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

Future networks

IMT-2020 network management and orchestration framework

Recommendation ITU-T Y.3111

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Recommendation ITU-T Y.3111

IMT-2020 network management and orchestration framework

Summary

The objective of Recommendation ITU-T Y.3111 is to provide network management and orchestration architecture and functional components for design, deployment and operation to implement IMT-2020 network covering fixed and mobile networks.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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* 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>.

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Recommendation ITU-T Y.3111

IMT-2020 network management and orchestration framework

1 Scope

This Recommendation provides an overview of IMT-2020 network management and orchestration. It also specifies the high-level architecture of IMT-2020 network management and orchestration, the slice life-cycle management and orchestration functional architecture, and an IMT-2020 network management and orchestration procedure and implementation scenarios. The architectures and capabilities defined in this Recommendation are based on the requirements specified in the [ITU-T Y.3110].

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*.
- [ITU-T Y.3110] Recommendation ITU-T Y.3110 (2017), *IMT-2020 network management and orchestration requirements*.
- [ITU-R M.2083-0] Recommendation M.2083-0 (2015), *IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond*.

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 management [b-ITU-T Y.3100]: In the context of IMT-2020, the processes aiming at fulfilment, assurance, and billing of services, network functions, and resources in both physical and virtual infrastructure including compute, storage, and network resources.

3.1.3 network softwarization [b-ITU-T Y.3100]: An overall approach for designing, implementing, deploying, managing and maintaining network equipment and/or network components by software programming.

NOTE – Network softwarization exploits the nature of software such as flexibility and rapidity all along the lifecycle of network equipment and components, for the sake of creating conditions enabling the re-design of network and services architectures, optimizing costs and processes, enabling self-management and bringing added values in network infrastructures.

3.1.4 orchestration [b-ITU-T Y.3100]: In the context of IMT-2020, the processes aiming at the automated arrangement, coordination, instantiation and use of network functions and resources for both physical and virtual infrastructure by optimization criteria.

3.1.5 software-defined networking [b-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.

3.1.6 network slice [b-ITU-T Y.3100]: A logical network that provides specific network capabilities and network characteristics.

NOTE 1 – A network slice enables the operator to create networks customized to provide flexible solutions for different market scenarios, which have diverse requirements, with respect to the functionality, performance and resource separation.

NOTE 2 – A network slice may have the ability to expose its capabilities.

NOTE 3 – The behaviour of a network slice is realized via network slice instance(s).

3.1.7 network slice instance [b-ITU-T Y.3100]: An instance of network slice, which is created based on network slice blueprint.

NOTE 1 – A network slice instance is composed of a set of managed run-time network functions, and physical/logical/virtual resources to run these network functions, forming a complete instantiated logical network to meet certain network characteristics required by the service instance(s).

NOTE 2 – A network slice instance may also be shared across multiple service instances provided by the network operator. A network slice instance may be composed of none, one or more sub-network slice instances which may be shared with another network slice instance.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 domain: (Based on the definition given in [b-ITU-T Y.110]) A collection of physical or functional entities which are owned and operated by a player and can include entities from more than one role. The extent of a domain is defined by a useful context and one player can have more than one domain.

3.2.2 IMT-2020: (Based on the definition given in [ITU-R M.2083-0]) Systems, system components and related aspects that support to provide far more enhanced capabilities than those described in [b-ITU-R M.1645]

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Program Interface
A&SP-CM	Applications and Service Plane Charging Management
A&SP-FM	Applications and Service Plane Fault Management
A&SPM	Applications and Service Plane Management
A&SP-MMCS	Applications and Service Plane Multi-Plane Management Coordination Support
A&SP-QM	Applications and Service Plane Quality Management
A&SP-RD	Applications and Service Plane Resource Discovery
A&SP-RMA	Applications and Service Plane Resource Monitoring and Analytics
A&SP-RR	Applications and Service Plane Resource Repository
A&SP-S	Applications and Service Plane Support
A&SP-SM	Applications and Service Plane Security Management
BSS	Business Support System

