



Research & Vehicle Technology
“Infotainment Systems Product Development”

Feature – Location Service

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

Version 1.10

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Version Date: July 10, 2019

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	SPSS Updates
	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-MetaDateTime	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 clarify 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

SPSS Updates

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	SPSS Updates
	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 accidentally 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)	ktune20 - 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 ArblD for when message is sent from the TCU and clarified the ArblD 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 feature 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 receiving 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



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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/B-LocationServiceLegacy_Tx (TcSE ROIN-294359)

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

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](#).

1.2.1.1 MD-REQ-022482/B-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	

1.2.1.2 MD-REQ-022483/B-GPSBFault_St (TcSE ROIN-221027-1)

Message Type: Status

Status used to indicate a [GPS-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	

1.2.1.3 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	

1.2.1.4 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	0xFFFFE	
	Fault	0xFFFFF	

1.2.1.5 MD-REQ-022486/B-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 <u>WGS84GPS</u> Latitude Degrees information. Unit:Degrees Resolution:1 Offset:-89
	Degrees	0x0 To 0xB2	



	Unknown	0xFE	
	Invalid	0xFF	
LatitudeMinutes	-	-	Indicates the WGS84GPS Latitude Minutes information. Unit:Minutes Resolution:1 Offset:0
	Minutes	0x0 To 0x3B	
	Unknown	0x3E	
	Fault	0x3F	
LatitudeMinutesDecimal	-	-	Indicates the WGS84GPS Latitude Minutes Decimal information. Unit:Minutes Resolution:0.0001 Offset:0
	Minutes	0x0 To 0x270F	
	Unknown	0x3FFE	
	Invalid	0x3FFF	
HemisphereLongitudeEastern	-	-	Indicates the WGS84GPS Hemisphere Longitude Eastern information. Unit:SED Resolution:1 Offset:0
	Invalid	0x0	
	Eastern	0x1	
	Western	0x2	
	Fault	0x3	
HemisphereLatitudeSouthern	-	-	Indicates the WGS84GPS Hemisphere Latitude Southern information. Unit:SED Resolution:1 Offset:0
	Invalid	0x0	
	Southern	0x1	
	Northern	0x2	
	Fault	0x3	
LongitudeDegrees	-	-	Indicates the WGS84GPS Longitude Degrees information. Unit:Degrees Resolution:1 Offset:-179
	Degrees	0x0 To 0x166	
	Unknown	0x1FE	
	Fault	0x1FF	
LongitudeMinutes	-	-	Indicates the WGS84GPS Longitude Minutes information. Unit:Minutes Resolution:1 Offset:0
	Minutes	0x0 To 0x3B	
	Unknown	0x3E	
	Fault	0x3F	



LongitudeMinutesDecimal	-	-	Indicates the <u>WGS84GPS</u> Longitude Minutes Decimal information. Unit:Minutes Resolution:0.0001 Offset:0
	Minutes	0x0 To 0x270F	
	Unknown	0x3FFE	
	Invalid	0x3FFF	
MSLAltitude	-	-	Indicates the <u>WGS84GPS</u> MSL Altitude information. Unit:Feet Resolution:10 Offset:-20460
	Feet	0x0 To 0xFFC	
	Unknown	0xFFE	
	Fault	0xFFF	

1.2.1.6 MD-REQ-022487/C-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 <u>GPS Location Engine measured</u> Speed. Unit:MPH Resolution:1 Offset:0
	MPH	0x0 to 0xFD	
	Unknown	0xFE	
	Invalid	0xFF	

1.2.1.7 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	

1.2.1.8 MD-REQ-022489/B-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 engine. Indicates the current positional dilution of precision. Unit: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	

1.2.1.9 MD-REQ-022490/B-GPSSatNumInView_St (TcSE ROIN-294417)

Message Type: Status

Status used to indicate the number of [GPS-GNSS](#) satellites currently in [view](#)solution.

Name	Literals	Value	Description
Number	-	-	Indicates the number of GPS GNSS satellites in view <u>the solution</u> . 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/E-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 6 different messages:

1. Meta Data/Time
2. Location 1
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)
9. Location 5 (Map Match Feedback from embedded nav, if equipped)

Each of these 6 messages consists of several fields of data within the 8 byte blocks. The first field of data in every message is an 8 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 6 messages.



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

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.

message \$45F is only for Engineering development testing. It will not be active in production vehicles.

In addition,

LocationServices_3 is currently defined as ArbID 0x21E transmitted by TCU on HS4.

