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Part 2: Proxy model-based quality of service

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Partie 2: Qualité de service basée sur un modèle de proxy

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Foreword

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Introduction

This document and ISO/IEC 21559-2 both pertain to the Future Network (FN).

This document analyses and specifies how to define the Future Network Quality of Service (FNQoS) based on AI-proxy, and how to express the architecture of FNQoS information system based on FNProxy. The goal of the FNQoS is directly related to ISO/IEC TR 29181-8.

FNQoS architecture not only defines the FNProxy contents of FNQoS, but also describes the necessary functional support required for the operation of FNQoS system. Further, FNQoS architecture itself is the basis for the normal operation of the protocol mechanism supporting FNProxy interaction specified in ISO/IEC 21559-2.

The function of Bidirectional Service (Bi-S) for interaction among FNProxies is the basic element of the FNQoS system. This document is based on the basic elements of Bi-S using ISO/IEC 19501 and ISO/IEC/IEEE 42010 to analyse and stipulate the reusable pervasive reference architecture technology of FNQoS.

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Telecommunications and information exchange between systems — Future network architecture —

Part 2: Proxy model-based quality of service

1 Scope

This document describes the architectural aspects of Future Network (FN) Quality of Service (QoS) based on an FNProxy model, taking into account the requirements described on ISO/IEC TR 29181-8. It describes:

— the concept of future network QoS (FNQoS),

— the architectural model of FNQoS system,

— the usage of FNQoS system.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 21559-2, *Telecommunications and information exchange between systems — Future network protocols and mechanisms — Part 2: Proxy model-based quality of service*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org

3.1 FNQoS Composition

3.1.1
Future Network Proxy
FNProxy
element or device to improve *Future Network Quality of Service (FNQoS)* (3.1.2) in the Future Network environment

3.1.2
Future Network Quality of Service
FNQoS
set of the comprehensive behaviour effects of services based on interactions among/between two or more FNProxies to meet the requirements of a Future Network

3.1.3
FNQoS System
information system that provides FNQoS based on the FNProxy model

Note 1 to entry: As the FNQoS system is an information system, there are two working modes: the first is the distribution mode, the second is the central mode. The distribution mode means that the FNQoS system can be distributed among all FNProxies; the central mode means that the FNQoS system is the centre of all FNProxies.

3.1.4
FNProxy Interface
set of elements that are defined as a named operation that are used to describe the behaviour

3.1.5
Domains in FNQoS system
functional classification in the FNQoS system which can be used by software programs

3.1.6
Engines in FNProxy
program that can actively complete specific tasks in an FNProxy

3.1.7
FNProxy Harmony Relation
FHR
relationship when two FNProxies interact

Note 1 to entry: For the effect evaluation or quantitative calculation of FHR, see ISO/IEC 21559-2:2023, Annex A.

Note 2 to entry: FNProxy Harmony can also be referred to as Machine Harmony or inter-machine Harmony in order to distinguish that the word "Harmony" has a special spiritual meaning for people.

3.1.8
Multiple FNProxies Harmony Relation
MFHR
relationship of multiple FHRs in an FNQoS system composed of three or more FNProxies

3.1.9
Bidirectional Services at Interaction Reference Point between two FNProxies
Bi-S
specialized service between two FNProxies

Note 1 to entry: The middle position of two FNProxies is called Bi-S interaction reference point.

Note 2 to entry: The interactive service between FNProxies across the Bi-S reference point has the concurrency, synchronization and bidirectional effect in nature.

Note 3 to entry: The Bi-S is one of the basic technical elements of FNQOS system.

3.2 Abbreviated terms

AI	Artificial Intelligence
AIEN	Artificial Intelligence Enabled Networking
AL	Access Layer
Bi-S	Bidirectional Service
CM	Conceptual Model
FHR	FNProxy Harmony Relation

FN	Future Network
HMI	Human Machine Interface
MFHR	Multiple FNProxies Harmony Relation
QoS	Quality of Service
RA	Reference Architecture
RM	Reference Model

4 Concept of FNQoS

4.1 Description of FNProxy

FNProxy has the abilities to provide services for specific FNProxies, and also to give requirements to other FNProxies. The component software or device that conforms to the FNProxy model includes the following three functions:

a) dynamic perception of special FNProxy requirements or changes in the environment;

b) negotiate with itself to sign a service contract according to the perceived requirements;

c) execute according to the signed quantity of the contract.

The software that performs each function is called perception, negotiation and execution engine in FNProxy.

The three engines of an FNProxy periodically perform the following real-time steps:

— The perception engine perceives the requirements from a special FNProxy or the requirements of environmental changes according to perception strategy.

