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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Future networks

Requirements and capabilities of name mapping and resolution for information-centric networking in IMT-2020

Recommendation ITU-T Y.3072

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ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	**Y.3000–Y.3499**
CLOUD COMPUTING	Y.3500–Y.3999
INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES	
General	Y.4000–Y.4049
Definitions and terminologies	Y.4050–Y.4099
Requirements and use cases	Y.4100–Y.4249
Infrastructure, connectivity and networks	Y.4250–Y.4399
Frameworks, architectures and protocols	Y.4400–Y.4549
Services, applications, computation and data processing	Y.4550–Y.4699
Management, control and performance	Y.4700–Y.4799
Identification and security	Y.4800–Y.4899
Evaluation and assessment	Y.4900–Y.4999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.3072

Requirements and capabilities of name mapping and resolution for information-centric networking in IMT-2020

Summary

Recommendation ITU-T Y.3072 specifies the requirements and capabilities of name mapping and resolution to achieve high performance such as low latency and scalability for a large number of named objects for information-centric networking in IMT-2020. The Recommendation provides the following: (1) It provides an introduction to name mapping and resolution in IMT-2020. (2) It describes the service and functional requirements of name mapping and resolution. (3) Based on the requirements, it specifies the capabilities of name mapping and resolution for information-centric networking in IMT-2020.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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ICN, IMT-2020, name mapping, name resolution

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Table of Contents

Recommendation ITU-T Y.3072

Requirements and capabilities of name mapping and resolution for information-centric networking in IMT-2020

1 Scope

This Recommendation describes the requirements and capabilities of name mapping and resolution for information-centric networking (ICN) to achieve high performance such as low latency and scalability for a large number of named objects in IMT-2020. The specific scope of this Recommendation is as follows:

- service requirements of name mapping and resolution;
- functional requirements of name mapping and resolution;
- capabilities of name mapping and resolution.

The general requirements and capabilities of name mapping and resolution are listed in [ITU-T Y.3031], [ITU-T Y.3032] and [ITU-T Y.3033] and are out of the scope of this Recommendation.

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 Y.3031] Recommendation ITU-T Y.3031 (2012), *Identification framework in future networks*.

[ITU-T Y.3032] Recommendation ITU-T Y.3032 (2014), *Configuration of node identifiers and their mapping with locators in future networks*.

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

[ITU-T Y.3071] Recommendation ITU-T Y.3071 (2017), *Data aware networking (information centric networking) – Requirements and capabilities*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 address [b-ITU-T Y.2091]: An address is the identifier for a specific termination point and it can be used for routing to this termination point.

3.1.2 identifier [b-ITU-T Y.2091]: 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.

3.1.3 identifier/locator separation [b-ITU-T Y.2015]: Identifier/locator separation is decoupling the semantic of IP address into the semantics of node identifiers and locators. Distinct namespaces

are used for node identifiers and locators so that they can evolve independently. Locators are associated with the IP layer whereas node identifiers are associated with upper layers in such a way that ongoing communication sessions or services shall not be broken by changing locators due to mobility and multi-homing.

3.1.4 IMT-2020 [b-ITU-T Y.3100]: Systems, system components, and related technologies that provide far more enhanced capabilities than those described in [b-ITU-R M.1645].

NOTE – [b-ITU-R M.1645] defines the framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000 for the radio access network.

3.1.5 latency [b-ITU-R M.2083]: Latency is the contribution by the network to the difference in time (e.g., in ms) between when the source sends a packet and when the destination receives it.

3.1.6 locator [b-ITU-T Y.2015]: A locator is the network layer topological name for an interface or a set of interfaces. Locators are carried in the IP address fields as packets traverse the network.

NOTE – In [b-ITU-T Y.2015] locators are also referred to location identifiers.

3.1.7 mobility [b-ITU-T Y.2091]: The ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment. The degree of service availability may depend on several factors including the access network capabilities, service level agreements between the user's home network and the visited network (if applicable), etc. Mobility includes the ability of telecommunication with or without service continuity.

