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SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for the NGN –
Testing for NGN networks

Testing and model network architecture for tag-based identification systems and functions

Recommendation ITU-T Q.3950



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Recommendation ITU-T Q.3950

Testing and model network architecture for tag-based identification systems and functions

Summary

There are a variety of applications and services which utilize the identification of objects and provide identification services to intended users. However, not all identification applications and services can be considered as those that are tag-based, which incorporate three mandatory functional elements: identifier, identification (ID) tag and ID terminal. Tag-based identification systems and functions are required to be developed to deploy tag-based identification applications and services. Typical tag-based identification systems are ID terminals, identifier resolution systems, object identifier (OID) resolution systems, application-specific OID resolution systems and service brokers. The tag-based identification functions running on the tag-based identification systems incorporate various standards-based implementations that need to be verified for conformity and interoperability. Recommendation ITU-T Q.3950 identifies target systems and functions that are to be tested and specifies a model network of testing for their conformity and interoperability.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Q.3950	2011-11-29	11

Keywords

Bar code, identifier, identifier resolution, ID tag, ID terminal, RFID, tag-based identification.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation ITU-T Q.3950

Testing and model network architecture for tag-based identification systems and functions

1 Scope

A set of standards and relevant implementations are necessary to enable tag-based identification applications and services over a next generation network (NGN) and other communication networks. The implementations are recommended to be verified according to given standards to evaluate their conformity and interoperability.

This Recommendation specifies a testing and model network architecture that describes target systems, target functions and system configurations in terms of a model network, general procedures and testing requirements.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T F.771] Recommendation ITU-T F.771 (2008), *Service description and requirements for multimedia information access triggered by tag-based identification*.
- [ITU-T H.621] Recommendation ITU-T H.621 (2008), *Architecture of a system for multimedia information access triggered by tag-based identification*.
- [ITU-T X.672] Recommendation ITU-T X.672 (2010) | ISO/IEC 29168-1:2011, *Information technology – Open systems interconnection – Object identifier resolution system (ORS)*.
- [ITU-T Y.2016] Recommendation ITU-T Y.2016 (2009), *Functional requirements and architecture of the NGN for applications and services using tag-based identification*.
- [ITU-T Y.2213] Recommendation ITU-T Y.2213 (2008), *NGN service requirements and capabilities for network aspects of applications and services using tag-based identification*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 associated information [ITU-T Y.2213]: The information which is associated with an identifier.

NOTE – Example associated information instances are URL, URN, IP address, E.164 number, etc.

3.1.2 B2B tag-based identification applications and services [ITU-T Y.2213]: This term refers to tag-based identification applications and services based on business relationships which involve exchanges of identification information between business partners.

3.1.3 B2B2C tag-based identification applications and services [ITU-T Y.2213]: This term refers to tag-based identification applications and services based on integrated business relationships of B2B and B2C which involve exchanges of identification information.

3.1.4 B2C tag-based identification applications and services [ITU-T Y.2213]: This term refers to tag-based identification applications and services based on business relationships which involve exchanges of identification information between business and consumer.

3.1.5 C2C tag-based identification applications and services [ITU-T Y.2213]: This term refers to tag-based identification applications and services based on business relationships which involve exchanges of identification information between consumers.

3.1.6 forward identifier resolution [ITU-T Y.2213]: A function to resolve an identifier into an associated information.

3.1.7 identifier [b-ITU-T Y.2091]: A series of digits, characters and symbols or any other form of data used to identify subscriber(s), user(s), network element(s), function(s), network entity(ies) providing services/applications, or other entities (e.g., physical or logical objects). Identifiers can be used for registration or authorization.

NOTE – Identifiers can be either public to all networks, shared between a limited number of networks or private to a specific network (private identifiers are normally not disclosed to third parties.)

3.1.8 identifier resolution [ITU-T Y.2213]: A function to resolve an identifier into associated information (see "Forward identifier resolution") and vice versa (see "Reverse identifier resolution").

3.1.9 identifier scheme [ITU-T Y.2213]: It is a numbering scheme that specifies the format and structure of the identifiers used within that scheme.

3.1.10 ID tag [ITU-T Y.2213]: A physical object which stores one or more identifiers and optionally application data such as name, title, price, address, etc.

NOTE – It may have a communication capability with an ID terminal depending on implementations.

3.1.11 ID terminal [ITU-T Y.2213]: A device with a data reading and optional writing capability which reads (and optionally writes) identifier(s) and optionally application data from/into an ID tag.

NOTE – The data reading (and optionally writing) capability depends on implementations.

3.1.12 model network [b-ITU-T Q.3900]: Network which simulates the capabilities similar to those available in present telecommunication networks, has a similar architecture and functionality and uses the same telecommunication technical means.

3.1.13 Object Identifier (OID) resolution process [ITU-T X.672]: process which provides information associated with an OID

3.1.14 OID resolution system [ITU-T X.672]: Implementation of the OID resolution process in accordance with [ITU-T X.672]

3.1.15 reverse identifier resolution (or backward identifier resolution) [ITU-T Y.2213]: A function to resolve an associated information into a corresponding identifier. It is the reverse operation of the forward identifier resolution.

3.1.16 tag-based identification [ITU-T Y.2213]: The process of specifically identifying a physical or logical object from other physical or logical objects by using identifiers stored on an ID tag.

3.1.17 tag-based identification applications and services [ITU-T Y.2213]: Applications and services which use tag-based identification.

3.1.18 tag-terminal interface [ITU-T Y.2213]: A communication interface between ID tag and ID terminal. The ID terminal reads identifier(s) and optionally application data from the ID tag and/or writes them into the ID tag.

NOTE – The interface medium may be infrared, RF, camera, optical scanner, and galvanic current. Communication techniques depend on the interface medium.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 OID resolution: Operation which provides information associated with an object identifier (OID).

3.2.2 tag-based identification system: All relevant equipment and software for providing tag-based identification applications and services.

3.2.3 tag data: Whole set of data encoded in a certain standard format and stored in an identification (ID) tag or to be written in an ID tag.

NOTE – Tag data may consist of an identifier and optional application data.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

1D	1-Dimension
2D	2-Dimension
B2B	Business-to-Business
B2B2C	Business-to-Business-to-Consumer
B2C	Business-to-Consumer
C2C	Consumer-to-Consumer
DNS	Domain Name Service
ENUM	Telephone Number Mapping
HTTP	Hypertext Transfer Protocol
ID	Identification
IP	Internet Protocol
LDAP	Lightweight Directory Access Protocol
MIDF	Multimedia Information Discovery Function
MIHF	Multimedia Information Handling Function
MIM	Multimedia Information Manager
NI	Network Interface
NGN	Next Generation Network
NID	Network aspects of Identification systems (including RFID)
OID	Object Identifier
RF	Radio Frequency
RFID	Radio Frequency Identification
SCM	Supply Chain Management

SOAP	Simple Object Access Protocol
TCP	Transmission Control Protocol
TTI	Tag Terminal Interface
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
URN	Uniform Resource Name

5 Conventions

None.

6 Overview of tag-based identification applications and services

Tag-based identification applications and services are defined by [ITU-T Y.2213] as applications and services which use and provide tag-based identification and are required to incorporate three mandatory elements, *identifier*, *ID tag* and *ID terminal*, and one optional element, *associated information*. Table II.1 of [ITU-T Y.2213] describes how to evaluate identification-involved applications and services in the context of the key elements.

6.1 Application and service use cases

Appendix III of [ITU-T Y.2213] describes several use cases of tag-based identification applications and services. It also classifies them as:

- Closed-domain tag-based identification applications and services:
 - Inventory management
 - Parking management
- Business-to-Business (B2B) tag-based identification applications and services:
 - Supply chain management
 - Manufacturing and production management
- Business-to-Consumer (B2C) tag-based identification applications and services:
 - Bus and subway route search
 - Mobile shopping
 - Tag-based payment
- Business-to-Business-to-Consumer (B2B2C) tag-based identification applications and services:
 - Food chain information service
 - Home delivery service
- Consumer-to-Consumer (C2C) tag-based identification applications and services:
 - Business card exchange

6.2 Reference architecture

Figure 1 depicts a reference architecture to support tag-based identification applications and services. [ITU-T Y.2213] and [ITU-T H.621] also describe relevant architecture models but [ITU-T Y.2213] focuses on operating over the NGN and [ITU-T H.621] focuses on general and functional operation models independent of the network environment. Figure 1 does not depend on a specific network type but describes the whole functional configuration consisting of key functional equipment.

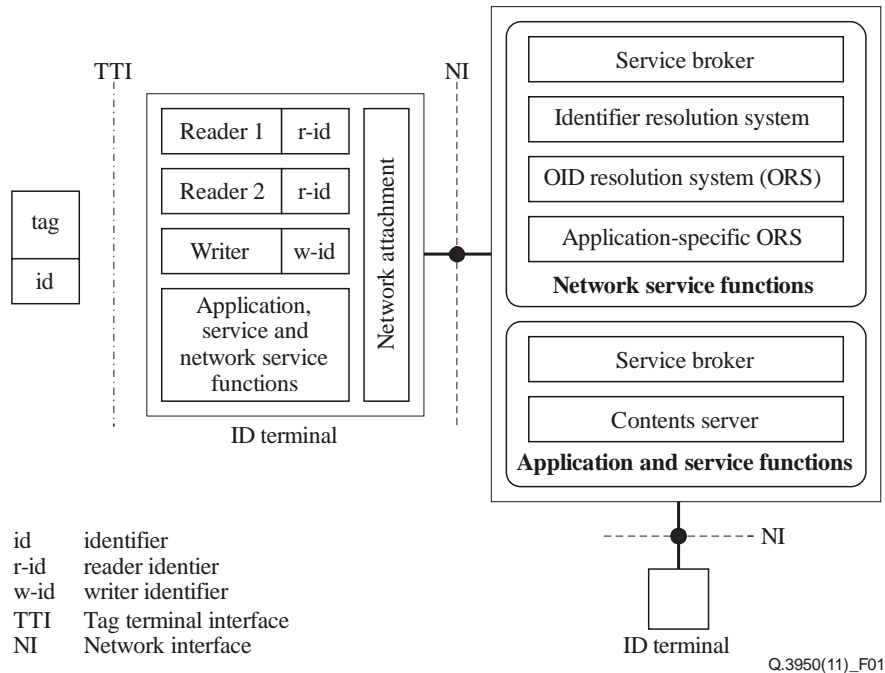


Figure 1 – Reference architecture for tag-based identification applications and services

Functional entities identified in Figure 1 are described as follows where each functional entity is a physical or logical object to provide one or multiple functions:

- tag – an ID tag;
- id – an identifier encoded in a standard format and contained in the ID tag. It is treated as tag data in this Recommendation;
- reader 1 – one of the devices for reading tag data (e.g., camera and RFID interrogator);
- reader 2 – one of the devices for reading tag data (e.g., camera and RFID interrogator);
- r-id – reader identifier to be identified among readers as a local matter within an ID terminal;
- writer – one of devices for writing tag data on an ID tag.

NOTE 1 – The reader and writer may be separate devices or a combined device. An RFID interrogator works as both reader and writer but a camera works only as a reader;

- w-id – writer identifier to be identified among writers only within an ID terminal;
- network attachment – network connectivity-supporting function (e.g., TCP/IP) between an ID terminal and a peer communication entity such as a service broker, contents server, identifier resolution system, OID resolution system and an application-specific OID resolution system;
- application functions – functions to invoke service functions and network service functions as well as to retrieve information from a contents server and present the information through an ID terminal to a consumer.

NOTE 2 – The multimedia information handling function (MIHF) described in [ITU-T H.621] is one of the application functions.

- service functions – functions to access a reader and/or a writer built in an ID terminal and to execute additional handling of information retrieved from a contents server according to service requirements (e.g., media transformation and compression/decompression).

NOTE 3 – The beginning part of the multimedia information discovery function (MIDF) described in [ITU-T H.621] corresponds to a service function.

- network service functions – functions to execute identifier resolutions through an identifier resolution system or a service broker, and to execute OID resolutions through an OID resolution system or a service broker.

NOTE 4 – The later part of the multimedia information discovery function (MIDF) described in [ITU-T H.621] corresponds to a network service function.

- service broker – a functional entity to invoke service functions and network service functions on behalf of the application functions of an ID terminal and to be triggered by the application functions of the ID terminal;
- identifier resolution system – a functional entity to provide identifier resolutions;
- OID resolution system – a functional entity to provide OID resolutions;
- application-specific OIS resolution system – a functional entity to provide application-specific information according to the information returned by a general OID resolution process; and
- contents server – a functional entity for storing, handling and providing information contents.

NOTE 5 – The multimedia information manager (MIM) described in [ITU-T H.621] corresponds to the contents server.

Figure 1 shows two external interfaces: the tag-terminal interface (TTI) and the network interface (NI). Their specific operation relationships and procedures are described in [ITU-T H.621], [b-ITU-T H.642.3] and [ITU-T X.672].

7 Classification of tag-based identification systems and functions to be tested

According to the reference architecture, the following tag-based identification systems and functions are specified to be tested. The tag-based identification systems are presented as physical entities, and the tag-based identification functions are presented as functions of the physical entities.

7.1 Classification of tag-based identification systems to be tested

Figure 1 depicts seven physical entities: ID tag, ID terminal, service broker, identifier resolution system, OID resolution system, application-specific OID resolution system, and contents server. The tag-terminal interface is out of the scope of this Recommendation because its interface standards and relevant testing standards have been covered by ISO/IEC 18046 for RFID device performance test methods and ISO/IEC 18047 for RFID device conformity test methods. However, some of the functions of the ID terminal are related to the network interface which has to be covered by this Recommendation. The contents server is also out of the scope of this Recommendation because it is usually established by using existing web technologies and is not involved with the network interfaces of tag-based identification systems defined in this Recommendation.

7.1.1 ID terminal

As shown in Figure 1, the ID terminal includes various functions. Some of those which are related to the tag terminal interface are out of the scope of this Recommendation, but the other functions

related to the network interfaces of tag-based identification systems are required to be covered by this Recommendation. Thus ID terminals are the target entities to be tested.

7.1.2 Identifier resolution system

The identifier resolution system is the peer entity of ID terminals in terms of identifier resolutions. A specific communication protocol is used between the identifier resolution system and the ID terminal (e.g., Domain Name System (DNS), ITU-T X.500, and the lightweight directory access protocol (LDAP)). The communication protocol implements a network interface of tag-based identification systems. A service broker may operate between them. Where two communication interfaces are required, they may be the same or different as described in clause 8. Clause 8 of [b-ITU-T H.642.3] defines this identifier resolution process.

7.1.3 OID resolution system

The OID resolution system is the peer communication entity of ID terminals to provide OID resolutions. A specific communication protocol is used between the OID resolution system and the ID terminal (e.g., Domain Name System (DNS), ITU-T X.500, and the lightweight directory access protocol (LDAP)). [ITU-T X.672] specifies the DNS for the communication protocol which is a network interface of tag-based identification systems. A service broker may operate between them. Where two communication interfaces are required, they may be the same or different as described in clause 8.

7.1.4 Application-specific OID resolution system

The application-specific OID resolution system is the peer communication entity of ID terms to provide application-specific OID resolutions. The OID has been used as the top level identification system in a variety of identification-involved applications and services, where the OID resolution system is required to support different applications and application-specific OID resolution systems may be necessary. The application-specific OID resolution system in this Recommendation provides identifier structure information associated with an OID in order to help an ID terminal convert an identifier into a specific protocol message for identifier resolution. Clause 7 of [b-ITU-T H.642.3] defines this application-specific OID resolution process.

7.1.5 Service broker

The service broker operates between the ID terminal and other tag-based identification systems. Its functions depend on service requirements and implementations. An interface between the service broker and the ID terminal is needed. On behalf of an ID terminal, the service broker may access network interfaces to other tag-based identification systems and operation results are finally delivered to the ID terminal. Involved network interfaces depend on the implementation of supporting functions of tag-based identification systems.

7.2 Classification of tag-based identification functions to be tested

Tag-based identification systems identified by clause 7.1 contain various application functions, service functions and network service functions. Some of them are out of the scope of this Recommendation because relevant standards have already been developed or they take advantage of existing technologies (e.g., TCP/IP, HTTP, SOAP, DNS, ITU-T X.500, and LDAP). This Recommendation covers application functions, service functions and network service functions newly specified for tag-based identification applications and services as below.

7.2.1 Application functions

There are no application functions to be tested. From an implementation point of view, there may be at least two application functions provided through: an application entity to invoke service functions and network service functions (e.g., a tag-terminal interface is executed to read tag data from an ID tag; a network interface of the identifier resolution is executed to translate an identifier into

associated information via identifier resolution systems; and a network interface is executed to translate an OID into associated information.); and another application entity to retrieve information content from a contents server (e.g., a worldwide web browser is a typical application entity example.). The former application entity does not provide service functions and network service functions to communicate with tag-based identification systems but just utilizes these functions. The later application entity is an existing one which has already been tested against its supporting functionalities. See also Table 1 below.

Table 1 – Application functions to be tested

Application function	Testing target
1) An application function to invoke service functions and network service functions	No
2) An application function to invoke the retrieval of information content from a contents server	No

7.2.2 Service functions

There may be four service functions as described in Table 2. Service functions 1) and 2) are required to follow existing relevant tag-terminal interface standards and are therefore out of this Recommendation's scope. Service function 3) corresponds to application-specific functionalities which are required to follow existing relevant standards and are therefore out of this Recommendation's scope. If a service broker operates between the ID terminal and other tag-based identification systems, a communication interface, function 4), is required between the ID terminal and the service broker because the service broker works on behalf of the ID terminal with other tag-based identification systems. The communication interface is specified by service broker-relevant standards.

Table 2 – Service functions to be tested

Service function	Testing target
1) A service function to access a reader or a writer to read tag data from an ID tag or write tag data on an ID tag	No
2) A service function to manipulate tag data returned from a reader or to be written by a writer	No
3) A service function to manipulate information content retrieved from a contents server (e.g., media transformation, and compression/decompression)	No
4) A service function for communication interfaces between ID terminal and service broker	Yes

NOTE – No specific communication interfaces between the ID terminal and the service broker are specified yet as shown in Figure 3. Usually web interfaces have been used, which means there are no testing items.

7.2.3 Network service functions

There may be more than two network service functions and all the network service functions are required to be tested. The identifier resolutions are performed between the ID terminal and the identifier resolution system, the OID resolutions are performed between the ID terminal and the OID resolution system, and the application-specific OID resolutions are performed between the ID terminal and the application-specific OID resolution system. See also Table 3. Relevant functions embedded in ID terminals, identifier resolution systems, OID resolution systems, and application-specific OID resolution systems are required to be tested.

Table 3 – Network service functions to be tested

Network service function	Testing target
1) A network service function to perform an identifier resolution	Yes
2 A network service function to perform a general OID resolution	Yes
3) A network service function to perform an application-specific OID resolution	Yes

NOTE – The network interface of the identifier resolution between the ID terminal and the identifier resolution system is specified by [b-ITU-T H.642.3]; the network interface of the application-specific OID resolutions between the ID terminal and the application-specific OID resolution system is specified also by [b-ITU-T H.642.3]; and the network interfaces of OID resolutions between the ID terminal and the OID resolution system are specified by [ITU-T X.672]. An example network interface for both identifier resolutions and OID resolutions between the ID terminal and service broker is ISO/IEC 29178 as shown in Figure 3.

7.3 Conformity of tag-based identification functions with tag-based identification systems to be tested

Clause 7.2 identified four tag-based identification functions to be tested as follows:

- A service function for communication interfaces between an ID terminal and a service broker;
- A network service function to perform an identifier resolution;
- A network service function to perform a general OID resolution; and
- A network service function to perform an application-specific OID resolution.

These functions run respectively on ID terminals as well as service brokers, identifier resolution systems, OID resolution systems and application-specific OID resolution systems. Thus conformity to relevant interface standards is required to be tested against the service functions and network service functions. Also, it is recommended that interoperability is tested

- between the ID terminal and the service broker;
- between the ID terminal and the identifier resolution system;
- between the ID terminal and the OID resolution system;
- between the ID terminal and the application-specific OID resolution system;
- between the service broker and the identifier resolution system;
- between the service broker and the OID resolution system; and
- between the service broker and the application-specific OID resolution system.

8 Testing architecture for tag-based identification systems and functions

8.1 The purpose of a model network

The testing architecture provides a reference model network to describe target systems and system configurations in terms of a model network, testing procedures and testing requirements.

The model network is a prototype configuration of tag-based identification systems. It supports system testing in order to evaluate the functioning and compatibility of the specific functions of target systems.

The model network may be used for testing the full list of functions of tag-based identification systems according to clause 8.3. The target systems to be tested should include all the technical functions defined in clause 7.2.

8.2 A model network for testing

Clause 7.1 specifies five testing targets, i.e., ID terminals, service brokers, identifier resolution systems, OID resolution systems and application-specific OID resolution systems. The basic configuration of the model network is shown in Figure 2. The two service brokers look to be located separately at different places but their functions may be built in a single physical entity and provide two different functions, i.e., service functions and network service functions, described in clause 6.2.

NOTE – There are conformity issues for the testing targets as described in clause 7.3.

Identifier resolution, OID resolution and application-specific OID resolution services in Figure 2 may be provided by an identifier resolution system, an OID resolution system and an application-specific OID resolution system to the ID terminal directly or indirectly through the service broker. It is an implementation issue and a decision for service providers.

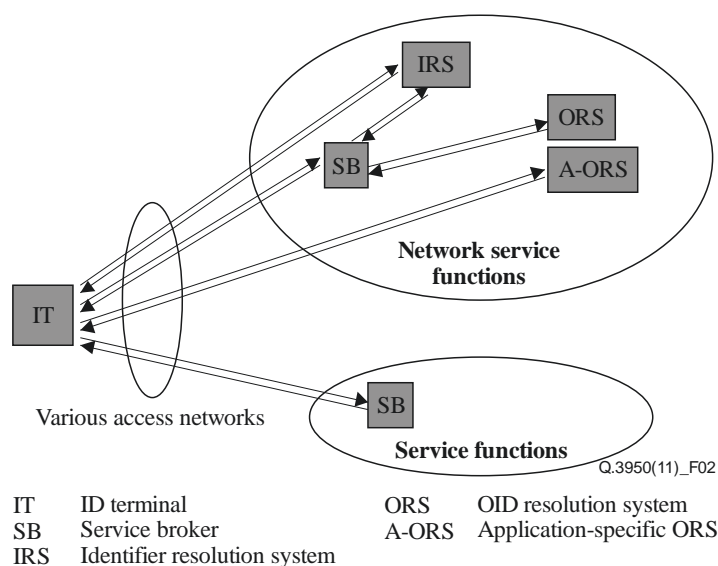


Figure 2 – Basic configuration of the model network

The two network service interfaces between the ID terminal and the identifier resolution system and between the ID terminal and the service broker may be identical or different. The representation in Figure 3 of different network service interfaces does not mean that the ID terminal is required to provide simultaneously two different network service interfaces. This is an implementation issue: either one interface for both the service broker and the resolution systems or one interface for each of the interfaced system types.

The two network service interfaces between the ID terminal and the identifier resolution system and between the service broker and the identifier resolution system are identical, which means the identifier resolution system provides the only single interface to either the ID terminal or the service broker. The network service interfaces of the OID resolution system and the application-specific OID resolution system may be identical or different.

8.3 Testing procedure

8.3.1 Service functions testing process

Following the classification of tag-based identification functions to be tested as specified in clause 7.2, the testing procedure is classified into two types: the service functions testing process and the network service functions testing process.

The following target systems are required to be tested at the service functions testing process:

- 1) ID terminal; and
- 2) service broker.

The test to be applied to ID terminals is as follows:

- 1) Client communication interface

The test to be applied to service brokers is as follows:

- 1) Server communication interface

Specific communication interfaces will be defined by an application interface standard and will depend on any service features.

8.3.2 Network service functions testing process

The following target systems are required to be tested at the network service functions testing process:

- 1) ID terminal;
- 2) service broker;
- 3) identifier resolution system;
- 4) OID resolution system; and
- 5) an application-specific OID resolution system.

The tests to be applied to ID terminals are as follows:

- 1) Client communication interface for identifier resolutions with the identifier resolution system;
- 2) client communication interface for identifier resolutions with the service broker;
- 3) client communication interface for OID resolutions with the OID resolution system;
- 4) client communication interface for OID resolutions with the service broker;
- 5) client communication interface for application-specific OID resolutions with the application-specific OID resolution system; and
- 6) client communication interface for application-specific OID resolutions with the service broker.

The network service interfaces for item 1) and 2) above may be identical or different as described in clause 8.2.

The tests to be applied to service brokers are as follows:

- 1) Server communication interfaces for identifier resolutions, OID resolutions and application-specific OID resolutions to the ID terminal;
- 2) client communication interface for identifier resolutions with the identifier resolution system;
- 3) client communication interface for OID resolutions with the OID resolution system;
- 4) client communication interface for application-specific OID resolutions with the application-specific OID resolution system.

The test to be applied to identifier resolution systems is as follows:

- 1) Server communication interface for identifier resolutions to the ID terminal and the service broker

The test to be applied to identifier resolution systems is as follows:

- 1) Server communication interface for OID resolutions to the ID terminal and the service broker

The test to be applied to application-specific OID resolution systems is as follows:

- 1) Server communication interface for application-specific OID resolutions to the ID terminal and the service broker

8.4 Testing requirements

8.4.1 Model network configuration requirements

The protocols scheme of the model network is required to be realized in accordance with the scheme illustrated in Figure 3.

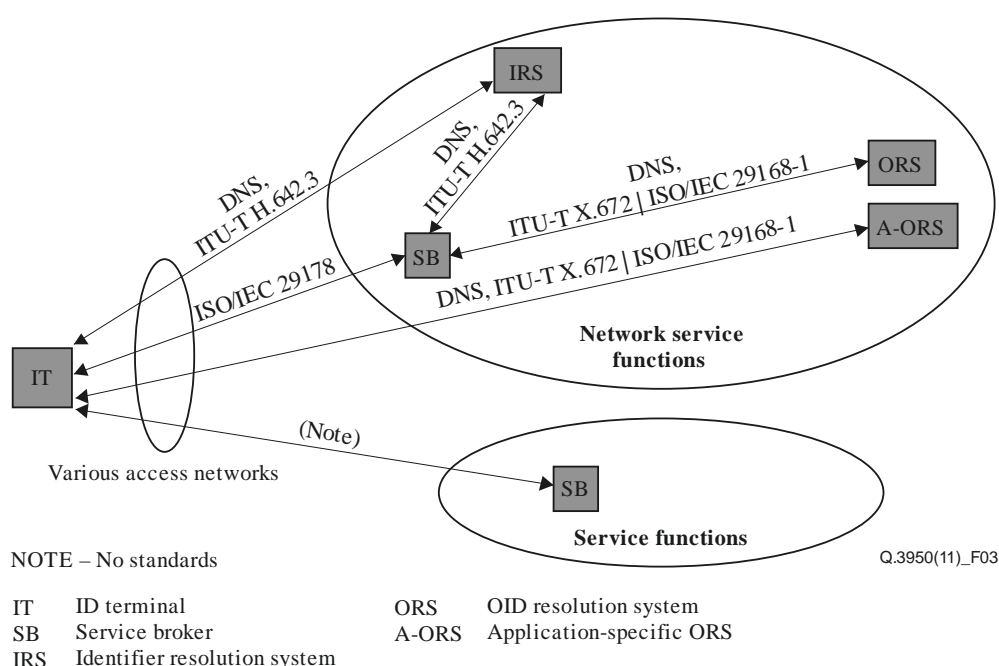


Figure 3 – Model network configuration with example standards

As described in clause 7.2.2, a dedicated communication interface for service functions between the ID terminal and the service broker has not been defined yet. But existing web interfaces have been utilized to exchange interface information between them.

8.4.2 Methodology of model networks testing

The methodology of testing on the model network is required to provide all the tests and accordingly allows for the checking of the two types of service functions which are described in clause 8.3. The testing scheme is shown in Figure 3 and specific sets of tests and testing procedures are specified by separate standards. The testing results of each service function should be delivered to the database, of which, structure and data format also have to be specified separately.

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