Research & Vehicle Technology
"Infotainment Systems Product Development"

Feature – Location Service

APIM Infotainment Subsystem Part Specific Specification (SPSS)

Version 1.13
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Version Date: August 30, 2021

FORD CONFIDENTIAL

Revision History

Date	Version	Notes	
May 31, 2013	1.0	**Initial Release**	
October 23, 2013	1.1	**Sorris1: Function & Requirement Updates**	
		FAS-LOCATN-GFUN-304495-Configuration Parameters	sorris1: New Function (Gen 3.2)
		FAS-LOCATN-GREQ-304494-Configuration	sorris1: New Requirement
		FAS-LOCATN-GFUN-304498-Diagnostics	sorris1: New Function (Gen 3.2)
		FAS-LOCATN-GREQ-304497-Diagnostics	sorris1: New Requirement
December 2, 2013	1.2	**Sorris1: Interface Updates**	
		GpsLatLong_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		GpsHeading_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		GpsDateTime_St	sorris1: Encoding updated to match up with pending CAN database (Null & Faulty removed).
		GpsSatNumber_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		GpsAltitude_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		GpsSpeed_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		Gps3dEstimatedError_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		GpsDilutionOfPrecision_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		GpsCompassDirection_St	sorris1: Encoding updated to match up with pending CAN database (Faulty removed).
		GpsSensorCalibration_St	sorris1: Encoding updated to match up with pending CAN database (None change to Null).
		GpsSatInfo_St	sorris1: Encoding updated to match up with pending CAN database (Null changed to Inactive).
		VehicleDynamics_St	sorris1: Encoding updated to match up with pending CAN database (Null removed).
		GpsDataAvailable	sorris1: New Method Description to align with pending CAN database release.
March 12, 2014	1.3		
		LOCATN-CLD-REQ-022480/B-Location Service(TcSE ROIN-294362)	sorris1: Changed labeling of GPS to GNSS or location engine to clarify meanings and specified WGS84 coordinates instead of the generic GPS
		MD-REQ-022483/B-GPSBFault_St(TcSE ROIN-221027-1)	Changed labeling of GPS to GNSS or location engine to clarify meanings and specified WGS84 coordinates instead of the generic GPS
		MD-REQ-022484/B-GPSDimension_St(TcSE ROIN-221028-1)	sorris1: Changed labeling of GPS to GNSS or location engine to clarify meanings and specified WGS84 coordinates instead of the generic GPS
		MD-REQ-022486/B-GPSLocation_St(TcSE ROIN-221031-1)	sorris1: Changed labeling of GPS to GNSS or location engine to clarify meanings and specified WGS84 coordinates instead of the generic GPS
		MD-REQ-022487/B-GPSSpeed_St(TcSE ROIN-221118-1)	sorris1: Changed labeling of GPS to GNSS or location engine to clarify meanings and specified WGS84 coordinates instead of the generic GPS
		MD-REQ-022489/B-GPSDilutionOfPrecision_St(TcSE ROIN-294409)	sorris1: Changed labeling of GPS to GNSS or location engine to clarify meanings and specified WGS84 coordinates instead of the generic GPS
		MD-REQ-022490/B-GPSSatNumInView_St(TcSE ROIN-294417)	sorris1: Changed labeling of GPS to GNSS or location engine to clarify meanings and specified WGS84 coordinates instead of the generic GPS
		LOCATN-IIR-REQ-022491/B-LocationService_Tx(TcSE ROIN-297354)	sorris1: The LocationService_Tx interface requirement has been redesigned to be a protocol. All previous method descriptions (GpsLatLong_St, GpsHeading_St,

			GpsFault_St, GpsDateTime_St, GpsSatNumber_St, etc.) have been removed and replaced by the Global Navigation Satellite System (GNSS) protocol and associated message type descriptions.
	MD-REQ-051835/A-MetaDataTime		sorris1: New method description for GNSS protocol.
	MD-REQ-051836/A-Location1		sorris1: New method description for GNSS protocol.
	MD-REQ-051837/A-Location2		sorris1: New method description for GNSS protocol.
	MD-REQ-051838/A-LocationQuality		sorris1: New method description for GNSS protocol.
	MD-REQ-051839/A-SensorQuality		sorris1: New method description for GNSS protocol.
	MD-REQ-051840/A-SkyView		sorris1: New method description for GNSS protocol.
	112568/A-Data Interpretation Example		
	LOCATN-REQ-022427/B-GPS Receiver Hardware Requirements(TcSE ROIN-294201)		sorris1: Included Compass/Bediou and Galileo as required when regulated
	LOCATN-UC-REQ-022432/B-Driving on Road – Clear Sky(TcSE ROIN-292579)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-UC-REQ-022436/B-WIFI Fault(TcSE ROIN-292583)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-UC-REQ-022437/B-WIFI Positioning Data Not Available(TcSE ROIN-292584)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-UC-REQ-022438/B-Driving on Road – Urban Canyon(TcSE ROIN-292585)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-UC-REQ-022441/B-Driving on Road – Multi-leveled Roads(TcSE ROIN-292588)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-UC-REQ-022442/B-Driving Off Road – Entering Parking Lot(TcSE ROIN-292589)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-UC-REQ-022443/B-Driving off Road – Exiting Underground Parking Lot(TcSE ROIN-292590)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-REQ-022450/B-Playback(TcSE ROIN-294174)		sorris1: Added text to clarifiy playback functionality via USB stick.
	LOCATN-REQ-022451/B-Shunting(TcSE ROIN-294175)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-REQ-022459/B-Wheel Tick Failure(TcSE ROIN-294197)		sorris1: Updated requirement for clarity.
	LOCATN-REQ-022464/B-WIFI(TcSE ROIN-294203)		sorris1: Clarified WIFI usage as if licensed
	LOCATN-REQ-022476/B-Configuration(TcSE ROIN-304494)		sorris1: Added usage of driveline type to determine which wheel to use as primary for dead reckoning
	LOCATN-REQ-022478/B-Diagnostics(TcSE ROIN-304497)		sorris1: Accepted changes from last release.
July 18, 2014	1.4		
	MD-REQ-022482/B-GPSActualVsInferredPosition_St (TcSE ROIN-221139-1)		Added clarification as to what these signals actually mean and how to use them
	MD-REQ-022484/C-GPSDimension_St (TcSE ROIN-221028-1)		Accepted Changes from previous release. No content changed.
	MD-REQ-022487/C-GPSSpeed_St (TcSE ROIN-221118-1)		Clarification as to which velocity to use in this field
	MD-REQ-051839/B-SensorQuality		Added not measured states for noise detection
	STR-069713/B-Use Cases (TcSE ROIN-292764)		Added use cases
	LOCATN-UC-REQ-022434/B-Sensor Fault – Gyro / Wheel Tick Issue (TcSE ROIN-292581)		Corrected post conditions to point to the requirements dealing with this
	LOCATN-REQ-022450/C-Playback (TcSE ROIN-294174)		Added initializing playback engine with configuration from the playback file instead of using ECU configs
	LOCATN-REQ-022451/C-Shunting (TcSE ROIN-294175)		Clarified shunting of velocity during playback
	LOCATN-REQ-022457/B-Wheel Tick Calibration (TcSE ROIN-294195)		Added ability to supersede the requirements based on limitations of a chosen location solution
	LOCATN-REQ-022460/B-3D Gyro/Accelerometer Initialization (TcSE ROIN-294198)		added requirements for clean data for bias determination at key up
	LOCATN-REQ-022462/B-3D Gyro/Accelerometer Failure (TcSE ROIN-294200)		corrected from 4 wheel to differential wheel tick mode
	LOCATN-REQ-022468/B-Navigation Map Matched Position Feedback (TcSE ROIN-294189)		clarified elements of the feedback methodology to match implementation
August 13, 2014	1.5		
	STR-069740/B-Location Service Interface (TcSE ROIN-294368)		rpaquet2 - added internal interface.
	MD-REQ-051835/B-MetaDataTime		rpaquet2 - Updated bit field Day and fault bit mask.
	MD-REQ-051837/B-Location2		rpaquet2 - Added Fix Type parameter per Dave Herman direction.

	112568/B-Data Interpretation Example	rpaquet2 - Update Byte 7 example hex for fault bit.
	LOCATN-UC-REQ-022433/B-GPS Fault – Antenna Issue (TcSE ROIN-292580)	rpaquet2 - update text in scenario to state HMI dependency.
	LOCATN-REQ-022463/B-GPS Receiver Failure (TcSE ROIN-294202)	rpaquet2 - Rev to B accidently no change to requirement.
September 3, 2014	**1.6** rpaquet1: Added use cases and method description	
	MD-REQ-051840/B-SkyView	rpaquet2 - per direction from Dave H. added text talking about making sky view configurable
	LOCATN-UC-REQ-094992/A-Startup - Boot with Vehicle in Motion	rpaquet2 - added use case for Dave H.
	LOCATN-UC-REQ-094994/A-Startup – System Crashes / Watchdog Forces Reboot	rpaquet2 - added use case for Dave H.
March 2, 2015	**1.7**	
	STR-069740/C-Location Service Interface (TcSE ROIN-294368)	rpaquet2 - Added Location Service_Ephemeris for Dave Herman
	LOCATN-IIR-REQ-022491/C-LocationService_Tx (TcSE ROIN-297354)	rpaquet2 - Added Location3 requirement for China shifting and Location 4 and 5.
	MD-REQ-051840/B-SkyView	rpaquet2 - per direction from Dave H. added text talking about making sky view configurable
	MD-REQ-132696/A-DownloadedEphemeris	rpaquet2 - per direction from Dave H. added text for Downloaded Ephemeris
	MD-REQ-132697/A-CalculatedEphemeris	rpaquet2 - per direction from Dave H. added text for Calculated Ephemeris
	STR-069713/C-Use Cases (TcSE ROIN-292764)	Added use cases
	LOCATN-UC-REQ-094992/A-Startup - Boot with Vehicle in Motion	rpaquet2 - added use case for Dave H.
	LOCATN-UC-REQ-094994/A-Startup – System Crashes / Watchdog Forces Reboot	rpaquet2 - added use case for Dave H.
	LOCATN-REQ-022459/C-Wheel Tick Failure (TcSE ROIN-294197)	rpaquet2 - Added text to requirement per Dave Herman.
	LOCATN-REQ-022476/C-Configuration (TcSE ROIN-304494)	rpaquet2 - Added new row to table for wheel tick time separation per Dave Herman.
	LOCATN-REQ-022478/C-Diagnostics (TcSE ROIN-304497)	rpaquet2 - Updated text to add 1 second of data.
June 16, 2015	**1.8**	
	LOCATN-REQ-022431/B-Position Accuracy (TcSE ROIN-294206)	kturne20 - Added positioning accuracy values to support overall system performance for location.
July 19, 2018	**1.9**	
	LOCATN-CLD-REQ-022480/C-Location Service (TcSE ROIN-294362)	rpaquet2 - revised per feature owner
	LOCATN-IIR-REQ-022481/B-LocationServiceLegacy_Tx (TcSE ROIN-294359)	rpaquet2 - revised per feature owner
	LOCATN-IIR-REQ-022491/D-LocationService_Tx (TcSE ROIN-297354)+	rpaquet2 - Added" All items in this subsection apply to an ECU that is a Localization Master."
	LOCATN-IIR-REQ-022491/E-LocationService_Tx (TcSE ROIN-297354)	rpaquet2 - Added the ArbId for when message is sent from the TCU and clarified the ArbID note for when the APIM sends the data.
	MD-REQ-051835/C-MetaDataTime	rpaquet2 - Update the Description for Fault Bit Mask
	LOCATN-IIR-REQ-091628/B-Internal	rpaquet2 - Updated per feature owner request
	LOCATN-REQ-022426/B-Architecture (TcSE ROIN-294207)	rpaquet2- Updated Text
	LOCATN-REQ-022429/B-GPS Fixes (TcSE ROIN-296600)	rpaquet2 - Updated per feature owner
	STR-069712/B-Requirements (TcSE ROIN-294224)	rpaquet2 - Added Reference Coordinate System requirement
	LOCATN-REQ-022431/C-Position Accuracy (TcSE ROIN-294206)	rpaquet2- updated per feature owner
	LOCATN-REQ-283027/A-Reference Coordinate System	rpaquet2- updated per feature owner
	LOCATN-UC-REQ-022432/C-Driving on Road – Clear Sky (TcSE ROIN-292579)	rpaquet2 - Update use case per feature owner
	LOCATN-UC-REQ-022433/C-GPS Fault – Antenna Issue (TcSE ROIN-292580)	rpaquet2 - Updated use case per feature owner
	LOCATN-UC-REQ-022434/C-Sensor Fault – Gyro / Wheel Tick Issue (TcSE ROIN-292581)	rpaquet2 - Updated use case per feature owner
	LOCATN-UC-REQ-022435/B-Sensor Reset – Wheel Tick Issue (TcSE ROIN-292582)	rpaquet2 - Updated per feature owner

LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022439/B-Map Data Not Available (TcSE ROIN-292586)	rpaquet2 - Update per featue owner
LOCATN-UC-REQ-022440/B-Navigation Application is Not Running (If Equipped) (TcSE ROIN-292587)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)	rpaquet2 - Update per feature owner
LOCATN-UC-REQ-091631/B-CAN Bus Wakeup (Generic)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-091639/B-CAN Bus Wakeup - Tracking Location Request	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-091657/B-Prior Location not Stored	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-091658/B-Startup – Customer sitting in vehicle	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-091659/B-Startup – Customer sitting in vehicle rolling start	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-091701/B-Battery Removal	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-094992/B-Startup - Boot with Vehicle in Motion	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-094994/B-Startup – System Crashes / Watchdog Forces Reboot	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022446/B-Data Logging (TcSE ROIN-292591)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022447/B-Data Logging File System Full (TcSE ROIN-292592)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022448/B-Data Logging File System Not Writeable (TcSE ROIN-292593)	rpaquet2 – Updated per feature owner
LOCATN-REQ-022450/D-Playback (TcSE ROIN-294174)	rpaquet2 - Updated per feature owner
LOCATN-REQ-022451/D-Shunting (TcSE ROIN-294175)	rpaquet2 - Updated per feature owner
LOCATN-UC-REQ-022452/B-Navigation Data Playback (TcSE ROIN-292594)	rpaquet2- Updated per feature owner
LOCATN-UC-REQ-022453/B-Data Playback File Corrupt (TcSE ROIN-292595)	rpaquet2 - Updated per feature owner
STR-069718/B-Requirements (TcSE ROIN-294222)	rpaquet2 - Added 289991
LOCATN-REQ-022459/D-Wheel Tick Failure (TcSE ROIN-294197)	rpaquet2 - Updated per feature owner
STR-069722/B-Requirements (TcSE ROIN-304496)	rpaquet2 - Added new requirement for Autoconfiguration
LOCATN-REQ-318210/A-Auto Configuration for Determining Message Set to Read	rpaquet2 - Added requirement for receving modules to be able to Auto config based on which module is transmitting the Locaiton data
LOCATN-REQ-022474/C-Performance (TcSE ROIN-294177)	rpaquet2 - updated per feature owner
LOCATN-REQ-022478/D-Diagnostics (TcSE ROIN-304497)	rpaquet 2- Updated per feature owner

July 10, 2019	1.10	
	MD-REQ-051838/B-LocationQuality	rpaquet2 - Added Speed Accuracy approximation
	MD-REQ-051838/C-LocationQuality	rpaquet2 - Fixed a format issue in the v1.10 version of spec

February 25, 2021	1.11	
	STR-069740/D-Location Service Interface (TcSE ROIN-294368)	rpaquet2 - Added new Unified GNSS SOA API interface
	LOCATN-IIR-REQ-022481/C-LocationServiceLegacy_Tx (TcSE ROIN-294359)	rpaquet2 - Updated to add statemen about missing Location data and Cloud Payload
	MD-REQ-051835/D-MetaDataTime	asimukhi: precised usage of DataGoodToUse parameter rpaquet2 updated table for Month to 4 bits
	MD-REQ-051836/B-Location1	rpaquet2 - Corrected Longitude Degrees Integer 0xB3 literal value per Kevin Turner
	MD-REQ-051837/C-Location2	rpaquet2 - Corrected Velocity, Satellites in solution and 3D Fix parameters Value range per Kevin Turner
	MD-REQ-051838/D-LocationQuality	rpaquet2 - Updated pDop, hDop and vDop value ranges and bits per Kevin Turner
	MD-REQ-130083/B-Location3	rpaquet2 - Updated Long Degrees Integer from 59 to 179 to match hex value
	MD-REQ-133270/B-Location4	rpaquet2 - Updated Long Degrees Integer from 59 to 179 to match hex value

	MD-REQ-133599/B-Location5		rpaquet2 - Updated Long Degrees Integer from 59 to 179 to match hex value
	LOCATN-IIR-REQ-393611/A-UnifiedLocationService_Tx		rpaquet2 - New
	MD-REQ-393612/A-LocationData		rpaquet2 - New
	MD-REQ-393741/A-SatelliteDataBasic		rpaquet2: New
	MD-REQ-405598/A-SatelliteDataExtended		rpaquet2: New
	STR-069741/B-Functional Definition (TcSE ROIN-292761)		rpaquet2 - No update
	LOCATN-FUN-REQ-393773/A-Unified GNSS		rpaquet2 - New
	STR-778381/A-Requirements		rpaquet2 - New
	LOCATN-REQ-393774/A-Architecture		rpaquet2- New
	LOCATN-REQ-393771/A-Transmission Rate for setLocationServicesDead-Reckoned Data		rpaquet2 - New
	LOCATN-REQ-393772/A-Transmission Rate for setLocationServicesRawGNSSandSenesor Data		rpaquet2 - New
June 22, 2021	**1.12**		
	LOCATN-FRD-REQ-022479/B-Location (TcSE ROIN-292759)		rpaquet2 - Added Appendix B
	LOCATN-IIR-REQ-022481/D-LocationServiceLegacy_Tx (TcSE ROIN-294359)		rpaquet2 - Added statement that FNV2 TCU does not support and No support at all for FNV3. Added PreFNV2 requirements
	920610/A-Location Services Client to send Last Known Location Data (Pre-FNV2 Only)		rpaquet2 - New
	LOCATN-REQ-425045/A-Location Services Client to Store the Last Known Location		rpaquet2 - New
	LOCATN-REQ-425047/A-Location Services Client to Send the Last Known Location		rpaquet2 - New
	MD-REQ-022482/C-GPSActualVsInferredPosition_St (TcSE ROIN-221139-1)		rpaquet2 - No content change just accepted last tracked change
	MD-REQ-022483/C-GPSBFault_St (TcSE ROIN-221027-1)		rpaquet2 - No content change just accepted last tracked change
	MD-REQ-022486/C-GPSLocation_St (TcSE ROIN-221031-1)		rpaquet2 - No content change just accepted last tracked change
	MD-REQ-022487/D-GPSSpeed_St (TcSE ROIN-221118-1)		rpaquet2 - No content change just accepted last tracked change
	MD-REQ-022489/C-GPSDilutionOfPrecision_St (TcSE ROIN-294409)		rpaquet2 - No content change just accepted last tracked change
	MD-REQ-022490/C-GPSSatNumInView_St (TcSE ROIN-294417)		rpaquet2 - No content change just accepted last tracked change
	LOCATN-IIR-REQ-022491/F-LocationService_Tx (TcSE ROIN-297354)		rpaquet2 - Updated
	MD-REQ-051835/E-MetaDataTime		rpaquet2 - Added Valid Location Messages bit mask
	MD-REQ-051836/C-Location1+		rpaquet2 - fixed a format issue no content change
	MD-REQ-051836/D-Location1		rpaquet2 - Update Value Range for Message Type no content change
	MD-REQ-051837/D-Location2		rpaquet2 - Added beidou next to Compass Satellite and updated Fix type
	MD-REQ-051838/E-LocationQuality		rpaquet2 - Update Value Range for Message Type no content change
	MD-REQ-051839/C-SensorQuality		rpaquet2 - Updated the Accelerometer, Wheel Tick and Gyro Cal status rows
	MD-REQ-051840/C-SkyView		rpaquet2 - No change just accepted changes from old update
	MD-REQ-130083/C-Location3		rpaquet2 - Updated the message type literal and value
	MD-REQ-133270/C-Location4		rpaquet2 - Update Value Range for Message Type no content change
	MD-REQ-133599/C-Location5		rpaquet2 - Updated
	LOCATN-IIR-REQ-091628/C-Internal		rpaquet2 - Format change no content change
	MD-REQ-132696/B-DownloadedEphemeris		rpaquet2 - Added note for TCU to be fully operational before they request download
	LOCATN-IIR-REQ-393611/B-UnifiedLocationService_Tx		rpaquet2 - Added new MD's
	MD-REQ-393612/B-LocationData		rpaquet2 - Added new parameters
	MD-REQ-412633/A-SensorData		rpaquet2 - Added new parameters
	MD-REQ-412634/A-SensorHwInfo		rpaquet2 - Added new parameters
	MD-REQ-393741/B-SatelliteDataBasic		rpaquet2 - Added new parameters
	MD-REQ-405598/B-SatelliteDataExtended		rpaquet2 - Added new parameters
	MD-REQ-419852/A-NMEAData		rpaquet2 - new
	LOCATN-REQ-022427/C-GPS Receiver Hardware Requirements (TcSE ROIN-294201)		rpaquet2 - No change to content just accepting old changes
	LOCATN-REQ-022429/C-GPS Fixes (TcSE ROIN-296600)		rpaquet2 - Added note for Sync only