CP	Control Plane
CP-CM	Control Plane Configuration Management
CP-FM	Control Plane Fault Management
CPM	Control Plane Management
CP-MMCS	Control Plane Multi-plane Management Coordination Support
CP-PM	Control Plane Performance Management
CP-PoM	Control Plane Policy Management
CP-RD	Control Plane Resource Discovery
CP-RMA	Control Plane Resource Monitoring and Analytics
CP-RR	Control Plane Resource Repository
CP-S	Control Plane Support
CP-SM	Control Plane Security Management
DoS	Denial of Service
DP	Data Plane
DP-CM	Data Plane Charging Management
DP-DB	Data Plane Discovery and Bootstrapping
DP-FM	Data Plane Fault Management
DPRM	Data Plane Resource Management
DP-MA	Data Plane Monitoring and Analytics
DP-MMCS	Data Plane Multi-Plane Management Coordination Support
DP-PM	Data Plane Performance Management
DPRR	Data Plane Resource Repository
EIPM	External IMT-2020 Policy Management
eMBB	Enhanced Mobile BroadBand
EMIS	External Management Interworking Support
ERM	External Relationship Management
ERM-MMCS	External Relationship Management Multi-plane Management Coordination Support
IPSC	Inter-Plane Service Coordination
IMT	International Mobile Telecommunications system
ISO	Inter Slice Orchestration
KPI	Key Performance Indicator
LTE	Long Term Evolution
MANO	Management and Orchestration
MIA	Management Information Abstraction

MMFC	Multi-plane Management Function Coordination
MMCS	Multi-plane Management Coordination Support
MMC	Multi-plane Management Coordination network equipment
NFV	Network Function Virtualization
NMS	Network Management System
OAM	Operations and Management
OSS	Operations Support System
PDA	Physical Data Abstraction
PDPR-SM	Physical Data Plane and Resource Security Management
RREM	Request/Reply with External Management
SCM	Slice Charging Management
SCPO	Slice Capacity Planning and Optimization
SDN	Software-defined Network
SFM	Slice Fault Management
SI	Slice Instance
SLM	Slice Lifecycle Management
SLM-CCS	Slice Lifecycle Management – Customer Care Support
SLMS	Slice Lifecycle Management Support
SP	Slice Provisioning
SRMA	Slice Resource Monitoring and Analytics
SRR	Slice Resource Repository
SSM	Slice Security Management
VDVIM	Virtual Data Abstraction Virtualized Infrastructure Manager
VNF	Virtual Network Function
VNFM	Virtual Network Function Manager
VPC	Virtual Physical Correlation
VPR-MO	Virtual/Physical Resource Management Orchestration
WAN	Wide Area Network

5 Conventions

None.

6 Overview of IMT-2020 network management and orchestration

Since the current network architecture may not be appropriate to support various IMT-2020 network requirements, enhancement of the network architecture has been studied. Among the enhanced capabilities including distributed function deployment, network slicing, and resource allocation,

IMT-2020 also requires a study on new aspects of network management and orchestration (MANO) whose results are described in this Recommendation.

6.1 Motivation

Based on the understanding of the new trends of networking technology as mentioned above, the following gap analysis items are identified [b-ITU-T Gap Analysis]

- Multiple network management protocols in different network domains make it difficult to support unified network operations over multiple network domains. A unified network management should be considered to ensure compatibility and flexibility for the operation and management of an IMT-2020 network.
- Operations and management (OAM) protocols are not standardized in some parts of IMT networks such as the front haul network. Standard OAM protocols should be studied for fault management and performance management between network equipment that may be commonly used across the IMT-2020 network.
- There are two aspects to consider for network management and orchestration for the network softwarization. The first aspect is how to manage and orchestrate the softwarized network components. The second is how to softwarize network management and orchestration functionality.
- Network slice lifecycle management and orchestration.

This Recommendation specifies a network management and orchestration framework for IMT-2020 in a systematic approach including the aforementioned gap analysis items.

