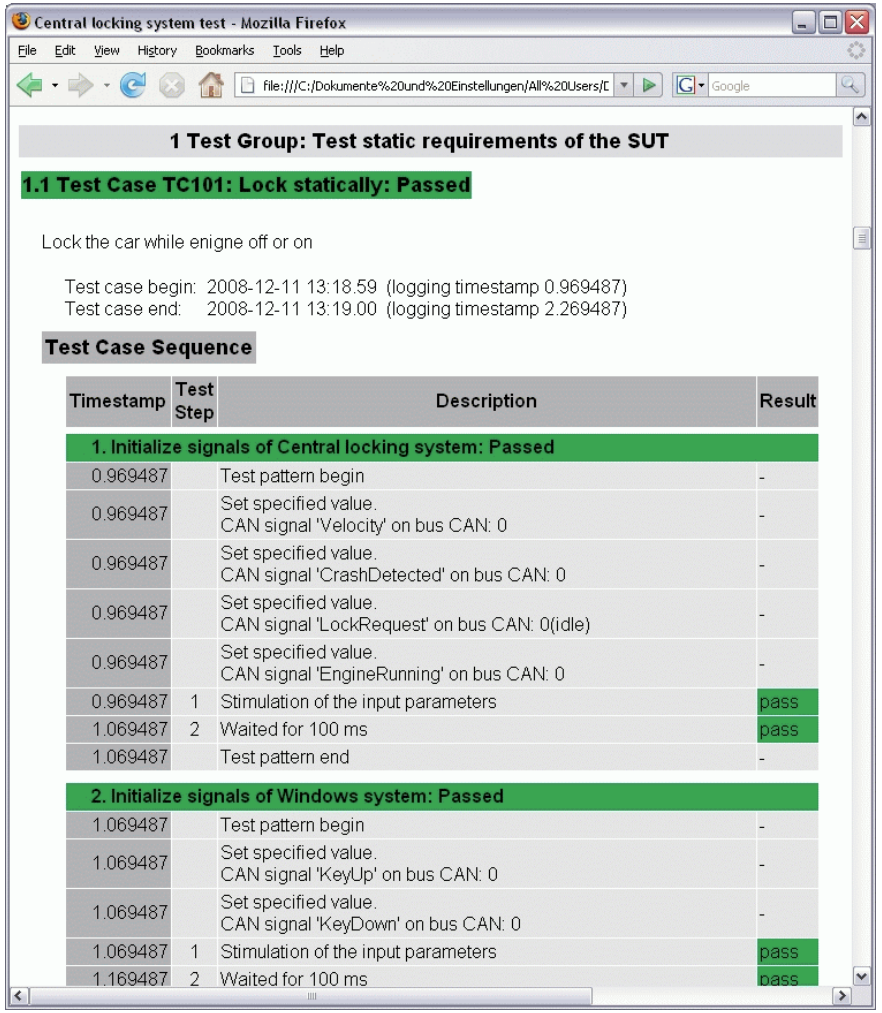
Test begin: 2008-12-11 13:18.59 (logging timestamp 0.791760)
Test end: 2008-12-11 13:19.49 (logging timestamp 51.028500)

Statistics

Overall number of test cases	13	
Executed test cases	13	100% of all test cases
Not executed test cases	0	0% of all test cases
Test cases passed	13	100% of executed test cases
Test cases failed	0	0% of executed test cases

Test Case Results

1		Test static requirements of the SUT	
1.1	TC101	Lock statically	pass
1.2	TC201	Statically open the window	pass
1.3	TC202	Statically close the window	pass
1.4	TC102	Unlock statically	pass
2		Test velocity dependent requirements of Central Locking System	
2.1	TC103	Lock by increasing velocity	pass
2.2	TC104	Check no unlock when slowing down	pass
2.3	TC105	Crash while engine is on	pass
2.4	TC106	Apply crash while engine is off and not moving	pass
2.5	TC107	Apply crash when engine is off but moving	pass
2.6	TC108	Run external test application	pass
3		Additional requirements of the Window System	
3.1	TC203	Timing check between Request and Response	pass
3.2	TC203	Ambiguous open and close	pass
3.3	TC204	Open and comfort-close	pass



1 Test Group: Test static requirements of the SUT

1.1 Test Case TC101: Lock statically: Passed

Lock the car while enigne off or on

Test case begin: 2008-12-11 13:18.59 (logging timestamp 0.969487)
Test case end: 2008-12-11 13:19.00 (logging timestamp 2.269487)

