

Document Identity

File name	Interface Specification - Train to OTM Service (Meter Data)
File location	CCMS
Version no	1.4
Author	Richard Sayes
Date created	02 July 2010
Date last amended	08 September 2011

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0. Document Control and Administration

0.1 Document History

Version	Date	Name / Role	Description of Changes
0.1	02/07/2010	Richard Sayes	Initial Draft
0.2	02/07/2010	Richard Sayes	Added in Reactive Energy attributes
0.3	09/11/2010	Richard Sayes	To reflect known changes since ITT was issued. Document completion still awaits workshops with EnergyICT and Operators
0.4	02/11/2010	Richard Sayes	Interim updates based on phone conference with EnergyICT (01/11/2010). Next set of changes pending workshop 03/11/2010 with First Group, London Midland, EnergyICT (other were invited)
0.5	06/12/2010	Richard Sayes	Significant changes based on Friday 03 Dec 2010 workshop with: First Group, London Midland, Interfleet, Logica and EnergyICT
0.6	24/12/2010	Richard Sayes	Further changes based on feedback from Virgin Trains, London Midland (Interfleet Technology), First Group (Scot Rail and First Capital Connect), National Express, Network Rail, Logica and EnergyICT.
0.7	14/01/2011	Richard Sayes	Various amendments for preparation for the final version for First Group and Interfleet to implement from. Virgin Trains and National Express feedback on version 0.6 still pending.
1.0	18/01/2011	Richard Sayes	Virgin Trains feedback received 04 Feb 2011; as a result change requests have been raised on behalf of Virgin Trains. These are not reflected in this document as they will be pending approval Final Version for April 01 Go-Live. Effectively version 0.7 as distributed to Operators + subsequent email clarifications
1.1	04 March 2011	Richard Sayes	Clarity required on Reactive Energy. London Midland asserts the spec allows them to send reactive values. However, if they do this then this equates to a commercial charge. The spec is not clear, but for April 01 it was always expected that null/blank values would be NOT passed through. Clarity added. Transmission ID – EnergyICT assert that alpha numeric means they should not accept underscore. Sample files clearly indicate underscore. Clarity added.

Version	Date	Name / Role	Description of Changes
1.2	19 August 2011	Richard Sayes	Updated to reflect Virgin Trains use of UTILTS Location – Quality Flag, estimated allowed – again to support Virgin Trains interpolation of GPS data via ERESS Various Appendixes added for completeness, reflecting changes agreed for April 01 2011 go-live
1.3	31 August 2011	Richard Sayes	Feedback from Logica (Dave Du Vergier) Refined appendix on GPS and ESTA handling.
1.4	02 September 2011	Richard Sayes	Feedback from EnergyICT (martin Noakes). Remove per Operator solution diagrams in Appendix.

0.2 Reviewers

Version	Date	Name / Role	Comment
0.5		First Group	Refer comments sheet provided by NR and completed by Operator
0.5		London Midland (Interfleet Technology)	Refer comments sheet provided by NR and completed by Operator
0.5		National Express	Refer comments sheet provided by NR and completed by Operator
0.5		Logica	Refer comments sheet provided by NR and completed by Operator
0.5		EnergyICT	Refer comments sheet provided by NR and completed by Operator
0.5		Freight Liner	None received
0.5		Southern	None received
0.5		Network Rail	Refer comments sheets provided by NR and completed by individuals
0.6		First Group	Refer comments sheet provided by NR and completed by Operator
0.6		London Midland (Interfleet Technology)	Refer comments sheet provided by NR and completed by Operator
1.1		David Hearne (Network Rail)	
1.3		Logica and EnergyICT	Refer comments sheet provided.

0.3 Document Approval

Version	Date	Name / Role	Qualifications to Approval
1.0		Network Rail	
1.0		Logica/EnergyICT	

0.4 Network Rail References

ID	Reference / Name	Version	Date
1.	OTM Business Architecture http://ccms.hiav.networkrail.co.uk/webtop/drl/objectId/09014d18815e930e	4.4	25/05/2011
2.	OTM Business Requirements Catalogue http://ccms.hiav.networkrail.co.uk/webtop/drl/objectId/09014d18814efe30	3.0	18/02/2011
3.	Outline Solution Design http://ccms.hiav.networkrail.co.uk/webtop/drl/objectId/09014d188151c227	2.2	20/01/2011
4.	UIC Leaflet http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fc9d06	1 st Edition (Draft)	Sep 2009
5.	Railway Group Standard GM/RT2132 http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fc2692	Issue One	Date September 2010
6.	EN 50463 http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fb8c21 (Part 1 - General) http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fc74e9 (Part 2 – Energy Measuring) http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fc86a2 (Part 3 – Data Handling) http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fc9ca3 (Part 4 – Communication)	Draft Draft Draft Draft	4 Sept 2009 4 Sept 2009 4 Sept 2009 4 Sept 2009
7.	OTM Charging Scenarios http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fcdabd	CCMS 1.2	18/12/2010
8.	Seven Day Rule http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b80fcd5fd	CCMS 1.0	18/12/2010
9.	OTM FAQ http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b81290c18	CCMS 1.3	21/04/2011
10.	OTM Glossary of Terms http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b811b2411	CCMS 2.0	18/02/2011

ID	Reference / Name	Version	Date
11	OTM Web Site http://www.networkrail.co.uk/aspx/12873.aspx	n/a	n/a
12	Metering Rules (link on above web site) http://www.networkrail.co.uk/documents/10690_EC4TMeteringRules.pdf	n/a	22 June 2011
13	OTM Service http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813cdfaf	2.0	
14	Visio diagrams supporting this document http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b8126fcc8	n/a	n/a
15	This document (and supporting files) http://ccms.hiav.networkrail.co.uk/webtop/drl/objectId/09014d18814ff420	1.1	

1. Introduction

This specification defines the provisioning of *Time Series Meter Data* from the Train Operator to the *OTM Service*.

Managed by Network Rail, the *OTM Service* is externally hosted (by EnergyICT) and is intended to provide an independent data collection, processing and distribution capability on behalf of the UK Rail Industry, *aligned* to UIC processes.

1.1 Purpose

The purpose of this interface specification is:

- 1) To detail the data to be provided by any Operator to the OTM Service.
- 2) To detail the data provisioning rules and associated interchange of messages/files to ensure robustness and data security
- 3) To detail the validation rules that will be applied to the data when received by the OTM Service.
- 4) To detail the meter data aggregation rules that will be applied to data sent to the OTM Service.
- 5) To automate the provision of data - in order to minimise any manual activities and/or resources required by all parties.

This specification does not support meter data collection for purposes other than billing e.g. energy analysis or driver behaviour.

Freight and International movements are not specifically supported within the overall design of the solution for April 01 2011.

To supplement understanding, the specification also provides *visibility* of data and business rules that subsequently execute in other Network Rail applications (e.g. OTMDS-DES and TABS). The *specific and most up-to-date details* are detailed in other documents.

Aspects of the interface specification are specific to the SFTP transfer mechanism and CSV data format. However, the bulk of the specification is applicable to other transfer mechanisms should this be required in the future.

1.2 Background

An interim OTM solution was implemented for Virgin Trains, for the financial period beginning April 01 2010. This solution required no changes to TABS and accommodated submission of train meter data via email.

The strategic OTM solution was implemented for the financial year beginning April 01 2011. Operators included London Midland, Southern, First Capital Connect, First Scott Rail and Virgin Trains.

Note that in order to support April 01 2011 Operators, this specification was developed in advance of:

- Specific TAA rules being developed and agreed with each Operator, *and*
- Business Rules being developed and agreed across all parties.

1.3 Change Control

All parties (Operators, ATOC and/or Network Rail) may request changes and/or clarifications to this specification through the OTM User Group.

1.4 Context

The diagram following summarises the data flows relevant to this interface. This specification principally addresses flows 3) 7) and 8).

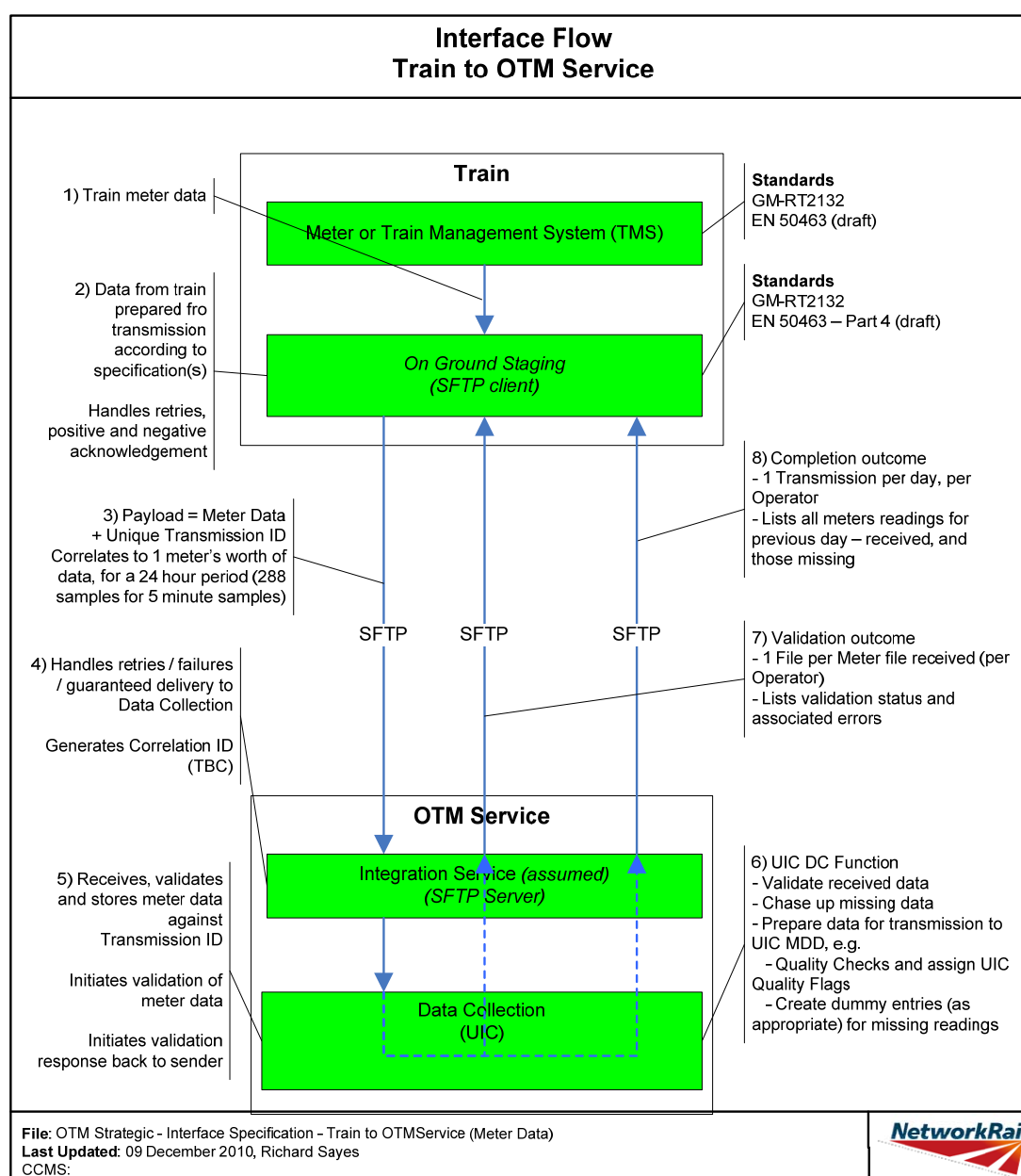


Figure 1 – Interface Overview

1.5 Assumptions

1. All Operators (01 April 2012 and beyond) are capable of supporting SFTP in a SFTP client configuration.
2. All Operators engage appropriate I.T resource that can design and implement the required data provisioning solution end-to-end.

1.6 Dependencies

1. Data Quality:
 - 1.1. Timely and accurate provision of the meter data from Train through to Network Rail is critical from the outset.
 - 1.1.1. The data volumes are significant and any *expectations* that all issues within hundreds-of-thousands of rows (per day) of meter data can be found by any one party and corrected are unrealistic, if not costly.
 - 1.1.2. Meter data will be validated by the OTM Service according to the validation rules and data provisioning detailed in this document. *GPS validation currently occurs in the OTMDS within Network Rail.*

Note - If any one record / attribute within the file fails the validation rules, then all the records in the file are effectively rejected.

 - 1.2. GPS accuracy within poor signal areas is a potential issue for this solution.
Note - validation of GPS readings is included in the solution and is derived in part from the accuracy stated in the Group Standard.
 - 1.3. Although not specific to this interface specification, the Train Movement and Consist data provided in Operational systems must be correct. Default consists are a recognised issue that may result in:
 - 1.3.1. Undesirable manual correction activity by the Operator, OTM Service and/or Network Rail resources.
 - 1.3.2. Non-matching of meter data to TABS Journey, or TABS Journey to meter data.
2. All parties establish I.T. infrastructure services and support processes to meet the end-to-end requirements of the OTM solution.
3. All train meters and/or Train Management Systems meet regulatory / engineering standards (i.e. GM/RT2132, an interim standard pending BS EN 50463)
 - 3.1. Network Rail uses the energy data supplied through this interface without question (other than the data and business validation rules detailed in this and other documents).
4. Time consistency and accuracy across all parties (Train meter, Operator I.T, OTM Service I.T and Network Rail I.T) is key to ensuring accurate processing of time-series meter data and Journey matching. This includes the:
 - 4.1. Capability on the Operator to provision meter data in UTC, which further necessitates the Operator converting between local time and UTC, including handling Summer/Winter changeovers;

- 4.2. Capability on Network Rail to match the UTC time to TABS, which further necessitates converting between local time and UTC, including handling Summer/Winter changeovers;

4.3. *Refer also GM/RT2132 section A.2.1 a)*

2. Data Provisioning

The data requirements detailed below are intended to:

1. Adhere to group standard GM/RT2132
2. Align to the UIC (draft)
3. Allow for robust and secure interchange of data, supporting non-repudiation concepts.
4. Support the data needed by the Network Rail Track Access Billing System (TABS) to provide a metered bill and detailed breakdown for reporting, challenge and audit

2.1 Static Data

Static data relevant to this interface is as follows. *Note that other static data is required to support the overall solution.*

1. Network Rail own and advise the 2 digit Operator code. *Refer section 9 Appendix – Operator Codes*
 - 1.1. Note - where a third party provides services on behalf of one or more Operators, that third party must provide the data in the context of each Operator it supports.
2. OTM Service provider own the Error Codes and Descriptions
3. Operators must have European Vehicle Numbers allocated for Vehicles that are metered.
 - 3.1. Operators must provide to Network Rail and OTM Service provider, “lookup” tables that correlate European Vehicle Number to UK Domestic Vehicle Number.