3.1.8 name [b-ITU-T Y.2091]: A name is the identifier of an entity (e.g., subscriber, network element, physical or logical objects) that may be resolved/translated into address.

3.1.9 service [ITU-T Y.3031]: A service is a set of functions and facilities offered to a user by a provider.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 mapping record: A mapping record is a basic information element of name mapping and resolution that contains the relationship between an identifier and address(es) of the object.

3.2.2 name mapping: Name mapping is a service that builds one-to-one or one-to-many relationships between an identifier of an object and addresses of the object, where the addresses can be IP addresses.

3.2.3 name resolution: Name resolution is a service that provides the translation between an identifier and address(es) of the object based on the relationship built by name mapping.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

eMBB	Enhanced Mobile Broadband
ICN	Information-Centric Networking
ID	Identifier
IoT	Internet of Things
IP	Internet Protocol
LOC	Locator
mMTC	Massive Machine Type Communications
MoD	Mobility on Demand

NA Network Address

PKI Public Key Infrastructure

QoS Quality of Service

UE User Equipment

URLLC Ultra-Reliable and Low Latency Communications

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this document is to be claimed.

The keywords "is prohibited from" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "is not recommended" indicate a requirement which is not recommended but which is not specifically prohibited. Thus, conformance with this specification can still be claimed even if this requirement is present.

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 this Recommendation.

6 Introduction

It is a common consensus that IMT-2020 is aiming to achieve high performance such as low latency and scalability for a large number of connected objects. For the existing IP-based infrastructure, in which IP addresses are used as both identifiers and locators, it would be hard to meet the IMT-2020 requirements, since the location-dependent model has its inherent limitations in supporting mobility and scalability. Research shows that information-centric networking has been identified as one of the most effective ways to overcome the above limitations.

It is necessary for information-centric networking (ICN) to effectively build the relationship between an identifier and the addresses of the object by name mapping due to ID/locator separation [b-ITU-T Y.2057]. It is also necessary for ICN to provide an efficient service of translation between an identifier and the addresses of the object. The mapping records, which contain the relationship between an identifier and addresses of the object, are the basic elements of the name mapping and resolution system. But for existing systems of name mapping and resolution for ICN it is hard to achieve high performance in IMT-2020 and beyond.

An enhanced system of name mapping and resolution for ICN is required to fulfil the demands of IMT-2020 scenarios such as enhanced mobile broadband (eMBB), ultra-reliable and low latency communications (URLLC), and massive machine type communications (mMTC) [b-ITU-R M.2083]. It is expected to handle enormous amounts of data objects by name mapping and resolution for ICN and to enable users to access named data objects quickly and safely, regardless of their locations. Therefore, the requirements and capabilities of name mapping and resolution are proposed.

7 Service requirements of name mapping and resolution

This clause addresses the service requirements of name mapping and resolution for ICN to achieve IMT-2020 performance including low latency and scalability.

7.1 Low latency

It is required that name resolution is enhanced with the constraints of scopes or distances to support deterministic low latency in IMT-2020, so that a predictable fast response to the request can be achieved in IMT-2020 scenarios such as URLLC.

It is required to have local name resolution so that users can be served from nearby locations in the network with fast responses to guarantee deterministic maximum latency of URLLC.

7.2 Scalability

It is required to have a unified namespace for a large number of objects in IMT-2020 scenarios such as mMTC.

It is required that the names, which represent diverse categories of objects including data, services, users and devices, are defined to efficiently access objects in networks regardless of their network addresses.

It is required that the maintenance for name mapping and resolution is realized with low complexity and low cost for a large number of connected nodes and other objects.

It is required that the system of name mapping and resolution is constructed as a global public network infrastructure with one or multiple domains and that each domain is able to manage its own mapping records.