Test Case Sequence

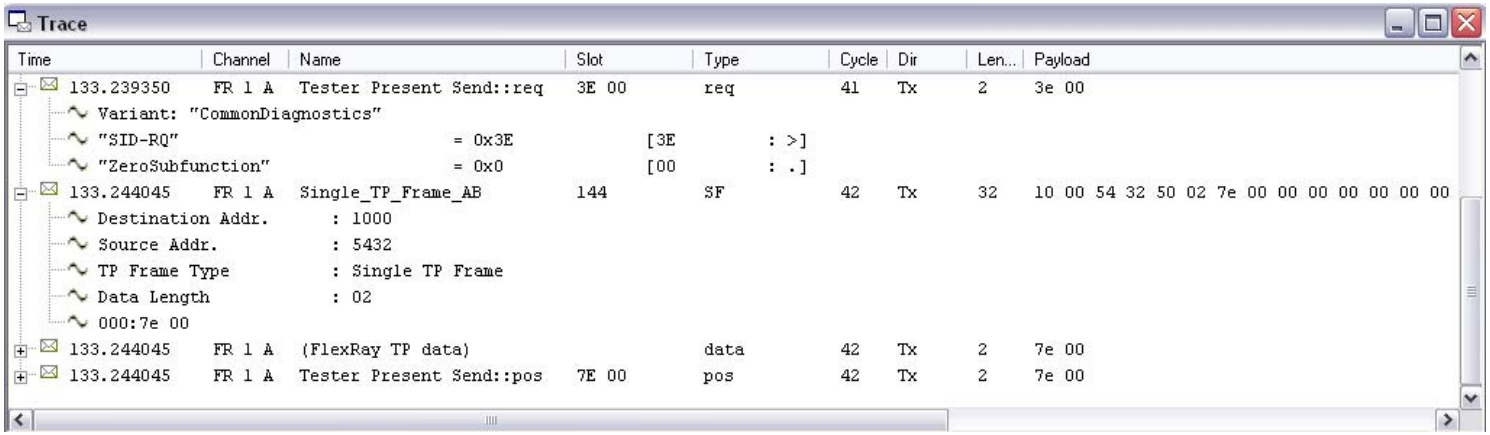
Timestamp	Test Step	Description	Result
1. Initialize signals of Central locking system: Passed			
0.969487		Test pattern begin	-
0.969487		Set specified value. CAN signal 'Velocity' on bus CAN: 0	-
0.969487		Set specified value. CAN signal 'CrashDetected' on bus CAN: 0	-
0.969487		Set specified value. CAN signal 'LockRequest' on bus CAN: 0(idle)	-
0.969487		Set specified value. CAN signal 'EngineRunning' on bus CAN: 0	-
0.969487	1	Stimulation of the input parameters	pass
1.069487	2	Waited for 100 ms	pass
1.069487		Test pattern end	-
2. Initialize signals of Windows system: Passed			
1.069487		Test pattern begin	-
1.069487		Set specified value. CAN signal 'KeyUp' on bus CAN: 0	-
1.069487		Set specified value. CAN signal 'KeyDown' on bus CAN: 0	-
1.069487	1	Stimulation of the input parameters	pass
1.169487	2	Waited for 100 ms	pass