This is because the Operational systems use the UK Domestic Vehicle Number predominantly

2.2 Message Interchange

The following summarises the data flows implemented.

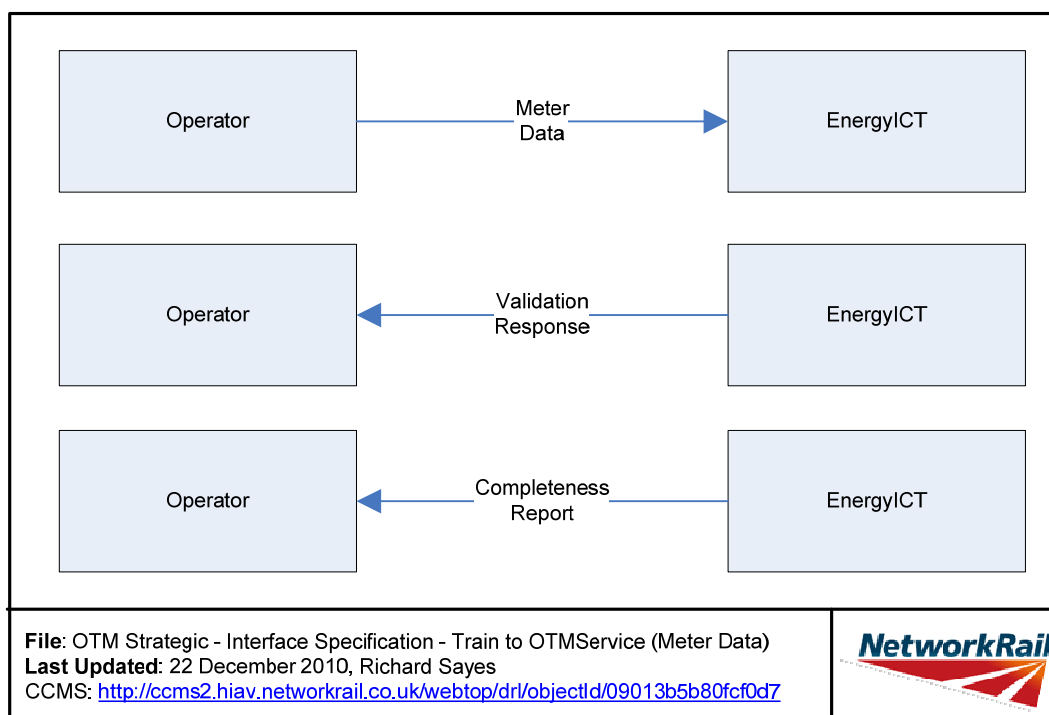


Figure 2 – Data Flows

As an SFTP implementation, this equates to:

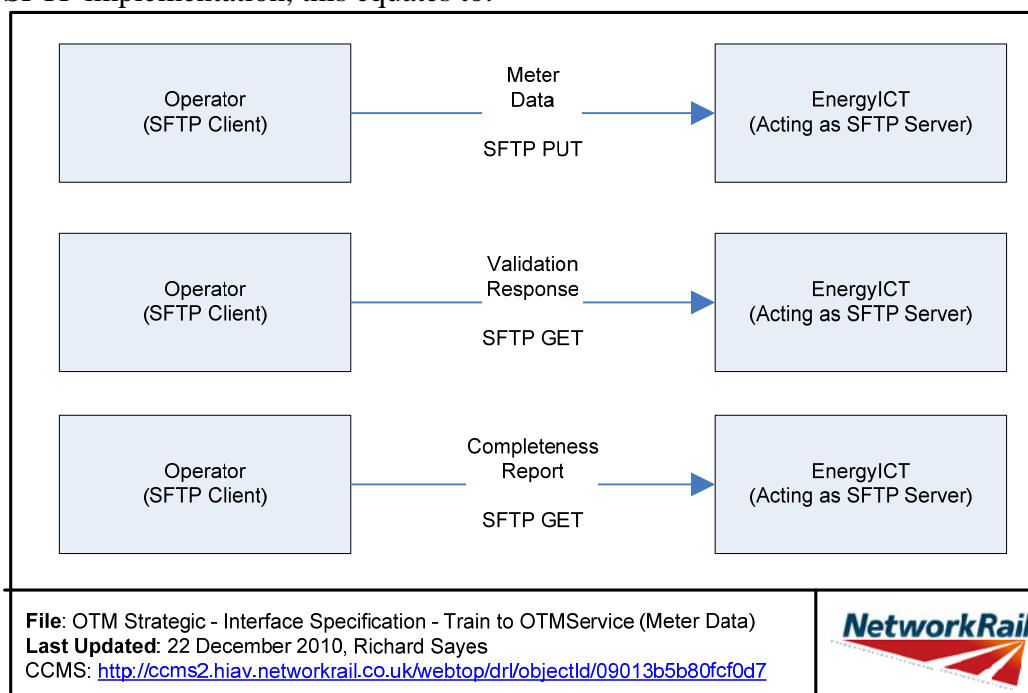


Figure 3 – SFTP Interactions

2.3 Message Implementation

The above flows will be realised as follows:

	Flow	Description
1.	Meter Data	This will be implemented as an SFTP PUT <ul style="list-style-type: none"> Operator executes an SFTP push to the OTM Service

	Flow	Description
2.	Validation Response	<p>This will be implemented as an SFTP GET</p> <ul style="list-style-type: none"> OTM Service generates Validation Files (1 per Meter data file received) and places them in predefined SFTP directory. Operators poll these directories on a regular basis, retrieving files placed there.
3.	Completeness Report	<p>This will be implemented as an SFTP GET</p> <ul style="list-style-type: none"> OTM Service generates Completeness File (1 per day) and places them in predefined SFTP directory. Operators poll these directories on a regular basis, retrieving files placed there.

Table 1 – Message Implementation

2.4 Transmission Protocol

- SFTP shall be used as the transfer protocol
- Operators in all scenarios will act as the *SFTP Client*
- OTM Service in all scenarios will act as the *SFTP Server*.

2.5 Transmission Payload

- Data will be provisioned in CSV format. *Refer Appendix – CSV Layout*

Note – the filenames of the samples below intentionally do not align the file naming convention outlined in this specification.

- The CSV files implicitly define the column order expected. for the exact CSV column layout.*** Therefore:
 - Actual data cannot include commas.
 - The sender is responsible for ensuring that data sent over the interface complies with this requirement.

By way of example:

- Numbers must NOT contain commas i.e. 3456 not 3,346
- Dates and Times must NOT contain commas (the format is specified in sections below)
- Meter Number, Vehicle Number must not contain a Comma.

2.6 Message Interchange Data

Note - The tables in this section define the data to be provided. The tables do NOT imply the order of the data in the CSV file. Refer section 4 Appendix – CSV Layout. The indicative files themselves define the CSV column order.

Terminology

The terms *null* and *blank*; are used interchangeably in this document to mean where any value is; not available / not defined / not to be provided i.e. “the value is set null”, “the value is set blank”.

Section 2.12 CSV file specifics, deals with how the are subsequent provisioned in CSV files

2.6.1 Logical Data Model - Message

The following logical model (UML notation) summarises the data supporting the interchange of messages across this interface.

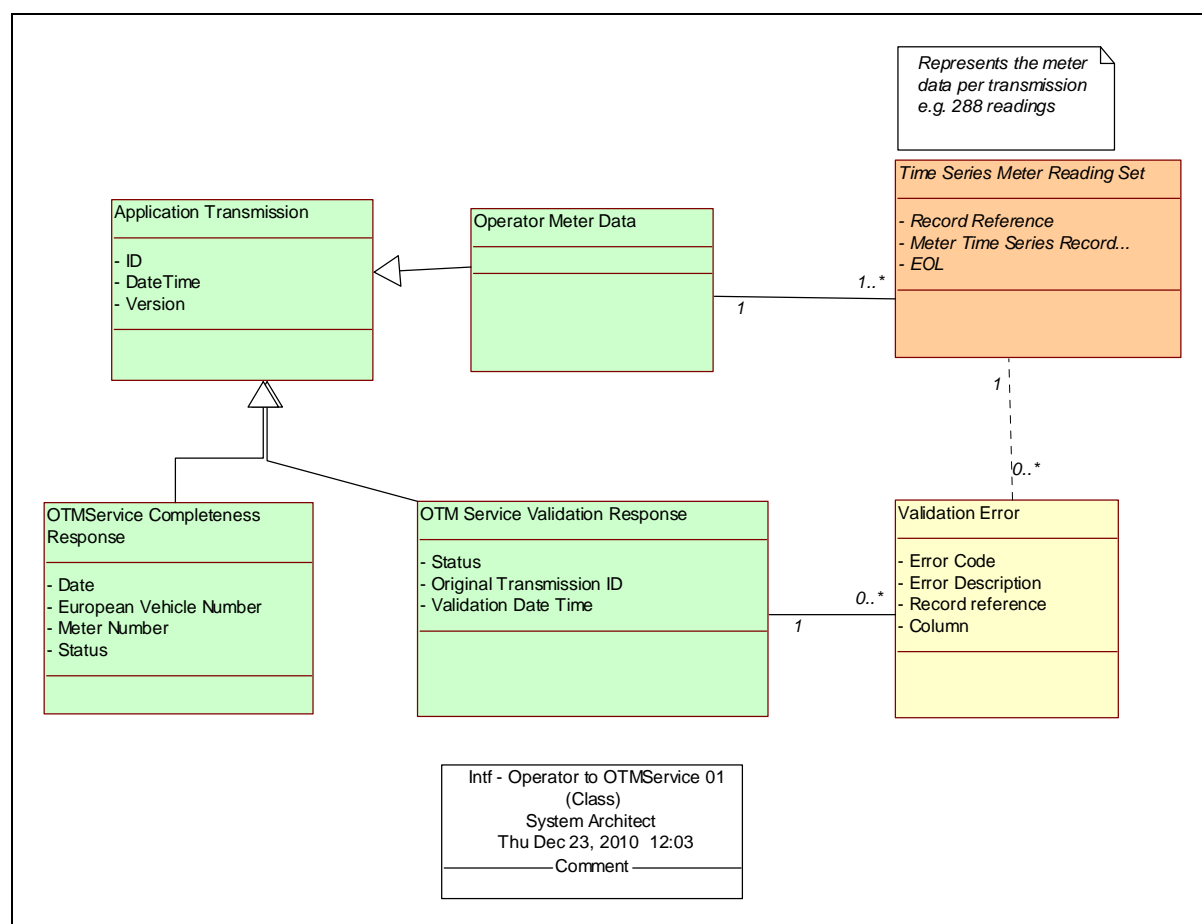


Figure 4 – Logical Model – Messages

2.6.2 Time Series Meter Reading Set

Represents the meter data (location, sample time, energy and quality flags) received by the OTM Service in a single transmission via a SFTP PUT from the Operator. *Refer section 2.7 Meter Data for the details.*

2.6.3 Application Transmission

Each message:

1. Is uniquely identified by a Transmission ID, generated by the application creating the message.
 - 1.1. The Transmission ID must be different for each transmission triggered through the application e.g. where meter data values have been amended.
 - 1.2. However, under certain scenarios e.g. automated resends due to network issues, the Transmission ID can remain the same. This is premised on the basis that:
 - 1.2.1. The message never reached the recipient

1.2.2. The resend is not an application initiated, rather initiated by underlying middleware or integration services, and/or Support initiated. Refer also section 3.9.2 *Recovery*.

1.3. Where an Operator uses more than one provider (e.g. where C2C/National Express both use Bombardier and Siemens) then to ensure Transmission ID uniqueness it is recommended that the Transmission ID is prefixed to distinguish the Provider e.g.

1.3.1. Transmission ID 12345 becomes S12345 for Siemens

1.3.2. Transmission ID 12345 becomes B12345 for Bombardier

2. Has an associated Transmission Date-Time

	Attribute	Description
1.	Transmission ID	<p>Unique identifier generated by the sending application</p> <ol style="list-style-type: none"> Unit of measure (UOM): n/a Format: <ol style="list-style-type: none"> Alpha-Numeric Text (including underscore) Up to and including 64 characters. This allows for GUID/UUID's to be implemented should the sender wish to adopt. E.g. per http://www.uuidgenerator.com/ Prefix with Operator 2 digit code Accuracy: Unique across all Operators Provisioning: Mandatory
2.	Transmission Date-Time	<p>This is the date-time at which the Application generated the file / message for initial sending (not retries)</p> <ol style="list-style-type: none"> Unit of measure (UOM): GMT/UTC Format: YYYYMMDDHHMMSS Accuracy: To seconds Provisioning: Mandatory
3.	Interface Version	<p>Allows for future change management capability.</p> <p>In concept, this applies predominantly to a change such as additional attributes in the interface and/or the validation of attributes by the OTM Service.</p> <ol style="list-style-type: none"> Unit of measure (UOM): n/a Format: Integer Accuracy: ≥ 1 Provisioning: Mandatory Validation: <ol style="list-style-type: none"> The version number for 01 April 2011 is <u>1</u>, no other values are acceptable. The version 01 April 2012 is expected to remain at 1 (as at version 1.2 of this document) <p>Rules:</p> <ol style="list-style-type: none"> Network Rail owns the Interface and therefore the version number.

Table 2 – Data – Application Transmission

2.6.4 Operator Meter Data

The interface meta-data provided when the Operator sends meter data to the OTM Service.
Note this includes the data specified above in “Application Transmission” above.