8 Functional requirements of name mapping and resolution

This clause addresses the functional requirements of name mapping and resolution for ICN in IMT-2020 including the support of mobility, routing and inter-operation.

8.1 Mobility support

It is required to serve all network elements including consumers, providers and intermediate nodes with dynamic name mapping and resolution for supporting mobility more efficiently in IMT-2020 scenarios such as eMBB.

It is required to support fast registration, update and deregistration for dynamic name mapping with the separation of identifiers and locators [b-ITU-T Y.2057] to effectively adapt to the changes of network addresses.

It is required to provide entries for the service of local resolution from nearby locations to realize fast responses based on the context of mobility.

8.2 Routing support

It is required to provide locally mapped addresses of an identifier for supporting locality-based routing to improve user experience.

It is required to have the mapping from a globally unique identifier to multiple addresses to improve reliability or performance such as throughput.

It can optionally have the mapping from multiple addresses to an identifier.

It is required to provide name mapping and resolution for supporting in-network caching of data chunks in order to accelerate the response for local requests, to improve data provisioning and to reduce unnecessary traffic.

It is recommended to provide name mapping and resolution with a multicast identifier and the addresses of nodes in the multicast tree for receivers to join the tree efficiently for supporting multicast routing.

8.3 Inter-operation support

It is required that the name mapping and resolution supports the inter-operation between coexisting networks, by supporting different types of addresses, which can be IP addresses, from different networks such as IMT-Advanced and IMT-2020 in order to realize smooth evolution from current networks to future networks.

9 Capabilities of name mapping and resolution

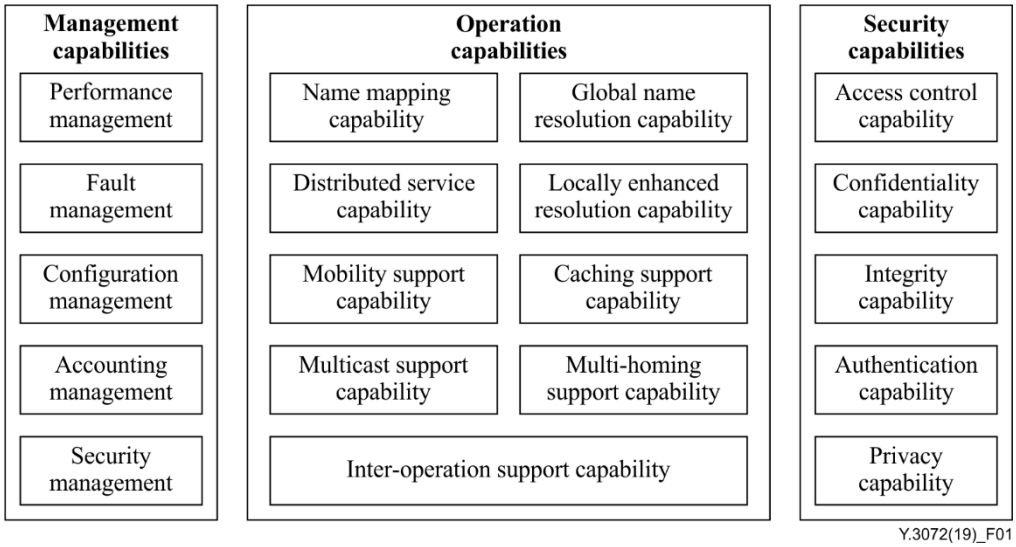

Figure 1 – Capabilities of name mapping and resolution for ICN in IMT-2020

This clause addresses the capabilities of name mapping and resolution for ICN in IMT-2020 including operation, management and security, as shown in Figure 1. The aspect of operation is the main focus of capabilities.