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

1.2.2.1 MD-REQ-051835/C-MetaDataTime

GNSS Message Type: Meta Data/Time

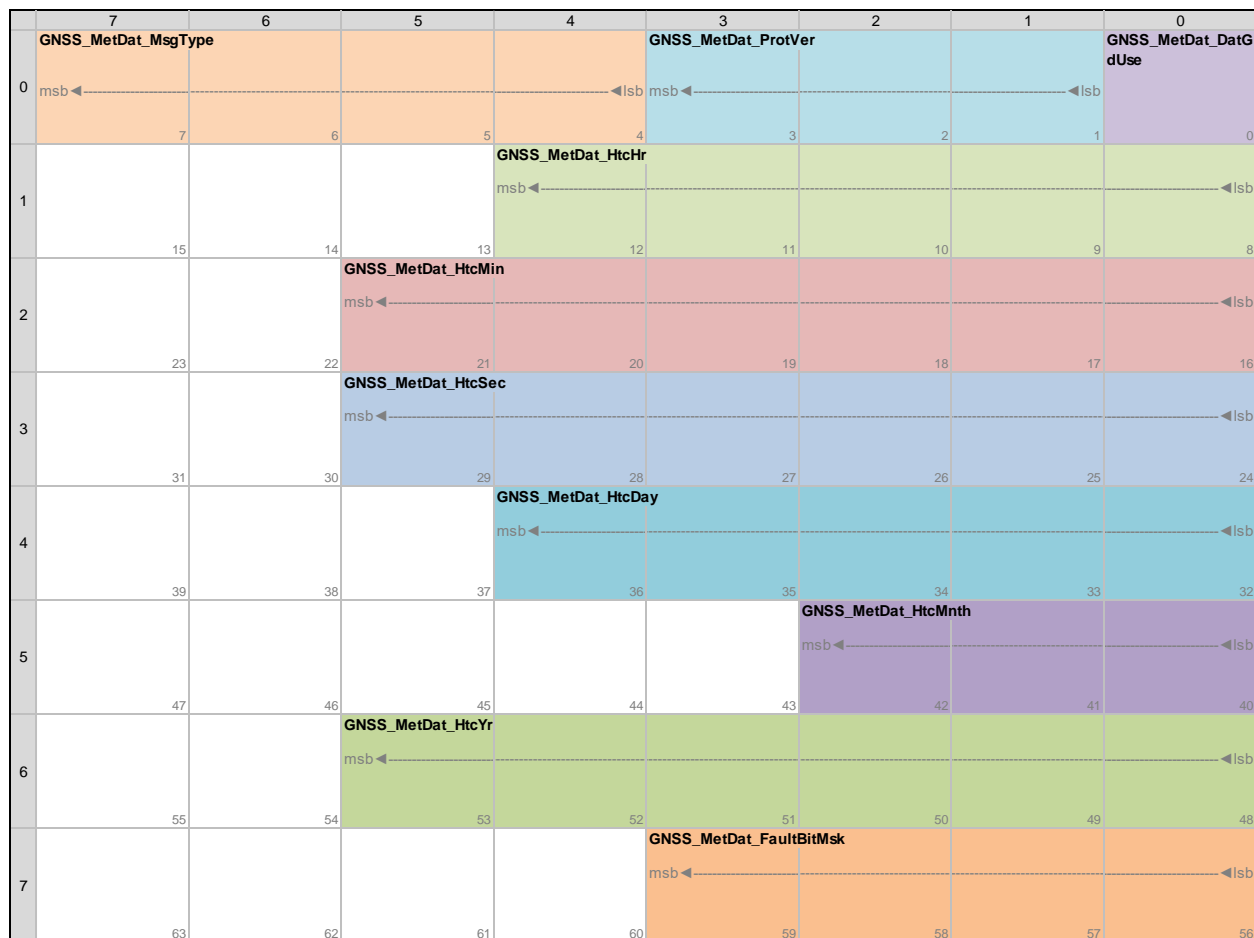
Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	0	MetaDataTime	0x0	See <i>Message Type Definition Table</i> .
Protocol Version	3	0 - 7	Version1	0x0	Any additional updates to the GNSS protocol will increment the protocol version. The Protocol Version data field will indicate which version is in use.
			Version2	0x1	
			
			Version8	0x7	
Data Good To Use	1	0 - 1	DataUnreliable	0x0	Indicates whether the data is reliable or not.
			DataReliable	0x1	
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	
			0	False	



		Bit3 (msb)	1	True	Indicates an Antenna fault where True = Fault Active.
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	

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/A-Location1

GNSS Message Type: Location 1

Data Field	Length (bits)	Value Range	Literals	Value	Description
------------	---------------	-------------	----------	-------	-------------

