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SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Multimedia services

Requirements for a name resolution service in information-centric networks

Recommendation ITU-T F.746.6

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Recommendation ITU-T F.746.6

Requirements for a name resolution service in information-centric networks

Summary

Recommendation ITU-T F.746.6 describes the requirements for a flexible name resolution service in information-centric networks (ICN). It also describes the functional modules, i.e., name resolution service access control module, namespace management module, interoperation module and resolution engine module, of name resolution service in ICN. The name resolution service can support name resolution for any particular ICN instance independently. It also can facilitate interoperation between ICN instances with their own namespaces.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.746.6	2017-12-14	16	11.1002/1000/13428

Keywords

Information-centric networks, name resolution.

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Requirements for a name resolution service in information-centric networks

1 Scope

This Recommendation describes the requirements for a flexible name resolution service for information-centric networks (ICN). It defines the key functional modules for name resolution service in ICN. This Recommendation covers the following:

– capabilities of name resolution service in ICN;

– requirements for name resolution service in ICN;

– scenarios of name resolution service for ICN instances.

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.746.4] Recommendation ITU-T F.746.4 (2017), *Requirements for deployment of information-centric networks*.

[ITU-T Y.3033] Recommendation ITU-T Y.3033 (2014), *Framework of data aware networking for future networks.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 future network (FN) [b-ITU-T Y.3001]: A network able to provide services, capabilities, and facilities difficult to provide using existing network technologies. A future network is either:

a) A new component network or an enhanced version of an existing one, or

b) A heterogeneous collection of new component networks or of new and existing component networks that is operated as a single network.

NOTE 1 – The plural form "Future Networks" (FNs) is used to show that there may be more than one network that fits the definition of a future network.

NOTE 2 – A network of type b may also include networks of type a.

NOTE 3 – The label assigned to the final federation may, or may not, include the word "future", depending on its nature relative to any preceding network and similarities thereto.

NOTE 4 – The word "difficult" does not preclude some current technologies from being used in future networks.

NOTE 5 – In the context of this Recommendation, the word "new" applied to a component network means that the component network is able to provide services, capabilities, and facilities that are difficult or impossible to provide using existing network technologies.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 name resolution: The process by which, given an initial name and an initial naming context, an association between a name and the entity designated by the initial name can be found (adapted from [b-ITU-T X.902]).

NOTE – The name resolution process does not necessarily provide sufficient information to interact with the designated entity.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DNS Domain Name System

GNRS Global Name Resolution Service

GUID Globally Unique Identifier

ICN Information-Centric Networks

NAT Network Address Translation

NDN Named Data Networking

NRS Name Resolution Service

5 Conventions

In this Recommendation:

– The expression "**is required to**" indicates a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

– The expression "**is recommended**" indicates a requirement which is recommended but not absolutely required. Thus, this requirement need not be present to claim conformance.

– The keywords "**can optionally**" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator / service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Motivation

Information-centric networks (ICN) is a promising technology for future Internet design with which a user can directly obtain a content object by its name (or identification) without specifying the location of the content object. In recent years, various ICN solutions have been proposed with their own namespaces such as named data networking (NDN) [b-Jacobson], MobilityFirst [b-Seskar] and publish subscribe Internet technology (PURSUIT) [b-Fotiou].

To identify different objects from their associated names, a name resolution service is needed. Different name resolution schemes are adopted for different ICN solutions, such as the rendezvous system in PURSUIT [b-Fotiou] and global name resolution service (GNRS) system in MobilityFirst [b-Seskar]. Various name resolution schemes differ from each other from the perspectives of resolution policies and management mechanisms. The comparison of resolution policies and management mechanisms among various existing name resolution schemes in the current Internet and ICN are shown in Table I.1 (see Appendix I).

As described in [ITU-T F.746.4], each solution has its own pros and cons and is best suited to some particular application requirements. Different ICN service providers may deploy their own ICN instances with their own namespaces on top of the same physical network.

To support the coexistence of various ICN instances on the same physical network, and to enable the potential interoperation among different ICN instances that employ different namespaces, a flexible name resolution service for information-centric networks is needed. This name resolution service provides dynamic resolution that allows the administrator of ICN instances to flexibly specify namespaces with their private naming schemes and resolution policies. Furthermore, this name resolution service is required to support any particular ICN instance independently, which means that internal-mapping relationships between multiple namespaces of the same ICN instance are maintained independently. It is also recommended that this name resolution service facilitate interoperation between different ICN instances with their own namespaces, which means the cross-mapping relationships between the multiple namespaces belonging to different ICN instances will be maintained.

