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THINGS AND SMART CITIES

Next Generation Networks – Enhancements to NGN

Next generation network evolution phase 1 – Overview

Recommendation ITU-T Y.2340

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Recommendation ITU-T Y.2340

Next generation network evolution phase 1 – Overview

Summary

Recommendation ITU-T Y.2340 provides an overview of phase 1 in the evolution of next generation networks (NGNs).

NGN evolution phase 1 supports enhanced capabilities based on NGN capability set 2, as per [ITU-T Y.2007]. The key objective of NGN evolution phase 1 is to satisfy the service and capability requirements for the support of network intelligence, virtualization and programmability for services and applications for humans and things.

This Recommendation summarizes the enhancements of NGN evolution phase 1 according to the relevant Recommendations which relate to these different enhancements.

History

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Capability, Internet of Things, network intelligence, NGN evolution, programmability, requirement, virtualization.

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Recommendation ITU-T Y.2340

Next generation network evolution phase 1 – Overview

1 Scope

This Recommendation gives a general overview of phase 1 of the evolution of next generation networks (NGNs) in terms of service and capability requirements, as well as a capability framework.

The Recommendations for NGN evolution will be developed phase by phase. This Recommendation addresses phase 1 of NGN evolution. The key objective of NGN evolution phase 1 is to satisfy any additional requirements with respect to NGN capability set 2 [ITU-T Y.2007], for the support of network intelligence, virtualization and programmability for services and applications for humans and things. In particular, this Recommendation provides the service and capability requirements as well as the capability framework of NGN evolution phase 1. Relevant NGN evolution deployment scenarios are addressed in Appendix I.

As this Recommendation addresses the overall requirements and capabilities for NGN evolution phase 1, and in order to avoid the overlap or inconsistency with the relevant Recommendations related to NGN evolution, this Recommendation makes reference to the relevant Recommendations, as appropriate.

Along with the introduction of the key enhancements mentioned above, Appendix II provides some additional potential requirements of NGN evolution phase 1 which need further study and are not currently addressed in specific Recommendations related to NGN evolution. This could be used as background information to assist the future development of Recommendations related to these potential requirements and corresponding capabilities.

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 M.3060] Recommendation ITU-T M.3060/Y.2401 (2006), *Principles for the Management of Next Generation Networks*.
- [ITU-T Y.2007] Recommendation ITU-T Y.2007 (2010), *NGN capability set 2*.
- [ITU-T Y.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.
- [ITU-T Y.2201] Recommendation ITU-T Y.2201 (2009), *Requirements and capabilities for ITU-T NGN*.
- [ITU-T Y.2240] Recommendation ITU-T Y.2240 (2011), *Requirements and capabilities for next generation network service integration and delivery environment*.
- [ITU-T Y.2301] Recommendation ITU-T Y.2301 (2013), *Network intelligence capability enhancement — Requirements and capabilities*.
- [ITU-T Y.2320] Recommendation ITU-T Y.2320 (2015), *Requirements for virtualization of control network entities in next generation network evolution*.

[ITU-T Y.3011]	Recommendation ITU-T Y.3011 (2012), <i>Framework of network virtualization for future networks</i> .
[ITU-T Y.3300]	Recommendation ITU-T Y.3300 (2014), <i>Framework of software-defined networking</i> .
[ITU-T Y.3321]	Recommendation ITU-T Y.3321 (2015), <i>Requirements and capability framework for NICE implementation making use of software-defined networking technologies</i> .
[ITU-T Y.4000]	Recommendation ITU-T Y.4000 (2012), <i>Overview of the Internet of things</i> .
[ITU-T Y.4100]	Recommendation ITU-T Y.4100 (2014), <i>Common requirements of Internet of Things</i> .
[ITU-T Y.4101]	Recommendation ITU-T Y.4101 (2014), <i>Common requirements and capabilities of a gateway for Internet of things applications</i> .
[ITU-T Y.4401]	Recommendation ITU-T Y.4401 (2015), <i>Functional framework and capabilities of the Internet of things</i> .

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 Internet of things (IoT) [ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

3.1.2 next generation network (NGN) [b-ITU-T Y.2001]: A packet-based network which is able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

3.1.3 network intelligence capability enhancement (NICE) [ITU-T Y.2301]: An enhancement for NGNs supporting some intelligence capabilities for the provisioning of services according to requirements of users and application providers. These intelligence capabilities (termed as "NICE capabilities") enable operators to assign and dynamically adjust specific network resources based on the requirements, as well as supporting interfaces for users and applications enabling on-demand resource and service provision.

