STAG – Multimodal Barcode Ticketing

Technical Consultation January 2024

Introduction

STAG have previously proposed use of the RSP Rail barcode ticketing standard[1] as a basis for multi-modal / multi-operator barcode tickets[2]. This concept has now been further developed, and it is important at this stage to obtain feedback on the technical proposals.

This paper covers the core technical proposals:
- Ticket data (the "B_Ticket"),
- Usage (tap) data sent to a back office,
- Ticket security including an option for dynamic refreshed barcodes when implemented in a mobile phone app., and
- Use of a back office based ticket validation database (eTVD) as developed for use in the rail industry.

Your views are very important! STAG is very keen to avoid developments going off in different directions and are therefore reaching out to all parties for their input.
- Please review the document, pass it on to your team, and feel free to circulate widely. The more responses STAG gets the better the outcome will be.

Please send all responses to Peter@pj-associates.co.uk

- Please also contact Peter if you wish to obtain a copy of STAGs 2023 proposal on barcode ticketing.

CLOSING DATE for contributions 29th February 2024.

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[1] The RDG specifications can only be obtained from the Rail Development Group.
[2] Reference STAG_n116_R1 multi-modal barcodes - a proposal

Summary

STAG's goal is to produce a "standard" specification covering all aspects of implementing barcode ticketing. This will enable interoperability between schemes and equipment types reducing industry costs and addressing customer convenience issues.

A specification for barcode ticket data has been devised which:

- Is intended to meet the needs of the non-rail transport industry, i.e., Buses, Trams and Ferries,

- Supports the inclusion of both rail and non-rail tickets within a single barcode where appropriate,

- Supports standard tickets, period passes, concessionary passes and account based tokens stored as barcodes.

The minimum usage data set returned by scanners has been identified and is included in this consultation.

Various ticket security measures have been identified and are included here. These are intended to prevent ticket misuse and cloning and will be subjected to an independent expert review in due course.

The rail industry has devised a back office based ticket validation database (the eTVD). The final section of this consultation considers how this technology can be used in the non-rail sector as a fraud prevention mechanism.

STAG will continue to work on this initiative, including:
- Key management,
- Settlement,
- Governance and Management, and a
- Security Review.

Specific Consultation Questions

All comments on this approach are welcome, in addition to responses to our specific questions:

1. A method for encoding two tickets, one rail, one non-rail, in a single barcode is proposed. However, in some circumstances this will not be practical, and separate barcodes for each ticket will be required. Therefore, both options must be supported.
   - Encoding all tickets in a single barcode is a customer benefit because it reduces confusion. However, will a single barcode in some cases, and multiple barcodes in others, simply create more confusion?
   - Is the additional engineering effort required to support both options outweighed by the customer benefit?
2. Ticket data.
   - Are there additional use cases which should be considered?
   - Are any additional ticket data elements required?
   - We could include a "valid times of day" element, however, this is not included in ITSO IPE data. Would it be useful?
   - Are additional methods of encoding location details required?
   - Any other comments on the proposed ticket data are welcome.
3. Scan data. Is this adequate for retailer's and operator's needs?
4. What are your views on the security measures outlined?
5. What are your views on use of the rail industry eTVD ticket validation database?

Barcode Options.

Clearly providing a single barcode for a customer's entire journey is an advantage, reducing the risk of customer confusion. This proposal includes an option for this but note that it only works in ideal circumstances[3].
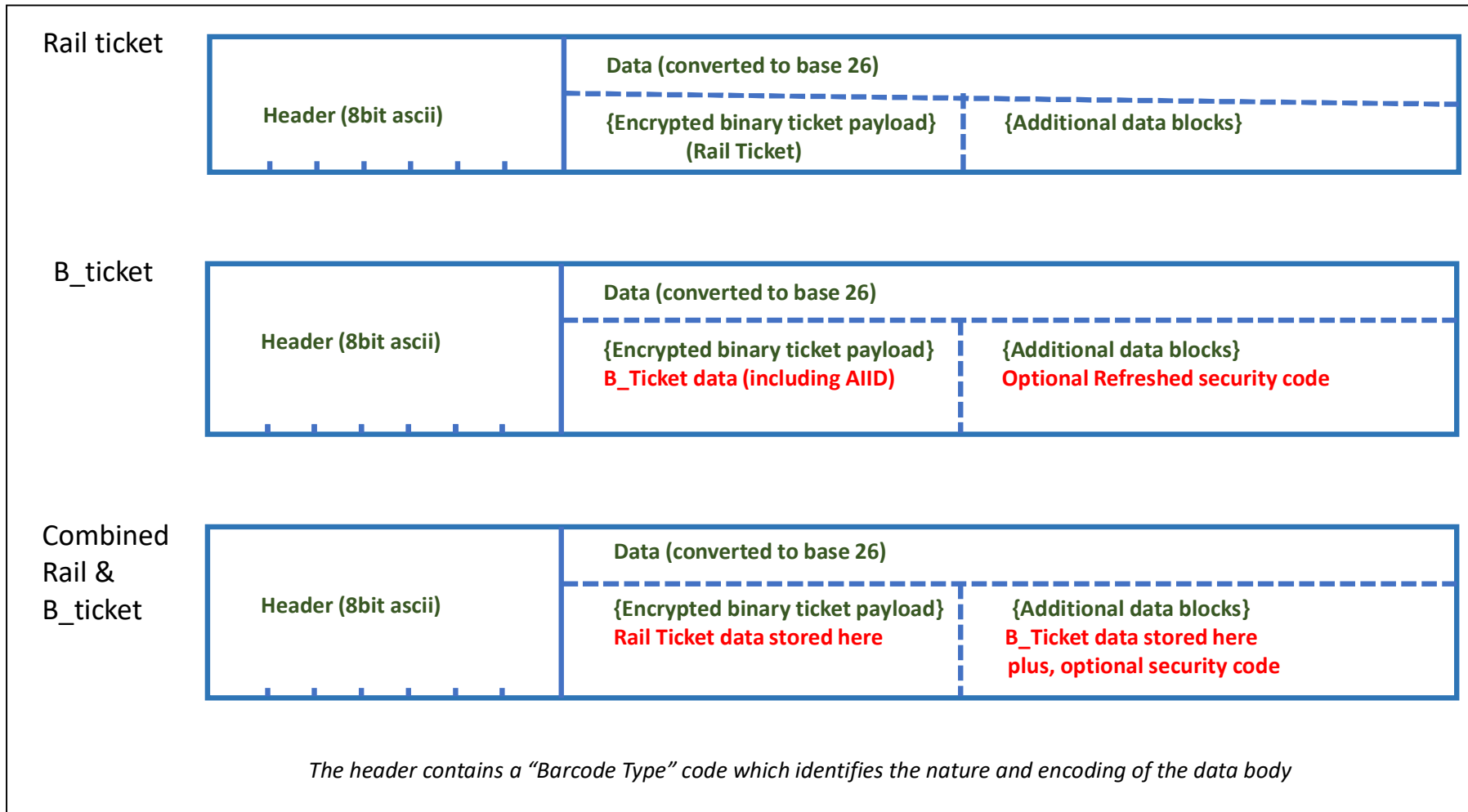
When a rail and non-rail ticket are encoded in the same barcode, the rail ticket occupies the normal place in the barcode data packet, and the non-rail ticket is encoded into an "additional data block" as allowed for in the rail specifications. A similar mechanism could be used where two non-rail tickets are required[4], e.g., a bus ticket and a ferry ticket. The concept is outlined in the diagram below.

One question is whether the data for the two tickets will fit within the barcode. The RSP specification requires that the total barcode size is no more than 300 bytes, so that transaction speed at gates does not become a problem. Analysis by STAG indicates that the barcode size can be kept within the limit, by using compressed dates and times and using binary encoding (rather than using whole bytes for each data element).

The following diagram shows how the ticket data is accommodated within the rail industry defined barcode.

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[3] Ideal circumstances means that the retailer is able to sell all the tickets required for a journey, only 2 tickets are required for the journey, and that these can all be accommodated in a single barcode data set (which may not be the case for longer distance or complex journeys).

[4] However, because of size constraints it is probable that the refreshed security code mechanism outlined in this paper could only be applied to one of these tickets.

Smart Transport Advisory Group   *STAG / n151*

Rail ticket

	Data (converted to base 26)
Header (8bit ascii)	**{Encrypted binary ticket payload}** **(Rail Ticket)** · **{Additional data blocks}**

B_ticket

	Data (converted to base 26)
Header (8bit ascii)	**{Encrypted binary ticket payload}** **B_Ticket data (including AIID)** · **{Additional data blocks}** **Optional Refreshed security code**

Combined Rail & B_ticket

	Data (converted to base 26)
Header (8bit ascii)	**{Encrypted binary ticket payload}** **Rail Ticket data stored here** · **{Additional data blocks}** **B_Ticket data stored here** **plus, optional security code**

The header contains a "Barcode Type" code which identifies the nature and encoding of the data body

Barcode Ticket Data (the B_Ticket).

This section outlines the data required for a ticket variant intended for bus, ferry and modes requiring similar ticket data, implemented within the RSP methodology. The intention is that the data stored in the barcode ticket will be sufficient to support all conceivable use cases.

Objective

- Allow a validator to determine whether a ticket is valid for travel at the point of presentation (and nothing else keeping it simple).
- If an inspector wants to confirm other ticket details, then they go on-line to the retailer for this (provided the retailer provides ticket information on-line) and/or use of RSP validation database.
- The data definition is intended to support all types of tickets and passes, including Account Based ticketing tokens.

Use Cases

	Any journey in a Zone(s)	Any journey on a Specific route	Point to point (fare stages)	Point to point (naptan bus stop numbers[5])	Any journey using a Specific Operator	Timed Ticket
Period	√	√	√	√	√	√
Single Journey	?	√	√	√	?	

Notes:
- Returns are realised by two single tickets, sold at the return ticket price.
- Carnets are a pot of single tickets, note fraud risk if the operator relies on inspection.
- Point to point using fare stages may not work for multi-operator but incorporated for single operator tickets - multi-operator use relies on operators using the same fare stage references.
- Singles - How do you stop the ticket being used again and again when multi-operator? The RDG Validation database may meet this need, see the section on security below.

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[5] Naptan location references may be used for other boarding/alighting points, ferry terminals and tram stops for example.

Data elements

A sub-set of these elements will be used for any specific ticket type.

Element	Notes	Coding
Ticket owner	(Equivalent to ITSO OID)	Code list defined globally[6]
Ticket type code	(Equivalent to ITSO TYP)	-single, -Multi-leg single, -Timed single, -Timed multi-leg single, -period, -ABT Token, *-other?*
Ticket Variant1	(Equivalent to ITSO PTYP) used to distinguish between tickets of the same ticket type, Subservient to Ticket type code.	Value determined by the ticket owner
Ticket Variant2	(Equivalent to ITSO CPICC) subservient to Ticket Variant1, provides further granulation of ticket variants	Value determined by the ticket owner
Issuer (retailer) ID.	May be same value as used in the Ticket owner data element	Code list defined globally
Ticket #	Value subservient to Issuer ID, so that concatenating these two values provides a unique ticket identity value	
Mode indicator	where relevant, i.e., bus, ferry, tram etc,	Code list TBA
Customer type / Party size: adult; child; concession	(Three separate elements, defining the type of customer and the group size).	Count of permitted passengers of each type
Validity start date + time (to the minute).		Coded as per ITSO / EN1545
Validity end date + time to the minute	allowing for post-midnight expiry. Validity end date defines the last day of validity	Coded as per ITSO / EN1545
Validity duration	(Used for a timed ticket, where the ticket is valid for use on any service for a time period following activation by the user, a time of 0 means that the ticket is not timed)	Count of minutes