7 Functional modules of name resolution service in ICN

As shown in Figure 7-1, the name resolution service in ICN includes four functional modules: name resolution service (NRS) access control module, namespace management module, resolution engine module and interoperation module. This clause addresses the capabilities of these functional modules.

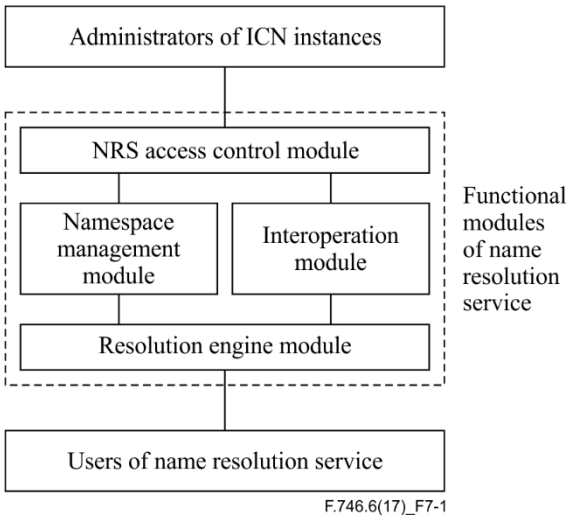

Figure 7-1 – Functional modules of name resolution service

7.1 Name resolution service access control module

The NRS access control module offers the capabilities of authentication and authorization. As there are multiple ICN instances coexisting in the same physical network, to safeguard the sensitive namespace information of each ICN instance, the administrators of the ICN instances must be authenticated and authorized to explore the capabilities provided by the namespace management module and interoperation module.

7.2 Namespace management module

The namespace management module is responsible for enabling the administrators of ICN instances flexibly to manage their own namespaces and specify their resolution policies. With this module, an administrator of the ICN instance can define namespaces with a particular naming scheme and indicate the scope of the namespace based on their design principles. The administrator can also create and update the names and the internal-mapping relationships between multiple namespaces of the same ICN instance.

7.3 Interoperation module

An object has different names in different ICN instances. The interoperation module maintains the cross-mapping relationships between the multiple namespaces belonging to different ICN instances. The administrator of the ICN instance can indicate objects to which access by other ICN instance(s) is allowed. The interoperation modules of different ICN instances exchange with each other the names of the objects that can be accessed by other ICN instance(s).

7.4 Resolution engine module

The resolution engine module uses the information and polices maintained in the namespace management module and interoperation module to accomplish the name resolution. When it receives the name resolution requests from NRS users, it queries the internal-mapping relationships provided by namespace management module and cross-mapping relationships provided by interoperation module in turn.

8 Requirements for name resolution service in ICN

This clause addresses the requirements for name resolution service in ICN.

8.1 General requirements

GEN-01: The name resolution service is required to support the name resolution for any particular ICN instance independently.

GEN-02: The name resolution service is required to enable dynamic resolution such that the administrators of ICN instances can flexibly define their own namespace and resolution policies.

GEN-03: The name resolution service is recommended to support interoperation between ICN instances.

8.2 Requirements for NRS access control module

NA-01: The NRS access control module is required to authenticate the validity of the administrators of ICN instances that try to access and update the namespaces maintained by namespace management module.

NA-02: The NRS access control module is required to authorize the administrators of ICN instances to explore the capabilities provided by the namespace management module and interoperation module.

8.3 Requirements for namespace management module

NM-01: The namespace management module is required to enable the administrators of ICN instances to flexibly define their own namespaces with particular naming schemes and indicate the scope of the namespaces based on their design principles.

NM-02: The namespace management module is required to allow the administrators of ICN instances to define their own resolution polices, such as where and how to conduct resolution, the used synchronization cycle, and the adopted algorithms.

NM-03: The namespace management module is required to allow the administrator of an ICN instance to create and update the names and the internal-mapping relationships between multiple namespaces of the same ICN instance.

8.4 Requirements for interoperation module

NI-01: The interoperation modules of ICN instances are recommended to exchange the names of the objects which are allowed to be accessed by other ICN instance(s).

NI-02: The interoperation module is recommended to register the cross-mapping relationships between the multiple namespaces belonging to different ICN instances.

NI-03: The interoperation module is recommended to deregister the cross-mapping relationships between the multiple namespaces belonging to different ICN instances.

NI-04: The interoperation module is recommended to modify cross-mapping relationships between the multiple namespaces belonging to different ICN instances.

8.5 Requirements for resolution engine module

NR-01: The resolution engine module is required to perform the name resolution using the information and policies maintained in the namespace management module and interoperation module.

9 Security consideration

This Recommendation has similar security considerations to those pertinent to data aware networking and aligns with the security requirements specified in [ITU-T Y.3033].

Annex A

Scenarios for name resolution services in ICN

(This annex forms an integral part of this Recommendation.)

In ICN, data is requested and located by its name. To deliver the content by name, various name resolution schemes are employed by different ICN solutions. For example, PURSUIT employs a rendezvous system to mapping a content name, i.e., rendezvous identifier and service identifier, to a forwarding identifier. Each solution has its own pros and cons and is best suited to some particular application requirements. Different ICN service providers may deploy their own ICN instances with their own namespaces on top of the same physical network. A flexible name resolution service is needed to support ICN instance deployment. Two scenarios of name resolution service for ICN instances are illustrated, i.e., scenario of providing name resolution service for two ICN instances independently, and scenario of providing name resolution service for interoperation between two ICN instances.

A.1 Scenario of providing name resolution service for two ICN instances independently

In this scenario, different ICN instances are deployed independently. As shown in Figure A.1, two different ICN instances are supported. There is no interoperation between them and the name resolution services for them are also independent. The interoperation modules are not used.

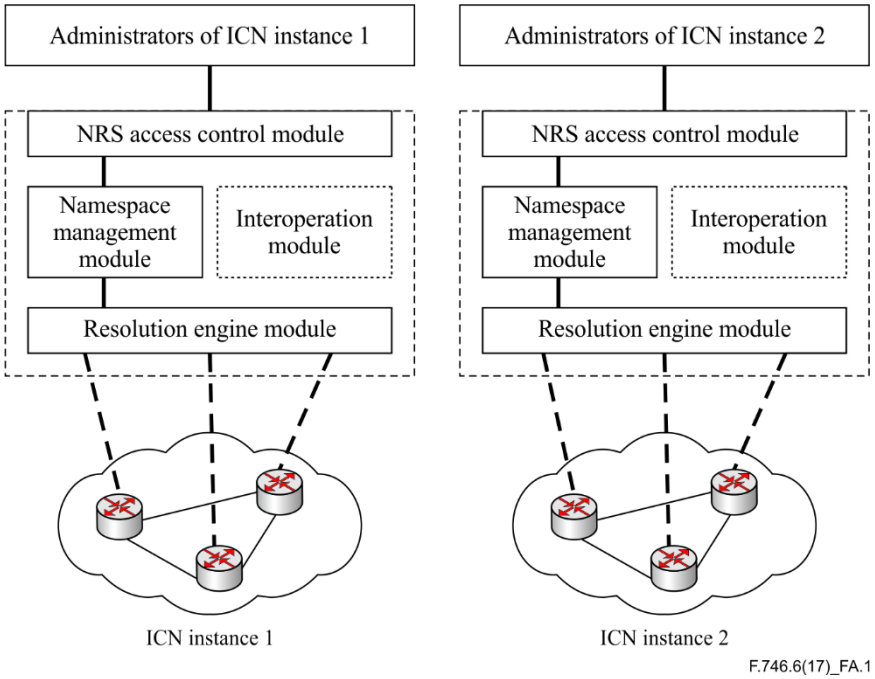

Figure A.1 – Scenario of supporting the name resolution for two ICN instances independently

A.2 Scenario of providing name resolution service for interoperation between two ICN instances

As shown in Figure A.2, the administrators of these two ICN instances specify a set of objects that can be accessed from the other ICN instance. These cross-mapping relationships are maintained in the interoperation modules.