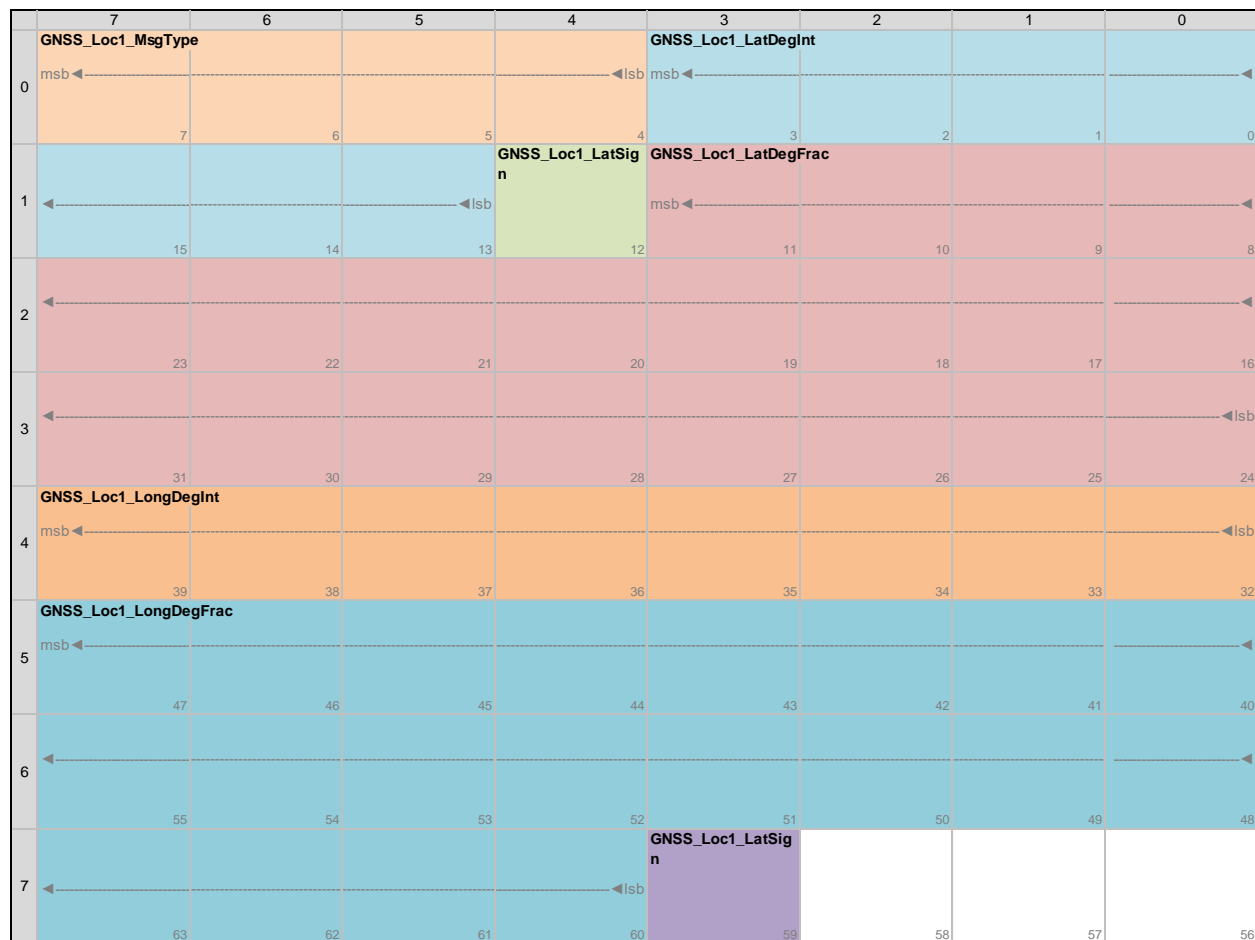


Message Type	4	1	Location1	0x1	See <i>Message Type Definition Table</i> .
Latitude Degrees Integer	7	0 - 89	0	0x00	Indicates the WGS84 Latitude integer portion in degrees.
			1	0x01	
			
			89	0x59	
Latitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the WGS84 Latitude Integer in degrees.
			Positive	0x1	
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	
			
			59	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 Longitude Integer in degrees.
			Positive	0x1	

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.

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



1.2.2.3 MD-REQ-051837/B-Location2

GNSS Message Type: Location 2

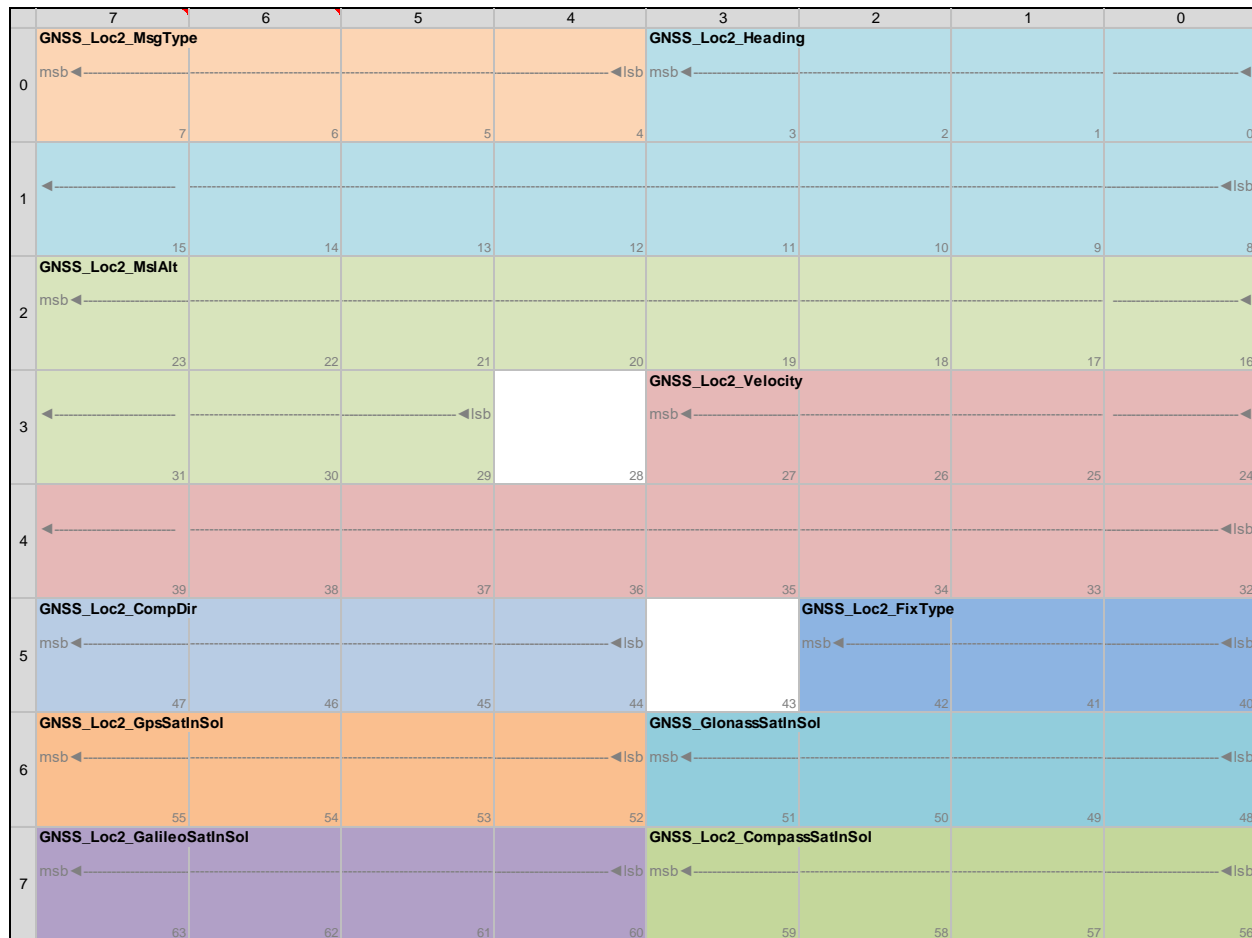
Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	2	Location2	0x2	See <i>Message Type Definition Table</i> .
Heading	12	0 – 359.9	0	0x000	Indicates the WGS84 Heading in degrees.
			0.1	0x001	
			
