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ITSO Technical Specification 1000-3 – Interoperable Public Transport Ticketing using contactless smart customer media – Part 3: Terminals

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Foreword

This document is a Part of ITSO TS 1000, a Specification published and maintained by ITSO, a membership company limited by guarantee without shareholders. The membership of ITSO comprises transport organisations, equipment and system suppliers, local and national government. For the current list of members see the ITSO web site www.itso.org.uk

ITSO TS 1000 is the result of extensive consultation between transport providers, sponsors, system suppliers and manufacturers. The Department for Transport (DfT) has also contributed funding and expertise to the process.

Its purpose is to provide a platform and tool-box for the implementation of interoperable contactless customer media public transport ticketing and related services in the UK in a manner which offers end to end Loss Less data transmission and security. It has been kept as open as possible within the constraints of evolving national, European and International standards in order to maximise competition in the supply of systems and components to the commercial benefit of the industry as a whole. In general, it promotes open standards but it does not disallow proprietary solutions where they are offered on reasonable, non-discriminatory, terms and contribute towards the ultimate objective of Interoperability.

ITSO has been established to maintain the technical specification and Business Rules required to facilitate Interoperability. It also accredits participants and interoperable equipment. ITSO is a facilitator of Interoperability at the minimum level of involvement necessary. It will not involve itself in any commercial decisions or arrangements for particular ticketing schemes; neither will it set them up nor run them. It will however “register” them in order to provide the necessary Interoperability services (e.g. issue and control of unique scheme identifiers, certification and accreditation, security oversight).

Consequently, adoption of this Specification for particular ticket schemes will be a matter for the commercial judgement of the sponsors/participants, as will the detailed Business Rules and precise partnership arrangements.

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1. Scope

ITSO TS 1000 defines the key technical items and interfaces that are required to deliver Interoperability. To this end, the end-to-end security system and ITSO Shell layout are defined in detail while other elements (e.g. terminals, 'back-office' databases) are described only in terms of their interfaces. The Business Rules that supplement the technical requirements are defined elsewhere.

1.1 Scope of Part 3

This Part of ITSO TS 1000 defines the requirements on Point Of Service Terminals (POSTs) in order that such terminals are able to support the Interoperable Smart Customer Media environment defined by ITSO. These POST requirements are grouped as follows:

- POST to Media interface (external interface) clause 2;
- POST to HOPS interface (external interface) clause 3;
- POST to ISAM interface (internal interface) clause 4;
- Human interface clause 5;
- Functional requirements of the POST software clause 6.

Only requirements that are pertinent to Interoperable Smart Customer Media usage and interfacing to other parts of the ITSO Environment are defined herein. These requirements shall be applied as an Interoperability layer over the basic specification of a ticketing terminal. The overall specification of such a device is outside of the scope of this document.

For the avoidance of doubt, the fact that a POST may be accredited as ITSO compliant does not mean that it is fit for purpose in any area other than its support for Interoperable Smart Customer Media usage.

1.2 Context of a POST within the ITSO Environment

Within the ITSO Environment, a POST is defined as one class of instances of equipment that allows transactions to be carried out with data entities held on the Customer Media.

Within the ITSO Environment, the following actors are typically POST users:

- Product Retailers (Sale and loading of ITSO Product Entity (IPE) instances into an ITSO Shell);
- Service Operators (Validation and use of IPE instances);
- Customer (In unattended transactions);
- ITSO Shell Retailers (Sale and loading of an ITSO Shell on to the Media).

POSTs provide the access mechanism to the Media platform to support the ITSO aim of permitting the interoperable use of a variety of ticketing products, retailed and used on a variety of platforms, from different issuers, on behalf of multiple product owners.

The range of equipment covered by the term 'POST' is wide and diverse. However, all POSTs shall have the following key attributes:

- they shall be able to read and write data to contactless Media that comply with the ITSO Specification;
- they shall periodically exchange data with a HOPS system;
- they shall physically contain an ITSO Security Application Module (ISAM), which is unique to the POST and is not shared by other POSTs.

Equipment classes that either do not contain a dedicated ISAM (e.g. Media viewer) or use shared ISAM resources (e.g. ISAM on a remote server) are outside the scope of this document.

1.3 Co-existence

Ticketing using ITSO Customer Media is likely to co-exist with other ticketing mechanisms within a given system. Thus the requirements specified herein for POSTs will, in many cases, co-exist with other functions on the unit.

POSTs shall be designed such that the ITSO functionality does not interfere with, or be compromised by, non-ITSO functionality. In particular:

- the POST may process other Customer Media or applications in whatever manner required by suppliers. Support for such Customer Media or applications shall not compromise the ITSO implementation;
- the ITSO implementation shall not adversely affect the reliability of the POST. If other ticketing modes are possible without ITSO Customer Media, then these may operate if the ITSO sub-system is non-functional.

1.4 Configurability / future enhancement

ITSO specifies the minimal level of POST configurability to allow interoperable operation based on this version of the Specification. As it is highly likely that additional Media platforms, products and messages will be developed and incorporated into future versions of the Specification, it is strongly recommended that POST designers use an architecture that allows for such future enhancement, preferably by means of configuration parameters.

This potential need to allow enhancement of the POST's capability in the future should also be noted by parties involved in system procurement.

2. POST to Media interface

2.1 General

Within the ITSO Environment, the primary purpose of a POST is to read and write to contactless Media. As such, all POSTs shall provide a contactless interface that complies with:

- ISO/IEC 14443-2:2001 Type A and B;
- ISO/IEC 14443-3:2001 Type A and B;
- ISO/IEC 14443-4:2001 Type A and B.

The POST shall also support the proprietary 'Mifare Classic' contactless interface.

The POST shall provide a single target area that allows Media to be easily presented by users and be read and written to in a reliable manner. The target area design shall be such that POSTs are able to process Media with form factors other than that defined by ISO/IEC 14443-1:2000.

ITSO does not require that POSTs be capable of operating with multiple Media in the reader field. If two or more devices, with which a POST is capable of conducting a transaction, are placed in the reader field at the same time, then the POST shall instigate an interaction with the customer before conducting a transaction.

2.2 Platform support

All POSTs shall support the entire set of platforms defined in ITSO TS 1000-10. POSTs shall also implement and use the appropriate Anti-tear mechanisms as defined in ITSO TS 1000-10 for each platform type.

It is strongly recommended that POSTs use a software architecture that allows further platforms to be added by means of configuration parameters.

Where the POST supports non-ITSO platforms, then the inclusion of this capability shall not compromise the terminal's ability to process ITSO defined Media platforms.

A POST shall not require any manual input to select Media type, but shall do this automatically by issuing the required ISO/IEC 14443-3:2001 'polling' commands in a manner that allows detection of all defined Media platforms.

A POST shall poll for all defined platforms in an un-biased manner, with each platform type having the same likelihood of detection and selection within a given time period.

2.3 Application Family Identifier

ISO/IEC 14443-3:2001 provides for support of an Application Family Identifier (AFI) pre-selection mechanism.

ITSO does not mandate the use of AFI coding. POSTs shall not assume that Media use AFI coding, and shall default to using the 'select all' code of 00 (hex).

2.4 ITSO Shell detection

Detection of the presence of an ITSO Application (also known as the ITSO Shell) on a presented Media requires a POST to interrogate and parse certain data from the Media. The mechanism of this process is platform dependant. All POSTs shall provide such mechanisms for all platforms defined in ITSO TS 1000-10.

See 6.1 for the associated functional requirements.

2.5 Data entity support

All POSTs shall be capable of parsing and processing the ITSO data entities defined in ITSO TS 1000-2. These entities include, but are not limited to:

- the ITSO Shell Environment Data Group;
- the Directory Data Group;
- the IPE Data Group;
- the Value Record Data Group;
- the Cyclic Log;
- the data structures that make up Data Groups:
 - the Label;
 - the Dataset;
 - the Instance ID;
 - the Seal.

ITSO TS 1000-10 defines the data entity locations and access mechanisms for each platform type.

2.6 IPE support

The complete set of IPEs is defined in ITSO TS 1000-5.

A POST shall support the required set of IPEs that are relevant to its use within an interoperable environment. This required IPE set is defined by ITSO.

3. POST to HOPS interface

3.1 General

As described in ITSO TS 1000-9, the ITSO communications architecture is hierarchical, with POSTs at the 'base' of the hierarchy. At the 'apex' of each ITSO Compliant Scheme is a first line HOPS, as detailed in ITSO TS 1000-9 which forms the interface between the scheme and the rest of the ITSO Environment. Between the POST and the HOPS there are typically scheme specific layers, where data concatenation (for upward flows) and distribution (for downward flows) take place.

