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

Future networks

Functional architecture of software-defined networking

Recommendation ITU-T Y.3302

ITU-T

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.3302

Functional architecture of software-defined networking

Summary

Recommendation ITU-T Y.3302 provides the functional architecture of software-defined networking (SDN) with descriptions of functional components and reference points. The described functional architecture is intended to be used as an enabler for further studies on other aspects such as protocols and security as well as being used to customize SDN in support of appropriate use cases (e.g., cloud computing, mobile networks).

This Recommendation is based on ITU-T Y.3300 and ITU-T Y.3301. Recommendation ITU-T Y.3300 describes the framework of SDN including definitions, objectives, high-level capabilities, requirements and the high-level architecture of SDN; Recommendation ITU-T Y.3301 describes more detailed requirements.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Abstraction, functional component, multi-layer management, orchestration, programmability, software-defined networking.

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

FOREWORD

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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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Table of Contents

		Page
1	Scope.....	1
2	References.....	1
3	Definitions	1
	3.1 Terms defined elsewhere	1
	3.2 Terms defined in this Recommendation.....	2
4	Abbreviations and acronyms	2
5	Conventions	3
6	Introduction.....	3
7	Functional architecture	4
	7.1 SDN application layer	5
	7.2 SDN control layer.....	6
	7.3 SDN resource layer.....	8
	7.4 Multi-layer management functions.....	10
8	SDN functional profiles.....	12
9	Environmental considerations	13
10	Security considerations	13
	Annex A – Multi-layer management functional components details	14
	A.1 Application layer management functional component.....	14
	A.2 Control layer management functional component	16
	A.3 Resource layer management functional component.....	18
	A.4 Multi-layer management orchestration functional component.....	20
	A.5 External relationship management functional component	21
	Appendix I – Orchestration in SDN.....	23
	Bibliography.....	24

Recommendation ITU-T Y.3302

Functional architecture of software-defined networking

1 Scope

This Recommendation defines the functional architecture of software-defined networking (SDN) by describing a layered architecture, the functional components of the architecture and its reference points. Details of multi-layer management are provided in Annex A and the role of orchestration is addressed in Appendix I. The architecture is based on [ITU-T Y.3300] which defines the SDN framework and [ITU-T Y.3301] which describes the functional requirements of the SDN architecture which the present Recommendation has to fulfil.

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.3400] Recommendation ITU-T M.3400 (2000), *TMN management functions*.
- [ITU-T Y.3001] Recommendation ITU-T Y.3001 (2011), *Future networks: Objectives and design goals*.
- [ITU-T Y.3300] Recommendation ITU-T Y.3300 (2014), *Framework of software-defined networking*.
- [ITU-T Y.3301] Recommendation ITU-T Y.3301 (2016), *Functional requirements of software-defined networking*.
- [ITU-T Y.3320] Recommendation ITU-T Y.3320 (2014), *Requirements for applying formal methods to software-defined networking*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

- 3.1.1 functional component** [b-ITU-T Y.3502]: A functional building block needed to engage in an activity, backed by an implementation.
- 3.1.2 network virtualization** [b-ITU-T Y.3011]: A technology that enables the creation of logically isolated network partitions over shared physical networks so that heterogeneous collection 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.
- 3.1.3 software-defined networking** [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

This Recommendation defines the following term:

3.2.1 SDN orchestration: A process that oversees and directs a set of software-defined networking activities and interactions with the objective of carrying out certain work in an automated manner.