2.6.5 OTM Service - Validation Response

The interface meta-data provided by the OTM Service in the context of a Validation Response. *Note this includes the data specified above in “Application Transmission” above.*

	Attribute	Description
4.	Operators Transmission ID	The original Operators Transmission ID received by the OTM Service is a previous transmission. 1. Provisioning: Mandatory
5.	Status	The validation outcome: 1. Unit of measure (UOM): n/a 2. Format: Text 3. Accuracy: Set of values [“PASS”, “FAIL”] 4. Provisioning: Mandatory 5. Validation: Per Accuracy
6.	Validation Date-Time	This is the date-time at which the OTM Service validated the message data 1. Unit of measure (UOM): GMT/UTC 2. Format: YYYYMMDDHHMMSS 3. Accuracy: To seconds 4. Provisioning: Mandatory

Table 3 – Data – Validation Response

2.6.6 Validation Error

Details specific errors associated with the above “OTM Service Validation Response”, where that response is “*FAIL*”. Note

1. OTM Service is responsible for defining Error Codes and Descriptions
2. Error codes should indicate to Operator the nature of error, such that they can investigate

	Attribute	Description
7.	Error Code	An error code as unique as possible to the error, which allows the Operator to confirm and resolve the error. 1. Unit of measure (UOM): n/a 2. Format: Alpha Numeric, max length 16 3. Accuracy: n/a 4. Provisioning: Mandatory 5. Validation: n/a Rules: 6. Error Codes (and Description) is owned by OTM Service provider. 7. Error Code is unique and cannot be reused for another error condition.
8.	Error Description	The corresponding error description to the above error code. 1. Unit of measure (UOM): n/a 2. Format: Alpha Numeric, max length 128 3. Accuracy: n/a

	Attribute	Description
		<p>4. Provisioning: Mandatory 5. Validation: n/a</p> <p>Rules:</p> <p>6. Error Codes (and Description) is owned by OTM Service 7. Error Code is unique and cannot be reused for another error condition.</p>
9.	Line	<p>This represents the line number in the CSV file (Column 1 value). <i>This allows the Operator to pin-point the data in relation to the above error code.</i></p> <p>1. Unit of measure (UOM): n/a 2. Format: Numeric Integer >= 1 3. Accuracy: n/a 4. Provisioning: Optional 5. Validation: n/a</p> <p>The first line (line 1) is the header in a CSV file. Column A defines the line number.</p> <p>Note</p> <ul style="list-style-type: none"> - In some cases the error may not be specific to a line/column e.g. duplicate record. - The number does not have to start at 1, it just needs to be unique within the file
10.	Column	<p>This represents the column name in the CSV. <i>This allows the Operator to pin-point the data in relation to the above Error Code.</i></p> <p>1. Unit of measure (UOM): n/a 2. Format: Text 64 3. Accuracy: n/a 4. Provisioning: Optional 5. Validation: Per Accuracy</p> <p>The first column is column 1 (Column A in Excel)</p> <p>Note - In some cases the error may not be specific to a line/column e.g. duplicate record.</p>

Table 4 – Data – Validation Response – Errors

2.6.7 OTM Service Completeness Response

OTM Service will generate this file on a *daily basis* at midday (configurable) for:

1. Meter Data for the previous day, that was NOT received
2. Meter Data for the previous day, which was received.

If the Operator does not receive a file, this will be handled by manual support process.

	Attribute	Description
11.	Original Transmission ID	The Transmission ID as provided by the Operator for the meter data transmissions previous pr.

	Attribute	Description
		1. Provisioning: Optional (as the data for a meter, for the Day – may not have been received)
12.	Day	The Day for which this completeness report applies 1. Unit of measure (UOM): n/a 2. Format: YYYYMMDD 3. Accuracy: to day 4. Provisioning: Mandatory 5. Validation: n/a
13.	Operator	Refer Operator in section 2.6.8 <i>End of Line</i> Each record (i.e. each line of the CSV file) will specifically include an EOL marker (the last column in the file). This is for readability of the file, test and production support reasons, providing a clear visual marker within the file. Meter Data below 1. Provisioning: Mandatory
14.	European Vehicle Number	Refer European Vehicle Number in section 2.6.8 below 1. Provisioning: Mandatory
15.	Meter Number	Refer Meter Number in section 2.6.8 <i>End of Line</i> Each record (i.e. each line of the CSV file) will specifically include an EOL marker (the last column in the file). This is for readability of the file, test and production support reasons, providing a clear visual marker within the file. Meter Data below 1. Provisioning: Mandatory
16.	Status	The validation status of the meter data received on the day given by Date 1. Unit of measure (UOM): n/a 2. Format: Text 3. Accuracy: Set of values [“PASS”, “FAIL”, “MISSING”] 4. Provisioning: Mandatory 5. Validation: n/a

Table 5 – Data – Completeness Report

2.6.8 End of Line

Each record (i.e. each line of the CSV file) will specifically include an EOL marker (the last column in the file). This is for readability of the file, test and production support reasons, providing a clear visual marker within the file.

2.7 Meter Data

The tables in this section define the data to be provided. The tables do NOT imply the order of the data in the CSV file. Refer section 4 Appendix – CSV Layout. The example files themselves define the CSV column order.

2.7.1 Logical Data Model

The following logical model (UML notation) summarises the meter data.

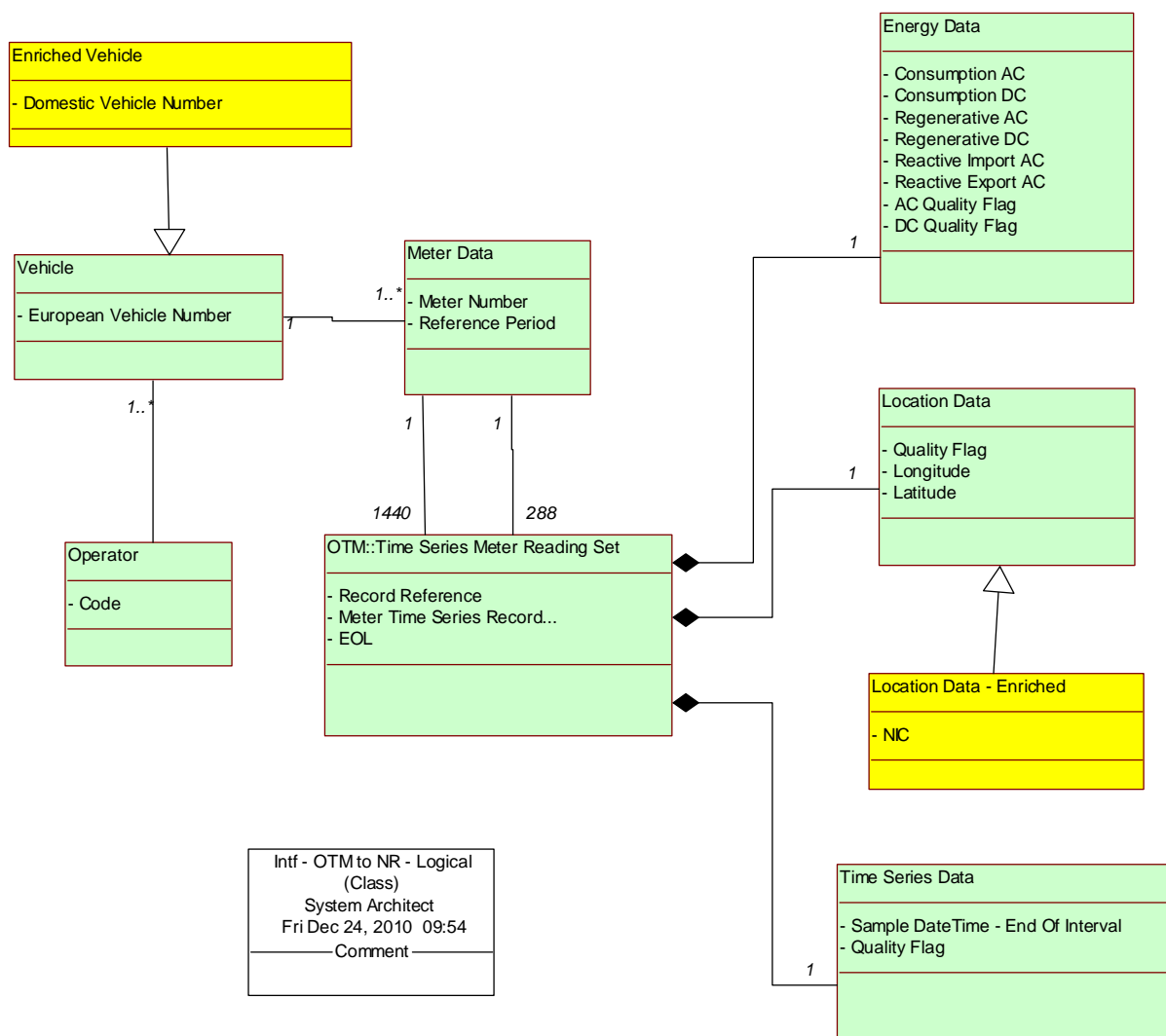


Figure 5 – Logical Data Model – Meter Data

	Attribute	Description
1.	Operator Code	A unique 2 digit Operator code as defined through TABS. Note - This is the Owner Operator. This is important for billing when the vehicle/MU is loaned out to another Operator. 1. Unit of measure (UOM): n/a 2. Accuracy: Mastered list provided by Network Rail to all Operators 3. Format: Text, max length 2 characters 4. Provisioning: Mandatory 5. Validation: 5.1. Code must be in list of valid Operator Codes 5.2. Operator must be OTM registered
2.	European Vehicle Number (EVN)	European Vehicle Number (not Unit Number) to which the meter(s) are

	Attribute	Description
		<p>fitted.</p> <ol style="list-style-type: none"> Unit of measure (UOM): European Vehicle Number Accuracy: Mastered through the Rolling Stock Library (or the OTM Service in the interim) Format: Alpha Numeric - 12 Digit European Vehicle Number (EVN) (see GM/RT2132) Provisioning: Mandatory Validation: <ol style="list-style-type: none"> The OTM Service will check against its registry of Metered Fleet (per Operator) that this EVN is declared as an OTM capable. Notes: <ol style="list-style-type: none"> A Vehicle can have 1 or more meters fitted. Operators will need to allocate EVN'S for all metered vehicles. Operators will need to provide EVN to UK Domestic Vehicle Number "lookup" tables – as Operational systems are UK based only (some exceptions for Freight)
3.	Meter Number	<p>A unique meter number, which has an association to one and only one Vehicle</p> <ol style="list-style-type: none"> Unit of measure (UOM): n/a Accuracy: Mastered through the Rolling Stock Library (or the OTM Service in the interim) Format: Alpha Numeric - 32 characters maximum Provisioning: Mandatory Validation: The OTM Service will check against the registry of metered fleet that this meter number is associated with the EVN. <p><i>Notes – it is understood that Meters can be moved, in which case the registry of metered fleet would need to be updated.</i></p>
4.	Reference Period	<p>The length of the sample interval of the meter data samples.</p> <ol style="list-style-type: none"> Unit of measure (UOM): seconds Accuracy: n/a Format: numeric integer Provisioning: Mandatory Validation: <ol style="list-style-type: none"> The current acceptable values are 60 (1 minute) and 300 (5 minutes) – configurable. Notes: <ol style="list-style-type: none"> For billing purposes, only 300 seconds (5 minutes) is required. More frequent provisioning into the OTM Service <i>may</i> result in additional charges attributed to that Operator (TBC) Refer also Aggregation Rules (below)
5.	Sample Time - Quality Flag	<p>GM/RT2312 indicates the provision of Location, Energy and Time quality flags from the meter. <i>It is the responsibility of the OTM Service to set the final Quality Flag. This provides for consistence and independence across Operators.</i></p> <ol style="list-style-type: none"> Unit of measure (UOM): n/a

	Attribute	Description
		2. Accuracy: Predefined UIC and GM/RT2132 codes 2.1. 127 (Measured) 2.2. 61 (Uncertain) 2.3. 46 (Non-Existent) 3. Format: Integer 4. Provisioning: Mandatory 5. Validation: Per codes above.
6.	Sample Time - End Of Interval	The sample time for the end of this 1-minute or 5-minute sample: 1. Unit of measure (UOM): GMT/UTC 2. Accuracy: To minute's accuracy on the interface. The second's component is always provided as 00. <i>See section 2.9.2 Provisioning Specifics.</i> 3. Format: YYYYMMDDHHMMSS 4. Provisioning: Mandatory 5. Validation: 5.1. Date is not in the future of processing day (i.e. cannot process meter data time stamps for tomorrow, today!)
7.	Location – Quality Flag	GM/RT2312 indicates the provision of Location, Energy and Time quality flags from the meter. <i>It is the responsibility of the OTM Service to set the final Quality Flag. This provides for consistence and independence across Operators.</i> 1. Unit of measure (UOM): n/a 2. Accuracy: Predefined UIC and GM/RT2132 codes 2.1. 127 (Measured) 2.2. 61 (Uncertain) 2.3. 46 (Non-Existent) 2.4. 56 (Estimated) has been allowed to Support the GPS estimations made by ERESS on behalf of Virgin Trains. 3. Format: Integer 4. Provisioning: Mandatory 5. Validation: Per codes above 6. Note Operators can set the value to Uncertain, if they know the value is invalid e.g. a longitude/latitude of 0,0. Or more generally a longitude/latitude value that falls well outside the UK boundary.
8.	Location – Longitude	The <u>Longitude</u> position of the vehicle <u>at the end</u> of the meter sample time of the meter reading 1. Accuracy: 250 meters (GM/RT2312) 1.1. Datum / Grid: Location data shall be based on the World Geodetic System, revision WGS 84 2. Provisioning: 2.1. Mandatory where quality flag is Measured, Estimated, Uncertain 2.2. Not specified / NULL where quality flag is Non-Existent 3. Format: 3.1. Decimal Degrees ± DDD.XXXXXX (positive values are East, negative values are West) e.g. +54.353180 / -2.938508

