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Recommendation

ITU-T Y.3127 (12/2023)

SERIES Y: Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

Future networks

Future networks including IMT-2020 – Requirements and framework for self-organizing core network

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Recommendation ITU-T Y.3127

Future networks including IMT-2020 – Requirements and framework for self-organizing core network

Summary

The self-organizing core network (SOCN) is a core network constituted by a group of self-organized network entities cooperating to provide core network functions based on available network capabilities and resources. It may reduce the capital expenditure and operating expense of core networks by efficiently utilizing available network capabilities and resources. Recommendation ITU-T Y.3127 provides an overview, and specifies requirements, framework and general procedures of a self-organizing core network, in the context of future networks including IMT-2020.

History *

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Core network, framework, future networks, IMT-2020, requirements, self-organizing.

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1 Scope

This Recommendation specifies the requirements and framework for a self-organizing core network (SOCN), in the context of future networks including IMT-2020.

The self-organizing core network is a core network constituted by a group of self-organized network entities cooperating to provide core network functions based on available network capabilities and resources. This Recommendation addresses the following aspects of self-organizing core network in future networks including IMT-2020:

- Overview;
- Requirements;
- Framework;
- General procedures.

Some relevant use cases are provided in Appendix I.

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 X.1313] Recommendation ITU-T X.1313 (2012), *Security requirements for wireless sensor network routing.*

[ITU-T Y.3101] Recommendation ITU-T Y.3101 (2018), *Requirements of the IMT-2020 network.*

[ITU-T Y.3102] Recommendation ITU-T Y.3102 (2018), *Framework of the IMT-2020 network.*

[ITU-T Y.3104] Recommendation ITU-T Y.3104 (2018), *Architecture of the IMT-2020 network.*

[ITU-T Y.3105] Recommendation ITU-T Y.3105 (2018), *Requirements of capability exposure in the IMT-2020 network.*

[ITU-T Y.3108] Recommendation ITU-T Y.3108 (2019), *Capability exposure function in IMT-2020 networks*.

[ITU-T Y.3110] Recommendation ITU-T Y.3110 (2017), *IMT-2020 network management and orchestration requirements*.

[ITU-T Y.3111] Recommendation ITU-T Y.3111 (2017), *IMT-2020 network management and orchestration framework.*

[ITU-T Y.3114] Recommendation ITU-T Y.3114 (2022), *Future networks including IMT-2020: requirements and functional architecture of lightweight core for dedicated networks.*

[ITU-T Y.3172] Recommendation ITU-T Y.3172 (2019), *Architectural framework for machine learning in future networks including IMT-2020.*

[ITU-T Y.3300] Recommendation ITU-T Y.3300 (2014), *Framework of software-defined networking.*

[ITU-T Y.3324] Recommendation ITU-T Y.3324 (2018), *Requirements and architectural framework for autonomic management and control of IMT 2020 networks.*

[ITU-T Y.4417] Recommendation ITU-T Y.4417 (2018), *Framework of self-organization networking in Internet of things environments.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 control plane [b-ITU-T Y.2011]: The set of functions that controls the operation of entities in the stratum or layer under consideration, plus the functions required to support this control.

3.1.2 data plane [b-ITU-T Y.2011]: The set of functions used to transfer data in the stratum or layer under consideration.

3.1.3 dedicated network [ITU-T Y.3114]: A network designed for application domains with common requirements.

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].

3.1.5 machine learning (ML) [ITU-T Y.3172]: Processes that enable computational systems to understand data and gain knowledge from it without necessarily being explicitly programmed.

3.1.6 network function [b-ITU-T Y.3100]: In the context of IMT-2020, a processing function in a network.

3.1.7 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.

3.1.8 user plane [b-ITU-T Y.2011]: A synonym for data plane.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 self-organizing core network (SOCN): A core network constituted by a group of self-organized network entities cooperating to provide core network functions based on the available network capabilities and resources.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI Artificial Intelligence

AMC Autonomic Management and Control

AN Autonomous Network

FCAPS Fault, Configuration, Accounting, Performance, Security

FMC Fixed Mobile Convergence

FMSC	Fixed, Mobile and Satellite Convergence
GBR	Guaranteed Bit Rate
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
LEO	Low Earth Orbit
ML	Machine Learning
NACF	Network Access Control Function
PCF	Policy Control Function
QoS	Quality of Service
RP	Reference Point
SDN	Software-Defined Networking
SOCN	Self-Organizing Core Network
SON	Self-Organized Network
TCP	Transmission Control Protocol
UAV	Unmanned Aerial Vehicle
UDP	User Datagram Protocol
UE	User Equipment
USM	Unified Subscription Management

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 Recommendation 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 "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 of self-organizing core network

The self-organizing core network (SONC) is a core network constituted by a group of self-organized network entities cooperating to provide core network functions based on available network capabilities and resources, in the context of future networks including IMT-2020. There is a single head entity and multiple member entities in a self-organizing core network. A group of network entities in a specific region, which constitute a self-organizing core network, automatically elect the head entity based on different factors, e.g., capabilities, resources, reliability, robustness, and mobility. The head entity takes the role of organizing the core network, while a member entity takes the role of constituting the core network under the control of the head entity. The head entity distributes the IMT-2020 core network functions to itself and each member entity. In the case that the head entity loses network connection, the member entities re-elect the head entity, and the

newly-elected head entity reorganizes the core network. In the case that a member entity loses network connection, the head entity reorganizes the core network. In summary, a self-organizing core network is a kind of autonomous network (AN) [b-ITU-T Y.3061], addressing the organization and operation of a core network in the function level.