As defined in clause 3, management is the processes aiming at fulfilment, assurance, and billing of services, network functions, and resources in both physical and virtual infrastructure including compute, storage, and network resources. The overall coordination and adaptation for configuration and event reporting are achieved between network functions and network management systems. The network management systems include the collection and feedback of performance measurement information and fault and anomalous events. Network function lifecycle management is included as a part of network function instance management. Network management system is authorized to exercise control over and/or collect management information from another system. It is tightly connected with the existing business support system/operations support system (BSS/OSS) such that the most efficient and effective way to access, control, deploy, schedule and bind legacy resources is chosen for the purpose of integrated management of IMT-2020 and legacy networks.

As defined in clause 3, orchestration is the processes aiming at the automated arrangement, coordination, instantiation and use of network functions and resources for both physical and virtual infrastructure by optimization criteria. Orchestration results in automation with control network systems. Orchestration is the key function in management and orchestration plane. Orchestration coordinates the management of network service life cycle, network function lifecycle and network function infrastructure resources to ensure optimized allocation of the necessary resources and connectivity.

Based on the analysis in Appendix I and corresponding definitions above, both management and orchestration capabilities are specified in a logically integrated way in the following functional architectures.

7 IMT-2020 network management and orchestration high-level architecture

IMT-2020 network shall provide network services with diverse requirements, by using network functions instantiated as appropriate. IMT-2020 infrastructure will provide the required infrastructure resources to instantiate the network functions. Network operators can provision and operate many different network slices according to their business strategies.

Network slicing enables the operator to create logically partitioned networks customized to provide optimized solutions for different market scenarios which demand diverse requirements in terms of service characteristics, required functionality, performance and isolation issues.

The functional architecture of IMT-2020 network shall provide a complete set of network functions required to support all IMT-2020 services. A network slice is comprised of only the necessary network functions. They are collected from a complete set of network functions in the IMT-2020 network functional architecture, and orchestrated for the particular service and purpose.

The general framework of IMT-2020 can be represented by two separate architecture levels, i.e., 'slice orchestration and management' level and 'network slice instances' level as shown in Figure 1. Functions for creating and managing network slice instances and the functions instantiated in the network slice instance are illustrated in the respective architectural level.

