

I n t e r n a t i o n a l T e l e c o m m u n i c a t i o n U n i o n

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.3011

(01/2012)

SERIES Y: GLOBAL INFORMATION
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS
AND NEXT-GENERATION NETWORKS

Next Generation Networks – Future networks

Framework of network virtualization for future networks

Recommendation ITU-T Y.3011



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Recommendation ITU-T Y.3011

Framework of network virtualization for future networks

Summary

Recommendation ITU-T Y.3011 describes the framework of network virtualization for future networks (FNs). It presents its motivation and definition, and describes the concept of logically isolated network partition (LINP) that is provisioned by network virtualization. This Recommendation also discusses the problem spaces of network virtualization and investigates its design goals. Finally, this Recommendation discusses the applicability of network virtualization by summarizing its advantages and disadvantages. An appendix provides detailed use cases on various aspects of network virtualization, such as experimental network and mobility.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y.3011	2012-01-13	13

FOREWORD

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

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

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

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

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

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Introduction

Future networks (FNs) are networks that will be able to provide revolutionary services, capabilities, and facilities that are difficult to support using existing network technologies. One of the basic objectives of FNs is service awareness. The number and range of services are expected to explode in the future, and FNs need to adapt to the surge in the number of services [ITU-T Y.3001]. That surge in the number of services makes it difficult to satisfy the requirements of every service on a single network architecture. However, it is unrealistic to realize heterogeneous network architectures using multiple physical networks because of the installation, operation, and maintenance costs. FNs therefore need to realize diverse services and heterogeneous network architectures on a common physical network.

The future information and communication infrastructure is expected to support arbitrary kinds of social and economic activities. For example, while a proliferating number of network services are emerging and such services require high-speed, large-volume, low-latency network connectivity for voice, video, database communications, it is also imperative to ensure low-power consumption. A mixture of contradicting goals, including those described above, is to be resolved by the flexibly reconfigurable networks that accommodate multiple virtual networks with different capabilities. It is therefore crucial to make the networks more flexible and more reconfigurable so that they continuously and dynamically evolve to adapt to the changing requirements for future network services and applications. It is especially important to optimize the usage of the limited resources and maximize the number of users of the resources by quickly and dynamically adapting to environmental changes, for example, the emergency situations caused by natural disasters, through tailoring the amount and the quality of resources allocated for each virtual network and switching between multiple virtual networks with different capabilities.

At the same time, to make diverse services flourish, it is preferable for networks to provide easy methods for experimenting and/or small-scale deployment. This has to be done without causing unexpected effects for others, so it is often done by building completely separate networks. If experimental networks and/or test-beds could be built on real networks that share common physical networks and could still provide isolated network environment, it will give developers, providers, and users of the emerging technologies an ideal environment to design, develop, and evaluate new services.

Network virtualization is a technology that realizes isolated and flexible networks in order to support a broad range of network architectures, services, and users that do not interfere with others. It also enables the easy establishment of experimental networks and accelerates research and development on future network technologies. Therefore, network virtualization is considered as a key technology for realizing FNs.

This Recommendation provides the framework of network virtualization technology.

Recommendation ITU-T Y.3011

Framework of network virtualization for future networks

1 Scope

This Recommendation defines network virtualization and provides an overview of, and motivation for, network virtualization. It also describes problem spaces, design goals, and applicability of network virtualization.

Use cases for network virtualization are discussed in an appendix.

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.3001] Recommendation ITU-T Y.3001 (2011), *Future networks: Objectives and design goals*.

3 Definitions

3.1 Term defined elsewhere

This Recommendation uses the following term defined elsewhere:

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

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 logical resource: An independently manageable partition of a physical resource, which inherits the same characteristics as the physical resource and whose capability is bound to the capability of the physical resource.

NOTE – "independently" means mutual exclusiveness among multiple partitions at the same level.

3.2.2 logically isolated network partition (LINP): A network that is composed of multiple virtual resources which is isolated from other LINPs.

NOTE – "logically isolated", which is the counter concept of "physically isolated", means mutual exclusiveness of the subjects (i.e., network partition, in this case), while the original subjects may be physically united/shared within the common physical constraints.

3.2.3 virtual resource: An abstraction of physical or logical resource, which may have different characteristics from the physical or logical resource and whose capability may be not bound to the capability of the physical or logical resource.

NOTE – "different characteristics" means simplification or extension of the resource characteristics. "different characteristics" allows the virtual resource to expose access or control methods different from the original physical or logical resource.

3.2.4 network virtualization: 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.

NOTE – Refer to the note of the definition of LINP for "logically isolated".

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FN	Future Network
IPsec	Internet Protocol security
LINP	Logically Isolated Network Partition
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator
PNM	Physical Network Manager
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
VRM	Virtual Resources Manager

5 Conventions

None.