With the introduction of innovative technologies including self-organization networking [ITU-T Y.4417], clustering networking [ITU-T X.1313], software-defined networking (SDN) [ITU-T Y.3300], and artificial intelligence (AI) / machine learning (ML) [ITU-T Y.3172], it is technically feasible to deploy the self-organizing core network in the context of future networks including IMT-2020. The self-organizing core network may reduce the capital expenditure and operating expense of core networks by efficiently utilizing available network capabilities and resources.

The use of a self-organizing core network is suited for, but not limited to, the following use cases:

- The use case of a network with high mobility, such as a vehicular network, an unmanned aerial vehicle (UAV) network, and a satellite network, in which the core network is required to adapt to the dynamic network topology;
- The use case of a network deployed to meet dynamic service requirements, such as emergency communications, event communications, and disaster recovery, in which the core network is required to be deployed in a timely manner;
- The use case of a network requiring extensive customization on functionalities, interfaces, protocols, and procedures, which may not fully conform to the requirements and design principles of the IMT-2020 core network [ITU-T Y.3104];
- The use case of a network requiring secure isolation from other networks, which may not be required to be supported in the IMT-2020 core network [ITU-T Y.3104];
- The use case of a network requiring AI/ML related capabilities, which may not be required as basic capabilities of the IMT-2020 core network [ITU-T Y.3104].

Specifically, the use cases of satellite-based wireless core networks and wireless core networks for emergency communications are provided in Appendix I.

7 Requirements of self-organizing core network

7.1 General requirements of self-organizing core networks

The general requirements of the self-organizing core network are as follows:

- It is required for self-organizing core networks to support the use cases identified in this Recommendation.
- It is required for self-organizing core networks to support the services and applications supported by the IMT-2020 network, as specified in [ITU-T Y.3101].
- It is required for self-organizing core networks to be compatible with user equipment (UE) and access networks supported by the IMT-2020 network.
- It is required for self-organizing core networks to support interworking with IMT-2020 networks.
- It is recommended for self-organizing core networks to support interworking with different access networks, including fixed access, mobile access and satellite access.
- It is required for self-organizing core networks to automatically organize and manage the IMT-2020 core network functions, as specified in [ITU-T Y.3102] and [ITU-T Y.3104].
- It is recommended for self-organizing core networks to support the following enabling technologies: self-organization networking [ITU-T Y.4417], clustering networking [ITU-T X.1313], SDN [ITU-T Y.3300], and AI/ML [ITU-T Y.3172].

- It is required for self-organizing core networks to discover and use services of the service plane.
- It is required for self-organizing core networks to have the ability to implement energy-efficient operations.

  NOTE 1 – The self-organizing core network may be deployed on nodes which have limitations on energy supply, such as vehicles, UAV and satellites.
- It is required for a self-organizing core network to exploit the mobility of its nodes.

  NOTE 2 – The mobile nodes may include, but are not limited to, vehicles, UAV and satellites. The mobility of nodes may affect the network connection, network organization and network management of the self-organizing core network, as specified in clause 9.
- It is required for self-organizing core networks to support the management and orchestration capability, as specified in [ITU-T Y.3110] and [ITU-T Y.3111].
- It is recommended for self-organizing core networks to use stateless and intent-driven protocols [b-ITU-T Y.2344].

7.2 Service requirements of self-organizing core networks

The service requirements supported by self-organizing core networks are as follows:

- It is required for self-organizing core networks to support the service requirements specified in [ITU-T Y.3101] and [ITU-T Y.3114].
- It is required for self-organizing core networks to support best-effort quality of service (QoS).
- It is recommended for self-organizing core networks to support guaranteed bit rate (GBR) QoS.
- It is recommended for self-organizing core networks to support service continuity among different access networks.
- It is recommended for self-organizing core networks to support traffic routing across different access networks.
- It is recommended for self-organizing core networks to have the ability to deploy services in a distributed manner using networking, computing and storage resources of the core networks, access networks and UEs.

7.3 Network capability requirements of self-organizing core network

The network capability requirements of self-organizing core networks are as follows:

- It is required for self-organizing core networks to support the network capability requirements specified in [ITU-T Y.3102] and [ITU-T Y.3104].
- It is required for self-organizing core networks to support the capability exposure requirements specified in [ITU-T Y.3105] and [ITU-T Y.3108].
- It is required for self-organizing core networks to support the customization of network functions based on the requirements of services and applications, including with respect to networking, computing and storage resources.
- It is required for self-organizing core networks to support the self-organizing capabilities [ITU-T Y.4417].
- It is recommended for self-organizing core networks to support fixed mobile convergence (FMC) [b-ITU-T Y.3131], and fixed, mobile and satellite convergence (FMSC) [b-ITU-T Y.3201].
- It is required for self-organizing core network to enable the use of AI/ML functionalities.

