
**Information technology — Data
protocol for radio frequency
identification (RFID) for item
management —**

**Part 3:
RFID data constructs**

*Technologies de l'information — Protocole de données relatif à
l'identification par radiofréquence (RFID) pour la gestion d'objets —
Partie 3: Constructions de données RFID*



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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see <http://patents.iec.ch>).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This first edition of ISO/IEC 15961-3, together with ISO/IEC 15961-1, ISO/IEC 15961-2 and ISO/IEC 15961-4, cancels and replaces ISO/IEC 15961:2004, which has been technically revised.

A list of all parts in the ISO/IEC 15961 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The technology of radio frequency identification (RFID) is based on non-contact electronic communication across an air interface. The structure of the bits stored on the memory of the RFID tag is invisible and accessible between the RFID tag and the interrogator only by the use of the appropriate air interface protocol, as specified in the appropriate part of ISO/IEC 18000. The transfer of data between the application and the interrogator in open systems requires data to be presented in a consistent manner on any RFID tag that is part of that open system. Application commands from the application and responses from the interrogator also require being processed in a standard way. This is not only to allow equipment to be interoperable, but in the special case of the data carrier, for the data to be encoded on the RFID tag in one system implementation for it to be read at a later time in a completely different and unknown system implementation. The data bits stored on each RFID tag must be formatted in such a way as to be reliably read at the point of use if the RFID tag is to fulfil its basic objective.

Manufacturers of RFID equipment (interrogators, RFID tags, etc.) and the users of RFID technology require a standard-based data protocol for RFID for item management. ISO/IEC 15961 and ISO/IEC 15962 specify this data protocol, which is independent of any of the air interface standards defined in ISO/IEC 18000. As such, the data protocol is a consistent component in the RFID system that may independently evolve to include additional air interface protocols. The International Standards that comprise the data protocol are as follows:

- ISO/IEC 15961-1, which defines the transfer of data to and from the application, supported by appropriate application commands and responses;
- ISO/IEC 15961-2, which defines the registration procedure of RFID data constructs to ensure that the data protocol supports new applications, in a relatively straightforward manner, as they adopt RFID technology. This can be achieved by the Registration Authority publishing regular updates of RFID data constructs that have been assigned, and as a means of incorporating these updates into the processes of ISO/IEC 15961-1;
- this document (ISO/IEC 15961-3), which defines the data constructs and the rules that govern their use;
- ISO/IEC 15961-4, which defines the transfer of data associated with sensors and batteries to and from the application, supported by appropriate application commands and responses;
- ISO/IEC 15962, which specifies the overall process and the methodologies developed to format the application data into a structure to store on the RFID tag.

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Information technology — Data protocol for radio frequency identification (RFID) for item management —

Part 3: RFID data constructs

1 Scope

This document specifies rules and code structures associated with the data constructs for RFID for item management. In particular, it:

- defines the application family identifier (AFI), including the range of code values that are available to use for RFID for item management;
- defines the data format, including the range of code values that are available to use for RFID for item management;
- describes the Object Identifier structure used for RFID for item management;
- specifies the function of the Object Identifier for the Unique Item Identifier (UII);
- specifies the function of the Object Identifier for other item attendant data.

NOTE Conventionally in International Standards, long numbers are separated by a space character as a “thousands separator”. This convention has not been followed in this document because the arcs of an Object Identifier are defined by a space separator (according to ISO/IEC 8824 and ISO/IEC 8825). As the correct representation of these arcs is vital to this document, all numeric values have no space separators except to denote a node between two arcs of an Object Identifier. For additional clarity, Object Identifiers are presented in **bold text**.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 9834-1, *Information technology — Procedures for the operation of object identifier registration authorities: General procedures and top arcs of the international object identifier tree — Part 1*

ISO/IEC 15961-2¹⁾, *Information technology — Radio frequency identification (RFID) for item management: Data protocol — Part 2: Registration of RFID data constructs*

ISO/IEC 15962, *Information technology — Radio frequency identification (RFID) for item management — Data protocol: data encoding rules and logical memory functions*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms apply.