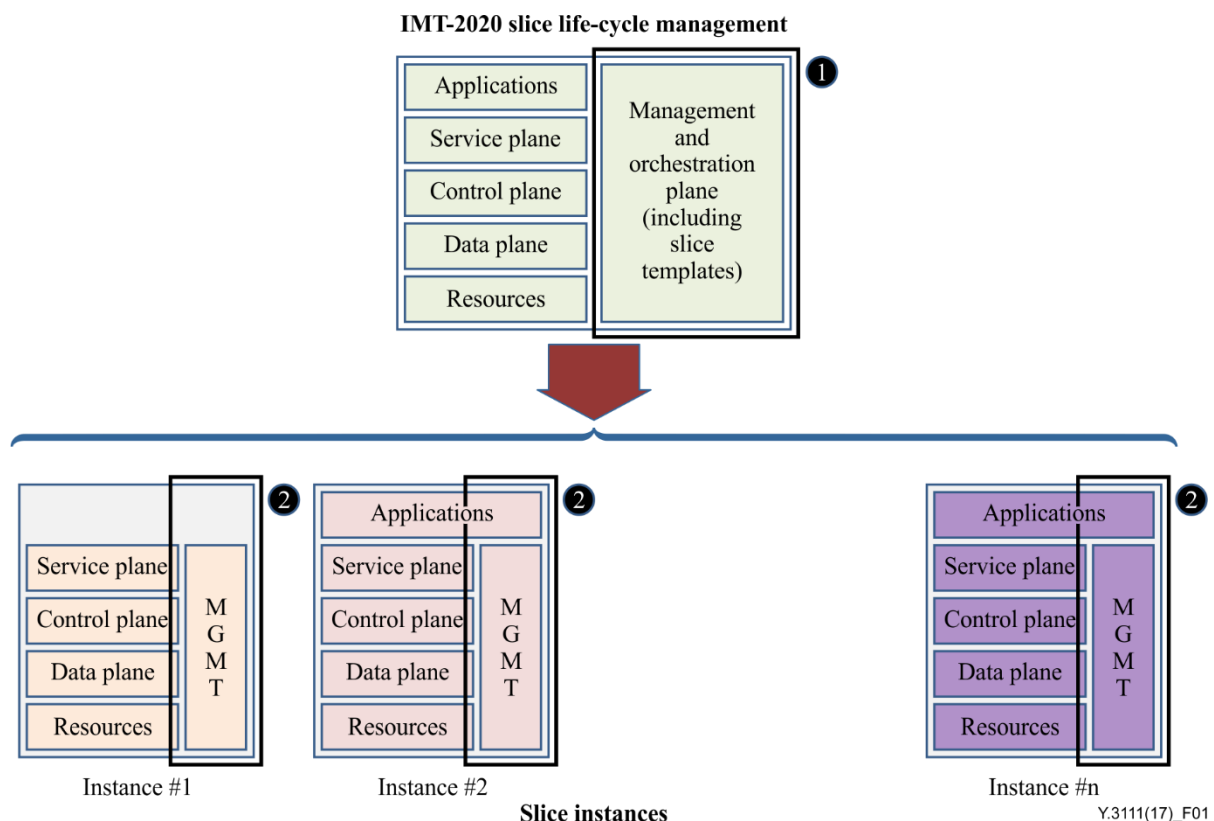


Figure 1 – Conceptual IMT-2020 network framework from the network slicing perspective

As the conceptual framework of IMT-2020 consists of two levels, the management and orchestration architecture is also required to deal with two levels: management and orchestration in IMT-2020 network slice life-cycle management (Instance 1) and management in each network slice instances (Instance 2). This Recommendation specifies management and orchestration architecture and capabilities of slice lifecycle in clause 8. It also specifies management architecture and capabilities of slice instances in clause 9.

The conceptual framework only describes the relationship between slice lifecycle management and slice instance functional entities. For a clear understanding of management and orchestration capabilities in IMT-2020, it is useful to describe the relationships with additional associated functional components such as a slice customer and an external management system.

Figure 2 illustrates such relationship among a slice customer, slice lifecycle management and orchestration and slice instance management functional components, and external management system with reference points.

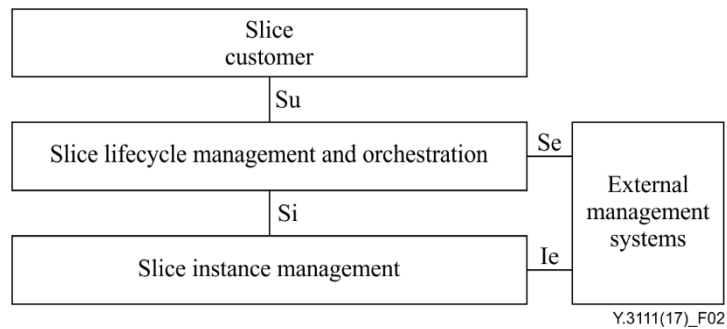


Figure 2 – Slice lifecycle management and orchestration functional relationship

Functional components specified in clauses 8 and 9 are decomposed into functional elements that represent a logical functionality provided by the functional component, independent of any implementation.

8 IMT-2020 network slice lifecycle management and orchestration plane functional architecture

This clause describes detailed management functionality in the slice lifecycle management (SLM) functional component. Figure 3 shows its functional elements.

As described in clause 6, orchestration and management functionalities are defined in an integrated manner in the IMT-2020 slice lifecycle management functional component. Orchestration functionalities are specified in the functional elements: slice capacity planning and optimization, slice provisioning (SP), and inter-slice orchestration. Management functionalities are specified in the functional elements: slice fault/security/charging management, slice resource monitoring and analytics and resource repository. They work together to achieve the slice lifecycle management objectives. Detailed interactions among functional elements are defined in clause 11, IMT-2020 slice lifecycle management procedure.

