Rail Delivery Group

National Rail BRITAIN RUNS ON RAIL

RDG/EC/GN/005
Guidance Note- On Train GPS/Darwin Interface specification
Issue Two
Date April 2018

RDG Guidance Note – On Train Satellite Navigation Equipment/Darwin Interface

Prepared by

Bryan Donnelly
National Fleet Performance Manager

Synopsis

This Guidance Note specifies the requirements for the interface between trains fitted with Global Navigation and Satellite System (GNSS) Equipment and systems that provide non-safety critical train information.

The following requirements specify the recommended GNSS data content and the compulsory and desirable train reporting functionality.

Authorised by

Simon Jarrett
Chair, Technical and Standards Forum

Tim Sayer
Chair, RDG Engineering Council

Guidance Note – On Train Satellite Equipment/Darwin Interface Specification

Contents

Guidance Note – On Train Satellite Equipment/Darwin Interface Specification

Part A

Issue record

This Guidance Note will be updated when necessary by distribution of a complete replacement.

Issue	Date	Comments
One	May 2016	Original document
Two	April 2018	Updated to include Interface Control

Responsibilities

Copies of this Guidance Note should be distributed by RDG members to relevant persons within their respective organisations.

Explanatory note

RDG is not a regulatory body and compliance with RDG Guidance Notes is not mandatory.

RDG Guidance Notes are intended to reflect good practice. RDG members are recommended to evaluate the guidance against their own arrangements in a structured and systematic way. Some parts of the guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not to adopt) elements of the guidance should be documented.

Guidance Note status

This document is not intended to create legally binding obligations for Network Rail or between Railway Undertakings.

Supply

The Controlled version of this document can be found on the RSSB website (http://www.rssb.co.uk/railway-group-standards)

Uncontrolled copies of this Guidance Note may be obtained from the RDG Director – Planning , Engineering, Operations.

Guidance Note – On Train Satellite Equipment/Darwin Interface Specification

Part B

1. Purpose

This Guidance Note provides guidance to all Train Operating Companies, Freight Operating Companies, Network Rail, RDG, RSSB and other relevant organisations involved in the provision of Train Location Services (TLS). It specifies the train location data interface requirements between Satellite Navigation Systems installed on passenger and freight trains and the Gateway to process the raw Satellite Navigation data.

2. Scope and Overview

This Guidance Note focuses on the Satellite Navigation Gateway. National Rail Enquiries (NRE) are developing and implementing a Satellite Navigation Gateway as part of the Customer Information Strategy (CIS) in Control Period 5. The Gateway shall be capable of receiving data from trains already fitted with Satellite Navigation equipment as well as new installations. This Guidance Note outlines the following requirements for the Satellite Navigation Gateway:

- The essential functionality of the train location equipment
- The essential data content and format to be received by the Satellite Navigation Gateway
- The recommended train reporting functionality

The scope of the Guidance Note is illustrated in figure 1 below.

