I n t e r n a t i o n a l   T e l e c o m m u n i c a t i o n   U n i o n

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TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Technical Report

(May 2026)

ITU-T Focus Group on AI Native for Telecommunication Networks

Standardization Gap Analysis of the FG-AINN

Summary

This Gap Analysis as a technical report identifies standardization gaps for AI-native networks in telecommunication networks, summarizes existing and ongoing standards, and provides an overview of related activities within SDOs in alignment with the original ToR. However, the scope is further defined in alignment with FG-AINN-O-08 (Study of concepts, characteristics and definitions of artificial intelligence native telecommunication networks) with special considerations about relevance to delimiting characteristics of AI-native networks. The report has provided in-depth discussions about technical challenges, missing protocols, and prospective development directions from use cases analysis beyond the initial ToR expectations.

Keywords
AI-native networks; standardization gap analysis

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Standardization Gap Analysis of the FG-AINN

1. Scope

This Gap Analysis as a technical report identifies standardization gaps for AI-native networks in telecommunication networks, summarizes existing and ongoing standards, and provides an overview of related activities within SDOs in alignment with the original ToR. However, the scope is further defined in alignment with FG-AINN-O-08 (Study of concepts, characteristics and definitions of artificial intelligence native telecommunication networks) with special considerations about relevance to delimiting characteristics of AI-native networks. The report has provided in-depth discussions about technical challenges, missing protocols, and prospective development directions from use cases analysis beyond the initial ToR expectations.

2. References

[ITU-T A.1] Recommendation ITU-T A.1 (2019), *Working methods for study groups of the ITU Telecommunication Standardization Sector (ITU-T).*

[ITU-T A.13] Recommendation ITU-T A.13 (2019), *Non-normative ITU-T publications, including Supplements to ITU-T Recommendations.*

3. Definitions

3.1 Terms defined elsewhere

This document uses the following terms defined elsewhere:

3.1.1 Standardization gap analysis [b- ITU-T A. 6]: Process of identifying discrepancies or deficiencies between current standardization activities in ITU, ISO, IEC and ITU-T A.5-qualified organizations, and desired or optimal standardization activities, aiming to identify the gaps within a specific domain.

3.2 Terms defined in this document

This document defines the following terms:

Editor's note: Unless some specific reasons, this document should not define any new terms, there is the FG-AINN Vocabulary document for any new terms. Relevant terminology used in existing standardization efforts which are collected in this document should be mentioned in the related clauses (and then, if adopted by the FG-AINN, copied in the Vocabulary document with the associated reference).

4. Abbreviations and acronyms

This document uses the following abbreviations and acronyms:

3GPP 3rd Generation Partnership Project
AI Artificial Intelligence
AINN AI-Native Networks
ETSI European Telecommunications Standards Institute
IEC International Electrotechnical Commission
IEEE Institute of Electrical and Electronics EngineersIETF Internet Engineering Task Force
IRTF Internet Research Task Force

ISG Industry Specification Group
ISO International Organization for Standardization
NMRG Network Management Research Group
ONAP Open Network Automation Platform
QoE Quality of Experience
QoS Quality of Service
RTGWG Routing Area Working Group
SDO Standards Development Organizations
SMB Standardization Management Board
SPCG Standardization Programme Coordination Group
TMB Technical Management Board
TMF TeleManagement Forum
Editor's note: the following abbreviations and acronyms are from FG-AINN-I-053: to be considered/included in future updates of this document if and as necessary.
ENI Experiential Networked Intelligence
IBN Intent-Based Networking
INT Core Network and Interoperability Testing
ZSM Zero-touch Service Management

5. Conventions

None

6. Gap analysis framework and methodology

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6.1 Analysis framework for collection and selection of relevant standards

6.1.1 Criteria and process for identifying relevant Standards Development Organizations (SDOs)

This section establish selection criteria for the identification of organizations that are highly relevant to AI-native telecommunication networks (AINN). Based on these criteria, AINN-related documents that have been published or are currently udner development by these SDOs are collected and analyzed to providea basis for the subsequent standardization gap analysis.
According to the above, the following SDOs have been determined to be included in the scope of the subsequent analysis: ITU-T SG13, ITU-T SG21, ITU-T SG2, ITU-T SG17, ITU-T SG20, IETF/IRTF, ETSI ISGs, ONAP and 3GPP. The delimiting characteristic mapping analysis of AINN-related documents provided by these organizations can provide support to mining the gaps in the existing standards landscape.
For detailed selection criteria, please refer to Annex A. For the process, please refer to Annex B.

6.1.2 Criteria for selecting relevant standards from the identified SDOs

Standards and documents relevant to AI-native networks were selected from the identified SDOs. This clause provides the basis for the detailed analysis of the subsequent clauses, with the objective of identifying relevant standardization gaps.
For detailed screening criteria, please refer to Annex C.

6.2 Gap analysis process and methodology

This section describes the methodology and process framework for the standardization gap analysis of AI-native telecommunication networks (AINN), for making the process of developing standard gap analysis more disciplined, structured and repeatable. This framework also provides a methodological foundation for cross-domain gap analysis research. It is based on a systematic review of 16 gap analysis standards published by ISO, IEC, and ITU-T, and integrates the findings from [b-FG-AINN-I-152]. By refining existing gap analysis methods, this framework further ensures the accuracy, systematicity and operability of gap identification.

Figure 1 illustrates the methodology and process framework for AINN standardization gap analysis. The parts highlighted in blue in the figure indicate the modifications made to existing analysis methods.

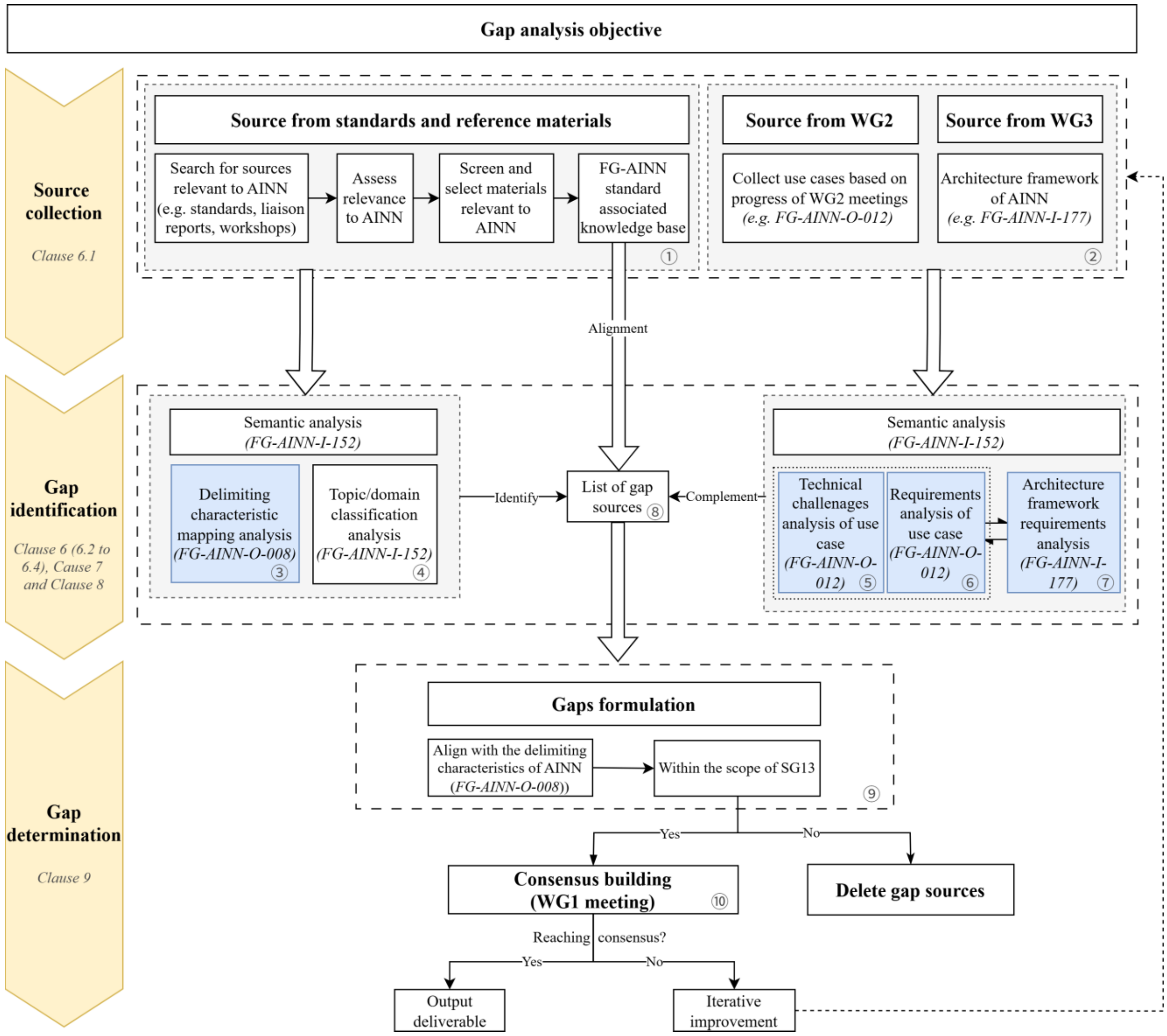

Figure 1 Methodology and process framework for AINN standardization gap analysis

The methodology and process for AINN standardization gap analysis comprise the following four steps:

Step 1: Define the objective of the AINN standardization gap analysis, including the scope, focus areas, and expected outcomes.

Step 2: Source collection: Collect gap analysis mateials relevant to AINN from multiple sources.

2.1 Collect source from standards and reference materials: Search for sources relevant to AINN, including published standards, standards under development, liaison statements, workshop reports, and other related technical documents. Then, assess their relevance to AINN and screen the materials accordingly. The selected materials are then organized into the FG-AINN standard associated knowledge base to support subsequent analysis.

2.2 Collect source from WG2: Based on the progess of WG2 meetings, collect use cases for AI-native telecomunication networks from WG2 deliverables.

2.3 Collect source from WG3: Collect the AINN architecture framework and related architectural requirements from WG3 deliverables (e.g., FG-AINN-I-177), which serve as complementary inputs for gap analysis.

Step 3: Gap identification: Apply multiple gap identification methods to analyze the content of collected sources.

3.1 Standard gap analysis

3.1.1 Delimiting characteristic mapping analysis: Based on semantic analysis method, map the delimiting characteristics of AINN, as defined in FG-AINN-O-008, to the content of collected standards and construct a mapping matrix to identify the delimiting characteristics of AINN not covered by existing standards.

3.1.2 Domain/topic classification: Based on semantic analysis method, conduct textual content analysis of the collected standards and map the main content of the standards into domain/topics categories.

3.2. Use case gap analysis

3.2.1. Requirement mapping analysis: By integrating semantic analysis method, extract practical requirements from use cases through coding and clustering, including functional requirements and performance requirements derived from WG2's deliverable FG-AINN-O-012 and architecture framework requirements from WG3's deliverable FG-AINN-I-177. These extracted requirements are then mapped with existing standards to identify uncovered requirements.

3.2.2. Technical challenge mapping analysis: By integrating semantic analysis method, extract technical challenges from use cases through coding and clustering. These challenges derive from WG2's deliverable FG-AINN-O-012. These extracted technical challenges are then mapped with existing standards to identify uncovered challenges.

3.3. Preliminarily identify gaps by integrating all analysis results from the first two steps and aligning them with the FG-AINN standard associated knowledge base established in the previous stage to generate a list of gap sources.

Step 4: Gap determination:

4.1 Gaps formulation: Formulate candidate gaps based on the list of gap sources and gap formulation criteria. Each candidate gap should align with the delimiting characteristics of AINN and be evaluated to determine whether it falls within the scope of SG13. Gap sources that fall outside the scope of SG13 are considered to be deleted.

4.2. Consensus building: The screened candidate gaps will be submitted to WG1 meetings for expert consensus building, where their validity, necessity, and completeness will be discussed and confirmed. If consensus is reached, the final gaps will be described, categorized, and prioritized using a standardized gap template, and a gap analysis report will be produced as an output deliverable. Otherwise, based on expert feedback, the gaps will be returned to the earlier analysis stages for iterative improvement until expert consensus is achieved.

6.3 Semantic analysis method for gaps

6.3.1 Analysis methods related to the definitions of AI-Native Networks and AI-Native Telecommunication Networks

Based on [b-FG-AINN-O-08], the definitions for "AI-native Telecommunication Networks" and "AI-Native Networks" have been adopted in this document. Through the semantic analysis and related coding of the two definitions, the foundational framework underpinning the mapping activities conducted in this document has been established.

The delimiting characteristics of AI-native networks [b-FG-AINN-O-08] considered in this document are the following:

[D1-C1] integrating AI

[D1-C1-1] as a core component

[D1-C1-2] through the entire lifecycle of telecommunication network's design, deployment, operation, and maintenance

[D1-C2] enabling novel value-added services
[D1-C3] enhancing the performance of the network and its services
[D1-C3-1] higher level of autonomy
[D1-C3-2] higher level of efficiency
[D1-C3-3] higher level of adaptability
[D1-C3-4] higher level of resource utilization
[D2-C1] all steps are managed by AI, using AI
[D2-C2] make AI integration easier in the network
For detailed coding and analysis methods, please refer to Annex D.

6.3.2 Analysis methods related to domain/topics

For the purpose of a structured analysis, existing standards and related work are organized into ten domains and topics. These categories were established to encompass the standardization lifecycle, from foundational concepts and technical specifications to operational and societal aspects. This categorization facilitates an examination of the current landscape and the identification of relevant gaps.Existing standards can be categorized according to the following domain/topics:
[D/T-1] Terminology/vocabulary and definitions/ concepts and characteristics of AI-native networks
[D/T-2] Use cases/applications
[D/T-3] Requirements
[D/T-4] Capabilities/functions
[D/T-5] Architecture
[D/T-6] Protocols and APIs
[D/T-7] Governance and management
[D/T-8] Semantic interoperability, digital twin, metaverse, data model, data infrastructure
[D/T-9] Security, privacy
[D/T-10] Societal impact assessment and ethics

6.3.3 Batch analysis method based on machine learning technology

Editor's note(210-R3): The following text has not been reviewed, and whether the following methods should be included is still under discussion.

Compared to using fixed semantic vocabulary, we can explore using LLM analysis to help preliminarily screen a large number of standards and reduce the workload. To ensure the reliability of LLM results and the credibility of this method, we can compare its results with manually screened results on a small dataset. By plotting a confusion matrix (Editor's note: the term "confusion matrix" is not currently defined) and confirming accuracy and recall rates (if applicable, model contributions can be submitted), we can ensure the reliability of this method.
For a detailed description of this method, please refer to Annex E.

6.4 Use case analysis method for gaps sources

This clause adopts a complementary bottom-up methodology to identify standardization gaps. The analysis is based on the requirements and technical challenges derived from the 12 representative use cases defined by FG-AINN WG2.
These use cases cover a range of scenarios, including disaster handling, AI-native digital twins, embodied intelligence, industrial automation, and generative AI services. To ensure a systematic derivation of gaps, the following analytical process was applied:

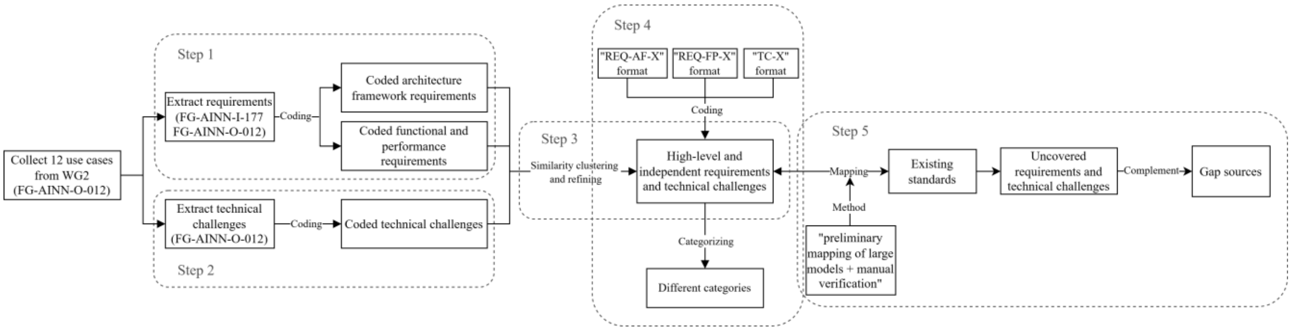

Figure 2 Use case analysis process

The use case analysis process consists of the following five steps:

Step 1: Each use case was analyzed individually to extract architecture framework requirements, functional requirements and performance requirements, and these requirements were then coded.

Step 2: Each use case was analyzed individually to extract technical challenges, and these technical challenges were then coded.

Step 3: The extracted requirements and technical challenges from 12 use cases were clustered based on content similarity. They were further refined into higher-level, logically independent requirements and technical challenges.

Step 4: These refined requirements and technical challenges were clustered into different categories based on the constructed first-level clustering framework. Subsequently, they were individually coded using different coding formats.

Step 5: The refined requirements and technical challenges were mapped against existing standard texts using a method of "preliminary mapping of large models + manual verification". Areas where current standards do not fully address these requirements and challenges were identified as gap sources.

This use case analysis method was used to conduct mapping analysis between 12 use cases and relevant SG13 standards. For a detailed analysis process and results, please refer to Annex G.

7. Overview of SDO standards and related work

This clause presents a high-level overview of existing standards relevant to AI-native networks, compiled from the collection and selection framework detailed in Clause 6. The analysis is structured from two complementary perspectives to provide a comprehensive view. Clause 7.1 provides a summary of standards coverage based on the delimiting characteristics of AI-native networks, while Clause 7.2 provides a summary organized by key technical domains and topics.

7.1 Summary of relevant standards according to delimiting characteristics of AI-Native Networks

Table 7-1③ – Example of mapping of relevant SG13 standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network

Y.2344	✓	✓		✓	✓	✓	✓	✓	✓		
Y.3060	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Y.3061	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Y.3083				✓	✓	✓	✓	✓			
Y.3091	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Y.3127	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Y.3161	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Y.3181	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Y.3182	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Y.3183	✓	✓	✓	✓	✓	✓	✓	✓			
Y.3184	✓	✓	✓	✓	✓	✓	✓	✓			
Y.3185	✓	✓	✓	✓	✓	✓	✓	✓			
Y.3325					✓	✓	✓	✓			✓
Y.3550	✓		✓	✓	✓		✓	✓	✓		
Y.3812	✓	✓		✓	✓		✓	✓			
Y.3814	✓	✓		✓	✓		✓	✓			
Y.3816	✓	✓		✓	✓		✓	✓			
Y.3819	✓	✓		✓	✓		✓	✓			
Y.3170	✓	✓	✓	✓	✓	✓	✓	✓			
Y.3175	✓	✓	✓	✓	✓		✓	✓			✓
Y.3180	✓	✓	✓	✓	✓	✓	✓	✓			
Y.3531	✓		✓	✓	✓		✓	✓			✓
Y.3172	✓	✓	✓	✓	✓	✓	✓	✓			✓
Y.3173	✓	✓			✓	✓	✓	✓	✓		
Y.3654	✓	✓			✓	✓		✓	✓		✓
Y.3174	✓	✓		✓	✓	✓	✓	✓	✓		✓
Y.Sup55				✓	✓	✓	✓	✓	✓		
Y.3176	✓	✓			✓	✓					✓
Y.3177	✓	✓			✓		✓	✓	✓		
Y.3178	✓	✓		✓	✓	✓		✓			
Y.3179	✓	✓			✓		✓	✓			✓
Y.3812	✓	✓			✓	✓		✓			
Y.Sup70	✓	✓			✓		✓	✓			
Y.3186	✓	✓			✓	✓	✓	✓			✓
Y.3187	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Y.det-qos-req-ml-jrs	✓	✓			✓			✓	✓		
Y.3086	✓	✓		✓	✓	✓		✓	✓		
Y.3142	✓	✓			✓	✓	✓	✓	✓		
Y.Sup71	✓	✓		✓	✓	✓	✓	✓			
TR-GenAI-Telecom Networks											
Y.IMT2020-DIC	✓	✓			✓	✓	✓	✓	✓		
TR.ACN	✓	✓		✓	✓	✓	✓	✓	✓		
Y.Benchframe-GenAI				✓	✓	✓	✓		✓		

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Based on the preceding analysis, a heatmap can be generated to depict the level of coverage provided by existing standards for the identified "essential set of information" (delimiting charecteristics).

NOTE - In this heatmap representation, darker colours indicate a higher degree of coverage, while lighter colours indicate a lower degree of coverage.