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[6] Note: a single code list is envisaged identifying Retailers, Ticket Owners, multi-operator Schemes and Operators

Element	Notes	Coding
Route or Service number	For use when a ticket is valid on a specific service, ideally a text string, but may mandate a number to reduce storage required. Multiple valid routes would be indicated using a "scheme / operator ID" code.	7 bit ASCII, upper case characters and numbers only[7]
Scheme / Operator ID	Scheme ID value used where ticket accepted by multiple operators	Global code List
Class		Code list TBA
Vehicle ID	For use when a ticket is valid for travel in a specific vehicle	ASCII
From location	for a season ticket or pass this may also serve as a destination location	Location code, see below
To location	For a season ticket or pass this may also serve as an origin location	Location code, see below
Via Location		Location code, see below
Valid on day types	ITSO half day of week	As per ITSO
Valid times of day (ranges)	*Not used in ITSO, which relies on validator config. Should we include this or not?*	*Not included*
Accessibility code	Identifies any customer special needs. Operators staff can use this to optionally provide additional assistance.	Code list TBA
Entitlement Type Code	Ticket/pass validity element	As per ITSO
Concessionary class	Ticket/pass validity element	As per ITSO
Discount	Percentage discount applied to the normal fare when the ticket or pass entitles the holder to a discount, i.e., they still pay part of the fare by other means	
App Instance ID (AIID)	Security option – a unique identity number created for each Application instance - encoded by the retailer at the time of ticket purchase	
Security & Governance data		TBA

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[7] The RSP specified encoding method does not support lower case and non-alphanumeric characters.

Notes:

For a multi-operator ticketing scheme, the "Scheme / Operator ID" data element identifies the participating operators, meaning that only a single barcode is required. This approach simplifies validator configuration.

For a car parking service associated with public transport then the Operator element defines the car park operator, and the service element defines the specific car park. Dates and times can use the relevant data elements.

The total size of the ticket data is 88 bytes, including the maximum size of location data, and excluding a seal, app instance ID and valid times of day data elements. Many data elements can be condensed if size proves to be a problem.

The RSP data encoding method requires all alphabetic characters be in upper case.

If the B_Ticket is encoded in an additional data block, then it must be proceeded by a 3 byte header:

- Intended audience ID (2)
- Data size excluding this header (1).

Definition of location:
The following encoding methods are proposed:
- Bus fare stage (operator ID / Service ID / Fare stage number);
- Naptan number;
- National location code (Rail NLC);
- Zone number;
- Zone bit map;
- Station or terminal ID (number);
- Northings and Eastings.

Provision is made for additional encoding types if required.

Minimum Usage (Scan) Data
Objective

This section defines the minimum data set which should be returned by terminals following scanning of a barcode ticket for travel or inspection purposes.

The communications protocol and message structure are not defined, the data may be returned by whatever means the terminal supplier and back office supplier agree upon.

Note that terminals will also return data to the RSP validation (eTVD) database used to record barcode ticket use as a fraud risk mitigation measure[8]. It is assumed that the data required for the RSP database will be combined with the data set identified here and returned in a single message to the back office.

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[8] See the section on security below.

Data set

Data Element	Comment
Date of validation	
Time of validation	To the minute, greater granularity acceptable
Validation Device ID	Device unique serial number
Validation Device type	*Do we need a code list to ensure consistency? Assume the code will be along the lines of [device supplier ID]+[device type]*
Validation Device version / build	
Operator ID	Code list
Location	The location coding used in tickets could be used here
Proposed destination	Sometimes used with concessionary and season passes, where the passenger states their intended destination at journey commencement.
Direction	Direction of travel
Transaction sequence number (device generated)	Enables detection of missing messages. The sequence number will be specific to barcoded tickets.
Fare foregone?	The fare the operator would have charged if the journey had been paid for.
Quantity of passengers travelling by passenger type (3 data elements)	Where a Holder + companion, or family ticket is used.
Message type	i.e., Test validation, journey record, inspection record, denied travel, travel allowed when ticket not valid, staff journey, check/tap in, check/tap out, data error, security error, *more?*
Full ticket data (the "ticket payload" as separate elements)	The ticket data read from the barcode. Includes a Ticket ID reference in the form of Retailer ID + Ticket#. *This will be defined in detail once the ticket data specification is finalised.*
Seal?	*Should we require that the validator generate a seal, as per ITSO, so that any changes during transmission can be detected? Note that this may not be as secure as an ITSO Seal due to lack of the security module (ISAM) used to create ITSO seals.*

Barcode Ticket Security

Various Security (anti-fraud) measures are proposed. These are intended to mitigate against the risk of copying barcodes from one device/media to another; re-use of an already used ticket; and to prevent unauthorised modification of the barcoded ticket data.

Data Encryption

One ticket per barcode, i.e., the B_Ticket is stored in the "Encrypted Binary Ticket Payload" portion of the barcode:

The ticket data stored in the barcode will be encrypted by the retailer mitigating against the risk that the data will be modified in some way. RDG have specified the PKI encryption method and it is proposed that this is used. Note that the mobile phone will not be supplied with the PKI keys, and therefore will be incapable of reading or modifying the barcoded ticket data. It is assumed that the retailer will provide a separate plain text data package to the phone which will be used to display ticket information to the customer and inspectors.