	Attribute	Description
		<p>4. Validation:</p> <p>4.1. Value check: between ≤ 180.00000 and ≥ -180.00000 (see below also for wider geospatial / boundary validation)</p> <p>4.2. Value is within national boundaries according to the Operator/Fleet profile e.g.UK only operators have the value checked against UK boundary polygon</p> <p>4.2.1. Note that due to functional constraint in the OTM Service, this check is undertaken subsequently in the OTMDS</p> <p>5. Notes</p> <p>5.1. The Network Rail OTMDS – DES processing will later explicitly validate the GPS location - in that it falls within an ESTA boundary.</p> <p>5.2. ESTA boundaries are defined geospatially using a 250m buffer either side of track line-of-route.</p> <p>5.3. Where the GPS falls outside all ESTA boundaries - the outcome will be to use the ESTA associated with the TABS Journey.</p> <p>5.4. Refer <i>Appendix – Location Validation</i> and GPS/ESTA Handling for further details.</p>
9.	Location – Latitude	<p>The <u>Latitude</u> position of the vehicle <u>at the end</u> of the meter sample Time of the meter reading. <i>Per above for details. See below for notes.</i></p> <p>1. Accuracy: 250 meters (GM/RT2132)</p> <p>1.1. Datum / Grid: Location data shall be based on the World Geodetic System, revision WGS 84</p> <p>2. Provisioning:</p> <p>2.1. Mandatory where quality flag is Measured, Estimated, Uncertain</p> <p>2.2. Not specified / NULL where quality flag is Non-Existent</p> <p>3. Format:</p> <p>Text - Decimal Degrees $\pm DD.XXXXX$ where positive values are North, negative values are South)</p> <p>e.g. +54.353180 / -2.938508</p> <p>4. Validation:</p> <p>4.1. Value check: between ≤ 90.00000 and ≥ -90.00000 (see below also for wider geospatial / boundary validation)</p> <p>4.2. Value is within national boundaries according to the Operator/Fleet profile e.g.UK only operators have the value checked against UK boundary polygon</p> <p>4.2.1. Note that due to functional constraint in the OTM Service, this check is undertaken subsequently in the OTMDS.</p> <p>5. Notes</p> <p>5.1. The Network Rail OTM DS – DES processing will later validate the GPS location in that it falls within an ESTA boundary.</p> <p>5.2. ESTA boundaries will be defined geospatially using a 250m buffer either side of track line-of-route, except where ESTA's intercept each other – in which case a more accurate approach will be adopted.</p> <p>5.3. Where the GPS falls outside the ESTA boundary - the default action will be to use the ESTA associated with the TABS Journey. No attempt will be made to resolve invalid GPS data.</p> <p>5.4. Refer <i>Appendix – Location Validation</i> and GPS/ESTA</p>

	Attribute	Description
		Handling for further details.
10.	DC Energy – Quality Flag	<p>GM/RT2312 indicates the provision of Location, Energy and Time quality flags from the meter.</p> <ol style="list-style-type: none"> Unit of measure (UOM): n/a Accuracy: Predefined UIC and GM/RT2132 codes <ol style="list-style-type: none"> 127 (Measured) 61 (Uncertain) 46 (Non-Existent) Format: Integer Provisioning: Mandatory where the traction unit is DC capable. Validation: Per codes above
11.	AC Energy – Quality Flag	<p>GM/RT2312 indicates the provision of Location, Energy and Time quality flags from the meter.</p> <ol style="list-style-type: none"> Unit of measure (UOM): n/a Accuracy: Predefined UIC and GM/RT2132 codes <ol style="list-style-type: none"> 127 (Measured) 61 (Uncertain) 46 (Non-Existent) Format: Integer Provisioning: Mandatory where the traction unit is AC capable. Validation: Per codes above
12.	Energy Consumption - AC	<p>Active energy value (kWh) representing the AC consumption delta between this sample and the previous sample (at the stated Reference Period)</p> <ol style="list-style-type: none"> Unit of measure (UOM): kWh (kilo Watt hour) Accuracy: to 1 decimal place Format: XXX.X Decimal point always provided i.e. 2 to be provided as 2.0 Provisioning: <ol style="list-style-type: none"> Mandatory where quality flag is Measured, Uncertain Not specified where quality flag is Non-Existent Basic Validation: <ol style="list-style-type: none"> Value ≥ 0.0, Value ≤ 999.9
13.	Consumption - DC	<p>Active energy value (kWh) representing the DC consumption between this sample time and the previous sample time</p> <p><i>Provisioning per above for “Energy Consumption – AC”</i></p>
14.	Regenerative - AC	<p>Active energy value (kWh) representing the AC regenerative / export between this sample time and the previous sample time</p> <p><i>Provisioning per above for “Energy Consumption – AC”</i></p>
15.	Regenerative - DC	<p>Active energy value (kWh) representing the DC regenerative / export between this sample time and the previous sample time</p> <p><i>Provisioning per above for “Energy Consumption – AC”</i></p>

	Attribute	Description
		<p><i>The following reactive energy attributes are specified for interoperability reasons only, where:</i></p> <ul style="list-style-type: none"> <i>UK rolling stock traverse non UK infrastructure and the Infrastructure owner requires this capability</i> <i>Non-UK rolling stock traversing UK (Network Rail) infrastructure, which have capable meters.</i> <p><i>Network Rail does not specifically require this for 01 April 2011 and this may apply to April 2012 Operators.</i></p>
16.	AC Reactive Energy - Import	<p>Reactive energy value (kVAr) representing the AC import between this sample time and the previous sample time</p> <p><i>Provisioning per above for “Energy Consumption – AC”</i></p>
17.	AC Reactive Energy - Export	<p>Reactive energy value (kVAr) representing the AC export between this sample time and the previous sample time</p> <p><i>Provisioning per above for “Energy Consumption – AC”</i></p>

Table 6 – Meter Data

2.8 Validation

2.8.1 Overview

There are four stages to validation of the data across the Solution; two specific stages within the OTM Service.

1. Basic Data Validation Checks (OTM Service)
 - 1.1. Relevant to this specification, e.g. checking format, mandatory values, semantics (dates are dates)
2. Business Rules Checks
 - 2.1. Implemented in the OTM Service, but most business rules are billing related and implemented in TABS.
 - 2.2. Business rules are not provided in this document and are subject to TAA ratification.
3. Enrichment failures
 - 3.1. Enrichment is implemented in the DES which may lead to specific failures
4. Journey Matching
 - 4.1. Journey matching is implemented in TABS and as a result, data inconsistencies may be highlighted e.g. Train Movement and meter data are inconsistent.

2.8.2 Basic Data Validation Checks

The following lists the data validation checks implemented in the OTM Service and parts of the interface flows covered by this specification.

1. Mandatory and conditional mandatory

- 1.1. Where an attribute is specified as mandatory, the OTM Service will check a value has been provided.
- 1.2. Where an attribute is specified mandatory in the context of another attribute, the OTM Service will ensure a value has been provided.

E.g. if the Quality Factor is measured, a consumption AC values must be supplied by the Operator where that meter is AC capable.

2. Format checks

All attributes will be checked against their designated format

3. Semantic checks

- 3.1. All attributes will be checked that they are semantically correct i.e. a date is a date; an integer number is an integer number.

4. The OTM Service will check that *combinations of attributes* are valid, as follows:

- 4.1. If the AC Energy Quality Flag is Measured or Uncertain, the corresponding AC Consumption and AC Regenerative values must be provided.
- 4.2. If the AC Energy Quality Flag is Non-Existent, the corresponding AC Consumption and AC Regenerative values must NOT be provided.
- 4.3. If the DC Energy Quality Flag is Measured or Uncertain, the corresponding DC Consumption and DC Regenerative values must be provided.
- 4.4. If the DC Energy Quality Flag is Non-Existent, the corresponding DC Consumption and DC Regenerative values must NOT be provided.
- 4.5. If the GPS Quality Flag is Measured, Estimated or Uncertain, the corresponding Longitude and Latitude values must be provided.
- 4.6. If the GPS Quality Flag is Non-Existent, the corresponding Longitude and Latitude values must NOT be provided.

5. Range checks

- 5.1. All attributes will be checked that they conform to any stated range of values and/or list of discrete values.

6. Record Count

- 6.1. 288 samples are provided for reference period of 5 minutes, per meter
Or:
- 6.2. 1440 samples are provided for reference period of 1 minute, per meter

7. Per Transmission Check

- 7.1. OTM Service checks that there are no repeated time series within the transmission provide.
 - 7.1.1. The sample time is used to determine this.

E.g. For a given Transmission ID X, the following would raise an error
(YYMMDDHHMMSS)

... etc

20110401232000

20110401232000 <<< duplicate

20110401232500

... etc

7.2. OTM Service checks that the Vehicle Number is the same

7.3. OTM Service checks that the Operator Code is the same

8. Resends (Meter Data amendments):

8.1. The Operator *may* resend meter data up until the *Daily Submission Cut-off* (refer section 2.9 Provisioning).

8.1.1. By way of example consider meter data for day X (UTC midnight to midnight)

8.1.1.1. Assuming the Operator triggers the first transmission for that meter on Day X + 1 (Operator has 7 days), then

8.1.1.2. On the same Day X + 1, the Operator can *resend* the Day X meter data multiple times until 11AM.

8.1.1.3. On Day X + 1, after 11AM, the Operator cannot resend meter data for days Day X

8.1.1.4. Assuming the Operator triggers the first transmission for that meter on Day X + 4 (Operator has 7 days), then

8.1.1.5. On the same Day X + 4, the Operator can *resend* the Day X meter data multiple times until 11AM.

8.1.1.6. On Day X + 4, after 11AM, the Operator cannot resend meter data for Day X

8.1.2. The meter data will be treated as amendment

8.1.3. All *existing meter data* will be replaced with the most recently received meter data.

8.1.4. *Existing meter data* is defined by the following business key:

Operator Code, European Vehicle Number, Meter Number and Sample Time.

8.1.5. Note - In these scenarios the Transmission ID must change.

8.2. In some support scenarios, the Operator may be required to resend meter data after the 11AM cut-off.

8.2.1. *A support process is defined to support this with specific functionality in the OTM Service to allow such files through.*

8.3. Duplicate Check:

After the *Daily Submission Cut-off* no further resends will be accepted by the OTM Service, and resent data is deemed duplicated and in error.

8.3.1. The OTM Service should send a Fail response in the corresponding Validation File.

8.4. *Note – Resends should be very infrequent, if at all.*

2.8.3 Business Rule Checks

1. OTM Service validates the data against business rules that are appropriate to the OTM Service. Most business rules are implemented in TABS in that they are billing rules.
 2. Each record that fails is flagged as “Suspect”, and sent through to Network Rail as UIC quality flag of uncertain.
- 2.1. TABS will infill such records

An example of a business rule is checking that energy value does not exceed the maximum possible value, based on vehicle characteristics.

2.9 Provisioning

2.9.1 Overview

1. Network Rail requires the meter data on a continual daily basis.
 - 1.1. This is to ensure peaks in processing volumes do not occur, and therefore do not compromise the capability of Network Rail to meet its regulatory commitments to provide timely reports (e.g. Charge File) and Invoices to ALL Operators.
2. TABS runs a billing cycle broadly 48 hours behind the actual date of the Journey. This is due to the provisioning of Train Movement and Consist data by both Operators and Network Rail / Industry systems (TOPS, TRUST, Gemini, Genius).

Refer section Appendix – Train Movement, Consist and Meter Data Flows for an overview of the data flows.

3. Network Rail requires the meter data at or before the Journey data is received into TABS:
 - 3.1. This broadly equates to a 48 hour period after a Train Journey
 - 3.2. This daily journey processing that occurs within TABS, with a scheduled start at around 10 PM, although Network Rail reserves the right to change this.
 - 3.3. In general, 95% of meter data should meet the above timeline, the exceptions allowing for trains going into depot for maintenance and other exceptional events.
 - 3.4. **Time Lines - Summary:**
 - 3.4.1. Daily Submission Cut-off - 11.00 am
 - 3.4.2. Completeness Report – starts midday
 - 3.4.3. TABS processing run 10PM
 - 3.4.4. TABS period end - Monday night / Tuesday Morning.

2.9.2 Provisioning Specifics

1. The Operator shall send the meter data on a per-day, per-meter basis.
This equates to 1 transmission per meter, per day.
2. Per transmission, the Operator provides:
 - 2.1. 288 samples are provided for reference period of 5 minutes, per meter
 - 2.1.1. The Minutes will be on 5 minute boundaries only i.e. 0 past, 5 past, 10 past etc
 - 2.2. 1440 samples are provided for reference period of 1 minute, per meter
 - 2.2.1. The Minutes will be on the minute boundary only i.e. 1 past, 2 past, 3 past etc
3. An Operator:
 - 3.1. *Must Aggregate* 30 second reference period data to 1-minute or 5-minute
 - 3.2. *Should Aggregate* 1-minute reference period data to 5-minute. *Refer section 2.14 Aggregation for details and reason why.*
4. The meter data records within the transmission payload shall be in time sequence order ascending (least recent to most recent).
5. For each transmission, ALL the meter data samples at the specified reference period, for that meter, for that that day; must be included in the payload.
6. The meter samples should be from midnight and midnight (the “day”) at GMT/UTC time. *Assuming provisioning at a 5 minute reference period:*
 - 6.1. The first sample time stamp component is 00:05:00 (HH:MM:SS)
 - 6.1.1. i.e. for the energy delta, Day X, 00:00:00 through Day X at time 00:05:00
 - 6.2. The last sample time stamp component is 00:00:00 (HH:MM:SS),
 - 6.2.1. i.e. for the energy delta, Day X, 23:55:00 through Day X+1 at time 00:00:00
7. All date-times must be provided at GMT/UTC i.e. at zero offset.
 - 7.1. Operators must understand the effective time context of the meter and/or their I.T. systems and adjust accordingly. *This is critical for subsequent Journey matching in TABS, which is always at UK Domestic/Local time.*
 - 7.2. By way of example:
 - 7.2.1. For UK Domestic Summer Time (1 hour ahead of GMT), the local date-time would need to be provisioned on this interface with the 1 hour subtracted.
 - 7.2.2. For a French Train in summer time (2 hours ahead of GMT), the French local date-time would need to be provisioned on this interface with the 2 hours subtracted.
 - 7.3. Note – Network Rail will convert these times to UK Domestic/Local Time (TABS time) such that Journeys are matched correctly.
8. The Operator shall never create and/or provide estimated values for Energy this is the role of the OTM Service and Data Enrichment service against agreed UIC and TAA Business Rules.

9. Dummy Time Series records

The Operator must create dummy time series records for missing meter samples to ensure that the expected record count per reference period is met.

These can have a values as follows:

9.1. Energy:

9.1.1. Quality Flag set Measured, with an energy value of 0.0
e.g. when the meter is known to be switched off and is therefore not recording.

9.1.2. Quality Flag set Non-Existent, with an energy value not set. *TABS will Infill such values.*

9.2. Location:

9.2.1. Location Quality Flag set Non-Existent with location not set. *The OTM Service may be able to derive the GPS values based on UIC rules for handling missing GPS locations.*

9.3. Time

Time Quality Flag set Uncertain with the time created as appropriate to the Reference Period.