3.1.4 network virtualization [ITU-T Y.3011]: A technology that enables the creation of logically isolated network partitions over shared physical networks so that heterogeneous collections of multiple virtual networks can simultaneously coexist over the shared networks. This includes the aggregation of multiple resources in a provider and appearing as a single resource.

3.1.5 software-defined networking (SDN) [ITU-T Y.3300]: A set of techniques that enables to directly program, orchestrate, control and manage network resources, which facilitates the design, delivery and operation of network services in a dynamic and scalable manner.

3.2 Terms defined in this Recommendation

None

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

IP	Internet Protocol
IoT	Internet of Things
NGN	Next Generation Network
NGNe1	Next Generation Network evolution phase 1
NICE	Network Intelligence Capability Enhancement
QoS	Quality of Service
SDN	Software-Defined Networking
VCN	Virtualization of Control Network entities

5 Conventions

This Recommendation uses the following conventions:

The term "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.

6 Introduction of NGN evolution phase 1

[ITU-T Y.2201] specifies the high level requirements and related capabilities of NGN. The motivation for NGN evolution is to provide the enhanced capabilities to suit the new demands from industry based on the NGN infrastructure.

NGN evolution is a non-stop long-term piece of work. NGN evolution phase 1 (NGNe1) addresses an evolved version of NGN with enhanced capabilities for the support of network intelligence, virtualization and programmability, in order to provide services and applications for humans and things. In particular, NGN evolution phase 1 addresses:

- requirements and capabilities for the support of Internet of things applications;
- requirements and capabilities for the support of network intelligence; for example, to enable operators to assign specific network resources according to given requirements and to dynamically adjust them based on several factors;
- requirements and capabilities of network programmability and network functions virtualization for supporting the reduction of network complexity and the easier and faster deployment of new capabilities.

7 Service and capability requirements for NGN evolution phase 1

The following clauses address the relevant requirements to be supported in NGN evolution phase 1 for the support of network intelligence, virtualization and programmability for services and applications for humans and things.

Appendix II provides some potential requirements of NGN evolution phase 1 related to service provision and management which need further study and are not currently addressed in specific Recommendations related to NGN evolution.

7.1 Support of services and applications for things

NGN evolution phase 1 is required to support capabilities for the deployment of Internet of things (IoT) applications in the NGN environment. This clause describes the relevant requirements which are to be supported in NGN evolution phase 1.

- NGN evolution phase 1 is required to support the IoT common requirements defined in [ITU-T Y.4100] as appropriate, including any non-functional requirements, application support requirements, service requirements, communication requirements, device requirements, data management requirements and security and privacy protection.
- NGN evolution phase 1 is required to support the capabilities of gateways defined in [ITU-T Y.4101] to enable the access of a variety of devices for IoT applications via a gateway.
- NGN evolution phase 1 is required to support the coexistence of existing NGN and IoT services and applications to enable the use by an NGN user of both kinds of services and applications as needed.
- NGN evolution phase 1 is required to support extended capabilities of the NGN service integration and delivery environment [ITU-T Y.2240] for the integration of NGN and IoT services and applications as needed, in order to provide innovative converged services and applications.

7.2 Support of network intelligence capabilities

NGN evolution phase 1 is required to support the capabilities for network intelligence capability enhancement (NICE) in the NGN environment. This clause describes relevant requirements which are required to be supported in NGN evolution phase 1.

- NGN evolution phase 1 is required to support the requirements and capabilities of awareness, on-demand provision, cooperation, optimization and openness, as defined in [ITU-T Y.2301] and [ITU-T Y.3321].

7.3 Support of network programmability

In line with [ITU-T Y.3300], network programmability means that "the behaviour of network resources can be customized by software-defined networking (SDN) applications through a standardized programming interface for network control and management functionality". In this respect, NGN evolution phase 1 is required to support the utilization of SDN in the NGN environment, in order to provide network programmability.

This clause describes relevant requirements which are required to be supported in NGN evolution phase 1.

- NGN evolution phase 1 is required to inherit the existing services and capabilities when utilizing software-defined networking technology in a part of or the whole network.
NOTE – [ITU-T Y.3300] provides a framework of software-defined networking, including orchestration of network resources and SDN applications, programmability of network resources and abstraction of underlying network resources.
- NGN evolution phase 1 is required to inherit the same quality of service (QoS) for the existing services when introducing software-defined technology in a part of or the whole network.
- NGN evolution phase 1 is required to simplify operation and management through automatic configuration by using software-defined technology.

