The challenge of state-of-the-art vehicle communication - FlexRay™ for the Masses

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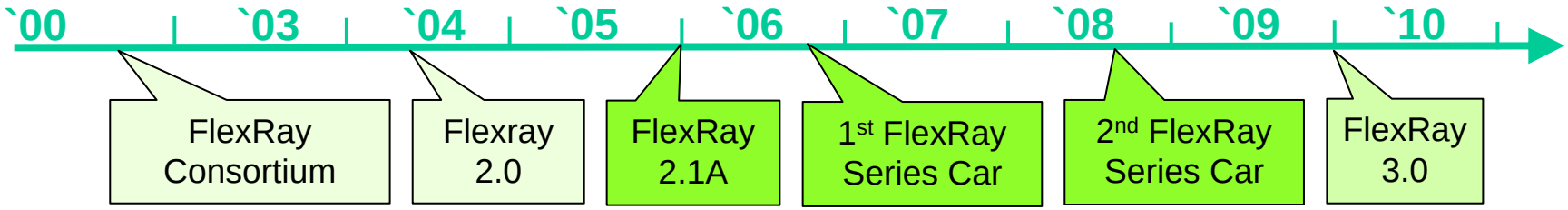
Overview

- The FlexRayTM Specification - Overview of Protocol Enhancements V3.0
- The FlexRayTM Specification - Overview of Physical Layer Enhancements V3.0
- Efficiency of FlexRayTM Architectures

FlexRay Evolution

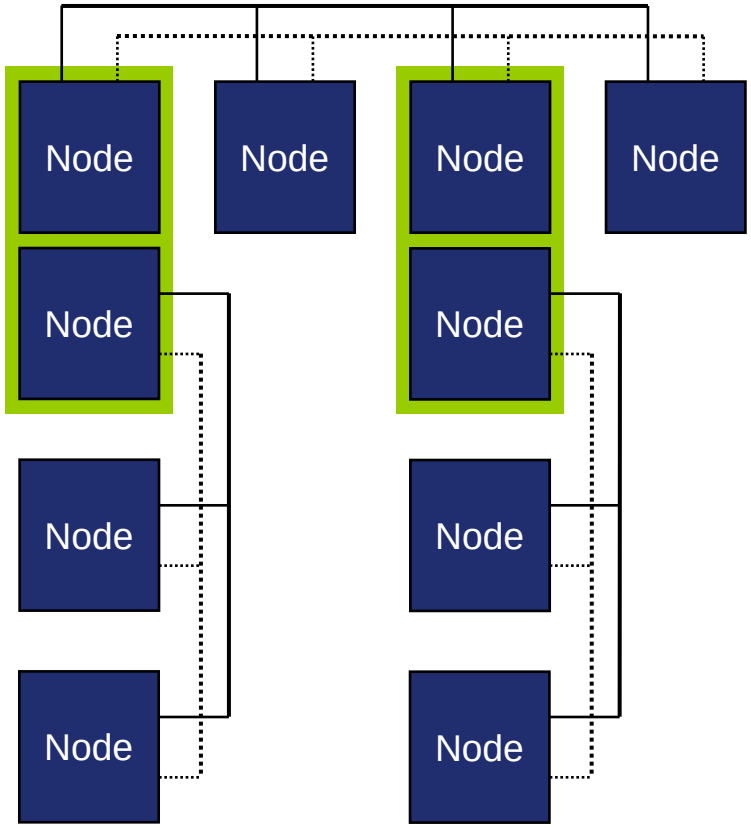


- Mature Communication Standard:
  - Several 10s of Microcontrollers with embedded FlexRay™ interface have passed conformance test
  - FlexRay™ projects at all Automotive OEMs
- FlexRay 3.0 incorporates experience from several series projects

The FlexRay™ Specification - Overview of Protocol Enhancements V3.0




Key Requirement Synchronization Modes



Key Requirement

- Provide simple means for connecting sub-networks to a FlexRay™ network such that synchronization is retained between the networks.