NOTE – The enabled AI/ML functionalities are internal to the self-organizing core network. These functionalities may be provided via an ML overlay [ITU-T Y.3172].

7.4 Network resource requirements of self-organizing core networks

The network resource requirements of self-organizing core networks are as follows:

- It is required for self-organizing core networks to manage the available resources.

  NOTE 1 – The resources include networking (e.g., access networks, core networks), computing and storage resources.
- It is required for self-organizing core networks to discover and use new resources.
- It is required for a self-organizing core networks to be able to cope with unreliable and constrained resources.

  NOTE 2 – The self-organizing core network may be deployed on nodes which have limitation on networking, computing and storage resources; also these resources may be deployed by unreliable sources.
- It is required to have the ability to implement self-organizing core networks using virtual resources [ITU-T Y.3300].
- It is recommended to have the ability to implement self-organizing core networks using terrestrial and satellite related resources [b-ITU-T Y.3201].

8 Framework of self-organizing core network

8.1 High-level framework of self-organizing core network

Figure 8-1 depicts the high-level framework of the self-organizing core network, in the context of future networks including IMT-2020.

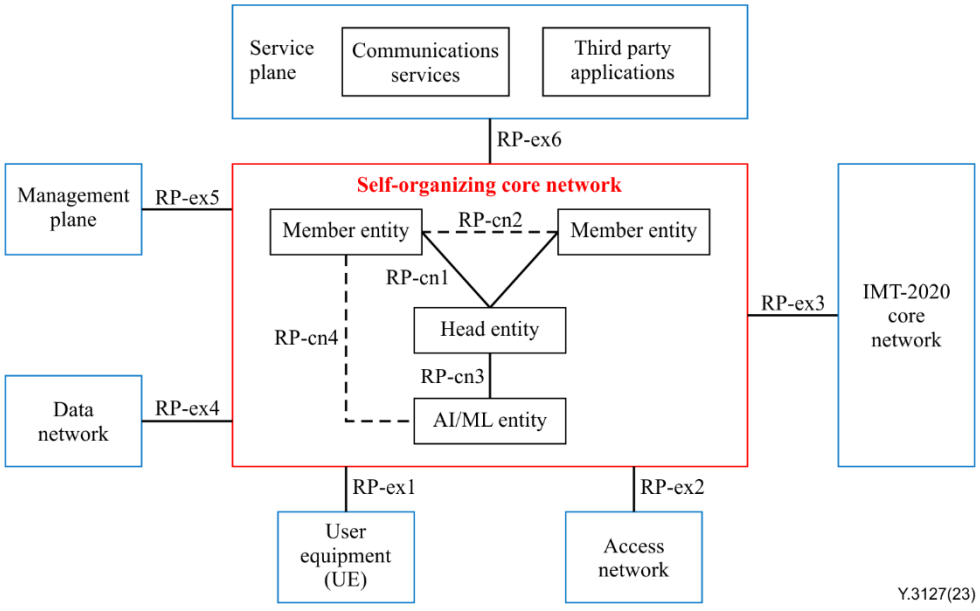

Figure 8-1 – High-level framework of self-organizing core network

In the high-level framework, the self-organizing core network interoperates with UE, access network, data network, management plane, and service plane, and may interoperate with other IMT-2020 core network(s). The self-organizing core network consists of a single head entity, multiple member entities, and an optional single entity supporting AI/ML functionalities (AI/ML entity), working in a self-organized and dynamic fashion. The interface between the head entity and a member entity, and the interface between the head entity and the AI/ML entity are required; while

the interface between member entities, and the interface between a member entity and the AI/ML entity are optional.

The self-organizing core network entities, i.e., the head entity, member entities and the AI/ML entity, operate in terms of control plane and user plane of the core network.

The self-organizing core network performs the organization and operation of a core network with the general procedures of network connection, network organization, network operation and network management, as specified in clause 9.

8.2 Functional entities of self-organizing core network

8.2.1 Head entity

The head entity is a required functional entity. It takes the role of organizing the core network in the function level. The role of core network organization includes, but is not limited to, distributing the core network functions to itself and each member entity; determining the service procedures between itself and each member entity; determining the service procedures between member entities; and reorganizing the core network in case that a member entity loses network connection. The head entity is automatically determined in the process of network organization; it is elected based on different factors, e.g., capabilities, resources, reliability, robustness, and mobility. The head entity consists of control related functionalities, user related functionalities and data related functionalities; and supports the processes of network organization, network operation and network management.

NOTE – The function level corresponds to the network functions of the IMT-2020 core network [ITU-T Y.3102] and [ITU-T Y.3104].