In order to provide the required data exchanges within the environment, all POSTs shall have the ability and means to carry out 2-way communications with a defined 'first-line' HOPS.

Secure, lossless data communication is an essential requirement of the ITSO Environment. Within a POST this is achieved by use of data retention rules, together with services provided by the ISAM for Data Frame sealing. Generation of a valid ITSO Message and verification of an ITSO Message is always a joint task involving the POST and its ISAM. For details of the ISAM functionality refer to ITSO TS 1000-7 and ITSO TS 1000-8.

Within the following clauses, the term POST is used to collectively describe the POST / ISAM ensemble for message generation and verification.

3.2 Mandated message set

Table 1 provides a summary of the messages that shall be supported by all POSTs. These are grouped by Message Class. (Rx = shall support reception of message; Tx = shall support transmission of message).

Table 1 Message set summary

| Message Class / Message | Requirement |
|-------------------------------|-------------|
| Class 0 | |
| ACK1 (Transmission Control) | Rx |
| ACK2 (Transmission Control) | Rx / Tx |
| NAK1 (Transmission Control) | Rx |
| NAK2 (Transmission Control) | Rx / Tx |
| Class 1 | |
| Transaction Record Data | Tx |
| Class 2 | |
| Query | Tx |
| Query Response | Rx |
| Configuration Data List | Rx |
| Parameter Table | Rx |
| Class 3 | |
| ISAM Security File | Rx |
| ISAM Security Acknowledgement | Tx |

ITSO provides a Class 2 User Defined message type that can be used between the POST and HOPS. Support for such a message type is not mandated.

ITSO TS 1000-9 defines the generic structure that shall be used for ITSO Messages.

ITSO TS 1000-6 defines the content and usage rules that shall be followed for each message type.

3.3 Transmission methods and data formats

As defined in ITSO TS 1000-9, there is no mandated transmission method or data format for communications between a POST and its first-line HOPS. System designers may use any transmission method or data format, provided that the following requirements as detailed in ITSO TS 1000-9 are met:

- the methods and formats support the Loss Less data transmission methodology;
- the methods and formats allow the required data to be transmitted in a robust and secure manner;
- the methods and formats allow the transmitted data to be fully recovered to its native format;
- the methods and formats allow the transmitted data to be verified against the ISAM generated Seal at the receiving node.

It is strongly recommended that POSTs be able to transmit and accept data in the ITSO transmission format as defined in ITSO TS 1000-9.

If a POST does not support either the full or the minimal XML tag set, then its certification will be endorsed. This endorsement will state what other systems and/or utilities (e.g. depot systems, data converters, etc.) are required to enable an XML ITSO interface to be provided. In effect this endorsement will list what is required to interface the POST to a HOPS that provides an ITSO-defined XML data portal.

3.4 Loss Less data transmission

As defined in ITSO TS 1000-9, the ITSO communications environment provides end-to-end Loss Less data transmission at application level by the use of:

- Positive Acknowledgements;
- Data retention & re-transmission.

3.4.1 Positive acknowledgements

All POSTs shall generate and transmit the appropriate Class 0 Transmission Control message (ACK2 or NAK2) on receipt of a Class 2 message from a HOPS. Refer to 6.3 for the functional requirements relating to the generation of acknowledgements.

All POSTs shall receive and correctly process Class 0 Transmission Control messages received from a HOPS. Refer to 6.3 for the functional requirements relating to the processing of acknowledgements.

3.4.2 Data retention

Data retention by POSTs is an integral part of the ITSO Loss Less data transmission mechanism. All POSTs shall retain a full copy of data transmitted within Class 1 and Class 2 messages in a secure and non-volatile manner until a valid ACK is received for such data transmission. Then, and only then, shall a POST be at liberty to clear the data from that secure storage. See 6.3 for functional requirements relating to the processing of acknowledgements and determination of ACK validity.

Note: ITSO does not mandate that transmitted data be cleared from secure storage after successful transmission and acknowledgement, and POSTs are allowed to maintain a copy of such data.

Continued ITSO-specific operation of a POST shall be subservient to the above requirement for data retention. This means that if the memory store of a POST becomes 'full' and the POST cannot successfully transmit the data onward and receive valid positive acknowledgements of this data, then the POST shall immediately suspend normal ITSO operation until successful data transfer and acknowledgement has been restored. The POST shall signal 'out of service' as defined in clause 5.

Note: The above requirement will be a factor in determining the appropriate memory sizing and communications technology for use in a given system. The ISAM can be configured via the AMS system to store Transaction Records, thus providing the POST with additional secure, non-volatile memory resources. See 6.3 for further details.

3.4.3 Re-transmission of data

If a POST does not receive the required ACK for a previously transmitted message within the defined timeout period, then it shall re-transmit the message to the HOPS.

Note: ITSO TS 1000-9 only specifies the maximum allowable timeout period. A scheme may use a shorter timeout if its communications infrastructure supports this.

3.4.4 Removable memory modules

Certain designs or installations of POSTs may employ removable memory modules to provide data transfer between the POST and a fixed infrastructure (and eventually the 'first-line' HOPS). In these cases the following rules shall apply:

- The POST shall store Transaction Records (or use the ISAM to store them) and retain them in secure non-volatile storage within its fixed memory regardless of whether they are simultaneously written to the removable memory module.

- The removable memory modules themselves are not subject to ITSO data retention and deletion rules, and are considered to be a form of transport medium between POST and HOPS.
- POSTs may employ either of the following modes to store Transaction Records:
 - update the memory module as Transaction Records are created in real time;
 - write the Transaction Records to the memory module as a 'batch' operation.
- If the Transaction Record storage in the POST (or ISAM if used) becomes full the POST shall cease ITSO-related operation as defined in 3.4.2. This applies regardless of whether or not the removable memory module has remaining storage capacity.
- If the POST is operating in the first mode, i.e. that of updating the memory module continuously, and the module's memory becomes full while the POST (or ISAM if used) has remaining memory capacity, then ITSO does not require that the POST suspend ITSO related operation.

4. POST to ISAM interface

4.1 General

The ISAM is an ITSO-supplied security sub-system, and is one of the main technical security components within the ITSO Environment. Refer to ITSO TS 1000-7 for further details of role and scope of the ISAM security sub-system.

Every instance of a POST operating within the ITSO Environment shall have an ISAM fitted.

4.2 Physical

Every POST shall be fitted with at least one ISAM socket. This socket shall accept devices conforming to the GSM 11.11 standard for 'Plug-in SIM Cards', otherwise known as the ID-000 format.

The socket design shall allow the ISAM to be inserted and removed without risk of damage to the ISAM or POST. When 'closed' the socket shall lock the ISAM securely in place.

The socket shall be located such that tool access is required to access it. However, such access shall not require any tamper-proof or warranty seals to be broken.

4.3 Electrical

4.3.1 3-volt device

The standard ISAM is a 3-volt device, with the following electrical requirements:

- the electrical contacts to the ISAM are as defined in GSM 11.12:03-1998;
- the POST shall supply the ISAM with a voltage in the range of 2.7VDC to 3.3VDC;
- the POST shall be able to supply a continuous current of at least 50mA to the ISAM;
- the POST shall use a clocking frequency to the ISAM in the range of 1MHz - 5MHz;
- the POST shall be capable of supporting an I/O baud rate of 115Kbitss⁻¹ at 3.579MHz. It is recommended that POSTs be capable of supporting the maximum ISAM I/O baud rate of 446.2Kbitss⁻¹ at 3.579MHz;
- all other electrical parameters shall be as defined in GSM 11.12:03-1998.

4.3.2 5-volt device

An alternative 5-volt non-standard version of the ISAM can be made available on special order. This device is not ISO Compliant as it has a restricted voltage range. It is not recommended for general use. This device has the following electrical requirements:

- the electrical contacts to the ISAM are as defined in GSM 11.12:03-1998;
- the POST shall supply the ISAM with a voltage in the range of 4.75VDC to 5.25VDC;
- the POST shall be able to supply a continuous current of at least 50mA to the ISAM;
- the POST shall use a clocking frequency to the ISAM in the range of 1MHz - 5MHz;
- the POST shall be capable of supporting an I/O baud rate of 115Kbitss⁻¹ at 3.579MHz. It is recommended that POSTs be capable of supporting the maximum ISAM I/O baud rate of 446.2Kbitss⁻¹ at 3.579MHz.
- All other electrical parameters shall be as defined in GSM 11.12:03-1998.

4.4 Protocol

The POST shall communicate with the ISAM using the T=1 protocol as defined in ISO/IEC 7816-3:1997.

The POST shall act in the role of 'interface device' as defined by ISO/IEC 7816-3:1997.