Two tickets per barcode:

The Rail ticket in the "Encrypted Binary Ticket Payload" portion of the barcode is encrypted in the normal way.

There are two options for the B_Ticket data stored in an additional data block. The data could be fully encrypted, or alternatively it could be stored as plain data with a cryptographic seal enabling unexpected changes to be detected, as per ITSO IPE data. With both approaches a cryptographic mechanism needs to be devised.

Anti-Passback

Validators can check that a ticket has not already been used on the current service when a barcode is scanned, preventing re-use of the ticket by multiple persons.

RDG Validation (eTVD) Database

RDG have within their suite of Barcode Ticket Specifications developed a method for recording all scan events in a "Tap Database". Validators send a record of all scan events to this database and can access the database to check that a ticket has not already been used when it is scanned. The database can also be used to create deny lists downloaded to validators as required.

The database is provided as a managed service by several providers.

Use does rely on the validator being provided with an internet connection. However, where wireless connectivity is intermittent records can be sent and received in batch mode when connection is possible.

Barcode is locked to a specific phone

The App instance ID (AIID) is a unique identifier generated for each App Instance. This is included in the B_Ticket data locking the ticket to a specific phone, when combined with the refreshed security code, preventing simple copying of tickets from one phone to another.

Retailers will need to provide a mechanism by which tickets can be moved from one phone to another when a user changes their phone, or when a ticket is purchased using one phone but will be used on a different phone.

Refreshed Security Code (Dynamic Barcode)

In addition to the ticket data, an encrypted and refreshed security code can be included as a separate data group within the barcode data. This may be refreshed every few seconds if so desired. This prevents the use of paper based copies of the App generated barcode.

Clearly this will only work with mobile phone Apps – for other applications (e.g., paper or a wallet) the code is simply omitted resulting in a static barcode. However, the static approach is not recommended as it opens the door to fraud by simple copying.

The refresh rate will be determined by the Retailer & Operator, based on their risk acceptance profile. The phone App will use the start date/time of the current time window to create the security code. Validators will check the code for validity, allowing a margin for transmission and processing delays. The code would for example be considered valid if there is an exact match or if the validator calculates the code to be within X seconds of the code calculated by the App.

The App Instance ID (AIID) which is generated when the App is initially created within the phone, is included in both the encrypted ticket data payload and the security code. During the validation process these are compared, and a match is required for successful validation. This locks the ticket to a specific App instance, and therefore to a specific phone. A retailer back office mechanism will be required to move tickets from one phone/App to another when for example the user changes their phone.

The advantage of this approach is that neither the phone nor the validator requires an internet connection during the validation process. Note however that the increased processing involved is likely to have an impact on energy used by the device, possibly impacting on portable device battery life. The following diagram explains the proposal in more detail.

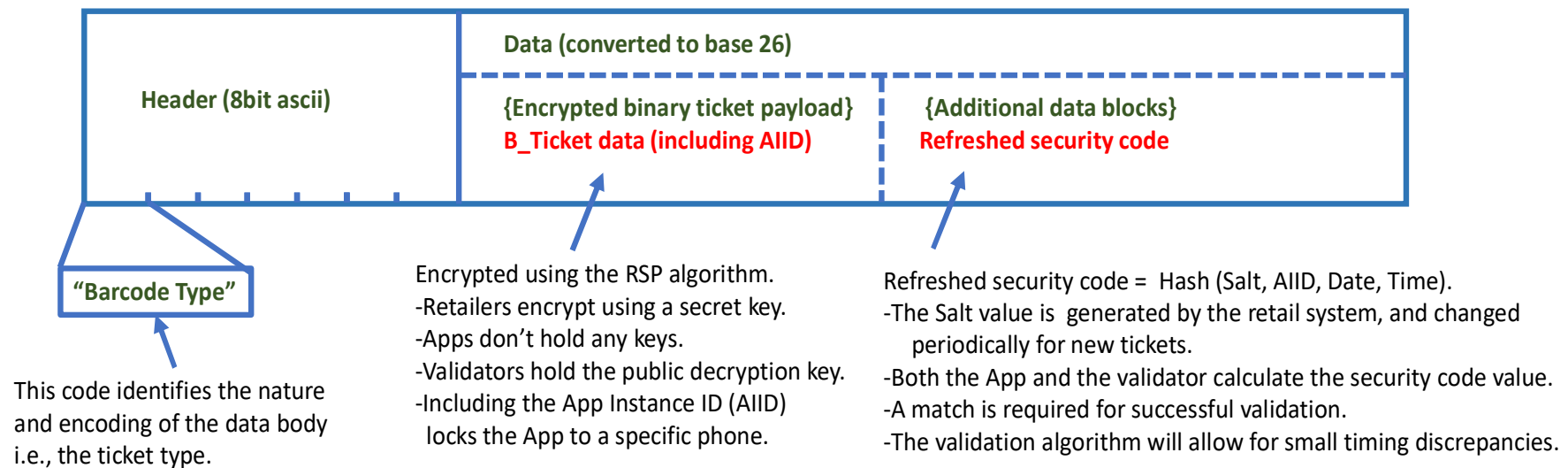Note that no final decision has been made on the Security Code encryption method.

The following diagram outlines how this method works when there is just one B_Ticket stored in the barcode. The mechanism is similar when two tickets are stored in the barcode, the B_Ticket and security code are both stored in additional data blocks.

B_Ticket security

The Barcode data consists of three separate data groups:
- A header as specified by RDG
- The binary ticket payload, encrypted according to the RDG specified PKI technology
  - This will contain the B_Ticket data
- A security code refreshed periodically (omitted for static barcodes)

Diagrammatic representation of the barcoded ticket data

Header (8bit ascii)	Data (converted to base 26)	
	{Encrypted binary ticket payload} **B_Ticket data (including AIID)**	{Additional data blocks} **Refreshed security code**

"Barcode Type"

This code identifies the nature and encoding of the data body i.e., the ticket type.