10. Stood down trains:

Where the Operator has NOT advised Network Rail that a Train is Stood Down:

10.1. The Operator must create dummy entries (per above) for stood down trains, for the period where no metered readings are available, such that the required number of records are provided in total (per day, per 24 hours period, midnight to midnight UTC)

10.2. The Energy Quality Flag is set Measured with Energy values of 0.0.

10.2.1. TABS will NOT infill

10.3. The Location Quality Flag is set Non-Existent with location values not set

10.3.1. OTM Service will default the ESTA to the Journey ESTA

Where the Operator has advised Network Rail that a Train is Stood Down:

10.4. The Operator may still need to provided dummy records for the period of time (across a 24-hour period) for which the train was stood down to make up a complete set of data (i.e. 288 records at 5-minute reference period) – per 10.2 and 10.3 above.

11. Time Provision: 5-minute Reference Period

Each Operator will need to determine a mechanism that results in the required number of unique samples being provided at the stated reference period, such that:

11.1. Minutes must be always specified as 00, 05, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55

11.2. Seconds must be always specified as 00

This might include truncation or rounding up or down.

12. Time Provision: 1-minute Reference Period

Each Operator will need to determine a mechanism that results in the required number of unique samples being provided at the stated reference period, such that:

12.1. Seconds must be always specified as 00.

This might include truncation or rounding up or down.

13. Time Truncation – Sub second capable meters:

Where meters provide time to a resolution greater than seconds, the *Sample Time* provided will still be provided on this interface to second's accuracy. As such:

Each Operator will need to determine a mechanism that results in the required number of unique samples being provided (per above requirement "Sample Count per Transmission").

This might include truncation or rounding up or down.

E.g.

Sample time off the meter 20110401094004213 (format effectively
YYYYMMDDHHMMSS_{sss}, where *sss* is sub second component)

provided on interface as 20110401094000 (format YYYYMMDDHHMMSS)

14. Should one or more days be missed, the Operator may catch-up:

14.1. However it is still required to provide 1 transmission per meter, per day (as described above).

15. OTM Service will forward the meter data to Network Rail (via the UIC MDD process) when:

15.1. The Vehicle has all associated meters accounted for

Or

15.2. Where the 7-day rule is triggered i.e. meter data from one or more meters associated with a Vehicle has not been received within the 7 day window.

16. AC only vehicles

16.1. The DC Energy Quality Flag is set null

16.2. The DC Energy Values (Consumption and Regen) are set null/blank

16.3. TABS will ignore the DC Energy.

17. DC only vehicles

17.1. The AC Energy Quality Flag is set null

17.2. The AC Energy Values (Consumption and Regen) are set null/blank

17.3. TABS will ignore the AC Energy.

18. AC and DC capable vehicles:

18.1. Operator always populates AC and DC Energy Quality Flag.

More specifically:

- 18.2. Where train is moving over AC supply – A DC metered value of 0.0 is expected from the meter, with DC Quality Flag of Measured (therefore no infill by TABS)
- 18.3. Where train is moving over DC supply – A AC metered value of 0.0 is expected from the meter, with AC Quality Flag of Measured (therefore no infill by TABS)
- 18.4. Where there is only one meter channel for Quality Factor, the Operator populates both AC and DC QF's with same value.
- 18.5. Note - Within a given 5-minute or 1-minute sample, the change over occur and therefore valid AC and DC values apply, overriding rules 18.2 and 18.3 above.
- 19. Regeneration NOT implemented
As there is one QF for AC (covering consumption and regenerative) and one for DC, the following provisioning rule applies:
 - 19.1. Where regeneration is NOT implemented, a regeneration value of:
 - 19.1.1. 0.0 should be supplied for a Quality Flag value of Measured or Uncertain
 - 19.1.2. *Null/blank* for a Quality Flag value of Non-Existent.
- 20. Faulty Meters
Where a meter is faulty – the assumption is that Consumption is still occurring and as such, the OTM Service will either:
 - 20.1. Receive no readings at all (for a given day) – therefore we infill after 7 days (the assumption is consumption is still occurring).
 - 20.2. Receive readings, with the Quality Flag set as Uncertain or Non-Existent, and infill will occur.
 - 20.3. A mix of Measured and Non-Existent / Uncertain
- 21. Meter Reference Data:
 - 21.1. As part of the “take on” process, Meter details must be provided **by the Operator** to the OTMS provider (via support process) describing the basic configuration of the each meter.
 - 21.1.1. This applies to any subsequent meters adopted ongoing.
 - 21.2. The reference data must reflect what the Train are actually capable of electrically, NOT what the meter may none-the-less produce by default. By way of example:
 - 21.2.1. If the Train is not electrically capable of producing regenerative energy, the Reference data should reflect this i.e. “No” specified, and no corresponding energy data provided in the meter files
 - 21.2.2. If the Train is not electrically capable of handling reactive energy, the Reference data should reflect this i.e. “No” specified, and no corresponding data provided in the meter files

The above is important for two reasons:

- 21.2.3. The data has to be processed and stored, across all parties (not just Network Rail). Storage costs, and has processing overheads.
- 21.2.4. Commercially, Network Rail is charged for per energy “channel”. In this case Network Rail is paying for data that has no business value.

Note - It may be in the future such costs are passed back to the Operator, in part or in full

21.3. Acceptance of data:

The OTMS will only accept meter data, where that meter data fully aligns to the Reference data. By way of example:

- 21.3.1. The meter number in the data matches one of those identified in the Meter Reference data.
- 21.3.2. The energy types are consistent with those specified in the Meter Reference Data. *For instance, if the reference data indicates that AC Consumption only, then DC consumption values would result in the meter data being rejected.*

22. Reactive Energy Import /Export

- 22.1. Although the specification caters for these attributes, UK Operators are currently NOT to provide values for these two attributes. These attributes should therefore be set as null/blank.

- 22.1.1. Per above, the Meter Reference Data provide MUST reflect this

23. Auxiliary Meter (non Traction):

- 23.1. The Operator will NOT send readings for Auxillary meters directly to the OTM Service. *This is to avoid challenges around in-filling e.g. defining business rules, calculating & applying meaningful average values for insignificant kWh vs. the corresponding Traction kWh*

Rather:

- 23.2. The Operator shall add the Auxillary meter reading to the Primary meter reading. By way of example:

	Primary Meter (Traction)	Auxillary Meter (Non-Traction)	Value sent to OTMS
Reference Period	Consumption AC (kWh)	Consumption AC (kWh)	Consumption AC (kWh)
20100401000500	10.0	0.1	10.1
20100401001000	10.0	0.2	10.2

- 23.3. Handling of Quality Flags
for any reference period, the Quality Flag value sent will be that of the Primary Meter measuring traction, according to the provisioning rules outlined in this document.

In addition:

- 23.4. Meter Reference Data (describing each meter, see above) is NOT required for Auxillary meters, as the OTMS will NOT expect separate readings for these meters (per above).

24. Third parties supporting more than 1 Operator

- 24.1. Network Rail will work directly with third parties as nominated by each Operator.

However:

- 24.2. Network Rail's customer is the Operator, not the third party.
- 24.3. A third party's solution for one Operator that has specific features, tweaks, constraints or capabilities for that Operator (and/or specific fleet or meter types) should not become an implicit constraint or requirement imposed on another Operator or their provisioning through this interface or interfaces to Operators trains.
- 24.4. Third party solutions should recognise that this interface specification *may* change over time and that subsequent Operators may implement against a later version of this interface specification.

2.10 File Naming Convention

2.10.1 Meter Data File

The meter data file will be named as follows: <Operator Code>_<Transmission ID>.csv

E.g. If the:

- Operator created unique Transmission ID is 334544354566

And

- Operator code is HF

Then the filename is HF_334544354566.csv

2.10.2 Validation Response File

The Validation Response file will be named as follows:

<Operator Code>_<Transmission ID>_RSP.csv

- The Transmission ID being that in 2.10.1 Meter Data File

E.g. If the:

- Operator Transmission ID is 34544354566

And

- Operator code is HF

Then the filename is HF_34544354566_RSP.csv

2.10.3 Completion File

The Completion file will be named as follows:

<Operator Code>_<Transmission ID>_CPL.csv

- The Transmission ID being that generated by the OTM Service

E.g. If the:

- OTM Service unique Transmission ID is 6766766766767232

And

- Operator code is HF

Then the filename is HF_6766766766767232_CPL.csv

2.11 SFTP specifics

1. The SFTP directory structure presented to the Operator, via their *SFTP Client*, will be identical to for ALL operators.
2. Each Operator shall have access to their directory and sub directories only.
3. Each Operator shall have 14 days (configurable) to retrieve Validation Files and Response files.
 - 3.1. After this period, the OTM Service provider may elect to move them to other location inaccessible by the Operator – e.g. for operational reasons
 - 3.2. The Operator may NOT delete files as the OTM Service provider is required to retain them.
4. The Operator must poll the appropriate directories for the existence of validation and completeness files generated by the OTM Service
 - 4.1. The suggested frequency for polling validation files is every 5 minutes (configurable), ideally undertaken only when validation response files are expected.
5. The SFTP URL is “networkrail.energyict.com”, on port 22
 - 5.1. Failover is transparent to the Operator.
 - 5.2. This applies to both Production and Test environments.
 - 5.3. The service presents an externally facing IP address of **194.7.156.133**

2.11.1 Directory Structure

SFTP User accounts \$TOC_LIVE and \$TOC_TEST:

Path	Description	TOC FTP-user Access Rights
\$TOC/Meter Data Import/In	Operators SFTP PUTs the meter data files in this location	Read
\$TOC/Meter Data Import/Error	EnergyICT place fail files received in this directory	Read
\$TOC/Meter Data Import/Processed	EnergyICT place successful files received in this directory	Read
\$TOC/Report	Report directory used for storing Validation Response and Completeness Report files.	Read

SFTP User accounts \$TOC *_IMPORT:

Path	Description	TOC FTP-user Access Rights
\$TOC/Meter Data Import/In	Operators SFTP PUT's the meter data files in this location. This account takes you straight to the IN location	write

\$TOC represents the per Operator 2 digit code e.g. HF

Directories above repeat per environment (test / prod).

The user account determines the test vs. production context. Operators will have production and test accounts per above e.g. HF_LIVE or HF_TEST

2.12 CSV file specifics

1. The first row will be the column titles, not data.
2. The order of the columns is fixed.
3. The last column of each CSV file is specified as EOL to provide clarity that the last column is provided. *Refer section 2.6.8 End of Line for an explanation.*
4. Providing null / blank values

Where any value is; not available / not defined / null or blank etc

 - 4.1. No text shall be provided in the CSV file
 - 4.1.1. Specifically the text “NULL” or “null” must NOT be used.

- 4.2. By way of example, consider a 4 column CSV file, with column 4 always specified as EOL (as in this specification), then a CSV record/line where all data values are null would look like:

,,,EOL

2.13 Transformations

1. The OTM Service provider will need to convert the CSV provisioning layout to/from the internal format as required.

2.14 Aggregation

The following is applicable to Operators whose meters have a reference period less than 5-minutes (e.g. 1-minute or 30-second). As:

1. Only 5-minute sampling is required for Billing Purposes
2. Note - Provisioning more frequent samples *may* attract an addition commercial charge to those Operators in the future, should this be agreed between all parties. This due to the commercial operating model of the OTMS.

Notes

1. Aggregation is potentially an auditable process, in that Operators may need to be able to demonstrate the derivation of the 5-minute energy values.
2. Network Rail will also undertake this process, if the Operator has not.

The following details the treatment of relevant attributes to aggregate into 5-minute reference periods:

	Attribute	Description
1.	General	All aggregated values will fall on the 5-minute value i.e. 0 minutes past, 5 minutes past, 10 minutes past etc.
2.	General	The aggregated value comprises the 5-minute boundary sample value and previous 4 sample values. By way of example, to provide a: <ul style="list-style-type: none"> • 10 minute past value, the following 1-minute samples are applicable: 00:06:00, 00:07:00, 00:08:00, 00:09:00, 00:10:00 • 55 minute past value, the following 1-minute samples are applicable: 00:51:00, 00:52:00, 00:53:00, 00:54:00, 00:55:00 • And so on
3.	Sample Time – Quality Flag	The Time Quality Flag will be set as follows: <ol style="list-style-type: none"> 1. If all 1-minute Sample Time QF's are <u>Measured</u>, then the aggregated 5-minute Sample Time QF will be set as <u>Measured</u>. 2. Else If any 1-minute Sample Time QF is <u>Uncertain</u>, then the aggregated 5-minute Sample Time QF will be set as <u>Uncertain</u>. 3. Else if any 1-minute Sample Time QF is <u>Non-Existent (Missing)</u>, then the aggregated 5-minute Sample Time QF will be set as <u>Non-Existent (Missing)</u>. Refer also section 2.9.2 Provisioning Specifics

	Attribute	Description
4.	Sample Time	<p>A 5-minute aggregated sample <u>must</u> always be provided. By way of example:</p> <ul style="list-style-type: none"> E.g. for five 1-minute times as follows: 00:06:00, <u>Measured</u> 00:07:00, <u>Measured</u> 00:08:00, <u>Measured</u> 00:09:00, <u>Measured</u> 00:10:00, <u>Non-Existent</u> The aggregated 5-minute QF value would be: 00:10:00, <u>Non-Existent</u> E.g. for five 1-minute times as follows: 00:06:00, <u>Measured</u> 00:07:00, <u>Measured</u> 00:08:00, <u>Measured</u> 00:09:00, <u>Measured</u> 00:10:00, <u>Uncertain</u> The aggregated 5-minute QF value would be: 00:10:00, <u>Uncertain</u> <p>Rationale: TABS makes no specific use of the <i>Quality Flag – Time</i>. However, having a sample time per time series record is critical, in order to allocate the Energy values to the Journey.</p>
5.	Energy – Quality Flag	<p>The Energy Quality Flag will be set as follows:</p> <ol style="list-style-type: none"> If <u>all</u> 1-minute samples are <u>Measured</u>, then the aggregated 5-minute Energy QF will be set as <u>Measured</u> (energy values summed) Else if any 1-minute samples is <u>Non-Existent (Missing)</u>, then the aggregated 5-minute Energy QF will be set as <u>Non-Existent (Missing)</u>, with an energy value of blank/null. <ol style="list-style-type: none"> This will trigger TABS to infill this 5-minute reference period Else If any 1-minute samples is <u>Uncertain</u>, then the aggregated 5-minute Energy QF will be set as <u>Uncertain</u>, with an energy value summed <p>E.g. for 5 1-minute samples as follows: 00:06:00, <u>Uncertain</u> 00:07:00, <u>Measured</u> 00:08:00, <u>Measured</u> 00:09:00, <u>Uncertain</u> 00:10:00, <u>Measured</u> The aggregated 5-minute would be: 00:10:00, <u>Uncertain</u></p>

