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

Future networks

Framework for evaluating intelligence levels of future networks including IMT-2020

Recommendation ITU-T Y.3173

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For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.3173

Framework for evaluating intelligence levels of future networks including IMT-2020

Summary

Recommendation ITU-T Y.3173 specifies a framework for evaluating the intelligence of future networks including IMT-2020 and a method for evaluating the intelligence levels of future networks including IMT-2020 is introduced. An architectural view for evaluating network intelligence levels is also described according to the architectural framework specified in Recommendation ITU-T Y.3172.

In addition, the relationship between the framework described in this Recommendation and corresponding work in other standards or industry bodies, as well as the application of the method for evaluating network intelligence levels on several representative use cases are also provided.

History

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FOREWORD

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Recommendation ITU-T Y.3173

Framework for evaluating intelligence levels of future networks including IMT-2020

1 Scope

This Recommendation describes a framework for evaluating the intelligence levels of future networks including IMT-2020. This includes:

- Development trend of network intelligence;
- Methods for evaluating network intelligence levels;
- Architectural view for evaluating network intelligence levels.

The appendices describe the relationship between the framework described in this Recommendation and corresponding work in other standards or industry bodies, as well as the application of the method for evaluating network intelligence levels on representative use cases.

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

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 machine learning pipeline [ITU-T Y.3172]: A set of logical nodes, each with specific functionalities, that can be combined to form a machine learning application in a telecommunication network.

NOTE – The nodes of a machine learning pipeline are entities that are managed in a standard manner and can be hosted in a variety of network functions [b-ITU-T Y.3100].

3.1.2 machine learning function orchestrator (MLFO) [ITU-T Y.3172]: A logical node with functionalities that manage and orchestrate the nodes in a machine learning pipeline.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 network intelligence level: Level of application of automation capabilities including those enabled by the integration of artificial intelligence techniques in the network.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI	Artificial Intelligence
API	Application Programming Interface
CM	Configuration Management
E2E	End to End
eMBB	Enhanced Mobile Broadband
ENI	Experiential Networked Intelligence
ETSI	European Telecommunications Standards Institute
GSM	Global System for Mobile Communications
GSMA	GSM Association
IoT	Internet of Things
INR	Interference and Noise
ISG	Industry Specification Group
KPI	Key Performance Indicator
MDT	Minimization of Drive Tests
MIMO	Multiple Input Multiple Output
ML	Machine Learning
MLFO	Machine Learning Function Orchestrator
mMTC	Massive Machine Type Communications
NF	Network Function
NHTSA	National Highway Traffic Safety Administration
OAM	Operation Administration and Maintenance
PM	Performance Management
RCA	Root Cause Analysis
RSRP	Reference Signal Received Power
SAE	Society of Automotive Engineers
SRC	Source
TMF	TM Forum
UE	User Equipment
URLLC	Ultra-Reliable and Low Latency Communications

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

6.1 Challenges in operation, administration and maintenance of IMT-2020 networks

Along with the network evolution to IMT-2020, key performance indicators (KPIs) such as the transmission rate, transmission delay and connection scale are constantly being improved. Application scenarios are becoming increasingly abundant, and the performance and flexibility of networks are being improved. In addition, more and more network functions are deployed on cloud computing platforms. This evolution enables flexible network orchestration, automated deployment, improvement of resource utilization, and provisioning of network slicing services for verticals.

However, even though IMT-2020 brings a qualitative leap in performance and flexibility, the complexity of networks is increasing significantly. This brings unprecedented challenges to the operation, administration and maintenance (OAM) of IMT-2020 networks such as:

- The network architecture is more flexible, the network deployment scenarios are diversified, and the user requirements are personalized, thus making networks more dynamic and more complex to manage.
- The introduction of diversified terminals, such as in Internet of things (IoT), has led to growth in the number of user equipment (UE) by orders of magnitude, thus the cost of network management tends to increase.
- The use of manual decision-making mechanisms makes it difficult to quickly understand any change in network conditions and to quickly adapt the network to such changes.
- Mechanisms for utilizing and analysing the large amount of network data generated daily need to be deployed and operated in the networks, in order to produce value.
- The extensive use of network connectivity among UEs and things leads to high requirements in terms of security and the protection of data being exchanged through networks.
- The decoupling of software from the hardware in networks requires efficient management solutions to realize high-frequency updates of software being used in these networks.
- Insufficient openness of network capabilities limits the efficient utilization of network resources and the enhancement of user value.
- Given that service-based architecture is a key enabler for IMT-2020 networks, the evolution of traditional network management towards a service-based intelligent network management approach needs to be addressed.

To address the above-mentioned challenges, the introduction of automation mechanisms relying on artificial intelligence (AI) including machine learning (ML) techniques is a key aspect to be considered in network management systems. In order to solve the current efficiency and capability problems of networks, introducing network intelligence is seen as a promising approach, in particular:

- To achieve network self-maintenance, automatic optimization, intelligent operation and high-efficiency OAM, AI including ML and other technologies for automation are introduced.
- To derive value from mining of massive network data and to address security assurance issues, AI (including ML) assisted data collection and analysis can further enhance the big

data analysis capability, enable timely identification of security risks, and strengthen security measures.