Encrypted using the RSP algorithm.
-Retailers encrypt using a secret key.
-Apps don't hold any keys.
-Validators hold the public decryption key.
-Including the App Instance ID (AIID) locks the App to a specific phone.

Refreshed security code = Hash (Salt, AIID, Date, Time).
-The Salt value is generated by the retail system, and changed periodically for new tickets.
-Both the App and the validator calculate the security code value.
-A match is required for successful validation.
-The validation algorithm will allow for small timing discrepancies.

For an explanation of the terms in green text , please see the RDG specifications

Use of an eTVD in non-rail applications

As a security measure, the Rail industry have developed a ticket validation database (the eTVD) for use with barcode tickets issued by the rail industry.

This paper considers how this facility may be utilised in the non-Rail environment.

Background.

The eTVD database functionality is currently provided as a managed service by three suppliers. These databases work together with the interface between them specified in Rail Specification RSPS5043. The interface between individual eTVDs and validation equipment is proprietary to each eTVD supplier.

STAG is developing specifications for non-rail barcode tickets based around the Rail Specifications for such tickets[9]. It would be useful for non-rail operators to take advantage of the eTVD technology.

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[9] Reference STAG_n116_R1 multi-modal barcodes - a proposal

STAG understanding of eTVD operation and data.

- The purpose of the eTVD is to provide a database of barcode ticket usage so that validators can confirm the validity of any given ticket.
- The eTVD databases form a network so that a validator can query ticket usage irrespective of which eTVD it is connected to.
- There are three eTVD suppliers: Masabi; The Ticket Keeper (TTK) & Team Technologies.
- eTVDs communicate with each other using the interface specified in RSPS5043.
- The interface between validators and the connected eTVD is proprietary – see the System Diagram in RSPS1024 (reproduced in Annex A).
    - However, it's assumed that the data specification in RSPS5043 is used as the minimum data set which should be transmitted by validators following a scan event.
- The eTVD dataset specified in RSPS5043 matches to an extent the minimum scan event dataset TF2 have identified,
    - However not all the data elements considered necessary for non-Rail applications are included, although there appears to be flexibility to add additional data elements.
    - This is analysed in more detail below.
- To use the eTVD, validators:
    - Send scan records to the eTVD;
    - Can query individual tickets; and
    - Accept deny lists from the eTVD;
    - All using the eTVD suppliers' proprietary interface.
- So, for a validator supplier not already accepting Rail barcode tickets and therefore not connected to an eTVD supplier, but wanting to take advantage of the security provided by an eTVD, they need to:
    - Enter into a commercial arrangement with an eTVD supplier.
    - Implement and test the proprietary interfaces specified by the eTVD supplier.
    - Note that communications between validator and eTVD may not be direct, but routed by the validator suppliers own back office system. This may cause communication delays.

Data Set

Comparison of the RSPS5043 eTVD data with TF2 minimum data set, identifying where the dataset does not meet non-rail operators needs.

Data element	Usage	RSPS5043 spec	TF2 minimum data spec	Notes
eTVD ID	The ID of the eTVD that first received the scanning record from a field device or generating system	Yes		
SCANID	Unique to the original recipient eTVD, so when concatenated to the eTVD ID above, creates a unique key to this record.	Yes		
UTN	The Unique eTicket Number (issuingSystemID and IssuingSystemUniqueETicketNumber)	Yes	An Equivalent is Contained in the ticket data (retailer ID and ticket ID)	STAG proposed data is not quite the same as RDG, who use the issuing system ID whereas Stag use retailer ID. Provided the number is unique there should not be an issue.
COUPON	The Coupon Type is recorded as single number where: 0=single, 1=season, 2=out coupon on a return, 3=return coupon on a return	Yes		Limited usefulness for non-rail modes
TIME	Scan Date and Time (All dates and times in this file will be provided in the ISO 8601 format, e.g. 2012-07-01T00:00:00+01:00)	Yes	Date & Time of validation	

Data element	Usage	RSPS5043 spec	TF2 minimum data spec	Notes
DELETE	Record Deletion Date and Time is the date on which the record is no longer relevant, usually the date the ticket itself is no longer valid, or for season tickets: when the passback protection period has finished if this record is a normal temporary passback prevention record rather than another record related to a season ticket	Yes		Useful for the eTVD, but does not apply to other databases where the data needs to be preserved, e.g. for settlement purposes (noting that Rail do not currently collect usage data for settlement purposes)
STATION	Station as an NLC where the scanning event occurred. Null or not completed means that the scanning event occurred off station e.g. on train, or record from the back-end processing	Yes	Not relevant	
DIRECTION	Direction: E=entry; X=exit; T=on train (If data contains a value that the eTVD does not understand do not throw an error, simply record it)	Yes		Could be relevant in non-rail case (where "T" could mean inspection)
RSID	Retail Service ID ATOC train code + 4 digit retail train ID	Yes	Not relevant	