Diagnostics over FlexRay

Overview

NEW 7.1

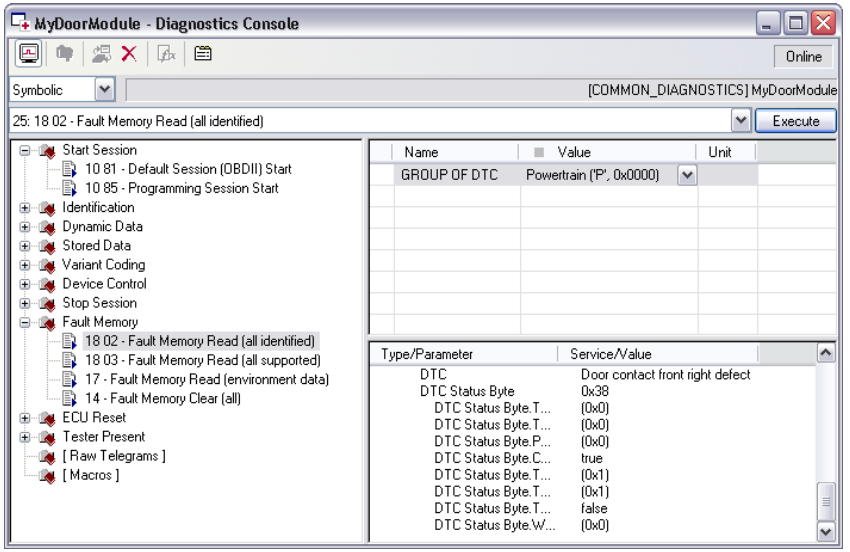
- Support of Fault Memory Window and Diagnostics Console
- Send and receive diagnostics requests and responses in simulations
- Support of TFS functionality, XML test patterns
- Diagnostic Observer for Trace window. Support of diagnostic parameter in Data and Graphics window
- CAPL callback interface for ECU simulations, TP layer access for tests (e.g. DiVa)
- Trace window FlexRay TP Observer for AUTOSAR FlexRay TP, BMW TP & ISO 10681-2 TP

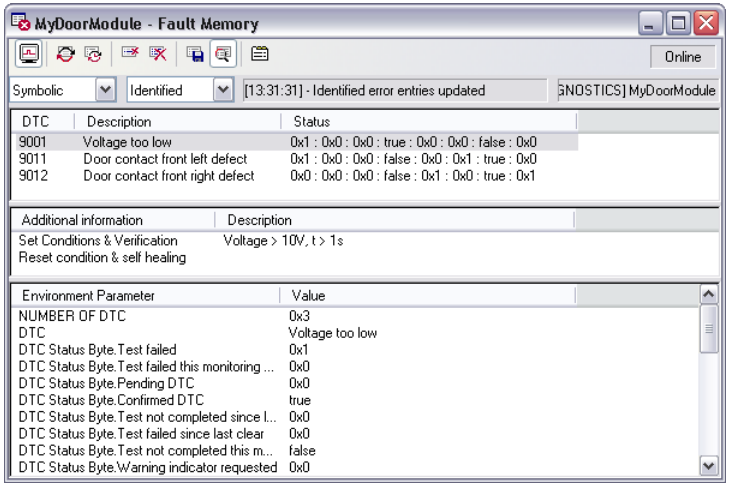


Diagnostics over FlexRay

Diagnostics Console & Fault memory

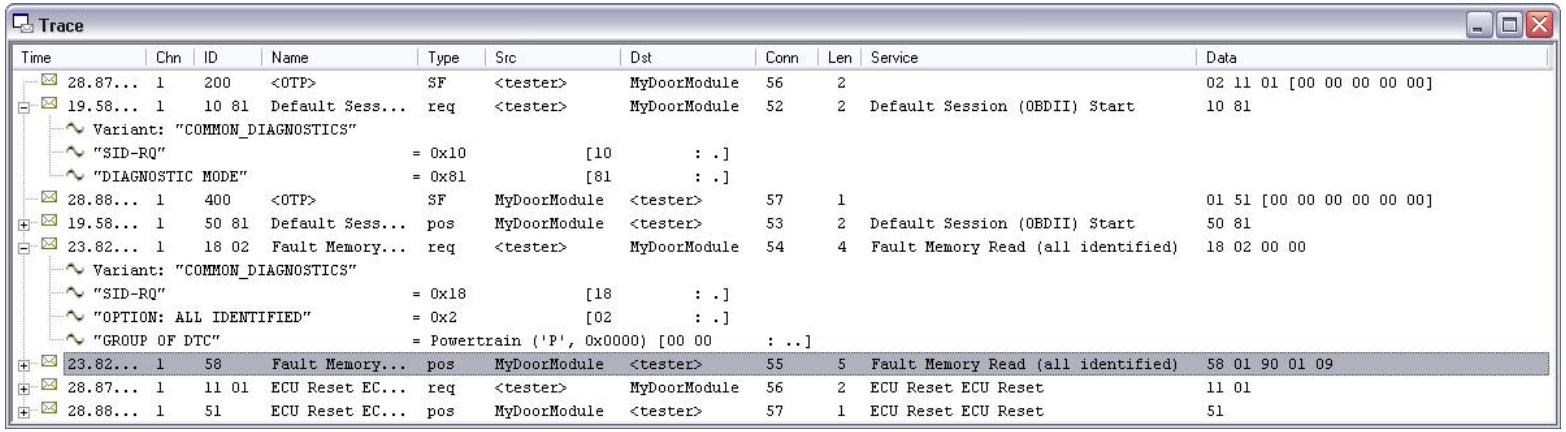
- Interactively browse & access available diagnostic services
- Cyclical update of fault memory contents / logging of DTCs for external processing
- One separate window per real / simulated network node
- No code development necessary → CDD/ODX file for ECU / network sufficient