— The negotiation engine compares the perceived requirements with FNProxy's own capability. If the perceived requirements can be satisfied by the FNProxy's capability, the FNProxy signs a service contract with the special FNProxy. Otherwise, according to the negotiation strategy, the requirements will be transited to other FNProxies.

— After executing according to the contract, the execution engine can put forward relevant requirements to specific FNProxy or other FNProxy according to the current execution value and the FNProxy's own configuration strategy until a new contract is generated.

4.2 Type of FNProxy

There are many software or devices that follow the FNProxy model in an FNQoS system. They are referred to as respective working FNProxies for specific goals. Any FNProxy has two functions: one is to provide services for the requirements of other FNProxies; the other is to make service requests to other FNProxies according to this FNProxy strategy (i.e. to make requirements). Each FNProxy has the capabilities to provide different types of services. The types of service capability of an FNProxy is determined by the characteristics of its own capability. Only if the type of service capability of one FNProxy matches the type of the required service from the other FNProxy, one FNProxy can provide services for the other FNProxy.

4.3 FNProxy interaction

4.3.1 General

The services of each FNProxy are one-way. When there is a pair of FNProxies, the mutual services of the two FNProxies represent the bidirectional property of their services based on Bi-S reference point. FNProxy interaction is the objective to improve the effect of the FNQoS system. FNProxy pairs can achieve bidirectional interaction through an FNProxy interface.

4.3.2 Bi-S based operator

A Bi-S based FNProxy interaction shown on the left in Figure 1 enhances the FNProxy interaction effect of the FNQoS system compared with the traditional QoS method.

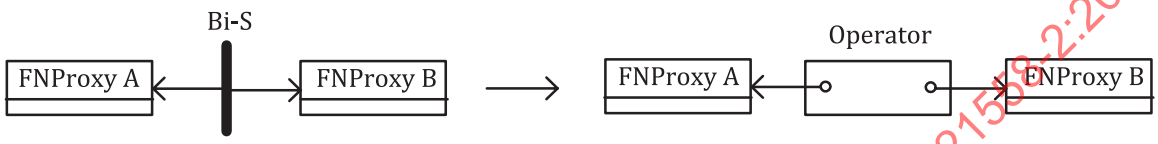

Figure 1 — Bi-S based interaction operator

The interoperation process of each pair of FNProxy based on Bi-S in the FNQoS system has an identified, specialized operational flow.

In order to facilitate a good understanding of the software implementation mechanism in the FNQoS system, the operational steps of FNProxy interaction can be viewed in the same way as the steps of an operator. The corresponding operator is shown on the right in the Figure 1.

The operation process is called the “operator function” of an FNProxy pair in the FNQoS system.

When two interacting FNProxies are connected at Bi-S position, the operator is generated by developer at this location. The task of the operator is dedicated to processing the Bi-S. In this case, the mutual service process of FNProxies is regarded as the operation between FNProxies.

The formal mathematical meaning of the operator can be expressed as:

(FNProxy 1) operator (FNProxy 2)

The operator can be used as a reference in ISO/IEC 21559-2:2023, Annex A for the calculation of harmony measures of special FNQoS system. The operator can be also carefully defined in ISO/IEC 21559-2:2023, Annex B for the negotiation, binding, identification, registration, and administration computing of two FNProxies.

The interaction process between FNProxies can be fixed onto corresponding operators, which will greatly simplify the engineering implementation process of a specific FNQoS system. Focusing on operators can better illustrate the machine harmony effect brought by FN than focusing on interactive details.

4.3.3 Interaction meaning more than communication

When the interaction between FNProxies is used for transmission purposes, the mechanism of interaction protocol can be used for communication transmission.

The purpose of FNQoS system to improve the Quality of Service is not only to improve the QoS of communication transmission. Therefore, when analyzing the FNQoS system, designers should pay more attention to "interaction" in the broad sense rather than "communication" in the narrow sense.

4.3.4 FNProxy harmony in collaborations

FNProxy harmony is developed in FNProxy collaborations.

The relationship of FNProxy collaborations have the following steps:

a) one FNProxy makes a request to the other FNProxy;

b) both FNProxies negotiate to produce the agreement based on the requirement;

c) both FNProxies successfully implement the contract in accordance with their own strategy.

Introducing the FNProxy harmony concept is not only in related the clean-slate design approach of ISO/IEC TR 29181-1, but also for backward compatibility which helps improve the service ability of interactions between machine FNProxy and human user FNProxy in the FNQoS system.

The requirement of either FNProxy is realized by the service of the other and when either FNProxy leaves, FHR or machine harmony phenomenon (effect) will not exist. FHR refers specifically to the harmony between FNProxies, which has no spiritual meaning of harmony between people.