Table 7-2③ – Example of mapping of relevant SG21 standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
F.CDN-AINW	✔				✔			✔	✔		
F.AIVSSPGC	✔	✔			✔	✔	✔	✔			
F.748.39	✔				✔	✔	✔	✔			
F.AI-SCVC	✔			✔	✔		✔				
F.MACVS	✔	✔		✔	✔	✔		✔			

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Table 7-3③ – Example of mapping of relevant SG2 standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
M.rosp-ia	✔	✔			✔	✔	✔	✔	✔		
M.fdcm-AITOM	✔	✔			✔		✔				✔
M.fidtom	✔	✔			✔	✔	✔				✔
M.la-AI-ia	✔	✔			✔	✔	✔	✔	✔		✔
M.fso-AITOM	✔	✔	✔	✔	✔	✔	✔	✔	✔		
M.la-AI-ir	✔	✔			✔	✔	✔		✔		✔
M. rcnitom-AI					✔	✔	✔	✔	✔	✔	
M.rcm-AI	✔									✔	✔
M.3167.1					✔	✔	✔				✔
M.3389		✔			✔	✔	✔	✔			

M.3390	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
M.3386	✔	✔			✔	✔	✔	✔	✔		✔
M.3388	✔	✔	✔		✔	✔	✔		✔	✔	
M.3367	✔	✔			✔	✔	✔				✔
M.3383	✔	✔			✔	✔	✔				✔
M.3384	✔	✔	✔		✔	✔	✔	✔	✔	✔	
M.3385	✔	✔	✔		✔	✔	✔	✔	✔	✔	
M.3382	✔	✔			✔	✔	✔				✔
M.3381	✔	✔			✔	✔	✔	✔	✔		✔
M.3080	✔	✔		✔	✔	✔	✔		✔		✔

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Table 7-4③ – Example of mapping of relevant SG17 standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
Contribution 182	✔		✔		✔	✔	✔				
X.SSDHN-AI-Atk	✔				✔	✔		✔			
XSTR.saAIoT	✔			✔	✔	✔	✔				

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Table 7-5③ – Example of mapping of relevant SG20 standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
Y.AIoT-dfs-arc	✔	✔		✔			✔				
Y.AIoT-dpsm	✔				✔	✔	✔				
Y.AIoT-fr	✔	✔	✔	✔	✔						
Y.AIoT-FRA											✔
Y.Agentic-AIoT					✔	✔					
Contribution 372	✔				✔						

Contribution 370					✓			✓			
Y.farm-adv	✓										
Y.RA-FML	✓		✓	✓							
Y.EPI-AIA	✓	✓			✓						
Y.Sup.ABIoT-usecase-I	✓	✓			✓		✓				
ITU-T Y.IoT-IWAT	✓	✓		✓	✓		✓	✓			✓
Y.IoT-IIEC	✓			✓	✓		✓				✓
Y.IoT-FETA	✓				✓						✓
Y.4417	✓	✓			✓			✓			✓
Y.AIoT-dpsm	✓	✓		✓	✓		✓		✓		✓
Y.IIoT-AIA	✓	✓		✓			✓	✓			
Y.Sup.ABIoT-usecase-O	✓	✓		✓	✓		✓				
Y.IoT-IS	✓	✓			✓		✓		✓		
Y.Sup.AI4IoT	✓			✓	✓		✓	✓	✓		✓

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Table 7-6③ – Example of mapping of relevant IETF/IRTF standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
RFC 9315						✓					
draft-irtf-nmrg-ibn-usecases-00						✓					
draft-irtf-nmrg-ai-challenges-04	✓	✓			✓						✓
draft-irtf-nmrg-ai-deploy-00	✓				✓		✓				✓
draft-king-rokui-ainetops-usecases-00	✓	✓		✓	✓						✓

draft-li-rtgwg-computing-network-routing-01											✔
draft-irtf-nmrg-network-digital-twin-arch-11	✔			✔		✔					

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Table 7-7③ – Example of mapping of relevant ETSI ISGs standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
ETSI GS ENI 005	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
ETSI TR 103 195	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
GS ZSM-001	✔	✔	✔		✔	✔	✔	✔	✔		✔
GS ZSM-002	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
GS ZSM-007	✔						✔	✔			
GS ZSM-009-1	✔				✔						
GS ZSM-009-2	✔				✔		✔				
GS ZSM-009-3	✔	✔			✔		✔	✔			
GR ZSM-011	✔				✔		✔	✔	✔		
GR ZSM-012	✔	✔			✔		✔	✔	✔		✔
GR ZSM-014	✔				✔			✔			
GR ZSM-016					✔		✔	✔			
GS ZSM 018	✔	✔		✔			✔	✔	✔		
GR ZSM 003	✔				✔						
GR ENI 051	✔	✔		✔	✔	✔	✔	✔	✔		
GR ENI 018	✔										
GR ENI 010	✔		✔		✔	✔		✔		✔	
GR ENI 008					✔	✔	✔	✔			

GR ENI 007	✓			✓	✓	✓	✓	✓		✓	
GR ENI 005	✓		✓	✓	✓	✓	✓	✓	✓		
GR ENI 004											
GR ENI 002					✓	✓	✓	✓	✓		
GR ENI 001	✓			✓	✓	✓	✓	✓	✓		

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Table 7-8③ – Example of mapping of relevant ONAP standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
Open Network Automation Platform — Ecosystem— Architecture	✓	✓			✓	✓	✓	✓			

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Table 7-9③ – Example of mapping of relevant 3GPP standards to delimiting characteristics

Standards reference	D1-C1 integrating AI	D1-C1-1 integrating AI as a core component	D1-C1-2 integrating AI through the entire lifecycle of network	D1-C2 enabling novel value-added services	D1-C3 enhancing the performance of the network and its services	D1-C3-1 higher level of autonomy	D1-C3-2 higher level of efficiency	D1-C3-3 higher level of adaptability	D1-C3-4 higher level of resource consumption	D2-C1 all steps are managed by AI, using AI	D2-C2 make AI integration easier in the network
37.817	✓	✓	✓		✓		✓				
38.843	✓	✓	✓		✓		✓	✓	✓		
28.908	✓	✓	✓								✓
28.105	✓	✓	✓								✓

Note: The superscript ③ indicates that the results in this table are based on the analysis and processing obtained from Module ③ in Figure 1.

Based on the preceding analysis, a heatmap can be generated to depict the level of coverage provided by existing standards for the identified "essential set of information" (delimiting charecteristics).

NOTE - In this heatmap representation, darker colours indicate a higher degree of coverage, while lighter colours indicate a lower degree of coverage.

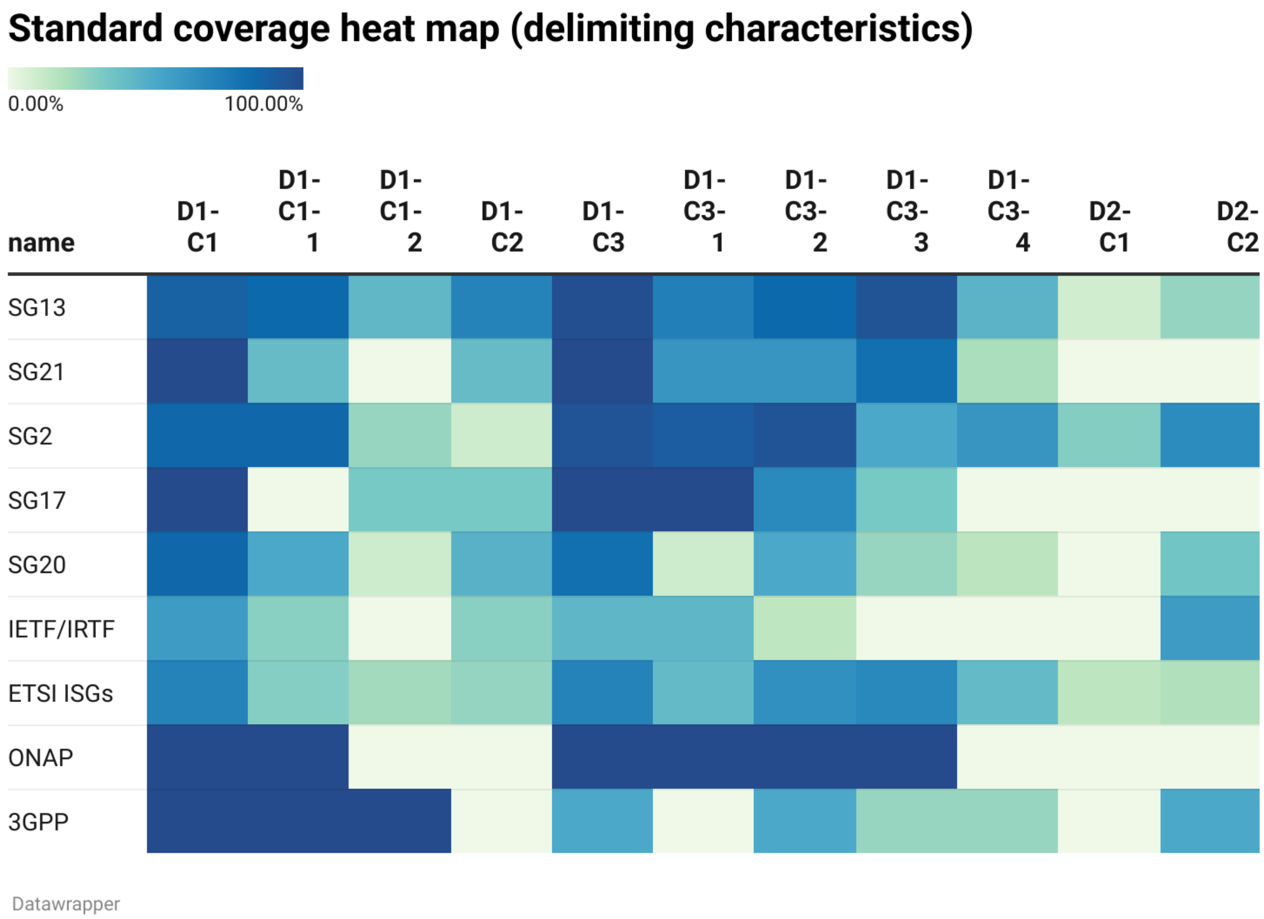

Figure 3 Standards coverage heat map for delimiting characteristics

7.2 Summary of relevant standards according to domains/topics

Editor's note: the following table 7.X provides only an example of mapping of relevants standards, the relevant SG13 standards (from clause Annex F). Additional tables, or an enhanced table 7.X, will have to be developed with respect to all relevant standards (from the other sub-clauses Annex F).

Table 7-10④ – Example of mapping of relevant SG13 standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics

Y.2344		✓	✓	✓	✓				✓	
Y.3060		✓								✓
Y.3061		✓	✓	✓	✓				✓	
Y.3083				✓					✓	
Y.3091				✓			✓		✓	✓
Y.3127		✓	✓	✓	✓			✓	✓	
Y.3161			✓		✓		✓		✓	
Y.3181			✓	✓	✓	✓			✓	
Y.3182		✓	✓	✓	✓		✓		✓	
Y.3183		✓	✓	✓	✓	✓			✓	
Y.3184				✓	✓				✓	
Y.3185			✓	✓	✓				✓	
Y.3325		✓	✓	✓					✓	
Y.3550		✓	✓	✓					✓	
Y.3812		✓	✓	✓				✓		
Y.3814		✓	✓	✓	✓					
Y.3816				✓	✓			✓	✓	
Y.3819		✓	✓		✓				✓	
Y.3170			✓	✓	✓			✓	✓	
Y.3175				✓	✓				✓	
Y.3180			✓	✓	✓			✓	✓	
Y.3531		✓	✓	✓				✓	✓	
Y.3172			✓		✓				✓	
Y.3173		✓	✓		✓				✓	
Y.3654		✓							✓	
Y.3174			✓		✓				✓	
Y.Sup55		✓	✓						✓	
Y.3176			✓		✓	✓			✓	
Y.3177					✓		✓		✓	
Y.3178			✓	✓		✓			✓	
Y.3179			✓		✓	✓			✓	
Y.3812		✓	✓	✓		✓			✓	
Y.Sup70		✓								✓
Y.3186		✓	✓		✓				✓	
Y.3187			✓		✓				✓	
Y.det-qos-req-ml-jrs			✓		✓				✓	
Y.MLaaS-arch										
Y.3086		✓	✓		✓				✓	
Y.3142		✓	✓		✓				✓	
Y.Sup71		✓	✓							
TR-GenAI-Telecom Networks		✓	✓	✓						
Y.IMT2020-DIC			✓		✓				✓	
TR.ACN		✓	✓		✓			✓	✓	
Y.Benchframe-GenAI			✓		✓			✓		

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-11④ – Example of mapping of relevant SG21 standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics
F.CDN-AINW		✓	✓			✓				
F.AIVSSPGC		✓	✓		✓					
F.748.39		✓	✓		✓	✓				
F.AI-SCVC			✓		✓					
F.MACVS		✓	✓	✓	✓				✓	

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-12④ – Example of mapping of relevant SG2 standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics
M.rosp-ia				✓		✓	✓	✓		
M.fdcm-AITOM				✓	✓		✓	✓		
M.fidtom		✓		✓	✓	✓	✓			
M.la-AI-ia				✓		✓	✓			
M.fso-AITOM	✓			✓	✓					
M.la-AI-ir		✓	✓	✓		✓				
M.rcnitom-AI		✓	✓							
M.rcm-AI			✓	✓			✓			
M.3167.1		✓	✓							
M.3389	✓	✓	✓							
M.3390		✓	✓		✓					
M.3386		✓	✓	✓	✓		✓			
M.3388		✓	✓	✓			✓			
M.3367		✓	✓	✓			✓			
M.3383		✓	✓	✓	✓					

M.3384		✓			✓		✓			
M.3385	✓	✓		✓	✓		✓			
M.3382		✓	✓	✓	✓	✓				
M.3381		✓	✓	✓	✓		✓			
M.3380			✓	✓	✓		✓		✓	

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-13④ – Example of mapping of relevant SG17 standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics
Contribution 182									✓	
X.SSDHN-AI-Atk		✓			✓				✓	
XSTR.saAIoT									✓	

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-14④ – Example of mapping of relevant SG20 standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics
Y.AIoT-dfs-arc		✓	✓	✓	✓			✓		
Y.AIoT-dpsm			✓		✓			✓		
Y.AIoT-fr	✓			✓	✓					
Y.AIoT-FRA	✓		✓	✓	✓				✓	
Y.Agentic-AIoT	✓	✓	✓		✓					
Contribution 372			✓		✓					
Contribution 370			✓		✓					
Y.farm-adv					✓					
Y.RA-FML		✓	✓	✓	✓					
Y.EPI-AIA		✓	✓	✓						
Y.Sup.ABIoT-usecase-I		✓		✓	✓	✓				

ITU-T Y.IoT-IWAT				✓	✓	✓			✓	
Y.IoT-IIEC		✓	✓	✓	✓					
Y.IoT-FETA				✓	✓			✓		
Y.4417			✓	✓	✓				✓	
Y.AIoT-dpsm			✓	✓	✓				✓	
Y.IIoT-AIA		✓	✓	✓						
Y.Sup.ABIoT-usecase-O		✓		✓	✓					
Y.IoT-IS				✓	✓					
Y.Sup.AI4IoT			✓	✓	✓	✓		✓	✓	✓

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-15④ – Example of mapping of relevant IETF/IRTF standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics
RFC 9315	✓									
draft-irtf-nmrg-ibn-usecases-00		✓								
draft-irtf-nmrg-ai-challenges-04	✓	✓	✓							
draft-irtf-nmrg-ai-deploy-00				✓						
draft-king-rokui-ainetops-usecases-00		✓	✓		✓					
draft-li-rtgwg-computing-network-						✓				

routing-01										
draft-irtf-nmrg-network-digital-twin-arch-11	✓									

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-16④ – Example of mapping of relevant ETSI ISGs standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics
ETSI GS ENI 005					✓	✓				
ETSI TR 103 195					✓					
GS ZSM-001		✓	✓	✓						
GS ZSM-002				✓	✓				✓	
GS ZSM-007	✓									
GS ZSM-009-1				✓						
GS ZSM-009-2				✓						
GS ZSM-009-3				✓						
GR ZSM-011				✓						
GR ZSM-012				✓						
GR ZSM-014									✓	
GR ZSM-016				✓						
GR ZSM-017									✓	
GS ZSM 018				✓						
GR ZSM 019				✓						

GR ZSM 020				✓						
GR ZSM-021				✓						
GR ZSM 003	✓				✓		✓			
GR ENI 051	✓	✓	✓							
GR ENI 018										✓
GR ENI 010								✓		
GR ENI 008		✓			✓					
GR ENI 007		✓								
GR ENI 005			✓		✓	✓				
GR ENI 004	✓									
GR ENI 002			✓							
GR ENI 001		✓								

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-17④ – Example of mapping of relevant ONAP standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics
Open Network Automation Platform — Ecosystem— Architecture					✓					

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Table 7-18④ – Example of mapping of relevant 3GPP standards to domains/topics

Standards reference	D/T-1 Terminology, definitions, concepts	D/T-2 Use cases/ applications	D/T-3 Requirements	D/T-4 Capabilities (enablers)/ functions	D/T-5 Architecture/ architectural framework	D/T-6 Protocols and APIs	D/T-7 Governance and management	D/T-8 Semantics, data and other technologies	D/T-9 Security, privacy	D/T-10 Societal impact assessment and ethics

37.817					✓					
38.843					✓					
28.908				✓						
28.105			✓	✓		✓				

Note: The superscript ④ indicates that the results in this table are based on the analysis and processing obtained from Module ④ in Figure 1.

Based on the preceding analysis, a heatmap can be generated to depict the level of coverage provided by existing standards for the domains/topics.
NOTE - In this heatmap representation, darker colours indicate a higher degree of coverage, while lighter colours indicate a lower degree of coverage.

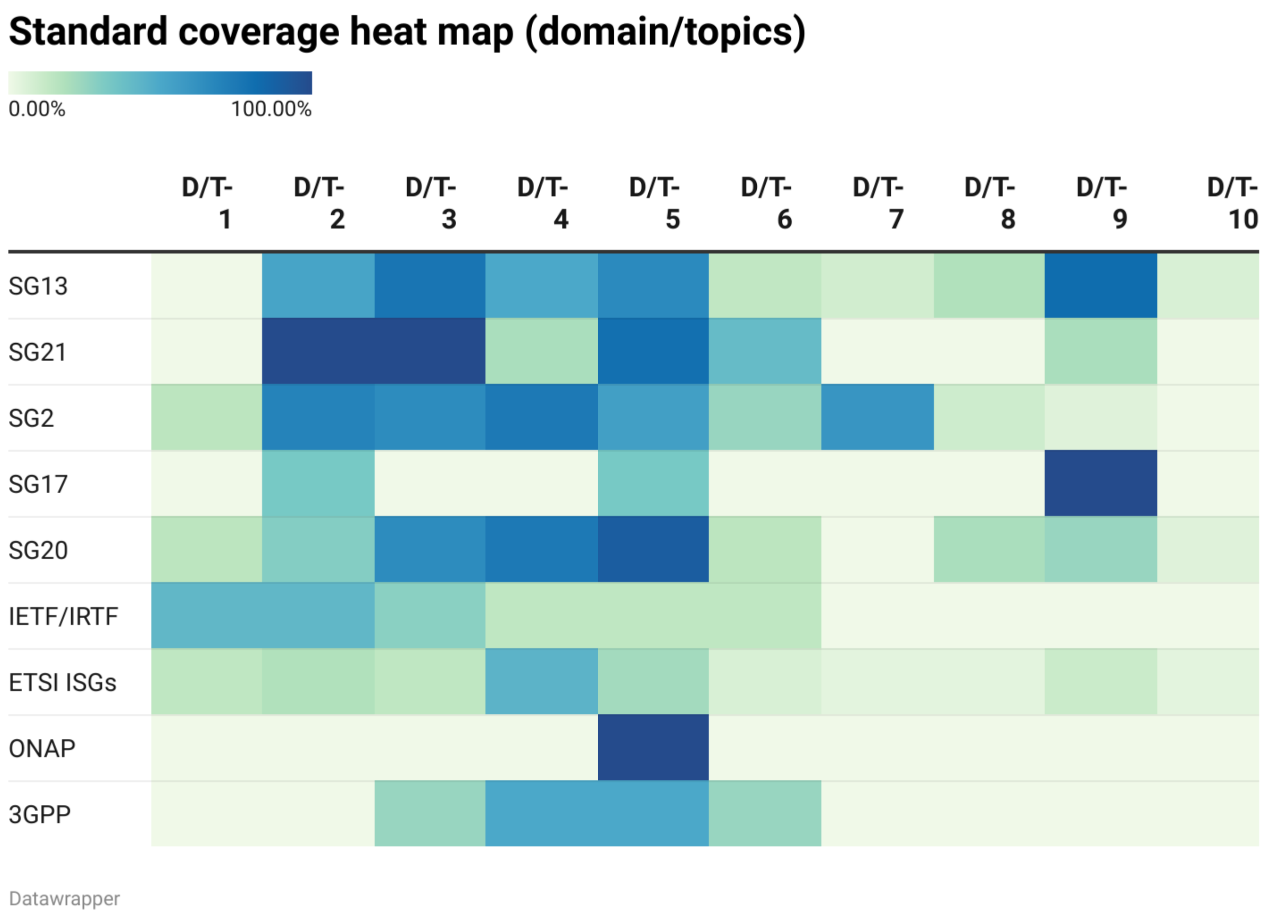

Figure 4 Standards coverage heat map for domains/topics

7.3 Gap sources from perspectives of delimiting characteristics and domain/topics

Table 7-19⑧ - Gaps identified from characteristic and domain analysis

Gap	Title	Gap description	Future work	Related work
GS1	Insufficient integration of AI throughout the network lifecycle	AI is mainly integrated into the design, operation, and maintenance stages of networks, with insufficient integration during the	1) Build an AI capability assessment index system and integrated framework covering the entire network lifecycle;	ITU-T Y.3142, ITU-T Y.3174, ITU-T Y.3091

		deployment stage. It has not yet achieved deep integration across the entire lifecycle of network design, deployment, operation, and maintenance.	2) Clarify the application scenarios, technical requirements, and capability boundaries of AI at each stage.	
GS2	Insufficient resource utilization due to high-power AI local workloads	Although AI applications can optimize network resource allocation, AI-native workloads are computationally intensive and can lead to excessive power consumption, limiting the effective improvement of overall network resource utilization.	1) Develop efficient and energy-saving AI workload scheduling algorithms; 2) Leverage lightweight AI models and high-efficiency hardware to reduce computational energy consumption through model optimization and edge acceleration devices	ITU-T Y.3550, ITU-T Y.3177
GS3	Not fully realizing the entire process management of network services driven entirely by AI	There's a lack of end-to-end AI-driven management covering every phase.	1) Build an AI model library that spans all lifecycle stages and standardizes data formats; 2) Develop cross-stage AI pipeline orchestration tools to enable seamless automation across multiple AI tasks, and establish real-time monitoring and rollback mechanisms to ensure swift transition to human or rule-driven modes when AI decisions deviate.	ITU-T Y.3161, ITU-T Y.3182, ITU-T Y.3325, GS ZSM-009-2, GS ZSM-012, ITU-T FG-AINN-I-009
GS4	Challenges in AI integration in networks	Currently, there are several reasons that make it difficult to integrate AI into existing networks. 1)Traditional network architectures are not designed to integrate AI; 2)There are no unified standard protocols or	1) Integrate AI into every component from the outset of network design and gradually introduce modular AI functional units into existing networks; 2) Design a unified AI-native network architecture,	ITU-T Y.3181, ITU-T FG-AINN-I-018, ITU-T FG-AINN-I-021