8.2.2 Member entity

A member entity is a required functional entity. It takes the role of constituting the core network in the function level, under the control of the head entity. A member entity is automatically determined in the process of network organization; it re-elects the head entity in case that the head entity loses network connection. A member entity consists of control related functionalities, user related functionalities and data related functionalities; and supports the processes of network organization, network operation and network management.

8.2.3 AI/ML entity

The AI/ML entity is an optional functional entity. It interacts with the head entity and the member entities to assist in the processes of self-organized network organization, network operation and network management. The AI/ML entity takes the role of AI/ML overlay [ITU-T Y.3172] internal to the self-organizing core network. The AI/ML entity may also use AI/ML related functionalities provided externally to the self-organizing core network as an AI/ML overlay. The AI/ML entity may adopt the high-level architectural framework specified in [ITU-T Y.3172].

8.3 Functions external to self-organizing core network

8.3.1 User equipment

The user equipment (UE) includes, but is not limited to, handset terminals, wearable terminals, customer premise equipment, satellite terminals and multi-access terminals.

8.3.2 Access network

The access network includes a fixed access network, mobile access network and satellite access network.

8.3.3 IMT-2020 core network

The IMT-2020 core network external to the self-organizing core network includes the core networks specified in [ITU-T Y.3102], [ITU-T Y.3104] and [ITU-T Y.3114].

8.3.4 Data network

The data network plays the same role as the data network specified in [ITU-T Y.3104].

8.3.5 Management plane

The management plane provides the functionalities for the management of the self-organizing core network according to the management functional areas listed in [b-ITU-T M.3010], i.e., performance management, fault management, configuration management, accounting management and security management, also known as fault, configuration, accounting, performance, security (FCAPS) functional areas.

These functionalities are expected to include the management of the functional entities of the self-organizing core network.

NOTE 1 – The detailed operations involving the management plane are out of scope of this Recommendation.

NOTE 2 – [b-SMN] provides an example for self-managed network, in which the management plane functionalities are addressed.

8.3.6 Service plane

The service plane supports communications services and third party applications.

Communications services may use the service invoking interfaces of the self-organizing core network, while third party applications may use the capability exposure interfaces of the self-organizing core network.

8.4 Reference points of self-organizing core network

Some of the reference points of the self-organizing core network are the same as the reference points of an IMT-2020 network; while others reflect the specific requirements of the three types of involved functional entities, i.e., head entity, member entity and AI/ML entity. As shown in Figure 8-1, the self-organizing core network has 4 internal reference points (RPs) and 6 external reference points as follows:

- RP-cn1: The reference point exists between the head entity and a member entity. This reference point is recommended to adopt the protocol stack based on hypertext transfer protocol (HTTP) [b-IETF RFC 7540] / Transmission control protocol (TCP) / Internet protocol (IP) for control plane [b-ITU-T Y.2011]; and the protocol stack based on HTTP / user datagram protocol (UDP) / IP for user plane [b-ITU-T Y.2011].
- RP-cn2: The reference point exists between member entities. This reference point is recommended to adopt the protocol stack based on HTTP [b-IETF RFC 7540] / TCP / IP for control plane [b-ITU-T Y.2011]; and the protocol stack based on HTTP / UDP / IP for user plane [b-ITU-T Y.2011].
- RP-cn3: The reference point exists between the head entity and the AI/ML entity. This reference point is recommended to adopt the protocol stack based on HTTP [b-IETF RFC 7540] / UDP / IP.
- RP-cn4: The reference point exists between a member entity and the AI/ML entity. This reference point is recommended to adopt the protocol stack based on HTTP [b-IETF RFC 7540] / UDP / IP.

- RP-ex1: The reference point exists between the UE and the self-organizing core network. RP-ex1 corresponds to the reference point RP-tn as defined in [ITU-T Y.3104]. The details of this reference point are out of the scope of this Recommendation.
- RP-ex2: The reference point exists between the access network and the self-organizing core network. RP-ex2 corresponds to the reference point RP-an as defined in [ITU-T Y.3104]. The details of this reference point are out of the scope of this Recommendation.
- RP-ex3: The reference point exists between the self-organizing core network and the IMT-2020 core network. RP-ex3 corresponds to the interoperability interfaces as defined in [b-3GPP TS 23.501]. The details of this reference point are out of the scope of this Recommendation.
- RP-ex4: The reference point exists between the self-organizing core network and the data network. RP-ex4 corresponds to the reference point RP-ud as defined in [ITU-T Y.3104]. The details of this reference point are out of the scope of this Recommendation.
- RP-ex5: The reference point exists between the self-organizing core network and the management plane, including, but not limited to, network function management interfaces, network connection management interfaces, resource management interfaces, capability management interfaces, and user management interfaces. The details of this reference point, including the operations carried out via this reference point, are out of the scope of this Recommendation.
- RP-ex6: The reference point exists between the self-organizing core network and the service plane, including service invoking interfaces and capability exposure interfaces. The details of this reference point are out of the scope of this Recommendation.