Refer to ITSO TS 1000-8 for details of the Answer to Reset (ATR) response that the ISAM provides.

Refer to ITSO TS 1000-8 for details of the Protocol & Parameter Selection (PPS) settings supported by the ISAM.

4.5 Command set

Refer to ITSO TS 1000-8 for details of the full command set supported by the ISAM.

Refer to ITSO TS 1000-7 for the ISAM command sequences that shall be generated by the POST to carry out the operational functions required.

4.6 Usage of the ISAM

The POST shall use the services provided by the ISAM when carrying out the following functions:

- verification of ISAM validity at POST startup / initialisation;
- mutual authentication between Customer Media and POST (where applicable);
- setting up a POST to Customer Media communications session;
- closing down a POST to Customer Media communications session;
- getting access keys for the ITSO Shell on presented Media;
- getting access keys for the ITSO Directory on presented Media;
- getting access keys for IPEs on presented Media;
- creating an instance of an IPE on presented Media;
- deleting an instance of an IPE on presented Media;
- verification of the validity of the ITSO Directory on presented Media;
- verification of the validity of IPEs within an ITSO Shell on presented Media;
- verification of the validity of Value Records within an ITSO Shell on presented Media;
- sealing of IPEs which have been modified by the POST;
- sealing of Value Records which have been modified by the POST;
- sealing of the ITSO Directory after modification by the POST;
- sealing of Transaction Records generated by the POST;
- initialising the IBatch Header;
- computation of a running IBatch Header for Transaction Records generated by the POST;
- clearing down an IBatch Header when the associated Transaction Records have all been successfully transferred to a HOPS;
- verification of the validity of Data Frames received by the POST;

5. Human interface

5.1 General

Specification of certain attributes of the human interface by ITSO are required to ensure that customers receive a consistent 'user experience' when faced with an ITSO-enabled POST. These ITSO-specific attributes form only a part of the overall human interface of the unit, and as previously stated, other essential scheme-specific requirements will need to be specified for realising an operational system.

Card terminals used by members of the public should comply with:

- accessibility requirements of Part 3 of the Disability Discrimination Act 1995 ('the DDA');
- EN 1332-1:1999 - Identification card systems; man-machine interface - Design principles for the user interface;
- EN 1332-3:1999 - Identification card systems; man-machine interface – Keypads.

5.2 Accessibility

The Media Target Area shall be clearly indicated to customers.

Accessibility to the Media Target Area shall conform to the requirements of the DDA.

Accessibility to the Media Target Area shall conform to the requirements of EN 1332-1:1999.

Accessibility to any keypads required by the customer shall conform to the requirements of the DDA.

Accessibility to any keypads required by the customer shall conform to the requirements of EN 1332-3:1999.

5.3 Customer signals

POSTs used in applications where the customer interacts directly with the unit shall provide both audible and visual signals to assist usage of Media carrying an ITSO Shell.

5.3.1 Audible signals

Audible signals should conform to the requirements of EN 1332-1:1999.

Audible signals shall be used to indicate and differentiate:

- completion of a successful ITSO Transaction
- an unsuccessful ITSO Transaction

5.3.2 Visual signals

Visual signals should conform to the requirements of EN 1332-1:1999.

Visual signals shall be used to indicate and differentiate:

- a POST that is 'In Service' and able to accept and process Media carrying an ITSO Shell
- a POST that is 'Out of Service' or unable to accept and process Media carrying an ITSO Shell
- completion of a successful ITSO Transaction
- an unsuccessful ITSO Transaction

5.4 Other I/O devices

5.4.1 Customer display

In addition to the visual signals defined in section 5.3.2, POSTs may have a display for conveying more detailed information to a customer.

Such a user display, if present, should conform to the requirements of BS EN 1332-1:1999.

If Media is presented that carries 'User Related Information' (URI) coding, then the POST should adapt any customer display settings to conform to the requirements of BS EN 1332-4:1999.

The message strings associated with ITSO Transactions are defined in Annex A – Standard customer Messages.

5.4.2 User console

POSTs may have a user console for allowing a customer to input and view data associated with their Customer Media and / or Transactions.

Such a user console, if present, should conform to the requirements of BS EN 1332-1:1999 and BS EN 1332-3:1999.

If Media is presented that carries 'User Related Information' (URI) coding, then the POST should adapt any user console settings to conform to the requirements of BS EN 1332-4:1999.

5.5 ITSO accreditation marking

Instances of a POST design that has been certified as ITSO Accredited, and are used in a scheme where ITSO Customer Media is accepted shall bear the approved ITSO Accreditation logo. This logo shall be situated in a location that is visible without requiring the POST to be removed from any mounting.

Refer to the ITSO Business Rules for further details.

6. Functional requirements of the POST software

This clause defines the functional requirements relating to:

- media handling;
- IPE handling;
- message generation and processing;
- configuration handling.

6.1 Media handling

This sub-clause defines the following functional requirements relating to handling of ITSO Customer Media:

- detection and validation of the ITSO Shell;
- validation of the Directory;
- selection of products;
- handling of Anti-tear;
- media re-presentation;
- transaction time.

6.1.1 Detection and validation of the ITSO Shell

As stated in clause 2, all POSTs shall be able to automatically detect and initiate communications with all Customer Media platforms (CMDs) defined in ITSO TS 1000-10.

Because of the range of platform types, there is no common mechanism that can be used to establish the existence or otherwise of an ITSO Shell on presented Media. The POST shall, for each CMD, carry out the required interrogation of the Media to establish if an ITSO Shell is present or not. See ITSO TS 1000-10 for details of ITSO Shell detection.

At the end of the above process, if the presented Media contains a valid, non-expired ITSO Shell, then the POST will have the required parameters to access and validate the Directory. These parameters include:

- MID;
- ISRN;
- FVC;
- KSC;
- KVC;
- KAS (Value determined by data entity being accessed).

Refer to ITSO TS 1000-2 and ITSO TS 1000-10 for further details on the meaning and usage of these parameters.

If the POST could not detect an ITSO Shell, or the detected ITSO Shell has expired, then the POST shall terminate the transaction and shall record an exception Transaction Record as defined in ITSO TS 1000-6.

6.1.1.1 Compact ITSO Shell processing

The concept of a 'Compact Shell' is defined in ITSO TS 1000-2. This form of ITSO Shell is used on platforms with limited storage capacity. See ITSO TS 1000-10 for details of such platforms.

When a POST detects a platform carrying a Compact ITSO Shell, then it shall 'reconstitute' a full ITSO Shell using the parameters defined in ITSO TS 1000-10. It shall use this 'reconstituted' ITSO Shell where required (e.g. for sending parameters as part of ISAM commands).

6.1.2 Validation of the Directory

ITSO Shell detection as described in the above sub-clause does not require the services of the ISAM. However, all further interaction with the platform must take place within a 'secured session'. This session requires the POST to make use of a number of ISAM services during dialogue with the Media. ITSO TS 1000-7 defines the detailed structure of a secured session.

When a valid ITSO Shell has been detected, the POST shall commence and execute a secured session as defined in ITSO TS 1000-7 and ITSO TS 1000-8.

The ISAM will signal an error condition if it determines that:

- the Format Version Code is not supported or authorised for use on the POST;
- the Key Strategy Code is not supported or authorised for use on the POST.

In both of the above cases the POST shall terminate the transaction and the session, and shall record an exception Transaction Record as defined in ITSO TS 1000-6.

The next phase of the secure session is Directory validation. During this phase the POST obtains the required keys from the ISAM to access the Directory and then passes the contents of that Directory to the ISAM for verification of the Directory Seal.

On platforms that have Anti-tear copies of the Directory, then checking of the copies shall be done in the manner defined in ITSO TS 1000-10.

If the ISAM indicates that the ITSO Shell contains a valid Directory, then the POST shall continue the transaction by establishing that the ITSO Shell is not blocked or Hotlisted.

If a valid Directory is not found the POST shall terminate the transaction and the session, and shall record an exception Transaction Record as defined in ITSO TS 1000-6.

If the ITSO Shell is Hotlisted or blocked the POST shall terminate the transaction and the session, and shall record an exception Transaction Record as defined in ITSO TS 1000-6.

If the Media contains a valid Directory, and its ITSO Shell is not blocked or Hotlisted then the POST shall continue the transaction by establishing the presence of suitable products(s) within the ITSO Shell.

6.1.3 Selection of products

The POST shall parse the Directory Entries to establish the presence (or otherwise) of products that are suitable for the application in which the POST is operating. Initial Directory Entry parsing does not require the use of ISAM services, the POST can check for Entries that:

- contain an IIN, OID, TYP, PTYP combination that the POST has operational / Interoperability rules for;
- are not blocked for use;
- are not expired.

Following this initial parsing, the POST shall assemble a 'candidate list' of products (IPE instances) that can then be verified. Within this context, IPE instance shall refer to both the 'static' IPE Data Group and any associated Value Record Data Group.

If no candidate IPE instances are found the POST shall terminate the transaction and the session, and shall record an exception Transaction Record as defined in ITSO TS 1000-6.

The selection order for candidate IPE instances shall be made using:

- configured selection rules¹ held within the POST, where such rules are agreed between the Service Operator and the Product Owner(s);
- IPE PriorityOverride flag settings;
- selection by the customer if the operating environment and POST design permits this.

The POST shall then submit the selected IPE instance to the ISAM for verification of validity in the manner defined in ITSO TS 1000-7 and ITSO TS 1000-8.

If the IPE instance is deemed to be invalid for use by the ISAM the POST shall record an exception Transaction Record as defined in ITSO TS 1000-6. If there is an alternative IPE instance, then this shall be submitted to the ISAM for verification.

If a valid IPE instance cannot be found, then the POST shall terminate the transaction and the session, and shall record an exception Transaction Record as defined in ITSO TS 1000-6.

If a valid IPE instance is found then the POST shall process the IPE as defined in 6.2.

6.1.4 Handling of Anti-tear

All POSTs shall implement and support the Anti-tear mechanisms outlined in ITSO TS 1000-2 and defined in ITSO TS 1000-10.

A POST shall not transact with Customer Media in a manner that will render the Media unreadable by other POSTs.

When a POST detects premature removal of Media, it shall signal an error condition to the user, and wherever possible, prompt for the Media to be re-presented. The POST shall make a record of the status of the transaction, such that if the Media is re-presented, then the transaction can be completed.

A POST shall always complete a transaction if the Customer Media in question is re-presented before any other Media is presented. It is recommended that POSTs be able to complete the transaction on Torn Customer Media if it presented within a defined number of transactions (say 10).

If a POST is unable to verify that the Media was correctly updated, it shall not create a 'successful' Transaction Record. Instead it shall record an exception Transaction Record as defined in ITSO TS 1000-6.

6.1.5 Media re-presentation

POSTs shall be designed to prevent 'Double Transactions' due to inadvertent re-presentation of Customer Media. The mechanisms used shall take into consideration the application, the operating environment and the ticketing products used.

Note: Certain applications may require the system to legitimately carry out relatively rapid transactions on a single platform; group use of a carnet product or Stored Travel Rights (STR) being two examples.

6.1.6 Transaction time

6.1.6.1 Benchmark Transaction

POSTs shall be able to carry out the defined benchmark Transactions defined in ITSO TS 1000-10.

¹ These rules shall aim to ensure that the customer is given 'best value' based on the available options.

The benchmark Transaction shall be deemed to start when the Media has fully entered the RF field of the POST.

The benchmark Transaction shall be deemed to end when the POST has received the last data item required from the Media as defined in ITSO TS 1000-10.

The benchmark Transaction shall not require any operator or customer input.

6.1.6.2 Throughput

POSTs shall be capable of maintaining an average sustained throughput of 3 transactions per second for the benchmark transaction described in the above sub-clause.

The maximum dwell time between cessation of Media activity from a transaction and being ready to commence activity with a subsequent user shall be no more than 100 ms.

6.2 IPE handling

This sub-clause defines functional requirements relating to handling of IPE instances present on the Customer Media. As before, unless otherwise stated the term IPE instance shall refer to both the 'static' IPE Data Group and any associated Value Record Data Group.

The following areas are covered:

- general IPE instance processing;
- IPE instance creation;
- IPE instance deletion;
- Cyclic Log updating;
- Auto-Renew;
- Stored Travel Rights (STR) processing;
- Ticket annulment;
- printing of Tickets and receipts.

6.2.1 General IPE instance processing

An IPE instance is an instantiation of an IPE embodiment specification. This embodiment specification defines, for a given IIN, OID, TYP and PTYP, the allowable ranges and usages of the data elements contained within the IPE. In addition, the embodiment specification defines the commercial purpose and mode of usage of the product (e.g. a weekly travelcard valid in a given area).

The ISAM within the POST enforces agreed business relationship rules, and determines if the product defined by IIN, OID, TYP and PTYP is valid for use at the POST in question (i.e. does the Product Owner of the product have an ITSO-registered agreement with the Service Operator of the POST).

The ISAM does **not** hold or control rules relating to the embodiment, which are defined by the Product Owner. The POST shall be configured with all such rules, and shall use those rules in a complete and accurate manner.

In addition to these product-specific embodiment rules, the POST shall always perform the following during the processing of an IPE instance:

- Apply any pending actions that are required, based on data held in the Actionlist. Those actions shall be applied in the sequence defined by their associated sequence number;
- Verify temporal validity of the product. This shall include 'Anti-passback' checks if relevant (see 6.2.1.1).

- Use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to generate updated Seals for the IPE Data Group and/or the Value Record Data Group of the IPE instance if changes are made to data elements with those groups;
- Update the Cyclic Log if this is present;
- Generate an updated copy of the Directory with the new entry and use the services of the ISAM to seal that directory;
- Write the updated Directory to the Media;
- Verify that all data written to the Media was carried out correctly;
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state;
- Correctly implement rollover on data fields within IPEs in the manner defined in ITSO TS 1000-5.

6.2.1.1 Anti-passback

'Anti-passback' is a period of time during which a Product may not be presented more than once, and is designed to prevent the deliberate multiple use of a travel permit by multiple users.

The POST shall support Anti-passback checking where this is required by a product. If Media carrying a Product that uses Anti-passback is presented twice within the number of minutes defined in the Product's 'PassbackTime' field, the POST shall signal an error, and shall not process the Product; however the ITSO Shell and other Products within the ITSO Shell are still valid for use.

6.2.2 IPE instance creation

The POST shall use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to establish if it has authority to create an IPE instance of a given IIN, OID, TYP and PTYP.

If the POST is authorised to create the IPE instance, then it shall carry out the following actions:

- Verify that there is a 'free' Directory Entry available. If a free entry is not available, and there are no expired IPE instances available for deletion (see 6.2.3), then the IPE instance shall not be created.
- Verify that there are sufficient storage sectors free to hold the IPE instance (IPE Data Group and any associated Value Record Data Group). If free sectors are not available, and there are no expired IPE instances available for deletion (see 6.2.3), then the IPE instance shall not be created.
- Create the required IPE Data Group and use the services of the ISAM to seal this.
- Create the associated Value Record Data Group (if required) and use the services of the ISAM to seal this.
- Write the above data group(s) to the Media.
- Generate an updated copy of the Directory with the new entry and use the services of the ISAM to seal that directory.
- Write the updated Directory to the Media.
- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state.

6.2.3 IPE deletion

Where there is insufficient space in the ITSO Shell to create an IPE instance, a POST may be authorised to delete expired IPEs created by other Product Owners.

The POST shall initially verify that both the Expiry Date in the Directory Entry and the date defined by RemoveDate in the IPE instance have passed. Note that:

- if the Expiry Date is set to zero, then the POST shall not delete the IPE under any circumstances;
- if the RemoveDate field is set to 255, then the IPE may not be deleted.

If both Expiry Date and RemoveDate are such that deletion is allowed, then the POST shall use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to establish if it has authority to delete the IPE instance.

If the POST is authorised to delete the IPE instance, then it shall carry out the following actions:

- Create the required (replacement) IPE Data Group and use the services of the ISAM to seal this.
- Create the associated Value Record Data Group (if required) and use the services of the ISAM to seal this.
- Write the above data group(s) to the Media.
- Generate an updated copy of the Directory with the new entry and use the services of the ISAM to seal that directory.
- Write the updated Directory to the Media.
- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state.

6.2.4 Cyclic Log updating

The POST shall check if a Cyclic Log is present in the ITSO Shell of the Media transacted with. The Log **is** fully defined in ITSO TS 1000-2.

6.2.4.1 Basic Mode Log

A basic mode Log change is conducted when use of an IPE is being recorded, but a Cyclic Log entry is not being written.

When a basic mode Log change is made then the POST shall update the following data elements of the Log Directory Entry. This update shall take place after any updates of the IPE Data Group(s) but prior to updates (and sealing) of the Directory.

- PTR Updated to the Directory Entry index of the most relevant IPE used in the transaction;
- EEI Updated to the required 'nesting level' if the transaction is associated with a closed system;
- DTS Updated with date and time of transaction;
- PTLBM Updated with the Anti-passback time appropriate to the IPE pointed to by PTR;
- LPF Set this flag to indicate a basic mode entry.