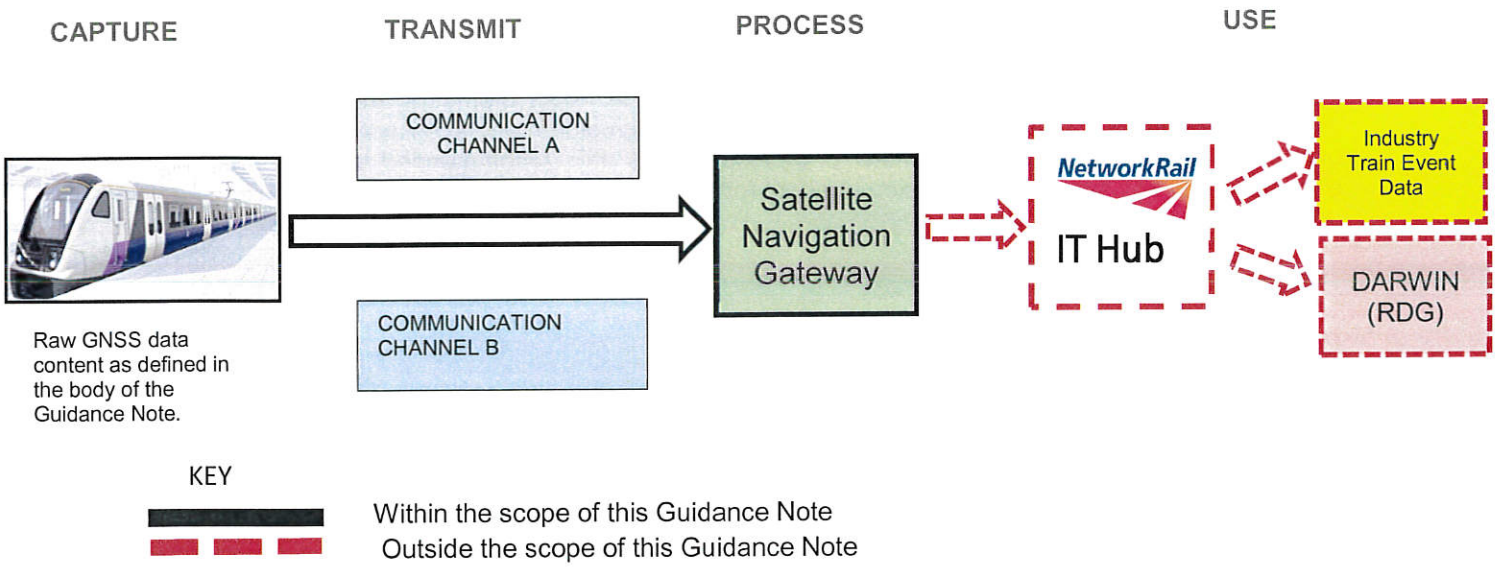

Figure 1 Overview of the flow of GNSS (e.g. GPS) data.

3. Background

The traditional approach for locating trains is via train describers, or when a train arrives at a station or junction at various stages during its journey. The Gateway will process the train location data that is then used to provide greater accuracy, granularity and timeliness of train location for various applications including customer information, delay attribution, traffic management, train and track condition monitoring etc. It is part of the Train Location Services programme, which is also part of the larger RDG led Customer Information Strategy.

The Train Location Services programme is comprised of four elements:

1. A Satellite Navigation equipment installation on passenger and freight trains
2. A data feed from the Satellite Navigation providers
3. A Gateway to process the raw Satellite Navigation data
4. A data warehouse and analytics tool.

To achieve the quickest rollout and provision of a useable customer information service the programme seeks to use existing equipment where possible, in particular on-board Satellite Navigation equipment, and to bring it up to an improved standard over time.
Although the objective is to provide non-safety critical customer and staff information, it is an aspiration that the 'from train' feed will be capable, over time, of using enhancement or augmentation to improve train location confidence and accuracy, to usefully feed systems such as Traffic Management, Industry Train Event Data (ITED) and the Combined Positioning Alternative Signalling System (COMPASS).

4. Train Reporting Functionality

The data to be supplied to the Gateway should comply with this Guidance Note, except where a deviation has been agreed explicitly with the back-office provider or the TLS project team. An example of a data sample that can be received by the Gateway is shown in Appendix A.

4.1. For trains in service and empty coaching stock moves:

- 4.1.1. Trains shall report when they stop and start (preferably using train odometer information).
- 4.1.2. Satellite Navigation data reports shall be generated, as a minimum, every 10 seconds or less.
- 4.1.3. Train position reporting shall be time-based.
- 4.1.4. Reports from the train can be batched up to include intermediate Satellite Navigation reports but the minimum frequency of reporting should be every 31 seconds. For example, if reports are received at the Gateway every 31 seconds, then they shall contain at least three train reports in accordance with requirement 4.1.2 above.

4.2. Train reporting data can be transmitted to the Satellite Navigation Gateway via two communication channels, Channel A or Channel B, as described below and illustrated in Appendix B.

- 4.2.1 Channel A: The supplier of the Satellite Navigation system will receive the train reporting data using wireless mobile telecom via the internet, for example a 3G or 4G network,

from individual trains. It is then directed to the Satellite Navigation Gateway via the Internet (using Standard Open Access Protocol). The Satellite Navigation Gateway should be able to receive data from a supplier's back office.

4.2.2. Channel B: Data can be transmitted directly from the train wireless mobile telecom to the Satellite Navigation Gateway. The Satellite Navigation Gateway should have the ability to receive data calls.