1) Under preparation. Stage at the time of publication: ISO/IEC/FDIS 15961-2:2018.

3.1 Terms and definitions

3.1.1

Application Family Identifier

mechanism used in the data protocol and the air interface protocol to select a class of RFID tags relevant to an application, or aspect of an application, and to ignore further communications with other classes of RFID tags with different identifiers

3.1.2

arc

specific branch of a hierarchical Object Identifier tree

Note 1 to entry: The top three arcs of Object Identifiers relevant to RFID, compliant with ISO/IEC 9834-1, are defined in [Annex A](#).

3.1.3

data format

mechanism used in the data protocol to identify how Object Identifiers are encoded on the RFID tag, and (where possible) identify a particular data dictionary for the set of relevant Object Identifiers for a specific application

3.1.4

Object

well-defined piece of information, definition or specification which requires a name in order to identify its use in an instance of communication

3.1.5

Object Identifier

value (distinguishable from all other such values) which is associated with an Object

3.1.6

Relative-OID

Object Identifier comprising the remaining arc or arcs positioned after a common Root-OID (for the first and subsequent arcs)

Note 1 to entry: The common Root-OID is often implied by other data constructs and not encoded in the RFID tag.

3.1.7

Root-OID

particular Object Identifier that constitutes the first, second and subsequent common arcs of a set of Object Identifiers (hence the common root)

Note 1 to entry: The Root-OID followed immediately by the Relative-OID equates to the complete Object Identifier.

3.1.8

Unique Item Identifier

mechanism that uniquely identifies a specific entity (e.g. a product, transport unit, returnable asset) during its life within a particular domain and scope of a code system

Note 1 to entry: When used with this data protocol, the particular Object Identifier that defines the Unique Item Identifier relies on the fact that each instance of its Object is required to be unique and unambiguous with respect to all other related Objects.

3.2 Abbreviated terms

AFI	Application Family Identifier
DSFID	Data Storage Format Identifier
OID	Object Identifier
RA	Registration Authority
UII	Unique Item Identifier

4 Conformance

4.1 Conformance of encoders

In addition to the conformance requirements for encoders as defined in ISO/IEC 15962, an encoder claiming conformance to this document shall access the data constructs register and provide the necessary additional encoding rules are defined by the particular data construct(s). These include:

- the recognition of a valid AFI;
- the recognition of a valid data format, including the capability to construct the DSFID, or extended DSFID if appropriate;
- the recognition of the common Root-OID for data to be encoded so that only the Relative-OID is encoded;
- the use of relevant tables for encoding as defined by the data format and registration of the data constructs, including Packed Objects, Tag Data Profiles and encoding that is declared in the data constructs register;
- the recognition of AFIs associated with Monomorphic-UIIs that require explicitly defined encoding rules.

Declarations of conformance shall be based on one of the following:

- for all registrations up to a particular publication date of the data constructs register;
- for one or more specific registrations, in which case the declaration shall refer to the specific registration(s).

4.2 Conformance of decoders

In addition to the conformance requirements for decoders as defined in ISO/IEC 15962, a decoder claiming conformance to this document shall access the data constructs register and provide the necessary additional encoding rules are defined by the particular data construct(s). These include:

- the recognition of a valid AFI;
- the recognition of a valid data format, including the capability to de-construct the DSFID, or extended DSFID if appropriate;
- the recognition of the common Root-OID for data to be pre-pended to the Relative-OID that is encoded;
- the use of relevant tables for decoding as defined by the data format and registration of the data constructs, including Packed Objects, Tag Data Profiles and encoding that is declared in the data constructs register;

- the recognition of AFIs associated with Monomorphic-UIIs that require explicitly defined decoding rules.

Declarations of conformance shall be based on one of the following:

- for all registrations up to a particular publication date of the data constructs register;
- for one or more specific registrations, in which case the declaration shall refer to the specific registration(s).