		interfaces for AI and network interaction; 3)Traditional network resource scheduling is difficult to match with AI's dynamic resource requirements; 4)Research related to AI-native networks is immature.	standardize AI model exchange protocols, and optimize AI task resource allocation mechanisms; 3) Further strengthen AI-native research, build an AI model knowledge base and advance the development of open-source toolchains and simulation environments, enabling researchers to rapidly integrate and validate the effectiveness of AI applications across diverse network scenarios.	
GS5	Lack of standards for AI-native network terminology, definitions, and concepts	There is no consensus on the definition of AI-native networks, the terminology system is incomplete, and key concepts are not clearly defined. This leads to misunderstandings in standard setting, technology development, and actual deployment, affecting interoperability.	1) Conduct standardized research on terminology, definitions, and core concepts related to AI-native networks, and establish a unified terminology system to promote the formation of a fundamental consensus.	ITU-T FG-AINN WG1 Vocabulary for Artificial Intelligence Native for Telecommunication Networks ITU-T FG-AINN-I-011
GS6	Lack of standards for AI-native network governance and management	Existing standards tend to focus on network functionality and capability requirements, architecture design, and security considerations, lacking governance and management guidelines and frameworks oriented toward AI-native networks.	1) Develop standards for AI-native network governance and management frameworks; 2) Define the responsibilities and authority of network operators, AI developers, and regulatory bodies in governance, decision-making, and oversight processes, and establish an	ITU-T Y.3060, ITU-T Y.3325, ITU-T Y.3812

			accountability tracking mechanism.	
GS7	Lack of unified standards at the levels of semantic modeling, data formats, communication protocols, and API interfaces	There is a lack of a unified description and interpretation framework at the semantic level. Inconsistencies in data formats, semantic models, and knowledge representations across different vendors and systems make it difficult to share and reuse AI models in cross-network scenarios. The absence of standardized communication protocols for AI agents and API interface definitions hinders modular integration and large-scale deployment of AI. Additionally, the lack of standardized norms for processes such as data preprocessing, annotation, and semantic mapping increases the difficulty of AI model transfer and interoperability.	1) Promote cross-vendor collaboration in building and sharing semantic ontologies and knowledge graphs, develop semantic mapping and conversion tools to support interoperability between different semantic models; 2) Establish a data quality management system, create standardized guidelines for data preprocessing and annotation workflows to enhance the quality and consistency of training data; 3) Develop standardized communication protocols for AI agents, defining message structures, interaction patterns, and security requirements; 4) Formulate universal API interface specifications to enable modular invocation of AI functions and cross-platform deployment.	ITU-T Y.3181, ITU-T Y.3183
GS8	Lack of a social impact assessment system and ethical guidelines for AI-native networks	Currently, standards for AI-native networks have not sufficiently considered their societal impacts and ethical concerns, including algorithmic bias, privacy	1) Establish a social impact assessment framework for AI-native networks, proposing evaluation metrics across dimensions such as fairness, transparency,	ISO/IEC TR 20226:2025

		breaches, insufficient decision-making transparency, and unclear accountability. The absence of unified methods for assessing social impacts and ethical governance norms may lead to trust and compliance challenges during the practical deployment of AI-native networks.	explainability, and accountability traceability; 2) Develop privacy protection and data compliance standards to strengthen user data security safeguards within AI-driven networks; 3) Formulate AI ethical governance and standardization guidelines to ensure the sustainable development and social acceptability of AI-native networks.	
GS9	Lack of specific evaluation criteria and metrics for assessing the performance level of AI-Native telecommunication networks	Telecommunication networks integrated with AI exhibit enhanced network performance—autonomy, efficiency, and adaptability. Existing standards primarily focus on network functions, architecture, and security. Currently, there is a lack of unified standards for evaluating the performance levels of AI-enhanced network operations and management (particularly adaptability), along with a lack of specific evaluation criteria and metrics. This deficiency limits the effective assessment and optimization of AI-native network performance.	Define clear classification and grading criteria for network performance evaluation, establishing a multidimensional, hierarchical, quantifiable, and verifiable AI-native network performance metric system. For autonomy, the following aspects can be considered: automated decision-making and control capabilities, self-healing and self-optimization capabilities, human-machine collaboration levels, explainability and controllability, etc.; For efficiency, the following aspects can be considered: resource utilization, energy consumption and cost, task execution efficiency, model and algorithm	ITU-T M.3388, ITU-T M.3384, ITU-T M.3385, ETSI GR ENI 010

			efficiency, customer service availability, etc.; For adaptability, the following aspects can be considered: environmental perception and response capabilities, model transfer and continuous learning capabilities, resilience and scalability, scenario generalization capabilities, etc.	

Note: The superscript ⑧ indicates that the results in this table are based on the analysis and processing obtained from Module ⑧ in Figure 1.

8. Overview of requirements and technical challenges from FG-AINN use case and architecture

Editor's note: This clause will summarize the mapping results between the requirements and technical challenges from use cases and the relevant SDOs' standards.

This clause summarizes the mapping results between the relevant SDOs' standards and the requirements as well as technical challenges from use cases. Table 7-19 shows all the uncovered requirements and technical challenges identified through mapping analysis.

Table 8-1⑧ Requirements and technical challenges uncovered by existing standards

Code	Requirements/technical challenges title	Detailed description	Source
GS10 (REQ-AF-10)	Application and network interactions	It expected that the AI native telecommunication network supports enhanced interactions between application and network, allowing applications to share relevant information to optimize the INC (in-network computing)-supported Split-AI inference service.	WG3 deliverable FG-AINN-I-177
GS11 (REQ-AF-17)	AI model transfer	It is of added value that AI native telecommunication network is capable of transferring additional layers of the AI model to the inference node to increase the model performance upon on	WG3 deliverable FG-AINN-I-177

		changes on the network conditions and AI service requirements.	
GS12 (REQ-AF-18)	AI model adaptability	It is of critical value that AINN architecture is capable of constructing AI models able to work in different configuration to trade-off AI service performance with network resource usage.	WG3 deliverable FG-AINN-I-177
GS13 (REQ-FP-10)	Unified Support for the Complete AI Model Lifecycle	The AINN is required to provide integrated support for the entire ML model lifecycle (MLOps), including training, validation, deployment, and inference, for both "AI for Network" and "Network for AI" paradigms. This implies a comprehensive, managed pipeline for AI models.	WG2 deliverable FG-AINN-O-012
GS14 (TC-1)	Absence of a unified network architecture	Current AI-Native Networks (AINN) lack a unified architectural framework and intelligent coordination mechanisms. Deep integration of heterogeneous technologies and network components, as well as cross-unit data sharing at the network level, are not fully supported by current specifications.	WG2 deliverable FG-AINN-O-012
GS15 (TC-3)	Absence of network-side AI training and inference support	Current networks primarily support "AI for Network" but lack native support for "Network for AI." They do not provide the native computing power and resource adaptation required for AI training and inference at the network side, relying instead on user equipment (UE) or application layers.	WG2 deliverable FG-AINN-O-012
GS16 (TC-13)	Limited handling of data bias	Absence of undefined mechanisms for handling data bias.	WG2 deliverable FG-AINN-O-012

GS17 (TC-16)	Limited model explainability and trustworthiness	Autonomous decision systems lack compliance frameworks aligned with international regulations (e.g., GDPR) and risk management requirements.	WG2 deliverable FG-AINN-O-012
GS18 (TC-18)	Undefined accountability framework for autonomous AI decisions	Autonomous network behaviors lack mechanisms for responsibility tracking, allocation, and auditing, making it difficult to assign accountability for AI-induced anomalies or erroneous decisions.	WG2 deliverable FG-AINN-O-012

Note: The superscript ⑧ indicates that the results in this table are based on the analysis and processing obtained from Module ⑧ in Figure 1.

9. Standardization gap analysis for AI-Native Networks

Editor's note: This clause becomes the core analytical section of the document, directly addressing its primary objective.It will retain the content of the original Clause 10

Editor's note: This clause addresses the (in principle) key goal of this document. To note the usual difficulties encountered in the gaps analysis, including the detail of the work needed (detailed analysis of all collected documents, beyond the possible preliminary analysis via automatic text (AI) tool) and the moving targets and developments within each relevant SDO (a gap at a given time may not be any more a gap at a later time (at least in terms of work plan declared by one or more SDOs)). Consideration has been raised in the FG-AINN that it should be discussed further which minimum goals (e.g., at which level and granularity a matter is identified as a gap) could be judged achievable within the FG-AINN life time, and the goals and expected content of this clause could be refined accordingly.

NOTE - The content of this clause could be based on input contributions including: analysis of the technical, terminological, and principal gaps of the studies under ITU and other standardization bodies, industry bodies, open-source bodies (with consideration of the collected activities listed in clause 7).

9.1 Standardization gap description template

The standardization gaps tables are described according to the following standardization gap description template, which is in alignment with A.Supplement 6.SupplSGA to ITU-T A-series Recommendations "Guidelines for the development of a standardization gap analysis" . https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-A.Sup6-202408-I!!PDF-E&type=items

Table 9-1 - Standardization gap description

Gap: Gx 〈Identifier〉	Title: 〈Short description title〉
Gap description:	<Description of the gap, including area(s) where the gap exists>
Future work:	<Description of the future work/study needed to fill the gap (as [ITU-T A.1] or [ITU-T A.13] justifications, when applicable)
Related work:	<Existing and draft standards which are relevant to the future work; SDOs impacted>

9.2 Standardization gaps analysis

Based on the use case analysis results of Clause 7.3, this clause details specific standardization gaps derived from the requirements and technical challenges of certain AI-native use cases. These gaps indicate areas where existing standards may not sufficiently address the requirements and challenges of emerging AI-native applications and services. The identification of these gaps is intended to provide input for future standardization activities.

***Editor's note: the next steps for the completion of the table** include – in order: to develop the text describing the gaps (second column from the left), to consider possible splitting and/or grouping of gaps based on their descriptions, to fill up the "future work" column (third column from the right), to complete the other details (title included) and to review globally the table (including usage of identified taxonomy/terminology); finally/in parallel, to describe the process used to fill up this table (and ensure alignment with clause 7 high level description of the process).*

***Editor's note:** The following initial draft list of gaps was proposed by WG1 after the use case analysis. These gaps need to be further reviewed by experts in WG1 meetings.*

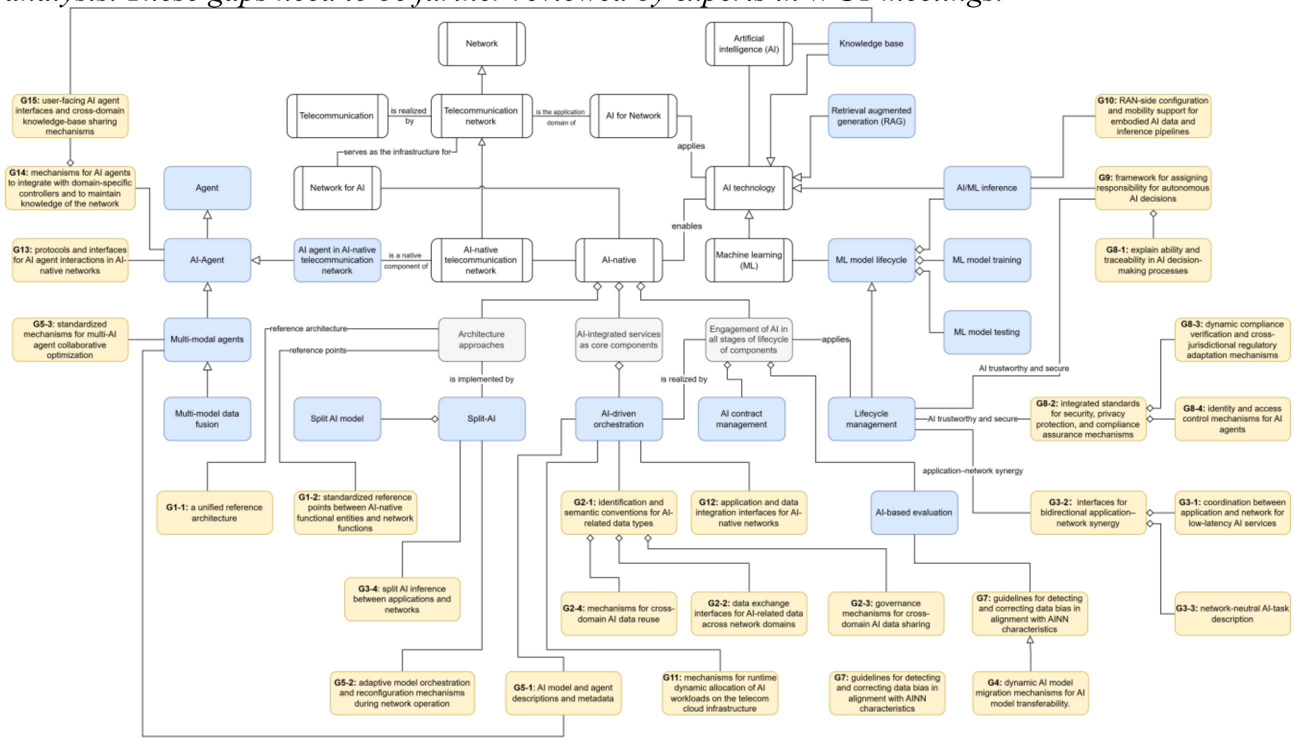

Figure 5 Standard gaps in alignment with FG-AINN characteristics and the Vocabulary

The specific gaps expressed in sub-gaps G1-1 and G1-2 identified through an analysis of gap source(s) GS14(absence of a unified network architecture), GS4 (challenges in AI integration in networks) and GS15 (Absence of network-side AI training and inference support), current AI-native network specifications lack a unified reference architecture covering the full set of delimiting characteristics of AI-native telecommunication networks, and do not define the reference points between AI-native functional entities and traditional network functions. Existing ML-oriented architectural frameworks (e.g., ITU-T Y.3172) are designed primarily for "AI for Network" scenarios and do not jointly address the "AI for Network" and "Network for AI" paradigms.

Gap: G1-1	Absence of a unified reference architecture for AI-native telecommunication networks in alignment of delimiting characteristics of AI-native

Gap description:	No existing standard specifies a unified reference architecture harmonization of key delimiting characteristics of AI-native telecommunication networks as defined in [b-FG-AINN-O-08]. (a) (Engagement of AI in all stages of the lifecycle of network components) The AI-native functional entities. This includes data ingestion, feature engineering, training, validation, deployment and monitoring components, inference nodes, model/artefact repositories, and intent-driven orchestrators — (b) (Architecture approaches for deep integration of AI) The architecture gaps includes integration of network functions include core network, RAN and data network functions and the management functions. Consequently, the joint specification of the "AI for Network" and "Network for AI" paradigms within a single architectural view is not supported.
Future work:	Develop a unified reference architecture for AI-native telecommunication networks, identifying the functional entities listed above (and any additional entities required by the delimiting characteristics of [b-FG-AINN-O-08]), their grouping into functional domains, and the high-level relationships among them.
Related work:	ITU-T Y.3172, ITU-T Y.3170, ITU-T Y.3061, ITU-T Y.3181, ITU-T Y.3182, FG-AINN-I-177, FG-AINN-I-038.

Gap: G1-2	Absence of standardized reference points between AI-native functional entities and network functions
Gap description:	No existing standard defines reference points between AI-native functional entities (e.g., AI agents, ML orchestrators, inference engines, data-pipeline components) and traditional network functions (e.g., core-network NFs, RAN elements, data-network elements). As a consequence, the interactions crossing these boundaries cannot be specified in an interoperable manner, in particular: 1) Control-/management-plane interactions such as model-deployment triggers, AI-task allocation signalling, inference invocation, and monitoring feedback; and 2) Data-plane interactions such as feature delivery, inference-input/output exchange, and model-artefact transport. The absence of such reference points prevents a consistent realization of the delimiting characteristics of [b-FG-AINN-O-08] across architectural boundaries, affects both "AI for Network" operation (where AI functions consume network telemetry and act upon network configuration) and "Network for AI" operation (where the network exposes computing, data, and inference capabilities to AI workloads). 3) Interactions between AI-native functional entities and RAN controllers as defined in [b-ITU-T Y.3061], as a specific instance of the above in the radio-access domain. ***Editor's note: maybe generic controllers rather than RAN***.
Future work:	Define the reference points between AI-native functional entities and network functions including integration of network functions within core network, RAN and data network functions and the management functions, following the standard ITU-T drafting sequence reference points → sequence of messages → contents of messages. The reference points, their sequences of messages and message contents

	shall cover both the control-/management-plane interactions and the data-plane interactions required by the delimiting characteristics of [b-FG-AINN-O-08] (e.g., autonomy, adaptability, AI-for-Network / Network-for-AI duality, data-model-compute integration). In particular, the standardized integration mechanisms shall encompass the integration with RAN controllers as defined in [b-ITU-T Y.3061].
Related work:	ITU-T Y.3172, ITU-T Y.3170, ITU-T Y.3181, ITU-T Y.3182, ITU-T Y.3061, FG-AINN-I-177, FG-AINN-I-038

The following gap has been identified through an analysis of gap source(s) GS13 (Unified Support for the Complete AI Model Lifecycle), with respect to the support for the lifecycle management of AI model.

Gap: G1-3	Insufficient native architecture support for the lifecycle management of AI model for “Network for AI”
Gap description:	AINN should provide support for the full lifecycle management of AI models—covering training, validation, fine-tuning, deployment, inference, monitoring, and update—across both the “network-driven AI” and “AI-driven network” paradigms. However, current standards for network architecture primarily support the “AI for network” model and do not define an architecture that supports the native operation of AI models across all lifecycle stages on the network side (specifically, how AI training, inference, and service orchestration are embedded within network functions). Furthermore, existing specifications do not define the native computing capabilities and resource allocation mechanisms required to support AI training and inference within network nodes (such as the edge and core networks), including resources such as computing power (CPU/GPU/dedicated accelerators), storage, and power consumption. These functions still rely on user equipment (UE) or the application layer for implementation. ***Editor’s note: whether the update can be dynamic.*** ***Editor’s note: wording editing.***
Future work:	1) Define a unified AI-native network architecture specification that supports both “AI for Network” and “Network for AI” and clarify how AI training, inference, and service orchestration are embedded within network functions to enable the manageable, controllable, and orchestrated operation of AI services on the network side. 2) Integrate computational paradigms such as quantum acceleration and classical parallel computing into the network architecture to enhance the training and inference capabilities of AI models, thereby optimizing network performance and scalability. 3) Establish standards for network-level management and control mechanisms covering the entire lifecycle of AI models, continuously monitoring, validating, and adjusting AI model performance online to ensure the models remain effective and sustainable throughout their lifecycle. Monitoring metrics include: model accuracy and reliability, network-level key performance indicators (such as throughput, latency, and reliability), and system-level metrics (such as resource utilization and energy efficiency). 4) Specify standardized AI model lifecycle management procedures covering training, fine-tuning, monitoring, and update.
Related work:	ITU-T Y.3181, ETSI GS ZSM 012, ETSI GS ZSM-001

Editor’s note: derives from original G12 issue 5 part b.

Gap: G1-4	Absence of standardized mechanisms for co-existence between AI-native and traditional ~~RAN~~ network
Gap description:	During the incremental deployment of AI-native networks functions(e.g. RAN), AI-native network functions are expected to operate alongside traditional network functions in the same network. Existing standards do not specify mechanisms for co-existence with traditional network (as opposed to AI native). ***Editor’s note: better to generalize the RAN into network functions and then let RAN into practical evidence(keep this gap saperate). And check if this can be merged into other gap. Co-existence is about integration .***
Future work:	Specify standardized mechanisms for the co-existence of AI-native and traditional network.
Related work:	ITU-T Y.3061, FG-AINN-I-63, FG-AINN-O-08

The following gap has been identified through an analysis of gap source(s) GS14(absence of a unified network architecture) and GS9 (lack of Standardized Evaluation Metrics for AI-Native Networks), with respect to protocols and interfaces for data sharing across heterogenous data sources. AI-native networks require the exchange of AI-related data across heterogeneous network domains (e.g., RAN, core network, data network, edge) in order to support integrated AI pipelines spanning multiple domains. Current specifications do not provide the dedicated exchange mechanisms needed for AI-native operation.

Gap: G2-1	Absence of standardized identification and semantic conventions for AI-related data types
Gap description:	AI-native networks generate and consume several categories of AI-related data — as non-exhaustive examples: training data, inference input/output, model metadata (e.g., hyperparameters, model versions, lineage), network-state data used as ML features, and monitoring data related to model performance. Existing data-exchange specifications do not provide a consistent taxonomy or semantic convention to identify, classify, and interpret these categories across network domains, leading to ambiguity in the construction of cross-domain AI workflows. A specific instance is application-based sampling configuration for AI models such as transformers (e.g. large volume), where existing specifications do not provide a uniform way to identify and convey, as part of the data-type semantics, the sampling parameters that govern data ingestion at training time. ***Editor’s note: check if the sampling parameters process could be more generic.*** ***Editor’s note: determine what is AI-related data types, not clear in this point. Check whether the sampling parameters are relevant to semantic conventions for AI-related data types.*** ***Editor’s note: make it more clear of what is AI-related data types, and check the original use case.***
Future work:	1) Define a standardized taxonomy and semantic conventions for AI-related data types, including identifiers, attributes, and interpretation rules applicable across network domains. 2) Specify standardized application-based sampling configuration mechanisms for large-scale AI models such as transformers.