LOCATN-UC-REQ-022433/D-GPS Fault – Antenna Issue (TcSE ROIN-292580)	rpaquet2 - Added DTC numbers to post condition
LOCATN-UC-REQ-022436/C-WIFI Fault (TcSE ROIN-292583)	rpaquet2 - format update no content change
LOCATN-UC-REQ-022437/C-WIFI Positioning Data Not Available (TcSE ROIN-292584)	rpaquet2 - No change just accepted old mark up
LOCATN-REQ-022450/E-Playback (TcSE ROIN-294174)	rpaquet2 - Fixed format issue no content change
LOCATN-REQ-022457/C-Wheel Tick Calibration (TcSE ROIN-294195)	rpaquet2 - No change just accepted old mark up
LOCATN-REQ-022460/C-3D Gyro/Accelerometer Initialization (TcSE ROIN-294198)	rpaquet2 - No change just accepted old mark up
LOCATN-REQ-022461/C-3D Gyro/Accelerometer Calibration (TcSE ROIN-294199)	rpaquet2 - No change just accepted old mark up
LOCATN-REQ-022462/C-3D Gyro/Accelerometer Failure (TcSE ROIN-294200)	rpaquet2 - Add DTC numbers
LOCATN-REQ-022463/C-GPS Receiver Failure (TcSE ROIN-294202)	rpaquet2 - Add DTC numbers
LOCATN-REQ-022464/C-WIFI (TcSE ROIN-294203)	rpaquet2 - No change just accepted old mark up
LOCATN-REQ-289991/B-WRTX/RKX/PPP	rpaquet2 - Fixed format issue no content change
LOCATN-REQ-022468/C-Navigation Map Matched Position Feedback (TcSE ROIN-294189)	rpaquet2 -No change just accepted old mark up
STR-166880/B-Can Bus Internal Interface Requirements	rpaquet2 - Changed name
LOCATN-REQ-091661/B-Timestamping	rpaquet2 - No change just accepted old mark up
LOCATN-REQ-091662/B-DataLoss Mitigation	rpaquet2 - No change just accepted old mark up
LOCATN-REQ-022476/D-Configuration (TcSE ROIN-304494)	rpaquet2 - No change
LOCATN-REQ-022472/B-Power State (TcSE ROIN-294176)	rpaquet2 -Added in SOA content
LOCATN-REQ-022474/D-Performance (TcSE ROIN-294177)	rpaquet2 - Fixed format issue no content change
STR-778381/B-Requirements	rpaquet2 - Added requirements
LOCATN-REQ-393774/B-Architecture	rpaquet2 - Updated diagram
LOCATN-REQ-393771/B-Transmission and Acquisition Rate for LocationData API	rpaquet2 - Changed Title name and updated for LocationData
LOCATN-REQ-393772/B-Transmission and Acquisition Rate for SensorData API	rpaquet2 - Changed Title name and updated for SensorData
LOCATN-REQ-412857/A-Transmission and Acquisition Rate for SatelliteDataBasic API	rpaquet2 - New
LOCATN-REQ-412858/A-Transmission and Acquisition Rate for SatelliteDataExtended API	rpaquet2 - New
LOCATN-REQ-412862/A-Establishing SOA - TCU	rpaquet2 - New
LOCATN-REQ-412859/A-Location Data Messages	rpaquet2 - New
LOCATN-REQ-412863/A-Location Accuracy	rpaquet2 - New
LOCATN-REQ-412864/A-CAN Bus Broadcast - TCU	rpaquet2 - New
LOCATN-REQ-412865/A-Cold Start Handling	rpaquet2 - New
LOCATN-REQ-412860/A-Disconnecting Old System	rpaquet2 - New
LOCATN-REQ-412861/A-Establishing SOA - Sync	rpaquet2 - New
LOCATN-REQ-412867/A-Support Different Location Sources	rpaquet2 - New
LOCATN-REQ-412868/A-Detection of Missing Data	rpaquet2 - New
LOCATN-REQ-422242/A-Cumulative Distance Reset at Ignition Off	rpaquet2 - New
LOCATN-REQ-422243/A-Cumulative Altitude Reset at Ignition Off	rpaquet2 - New
LOCATN-REQ-422244/A-NMEA Data Message	rpaquet2 - New
STR-069742/B-Appendix A: Reference Documents (TcSE ROIN-292762)	rpaquet2 - Updated name added A and updated table
STR-916197/A-Appendix B: Features Requiring Location Data	rpaquet2 - New

August 30, 2021	1.13	
	LOCATN-FRD-REQ-022479/C-Location (TcSE ROIN-292759)	rpaquet2 - added append C
	MD-REQ-022489/D-GPSDilutionOfPrecision_St (TcSE ROIN-294409)	rpaquet2 - no content change just corrected spelling
	LOCATN-IIR-REQ-022491/G-LocationService_Tx (TcSE ROIN-297354)+	rpaquet2 - clarified and added China content and default field information
	LOCATN-IIR-REQ-022491/H-LocationService_Tx (TcSE ROIN-297354)	rpaquet2 - updated Location 1 note in brackets
	MD-REQ-051835/F-MetaDataTime+	rpaquet2 - updated Valid Location Bit mask description for bit 0 and updated table to show UTC instead of HTC
	MD-REQ-051835/G-MetaDataTime	rpaquet2 - added note to Protocol Version
	MD-REQ-051836/E-Location1	rpaquet2 - Added note for China

MD-REQ-051837/E-Location2	rpaquet2 - updated fix type
MD-REQ-130083/D-Location3+	rpaquet2 - updated description column
MD-REQ-130083/E-Location3	rpaquet2 - update CGJ to GCJ
MD-REQ-133270/D-Location4	rpaquet2 - updated note for China
112568/C-Data Interpretation Example	rpaquet2 - changed HTC to UTC
LOCATN-IIR-REQ-393611/C-UnifiedLocationService_Tx+	rpaquet2 - updated for China
LOCATN-IIR-REQ-393611/D-UnifiedLocationService_Tx	rpaquet2 - removed and time and added via in first sentence
MD-REQ-393612/C-LocationData+	rpaquet2 - updated
MD-REQ-393612/D-LocationData	rpaquet2 - udated content
MD-REQ-393741/C-SatelliteDataBasic	rpaquet2 - no change
MD-REQ-436762/A-LocationDataShifted+	rpaquet2 - new
MD-REQ-436762/B-LocationDataShifted	rpaquet2 - updated table
LOCATN-UC-REQ-091657/C-Prior Location not Stored	rpaquet2 - no content change just made spelling update
STR-778381/C-Requirements+	rpaquet2 - added reqs
STR-778381/D-Requirements	rpaquet2 - added reqs
LOCATN-REQ-436767/A-Architecture (China Only)	rpaquet2 - New
LOCATN-REQ-412859/B-Location Data Messages	rpaquet2 - added NMEA Data
LOCATN-REQ-422244/B-NMEA Data Message+	rpaquet2 - updated font
LOCATN-REQ-422244/C-NMEA Data Message	rpaquet2 - Added Note for Phoenix and China market
LOCATN-REQ-412863/B-Location Accuracy	rpaquet2 -updated
LOCATN-REQ-412864/B-CAN Bus Broadcast - TCU	rpaquet2 - updated
LOCATN-REQ-436768/A-LocationDataShifted Message (China Only)	rpaquet2 - New
LOCATN-REQ-436769/A-CAN Bus Broadcast - China IVI+	rpaquet2 - New
LOCATN-REQ-436769/B-CAN Bus Broadcast - China IVI	rpaquet2 - replaced numbers with bullet points
LOCATN-REQ-437839/A-Startup Handling - China IVI	rpaquet2 - new
LOCATN-REQ-437840/A-Shifted Location Data Latency	rpaquet2 - new
STR-916197/B-Appendix B: Features Requiring Location Data	rpaquet2 - deleted SPSS release column
STR-946032/A-Appendix C: CAN Messages Protocol Version+	rpaquet2 - New
STR-946032/B-Appendix C: CAN Messages Protocol Version	rpaquet2 - updated table

Table of Contents

1 Architectural Design

1.1 LOCATN-CLD-REQ-022480/C-Location Service (TcSE ROIN-294362)

Responsibility:
(Internal) The Location Service shall provide an accurate positioning solution to feed various applications.
(External – if ECU is Localization Master for Vehicle) The Location Service shall transmit GNSS data to the vehicle system interface for use by other vehicle systems.

1.2 Location Service Interface

1.2.1 LOCATN-IIR-REQ-022481/D-LocationServiceLegacy_Tx (TcSE ROIN-294359)

All items in this subsection apply to an ECU that is a Localization Master. Legacy messages are not supported by TCU in FNV2 architecture and beyond. Legacy messages are not supported by any broadcasting ECU in FNV3 architecture or beyond.

These "Legacy" signals are used for backward compatibility as provided by a Localization Master. They shall be maintained until all vehicle systems that utilize them are updated to incorporate the change to the upgraded signals in LOCATN-GIF-297354-LocationService_Tx.

If the message structure is partially populated, where in MetaDataTime is available, and Location 1 is missing in this case TCU shall not populate latitude and longitude on the payload and send it to the cloud.

1.2.1.1 Location Services Client to send Last Known Location Data (Pre-FNV2 Only)

1.2.1.1.1 LOCATN-REQ-425045/A-Location Services Client to Store the Last Known Location

a. During ignition_status=RUN, when the location data is received it will be stored in a variable memory continually and transmitted.
b. When ignition_status=Off, the Last known location data should be stored on Disc/NVM.
c. The Last known location should be restored from the Disc/NVM when initializing after a Key- cycle.

1.2.1.1.2 LOCATN-REQ-425047/A-Location Services Client to Send the Last Known Location

The Location Services client will send the Last Known Location when:

a. Fix Type=0x0 or any other value other than 0x01 to 0x05.
b. When Latitude degrees Integer>90 and/or Longitude degrees integer>180.
c. When the Location Services Client does not receive the 15 E message (with any types) more than 1 second and until the next Valid Message data is received.

1.2.1.2 MD-REQ-022482/C-GPSActualVsInferredPosition_St (TcSE ROIN-221139-1)

Message Type: Status

Status used to indicate if the data in the signal is actual or inferred.
Actual means that sky is used in the current location solution. Inferred is DR only

Name	Literals	Value	Description
Type	-	-	Signal to indicate if data is actual or inferred. Unit:SED Resolution:1 Offset:0
	ActualPosition	0x0	
	InferredPosition	0x1	

1.2.1.3 MD-REQ-022483/C-GPSBFault_St (TcSE ROIN-221027-1)

Message Type: Status

Status used to indicate a fault of the location engine.

Name	Literals	Value	Description
Type	-	-	Used to indicate a GPS fault. Unit:SED Resolution:1 Offset:0
	No	0x0	
	Yes	0x1	

1.2.1.4 MD-REQ-022484/C-GPSDimension_St (TcSE ROIN-221028-1)

Message Type: Status

Status used to indicate the GNSS Solution Dimension.

Name	Literals	Value	Description
Type	-	-	Used to indicate GPS Dimension. Unit:SED Resolution:1 Offset:0
	NoFix	0x0	
	TwoDimensional	0x1	
	ThreeDimensional	0x2	

1.2.1.5 MD-REQ-022485/A-GPSDirection_St (TcSE ROIN-221029-1)

Message Type : Status

Represents the Direction and Heading.
Status used to indicate which direction the vehicle is heading or facing.

Name	Literals	Value	Description
Compass	-	-	Direction of vehicle. Unit:SED Resolution:1 Offset:0
	North	0x0	
	NorthEast	0x1	
	East	0x2	
	SouthEast	0x3	
	South	0x4	
	SouthWest	0x5	
	West	0x6	
	NorthWest	0x7	
Heading	-	-	Heading in degrees of current vehicle. Unit:Degrees Resolution:0.01 Offset:0
	degrees	0x0 to 0x8C9f	
	Unknown	0xFFFE	
	Fault	0xFFFF	

1.2.1.6   MD-REQ-022486/C-GPSLocation_St (TcSE ROIN-221031-1)

Message Type: Status

Status used to indicate Latitude, Longitude, Hemisphere and Altitude information. As the Legacy messages have no method to account for negative minutes, hemispheres are used to represent this condition. The expectation is that hemispheres are always populated correctly and encoding of a 0 degree, negative minute is accomplished with that. All published locations (Lat / Long) are DR'd Solution (output of location engine in WGS84 coordinates)

Name	Literals	Value	Description
LatitudeDegrees	-	-	Indicates the WGS84 Latitude Degrees information. Unit:Degrees Resolution:1 Offset:-89
	Degrees	0x0 To 0xB2	
	Unknown	0xFE	
	Invalid	0xFF	
LatitudeMinutes	-	-	Indicates the WGS84 Latitude Minutes information. Unit:Minutes Resolution:1 Offset:0
	Minutes	0x0 To 0x3B	
	Unknown	0x3E	
	Fault	0x3F	
LatitudeMinutesDecimal	-	-	Indicates the WGS84 Latitude Minutes Decimal information. Unit:Minutes Resolution:0.0001 Offset:0
	Minutes	0x0 To 0x270F	
	Unknown	0x3FFE	
	Invalid	0x3FFF	
HemisphereLongitudeEastern	-	-	Indicates the WGS84 Hemisphere Longitude Eastern information. Unit:SED Resolution:1 Offset:0
	Invalid	0x0	
	Eastern	0x1	
	Western	0x2	
	Fault	0x3	
HemisphereLatitudeSouthern	-	-	Indicates the WGS84 Hemisphere Latitude Southern information. Unit:SED Resolution:1 Offset:0
	Invalid	0x0	
	Southern	0x1	
	Northern	0x2	
	Fault	0x3	
LongitudeDegrees	-	-	Indicates the WGS84 Longitude Degrees information.

				Unit:Degrees Resolution:1 Offset:-179
		Degrees	0x0 To 0x166	
		Unknown	0x1FE	
		Fault	0x1FF	
LongitudeMinutes		-	-	Indicates the WGS84 Longitude Minutes information. Unit:Minutes Resolution:1 Offset:0
		Minutes	0x0 To 0x3B	
		Unknown	0x3E	
		Fault	0x3F	
LongitudeMinutesDecimal		-	-	Indicates the WGS84 Longitude Minutes Decimal information. Unit:Minutes Resolution:0.0001 Offset:0
		Minutes	0x0 To 0x270F	
		Unknown	0x3FFE	
		Invalid	0x3FFF	
MSLAltitude		-	-	Indicates the WGS84 MSL Altitude information. Unit:Feet Resolution:10 Offset:-20460
		Feet	0x0 To 0xFFC	
		Unknown	0xFFE	
		Fault	0xFFF	

1.2.1.7   MD-REQ-022487/D-GPSSpeed_St (TcSE ROIN-221118-1)

Message Type: Status

Represents the current GPS Speed.
Status used to indicate current speed as calculated by the location engine. If dead reckoning is compromised (wheel tick failure) then using speed from the GPS chipset would be allowed

Name	Literals	Value	Description
Type	-	-	Indicates the current Location Engine measured Speed. Unit:MPH Resolution:1 Offset:0
	MPH	0x0 to 0xFD	
	Unknown	0xFE	
	Invalid	0xFF	

1.2.1.8   MD-REQ-022488/A-GPSUTCDateTime_St (TcSE ROIN-221119-1)

Message Type: Status

Status used to indicate current GPS Date and Time.

Name	Literals	Value	Description
UTCDay	-	-	Indicates the current UTC day. Unit:Day Resolution:1 Offset:1
	Day	0x0 To 0x1E	
	Fault	0x1F	
UTCMonth	-	-	Indicates the current UTC month. Unit:Month Resolution:1 Offset:1
	Month	0x0 To 0xB	
	Fault	0xF	
UTCYear	-	-	Indicates the current UTC year. Unit:Year Resolution:1 Offset:1
	Year	0x0 To 0x1E	
	Fault	0x1F	
UTCHours	-	-	Indicates the current UTC hour. Unit:Hour Resolution:1 Offset:0
	Hours	0x0 To 0x17	
	Unknown	0x1E	
	Fault	0x1F	
UTCMinutes	-	-	Indicates the current UTC minute. Unit:Minutes Resolution:1 Offset:0
	Minutes	0x0 To 0x3B	
	Unknown	0x3E	
	Fault	0x3F	
UTCSeconds	-	-	Indicates the current UTC second. Unit:Seconds Resolution:1 Offset:0
	Seconds	0x0 To 0x3B	
	Unknown	0x3E	
	Fault	0x3F	

1.2.1.9   MD-REQ-022489/D-GPSDilutionOfPrecision_St (TcSE ROIN-294409)

Message Type: Status

Status used to indicate the Dilution of Precision (DOP) of the current GPS data.

