

# S32G2 LLCE Standard Firmware Product Brief

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## 1. Software Product Overview

### **NXP Low Latency Communication Engine**

(LLCE) controls the traditional automotive communication interfaces such as CAN, LIN, and FlexRay™. The LLCE offloads the Host CPU from all interface level tasks along with validating, authenticating of frames for security and also handles the encryption/decryption process of frames with the help of on-chip Hardware Security Module (HSE).

It provides a platform to develop software to customize the processing of communication interfaces and handshaking with the host CPU.

LLCE is aimed to offer:

- Low latency processing of communication interface
- Offloading of host CPU for all interface related tasks
- Direct data transfer to/from HSE for security related tasks

The communication interfaces handled by LLCE are as below:

- 16 CAN interfaces, capable of CAN2.0 and CAN FD (Flexible Data rate) (5 Mbps)
- 4 LIN interfaces, capable of 20 Kbps each
- 1 FlexRay interface (20 Mbps)

NXP Low Latency Communication Engine runs a multicore application that controls the hardware communication interfaces and is called “firmware” Its architecture is described in Figure 1.

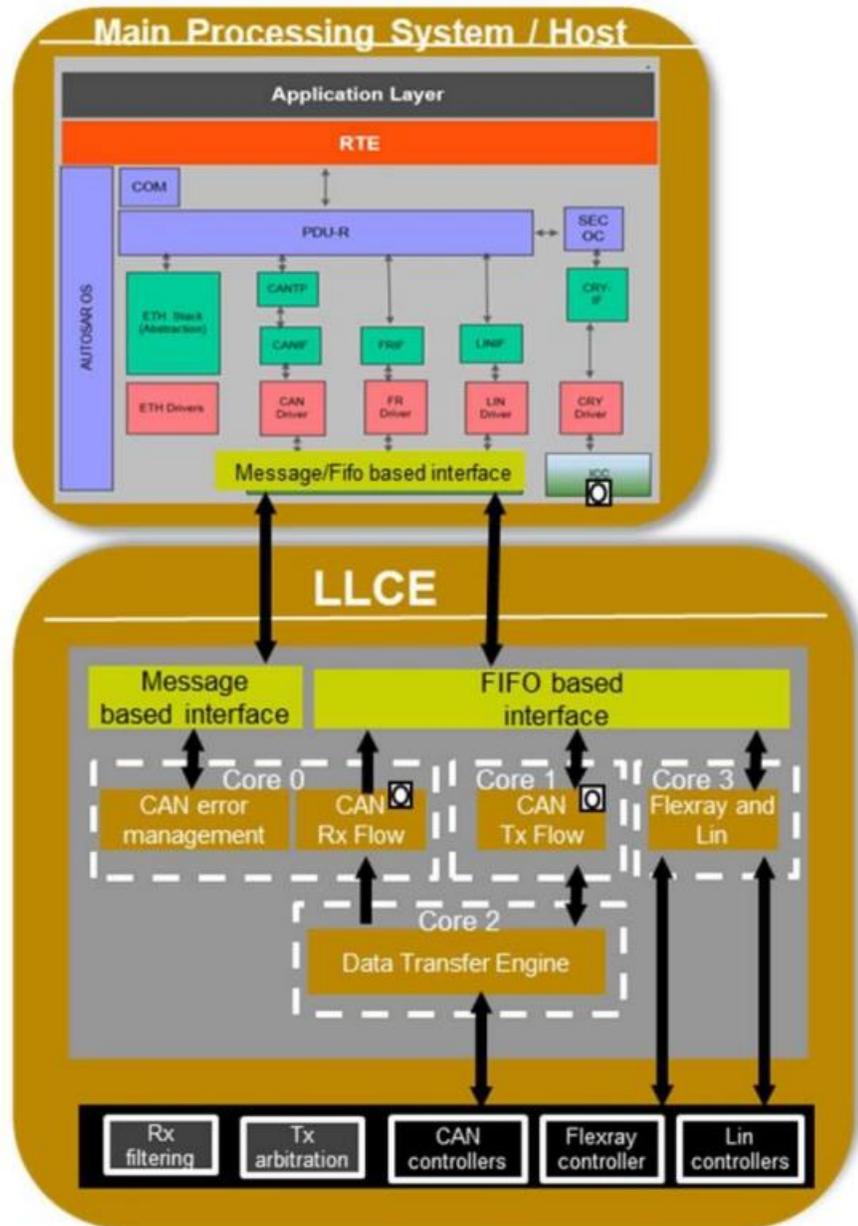


Figure 1. LLCE Architecture Diagram

## 2. Software Content

NXP solution is a fully programmable engine with firmware that supports:

- Offload of host CPU for all communication interface related tasks
  - Reduced interrupt load on the host core
  - Advanced software filtering
- Flexible control and data interface exposed to the Host cores
- Hardware acceleration for filtering and prioritization of messages

The firmware services are integrated into the AUTOSAR<sup>®</sup> Communication stack via AUTOSAR MCAL drivers that are provided by NXP:

- CAN\_LLCE
- LIN\_LLCE
- FR\_LLCE

AUTOSAR drivers for LLCE run in parallel with the CAN/LIN/FR drivers for the standard communication modules (from the NXP MCAL package).

NXP LLCE firmware can support advanced extensions created by NXP or by the customers.

- CAN frame authentication with HSE services
- CAN to CAN routing
- CAN to Ethernet and Ethernet to CAN routing

### 2.1. LLCE Standard

LLCE enablement consist of binary images for the code running on each of the LLCE cores. Support for 16 CAN and 4 LIN communication controllers as it is expected by the AUTOSAR 4.4 drivers on the host side.

- Timestamping of received and transmitted frames
- Support for up to 1024 filters and 2000 message buffers

### 2.1.1. Release package content

- Enablement (binary) release
  - AUTOSAR drivers for CAN, LIN, FlexRay
  - Firmware binaries for the 4 cores (DTE, PPE\_RX, PPE\_TX, FRPE)
  - LLCE firmware user guide
  - LLCE host interface header files + data structures
  - Sample applications (CAN, LIN)
  - Quick Start Guide
  - Release notes
- Quality Package - delivered to customers for RTM releases

## 2.2. High-Level Architecture of the LLCE Firmware

### 2.2.1. Host Interface

Interface with host cores is done through the LLCE host interface. It consists of messages exchanged via shared memory, hardware FIFOs and Core2Core hardware communication module.

- Host side applications interacts with LLCE firmware by using 3 different/independent interfaces for each type of buses: CAN, LIN and FlexRay
- The host interface for each bus is composed from independent hardware (HW) elements.
- All the source files servicing each bus behavior are compiled together and the execution is distributed between multiple internal cores

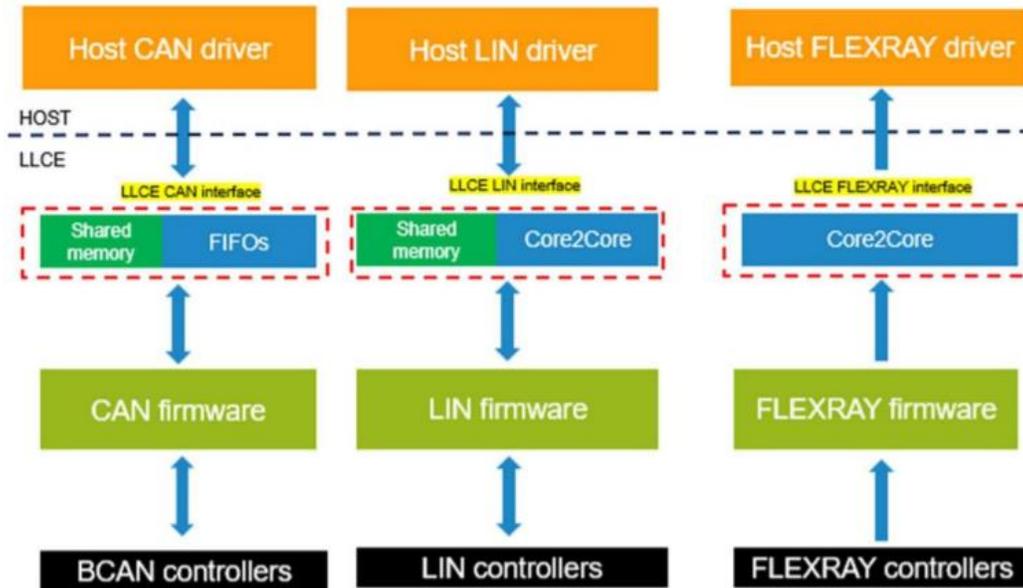


Figure 2. LLCE interface with host

### 2.2.2. CAN protocol

High level architecture of the LLCE CAN communication firmware is presented in *Figure 3*.

- LLCE CAN firmware is distributed and runs on all 4 internal cores
- Interactions between host applications and CAN firmware is done by using multiple custom interfaces composed from different shared memory areas and HW FIFOs
- HW FIFOs are used also as inter-core communication mechanism inside LLCE
- Data Transfer Engine (DTE) core run fully in polling mode in order to get all frames from all BCANs

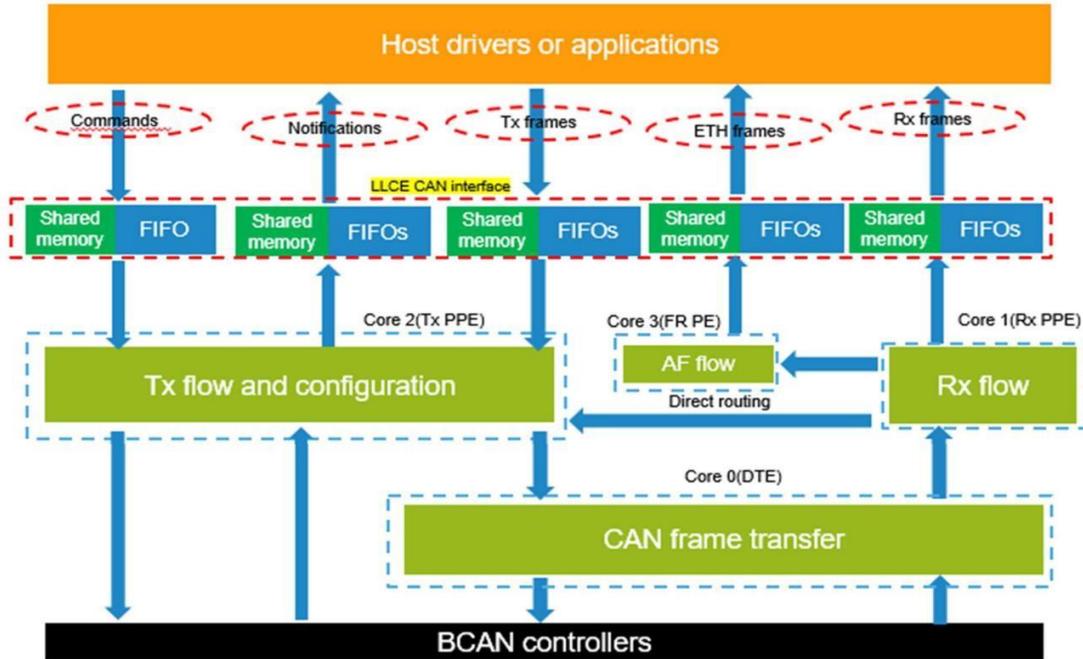


Figure 3. LLCE Firmware architecture for CAN

### 2.2.3. LIN Protocol

High level architecture of the LLCE LIN communication firmware is presented in *Figure 4*.

- LLCE LIN firmware is running fully on the Rx PPE core
- LIN firmware behave like a master on the LIN bus
- LIN firmware reacts only by responding to the host commands
- Host driver writes into shared memory the command parameters and notify LIN firmware by raising a flag inside Core2Core module

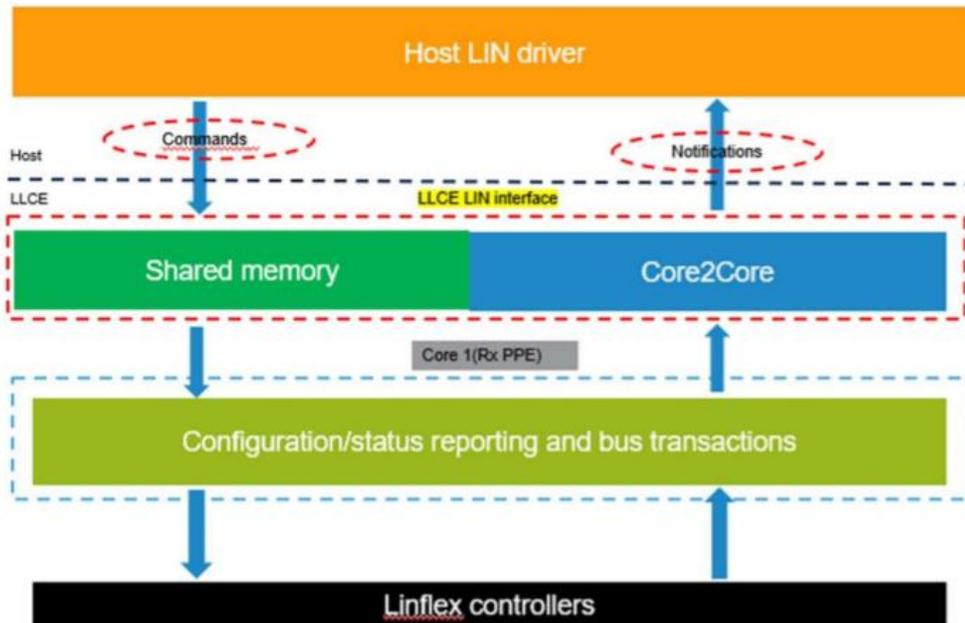


Figure 4. LLCE Firmware architecture for LIN

### 2.2.4. FlexRay Protocol

High level architecture of the LLCE FlexRay communication firmware is presented in *Figure 5*.

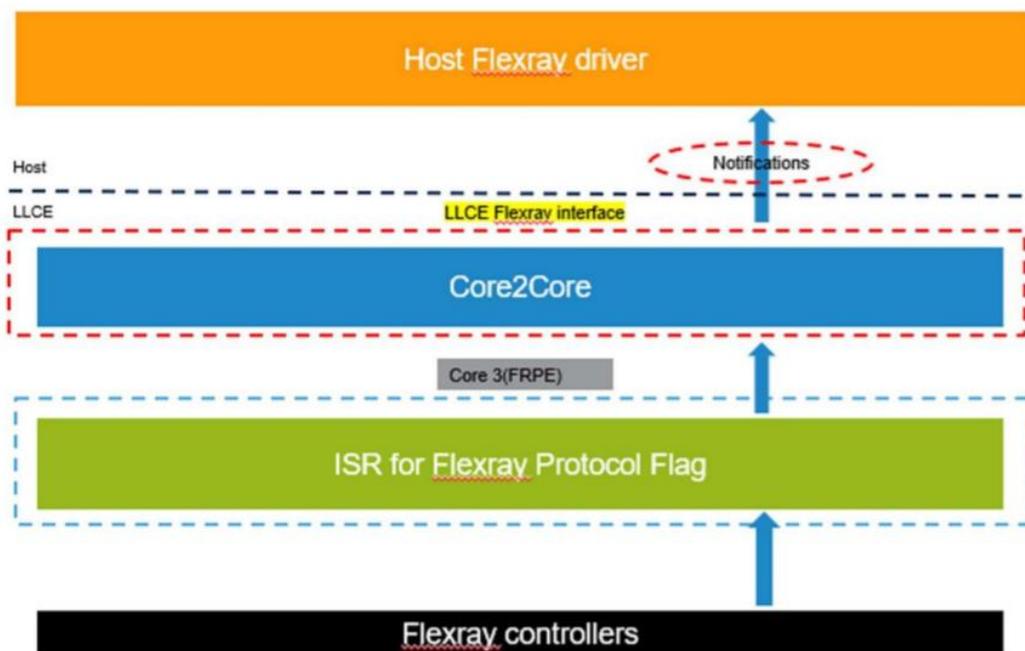


Figure 5. LLCE Firmware architecture for FlexRay

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## 3. Supported Targets

The software described in this document is intended to be used with NXP Semiconductors S32G2 devices.

## 4. Quality, Standards Compliance and Testing Approach

LLCE Firmware product is developed according to NXP Software Development Processes that are Automotive-SPICE, IATF16949 and ISO 9001 compliant.

LLCE Firmware Software (SW) Releases starting with Beta are accompanied by SW quality packages containing at minimum the following deliverables:

- Requirements Specification and Traceability Matrix (features-design-code-test);
- Test Specification;
- Test Report;
- Static Analysis Report (MISRA) Report;
- Code Coverage Report.

SW Testing approach is documented in LLCE Firmware Test Strategy document that contain the following information and can be shared with customers in request.

- Testing scope and objectives;
- Test levels: unit tests, unit integration tests;
- Test types: functional, non-functional, regression tests, robustness, performance tests, conformance testing (MISRA 2012);
- Test techniques: white-box, black-box tests;
- Test cases organization and prioritization;
- Test deliverables (test report, test specification, code coverage report, traceability matrix, static analysis report).

## 5. Document Information

Table 1. **Sample revision history**

<b>Revision number</b>	<b>Date</b>	<b>Substantive changes</b>
1	10/2021	Initial release



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