Related work:	ITU-T Y.3172, ITU-T Y.3174, ITU-T Y.3170, ITU-T Y.3181, ITU-T Y.3182, FG-AINN-I-177, FG-AINN-I-038

Gap: G2-2	Absence of standardized data exchange interfaces for AI-related data across network domains
Gap description:	Data exchange interfaces for AI-related data are not standardized across heterogeneous network domains. This includes: the control-plane signalling needed to negotiate data-sharing sessions (e.g., request, consent, parameter negotiation); the data-plane protocols suited to bulk and streaming AI data transport; and the interfaces to model and data repositories. As a consequence, the reference points, sequences of messages, and message contents required to carry AI-related data across domain boundaries cannot be specified in a network-neutral(i.e., independent of who is providing or operating the equipment) manner.
Future work:	Define standardized data exchange interfaces for AI-related data across network domains, including the associated reference points, sequences of messages, and message contents.
Related work:	ITU-T Y.3172, ITU-T Y.3174, ITU-T Y.3170, ITU-T Y.3181, ETSI GS ZSM 002, ETSI GS ZSM 009, FG-AINN-I-177

Gap: G2-3	Absence of standardized governance mechanisms for cross-domain AI data sharing
Gap description:	Current specifications do not provide governance mechanisms tailored to cross-domain AI data sharing. In particular, there is no standardized provision for: access-control policies that reflect AI-specific roles (e.g., model trainer, model consumer, inference provider); data-sovereignty constraints applied to AI features and models; privacy-preserving exchange patterns (e.g., on-path anonymization, exchange patterns compatible with federated learning); and auditability requirements adapted to AI pipelines.
Future work:	Specify governance mechanisms for cross-domain AI data sharing, covering access control, data sovereignty, privacy preservation, and auditability, each tailored to AI-native operation.
Related work:	ITU-T Y.3172, ITU-T Y.3174, ITU-T Y.3170, ITU-T Y.3181, ETSI GR ZSM 010, FG-AINN-I-177

Gap: G2-4	Absence of mechanisms for cross-domain AI-related data reuse
Gap description:	Beyond point-to-point exchange, AI-native operation may involve the reuse of AI-related data and AI-related knowledge-base content across different AI tasks, services, and network domains (e.g., reusing network-state features collected in the RAN for core-network anomaly detection). Existing standards do not define mechanisms to advertise, discover, and consent to the reuse of AI-related data or knowledge-base content across domain boundaries, nor the lifecycle constraints (e.g., freshness, retention, re-anonymization) that such reuse shall observe. ***Editor's note: clarify of the "domain", what it means, which it refers to .***
Future work:	Define mechanisms for advertising, discovering, and consenting to cross-domain AI data and knowledge-base content reuse, together with the lifecycle constraints applicable to reused AI-related data and

	knowledge-base content (including freshness, retention, and re-anonymization).
Related work:	ITU-T Y.3172, ITU-T Y.3174, ITU-T Y.3170, ITU-T Y.3181, FG-AINN-I-177

The specific gaps expressed in sub-gaps G3-1 to G3-4 has been identified through an analysis of gap source(s) GS10 (Application and network interactions), with respect to enhanced interactions between application and network.

Gap: G3-1	Absence of standardized coordination between application and network-for low-latency AI services
Gap description:	Latency-critical AI services (e.g., closed-loop industrial control, immersive XR, real-time network automation) require the application and the network to coordinate on latency budgets, placement of inference endpoints, and pre-emption/prioritization of AI traffic for example, the allocation and use of compute for AI in the network that enables real-time AI services. Existing application–network interfaces do not expose the standardized mechanisms needed for such coordination in an interoperable manner —for instance, no standardized mechanism allows an application to negotiate an end-to-end latency budget with the network and to be informed of its feasibility across RAN, transport, and compute. This gap is specific to AI-native networks, in which compute for AI is an intrinsic network capability — consistent with the delimiting characteristics of [b-FG-AINN-O-08] — rather than an application-side concern. The specific aspects in which standardized support is missing are as follows: 1) policy support in the RAN for the data characteristics of embodied AI (e.g., burstiness, mixed sensor-and-control flows, freshness sensitivity), distinct from generic application traffic. 2) enabling low-latency prediction and high degree of generalization. ***Editor's note: network domains/ network functions/ complete network rather than RAN.*** ***Editor's note: low-latency embodied AI better in bracket.*** ***Editor's note: check with work already existed, if this is a ture gap (Y.3400 Y.3401 both about coordination between AI application.)***
Future work:	Develop standardized application–network interaction primitives for latency-budget negotiation, AI-traffic prioritization, and end-to-end feasibility feedback across RAN, transport, and compute. 1) Specify RAN-side policy support tailored to the data characteristics of embodied AI. 2) Specify standardized enablers for low-latency prediction with generalization capability.
Related work:	ETSI GS ZSM 012, 3GPP TS 23.501

Gap: G3-2	Absence of standardized interfaces for bidirectional application–network synergy
Gap description:	Bidirectional synergy between applications and networks — in which the network exposes computing, data, and inference capabilities to applications, and applications expose AI-task context to the network — is not addressed by standardized interfaces. What is missing is specifically an AI-native interaction model, including information

	elements, negotiation procedures, and lifecycle bindings, by which the network and the application jointly determine the delivery of an AI service. This is specific to AI-native networks and is not covered by a generic AI pipeline overlay in which the network provides only connectivity. The specific aspects in which standardized support is missing are as follows: 1) RAN-side configuration support for service requirements arising specifically from embodied AI operation.
Future work:	Define a standardized application–network interaction model dedicated to bidirectional application–network synergy, including the information elements, negotiation procedures, and lifecycle bindings required to jointly determine an AI service delivery. Specify RAN-side configuration support, following the ITU-T drafting sequence reference points → sequence of messages → contents of messages where applicable, addressing service requirements arising from embodied AI.
Related work:	ITU-T Y.3181, ETSI GS ZSM 012

Gap: G3-3	Absence of a standardized, network neutral AI-task description
Gap description:	Applications and networks currently cannot exchange, in a network-neutral manner(i.e., independent of who is providing or operating the equipment), a semantic description of the AI task to be delivered. No standardized schema is available to describe, for example, the AI task type, data dependencies, model constraints, acceptable degradation modes, and privacy/compliance attributes. A standardized AI-task description is a prerequisite for interoperability across equipment vendors and network operators in AI-native service delivery and is specific to AI-native networks (as opposed to generic AI pipelines, in which such descriptions remain internal to the AI platform). The specific aspects in which standardized support is missing are as follows: 1) Task-specific intents and languages.
Future work:	Define a standardized AI-task description schema usable independently of the equipment vendor and the network operator, covering at least: AI task type, data dependencies, model constraints, acceptable degradation modes, and privacy/compliance attributes. Specify standardized task-specific intents and languages.
Related work:	ISO/IEC 5338:2023

Gap: G3-4	Absence of standardized split AI inference mechanisms between applications and networks
Gap description:	In split AI inference, the inference computation of a single AI task is partitioned between the application endpoint (e.g., UE) and one or more network-side inference nodes (e.g., edge-hosted, UPF-hosted, or RAN-hosted inference). Existing standards do not define: 1) a standardized model-partitioning mechanism between application-side and network-side inference endpoints (applicable to inference); 2) the corresponding split-point signalling and dynamic re-partitioning triggers driven by network conditions and QoS/QoE requirements (applicable to inference); 3) within the split AI inference context, the associated task-distribution and coordination procedures among AI agents located

	across application-side and network-side inference endpoints. This point is intentionally limited to the split-AI scope; broader AI-agent coordination concerns (e.g., agent-to-agent (A2A) and Model Context Protocol (MCP) mechanisms) are out of scope of this gap and are noted for separate treatment
Future work:	1) Develop a standardized model-partitioning mechanism between application-side and network-side inference endpoints, together with the associated split-point signaling and dynamic re-partitioning triggers. 2) Specify task-distribution and coordination procedures among AI agents across application-side and network-side inference endpoints, to support split AI inference as a native capability of AI-native networks.
Related work:	ETSI GS ZSM 012, 3GPP TR 23.700-80

Editor's note: derived from original G10 issue 3

Gap: G3-5	Absence of RAN-side mobility support preserving AI and data pipeline continuity for embodied AI endpoints
Gap description:	Embodied AI endpoints (such as AI-enabled drones, intelligent vehicles and robots) move across the network while consuming AI services delivered through AI and data pipelines that span the endpoint and the network. Existing RAN-side mobility procedures do not preserve the continuity of the AI and data pipelines, including handover behaviour for active inference contexts, as embodied AI endpoints move across the network.
Future work:	Specify RAN-side mobility support that preserves the continuity of the AI and data pipelines, including handover behaviour for active inference contexts, as embodied AI endpoints move across the network.
Related work:	FG-AINN-I-61, FG-AINN-O-08

The following gap has been identified through an analysis of gap source(s) GS11 (AI model transfer), with respect to the capability of transferring additional layers of the AI model to the inference node.

Gap: G4	Lack of dynamic AI model migration mechanisms for AI model transferability
Gap description:	Current standards have not yet defined or standardized AI model migration capabilities, resulting in a lack of model migration mechanisms tailored to real-time latency, user density, and computational load. In traditional networks, AI models are typically deployed statically on fixed cloud or edge nodes, lacking the ability to adapt to changes in the network environment. However, AINN possesses autonomous sensing, decision-making, and execution capabilities, requiring AI models with the ability to migrate in real time to different computing nodes (such as centralized cloud environments or edge nodes) based on network conditions and service demands. The AI model migration mechanism enables AI models to dynamically migrate between different nodes—including cloud, edge, and endpoint—after considering multiple factors such as resource load, latency requirements, service continuity, and cost. This ensures efficient resource utilization and guarantees low-latency service delivery.

Future work:	1) Establish unified standards and specifications for model migration decision-making logic and migration strategies, defining standardized trigger conditions for model migration to clearly characterize "dynamic" behavior, including when and under what system conditions migration should be initiated. Incorporate multidimensional factors such as network latency, user distribution, and computing load, thereby achieving coordinated optimization of model migration and network resource scheduling. 2) Define a unified method for describing the hierarchy and portable granularity of AI models in cloud-edge-end environments, and establish standard specifications for model packaging, version management, and rollback mechanisms to support the flexible deployment and secure migration of models across different nodes. 3) Design a unified model migration control interface and communication protocol, standardizing key processes such as model state synchronization, context migration, migration triggering, and completion confirmation to ensure efficient interoperability and seamless migration capabilities between centralized cloud and edge nodes.
Related work:	3GPP 28105-j40

The following gap has been identified through an analysis of gap source(s) GS12 (AI model adaptability), with respect to the adaptive configuration capabilities of AI models. AI-native networks require the adaptive generation, selection, and application of AI agent tools and comprehensive solutions tailored to different services and scenarios. However, existing standards have not yet defined the adaptive capabilities of AI models, making it difficult for networks to achieve unified management of heterogeneous AI models and dynamic reconfiguration at runtime.

Gap: G5-1	Lack of unified AI-native semantic modelling and metadata standards for heterogeneuos AI models and agents
Gap description:	Existing standards do not define a unified semantic description mechanism for heterogeneous AI models and agents. The specific aspects in which standardized support is missing are as follows: 1) There is a lack of standardized modelling methods for model structure representation, performance metrics (such as latency, accuracy, and energy consumption), data dependencies, and runtime monitoring parameters. 2) For AI agents, there is also a lack of standardized methods for agent capabilities, interaction protocols, autonomy levels, delegation mechanisms, and meta-reasoning attributes. This makes it difficult to ensure that models are interpretable, comparable, and manageable across domains and platforms. 3) A lack of standardized methods for the integration of foundation models and fine-tuned models within a unified description framework. 4) A lack of standardized methods for the description of agent memory, including the capturing of knowledge and experience. Collectively, these gaps make it difficult to ensure that AI models and agents are interpretable, comparable, and manageable across domains and platforms.
Future work:	Define a unified description and metadata standard for AI models and AI agents. Establish a semantic modelling method that covers:

	1) For AI models: model structure, performance metrics, data dependencies. 2) For AI agents: agent capabilities, interaction protocols, autonomy levels, delegation mechanisms, and meta-reasoning attributes.3) Integration of foundation models and fine-tuned models within the unified description framework. 4) Description of agent memory, including the capturing of knowledge and experience.
Related work:	ITU-T TR.ACN, ITU-T Y.Agentic-AIoT

Gap: G5-2	Lack of standards for adaptive model orchestration and reconfiguration mechanisms during network operation
Gap description:	Current standards do not define mechanisms for dynamically selecting, splitting, combining, and reconfiguring. AI models during runtime based on service requirements (e.g., QoS/QoE), network conditions (e.g., load, latency), and hardware constraints (computing power, storage, power consumption). In particular, there is a lack of standardized methods for splitting AI models into functional or hierarchical fragments, as well as orchestration capabilities to adaptively deploy these model fragments across different infrastructure nodes (cloud, edge, endpoints) to optimize network performance metrics (such as latency, resource utilization, and energy consumption). Specifically, there is a lack of unified specifications in the following aspects: 1) Standardized methods for describing model splitting points and splitting levels, including the definition of a unified system of splitting point identifiers, splitting granularity, splitting hierarchy structures, and splitting constraint metadata; 2) General rules for deployment decision logic. For example, determining which layers should be deployed to edge nodes and which layers should remain in the cloud; 3) The ability to reconfigure or dynamically adjust deployed model fragments during runtime.
Future work:	Develop standards for adaptive orchestration including: 1) a model decomposition description language defining possible split points and granularity; 2) a placement decision framework that matches model fragments to infrastructure capabilities (computing, storage, latency); 3) a runtime reconfiguration interface to enable dynamic reassignment of model fragments without service interruption.
Related work:	ITU-T Y.3177, ITU-T Y.Agentic-AIoT, ITU-T Y.AIoT FRA

Gap: G5-3	Lack of standardized mechanisms for multi-AI agent collaborative optimization
Gap description:	Existing standards do not address the modelling of collaborative relationships among multiple AI agents, task decomposition mechanisms, or conflict resolution strategies. There is a lack of unified interfaces for agent-to-agent interaction, collaborative decision-making protocols, and strategy learning frameworks, making it difficult to achieve system-level performance optimization in multi-agent scenarios (such as multi-model collaborative reasoning

	and cross-task optimization). The specific aspects in which standardized support is missing are as follows: 1) Protocols and interfaces for orchestration and workload distribution and AI agent interactions. 2) Environment sensing and network state derivation, task decomposition and AI agent discovery and task scheduling.
Future work:	Standardize the collaborative optimization mechanism for multi-agent systems, define the interaction interfaces between agents, task decomposition models, conflict resolution strategies, and collaborative learning frameworks, and ensure the coordinated operation of multi-agent systems. The standardization shall in particular include: 1) protocols and interfaces for orchestration, workload distribution, and AI agent interactions; 2) mechanisms for environment sensing and network-state derivation, task decomposition and AI agent discovery, and task scheduling.
Related work:	ITU-T Y.Agentic-AIoT, ITU-T Y.IMT2020-DIC, ITU-T TR.ACN

The following gap has been identified through an analysis of gap source(s) GS16 (Limited handling of data bias), with respect to data bias.

Gap: G7	Lack of standard guidelines for detecting and correcting data bias in alignment with characteristics of AI-native telecommuting networks
Gap description:	Data bias may stem from data collection, annotation, or historical business distributions, directly affecting the fairness, reliability, and generalization ability of models. In AI-native networks, the integration of AI across the entire workflow and all components causes sources of data bias to extend from static data distributions to dynamic couplings between components and closed-loop feedback, resulting in bias being amplified throughout the entire process and becoming difficult to trace. Currently, existing standards has not established specific, unified procedures for identifying, quantifying, providing feedback on, and correcting data bias, resulting in trained models that may exhibit imbalanced performance in specific scenarios or among certain user groups.
Future work:	1) Establish data bias handling standards and guidelines, such as: 2) Define standard methods and a metric system for identifying and quantifying data bias, covering bias detection rules and evaluation processes throughout data collection, annotation, and usage, to ensure that bias is measurable and comparable. 3) Establish standards for bias governance and traceability mechanisms across the data lifecycle, standardizing processes for representative sample expansion, category balancing, bias correction, and data traceability, thereby enhancing dataset quality and auditability. 4) Establish standards for bias detection and audit mechanisms throughout the model lifecycle, define multi-dimensional fairness evaluation metrics and continuous monitoring processes, and introduce a review and ethical evaluation framework involving multiple stakeholders.
Related work:	ETSI GS ZSM 012

The following gap has been identified through an analysis of gap source(s) GS17 (Limited model explain ability and trustworthiness), with respect to the explain ability and trustworthiness of AI model. In AI-native networks, artificial intelligence models—particularly AI agents capable of autonomous decision-making and continuous learning—have a critical impact on network operations and service quality. However, existing standards have yet to establish a regulatory framework or measures covering the explain ability, reliability, security, and compliance of autonomous decision-making systems, making it difficult to ensure the trustworthy operation of AI systems in complex network environments.

Gap: G8-1	Lack of standards and specifications for explain ability and traceability in AI decision-making processes across all processes, components and systems
Gap description:	Current standards do not define a unified mechanism for AI model decision logs and auditing, nor do they specify the methods and content requirements for recording data sources, feature processing procedures, algorithmic logic, and output results. This results in a lack of end-to-end traceability in AI decision-making processes, making it difficult to provide a basis for compliance verification and accountability. **Editor note: add a gap about problem solving and debugging (discuss with Marco)** **Vishnu's comment: G8-1: Interoperability in explainability, traceability and (problem solving and debugging) in AI ML pipelines (Y.3172).**
Future work:	1) Establish standards and specifications for the explainability and traceability of AI-driven decision-making. 2) Standardize the minimum recording units for decision logs to include data source identifiers, feature processing chains, model versions and inference process information, output results, and confidence scores, and ensure end-to-end traceability and auditability of the entire process—from data collection to decision output—through end-to-end logging. 3) Develop and standardize technical specifications and procedural requirements for AI-based verification and AI-driven validation process to ensure the traceability and accountability of AI system self-verification and cross-validation activities.
Related work:	ETSI 005, ETSI GS ZSM 012, ITU-T Y.3172

Gap: G8-2	Lack of standards for autonomous and adaptive security, privacy protection, and compliance assurance mechanisms across processes, components and systems, including AI/ML pipelines
Gap description:	Existing cybersecurity and privacy protection standards are primarily designed for traditional network functions and do not define a unified integrated framework for autonomous learning and dynamic evolution. There is a lack of standardized methods for uniformly incorporating monitoring mechanisms, privacy protection policies, security measures, compliance controls, and trust management (such as anomaly detection, boundary decisions, and explainable behavioral constraints) into AI-driven network architectures (including every stage and every component of the network architecture). This should include AI/ML pipelines as well.
Future work:	Build an integrated framework for security, privacy, compliance, and trust management that unifies runtime behavior monitoring, anomaly

	detection, and policy enforcement within an AI-driven network architecture; enable the dynamic deployment of access control and data protection rules through an executable policy language; and introduce a trust scoring mechanism based on historical behavior to support continuous risk assessment.
Related work:	ETSI 005, ETSI GS ZSM 012

Gap: G8-3	Lack of standards for dynamic compliance verification adaptable to regional and local AI regulations
Gap description:	Existing standards do not define dynamic compliance verification processes for continuously learning AI models including regional and local AI regulations. This gap handles data exchange compliance verification, policy enforcement, and continuous auditing mechanisms.
Future work:	Establish a dynamic compliance verification process for continuously learning AI models with capabilities of data exchange compliance verification, policy enforcement, and continuous auditing mechanisms. Set up compliance checkpoints at each stage of data collection, model training, and model updates. Simultaneously, implement policy-tag-based automated controls and data masking for cross-jurisdictional data flows to ensure end-to-end compliance throughout the continuous learning process.
Related work:	ETSI 005, ETSI GS ZSM 012

Gap: G8-4	Lack of standards for identity and access control mechanisms for AI agents
Gap description:	Existing specifications do not explicitly address authentication, authorization, and access control models for AI agents, nor do they define the operational boundaries and scope of privileges for such agents, making it difficult to ensure that their actions are carried out within established security policies and controls. This gap is important because there are actions and decisions taken by AI agent possibly autonomously and hence they require identity and access control mechanisms. Interoperability of such identity and access control for AI agents is important for scalability.
Future work:	Establish standards and specifications for identity authentication and access control for AI agents; build a unique identity identification system and a tiered permission model; define the operational boundaries for agents in data access, tool invocation, and autonomous decision-making; and implement a traceable auditing mechanism through end-to-end “identity-behavior-result” logging, introducing additional authorization or multi-level approval constraints for high-risk operations.
Related work:	ETSI 005, ETSI GS ZSM 012

The following gap has been identified through an analysis of gap source(s) GS18 (Undefined accountability framework for autonomous AI decisions), with respect to the allocation of responsibilities for AI decisions.

Gap: G9	Lack of a clear responsibility framework for AI agents assigning responsibility for autonomous AI decisions
Gap description:	The existing standards framework lacks sufficient regulations regarding the attribution of responsibility and traceable accountability

	for autonomous AI decision-making, and has yet to establish a standard framework for defining responsibility for AI decision outcomes. Although some network systems have introduced recording technologies such as distributed ledgers and timestamps, these remain at the event-level recording stage and have not yet established semantic associations or link-level traceability standards for determining responsibility. Furthermore, the absence of independent audit and public oversight mechanisms for AI decision-making under a multi-regulatory framework has created a disconnect between legal and technical frameworks regarding the determination of responsibility. The responsibility framework for AI agents refers to a set of processes in AI-native networks, where the autonomous decision-making process involves multi-party collaboration (models, data providers, network operators, and AI agents) including structured representation of AI decision chains and mechanisms for semantic description. NOTE: The framework helps to map model behavior, data sources, and policy execution processes into standardized units of responsibility that are auditable and traceable.
Future work:	1) Establish uniform standards for assigning responsibility, clearly defining how liability can be systematically attributed to specific functional modules, algorithmic components, or operators in the event of anomalies in AI autonomous decision-making or risk incidents; 2) Establish a regular audit mechanism covering AI decision-making and autonomous behavior to ensure that system operations consistently comply with security, regulatory, and operational standards.
Related work:	ETSI 005

Editor's note: The former expert-contributed gaps G10–G15 were revised to address the granularity mismatch between these items and the methodologically derived gaps G1–G9. The revision primarily follows a redistribution approach: where an expert issue was semantically aligned with an existing gap, it was moved into that gap as a supporting example or corresponding future-work item; where no appropriate existing gap was available, the issue was retained as a new atomic gap. Specifically, the former G10 issues on RAN policy support and RAN-side configuration for embodied AI were incorporated into G3-1 and G3-2 respectively, while its issue on handover and continuity of active AI/data pipelines was retained as a new atomic gap, G3-5. The former G11 was deleted because its scope was considered covered by existing requirements and related standards on workload monitoring, optimization and resource control. The former G12 was redistributed: application-based sampling configuration was moved to G2-1, model lifecycle management to G1-3, low-latency prediction and generalization to G3-1, RAN-controller integration to G1-2, tool usage to the revised AI-agent tool/knowledge-retrieval gap, and co-existence with traditional RAN was retained as the new G1-4. The former G13 was also redistributed: orchestration, workload distribution, environment sensing, agent discovery and task scheduling were moved to G5-3; foundation/fine-tuned model integration and memory-related knowledge capture were moved to G5-1; tool-usage integration was consolidated with the revised AI-agent tool/knowledge-retrieval gap; and task-specific intents and languages were moved to G3-3. The former G14 was narrowed: its intent-to-execution issue was redistributed to G3-3 and G5-3, while the RAG/tool-usage and asynchronous knowledge-update issues were retained in the revised AI-agent knowledge and tool-access gap. The former G15 was split: cross-domain knowledge-base sharing was incorporated into

G2-4, while the user-facing AI-agent interface was retained as a separate atomic gap. These changes were made to preserve the substance of the expert contributions while aligning the final gap catalogue with a more consistent, atomic level of standardization granularity.