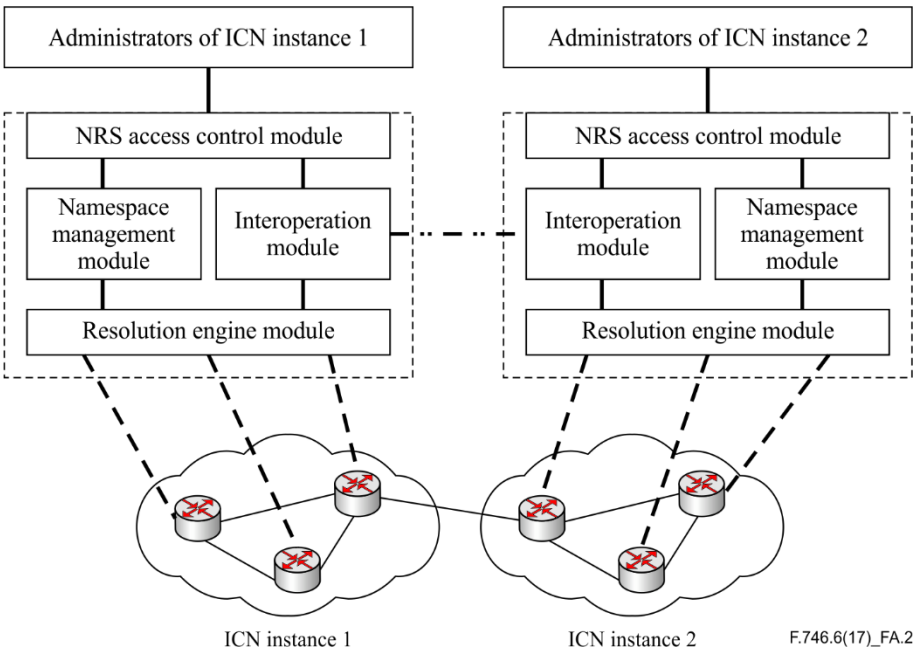

Figure A.2 – Scenario of interoperation between two ICN instances

When a host in ICN instance 1 wants to access an object in ICN instance 2, the resolution engine module finds the resolution results in the interoperation module and returns it to the requesting host. To support the interoperation between two ICN instances, the border switch needs to execute some procedures, e.g., packet translation and protocol adaption, as described in [ITU-T F.746.4]. In order to protect the border switch and guarantee that the message is not tampered with, the device that is responsible for name resolution chooses a trusted border switch. The resolution engine of the device generates a cipher text based on the name of the source host, the name of the destination host, and the identifier of the selected device (the selected border switch). The resolution engine module sends the cipher text to the source host. The source host then uses the cipher text to encapsulate the packets. The selected switch checks the validity of the packets from the source according to the information of the source host. The identifier of the selected switch and cipher text are then used to generate the verification information that is also included in the header of the packets before they are forwarded to the destination host. The cipher text and verification information will be used by the destination host to verify the received packets.

Appendix I

Survey of name resolution schemes used in Internet and information-centric networks

(This appendix does not form an integral part of this Recommendation.)

In the current Internet and ICN, various name resolution solutions are proposed. Each name resolution solution employs its own resolution policies and management methods as shown in Table I.1. A name resolution policy specifies how the names are resolved, including the type of resolution (e.g., one-way resolution, or two-way resolution) and the mapping relationship (e.g., one-to-one mapping or one-to-many mapping). The management mechanism is related to where the resolution procedures are performed (e.g., at individual routers or at dedicated servers), and how those nodes performing resolution are organized (e.g., in a distributed way, in a centralized way, or in a hierarchical way). These name resolution solutions employ their own resolution policies, which are static and lacks of flexibility to quickly provision efficient services.

Table I.1 – Existing name resolution solutions

Project	Namespace	Resolution policy	Resolution management
Domain name system (DNS) [b-RFC 2136]	Domain name (global) → IP Address (global)	One-way resolution One-to-many mapping	Dedicated DNS server Hierarchically organized
Network address translation (NAT) [b-RFC 2766]	Private IP address + Port number ↔ Global IP address + Port number	Bi-directional resolution One-to-one mapping	At a gateway
MobilityFirst (Destination Resolution) [b-Seskar]	(Globally unique identifier) GUID → NA	One-way resolution	At distributed servers. Dynamic updating and late binding.
Named data networking (NDN) [b-Jacobson]	Content name (global) → Interface identifier (local);	One-way resolution One-to-many mapping	At individual router. Pending Interest Table. Distributed: Forwarding information base.
eXpressive Internet architecture (XIA) (Routing) [b-Naylor]	XIA Identifier (global) → Interface identifier (local)	One-way resolution	At router.
PURSUIT (Content routing) [b-Fotiou]	Rendezvous identifier + Service identifier → Forwarding identifier (Regional)	One-way resolution One-to-many mapping Bloom filter	Dedicated server (Topology management) Hierarchically organized

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