	Attribute	Description
		<p>Or E.g. for 5 1-minute samples as follows: 00:06:00, <u>Measured</u> 00:07:00, <u>Measured</u> 00:08:00, <u>Non-Existent</u> 00:09:00, <u>Uncertain</u> 00:10:00, <u>Uncertain</u> The aggregated 5-minute QF value would be: 00:10:00, <u>Non-Existent</u></p> <p><i>Notes:</i> - <i>The above applies for both the AC Energy QF and DC Energy QF.</i></p>
6.	Energy values.	<p>Following on from the above, the following takes place for the Measured and Uncertain scenarios.</p> <p>The value will be the summation of the 5 individual 1-minute values where ALL the 5 1-minute samples are measured.</p> <p>E.g. for 5 1-minute samples as follows: 00:06:00, <u>Measured, 10.0</u> 00:07:00, <u>Measured, 10.0</u> 00:08:00, <u>Measured, 10.0</u> 00:09:00, <u>Measured, 10.0</u> 00:10:00, <u>Measured, 10.0</u> The aggregated 5-minute value would be: 00:10:00, <u>Measured, 50.0</u></p> <p>E.g. for 5 1-minute samples as follows: 00:06:00, <u>Uncertain, 10.0</u> 00:07:00, <u>Measured, 10.0</u> 00:08:00, <u>Measured, 10.0</u> 00:09:00, <u>Uncertain, 10.0</u> 00:10:00, <u>Measured, 10.0</u> The aggregated 5-minute would be: 00:10:00, <u>Uncertain, 50.0</u></p> <p>Or E.g. for 5 1-minute samples as follows: 00:06:00, <u>Measured, 10.0</u> 00:07:00, <u>Measured, 10.0</u> 00:08:00, <u>Non-Existent, blank/null</u> 00:09:00, <u>Uncertain, 10.0</u> 00:10:00, <u>Uncertain, 10.0</u> The aggregated 5-minute QF value would be: 00:10:00, <u>Non-Existent, blank/null</u></p> <p><i>Notes:</i> - <i>The above applies for both the AC Energy QF and DC Energy QF.</i> - <i>When TABS sees Non-Existent_or Uncertain, TABS will infill the 5-minute reference period.</i></p> <p>This applies for Consumption – AC, Consumption – DC, Regenerative – AC, Regenerative – DC, AC Reactive Energy – Import and AC Reactive</p>

	Attribute	Description
		Energy – Export.
7.	Location: <i>Quality Flag,</i> <i>Longitude,</i> <i>Latitude,</i>	<p>1. If the most recent 1-minute samples Location QF is <u>Measured</u>, then the aggregated 5-minute flag will be set as <u>Measured</u></p> <p>a. The Latitude and Longitude values will be set to the <u>most recent</u> value.</p> <p>E.g. for 5 1-minute sample locations flags as follows: 00:06:00, <u>Measured</u>, Location A 00:07:00, <u>Measured</u>, Location B 00:08:00, <u>Measured</u>, Location C 00:09:00, <u>Measured</u>, Location D 00:10:00, <u>Measured</u>, Location E The aggregated flag value would be: 00:10:00, <u>Measured</u>, Location E</p>
		<p>2. If the most recent 1-minute samples Location QF is <u>Non-existent (Missing)</u>, then:</p> <p>a. The aggregated 5-minute flag will be set as the next most recent <u>Measured</u> or <u>Uncertain</u> location value, and the quality flag set as <u>Uncertain</u>.</p> <p>b. The latitude and Longitude values will be set to the corresponding values</p> <p>E.g. for 5 1-minute sample locations flags as follows: 00:06:00, <u>Measured</u>, Location A 00:07:00, <u>Measured</u>, Location B 00:08:00, <u>Measured</u>, Location C 00:09:00, <u>Non-Existent (no Location)</u> 00:10:00, <u>Non-Existent (no Location)</u> The aggregated Location QF value would be: 00:10:00, <u>Uncertain</u>, Location C</p> <p>Or E.g. for 5 1-minute sample locations flags as follows: 00:06:00, <u>Measured</u>, Location A 00:07:00, <u>Measured</u>, Location B 00:08:00, <u>Measured</u>, Location C 00:09:00, <u>Uncertain</u> Location D 00:10:00, <u>Non-Existent (no Location)</u> The aggregated Location QF value would be: 00:10:00, <u>Uncertain</u>, Location D</p> <p>The OTMDS-DES will linear interpolate between the 00:05:00 value (assuming Measured) and the 00:15:00 value (assuming measured).</p>
		<p>3. If the most recent 1-minute sample Location QF is <u>Uncertain</u>, then:</p> <p>a. The aggregated 5-minute Location QF will be set as the <u>Uncertain</u></p>

	Attribute	Description
		<p>b. The latitude and Longitude values will be set to the corresponding values</p> <p>E.g. for 5 1-minute sample locations flags as follows: 00:06:00, <u>Measured</u>, Location A 00:07:00, <u>Measured</u>, Location B 00:08:00, <u>Measured</u>, Location C 00:09:00, <u>Measured</u>, Location D 00:10:00, <u>Uncertain</u>, Location E The aggregated flag value would be: 00:10:00, <u>Uncertain</u>, Location D</p> <p>Or E.g. for 5 1-minute sample locations flags as follows: 00:06:00, <u>Uncertain</u>, Location A 00:07:00, <u>Uncertain</u>, Location B 00:08:00, <u>Uncertain</u>, Location C 00:09:00, <u>Uncertain</u>, Location D 00:10:00, <u>Uncertain</u>, Location E The aggregated flag value would be: 00:10:00, <u>Uncertain</u>, Location E</p>

Table 7 – Aggregation Rules

3. Non Functional Requirements

3.1 Source of Truth

1. Network Rail is the *source of truth* for meter energy data used in the context of billing.
This is because some meter data will undergo manipulations based on agreed processes and business rules as defined in the TAA e.g. Enrichment, boundary splits across a 5-minute interval and infill.
 - 1.1. *As such, only Network Rail has the most complete view of meter data as prepared for billing purposes.*

3.2 Information Security

3.2.1 Authentication

1. SFTP
 - 1.1. SFTP username and password will be provided by the OTM Service provider to a nominated representative of each Operator
 - 1.2. SFTP username will be different for each Operator
 - 1.3. SFTP password change policy will be managed by the OTM Supplier and communicated to the Operator in sufficient lead time that the Operator can make and test any changes.
 - 1.4. It is the responsibility of each Operator to protect the credentials provided to them and/or request the OTM Service provider to change those credentials. This includes where the username and password exists in clear text within scripts and/or application code.
2. Digital Certificate
 - 2.1. OTM Service provider is responsible for generating and managing digital certificates
 - 2.2. OTM Service provider will distribute the private key to each Operator (if required).
However, it is understood SFTP takes care of this as when the connection is established.
 - 2.3. Managing digital certificate expiry is the responsibility of the OTM Service provider (as they implement the SFTP Server component)

3.2.2 Authorisation

1. OTM Service – SFTP Server authorisation:
 - 1.1. Each Operators SFTP client will need to be able to:
 - 1.1.1. SFTP PUT
 - 1.1.2. SFTP GET
 - 1.1.3. SFTP LIST remote directory
 - 1.1.4. SFTP CD change remote directory
 - 1.1.5. SFTP RENAME file on remote directory
 - 1.2. SFTP deletes of remote files (by the Operator) should not be allowed (SFTP Server configuration)

3.2.3 Confidentiality

1. Data will be encrypted in transit. Hence:

- 1.1. SFTP will be used instead of FTP

Notes:

- 1.2. Data transmitted off-the-train to ground station is outside of the scope of this interface and is the responsibility of the Operator.

- 1.2.1. It is the Operator's choice as to how confidentiality is supported for those data flows, if at all.

- 1.3. SFTP effectively implements a message digest, thereby protecting against inadvertent data corruption e.g. 10kWh being sent through as 12 kWh

3.2.4 Data integrity

1. In a UAT and Production context, energy data must never be manually changed.

3.3 Internationalisation

1. All date-time fields will be provided in the format specified in section 2.6 and 2.7.
2. The use of a comma as a delimiter in date-times will NOT be accommodated.
3. The use of a comma within numeric fields will NOT be accommodated.
4. All data will be provisioned and/or reported on in:
 - 4.1. English
 - 4.2. Using UK date formats (where applicable and not otherwise specified)
5. Supporting Pound (£) (where applicable).

3.4 Data Loss

Under catastrophic systems failure, data loss can be expected, and this can apply to interfaces where the interface holds the data in files (per SFTP), message queues and/or staging databases for a period.

All parties should implement appropriate procedures and services to minimise any impact, including backups of data and files, including interface software configuration artefacts/files.

3.5 Data Retention

1. Operator
 - 1.1. The Operator may elect to retain meter data for their own purposes (Energy analysis)
 - 1.1.1. The *OTM Service* provider and Network Rail have no input or responsibility regards data retention within the Operators systems / I.T.
 - 1.2. The Operator is subject to audit requirements defined in the TAA and UIC.
2. Network Rail
 - 2.1. The Meter Data passed into Network Rail is retained for a period of 2 years online, and for 7 years in total, at least.
 - 2.1.1. This is to support billing audit and dispute processes.
 - 2.1.2. TABS is the Network Rail application supporting the billing function.
3. OTM Service

- 3.1. The Meter Data passed across this interface is retained for a period of 2 years online at least and for 7 years in total (existing requirement)

3.6 Audit

An audit capability is stipulated in the TAA and UIC (draft), and applies to Operator, Network Rail and OTM Service. However, it is not prescribed as to what Audit means in any detail w.r.t to meter data and/or this interface. *The following should be treated as indicative only.*

1. Train Operator:

- 1.1. The Train Operator may have specific internal requirements they are required to adhere to irrespective of OTM. This specification in no way changes that.

In addition:

- 1.2. Be able to associate meter data transmitted to the OTM Service with the meter data as received off the Train meter
- 1.3. Demonstrate aggregation is compliant to Aggregation Rules
- 1.4. Retain a record of files created
 - 1.4.1. Transmission ID, File name, Transmission date, Vehicle Number, Meter Number, OTM acknowledgement status, OTM Acknowledgement Transmission ID, OTM acknowledgement date-time
 - 1.4.2. Tied to each meter reading
- 1.5. Retains actual files transmitted to OTM for a period of time (configurable) e.g. 3 months.

2. OTM Service:

- 2.1. Be able to correlate meter data received from the Operator with the meter data transmitted to Network Rail.
 - 2.1.1. By Operator, Day, Vehicle, Meter Number, Transmission ID's and response Transmission ID's
- 2.2. Retain Meter files received for a period of time (configurable) e.g. 3 months
- 2.3. Retains Validation and Completeness files for a period of time (configurable) e.g. 3 months.

3.7 Support

Support processes will be defined externally to this specification. The following is indicative for production:

1. Network Rail has overall management responsibility for the OTM Solution encompassing the OTM Service and Network Rail I.T.

However, Network Rail has no *day-to-day operational* involvement in running the external I.T supporting the OTM Service, specifically:

- 1.1. Operators are fully responsible for the support of their Train Meters, On Ground and associated I.T. systems.

- 1.1.1. Network Rail and the OTM Service provider have NO role in the support of these systems.
- 1.2. The OTM Service provider is fully responsible for the support of the OTM Service offering (Software as a Service model) and ALL associated I.T. and Infrastructure.
 - 1.2.1. Network Rail and the Operators have NO role in the support of these systems.
2. Operators will initiate support issues through Network Rail e.g.
 - 2.1. Cannot send meter data to the OTM Service, initial instigation suggesting not an Operator issue.
 - 2.2. Meter data is being erroneously rejected by OTM Service
 - 2.3. Invoicing, Charge File and other reporting issues associated with meter data (as they currently doing for existing TABS).
3. The OTM Service provider may also initiate support issues through Network Rail e.g.
 - 3.1. Interface issues between Operator or Network Rail
 - 3.2. Specific issues with an Operators meter data
 - 3.3. Outage requirements.
4. Network Rail will investigate and escalate as appropriate to the parties concerned:
 - 4.1. Detailed fault investigation and resolution w.r.t, this Interface lies with the Operator and OTM Service.
 - 4.2. If an error or issue occurs within the Operators I.T., the Operator must initiate the investigation and resolution process.
 - 4.3. If an error / issue occur within the OTM Service I.T., the OTM Service Provider must initiate the investigation and resolution process.
5. In some fault scenarios:
 - 5.1. The Operator will need to correct the meter data and resend.
 - 5.1.1. A process to allow this is designed into the OTM Service
 - 5.2. If correction cannot be undertaken within 7 days, creating dummy records for the applicable time series meter data may be required

3.8 Availability

1. Operators:
 - 1.1. Operators need to ensure that their Train Meter, On Ground and associated I.T. systems and infrastructure are sufficiently specified, configured and monitored to meet the overall data provisioning requirements.
 - 1.2. Non availability, for whatever reason, may risk the 7 day rule triggering within the OTM Service
 - 1.3. *Disaster Recovery* capability and internal *business continuity* processes are the responsibility of the Operator
2. OTM Service:
 - 2.1. The OTM Service (including this interface) is *nominally* a 365x24x7 service, subject to specifics documented in commercial / contractual documents.

2.2. *Disaster Recovery* capability and internal *business continuity* processes are the responsibility of the OTM Service.

3.9 Resilience

3.9.1 Monitoring

Sending and Recipient parties should implement appropriate monitoring, logging and alerting capabilities. This would broadly include (but not necessarily be limited to):

1. Transmission failures
2. Disc Capacity failures
3. Memory limitations
4. Excessive CPU
5. Network failures and/or issues

3.9.2 Recovery

1. Where possible, automated recovery of transmission failure should be implemented e.g. on failure to transmit, sender implements an automated retry e.g. 3 retries, 1 minute apart
2. All Senders should be capable of initiating a resend of an existing file(s) once issues have been resolved.

3.10 Timeliness

Refer section 2.9 Provisioning.