			359.9	0xE0F	
Mean Sea Level (MSL) Altitude	11	-1000 - 9000	-1000	0x000	Indicates the WGS84 altitude in meters.
			-995	0x001	
			
			-5	0x0C7	
			0	0x0C8	
			5	0x0C9	
			
			9000	0x7D0	
Velocity	12	0.1 - 409.5	0	0x000	Indicates the WGS84 velocity in kilometers per hour (kph).
			0.1	0x001	
			
			409.5	0xFFFF	
Compass Direction	4	N/A	Null (Unknown)	0x00	Indicates compass direction.



			North	0x01	
			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)	0xFF	
GLONASS Satellites In Solution	4	0 - 15	0	0x00	Indicates the number of GLONASS satellites in solution.
			1	0x01	
			
			15 (or more)	0xFF	
Galileo Satellites In Solution	4	0 - 15	0	0x00	Indicates the number of Galileo satellites in solution.
			1	0x01	
			
			15 (or more)	0xFF	
Compass Satellites In Solution	4	0 - 15	0	0x00	Indicates the number of Compass satellites in solution.
			1	0x01	
			
			15 (or more)	0xFF	
<u>Fix Type</u>	<u>3</u>	<u>N/A</u>	<u>Sensors</u> <u>Uncalibrated</u> <u>with no Fix</u> <u>(DR Off)</u>	<u>0x0</u>	<u>Indicates Fix type</u>
			<u>Sensors</u> <u>Calibrated</u> <u>with no Fix</u> <u>(DR On)</u>	<u>0x1</u>	
			<u>2D Fix</u>	<u>0x2</u>	
			<u>3D Fix (DR</u> <u>Uncalibrated)</u>	<u>0x3</u>	
			<u>3D Fix DR</u> <u>Blended (DR</u> <u>Calibrated)</u>	<u>0x4</u>	
			<u>3D Fix DR</u> <u>Blended w</u> <u>DGPS (DR</u> <u>Calibrated)</u>	<u>0x5</u>	

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

The physical bit/byte position layout of the Location²⁴ message is as follows:

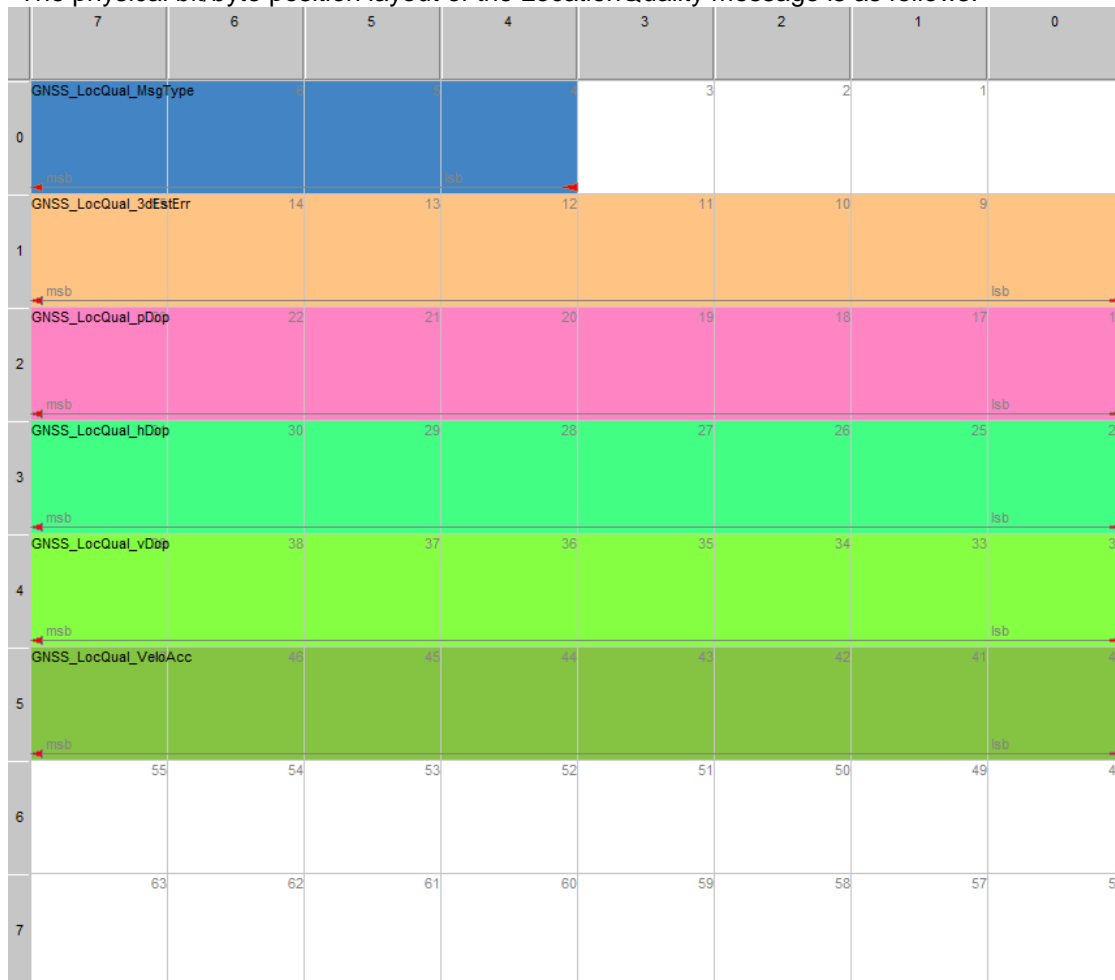




Speed accuracy approximation (VeloAcc)		0.00 – 2.54	0.01	0x01	Indicates the current speed accuracy approximation in m/s. Corresponding to Velocity. (see Location2)
			