- To address the problem of insufficient network openness, combining AI (including ML) techniques and virtualization technologies can improve the management capabilities and efficient use of network resources, shorten the implementation cycle of new technology applications, and accelerate its iteration.
- To help in the evolution towards intelligent network management, an approach to enable the use of AI including ML in networks is needed. [ITU-T Y.3172] describes an architectural framework that supports such approach, including for intelligent network management.
- Network intelligence levels may be used for specifying liability aspects in contractual agreements (e.g., between network operators and network equipment suppliers). For example, costs for network support contracts or insurance costs for network equipment may be determined based on network intelligence levels.

6.2 Significance of evaluating network intelligence levels

As explained in clause 6.1, AI (including ML) is considered to be a promising technology to cope with the increasing complexity and to improve the performance of future networks including IMT-2020. As networks become more and more intelligent, it is important to adopt a standard method for evaluating network intelligence levels.

A standard method for evaluating network intelligence levels has the following implications:

- It provides an evaluation basis for measuring the intelligence levels of a network and of its components.
- It helps the industry to reach a consensual and unified understanding of network intelligence concepts.
- It provides a reference for industry supervisors to formulate relevant strategies and development planning of future networks including IMT-2020 in various countries.
- It provides a decision mechanism to operators, equipment vendors and other network industry participants for planning of network technology features and products' roadmaps.

7 Methods for evaluating network intelligence levels

7.1 Dimensions for evaluating network intelligence levels

In order to evaluate network intelligence levels, this Recommendation makes use of the following five widely applicable dimensions:

- a) **Demand mapping:** This dimension corresponds to the process of converting configuration or the adjustment of requirements from operation and maintenance teams into specific instructions that network components can understand and execute.
NOTE – Examples of network component are network elements and network functions. Network components are typically used in network subsystems.
- b) **Data collection:** This dimension relates to the process of collecting network data required by the various analysis processes.
- c) **Analysis:** This dimension refers to the process of performing an analysis (including data pre-processing) of collected networked data:
 - to obtain context information of the network (perception analysis), e.g., current operating environment, services, users and other information,

- to further predict based on historical data, the future trends in the change of the network context information and make inference for decision (prediction analysis).
- d) **Decision:** This dimension corresponds to the process that takes decisions about network and/or service configuration based on the results of the analysis process.
- e) **Action implementation:** This dimension is related to the process of executing corresponding configuration triggered by the decision process.

Two main areas used for evaluating network intelligence levels are workflows (related to the whole lifecycle of networks) and network subsystems (different classes of network components), since these are mainly involved in the operation and deployment of networks.

NOTE 1 – The method used by the Society of Automotive Engineers (SAE) for describing automatic driving levels provides a good reference for elaborating a method for evaluating network intelligence levels. However, as described in Appendix I, the evaluation method for network intelligence levels is much more complicated compared to the one used for automatic driving levels.

The overall network intelligence level of a whole network is a comprehensive reflection of intelligence levels of the individual workflows and subsystems.

As shown in Figure 7-1, the five dimensions identified in clause 7.1 are applicable for evaluating the network intelligence levels from both the workflow and subsystem perspectives. Figure 7-1 illustrates examples of possible workflows and subsystems to be considered for evaluating network intelligence levels.

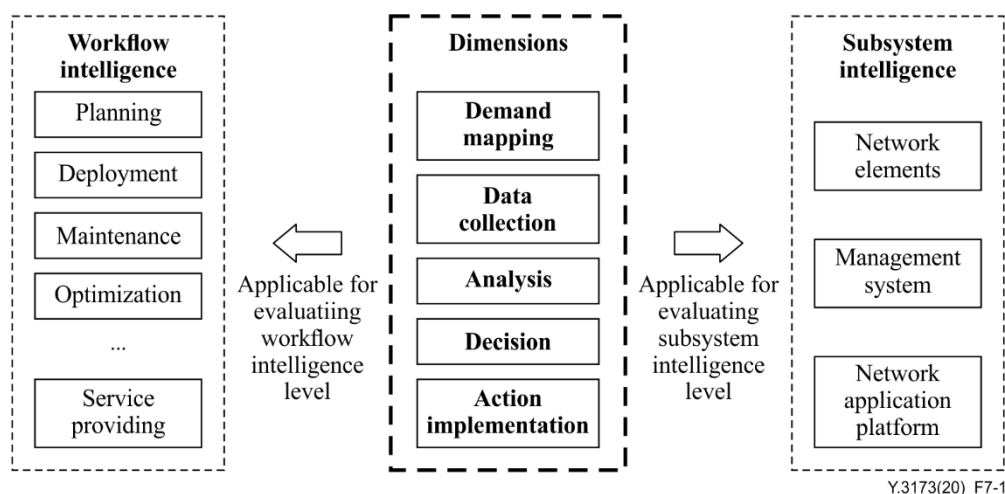


Figure 7-1 – Dimensions for evaluating network intelligence levels

The intelligence levels of individual workflows and subsystems can be determined based on the above dimensions. Only when the intelligence levels of each subsystem and workflow reach or exceed a certain level, then the intelligence level of the whole network can be regarded as reaching the corresponding level.

The workflows and the subsystems may vary from use case to use case. Hence, network intelligence capability levels when measured along a dimension may differ for each use case. Correspondingly, the intelligence levels of the network can vary depending on the use cases being considered for evaluation.

NOTE 2 – Appendix II describes various example use cases and their corresponding evaluation of network intelligence levels.