Automotive & Embedded Info

Never Forget Basics Whether its Life or Anything Else … Basics are Cores. While seeing a Tree how can we forget Seed…

FLEXRAY

Flex-Ray

Why Flex-Ray?

Safety-critical driver assistance functions with electronic interfaces to the chassis place extremely stringent requirements on the reliability, safety and real-time capability of the communication system. What is needed is a communication system with the property of composability, whose core property is to guarantee **deterministic and fault tolerant data communication** independent of bus load.

CAN (Controller Area Network), the **communication technology** that has become established in the automotive field, cannot fulfil this challenging set of requirements, since CAN is based on an **event-driven communication approach**, which means that every bus node of a communication system must be able to access the common communication medium at any time. The use of technologies for resolving collisions leads to a communication flow that cannot be determined until runtime. Event-driven communication systems enable quick reaction to asynchronous processes, but they are **non-deterministic**.

Because there is no strict schedule in an event-driven communication system, adding and removing bus nodes affects the communication flow. Strictly speaking, such changes make it necessary to comprehensively revalidate the entire system. Event-driven communication systems do **not** exhibit the property of **composability**.

CAN communication technology cannot fulfil the high requirements for **fault tolerance** due to its lack of redundant structures and mechanisms and can also only deliver a maximum data rate of 500 Kbit/s in series production. Therefore some automotive OEMs were already experimenting with fault tolerant, time-triggered communication technologies, which allowed very high data rates.

Understanding Flex-Ray

In order to meet the requirements of comfortable and safe upgrades, the modern vehicles include the more electronic controller, sensors and drivers and lead to the rapid increase of vehicular electronic control units. Therefore, the automotive communication network is greatly increased the engineering and technical complexity for data transmission. New tasks have increased the requirement of communication between control units. CAN is not sufficient any more. In CAN real time capabilities are not supported because of bit arbitration.

Flex Ray protocol is proposed to provide the high-speed communication system with high flexibility and reliability between electronic control units for automotive applications.

The networking platform is proposed and developed to implement a vehicular Drive-by-Wire system, which uses Flex Ray Protocol as the backbone of data communication. This Drive-by-Wire system is designed and integrated by Steer-by-Wire and Throttle-by-Wire functions. The Steer-by-Wire system is used to replace the mechanical structure between the steering wheel and the wheels into electronic equipment to control the wheel steering. Then, the Throttle-by-Wire system is proposed to substitute the traditional pull throttle cable to control the engine valve opening and closing for electronic signals to control the throttle. Furthermore, this Drive-by-Wire system is integrated and networked by four ECU nodes to achieve the Steer-by-Wire, and Throttle-by-Wire control.

In conclusion, the Drive-by-Wire system platform is constructed by integrating the Steer-by-Wire and Throttle-by-Wire functions based on Flex Ray communication to illustrate and evaluate the feasibility and performance of the proposed network architecture for vehicular applications.

Behind of all these systems, the control applications cannot be contained within one ECU any longer and instead require multiple ECUs working with the help of a communication system. It is no longer autonomous ECUs, rather **distributed systems** that are increasingly forming the backbone of modern safety and driver assistance systems. Simply incorporating a communication system is not enough; strictly specified time-based cause-and-effect chains also need to be assured. The focus has turned to communication systems that ideally offer deterministic data communication which is independent of bus load, i.e. they guarantee equidistant signal transmission. One speaks of a **real-time communication systems with a time-triggered approach**.

X-by-wire Technique à Steer-by-wire, brake-by-wire etc. Hydraulic steering and braking is replaced by an electronic system of sensors and actuators. **Drive by wire**, **DbW**, **by-wire**, **Steer-by-wire**, or **x-by-wire** technology in the automotive industry is the use of electrical or electromechanical systems for performing vehicle functions traditionally achieved by mechanical linkages. This technology replaces the traditional mechanical control systems with electronic control systems using electromechanical actuators and human-machine interfaces such as pedal and steering feel emulators. Components such as the steering column, intermediate shafts, pumps, hoses, belts, coolers and vacuum servos and master cylinders are eliminated from the vehicle. This is similar to the fly-by-wire systems used widely in the aviation industry.