5 Application Family Identifier (AFI)

5.1 General

The Application Family Identifier (AFI) is a data protocol mechanism that enables selective addressing of RFID tags to achieve an efficient use of radio communications. The AFI is generally supported by a mechanism at the air interface, enabling the use of the AFI in application commands defined in ISO/IEC 15961-1 to be converted into air interface commands. Such commands maintain communication with RFID tags with the selected AFI and generally ignore RFID tags with different encoded AFIs.

The value of the AFI for RFID for item management can be stored on the RFID tag in some form, or can be determined by the air interface services if these are sufficiently specific. It is a single byte value, although provisions are made below for an extension mechanism in case the set of single byte AFIs becomes fully utilised.

5.2 AFI values

The AFI is encoded as a byte value, with possible extensions to multiple bytes to meet future application needs. The commands and responses of ISO/IEC 15961-1 require the AFI to be represented as decimal values, whereas the processes of ISO/IEC 15962 and the air interface protocols (ISO/IEC 18000) require the AFI to be represented as hexadecimal values. Both forms are used in [Table 1](#).

For compatibility with other RFID protocols and standards, the AFIs assigned in accordance with ISO/IEC 15961-2 are restricted to:

- AFIs 0 to 15 (00₁₆ to 0F₁₆);
- AFIs 144 to 206 (90₁₆ to CE₁₆).

5.3 AFI assignment

AFIs in the range 144 to 206 (90₁₆ to CE₁₆) shall be assigned in accordance with ISO/IEC 15961-2. The RA is also responsible for assigning AFIs in the range 1 to 15 (01₁₆ to 0F₁₆) for closed system applications. Details of assigned AFIs, together with the other data constructs associated with particular application standards, are available on the data constructs register published by the RA. A copy of the register of RFID data constructs can be obtained from the dedicated website of the RA for ISO/IEC 15961-2 at: https://www.iso.org/iso/maintenance_agencies.htm.

5.4 Monomorphic-UIIs and AFI

There is a class of UII that is declared directly by the AFI without reference to a data format. A UII that is declared in this manner is defined as a Monomorphic-UII, and needs to be properly registered in accordance with ISO/IEC 15961-2. A Monomorphic-UII shall either be the only encoded data in a dedicated UII memory bank, or be the only data element encoded on an RFID tag with a single encoding memory.

The encoding process uses the rules that are defined for a specific AFI on the data constructs register to carry out the encoding, resulting in the absence of a DSFID and other syntactical components. The decoding process, on recognising the specific AFI, interprets the bytes on the tag without the need for a DSFID in the first byte.

Table 1 — Allocated AFIs for RFID for item management

ISO/IEC 15961 (Decimal)	ISO/IEC 15962 (Hexadecimal)	Function
0	00	AFI not configured
1 to 3	01 to 03	Assigned to closed application environments, which allows up to three means of selection across the air interface
4	04	Assigned to closed system data under the control of the manufacturer of the item associated with the RFID tag, when encoded in RFID tags with partitioned memory
5	05	Assigned to closed system data under the control of the transport company of the item associated with the RFID tag, when encoded in RFID tags with partitioned memory
6	06	Assigned to closed system data under the control of the end user of the item associated with the RFID tag, when encoded in RFID tags with partitioned memory
7	07	Assigned to closed systems control of re-circulating items (e.g. library items, media, returnable assets)
8 to 15	08 to 0F	Reserved for allocation by ISO/IEC 15961-2 RA to other closed system data or applications
16 to 143	10 to 8F	Not assigned by ISO/IEC 15961-2 RA
144 to 206	90 to CE	Assigned in accordance with ISO/IEC 15961-2
207	CF	Reserved as an extension code for multiple byte AFI for RFID for item management
208 to 255	D0 to FF	Not assigned by ISO/IEC 15961-2 RA

NOTE As AFIs 8 to 15 (08₁₆ to 0F₁₆) are assigned a function, this will be declared on the RFID data constructs register.