Data element	Usage	RSPS5043 spec	TF2 minimum data spec	Notes
LAT	Both LAT and LONG fields must be included, or not at all Latitude and Longitude of event if provided, e.g. GPS coordinate Common for passenger self check-ins, or in some cases on-train scans where location is important Lat/Long for Kings Cross is +51.5321, -0.1233, so this field would be 51.5321	Yes		These two elements could be used for geographical location of scan events – BUT not clear if all non-rail validator devices can support this. Therefore, a separate non-rail location element is proposed
LONG	Both LAT and LONG fields must be included, or not at all Longitude of event if provided, e.g. GPS coordinate Common for passenger self check-ins Lat/Long for Kings Cross is +51.5321, -0.1233, so this field would be -0.1233	Yes		
ACTION	Only one action code is allowed for each scan upload record. If mulitple actions need to be recorded then they must be sent in separate upload records. See ScanAction tab in this excel document for more information on the available action codes	Yes	Message type	Propose to use the RDG code list (see annex B)

| Data element	Usage	RSPS5043 spec	TF2 minimum data spec	Notes
CHECKIN	Any data passed by the customer as part of a check-in action. If passenger supplied time, structure is UntrustedTimeHH:MM. Example: "UntrustedTime13:34" If a server verified time, structure is TimeHH:MM. Example: "Time13:34" Data may contain an additional code following the time. Example: "UntrustedTime13:45TagXC561245" would be an untrusted time check-in supplied with the tag code read from the on-train or in-station tag provided for customers to check-in – in the given example, the tag has provided XC at the start to delineate that the tag was managed by XC	Yes		
DEVICE	ScanningDeviceType or user type where known. Scanning Device ID Codes are listed in the Device Field tab of this spreadsheet (If data contains a value that the eTVD does not understand do not throw an error, simply record it)	Yes	Validation Device type	RSP record the type of validation device, but not the manufacturer / model data, Seen Annex B. Do we want the additional data?
DEVICEID	ScanningDeviceID or userID of handheld device	Yes	Validation Device ID	

Data element	Usage	RSPS5043 spec	TF2 minimum data spec	Notes
PREV	NLC of previous Station called at by the train prior to scan event (optional in all cases, useful to show where on the route the scan took place if that is known) (May only be populated if STATION is not populated, and RSID is populated)	Yes	Not relevant	
NEXT	NLC of next Station called at by the train after the scan event (optional in all cases, useful to show where on the route the scan took place if that is known) (May only be populated if STATION is not populated, and RSID is populated)	Yes	Not relevant	
ORIGIN	NLC of the barcode's origin station (therefore a return coupon will not have the same origin as an outward coupon for a return product) Null if Type 08 barcode	Yes	Not relevant	
DESTINATION	NLC of the barcode's destination station (therefore a return coupon will not have the same destination as an outward coupon for a return product) Null if Type 08 barcode	Yes	Not relevant	
COMMENTS	Scan Comments added manually by train staff	Yes		Do non-rail want this?
TICKET	Full copy of complete eTicket data packet	Yes	Full ticket data (the "ticket payload" as separate elements)	

Data element	Usage	RSPS5043 spec	TF2 minimum data spec	Notes
UNDO	The Scan ID that the sending system wants to undo, eg a customer scans the wrong ticket at a gate, and asks station staff to return their ticket to non activated state.	Yes		Could be useful
ASSOCIATEDSCAN	Included in the Scanning Record of an entitlement (such as Type 08 barcode). The Scan ID of the travel ticket that the entitlement is used in conjunction with	Yes		Do non-rail modes have separate entitlement documents, e.g., separate photo-cards?
Others	If a recipient system comes across a field it does not recognize it should store the data field without error. A recipient system may choose to raise an internal flag of some kind to indicate records with unrecognized fields are being received	Yes		I assume that this catchall allows us to append additional data.
Data identified by STAG as required by non-rail operators, but not included in the RSPS5043 data set				
Validation Device version / build		No	Needed?	Needed or not?
Operator ID	The identity of the operator of the scan device	No	Needed	

Data element	Usage	RSPS5043 spec	TF2 minimum data spec	Notes
Location			The location where the validation took place. Needed	A new element is required because rail only store NLCs & lat + long, which are inadequate for other modes
Proposed destination	Sometimes used with concessionary and season passes, where the passenger states their intended destination at journey commencement.		Needed	
Transaction sequence number (device generated)	Enables detection of missing messages. The sequence number will be specific to barcoded tickets.		Needed	Note that RSP store eTVD ID + a unique number, but this is not end-to-end protection
Fare foregone	The fare the operator would have charged if the journey had been paid for.		Needed	
Quantity of passengers travelling by passenger type (3 data elements)	Where a Holder + companion, or family ticket is used.		Needed	
Seal				No security coding specified in RSPS5043(?), however error detection is specified.

