

**Research & Vehicle Technology**

**“Infotainment Systems Product Development”**

**GNSS Shifting Agent for China C-V2X**

**Infotainment Subsystem Part Specific Specification (SPSS)**

Version 0.1

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**Version Date: November 8, 2019**

**FORD CONFIDENTIALF**

**Revision History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Ver** | **Notes** | |
| **November 8, 2019** | **0.1** | **Initial Draft** |  |
| **November 12, 2019** | **0.2** | **Draft** | **First round reviewed internally** |
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# Overview

**Purposes:**

GNSS shifting Agent is solution for China C-V2X TCU to get shifted GNSS coordinates from IVI since TCU itself doesn’t have authority to do China data shifting. Once implemented, C-V2X TCU transmits raw GNSS coordinates to IVI. Then IVI does China data shifting and sends shifted coordinates back to C-V2X TCU. This document describes the basic background, technical requirements, detailed solution and interface for GNSS shifting Agent.

## Terminology and Abbreviations

The following table lists terminologies that are used in this document along with a brief description.

| **Term** | **Description** |
| --- | --- |
| CAN | Controller Area Network |
| ECG | Enhanced Central Gateway |
| ECU | Electronic Control Unit |
| FNV | Fully Networked Vehicle |
| TCU | Telematics Control Unit |
| IVI | In Vehicle Infotainment |
| GNSS | Global Navigation Satellite System |
| GSA | GNSS Shifting Agent |
|  |  |

# Architectural Design

## GSA-CLD-REQ-xxxxxx/A-GNSS Shifting Client

The GNSS Shifting Client is responsible for the tasks listed below:

* Capture raw GNSS coordinates with timestamp after dead reckoning.
* Transmit raw GNSS coordinates message from C-V2X TCU to IVI
* Handle shifted coordinates message from IVI

Please review the implementation guide/ block diagram to locate the XXX class.

## GSA-CLD-REQ-xxxxxx/A-GNSS Shifting Server

The GNSS Shifting Server is responsible for the tasks listed below:

* Handle raw GNSS coordinates message from C-V2X TCU.
* Do china data shifting to convert raw coordinates to shifted coordinates (China high accuracy shifted axis).
* Loopback shifted coordinates message to C-V2X TCU

Please review the implementation guide/ block diagram to locate the GNSS Shifting Agent class.

## Physical Mapping of Classes

The table below shows an example of how the logical classes that make up the GNSS shifting protocol may be mapped into physical modules. This mapping example is specific to the FNV2 architecture and does not necessarily carryover to other carlines or vehicle architectures.

|  |  |
| --- | --- |
| **Logical Class** | **Physical Module (ECU)** |
| GNSS Shifting Client | C-V2X TCU |
| GNSS Shifting Server | IVI |
|  |  |

## GNSS Shifting Agent Interface

### GSA-IIR-REQ-xxxxxx/A-GSAClientInterface\_Tx

The GSAClientInterface\_Tx represents all the GNSS Shifting Agent related signals sent by the GSAClientInterface object. The below table represents the mapping of the logical signal names (as described in this specification) to the global GSDB signal names.

|  |  |  |
| --- | --- | --- |
| **GSDB Signal Name** | **Parameter Name** | **Broadcast In** |
| LocationLoopback\_TCUToIVI? | Message Count | LocationLoopback\_TCUToIVI |
| Data Validity | LocationLoopback\_TCUToIVI |
| Longitude Direction | LocationLoopback\_TCUToIVI |
| Longitude Degree Integer | LocationLoopback\_TCUToIVI |
| Longitude Degree Fractional | LocationLoopback\_TCUToIVI |
| Latitude Direction | LocationLoopback\_TCUToIVI |
| Latitude Degree Integer | LocationLoopback\_TCUToIVI |
| Latitude Degree Fractional | LocationLoopback\_TCUToIVI |

#### MD-REQ-xxxxxx/A- LocationLoopback\_TCUToIVI

Message Type: Raw GNSS Coordinates (after dead reckoning)

This message is used to transmit raw GNSS coordinates from TCU to IVI for data shifting.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Seq.** | **Field Name** | **Length**  **(bits)** | **Value**  **(decimal)** | **Literals** | **Description** |
| 1 | Message Count | 4 | 0~15 | message count  0~15 | Indicates the order of each message. Message count increases from 0 to 15 per message. Message count will increase from 0 again if current message count is 15. |
| 2 | Data Validity | 1 | 0 | Invalid | Indicates whether the data is valid |
| 1 | Valid |
| 3 | Longitude Direction | 1 | 0 | East | Indicates direction of longitude |
| 1 | West |
| 4 | Longitude Degree Integer | 7 | 0 | 0 degree | Indicates integer part of longitude degree |
| … | … |
| 89 | 89 degree |
| 5 | Longitude Degree Fractional | 20 | 0 | 0.000000 degree | Indicates fractional part of longitude degree |
| … | … |
| 999999 | 0.999999 degree |
| 6 | Latitude Direction | 1 | 0 | North | Indicates direction of Latitude |
| 1 | South |
| 7 | Latitude Degree Integer | 8 | 0 | 0 degree | Indicates integer part of latitude degree |
| … | … |
| 179 | 179 degree |
| 8 | Latitude Degree Fractional | 20 | 0 | 0.000000 degree | Indicates fractional part of latitude degree |
| … |  |
| 999999 | 0.999999 degree |

### GSA-IIR-REQ-xxxxxx/A- GSAClientInterface\_Rx

The GSAClientInterface\_Rx represents all the related signals sent by the GSAClientInterface object. The below table represents the mapping of the logical signal names (as described in this specification) to the global GSDB signal names.

|  |  |  |
| --- | --- | --- |
| **GSDB Signal Name** | **Parameter Name** | **Broadcast In** |
| LocationLoopback\_IVIToTCU | Message Count | LocationLoopback\_IVIToTCU |
| Data Validity | LocationLoopback\_IVIToTCU |
| Longitude Direction | LocationLoopback\_IVIToTCU |
| Longitude Degree Integer | LocationLoopback\_IVIToTCU |
| Longitude Degree Fractional | LocationLoopback\_IVIToTCU |
| Latitude Direction | LocationLoopback\_IVIToTCU |
| Latitude Degree Integer | LocationLoopback\_IVIToTCU |
| Latitude Degree Fractional | LocationLoopback\_IVIToTCU |

#### MD-REQ-xxxxxx/A- LocationLoopback\_IVIToTCU

Message Type: China shifted coordinates

This message is used to transmit China shifted coordinates from IVI to TCU for use case such as V2X BSM message.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Seq.** | **Field Name** | **Length**  **(bits)** | **Value**  **(decimal)** | **Literals** | **Description** |
| 1 | Message Count | 4 | 0~15 | message count  0~15 | Indicates the order of each message. Message count increases 1 per message. Message count will increase from 0 again if current message count is 15. |
| 2 | Data Validity | 1 | 0 | Invalid | Indicates whether the data is valid |
| 1 | Valid |
| 3 | Longitude Direction | 1 | 0 | East | Indicates direction of China shifted longitude |
| 1 | West |
| 4 | Longitude Degree Integer | 7 | 0 | 0 degree | Indicates integer part of China shifted longitude degree |
| … | … |
| 89 | 89 degree |
| 5 | Longitude Degree Fractional | 20 | 0 | 0.000000 degree | Indicates fractional part of China shifted longitude degree |
| … | … |
| 999999 | 0.999999 degree |
| 6 | Latitude Direction | 1 | 0 | North | Indicates direction of China shifted Latitude |
| 1 | South |
| 7 | Latitude Degree Integer | 8 | 0 | 0 degree | Indicates integer part of China shifted latitude degree |
| … | … |
| 179 | 179 degree |
| 8 | Latitude Degree Fractional | 20 | 0 | 0.000000 degree | Indicates fractional part of China shifted latitude degree |
| … |  |
| 999999 | 0.999999 degree |

# Functional Definition

## GSA-FUN-REQ-xxxxxx/A-Physical Architecture

### Requirements

#### GSA-REQ-xxxxxx/A-Architecture



1. The only one GNSS antenna and chipset is connected to C-V2X TCU.
2. IMU and dead reckoning algorithm is integrated in C-V2X TCU
3. Raw GNSS coordinates shall be captured after dead reckoning
4. China data shifting plugin in IVI supports converting raw GNSS coordinates to shifted coordinates.
5. The above system diagram shows message data flow (from message number 1 to 4).

## GSA-FUN-REQ-xxxxxx/A-Get Shifted Coordinates

### Requirements

#### GSA-REQ-xxxxxx/A-Capture Raw GNSS coordinates

TCU shall be able to capture raw GNSS coordinates with timestamp.

#### GSA-REQ-xxxxxx/A-TCU transmits raw coordinates to ECG

TCU shall be able to transmit raw coordinates to ECG by separated message ID.

#### GSA-REQ-xxxxxx/A-ECG routing raw coordinates to IVI

ECG shall routing raw coordinates to IVI according to separated message ID and roles in DBC

#### GSA-REQ-xxxxxx/A-IVI do china data shifting

IVI shall support china data shifting to convert raw GNSS coordinates to shifted coordinates.

#### GSA-REQ-xxxxxx/A-IVI transmits shifted coordinates to ECG

IVI shall be able to transmit shifted coordinates to ECG by separated message ID.

#### GSA-REQ-xxxxxx/A-ECG routing shifted coordinates to TCU

ECG shall routing shifted coordinates to TCU according message ID and roles in DBC.

### Use Cases

#### GSA-UC-REQ-xxxxxx/A-TCU gets shifted coordinates from IVI

|  |  |
| --- | --- |
| **Actors** | C-V2X TCU, ECG, IVI |
| **Pre-conditions** | 1. C-V2X TCU, ECG, IVI is in normal power mode 2. Raw GNSS coordinates after dead reckoning is valid |
| **Scenario Description** | 1. TCU captures GNSS raw coordinates after dead reckoning and record message count with timestamp at 10Hz. 2. TCU packages raw GNSS coordinates into CAN message with message count and data validity. 3. TCU transmits raw GNSS coordinates message to ECG. 4. ECG routing raw GNSS message to IVI with low latency. 5. IVI validates message and then pass raw coordinates to China shifting plugin to do data shifting. 6. IVI packages shifted coordinates with original message count and current data validity. 7. IVI transmits shifted coordinates message to TCU via ECG 8. TCU validates message with message count and validity. 9. TCU pass shifted coordinates to V2X application. 10. V2X application at TCU adds timestamp according to message count then broadcast V2X BSM message. |
| **Post-conditions** | Remote vehicle receives V2X BSM message. |
| **Interfaces** |  |
| **Notes** | Exception use cases  1 – GNSS data invalid (not fixed, GNSS failure…)  2 – CAN message communication failed such as delay or lost  3 – Message handling failed |

### White Box View

#### Sequence Diagrams

##### GSA-SD-REQ-xxxxxx/B-Application XXX Request

Constraints

Pre-Condition

Vehicle is ON

Scenarios

Normal Usage

Post-Condition

Sequence Diagram

## GSA-FUN-REQ-xxxxxx/A-GNSS Shifting Agent Performance

### Requirements

#### GSA-REQ-xxxxxx/A-Performance

TCU shall support capture valid GNSS coordinates at 10Hz.

TCU shall be able to package and transmits related message to ECG at 10Hz.

ECG shall support 10Hz raw and shifted coordinates routing at 10Hz with each routing latency <=20ms?.

IVI shall be able to do china data shifting at 10Hz with total latency in IVI system <= 30ms?.

TCU shall support 10Hz received message handling and BSM message broadcasting.

### Use Cases

### White Box View

## GSA-FUN-REQ-xxxxxx/A-GNSS Shifting Agent Configuration

### Requirements

#### GSA-REQ-xxxxxx/A-Configuration parameters

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

### Use Cases

### White Box View

# Appendix: Reference Documents

|  |  |
| --- | --- |
| Reference # | Document Title |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |
| 11 |  |
| 12 |  |
| 13 |  |
| 14 |  |
| 15 |  |
| 16 |  |
| 17 |  |