Gap: G10	Absence of standardized mechanisms for AI agent external-knowledge use, tool-usage integration, and asynchronous knowledge-base update
Gap description:	AI agents in AI-native networks rely at runtime on external knowledge and external tools, and on a knowledge base that reflects the live state of the network. Existing standards do not specify: 1) Techniques such as retrieval-augmented generation (RAG) for the use of external knowledge by AI agents, both to provide them with updated information and to support content generation; 2) Integration mechanisms by which AI agents discover, register, and invoke external tools — including, but not limited to, the tools used in the retrieval mechanisms of 1); 3) Asynchronous update of the agent knowledge base for the real-time status of the network. ***Editor's note: check if the gap is only focus on AI inference, whether including AI validation.*** ***Editor's note: asynchronous update(whether it is updated dynamically), discovering tool usage.***
Future work:	1) Specify standardized mechanisms for the use of external knowledge by AI agents, including retrieval-augmented generation (RAG), both to provide AI agents with updated information and to support content generation. 2) Specify standardized mechanisms for tool-usage integration. 3) Specify standardized mechanisms for asynchronous update of the AI agent knowledge base for real-time status of the network.
Related work:	ITU-T Y.3061, ITU-T Y.3064, FG-AINN-I-WG2-005-R3, FG-AINN-I-60, FG-AINN-O-08 ***Editor's note: check reference of ITU-T Y.3061, and other reference related to AI-agents and knowledge base(Y.3064).***

Gap: G11	Absence of a standardized user-facing AI agent interface for consumer-side agents
Gap description:	AI-native networks expose AI services to end-users through agents acting on the consumer side. Existing standards do not specify a standardized user-facing AI agent interface applicable to consumer-side agents such as AI assistants, drones and intelligent vehicles. ***Editor's note: further study on what should be standardized, explain of the interface(template / specific-interface/ intent).***
Future work:	Specify a standardized user-facing AI agent interface, applicable to consumer-side agents such as AI assistants, drones and intelligent vehicles.
Related work:	FG-AINN-I-59, FG-AINN-O-08 ***Editor's note: agent related reference (TR-ACN)***

Editor's note: *Original G17 (formerly titled "Lack of Standardized Evaluation Metrics for AI-Native Networks", source: FG-AINN-I-054-R1) has been examined against the existing gap* *catalogue. Two structural problems were identified: (a) the original title does not match the substantive content of Issues 1–6, none of which address performance-evaluation metrics; and (b) each of the six issues is already covered by an existing gap.*

Annex A Criteria for identifying Standards Development Organizations (SDOs) relevant to AI-Native Networks

Editor's note: The following text is considered to require further discussion.

To ensure that the standards published by the SDOs included in the analysis are highly relevant to the AI-native telecommunication network (AINN), this study looks for the work responsibilities, research content and published/developing standards of the SDOs to select those that are substantively related to AINN.

The selection criteria were as follows: for each SDO,

a) Analyze whether its responsibilities and scope of research includes the application of AI/ML-based technologies in network design, network management, network optimization, etc., and preliminarily determine if the work of the SDO is related to AINN.
b) Further evaluate whether the standards it has published or is developing involve the delimiting characteristics of AINN, especially the integration of AI as a core component, the penetration of AI across the whole network lifecycle, the enhancement of network performance and services, or the use of AI for network management to ultimately determine if the SDO is substantially related to AINN.

If the responsibility, scope of research and published/developing standards of the SDO do not intersect with the delimiting characteristics of AINN, it is judged to be irrelevant and excluded; otherwise, it is included in the subsequent specific analysis.

Annex B Process for identifying Standards Development Organizations (SDOs) relevant to AI-Native Networks

Editor's note: The following points are considered to require further discussion, and conclusions on them need to be aligned with the content in Clause 6.1.

This section analyzes each SDO based on the selection criteria established in Annex A. Specifically, by examining their scope of work, research content, and published standards, we assess the degree of relevance between the SDO and AINN to determine whether to include it in subsequent analysis. Table 8-1 lists the scope of responsibilities for each SDO, the results of the assessment of their alignment with AINN, and whether they were ultimately included in the analysis. The final column clearly states the specific reasons for including or excluding each SDO.

The scope of work and selection of each SDO is shown in Table B1:

Table B1 – Overview of SDO's work and selection status related to AI-native networks

SDOs and study groups	Responsibility	Potential scope of research	Selection results and reasons
ITU-T SG13 Future networks	focuses on the technical evolution and standardization of Future Networks (FN)	• The requirements, architectures, capabilities and application programming interfaces (APIs), softwarization, orchestration and the use of artificial intelligence (AI), including machine learning of future networks (FN);	√ Reasons for inclusion: this group focuses on future networks, emphasizing the application of artificial intelligence

		• The integration of computing and networking from the viewpoint of future networks; • Future computing, including cloud computing and data handling in telecommunication networks, and also end-to-end awareness, control and management of future computing	technology in networks, the integration of computing and future networks.
ITU-T SG21 Technology for multimedia, content delivery & cable TV	focuses on multimedia technologies, systems, applications, and services for current and future networks, including IP-based and cable-based networks	• The use of telecommunication systems for the contribution, primary and secondary distribution of audiovisual content, and immersive multimedia applications like virtual reality, augmented reality, and 3D; • Leveraging advanced technologies such as cloud computing and AI to enhance multimedia applications and services	√ Reasons for inclusion: the scope of research covers the application of advanced technologies such as cloud computing and artificial intelligence in the multimedia of future networks.
ITU-T SG2 Operational aspects	responsible for standardization of telecommunication services, network management systems and code resource allocation, including fault, configuration, accounting, performance and security management	• The use of AI for the various aspects of network management; • The maintenance of ITU's International Numbering Resource (INR) database; • Leading ITU's work on standards in support of telecommunications for disaster relief/early warning, network resilience and recovery	√ Reasons for inclusion: the scope of research covers the application of AI technology in network management.
ITU-T SG5 Environment, EMF, climate action & circular economy	responsible for the development of standards relating to telecommunications/ICT (including emerging technologies) environment as well as environmental protection, including electromagnetic phenomena and climate change	• How to shape these telecom/ICT and digital transformations; • Issues related to resilience, human exposure to electromagnetic fields (EMF), circular economy, energy efficiency, and climate change adaptation and mitigation; • Assessing the environmental performance of emerging telecom/ICT	× Reasons for exclusion: its research focuses on telecommunications environments, EMF, and climate issues, which are unrelated to the integration and application of artificial intelligence in networks.
ITU-T SG9 Broadband cable and TV	responsible for the delivery, primary distribution and secondary distribution of telecommunications systems for audio and video content (e.g., television programs) and related data services (including interactive services and applications)	• Cable broadband Internet broadcasting of audio programs; • Digital transmission of standard-definition and high-definition television signals; • Cable network delivery of IP (and/or packet data)-based	× Reasons for exclusion: the standards it publishes do not involve the application of AI technology.

		digital services and applications; • High-speed Internet broadcasting services based on cable networks; • Transmission of digital cinema programs in feeder and distribution networks	
ITU-T SG11 Protocols, testing & combating counterfeiting	responsible for research related to signaling system architecture, signaling requirements and protocols for various types of networks, including Future Networks (FN), Cloud Computing Networks, interconnection of networks based on VoLTE/ViLTE/VoNR/ViNR, and legacy network interoperability signaling	• How to combat counterfeiting, tampering and theft of telecom/ICT equipment, counterfeiting and tampering of telecom/ICT software and the negative impacts of these issues; • Development of test specifications for testing conformance and interoperability (C&I) of various types of networks, technologies and services	× Reasons for exclusion: its research focuses on signaling protocols and anti-counterfeiting, and is not related to AI integration, performance enhancement, and other characteristics of AINN.
ITU-T SG12 Performance, QoS & QoE	responsible for the development of international standards (ITU-T Recommendations) on performance, quality of service (QoS) and quality of experience (QoE)	• Quality of service and quality of experience; • Performance and quality assessment of voice and multimedia communications systems (including in-vehicle communications systems); • Video quality assessment of communications, applications and system components	× Reasons for exclusion: mainly focuses on network performance evaluation, and the published standards do not involve the application of AI technology.
ITU-T SG17 Security	responsible for developing international standards to enhance confidence, security and trust in the use of telecommunications/ICTs	• Security model, framework, architecture and lifecycle; • Cybersecurity and service; • Security management; End-device, edge, network, cloud and application security; • New and emerging security technologies;	√ Reasons for inclusion: emphasizes network security, and some of the standards it publishes involve the application of AI and other technologies in network security management.
ITU-T SG20 IoT, digital twins & smart cities	responsible for developing innovative standards, guidelines, reports, methodologies and best practices on the Internet of Things (IoT), digital twins, meta-universes and Sustainable Smart Cities and Communities (SSC&C) to accelerate the digital transformation of cities and rural areas	• Technology areas: research into IoT, digital twins, edge computing, artificial intelligence and machine learning, big data, data processing and management, advanced analytics, orchestration and automation technologies, and advanced sensing and actuation;	√ Reasons for inclusion: some of the published standards involve the application of AI technology in the Internet of Things (IoT, which is one of the application scenarios of communication networks).

ITU-R SG6 Broadcasting service	responsible for radiocommunication broadcasting, including vision, sound, multimedia and data services principally intended for delivery to the general public	• The production and distribution of programmes (vision, sound, multimedia, data, etc.); • Contributionl circuits among studios; • Information gathering circuits (ENG, requirements for SNG, etc.); • Primary distribution to delivery nodes, and secondary distribution to consumers	× Reasons for exclusion: the scope of research emphasizes radio communication broadcasting, but the published standards do not involve the application of AI in telecommunication networks.
ISO/IEC JTC 1/SC 42 Artificial intelligence	its work plan looks at the entire AI ecosystem and is responsible for standardization in the field of Artificial Intelligence (AI)	• Standardization in foundational AI standards; • Data standards related to AI; • Big data and analytics; • AI trustworthiness, use cases and applications; • Governance implications of AI; • Computational approaches of AI; • Testing of AI systems; • Ethical and societal concerns	× Reasons for exclusion: although this organization is at the core of foundational AI standardization, it does not specifically focus on telecommunications networks.
ISO/TC46 & ISO/TC46/SC11 Archives/records management	standardization of principles for the creation and management of documents, records and archives as evidence of transactions and covering all media including digital multimedia and paper	• Codifying best practices for managing records into internationally applicable management systems and other standards, serving both business and societal purposes; • Influencing others to enhance the guidance provided on recordkeeping and records management mechanisms and techniques; • Influencing the development of systems that create and manage records, aiming for continuous improvement	× Reasons for exclusion: this organization focuses on record and archive management, not telecommunications networks or AI network integration.
W3C	Development of Web technology standards and implementation guidelines to provide an appropriate basis for meeting Web accessibility, internationalization, privacy and security requirements	• Web design and applications; • Web architecture; • Semantic Web; • Extensible Markup Language; • Services for the Web; • Web for all kinds of access devices	× Reasons for exclusion: focuses on Web technology standards, unrelated to AINN.
IETF/IRTF	IETF: produces high quality, relevant technical and engineering documents that influence the way people design, use, and manage the Internet in such a way as to make the Internet work better;	IETF: • produces technical documents (RFCs) that define how Internet technology works in detail, and can be operated and managed at scale IREF:	√ Reasons for inclusion: the standards published involve AI technology-supported Internet and network

	IREF: focuses on longer term research issues related to the Internet while the parallel organization	• work on topics related to Internet protocols, applications, architecture and technology	operation and management.
IEEE	publicates high-level academic journals and conference proceedings, develops industry technical standards, and organize global technical conferences and symposiums	• Electrical and Electronic Devices; • Network Communications; • Aerospace; • Software Engineering; • Intelligent Transportation; • Instrumentation and Measurement	× Reasons for exclusion: although the organization's research covers a wide range of fields, such as network communications and intelligent transportation, its standardization work does not pay enough attention to AI native integration in telecommunications networks.
TMF	a leading provider of core administrative services dedicated to helping clients secure their investments and operations globally	• Accounting & Reporting Services; • Corporate Secretarial Services; • HR & Payroll Services	× Reasons for exclusion: the scope of research is unrelated to AINN.
ETSI ISGs	develops standards related to fixed, mobile, radio, converged, broadcast, and internet technologies	• Focus on innovation: ISGs often tackle new or rapidly evolving technologies, such as Network Functions Virtualisation (NFV), Quantum Key Distribution (QKD), and AI	√ Reasons for inclusion: the scope of research covers the application of emerging technologies in wireless communication networks and mobile communication networks.
ONAP	a comprehensive platform for orchestration, management, and automation of network and edge computing services for network operators, cloud providers, and enterprises	• Support automated deployment, management and optimization of physical and virtual network devices; • Functions: 5GRAN automation, network slicing and performance optimization; • Key technologies: PNF discovery and integration, network slicing and real-time analytic intelligence	√ Reasons for inclusion: the scope of research covers the application of core technologies in network automation operations, management, and optimization.
3GPP	covers cellular telecommunications technologies, including radio access, core network and service capabilities, which provide a complete system	• Radio Access Networks; • Services and Systems Aspects; • Core Network and Terminals	√ Reasons for inclusion: this organization focuses on wireless access networks and core networks,

	description for mobile telecommunications		and some of the standards it publishes cover AI/ML management and service functions in networks.

Annex C Criteria for selecting relevant standards from the identified SDOs

Editor's note(210-r3): Add a (detailed) explanation of the specific criteria for selection, which should be aligned with clause 6.1.2. The following text has not been reviewed.

1. Explicit AI references: Standards whose titles, abstracts, and keywords explicitly include terms such as "AI," "artificial intelligence," "AI-driven," or "machine learning", "ML" are considered directly relevant.
2. AI-Derived Characteristics: Standards whose titles, abstracts, and keywords reflect AI-related characteristics identified through semantic analysis, such as "automation/autonomy," "self-organizing," "intelligent perception," "intelligent awareness," or "intent network," will also be considered relevant.
3. Support for Future Networks: Standards emphasizing support for functionalities aligned with future network paradigms (e.g., IMT-2020 and beyond)

Conversely, any standard whose title, abstract, and keywords exclusively address topics referring to specific technologies without including any of the above AI-related criteria will not be considered.

Annex D Coding scheme of labels derived from AI-Native Telecommunication Network definitions

The rule used for the coding is as follows: It is followed the template "*D[n]-C[m]-[k]...*", where *n* denotes the numbering of the source definition (e.g., *D1/D2/D3*), *C* indicates characteristics, and subsequent numeric labels *m* and *k* represent progressive hierarchical levels of conceptual decomposition. Codes with the same prefix indicate branching from a shared parent concept. For example: 'Integrating AI as a core component *[D1-C1-1]'* and 'Integrating AI through the entire lifecycle of telecommunication networks *[D1-C1-2]*' are both sub-concepts derived from the parent "integrating AI *[D1-C1]*."
This pattern is repeated consistently for subsequent conceptual subdivisions, ensuring traceability across hierarchical levels.

Table D1 – Coding of the delimiting characteristics from the definitions of AI-native telecommunication networks and AI-native networks [b-FG-AINN-O-08]

Term	Related definition and associated coding
AI Native telecommunication network	AI Native telecommunication network is telecommunication networks integrating AI[D1-C1] as a core component[D1-C1-1], enabling novel value-added services[D1-C2], and enhancing the performance of the network and its services[D1-C3].

	NOTE1: Integrating AI refers to use AI technologies as enablers through the entire lifecycle of telecommunication network's design, deployment, operation, and maintenance[D1-C1-2]. NOTE2: Enhance performance refers to higher level of autonomy[D1-C3-1], efficiency[D1-C3-2], adaptability[D1-C3-3] resource utilization[D1-C3-4]. NOTE3: AI-native telecommunication network environment refers to all components and entities external to the network interacting with the AI-native telecommunication network including humans, devices, and applications. NOTE4: AI-native telecommunication network value-added services refer to added-value services integrating AI and leveraging telecommunication network communication and computing capabilities. This extends the definition of value-added services based on [3GPPTR 21.905]."
AI-native network	AI-native network is networks in which : • all steps in the lifecycle of network services, applications and functions, and AI pipelines, are managed by AI, using AI[D2-C1], • with specific aim to make AI integration easier in the network[D2-C2]. NOTE- AI pipelines are machine learning pipelines [ITU-T Y.3172] with enhanced support for AI models.

Annex E Validation of standards' relevance by AI-assisted analysis

Editor's note(210-r3): the content of this clause (from FG-AINN-I-WG1-047-R10 and 4th June meeting brief related exchanges) has not been discussed in detail.
Editor's note: this appendix considers for the moment relevance only with the respect to domains/topics. It could be extended to relevance with respect to delimiting characteristics.
Contributor's note from FG-AINN-I-WG1-047-R10 (note not yet discussed): The extent to which technical details should be included in the description of this method is open to discussion. From the perspective of maintaining the purpose of the report, we should minimise irrelevant content, but from the perspective of ensuring repeatability, we should clarify the method's process.

To enhance the efficiency and consistency of identifying relevant existing standards, a structured methodology leveraging Artificial Intelligence (AI) is employed for the screening process. This methodology is predicated on a comparative validation framework.

The process commences with the meticulous annotation of a defined corpus of existing standards by human domain experts. These manual annotations establish the authoritative ground truth, representing expert judgment on the relevance and thematic coverage of each standard concerning the delimiting characteristics of AI-native networks.

Concurrently, an AI-driven approach is utilized to perform an analogous annotation task on the identical set of standards. The AI-generated annotations are subsequently subjected to a rigorous statistical comparison against the annotations provided by the human experts. The outcomes of this comparative analysis are quantitatively presented and evaluated using a confusion matrix. This matrix serves to elucidate the degree of concordance and divergence between the AI-driven and human expert classifications, thereby identifying true positives, true negatives, false positives, and false negatives.

By treating the human expert annotations as the definitive benchmark, the analysis of the confusion matrix, potentially supplemented by metrics such as precision, recall, and F1-score, facilitates a robust assessment of the AI methodology's accuracy and reliability.

Table E1 - Mapping of human and AI expert annotations

Standards reference	9.1 Terminology, definitions, concepts	9.2 Use cases/ applications	9.3 Requirements	9.4 Capabilities (enablers)/ functions	9.5 Architecture/ architectural framework	9.6 Protocols and APIs	9.7 Governance and management	9.8 Semantics, data and other technologies	9.9 Security, privacy	9.10 Societal impact assessment and ethics
Y.3086		✓	✓	✓	✓			✓	✓	
Y.3142		✓	✓	✓	✓				✓	
Y.3170	✓		✓	✓	✓			✓	✓	
Y.3172			✓	✓	✓				✓	
Y.3173		✓	✓	✓	✓				✓	
Y.3174			✓		✓				✓	
Y.3175	✓			✓	✓		✓		✓	
Y.3176			✓	✓	✓	✓			✓	
Y.3177				✓	✓		✓	✓	✓	
Y.3178			✓	✓		✓			✓	
Y.3179			✓		✓	✓			✓	
Y.3186	✓	✓	✓		✓				✓	
Y.3187			✓		✓				✓	
Y.3812		✓	✓		✓			✓		
Y.3814		✓	✓	✓	✓				✓	
Y.Sup55		✓	✓						✓	
Y.Sup70		✓		✓						✓
Y.Sup71		✓	✓							

Table E2 - Confusion matrix comparing human experts and LLM annotations

	Prediction: Negative	**Prediction: Positive**
Reality: Negative	103	14
Reality: Positive	4	59

The empirical evaluation of the AI-assisted screening methodology, conducted on a dataset of 180 items and benchmarked against human expert annotations, reveals its substantial efficacy and significant potential to enhance the rigor and efficiency of the standardization gap analysis process within FG-AINN, with:
Accuracy: (TP + TN) / Total = (59 + 103) / 180 = 162 / 180 = 90.0%
Precision: TP / (TP + FP) = 59 / (59 + 14) = 59 / 73 ≈ 80.8%
Recall: TP / (TP + FN) = 59 / (59 + 4) = 59 / 63 ≈ 93.7%

F1-Score: 2 * (Precision * Recall) / (Precision + Recall) = 2 * (0.808 * 0.937) / (0.808 + 0.937) ≈ 86.8%
The methodology demonstrated a high overall accuracy of 90.0%, signifying its robust capability in correctly distinguishing between relevant and non-relevant standards. with its recall rate of approximately 93.7%. This high sensitivity ensures a remarkably comprehensive capture of pertinent documents, effectively minimizing the oversight of critical standards (evidenced by only 4 false negatives).

With a precision of approximately 80.8%, the approach exhibits the ability to correctly identify standards that are indeed relevant. While this entails a modest number of false positives (14 instances), these are readily manageable within a subsequent expert review phase, ensuring that expert scrutiny is efficiently targeted. The F1-Score, a harmonized measure of precision and recall, stands at a strong 86.8%, further attesting to the balanced and effective performance of the methodology.

Furthermore, the methodology achieved a specificity of 88.0%, indicating its effectiveness in correctly filtering out a significant majority of non-relevant documents. This capacity for exclusion is instrumental in reducing the initial review burden and conserving valuable human expert resources for more nuanced analytical endeavors.