7.4 Support of network functions virtualization

NGN evolution phase 1 is required to support control network functions virtualization in the NGN environment. This clause describes the relevant control network functions virtualization requirements which are required to be supported in NGN evolution phase 1.

- NGN evolution phase 1 is required to support the requirements for the deployment of virtualization of control network entities (VCN), virtual resource management, portability, network reliability and coexistence with legacy networks, as defined in [ITU-T Y.2320].

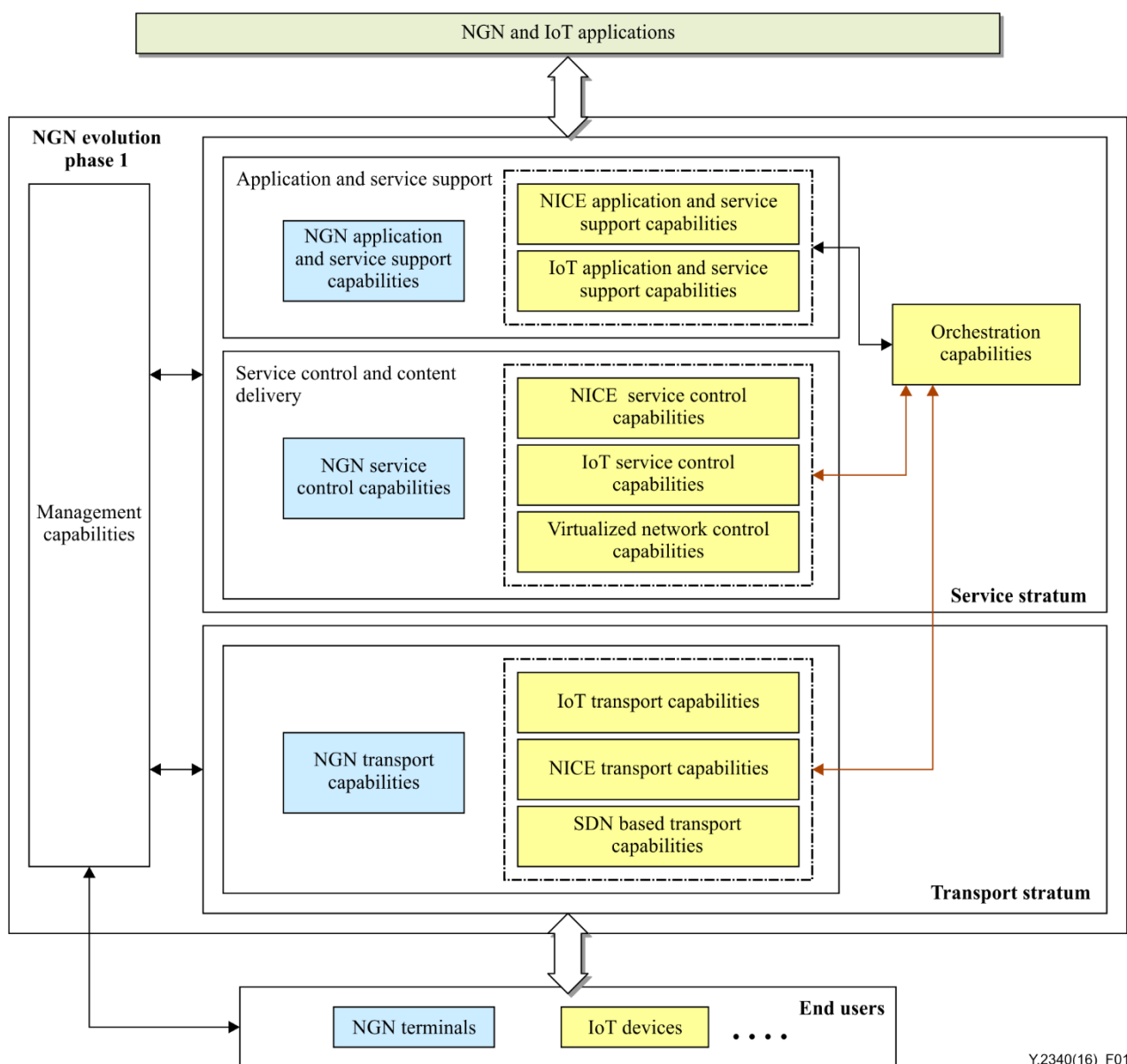
- NGN evolution phase 1 is required to inherit the existing services and capabilities when implementing a VCN system in a part of or the whole network.
- NGN evolution phase 1 is required to support the guarantee of inheriting the same QoS for the existing services when implementing a VCN system in a part of or the whole network.

