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**GE/GN8578**

**Guidance on the Use of On-Train Satellite Positioning Technology Based  
Locator for Railway Applications**

**Issue Three December 2015  
Rail Industry Guidance Note**



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# Guidance on the Use of On-Train Satellite Positioning Technology Based Locator for Railway Applications

## Issue record

| Issue | Date           | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| One   | December 2008  | Original document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Two   | September 2011 | Replaces issue one<br>Small scale change amendment to include new section 6.4.2.9, and change to colour coding in Figure 3. Also, new Appendix D – Locator Interface Specification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Three | December 2015  | Replaces issue two<br>The document has been restructured throughout and the following key changes have been incorporated: <ul style="list-style-type: none"><li>• Title has been changed to align with the scope of the document.</li><li>• Updated Figure 1 of issue two, to illustrate locator interfaces to applications both on board and at trackside, and to clarify the boundary between the guidance note and other documents.</li><li>• Clarification of the definition of the locator and its classifications.</li><li>• The capability of the Class B locator.</li><li>• Incorporating previous Appendix D on standard interface into the main body.</li><li>• Additional guidance on defining requirements, choice and procurement of the locator.</li><li>• Providing an overview of location dependent applications within the Great Britain (GB) railway.</li><li>• Example applications are provided in the Appendix A to illustrate use of a locator.</li><li>• The technology overview in Appendix A of issue two has been removed.</li></ul> |

Revisions have not been marked by a vertical black line in this issue because the document has been revised throughout.

## Superseded documents

The following Railway Industry Guidance Note is superseded, either in whole or in part as indicated:

| Superseded documents                                            | Sections superseded | Date when sections are superseded |
|-----------------------------------------------------------------|---------------------|-----------------------------------|
| GE/GN8578 issue two Guidance on the Use of Satellite Navigation | All                 | 05 December 2015                  |

GE/GN8578 issue two Guidance on the Use of Satellite Navigation is withdrawn as of 05 December 2015.

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## Supply

The authoritative version of this document is available at [www.rssb.co.uk/railway-group-standards](http://www.rssb.co.uk/railway-group-standards). Enquiries on this document can be forwarded to [enquirydesk@rssb.co.uk](mailto:enquirydesk@rssb.co.uk).

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## Part 1 Introduction

### G 1.1 Purpose of this document

- G 1.1.1 This document gives guidance on the use of satellite positioning technology for location dependent railway applications. This document does not set out mandatory requirements.
- G 1.1.2 This document gives guidance on good practice for the specification, selection, implementation and installation of on-train satellite positioning technology based equipment (the 'locator'), in support of applications requiring train position, speed and time (PVT).
- G 1.1.3 This document gives guidance to:
- a) Users of the locator for position dependent railway applications; this includes Train Operating Companies (TOCs), Freight Operating Companies (FOCs), Rolling Stock Operating Companies (ROSCOs) and infrastructure managers.
  - b) Satellite positioning equipment manufacturers.
  - c) System integrators.
  - d) Train builders.

### G 1.2 Copyright

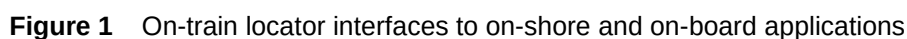
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### G 1.3 Approval and authorisation of this document

- G 1.3.1 The content of this document was approved by Control Command and Signalling Standards Committee on 01 October 2015.
- G 1.3.2 This document was authorised by RSSB on 28 October 2015.

## G 2.1 Scope

- |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| G 2.1.1 | The scope of this document is the on-train arrangements that include the locator and its external interfaces.                                                                                                                                                                                                                                                                                                                                                            |
| G 2.1.2 | Interfaces of the on-train locator to on-board and on-shore applications, assuming the train is fitted with a common on-board databus and a Mobile Communications Gateway (MCG) are shown in Figure 1. The MCG provides a gateway for data communications between the train and the trackside. Guidance on the implementation of data communications between the train and the trackside is given in GE/GN8579. Guidance on train rooftop antenna is given in GK/GN0602. |
| G 2.1.3 | The guidance is applicable to all Global Navigation Satellite Systems (GNSSs) based positioning technology. GNSS includes the Global Positioning System (GPS), GLONASS (the system of the Russian Federation) and GALILEO (the European global satellite navigation system under development to provide Europe independence and greater robustness).                                                                                                                     |