Other elements of the Log Directory Entry shall not be changed.

6.2.4.2 Normal Mode Log

A normal mode Cyclic Log change shall only be made when the conditions for adding a Transient Ticket Data Record specified in ITSO TS 1000-5 are satisfied. The data set stored in the Cyclic Log shall conform to the definition of a Transient Ticket Data Record as specified in ITSO TS 1000-5. The directory entry shall be updated as defined above for basic mode, excepting that the LPF flag shall be set so as to indicate a normal mode entry, and the record offset RO shall be set to indicate the next record to be written.

Refer to ITSO TS 1000-6 for definitions of the Transaction Record type.

6.2.5 Auto-Renew

The POST shall check if the product to be used supports Auto-Renew (as defined in ITSO TS 1000-5), and shall have the capability to carry out this operation if required.

If the IPE instance has its Auto-Renew flag set, and the entitlement available has run out / expired, then the POST shall use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to establish if it has authority to 'top-up' the IPE instance.

If the POST is authorised to Auto-Renew the IPE instance, then it shall carry out the following actions:

- Modify the associated Value Record Data Group as required and use the services of the ISAM to seal this.
- Generate an updated copy of the Directory with the new entry and use the services of the ISAM to seal that directory.
- Write the updated Directory to the Media.
- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state.

6.2.6 Stored Travel Rights processing

6.2.6.1 STR presence

ITSO mandates that all Media platforms used in ITSO Compliant Schemes shall contain a STR IPE instance, save where such a platform does not have the available storage capacity. Such 'restricted memory' platforms are explicitly identified in ITSO TS 1000-10.

The STR IPE instance shall be created at the same time as the ITSO Shell (i.e. on the ITSO Shell Retailer's POST equipment). If the ITSO Shell Owner wishes to provide a local STR scheme, then they shall create two TYP 2 IPEs, where one shall be reserved for use by a future national STR scheme and the OID for this STR product shall be set to the 'reserved OID' value 8000. An IPE embodiment specification for this reserved IPE is available from ITSO.

Transaction Records shall be created for the reserved STR IPE in the same way as for any other IPE. The code 0005 message shall be sent to the Shell owner in the normal way. The code 0120 message shall be sent to the POST owner and the copy which would normally be sent to the IPE owner shall be held by the POST owner's HOPS pending instructions from ITSO on its disposition.

6.2.6.2 STR ownership transfer

Providing that the STR product on a platform has not been used then POSTs shall have the capability to change the owning OID of that product.

POSTs shall have the capability to change the owning OID of the STR product. Such a change shall only be allowed if:

- The STR product instance on the Media has not been used (i.e. the coding in the Sector Chain Table indicates that the IPE has never been used as defined in ITSO TS 1000-2); and

- The services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) were used to establish if the POST has the authority to carry out such a change. Such authority can be identified where the ISAM contains the appropriate keys and permissions for both the old and new OIDs.

If the POST is authorised to change the owning OID, then it shall carry out the following actions atomically:

- Delete the existing IPE Data Group and the associated Value Record Data Group and generate the appropriate code 0007 Transaction Record message. Where the IPE owner was identified by OID 8000 then the message shall be held by the POST owner's HOPS, and not sent to the IPE owner, pending instructions from ITSO on its disposition.
- Create the new IPE Data Group and associated Value Record Data Group and use the services of the ISAM to seal this.
- Generate an updated copy of the Directory with the new entry and use the services of the ISAM to seal that directory.
- Write the updated Directory to the Media.
- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state. The following message types shall normally be generated: code 0005 "Create IPE" sent to the Shell owner; and code 0120 "Create Stored Travel Rights TYP 2" sent to the POST and IPE owners.

6.2.6.3 STR load limits

The ISAM is designed to control the STR loading / incrementing. The checks and controls are:

- The ability, or not, to increment the STR product on any Customer Media;
- The maximum value that can be held in the STR product on a given instance of Customer Media;
- The maximum aggregate value that can be added by the POST (over multiple Media instances);

POSTs shall always use the services of the ISAM to ensure that these checks and controls are adhered to.

6.2.6.4 STR loading

As defined in the above sub-clause, STR loading / incrementing by a POST is subject to checks and controls by the ISAM. POSTs shall use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to carry out such loading / incrementing in the approved manner.

If the POST is authorised to load the STR product, then it shall carry out the following actions:

- Modify the associated Value Record Data Group and use the services of the ISAM to seal this.
- Generate an updated copy of the Directory with the new entry and use the services of the ISAM to seal that directory.
- Write the updated Directory to the Media.
- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state.

6.2.6.5 Reporting of the addition of STR value

If the STR product is used in a Transaction, the POSTs shall check for the presence of an 'add value' record in the STR IPE Value Record Data Group.

If such a record is found, the POST shall use it to create a Transaction Record (of message code 0103) pertaining to this previous 'add value' transaction. This Transaction Record shall be transmitted along with all the normal Transaction records for the actual transaction carried out.

Note: This mechanism offers a measure of protection in case the original 'add value' Transaction Record was not transmitted or received.

6.2.6.6 STR priority

The STR IPE contains a priority override flag. The definition of this flag is that it indicates to a POST to use the STR product in preference to any other payment mechanism contained within the Customer Media.

Because STR product selection is determined by external rules applied to the candidate product list (see 6.1.3), such rules have to also provide priority to the STR product in order for the product to be checked and parsed and this flag read by the POST.

6.2.6.7 Auto-Top-Up

Auto-Top-Up enables a STR IPE instance to be automatically 'topped-up' to a preset value as and when a defined minimum threshold is reached. See ITSO TS 1000-5 for the associated thresholds.

The POST shall check the Auto-Top-Up start date to ensure that Auto-Top-Up is permitted at this time even though the flag is set to indicate Auto-Top-Up is allowed. This date is used for newly created STR product instances to allow time for customer credit worthiness to be checked.

The POST shall only process one Auto-Top-Up action per transaction.

In the case of Auto-Top-Up flagged as being supported from an external purse, the POST shall indicate this to the operator and shall terminate the ITSO Auto-Top-Up sequence. As and when (external) top-up has taken place, the ITSO Transaction may be re-attempted.

6.2.7 Annulment

If the POST supports Product annulment and the capability criteria tables in the ISAM are set to allow IPE deletion, then it shall annul Products stored on the Media as follows:

- Delete the IPE using the Delete IPE command.
- Generate an updated copy of the Directory, with the IPE entry deleted and use the services of the ISAM to seal the directory.
- Write the updated Directory to the Media.
- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state.

Notes:

Since the Product is effectively deleted by the annulment process above, reversal of a Product annulment is effectively recreation of the IPE. This can be carried out in the same ISAM session as the IPE deletion described above. The process is the same as for IPE instance creation (clause 6.2.2).

Where the platform utilises a one time programmable area for the usage of a product then instance annulment will not be possible.

6.2.8 Printing of Tickets and receipts

If the POST has a printer, then it shall issue a Ticket or receipt as defined by the control flags within the IPE instance used (see ITSO TS 1000-5).

6.3 Message generation and processing

As defined in clause 3, all POSTs shall support 2-way communication to a HOPS. Four classes of ITSO application message, as defined in ITSO TS 1000-9, are exchanged between the POST and the HOPS:

- Class 0 Positive acknowledgement messages;
- Class 1 Batch-oriented POST to HOPS message;
- Class 2 General frame-oriented message;
- Class 3 ISAM security message.

All POSTs shall support the above message classes and shall generate and process those messages as follows:

6.3.1 Class 0 message generation

Each Data Frame within a Class 0 message will be one of the following (see ITSO TS 1000-6 and ITSO TS 1000-9):

- ACK1;
- ACK 2;
- NAK1;
- NAK2.

The only Data Frame types that the POST generates for Class 0 messages are ACK2 and NAK2. These Data Frames are generated in response to the POST receiving a Class 2 message.

6.3.1.1 ACK2 generation

ACK2 Data Frames are generated by the POST and sent to a HOPS when the POST receives a valid Class 2 Data Frame from the HOPS.

The POST shall determine the validity of the received Class 2 message and its constituent Data Frames as defined in ITSO TS 1000-9. This is summarised as follows:

- Verify the integrity of the overall message using the Message CRC.
- Verify if authorised to process the message.
- Verify the integrity of each Data Frame using the necessary ISAM services (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to carry out such verification.
- For each correctly validated Data Frame, extract the data elements contained within the Data Frame and store / process these in the appropriate manner (see ITSO TS 1000-6).
- For each correctly validated Data Frame, extract the Data Frame sequence number parameter (see ITSO TS 1000-6).
- Using that parameter data, generate an ACK2 Data Frame and use the services of the ISAM to seal said Data Frame.
- At the earliest possible time, transmit this ACK2 Data Frame to the HOPS as part of a Class 0 message.