This method as a advantageous tool for various critical scenarios within the standardization lifecycle:

Accelerated Large-Scale Document Review: In contexts involving extensive corpora of standards and technical documents, the methodology offers an acceleration of the preliminary screening process.

Enhanced Comprehensiveness in Gap Analysis: The approach's low false negative rate provides a heightened assurance of comprehensiveness

Annex F Detailed analysis of standards relevant to FG-AINN

AnnexF.1 ITU-T SG13

The following table identifies a set of collected SG13 standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F1 - Existing ITU-T SG13 (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics

ITU-T SG13	Recommendation ITU-T Y.2344 Scenarios and requirements of Intent-Based Network for network evolution	Defines scenarios, a general framework, and requirements for Intent-Based Networking (IBN) in network evolution. Covers IBN workflow, including intent instantiation and updates. Specifies capability requirements for the intent, control, and network layers, emphasizing intent analysis, translation, configuration, verification, network control, and configuration execution. Addresses security with enhanced single-point failure protection, secure authorization mechanisms, and detailed log analysis. Presents use cases including E2E service guarantees, business intent implementation, and connectivity and cloud services. Includes typical scenarios like online shopping and data center network management, showcasing IBN's application in real-world situations.	2024, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-2] Use cases [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3060 Autonomous networks – overview on trust	Provides an overview of trust for autonomous networks (ANs). Introduces background and necessity of trust in network autonomy and intelligence. Defines key concepts, including Trusted AN, Trust in AN (TiAN), Trustor in AN, and Trustee in AN. Explains and describes basic principles of trusted ANs, including accountability, equitability, explanability, robustness, and safety. Presents a workflow model for developing trusted ANs, covering initiation and continuation of trust. Includes use cases of trust for autonomous networks in an appendix, showcasing applications in OAM, knowledge exchange, and AI-driven network automation.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-4] Capabilities/enablers [D/T-7] Governance and management [D/T-9] Security, privacy [D/T-10] Societal impact assessment and ethics
ITU-T SG13	Recommendation ITU-T Y.3061 Autonomous Networks - Architecture framework	Provides an architectural framework for autonomous networks (AN). Covers requirements, architecture, components, and related sequence diagrams. Includes requirements for exploratory evolution, online experimentation, dynamic adaptation, knowledge in AN, and AN orchestration. Describes an architecture with components such as the Autonomy Engine, Dynamic Adaptation subsystem, Knowledge Base, AN Orchestrator, Underlay Network, and E2E Network Orchestrator. Presents sequence diagrams explaining interactions between components. Provides deployment examples in an IMT-2020 network underlay, addresses self-reflective use of	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4] [D2-C2]	[D/T-1] Terminology, definitions, concepts [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architect

		the AN architecture, and lists external functionalities.			ural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3083 Information-centric networking in networks beyond IMT-2020: Reference model of on-site elastic and autonomous network	Specifies the reference model for on-site, elastic, and autonomous information-centric networking (SEAN) to meet requirements of look-up-based forwarding ICN network per [ITU-T Y.3075]. Describes architecture and functional framework, including a control plane with elastic control/management, a data plane with on-site processing/forwarding, and an autonomously maintained Name Mapping and Resolution System (NMRS). Supports instant re-addressing and routing. Covers interaction mechanisms between components and deployment considerations. Details interaction mechanism of components for the scenarios like multi-homing, mobility, caching, and in-network processing.	2023, in force	[D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3091 Digital Twin Network - Capability Levels and Evaluation Methods	Specifies capability levels and evaluation methods for digital twin network (DTN) systems. Defines five capability levels (L1-Representation, L2-Interaction, L3-Prediction, L4-Optimization, L5-Autonomy) based on the degree of interaction and automation between the physical and virtual networks. Introduces six evaluation dimensions: Data Service, Digital Twin Modeling, Interactive Mapping, Intelligence, User Experience, and Trustworthiness. Provides detailed evaluation indicators and methods for each dimension, and outlines the requirements for each DTN capability level. Aims to establish a common understanding and roadmap for DTN development in the telecommunications industry.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-1] Terminology, definitions, concepts [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other

					technologies [D/T-9] Security, privacy
ITU-T SG13	[Recommendation ITU-T Y.3127](#) Future networks including IMT-2020 - Requirements and framework for self-organizing core network	Defines requirements and a framework for a self-organizing core network (SOCN) in future networks, including IMT-2020. Specifies an SOCN as a core network constituted by self-organized network entities cooperating to provide core network functions, aiming at efficient utilization of capabilities and resources to potentially reduce CAPEX and OPEX. Covers the overview, requirements, framework, and general procedures for SOCN, including network connection, organization, operation, and management. Addresses compatibility with existing IMT-2020 standards and technologies like SDN, AI/ML, and self-organization. Highlights applicability to scenarios requiring high mobility (e.g., vehicular, UAV, satellite networks), dynamic service deployment (e.g., emergency communications), extensive customization, and secure network isolation.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-6] Protocols and APIs [D/T-8] Semantics, data and other technologies [D/T-9] Security, privacy
ITU-T SG13	[Recommendation ITU-T Y.3161](#) Intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond	Describes requirements, architecture, and mechanisms for intent-based network management and orchestration (IBNMO) of network slicing in IMT-2020 (and beyond) networks. Specifies intent translation from high-level user input to network configurations, leveraging AI technologies. Details configuration verification, automated configuration, and intent verification processes. Defines a lifecycle management procedure for network slices, encompassing creation, modification, activation, monitoring, repair, and termination. Presents methods for handling multiple intents, intent-based verification and measurement, and feasibility checks.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D2-C1]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architect

					ural framework [D/T-7] Governance and management [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3181 Architectural framework for Machine Learning Sandbox in future networks including IMT-2020	Defines an architectural framework for a machine learning (ML) sandbox within future networks, including IMT-2020. Specifies requirements, high-level architecture, components, reference points, and APIs for the ML sandbox. Focuses on simulating ML underlay networks, enabling training, testing, and evaluation of ML models in an isolated environment before deployment. Includes components such as simulated network functions (NFs), application functions (AFs), a simulation manager, an evaluation ML pipeline, data handling, and an inference engine. Integrates with existing ITU-T Y.3172, Y.3174, Y.3176, and Y.3179.	2022, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4] [D2-C1]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3182 Machine learning based end-to-end multi-domain network slice management and orchestration	Defines a machine learning-based framework for end-to-end, multi-domain network slice management and orchestration. Specifies interoperability and functional requirements, a hierarchical architectural framework, and cognitive components leveraging ML for closed-loop automation. Addresses the derivation of QoE from QoS metrics. Includes use case examples (smart grid, eHealth) and considerations for multi-domain FCAPS management. Aims to minimize human intervention, automate slice lifecycle management, and support runtime operation in IMT-2020 and future networks.	2022, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D2-C1]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework

					[D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3183 Framework for network slicing management assisted by machine learning leveraging QoE feedback from verticals	Defines a framework for machine-learning-assisted network slicing management, leveraging QoE feedback from vertical end-users to achieve run-time optimization of perceived performance. Specifies the overall architecture, components (including One-Stop Access (OSA), Plug & Play (P&P) Controller, and control plane services), workflow, and related APIs concerning identified high-level requirements. Presents an eHealth use case as an application example, including example API implementations. Aligns with existing ITU-T Recommendations for network slicing (Y.3110, Y.3111, Y.3172, Y.3177, Y.3178, Y.3170) and complements the functional model by including OSA, QoE-QoS mapping, P&P control, and overlay control plane services.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3184 Mechanism of intelligent awareness for network status	Specifies mechanisms for intelligent awareness of network status, utilizing AI and machine learning techniques. Covers the introduction, overview, and security considerations for such mechanisms. Details specific mechanisms for intelligent awareness of network faults (including root cause analysis and prediction), network performance (including prediction and optimization proposals), network resource utilization (including bandwidth, computing, queue, and storage resources, and physical resource lifetime prediction), network load (including prediction and balancing), and other network status aspects (physical environment and partner context). Emphasizes data collection, analysis, and proposal generation using machine learning. Incorporates security considerations, referencing existing ITU-T recommendations.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and

					other technologies
ITU-T SG13	[Recommendation ITU-T Y.3185](#) Functional architecture for intelligent awareness for network requirements	Specifies a functional architecture for intelligent awareness of network requirements (INRA) leveraging AI and machine learning. Introduces general and specific architectural models, including network service data-based and crowdsourcing-based approaches. Defines functional components for correlated data collection, requirement source identification, mining, description, brokering, and evaluation. Addresses network requirement awareness by analyzing multi-dimensional network service data and user-reported data, using techniques like DPI/DFI, big data analysis, and machine learning. Highlights the use of a requirement descriptor, broker, and evaluator layers for representing, matching, and validating network requirements. Includes security considerations.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	[Recommendation ITU-T Y.3325](#) Framework for high-level AI-based management communicating with external management systems	Defines a reference model for capability exposure (communication exchange) between an AI-based network slice management and orchestration system (operated by a network provider) and external management systems (operated by service providers). Specifies functional requirements, procedures, and metadata for interactions including network resource configuration, performance, failure, security, and accounting notifications. Leverages AI for predictive network management and automation, supporting applications like ultra-high-definition video and low-latency IoT services. Includes a high-level communication model encompassing APIs and data structures to facilitate these interactions.	2023, in force	[D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D2-C2]	[D/T-1] Terminology, definitions, concepts [D/T-3] Requirements [D/T-4] Capabilities (enablers)/functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies

ITU-T SG13	Recommendation ITU-T Y.3550 Cloud computing - Requirements for AI based cloud service development and operation management	Recommendation ITU-T Y.3550 outlines requirements for AI-based cloud service development and operation management, building upon Recommendation ITU-T Y.3525. Defines an AI-enhanced framework impacting four lifecycle stages: code, test, deploy/release, and operation. Specifies twelve functional requirements derived from use cases, covering areas like code generation, testing, deployment, anomaly detection, fault management, resource optimization, and intelligent response. Addresses security by referencing ITU-T X.1601. Includes typical use cases of AI based cloud service development and operation management.	2023, in force	[D1-C1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-1] Terminology, definitions, concepts [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3812 Quantum key distribution networks - Requirements for machine learning based quality of service assurance	Specifies requirements for applying machine learning in QoS assurance of quantum networks. Defines:1. Functional model for ML-based QoS assurance; 2. High-level requirements (data collection, preprocessing, model training); 3. Functional requirements (anomaly detection/prediction, policy enforcement); 4. Use cases: quantum channel performance optimization, QoS fault diagnosis	2022, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3814 Amd 1 Quantum key distribution networks – Functional requirements and architecture for machine learning enablement	Specifies the Mx reference point between QKDN managers for management information communication, and aligns functional architecture with updated Y.3802 recommendations.	2023, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications

					[D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3816 Quantum key distribution networks - Functional architecture enhancement of machine learning based quality of service assurance	Specifies functional architecture enhancement for ML-based QoS assurance in QKDN, including: • Enhanced functional entities across control/key/quantum layers • ML-driven QoS anomaly detection and prediction • Cross-layer QoS policy provisioning procedures	2023, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3819 Quantum key distribution networks - Requirements and architectural model for autonomic management and control enablement	Specifies requirements and architectural model for AMC-enabled QKD networks. Key components: 1. Cognition process design for self-optimization; 2. ML-based operational procedures (channel prediction, key storage management, routing optimization); 3. Cross-layer management orchestration framework	2023, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities

					(enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3170 Requirements for machine learning-based quality of service assurance for the IMT-2020 network	This Recommendation specifies requirements of machine learning-based QoS assurance for the international mobile telecommunications 2020 (IMT-2020) network. It describes capabilities for QoS anomaly detection and prediction using machine learning. In addition, this Recommendation describes a functional model of machine learning-based QoS assurance which includes functional components such as QoS data collection, data pre-processing, data storage, modelling and training, QoS anomaly detection and prediction, QoS policy decision making, enforcement and reporting. Based on the capabilities and functionalities described in the functional model, this Recommendation specifies the high-level requirements and functional requirements of machine learning-based QoS assurance for IMT-2020 network.	2018, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3175 Functional architecture of machine learning based quality of service assurance for the IMT-2020 network	This Recommendation specifies architecture of machine learning based QoS assurance for the international mobile telecommunications 2020 (IMT-2020) network. It provides an overview of unified architecture for ML in 5G and future networks. In addition, it describes the architecture of machine learning based QoS assurance. Based on the architecture, this Recommendation specifies the procedures of machine learning based QoS assurance for IMT-2020 network.	2020, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-2] [D1-C3-1-3] [D2-C2]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions

					[D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3180 Mechanism of traffic awareness for application-descriptor-agnostic traffic based on machine learning	Application-descriptor-agnostic traffic is the traffic which cannot be identified by an application descriptor. On the one hand, traditional traffic awareness technologies such as deep packet inspection are not highly effective when they are applied to application-descriptor-agnostic traffic. On the other hand, with development of the artificial intelligence, many related technologies are emerging and applied in various areas. Compared to traditional traffic methods, traffic awareness method combining with machine learning based technologies will be more effective when it is used to process other application-descriptor-agnostic. Therefore, it is time to study mechanism and methods to implement application-descriptor-agnostic traffic awareness functions based on machine learning. This Recommendation specifies the mechanism of traffic awareness for application-descriptor-agnostic traffic based on machine learning.	2022, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	Recommendation ITU-T Y.3531 Cloud computing-functional requirements for machine learning as a service	This Recommendation provides cloud computing requirements for machine learning as a service, which addresses requirements from use cases. Machine learning as a service (MLaaS) is a cloud service category to support the development and applications of machine learning in the cloud computing environments. On the perspective of cloud computing service provisioning, this Recommendation defines the functional requirements for MLaaS to identify functionalities such as data gathering, machine learning modelling and computing resources, etc. Also, this Recommendation aligned with the cloud computing reference architecture of ITU-T Y.3502. Developments of machine learning algorithms and methodology are out of the scope on this Recommendation.	2020, In force	[D1-C1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-2] [D1-C3-1-3] [D2-C2]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architect

					ural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	[Recommendation ITU-T Y.3172](#) Architectural framework for machine learning in future networks including IMT-2020	This Recommendation specifies an architectural framework for machine learning (ML) in future networks including IMT-2020. A set of architectural requirements and specific architectural components needed to satisfy these requirements are presented. These components include, but are not limited to, ML pipeline and ML management and orchestration functionalities. The integration of such components into future networks including IMT-2020 and guidelines for applying this architectural framework in a variety of technology-specific underlying networks are also described.	2019, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D2-C2]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies
ITU-T SG13	[Recommendation ITU-T Y.3173](#) Framework for evaluating intelligence levels of future networks including IMT-2020	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.	2020, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	[Recommendation ITU-T Y.3654](#) Big data driven networking – Machine learning mechanism	This Recommendation specifies the mechanisms of machine learning for big data driven networking, its scope includes the following aspects: studying the procedures of machine learning applied in bDDN; studying the general machine learning approach for bDDN; studying the interfaces related to machine learning for bDDN; studying	2022, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-1] [D1-C3-1-3] [D1-C3-1-4] [D2-C2]	[D/T-2] Use cases/applications [D/T-9] Security, privacy

		the learning and control path based on machine learning for bDDN; studying other aspects related to machine learning for bDDN.			
ITU-T SG13	Recommendation ITU-T Y.3174 Framework for data handling to enable machine learning in future networks including IMT-2020	A framework of data handling to enable machine learning in future networks including IMT 2020 is described in this Recommendation. The requirements for ML data collection and ML processing mechanisms in various usage scenarios for ML in future networks are identified along with the requirements of corresponding targets for ML output in the network. Based on this, a generic framework of data handling and examples of its realisation on specific underlying networks are described.	2020, In force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4] [D2-C2]	[D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Supplement ITU-T Y.Sup55 Machine learning in future networks including IMT-2020: use cases	This Supplement analyses the use cases for machine learning in future networks including IMT-2020 and presents them in a unified format. The Supplement provides use cases descriptions and indicates the basic set of possible requirements for each use case. The use cases are divided into categories.	2019, In force	[D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3176 Machine learning marketplace integration in future networks including IMT-2020	This Recommendation provides high-level requirements and the architecture for integrating ML marketplaces in future networks including IMT-2020. The scope of this Recommendation includes: – The main motivations and challenges related to ML marketplace integration in networks, – High level requirements of ML marketplace integration, – Architecture for the integration of ML marketplaces in networks.	2020, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-1] [D2-C2]	[D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-6] Protocols and APIs [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3177 Architectural framework for artificial intelligence-based network automation for resource and fault management in future networks including IMT-2020	This Recommendation specifies the architectural framework of artificial intelligence (AI)-based network automation for resource management and fault management in future networks including IMT-2020. The purpose of the framework is to improve network efficiency and maintain QoS by continuously monitoring the network and promptly decide about appropriate actions by using AI including machine learning. The scope of this Recommendation includes the following items: " High-level architecture of network automation for resource management and fault management with AI including machine learning " Resource management functions " Fault management functions.	2021, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-5] Architecture/architectural framework [D/T-7] Governance and management [D/T-9] Security, privacy

ITU-T SG13	Recommendation ITU-T Y.3178 Functional framework of AI-based network service provisioning in future networks including IMT-2020	This Recommendation specifies a functional framework of artificial intelligence (AI)-based network service provisioning in future networks, including IMT-2020. This Recommendation addresses the following aspects: - Business role-based model for AI-based network service provisioning; - High-level requirements for the roles and their interactions from an AI-based operational perspective; - Functional components and their interactions for AI-based operations for network service provisioning.	2021, In force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-3]	[D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3179 Architectural framework for ML model serving in future networks including IMT-2020	The present Recommendation provides an architectural framework for ML model serving in future networks including IMT-2020, i.e., preparing and deploying ML models in different deployment environments to enable the application of ML model inference to ML underlay networks. The framework includes high-level requirements, and a high-level architecture description covering the definition of architectural components and reference points.	2021, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-2] [D1-C3-1-3] [D2-C2]	[D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-6] Protocols and APIs [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3812 Quantum key distribution networks - Requirements of machine learning based QoS assurance	This Recommendation is to specify requirements of machine learning based QoS assurance for quantum key distribution networks as follows: Overview; Functional model of machine learning based QoS assurance for quantum key distribution networks; High-level requirements of machine learning based QoS assurance for quantum key distribution networks; Functional requirements of machine learning based QoS assurance for quantum key distribution networks.	2022, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-1] [D1-C3-1-3]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions [D/T-6] Protocols and APIs [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.Sup70 Quantum Key Distribution Networks – Applications of Machine Learning	For quantum key distribution networks (QKDN), the Supplement presents the applications of machine learning (ML) in the quantum layer, the key management layer and the management and control layers of QKDN including the use case background, issue, role of ML in QKDN, use case analysis and, benefits and impact.	2021, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-2] [D1-C3-1-3]	[D/T-2] Use cases/applications [D/T-10] Societal impact assessment and ethics
ITU-T SG13	Recommendation ITU-T Y.3186	The Recommendation specifies scenarios, requirements, framework and	2024, In force	[D1-C1] [D1-C1-1] [D1-C3]	[D/T-2] Use

	Requirements and framework for distributed joint learning to enable machine learning in future networks including IMT-2020	flow diagram for distributed joint learning to enable machine learning in future networks including IMT-2020. The Recommendation can help to realize a highly automated, intelligent, and multi-party collaborative network.		[D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D2-C2]	cases/applications [D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3187 Architectural Framework for Machine learning function orchestrator in future networks including IMT-2020	This Recommendation provides an architectural framework for Machine Learning Function Orchestrator (MLFO) in future networks including IMT-2020. More precisely, it describes high-level requirements and high-level architecture of MLFO in future networks including IMT-2020.	2024, In force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4] [D2-C1] [D2-C2]	[D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Draft Recommendation ITU-T Y.det-qos-req-ml-jrs QoS requirements of machine learning based joint resource scheduling to support deterministic communication services across heterogeneous networks including IMT-2020 and beyond	This draft new Recommendation specifies the requirements, framework and operational procedures for ML-based joint resource scheduling to support deterministic communication services across heterogeneous networks including IMT-2020 and beyond. The scope of this recommendation is as follows. – Overview; – QoS requirements of ML-based joint resource scheduling; – Framework of ML-based joint resource scheduling for heterogeneous networks; – Operational procedures of ML-based joint resource scheduling to provide QoS assurance to deterministic communication services across heterogeneous networks.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-3] [D1-C3-1-4]	[D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Recommendation ITU-T Y.3086 Information-centric networking in networks beyond IMT-2020: Requirements and functional framework enhancement to support machine learning	This Recommendation specifies the requirements and functional framework of information-centric networking (ICN) to support machine learning (ML) in networks beyond international mobile telecommunications (IMT-2020). The scope of this Recommendation includes: – Requirements of enhanced ICN to support ML; – Functional framework of enhanced ICN to support ML; – Scenarios of enhanced ICN to support ML in networks beyond IMT-2020.	2024, In force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-3] [D1-C3-1-4]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy

ITU-T SG13	Recommendation ITU-T Y.3142 Requirements and framework for AI/ML-based network design optimization in future networks including IMT-2020	This Recommendation considers the comprehensive application of artificial intelligence (AI)/ machine learning (ML) technologies in network design optimization, including network topology, network capacity, and routing. It specifies functional requirements, framework and process for AI/ML-based network design optimization in IMT-2020 networks and beyond. The scope of this Recommendation includes: • Requirements for the framework of AI/ML-based network design optimization; • AI/ML-based network design optimization framework and its components; • AI/ML-based network design optimization process.	2024, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Supplement ITU-T Y.Sup71 Use Cases for Autonomous Networks	This Supplement discusses use cases for autonomous networks. The use cases are divided into two categories, and possible requirements, interactions among actors and possible key components are also discussed. Various use cases are derived according to the key concepts behind autonomous networks of exploratory evolution, real-time responsive experimentation and dynamic adaptation to enable handling of hitherto unseen changes in network scenarios or inputs to reduce the human effort involved in managing the network.	2022, In force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3]	[D/T-2] Use cases/applications [D/T-3] Requirements
ITU-T SG13	Technical Report ITU-T TR-GenAI-Telecom Networks Potential requirements and methodology for deploying and assessing Generative AI models in telecom networks	This Technical Report studies potential requirements and methodology for deploying and assessing Generative AI (GenAI) models in telecom networks. The scope of this Technical Report includes: • The study of the potential requirements on knowledge of telecom networks for GenAI; • The study of potential functional requirements of telecom networks for supporting GenAI; • The overview of impactful use cases for GenAI in telecom networks, including potential requirements and implementation challenges, highlighting the expected benefits of GenAI for use cases; • The methodologies to assess and compare GenAI models with respect to the identified potential requirements; • The analysis of the potential risks of integrating GenAI to telecom	2025, Agreed	*To be completed*	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities (enablers)/ functions

		operations, and the strategies to mitigate and assess the possible harmful impacts of GenAI.			
ITU-T SG13	Draft Recommendation ITU-T Y.IMT2020-DIC Distributed intelligence collaboration for IMT-2020 and beyond	This Recommendation specifies distributed intelligence collaboration in IMT-2020 and beyond, in the aspects of general considerations, requirements, functional architecture, procedures and security considerations.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-9] Security, privacy
ITU-T SG13	Draft Technical Report ITU-T TR.ACN AI-agent communication network in IMT-2020 networks and beyond	This Technical Report studies the general considerations, potential use cases, potential requirements, potential framework, potential procedures and potential security considerations of AI-agent communication network, in the context of IMT-2020 and beyond.	Under study	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-3] [D1-C3-1-4]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies [D/T-9] Security, privacy
ITU-T SG13	Draft Recommendation ITU-T Y.Benchframe-GenAI Benchmarking Framework for Generative AI in telecommunication networks	This Recommendation aims to provide a standardized benchmarking framework for Generative AI in telecommunication networks. The scope of this Recommendation is as follows: • Overview • Requirements for Standard Generative AI Benchmarking in telecommunication networks • Framework of Benchmarking for Generative AI integration in telecommunication networks, including evaluation parameters and evaluation techniques	Under study	[D1-C2] [D1-C3] [D1-C3-1-1] [D1-C3-1-2] [D1-C3-1-4]	[D/T-3] Requirements [D/T-5] Architecture/architectural framework [D/T-8] Semantics, data and other technologies

The following table identifies a set of collected SG21 standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

AnnexF.2 ITU-T SG21

The following table identifies a set of collected SG21 standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F2 - Existing ITU-T SG21 (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics
ITU-T SG21	Draft Recommendation ITU-T F.CDN-AINW Requirements and reference model for CDN services over AI network	This draft Recommendation describes requirement for the data linkage regarding network status and service status between systems of content delivery network (CDN) service providers over AI network. And this Recommendation describes reference model of AI network based CDN including metadata, protocols and API about CDN services over AI network.	Under study	[D1-C1] [D1-C3] [D1-C3-3] [D1-C3-4]	[D/T-2] Use Cases [D/T-3] Requirements [D/T-6] Protocols and API
ITU-T SG21	Draft Recommendation ITU-T F.AIVSSPGC Requirements and framework of artificial intelligence-based video surveillance system for power grid construction	This Recommendation defines requirements and reference framework of artificial intelligence (AI) -based video surveillance system for power grid construction. It includes the overview, framework, requirements and use cases of AI-based video surveillance system for power grid construction.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3]	[D/T-2] Use Cases [D/T-3] Requirements [D/T-5] Architecture
ITU-T SG21	Draft Recommendation ITU-T F.748.39 (ex F.AICP-FRRC) Functional requirements and reference architecture of artificial intelligence cloud platform for intelligent power grid facilities maintenance	This Recommendation provides the reference architecture of artificial intelligence cloud platform for intelligent power grid facilities maintenance (AICP-IPGFM), which includes the data base, function modules and interfaces. This Recommendation also specifies the functional requirements of AICP-IPGFM.	Under study	[D1-C1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3]	[D/T-2] Use Cases [D/T-3] Requirements [D/T-5] Architecture [D/T-6] Protocols and APIs
ITU-T SG21	Draft Recommendation ITU-T F.AI-SCVC Requirements and framework of AI-based semantic communication for video calls"	This recommendation specifies technical requirements, reference framework, and processing procedure of semantic video call. This Recommendation includes the application scenarios, service requirements, reference framework, technical requirements and processing procedure of AI-based semantic communication for video calls.	Under study	[D1-C1] [D1-C2] [D1-C3] [D1-C3-2]	[D/T-3] Requirements [D/T-5] Architecture
ITU-T SG21	Draft Recommendation ITU-T New F.MACVS	This Recommendation specifies the requirements and framework of multi-agent collaborative video	Under study	[D1-C1] [D1-C1-1] [D1-C2]	[D/T-2] Use cases

	Requirements and framework of multi-agent collaborative video surveillance system"	surveillance system. This recommendation includes the requirements, framework, scenarios of multi-agent collaborative video surveillance system as well as security and privacy consideration.		[D1-C3] [D1-C3-1] [D1-C3-3]	[D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-9] Security, privacy

AnnexF.3 ITU-T SG2

The following table identifies a set of collected SG2 standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F3 - Existing ITU-T SG2 (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics
ITU-T SG2	Draft Recommendation ITU-T M.rosp-ia Interface for robot-based on-site smart patrol of telecommunication networks - Protocol neutral analysis	This draft Recommendation provides the analysis specification of the interface for robot-based on-site smart patrol of telecommunication networks. It specifies the interface operations for robot-based on-site smart patrol of telecommunication networks, including the managed entities and their relationships for the interface, the interactive control information exchanged through this interface, and detailed parameter definitions of each interface operation at a technology-independent level (protocol-neutral).	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-4] Capabilities/ functions [D/T-6] Protocols and APIs [D/T-7] Governance and management [D/T-8] Semantic interoperability, digital twin, metaverse, data model, data infrastructure
ITU-T SG2	Draft Recommendation ITU-T M.fdcm-AITOM Functions for data convergence and management within artificial intelligence enhanced telecom	This draft Recommendation proposes the functions for data convergence and management within artificial intelligence enhanced telecom operation and management (AITOM) [ITU-T M.3080], to ensure that AI models (including network large	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-2] [D2-C2]	[D/T-4] Functions [D/T-5] Architecture [D/T-7] Governance

	operation and management (AITOM)	model) within AITOM can be trained, inferred, tested, deployed and utilized effectively with continuous access to high-quality telecommunication data. This draft Recommendation is used to guide how to integrate, process, and manage multi-source telecom operation and management data to provide solid data support for AITOM functions including artificial intelligence engine.			and management [D/T-8] Semantic interoperability, digital twin, metaverse, data model, data infrastructure
ITU-T SG2	[Draft Recommendation ITU-T M.fidtom](#) Framework of intent driven telecom operation and management (for consent)	This draft Recommendation provides the framework of intent driven management in telecommunication network and services' operation and management, including the function requirements and workflows. It also describes the relationship with artificial intelligence enhanced telecom operation and management (AITOM). This Recommendation aims to support autonomous operation and management in a way of intent driven close-loop mechanism for improving customer experience, operation efficiency, service quality assurance and other applications. Moreover, workflows of intent driven telecom operation and management are also described.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D2-C2]	[D/T-2] Use cases [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-6] Protocols and APIs [D/T-7] Governance and management
ITU-T SG2	[Draft Recommendation ITU-T M.la-AI-ia](#) Interface for Log analysis in telecommunication management with artificial intelligence - Protocol neutral analysis	This draft Recommendation specifies the generic interface analysis model (information model) required to implement the log analysis in telecommunication management with artificial intelligence (AI). The main contents of this Recommendation include the interface position, the definition and description of general information model object classes and attributes, and the relationship between general information model object classes. This draft Recommendation is applicable to the design, development and application of log analysis in telecommunication management with AI.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C2]	[D/T-4] Capabilities/ functions [D/T-6] Protocols and APIs [D/T-7] Governance and management
ITU-T SG2	[Draft Recommendation ITU-T M.fso-AITOM](#) Functions for service opening within artificial intelligence enhanced telecom operation and management (AITOM)	Based on the output of the Q6/2 meeting from 29 May 2025, it provides revised baseline text. The proposed modifications include adding conventions, revising the overall process diagram for service opening, detailing new processes for service registration, preparation, and testing, and introducing a new chapter on interfaces. The draft	Under study	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-1] Definitions [D/T-4] Functions [D/T-5] Architecture

		Recommendation defines the functions, processes, and interface overview for service opening within the AITOM framework, aiming to enhance the cost-efficiency, flexibility, and valuation of telecommunication operation and management systems.			
ITU-T SG2	Draft Recommendation ITU-T M.la-AI-ir Interface for Log analysis in telecommunication management with artificial intelligence - Protocol neutral requirements	This document specifies the protocol-neutral requirements for the management interfaces between Network Elements (NEs), the Log Analysis System in telecommunication management with AI (LAS-AI), the AI engine, and the upper-layer Operation Management System.The Recommendation outlines the position and requirements for three key interfaces and provides a comprehensive set of business-level and specification-level requirements, detailed use cases, definitions, and conventions. Its primary goal is to standardize these interfaces to enhance the stability, transparency, and interoperability of AI-enhanced log analysis systems within telecommunications management frameworks.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-4] [D2-C2]	[D/T-2] Use cases [D/T-3] Requirements [D/T-4] Functions [D/T-6] Protocols and APIs
ITU-T SG2	Draft Recommendation ITU-T M. rcnitom-AI Requirements for customer needs identification in telecom operation and management with artificial intelligence"	This contribution proposes changes in the base text of M. rcnitom-AI"Requirements for customer needs identification in telecom operation and management utilizing artificial intelligence available in SG2-TD533R1/PLEN. The contribution inter-alia proposes addition of relevant definitions in section 3, elaborates requirements of customer needs identification in telecom operation and management using AI in section 7, provide some typical use cases for customer needs identification in telecom operation and management with AI in Appendix I, and some minor modifications in different sections.	Under study	[D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C1]	[D/T-2] Use cases [D/T-3] Requirements
ITU-T SG2	Draft Recommendation ITU-T M.rcm-AI Requirements for AI capability management within AITOM	Based on previous meeting discussions and feedback, this contribution proposes updates to the draft Recommendation M.rcm-AI, primarily involving the addition of a new Chapter 8 that systematically describes the functional modules for AI capability management, the renaming of the former Chapter 7 to "Management functions of AI Capability Management within	2025, in force	[D1-C1] [D2-C1] [D2-C2]	[D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-7] Governance and management

		AITOM," and the provision of detailed functional requirements for Sections 8.2, 8.3, and 8.4. The document further specifies the functional requirements for the full lifecycle management of AI capabilities within the AITOM framework, covering key stages such as capability requirements parsing, registration, cancellation, activation, and distribution. Accompanied by process diagrams and use case explanations, the proposal aims to promote the standardized management and efficient sharing of AI capabilities in telecom operation and management.			
ITU-T SG2	Recommendation ITU-T M.3167.1 Interface for robot-based on-site smart patrol of telecommunication networks – Protocol neutral requirements	With the continuous development of Internet of things (IoT) technology, the application of intelligent maintenance robots (IMRs) in the field of telecommunication smart maintenance (TSM) is increasing. Recommendation ITU-T M.3167.1 provides the requirements for the interface between the IMR-based smart patrol system (IbSPS) and the telecommunication smart maintenance system (TSMS) at a protocol-neutral level. It describes the position of the relevant interface and specifies the high-level requirements for interface interaction, as well as specification level use cases for each requirement.	2025, in force	[D1-C3] [D1-C3-1] [D1-C3-2] [D2-C2]	[D/T-2] Use cases [D/T-3] Requirements
ITU-T SG2	Recommendation ITU-T M.3389 Requirements for artificial intelligence-based customer experience management of telecom services	Recommendation ITU-T M.3389 provides the requirements for artificial intelligence (AI)-based customer experience management of telecom services, key implementation processes, typical application scenarios and a use case. The goal is to explain the use of AI technology to achieve closed-loop management of customer experience evaluation, analysis, guarantee and optimization. This Recommendation considers the application of AI technology in customer experience quality monitoring, analysis and optimization strategy generation.	2025, in force	[D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3]	[D/T-1] Definitions [D/T-2] Applications [D/T-3] Requirements
ITU-T SG2	Recommendation ITU-T M.3390 Requirements for smart comprehensive analysis within artificial intelligence enhanced	Recommendation ITU-T M.3390 proposes the requirements for smart comprehensive analysis within artificial intelligence enhanced telecom operation and management (AITOM), which includes network resource assurance analysis, network	2025, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-2] Use cases [D/T-3] Requirements [D/T-5] Architecture

	telecom operation and management (AITOM)	service quality analysis, End-to-End (E2E) service quality analysis, strategy generation of service quality assurance and other requirements. The goal of the Recommendation is to specify the requirements of using AI technology to achieve smart comprehensive analysis, focusing on service quality assurance, from the operation support system (OSS) level.		[D2-C1] [D2-C2]	
ITU-T SG2	Recommendation ITU-T M.3386 Requirements for the management of network operation cost within AI enhanced Telecom Operation and Management (AITOM) in telecommunication operational aspects	Recommendation ITU-T M.3386 focuses on network operation cost management within AITOM in telecommunication operational aspects. This Recommendation provides the classification standard and functional requirements of network operation cost management.	2024, in force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C2]	[D/T-2] Use cases [D/T-3] Requirements [D/T-4] Functions [D/T-5] Architecture [D/T-7] Governance and management
ITU-T SG2	Recommendation ITU-T M.3388 Effectiveness indicators for intelligence level of AI-enhanced telecom operation and management	This Recommendation provides the effectiveness indicators to evaluate the intelligence level of systems which follow the framework of AI-enhanced Telecom Operation and Management (AITOM). It aims to evaluate effectiveness with quantitative methods and could be used as the guidelines to provide more evaluation dimensions on the effects and benefits of applying AI in terms of operational optimization, cost reduction, service fulfilment and customer experience upgrades, etc.	2024, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-4] [D2-C1]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/functions [D/T-7] Governance and management
ITU-T SG2	Recommendation ITU-T M.3367 Requirements for robot-based on-site smart patrol of telecommunication networks	This Recommendation proposes requirements for on-site smart patrol of telecommunication networks based on intelligent maintenance robots (IMRs), principally including the network elements to be patrolled, requirements for the management function of IMR-based patrols and related management interface technology to develop the IMR itself.	2023, in force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D2-C2]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/functions [D/T-7] Governance and management
ITU-T SG2	Recommendation ITU-T M.3383 Requirements for log analysis in telecom management with artificial intelligence	This Recommendation specifies, for log analysis in telecom management with artificial intelligence (AI), including functional framework, functional requirements, and typical scenarios of log analysis in telecom management with AI. This Recommendation is applicable to the design, development, and application	2023, in force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D2-C2]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/functions

		of log analysis in telecom management with AI.			[D/T-5] Architecture
ITU-T SG2	Recommendation ITU-T M.3384 Intelligence levels of artificial intelligence enhanced telecom operation and management	This Recommendation describes the principles for intelligence levels of artificial intelligenceenhanced telecom operation and management (IL-AITOM) systems that follow the framework specified in [ITU-T M.3080]. This Recommendation can be used as a guideline to plan the evolution of intelligent operation and management systems.	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C1]	[D/T-2] Use cases/applications [D/T-5] Architecture [D/T-7] Governance and management
ITU-T SG2	Recommendation ITU-T M.3385 Intelligence levels evaluation framework of artificial intelligence enhanced telecom operation and management	Based on [ITU-T M.3384], this Recommendation provides a detailed evaluation framework, evaluation rating method and automatic evaluating process for intelligence levels of systems which follow the framework of artificial intelligence enhanced telecom operation and management (AITOM) presented in [ITU-T M.3080].	2023, in force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C1]	[D/T-1] Definitions [D/T-2] Use cases/applications [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-7] Governance and management
ITU-T SG2	Recommendation ITU-T M.3382 Requirements for work order processing in telecom management with artificial intelligence	This Recommendation describes the requirements for work order processing in telecom management with AI. Based on AI models and features extraction, work orders will be collected, analysed, forwarded and archived. This Recommendation covers the framework for work order processing in telecom management with AI, the functional requirements for work order processing in telecom management with AI, the requirements of work orders and the feature extraction process of sample work orders.	2022, in force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D2-C2]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-6] Protocols and APIs
ITU-T SG2	Recommendation ITU-T M.3381 Requirements for energy saving management of 5G radio access network (RAN) systems with artificial intelligence (AI)	This Recommendation provides requirements for energy saving management of a fifth generation (5G) radio access network (RAN) system with artificial intelligence (AI). This Recommendation explains the requirements of the use of AI technology to achieve energy saving management for communication units and virtualized hardware resources of a 5G RAN system, via an element management system (EMS) and open interfaces provided by vendors, from the operation support system (OSS) level. In addition, this Recommendation includes process recommendations for sending intelligent energy saving	2022, in force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C2]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-7] Governance and management

		strategies from OSS to EMS and then to wireless equipment.			
ITU-T SG2	Recommendation ITU-T M.3080 Framework of artificial intelligence enhanced telecom operation and management (AITOM)	This recommendation describes the functional framework of AITOM to support telecom operation management for efficiency improvement, quality assurance, cost management, and security assurance. It also describes the artificial intelligence (AI) pipeline which combines some components to enable AI based applications. This Recommendation also describes the relationship of the functional framework of AITOM with smart operations, management and maintenance (SOMM). General requirements of security are also described.	2021, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-4] [D2-C2]	[D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-7] Governance and management [D/T-9] Security, privacy

AnnexF.4 ITU-T SG17

The following table identifies a set of collected SG17 standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F4 - Existing ITU-T SG17 (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics
ITU-T SG17	Draft Recommendation ITU-T X.SSDHN-AI-Atk Security Guidelines for Secured Software-Defined Heterogeneous Networks Architecture for AI generated Attacks and Threats	This recommendation defines security guidelines for SDHN to mitigate AI-generated cyber threats. It focuses on securing control planes, data planes, and VNFs using AI-driven anomaly detection, zero-trust, and real-time threat intelligence while ensuring compliance with global standards.	Under study	[D1-C1] [D1-C3] [D1-C3-1] [D1-C3-3]	[D/T-2] Use cases [D/T-5] Architecture [D/T-9] Security
ITU-T SG17	Technical Report ITU-T XSTR.saAIoT (ex TR.saAIoT) Security Threat Analysis for Artificial Intelligence of Things on Devices	This draft technical report provides security threats for Artificial Intelligence of Things on devices, in particular: - Provide a security threat analysis framework for analyzing the specific security threats and	Under study	[D1-C1] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2]	[D/T-9 Security

		challenges of artificial intelligence of things on devices; - Provide the landscape for artificial intelligence of things on devices.			

AnnexF.5 ITU-T SG20

The following table identifies a set of collected SG20 standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F5 - Existing ITU-T SG20 (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics
ITU-T SG20	Draft Recommendation ITU-T Y.AIoT-dfs-arc Reference architecture of data fusion service in artificial intelligence of things	The draft Recommendation aims to study Data Fusion Service (DFS) in AIoT integrates metadata from diverse sources, like IoT devices and cloud platforms, into unified, intelligent datasets for use in AI/ML applications. It enhances real-time data cataloging, smart provisioning, and quality-aware access using AI, ML, and knowledge databases. DFS improves data governance, interoperability, and collaboration across organizational data systems.	Under study	[D1-C1-1] [D1-C2] [D1-C3-2]	[D/T-2] Use cases [D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-8] Semantic interoperability, digital twin, metaverse, data model, data infrastructure
ITU-T SG20	Draft Recommendation ITU-T Y.AIoT-dpsm Requirements and framework of data processing for smart manufacturing with Artificial Intelligence of Things	The draft Recommendation aims to study Smart manufacturing with Artificial Intelligence of Things (AIoT) as it integrates advanced technologies like AI to transform manufacturing and production processes. AIoT enables smart manufacturing in high level intelligence and autonomous. Data processing for smart manufacturing with AIoT improves production	Under study	[D1-C1] [D1-C3-1] [D1-C3-2]	[D/T-3] Requirements [D/T-5] Architecture [D/T-8] Semantic interoperability, digital twin, metaverse,

		efficiency, reduces operational costs and enhances quality control by enabling real-time data processing based on the data collected from smart manufacturing environments. This Recommendation describes the requirements and framework of data processing for smart manufacturing with AIoT.			data model, data infrastructure
ITU-T SG20	Draft Recommendation ITU-T Y.4612 (ex Y.AIoT-fr) Framework of Artificial Intelligence of Things	This document aims to describe concepts, characteristics, technical features and approaches of AIoT. Then, it presents a conceptual model for AIoT.	Under study	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3]	[D/T-1] Concepts and characteristics [D/T-4] Capabilities/ functions [D/T-5] Architecture
ITU-T SG20	Draft Recommendation ITU-T Y.AIoT-FRA Functional requirements and architecture for Artificial Intelligence of Things	The Artificial Intelligence of Things (AIoT) is the combination of artificial intelligence (AI) technologies with the Internet of Things (IoT) infrastructure to achieve more efficient IoT operations, improve human-machine interactions and enhance data management and analytics, but not limited to. From a comprehensive review of existing standardization efforts on AI and IoT, this draft Recommendation specifies functional requirements and architecture for AIoT.	Under study	[D2-C2]	[D/T-1] Concepts [D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-9] Security, privacy
ITU-T SG20	Draft Recommendation ITU-T Y.Agentic-AIoT Functional requirements and architecture for Agentic Artificial Intelligence powered Internet of Things	The proposal outlines the evolution from traditional AIoT to "Agentic AIoT," which emphasizes autonomous, goal-directed AI agents operating within IoT infrastructures. It includes a gap analysis demonstrating that current ITU-T standards do not address agentic autonomy and provides a justification form and initial draft text for the proposed new recommendation.	Under study	[D1-C3-1]	[D/T-1] Definitions [D/T-2] Use cases [D/T-3] Requirements [D/T-5] Architecture
ITU-T SG20	ITU-T SG20 (Study Period 2025) Contribution 372 Requirements and framework of AI agent collaboration in distributed Internet of things	This document clarifies the motivation, conceptual model, reference framework, and gap analysis to justify the need for standardizing AI agent collaboration mechanisms within the device, network, and service support layers of distributed IoT systems, aiming to enhance autonomy, scalability, and resilience.	Under study	[D1-C1] [D1-C3]	[D/T-3] Requirements [D/T-5] Architecture
ITU-T SG20	ITU-T SG20 (Study Period 2025) Contribution 370	This document clarifies the motivation, reference process, framework, and a comprehensive gap analysis justifying the need for this	Under study	[D1-C3-3]	[D/T-3] Requirements