Name	Literals	Value	Description
PositionalDop	-	-	This field is in reality 3D estimated error from the location engineUnit:Value Resolution:0.2 Offset:0
	Value	0x0 To 0x1D	
	Unknown	0x1E	
	Invalid	0x1F	
HorizontalDop	-	-	Indicates the current horizontal dilution of precision. Unit:Value Resolution:0.2 Offset:0
	Value	0x0 To 0x1D	
	Unknown	0x1E	
	Invalid	0x1F	
VerticalDop	-	-	Indicates the current vertical dilution of precision. Unit:Value Resolution:0.2 Offset:0
	Value	0x0 To 0x1D	
	Unknown	0x1E	
	Invalid	0x1F	

1.2.1.10 MD-REQ-022490/C-GPSSatNumInView_St (TcSE ROIN-294417)

Message Type: Status

Status used to indicate the number of GNSS satellites currently in solution.

Name	Literals	Value	Description
Number	-	-	Indicates the number of GNSS satellites in the solution. Unit:Integer Resolution:1 Offset:0
	0	0x0	
	1	0x1	
	2	0x2	
	…		
	29	0x1D	
	Unknown	0x1E	
	Invalid	0x1F	

1.2.2   LOCATN-IIR-REQ-022491/H-LocationService_Tx (TcSE ROIN-297354)

All items in this subsection apply to an ECU that is a Localization Master.

The Location Service shall utilize a Global Navigation Satellite System (GNSS) multi-plex messaging protocol as defined below. The GNSS protocol shall utilize one or more data messages on the vehicle system interface that consists of 8 bytes of data. Each 8 byte block of data will represent one of 9 different messages:

1. Meta Data/Time
2. Location 1 (GNSS, Dead Reckoning, and Map matching (for vehicles with Embedded Navigation) combined to estimate vehicle's location)
3. Location 2
4. Location Quality
5. Sensor Quality
6. Sky View
7. Location 3 (same as Location 1, but with shifted coordinates for China – only for China)
8. Location 4 (RAW GNSS from Chipset without Dead Reckoning)
9. Location 5 (Map Match Feedback from embedded nav, if equipped)

SYNC will send message types 0 to 8, TCU in FNV2 architecture and beyond will send message types 0 to 4 and 6 to 8. Each of these 9 messages consists of several fields of data within the 8 byte blocks. The first field of data in every message is an 4 bit block called "Message Type" that indicates what fields of data are present in the remaining 60 bits of data. The *Message Type Definition Table* below defines the "Message Type" field used by all 9 messages. The entire message sequence (except for sky view message) will be sent over CAN every 1 second.

Messages are sent in the following order:
3, 4, 0, 1, 2, 7, 8, 6

For China modules, message order is:

FNV2: 0, 1, 2, 3, 4, 6, 7, 8
FNV3 and beyond: 3, 4, 0, 1, 2, 7, 8, 6

Message Type	Message	Broadcast In
0	MetaDataTime	LocationServices_Data1 or LocationServices_Data3
1	Location1	LocationServices_Data1 or LocationServices_Data3
2	Location2	LocationServices_Data1 or LocationServices_Data3
3	LocationQuality	LocationServices_Data1 or LocationServices_Data3
4	SensorQuality	LocationServices_Data1 or LocationServices_Data3
5	SkyView	LocationServices_Data2
6	Location3	LocationServices_Data1 or LocationServices_Data3
7	Location4	LocationServices_Data1 or LocationServices_Data3
8	Location5	LocationServices_Data1 or LocationServices_Data3

LocationServices_data1 is currently defined as ArbID 0x45E transmitted by APIM/CHR/CTR on HS3.
LocationServices_data2 is currently defined as ArbID 0x45F transmitted by APIM/CHR/CTR on HS3.   In addition, message $45F is only for Engineering development testing. It will not be active in production   vehicles.

LocationServices_Data3 is currently defined as ArbID 0x21E transmitted by TCU.

Please see database file for ArbID's reassigned across the gateway.

The default values for Location 1, Location 3, Location 4 and Location 5 shall indicate the location as Ford World Headquarters ((Latitude = 42.313862° Longitude = -83.210067°). The default value for other location message fields is 0.

1.2.2.1   MD-REQ-051835/G-MetaDataTime

GNSS Message Type: Meta Data/Time

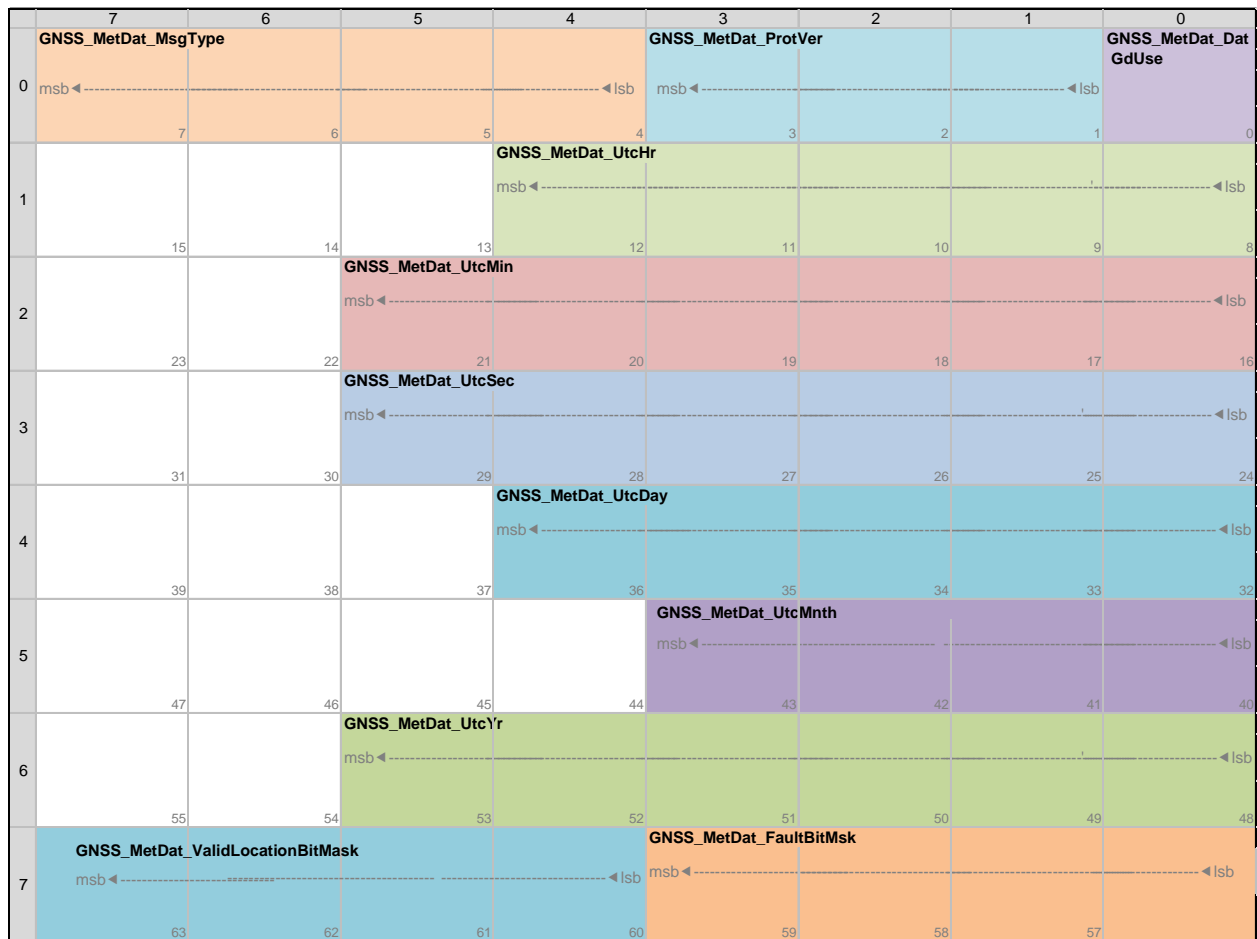| Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	MetaDataTime	0x0	See *Message Type Definition Table.*
Protocol Version	3	0 - 7	Version1	0x0	Any additional updates to the GNSS protocol will increment the
			Version2	0x1	

Name	Size	Range	Value	Hex	Description
			…	…	protocol version. The Protocol Version data field will indicate which version is in use. See appendix C.
			Version8	0x7	
Data Good To Use	1	0 - 1	DataUnreliable	0x0	The flag DataGoodToUse shall only be set to "DataReliable {0x1}" if TCU received valid time and date via GNSS. Otherwise it shall be "Data Unreliable {0x0}" till valid time and date are received via GNSS.
			DataReliable	0x1	The flag DataGoodToUse shall be set to "DataReliable {0x1}" independently of location data received via GNSS. The flag DataGoodToUse shall only indicate if time and date data is valid or not.
UTC Time Hours	5	0 - 23	0	0x00	Indicates the hour portion of the GPS time.
			1	0x01	
			…	…	
			23	0x17	
UTC Time Minutes	6	0 - 59	0	0x00	Indicates the minute portion of the GPS time.
			1	0x01	
			…	…	
			59	0x3B	
UTC Time Seconds	6	0 - 59	0	0x00	Indicates the second portion of the GPS time.
			1	0x01	
			…	…	
			59	0x3B	
Fault Bit Mask	4	Bit0 (lsb)	0	False	Indicates a Wheel Tick fault where True = Fault Active.
			1	True	
		Bit1	0	False	Indicates a Gyro fault where True = Fault Active.
			1	True	
		Bit2	0	False	Indicates an Accelerometer fault Or GNSS receiver internal fault or both where True = Fault Active.
			1	True	
		Bit3 (msb)	0	False	Indicates an Antenna fault where True = Fault Active.
			1	True	
UTC Time Day	5	1 - 31	1	0x01	Indicates the day portion of the GPS date, where 0 is reserved.
			2	0x02	
			…	…	
			31	0x1F	
UTC Month	4	1 - 12	1	0x1	Indicates the month portion of the GPS date where 0 is reserved, 1 = January, 2 = February, etc.
			2	0x2	
			…	…	
			12	0xC	
UTC Year	6	2014 - 2077	2014	0x00	Indicates the year portion of the GPS date.
			2015	0x01	
			…	…	
			2077	0x3F	
Valid Location Messages Bit Mask (FNV2 and beyond)	4	Bit0 (lsb)	0	False	Indicates when Location1 message contains valid data.
			1	True	
		Bit1	0	False	

			1	True	Indicates when Location 3 message contains valid data. The flag shall be set to 1 if the vehicle is in China. Otherwise, it should be set to 0.
		Bit2	0	False	Indicates when Sensor quality message contains valid data.
			1	True	
		Bit3 (msb)	0	False	Indicates when Location 5 message contains valid data.
			1	True	

Note: All values outside the defined range above shall remain reserved.

The physical bit/byte position layout of the MetaDataTime message is as follows:

1.2.2.2 MD-REQ-051836/E-Location1

GNSS Message Type: Location 1

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	Location1	0x1	See *Message Type Definition Table.*
Latitude Degrees Integer	7	0 - 89	0	0x00	Indicates the WGS84 Latitude integer portion in degrees.
			1	0x01	
			…	…	

				89	0x59	
Latitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the WGS84
			Positive	0x1	Latitude Integer in degrees.
Latitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the WGS84 Latitude fractional portion in degrees.
			0.000001	0x00001	
			…	…	
			0.999999	0xF423F	
Longitude Degrees Integer	8	0 - 179	0	0x00	Indicates the WGS84 Longitude integer portion in degrees.
			1	0x01	
			…	…	
			179	0xB3	
Longitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the WGS84 Latitude fractional portion in degrees.
			0.000001	0x00001	
			…	…	
			0.999999	0xF423F	
Longitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the WGS84
			Positive	0x1	Longitude Integer in degrees.

Notes:

1. All values outside the defined range above shall remain reserved.
2. Latitude and Longitude values are a derived solution from the output of the location engine in WGS84 coordinates.
3. For China, Latitude and Longitude values are a derived solution from the output of the location engine in WGS84 coordinates and the data will be unshifted.

The physical bit/byte position layout of the Location1 message is as follows:

7	6	5	4	3	2	1	0

GNSS_Loc1_MsgType

msb ◄-------------------------------------- ◄ lsb | **GNSS_Loc1_LatDegInt** msb ◄-- ◄

0 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

◄-------------------------------------- ◄ lsb | **GNSS_Loc1_Lat Sign** | **GNSS_Loc1_LatDegFrac** msb ◄--------------------------------- ◄

1 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |

◄-- ◄

2 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |

◄-- ◄ lsb

3 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |

GNSS_Loc1_LongDegInt

msb ◄-- ◄ lsb

4 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 |

GNSS_Loc1_LongDegFrac

msb ◄-- ◄

5 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 |

◄-- ◄

6 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 |

◄--- ◄ lsb | **GNSS_Loc1_Long Sign** | | | |

7 | 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 |
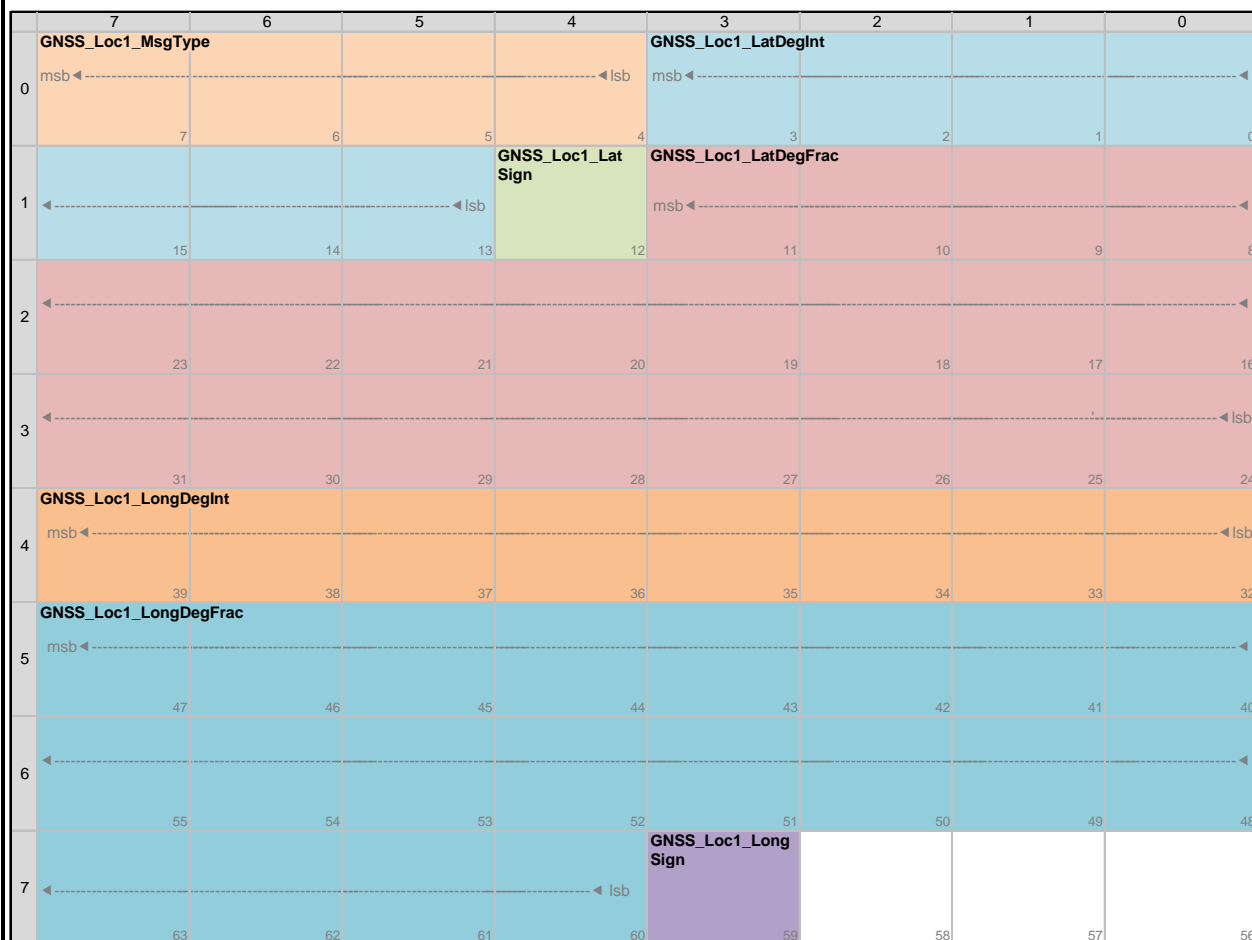
1.2.2.3 MD-REQ-051837/E-Location2

GNSS Message Type: Location 2

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	Location2	0x2	See *Message Type Definition Table.*
Heading	12	0 – 359.9	0	0x000	Indicates the WGS84 Heading in degrees.
			0.1	0x001	
			…	…	
			359.9	0xE0F	
Mean Sea Level (MSL) Altitude	11	-1000 - 9000	-1000	0x000	Indicates the WGS84 altitude in meters.
			-995	0x001	
			…	…	
			-5	0x0C7	
			0	0x0C8	
			5	0x0C9	
			…	…	
			9000	0x7D0	
Velocity	12	0 - 409.5	0	0x000	Indicates the WGS84 velocity in kilometers per hour (kph).
			0.1	0x001	
			…	…	
			409.5	0xFFF	

			Null (Unknown)	0x00	
Compass Direction	4	N/A	North	0x01	Indicates compass direction.
			NorthEast	0x02	
			East	0x03	
			SouthEast	0x04	
			South	0x05	
			SouthWest	0x06	
			West	0x07	
			NorthWest	0x08	
GPS Satellites In Solution	4	0 - 15	0	0x00	Indicates the number of GPS satellites in solution.
			1	0x01	
			…	…	
			15 (or more)	0x0F	
GLONASS Satellites In Solution	4	0 - 15	0	0x00	Indicates the number of GLONASS satellites in solution.
			1	0x01	
			…	…	
			15 (or more)	0x0F	
Galileo Satellites In Solution	4	0 - 15	0	0x00	Indicates the number of Galileo satellites in solution.
			1	0x01	
			…	…	
			15 (or more)	0x0F	
Compass (Beidou) Satellites In Solution	4	0 - 15	0	0x00	Indicates the number of Compass (Beidou) satellites in solution.
			1	0x01	
			…	…	
			15 (or more)	0x0F	
Fix Type	3	N/A	Sensors Uncalibrated with no Fix (DR Off)	0x0	Indicates Fix type
			Sensors Calibrated with no Fix and no updated location	0x1	
			2D Fix	0x2	
			3D Fix (DR Uncalibrated)	0x3	
			DR only	0x4	
			3D Fix DR (DR Calibrated)	0x5	
			Last Known Location	0x6	

Note: All values outside the defined range above shall remain reserved.