Flex-Ray Communication

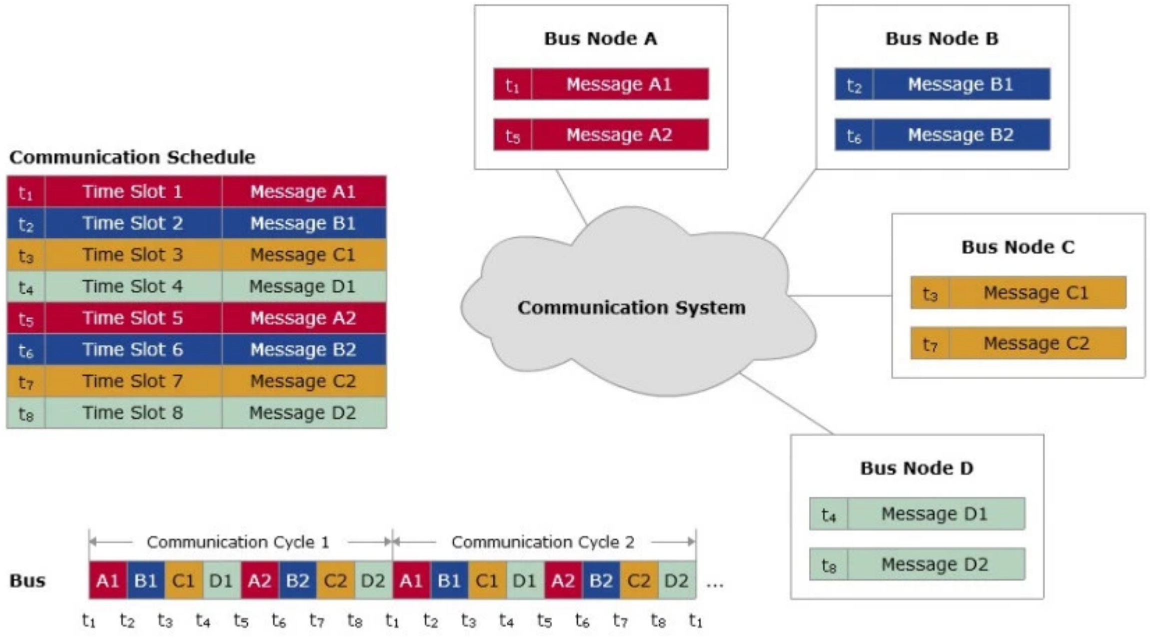
COMMUNICATION ARCHITECTURE

A FR communication system is made up of a number of FR nodes and a physical transmission medium interconnecting all of the flex ray nodes.

To minimize the risk of failure, Flex Ray provides for **redundant layout of the communication channel**. Each of the two communication channels may be operated at a data rate of up to 10 Mbit/s. However, as an alternative this redundant channel may be used to increase the data rate to 20 Mbit/s. The choice between fault tolerance and increased transmission rate can be made individually for each Flex Ray message.

The Flex Ray cluster is based on a **time-triggered communication architecture**, whose core property is static, time defined triggering of actions in the distributed system. The principle of time control not only enables **deterministic data communication**, but also simple **composability** of a communication system and implementation of concepts building upon it, such as **fault tolerance** that is attained by integrating **redundancies** and synchronous triggering of actions.

Multiple Access) is used, which means that the Flex Ray nodes may not access the bus in an uncontrolled manner in response to application-related events as in CAN. Flex Ray nodes must conform to a precisely defined **communication schedule**, which assigns a specific time slot to each Flex Ray message per communication cycle and thereby prescribes the send times of all Flex Ray messages.



Topologies

Passive Topologies:

1. Point to Point
2. Passive Star
3. Line Topology with redundant bus

Active Topologies:

1. Active star
2. Active Star Topology with redundant bus
3. Cascaded Active Star Topology

Node, Controller, Bus, Bus Level, Bus Interface, Bus Guardian

A FlexRay node is an electronic control unit (ECU), which is connected to a FlexRay bus via a FlexRay interface. The **FlexRay interface** is made up of a communication controller and one or two bus drivers, depending on the number of channels. The communication controller is referred to as a **FlexRay controller**. The bus driver is referred to as a **FlexRay transceiver**.

Representing the core of the FlexRay controller is the **protocol engine**. It consists of several communication components. The **media access control (MAC)** component for bus access. The **coding** component handles coding of the bytes obtained from the MAC. The **decoding** component handles decoding of the logical bit stream received by the FlexRay transceiver.

The FlexRay controller executes the **communication protocol** defined in the FlexRay specification. The primary tasks of the FlexRay controller include framing, bus access, error detection and handling, synchronization, putting the FlexRay bus to sleep and waking it up, as well as coding TX messages and decoding RX messages.

A FlexRay controller may enter eight different **states** depending on the progress of communication. Each controller state is characterized by certain communication-specific activities, in which very specific communication components are active. The communication component **protocol operation control (POC)** is responsible for controller state transitions.

The **FlexRay transceiver** couples the FlexRay controller to the physical transmission medium. The primary task of the FlexRay transceiver is signal transformation. On the one hand, it transforms the logical signal stream received by the FlexRay controller into a physical signal stream. In a logical signal stream.

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