5.5 Self-assignment of AFIs

A limited range of AFIs is available for self-assignment by users for closed application environments.

NOTE ISO/IEC 19762 defines closed application environment as “application which is intended for use by a closed group of users” and further notes that “[a] closed group of users is typically within a single organisation or subject to a specific agreement.”

Users of RFID technology in closed application environments have up to three AFI codes 1 to 3 (01₁₆ to 03₁₆) that they may use without registration. This allows the AFI to distinguish between different closed applications if necessary.

There can also be occasions where closed system data can be encoded separately from open system data (e.g. in RFID tags with partitioned memory). One of the partitioned memories could contain closed system data on some occasions and open system data on others. The AFI codes 4 to 15 (04₁₆ to 0F₁₆) are available for this purpose, and shall only be used as defined in Table 1. A copy of the register of RFID data constructs can be obtained from the dedicated website of the RA for ISO/IEC 15961-2 at: https://www.iso.org/iso/maintenance_agencies.htm.

5.6 AFI extension mechanism

AFI value CF₁₆ is reserved to extend the AFI mechanism beyond the 64 code points defined in Table 1.

NOTE The precise mechanism has not been defined yet. In defining it, due consideration will be given to the implications for the air interface protocols and RFID tag architectures defined in ISO/IEC 18000.

6 Data format

6.1 General

The prime purpose of the data format is to provide a link between the Object Identifier structure of ISO/IEC 9834-1 and the application data, which can be in the form of a data dictionary or specification of a set of data elements.

EXAMPLE Data format 10 indicates that the Root-OID 1 0 15961 10 is assigned to the data elements known as Data Identifiers as defined in ISO/IEC 15418.

The data format is usually a component in the encoding of Object Identifiers in any memory space where it is possible to encode application data. This applies whether the data is a Unique Item Identifier or is optional item-related data. There is an exception to this rule for Monomorphic-UIIs that are properly registered in accordance with ISO/IEC 15961-2 (see 5.4).

A secondary purpose of the data format is to enable the Object Identifier to be truncated when encoded on the RFID tag, without the loss of uniqueness. The data format is encoded once as part of the system information, and because of the one-to-one mapping between the data format and the Root-OID, this does not need to be encoded for any data Objects encoded on the RFID tag.

When called in the application commands of ISO/IEC 15961-1, and encoded in the RFID tag, the data format is the last 5 bits of the DSFID (previously called the storage format) byte value.

6.2 Data format values

Data format values 0 to 30 (00000₂ to 11110₂) are currently available for directly encoding in a single byte DSFID.

Data format 31 signals an extension mechanism when the basic set becomes fully utilized. As such, data format 31 can never be assigned to an application. The extended data formats cover the range from 32 to 287. The representation in the RFID tag is specified in ISO/IEC 15962, and the encoding is spread over two bytes: the DSFID and the Extended-Data-Format byte.

The range of values is shown in Table 2.

Table 2 — Allocated data formats for RFID for item management

ISO/IEC 15961 (Decimal)	Function
0	This value is also the default for an RFID tag yet to be formatted.
1	Full featured This data format supports any type of data format where the full OBJECT IDENTIFIER is encoded. Its prime purpose is to enable heterogeneous data (i.e. from different data dictionaries) to be encoded on the one RFID tag. For example, it could be used to encode data from different open system applications and also to encode closed system data unambiguously, using the ISO/IEC 9834-1 registered Object Identifiers for each application.
2	Root-OID encoded This data format is used when all the data on the RFID tag have a common Root-OID, but where this does not comply with one of the specific Root-OIDs for the data formats assigned by the Registration Authority.
3 to 28	Only to be allocated in accordance with ISO/IEC 15961-2. The pre-assignment of this range of values was permissible in the previous edition, ISO/IEC 15961:2004.
29	Assigned to closed application environments where the encoded data is encoded to the rules of ISO/IEC 15961-1 and ISO/IEC 15962.