6.3.1.2 NAK2 generation

NAK2 Data Frames are generated by the POST and sent to a HOPS when the POST receives an invalid Class 2 Data Frame from the HOPS.

The POST shall determine the validity of the received Class 2 message and its constituent Data Frames as defined in ITSO TS 1000-9. This is summarised as follows:

- Verify the integrity of the overall message using the Message CRC.
- Verify if authorised to process the message.
- Verify the integrity of each Data Frame using the necessary ISAM services (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to carry out such verification.
- For each Data Frame that was not correctly validated, extract the Data Frame sequence number parameter (see ITSO TS 1000-6).
- Using that parameter data, generate a NAK2 Data Frame and use the services of the ISAM to seal said Data Frame.
- At the earliest possible time, transmit that NAK2 Data Frame to the HOPS as part of a Class 0 message.

6.3.2 Class 0 message processing

The POST shall process received Class 0 messages as defined in ITSO TS 1000-9. This is summarised as follows:

- Verify the integrity of the overall message using the Message CRC.
- Verify if authorised to process the message.
- Verify the integrity of each Data Frame using the necessary ISAM services (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to carry out such verification.
- Verify the destination of each Data Frame is correct (i.e. to the POST / ISAM in question).

Processing of the different types of Class 0 Data Frame is detailed in the following sub-clauses.

6.3.2.1 ACK1 processing

ACK1 Data Frames are generated by a HOPS and sent to a POST.

The purpose of the ACK1 is to explicitly acknowledge correct and full receipt (by the HOPS) of a batch of (Class 1) Transaction Records that were sent previously by the POST. This collection of Transaction Records is termed a Transaction Session Batch, and may have been transmitted between POST and HOPS over a period of time in multiple Class 1 messages (see ITSO TS 1000-9).

The POST shall process received ACK1 Data Frames as follows:

- Verify message integrity, Data Frame integrity and Data Frame destination as defined in 6.3.2.
- For each correctly validated Data Frame, extract the IBatch Header sequence number and the IBatch Header delete parameters (see ITSO TS 1000-6).
- Using that parameter data, generate the required ISAM command (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to 'clear down' the IBatch Header stored within the ISAM for the acknowledged message batch.

Note: ITSO does not mandate that the POST delete stored Transaction Records after the batch to which they are associated has been ACK'ed. The decision to retain or remove the Transaction Records is left to POST designers.

6.3.2.2 ACK2 processing

ACK2 Data Frames are generated by a HOPS and sent to a POST.

The purpose of the ACK2 is to explicitly acknowledge correct receipt (by the HOPS) of a Data Frame sent by the POST within a Class 2 message.

The POST shall process received ACK2 Data Frames as follows:

- Verify message integrity, Data Frame integrity and Data Frame destination as defined in 6.3.2.
- For each correctly validated Data Frame, extract the Data Frame sequence number parameter (see ITSO TS 1000-6).
- Using that parameter data, determine the (Class 2) Data Frame to which the ACK2 pertains and mark said Data Frame as being successfully transmitted.

Note: ITSO does not mandate that the POST delete stored Class 2 Data Frames after they have been ACK'ed. The decision to retain or remove the Data Frame is left to POST designers.

6.3.2.3 NAK1 processing

NAK1 Data Frames are generated by a HOPS and sent to a POST.

The purpose of the NAK1 is to explicitly indicate incorrect receipt (by the HOPS) of a Transaction Session Batch.

The POST shall process received NAK1 Data Frames as follows:

- Verify message integrity, NAK1 Data Frame integrity and NAK1 Data Frame destination as defined in 6.3.2.
- For each correctly validated NAK1 Data Frame, extract the IBatch Header sequence number parameter (see ITSO TS 1000-6).
- At the earliest possible time, re-transmit all the Transaction Records that make up the Transaction Session Batch that is associated with that parameter data.

6.3.2.4 NAK2 processing

NAK2 Data Frames are generated by a HOPS and sent to a POST.

The purpose of the NAK2 is to explicitly indicate incorrect receipt (by the HOPS) of a Data Frame sent (by the POST) within a Class 2 message.

The POST shall process received NAK2 Data Frames as follows:

- Verify message integrity, NAK2 Data Frame integrity and NAK2 Data Frame destination as defined in 6.3.2.
- For each correctly validated NAK2 Data Frame, extract the Class 2 Message Data Frame sequence number parameter (see ITSO TS 1000-6).
- At the earliest possible time, re-transmit (as part of a Class 2 message) the Class 2 Message Data Frame that is associated with that parameter data.

6.3.3 Class 1 message generation

Each Data Frame within a Class 1 message contains a Transaction Record (see ITSO TS 1000-6). Transaction Records form the basis of POST to HOPS data exchange.

All POSTs shall generate all required Transaction Records for activity carried out by the POST. ITSO TS 1000-5 and ITSO TS 1000-6 define what records shall be generated, and the data content and format of such records.

ITSO defines the concept of a Transaction Session Batch. This consists of a set of Transaction Records that all share a common IBatch Header (see ITSO TS 1000-9). The IBatch Header is automatically computed / updated by the ISAM when its services are used to seal a Transaction Record within a (Class 1) Data Frame.

All Transaction Records shall form part of a Transaction Session Batch. The POST shall use the services of the ISAM to initialise a Transaction Session Batch and generate an associated IBatch Header prior to carrying out transactions.

Note: ITSO does not prescribe the length of time or the number of transactions that a Transaction Session Batch may span. The only requirement is that there must be an 'open' Transaction Session Batch, with its associated IBatch Header, before the POST is allowed to carry out transactions.

Each Transaction Record within a Data Frame shall contain the data elements defined in ITSO TS 1000-6, and shall be sealed using the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8).

A Class 1 message shall comprise of one or more (sealed) Data Frames, together with the IBatch Header that the ISAM generated for the 'newest' Data Frame within the message. See ITSO TS 1000-7 and ITSO TS 1000-8 for details of how the IBatch Header is accessed.

The POST shall store a copy of all Data Frames transmitted as part of a Transaction Session Batch, together with the relevant IBatch Header, until an ACK1 has been received from the HOPS for said Transaction Session Batch. That storage shall be in a secure and non-volatile medium.

If the POST has 'closed' a Transaction Session Batch and indicated this to the HOPS, then it shall start an 'ACK timeout' as defined in ITSO TS 1000-9. If the required ACK1 is not received after this timeout expires, then the POST shall resend the Data Frames that make up said Transaction Session Batch to the HOPS.

Note: The ISAM can be configured via the AMS system to store Transaction Records, thus providing the POST with additional secure, non-volatile memory resources

6.3.3.1 Transaction Records destinations

The POST shall ensure that Transaction Records are generated and distributed to all required destinations, where those destinations are associated with the relevant entities in the ITSO Environment. These actors are:

- the ITSO Shell Owner;
- the ITSO Shell Retailer;
- the Product Owner;
- the Product Retailer;
- the Service Operator.

ITSO TS 1000-6 defines the required distribution of each Transaction Record type.

ITSO TS 1000-9 defines how Transaction Record Data Frames can be given multiple destinations.

6.3.4 Class 1 message processing

Class 1 messages are only ever generated by a POST and sent to a HOPS. As such a POST shall never have to process such messages.

6.3.5 Class 2 message generation

Class 2 messages generated by a POST shall contain Data Frames with the 'POST to HOPS Query' message code (see ITSO TS 1000-6).

A Class 2 message shall comprise of one or more (sealed) Data Frames. The POST shall use the services of the ISAM to seal those Data Frames.

The POST shall store a copy of each Data Frame transmitted, until an ACK2 has been received from the HOPS for said Data Frame. That storage shall be in a secure and non-volatile medium.

On sending Class 2 Data Frames, the POST shall start an 'ACK timeout' as defined in ITSO TS 1000-9. If the required ACK2 is not received after this timeout expires, then the POST shall resend the required Data Frame(s) to the HOPS.

6.3.6 Class 2 message processing

Class 2 messages received by a POST will consist of Data Frames, each of which will have one of the following message codes:

- Query Response;
- Configuration List;
- Parameter Table.