NOTE – In SDN, orchestration can be used to arrange, configure and coordinate a set of operations in multi-domain, multi-layer or end-to-end heterogeneous networking environments in order to execute a specific task.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ACI	Application Control Interface
AL	Application Layer
ALM	Application Layer Management
AL-MSO	Application Layer Management Support and Orchestration
BSS	Business Support System
CL	Control Layer
CL-AS	Control Layer Application Support
CL-MSO	Control Layer Management Support and Orchestration
CL-RA	Control Layer Resource Abstraction
CLM	Control Layer Management
DevOps	Development Operations
ERM	External Relationship Management
FCAPS	Fault, Configuration, Accounting, Performance and Security
KPI	Key Performance Indicator
MMF	Multi-layer Management Functions
MMFA	Multi-layer Management Functions Application layer
MMFC	Multi-layer Management Functions Control layer
MMFO	Multi-layer Management Functions OSS/BSS
MMFR	Multi-layer Management Functions Resource layer
MMO	Multi-Layer Management Orchestration
OSS	Operations Support System
RCI	Resource Control Interfaces
RL	Resource Layer
RL-CS	Resource Layer Control Support
RL-DP	Resource Layer Data Processing
RL-DT	Resource Layer Data Transport
RL-MS	Resource Layer Management Support
RLM	Resource Layer Management
SDN	Software-Defined Networking
SDN-AL	SDN Application Layer
SDN-CL	SDN Control Layer
SDN-RL	SDN Resource Layer

5 Conventions

None.

6 Introduction

As described in [ITU-T Y.3300], key properties of SDN include:

- 1) logically centralized network control which allows for controlling and managing network resources by software;
- 2) support for network virtualization, and;
- 3) network customization, for efficient and effective network deployments and operations.

Requirements for SDN [ITU-T Y.3300] include:

- 1) separation of SDN control from network resources;
- 2) programmability of network resources;
- 3) abstraction of network resources, by means of standard information and data models, and;
- 4) support for orchestration of network resources and SDN applications.

More detailed requirements are provided in [ITU-T Y.3301].

This Recommendation provides a description of the SDN functional architecture with the aim of ensuring that the key properties and requirements of SDN are appropriately supported. The SDN functional architecture is based on the layering framework derived from clause 11 of [ITU-T Y.3300] and shown in Figure 6-1.

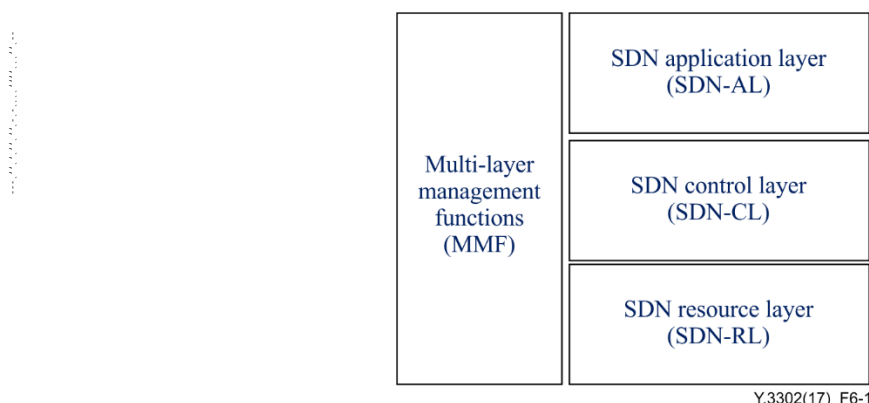


Figure 6-1 – SDN layering framework

Considering other efforts to design an SDN architecture [b-ONF-arch 1.0], [b-ONF-arch 1.1], [b-IETF RFC 7426], the SDN architecture described in this Recommendation takes into account factors that are important in large-scale public networks:

- Orchestration-based run-time lifecycle management of software-based SDN functions.

Since public networks are becoming even more complex due to the emerging technologies, services and companion usage behaviors as well as the integration of fixed and mobile networks, SDN technologies need to contribute to the orchestration of operations and the resulting lifecycle management of network functions. SDN orchestration in this Recommendation is used to automate a set of operations;

NOTE – The background, design principle and role of SDN orchestration is described in more details in Appendix I.

- Interaction with operators' legacy operations support system (OSS)/business support system (BSS).

The SDN architecture is designed to be capable to interact with the existing OSS/BSS;

- Scalability.

In order to cope with appropriate control and application layers (ALs) performance in SDN networks potentially involving a huge number of customers, providing various types of services and covering vast geographical areas, the SDN architecture provides independent control and management capabilities, which enables performance monitoring of available resources in all layers, and enables dynamic adaptation of resources, e.g., scaling up and scaling down. The SDN architecture also allows for implementation of functions in a distributed manner, and enables distribution of fault, configuration, accounting, performance and security (FCAPS) management in each of the SDN layers;

- Reliability.