8.5 Enabling technologies of self-organizing core network

In support of the network connection, network organization, network operation and network management of the self-organizing core network, the enabling technologies of the self-organizing core network include the following:

- Self-organization networking

Self-organization networking refers to networking established by individual devices where the devices interact with their peers and perform self-control. The self-organizing core network uses self-organization networking technologies for dynamic and flexible network connection and network organization of functional entities. The self-organization networking functionalities are specified in [ITU-T Y.4417].

- Clustering networking

Clustering networking is a networking method in which neighbouring nodes advertise their existence to each other to form a cluster, where a clustering head has more computing resources for information processing. The self-organizing core network uses clustering networking technologies for efficient network connection and network organization of functional entities. The clustering networking functionalities are specified in [ITU-T X.1313].

- SDN

SDN is 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. The self-organizing core network uses SDN technologies for dynamic and flexible network connection, network organization and network management of functional entities. The basic SDN functionalities are specified in [ITU-T Y.3300].

- AI/ML

The self-organizing core network uses AI/ML technologies for automatic network organization, network operation and network management of functional entities.

NOTE – The basic ML functionalities are specified in [ITU-T Y.3172].

9 General procedures of self-organizing core network

This clause specifies the general procedures of self-organizing core networks, including network connection procedure, network organization procedure, network operation procedure, and network management procedure. The network operation procedure and network management procedure are provided in the form of examples. These general procedures do not impact the detailed procedures of the IMT-2020 network specified in [ITU-T Y.3104], which include registration management procedures, connection management procedures, session management procedures, and handover procedures.

9.1 Network connection procedure

Figure 9-1 depicts the network connection procedure of a self-organizing core network.

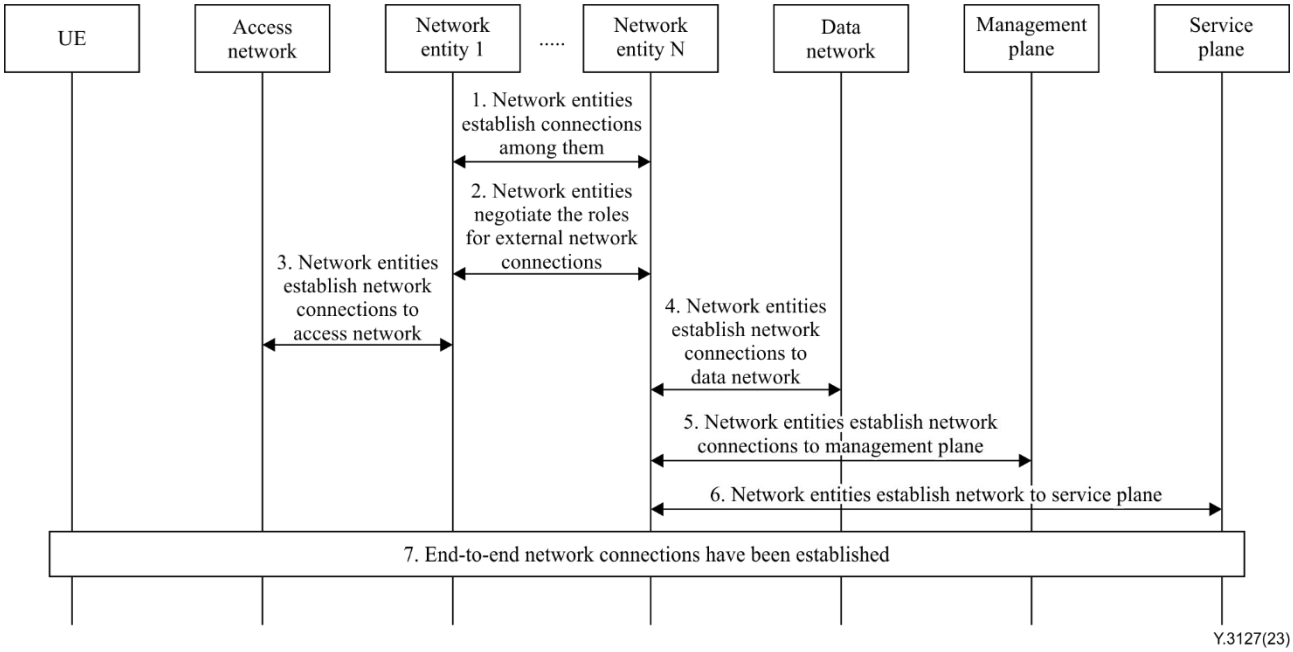

Figure 9-1 – Network connection procedure of self-organizing core network

The steps shown in Figure 9-1 are as follows:

1) A group of network entities in a specific region establish network connections among them in a self-organized manner.

2) The group of network entities negotiate their roles for external network connections in a self-organized manner, in which the roles include connecting to the access network, connecting to the data network, connecting to the management plane, and connecting to the service plane.

3) Based on the role for external network connections, some of the network entities establish network connections to the access network.