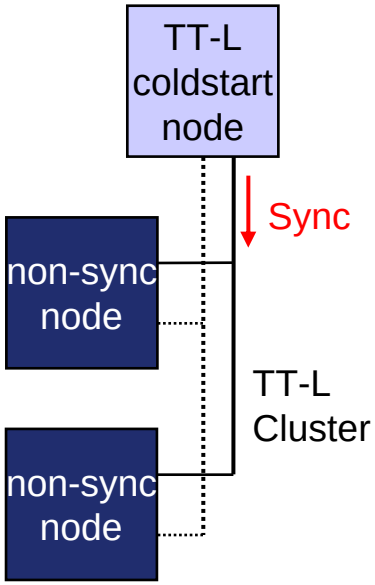
Key Aspects

- Alignment of schedules
- Synchronization transparent to higher layers
- Scalable (single or dual channel)
- Simplicity

Basic Solution

- Introduced time-triggered master mode (TT-L and TT-E)

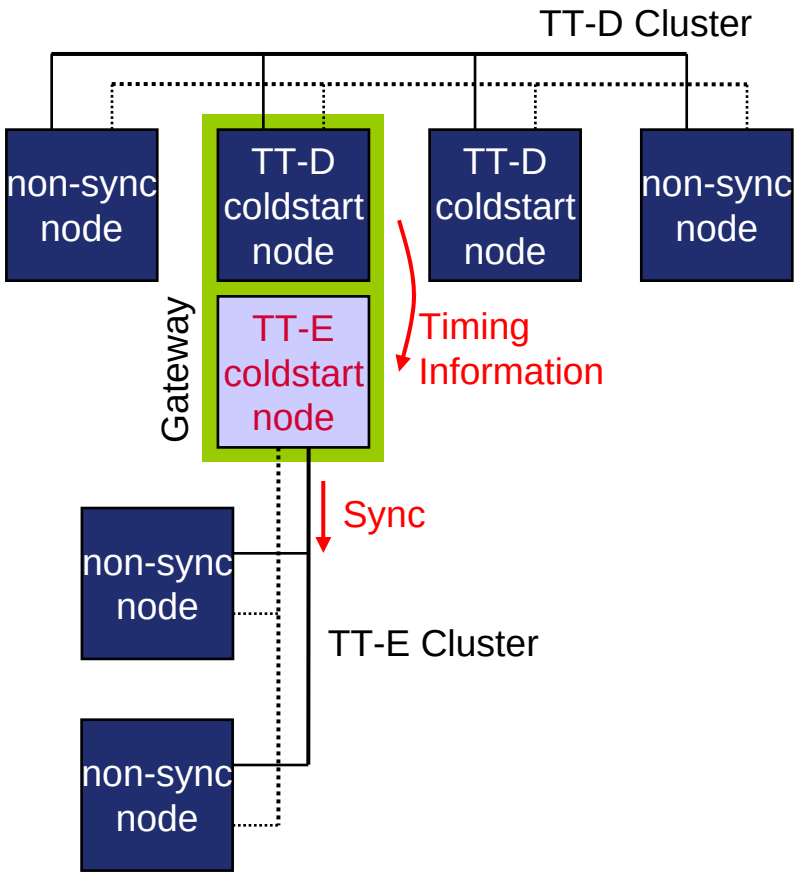
TT-L Use Case “Local Sync Mode”