Annex A: System diagram from RSPS1024
With STAG Annotation.
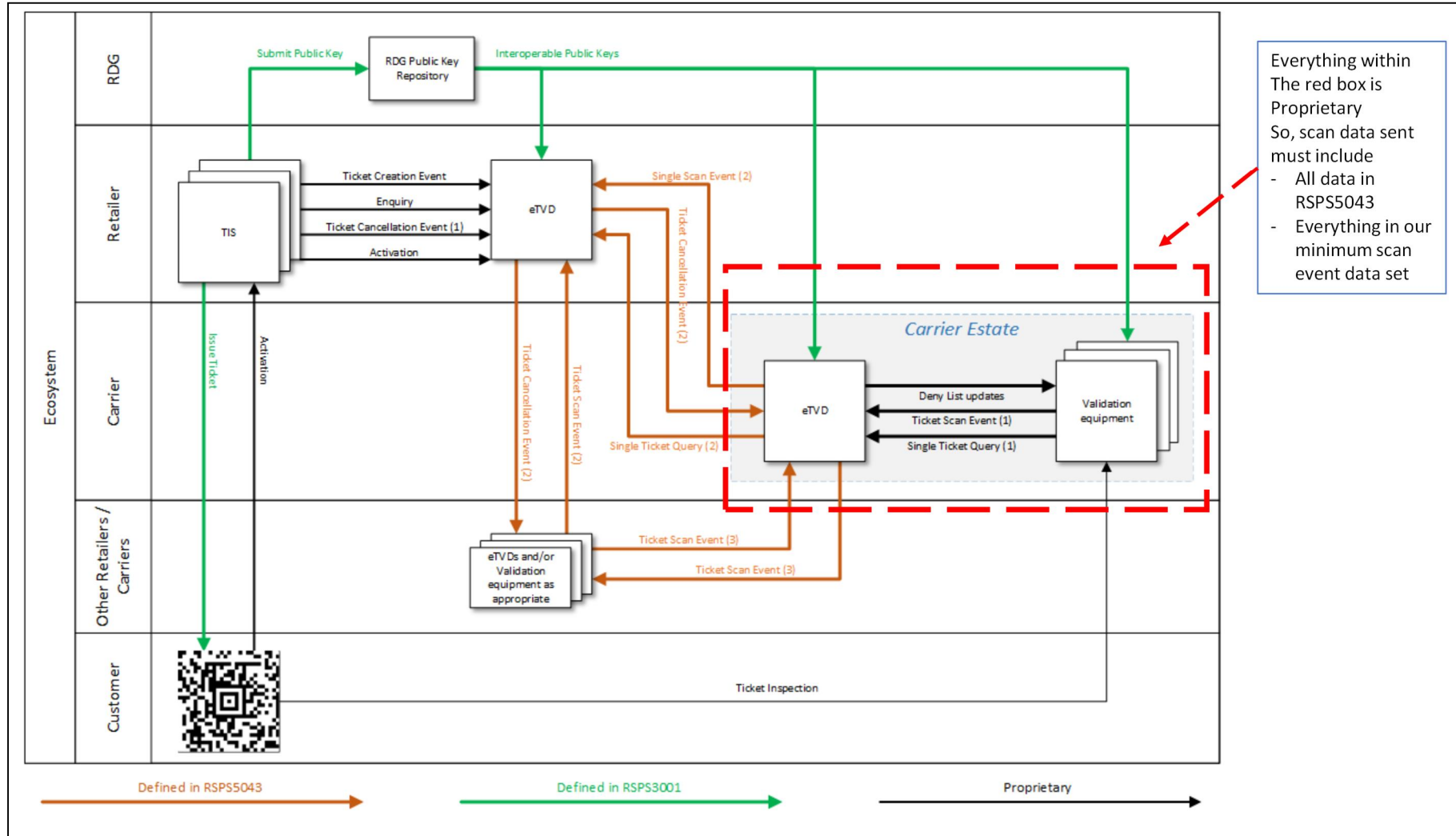
Everything within
The red box is
Proprietary
So, scan data sent
must include
- All data in
  RSPS5043
- Everything in our
  minimum scan
  event data set

Annex B – RSPS5043 Action Codes and Device types
Informative – for definitive specification see RSPS5043

Device types:

Value	Description
0	Fixed Gate Validator
1	Non-gate fixed validator (like a free standing oyster validator post)
2	passengerAction (i.e. self-activation, check-in or cancellation via mobile app/website)
3	Handheld Device (i.e. Ticket Inspector Mobile Ticket Machine)
4	~~Revenue Protection Officer (RPO)~~
5	~~RPO /Inspector~~
6	~~British Transport Police~~
7	Ticket Office
8	eTVD
9	customerService
10	ticketRetailer
11	Other
12	12 and above are reserved for future use – if a code of 12 or higher is encountered the system should store it anyway and not error

For Non-Rail use an additional device type is required – Bus ETM.

Use of code 11, "Other", is not recommended because it tends to be used unnecessarily when specific codes are suitable. Propose to mandate that it shall not be used in non-rail applications.

Action Codes

Code	Definition	Description
0	new Ticket Created	If participants wish to share new ticket sales records, this is the appropriate scan code. This is entirely optional but may be useful as new ticketless travel options are introduced. Usually the first scan record to appear for a ticket will be the first time it is used by the customer, e.g. customer passes through gate
1 - 499	*RFU*	*Reserved Future Use - any code in this range should not affect ticket validity decision*
500	Ticket was read by scanner but no action was taken, information only	Ticket inspected but not for travel, such as RPO helps a customer to interpret a ticket and check if it has been used before, but it was not being validated for a journey at that time, e.g. customer asks "how many uses of my carnet are remaining?"
501	Ticket logged for automatic refund, but still valid for travel	DO NOT USE Previously: If a customer's journey has been severely delayed or inconvenienced then an RPO may register the ticket for automatic refund. Note that this record does NOT mark that the ticket is not valid for further travel, as there may be more on their journey yet to run, despite an incident occurring mid-journey that warranted the refund
502 - 1000	*RFU*	*Reserved Future Use - any code in this range should not affect ticket validity decision*
1001	Ticket Active	
1002	Ticket Activated by Customer - Unverified	Customer activated their ticket (such as on a mobile phone) and that activation record was uploaded, showing that the customer was using the ticket. This record is unverified, as any time or location information may not be accurate
1003	Ticket Activated by Customer - Verified time	Same as 1002 except that the time was verified, e.g. by remote server connection
1004	Ticket Activated by Custimer - Verified location	Same as 1002 except that the location was verified, e.g. by location specific tag or GPS data
1005	Ticket Activated by Customer - Verified time and location	Both the time and location have been verified
1006 - 2000	*RFU*	*Reserved Future Use - any code in this range should not affect ticket validity decision*
2001	Ticket Rejected - Unspecified reason	Ticket rejected but reason for rejection unknown
2002	Excess Fare Issued	DO NOT USE Should be listed as permanent rejection (5000+) Previous description: Excess fare issued - this ticket no longer valid, and new excess fare issued to customer