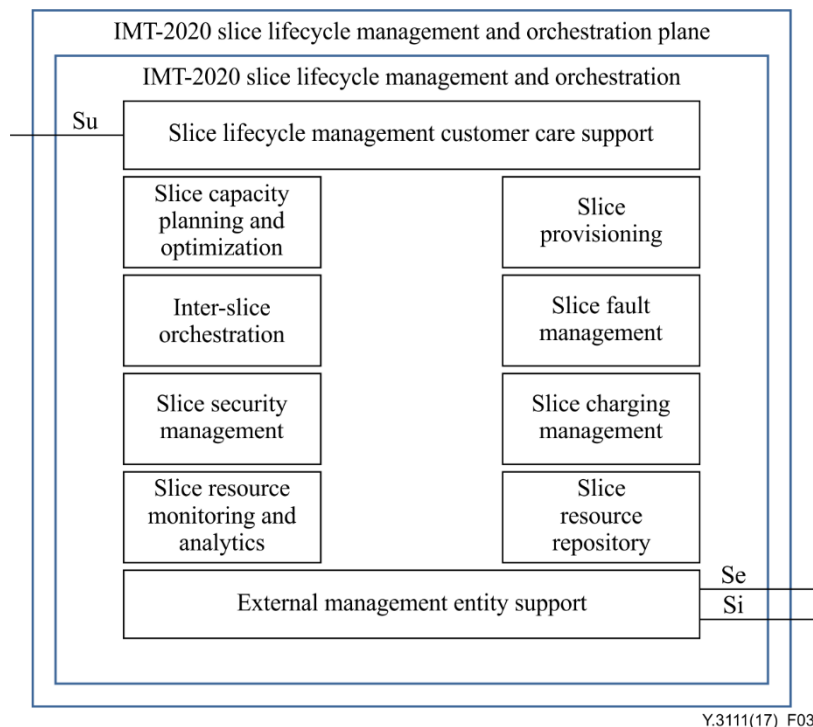


Figure 3 – Slice lifecycle management and orchestration functional component

IMT-2020 slice lifecycle management customer care support

The IMT-2020 slice lifecycle management customer care support (SLM-CCS) functional element provides a standard interface to the slice lifecycle management functionality to its customers and applications. It supports requesting and receiving management operations and associated information in SLM.

The request from slice customer to create a slice includes the specific catalogue of service requirements on network slice, e.g., service type (eMBB, mMTC, URLLC, etc.), slice priority, slice sharing option.

NOTE 1 – Slice priority is used to indicate that a network slice with higher priority has the preference to obtain resources under circumstances of limited resources.

NOTE 2 – The slice sharing option is used to indicate whether a network slice can be shared with other customers.

Slice capacity planning and optimization

The slice capacity planning and optimization (SCPO) functional element is responsible for the planning of necessary resources for the requested slice provisioning and optimizing usage of resources for creating and maintaining slices. It provides capabilities as follows:

- making planning decisions based on a slice catalog, available resources discovered by the slice resource monitoring and analytics functional element and customers' requests, slice sharing option and availability of existing or activated network slice instance;
- finding optimal available resource matches against a customer's request;
- monitoring and ensuring the quality of the provisioned slices and take the necessary actions (including re-provisioning or modification – e.g., scaling up/down – of the existing slice resource) if resource re-optimization is needed.

Slice provisioning

The slice provisioning (SP) functional element is responsible for provisioning requested slices by the customers and provides capabilities for:

- provisioning the requested slices by the customers;
- mapping and translating customer's high-level slice provisioning profile into technology-aware slice provisioning policies;
- managing provisioning policy lifecycle.

NOTE – Slice provisioning can involve interactions with the MANO network function virtualization (NFV) orchestrator, other NFV management systems, and/or software-defined network (SDN) controllers depending on the administration boundaries of the underlying slice resources. If the SP functional element provides full provisioning capabilities, the slice provisioning can be done internally by itself. If interactions with external provisioning functional entities are needed, it can be done through IMT-2020MPS functional element which is the interface to the external IMT-2020 management systems.

Inter-slice orchestration

The inter-slice orchestration (ISO) functional element is responsible for the orchestration of inter-slice matters and provides capabilities for:

- orchestrating multiple slices provisioning;
- resolving inter-slice quality, fault, anomaly, and charging issues.

Slice fault management

The slice fault management (SFM) functional element is responsible for the fault management of the provisioned slices and provides capabilities for: