



TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(04/2014)

SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Directory services

Directory service – Support of tag-based identification services

CAUTION !

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Recommendation ITU-T F.511

Directory service – Support of tag-based identification services

Summary

Recommendation ITU-T F.511 provides guidance for the use of directory services to support tag-based identification applications by reference to the directory capabilities as specified in the ITU-T X.500 series of Recommendations | ISO/IEC 9594-All Parts, and in the lightweight directory access protocol (LDAP) specifications as developed within Internet Engineering Task Force (IETF). A tag is also called an automatic identification and data capture (AIDC) media. It holds an identifier that identifies the item to which the AIDC media is affixed or associated. The directory may be used to store information associated with the AIDC media.

This Recommendation identifies two cases: one case is where the identifier is used as a whole to access a centralized directory, and the other case is where the structure of the identifier is explored to access distributed directory systems, when it is not feasible for a specific environment to hold all relevant information in a single directory. In the latter situation the top-level information could be held by some type of independent service providers, while the company and/or item-related information may be held by the information owner.

The primary focus is on radio frequency identification (RFID) tags as specified in the GS1 EPCglobal specifications and in ISO and ISO/IEC International Standards.

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Recommendation ITU-T F.511

Directory service – Support of tag-based identification services

1 Scope

The scope of this Recommendation is to provide sufficient information for the use of directories to support tag-based identification applications without having to study the details of the many specifications on tag-based identification. It describes how this support may be provided using systems supporting the ITU-T X.500 series of Recommendations | ISO/IEC 9594-All Parts. The capabilities required are primarily limited to those capabilities that are also supported by the lightweight directory access protocol (LDAP) specifications.

NOTE 1 – Use of LDAP-based systems provides low-cost solutions.

For environments that are more complex this Recommendation also provides guidance on how directory responsibilities may be split between general service providers and information owners.

This Recommendation is only concerned with tag-based identification as related to automatic identification and data capture (AIDC) media as specified in numerous ISO/IEC and ISO International Standards and in GS1 specifications. This Recommendation is limited to the following types of AIDC media:

- The ISO/IEC 18000-6C tag type as defined in [ISO/IEC 18000-63]. This tag type is identical to the GS1 Class 1 Gen 2 tag type.
- The ISO/IEC 18000-3 Mode 3 tag type as defined in [ISO/IEC 18000-3].

NOTE 2 – Support for other types of AIDC media may be added in the future.

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 X.500 S] | The ITU-T X.500 Series of Recommendations ISO/IEC 9594-All Parts. |
| [ITU-T X.500] | Recommendation ITU-T X.501 (2012) ISO/IEC 9594-2:2014, <i>Information technology – Open Systems Interconnection – The Directory: Overview of concepts, models and services.</i> |
| [ITU-T X.501] | Recommendation ITU-T X.501 (2012) ISO/IEC 9594-2:2014, <i>Information technology – Open Systems Interconnection – The Directory: Models.</i> |
| [ITU-T X.509] | Recommendation ITU-T X.509 (2012) ISO/IEC 9594-8:2014, <i>Information technology – Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks.</i> |
| [ITU-T X.511] | Recommendation ITU-T X.511 (2012) ISO/IEC 9594-3:2014, <i>Information technology – Open Systems Interconnection – The Directory: Abstract service definition.</i> |

- [ITU-T X.518] Recommendation ITU-T X.518 (2012) | ISO/IEC 9594-4:2014, *Information technology – Open Systems Interconnection – The Directory: Procedures for distributed operation.*
- [ITU-T X.519] Recommendation ITU-T X.519 (2012) | ISO/IEC 9594-5:2014, *Information technology – Open Systems Interconnection – The Directory: Protocol specifications.*
- [ITU-T X.520] Recommendation ITU-T X.520 (2012) | ISO/IEC 9594-6:2014, *Information technology – Open Systems Interconnection – The Directory: Selected attribute types.*
- [ITU-T X.521] Recommendation ITU-T X.521 (2012) | ISO/IEC 9594-7:2014, *Information technology – Open Systems Interconnection – The Directory: Selected object classes.*
- [ITU-T X.525] Recommendation ITU-T X.525 (2012) | ISO/IEC 9594-9:2014, *Information technology – Open Systems Interconnection – The Directory: Replication.*
- [ITU-T X.680] Recommendation ITU-T X.680 (2008) | ISO/IEC 8824-1:2008, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation.*
- [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.*
- [ISO/IEC 15459 S] ISO/IEC 15459 all parts, *Information technology – Unique identifiers.*
- [ISO/IEC 15459-1] ISO/IEC 15459-1:2006, *Information technology – Unique identifiers – Part 1: Unique identifiers for transport units.*
- [ISO/IEC 15459-2] ISO/IEC 15459-2:2006, *Information technology – Unique identifiers – Part 2: Registration procedures.*
- [ISO/IEC 15459-3] ISO/IEC 15459-3:2006, *Information technology – Unique identifiers – Part 3: Common rules for unique identifiers.*
- [ISO/IEC 15459-4] ISO/IEC 15459-4:2008, *Information technology – Unique identifiers – Part 4: Individual items.*
- [ISO/IEC 15459-5] ISO/IEC 15459-5:2007, *Information technology – Unique identifiers – Part 5: Unique identifiers for returnable transport items (RTIs).*
- [ISO/IEC 15459-6] ISO/IEC 15459-6:2007, *Information technology – Unique identifiers – Part 6: Unique identifier for product groupings.*
- [ISO/IEC 15961-1] ISO/IEC 15961-1:2013, *Information technology – Radio frequency identification (RFID) for item management: Data protocol – Part 1: Application interface.*
- [ISO 17363] ISO 17363:2013, *Supply chain applications of RFID – Freight containers.*
- [ISO 17364] ISO 17364:2013, *Supply chain applications of RFID -- Returnable transport items (RTIs) and returnable packaging items (RPIs).*
- [ISO 17365] ISO 17365:2013, *Supply chain applications of RFID – Transport units.*
- [ISO 17366] ISO 17366:2013, *Supply chain applications of RFID – Product packaging.*
- [ISO 17366] ISO 17367:2013, *Supply chain applications of RFID – Product tagging.*

- [ISO/IEC 18000-3] ISO/IEC 18000-3:2010, *Information technology – Radio frequency identification for item management – Part 3: Parameters for air interface communications at 13,56 MHz.*
- [ISO/IEC 18000-6] ISO/IEC 18000-6:2013, *Information technology – Radio frequency identification for item management – Part 6: Parameters for air interface communications at 860 MHz to 960 MHz General.*
- [ISO/IEC 18000-63] ISO/IEC 18000-63:2013, *Information technology – Radio frequency identification for item management – Part 6: Parameters for air interface communications at 860 MHz to 960 MHz Type C.*
- [IETF RFC 3061] IETF RFC 3061 (2001), *A URN Namespace of Object Identifiers.*
- [IETF RFC 4510] IETF RFC 4510 (2006), *Lightweight Directory Access Protocol (LDAP): Technical Specification Road Map.*
- [IETF RFC 4511] IETF RFC 4511 (2006), *Lightweight Directory Access Protocol (LDAP): The Protocol.*
- [IETF RFC 4516] IETF RFC 4516 (2006), *Lightweight Directory Access Protocol (LDAP): Uniform Resource Locator.*
- [IETF RFC 5134] IETF RFC 5134 (2008), *A Uniform Resource Name Namespace for the EPCglobal Electronic Product Code (EPC) and Related Standards.*

3 Definitions

This Recommendation uses the following terms defined elsewhere:

3.1 Terms defined in the ITU-T X.500 Series of Recommendations

3.1.1 attribute [ITU-T X.501]: Information of a particular type. Entries are composed of attributes.

3.1.2 attribute type [ITU-T X.501]: That component of an attribute which indicates the class of information given by that attribute.

3.1.3 attribute value [ITU-T X.501]: A particular instance of the class of information indicated by an attribute type.

3.1.4 attribute value assertion [ITU-T X.501]: A proposition, which may be true, false, or undefined, according to the specified matching rules for the type, concerning the presence in an entry of an attribute value of a particular type.

3.1.5 directory information tree (DIT) [ITU-T X.501]: The DIB considered as a tree, whose vertices (other than the root) are the Directory entries.

NOTE – The term "DIT" is used instead of "DIB" only in contexts where the tree structure of the information is relevant.

3.1.6 distinguished name (of an entry) [ITU-T X.501]: the name of an entry which is formed from the sequence of the relative distinguished names (RDNs) of the entry and each of its superior entries. Every object entry, alias entry and subentry has precisely one distinguished name.

3.1.7 filter [ITU-T X.511]: An assertion about the presence or value of certain attributes of an entry in order to limit the scope of a search.

3.1.8 filter item [ITU-T X.511]: A filter item is an assertion about the presence or value(s) of attributes in the entry under test.

3.19 relative distinguished name (RDN) [ITU-T X.501]: A set of one or more attribute type and value pairs, each of which matches a distinct distinguished attribute value of the entry.

3.2 Terms defined in [b-ITU-T Y.2091]

3.2.1 identifier: An identifier is 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. They can be either public to all networks, shared between a limited number of networks or private to a specific network (private IDs are normally not disclosed to third parties) (is in this Recommendation used a common nomination for Electronic Product Code (EPC) or Unique Item Identifier (UII).

3.3 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.3.1 associated information: This is the information external to an AIDC media that is associated with the identifier on the AIDC media. The associated information may be a movie, information about a parcel, manufacture contact information, product specification, or it could be anything else.

3.3.2 automatic identification and data capture (AIDC): Data input without typing. Data is captured automatically usually using equipment such as barcode readers, magnetic-stripe readers, RFID tag readers, etc.

3.3.3 automatic identification and data capture (AIDC) client system: A component that format information retrieved by an ID terminal and format it into either a DAP request or an LDAP request.

3.3.4 automatic identification and data capture (AIDC) media: A media that may hold information to be retrieved using AIDC techniques.

3.3.5 electronic product code (EPC): The GS1 term for a unique item identifier (UII) in a radio frequency identification (RFID) tag.

3.3.6 EPCglobal environment: The context within GS1 for generating radio frequency identification – automatic identification and data capture (RFID-AIDC) media specifications.

3.3.7 identity (ID) terminal: A device with a data reading and optional writing capability which reads (and optionally writes) identifier(s) and possible application data from/to an automatic identification and data capture (AIDC) media. It is a common term for radio frequency identification (RFID) tag readers, barcode readers, etc.

3.3.8 ISO environment: The context established by ISO or ISO/IEC for generating automatic identification and data capture (AIDC) media specification.

3.3.9 RFID tag: Automatic identification and data capture (AIDC) media that can be queried by means of suitably modulated inductive or radiating electromagnetic carriers from an interrogator s Centralised tag-based identification application to transfer information to an information system is by some specification called RF tag).

3.3.10 unique item identifier (UII): An identifier as defined in the ISO environment and which is unique within a specific context.

3.3.11 X.500 system: An infrastructure consisting of one or more interconnected directory system agents (DSAs) and zero or more lightweight directory access protocol (LDAP servers).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AFI	Application Family Identifier
AI	Application Identifier
AIDC	Automatic Identification and Data Capture
ASCII	American Standard Code for Information Interchange
ASN.1	Abstract Syntax Notation One
CFR	Code of Federal Regulations
CIN	Company Identification Number
CRC	Cyclic Redundancy Check
DAP	Directory Access Protocol
DI	Data Identifier
DIT	Directory Information Tree
DoD	Department Of Defence
DSA	Directory System Agent
DSFID	Data Storage Format Identifier
DUA	Directory User Agent
EDI	Electronic Data Interchange
EOT	End Of Transmission
EPC	Electronic Product Code
GDTI	Global Document Type Identifier
GIAI	Global Individual Asset Identifier
GID	General Identifier
GRAI	Global Returnable Asset Identifier
GSRN	Global Service Relation Number
IAC	Issuing Agency Code
IATA	International Air Transport Association
ID	IDentity
LDAP	Lightweight Directory Access Protocol
MDID	Mask-Designer Identification Code
NEN	Nederlands Normalisatie-instituut
NGN	Next-Generation Network
OID	Object Identifier
RAID	Redundant Arrays of Inexpensive Disks
RDN	Relative Distinguished Name

RFID	Radio Frequency Identification
RTI	Returnable Transport Item
SGLN	Serialized Global Location Number
SGTIN	Serialized Global Trade Item Number
SSCC	Serial Shipping Container Code
SSL	Secure Socket Layer
TID	Tag Identifier
TLS	Transport Layer Security
TMN	Tag Model Number
UII	Unique Item Identifier
UPU	Universal Postal Union
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
URN	Uniform Resource Name
VIN	Vehicle Identification Number
XML	eXtensible Markup Language
XPC	eXtended Protocol Control

5 Conventions

The term *X.500 system* is used to denote an infrastructure consisting of one or more ITU-T X.500 directory service agents (DSAs) and zero or more lightweight directory access protocol (LDAP) servers, where a DSA provides the access point for an accessing client. The term *LDAP server* is used to denote a system according to [IETF RFC 4510]. A *directory system* is either an X.500 system or a single LDAP server.

NOTE – A DSA is a directory server that follows the specifications in the [ITU-T X.500 S].

The ITU-T *X.500 Directory Specifications* are used to denote the specifications as given by [ITU-T X.500 S].

[ITU-T X.680] notations for character strings, hexadecimal strings and binary strings are used by this Recommendation, i.e., a character string, including a pure numeric string, is surrounded by double quotes (e.g., "string" or "12345"), a hexadecimal string is surrounded by single quotes followed by the letter H (e.g., 'A1'H) and a binary string is surrounded by single quotes followed by the letter B (e.g., '1010 0001'B). A binary number is just given as a figure without quotes.

6 Involved standards organisations

6.1 GS1 EPCglobal

GS1 is a major player in the development of automatic identification and data capture (AIDC) specifications. GS1, formerly called *EAN International*, adopted the name *GS1* in 2005. It is an international not-for-profit association. There are GS1 member organizations in many countries.

EPCglobal is part of GS1 and leads the development of industry-driven standards for the Electronic Product Code™ (EPC) to support the use of radio frequency identification (RFID).

6.2 ISO and ISO/IEC

ISO/IEC JTC 1/SC 31 is the major player in the AIDC standardisation and is responsible for a large number of International Standards in the AIDC area.

ISO TC 104 and ISO TC 122 are other committees involved in AIDC standardisation.

7 AIDC media and associated information

Automatic identification and data capture (AIDC) is a technique where information is stored on some kind of media called an AIDC media. Examples of AIDC media are radio frequency identification (RFID) tags, bar codes, smart cards, etc.

NOTE – Only RFID tags are the subject of this Recommendation. However, to prepare for other types of tags, the term AIDC media is used in many places as a synonym for RFID tag.

There are two types of specifications for AIDC media: those as defined by GS1 EPCglobal and others as defined by ISO/IEC or ISO.

An AIDC media is affixed or associated with some item and holds a unique identification of that item (or a unique identification of the type of item).

The AIDC media may contain some information beyond the identifier, but more substantial external information may be associated with an AIDC media. Such information could be:

- description of the item;
- manufacturing information;
- price;
- position of the item, such as postal address, coordinates or other location information;
- customs information.

This information must be available in some information system and accessed based on the identifier of the AIDC media.

There are other standards covering similar considerations as made by this Recommendation, such as:

- [b-ITU-T F.771] gives some high-level specification for how information retrieved from an AIDC media may be transformed in such a way that multimedia information may be retrieved from some repository.
- [b-ITU-T H.621] defines a system architecture for multimedia information access. The model defined in this Recommendation can be mapped in the model defined in [b-ITU-T H.621] with the difference that the identification scheme for access can be deducted from the AIDC media information without an additional access as required by [b-ITU-T H.621].
- [b-ITU-T H.642.1] defines an alternative identification scheme for accessing multimedia information.

8 Access to associated information using directory technology

Information associated with an AIDC media may be stored in a directory infrastructure. In some cases, the associated information may be huge, such as a movie, and the directory may then provide the uniform resource locator (URL) for that information.

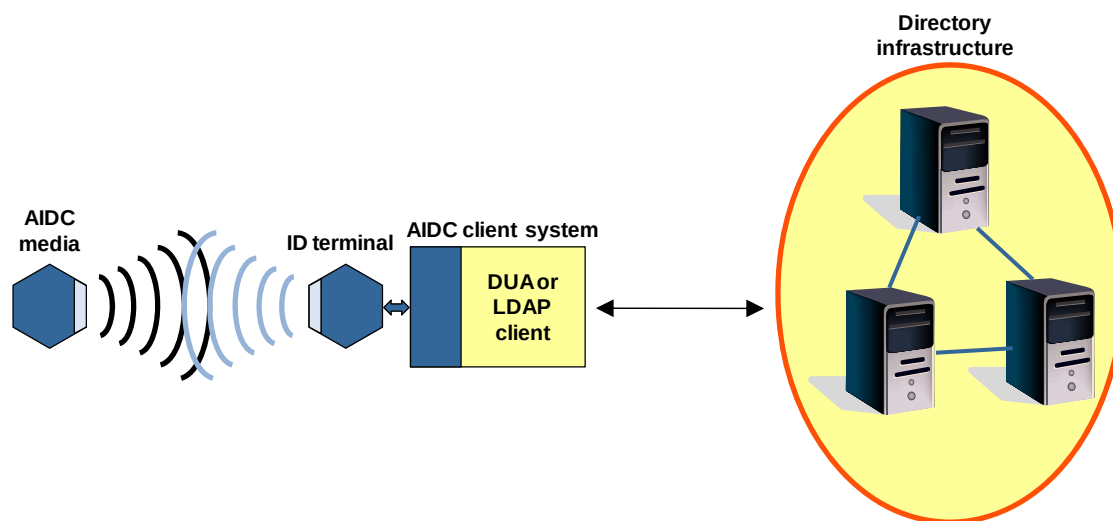


Figure 1 – AIDC use of Directory technology

Figure 1 shows how the identifier on an AIDC media may be used to access a directory infrastructure to retrieve the information associated with the AIDC media. The identifier is read from the AIDC media and forwarded to the directory, typically within a Search operation, to retrieve the associated information.

The *AIDC client system* is some intermediate system that takes the information from the identity (ID) terminal (e.g., a RFID tag reader) and converts that information into a directory request acting either as an LDAP client or as a directory user agent (DUA).

NOTE – DUA is a directory client using the directory access protocol (DAP) according to the specifications in [ITU-T X.500 S].

The AIDC client system could be integrated in the ID terminal or it could be a separate system, e.g. a lap-top computer.

A directory system may be an LDAP system consisting of a single LDAP server or it may be an ITU-T X.500 system defined as an interconnection of one or more DSAs and zero or more LDAP servers.

Appendix II provides an [ITU-T X.500 S]/LDAP introduction containing sufficient material to obtain a reasonable understanding of the specification principles established by this Recommendation.

9 Unique item identifier (UII) and electronic product code (EPC)

9.1 General

An AIDC media that holds an identifier in the EPCglobal environment is called an electronic product code (EPC) and in the ISO environment it is called a unique item identifier (UII).

As stated in the scope clause, only the RFID tag type defined as ISO/IEC 18000-6C or as ISO/IEC 18000-3 Mode 3 is considered by this Recommendation. Appendix III gives an overview of this tag type.

As described in Appendix III, such a tag type has a bit, called the *toggle switch* that indicates whether the tag contains an EPC or a UII.

EPCs and UIIs have structures that allow them to be globally unique.

An EPC or a UII is a series of characters or bit fields with an implied hierarchical structure. As an example, some fields may denote a manufacturer; some fields may denote a type of product; and another field may be a serial number.

9.2 Electronic product code (EPC) types

The different EPC formats are described in Appendix IV.

The first eight bits of an EPC is the header and indicates the EPC type. An escape mechanism is defined that allows multi-octet headers to be defined in the future.

9.3 Unique item identifier (UII) types

In the ISO environment many different UII types are defined and others will be further defined in the future. A UII is characterized by having an associated field called the application family identifier (AFI). The AFI field is not part of the actual UII. It is a one-octet field. There is an escape mechanism defined to provide multiple-octet AFIs in the future.

AFIs are allocated to UII types by ISO/IEC JTC 1/SC 31 for items (physical and virtual) not being persons, while ISO/IEC JTC 1/SC 17 is concerned with personal identification.

9.4 Global uniqueness of EPCs and UIIs

An EPC, as identified by the toggle switch (see clause 9.1), is globally unique.

Many different ISO or ISO/IEC committees define UII types. Accordingly, there is no guaranty that a particular UII is globally unique in itself. A UII may only be unique within a specific environment or application. Additional information is necessary to ensure global uniqueness. AFI may be read from the ID-tag or otherwise, as available. AFI together with UII provides a globally unique identification within the context of RFID tags. A reference to the specification defining the UII format is another way to achieve uniqueness.