Table 2 (continued)

ISO/IEC 15961 (Decimal)	Function
30	Assigned to closed application environments where the encoded data is not formatted to the rules of ISO/IEC 15961-1 and ISO/IEC 15962.
31	Not assigned, but used to signal the use of the Extended-Data-Format byte.
32 to 287	Only to be allocated in accordance with ISO/IEC 15961-2.

NOTE Data format 0, simply by its bit value, can be present in an RFID tag before any encoding takes place.

Data formats 1 and 2 are encoded automatically by the processes defined in ISO/IEC 15962.

Data format 29 is provided to enable closed system applications to apply any of the access methods (encoding schemes) of ISO/IEC 15962, and for the encoding and decoding to be performed by compliant ISO/IEC 15962 general purpose systems. This allows closed system applications and prototype applications to be intermixed with open system solutions.

Data format 30 is provided to enable closed system applications developed before, or independently of, the availability of ISO/IEC 15962 systems to achieve a minimum of interoperability when migration or integration is later required. At that point of time, the closed system tags need to have data format 30 encoded and when read by a system compliant with ISO/IEC 15962, the decoding can be diverted to a closed system decoder rather than be rejected.

6.3 Data format assignment by the Registration Authority

As defined in ISO/IEC 15961-2, the RA shall be responsible for assigning data formats in the range 3 to 28, and when these are assigned to continue with the assignments from 32 to 287. Details of assigned data formats, together with the other data constructs associated with particular application standards, are available on the data constructs register (https://www.iso.org/iso/maintenance_agencies.htm).

6.4 Self-assignment of data formats 29 and 30

6.4.1 Data format 29

Data format value 29 indicates that the RFID tag is being used in a closed application environment that is making use of the closed system Object Identifier structure described in 6.2, and the access methods that declare the ISO/IEC 15962 encoding rules. This means that all the encoded data are assumed to be fully compliant with the data protocol, and that the data protocol devices can simply read or write all the encoded data in the normal way.

6.4.2 Data format 30

Data format value 30 is intended for use in a particular set of circumstances. A previously developed closed system RFID application encodes data to some private encoding rule. The new situation requires RFID tags compliant with this proprietary encoding to coexist with a new set of tags that are fully compliant with the encoding rules of one of the access methods of ISO/IEC 15962. To provide a simple filter to sort between the compliant tags and the proprietary tags, a decoding system can use data format 30 to filter these tags to a separate proprietary decoder. This requires the previous closed system tags to have the capability of encoding a DSFID. All DSFID codes with the hexadecimal values 1E, 3E, 5E, 7E, 9E, BE, DE and FE shall bypass the ISO/IEC 15962 decoding procedures.

NOTE This particular solution is intended to assist in preserving the investment made in an RFID proprietary system, while providing a pathway for the application to migrate to the standardised RFID data protocol.

6.5 Data format extension mechanism

Data format value 31 is reserved to extend the data format mechanism beyond the basic code points defined within the range 0 to 30. This document simply defines the extension range and the RA is

only responsible for assigning codes in the range 32 to 287 to applicants as the data constructs are registered. The detailed encoding methods are defined in ISO/IEC 15962.

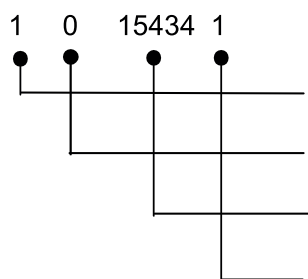
7 Object Identifiers

7.1 General

ISO/IEC 15961-1 uses the OBJECT IDENTIFIER type as defined in ISO/IEC 8824-1. The Object Identifier structure shall be as specified in ISO/IEC 9834-1. This uses a registration tree with a common implied root node (ISO/IEC 9834-1), a series of arcs from each node, with new arcs added as required to define a particular Object. Thus, the body responsible for a particular node:

- has a defined set of arcs to identify itself;
- can manage the allocation of arcs under its node, independently of other bodies;
- is assured of uniqueness from all other arcs in the registration tree.