3.11 Environments

3.11.1 General

1. Under no circumstances will production environments be used for Testing, to avoid compromising either the OTM Service and/or Network Rail systems e.g. TABS

3.11.2 Operators

1. Operators **will be expected** to support *as a minimum* both a Production and *separate* on-going Testing capability – post go-live.
2. Production:
It is the Operators responsibility to determine the nature of the Production infrastructure. This may or may not include DR capability, as determined by each Operator.
3. Testing Expectations:
 - 3.1. Initial go-live testing between Operator and OTM Service
 - 3.2. Initial go-live UAT testing between Operator and Network Rail (via OTM Service)
 - 3.3. Support post production issues and testing
 - 3.4. Support implementation of new meter types and/or addition rollout of existing meter types to additional fleet, where testing is deemed necessary.
4. Operators may elect to have additional environments e.g. development or internal testing etc. as they deem necessary.

3.11.3 OTM Service

1. OTM Service - Test Service
 - 1.1. OTM Service will provide 1 Test Environment supporting connectivity to/from the Operators.
 - 1.2. That environment will support all testing scenarios including UAT between the Operator and Network Rail.
2. OTM Service - Production
 - 2.1. The OTM production service aligns to a SaaS model. The physical infrastructure is unknown to Network Rail; rather the emphasis is on availability via commercially agreed SLAs.

3.11.4 Network Rail

1. Network Rail will have multiple TABS and OTM-DS environments for internal development and test purposes.
 - 1.1. No external integration will be supported to / from these environments.
 - 1.2. However NR will support infrequent ad-hoc manual submission of single files as received from the OTM Service by email
 - 1.2.1. Note - a separate interface specification defines the interface between the OTM Service and Network Rail.
2. Network Rail will provide a single UAT environment for end-to-end testing with Operators.
 - 2.1. Note- This environment routes files via a production DMZ
3. Network Rail implements fully resilient systems w.r.t. TABS and OTM-DS, include DR capability.

3.12 Testing

1. The Operator shall have the capability to support User Acceptance Testing (UAT) with Network Rail through a suitable test environment.
 - 1.1. This includes initial go-live testing
 - 1.2. On-going take-on of new fleet and/or new meter types and/or new I.T. infrastructure - as deemed necessary by Network Rail.

4. Appendix – CSV Layout

Note – the filenames of the samples below intentionally do not align the file naming convention outlined in this specification.

The CSV files implicitly define the column order expected.

4.1 Operator to OTM Service – Meter Data



XLS (master)	CSV
 C:\Documents and Settings\rsayes\Docu	 C:\Documents and Settings\rsayes\Docu

Table 8 – Meter Data Sample File (XLS and CSV)

4.2 OTM Service to Operator – Validation Response

4.2.1 Pass



XLS (master)	CSV
 C:\Documents and Settings\rsayes\Docu	 C:\Documents and Settings\rsayes\Docu

Table 9 – Validation Response – Pass - Sample File (XLS and CSV)

4.2.2 Fail



XLS (master)	CSV
 C:\Documents and Settings\rsayes\Docu	 C:\Documents and Settings\rsayes\Docu

Table 10 – Validation Response – Fail - Sample File (XLS and CSV)

4.3 OTM Service to Operator – Completion Response



XLS (master)	CSV
 C:\Documents and Settings\rsayes\Docu	 C:\Documents and Settings\rsayes\Docu

Table 11 – Completion Response - Sample File (XLS and CSV)

4.4 Production Examples

As at version 1.2 of this document, the Appendices further below have production CSV files for some Operator.

5. Appendix – Key Decisions

5.1 Confidentiality

At the Operator / EnergyICT meeting December 03, 2010, meter data is considered confidential and will be treated as such via this interface specification. It is also Network Rail policy (if not wider accepted IT best practice) that data transmitted over public networks is encrypted as a matter of course.

5.2 Protocol and Payload format

The protocol and payload format was discussed at the Operator / EnergyICT meeting December 03, 2010.

The selected protocol is SFTP using CSV formatted payloads. SFTP was selected over FTP due to the confidentiality outcome (above). Further, Operators will only use SFTP in client mode.

Each Operator indicated certain preferences, as did EnergyICT. This was either FTP or Web Services.

The primary driver presented to Network Rail by Logica/EnergyICT was the need to ensure the service was available by 01 April 2011. This seeks to help ensure Network Rail met its ORR deadline. In addition, one Operator was averse to implementing an *SFTP Server* service.

6. Appendix – Definitions and Acronyms

Acronyms	Description
AC	Alternating Current
DC	Direct Current
DES	Data Enrichment Service (<i>a component within the Network Rail OTMDS</i>)
DMZ	Demilitarized zone – the security perimeter that allows secure access to NR's services via external untrusted computers and networks, usually via the Internet.
EVN	European Vehicle Number
FOC	Freight Operating Company
FTP	File Transfer Protocol
GPS	Global Positioning System
GMT	Greenwich Mean Time <i>Note – in this document, GMT and UTC are used interchangeably, even though technically they are different in pure definition – see UTC</i>
MDC	Meter Data Collector
MDD	Meter Data Distributor
OTM	On-Train Metering
OTMDS	The On-Train Metering Data Store (<i>Network Rail – Data Warehouse component</i>)
QF	Quality Flag
SFTP	Secure File Transfer Protocol (<i>an extension of the secure shell protocol</i>)
TABS	Track Access Billing System (<i>Network Rail system</i>)
TODS	Train Operational Data Store (<i>Network Rail – Data Warehouse component</i>)
TBA	To Be Advised
TBC	To Be Confirmed
TOC	Train Operating Company (<i>Passenger</i>)
SaaS	Software as a Service
SLA	Service Level Agreement
TMS	Train Management System
UAT	User Acceptance Testing – formal testing between Network Rail and Operators as a prerequisite to go-live
UIC	International Union of Railways. Refer http://www.uic.org/
UTC	Universal Time Coordinated (Greenwich Mean Time updated with leap seconds) <i>Note – in this document, GMT and UTC are used interchangeably, even though technically they are different per above.</i>
UTILTS	Utility Time Series (data / payload format).
w.r.t	with respect to

Table 12 – Acronyms

Definition	Meaning in this Document
Aggregation	The process where Operators provide meter data at a 5-minute reference period, but off-the-meter, the reference period is 1-minute or 30-seconds.
Auxiliary Meter	A meter that measures non traction consumption, in addition a separate meter that measures traction consumption only. <i>Note – this is not a configuration typically expected.</i>
Bureau	Term no longer used, Refer OTM Service instead
EnergyICT	The provider providing the OTM Service. Refer http://www.energyict.com/ EnergyICT was selected in late November 2010 through a competitive tender process managed by Network Rail.
Infill	Infill refers to derived consumption and regenerative values used in place of missing readings. Indicative: During each week 4 of each period, TABS calculates average 5 minute consumption and regeneration values from actual metered journeys that ran during the period and for non-journey readings for the previous 4 weeks (i.e. previous period week 4 and current period weeks 1-3). These are published to all operators.
non-repudiation	Mechanisms by which: <ul style="list-style-type: none"> - The sender of data is provided with proof of delivery and cannot assert delivery without the proof - The recipient is assured of the sender's identity so that neither party can later deny having sent, received or processed the data (in an agreed way)
Operator	Operator in this document means the TOC or FOC <i>Where an Operator uses a third party supplier to implement this interface and/or I.T generally, meter data must still be provided as though it is from the specific Operator e.g. Virgin Trains use Alstom/ERESS, but the Operator code remains as HF</i>
OTM Service	Refers to the Network Rail externally hosted service (provisioned by EnergyICT) that receives metered data from UK and Non UK Operators; validates, processes and distributes to Rail Infrastructure Owners (directly or indirectly) in alignment with UIC Guidelines and Processes.
Party / Parties	Refers to; any Operator, Network Rail or EnergyICT
SFTP Client	The client software supporting SFTP exchange of files. Operators are required to have this capability
SFTP Server	The server software supporting SFTP exchange of files. The OTM Service has this capability (and SFTP client capability)
Transmission	In this document, Transmission refers to the application level sending of: <ul style="list-style-type: none"> • 1 file using SFTP Conversely, transmission <u>does not</u> refer the underlying protocol (e.g. TCP) level exchanges that support SFTP.
Universal Time Coordinated	Greenwich Mean Time updated with leap seconds

Table 13 – Definitions

7. Appendix – Meter Data Flow Overview

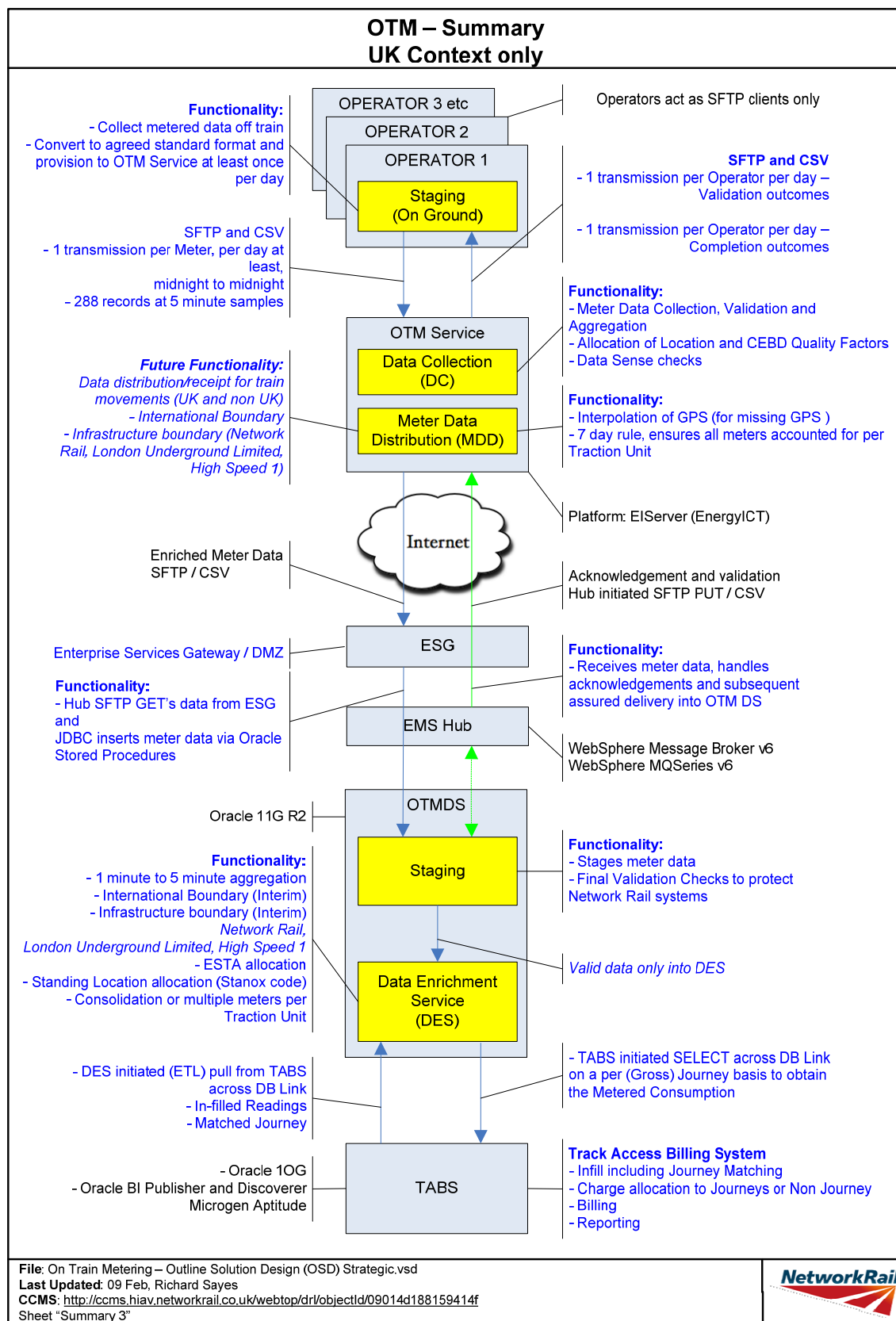


Figure 6 – Interface Context

8. Appendix – Train Movement, Consist and Meter Data Flows

The following diagram provides readers with an overall context of the data flows for both Train Movement and Consist data, and Meter Data Flows