4) Based on the role for external network connections, some of the network entities establish network connections to the data network.

5) Based on the role for external network connections, some of the network entities establish network connections to the management plane.

6) Based on the role for external network connections, some of the network entities establish network connections to the service plane.

7) The end-to-end network connections, which include the network connections among UE, access network, network entities, data network, management plane and service plane, have been established.

9.2 Network organization procedure

Figure 9-2 depicts the network organization procedure of a self-organizing core network.

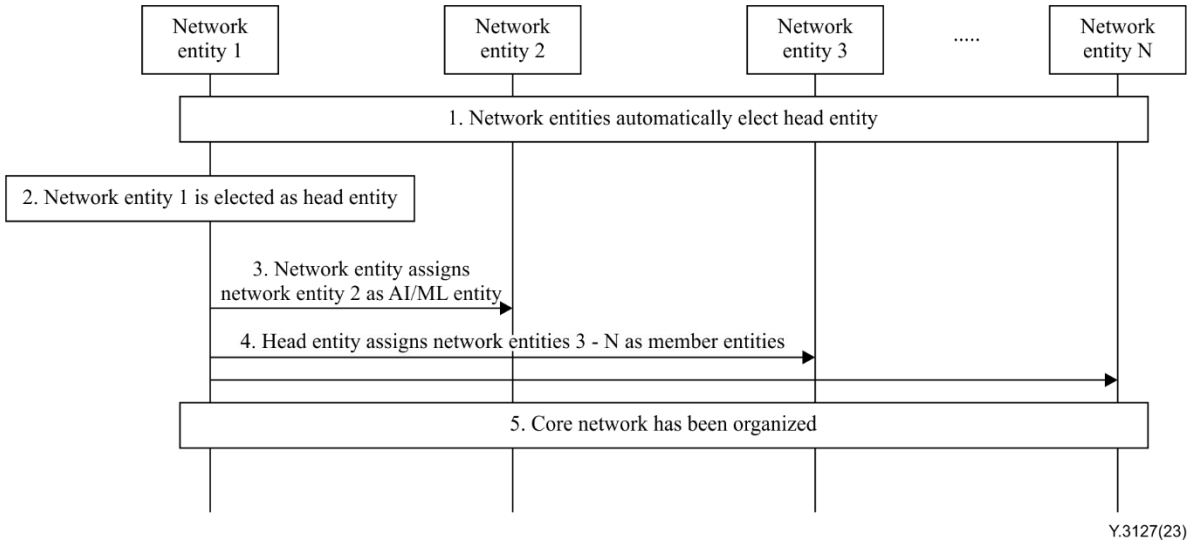

Figure 9-2 – Network organization procedure of self-organizing core network

The steps shown in Figure 9-2 are as follows:

1) A group of network entities automatically elect the head entity in a self-organized manner, based on different factors, e.g., capabilities, resources, reliability, robustness, and mobility.

2) The network entity 1 is elected as the head entity, it takes the role of organizing the core network in the function level. The head entity distributes some of IMT-2020 core network functions to itself.

3) The head entity (network entity 1) considers the AI/ML related functionalities of other network entities, and assigns network entity 2 as the AI/ML entity. The head entity distributes some of IMT-2020 core network functions to the AI/ML entity.

4) The head entity (network entity 1) assigns network entities 3-N as member entities. The head entity distributes some of IMT-2020 core network functions to member entities.

5) The core network has been organized under the control of the head entity.

9.3 Network operation procedure

Figure 9-3 depicts an example of network operation procedure of a self-organizing core network.