The POST shall process received Class 2 messages as defined in ITSO TS 1000-9. This is summarised as follows:

- Verify the integrity of the overall message using the Message CRC.
- Verify if authorised to process the message.
- Verify the integrity of each Data Frame using the necessary ISAM services (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to carry out such verification.
- For each correctly validated Data Frame, extract the Data Frame sequence number parameter (see ITSO TS 1000-6). Using this parameter data, generate an ACK2 Data Frame and seal this Data Frame using the services of the ISAM. See also 6.3.1.1.
- For each Data Frame that was not correctly validated, extract the Data Frame sequence number parameter (see ITSO TS 1000-6). Using this parameter data, generate an NAK2 Data Frame and seal this Data Frame using the services of the ISAM. See also 6.3.1.2.
- At the earliest possible time, transmit (as part of a Class 0 message) these Data Frames.
- For each correctly validated Data Frame, extract the data elements contained within the Data Frame and store / process these in the appropriate manner (see ITSO TS 1000-6).

6.3.7 Class 3 message generation

Class 3 messages generated by a POST shall contain Secure Data Frames generated by the ISAM, together with a POST-generated Batch Header.

After passing a received ISAM Security File to the ISAM (see 6.3.8), the POST shall retrieve the ISAM Security Acknowledgement, which the ISAM will generate in the form of a Secure Data Frame (see ITSO TS 1000-7 and ITSO TS 1000-8).

The POST shall then, at the earliest possible time, transmit (as part of a Class 3 message) said Secure Data Frame.

6.3.8 Class 3 message processing

Class 3 messages received by a POST shall contain one or more ISAM Security Files destined to the POST's ISAM. These files will be in the form of Secure Data Frames.

The POST shall transfer said Security Files to the ISAM, in the manner defined in ITSO TS 1000-7 and ITSO TS 1000-8.

The POST shall then retrieve the ISAM Security Acknowledgement which shall be generated by the ISAM in response to the ISAM Security File previously transferred.

6.3.9 Sequence numbers

Every Data Frame contains a sequence number as described in ITSO TS 1000-6. However, sequence numbers are handled differently between Data Frames in a Class 1 message and Data Frames in Class 0 and Class 2 messages.

In a 'Class 1' Data Frame, the sequence number is generated by the ISAM as part of the Data Frame sealing process and this sequence number is linked to the IBatch Header.

In 'Class 0' and 'Class 2' Data Frames, the POST shall provide the sequence number. In the case of Data Frames that are used in Class 2 messages, it is important that this number is unique for all Data Frames that are pending ACKs as the ACK will contain that number as a reference. For Data Frames in Class 0 messages, sequence number uniqueness is not important.

6.4 Configuration handling

The POST shall be capable of receiving and processing the following configuration files from a HOPS:

- Hotlist;
- Actionlist;
- Interoperability list.
- IPE Embodiment Parameters file. (if IPE creation is required)

ITSO does not mandate minimum storage requirements for these lists. Suppliers shall state the storage capacity (in records) of the POST for each of the above. These capacities shall be stated on the POST accreditation certificate.

POSTs shall only action data records contained in these configuration files if it can ascertain the validity of such records.

6.4.1 Hotlist

The ITSO Hotlist mechanism allows for the blocking of entities on the Media (ITSO Shell / IPE instances). ITSO Hotlists will be sent to a POST from its first-line HOPS.

The ITSO Environment and message set does not support the blocking of the customer Media itself. The highest level entity which may be blocked is the ITSO Shell.

6.4.1.1 Hotlist structure

The structure of the Hotlist is defined ITSO TS 1000-6. In summary, the list consists of one or more records, where each record is made up of a number of fields as follows:

- Header;
- IPE identifier(s) (optional);
- A Hotlist data group.

6.4.1.2 Hotlist storage

The POST shall store the received Hotlist either:

- within its own secure non-volatile memory; or
- within the ISAM; or
- optionally within both its own secure non-volatile memory and within the ISAM.

For lists stored in the POST's own memory:

- The HOPS shall transmit each Hotlist record as a (signed) Class 2 Data Frame, which the POST shall check and process as defined in 6.3.6.

- ITSO does not prescribe the storage format for the Hotlist, but does require that the format retains all data elements specified, and allows searching using the criteria specified in subsequent sub-clauses.

For lists stored in the ISAM:

- The HOPS shall transmit each Hotlist record as a Secure Data Frame within a Class 3 message. The POST shall 'pass' that frame to the ISAM as defined in 6.3.8.
- The POST cannot directly access lists stored in the ISAM. It shall use the services provided by the ISAM to search those lists.

6.4.1.3 Hotlist updates

For lists stored in the POST's own memory:

- If the HotListIdentifier in a received Hotlist record is greater than that of the currently stored records (taking roll-over into account) then the POST shall clear down its current Hotlist. It shall then start a new Hotlist, the first record of which shall be the newly received one.
- If the HotListIdentifier in a received Hotlist record is the same as that of the currently stored records then the POST shall append that record to the list.

For lists stored in the ISAM:

- The above rules shall apply, but are executed by the ISAM.

6.4.1.4 Hotlist searching

The POST shall support searching of the Hotlist by both:

- ITSO Shell reference (key type 0) and
- IPE reference (key type 1).

ITSO Shell reference (key type 0) searches shall be used whenever the presented Media platform carries a 'full' (version 1) ITSO Shell (see ITSO TS 1000-2 and ITSO TS 1000-10).

IPE reference (key type 1) searches shall only be used whenever the presented Media platform carries a 'compact' (version 2) ITSO Shell (see ITSO TS 1000-2 and ITSO TS 1000-10).

In both search mechanisms (key type 0, key type 1) the 'search string' generated by the POST shall consist of 8 bytes, which match the first 8 bytes of the header within the Hotlist record.

Where the ISAM is used for Hotlist storage, then the POST shall use the defined ISAM services to carry out searching of the Hotlist, using the above 8-byte search string. See ITSO TS 1000-7 and ITSO TS 1000-8 for details. The file to be selected by the POST for the Hotlist search shall be that notified to the POST in the contents of the Interoperability List table entitled ISAM Management File Parameters. See ITSO TS1000-6 for details.

6.4.1.4.1 Key type 0

This search type shall be used when the prime reference is the ITSO Shell instance. The search string consists of the following elements, and is fully defined in ITSO TS 1000-6:

- Key type;
- ITSO Shell iteration number;
- IIN index;
- ISRN (excluding IIN).

The full ISRN is not used. Instead of an explicit IIN value, an IIN 'reference index' is used. Both the HOPS and the POST shall contain a copy of the 'IIN Index Table', thus supporting this abbreviated mechanism. See 6.4.3.4 for further details.

6.4.1.4.2 Key type 1

This search type shall be used when the prime reference is an IPE instance. The search string consists of the following elements, and is fully defined in ITSO TS 1000-6:

- Key type;
- IPE iteration number;
- ISAM ID (The ID of the ISAM that created the IPE instance);
- ISAM sequence number (The sequence number for the IPE instance creation transaction).

6.4.1.5 Hotlist matching

If a match is found against a Hotlist search, then the POST shall:

- If HotType = 2, where an IPE ID Optional Additional Identification Group is included in the Hotlist record, then the POST shall use this information to identify the IPE that is the target of the Hotlist record.
- Update the required data element(s) in the affected entity to indicate usage of this entity is blocked. The relevant entities are defined by the HotType and HotAction fields in the Hotlist record (see ITSO TS 1000-6).
- Use the services of the ISAM to seal these modified entities (i.e. ITSO Shell, Directory, IPE) and write these back to the Media.
- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal those records and maintain the IBatch Header in an accurate state.
- Signal to the POST operator the required action to be taken as regards to the Media / user. The action types are defined by the CardDisposition field in the Hotlist record (see ITSO TS 1000-6).

6.4.1.5.1 ITSO Shell blocking

If the HotType and HotAction parameters require the ITSO Shell to be blocked, then the POST shall set the 'ShellBlocked' flag within the DirBitMap element of the Directory (see ITSO TS 1000-2).

6.4.1.5.2 IPE blocking

If the HotType and HotAction parameters require the IPE instance to be blocked, then the POST shall set the terminating SCT entry of that IPE according (see ITSO TS 1000-2).

6.4.1.5.3 Unblocking

An entity that has been blocked may be 'un-blocked' by either of the following processes:

- Via an Actionlist action or
- Via a manual process at the POST.

ITSO does not mandate that POSTs must support the manual process method. If a POST does support this manual method, then the POST shall carry out the following actions:

- Increment the relevant iteration number (ITSO Shell or IPE) within the affected entity. The new iteration number shall be used within the Transaction Records generated (see below).
- Use the services of the ISAM to seal the modified entity and write this back to the Media.
- Verify that all data written to the Media was carried out correctly.

- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state.

6.4.2 Actionlist

The ITSO Actionlist mechanism allows for a central facility (e.g. a HOPS) to define actions that will be remotely executed on a given instance of Customer Media when such Media is presented to a POST. In concept, this is a wider scoped variation on the Hotlist functionality defined previously. Like Hotlists, Actionlists will be sent to a POST from its first-line HOPS.