			2.54	0xFE	
			Over 2.54 / not supported	0xFF	

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

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



1.2.2.5 MD-REQ-051839/B-SensorQuality

GNSS Message Type: Sensor Quality

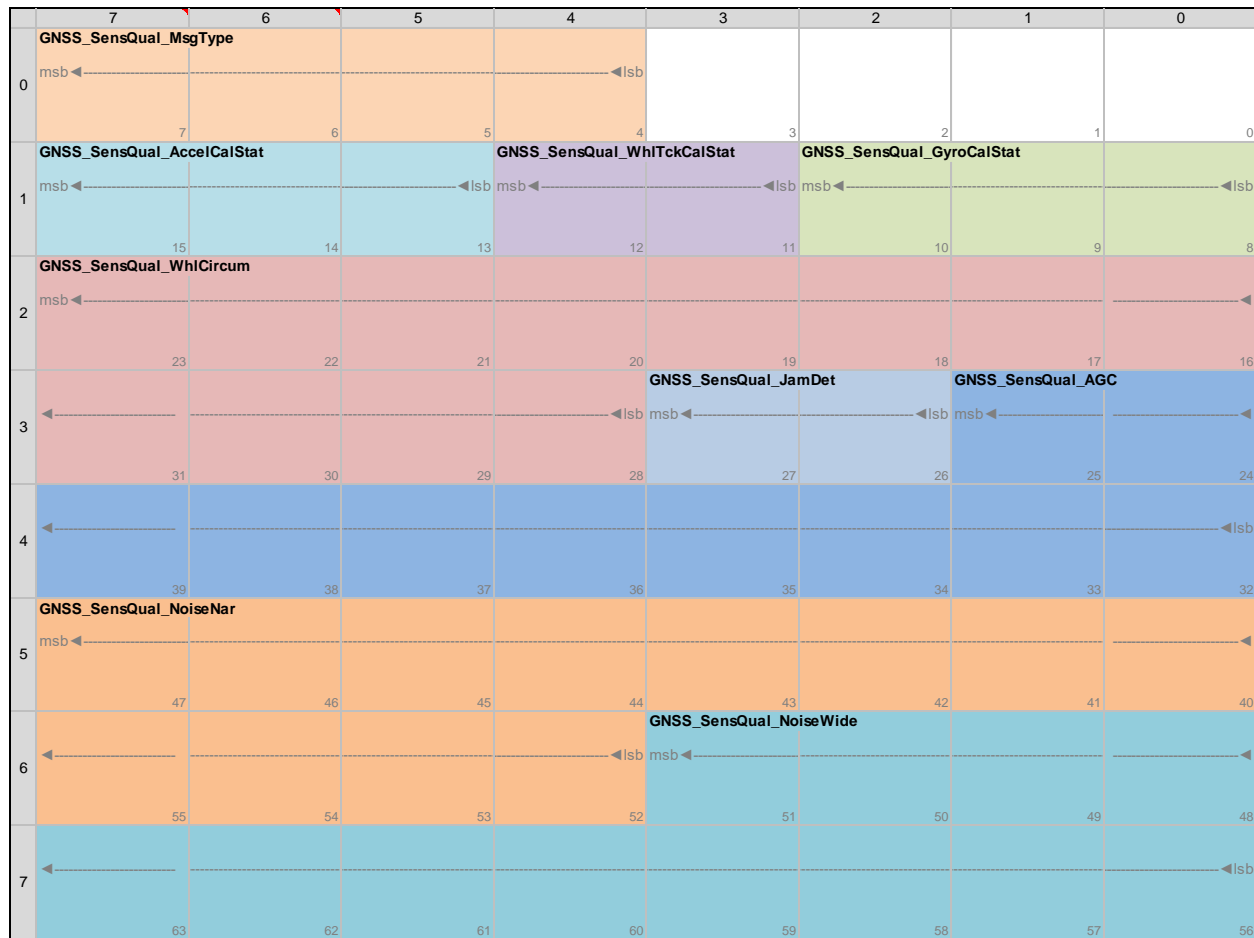
Note: All values outside the defined range above shall remain reserved.

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	4	SensorQuality	0x4	See <i>Message Type Definition Table</i> .
Accelerometer Calibration Status	3	N/A	NotCalibrated	0x0	
			RoughCal	0x1	Calibration in process
			GoodCal	0x2	Calibration in process



			Reserved	0x3 - 0x5	
			GyroNotPresent	0x6	
			CalFault	0x7	
Wheel Tick Calibration Status	2	N/A	NotCalibrated	0x00	Calibration Fault
			RoughCal	0x01	
			GoodCal	...	
			CalFault	0xFF	
Gyro Calibration Status	3	N/A	NotCalibrated	0x0	
			RoughCal	0x1	
			GoodCal	0x2	
			Reserved	0x3 - 0x5	
			GyroNotPresent	0x6	
Wheel Circumference	12	1000 - 5000	CalFault	0x7	Calibration Fault
			1000	0x000	
			1001	0x001	
			
Jamming Detection	2	Bit0 (lsb)	5000	0xFA0	Indicates the computed circumference of the wheel in millimeters.
			0	False	
		Bit1 (msb)	1	True	Indicates Narrow Band Detection where True = Narrow Band Detected.
			0	False	
Active Gain Control (AGC)	10	0 - 100	1	True	Indicates Wide Band Detection where True = Wide Band Detected.
			0	False	
			0.1	0x001	
			