The physical bit/byte position layout of the Location2 message is as follows:

The following table represents the bit layout (bits 7 through 0 across, byte rows 0 through 7):

Byte	7	6	5	4	3	2	1	0
0	GNSS_Loc2_MsgType msb◄────			────◄lsb	GNSS_Loc2_Heading msb◄────			────
1	◄────							◄lsb
2	GNSS_Loc2_MslAlt msb◄────							────
3	◄────		◄lsb		GNSS_Loc2_Velocity msb◄────			────
4	◄────							◄lsb
5	GNSS_Loc2_CompDir msb◄────			────◄lsb	GNSS_Loc2_FixType msb◄────			◄lsb
6	GNSS_Loc2_GpsSatInSol msb◄────			────◄lsb	GNSS_GlonassSatInSol msb◄────			◄lsb
7	GNSS_Loc2_GalileoSatInSol msb◄────			────◄lsb	GNSS_Loc2_CompassSatInSol msb◄────			◄lsb

1.2.2.4 *MD-REQ-051838/E-LocationQuality*

GNSS Message Type: Location Quality

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	LocationQuality	0x3	See *Message Type Definition Table.*
3D Estimated Error	8	0 – 255	0	0x00	Indicates the three dimensional error in meters of the location solution.
			1	0x01	
			…	…	
			255	0xFF	
Positional Dilution Of Precision (pDop)	8	0 - 25.5	0	0x00	Indicates the current positional dilution of precision.
			0.1	0x01	
			…	…	
			25.5	0xFF	
Horizontal Dilution Of Precision (hDop)	8	0 - 25.5	0	0x00	Indicates the current horizontal dilution of precision.
			0.1	0x01	
			…	…	
			25.5	0xFF	
Vertical Dilution Of Precision (vDop)	8	0 - 25.5	0	0x00	Indicates the current vertical dilution of precision.
			0.1	0x01	
			…	…	
			25.5	0xFF	
	8		0	0x00	

			0.01	0x01	Indicates the current
Speed accuracy approximation (VeloAcc)		0.00 – 2.54	…	…	speed accuracy approximation in m/s. Corresponding to Velocity. (see Location2)
			2.54	0xFE	
			Over 2.54 / not supported	0xFF	

Note: All values outside the defined range above shall remain reserved.

The physical bit/byte position layout of the LocationQuality message is as follows:

	7	6	5	4	3	2	1	0
0	GNSS_LocQual_MsgType				3	2	1	0
1	GNSS_LocQual_3dEstErr 14	13	12	11	10	9	8
2	GNSS_LocQual_pDop 22	21	20	19	18	17	16
3	GNSS_LocQual_hDop 30	29	28	27	26	25	24
4	GNSS_LocQual_vDop 38	37	36	35	34	33	32
5	GNSS_LocQual_VeloAcc 46	45	44	43	42	41	40
6	55	54	53	52	51	50	49	48
7	63	62	61	60	59	58	57	56
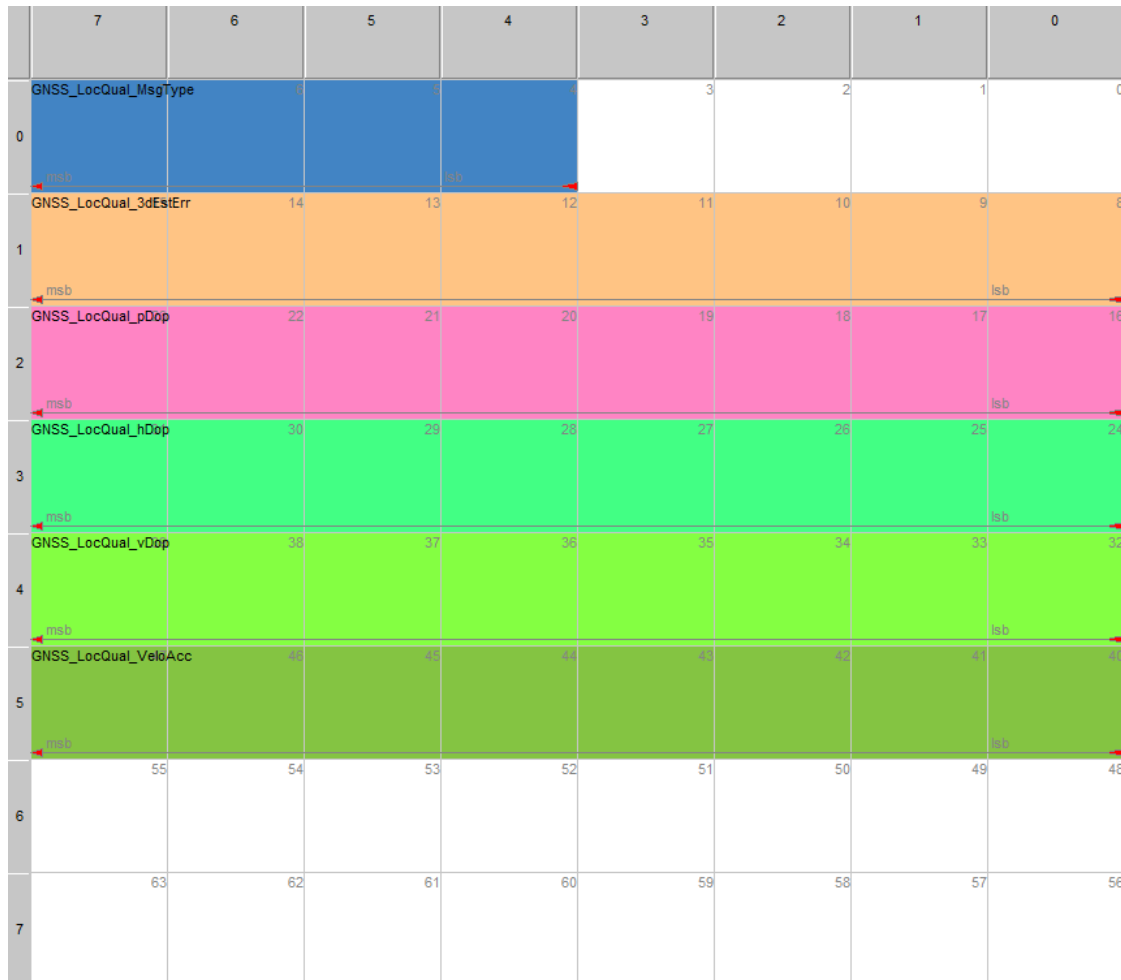
1.2.2.5   MD-REQ-051839/C-SensorQuality

GNSS Message Type: Sensor Quality

Note: All values outside the defined range above shall remain reserved.

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	SensorQuality	0x4	See *Message Type Definition Table.*
Accelerometer Calibration Status	3	N/A	NotCalibrated	0x0	
			RoughCal	0x1	Calibration in process
			GoodCal	0x2	Calibration successful
			Reserved	0x3 - 0x5	
			AccelNotPresent	0x6	
			CalFault	0x7	Calibration Fault
Wheel Tick Calibration Status	2	N/A	NotCalibrated	0x00	
			RoughCal	0x01	Calibration in process
			GoodCal	0x02	Calibration successful
			CalFault	0x03	Calibration Fault
Gyro Calibration Status	3	N/A	NotCalibrated	0x0	
			RoughCal	0x1	Calibration in process
			GoodCal	0x2	Calibration successful
			Reserved	0x3 - 0x5	
			GyroNotPresent	0x6	
			CalFault	0x7	Calibration Fault
Wheel Circumference	12	1000 - 5000	1000	0x000	Indicates the computed circumference of the wheel in millimeters.
			1001	0x001	
			…	…	
			5000	0xFA0	
Jamming Detection	2	Bit0 (lsb)	0	False	Indicates Narrow Band Detection where True = Narrow Band Detected.
			1	True	
		Bit1 (msb)	0	False	Indicates Wide Band Detection where True = Wide Band Detected.
			1	True	
Active Gain Control (AGC)	10	0 - 100	0	0x000	Indicates the active gain control level in percentage.
			0.1	0x001	
			…	…	
			100.0	0x3E8	
Narrow Band Noise Level	12	0 - 409.5	0	0x000	Indicates the level of Narrow Band noise in db.
			0.1	0x001	
			…	…	
			409.4	0xFFE	
			Not Measured	0xFFF	
Wide Band Noise Level	12	0 - 409.5	0	0x000	Indicates the level of Wide Band noise in db.
			0.1	0x001	
			…	…	
			409.4	0xFFE	
			Not Measured	0xFFF	

The physical bit/byte position layout of the Sensor Quality message is as follows:
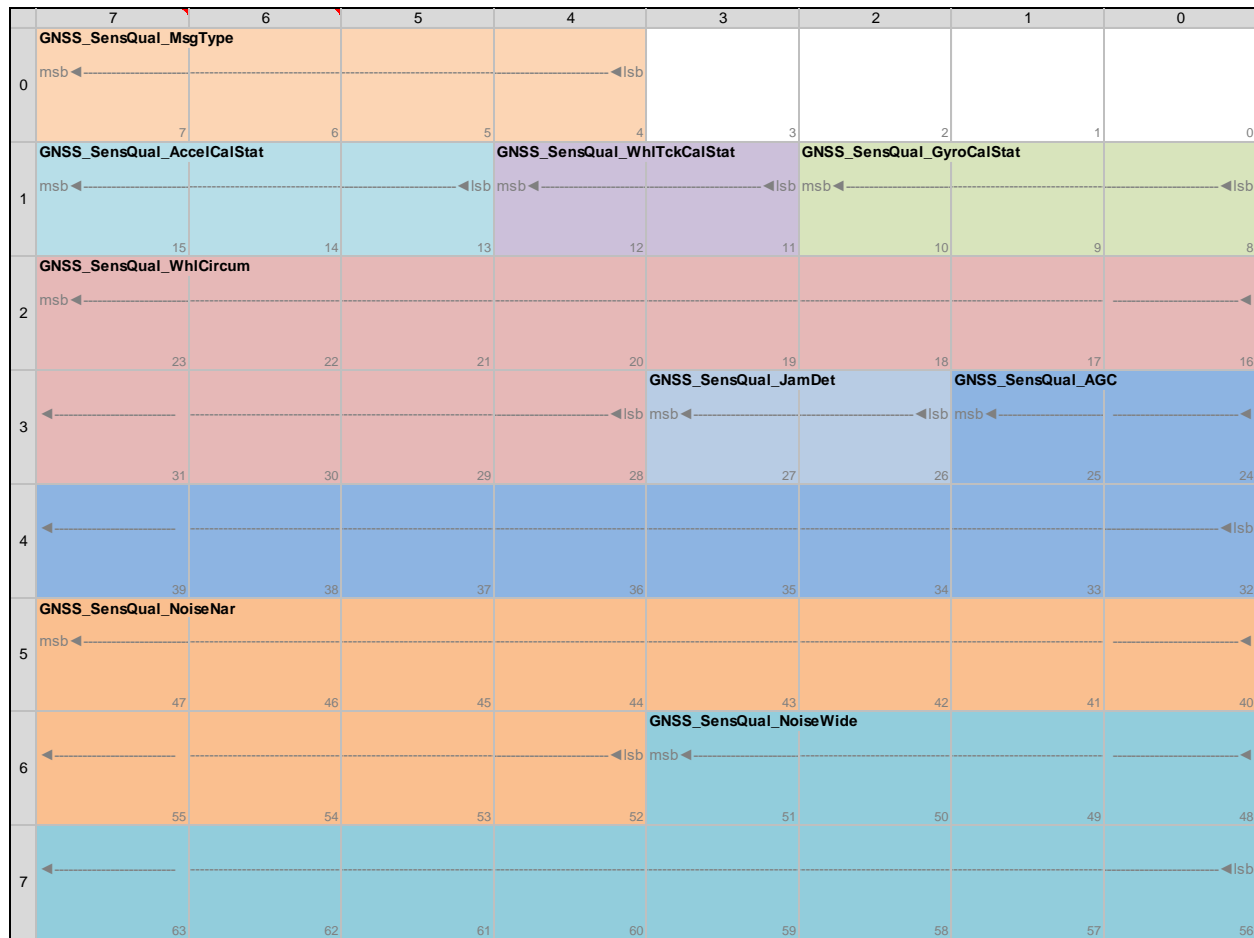
1.2.2.6 MD-REQ-051840/C-SkyView

Sky View Message shall be configurable on/off and only to be used for development. The bus load for this is extreme and could destabilize the intended platform.

GNSS Message Type: Sky View

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	SkyView	0x5	See *Message Type Definition Table.*
Rolling Counter	4	0 - 15	0	0x00	Indicates the GNSS Satellite Rolling Counter.
			0.1	0x01	
			…	…	
			25.5	0xFF	
Satellite Channel	8	0 - 255	0	0x00	Indicates the GNSS Satellite Channel of the identified satellite.
			1	0x01	
			…	…	
			255	0xFF	
Satellite PRN ID	8	0 - 255	0	0x00	Indicates the GNSS Satellite PRN ID of the identified satellite.
			1	0x01	
			…	…	
			255	0xFF	
Satellite Carrier To Noise	8	0 - 255	0	0x00	Indicates the GNSS Satellite Carrier to Noise Ratio (CN0) in dbHz of the identified satellite.
			1	0x01	
			…	…	
			255	0xFF	

Satellite Elevation	8	0 - 255	0	0x00	Indicates the GNSS Satellite Elevation in degrees of the identified satellite.
			1	0x01	
			…	…	
			255	0xFF	
Satellite Azimuth	8	0 - 255	0	0x00	Indicates the GNSS Satellite Azimuth in degrees of the identified satellite.
			1	0x01	
Satellite Signal Quality	3	N/A	Idle	0x0	This channel is idle
			Searching	0x1	This channel is searching
			Acquired	0x2	Signal Acquired
			Unstable	0x3	Signal is detected but unstable
			CodeLock	0x4	Code lock on signal
			CodeCarrier Lock1	0x5	Code and carrier locked
			CodeCarrier Lock2	0x6	Code and carrier locked
			CodeCarrier Lock3	0x7	Code and carrier locked
Satellite Status Bit Mask	7	Bit0 (lsb)	0	False	Indicates the identified Space Vehicle (SV) is used for Navigation when True.
			1	True	
		Bit1	0	False	Indicates differential correction data of the identified satellite is available for this SV when True.
			1	True	
		Bit2	0	False	Indicates orbit information of the identified satellite is available for this SV (Ephemeris or Almanach) when True.
			1	True	
		Bit3	0	False	Indicates orbit information of the identified satellite is Ephemeris when True.
			1	True	
		Bit4	0	False	Indicates the identified Space Vehicle (SV) is unhealthy/shall not be used when True.
			1	True	
		Bit5	0	False	Indicates orbit information of the identified satellite is Almanac Plus when True.
			1	True	
		Bit6 (msb)	0	False	Indicates orbit information of the identified satellite is Autonomous Orbit Prediction when True.
			1	True	

Notes:

1. All values outside the defined range above shall remain reserved.
2. The above set of data is broadcast one message per satellite seen in the sky (per epoch).
3. The entire set of data above shall be tied to the same "rolling counter".

The physical bit/byte position layout of the SkyView message is as follows:

	7	6	5	4	3	2	1	0
0	GNSS_SkyView_MsgType msb◄			◄lsb	GNSS_SkyView_RolCount msb◄			◄lsb
	7	6	5	4	3	2	1	0
1	GNSS_SkyView_SatChan msb◄							◄lsb
	15	14	13	12	11	10	9	8
2	GNSS_SkyView_SatPRN msb◄							◄lsb
	23	22	21	20	19	18	17	16
3	GNSS_SkyView_SatCarToNoise msb◄							◄lsb
	31	30	29	28	27	26	25	24
4	GNSS_SkyView_SatElev msb◄							◄lsb
	39	38	37	36	35	34	33	32
5	GNSS_SkyView_SatAzim msb◄							◄lsb
	47	46	45	44	43	42	41	40
6	GNSS_SkyView_SatSigQual msb◄			◄lsb	GNSS_SkyView_SatStatBitMsk msb◄			◄
	55	54	53	52	51	50	49	48
7	◄		◄lsb					
	63	62	61	60	59	58	57	56

1.2.2.7   MD-REQ-130083/E-Location3

GNSS Message Type: Location 3

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	Location3	0x6	See *Message Type Definition Table.*
Latitude Degrees Integer	7	0 - 89	0 1 … 89	0x00 0x01 … 0x59	Indicates the China Shifted Latitude integer portion in degrees in the GCJ-02 coordinate system.
Latitude Sign	1	0 - 1	Negative Positive	0x0 0x1	Indicates the sign of the China Shifted Latitude Integer in degrees.
Latitude Degrees Fractional	20	0.000001 - 0.999999	0 0.000001 … 0.999999	0x00000 0x00001 … 0xF423F	Indicates the China Shifted Latitude fractional portion in degrees in the GCJ-02 coordinate system.
Longitude Degrees Integer	8	0 - 179	0 1 … 179	0x00 0x01 … 0xB3	Indicates the China Shifted Longitude integer portion in degrees in the GCJ-02 coordinate system.
Longitude Degrees Fractional	20	0.000001 - 0.999999	0 0.000001 … 0.999999	0x00000 0x00001 … 0xF423F	Indicates the China Shifted Latitude fractional portion in degrees in the GCJ-02 coordinate system.

			Negative	0x0	Indicates the sign of the China
Longitude Sign	1	0 - 1	Positive	0x1	Shifted Longitude Integer in degrees.

Notes:

1. All values outside the defined range above shall remain reserved.
2. China Shifted values; Latitude and Longitude, are outputted in the GCJ-02 coordinate system. The algorithm to shift the data uses the WGS-84 coordinates from the location engine and converts them into GCJ-02. The conversion is done by the tier 1 navigation map supplier.
3. For Non-China market, location 3 message content will be identical to location 1.

The physical bit/byte position layout of the Location 3 message is identical to location 1.

1.2.2.8 MD-REQ-133270/D-Location4

GNSS Message Type: Location 4 Raw GNSS

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	Location4	0x7	See *Message Type Definition Table.*
Latitude Degrees Integer	7	0 - 89	0	0x00	Indicates the Raw GNSS Latitude integer portion in degrees.
			1	0x01	
			…	…	
			89	0x59	
Latitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the Raw GNSS Latitude Integer in degrees.
			Positive	0x1	
Latitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the Raw GNSS Latitude fractional portion in degrees.
			0.000001	0x00001	
			…	…	
			0.999999	0xF423F	
Longitude Degrees Integer	8	0 - 179	0	0x00	Indicates the Raw GNSS Longitude integer portion in degrees.
			1	0x01	
			…	…	
			179	0xB3	
Longitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the Raw GNSS Latitude fractional portion in degrees.
			0.000001	0x00001	
			…	…	
			0.999999	0xF423F	
Longitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the Raw GNSS Longitude Integer in degrees.
			Positive	0x1	

Notes:

1. All values outside the defined range above shall remain reserved.
2. This message is for the Raw GNSS Location fed by the GNSS Chipset.
3. For China, Latitude and Longitude values are a derived solution from the output of the location engine in WGS84 coordinates and the data will be unshifted.

The physical bit/byte position layout of the Location 4 message is identical to location 1.

1.2.2.9 MD-REQ-133599/C-Location5

GNSS Message Type: Location 5 – Map Match

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0 - 8	Location5	0x8	See *Message Type Definition Table.*
Latitude Degrees Integer	7	0 - 89	0	0x00	Indicates the Map Matched Latitude integer portion in degrees.
			1	0x01	
			…	…	
			89	0x59	
Latitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the Map Matched Latitude Integer in degrees.
			Positive	0x1	
Latitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the Map Matched Latitude fractional portion in degrees.
			0.000001	0x00001	
			…	…	
			0.999999	0xF423F	
Longitude Degrees Integer	8	0 - 179	0	0x00	Indicates the Map Matched Longitude integer portion in degrees.
			1	0x01	
			…	…	
			179	0xB3	
Longitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the Map Matched Latitude fractional portion in degrees.
			0.000001	0x00001	
			…	…	
			0.999999	0xF423F	
Longitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the Map Matched Longitude Integer in degrees.
			Positive	0x1	

Notes:
1. All values outside the defined range above shall remain reserved.
2. This message is only if an embedded navigation product is installed.
3. Map Match value from the Embedded navigation product shall feed this message
4. If no map match is provided, do not publish

The physical bit/byte position layout of the Location 5 message is identical to location 1.