TT-L cold start node for simple networks

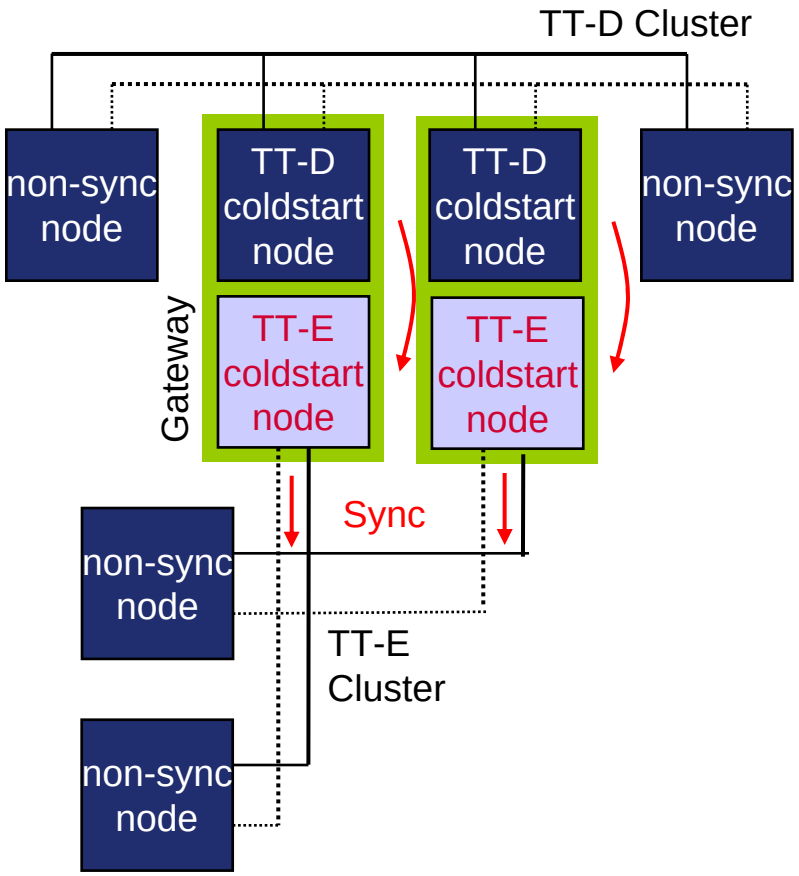
- A TT-L coldstart node is able to act as the only start-up node and the only synchronization node in the TT-L cluster.
- TT-L coldstart node sends synchronization frames in two static slots
- TT-L is transparent to non-sync nodes
- Useful for small stand-alone systems and for developing sub-networks for multi-cluster systems

TT-E Use Case "External Sync Mode"



- TT-E coldstart node for externally synchronized networks
  - A TT-E coldstart node is able to retrieve start-up and synchronization information from another cluster and provide this information to the TT-E cluster.
  - TT-E is transparent to non-sync nodes
  - TT-E coldstart node can switch autonomously to local sync mode in order to keep communication within the TT-E cluster ongoing if TT-D cluster is not active.

TT-E Use Case "External Sync Mode" Variant



TT-E coldstart nodes for externally synchronized networks

- Increase robustness: Multiple TT-E coldstart nodes in one TT-E cluster
- Both TT-E coldstart nodes are able to start-up the TT-E cluster and keep communication ongoing without the respective other TT-E cold start node.
- Both TT-E coldstart nodes are synchronized via the TT-D cluster.
- Operation of TT-D and TT-E coldstart nodes remains transparent to non-sync nodes

Overview of Key Protocol Enhancements V3.0

- **Enhancements to the Protocol Logic**
  - Bit rates
  - Wakeup
  - Synchronization Modes
  - Dynamic Segment
- **Enhancements to the Controller Host Interface**
  - Slot Multiplexing
  - FIFO Buffer
  - Cycle Counter

Overview of Key Protocol Enhancements V3.0

Enhancements to the Protocol Logic	
Bit rates	Support for 2.5 MBit/s, 5 MBit/s and 10 MBit/s
Wakeup	Wakeup During Operation Pattern (WUDOP) can be transmitted in symbol window to support wakeup during normal operation
Synchronization Modes	Two new synchronization modes TT-L and TT-E allow a single node to control startup and clock synchronization by transmitting two startup frames per communication cycle
Dynamic Segment	Increased masking of noise in the dynamic segment by re adjusting slot counter for noise events
Enhancements to the Controller Host Interface	
Slot Multiplexing	
FIFO Buffer	
Cycle Counter	

Overview of Key Protocol Enhancements V3.0

Enhancements to the Protocol Logic	
Bit rates	
Wakeup	
Synchronization Modes	
Dynamic Segment	
Enhancements to the Controller Host Interface	
Slot Multiplexing	Slot multiplexing (i.e. sharing of static communication slots between multiple nodes) is allowed in the static segment for all slots except for keyslots
FIFO Buffer	At least one FIFO buffer now mandatory Detailed FIFO filter criteria specified
Cycle Counter	Cycle counter wraparound value became configurable (any even number between 8 & 64 possible) Cycle counter filtering extended to repetition values of 5, 10, 20, 40 and 50