Narrow Band Noise Level	12	0 - 409.5	100.0	0x3E8	Indicates the active gain control level in percentage.
			0	0x000	
			0.1	0x001	
			
Wide Band Noise Level	12	0 - 409.5	409.4	0xFFE	Indicates the level of Narrow Band noise in db.
			409.5Not Measured	0xFFF	
			0	0x000	
			0.1	0x001	
Wide Band Noise Level	12	0 - 409.5	Indicates the level of Wide Band noise in db.
			409.4	0xFFE	
			Not Measured	0xFFF0x FFF	
			409.5	0xFFF	

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



1.2.2.6 MD-REQ-051840/B-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	5	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 (CNO) in dBHz of the identified satellite.
			1	0x01	
			
			255	0xFF	

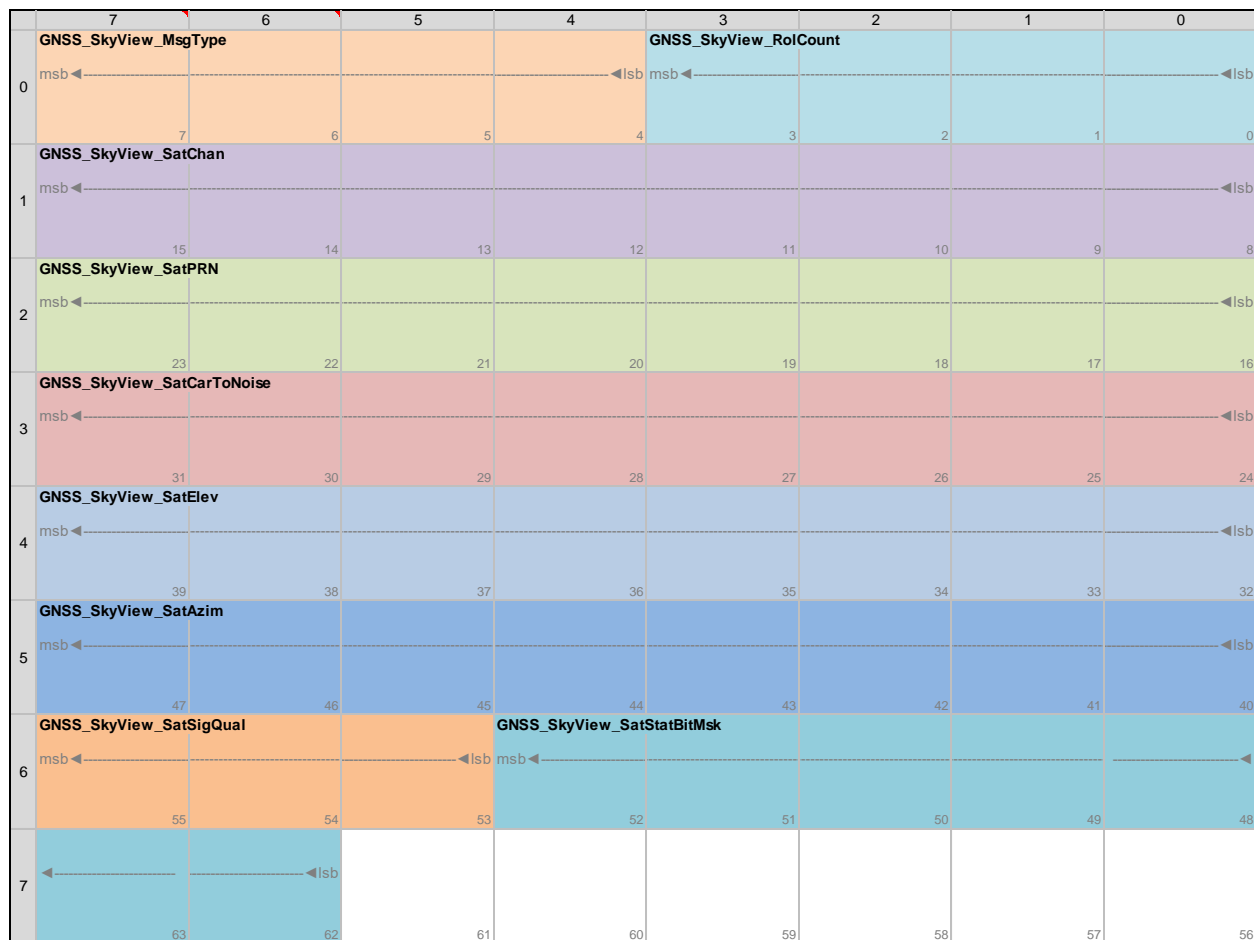


Satellite Elevation	8	0 - 255	0	0x00	Indicates the GNSS Satellite Elevation in degrees of the identified satellite.
			1	0x01	
			
			255	0xFF	
Satellite Azimuth	8	0 - 255	0	0x00	Indicates the GNSS Satellite Azimuth in degrees of the identified satellite.
			1	0x01	
Satellite Signal Quality	3	N/A	Idle	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 Location1 message is as follows:



1.2.2.7 MD-REQ-130083/A-Location3

GNSS Message Type: Location 3

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	1	Location1	0x1	See <i>Message Type Definition Table</i> .
Latitude Degrees Integer	7	0 - 89	0	0x00	Indicates the China Shifted Latitude integer portion in degrees.
			1	0x01	
			
			89	0x59	
Latitude Sign	1	0 - 1	Negative	0x0	Indicates the sign of the China Shifted Latitude Integer in degrees.
			Positive	0x1	
Latitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the China Shifted Latitude fractional portion in degrees.
			0.000001	0x00001	
			
			0.999999	0xF423F	
Longitude Degrees Integer	8	0 - 179	0	0x00	Indicates the China Shifted Longitude integer portion in degrees.
			1	0x01	
			
			59	0xB3	
Longitude Degrees Fractional	20	0.000001 - 0.999999	0	0x00000	Indicates the China Shifted Latitude fractional portion in degrees.
			0.000001	0x00001	
			
			0.999999	0xF423F	



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

Notes:

1. All values outside the defined range above shall remain reserved.
2. China Shifted Latitude and Longitude values are a derived solution from the output of the location engine (which is output in WGS84 coordinates).. The algorithm to shift the data is to be procured by the tier 1 supplier of the system from the Chinese Government

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

1.2.2.8 MD-REQ-133270/A-Location4

GNSS Message Type: Location 4 Raw GNSS

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	1	Location4	0x7	See <i>Message Type Definition Table</i> .
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	
			
			59	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.