NOTE – Alternatively to using AFI, an object identifier may be encoded on the RFID tag. Such an OID together with the UII also provides a globally unique identification.

10 Locating associated information for centralized AIDC identification applications

This Recommendation identifies two distinct scenarios:

- a) A particular tag-based identification application may be limited, e.g., to a limited geographical area and it may be under a single management. All the information associated with the AIDC media is held by a single directory system (which could be a distributed ITU-T X.500 system). In this environment, the use of directory technology becomes rather straight forward as discussed in the remainder of this clause.
- b) The situation becomes considerably more complicated when a tag-based identification application is highly distributed and several different user groups access the information associated with the AIDC media. An example could be goods produced at different location, packed in containers, transferred by trucks or trains to container docks and then carried by ship to some distant location. Containers are then forwarded by trucks or trains to the final destinations, from where the goods are distributed to different recipients. Several user groups may need to access the information associated with the AIDC medias, such as the manufacturers, the different shipping companies, the custom authorities, the

recipients of the goods, etc. A suggestion on how to handle this more complex information situation is given in clause 11.

10.1 Search using EPC in a centralized environment

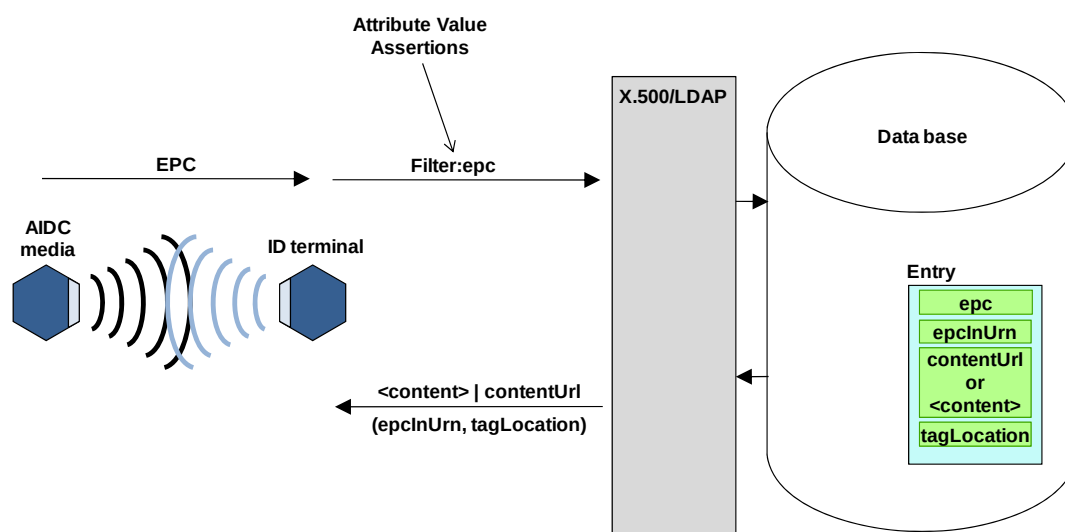


Figure 2 – Search using complete EPC as the search argument

Figure 2 illustrates the case where an ID terminal reads an ISO/IEC 18000-6C RFID tag (GS1 Class 1 Gen 2 tag type) to obtain EPC. EPC is forwarded as the argument of a directory request. The directory will search the database to locate an entry that holds an attribute of type **epc** with the same value as presented in the argument. This entry may hold either the information associated with the RFID tag or it may hold a URL in an attribute of type **contentUrl** pointing to the location where the associated information might be found. Alternatively, a pointer to another directory location may be provided in the form of a referral, e.g. to another directory server (ITU-T X.500 DSA or LDAP server).

The associated information may take many shapes. The information may be composed of several directory attributes of different types. The directory specifications have defined a large number of different attribute types for general use. New attribute types may be defined as required. This is business as usual for directories.

If for some reason, EPC is wanted in a uniform resource name (URN) format, a ready-made URN could be stored in the located entry and could be returned in an attribute of type **epcInUrn**.

Other information may also be available and provided, such as location information in the form of postal address, shipping company or in the form of coordinates provided in an attribute of type **tagLocation**.