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## **G 2.2 Why the guidance is needed**

- G 2.2.1 There is, potentially, a wide range of position dependent applications, from safety-related applications and asset management, to on-board passenger information. The implementation of these applications could provide substantial operations, commercial and safety benefits to the railway. Satellite positioning technology is one of the technologies which has the potential to support these applications.
- G 2.2.2 Global Navigation Satellite Systems is already being used extensively within the Great Britain (GB) rail industry to provide common time and position information for managing the assets and operations across the rail network. However, the current pattern of deployment is on an ad hoc case-by-case basis, with little appreciation of the type of GNSS technology being used. Furthermore, what works for one operator may not work for another operator due to the topography of the route and the layout of stations and surroundings.
- G 2.2.3 Most purchases of GNSS equipment to-date are not through direct GNSS equipment procurements, but through larger on-train systems that already incorporate GNSS equipment within their system architectures (for example, On Train Monitoring Recorder (OTMR), closed-circuit television (CCTV), Selective Door Operation (SDO), Passenger Information Service (PIS) and Eco-driving). As a result, several discreet GNSS systems could be fitted to one train, which are adequate for the intended application, but their ability to add new functionality is limited as they are not specified to meet the needs of other applications.
- G 2.2.4 It follows that, when the train operator or infrastructure manager identifies a new need for GNSS, a new GNSS based system is usually procured and installed. Furthermore, it is evident that existing deployments do not embrace the latest GNSS technology and the selection of the GNSS equipment is naturally governed by the cost factor, with little consideration of future-proofing the investment.
- G 2.2.5 An alternative single locator approach is promoted by this document, especially to support applications requiring high quality GNSS positioning information that is not achievable by low cost equipment. Using a single locator, together with an MCG to provide standard communications services between the train and the trackside, will allow application designers to focus on the applications themselves and justify those applications on the marginal benefits of each application, rather than the application having to bear separately the full costs of a supporting infrastructure.
- G 2.2.6 This document gives guidance on:
- a) One antenna being shared between as many radio frequency receivers as is reasonably practicable.
  - b) One locator accommodating the requirements for as many applications as is reasonably practicable, with a definition of the common interfaces.
- G 2.2.7 The single locator approach facilitates effective life cycle management of the equipment, as follows:
- a) It provides for the upgrading of the locator by straightforward replacement, with minimum impact on the applications. This makes it easier to support migration to future applications.
  - b) It limits the proliferation of multiple equipment providing similar functions, with the potential to compromise performance.
- G 2.2.8 This document also gives guidance on how to facilitate the achievement of a level of system performance in these applications commensurate with their needs. It aims to provide a foundation for users to establish best practice and hence to use these positioning technologies to meet the needs of the rail industry more effectively.

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## **G 2.3 Structure of the document**

G 2.3.1 This document is structured as follows:

### **Part 1 Introduction**

This part sets out the purpose of the guidance and for whom it is intended.

### **Part 2 Overview**

This part explains the scope of the guidance, why the guidance is needed and how to use the guidance.

### **Part 3 On-train locator**

This part introduces the concept of a locator, service classes, performance requirements and design options for a locator.

### **Part 4 Locator interfaces**

This part sets out the standard external interfaces for the locator.

### **Part 5 Implementation and installation**

This part gives guidance on defining requirements, choice of locator, receiver procurement, system integration, equipment installation and other practical issues of implementation.

G 2.3.2 Appendix A sets out a summary of five applications with their performance requirements and a potential locator that can be used to achieve the requirements.

## **G 2.4 How to use this document**

G 2.4.1 This document informs industry of the performance of the satellite positioning technology based on-train locator, as well as providing practical advice about applying the technology, and pointers to where more detailed technical information may be found.

G 2.4.2 As this document is not intended to set mandatory requirements, readers should consider it to be a framework which enables better judgement of what can be expected from a satellite positioning technology-based on-train locator and the design options for different classes of locators.