8 The capability framework of NGN evolution phase 1

8.1 Overview of capability framework

NGN evolution phase 1 supports enhanced capabilities based on NGN capability set 2, as per [ITU-T Y.2007]. The capability framework of NGN evolution phase 1 supports the NGN requirements, as well as the requirements identified in clause 7.

Figure 1 shows the capability framework of NGN evolution phase 1. It is composed of the service stratum and transport stratum, as well as management capabilities which are associated with the two strata and the end users [ITU-T Y.2012].



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Figure 1 – Capability framework of NGN evolution phase 1

The service stratum provides service support and service control to the end users for applications for humans and things, i.e., NGN and IoT applications.

The transport stratum provides IP connectivity services to the end users.

The end users of NGN evolution phase 1 include IoT devices alongside the NGN end users.

The management capabilities address management for the end users, transport stratum and service stratum.

NOTE – The blue blocks represent NGN capabilities, as per [ITU-T Y.2007] and the yellow ones represent the enhanced capabilities of NGN evolution phase 1.

The following clauses provide details of the capabilities of service stratum and transport stratum, as well as the management capabilities.

8.2 Service stratum capabilities of NGNe1

The NGNe1 service stratum capabilities can be distinguished by application and service support capabilities, service control and content delivery capabilities and orchestration capabilities.

The application and service support capabilities consist of:

- NGN application and service support capabilities including: registration, authentication and authorization capability at the application level, as per [ITU-T Y.2007]; service integration and delivery environment capabilities, as per [ITU-T Y.2240];
- NICE application and service support capabilities, including NICE open environment capabilities, as per [ITU-T Y.2301];
- IoT application and service support capabilities, which correspond to IoT service support capabilities, as per [ITU-T Y.4401].

The service control and content delivery capabilities consist of:

- NGN service control capabilities, including the resource control capability, registration, authentication and authorization capability at the service level for both mediated and non-mediated services, and the capability for controlling media resources, as per [ITU-T Y.2007];
- NICE service control capabilities, including NICE service user profile capability and capabilities which support the receiving and transferring of NICE application requests or traffic scheduling to the transport layer, and the receiving and transferring of transport-related information to the service layer, as per [ITU-T Y.2301];
- IoT service control capabilities, which satisfy IoT specific service control requirements such as time synchronization, semantic-based service configuration and monitoring, as per [ITU-T Y.4401];
- virtualized network control capabilities, which correspond to VCN capabilities, as per [ITU-T Y.3011], aiming to achieve identified network virtualization goals, such as isolation, topology awareness and quick reconfigurability.

The orchestration capabilities provide interactivity with applications for various purposes (e.g., for service creation and provisioning based on applications' requirements), as well as coordination for the control and management of network resources [ITU-T Y.3300], [ITU-T Y.3321] and [ITU-T Y.2240].

NOTE – Orchestration capabilities to support an integrated environment of NGNe1 capabilities need further study. Appendix II provides some related potential requirements of unified orchestration.

8.3 Transport stratum capabilities of NGNe1

The NGNe1 transport stratum supports the communication between end users and service stratum. The transport stratum capabilities consist of:

- NGN transport capabilities, including an NGN transport capability and transport control capability, as per [ITU-T Y.2007];
- NICE transport capabilities, as per [ITU-T Y.2301];
- additional transport capabilities in support of IoT applications (IoT transport capabilities), including IoT specific control capabilities for configuring and monitoring, autonomic networking, content-aware and location-based communication, as per [ITU-T Y.4401];
- SDN-based transport capabilities, which correspond to SDN capabilities, as per [ITU-T Y.3300], including a programmability capability and resource abstraction capability.

NOTE – Interoperability aspects at the transport stratum need further study and related potential requirements are addressed in Appendix II.

8.4 Management capabilities of NGNe1

The NGNe1 management capabilities support the management of existing NGN capabilities, as per [ITU-T M.3060] and [ITU-T Y.2007], as well as the enhanced capabilities of NGN evolution phase 1, as per [ITU-T Y.4401], [ITU-T Y.2301], [ITU-T Y.3011], [ITU-T Y.3300] and [ITU-T Y.3321].