Diagnostic Observer & Symbolic Output

- Pure observer for monitoring diagnostic traffic on existing networks → no adverse influence on network
- Fallback option to KWP2000 generic interpretation → starting without specific diagnostic definition possible
- Symbolic presentation of traffic according to diagnostic description files → “speaking” service names & “meaningful” parameters
- Output to Trace, Graphics & Data windows



Add-on Packages

Availability of Add-in Concept for OEM Modules on FlexRay

FlexRay Interaction Layer	OEM	State
AudiFrIL	Audi	Available
BMWFrIL	BMW	Available
DAGFrIL	Daimler	Beta

Network Management	OEM	State
AUTOSAR NM with VAG specific modifications	Audi	Available
AUTOSAR NM	Generic	Beta

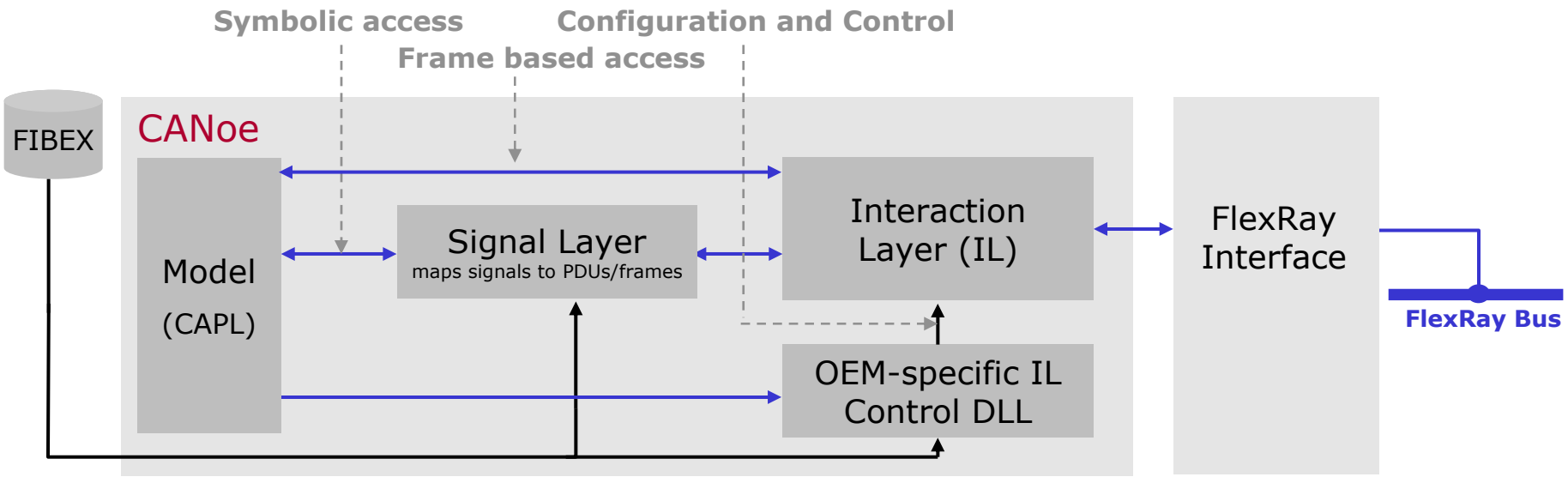
Transport Protocol	OEM	State
AUTOSAR FlexRay TP	Generic	Available
BMW FlexRay TP	BMW	Available
ISO 10681-2 TP	Generic	Available

Note: Further variants can be supported on request.

Automatic Communication Control

NEW 7.0

- **FlexRay Interaction Layer** considers OEM specific definitions for
  - Cyclic sending of frames/PDUs with application specific cycle periods
  - Automatic calculation of message CRCs and message counters
  - Modification of signal values and/or timings according to global system states (clamp15/IGN, …)



Thank you for your attention.

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