1.2.2.10 Data Interpretation Example

Conditions:
MsgType = MetaDataTime (0x0)
ProtVer = Version 3 (0x2)
DataGoodToUse = Data Reliable (0x1)
UTC Hour = 1
UTC Min =2
UTC Sec =3
UTC Day =4
UTC Month =5
UTC Year =2020 (0x6),
Fault Indication:
    Bit3: Antenna Fault = False (0)
    Bit2: Accelerometer Fault = False (0)
    Bit1: Gyro Fault = True (1)
    Bit0: Wheel Tick Fault = True (1)

Resulting Data:

Byte0 = 0000 0101 → Hex 05
Byte1 = 0000 0001 → Hex 01

Byte2 = 0000 0010 → Hex 02
Byte3 = 0000 0011 → Hex 03
Byte4 = 0000 0100 → Hex 04
Byte5 = 0000 0101 → Hex 05
Byte6 = 0000 0110 → Hex 06
Byte7 = 0000 0011 → Hex 03

CAN Frame = 05 01 02 03 04 05 06 03

1.2.3   LOCATN-IIR-REQ-091628/C-Internal

The location service will be responsible for providing the following data elements as available to client applications inside the host micro processing operating system:

System timestamp (microseconds) for the solution
2D DR Elements
      Lattitude and longitude in WGS84 with 6 decimals of precision of degree
      Heading with two decimals of precision
      Calibration status
      Estimate of 67%ile spherical position error (in cm)
      Estimate of 67%ile heading error (in degrees)
      Error States (RF, CAN, IMU)

if supported by localization provider - 3D DR Elements:
      Altitude filter (g-sensor): status flags
      Altitude filter (g-sensor): cumulative delta-distance (m)
      Altitude filter (g-sensor): cumulative delta-altitude (m)
      Altitude filter (g-sensor): noise component independent of distance travelled
      Altitude filter (g-sensor): noise component to multiply by distance travelled

This requirement only applies to SYNC 3 and SYNC 4 variants.
.

1.2.4   LOCATN-IIR-REQ-132695/A-LocationService_Ephemeris

    As specified in section *LOCATN-REQ-022427/B-GPS Receiver Hardware Requirements (TcSE ROIN-294201), autoephemeris support is expected*

    A position fix using any satellite cannot be calculated until the receiver has an accurate and complete copy of that satellite's ephemeris data. If the signal from a satellite is lost while its ephemeris data is being acquired, the receiver must discard that data and start again. Ephemeris information is highly detailed and considered valid for no more than four hours.

    In order to give customers the best possible experience between commute cycles, a hot start is preferable for these occurrences. For a hot start to work, ephemeris must be up to date. As Such, two methods exists in order to facilitate increasing the validity time of the ephemeris data. The first is downloaded extended ephemeris information and the second being self-generated predicted ephemeris.

1.2.4.1   *MD-REQ-132696/B-DownloadedEphemeris*

If Ford establishes via its cloud infrastructure a method for downloading an off board ephemeris (via TCU, WIFI or Applink), then system shall support downloading said data and using internally. . If a download is incomplete prior to a key cycle, the prior file shall be maintained (assuming file is still valid). Valid files shall not be deleted until new download is complete. Download request will only be requested when the TCU is fully operational.

1.2.4.2   *MD-REQ-132697/A-CalculatedEphemeris*

Location engine shall calculate (maintain) at a minimum a 24 hour predicted ephemeris at all times . If a calculation is incomplete prior to a key cycle, the prior calculation shall be maintained (assuming file is still valid). Valid files shall not be deleted until new calculation is complete.

1.2.5 LOCATN-IIR-REQ-393611/D-UnifiedLocationService_Tx

With the introduction of the FNV3 architecture, a single source of vehicle location is available via SOA. The ECU with the GNSS receiver will be responsible for providing the following 6 messages over SOA:

1. Vehicle Location Data
2. IMU Sensor Data
3. IMU Sensor Hardware Information
4. Basic Satellite Data
5. Extended Satellite Data
6. NMEA Data

China IVI Module will be responsible for providing the following message over SOA in China only:
1.   LocationDataShifted

Only valid data will be sent over SOA when parameters are marked as optional.

1.2.5.1   MD-REQ-393612/D-LocationData

The full message is defined in the table below. The minimum set of data that will always be included is:
- System time
- Protocol version
- Year of last software update
- Fix dimension
- Fault Info
- Message sequence number

When the fix dimension indicates that there is no fix available, it is expected that none of the optional fields will be included.

Method Type	Periodic				
QoS Level	Default				
Retained	No				
R/O	**Name**	**Type**	**Literals**	**Value**	**Description**
Request (_St)					
R	System_time	uint64	-	-	Vehicle system time in milliseconds
R	protocol_version	uint32	-	-	
R	year_of_last_sw_update	uint32	-	-	year of last software update, ex: 2021
R	msg_seq_num	unit32	-	-	message sequence number (used to pair shifted coordinates in LocationDataShifted message with the unshifted coordinates in LocationData message)
O	utc_time	uint64	-	-	GNSS UTC time in milliseconds since Jan 1, 1970
O	utc_time_unc	float	-	-	time uncertainty in milliseconds
O	coord_final	-	-	-	lat,lon calculated using all available inputs, ex: GNSS+DR
		Coordinates	-	-	Type
		double		-90 to 90 in decimal degrees	latitude
		double		-180 to 180 in decimal degrees	longitude
O	coord_raw	-	-	-	lat,lon calculated using GNSS only
		Coordinates	-	-	Type
		double		-90 to 90 in decimal degrees	latitude

				-180 to 180 in decimal degrees	longitude
O	heading	float	-	0 to 359.999 degrees	heading relative to true north
O	altitude	double	-	-	altitude above the WGS 84 reference ellipsoid (m)
O	msl_altitude	double	-	-	altitude in meters with respect to mean sea level
O	velocity	float	-	-	velocity in meters per second
O	enu_vel	-	-	-	east, north, up velocity in m/s
		float		-	East velocity in meters per second
		float		-	North velocity in meters per second
		float		-	Up velocity in meters per second
O	compass_dir	enum	-	-	indicates compass direction
			COMPASS_DIR_UNKNOWN	0	unknown compass direction
			COMPASS_DIR_N	1	north
			COMPASS_DIR_NE	2	north east
			COMPASS_DIR_E	3	east
			COMPASS_DIR_SE	4	south east
			COMPASS_DIR_S	5	south
			COMPASS_DIR_SW	6	south west
			COMPASS_DIR_W	7	west
			COMPASS_DIR_NW	8	north west
R	fix_dimension	enum	-	-	indicates 2d/3d or no fix at all
			FIX_DIMENSION_NO_FIX	0	location not available
			FIX_DIMENSION_2D	1	2D location
			FIX_DIMENSION_3D	2	3D location
			FIX_DIMENSION_LAST_KNOWN_LOCATION	3	last known location
O	final_fix_tech_mask	uint32	-	-	final fix tech type
			TECH_MASK_BIT_UNKNOWN	0x0	unknown location
			TECH_MASK_BIT_GNSS	0x1	numeration indicates GNSS was used when calculating the final coordinates
			TECH_MASK_BIT_DR	0x2	numeration indicates dead reckoning was used when calculating the final coordinates
			TECH_MASK_BIT_SBAS	0x3	numeration indicates SBAS was used when calculating the final coordinates
			TECH_MASK_BIT_DR_GNSS	0x4	numeration indicates that dead reckoning and GNSS were used when calculating the final coordinates
			TECH_MASK_BIT_DR_SBAS	0x5	numeration indicates that dead reckoning and SBAS were used when calculating the final coordinates
			TECH_MASK_BIT_GNSS_SBAS	0x6	numeration indicates that GNSS and SBAS were used when calculating the final coordinates
			TECH_MASK_BIT_GNSS_DR_SBAS	0x7	numeration indicates that GNSS, dead reckoning and SBAS were used when calculating the final coordinates
R	fault_info	-	-	-	fault info
		boolean	WHEEL_TICK		value of True indicates a wheel tick fault
		boolean	GYRO		value of True indicates a gyro fault
		boolean	ACCEL		value of True indicates an accelerometer fault
		boolean	GNSS_RECEIVER		value of True indicates a GNSS receiver fault

		boolean	GNSS_ANT		value of True indicates a GNSS antenna fault
O	horizontal_unc	float	-	-	horizontal uncertainty in meters
O	vertical_unc	float	-	-	vertical uncertainty in meters
O	speed_unc	float	-	-	speed uncertainty in m/s
O	heading_unc	float	-	0 to 359.999 degrees	heading uncertainty in degrees
O	pdop	float		0 (highest accuracy) to 25.5 (lowest accuracy)	position dilution of precision
O	hdop	float		0 (highest accuracy) to 25.5 (lowest accuracy)	horizontal dilution of precision
O	vdop	float		0 (highest accuracy) to 25.5 (lowest accuracy)	vertical dilution of precision
O	num_gps_sv_used	uint32	-	-	number of GPS satellites used to calculate position
O	num_glo_sv_used	uint32	-	-	number of Glonass satellites used to calculate position
O	num_gal_sv_used	uint32	-	-	number of Galileo satellites used to calculate position
O	num_bds_sv_used	uint32	-	-	number of Beidou satellites used to calculate position
O	cumulative_distance	double	-	-	distance traveled in meters for the current ignition cycle
O	cumulative_altitude	double	-	-	Total change in altitude (meters) for the current ignition cycle

1.2.5.2   MD-REQ-412633/A-SensorData

Method Type	Periodic				
QoS Level	Default				
Retained	No				

R/O	Name	Type	Literals	Value	Description
Request (_St)					
R	system_time	uint64	-	-	vehicle system time in milliseconds
O	lon_accel	float	-	-	forward acceleration (m/s^2)
O	lon_accel_bias	float	-	-	forward acceleration bias
O	lat_accel	float	-	-	sideways acceleration (m/s^2)
O	lat_accel_bias	float	-	-	sideways acceleration bias
O	vert_accel	float	-	-	vertical acceleration (m/s^2)
O	vert_accel_bias	float	-	-	vertical acceleration bias
O	yaw_rate	float	-	-	yaw rate (rad/s)
O	yaw_rate_bias	float	-	-	yaw rate bias
O	pitch_rate	float	-	-	pitch rate (rad/s)
O	pitch_rate_bias	float	-	-	pitch rate bias
O	roll_rate	float	-	-	roll rate (rad/s)
O	roll_rate_bias	float	-	-	roll rate bias

1.2.5.3 MD-REQ-412634/A-SensorHwInfo

Method Type	One Shot	
QoS Level	Default	
Retained	No	

R/O	Name	Type	Literals	Value	Description
Request (_St)					
R	type_of_sensor	string	-	-	type of sensor (accelerometer, gyro, other)
O	sensor_name	string	-	-	sensor hardware name
O	vendor	string	-	-	sensor vendor
O	version	int32	-	-	sensor version
O	max_value	float	-	-	max measurement value
O	resolution	float	-	-	smallest difference between two measurements reported by the sensor

1.2.5.4 MD-REQ-393741/C-SatelliteDataBasic

Method Type	Periodic	
QoS Level	Default	
Retained	No	

R/O	Name	Type	Literals	Value	Description
Request (_St)					
R	system_time	uint64	-	-	Vehicle system time in milliseconds
R	sv_list_size()	int	-	-	returns the number of SvInfo objects in the sv_list
O	sv_list	-	-	-	a list of SvInfo objects
		SvInfo	-	-	Type
	svid	uint32	-	-	the GNSS satellite vehicle ID
	constellation	enum	-	-	the constellation to which this SV belong
			CONSTELLATION_UNKNOWN	0	
			CONSTELLATION_GPS	1	
			CONSTELLATION_GLONASS	2	
			CONSTELLATION_GALILEO	3	
			CONSTELLATION_BDS	4	
			CONSTELLATION_SBAS	5	
			CONSTELLATION_QZSS	6	
			CONSTELLATION_NAVIC	7	
	sv status	enum	-	-	SV processing status
			SV_STATUS_UNKNOWN	0	unknown SV status
			SV_STATUS_IDLE	1	SV is not being actively processed
			SV_STATUS_SEARCH	2	the system is searching for this SV
			SV_STATUS_TRACK	3	SV is being tracked
	cno	float	-	-	signal-to-noise ratio in dB-Hz
	elevation	float	-	0 to 90	SV elevation angle in degrees
	azimuth	float	-	0 to 360	SV azimuth angle in degrees
	carrierFreq	float	-	-	Carrier frequency of the signal in Hz
	sv_healthy	bool	-	-	indicates whether or not the SV is operational
	has_ephemeris	bool	-	-	indicates whether the ephemeris data is available
	has_almanac	bool	-	-	indicates whether the almanac data is available

1.2.5.5 MD-REQ-405598/B-SatelliteDataExtended

Method Type	Periodic	
QoS Level	Default	
Retained	No	

R/O	Name	Type	Literals	Value	Description
Request (_St)					
R	system_time	uint64	-	-	vehicle system time in milliseconds
O	leap_second	int32	-	-	leap second, in unit of seconds
O	time_ns	int64	-	-	time, monotonically increasing as long as power is on, in unit of nanoseconds
O	time_unc_ns	double	-	-	time uncertainty (one sigma) in unit of nanoseonds
O	full_bias_ns	int64	-	-	full bias in nanoseconds
O	bias_ns	double	-	-	sub-nanosecond bias in unit of nanoseconds
O	bias_unc_ns	double	-	-	bias uncertainty (one sigma) in nanoseconds
O	drift_nsps	double	-	-	clock drift in nanoseconds/second
O	drift_unc_nsps	double	-	-	clock drift uncertainty (one sigma) in nanoseconds/second
O	hw_clock_discontinuity_count	int32	-	-	HW clock discontinuity count, incremented for each discontinuity in HW clock
R	measurement_list_size()	int	-	-	returns the number of SvMeasurement objects in the measurement_list
O	measurement_list	-	-	-	a list of SvMeasurement objects
		SvMeasurement	-	-	Type
	svid	uint32	-	-	the GNSS satellite vehicle ID
	constellation	enum	-	-	the constellation to which this SV belong
			CONSTELLATION_UNKNOWN	0	
			CONSTELLATION_GPS	1	
			CONSTELLATION_GLONASS	2	
			CONSTELLATION_GALILEO	3	
			CONSTELLATION_BDS	4	
			CONSTELLATION_SBAS	5	
			CONSTELLATION_QZSS	6	
			CONSTELLATION_NAVIC	7	
	sv_state_mask	uint32	-	-	GNSS measurement state
			SV_STATE_MASK_BIT_UNKNOWN	0x0001	
			SV_STATE_MASK_BIT_CODE_LOCK	0x0002	
			SV_STATE_MASK_BIT_BIT_SYNC	0x0004	
			SV_STATE_MASK_BIT_SUBFRAME_SYNC	0x0008	
			SV_STATE_MASK_BIT_TOW_DECODED	0x0010	
			SV_STATE_MASK_BIT_MSEC_AMBIGUOUS	0x0020	

			SV_STATE_MASK _BIT_SYMBOL_SY NC	0x0040	
			SV_STATE_MASK _BIT_GLO_STRIN G_SYNC	0x0080	
			SV_STATE_MASK _BIT_GLO_TOD_D ECODED	0x0100	
			SV_STATE_MASK _BIT_BDS_D2_BIT _SYNC	0x0200	
			SV_STATE_MASK _BIT_BDS_D2_SU BFRAME_SYNC	0x0400	
			SV_STATE_MASK _BIT_GAL_E1BC_ CODE_LOCK	0x0800	
			SV_STATE_MASK _BIT_GAL_E1C_2 ND_CODE_LOCK	0x1000	
			SV_STATE_MASK _BIT_GAL_E1B_P AGE_SYNC	0x2000	
			SV_STATE_MASK _BIT_SBAS_SYNC	0x4000	
	received_sv_time_ns	int64	-	-	GNSS TOW in ns when the measurement was taken
	received_sv_tunc_ns	int64	-	-	GNSS time uncertainty in ns when the measurement was taken
	carrier_to_noise_dbHz	double	-	-	signal strength in dB-Hz
	pseudorange_rate_mps	double	-	-	uncorrected pseudorange rate in m/s
	pseudorange_rate_unc_ mps	double	-	-	uncorrected pseudorange rate uncertainty in m/s
	adr_state_mask	uint32	-	-	ADR state bit mask
			ADR_STATE_MAS K_BIT_UNKNOWN	0x1	
			ADR_STATE_MAS K_BIT_VALID	0x2	
			ADR_STATE_MAS K_BIT_RESET	0x4	
			ADR_STATE_MAS K_BIT_CYCLE_SLI P	0x8	
	adr_meters	double	-	-	accumulated delta range in meters
	adr_unc_meters	double	-	-	ADR uncertainty in meters
	carrier_freq_hz	float	-	-	carrier frequency of the tracked signal in Hz
	carrier_cycles	int64	-	-	number of full carrier cycles between the receiver and satellite
	carrier_phase	double	-	-	RF carrier phase detected by the receiver
	carrier_phase_unc	double	-	-	RF carrier phase uncertainty
	multipath_indicator	bool	-	-	multipath present or not
	signal_to_noise_ratio_db	double	-	-	signal to noise ratio in dB
	acg_level_db	double	-	-	automatic gain control level in dB

1.2.5.6 MD-REQ-419852/A-NMEAData

Method Type	Periodic
QoS Level	Default
Retained	No

R/O	Name	Type	Literals	Value	Description
Request (_St)					
R	system_time	uint64	-	-	vehicle system time in milliseconds
R	Payload	string	-	-	NMEA message content fixed string

1.2.5.7 MD-REQ-436762/B-LocationDataShifted

Method Type	Periodic
QoS Level	Default
Retained	No

R/O	Name	Type	Literals	Value	Description
Request (_St)					
R	protocol_version	uint32	-	-	
R	System_time	uint64	-	-	Vehicle system time in milliseconds
R	msg_seq_number	uint32	-	-	Message sequence number (used to pair shifted coordinates in LocationDataShifted message with the unshifted coordinates in LocationData message)
O	coord_china_shifted	-	-	-	lat,lon shifted for China
		Coordinates	-	-	Type
		double		-90 to 90 in decimal degrees	latitude
		double		-180 to 180 in decimal degrees	longitude
O	coord_map_matched	-	-	-	Map matched location
		Coordinates	-	-	Type
		double		-90 to 90 in decimal degrees	latitude
		double		-180 to 180 in decimal degrees	longitude