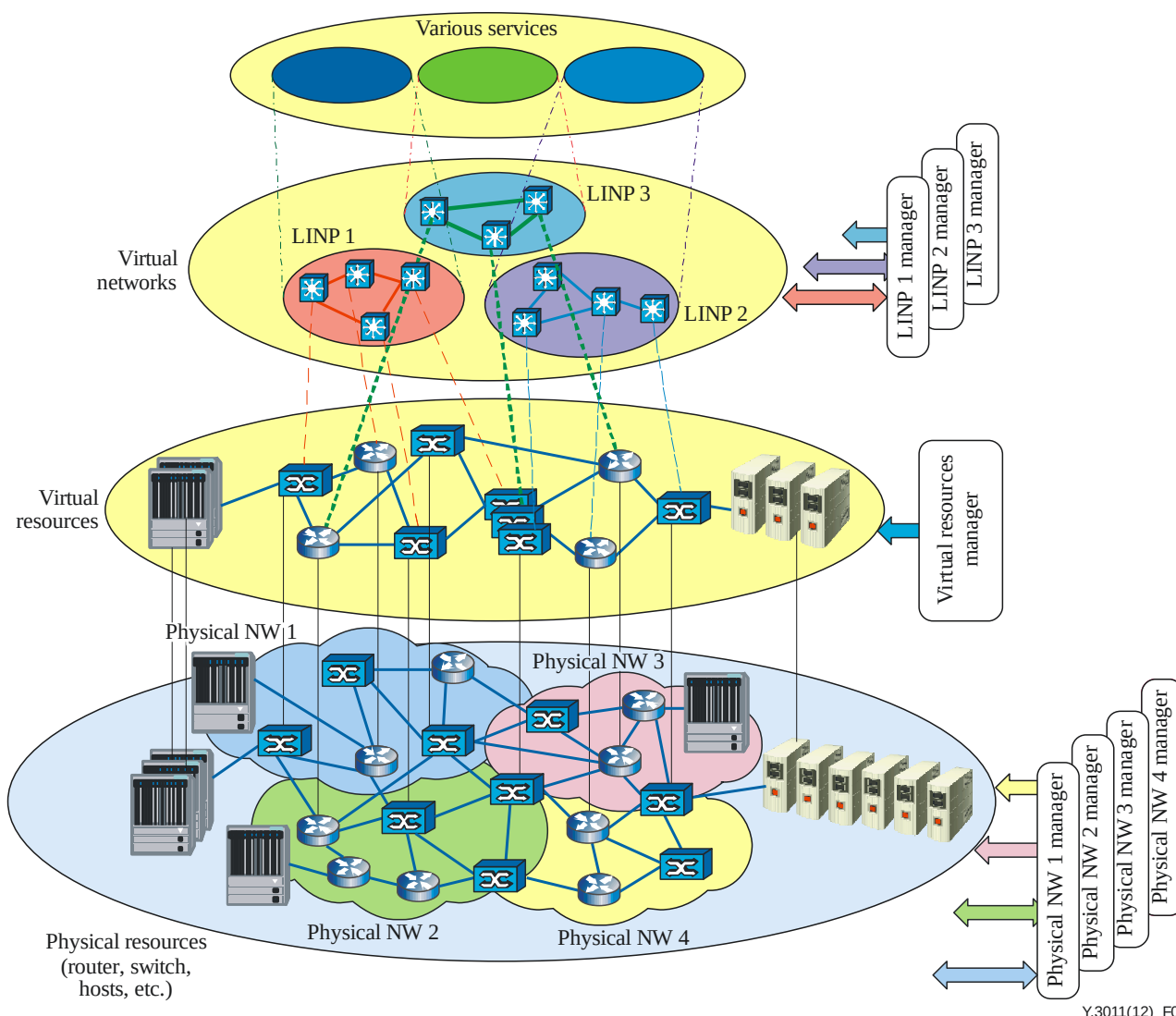
6 Overview

Network virtualization is a method that allows multiple virtual networks, called logically isolated network partitions (LINPs), to coexist in a single physical network. In order to provide LINPs, physical resources are partitioned and abstracted as virtual resources and the virtual resources are interconnected to create an LINP [b-Chowdhury][b-GENI GDD0608][b-Nakao]. These virtual resources can be created on physical resources such as routers, switches and hosts. As such, virtual resources are either allocated to each LINP or else multiple virtual resources are aggregated into a single virtual resource.

LINPs are isolated from each other, and when combined with programmability in virtual resources, users of LINPs can program the virtual resources on the virtualization layer. In other words, each LINP can provide the corresponding users with services similar to those provided by traditional networks without network virtualization. The users of LINPs are not limited to the users of services or applications, but can include service providers. For example, a service provider can lease an LINP and can provide emerging services or technologies such as the cloud computing service. The service providers can realize the emerging services as if they own a dedicated physical network. In order to facilitate the deployment of network virtualization, it is necessary to provide control and management procedures such as creating, monitoring, and measuring the status of LINPs.

Figure 1 represents the conceptual architecture of network virtualization, which consists of LINPs over physical resources supporting network virtualization. A single physical resource can be shared among multiple virtual resources and each LINP consists of multiple virtual resources. Each LINP is managed by an individual LINP manager. In the figure, the physical resources in a physical network(s) are virtualized and may form a virtual resources pool. These virtual resources are managed by the virtual resources manager (VRM). The VRM interacts with the physical network manager (PNM) and performs control and management of virtual resources. Once an LINP is

constructed by using the virtual resources, an LINP manager is allocated to the LINP. The LINP manager performs a management function.



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Figure 1 – Conceptual architecture of network virtualization

Figure 2 represents the concept of LINP, which consists of multiple coexisting LINPs over network resources supporting network virtualization. Each LINP is provided based on user requirements. The requirements are delivered to the VRM which coordinates the allocation of LINPs so that appropriate LINP is provided to users. The VRM handles the requirements based on its administration policy. Each LINP is controlled and managed by an LINP manager. The VRM which is controlling all virtual resources creates an LINP manager and allocates appropriate authorities to control each LINP. An LINP generated by using network virtualization has various characteristics, such as partitioning, isolation, abstraction, flexibility or elasticity, programmability, authentication, authorization, and accounting [b-Vermesan] [b-Nakao2]. The detailed description of the LINP characteristics is provided in Appendix I.