6.4.2.1 Actionlist structure

The structure of the Actionlist is defined ITSO TS 1000-6. In summary, the list consists of one or more records, where each record is made up of a number of fields as follows:

- Header;
- IPE identifier (optional);
- An Actionlist data group;
- Actionlist data elements (depending on the type of action).

6.4.2.2 Actionlist storage

The POST shall store the received Actionlist either:

- within its own secure non-volatile memory or
- within the ISAM.

For lists stored in the POST's own memory:

- The HOPS shall transmit each Actionlist record as a (signed) Class 2 Data Frame, which the POST shall check and process as defined in 6.3.6.
- ITSO does not prescribe the storage format for the Actionlist, but does require that the format retains all data elements specified, and allows searching using the criteria specified in subsequent sub-clauses.

For lists stored in the ISAM:

- The HOPS shall transmit each Actionlist record as a Secure Data Frame within a Class 3 message. The POST shall 'pass' that frame to the ISAM as defined in 6.3.8.
- The POST cannot directly access lists stored in the ISAM. It shall use the services provided by the ISAM to search those lists.

6.4.2.3 Actionlist updates

For lists stored in the POST's own memory:

- If the ActionListIdentifier in a received Actionlist record is greater than that of the currently stored records (taking roll-over into account) then the POST shall clear down its current Actionlist. It shall then start a new Actionlist, the first record of which shall be the newly received one.
- If the ActionListIdentifier in a received Actionlist record is the same as that of the currently stored records then the POST shall append the Actionlist record to the list.

For lists stored in the ISAM:

- the above rules shall apply, but are executed by the ISAM.

6.4.2.4 Actionlist searching

The POST shall support searching of the Actionlist by both:

- ITSO Shell reference (key type 0) and
- IPE reference (key type 1)

ITSO Shell reference (key type 0) searches shall be used whenever the presented Media platform carries a 'full' (version 1) ITSO Shell (see ITSO TS 1000-2 and ITSO TS 1000-10).

IPE reference (key type 1) searches shall only be used whenever the presented Media platform carries a 'compact' (version 2) ITSO Shell (see ITSO TS 1000-2 and ITSO TS 1000-10).

In both search mechanisms (key type 0, key type 1) the 'search string' generated by the POST shall consist of 8 bytes, which match the first 8 bytes of the header within the Actionlist record.

Where the ISAM is used for Actionlist storage, then the POST shall use the defined ISAM services to carry out searching of the Actionlist, using the above 8-byte search string. See ITSO TS 1000-7 and ITSO TS 1000-8 for details. The file to be selected by the POST for the Actionlist search shall be that notified to the POST in the contents of the Interoperability List table entitled ISAM Management File Parameters. See ITSO TS1000-6 for details.

6.4.2.4.1 Key type 0

This search type shall be used when the prime reference is the ITSO Shell instance. The search string consists of the following elements, and is fully defined in ITSO TS 1000-6:

- Key type;
- ITSO Shell iteration number;
- IIN index;
- ISRN (excluding IIN).

The full ISRN is not used. Instead of an explicit IIN value, an IIN 'reference index' is used. Both the HOPS and the POST shall contain a copy of the 'IIN Index Table', thus supporting this abbreviated mechanism. See 6.4.3.4 for further details.

6.4.2.4.2 Key type 1

This search type shall be used when the prime reference is an IPE instance. The search string consists of the following elements, and is fully defined in ITSO TS 1000-6:

- Key type;
- IPE iteration number;
- ISAM ID (The ID of the ISAM that created the IPE instance);
- ISAM sequence number (The sequence number for the IPE instance creation transaction).

6.4.2.5 Actionlist matching

If a match is found against an Actionlist search, then the POST shall:

- Update the required data element(s) in the affected entity as required by the action codes in the relevant Actionlist record. See ITSO TS 1000-6 for full details of the available actions.
- Update the ActionSequenceNumber within the IPE (see below).
- Use the services of the ISAM to seal these modified entities (i.e. ITSO Shell, Directory, IPE) and write these back to the Media.

- Verify that all data written to the Media was carried out correctly.
- Generate all required Transaction Records (including exception records if required) and use the services of the ISAM (as defined in ITSO TS 1000-7 and ITSO TS 1000-8) to seal said records and maintain the IBatch Header in an accurate state.

6.4.2.5.1 Action sequence number

The ActionSequenceNumber field stored in the IPE instance on the central IPA prevents the application of the same action to an IPE instance more than once. This field also enforces the correct sequencing of action events.

When the POST attempts to action an Actionlist match, if the ActionSequenceNumber within the record is not equal to the ActionSequenceNumber in the IPE instance, then the action shall not be carried out.

If the ActionSequenceNumber within the record is equal to the ActionSequenceNumber in the IPE instance, then the action shall be carried out and the ActionSequenceNumber in the IPE instance shall be incremented. This new ActionSequenceNumber shall be returned in the Transaction Records for the action.

Note: ITSO Shells do not contain an ActionSequenceNumber.

Note: ITSO does not provide a mechanism which prevents Actionlist items which create IPEs (where ActionToTake = 1) from being actioned more than once. Prevention of multiple actioning is the responsibility of the Product Owner.

6.4.3 Interoperability list

The ITSO Interoperability list mechanism allows for a central facility (e.g. a HOPS) to define the parameters that are required for Interoperability. Like Hot and Actionlists, Interoperability lists will be sent to a POST from its first-line HOPS.

6.4.3.1 Interoperability list structure

The structure of the Interoperability list is defined ITSO TS 1000-6. In summary, the list consists of one or more records, where each record is made up of a number of fields as follows:

- Identifier;
- Action;
- A single row of a defined parameter table.

The HOPS sends each Interoperability list record as a (signed) Class 2 Data Frame, which the POST shall check and process as defined in 6.3.

6.4.3.2 Interoperability list storage

The POST shall store the received Interoperability list within its own secure non-volatile memory. ITSO does not prescribe the storage format for the list.

6.4.3.3 Interoperability list updates

If the InteroperabilityListIdentifier in a received Interoperability list record is greater than that of the identifier of the associated parameter table currently stored (taking roll-over into account), then the POST shall clear down that parameter table. It shall then start a new parameter table, the first row of which shall be the newly received record.

If the InteroperabilityListIdentifier in a received Interoperability list record is the same as the identifier of the associated parameter table currently stored (taking roll-over into account), then the POST shall append the Interoperability list record as a new row in that parameter table.

6.4.3.4 Interoperability parameter tables

POSTs shall support and use the following Interoperability parameter tables:

- OID / TYP parameters;

- Peak times;
- Public holidays accept off peak;
- Transfers;
- Rebates;
- Loyalty rules;
- Currency;
- Zone table reference;
- Zone table bitmap;
- Sale price table;
- IIN Index Table;
- IPE parameters table.
- ISAM Management File Parameters

Each of the above tables consists of one or more rows, where each row was transferred as a single Interoperability list record within a (Class 2) Data Frame. The above tables are defined and detailed in ITSO TS 1000-6.

6.4.4 IPE Embodiment Parameters

The IPE Embodiment mechanism allows for a central facility (e.g. a HOPS) to define the parameters that are required for IPE creation.

6.4.4.1 IPE Embodiment Parameters file structure

The structure of the IPE Embodiment Parameter file is defined ITSO TS 1000-6. In summary, the file consists of one or more records, where each record is made up of a number of fields as follows:

- Element number;
- Rule code;
- Data size;
- Data.

The HOPS sends each record as a (signed) Class 2 Data Frame, which the POST shall check and process as defined in 6.3.

6.4.4.2 IPE Embodiment Parameters file storage

The POST shall store the received embodiment parameter file within its own secure non-volatile memory. ITSO does not prescribe the storage format for the list.

Annex A normative Customer Information Messages

Table A.1 – Customer messages

| Condition | ITSO Customer Message |
|---|------------------------------|
| POST In Service | Ready |
| POST Out of service | Out of service |
| ITSO Shell CRC failed | Seek assistance |
| ITSO Shell expired | Seek assistance |
| ITSO Shell blocked | Seek assistance |
| FVC not supported / authorized | Seek assistance |
| KSC not supported / authorized | Seek assistance |
| Invalid Seal on both Directories | Seek assistance |
| Product candidate list is empty | Seek assistance |
| No authorized products found | Seek assistance |
| Product selection by Customer Media holder required | Please select product to use |
| Selected product not valid @ time or place | Seek assistance |
| Selected product cannot cover cost of journey | Seek assistance |
| Successful transaction | OK |
| Action applied | Update successful |
| Auto-Renew applied | Update successful |
| Media prematurely removed | Please replace Media |