2 Functional Definition

2.1 LOCATN-FUN-REQ-022425/A-Physical Architecture (TcSE ROIN-294216)

2.1.1 Requirements

2.1.1.1 *LOCATN-REQ-022426/B-Architecture (TcSE ROIN-294207)*

Wheel Ticks
Reverse Indication
Power Mode
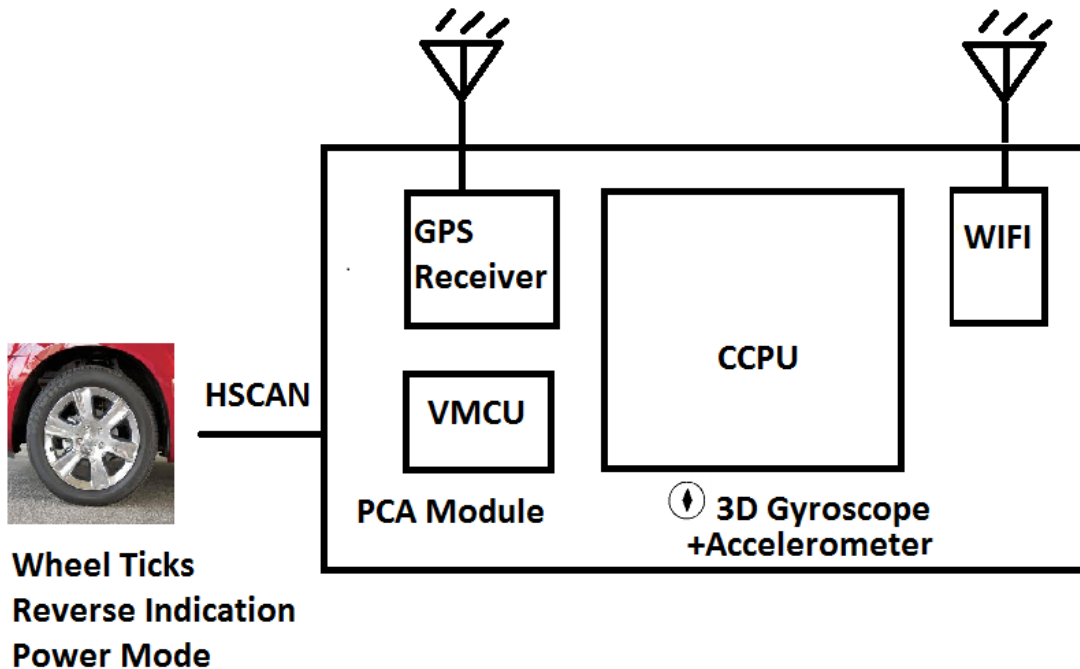
There are 2 Architecture Potentials for the Location features.
1. Smart GPS Receiver with built in dead reckoning (with a second location engine augmenting the GPS receiver in the Host Micro)
2. Dumb GPS receiver with entire location engine running in Host Micro

2.1.1.2 *LOCATN-REQ-022427/C-GPS Receiver Hardware Requirements (TcSE ROIN-294201)*
The GPS Receiver shall be selected from Ford approved vendors only. It shall provide the following features in it's chipset (independent of smart/dumb delineation)

Support of a minimum of both GPS and GLONASS constellations. Galileo and Compass/Beidou must be supported when regulations require them.
Auto-ephemeris calculation for a minimum 24 hour period

Jamming Detection, with real time reporting and internal mitigation

2.1.1.3 *LOCATN-REQ-022428/A-GPS Chipset Tuning (TcSE ROIN-296599)*
GPS Chipset shall be tuned such that errant fixes (leading to position flyways) after periods of poor reception will not occur. All GPS chipset settings shall be reviewed with both Ford and the Chipset vendor prior to implementation.

2.1.1.4 *LOCATN-REQ-022429/C-GPS Fixes (TcSE ROIN-296600)*
Any fix with less than 4 satellites and/or lacking a 3D fix designation shall default to the use of the Dead Reckoning engine.

Note: This requirement is for SYNC only.

2.2 LOCATN-FUN-REQ-022430/A-Position (TcSE ROIN-292763)

2.2.1 Requirements

2.2.1.1 LOCATN-REQ-022431/C-Position Accuracy (TcSE ROIN-294206)

Positioning shall always be accurate.

System accuracy shall be calculated via the following method:
A drive cycle of 500 hours consisting of 50% Urban Canyon, 30% Open Sky and 20% Dense Foliage shall be driven with data collected.
A high resolution ground truth (RTK or PPP based) system shall be utilized and recorded with the same time domain (UTC Seconds, and publishing at the same epoch integer)
Each point shall be measured relative to each other and a distance calculated
An analysis shall be performed on the dataset such that a 98% confidence value (largest distance in achieving 98% of the points in 2 Dimensions).

System performance shall be:
High resolution (>100hz) Acceleromoter+Gyro+Wheel Ticks 10m or less
Low resolution (<20hz) Acceleromoter+Gyro+Wheel Ticks 13m or less
Differential Wheel Ticks (4 wheel input) 15m or less

Pure Open Sky performance shall be 1.5m for all solutions

The following edge cases must be verified to work error free:
- Slight bi-furcation deviation in a tunnel (if a map is available for map-match)

- Exiting Parking Garage (valet at Palmer House Chicago Example) (if a map is available for map-match)
- Multi-leveled roads (Upper/lower/Service level Wacker Dr in Chicago / Randolph st in Chicago) (if a map is available for map-match)
- Parking Lot / Off road handling (if a map is available for map-match)
- Express lane vs Service drive vs freeway (if a map is available for map-match)
- Startup in dense foliage (after 24 hour soak – autoephemeris expired)
- Startup in Complicated Airport Parking deck (after 24 hour soak – autoepemeris expired)
- US/Canada Tunnel in Detroit/Windsor (if a map is available for map-match)
- Multipath Mitigation (Downtown Chicago Test Route)
- Big Dig in Boston (if a map is available for map-match)

2.2.1.2   LOCATN-REQ-283027/A-Reference Coordinate System

Localization engine shall provide a solution based on Center point of vehicle at ground altitude. Appropriate transformations shall be applied such that the solution matches that for each vehicle variant. This shall be verified in clear sky conditions with a high resolution GNSS system as ground truth.

Figure 21 - BSM position reference
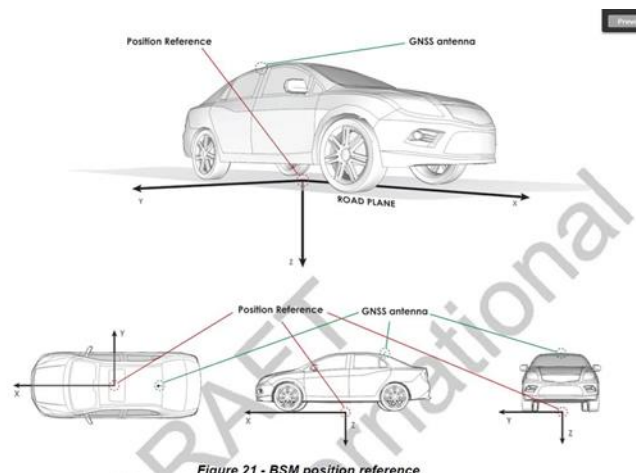
2.2.2 Use Cases

2.2.2.1 LOCATN-UC-REQ-022432/C-Driving on Road – Clear Sky (TcSE ROIN-292579)

Actors	Vehicle Occupant
Pre-conditions	The current location is available. A navigation route is not active.
Scenario Description	The customer is driving on a road.
Post-conditions	The current location is correctly identified (position of vehicle on road). The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus if the ECU is the localization master. The position is provided for internal consumption.
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – Sensor Reset – Wheel Tick Issue E4 – WIFI Fault (if licensed by Ford) E5 – WIFI Positioning Data Not Available (if licensed by Ford)
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal IMU) Wheel Ticks (via Vehicle Data bus)

2.2.2.2 LOCATN-UC-REQ-022433/D-GPS Fault – Antenna Issue (TcSE ROIN-292580)

Linked Elements
LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)
LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)
LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)
LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)
LOCATN-UC-REQ-022432/C-Driving on Road – Clear Sky (TcSE ROIN-292579)

Actors	Host Vehicle
Pre-conditions	Same as Normal Usage Use Case
Scenario Description	An RF Path failure
Post-conditions	No map will be displayed by the infotainment system (if equipped AND if HMI is in agreement with this requirement). The last know position is broadcast on the vehicle data bus with relevant quality factors set (localization master). The last know position is provided for internal consumption (localization master) and an internal failure flag is set. An error message is displayed to the customer (if HMI is in agreement with this requirement – if consumption of data is limited only to V2V features, this is covered by the V2V malfunction warning). A vehicle Diagnostic Trouble Code (DTC) is set. For SYNC, DTCs are 919F13 (B119F-13) and 919F01 (B119F-01), see Reference [3]. For TCU, DTCs are 0x919F11 (B119F-11) and 0x919F13 (B119F-13) see references [4, 5]
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.2.2.3   LOCATN-UC-REQ-022434/C-Sensor Fault – Gyro / Wheel Tick Issue (TcSE ROIN-292581)

Linked Elements
LOCATN-UC-REQ-022432/C-Driving on Road – Clear Sky (TcSE ROIN-292579)
LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)
LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)
LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)
LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)

Actors	Host Vehicle
Pre-conditions	Same as Normal Usage Use Case
Scenario Description	The customer is driving on a road and there is a sensor malfunction or sensor data is not received via vehicle data bus.
Post-conditions	See the following requirements for specific behaviors LOCATN-REQ-022459/B-Wheel Tick Failure(TcSE ROIN-294197) LOCATN-REQ-022462/A-3D Gyro/Accelerometer Failure(TcSE ROIN-294200) Degraded location performance
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.2.2.4   LOCATN-UC-REQ-022435/B-Sensor Reset – Wheel Tick Issue (TcSE ROIN-292582)

Linked Elements
LOCATN-UC-REQ-022432/C-Driving on Road – Clear Sky (TcSE ROIN-292579)

Actors	Vehicle Occupant
Pre-conditions	Same as Normal Usage Use Case
Scenario Description	The customer is driving on a road and the wheel tick sensor resets back to a zero count. (data is received via vehicle data bus)
Post-conditions	The ECU correctly identifies the reset and no noticeable position error is present.
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.2.2.5   LOCATN-UC-REQ-022436/C-WIFI Fault (TcSE ROIN-292583)

Linked Elements
LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)
LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)
LOCATN-UC-REQ-022432/C-Driving on Road – Clear Sky (TcSE ROIN-292579)
LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)
LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)

Actors	Vehicle Occupant
Pre-conditions	WIFI (if licensed by Ford) is unable to provide SSID data to the location core.
Scenario Description	WIFI assistance is not available for position enhancement.
Post-conditions	The vehicle position may be compromised. An error message may be displayed. A vehicle Diagnostic Trouble Code (DTC) is set. For SYNC, DTC is F00004 (U3000-04), see Reference [3]. For TCU, DTC is 0xDA4B52 (U1A4B-52) see references [4, 5]
List of Exception Use Cases	NA
Interfaces	G-HMI

2.2.2.6 LOCATN-UC-REQ-022437/C-WIFI Positioning Data Not Available (TcSE ROIN-292584)

Linked Elements
LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)
LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)
LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)
LOCATN-UC-REQ-022432/C-Driving on Road – Clear Sky (TcSE ROIN-292579)
LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)

Actors	Vehicle Occupant
Pre-conditions	Underlying Data for WIFI Positioning (if licensed by Ford) is not available.
Scenario Description	WIFI assistance is not available for position enhancement.
Post-conditions	The vehicle position may be compromised. An error message may be displayed. A vehicle Diagnostic Trouble Code (DTC) is set. For SYNC, DTC is F00004 (U3000-04), see Reference [3]. For TCU, DTC is 0xDA4B52 (U1A4B-52)see references [4, 5]
List of Exception Use Cases	NA
Interfaces	G-HMI

2.2.2.7 LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)

Actors	Vehicle Occupant
Pre-conditions	The current location is available. Navigation data is available. A navigation route is not active.
Scenario Description	The customer is driving on a road in an urban canyon.
Post-conditions	The current location is correctly identified (position of vehicle on road) by the ECU. The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus if the ECU is the Localization Master. The position is provided for internal consumption. The navigation application feeds back a map matched candidate to the localization engine (if equipped).
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – WIFI Fault (if licensed by Ford) E4 – WIFI Positioning Data Not Available (if licensed by Ford) E5 – Map Data Not Available E6 – Navigation Application is Not Running
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro) Wheel Ticks (via Vehicle Data bus)

2.2.2.8 LOCATN-UC-REQ-022439/B-Map Data Not Available (TcSE ROIN-292586)

Linked Elements
LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)
LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)
LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)
LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)

Actors	Vehicle Occupant
Pre-conditions	Same as Normal Usage Use Case
Scenario Description	The map data for the current vehicle market does not support the road the customer is driving on. Without a map (corresponding to current location), map matching is not possible.
Post-conditions	No map will be displayed by the infotainment system. The best location solution possible is output to the vehicle data bus.
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.2.2.9   LOCATN-UC-REQ-022440/B-Navigation Application is Not Running (If Equipped) (TcSE ROIN-292587)

Linked Elements
LOCATN-UC-REQ-022438/C-Driving on Road – Urban Canyon (TcSE ROIN-292585)
LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)
LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)
LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)

Actors	Vehicle Occupant
Pre-conditions	The navigation application is not running (if equipped).
Scenario Description	The customer is driving on a road without clear sky access (urban canyon, multi- level road, covered parking garage, etc.) while the navigation application is not running (for whatever reason). Without the navigation application running map matching is not possible.
Post-conditions	No map will be displayed by the infotainment system. The best location solution possible is output to the vehicle data bus.
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.2.2.10   LOCATN-UC-REQ-022441/C-Driving on Road – Multi-leveled Roads (TcSE ROIN-292588)

Actors	Vehicle Occupant
Pre-conditions	The current location is available. Navigation data is available (if equipped). A navigation route is not active.
Scenario Description	The customer is driving on a road with multiple levels (Example: Wacker Dr in Chicago – 3 levels).
Post-conditions	The current location is correctly identified by the ECU= including vehicle altitude. The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus if ECU is Location Master. The position is provided for internal consumption. The navigation application feeds back a map matched candidate for the location engine.
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – WIFI Fault (if licensed by Ford) E4 – WIFI Positioning Data Not Available (if licensed by Ford) E5 – Map Data Not Available E6 – Navigation Application is Not Running
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro)

	Wheel Ticks (via Vehicle Data bus)

2.2.2.11 LOCATN-UC-REQ-022442/C-Driving Off Road – Entering Parking Lot (TcSE ROIN-292589)

Actors	Host Vehicle
Pre-conditions	The current location is available. Navigation data is available (if equipped). A navigation route is not active (if equipped).
Scenario Description	The customer is driving off Road entering a parking Lot.
Post-conditions	The current location (position of vehicle off-road) is correctly identified by the ECU. The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus if the ECU is the Location Master. The position is provided to Navigation Application for Display (if equipped). The navigation application feeds back a map matched candidate for the location engine (if equipped). The position data is shared for internal consumption.
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – WIFI Fault (if licensed by Ford) E4 – WIFI Positioning Data Not Available (if licensed by Ford) E5 – Map Data Not Available (if equipped) E6 – Navigation Application is Not Running (if equipped)
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro) Wheel Ticks (via Vehicle Data bus)

2.2.2.12 LOCATN-UC-REQ-022443/C-Driving off Road – Exiting Underground Parking Lot (TcSE ROIN-292590)

Actors	Vehicle Occupant
Pre-conditions	The current location is available. Navigation data is available. A navigation route is not active.
Scenario Description	The customer is driving off Road exiting an underground Parking Lot (Example: Palmer House Hotel in Chicago).
Post-conditions	The current location (position of vehicle off-road) is correctly identified by the ECU. The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus if the ECU is the Location Master. The position is provided to Navigation Application for Display (if equipped). The navigation application feeds back a map matched candidate for the location engine (if equipped). Position data is shared for internal consumption.
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – WIFI Fault (if licensed by Ford) E4 – WIFI Positioning Data Not Available (if licensed by Ford) E5 – Map Data Not Available (if equipped)

	E6 – Navigation Application is Not Running (if equipped)
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro) Wheel Ticks (via Vehicle Data bus)

2.2.2.13 LOCATN-UC-REQ-091631/B-CAN Bus Wakeup (Generic)

Actors	ECU on CAN Bus
Pre-conditions	Prior location is stored
Scenario Description	Vehicle is sitting in a garage or other parking area. An ECU wakes up the CAN Bus
Post-conditions	The last known location is correctly identified (position of vehicle on road) by the ECU. The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus if the ECU is the Location Master. The data for the various location quality factors should be set to unknown and #of satellites should be 0. GPS_dimension should be 0 (no fix). The Correct (actual) UTC Date/Time is to be transmitted on the can bus. Once the Localization Engine is up and running, an updated location shall be published.
List of Exception Use Cases	E10 – Prior Location not stored
Interfaces	CAN Bus

2.2.2.14 LOCATN-UC-REQ-091639/B-CAN Bus Wakeup - Tracking Location Request

Actors	ECU on CAN Bus
Pre-conditions	Prior location stored
Scenario Description	Vehicle has been stolen. The consumer requests a vehicle location through the MyFordMobile app.
Post-conditions	The last known location is correctly identified (position of vehicle on road) by the ECU. If the ECU is the Location Master, for this function, the following applies: The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus. The data for the various location quality factors should be set to unknown and #of satellites should be 0. GPS_dimension should be 0 (no fix). The Correct (actual) UTC Date/Time is to be transmitted on the can bus until a location can be found from the GNSS Chipset At the same time, if in a multi-microcontroller solution (See APIM Gen3), the Vehicle facing microcontroller (VMCU) must power up the Consumer microcontroller (CCPU) with direction to not enable the display and not to boot the HMI. Only bring up location, get a quick GNSS fix, stay up for 30 seconds and then power down
List of Exception Use Cases	E10 – No Prior location stored
Interfaces	

2.2.2.15 LOCATN-UC-REQ-091657/C-Prior Location not Stored

Actors	Vehicle Occupant
Pre-conditions	Prior location is not stored in the system
Scenario Description	System has had a file system error or is in a virginal state and has no prior location data.
Post-conditions	If the ECU is the Location Master, System shall use the default location of Ford World Head Quarters in Dearborn, MI as the prior location For other GNSS ECUs (non Location Master) the post condition is application specific. Please consult application specific specification .
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.2.2.16 LOCATN-UC-REQ-091658/B-Startup – Customer sitting in vehicle

Actors	Vehicle Occupant
Pre-conditions	Customer is sitting in vehicle for an extended period with CAN bus off
Scenario Description	Given the pre-soak described in the above line, customer starts vehicle and drives off quickly
Post-conditions	Location engine initialized correctly
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – Sensor Reset – Wheel Tick Issue E4 – WIFI Fault (if licensed by Ford) E5 – WIFI Positioning Data Not Available (if licensed by Ford)
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro) Wheel Ticks (via Vehicle Data bus)

2.2.2.17 LOCATN-UC-REQ-091659/B-Startup – Customer sitting in vehicle rolling start

Actors	Vehicle Occupant
Pre-conditions	Customer is in vehicle for an extended period (With can bus off) Vehicle is a manual Transmission
Scenario Description	Customer starts vehicle via popping the clutch and leaves very quickly
Post-conditions	Location engine initializes correctly
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – Sensor Reset – Wheel Tick Issue E4 – WIFI Fault (if licensed by Ford) E5 – WIFI Positioning Data Not Available (if licensed by Ford)
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro) Wheel Ticks (via Vehicle Data bus)