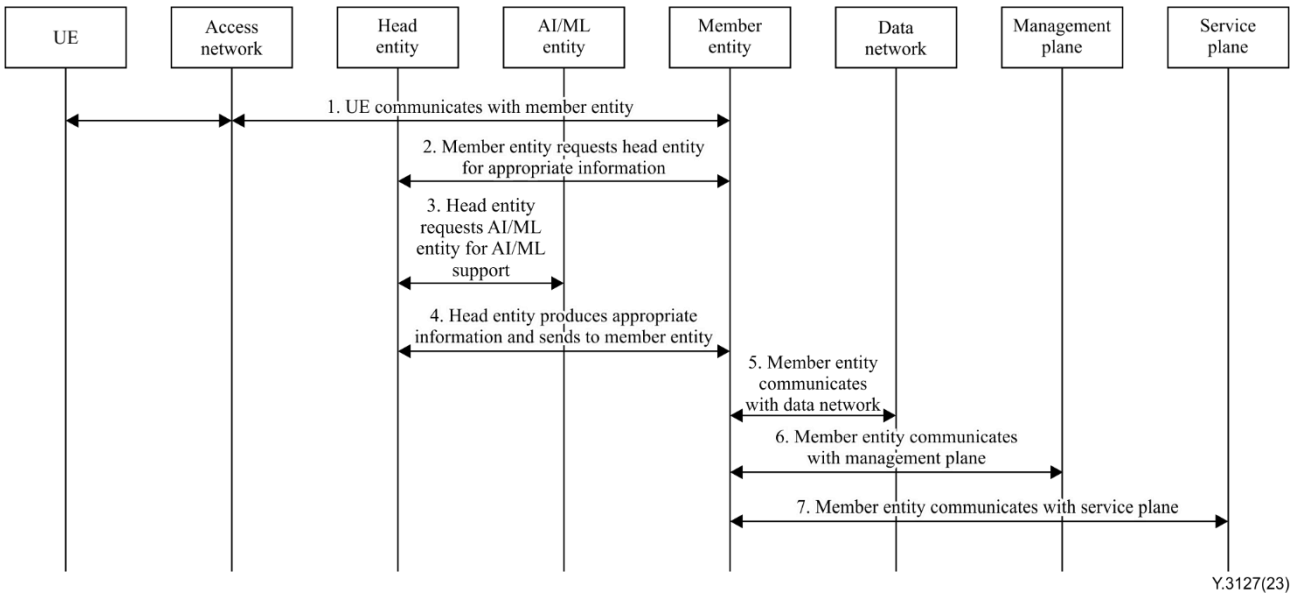

Figure 9-3 – An example of network operation procedure of self-organizing core network

The steps shown in Figure 9-3 are as follows:

1) The UE communicates with a member entity through the access network. In this example, the member entity contains the network access control function (NACF) [ITU-T Y.3102].

2) The member entity requests the head entity for appropriate information for the UE. In this example, the head entity contains the policy control function (PCF) and unified subscription management (USM) [ITU-T Y.3102]; the appropriate information is the available services and corresponding QoS.

3) The head entity requests the AI/ML entity for AI/ML support, i.e., to use AI/ML related functionalities of AI/ML entity. In this example, the head entity requests the AI/ML entity for the expected connection date rate for the UE, which is useful for determining which services and corresponding QoS can be provided to the UE.

4) The head entity produces appropriate information with AI/ML support, and sends appropriate information to the member entity.

5) The member entity communicates with the data network.

6) The member entity communicates with the management plane.

7) The member entity communicates with the service plane.

9.4 Network management procedure

Figure 9-4 depicts an example of network management procedure of a self-organizing core network.

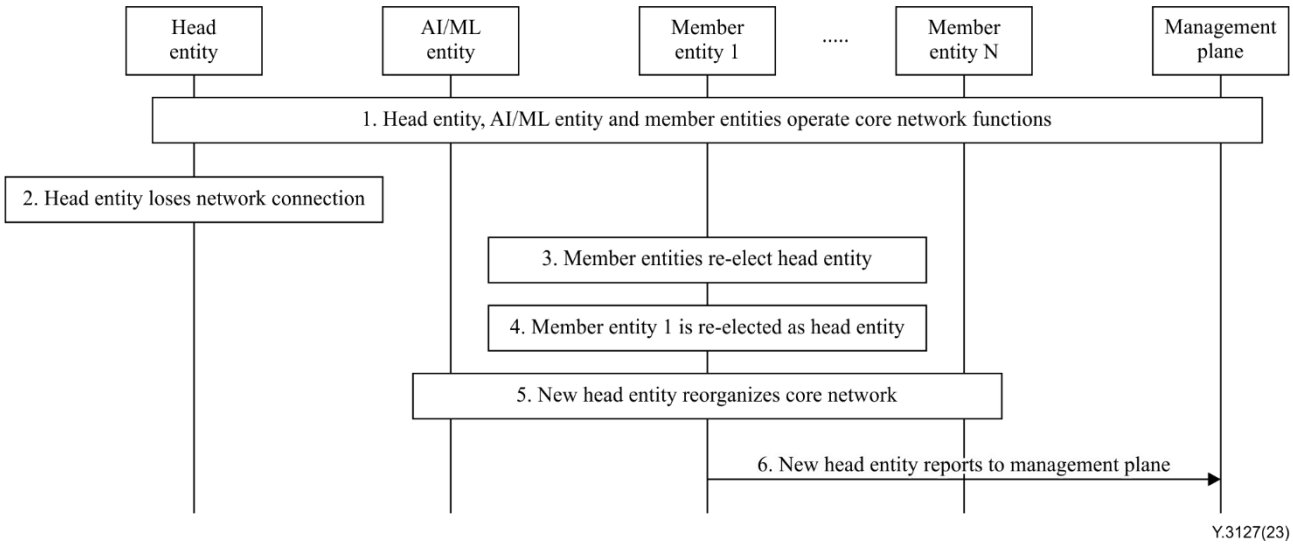

Figure 9-4 – An example of network management procedure of self-organizing core network

The steps shown in Figure 9-4 are as follows:

1) The head entity, AI/ML entity and member entities operate core network functions, under the management of the management plane.
2) The head entity loses network connection.
3) The member entities re-elect the head entity in a self-organized manner.
4) The member entity 1 is re-elected as the head entity.
5) The new head entity (original member entity 1) reorganizes the core network, including the assignment of AI/ML entity and member entities.
6) The new head entity (original member entity 1) reports to the management plane about the reorganization of core network.