In FNQoS system, the relationship between machines and people is complex, which shows the interaction of FNProxies. The effect of interaction between two FNProxies is FHR, and the effect of interaction among multiple FNProxies is MFHR. See Annex B for the evolution process of FHR.

4.4 Composition of FNQoS system

4.4.1 General

The composition of FNQoS system is based on the architecture description method in ISO/IEC/IEEE 42010 and the symbols/figures in ISO/IEC 19501.

4.4.2 Relationships of FNProxies and domains

As described in 5.1, FNQoS system has six domains. They are FNProxy, User, Communication, Intelligence Resources, Operation and Management domain.

In Figure 2, the relationships among FNProxies and domains are shown. Composition and aggregation are two types of relationships.

FNProxy domain is a specific domain, which is composed of many FNProxies. It is a set of specialized functions of the FNQoS system developed by designers. The design of FNProxies in the FNProxy domain is the main goal that designers focus on when they implement the FNQoS system. The solid (black) arrows in ISO/IEC 19501 used in Figure 2 represent the composition relationship between the FNProxy domain and FNProxies.

Since FNProxies are elements or devices, each FNProxy should be aggregated from the capabilities of different domains. The hollow arrows in ISO/IEC 19501 are used in Figure 2 to express the aggregation relationship between the FNProxy and the domain.

Each FNProxy (software/hardware) of the FNProxy domain is a key element to improve the effect of the FNQoS system.

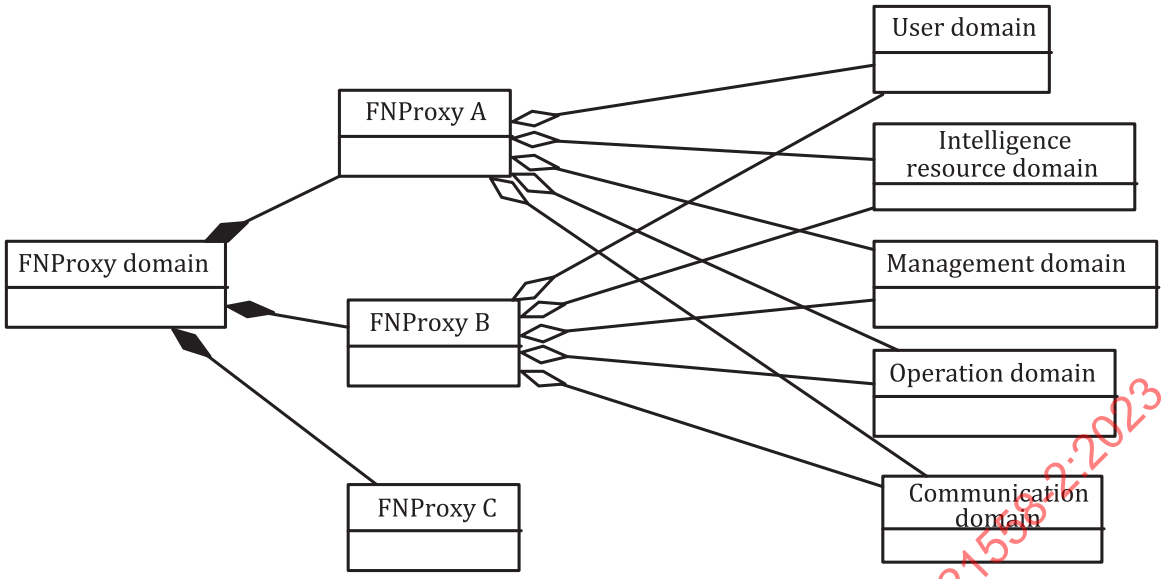

Figure 2 — Relationships between FNProxies and domain

4.4.3 Engines in FNProxy

Each FNProxy is composed of three different kinds of engines (perception, negotiation and execution) which can work independently or collaboratively.

The composition relationship between engines and the FNProxy is shown in Figure 3.