4.3. A 'confidence' measure of the position accuracy shall be included (e.g. number of satellites, Horizontal Dilution of Precision (HDOP), Position Dilution of Precision (PDOP).

4.4. Train location reports with PDOP of up to 8.0 shall be made available.

5. Required Satellite Navigation Data Content

The minimum data content required from the train is stated below:

Field	Format	Comment
Device Identity	Alpha-numeric	Unique alpha-numeric device ID shall be provided by the supplier.
Vehicle Identity	NNNNNNNNNNNN	If maintenance is performed through exchange of Satellite Navigation Equipment, then the linkage between device ID and the vehicle ID (12-digit number) to which it is currently fitted shall be updated in the local/central reference data.
Speed	NNN.NNN	Speed shall be reported in Kilometres per hour e.g. 095.000 km/h
Heading	NNN°	Numeric Degrees azimuth e.g. 024° N
Latitude	NNNNN.NNNNN	Decimal at least 5 decimal points plus direction (North or South) (WGS84) e.g. 55125.28100
Longitude	NNNNN.NNNNN	Decimal at least 5 decimal points plus direction (East or West) (WGS84) e.g. 00009.47470
Date Time Stamp for the Satellite Navigation position.	hh.mm.ss.milliseconds ddmmyyyy	W3C format, UTC (i.e. not corrected for the summer time change) Time: 18.04.50.000 Date: 22022016
Quality / Confidence (highly desirable)	NN	Number of satellites used e.g. 06
	NN.NN	HDOP (Horizontal Dilution of Precision) e.g. 01.29
	NN.NN	PDOP (Position Dilution of Precision) e.g. 02.00

6. Desirable Train Reporting Functionality

The following should also be considered:

6.1. A 'Class B' system, as defined in GE/GN8578 (*Guidance on the Use of Satellite Navigation*), is the preferred GNSS solution. These systems provide:

- Satellite Navigation location enhancement through using the train odometer and other augmentation, and;
- A compass bearing reading.

6.2. Satellite Navigation reports are temporarily stored locally in case of communications failure for up to one hour.

6.3. The Satellite Navigation platform should be capable of remote interrogation and diagnosis.

7. Interface control

The GPS gateway needs to receive the train location information described in this guidance note in a certain format. A generic interface from a 3rd party GPS supplier to the GPS Industry Train Reporting Service is described in NR GPS/IS/IS010. The latest version of the interface control is included in Appendix B.

8. Definitions

Augmentation: Aids the GNSS receiver through improving the accuracy, integrity and availability by reducing errors and temporal effects.

Back office: System interface and data that are not directly seen by customers.

COMPASS: Combined Position Alternative Signalling System is a system being developed to enable trains to continue to move when the line-side signalling system fails and provides signallers with an alternative view of a train's position, speed and direction of travel in real time.

Communication Channel A/B: Refers to the way information is transmitted

Confidence: An indication of the accuracy of any given value and the probability that it is within an allowable range.

Darwin: The GB rail industry's official train running information engine. It provides real-time arrival and departure predictions, platform numbers, delay estimates, schedule changes and cancellations. It is the only system in the UK to take feeds directly from every TOC Customer Information System (CIS), combining it with train location data provided by the railway infrastructure manager, Network Rail.

Degrees Azimuth: An angular measurement in a spherical coordinate system.

Gateway: A Network Rail/RDG project created as part of the RDG Customer Information Strategy. It draws in additional information about the trains, i.e. Headcode, direction, etc. More information regarding this project

will be published on the RDG website in the near future, and the Guidance will be updated accordingly.

GNSS: Global Navigation Satellite System. GNSS provides signals from space for global coverage through the collection of data from all the satellites. Performance of these satellites is measured against accuracy, integrity, continuity and availability.

HDOP: Horizontal Dilution of Precision. Defines the precision of the horizontal position and measures the quality of a GNSS configuration.

ITED: Industry Train Event Data is a Network Rail IT project which will design and deliver a new data warehouse and analytics tool for the industry in order to analyse the performance of trains.

PDOP: Position Dilution of Precision is a measure of the amount of error caused by satellite geometry by a combination of vertical and horizontal components of position error.