NOTE – Capabilities related to unified management aspects need further study and related potential requirements are addressed in Appendix II.

9 Security considerations

NGN evolution phase 1 supports the security features for NGN, as well as the security features for network intelligence, virtualization, programmability and Internet of things. Further information can be found in [ITU-T Y.2007], [ITU-T Y.2301], [ITU-T Y.3321], [ITU-T Y.3011], [ITU-T Y.3300] and [ITU-T Y.4100].

Appendix I

Deployment scenarios in NGN evolution phase 1

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

I.1 Scenarios of network functions virtualization in NGN evolution phase 1

According to the VCN concept developed in [ITU-T Y.2320], the virtualization of NGN functions can be applied at first to service the control functions of the NGN service stratum.

The virtualization of NGN functions is a long-term process and operators can plan their own evolution path based on their specific requirements, as well as the network status. The full virtualization of the service control functions is in principle a key objective for each operator's network domain.

I.1.1 Partial virtualization of NGN service control functions in single NGN domain scenario

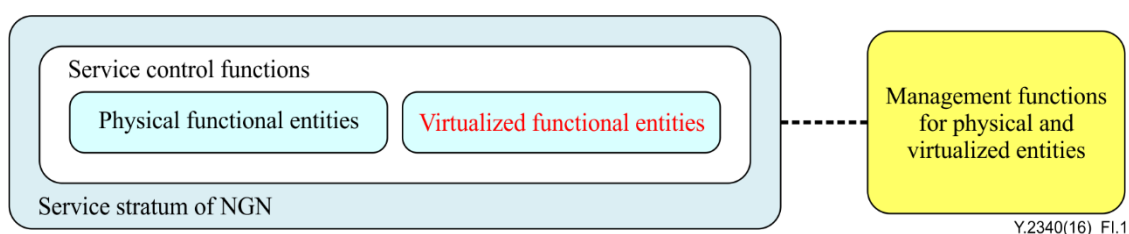


Figure I.1 – Partial virtualization in NGN service stratum

In this scenario, as shown in Figure I.1, there is partial virtualization of the service control functions. Physical functional entities and virtualized functional entities coexist in the NGN service stratum. The management functions administrate the two kinds of functional entities.

I.1.2 Full virtualization of NGN service control functions in single NGN domain scenario

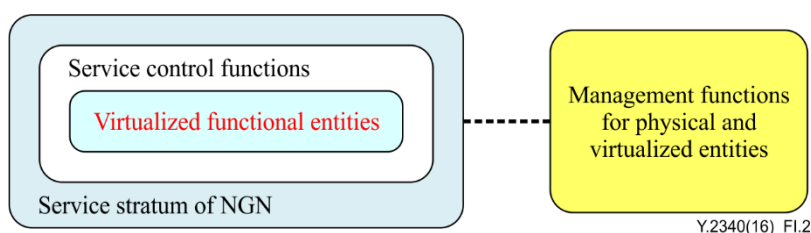


Figure I.2 – Full virtualization in NGN service stratum

In this scenario, as shown in Figure I.2, all the NGN service control functions are virtualized.

I.1.3 Partial domain-restricted virtualization of NGN service control functions in multiple NGN domain scenario

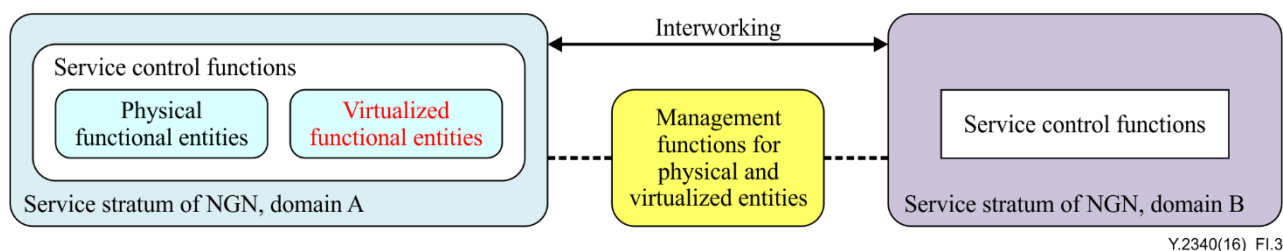


Figure I.3 – Partial domain-restricted virtualization in NGN service stratum

In this scenario, as shown in Figure I.3, virtualization has been partly introduced in the service stratum of NGN domain A, while this has not been done in NGN domain B. NGN domain A interworks with NGN domain B. If the two domains belong to the same NGN operator, the management functions administrate both domains.