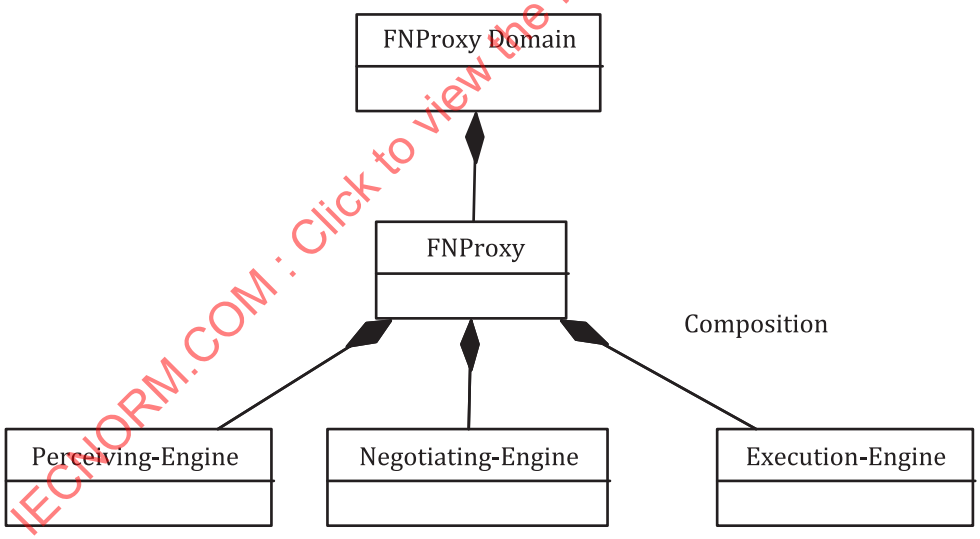

Figure 3 — Relationship between engines and FNProxy

4.4.4 FNQoS system

FNQoS can provide comprehensive behaviour effects and measure of the FNQoS system. The designer realizes the FNQoS system according to FNQoS reference architecture (RA). As shown in Figure 4, FNQoS RA depends closely on FNQoS reference model (RM).

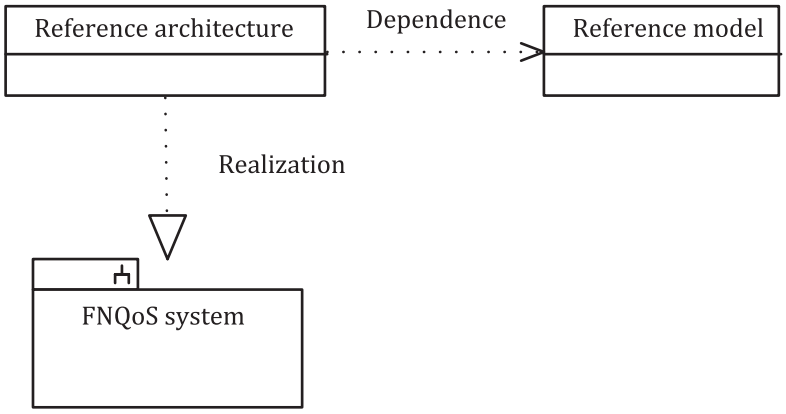

Figure 4 — FNQoS RA realizing FNQoS system

4.4.5 Users of FNQoS system

As shown in Figure 5, the user classification of an FNQoS system includes:

— Human users.

— FNProxy users. Since FNProxy is an intelligent body that makes a request to another FNProxy, FNProxy can be understood as a virtual user to another FNProxy.

— Third party users of FNQoS system. Third party users of FNQoS system can also be called an external user of the FNQoS system, i.e. the users from an environmental perspective. It refers to the users who experience the quality effect of the system from the external perspective of the whole FNQoS system. A third-party user of an FNQoS system depends closely on human users.

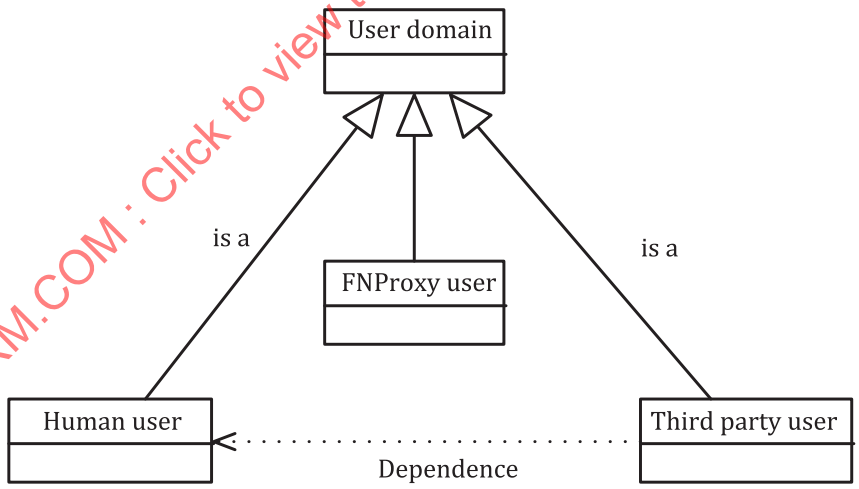

Figure 5 — User classifications of FNQoS system

5 Architectural model of FNQoS systems

5.1 Reference model of FNQoS system

According to the definition of FNProxy and FNQoS system, the six domains of the FNQoS system are analyzed and considered as shown in Figure 6. See Annex A for more information on the FNQoS system.