10 Security considerations

The security and privacy considerations of a self-organizing core network include the following aspects:

- Functional entity security, which includes the security considerations on the head entity, member entities, and AI/ML entity. The secure operations of control related functionalities, user related functionalities, data related functionalities, and AI/ML related functionalities are to be addressed.
- Interoperation security, which refers to the secure interoperation between functional entities of the self-organizing core network and external functions (including UE, access network, IMT-2020 core network, data network, management plane, and service plane). The mechanisms for secure interoperation are to be addressed.
- User and service privacy, which include the privacy considerations on the processes of the self-organized network connection, network organization, network operation and network management, in which the privacy sensitive user data and service data are stored, cached and processed.

In addition, the security and privacy considerations of self-organizing core network should be aligned with the requirements specified in [ITU-T Y.3101] and [b-ITU-T Y.2701].

Appendix I

Use cases of self-organizing core network

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

Use case 1: Satellite-based wireless core network

With the development of satellite communications technologies, especially low earth orbit (LEO) satellite communications technologies, the technical capabilities of satellite communications are enhanced to the level of 4G/IMT-Advanced or 5G/IMT-2020, and the use cases and services of satellite communications are enriched. In geographic areas such as oceans, seas, deserts, deep mountain, deep forest, and polar regions, and in the scenarios of international roaming and global communications, there exists the need to introduce satellite-based core networks, which could complement and interact with land-based core networks.

However, LEO satellite has high mobility with respect to the ground and with respect to LEO satellites of different orbits. In addition, the communications capabilities and capacity of LEO satellites are relatively limited, typically similar to a land-based base stations; it is practically impossible to deploy all the network functions of IMT-2020 core network in one LEO satellite. Therefore, it is required for satellite-based wireless core networks to support distributed deployment in dynamic network topology, and to dynamically load network functions on different LEO satellites on demand. Traditional IMT-2020 core network does not possess these capabilities.

NOTE – Even in the same LEO constellation, the LEO satellites are distributed in different orbits.

Consisting of a group of self-organized network entities cooperating to provide core network functions based on the available network capabilities and resources, the self-organizing core network possesses the capabilities to be deployed in dynamic network topology and to dynamically load network functions. Therefore, the self-organizing core network is a potential and technically possible solution for satellite-based core networks.

Experiments on self-organizing core networks based on LEO satellites have been already conducted, proving it is a technically possible solution. Some of the LEO constellations have already deployed core network functions on the satellites, and self-organizing core networks may be introduced. Considering that a LEO constellation has the capabilities to provide communications services to multiple regions and multiple operators, interoperable self-organizing core networks are needed.

Use case 2: Wireless core network for emergency communications

In emergency scenarios, such as earthquakes, floods, tsunamis and typhoons, land-based communications infrastructure and networks may be damaged or destroyed. However, the communications requirements increase dramatically in the geographic areas in an emergency, and it is of great importance to satisfy these communications requirements for their economic and social benefits. However, traditional IMT-2020 core network requires a relatively long time for deployment, typically a couple of days or a couple of weeks, which could not satisfy the sudden spikes in communications requirements.

Consisting of a group of self-organized network entities cooperating to provide core network functions based on the available network capabilities and resources, the self-organizing core network requires much less time for deployment than traditional networks, typically a couple of hours. Therefore, the self-organizing core network is a potential and technically possible solution for wireless core network for emergency communications.

The self-organizing core network has already been deployed in the form of a "5G customized core network", which aims to meet the requirements of emergency communications. Considering that emergencies may occur over a vast area, covering multiple regions and multiple operators, interoperable self-organizing core networks are needed.

Bibliography

[b-ITU-T M.3010] Recommendation ITU-T M.3010 (2000), *Principles for a telecommunications management network.*

[b-ITU-T Y.2011] Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks.*

[b-ITU-T Y.2344] Recommendation ITU-T Y.2344 (2024), *Scenarios and requirements of intent-based network for network evolution.*

[b-ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1.*

[b-ITU-T Y.3061] Recommendation ITU-T Y.3061 (2023), *Autonomous networks - Architecture framework.*

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

[b-ITU-T Y.3131] Recommendation ITU-T Y.3131 (2019), *Functional architecture for supporting fixed mobile convergence in IMT-2020 networks.*

[b-ITU-T Y.3201] Recommendation ITU-T Y.3201 (2023), *Fixed, mobile and satellite convergence – Framework for IMT-2020 networks and beyond.*

[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-3GPP TS 23.501] Recommendation 3GPP TS 23.501 (2022), *System architecture for the 5G System (5GS), Stage 2 (Release 17).*

[b-IETF RFC 7540] IETF RFC 7540 (2020), *Hypertext Transfer Protocol Version 2 (HTTP/2).*

[b-SMN] M. Toy, *Self-Managed Networks with Fault Management Hierarchy*, in Procedia Computer Science, vol. 36, pp. 373-380, 2014.

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