I.1.4 Full domain-restricted virtualization of NGN service control functions in multiple NGN domain scenario

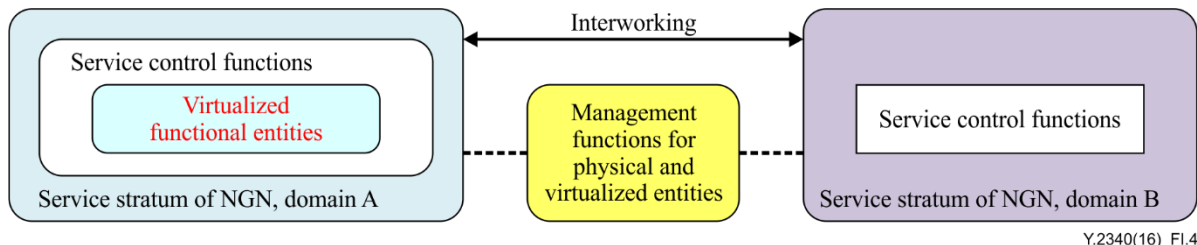


Figure I.4 – Full domain-restricted virtualization in NGN service stratum

In this scenario, as shown in Figure I.4, there is full virtualization of the service control functions in NGN domain A, while the service control functions in NGN domain B are not virtualized. NGN domain A interworks with NGN domain B. If the two domains belong to the same NGN operator, the management functions administrate both domains.

I.2 Scenarios for support of IoT applications in NGN evolution phase 1

IoT applications can be supported by the capabilities of NGN evolution phase 1 at different levels.

I.2.1 Transit scenario

In a transit scenario, as shown in Figure I.5, NGN evolution phase 1 acts as transit network to interconnect IoT gateways and IoT devices with IoT platforms and IoT applications. NGNe1 is only an intermediary transport network and does not provide any services.

IoT transport capabilities are provided by the NGN transport stratum.