G 2.4.3 For all potential users of the GNSS positioning technology within the rail domain, the users should consider what is required from their applications, and how they intend to use satellite positioning technology. Section G 5.1 proposes attributes and performance parameters of applications to be considered before choosing a locator.

G 2.4.4 Train operators and ROSCOs can use the guidance given in Parts 3, 4 and section 5.1 when considering and specifying application requirements. They can also refer to G 5.2 and G 5.3 when considering how equipment may be selected to achieve different levels of service, and to G 4.3 to check what data outputs are expected from the locator, in order to purchase the relevant GNSS equipment.

G 2.4.5 Infrastructure managers can use Part 3 of this document, to assist their assessment on how an on-train locator contributes to the overall solution, and G 4.3 on what data could be made available from the locator.

G 2.4.6 For suppliers of satellite positioning equipment, section G 2.5 and Part 3 can help them to gain an overview of the potential applications for the railway and align their products to the classes of locators, in order to serve the rail market more effectively. Parts 4 and 5 of this document provide train builders and potential system integrators with practical advice on interfaces, and on implementation and installation of a locator on a train.

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## G 2.5 Location dependent applications within GB railway

- G 2.5.1 RSSB research report T892 provides an overview of the scope and a diverse range of location dependent applications in the rail domain. The document consists of a catalogue of applications at various stages of development, ranging between those fully operational and those which are not yet in any formal plans. The description of each application includes its purpose, a high level summary of how it is expected to work, and how PVT information contributes.
- G 2.5.2 An on-train locator can be used as the sole train position solution for multiple on-train applications. The output from a locator may also be combined with other on-train or trackside train positioning information, to provide a more robust solution for some applications, including safety applications.
- G 2.5.3 The applications have been classified into five groups:
- a) Signalling and control.
  - b) Operations.
  - c) Customer.
  - d) On-train monitoring and diagnosis.
  - e) Infrastructure.
- G 2.5.4 The following tables set out the applications identified by RSSB research report T892\_D1.1. Descriptions for each application can be found in T892\_D1.1, which is available on the SPARK website provided by RSSB, for the rail industry to share and find key information, and help drive innovation.
- G 2.5.5 A list of signalling and control applications is set out in Table 1. These applications are typically safety critical or safety related. The locator technology could be used to contribute to the positioning solution, thus reducing the cost of implementing the applications. Guidance on how to use an on-train locator for safety related applications is given in G 3.6.3 and G 5.3.4.

| ID   | Title                                       |
|------|---------------------------------------------|
| 1.1  | Automatic Train Protection (ATP)            |
| 1.2  | On-train ERTMS Interface                    |
| 1.3  | Train Awakening                             |
| 1.4  | Cold Movement Detector                      |
| 1.5  | Train Integrity and Train Length Monitoring |
| 1.6  | Location of GSM-R Reports                   |
| 1.7  | User Worked Crossings                       |
| 1.8  | Secondary Line Signalling                   |
| 1.9  | Trackside Personnel Protection              |
| 1.10 | Possessions Management                      |
| 1.11 | Track Circuit Diversity During Leaf Fall    |

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| ID   | Title                                       |
|------|---------------------------------------------|
| 1.12 | Alternative Temporary Block Working         |
| 1.13 | Diverse Positioning Systems (COMPASS)       |
| 1.14 | Detonator Replacement ('Virtual Detonator') |
| 1.15 | Tilting Trains                              |

**Table 1** Signal and control applications

G 2.5.6 A list of operation related applications is set out in Table 2. These applications cover both normal as well as degraded modes of operation and typically deliver benefits in terms of performance and efficiency.