EXAMPLE



Arcs

$$= \text{iso}$$

= standard

= particular standard

= sub-division within 15434 (= Format 01)

The only top arcs permitted for all Object Identifiers are shown in [Table 3](#).

Table 3 — Object Identifier top arcs

Identifier arc name	Numeric value
itu-t	0
iso	1
joint-iso-itu-t	2

NOTE 1 Any ISO/IEC standards, such as this document, have Object Identifiers under the ISO top arc.

The second arc is administered by the relevant organization named for the top arc. The current list of top and second arcs relevant to RFID is given in [Annex A](#).

The third arc is controlled by the system or body defined for the second arc (see [Annex A](#)); sometimes this is a Registration Authority. The hierarchical structure continues until the Object is identified uniquely. The procedure of naming Object Identifiers ensures that each Object is unique within its "parent" arc and that each parent arc is unique within its previous level, right back to the top 3 arcs.

NOTE 2 This structure enables Object Identifiers from different domains (e.g. open and closed systems) to be encoded unambiguously on an RFID tag memory.

7.2 General use of Object Identifiers in open application environments

There are pre-existing unique identifier schemes that are already compliant with Object Identifiers as defined in ISO/IEC 9834-1. There are also data dictionaries that support unique identification and/or other item attendant data in widespread use that are compliant with Object Identifiers. A number of these link to standards developed by JTC 1/SC 31. Details of assigned Object Identifiers, together with

the other data constructs associated with particular application standards, are available on the data constructs register. A copy of the register of RFID data constructs can be obtained from the dedicated website of the RA for ISO/IEC 15961-2 at: https://www.iso.org/iso/maintenance_agencies.htm.

If a pre-existing Object Identifier scheme is not available, the organization responsible for the application should consider applying for a Root-OID under one of the primary schemes described in [Annex A](#). The RA for ISO/IEC 15961-2 might be able to assist an organization applying for data constructs to be assigned.

7.3 Use of Object Identifiers in closed application environments

For closed application environments, the Root-OID **1 0 15961 0** shall be used. In such systems, it is therefore possible for an organization to self-assign the Relative-OID for the UII and additional Relative-OIDs for any other item attendant data.

7.4 Object Identifier for the Unique Item Identifier

The encoding of a Unique Item Identifier (UII) is supported in the data protocol standards (ISO/IEC 15961-1 and ISO/IEC 15962) and the air interface standards (ISO/IEC 18000). Generally, two methods are available:

- The UII can be encoded in a particular area of a partitioned memory.
- The UII can be encoded in, and accessed from, the first logical position in a generic memory structure.

Either method enables the UII to be accessed efficiently.

For open application environments, the relevant Relative-OID (or sometimes a limited choice of values) is usually defined directly, or related to some legacy data dictionary.

EXAMPLE **1 0 15459 1 2**: for a transport unit identifier equivalent to ASC MH10 Data Identifier J

For closed application environments when using the Root-OID **1 0 15961 0**, any relevant Relative-OID may be used to identify the UII.

7.5 Object Identifiers for other item attendant data

The Object Identifiers for other item attendant data can share the same Root-OID as the Object Identifier for the UII, or may have a completely different Root-OID.

EXAMPLE 1

Object Identifier for UII = **1 0 15459 n**

Object Identifiers for item attendant data = **1 0 15434 n** or **1 0 15961 10 n**

The decision is based on the requirements of the application. This document only imposes two requirements:

- If the same Root-OID is used for the UII and other item attendant data, the Relative-OIDs shall be different, so that there is no ambiguity in the data encoded on the RFID tag and processed by the data protocol.
- Each distinctive item of data that constitutes one of the set of item attendant data shall have a specific Object Identifier. This is usually achieved by applying different Relative-OIDs to the distinct items of data.

EXAMPLE 2

IATA baggage handling Object Identifiers:	1 0 15961 12 2	Flight date
	1 0 15961 12 5	Baggage routing
	1 0 15961 12 8	Airline frequent flyer level
	1 0 15961 12 10	Destination code

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