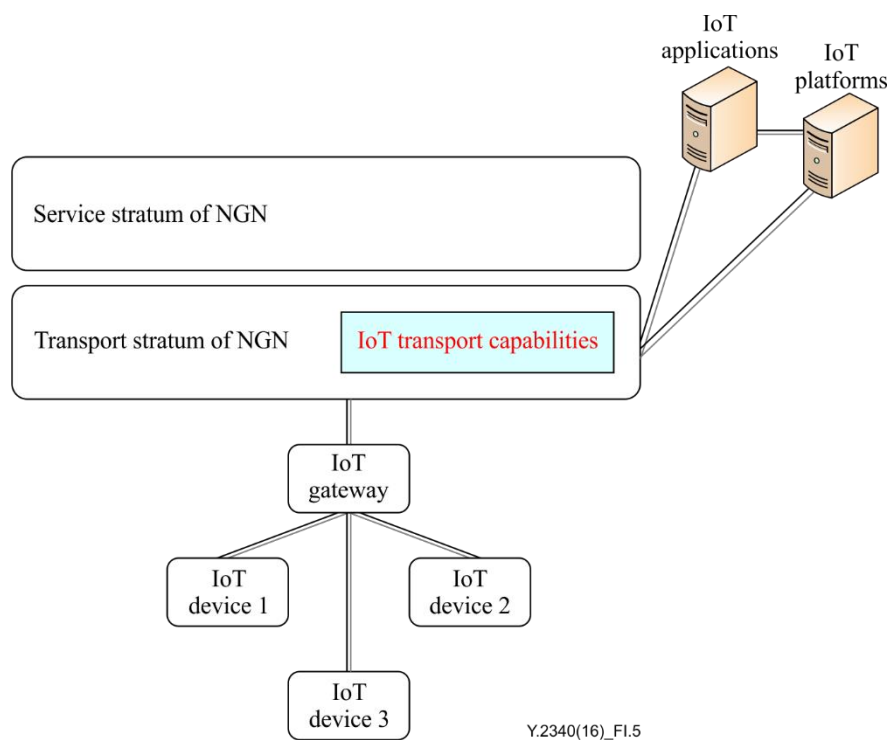


Figure I.5 – Transit scenario

I.2.2 Interworking scenario

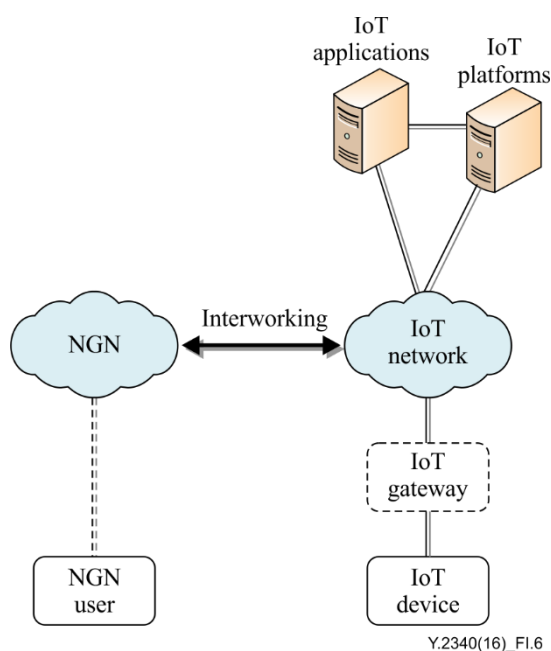


Figure I.6 – Interworking scenario for support of IoT applications

In an interworking scenario, as shown in Figure I.6, IoT devices are connected to a separate network (IoT network) than the NGN. An IoT device can communicate with an NGN user by means of interworking between the IoT network and the NGN. For example, the NGN user may get real-time information from an automotive telematics application running over the IoT network by means of Short Messaging.

I.2.3 Registration scenario

In a registration scenario, an IoT device is a kind of NGN user and the NGN provides both NGN applications and IoT applications to the users. The IoT devices register to the NGN like a traditional NGN user.

There are two ways to perform the registration of an IoT device: one is by individual registration of the IoT device, as shown in Figure I.7, and the other one is by proxy registration of the IoT device via an agent such as an IoT gateway, as shown in Figure I.8.

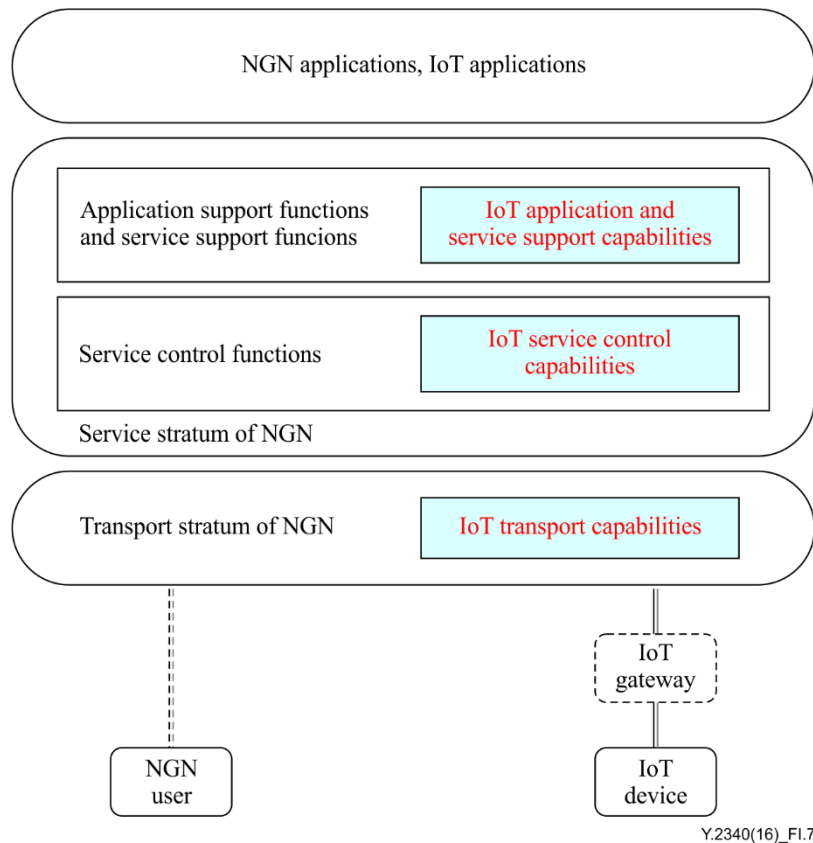


Figure I.7 – Individual registration of the IoT device

In the individual registration scenario, the IoT devices are NGN users and have to register one by one. The IoT devices can access the NGN network directly or through an IoT gateway.