2.2.2.18 LOCATN-UC-REQ-091701/B-Battery Removal

Actors	Vehicle Operator or Dealership
Pre-conditions	Battery Disconnected (or module unplugged)
Scenario Description	Given a standard repair cycle to the vehicle (after reconnection of Battery or ECU), system shall initialize with last known data from prior key cycle (if available)
Post-conditions	The last known location is correctly identified (position of vehicle on road) by the ECU. The position data (Lat/Long/Heading/ Satellite constellation information /etc) is output on the vehicle data bus if the ECU is the Location Master for the vehicle. The data for the various location quality factors should be set to unknown and #of satellites should be 0. GPS_dimension should be 0 (no fix). The Correct (actual) UTC Date/Time is to be transmitted on the can bus. Once a new location solution is available it is published via the various interfaces
List of Exception Use Cases	EX (11) No Prior Location stored in system
Interfaces	

2.2.2.19 LOCATN-UC-REQ-094992/B-Startup - Boot with Vehicle in Motion

Actors	Vehicle Occupant
Pre-conditions	Vehicle is in motion
Scenario Description	Either 1) System reboots due to crash (or key cycle) 2) System boot is after vehicle is in motion
Post-conditions	1. Center map on last known position (NO GPS Icon is illuminated) (if equipped) 2. Wait for a 3D Fix 3. initialize location with that fix 4. If wheels are spinning at this time, wait for a standstill to initialize the DR engine –or- use prior saved calibration data (if available) Lack of map movement will be considered acceptable until a 3D fix is achieved (if equipped)
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue E2 – Sensor Fault – Gyro / Wheel Tick Issue E3 – Sensor Reset – Wheel Tick Issue E4 – WIFI Fault (if licensed by Ford) E5 – WIFI Positioning Data Not Available (if licensed by Ford)
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro) Wheel Ticks (via Vehicle Data bus)

2.2.2.20 LOCATN-UC-REQ-094994/B-Startup – System Crashes / Watchdog Forces Reboot

Actors	Vehicle Occupant
Pre-conditions	Vehicle is in motion
Scenario Description	Either 1) System reboots due to crash 2) System watchdog forces an immediate reboot

Post-conditions	Location engine state and calibration information is saved
List of Exception Use Cases	E1 – GPS Fault – Antenna Issue
	E2 – Sensor Fault – Gyro / Wheel Tick Issue
	E3 – Sensor Reset – Wheel Tick Issue
	E4 – WIFI Fault (if licensed by Ford)
	E5 – WIFI Positioning Data Not Available (if licensed by Ford)
Interfaces	G-HMI (IF EQUIPPED)
	Sensors (Internal Gyro)
	Wheel Ticks (via Vehicle Data bus)

2.3 LOCATN-FUN-REQ-022444/A-Data Logging (TcSE ROIN-294214)

2.3.1 Requirements

2.3.1.1 *LOCATN-REQ-022445/A-Logging (TcSE ROIN-294204)*

There shall be 2 logging modes. The first shall be active at all times and logged into stdout (devlog). Contents shall support the following stdout messages.

Location: RAW GPS [Lat, Long, Heading, Altitude], Display Candidate [Lat, Long, Heading, Altitude, last Feature ID], DR Candidate [Lat, Long, Heading, Altitude]
Sensor [Gyro]: Sample rate xx Hz, Current Bias X,Y,Z, Calibration Status, FAULT State
Sensor [Accelerometer]: Sample rate xx Hz, Current Bias X,Y,Z, Calibration Status, FAULT State
Sensor [Wheel Ticks]: Sample rate xx Hz,Ticks per Meter xx, Calibration Status, FAULT State
Location Loop Timing Blockage > 200ms xxx ms blocked
Calibration Status shall be:
      Not Calibrated
      Coarse Calibration
      Fine Calibration
Fault State shall be:
      Faulted
      Not Faulted

The second method will log all inputs to the location engine to the internal (or external) filesystem given logging mode enabled.

2.3.2 Use Cases

2.3.2.1 *LOCATN-UC-REQ-022446/B-Data Logging (TcSE ROIN-292591)*

Actors	Development Engineer
Pre-conditions	The current location is available. Navigation data is available. (if equipped) A navigation route is or is not active. (if equipped) A USB stick may/may not be inserted. Logging mode is engaged.
Scenario Description	The development engineer enters logging mode, which enables logging of all raw sensor data (inputs into the Location engine) to allow for fault case reproduction / regression testing. If a USB stick is inserted, logging is to USB stick. (if equipped) Otherwise, logging is into internal file system (with a method to extract).
Post-conditions	A data logging file is saved to the USB stick or internal file system.
List of Exception Use Cases	E1 – Data Logging File System Full
	E2 – Data Logging File System Not Writeable

Interfaces	G-HMI (If Equipped)
	Sensors (Internal Gyro)
	Wheel Ticks (via Vehicle Data bus)
	WIFI
	RAW GPS Data
	File System

2.3.2.2   LOCATN-UC-REQ-022447/B-Data Logging File System Full (TcSE ROIN-292592)

Linked Elements
LOCATN-UC-REQ-022446/B-Data Logging (TcSE ROIN-292591)

Actors	Development Engineer
Pre-conditions	Same as normal usage use case.
Scenario Description	The development engineer enters logging mode while the file system in which the Location application logs data is full.
Post-conditions	The ECU removes the oldest log data (FIFO behavior) as needed.
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.3.2.3   LOCATN-UC-REQ-022448/B-Data Logging File System Not Writeable (TcSE ROIN-292593)

Linked Elements
LOCATN-UC-REQ-022446/B-Data Logging (TcSE ROIN-292591)

Actors	Development Engineer
Pre-conditions	Same as normal usage use case.
Scenario Description	The development engineer enters logging mode while the file system in which the Location application logs data is not writeable.
Post-conditions	ECU provides a notification to the user that logging is not possible.
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.4   LOCATN-FUN-REQ-022449/A-Data Playback (TcSE ROIN-294209)

2.4.1   Requirements

2.4.1.1   LOCATN-REQ-022450/E-Playback (TcSE ROIN-294174)

Data from Logging shall be usable to playback as inputs into location engine (with a shunting of external/internal inputs). Input file shall be accessible from external storage. Playback function shall have a clean failover behavior when usb stick (if equipped) is removed. Playback function shall play multiple files in alphabetic order. Playback function shall restart the playback from the beginning if the media is removed and replaced. Configuration shall be utilized from the playback file for initialization of the location engine.

2.4.1.2   LOCATN-REQ-022451/D-Shunting (TcSE ROIN-294175)

- Applicable to Host-Micro Localization Engines, not 'Smart Chip' architecture: The Location engine shall allow the selectable shunting of various inputs to allow for playback.

- Selectable inputs shall be: GPS Data,Wifi Data (if licensed by Ford), Vehicle data {Powermode, reverse indication, wheel ticks, vehicle speed}, Gyro/accelerometer Data
- Date/Time shunting shall allow adjusting system clock (date/time) to a new start time (any valid date/time) separated from the GPS data. This will allow time (and/or date) restricted road / speed limit validation

- When shunting is active there will be no GPS time syncing with the master clock time as GPS data is in test mode.

- During playback, any velocity feeds to other functions in the system shall utilize the playback data in place of real time velocity data

2.4.2 Use Cases

2.4.2.1 LOCATN-UC-REQ-022452/B-Navigation Data Playback (TcSE ROIN-292594)

Actors	Development Engineer
Pre-conditions	Playback Sensor Data is available. Navigation data is available. A navigation route is or is not active. Playback mode is engaged.
Scenario Description	The development engineer enters playback mode, which enables playback of all raw sensor data (inputs into location engine) to allow for fault case reproduction / regression testing.
Post-conditions	Internal Sensor data is shunted (and replaced with playback data).
List of Exception Use Cases	E1 – Data Playback File Corrupt
Interfaces	G-HMI (IF EQUIPPED) Sensors (Internal Gyro) Wheel Ticks (via Vehicle Data bus) WIFI RAW GPS Data Filesystem

2.4.2.2 LOCATN-UC-REQ-022453/B-Data Playback File Corrupt (TcSE ROIN-292595)

Linked Elements
LOCATN-UC-REQ-022452/B-Navigation Data Playback (TcSE ROIN-292594)

Actors	Development Engineer
Pre-conditions	Same as normal usage use case.
Scenario Description	The development engineer enters playback mode but the file selected for navigation data playback is corrupt.
Post-conditions	ECU provides a notification to the user that navigation data playback is not possible from the selected file.
List of Exception Use Cases	NA
Interfaces	G-HMI (IF EQUIPPED)

2.5 LOCATN-FUN-REQ-022454/A-Sensor Inputs (TcSE ROIN-294213)

2.5.1 Requirements

2.5.1.1 LOCATN-REQ-022455/A-Wheel Ticks (TcSE ROIN-294193)

Wheel Tick performance is documented in AN-0234.

2.5.1.2 LOCATN-REQ-022456/A-Wheel Tick Initialization (TcSE ROIN-294194)

System shall use rear left wheel (non-driven) as first wheel tick input. Prior ignition cycle calibration to be maintained

2.5.1.3   LOCATN-REQ-022457/C-Wheel Tick Calibration (TcSE ROIN-294195)

Location service shall calibrate the distance per tick ratio within 5 miles of open sky driving. Location service will have a default ratio of 0.0762 per tick. This value must be maintained from key cycle to key cycle and not be lost on battery removal. System shall detect tire size changes and shall replace calibration values automatically. This may be superseded by limitations of the chosen location engine and performance must be agreed to by Ford

2.5.1.4   LOCATN-REQ-022458/A-Wheel Tick Counter Resets (TcSE ROIN-294196)

Location service shall be resilient to resets of the wheel tick signal. If a tick to tick delta greater than 8 m/s^2 is observed it shall be considered a reset. Monitoring Ignition status transitions might help mitigate some resets.

2.5.1.5   LOCATN-REQ-022459/D-Wheel Tick Failure (TcSE ROIN-294197)

Location service will utilize the fault state of a given wheel's direction (if available upon the can bus in signal WhlDiryx_D_Actl). A fault is determined if the aforementioned signals has a state of **Failed (0x3)**
Wheel Fallback strategy should follow:
Undriven Left (see configuration Drive_Type to determine)
Undriven Right
Driven Left
Driven Right
If all 4 sensors are faulted, the limp mode Popup message and GPS Failsafe mode shall be engaged as required by the application specific implementation of HMI – please reference application specific requirements. A DTC IS REQUIRED. At the next key cycle, the fault state shall be reset and Undriven Left Wheel is utilized as the monitored wheel.

If location engine is axle based (average of both wheels on an axle), then if one sensor fails, move to the driven axle (as the initial axle is undriven). If failures occur on one wheel of each axle, then behavior is to be implemented based on the strategy of the location supplier. If all wheels are failed, fall back to non-Dead reckoned as specified above.

2.5.1.6   LOCATN-REQ-022460/C-3D Gyro/Accelerometer Initialization (TcSE ROIN-294198)

Gyro/Accelerometer shall re-zero upon every ignition cycle. In order to support a clean calibration, 4 seconds of sensor data shall be samples prior to the vehicle moving.

2.5.1.7   LOCATN-REQ-022461/C-3D Gyro/Accelerometer Calibration (TcSE ROIN-294199)

Location service shall calibrate the bias of the gyro and accelerometers within 5 miles of open sky driving. These values must be maintained from key cycle to key cycle and not be lost on battery removal. Temperature compensation algorithms are expected. This may be superseded by limitations of the chosen location engine and performance must be agreed to by Ford.

2.5.1.8   LOCATN-REQ-022462/C-3D Gyro/Accelerometer Failure (TcSE ROIN-294200)

If the Internal Gyro fails, then the system shall set the appropriate DTC and then fallback into differential wheel tick Dead Reckoning mode. For SYNC, DTC is F00009 (U3000-09), see reference [3]. For TCU, DTC is 0x406A00 (C006A-00), see references [4, 5].

2.5.1.9   LOCATN-REQ-022463/C-GPS Receiver Failure (TcSE ROIN-294202)

If the GPS Receiver fails, then the system shall notify the user and set the appropriate DTC. For SYNC, DTC is F00004 (U3000-04), see reference [3].

2.5.1.10   LOCATN-REQ-022464/C-WIFI (TcSE ROIN-294203)

WIFI data (SSID and signal strength) shall be used as inputs into a third party WIFI positioning engine and utilized as a feedback into the location engine for position augmentation (if licensed by Ford).

2.5.1.11   LOCATN-REQ-289991/B-WRTX/RKX/PPP

Localization correction shall be provided by cellular (or other) interfaces and utilized by the localization engine in order to improve the solution (if licensed)

2.6 LOCATN-FUN-REQ-022465/A-System Inputs (TcSE ROIN-294212)

2.6.1 Requirements

2.6.1.1 *LOCATN-REQ-022466/A-Powermode (TcSE ROIN-294187)*
Powermode shall be utilized from the can bus to assist in the debounce of wheel tick resets

2.6.1.2 *LOCATN-REQ-022467/A-Reverse Indication (TcSE ROIN-294188)*
Reverse indication shall be provided to the location engine

2.6.1.3 *LOCATN-REQ-022468/C-Navigation Map Matched Position Feedback (TcSE ROIN-294189)*
Location engine shall provide a methodology to allow the navigation application (if equipped) to provide a map matched location (system timestamp representing which fix the map match is against, lat,long,altitude, heading) to be used as part of fusion solution. Confidence values for the lat/long and heading (separate values) should be provided to tell the location engine how confident the match is. Additionally, right hand drive market indication, one way road, lane width and number of lanes must also be provided in order to prevent a center line map match pulling location over from the far right lane into the left lane. Additional items that could be provided include:
Distance to last bi-furcation, Route Active flag, and Altitude,

2.6.1.4 *LOCATN-REQ-022469/A-Camera Detected lane (TcSE ROIN-294190)*
If available, camera based lane recognition data shall be provided to location/navigation engine to offer lane level guidance

2.6.1.5 *LOCATN-REQ-022470/A-Steering Wheel Angle (TcSE ROIN-294191)*
If available, steering wheel angle shall be fed into the location engine to augment turn detection

2.6.1.6 *Can Bus Internal Interface Requirements*
Can Bus Internal Interface Requirements.

2.6.1.6.1 LOCATN-REQ-091661/B-Timestamping
CAN data (as applicable) shall be time stamped upon receipt and fed to the location engine. The timestamping shall have no jitter greater than 10% of the delta time between updates of that signal.

2.6.1.6.2 LOCATN-REQ-091662/B-DataLoss Mitigation
CAN Bus interface will be verified to never drop data. This testing shall be done under worst case system load.

2.6.1.6.3 LOCATN-REQ-091663/A-Data Over Buffering
CAN Bus interface will insure that spacing between consecutive messages is representative of the actual inputs. If typical seperation is 20ms, having 1ms between messages is unacceptable.

2.7 LOCATN-FUN-REQ-022475/A-Configuration Parameters (TcSE ROIN-304495)

2.7.1 Requirements

2.7.1.1 *LOCATN-REQ-022476/D-Configuration (TcSE ROIN-304494)*
The system shall obtain the following configuration from the ECU end of line configuration as specified in the Infotainment Diagnostic Specification (IDS).

Parameter	Units	Usage
Install angle of Apim for Accelerometer (X)	0 -> 393.21 degrees	Needed for quicker calibration of sensors
Install angle of Apim for Accelerometer (Y)	0 -> 393.21 degrees	Needed for quicker calibration of sensors
Install angle of Apim for Accelerometer (Z)	0 -> 393.21 degrees	Needed for quicker calibration of sensors
Wheel ticks to revolution front	40->100	Needed for quicker calibration of sensors
Wheel ticks to revolution rear	40->100	Needed for quicker calibration of sensors
Tire Circumference as built	100 -> 455 cm	Needed for quicker calibration of sensors
distance from IP to rear axle	100 -> 65735 cm	Needed for quicker calibration of sensors
Antenna Type	Harada; Laird (0-255 table)	Used for Tuning GNSS Driver to the patch's unique pattern
Front Track	0->655.35 inches	Needed for quicker calibration of sensors
Rear Track	0->655.35 inches	Needed for quicker calibration of sensors
Wheel Base	0->655.35 inches	Needed for quicker calibration of sensors
Drive_Type	00 – FWD 01 – RWD 02 – AWD 03 – 4WD 04 – Dually 2WD 05 – Dually 4WD 06-FF - Reserved	This is used for selecting which wheel to use as primary for dead reckoning If FWD, send rear left If RWD, send front left if AWD or 4wd send front left 04 or 05 = RWD, so send front left if 06-FF send front left
Time Seperation between wheel tick messages	0x00 – 20ms 0x01 – 30ms 0x02 – 40ms 0x03 – 50ms 0x04 – 60ms 0x05 – 70ms 0x06 – 80ms 0x07 - Reserved	Vehicle specific timing for periodicity of wheel tick messages (work around for non-realtime/timestamped wheel ticks from Can interface)

2.7.1.2   *LOCATN-REQ-318210/A-Auto Configuration for Determining Message Set to Read*

On bus wake up the potential Location Service modules will send their respective messages 45E and 21E once and the value will be defaulted to zero. Once the module that is providing the actual data starts writing to the signal the value will no longer be zero. The module that is not providing the actual data will no longer send the message on the bus after the initial messsage is sent.

The client will initially receive messages 0x45E and 0x21E on bus wake up (initialization) due to the Network initialization attribute being set to Yes. The client shall monitor bits 4 through 7 of each message as they contain the Message Type parameter which will be used for auto configuration within the client. When the Message Type is equal to 0x2 (Location2) the client shall use the CAN ID that transmitted the 0x2 as the Location Services data provider.

For FNV2 architecture the LocationServiceLegacy_Tx interfaces (0x465, 0x466 and 0x467) will not be sent in all configurations. LocationService _Tx (45E or 21E) shall be used for all location data needs.

2.8 LOCATN-FUN-REQ-022471/A-Power State (TcSE ROIN-294210)

2.8.1 Requirements

2.8.1.1 *LOCATN-REQ-022472/B-Power State (TcSE ROIN-294176)*

The system is expected to start calculating location and populate it over CAN as soon as the bus wakes up. For SOA based communication, location information shall be sent as soon as SOA is available. Any vehicle movement shall be captured and reflected in the position solution.

2.9 LOCATN-FUN-REQ-022473/A-Performance (TcSE ROIN-294211)

2.9.1 Requirements

2.9.1.1 *LOCATN-REQ-022474/D-Performance (TcSE ROIN-294177)*

Localization engine shall meet experience requirements as follows:

If supporting Navigation functions the Location engine is required to publish a solution at 10hz to support smooth map rendering (if equipped). The Navigation supplier and Tier 1 system supplier may require a higher solution rate and must be provided as part of an RFI process and added to the implementation guide for that product. Expectation is Rendering is at two times the location solution output rate.

If supporting Racing computer applications, a 10hz minimum rate is expected

Location master ECU shall provide Can bus output of position shall be at 1hz (or as specified by dbc) .