When the six domains interact with each other in the FNQoS system, their actions are as follows:

— Communication domain: the whole set of communication functions required for both traditional and future networks. The specific functions of communication domain include:

  a) In the operation of FNQoS system, transmitted information needs to use the functions of current network or future network.

  b) The purpose of FNQoS system is to improve the QoS of specific parameters of current network or future network. In this way, the FNProxy needs to call (access) the corresponding functions of the communication domain. When the functions accessed by an FNProxy are related to a layer, the FNProxy is called an access layer (AL) FNProxy.

  NOTE These functions can be carefully combined to form new network forms. For example, when these functions are designed for new special communication purposes and effects, they are called Future Networks based on FNProxy definition.

— User domain: functions that all types of users, including human users, may be called by an FNProxy. These functions are called by the FNProxy to improve the effect of the user's perspective of FNQoS system.

— Management domain: all maintenance related functions called by the FNProxy in order to maintain the operation of FNQoS system. These functions are called by FNProxy to manage FNQoS system and their FNProxies.

— Operation domain: used by the FNProxy to control the operation of the FNProxy according to the type and size of the FNProxy capability and to implement the strategy of the FNProxy interaction.

— Intelligent resource domain: the functions related to intelligent processing of FNProxies. These functions are called by FNProxies to improve the intelligence of FNProxies.

— FNProxy domain: multiple FNProxies are set up in advance by the implementer. These FNProxies interact with each other to realize the comprehensive service effect of FNQoS system. The function of the FNProxy domain is embedded in the specific working FNProxy. FNProxy can call the function of any domain, but the function of FNProxy domain cannot be called by any other domain.

The six domains invoke each other's functions according to the principles listed above to support different kinds of FNQoS systems with special targets.

The following reference model (RM) based on the six domains is the basis for the design and conception of a specific FNQoS system.

Functionality in the FN communication domain can either be derived from current network standards, or it can be encouraged to develop new communication network standards from scratch. Its purpose is to improve the QoS of the FN.

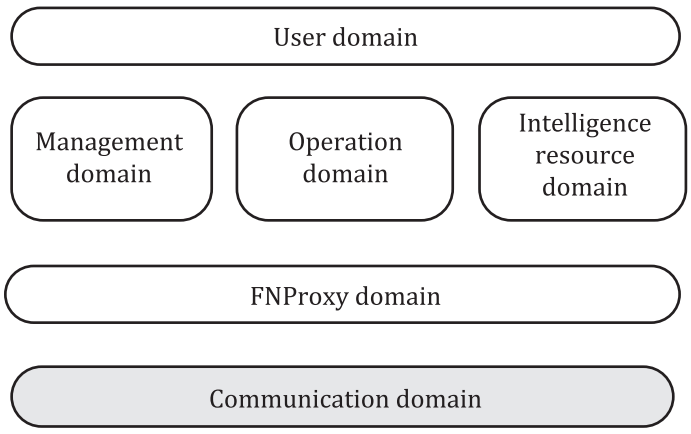

Figure 6 — Domain-based reference model

Figure 7 shows the architectural model, which is universally applicable to specific FNQoS systems.

The points below the architectural model in Figure 7 indicate that according to ISO/IEC TR 29181-8, the 12 requirements of FNQoS technology are suitable for the architecture model.

In addition, the interactions and collaborations between these FNProxies in the FNProxy Domain of the architectural model are followed by both the mechanisms of ISO/IEC 21559-2:2023, and the implementation of the FNQoS system supporting the specific requirements.