9.1 Operation capabilities

Operation capabilities are considered in terms of the aspect of operation for the name mapping and resolution system for ICN as follows:

- Name mapping: Name mapping is a mechanism to build one-to-one or one-to-many relationships between an identifier and addresses. The identifiers can be assigned to diverse objects such as data, services, users and devices. The mapping information can be registered, stored, updated and deregistered in the name mapping system.
- Global name resolution: Global name resolution is a mechanism to globally provide one-to-one or one-to-many relationships between an identifier and address(es).
- Locally enhanced resolution: The locally enhanced resolution is a mechanism to provide a one-to-many relationship between an identifier and addresses with the constraints of scopes or distances in order to achieve IMT-2020 performance such as deterministic low latencies in a limited domain by accelerating the name resolution process.
- Distributed service: The distributed service is a mechanism to hierarchically organize the system of name mapping and resolution with the increase of the volume of mapping records.

- Mobility support: Mobility support is a mechanism to provide dynamic name mapping and resolution for the mobility of an object during which the addresses of the object are changing.
- Caching support: Caching support is a mechanism to provide the name mapping and resolution of a data chunk which is cached in network nodes to reduce unnecessary traffic and latency in IMT-2020.
- Multi-homing support: Multi-homing support is a mechanism to provide the name mapping and resolution of a UE with multiple addresses to improve reliability or performance.
- Multicast support: Multicast support is a mechanism to provide the name mapping and resolution of a multicast identifier and the addresses of nodes in the multicast tree to enable receivers to join the tree efficiently.
- Inter-operation support: Inter-operation support is a mechanism to provide the name mapping and resolution of an object or objects in different coexisting networks for supporting interoperability to get different types of addresses such as IPv4, IPv6 and IoT addresses accordingly.

9.2 Management capabilities

Management capabilities are considered in terms of the aspect of management to facilitate the capabilities defined in [b-ITU-T M.3400] and [ITU-T Y.3071], which are:

- Performance management: Performance management is a set of capabilities that enables the performance of the name mapping and resolution services to be measured and for corrective actions to be taken.
- Fault management: Fault management is a set of capabilities that enables the detection, isolation and correction of abnormal operation of the name mapping and resolution system and its environment.
- Configuration management: Configuration management is a set of capabilities that exercises control over the extensions or reductions of the name mapping and resolution system, the status of the constituent parts and the identity of their allocation.
- Accounting management: Accounting management is a set of capabilities that enables the usage of the name mapping and resolution services to be measured and the costs for such usage to be determined and rendered.
- Security management: Security management is a set of capabilities that is used to perform operations, administration, maintenance and provisioning of security mechanisms, policies and services within the name mapping and resolution system.

9.3 Security capabilities

Security capabilities are considered in terms of the aspect of security for objects such as data, services, users and devices as follows:

- Access control: Access control is a mechanism to secure objects such as the named data which are controlled to not be revealed during the process of name mapping and resolution to unauthorized users.
- Confidentiality: Confidentiality is a mechanism to encrypt a set of objects, which is not made available or disclosed to unauthorized objects, so that it is hard to be decrypted even if it is intercepted during the process of name mapping and resolution by adding restrictions on certain types of information.
- Integrity: Integrity is a mechanism to ensure that the object is not altered or destroyed in an unauthorized manner during the process of name mapping and resolution or over the entire life cycle of the object.

- Authentication: Authentication is a mechanism to secure objects during the process of name mapping by binding the object to an identifier with certifying schemes such as PKI and block chain so that the named data is claimed to be true by certification.
- Privacy: Privacy is a mechanism to secure user information not leaked in the transmission process of name mapping and resolution so that the private data cannot be propagated outside a certain group of users or domains to avoid the information leaking during network operations and communication services.

Bibliography

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[b-ITU-T Y.3100] Recommendation ITU-T Y.3100 (2017), *Terms and definitions for IMT-2020 network.*

[b-ITU-R M.1645] Recommendation ITU-R M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000.*

[b-ITU-R M.2083] Recommendation ITU-R M.2083 (2015), *Framework and overall objectives of the future development of IMT for 2020 and beyond*.

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Series E	Overall network operation, telephone service, service operation and human factors
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Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
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Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
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Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
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