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

1.2.2.9 MD-REQ-133599/A-Location5

GNSS Message Type: Location 5 – Map Match

Data Field	Length (bits)	Value Range	Literals	Value	Description
Message Type	4	1	Location5	0x8	See <i>Message Type Definition Table</i> .



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	
			
			59	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)
 HTC Hour = 1
 HTC Min =2
 HTC Sec =3
 HTC Day =4
 HTC Month =5
 HTC 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/B-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

- Latitude 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, etc.)

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

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/A-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.

1.2.4.2 MD-REQ-132697/A-CalculatedEphemeris

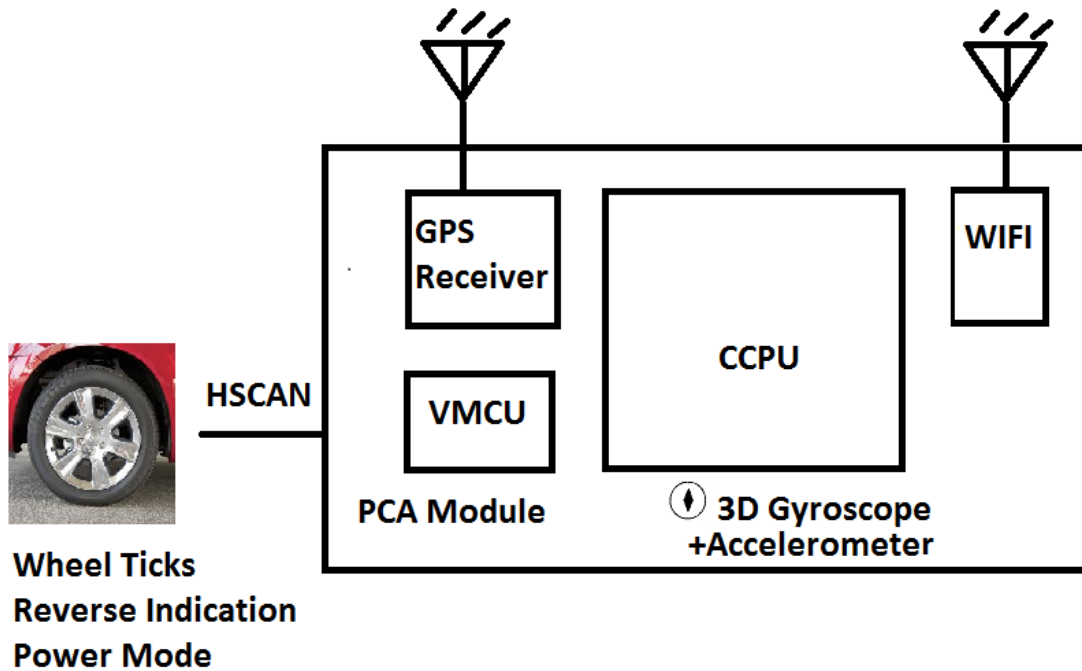
Location engine shall calculate (maintain) at a minimum a 24 hour predicted ephemeris at all times . If a calculation is incomplete prior to a key cycle, the prior calculation shall be maintained (assuming file is still valid). Valid files shall not be deleted until new calculation is complete.

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)



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/B-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/B-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.



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) Accelerometer+Gyro+Wheel Ticks 10m or less

Low resolution (<20hz) Accelerometer+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 – autophemeris expired)
- Startup in Complicated Airport Parking deck (after 24 hour soak – autophemeris 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.

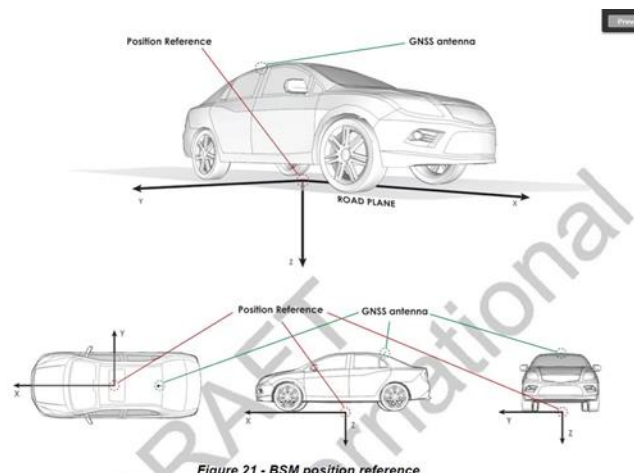


Figure 21 - BSM position reference



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/C-GPS Fault – Antenna Issue (TcSE ROIN-292580)

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	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.
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/B-WIFI Fault (TcSE ROIN-292583)**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-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)
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.
List of Exception Use Cases	NA
Interfaces	G-HMI