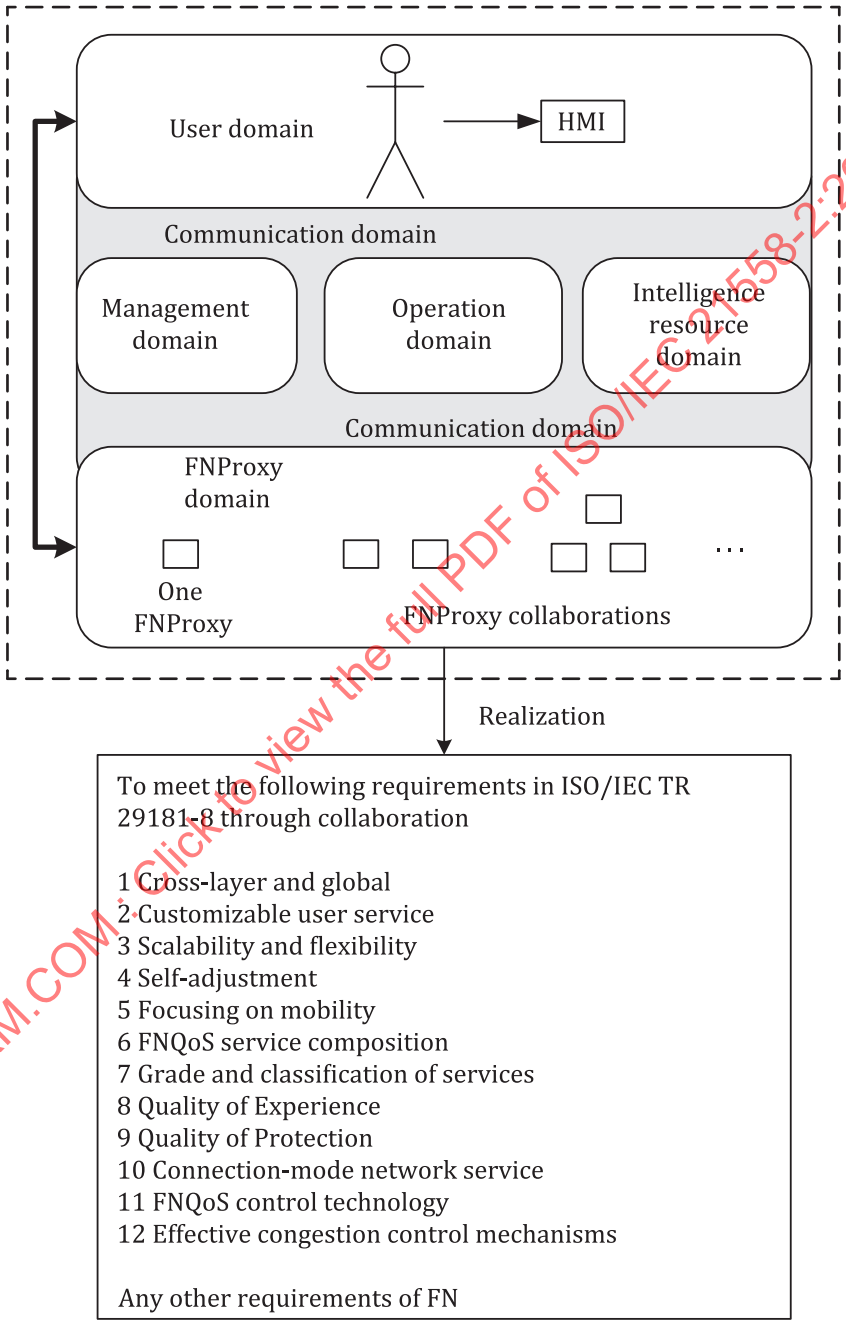

Figure 7 — Architectural model and supported FN requirements

5.2 Usage of FNQoS system

5.2.1 Human-centric usage

Figure 8 shows a human-centric FNQoS system.

The human user FNProxy in the FNProxy domain represents a real human user of the user domain.

Human-machine interface (HMI) is a specialized FNProxy interface in the user domain that connects human beings to FNQoS systems.

Human user FNProxy replaces real people and interacts with a non-human FNProxy in the domain of FNProxy. The data conversion between human user of FNProxy domain and the human user of user domain relies on HMI.

The thick solid line between FNProxy and HMI in Figure 8 shows that the FNProxy A that invokes the functions of HMI is mainly realized through user domain.

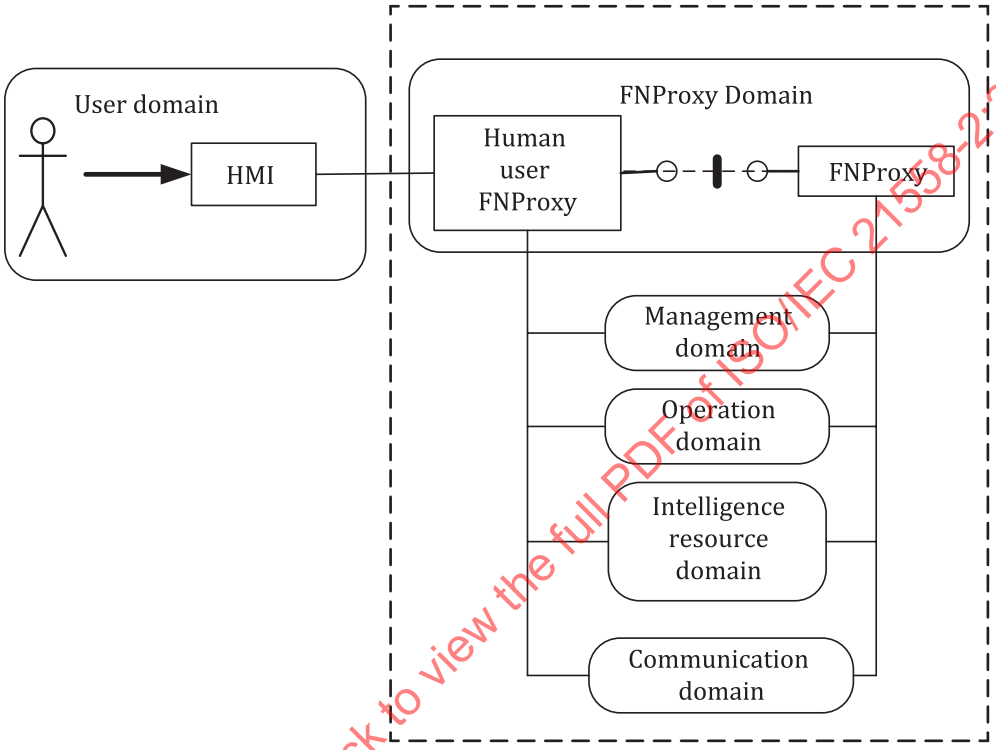

Figure 8 — Human-centric FNQoS system

5.2.2 Interaction between FNQoS systems

Figure 9 represents interaction between the FNQoS systems. Interactions between FNProxies can be in different FNQoS systems. The comprehensive behaviour effects for interaction between different FNQoS systems are usages of architectural model.

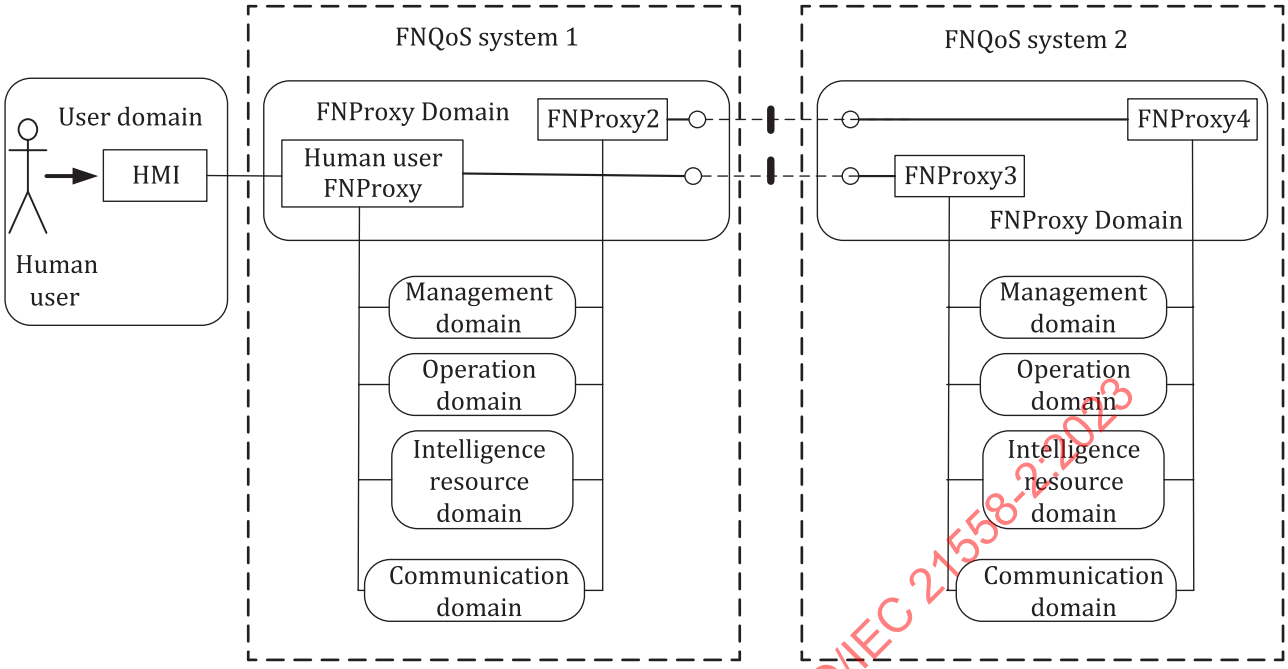

Figure 9 — Interaction between FNQoS systems

5.2.3 Inter-working with legacy networks

Figure 10 represents an inter-working model of FNQoS systems with the existing legacy networks. The inter-working model can support the evolution of legacy networks QoS to FNQoS.

In the operation of the FNQoS system, the interactive content between FNProxies is transmitted by a current network or future network. The inter-working model solves the QoS improvement of the network itself. The functions of the communication domain in Figure 10 refer to the following:

— In the FNQoS system, in order to improve the specific parameters of the current network or future network operation, the FNProxy needs to call (access) the corresponding lower level functions of the network involved in the communication domain. In this case, the FNProxy does not use the network, but only calls some underlying functions. Its purpose is to improve the effect of some QoS parameters of the network itself.

— When the functions accessed by an FNProxy are related to a layer, the FNProxy can be called as an access layer (AL) FNProxy. It is used to deal with the functions of the accessing layer.

— An access layer (AL) FNProxy in FNProxy domain can invoke the functions in communication domain to provide access service with its own strategies or algorithms to support the special QoS promotion of special networks.

The thick solid line in Figure 10 shows that the function of the FNProxies invoking to layers is mainly realized through communication domain.

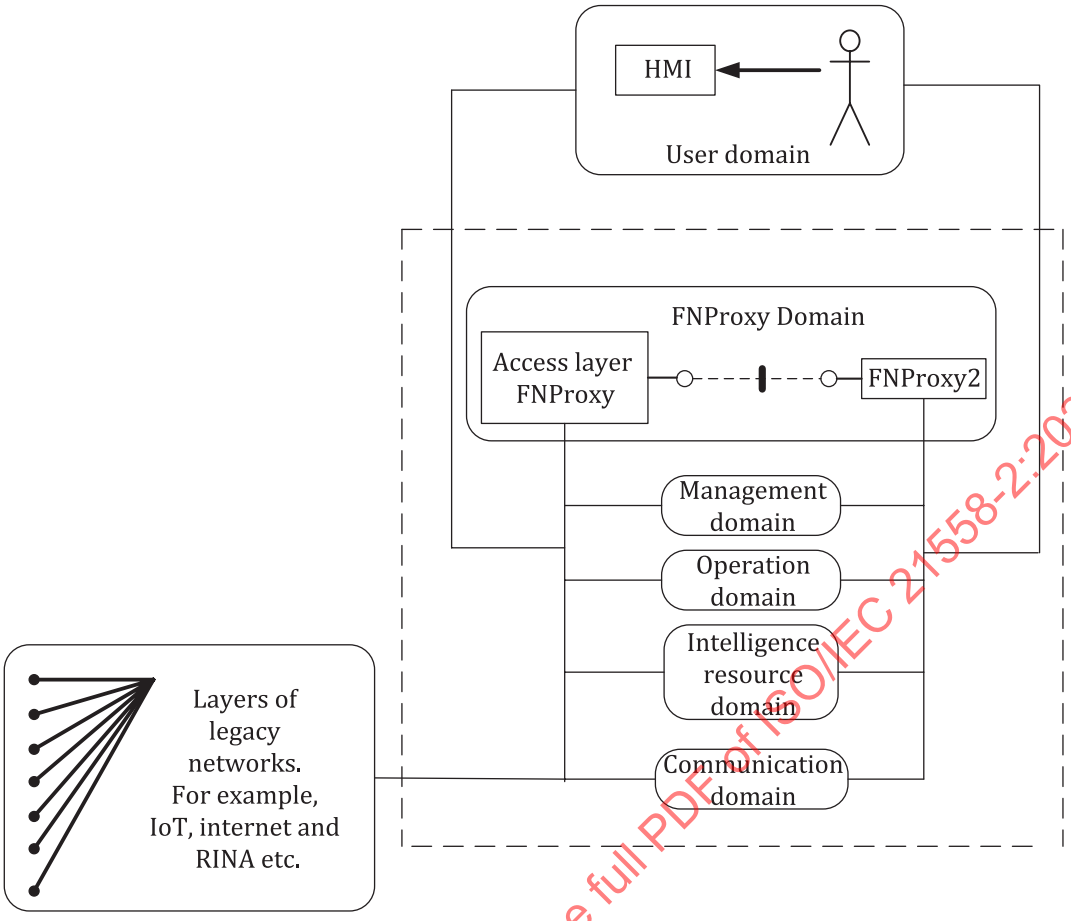

Figure 10 — Inter-working model of FNQoS systems with legacy networks

Annex A
(informative)

Tracking concerns of stakeholders to FNQoS system

In order to partition the functionality of the domain required by RM, a certain number of CMs are to be determined in the problem field.

The basic reference of CM should analyse the current and future interest of various stakeholders in RA-related projects.

The stakeholders of FNQoS system are: users, operators, acquirers, owners, suppliers, developers, builders, maintainers.

The concerns of various stakeholders are: purposes, suitability, feasibility, potential risk, impact, maintainability and evolution.

The concern level of stakeholder shown in Table A.1 can be used as a reference when generating conceptual models.