The FlexRay™ Specification - Overview of Physical Layer Enhancements V3.0



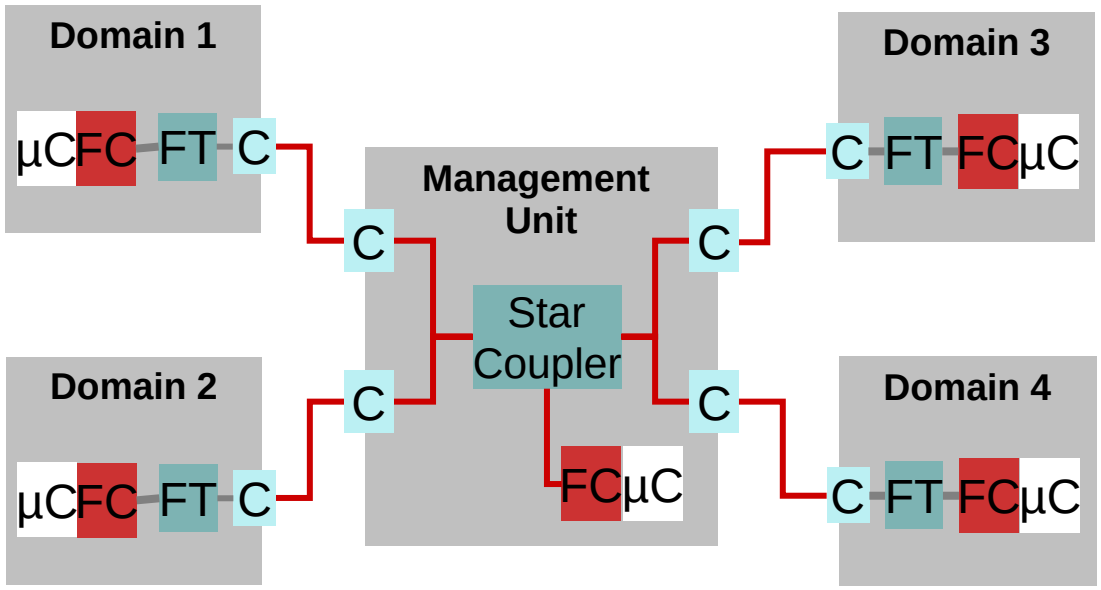

Overview of Key Physical Layer Enhancements V3.0

Enhancements	
Bit rates	Support for 2.5, 5 & 10MBit/s eye diagrams for 2.5, 5 & 10MBit/s added & reworked minimum bit time was reduced to 70ns introduction of the signal integrity voting
Active Star	Interface to a CC/host added distinguishing between monolithic and non-monolithic implementations
Signal Integrity & Timing	Detailed consideration of ringing effects bus timing harmonized with Jaspar
Interfaces	Specification of the CC-BD interface (timings, thresholds, PCB influences etc.) Timing specifications covering all components between the transmitting and receiving protocol engine Leakage and short circuit currents defined

