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Application Guideline on Data Carriers for Supply Chain Management

Directive d'application sur des supports d'informations pour le supply chain management

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote. Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

In exceptional circumstances, when the technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide to publish a Technical Report. A Technical Report is entirely informative in nature and shall be subject to review every five years in the same manner as an International Standard.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 17370 was prepared by Technical Committee ISO/TC 122, *Packaging*.

Introduction

Supply chain management makes use of a variety of data carriers, including linear symbols, two-dimensional symbols and Radio Frequency Identification (RFID). Care should be taken when using these data carriers in combination because the data structure of RFID is different from that of the other data carriers. This Technical Report outlines the basic structure of the supply chain layers defined in ISO standards. It describes how to store data in linear symbols, two-dimensional symbols and in RFID. In addition, this document shows the structure of the data transmitted from an interrogator to a host computer. This Technical Report is provided as a guideline for the effective use of these data carriers.

RFID technology, especially when equipped with the ability to additionally write data, is essential to traceability in Supply Chain Management (SCM). However, consideration should be given to the following issues for the use of RFID:

a) Approximately 10 standards, each having its own air interface and memory structure, have been developed for the RFID technology. Work on the standardization of middleware is currently in progress in order to achieve compatibility among these standards, but middleware that supports various RFID air interfaces is not available at this time. And in addition, operators who handle only one type of RFID do not necessarily need to use middleware.

b) The memory size of commonly available RFID is relatively small compared to the size of EDI data requiring standardized compaction methods to address this issue.

c) The structure of the data transmitted from a linear or two-dimensional symbol to the host computer is different from the one transmitted from an RFID interrogator.

This Technical Report provides a potential solution for dealing with these challenging issues. Those wishing to understand the GS1 approach to similar issues are invited to contact GS1.

This document has 11 annexes, A, B, C, D, E, F, G, H, I, J and K, all which provide informative information.

— Annex A – Examples of Containers Used for Supply Chain Management

— Annex B – Rewritable Hybrid Media

— Annex C – Data Carrier Identifiers

— Annex D – Layered Structure of Automotive Industry

— Annex E – Layered Structure of Electric Home Appliance Industry

— Annex F – Layered Structure of Medical Industry

— Annex G – Syntax for High-Capacity Automatic Data Capture Med

— Annex H – Assignment of Application Family Identifiers (AFIs)

— Annex I – Memory Structure of ISO/IEC 18000-63 and ISO/IEC 18000-3, M3

— Annex J – Data storage capacity and number of RF tag

— Annex K – 6-bit coding scheme

Application Guideline on Data Carriers for Supply Chain Management

1 Scope

This Technical Report specifies a method to establish compatibility among various data carriers such as linear symbols, two-dimensional symbols and RFID, as well as their one-to-one relationship by illustrating the structure supporting the basic ISO-compliant supply chain control system. In particular, it

— specifies the relationship of various global standards related to the supply chain,

— illustrates the types and data structures in the layered supply chain network,

— specifies the relationship among the layered structure of the supply chain,

— specifies the management of serial numbers in supply chain management,

— specifies data storage on the named data carriers,

— specifies the required data volume for each data carrier,

— specifies the data structure between the data carrier and the reader (interrogator),

— specifies the data structure between the host system (computer) and the reader (interrogator), and

— illustrates complex data carriers (rewritable hybrid media, etc).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 445, *Pallets for materials handling — Vocabulary*

ISO/IEC 19762 (all parts), *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

ISO 21067, *Packaging — Vocabulary*

3 Terms, definitions, and abbreviated terms

For the purposes of this document, the terms, definitions, and abbreviations given in ISO/IEC 19762 (all parts), ISO 445, ISO 21067 and the following apply.

3.1
RHM
rewritable hybrid media

4 Supply Chain Model

4.1 Supply chain model

The "supply chain" is a multi-level concept that covers all stages of a product, from the management of raw material to the final product process, including shipping the product to the point-of-sale, the use and maintenance of the product and, depending on the application, to the point of disposal. This supply chain further includes reverse logistics and the handling of returned goods. Each of these levels is unique, but the levels overlap.

Figure 1 below is a basic concept of "supply chain" that illustrates the correlative relationship of the supply chain, not a "one-to-one" representation of physical objects. Figure 1a shows the *supply chain model for radio frequency identification (RFID)* and Figure 1b shows the *supply chain model for optically readable media (ORM)*. Although several layers in Figure 1 have clear physical counterparts, some items are categorized into more than one layer, depending on their usage. In Figure 1, RPI represents "Returnable Packaging Items". In Figure 1, RTI represents "Returnable Transport Items", defined in ISO/IEC 15459-5. The use cases of these items introduced to the supply chain management are specified in Annex A.

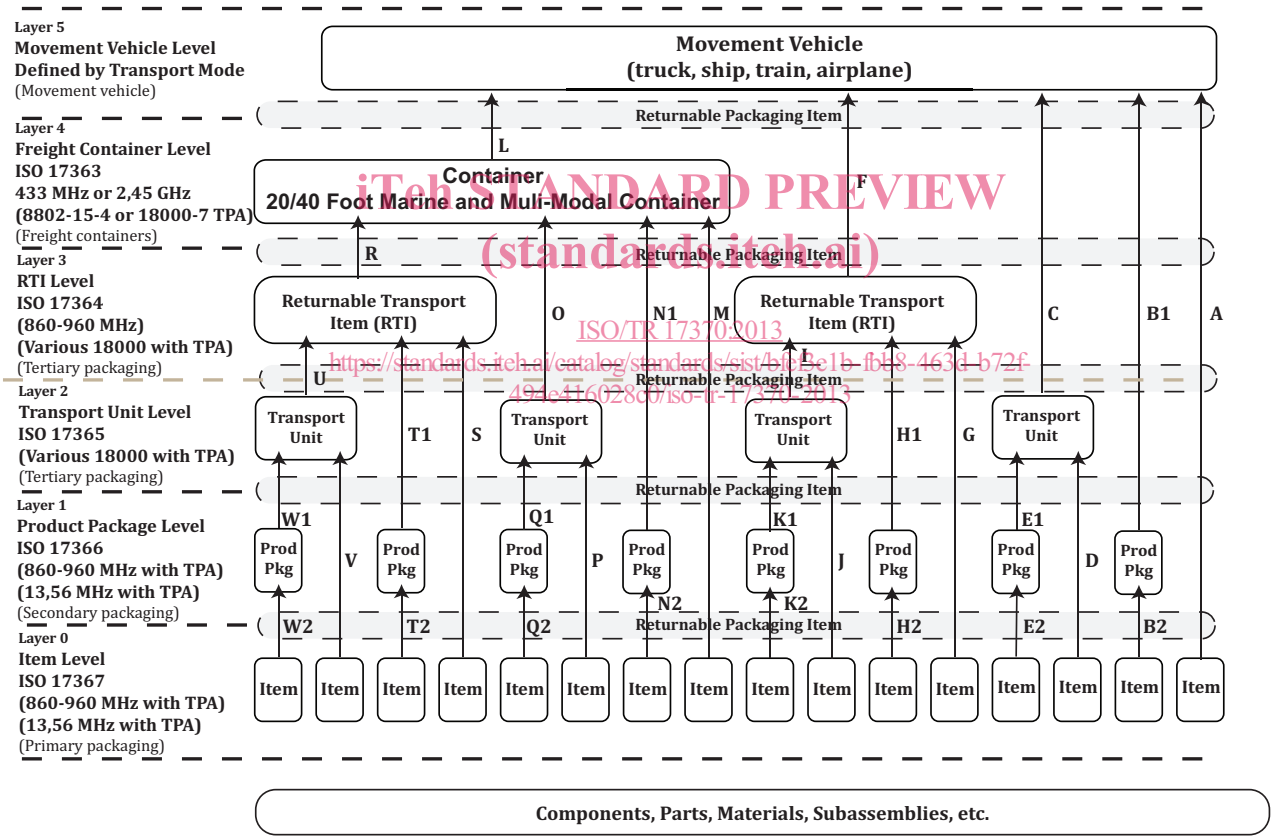

Figure 1a — Supply chain model for radio frequency identification (RFID)

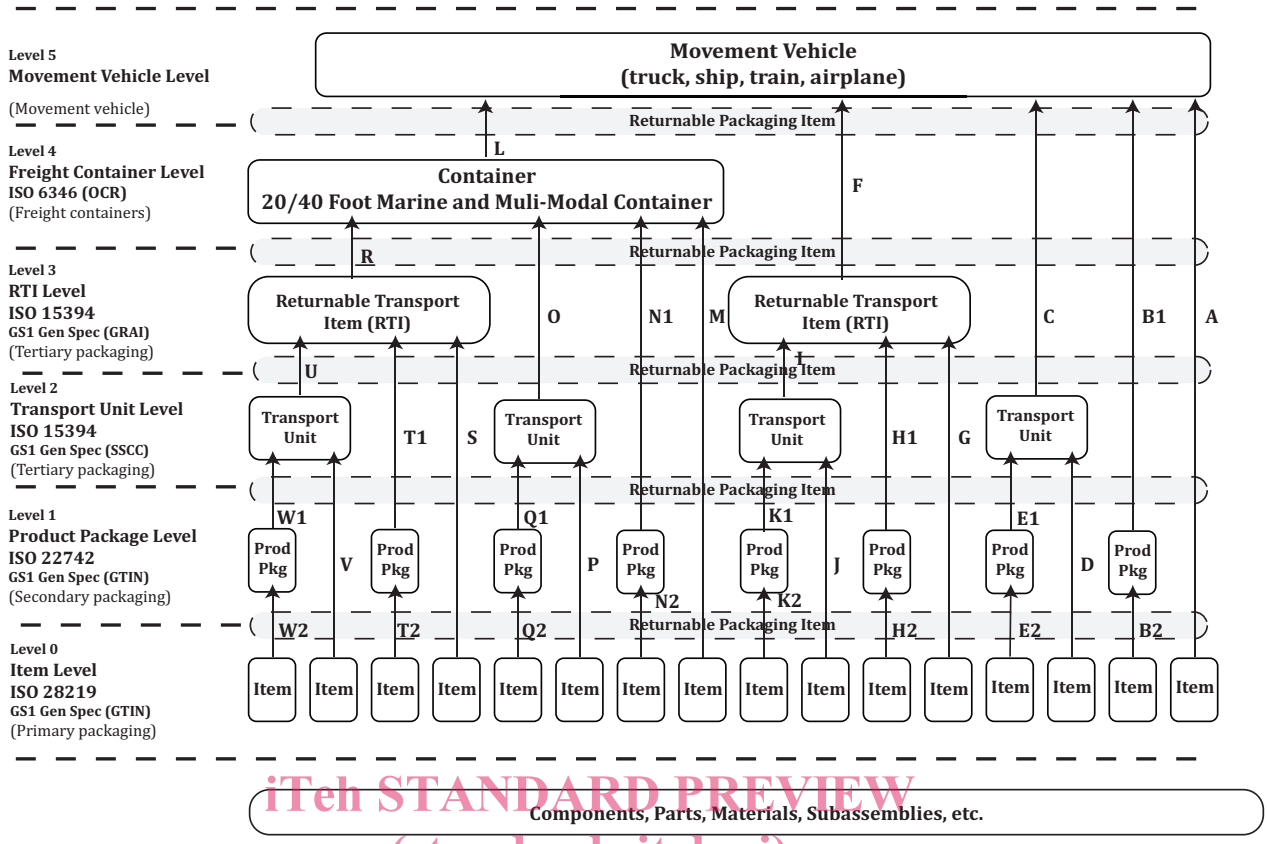

Figure 1b — Supply chain model for optically readable media (ORM)

Key

Alphabetic reference	Associated annex	Associated example
B2, B1	F	1
E2, E1	F	2
N_2, N1, L	F	3
K2, K1, I, F	F	4
Q2, Q1, O, L	F	5, 6, 7
G, F	D	1, 2, 3
W2, W1, Q2, Q1, K2, K1, E2, E1, T2	E	1, 4, 5, 8
V, P, J, D	E	2, 3, 6, 7
G, F	E	9
A	E	10

Figure 1 — Physical layer of supply chain model

4.2 Types of data carriers for supply chain management

Data carriers such as linear symbols, two-dimensional symbols and RFID, used for supply chain management should be selected based on their respective characteristics. Most readers available in today's market have the ability to automatically distinguish and read various types of linear and two-dimensional symbols, allowing the use of these symbologies without restriction.

RFID can be used at various frequencies: 135 kHz or lower, 13,56 MHz, 433 MHz, 860 MHz to 960 MHz or 2,45 GHz, and each frequency can have a separate memory structure and communication protocol, making it difficult for existing interrogators to automatically distinguish among the various frequencies.

Although the appropriate air interface can be selected depending on the specific layer of the supply chain in Figure 1, more than one interrogator should be available when using a variety of air interfaces. As this will increase the cost, the number of air interfaces should be limited to the fewest possible number.

This Technical Report uses the data carriers shown in Figure 1 as examples, including the linear symbols Code 128 (ISO/IEC 15417) and Code 39 (ISO/IEC 16388), the two-dimensional symbols QR Code (ISO/IEC 18004) and Data Matrix (ISO/IEC 16022), and RFID at 13,56 MHz (ISO/IEC 18000-3, Mode 3) and 860 to 960 MHz (ISO/IEC 18000-63) as well as a hybrid media (ISO/IEC 29133). A description of rewritable hybrid media is found in Annex B. Table 1 below is a list of the data carriers supported by this Technical Report.

Table 1 — Examples of data carriers for the supply chain

Data carrier	Type
Linear symbol	Code 39 (ISO/IEC 16388) Code 128 (ISO/IEC 15417)
2D symbol	QR Code (ISO/IEC 18004) Data Matrix (ISO/IEC 16022)
RFID	13.56 MHz (ISO/IEC 18000-3, Mode 3) 860 - 960 MHz (ISO/IEC 18000-63)
Rewritable hybrid media	Complex data carrier (ISO/IEC 29133) in which linear and/or 2D symbols printed on a paper-based rewritable media are combined with RFID.

4.3 Characteristics of data carriers for the supply chain

In a linear or two-dimensional symbol used in the supply chain structure, the type of symbol, label or direct marking is usually selected according to the layer of the supply chain (see Figure 2 below). In the delivery process, a distributor may be required to read not only the transport label but also the product package label attached to the transport unit. In this operation, the type of label is manually identified.

In the supply chain layers shown in Figure 2, the distributor usually attaches the RF tags on the transport units. If Tags A in Layer 0, Tags B in Layer 1 and Tags C in Layer 2 use the same type of RF tag, all of the tags will be read, even if the information needed is contained only in Tags C. A mechanism should be established for selecting and reading only the intended tags.

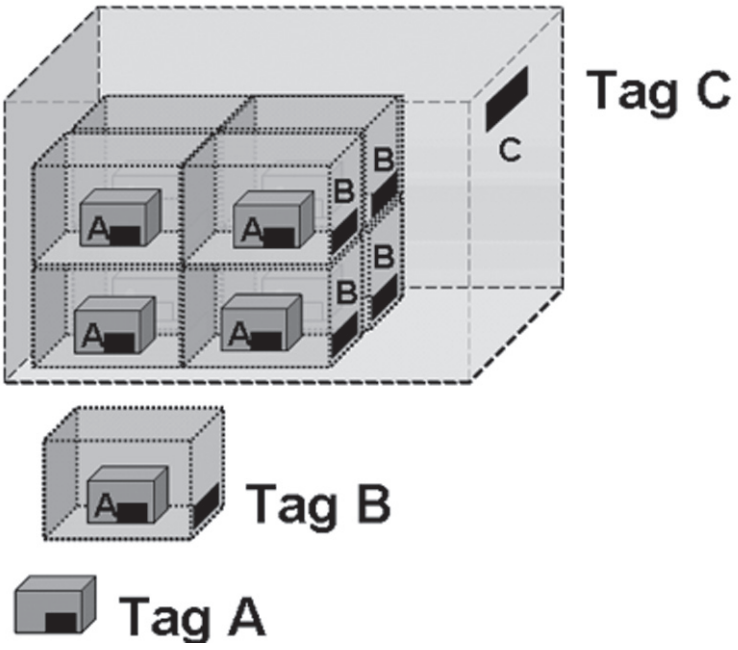

Figure 2 — Supply chain layers and RFID

5 Layers Related to Supply Chain Standards

Table 2 below outlines the layered structure of the types of standards related to supply chain management and Table 3 lists the specific standards corresponding to the layers that meet the supply chain standards identified in Table 2. The standard in Layer 0 is a data carrier standard supported by the supply chain standard. Table 1 above is a list of data carriers supported by this Technical Report.

Table 2 — Supply chain standard layers

Layer	Standards
3	Supply chain (application) standard
2	Data carrier identification standard, Data storage standard, Communication data structure standard
1	Identification standard of products and parts
0	Data carrier standard

Table 3 — Standard numbers

Layer	Standard number
0, 1, 2, 3, 4	ISO 15394, ISO 22742, ISO 28219, ISO 17363, ISO 17364, ISO 17365, ISO 17366, ISO 17367
0, 1, 2, 3	ISO/IEC 15418, ISO/IEC 15434, ISO/IEC 15962
0, 1, 2, 3	ISO/IEC 15459 Series
0, 1, 2, 3	ISO/IEC 15417, ISO/IEC 16388, ISO/IEC 16022, ISO/IEC 18004, ISO/IEC 18000-3, ISO/IEC 18000-63

The standards in Layer 1 of Table 2 are based on ISO/IEC 15418 to uniquely specify individual items and parts (components) of the layers of Figure 1. Some of the identifiers in ISO/IEC 15418 are defined in the ISO/IEC 15459 series of standards. The cross relationship of these standards is shown in Figure 3 below.

ISO/IEC 15418 specifies the Data Identifiers widely implemented in the manufacturing industry alongside the Application Identifiers and the data structures commonly implemented in the logistics industry.

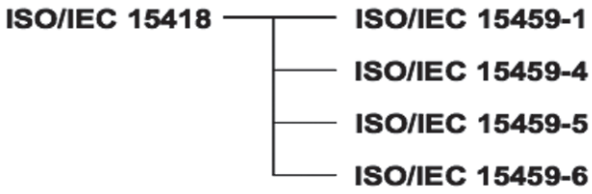

Figure 3 — Relationship of product/part identification codes

— ISO/IEC 15459-1 is a standard developed for the unique identification of items and parts.

— ISO/IEC 15459-4 for the unique identification of returnable transport items intended for delivery and transportation.

— ISO/IEC 15459-5 is a standard for unique identification of RPIs and RTIs introduced to supply chain management.

— ISO/IEC 15459-6 is a standard used for the identification of items and parts, which generally come in a liquid or power form and are controlled by a lot or batch number.

The data treated in Layer 1 is stored in the corresponding data carriers pursuant to the standards in Layer 2. The ISO/IEC 15418 (ISO/IEC 15459 Series) standards stipulating the data structure can also be referenced when storing data in a linear or two-dimensional symbol and the data structure specified in ISO/IEC 15418 is directly applied to the symbol without any changes. The method for storing large amounts of data in a two-dimensional symbol or an RF tag is defined in ISO/IEC 15434 and the method for storing data in RFID is found in ISO/IEC 15962.

Of the standards in Layer 3, ISO 15394, ISO 22742 and ISO 28219 support linear and two-dimensional symbols, whereas ISO 17363, ISO 17364, ISO 17365, ISO 17366 and ISO 17367 apply to RFID. Table 4 is a list of standards that correspond to each of the supply chain layers in Figure 1.

Table 4 — Standard numbers corresponding to the layers in Figure 1

Layer	Basic data structure	Linear/2D symbol	RFID
4	ISO 10374	—	ISO 17363
2, 3	ISO/IEC 15459-1 (ISO/IEC 15459-5)	ISO 15394	ISO 17365 (ISO 17364)
1	ISO/IEC 15459-4 (ISO/IEC 15459-5)	ISO 22742	ISO 17366 (ISO 17364)
0	ISO/IEC 15459-4 ISO/IEC 15459-6 (ISO/IEC 15459-5)	ISO 28219	ISO 17367 (ISO 17364)
NOTE Parenthetical references are shown to illustrate situations where an RTI might be considered as a product (ISO 28219) by the RTI manufacturer, or product packaging (ISO 22742).			

In this supply chain model, Layers from 0 to 3 are divided into two categories:

— transport units

— RTI and/or RPI

No standards exist for the basic data structure supporting containers in Layer 4 nor for those specifying linear and two-dimensional symbols for Layer 4 applications. It is therefore critical for the user to understand the relationship of the standards listed in Table 4.

In the standards that support both linear and two-dimensional symbols, such as ISO 15394, ISO 22742 and ISO 28219, the data structure in the ISO/IEC 15459 standards is used for linear symbols, while the structure of two-dimensional symbols is based on the ISO/IEC 15459 Series or ISO/IEC 15434. See Table 5.

Table 5 — Data storage structure of linear and two-dimensional symbols

Layer	Basic standard	Linear symbol storage structure	2D symbol storage structure	
3	ISO 15394	ISO/IEC 15459-5	ISO/IEC 15459-5	
2	ISO 15394	ISO/IEC 15459-1	ISO/IEC 15459-1	
1	ISO 22742	ISO/IEC 15459-4	ISO/IEC 15459-4	ISO/IEC 15434
0	ISO 28219	ISO/IEC 15459-4 ISO/IEC 15459-6	ISO/IEC 15459-4 ISO/IEC 15459-6	

Examples of identifiers defined in ISO/IEC 15459 Series are provided in Table 6.

Table 6 — Examples of ISO/IEC 15459 Series identifiers

Layer	Standard number	Data Identifier	Application Identifier	EPC Identifier
3	ISO/IEC 15459-5	25B or 55B	8003 or 8004	GRAI or GIAI
2	ISO/IEC 15459-1	J to 6J	00	SSCC
1	ISO/IEC 15459-4	25S or 3I (for a serialized component)	8004 (for a serialized component)	GIAI (for a serialized component)
		25P+S (for a separate serialized component)	01+21 (for a separate serialized component)	SGTIN (GTIN+S/N) (for a serialized serial component)
0	ISO/IEC 15459-4	25S or 3I (for a serialized component)	8004 (for a serialized component)	GIAI (for a serialized component)
		25P+S (for a separate serialized component)	01+21 (for a separate serialized component)	SGTIN (GTIN+S/N) (for a serialized serial component)

NOTE ISO/IEC 15459-5 predates the assignment of “55B” for RPIs. The next edition of ISO/IEC 15459-5 will be requested to include “55B”.

The Data Identifiers stored in linear symbols, two-dimensional symbols and RFID should be compatible and the data format used for reading and transmitting the data in these data carriers from a reader to a host computer should be uniform throughout the supply chain.

6 Example for Unique Identifier of Product Package

Examples of identifiers defined in the ISO/IEC 15459 Series of standards are provided in Table 6. This clause describes examples of the data structure of the identifier “25S” defined in ISO/IEC 15459-4. The identifier and data supported here are stored in linear symbols, two-dimensional symbols or in RF tags and are used for online electronic commerce. To effectively use various types of data carriers in the same application, there should be a match between the data in the data carrier and the data stored in the database of the host computer.

6.1 Data field identification

The Data Identifier “25S” defined in ISO/IEC 15459-4 and ANS MH 10.8.2 should be used for the identification of product packages. Refer to Table 7 for the data structure of the Data Identifier.

6.2 Data structure

Table 7 shows the data structure of the Unique Identifier of a package.

Table 7 — Data structure

25S	IAC	CIN	SN

6.2.1 Issuing Agency Code (IAC)

The Issuing Agency Code (IAC) is used to identify the entity, organization and/or company authorized by the appropriate registration authority as an issuing agency in accordance with ISO/IEC 15459-2. Following are examples of issuing agencies and their associated codes:

— UN (Dun and Bradstreet)

— OD (Odette Europe)

— LA (JIPDEC/CII)

— D (NATO AC135)

6.2.2 Company Identification Number (CIN)

The Company Identification Number (CIN) is a unique code assigned by the issuing agency to each individual company. Each issuing agency has its own format for the CIN. The CIN code may be partly determined by the company, i.e. Factory Identification Code (FIC). In Table 9 the FIC is illustrated as part of the Object Sequence Number.

6.2.3 Serial Number (SN)

When the Serial Number (SN) is combined with IAC and CIN, the combination constitutes a globally unique identifier for the product package. Once created and attached to the product package, the IAC, CIN and SN combination is intended to be fixed and unchangeable for that specific product package throughout its lifetime.

The Serial Number may be composed of numeric characters, alphabetic characters or a combination of both. The data significant to the package should be regarded as part of the Serial Number, as illustrated in Table 8. In this case, the data with significance is called Object Data (OD) and the identifier is called the Object Sequence Number (OSN).

Table 8 — Example of Serial Number data structure

Serial Number (SN)	
Object Data (OD)	Object Sequence Number (OSN)

In general, the Object Data are a code indicating the product or component number and it does not need to be a sequence number. The Object Sequence Number may have a structure, as illustrated in Table 9. It should be noted that the number of digits can be decreased by using a simple sequence number, if the amount of data in the data carrier is comparatively small.

Table 9 — Example of Object Sequence Number

Object Sequence Number (OSN)			
Factory Identification Code	Data of manufacture	Time of manufacture	Simple Serial Number
3 digits	8 digits	4 digits	5 digits

6.3 Character set

The character set used in the ISO/IEC 15459 Series standards consists of upper-case alphabetic characters and numbers from the 7-bit ASCII characters defined in ISO/IEC 646.

7 Layered Structure of Supply Chain Management

7.1 Complex layered structure

Figure 4 is a tree diagram showing the supply chain structure consisting of the container, transport unit, Returnable Transport Item (RTI) and Returnable Packaging Item (RPI) loaded on a movement vehicle for the scenarios "O", "N", "L" and "H" (see Figure 1). In Figure 4, the identification number of the container complies with ISO 10374, the RPI and the RTI comply with ISO/IEC 15459-5 and the transport unit complies with ISO/IEC 15459-1. Likewise, the product package conforms to ISO/IEC 15459-4 and the product itself to either ISO/IEC 15459-4 or ISO/IEC 15459-6.

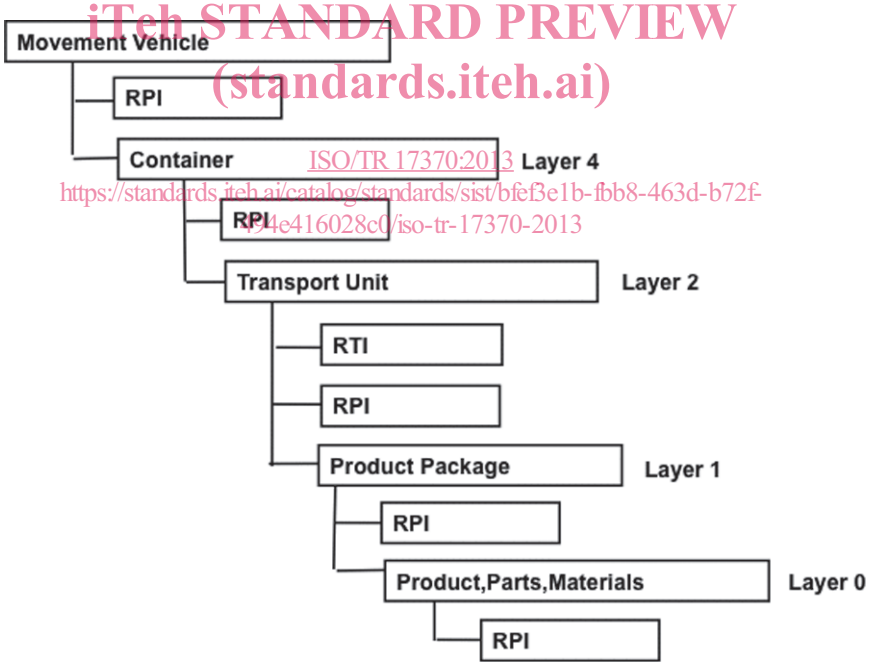

Figure 4 — Complex layered structure

Unlike the case in Figure 4 in which RPI and RTI are used, neither of them is included in the structure in Figure 5.