2003	Penalty Fare Issued	DO NOT USE Should be listed as permanent rejection (5000+) Previous description: Penalty fare issued - this ticket no longer valid, and new penalty fare issued to customer
2004	Unpaid Fare Notice Issued	DO NOT USE Should be listed as permanent rejection (5000+) Previous description: Unpaid Fare Notice issued - up to train staff to determine validity of travel
2005	Ticket Endorsed	DO NOT USE
2006	Bad Ticket - decrypt failed	Decryption of the barcode data failed - could be issuer ID is wrong in the header, or barcode data has been corrupted when created by issuing system or read by scanner. Also possible attempted travel fraud if customer manipulated barcode data
2007	Bad Ticket - header doesn't match	Header code does not conform with the data inside the encrypted payload of the ticket - e.g. UTN in the header does not match the UTN in the barcode data. Could be issuer system error, or attempt at fraud where customer changed UTN in header code
2008	Bad Ticket - SHA256 doesn't match	The SHA256 hash inside the ticket does not match the ticket data - possible causes are data corruption or error when ticket was generated, or scanner error when reading barcode data
2009	Issue Code not available to scanning device	Ticket Issuer ID in the ticket is not known to the scanner - e.g. Issue is XX in the ticket, and the scanner does not have a public key for XX issuer. Ticket might be valid, but scanner unable to confirm as the ticket data cannot be decrypted. Contact RSP to determine who XX issuer is
2010	Ticket marked for full manual check by RPO	Fraud suspected and ticket must be checked by staff including check customer ID and any railcards. Gates DO NOT allow ticket to pass. Also see code 3010
2011	Wrong Time	Ticket not valid at this time
2012	Missing railcard	Unable to present railcard
2013	Not child	Ineligible for child ticket
2014	Not activated	Mobile ticket not activated
2015	Wrong route	Riding beyond ticket entitlement or on wrong route
2016	Ticket expired	Ticket expired
2017	Wrong class	Customer seated in wrong class
2018	Wrong seat	Customer not in mandatory seat
2019	Already validated	Ticket already validated too many times

2020	Denied before start date	Ticket is used before the start date
2021	Already used max number of times	Ticket already used max number of times
2022	Already marked as killed	Ticket already marked as killed
2023	Passback	Same ticket used at same location within time period
2025	Wrong mode	Wrong transport mode
2026	Activation time expired	Activation time expired
2027	Wrong phone time	The user has deliberately changed their phone time to affect their ticket's validity
2028	Ticket usage period expired	The usage period for the ticket has expired
2029	Missing mandatory fields	Mobile ticket missing mandatory fields
2030	Railcard - Invalid Passenger	The passenger presenting the Railcard is not (one of) the Railcard holder(s)
2031	Railcard - Invalid Journey	The Railcard is not valid for the journey where the scan occurred, For example Two Together Railcard discount not valid before 09:30 Monday-Friday (except Public Holidays)
2032- 2999	*RFU*	*Reserved Future Use - reject the ticket if a code in this range is present*
3000	Customer warned - unspecified reason	For all these warning codes staff should check comments field, and if possible make online request for latest information about this ticket. Train crew discretion whether to permit further travel on this ticket
3001	Customer warned they are travelling in the wrong timeframe allowed by this ticket e.g. using advance ticket too early or using offpeak ticket at peak times	
3002	Customer warned they need to carry railcard/photo ID card for this ticket	
3003	Customer warned they are too old to travel with a child ticket	
3004	Customer warned about correct ticket activation	
3005	Customer warned they have been using their ticket beyond the route restrictions imposed by this ticket	

3006	Customer warned that their season ticket expiry date has just passed	
3007	Customer warned that they are travelling in the wrong seating class (1st class with standard ticket)	
3008	Customer is to be identified to British Transport Police - do not approach without police present	
3009	Customer warned for sitting in the wrong seat on a mandatory reservation ticket (usually only advance purchase only valid with reservation coupon)	
3010	Ticket marked for full manual check by RPO	
3011 - 4000	*RFU*	*Reserved Future Use - accept the ticket if a code in this range is present*
4001	Ticket accepted	This field is used to mark a ticket as "partially used", for example when coming through an entry gate, or when scanned mid-journey, but in general should not be used by exits gates at the destination on one-passenger single tickets; (when finishing a journey at an exit gate a ticket should be marked as "fully used" i.e. as a "kill record". See code 5001: Ticket accepted and marked for no further travel until after record deletion time)
4002	Ticket accepted - excess fare charged	Ticket accepted, with Excess fare charged
4003	Ticket accepted - endorsed	Ticket accepted, and endorsed
4004 - 4999	*RFU*	*Reserved Future Use - accept the ticket if a code in this range is present*
5000	Ticket was scanned for exit at final destination	This is the action to send when a ticket is accepted by an exit gate that is the final destination NLC for the ticket, and no further use is permitted
5002	Ticket cancelled due to suspected payment fraud	These codes are used when the passengers current or previous tickets have been identified as having evidence of fraudulent use - the customer should contact their retailer for more information
5003	Ticket cancelled due to suspected travel/ticket fraud	

5004	Ticket deactivated by server, now in expired state	Only used for Open Tickets or Return Coupons Flexible tickets, where the server knows that the ticket has been activated and conditions of carriage mandate that it cannot be used again (e.g. break of journey not allowed) N.B. Number of server de-activations should be limited by not sending them for tickets that have already reached the end of their encoded validity (e.g. as determined by NumberOfDaysValid)
5005	Ticket cancelled - unspecified	
5006	Ticket cancelled due to payment problem	This isn't fraud, just an issue with taking payment, such as chargeback or the failure of a direct debit.
5007	Ticket cancelled due to modified or upgraded ticket sold to customer	Ticket cancelled due to new modified or upgraded ticket sold to customer under a separate UTN and this ticket is no longer valid for travel
5008	Ticket cancelled - refunded	Ticket has been refunded by the retailer.
5009+	*RFU*	*Reserved Future Use - reject the ticket if a code of 5008 or greater is present.*

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