Efficiency of FlexRay™ Architectures

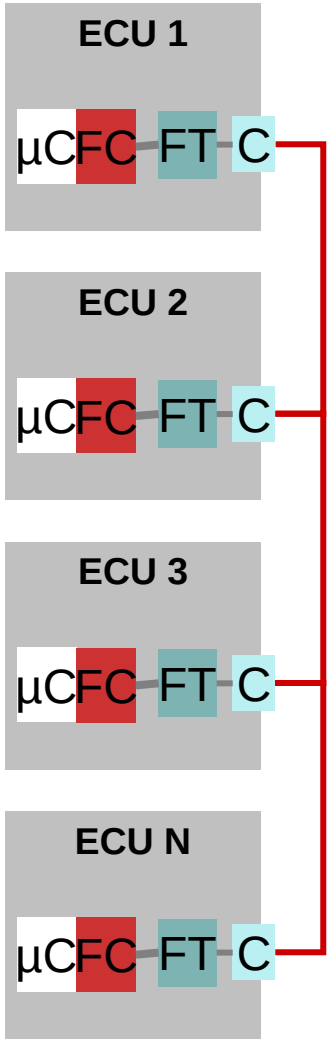



FlexRay™ Implementation Cost



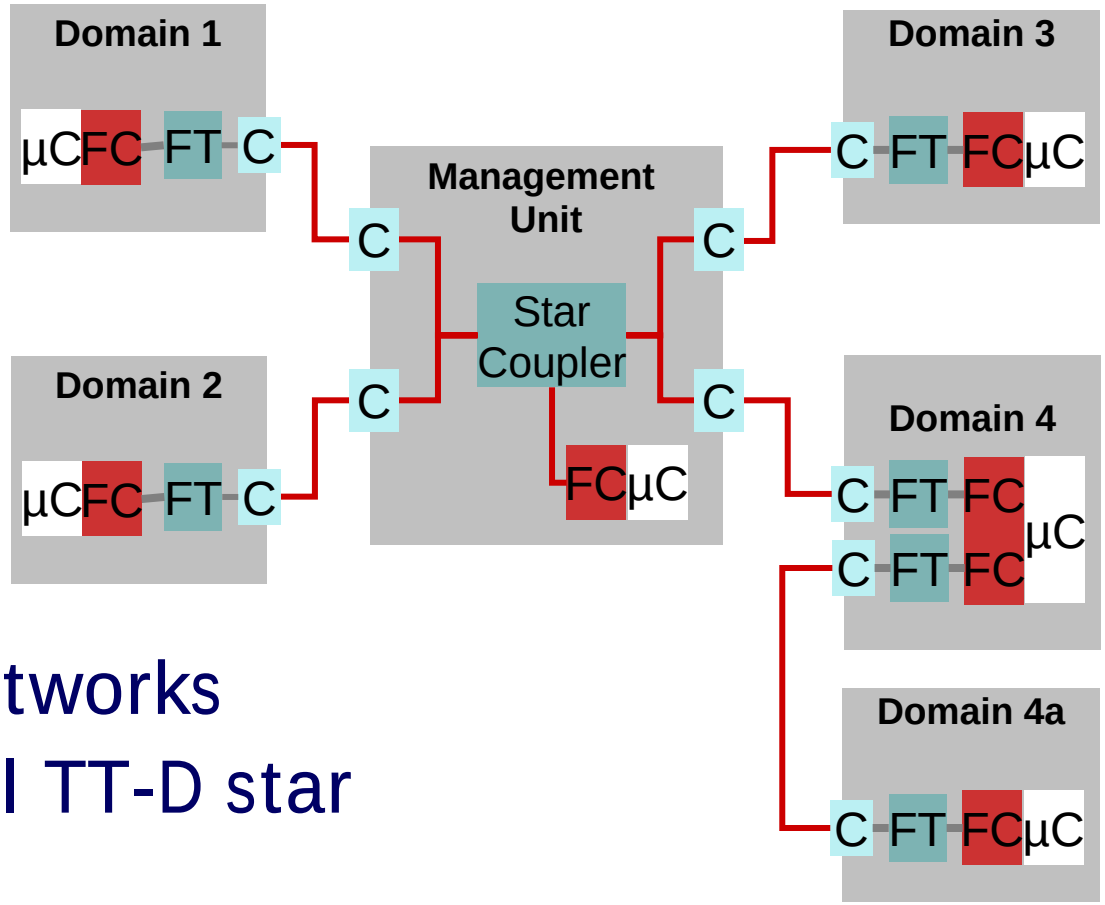
- Integration
  - Monolithically integrated FlexRay™ active star (4 or more FlexRay™ busses)
  - FlexRay™ System Basis Chips (SBC)

FlexRay™ Implementation Cost



- Lower cost topologies
  - Large linear bus topologies (> 20 members) w/ high wiring margin, use of 2.5 MBit/s speed
  - Use of TT-L local sync mode
  - Simple CAN replacement, efficient use of dynamic segment

FlexRay™ Implementation Cost



- Extensibility
  - Hierarchical networks
  - Stable top-level TT-D star configuration
  - Variations of fitting confined to lower level TT-E bus topologies

Summary

- The FlexRay™ communication system has become the standard solution for automotive distributed control systems
- The next generation will focus on cost effective FlexRay™ systems
  - Easy replacement of CAN: simple, linear bus structures
  - Multi-tiered topologies: FlexRay-2-Flexray architectures
- At the same time, innovation in Chassis Electronics can still continue to use the FlexRay™ system as a vehicle for Domain-based architecture redefinition

Getting Assistance

- FlexRay Specifications: www.flexray.com
- Freescale FlexRay Portal: www.freescale.com/flexray
- Inquires
  - Freescale Sales & FAE representative
  - FlexRay Technical Experts: via Service Request on www.freescale.com