| ID   | Title                                                       |
|------|-------------------------------------------------------------|
| 2.1  | Centralised Clock                                           |
| 2.2  | Traffic Management & Regulation                             |
| 2.3  | Eco-Driving                                                 |
| 2.4  | Driver Advisory Systems                                     |
| 2.5  | Track Discrimination                                        |
| 2.6  | Automatic Train Operation                                   |
| 2.7  | Driverless Trains                                           |
| 2.8  | Temporary Speed Restrictions & Emergency Speed Restrictions |
| 2.9  | Fleet Management                                            |
| 2.10 | Cargo Monitoring                                            |
| 2.11 | Terminal Management                                         |
| 2.12 | Door Operations                                             |
| 2.13 | Passenger Count                                             |
| 2.14 | Pantograph Control                                          |
| 2.15 | Driver Route Knowledge Assistant                            |
| 2.16 | On-Train Ticketing, Retail & Authentication                 |
| 2.17 | On-Train Reservations                                       |
| 2.18 | On-Train Catering & Services                                |
| 2.19 | Train Crew Information Services                             |
| 2.20 | Infrastructure Charges                                      |

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| ID   | Title                                                |
|------|------------------------------------------------------|
| 2.21 | Delay Attribution                                    |
| 2.22 | Incident Management Response                         |
| 2.23 | Logistics Planning And Monitoring (Support Vehicles) |

**Table 2** Operation related applications

- G 2.5.7 A list of customer related applications is set out in Table 3. Providing accurate and timely train location and speed information would help train passengers plan their journey and reduce stress when there are disruptions.

| ID  | Title                                        |
|-----|----------------------------------------------|
| 3.1 | Customer Information Systems                 |
| 3.2 | Passenger Information Systems                |
| 3.3 | Personal Journey Assistant                   |
| 3.4 | Location Based Services & Points of Interest |
| 3.5 | Passenger Broadband                          |
| 3.6 | Train Approaching Warnings                   |

**Table 3** Customer related applications

- G 2.5.8 A list of applications relating to on-train monitoring and diagnosis is set out in Table 4. These applications help maintenance staff within TOCs and / or maintenance companies, and infrastructure managers, to monitor and diagnose defects more efficiently.

| ID  | Title                               |
|-----|-------------------------------------|
| 4.1 | On-Train Monitoring Recorder (OTMR) |
| 4.2 | On-Train CCTV                       |
| 4.3 | On-Train Monitoring                 |
| 4.4 | On-Train Automation                 |
| 4.5 | On-Train Braking Measurement        |
| 4.6 | Odometer Calibration                |

**Table 4** Applications relating to on-train monitoring and diagnosis

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- G 2.5.9 A list of infrastructure related applications are set out in Table 5. These applications focus on referencing, measuring and monitoring rail infrastructure.

| ID  | Title                                |
|-----|--------------------------------------|
| 5.1 | Digital Route Map Creation           |
| 5.2 | Structural Monitoring                |
| 5.3 | Gauging Surveys                      |
| 5.4 | Automated Infrastructure Maintenance |

**Table 5** Infrastructure related applications

### G 2.6 Related documents

- G 2.6.1 The following summarises the documents associated with this guidance note. Reference documents are also provided at the end of this guidance note.
- RSSB research report T510. This research focusses on collecting and analysing data to assess the dependability of GNSS technology.
  - RSSB research report T671. Communication and positioning system in the GB rail industry. This research recommends the standardisation and methodology needed for the implementation of satellite positioning and digital communications technology within the railway environment.
  - RSSB research report T740. The analysis of historical GPS data from the railway network. This sets out the quality of the reception of GPS signals over the GB railway network as experienced on the Network Rail data recording trains.
  - RSSB research report T892. Data and analysis for a cost-effective GPS-based locator with simple augmentations. This research continues the investigation of the performance of the GNSS based locator following the previous RSSB research project T510. It has identified candidate architectures for increasing the availability of positioning data using a Class B locator (as defined in G 3.5 of this guidance note). The research delivered nine reports which are referenced as T892\_D1 to T892\_D9.
  - RSSB research report T990. Development of a strategy for on-train positioning. This research has developed a high-level industry strategy for on-train positioning, based on a common train location service that brings coherence to the provision of trainborne and trackside positioning capability.
  - The Galileo project GRAIL deliverables. This project investigates the use of GNSS to support applications related to ETCS. It includes a broader review of other applications in less detail.
  - Guidance on applicable digital communication and positioning technologies is given in GE/GN8577.
  - Guidance on the implementation of shared data connections between the train and the trackside is given in GE/GN8579.