The possibility of decomposition of the SDN architecture and their functionalities enabled by this Recommendation, with the important role of management, contribute to the increased overall SDN reliability. Some reliability-related mechanisms are implementation dependent;

- Covering multiple resource layer (RL) technologies.

The SDN architecture is designed to cover multiple resource layer technologies including basic data forwarding and more complex data processing, which makes it easier for future expansion towards software-defined infrastructure;

- Efficiency of resource usage.

The decomposition of the control and management architectures and their functionalities contributes to overall efficiency of SDN resource usage. It is realized by monitoring and analytics of all layers' resource usage together with dynamic resource provisioning in order to reach the required system performance but at the same time to maintain optimal resource usage, taking into account energy consumption reduction.

7 Functional architecture

Figure 7-1 presents an overview of the SDN functional architecture organized by means of the SDN layering framework shown in Figure 6-1.

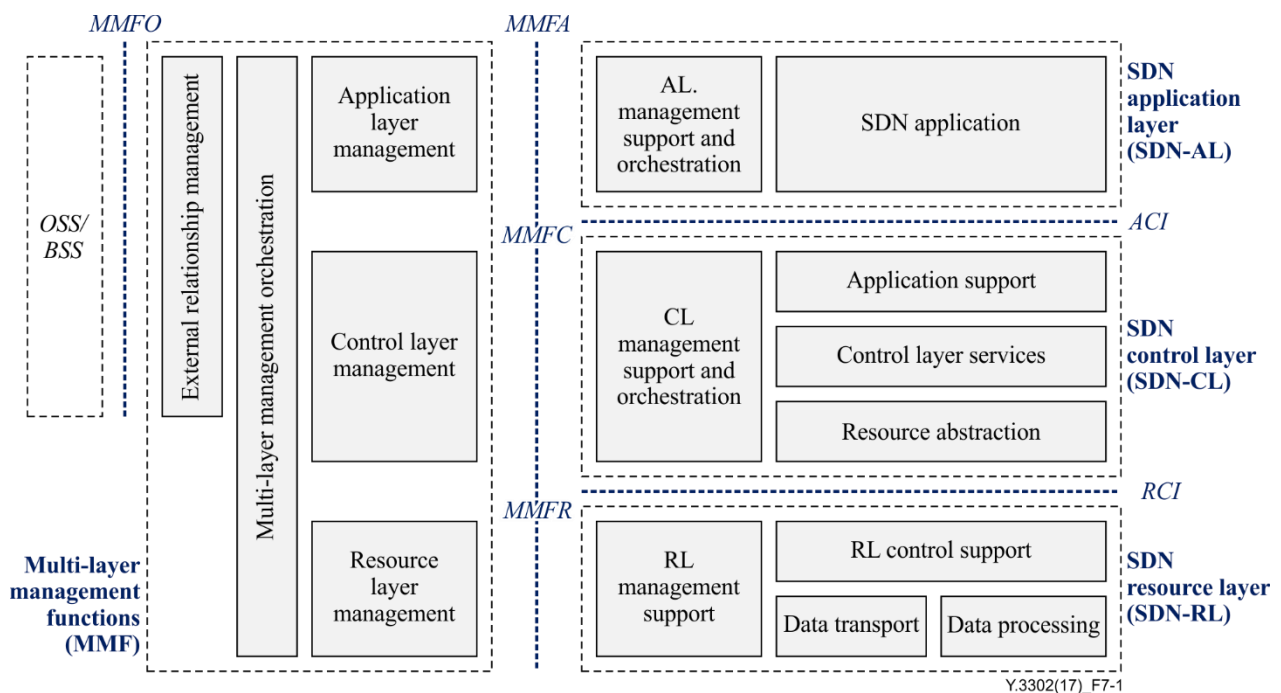


Figure 7-1 – SDN functional architecture