**2.2.2.6 LOCATN-UC-REQ-022437/B-WIFI Positioning Data Not Available (TcSE ROIN-292584)****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	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.
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	<p>The last known location is correctly identified (position of vehicle on road) by the ECU.</p> <p>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.</p>
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	<p>The last known location is correctly identified (position of vehicle on road) by the ECU.</p> <p>If the ECU is the Location Master, for this function, the following applies:</p> <p>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</p> <p>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</p>
List of Exception Use Cases	E10 – No Prior location stored
Interfaces	

2.2.2.15 LOCATN-UC-REQ-091657/B-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/D-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/B-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/s² 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/B-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/B-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/B-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-4-Wheel](#) Dead Reckoning mode

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

If the GPS Receiver fails, then the system shall notify the user and set the appropriate DTC

2.5.1.10 LOCATN-REQ-022464/B-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/A-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/B-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 Rqmts

Can Bus Internal Interface Rqmts

2.6.1.6.1 LOCATN-REQ-091661/A-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/A-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/C-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 Separation 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 message 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/A-Power State (TcSE ROIN-294176)

The system is expected to start calculating location as soon as the bus wakes up. 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/C-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 a 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

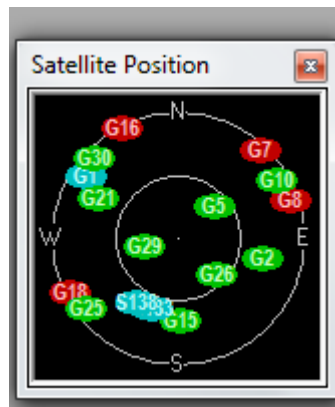
2.10 LOCATN-FUN-REQ-022477/A-Diagnostics (TcSE ROIN-304498)

2.10.1 Requirements

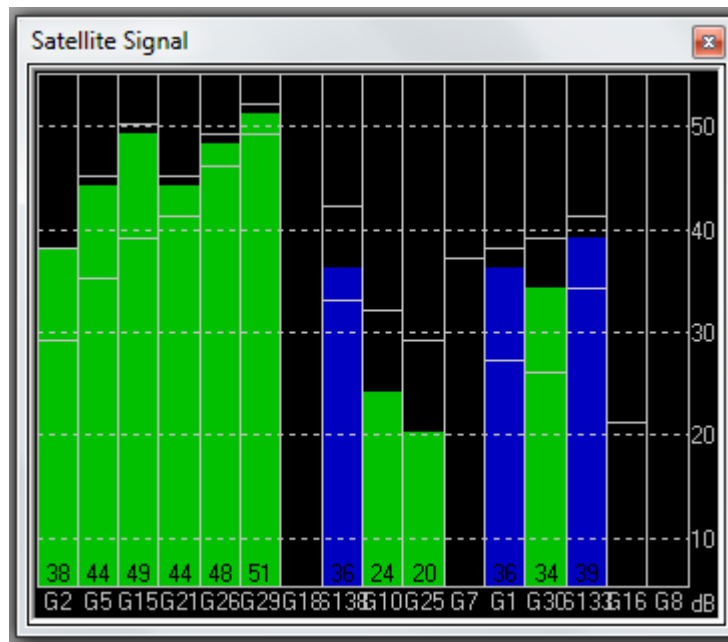
2.10.1.1 LOCATN-REQ-022478/D-Diagnostics (TcSE ROIN-304497)

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

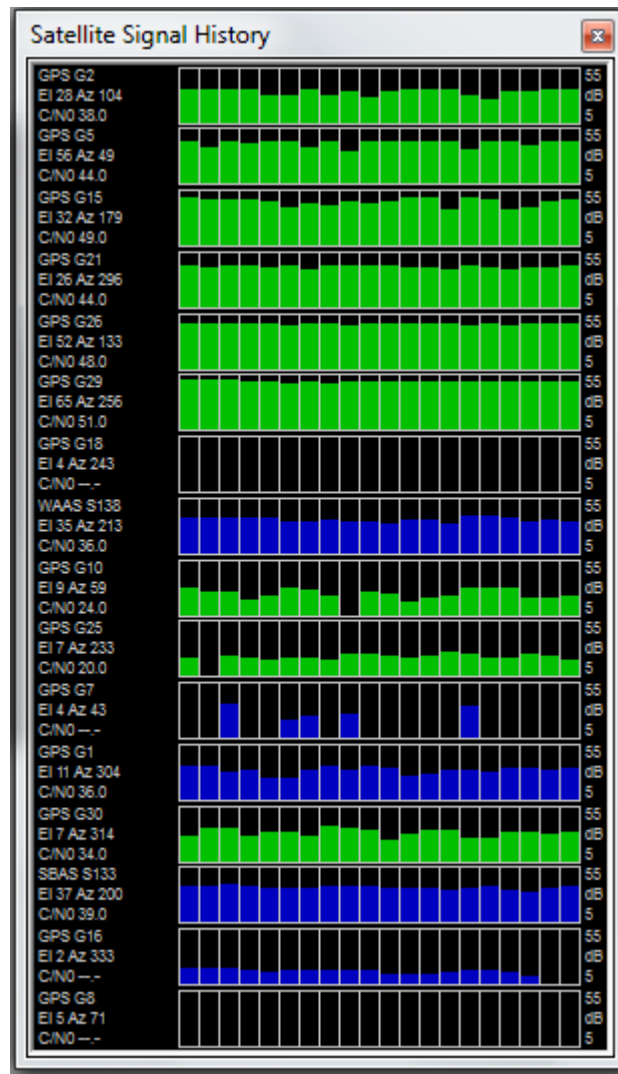
If equipped, System HMI shall provide the following widgets via Bezel Diagnostics and via external tools (with a 1hz update rate).



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





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/



3 Appendix: Reference Documents

Reference #	Document Title
1	Chicago GPS Drive Test 2013
2	WHEEL SPEED/DISTANCE/DIRECTION INFORMATION SHARING (AN-0234)
3	
4	
5	