# Guidance on the Use of On-Train Satellite Positioning Technology Based Locator for Railway Applications

## Part 3 On-Train Locator

### G 3.1 Definition of a locator

G 3.1.1 A locator is an on-train system that provides train location, speed and timing information to support a range of on-train and back-office applications.

### G 3.2 Locator architecture

G 3.2.1 The basic equipment required for an on-train GNSS based location system with the locator unit in its simplest form consisting only of a GNSS receiver is shown in Figure 2. The locator provides a standardised positioning output to the applications, and receives standard inputs from the antenna(s) either directly or through a splitter which would allow external devices to make use of the same GNSS radio frequency (RF) signal.

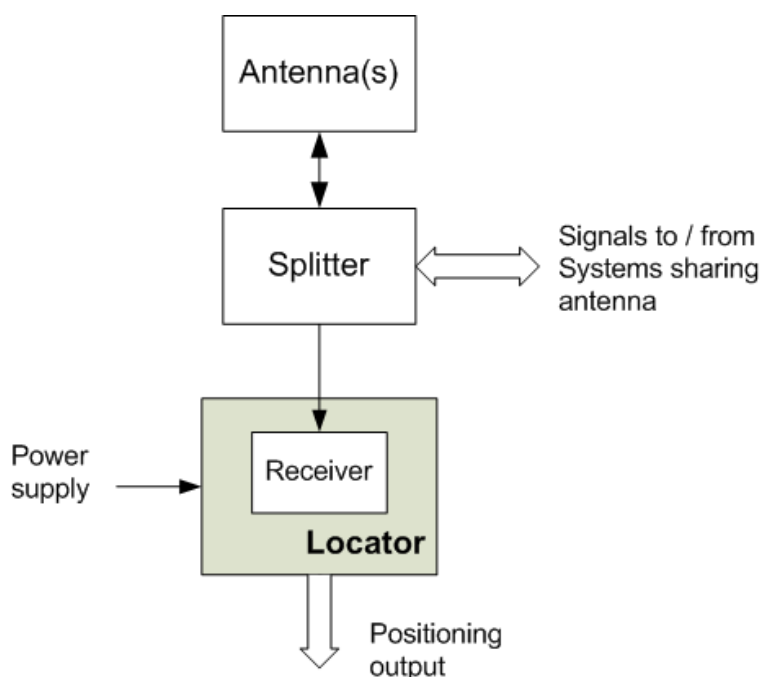


**Figure 2** Basic equipment for an on-train GNSS based location system

G 3.2.2 The performance of a basic locator with a GNSS receiver can be improved through a method called augmentation. There are various satellite-based and ground-based augmentations available. For example, differential GNSS (DGNS) is an augmentation which provides corrections to the GNSS signals to reduce errors and spatial-temporal effects that are difficult to model accurately. Details of DGNS and other augmentation technologies are set out in T892\_D8.

G 3.2.3 The locator architecture where an augmented signal is provided to a GNSS receiver is shown in Figure 3.

## Guidance on the Use of On-Train Satellite Positioning Technology Based Locator for Railway Applications

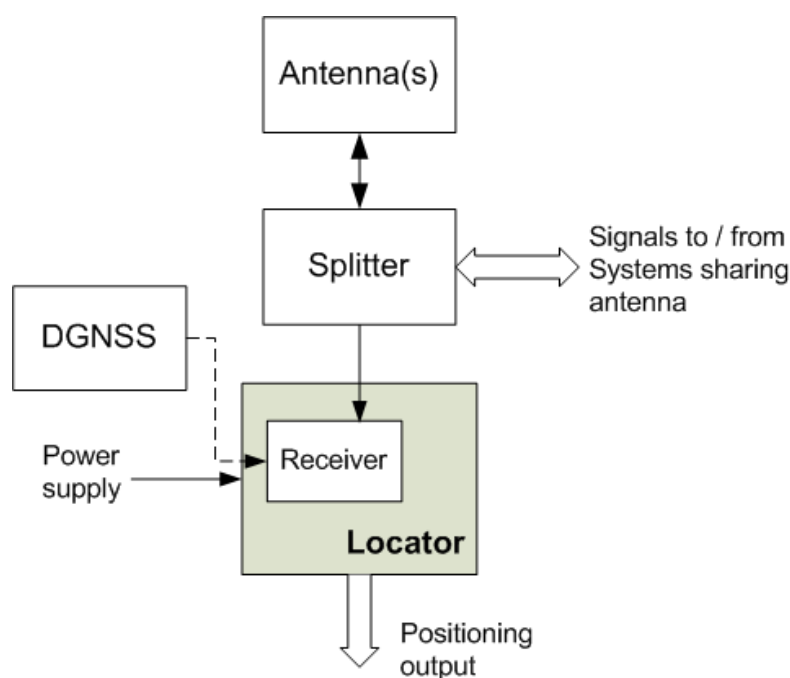


**Figure 3** Locator architecture with DGNSS augmentation

- G 3.2.4 The limitation of the augmentation technique is that it can only improve the performance of a locator when a GNSS solution is available. In order to provide a positioning solution during periods when insufficient GNSS satellite signals are present, other complementary sensors and systems can be used to provide the infill. The method of integrating GNSS with other complementary sensors and systems is termed 'hybridisation'. The sources of hybridisation data could include Inertial Measurement Units (IMUs), location database or map, speed sensors and terrestrial positioning signals.
- G 3.2.5 A generic locator architecture indicating some potential hybridisation and augmentation sources that could be considered is shown in Figure 4. In the case where hybridisation is used, data from the GNSS receiver is integrated with one or more independent sources within a data fusion algorithm before the resultant position is output to the application. The 'track beacons' shown in Figure 4 refer to a number of trackside location technologies, including Eurobalises, or a radio frequency identification (RFID) source.
- G 3.2.6 More descriptions on the augmentation and hybridisation sources shown in Figure 4 are set out in G 3.6.
- G 3.2.7 Whether to apply hybridisation or augmentation sources to improve the performance of a locator is dependent on the application requirements and operating conditions. Further considerations of how to choose hybridisation or augmentation sources for a locator are set out in G 5.2.

# Guidance on the Use of On-Train Satellite Positioning Technology Based Locator for Railway Applications

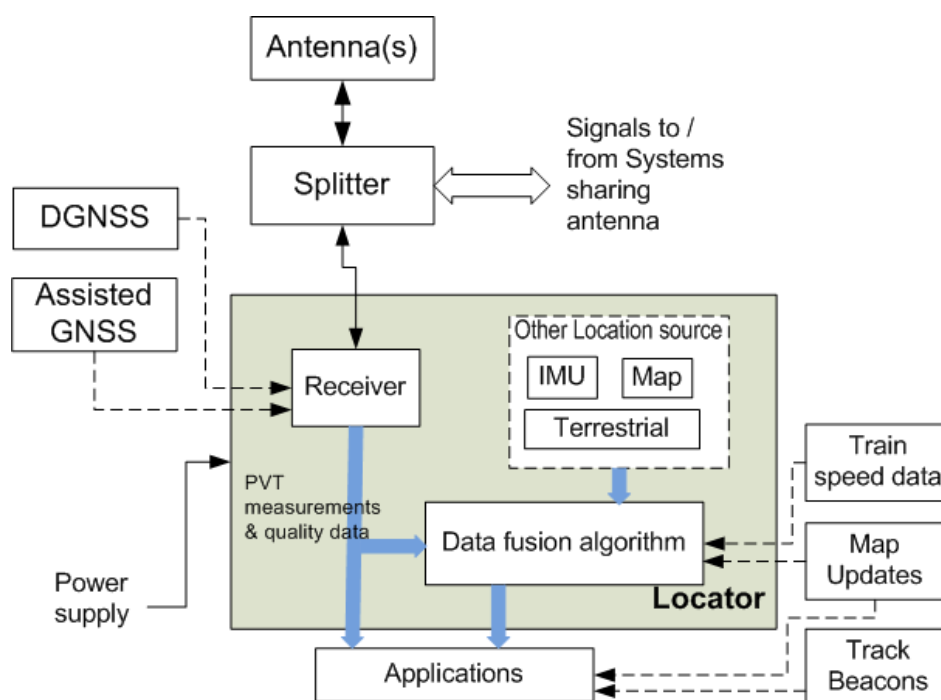


**Figure 4** Generic locator architecture with augmentation (inputs to the receiver) and hybridisation (inputs to the data fusion algorithm)

## G 3.3 Locator quality of service

- G 3.3.1 The term 'quality of service' is used to describe the characteristics of the output of a locator in the area of the rail network where the locator is required to operate.
- G 3.3.2 The three principal parameters of quality of service are:
- Service coverage.
  - Accuracy.
  - Integrity.
- G 3.3.3 Each of these parameters is statistical in nature, and there is no absolute guarantee of a particular level of performance, but rather a level of confidence that the equipment operates at or above the required performance. The parameters are interrelated (for example, specifying a high accuracy has a negative impact on integrity, and a low accuracy can make integrity more readily achievable).
- G 3.3.4 The meanings of these terms in other transport sectors can be different. In official references, for example, the Federal Radio Navigation Plan (FRNP), the definition of the performance of the GNSS signals-in-space conforms to aviation usage. The definitions in this guidance note, and the use of the terms, conform to railway usage.
- G 3.3.5 Although the GNSS signals have a specified continuity property, this is masked by the variable coverage experienced in the railway environment. The first decision for a railway application is the service coverage performance required from the locator.
- G 3.3.6 Different applications require different qualities of service. For example, the simplest applications (such as an on-board automatic passenger information system) only need a basic level of service, getting occasional input from the locator unit as a 'trigger' to indicate that the train is within a defined geographical range of a given point. Other applications may require a continuous stream of highly accurate position information to be available.

# Guidance on the Use of On-Train Satellite Positioning Technology Based Locator for Railway Applications

## G 3.4 Quality of service parameters

### G 3.4.1 Service coverage

G 3.4.1.1 Service coverage provided by the locator refers to the proportion of the railway network on which a train's position can be determined at the required level of accuracy and integrity. It is the characterisation of a lack of service coverage that is the main factor in determining whether an application can operate with GNSS alone, or whether hybridisation is required.

G 3.4.1.2 It is in the nature of the railway and GNSS processing that some temporary loss of service coverage should be accepted. The extent of the acceptability is defined by the application.

G 3.4.1.3 Depending upon the needs of the application, service coverage can be specified as:

- The specific geographical area(s) where coverage is required.
- The maximum distance that may be travelled without coverage.
- The maximum time that may pass without coverage.

### G 3.4.2 Accuracy

G 3.4.2.1 The specification for a locator may need to include accuracy for position, speed, time and direction / heading.

G 3.4.2.2 The accuracy of GNSS and the supporting technologies vary continually in time. An indication of the instantaneous accuracy can be given by the Dilution of Precision (DOP). The actual error present at any moment cannot be determined absolutely, for example, because of the presence of multipath effects, and varying durations of obscuration from the signals-in space. Thus, although accuracy is the most commonly referenced performance parameter, it is meaningless without an associated measure of acceptable statistical variation, as shown in Figure 5.

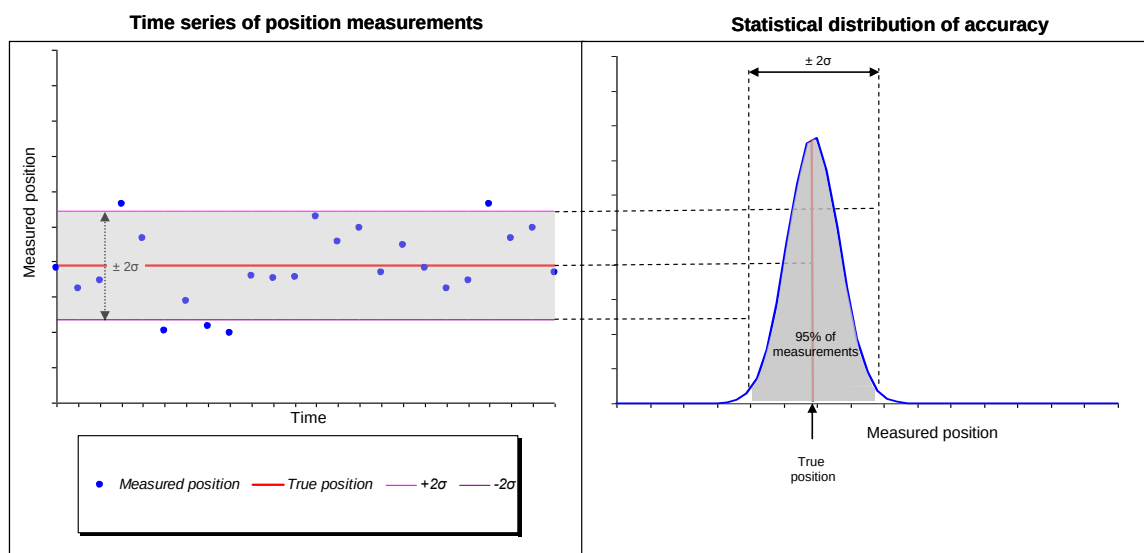


**Figure 5** Statistical nature of accuracy

G 3.4.2.3 It is important to specify the minimum accuracy. Experience shows that for most of the time, much better accuracy can be expected. However, for a small amount of time it is inevitable that the specified minimum accuracy cannot be obtained. The application should be assessed to determine the consequences of inadequate accuracy and whether compensatory measures are required.

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G 3.4.2.4 In many applications the occasional operating inconvenience arising from inaccuracy will be acceptable; in others, the detection of marginal or inadequate accuracy could be required so that other measures can be put in place. Where, despite these measures, undetected inaccuracy could lead to safety concerns, an integrity limit can be specified to reduce to an acceptable level the risk that would arise from undetected inaccuracy or undetected lack of coverage.

## **G 3.4.3 Integrity**

G 3.4.3.1 Integrity describes the trustworthiness of the output of a locator. It is a measure that is applied when the application is safety related or safety critical. There are three components to integrity:

- a) Integrity risk (usually expressed as a probability of an undetected failure), that is, that a fault is present somewhere in the system and is not detected and, as a consequence, the data at the output of the locator is not trustworthy.
- b) Integrity alert limit (also known as the threshold value) is the maximum allowable error in the measured position (or speed or time) before an alarm is triggered. The threshold value is normally greater than the nominal accuracy of the locator unit, to avoid excessive false alarms.
- c) Time to alarm is the time elapsed between the occurrence of the failure in the system and its presentation to the user.

G 3.4.3.2 In Europe, GPS signals are monitored by the European Geostationary Navigation Overlay Service (EGNOS). The integrity information is not readily available to trains at present. However, it is readily available to control centres, which can take appropriate action if an integrity failure is detected.

G 3.4.3.3 In the locator, integrity can be provided by Receiver Autonomous Integrity Monitoring (RAIM). Doppler and carrier phase measurements can also be used.

G 3.4.3.4 The monitoring of GNSS signals to confirm integrity is only acceptable for safety-related tasks if the monitoring itself meets a defined level of integrity.

## **G 3.4.4 Other quality of service parameters**

G 3.4.4.1 In addition to the main parameters set out above, there are other quality of service parameters that can be considered for applications on a case-by-case basis:

- a) Availability / reliability: these terms are used in this document to describe the intrinsic performance of the on-board hardware.
- b) Time To First Fix (TTFF): the time taken between switching the locator on, or resuming visibility of the satellites following a prolonged period of obscurity or being out of service, and obtaining the first reliable position and speed reports from the locator.
- c) Time To Fix (TTF): the time taken between resuming visibility following a shorter period of obscurity (typically less than two hours) and obtaining the first reliable position and speed reports from the locator.
- d) Fix rate: the frequency at which the locator unit is able to provide position solutions meeting accuracy and integrity requirements.

G 3.4.4.2 Further parameters defining performance requirements for applications are set out in G 5.1.