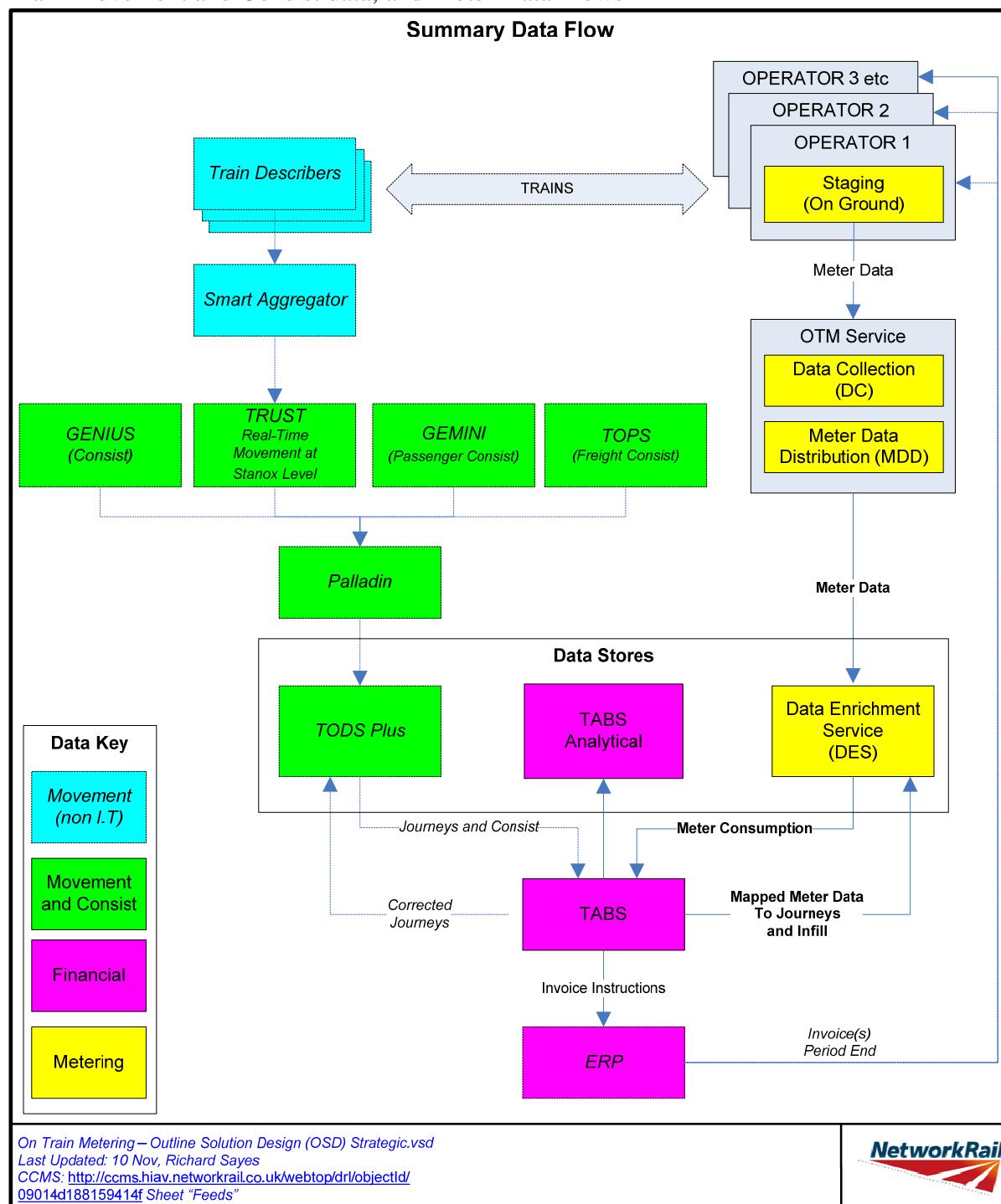


Figure 7 – Train Movement, Consist and Meter Data Flows

9. Appendix – Operator Codes

OPERATOR CODE	NAME	CUSTOMER TYPE	CUSTOMER GROUP
PI	Advenza	FOC	Advenza
HL	Arriva Trains Wales	TOC	Arriva PLC
YC	Balfour Beatty	FOC	Balfour Beatty
HT	c2c	TOC	National Express Group plc
HO	Chiltern Railways	TOC	DB Regio AG
YA	Colas	FOC	Colas
EH	CrossCountry	TOC	Arriva PLC
WA	DB Schenker	FOC	DB Schenker
FR	Direct Rail Services	FOC	DRS
EM	East Midlands Trains	TOC	Stagecoach Group plc
GA	Eurostar	OAO	Eurostar Group
RJ	Fastline Commercial	FOC	Fastline
YG	Fastline Track Renewals	FOC	Fastline
EG	First Capital Connect	TOC	FirstGroup plc
EF	First Great Western	TOC	FirstGroup plc
PN	Freight Europe	FOC	Freight Europe
FB	Freightliner	FOC	Freightliner
DB	Freightliner Heavy Haul	FOC	Freightliner
PE	GB Railfreight	FOC	GBRf
EC	Grand Central	OAO	Equishare Partners
EE	Heathrow Connect	OAO	FirstGroup plc / BAA
HM	Heathrow Express	OAO	BAA
PF	Hull Trains	OAO	FirstGroup/Renaissance Trains
XX	Hutchinson Ports	OAO	WTF
HZ	Island Line Trains	TOC	Stagecoach Group plc
YH	Jarvis Yellow Plant	FOC	Fastline
EJ	London Midland	TOC	Govia
EK	London Overground Rail Operations Ltd	TOC	DB Regio AG / MTR Corporation
XC	LUL Bakerloo	OAO	Transport for London
XE	LUL District (Richmond)	OAO	Transport for London
XB	LUL District (Wimbledon)	OAO	Transport for London
HE	Merseyrail	TOC	Serco-NedRailways
EB	National Express East Anglia	TOC	National Express Group plc
HB	National Express East Coast	TOC	National Express Group plc
PG	Nexus	OAO	Tyne & WearTrans. Auth.
PR	North Yorkshire Moors Railway	OAO	North York Moors Hist Railway
ED	Northern Rail	TOC	Serco-NedRailways
HA	ScotRail	TOC	FirstGroup plc
FX	SERCO	FOC	SERCO
PS	SNCF	FOC	SNCF
HY	South West Trains	TOC	Stagecoach Group plc
HU	Southeastern	TOC	Govia
HW	Southern	TOC	Govia
H2	Southern Pre 20/09/09	TOC	Govia
IC	SW Excluded from PABS Billing	TOC	Stagecoach Group plc
EA	Transpennine Express	TOC	FirstGroup plc / Keolis
HF	Virgin Trains	TOC	Stagecoach Group/Virgin Group
IJ	VT Excluded from PABS Billing	TOC	Stagecoach Group/Virgin Group
PA	West Coast Railway	OAO	West Coast Railway
EI	Wrexham Shropshire & Marylebone Railway	OAO	DB Regio AG/Renaissance Trains

Table 14 – Operator Codes

10. Appendix – Location Validation and GPS/ESTA Handling

The following *summarises* how location values (latitude and longitude) are validated.

Location Quality Flag	Latitude	Longitude	Validation Outcome	Comment
Non-Existent	non blank/null value	non blank/null value	Fail	A value should NOT be provided.
Non-Existent	non blank/null value	blank/null	Fail	A value should NOT be provided
Non-Existent	blank/null	non blank/null value	Fail	A value should NOT be provided
Non-Existent	blank/null	blank/null	Success	No value has been provided - per the quality flag.
Estimated, Uncertain, Measured	non blank/null value	non blank/null value	Success if semantic check met (see comment), else Fail	Longitude: ≤ 180.00000 and ≥ -180.00000 Latitude: ≤ 90.00000 and ≥ -90.00000
Estimated, Uncertain, Measured	non blank/null value	non blank/null value	Success - if long/lat values within NR Infrastructure boundary (defined geospatially) Fail otherwise.	A long/lat value of 0,0 would for instance fail validation
Estimated, Uncertain, Measured	non blank/null value	blank/null	Fail	A value must be provided
Estimated, Uncertain, Measured	blank/null	non blank/null value	Fail	A value must be provided
Estimated, Uncertain, Measured	blank/null	blank/null	Fail	A value must be provided

GPS Handling and ESTA allocation

The following summarises the handling of GPS within the solution as a whole and is provided *for information only and subject to change* if testing requires refinement.

Network Rail are not correcting GPS readings, but implementing a strategy to handle readings that are designated missing or uncertain (via the quality flag), and/or fail to map to an ESTA (within ESTA boundary polygons)

GPS readings can be problematic under various scenarios, including but not limited to:

- 1) Train moving within a deep cutting
- 2) Train enclosed by building structures (stations, depots, tunnels)
- 3) TMS power up and TMS GPS freezing
- 4) Atmospheric conditions.

Within the solution for Virgin Trains, ERESS undertake GPS correction; the specifics are not documented or otherwise known to Network Rail.

Assumption

- 1) Poor GPS readings are infrequent, so any rules (below) for dealing with Missing and Uncertain have negligible impact overall.
- 2) The basis on which Metering Equipment provides Uncertain values is unknown. The following is assumed:

- a) Uncertain is the result of insufficient satellite signals, so there is a reading, but it may not fall within the +/- 250 meters per group standard

Operator

- 1) The Operator may provide a GPS with Measured, Uncertain, Estimated or Missing

OTM Service (receives metered data from Operators)

- 2) OTM Service – Quality Factor is Missing for a single 1-minute or 5-minute Reading Sample
 - a. If the two adjacent reading are both Measured, then the OTM service will linear interpolate the GPS Reading, Quality Flag of Estimated
 - b. *Note – the Estimated reading could still fall outside the ESTA boundaries*
- 3) OTM Service – Quality Factor is Uncertain for a single 1-minute or 5-minute Reading Sample
 - a. If the two adjacent readings are both Measured then the OTM service will set the Quality Flag to Estimated.
 - b. *Note – the Estimated reading could still fall outside the ESTA boundaries.*
- 4) After applying the two above rules, if the Quality Factor is remains as Missing or Uncertain then
 - a. The OTM Service will take no further action.
 - b. The OTM-DES will implement its rules (below)

OTM Data Store – Data Enrichment Service (DES)

- 5) The DES aggregates (1-minute to 5-minute) as per the Interface Specification rules (where the Operator has not done so)
- 6) Consolidation (multiple meters per Traction Unit)
 - a. Consolidation takes place, as TABS requires the total per Traction Unit
 - b. Consolidation will use the average highest ranking GPS reading (for Measured, Estimated and Uncertain)
- 7) Boundary Split now takes place for 5-minute samples with allocated GPS start and end positions, crossing an ESTA boundary (or NIC boundary and/or with multiple consumption types).
- 8) Attempt to assign ESTA's for Measured, Estimated and Uncertain (based on start and end GPS per reading), this includes handling Areas of Uncertainty (more than 1 ESTA could potentially be mapped e.g. areas of intersection / crossover)
 - a. *Note - If the GPS is outside the ESTA boundary (+/- 250M), no ESTA will be assigned.*
- 9) If the ESTA remains missing:
 - a. The ESTA is set to that of the nearest assign previous 5 minute sample ESTA and the TABS trusted flag is set False

TABS

- 10) If the TABS trusted flag is set to false
 - a. For Matched Journeys, TABS overrides the ESTA to that of the TABS modelled Journey ESTA
 - b. For Un-Matched Journeys (Standing), TABS uses the DES allocated ESTA regardless of Trust Level.
- 11) If the TABS trusted flag is set to true
 - a. The DES allocated ESTA is used for Matched and Non-Matched Journeys

11. Appendix – UTILTS Data Format

The following section applies to the UK boundary for UK Operators only. European movements through the channel tunnel will be addressed separately, as these relate to different UTILTS standards (assuming adopted).




UTILTS is treated within the specification as a one-off payload format for Virgin Trains / ERESS. The UTILTS EDIFACT format is arguably obsolete with limited end user tools support (unlike Excel supporting CSV or the many products supporting XML).

Operators I.T resources are less likely to have expertise in the format and may need to engage specialist I.T suppliers should they wish to adopt.

Web References:

- http://live.unece.org/trade/untdid/d04b/trmd/utirts_c.htm
- <http://www.stylusstudio.com/edifact/d04b/UTILTS.htm>
- <http://www.edisys.no/ediel/brukerveil/UTILTS-NO-v1r0F-D02B%2020060203.pdf>

Specifications utilised:

<p>“APERAK-D05A-10A-Acknowledge.doc”</p> <p>Message handbook by UIC that describes the APERAK message used within UTILTS standard.</p> <p>http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813ccd2e</p>	 C:\Documents and Settings\rsayes\My D
<p>“D05A-10A-Transfer”</p> <p>Message handbook by UIC that describes the meter data message used within UTILTS standard.</p> <p>http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813ccd2f</p>	 C:\Documents and Settings\rsayes\My D
<p>“CONTRL-3D-10A-Control message.doc” (This was not used)</p> <p>http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813ccdf4</p>	 C:\Documents and Settings\rsayes\My D

Provisioning




1. The provisioning and data requirements and rules detailed in the main sections of this document still apply.
 - However, there is no UTILTS equivalent to the Completeness File.

Summary of Implementation Variances

1. The EOL concept does not apply to EDI, a single quote is used instead.
2. EDI requires Missing be provided as it still treats these attributes as mandatory.
EnergyICT have had to implement custom code to address this, as a preload function – which is undesirable for a COTS product.
3. EDI files have separate sections for consumption and regenerative energy, which then repeats the Quality Flags.
4. Time references 00:00, 00:05 are replaced with SEQ 01, SEQ 02 etc.
5. The meter number is specified once.
6. File naming convention, EDI requires a “.edi” extension.

12. Appendix – Meter Reference Data

All Operators are required to provide meter reference data to support the configuration of the EnergyICT OTM service.



Version Used for April 01 2011 Operators http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b8126fb03	 C:\Documents and Settings\rsayes\My D
An example of a completed form	 C:\Documents and Settings\rsayes\My D
Revised version proposed (not agreed) http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b8126fb06 <i>UK Unit Number (MU) column added</i>	 C:\Documents and Settings\rsayes\My D

13. Appendix – Production Data Samples

Production File – London Midland http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813cd093	 C:\Documents and Settings\rsayes\My D
Corresponding response – London Midland http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813cd092	 C:\Documents and Settings\rsayes\My D
Production File – Southern http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813ce029	 C:\Documents and Settings\rsayes\My D
Corresponding response – Southern http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813ce028	 C:\Documents and Settings\rsayes\My D

Production UTILTS Messages (Virgin Trains / ERESS)

These EDI files require a text editor to view. However, interpretation is difficult given the nature of the format.

“APERAK-D05A-10A-Acknowledge.doc” http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813ccdec	 C:\Documents and Settings\rsayes\My D
“D05A-10A-Transfer” http://ccms2.hiav.networkrail.co.uk/webtop/drl/objectId/09013b5b813ccdee	 C:\Documents and Settings\rsayes\My D

14. Appendix – April 2011 - Implementation observations

The following summarises key observations from the April 01 2011 go-live, which have been addressed or *may* need to be in the future:

- 1) Meter Configuration vs. Actual Supply / Capability:
 - a) Depending on meter configuration, meters can generate “Measured zero” readings even though the supply, vehicle / unit itself is not capable e.g. AC regenerative, Reactive Import/Export.
 - b) The EnergyICT (OTM Service) has a commercial model based on “channels”, each of the following is a channel:
 - i) AC consumption
 - ii) AC regenerative
 - iii) DC consumption
 - iv) DC regenerative
 - v) Reactive import
 - vi) Reactive export
 - vii) Location (lat / long)
 - c) This is an issue then because in effect, “someone” is liable for the commercial charge associated with the Measured Zero readings, which are of no business value.
- 2) Completeness File – Not a *rolling* 7 days:

The current completeness file should be a rolling 7 days. Currently it reflects the previous day only. However, per Operator accessible reports are available for the entire month.
- 3) Energy Quality Flag:

There is only one Energy Quality Flag covering all of AC, DC and Reactive. This is based on the driving standards.
- 4) Invalid GPS Locations:

Occasionally, files are rejected because one or more samples have GPS locations that fall well outside of the UK e.g. the Equator.

The consideration will be whether such files should *continue* to be rejected in their entirety or whether the offending references samples should have their GPS interpolated in some way (per GPS treatment detailed above).

Conversely, failed files for this reason act as an alert mechanism to the Operator regards potential GPS hardware and/or software issues – which may otherwise not be addressed at root cause.