Logging shall be at 1hz or a specified rate

2.10 LOCATN-FUN-REQ-022477/A-Diagnostics (TcSE ROIN-304498)

2.10.1 Requirements

#### 2.10.1.1 *LOCATN-REQ-022478/D-Diagnostics (TcSE ROIN-304497)*

Localization engine shall provide a method to perform functions below (via external interfaces if not via HMI).

If equipped, System HMI shall provide the following widgets via Bezel Diagnostics and via external tools (with a 1hz update rate).
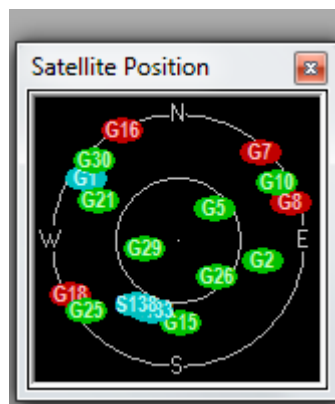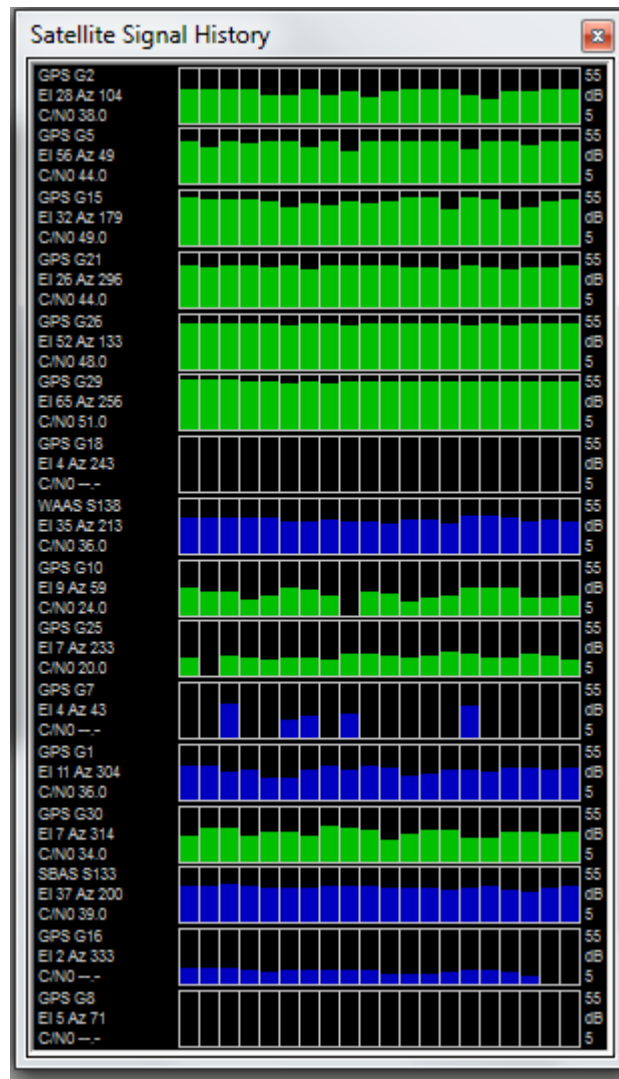
This shows the distribution of satellites around the vehicle. Inner Circle represents directly above vehicle to 45 degrees down, out circle represents +/- 45 degrees to horizon
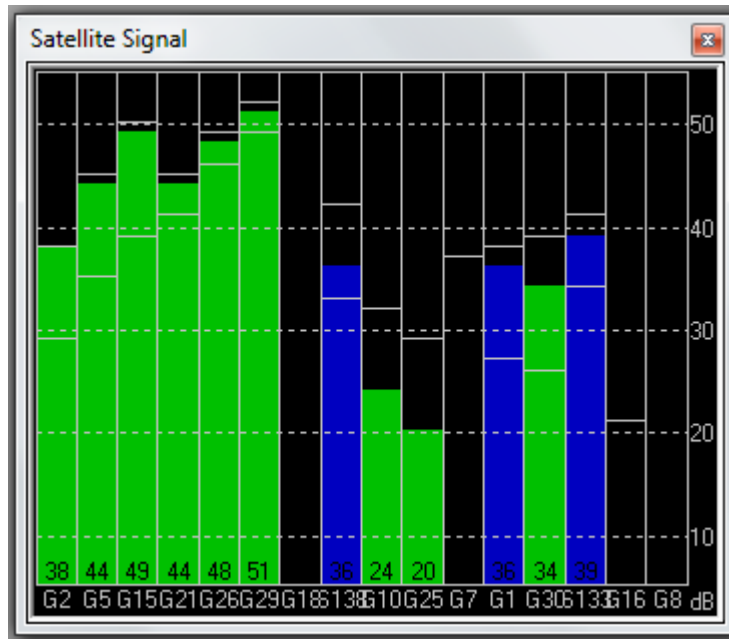
This shows real time satellite constellation status and CNO Levels

Satellite Signal History

This widget shows the data from above widget, but over time. With last 30 seconds displayed as a histogram. If 30 seconds not available start with 1 second of data.

Final Widget provides textual data for the following data elements:

Lat/Long/Heading/Altitude/Hdop/Pdop/Vdop/2d Accuracy/3d Accuracy/Vehicle speed/number of satellites (used in solution/seen [which may/may not be used in solution])
Fix Mode/Time To First Fix/Jamming Active/AGC level/Noise Level/Sensor Calibration Status [Wheels/Gyro]/UTC Date/UTC Time/
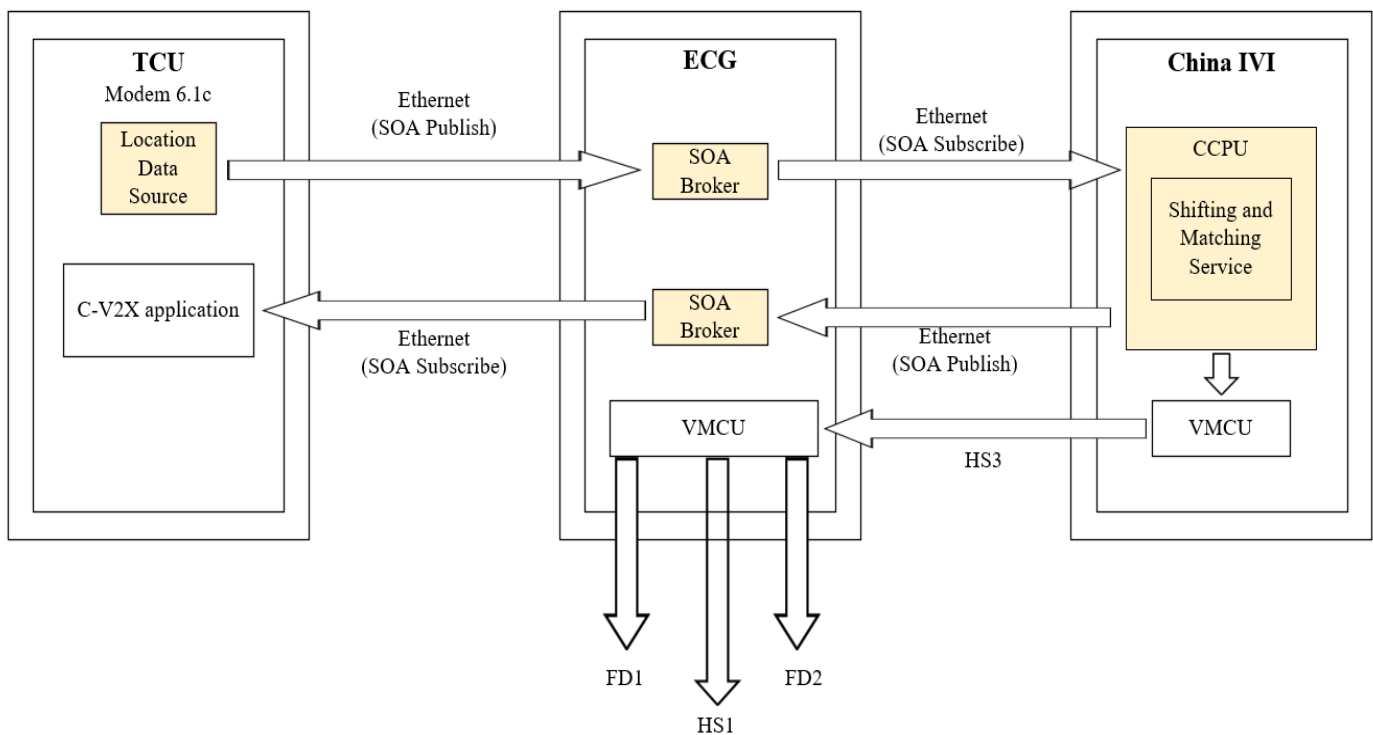
2.11 LOCATN-FUN-REQ-393773/A-Unified GNSS

2.11.1 Requirements

2.11.1.1 *LOCATN-REQ-393774/B-Architecture*
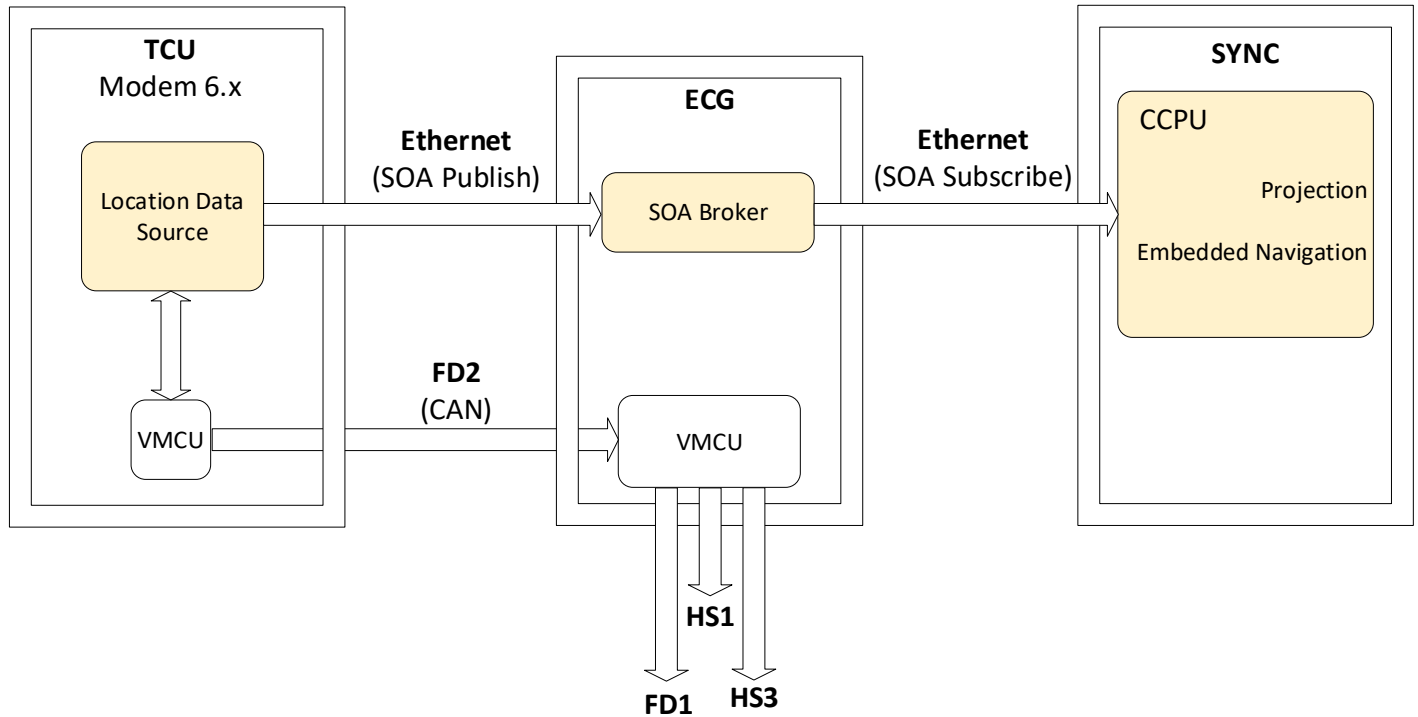
2.11.1.2 *LOCATN-REQ-436767/A-Architecture (China Only)*

2.11.1.3 LOCATN-REQ-393771/B-Transmission and Acquisition Rate for LocationData API

Sync 4.0 QNX:

Message	Acquisition Rate	Transmission Rate
LOCATION_DATA	10 Hz, every 100 ms	10 Hz, every 100 ms

Phoenix:

Message	Acquisition Rate	Transmission Rate
LOCATION_DATA	10 Hz, every 100 ms	10 Hz, every 100 ms

2.11.1.4 LOCATN-REQ-393772/B-Transmission and Acquisition Rate for SensorData API

Sync 4.0 QNX:

Message	Acquisition Rate	Transmission Rate
SENSOR_DATA	10 Hz, every 100 ms	10 Hz, every 100 ms

Phoenix:

Message	Acquisition Rate	Transmission Rate
SENSOR_DATA	200 Hz, every 5 ms	20 Hz, every 50 ms

2.11.1.5 LOCATN-REQ-412857/A-Transmission and Acquisition Rate for SatelliteDataBasic API

Sync 4.0 QNX:

Message	Acquisition Rate	Transmission Rate
SATELLITE_DATA_BASIC	1 Hz, every 1 sec	1 Hz, every 1 sec

Phoenix:

Message	Acquisition Rate	Transmission Rate
SATELLITE_DATA_BASIC	1 Hz, every 1 sec	1 Hz, every 1 sec

2.11.1.6 LOCATN-REQ-412858/A-Transmission and Acquisition Rate for SatelliteDataExtended API

Sync 4.0 QNX:

Message	Acquisition Rate	Transmission Rate
SATELLITE_DATA_EXTENDED	1 Hz, every 1 sec	1 Hz, every 1 sec

Phoenix:

Message	Acquisition Rate	Transmission Rate
SATELLITE_DATA_EXTENDED	1 Hz, every 1 sec	1 Hz, every 1 sec

2.11.1.7 LOCATN-REQ-412862/A-Establishing SOA - TCU

- Register SOA channels on ECG to publish location data.

2.11.1.8 LOCATN-REQ-412859/B-Location Data Messages

Location data messages to publish on SOA:

- Location_Data
- Sensor_Data
- Satellite_Data_Basic
- Satellite_Data_Extended
- NMEA Data

The message should be published whenever SOA is available.

2.11.1.9 *LOCATN-REQ-422244/C-NMEA Data Message*

The TCU shall send NMEA Data message once per second. (Note: Required for Phoenix and China market)

NMEA GGA (Required)
NMEA RMC (Required)
NMEA GNS (Optional)
NMEA GSA (Optional)

2.11.1.10 *LOCATN-REQ-412863/B-Location Accuracy*

The accuracy of the location shall be 1.5 m in an open sky environment at 1 sigma (68% of the time).

2.11.1.11 *LOCATN-REQ-412864/B-CAN Bus Broadcast - TCU*

- Publish LocationServices_Data3 CAN message 21E on FD2 once every 1 sec for Non China market.
- The message should be published by the VMCU when CAN bus is up.

2.11.1.12 *LOCATN-REQ-412865/A-Cold Start Handling*

- Before going to power-off (after 14 days) store the latest location in a non-volatile memory.
- At cold start (after 14 days), publish the stored latest location data (by the VMCU) until an updated location is available from positioning engine.

2.11.1.13 *LOCATN-REQ-412860/A-Disconnecting Old System*

Disable the Map-Matching library feedback from SYNC. The Unified GNSS will not utilize map-matching feedback for location calculation.

2.11.1.14 *LOCATN-REQ-412861/A-Establishing SOA - Sync*

- Subscribe to the location data topic on SOA.
- Listen to the raw GNSS and sensors readings coming on SOA at 10 Hz and pass it to Projection for Android Auto

2.11.1.15 *LOCATN-REQ-412867/A-Support Different Location Sources*

SYNC must support location data input from the following sources: internal, CAN, or SOA (Configuration by a DID).

2.11.1.16 *LOCATN-REQ-412868/A-Detection of Missing Data*

Sync will detect when the data message is not received and generate a DTC accordingly.

Over CAN

DTC C19800 (U0198-00) please reference [3] for DTC trigger information

Over SOA

DTC E40092 (U2400-92) and E40081(U2400-81), please see reference [3] for DTC trigger information

2.11.1.17 LOCATN-REQ-422242/A-Cumulative Distance Reset at Ignition Off
Cumulative distance shall be set to 0 at ignition OFF.

2.11.1.18 LOCATN-REQ-422243/A-Cumulative Altitude Reset at Ignition Off
Cumulative altitude shall be set to 0 at ignition OFF.

2.11.1.19 LOCATN-REQ-436768/A-LocationDataShifted Message (China Only)
- China IVI module shall send LocationDataShifted whenever SOA is available.

- LocationDataShifted shall be sent at a rate of 10Hz.

2.11.1.20 LOCATN-REQ-436769/B-CAN Bus Broadcast - China IVI
- Publish LocationServices_Data1 CAN message $45E on HS3 once every 1 sec.

- The message should be published by the VMCU when CAN bus is up.

2.11.1.21 LOCATN-REQ-437839/A-Startup Handling - China IVI
- At ignition off, store the latest location in a non-volatile memory.
- Publish the stored latest location data (by the VMCU) until an updated location is available from positioning engine.

2.11.1.22 LOCATN-REQ-437840/A-Shifted Location Data Latency
The overall latency of shifted location data (including round-trip time and modules' internal processing time) shall be less than 50ms.

3   Appendix A: Reference Documents

Reference #	Document Title
1	Chicago GPS Drive Test 2013
2	WHEEL SPEED/DISTANCE/DIRECTION INFORMATION SHARING (AN-0234)
3	Infotainment Diagnostics Specification APIM Gen 4, Version 7.38.0
4	Continental (DSJX7T-14G087-AG)
5	Clarion (DS-GJ5T-14G087-AG) part 2 specifications

4 Appendix B: Features Requiring Location Data

Features Requiring Location Data

Module	Feature
Telematic Control Unit (TCU)	Stolen Vehicle Service (SVS)
	Emergency Embedded Call System (Ecall)
Bluetooth Low Energy Module (BLEM)	Phone as a Key (PaaK)
Anti-lock Braking System (ABS)	Vehicle Speed Accuracy Improvement (VSAI)
Advanced Driver Assistance System (ADAS)	Road Experience management (REM)
	Congestion Assist/Rural Road Assist (CA/RRA)
	Map Previewer and Localizer (MPL)
Headlamp Control Module (HCM)	Predictive Dynamic Bending Light (PDBL)
Hybrid Powertrain Control Module (HPCM)	-
Instrument Panel Cluster (IPC)	Compass
Augmented Reality (AR)	-
APIM	Projection
Enhanced Control Gateway (ECG)	ECG Apps
Off Board Charge Controller Module (OBCC)	-

5   Appendix C: CAN Messages Protocol Version

Protocol version	Message structure	updates
0	Location service APIM SPSS version 1.11	-
1	Location service APIM SPSS version 1.12	MD-REQ-051835/E-MetaDataTime Valid location message bit mask field added to the MetaData message
2	Location service APIM SPSS version 1.13	MD-REQ-051837/D-Location2 A new value was added to the Fix Type field |	Literals	Value
Fix Type	Last Known Location	0x6	