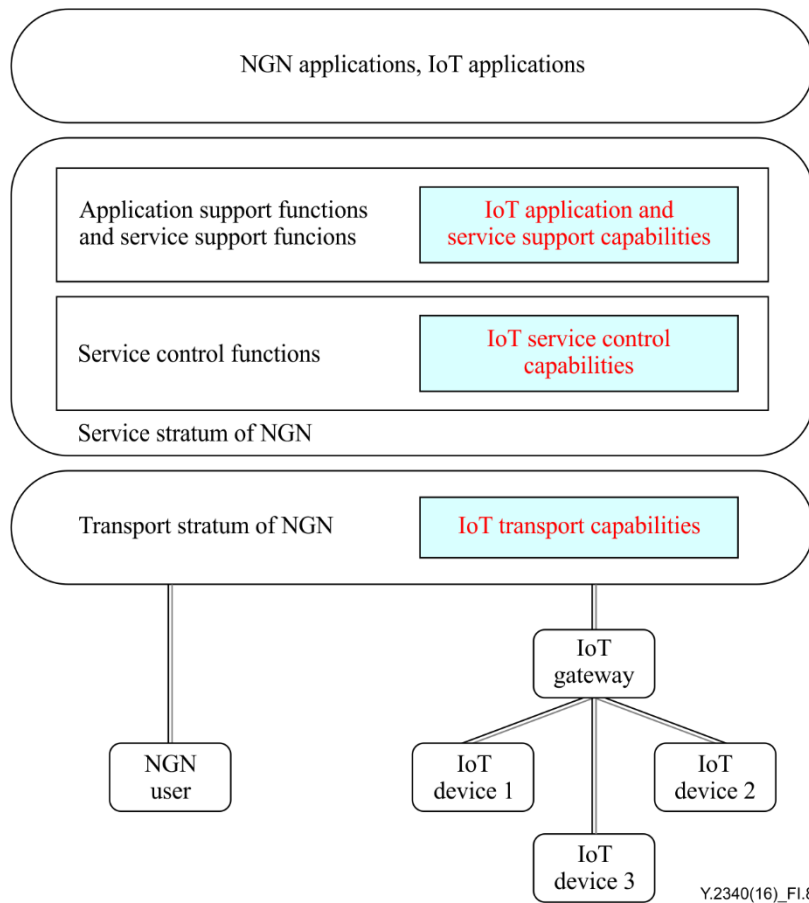


Figure I.8 – Proxy registration of the IoT device via IoT gateway

The proxy registration scenario is used for IoT devices which may not be able to register to NGN (e.g., IoT devices with constrained capabilities) or where individual registration of IoT devices is not necessary. In this case, the NGN registration is completed by an IoT gateway or other agents instead of a single device or group of devices.

Appendix II

Potential requirements for further study concerning NGN evolution phase 1

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

Some requirements are expected from the integration in NGN evolution phase 1 of the enhancements described in this Recommendation. This appendix summarizes relevant potential requirements for further study.

II.1 Support of unified service provision and management

The requirements of unified service provision and management for NGN evolution phase 1 include:

- unified service provision for the support of the creation of new services, and delivery of service deployment requests to the related network functions, in order to realize unified service deployment in an NGN evolution environment;
- unified orchestration for the support of the coordination, chaining and integration of services provided by existing NGN functions and newly deployed network functions;
- unified access and configuration of services, and unified storage and management of service data for users.

II.2 Support of interoperability and interworking

The requirements of service interoperability for NGN evolution phase 1 include:

- the support of interoperability between existing NGN services and IoT services where applicable;
- the support of interoperability between VCN functions and the existing service and application functions of NGN.

The requirements of network interworking for NGN evolution phase 1 include:

- in case of partial implementation of software-defined networking technology in NGN evolution phase 1, interworking between network entities implementing SDN technology and network entities not implementing SDN technology. As an example, the interworking between SDN-based access network and non-SDN-based core network is required;
- the support of the interworking between networks implementing at different levels enhancements related to SDN, NICE and VCN capabilities and networks not implementing such enhancements.

II.3 Support of unified network management

The NGN evolution phase 1 is required to support the unified management of network functions, including the existing NGN functions and the newly deployed functions along the effective deployment path of these new functions.

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