Satellite Navigation: A programme that uses satellites to show the intended user their location, position and direction to the desired location.

Telecommunication: Communication over a distance by cable, telegraph, telephone, or broadcasting.

WGS84: A standard for use in cartography, geodesy, and navigation including by GPS.

W3C: The standard machine-readable method for formatting dates.

Guidance Note – On Train Satellite Equipment/Darwin Interface Specification

APPENDIX A

An example of a compatible xml message from Satellite Navigation equipment is provided below:

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2015 sp1 (x64) (http://www.altova.com)-->
-<GPSGenericMsgV1 xsi:schemaLocation="http://xml.hiav.networkrail.co.uk/schema/itm/gps/1
itm_gps_messaging_v1.xsd" timestamp="2001-12-17T09:28:47Z"
xmlns:eai="http://xml.hiav.networkrail.co.uk/schema/eai/11.5"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns="http://xml.hiav.networkrail.co.uk/schema/itm/gps/1">
    <eai:Sender/>
        -<GPSRawMsg operatorCode="EW">
            -<GPSReport reportingEntity="Device123">
                -<GPSPosition longitude="3.141592" latitude="3.141592" heading="45" speed="25"
                    reportedTime="2001-12-17T09:30:47Z">
                        <HorizontalAccuracy horizontalDoP="8.9"/>
                 </GPSPosition>
                -<GPSPosition longitude="43.141592" latitude="23.141592" heading="67"
                        speed="45" reportedTime="2001-12-17T09:40:47Z">
                        <HorizontalAccuracy horizontalDoP="10"/>
                  </GPSPosition>
            </GPSReport>
    </GPSRawMsg>
    </GPSGenericMsgV1>
```

APPENDIX B

GPS Industry Train Reporting Service

Interface Control Document - Generic GPS

NR GPS/IS/IS010

Version: 2 (Final)
30 January 2014

Guidance Note – On Train Satellite Equipment/Darwin Interface Specification

Contents

This document

1.1 Purpose

This document is intended to identify and track the necessary information required to implement a generic GPS input interface to the GPS Industry Train Reporting Service.

1.2 Scope

This document describes a generic interface from a 3rd party GPS supplier to the GPS Industry Train Reporting Service.

1.3 Owner

The Atos **GPS Industry Train Reporting Service Project Manager** owns this document.

The owner is responsible for approval of this document and all related feedback should be addressed to them.

1.4 References

The following documents are referenced by this architecture:

Reference	ID
ICD Network Rail - EMS	IS005

2.0 Interfaces

2.1 Interface Descriptions

The following sections describe each interface.

2.1.1 Submit GPS Reports

This interface will be used to submit GPS reports from the 3rd party supplier to the GPS Service.

This interface is intended for GPS providers whose sample rate is 10 seconds. This frequency has been chosen in order to minimise the number of GPS reports that need to be supplied and processed whilst maintaining an acceptable level of accuracy for the resulting train reporting.

Where the sampling rate is lower than this (i.e. the period between reports is more than 10 seconds) then the supplier will need to discuss the implications with the relevant parties (including Network Rail and Atos) to understand what impact there may be on the quality of train reporting. Where the rate is higher, the supplier will be expected to provide only a subset of the available reports that would equate to an effective sampling rate of 10 seconds.

These restrictions are designed to ensure a consistent quality of reporting across the service and are not intended to exclude situations where the frequency of reporting is reduced under exceptional circumstances such as in periods or regions of poor GPS and/or GSM coverage.

Data provided to the interface should be formed into batches that will allow the supplier to reduce the overall number of calls to the interface. This is intended to allow reports for multiple units to be provided in a single call every 10 seconds. It is not intended for multiple consecutive reports for a given unit to be batched into a single interface call as this will reduce the effectiveness of the GPS Service. However, this approach is supported in order to cater for brief outages (see Recovery details in *2.3.1 Interface: Generic GPS Reports*).

Where a GPS supplier provides data for multiple Operators, the data must be segregated such that each call to the web service contains data only for a single Operator.

Where a unit is stationary, multiple reports with the same position data should not be supplied. In this case if the position varies by less than 20m from the previous report then it should not be reported. However, in order to provide a "keep alive" message at least one report should be provided for the unit each hour.

In order to ensure that only reports that have a sufficient GPS quality are provided the supplier will be expected to provide only those reports that have a DOP value of at most 8.0. Where the supplier's GPS does not provide DOP values then the supplier will be expected to implement an alternative method of accuracy checking at a similar level.

2.1.2 GPS Service Response

The web service call will return details success or failure relating to the call to the GPS Service. This will relate only to the handling of the web service call and the pre-processing of the received data (such as authentication and validation) and will not relate to the processing of the received GPS reports by the GPS Service.

2.2 Message Definitions

The following sections define the content of each message type. All messages will consist of well-formed XML conforming to an agreed schema.

2.2.1 Message Type: Generic GPS Report

This schema corresponds to the RawGPSType complex type defined in the Network Rail EMS schemas and which is used to distribute Raw GPS messages to Network Rail. In this interface the Network Rail standard headers have been omitted in order to reduce the size of the data and also because the data does not need to pass through the EMS.

The RawGPSType complex type includes an attribute for the Operator Id and a list of one or more GPS Reports; allowing multiple reports for the same operator to be supplied in a single call to the web service.

The GPSReportType complex type then contains the ReportingEntity attribute which identifies the physical device that is providing the report (i.e. the unit or vehicle identifier) and a list of one or more position reports.

This structure caters for scenarios where multiple reports for a Unit, and reports for multiple units can be supplied in a single message. This would not be expected under normal operating conditions but, after an outage or other brief period of disruption, could allow the supplier to provide the missing data with minimal additional calls to the interface.

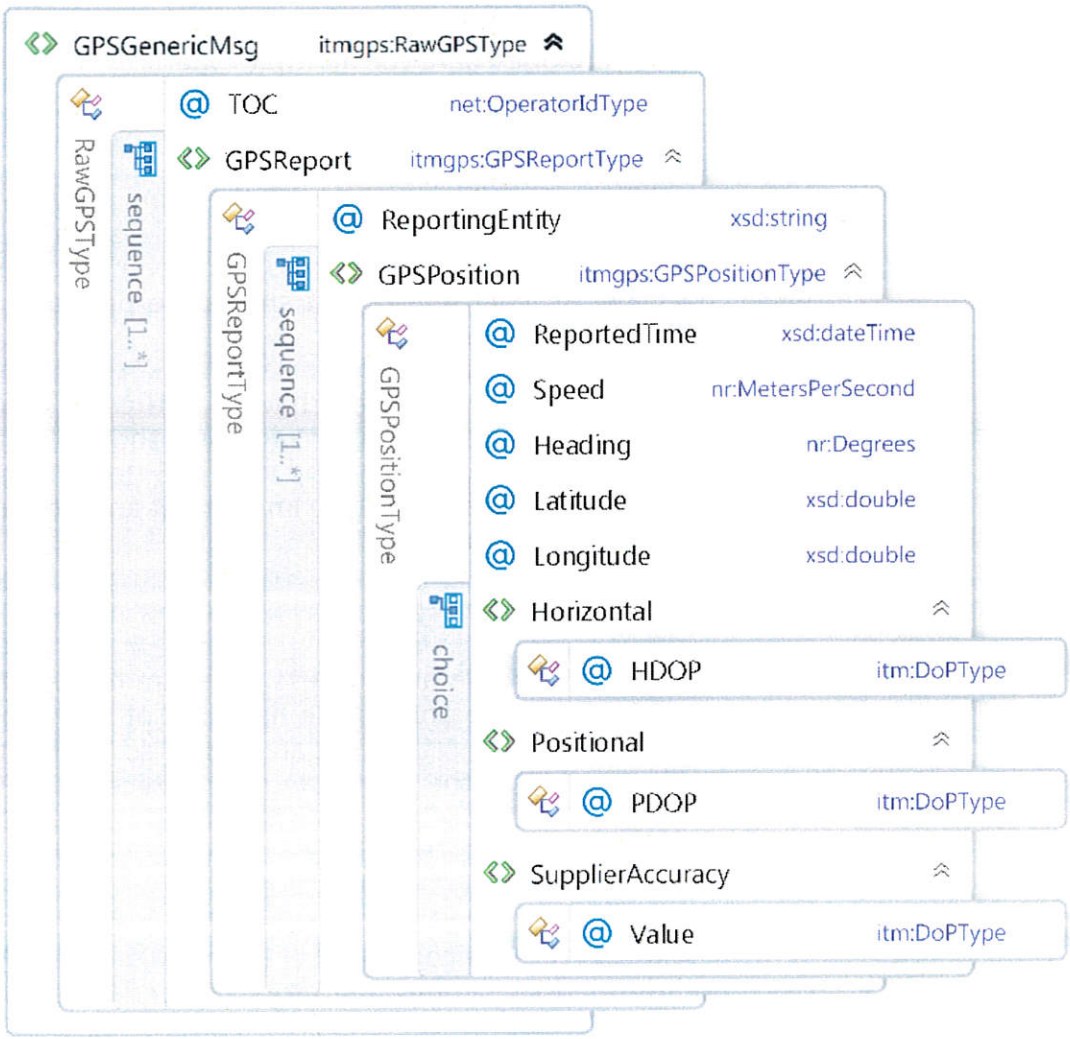

Figure 2 Generic GPS Report Schema

Table 1 provides additional information relating to the description and restriction of data items within this interface:

Table 1 Data Item Descriptions

Item	Format	Description
Operator Id	Alphanumeric	2 character business code of the Freight/Train operator whose data is being supplied.
ReportingEntity	Alphanumeric	The device which provided the GPS report. In general this should be the unit or vehicle number. However, if a supplier-specific GPS device Id is used then a mapping from this to the unit/vehicle must also be provided (outwith the interface described here).
TrainId	String	Optional train Id supplied by the GPS supplier (either by on-train or shore-based process). If populated this should contain the operational headcode (in the format nXnn).
ReportedTime	ISO Date/Time	UTC date and time at which the position was determined.
Speed	Numeric	GPS derived speed in metres per second.
Heading	Numeric	The heading in degrees, clockwise from North.
Latitude	Decimal	WGS84 latitude.
Longitude	Decimal	WGS84 longitude.
H/PDOP	Decimal	A decimal value between 0.0 and 20.0 indicating the quality of the GPS position data. The lower the value the more accurate the data.

Additionally, the three options for the accuracy measure are shown in the diagram in order of preference:

- **Horizontal Dilution of Precision (HDOP)**: where this measure is available it should be provided in preference to the other suggested values;
- **Positional Dilution of Precision (PDOP)**: where the specific Horizontal measure is not available this, more generic, measure should be provided;
- **Supplier Accuracy Rating**: where DOP values are not available from the supplier's GPS system; their own measure of accuracy should be provided (implemented at a similar level to DOP readings).

2.2.2 Message Type: GPS Service Response

This structure will contain the response to the call to the GPS hosted web service.

It will contain the following information:

- The supplied TOC Id to ensure that the response can be matched to the correct data;
- A success flag indicating whether any errors occurred;
- If the success flag is false, a collection of Errors. Each Error entry will consist of:
    - An optional copy of the supplied GPS report data (this will be included if the error relates to a specific report);
    - A list of one or more errors (with a description and an optional error code) relating to this GPS report.

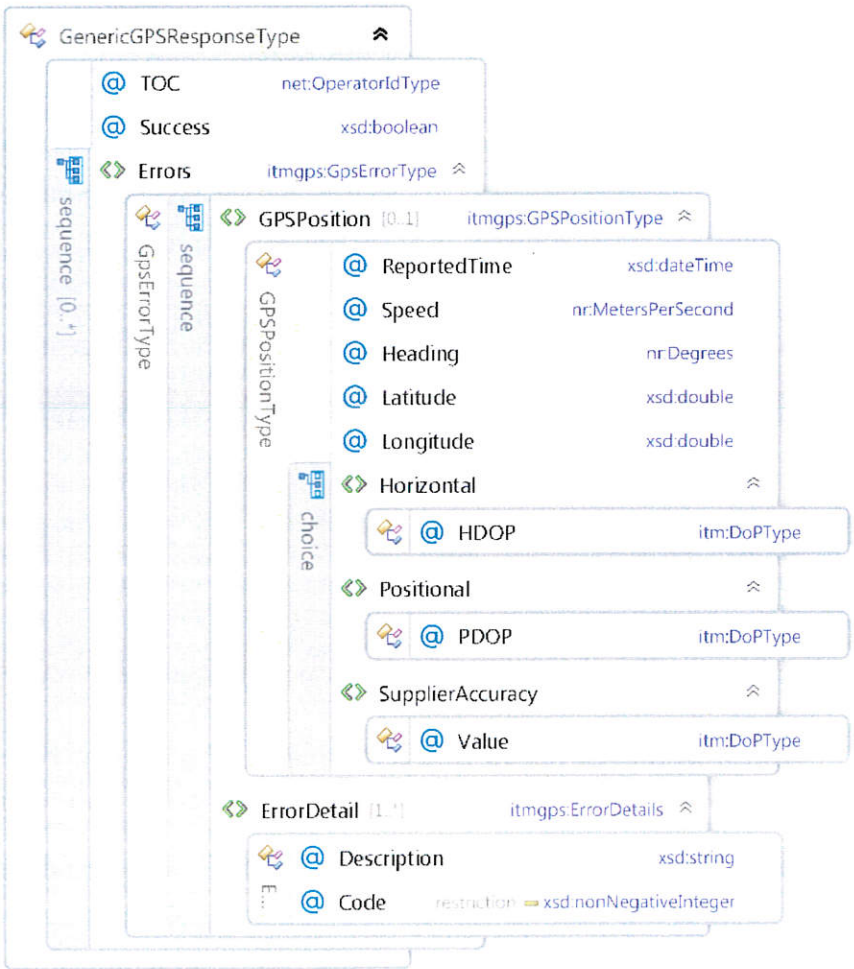

Figure 3 Generic GPS Response Schema

2.3 Interface Definitions

2.3.1 Interface: Generic GPS Reports

Interface	Receipt of GPS report details from a generic GPS supplier.
Message Type	2.2.1 Message Type: Generic ***GPS Report*** (0)
Transport Mechanism	SOAP WCF Web services; HTTPS.
Source	3rd party GPS supplier system
Destination	GPS Service web server
Security & Auditing	Calls to the GPS Service will need to use SSL and supply a valid username and password in the header. Calls to the service that fail the application authentication will be logged by the GPS service.
Volumes	Using the schema definition shown above (*0*) a message containing a single GPS report will be in the region of 380 bytes. For each additional GPS report added to the overall message the size will increase by approximately 240 bytes.
Frequency	A call to the web service should be made not more frequently than every 10 seconds containing the latest report for each applicable unit. On agreement with both parties, position data may be batched by the supplier system but must be transmitted at least every 60 seconds.
Impact of Failure	If this interface fails then the GPS Service will be unable to track units and train services operated by TOCs that use this GPS supplier.
Recovery	There are no specific recovery requirements for this interface. Once the interface has recovered data should be obtained from the point of failure up to a maximum age of 60 minutes.
Other Information	N/A

2.3.2 Interface: Generic GPS Response

Interface	Response to the Generic GPS Report interface by the GPS Service
Message Type	*2.2.2 **Message Type: GPS Service Response*** (-)
Transport Mechanism	WCF Web Service
Source	GPS Service web server
Destination	3rd party GPS supplier system
Security & Auditing	This interface will be returned as the response to the call to the Generic GPS Reports interface *(0)* Calls to the GPS Service will need to use SSL and supply a valid username and password in the header. Calls to the service that fail the application authentication will be logged by the GPS service.
Volumes	As *2.2.1 Message Type: Generic **GPS Report** (0)*
Frequency	Once in response to each call to the Generic GPS Reports interface *(0)*.
Impact of Failure	As *2.2.1 Message Type: Generic **GPS Report** (0).*
Recovery	As *2.2.1 Message Type: Generic **GPS Report** (0).*
Other Information	N/A

Version history

Version	Date	Comment	Author
1a	14/03/2013	Initial document	E Mallon
1b	13/05/2013	Updated following review.	E Mallon
1	23/05/2013	Final version	E Mallon
2a	09/07/2013	Added train Id field at request of Jason D'Arcy	E Mallon
2	30/01/2014	Final version	E Mallon
3	18/04/2018	Updated for external use.	H Richardson

About this version

- *Schema based on Network Rail Raw GPS schema.*