	Requirements and framework of human-centric human-AI collaboration for IoT system	standard. The proposal aims to define a dynamic, closed-loop collaboration mechanism between humans and AI across IoT layers (device, edge, network, cloud, application) to enhance adaptability, transparency, trust, and reliability in complex IoT environments.			[D/T-5] Architecture
ITU-T SG20	Draft Recommendation ITU-T Y.farm-adv IoT and AI-powered augmented reality framework for smartphone-based farm advisory systems	The proposed standard aims to define a framework that leverages IoT, AI, and Augmented Reality (AR) to deliver affordable, offline-first, and multilingual farm advisory services via smartphones. It is designed to address challenges in agriculture, particularly in remote and underserved areas with limited internet connectivity and digital literacy, by providing real-time monitoring, AI-driven decision support, and immersive guidance to farmers. The proposal includes a gap analysis, justification for the new work item, and the initial draft text of the recommended framework.	Under study	[D1-C1]	[D/T-5] Architecture
ITU-T SG20	Draft Recommendation Y.RA-FML Requirements and reference architecture of IoT and smart city & community service based on federated machine learning	The recommendation defines the requirements and reference architecture for implementing Federated Machine Learning (FML) in Internet of Things (IoT) and Smart City & Community (SC&C) services. Key updates include refining definitions (e.g., data owner), updating architectural diagrams, enhancing requirement descriptions for various roles (user, coordinator, data owner, model developer), and revising the reference architecture and use cases. The primary goal is to standardize a privacy-preserving, distributed AI framework that enables collaborative model training across decentralized data sources without sharing raw data, addressing challenges like resource consumption, data heterogeneity, and security in large-scale IoT and SC&C systems.	Under study	[D1-C1] [D1-C1-2] [D1-C2]	[D/T-2] Use Cases [D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture
ITU-T SG20	Draft Recommendation Y.EPI-AIA AI agent for IoT-based electric power infrastructure monitoring systems	The proposal aims to specify the requirements and capabilities of AI agents specifically for monitoring electric power infrastructure using IoT systems (IoT-EPIMS). It identifies a gap in the existing ITU-T Y.4221 standard, which lacks provisions for AI agents. The proposed recommendation seeks to address issues of technological	Under study	[D1-C1] [D1-C1-1] [D1-C3]	[D/T-2] Use cases [D/T-3] Requirements [D/T-4] Capabilities/ functions

		fragmentation and lack of interoperability, ultimately enabling proactive fault prevention and enhancing operational intelligence. The document includes a draft of the proposed recommendation, gap analysis, justification, and supporting background information.			
ITU-T SG20	Draft Recommendation ITU-T Y.Sup.ABIoT-usecase Intelligent IoT service with Best Practices on interworking with agent-based things	In the Internet of Things (IoT) domain, devices in sectors such as transportation, homes, and factories incorporate software-like agents, defined as IoT things, which collect and transmit real-time data including sensor, state, and event information. This data enhances intelligent IoT services, facilitates the development of converged services through interactions, and supports optimization and integration. The appendix presents use cases for linking agent-based things with intelligent IoT services, while identifying related challenges and opportunities.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-2]	[D/T-2] Use cases/applications [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-6] Architecture
ITU-T SG20	Draft Recommendation ITU-T Y.IoT-IWAT Framework of interworking with agent-based transportation for intelligent IoT services	This document is a draft ITU-T Recommendation Y.IoT-IWAT, titled "Framework of interworking with agent-based transportation for intelligent IoT services." It specifies a framework for integrating agent-based IoT devices in transportation systems—such as vehicles equipped with sensors and software agents—within smart cities to enhance intelligent IoT services and enable converged applications. The recommendation covers the scope, references to related standards, definitions, requirements for AI model support, IoT data discovery/exchange, communication, and security/privacy. It also details a functional architecture with layers for AI service support, agent-based IoT data support, and IoT data transmission, along with high-level procedures for data transmission and AI model service support, illustrated through figures and interaction flows.	Under study	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-2] [D1-C3-3] [D2-C2]	[D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-6] Protocols and APIs [D/T-9] Security, privacy
ITU-T SG20	Draft Recommendation ITU-T Y.IoT-IIEC Framework of the integrated intelligent IoT service based on multi edge computing	This draft recommendation aims to define the integrated intelligent IoT service based on multi edge computing as a key technology for real-time decision-making and service delivery by collecting, analyzing, and processing various data generated in smart cities, and	Under study	[D1-C1] [D1-C2] [D1-C3] [D1-C3-2] [D2-C2]	[D/T-2] Use cases/applications [D/T-3] Requirements

		integrating heterogeneous data, intelligent service, IoT technology, and edge computing technology.			[D/T-4] Capabilities/ functions [D/T-5] Architecture
ITU-T SG20	Draft Recommendation ITU-T Y.IoT-FETA Framework for Ensuring Trust of AI Data across Distributed Systems for Intelligent IoT Services	This contribution proposes a new work item on the “Framework for Ensuring Trust of AI Data across Distributed Systems for Intelligent IoT Services.” It aims to establish standardized metrics and trust assurance mechanisms that provide measurable confidence in the reliability of AI data exchanged across distributed AI models deployed at each system layer. The proposed framework supports seamless AI service integration and promotes standardization activities within ITU-T SG20.	Under study	[D1-C1] [D1-C3] [D2-C2]	[D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-8] Semantic interoperability, digital twin, metaverse, data model, data infrastructure
ITU-T SG20	Draft Recommendation ITU-T Y.4417-Rev Framework of self-organization networking in Internet of things environments	It defines a framework for autonomous, decentralized networking in IoT, where devices self-organize without infrastructure support, adapting to dynamic conditions. Coverage includes concepts (e.g., infrastructure-less networks), characteristics (e.g., decentralization, robustness), requirements (e.g., heterogeneous support, AI-based optimization, security), functional architecture (coordination and network layers), and core functionalities (e.g., routing, data forwarding, recovery, resource management).	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-3] [D2-C2]	[D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-9] Security, privacy
ITU-T SG20	Draft Recommendation ITU-T Y.AIoT-dpsm Requirements and framework of data processing for smart manufacturing with Artificial Intelligence powered Internet of Things" for consent	This is Contribution is proposed to enhance the main text based on the editorial checking of draft Recommendation ITU-T Y.AIoT-dpsm “Requirements and framework of data processing for smart manufacturing with Artificial Intelligence powered Internet of Things” for consent.	Under study	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-2] [D1-C3-4] [D2-C2]	[D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-9] Security, privacy
ITU-T SG20	Draft Recommendation ITU-T Y.IIoT-AIA Requirements and framework for AI agent in industrial IoT environment	It introduces AI agents—autonomous systems built on foundation models for perception, reasoning, and action in industrial settings—to address challenges like poor data quality, model interoperability, API management, and service discovery. The proposal outlines background on foundation models and AI agents, pain points in industrial IoT (e.g., defect detection, robot navigation),	Under study	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3-2] [D1-C3-3]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/ functions

		discussion on integration technologies (e.g., RAG, knowledge graphs), a gap analysis against existing ITU-T/IEEE standards (e.g., Y.4000, IEEE P2806), and details for the new item including scope (requirements, framework), relations to other recommendations, and liaisons. It emphasizes enabling collaborative AI agents for efficient, adaptive industrial applications like production simulation and layout optimization.			
ITU-T SG20	Draft Recommendation ITU-T Y.Sup.ABIoT-usecase Optimizing intelligent IoT service with Best Practices on interworking with agent-based things	This contribution explores the integration of artificial intelligence (AI) with Internet of Things (IoT) technologies to advance smart sustainable cities. It examines AI's role in managing IoT-generated data, enabling real-time analytics, and addressing urban challenges like resource optimization and cybersecurity. Key sections cover IoT-AI concepts (e.g., cognitive architectures, big data synergy), a use case on smart water management (e.g., predictive forecasting, digital twins), AI's contributions to Sustainable Development Goals (SDGs), and complementary standards from ISO/IEC and ETSI. The document emphasizes AI's potential for efficiency, adaptability, and innovation while highlighting challenges like bias and energy consumption.	Under study	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-2]	[D/T-2] Use cases/applications [D/T-4] Capabilities/ functions [D/T-5] Architecture
ITU-T SG20	Draft Recommendation ITU-T Y.IoT-IS A reference architecture for agent-based IoT interactive services	It motivates the need for agent-based models (ABM) to manage interactive IoT demands in distributed systems, such as device-to-device collaboration, social networking, smart object autonomy, user engagement, service composition, trust management, and adaptability. The proposal highlights ABM advantages like handling complexity, scalability, and interdisciplinary research, with a framework for multi-agent coordination (e.g., goal setting, perception, learning, decision-making). It includes a gap analysis against existing standards (e.g., ITU-T Y.4000 for IoT overview, Y.4555 for semantic models), scope (concepts, requirements, architecture, security), and commitments from supporters like China Unicom and Huawei.	Under study	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-2] [D1-C3-4]	[D/T-4] Capabilities/ functions [D/T-5] Architecture

ITU-T SG20	ITU-T Y.Sup.AI4IoT Unlocking Internet of things with artificial intelligence	This contribution explores the integration of artificial intelligence (AI) with Internet of Things (IoT) technologies to advance smart sustainable cities. It examines AI's role in managing IoT-generated data, enabling real-time analytics, and addressing urban challenges like resource optimization and cybersecurity. Key sections cover IoT-AI concepts (e.g., cognitive architectures, big data synergy), a use case on smart water management (e.g., predictive forecasting, digital twins), AI's contributions to Sustainable Development Goals (SDGs), and complementary standards from ISO/IEC and ETSI. The document emphasizes AI's potential for efficiency, adaptability, and innovation while highlighting challenges like bias and energy consumption.	2020, in force	[D1-C1] [D1-C2] [D1-C3] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C2]	[D/T-3] Requirements [D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-6] Protocols and APIs [D/T-8] Semantic interoperability, digital twin, metaverse, data model, data infrastructure [D/T-9] Security, privacy [D/T-10] Societal impact assessment and ethics
ITU-T SG20	Recommendation ITU-T Y.4509 Functional architecture of artificial intelligence-enabled collaborative services across device, edge and cloud environments for the Internet of things and smart cities	This document aims to specify the functional architecture of AI enabled device-edge-cloud collaborative services for IoT and smart city.	2025, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-2] [D1-C3-4]	[D/T-1] Characteristics [D/T-5] Architecture
ITU-T SG20	Draft Recommendation ITU-T Y.4613 (ex Y.AIoT-dpsm) Functional requirements and capabilities of data processing for smart manufacturing with Artificial Intelligence of Things	This document aims to describe the requirements and framework of data processing for smart manufacturing with AIoT.	Under study	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-3] Requirements [D/T-4] Capabilities [D/T-9] Security
ITU-T SG20	Draft Recommendation ITU-T Y.AIoT-DA Framework of network resource management with data affinity in AIoT environments	This document aims to identify requirements and functional architecture for network resource management with affinity group, utilizing data-driven relational intelligence from AIoT environments.	Under study	[D1-C1] [D1-C3] [D1-C3-1] [D1-C3-2]	[D/T-3] Requirements [D/T-5] Architecture [D/T-9] Security
ITU-T SG20	Draft Recommendation ITU-T Y.AIoT-RSreq General requirements of on-device AIoT	This document aims to address functional components and requirements for on-device AIoT framework for robot services	Under study	[D1-C1] [D1-C2] [D1-C3] [D1-C3-1]	[D/T-2] Use cases/applications

	framework for robot services			[D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C2]	[D/T-3] Requirements [D/T-5] Architecture
ITU-T SG20	Draft Recommendation ITU-T YSTR.GenAI-Sem-Interop Implications of Generative Artificial Intelligence on Semantic Interoperability for Data Use	This technical report aims to explore how GenAI is already used to solve semantic interoperability challenges within smart cities and communities.	Under study	[D1-C1] [D1-C3] [D1-C3-2] [D1-C3-3]	[D/T-8] Semantic interoperability, data infrastructure
ITU-T SG20	Draft Recommendation ITU-T Y.AIA-SH Requirements and capabilities of AI agent system for smart home	This document aims to specify the requirements and scenarios of the Artificial Intelligence (AI) Agent system for smart home.	Under study	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-3] [D1-C3-4]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/functions [D/T-9] Security
ITU-T SG20	Draft Supplement ITU-T Y.Sup-DIoT-IS Supplement to ITU-T Y.4000 - A framework for agent-based distributed IoT interactive services	This draft Supplement aims to describe a framework of agent-based IoT interactive services, which includes goal setting, environmental perception, constraints management, learning and reasoning, error calculation, planning and decisionmaking, and optimization.	Under study	[D1-C1] [D1-C2] [D1-C3] [D1-C3-3]	[D/T-5] Architecture

The following table identifies a set of collected IETF/IRTF standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

AnnexF.6 IETF/IRTF

The following table identifies a set of collected IETF/IRTF standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F6 - Existing IETF/IRTF (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics
IRTF NMRG	RFC 9315: Intent-Based Networking - Concepts and Definitions	This document clarifies the concept of "intent" and provides an overview of the functionality that is associated with it.	Published (2022)	[D1-C3-1]	[D/T-1] Definitions

		Intent-Based Networking is "an ideal candidate for artificial intelligence techniques that can bring about the next level of network automation".			
IRTF NMRG	draft-irtf-nmrg-ibn-usecases-00: Use Cases and Practices for Intent-Based Networking	This document proposes several use cases of Intent-Based Networking (IBN) and the methodologies to differ each use case by following the lifecycle of a real IBN system. In the document, a method mentioned is often applied to Artificial Intelligence (AI) data center network monitoring. Some functions mentioned can be performed by Artificial Intelligence (AI) and Machine Learning (ML) algorithms.	Under study (last update: 2025)	[D1-C3-1]	[D/T-2] Use Cases
IRTF NMRG	draft-irtf-nmrg-ai-challenges-04 Research Challenges in Coupling Artificial Intelligence and Network Management	This document is intended to introduce the challenges to overcome when Network Management (NM) problems may require coupling with Artificial Intelligence (AI) solutions.	Waiting for Document Shepherd (last updated: 2025-03-18)	[D1-C1] [D1-C1-1] [D1-C3] [D2-C2]	[D/T-1] Terminology, definitions, concepts [D/T-2] Use cases/ applications [D/T-3] Requirements
IRTF NMRG	draft-irtf-nmrg-ai-deploy-00 Considerations of network/system for AI services	This document considers how to configure the network and the system in terms of AI inference service to provide AI service in a distributed method.	Under study (last update: 2025)	[D1-C1] [D1-C3] [D1-C3-2] [D2-C2]	[D/T-4] Capabilities (enablers)/ functions
IRTF NRMG, IETF RTGWG	draft-king-rokui-ainetops-usecases-00: Artificial Intelligence (AI) for Network Operations	This document explores the role of the IETF and IRTF in advancing Artificial Intelligence for network operations (AINetOps), focusing on requirements for IETF protocols and architectures. The document defines the concept of AINetOps for networking and provides its operational benefits such as network assurance, predictive analytics, network optimization, multi-layer planning, and more.	Under study (last update: 2025)	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D2-C2]	[D/T-2] Use cases/Applications [D/T-3] Requirements [D/T-5] Architecture
IETF RTGWG	draft-li-rtgwg-computing-network-routing-01: The Challenges and Requirements for Routing in Computing Cluster network	This document explores the characteristics of computing cluster network to accommodate the training and inference of large AI models, and analyzes the challenges of employing the traditional distributed or centralized routing mechanisms in it. In order to achieve the enhanced scalability, improved resilience and optimized performance simultaneously,	Under study (last update: 2025)	[D2-C2]	[D/T-6] Protocols

		hybrid routing is briefly examined as a potential way to combine the advantages of distributed and centralized mechanisms.			
IRTF	draft-irtf-nmrg-network-digital-twin-arch-11: Network Digital Twin: Concepts and Reference Architecture	The draft document provides basic definitions and a reference architecture for Network Digital Twins. Application scenarios are also listed, together with associated benefits and challenges.	Under study (last update: 2025)	[D1-C1] [D1-C2] [D1-C3-1]	[D/T-1] Terminology, definitions, concepts [D/T-4] Capabilities [D/T-5] Architecture

AnnexF.7 ETSI ISGs

The following table identifies a set of collected ETSI ISGs standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F7 - Existing ETSI ISGs (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics
ETSI ISG ENI NOTE – Future enhancements in terms of ETSI ISG ENI specifications will be considered upon coordination with ITU-T SG13.	ETSI GS ENI 005: Experiential Networked Intelligence (ENI); System Architecture	This document defines a high-level functional abstraction of the ENI System Architecture. ENI uses Artificial Intelligence (AI) techniques and context-aware policies to adjust offered services based on changes in user needs, environmental conditions and business goals.	2023, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C2]	[D/T-5] Architecture [D/T-6] Protocols and APIs
ETSI ISG INT	ETSI TR 103 195 : Core Network and Interoperability Testing (INT/ WG AFI)	This document describes the business drivers behind this Autonomic Management & Control (AMC) ecosystem as described through	2023, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C2]	[D/T-5] Architecture

	Generic Autonomic Network Architecture; Part 1: Business drivers for autonomic networking	Generic Autonomic Network architecture (GANA) framework. This document mainly focuses on the application of AI in autonomic network management and control.		[D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C1] [D2-C2]	
ETSI ISG ZSM	GS ZSM-001 Requirements based on documented scenarios	The deliverable defines requirements on the zero-touch end-to-end network and service management. Scenarios are documented and used to derive the requirements.	2019, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C2]	[D/T-2] Use cases/applications [D/T-3] Requirements [D/T-4] Capabilities/ functions
ETSI ISG ZSM	GS ZSM-002 Reference Architecture	This work item specifies architectural principles, architectural requirements and an end-to-end abstract reference architecture for Zero-Touch Network and Service Management.	2019, In force	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4] [D2-C1] [D2-C2]	[D/T-4] Capabilities/ functions [D/T-5] Architecture [D/T-9] Security, privacy
ETSI ISG ZSM	GS ZSM-007 Terminology for concepts in ZSM	This document provides a glossary of terms and concepts related to Zero-Touch Network and Service Management (ZSM).	2019, In force	[D1-C1] [D1-C3-2] [D1-C3-3]	[D/T-1] Terminology, definitions, concepts
ETSI ISG ZSM	GS ZSM-009-1 Closed-Loop Automation; Part 1: Enablers	This work item describes how to enable closed-loop automation based on the ZSM architectural framework.	2021, In force	[D1-C1] [D1-C3]	[D/T-4] Capabilities (enablers) / functions
ETSI ISG ZSM	GS ZSM-009-2 Closed-Loop Automation; Part 2: Solutions for automation of E2E service and network management use cases	This work item describes specification for solutions of particular E2E service and network automation use cases, based primarily on the generic enablers and architectural elements for closed loops defined in ZSM002, ZSM009-1.	2022, In force	[D1-C1] [D1-C3] [D1-C3-2]	[D/T-4] Capabilities (enablers) / functions
ETSI ISG ZSM	GS ZSM-009-3 Closed-Loop Automation; Part 3: Advanced topics	This study investigates advanced topics related to closed-loop operations such as learning and cognitive capabilities, ways to set and evaluate levels of oversight, autonomy, and operational confidence on the behaviour of the closed loops.	2023, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-2] [D1-C3-3]	[D/T-4] Capabilities (enablers) / functions
ETSI ISG ZSM	GR ZSM-011 Intent-driven autonomous networks; Generic aspects	This study investigates the potential use of intents as key enabler for enhancing autonomous network and service management within ZSM framework.	2024, In force	[D1-C1] [D1-C3] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-4] Capabilities (enablers) / functions
ETSI ISG ZSM	GS ZSM-012 Enablers for Artificial Intelligence-based Network and Service Automation	The work item specifies extensions and new capabilities (so-called "AI enablers") for the ZSM framework reference architecture providing support for the automation of	2022, In force	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-2] [D1-C3-3]	[D/T-4] Capabilities (enablers) / functions

		management functionalities and operations based on Artificial Intelligence (AI), applicable end-to-end and per management domain.		[D1-C3-4] [D2-C2]	
ETSI ISG ZSM	GS ZSM-014 ZSM security aspects	The work item specifies new capabilities (so called security capabilities) of the ZSM framework architecture to support automatic/zero-touch security controls for ZSM framework to align with zero-touch objective, applicable end-to-end and per management domain.	2024, In force	[D1-C1] [D1-C3] [D1-C3-3]	[D/T-9] Security, privacy
ETSI ISG ZSM	GS ZSM-016 Intent-driven Closed Loops	The work item specifies capabilities to support the combination of closed-loop automation with intents originating from ZSM consumers (via northbound interface), focusing on intent-driven governance and coordination of closed loops.	2024, In force	[D1-C3] [D1-C3-2] [D1-C3-3]	[D/T-4] Capabilities (enablers) / functions
ETSI ISG ZSM	GS ZSM018 Network Digital Twin for enhanced zero-touch network and service management	This work item specifies extensions and new capabilities to support and integrate digital twin technologies with the ZSM framework reference architecture in order to improve end to end zero-touch network and service management and automation.	2024, In force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-4] Capabilities (enablers) / functions
ETSI ISG ZSM	GR ZSM 003 Zero-touch network and Service Management (ZSM); End-to-end management and orchestration of network slicing	The present document specifies the E2E network slicing management solutions and related management interfaces. The E2E network slicing including provisioning, performance assurance and fault management of an E2E slice instance across multiple management domains.	2021, In force	[D1-C1] [D1-C3]	[D/T-1] Concepts [D/T-5] Architecture [D/T-7] Governance and management
ETSI ISG ENI	GR ENI 051 Experiential Networked Intelligence (ENI); Study on AI Agents based Next-generation Network Slicing	The present document covers the areas and needs for new technical projects using 6G native AI capabilities. This covers: definition of the use cases and requirements of Core Network (CN) Large Language Models (LLMs), definition of the CN-Agent to facilitate interaction between the CN and the CN LLMs, identification of the key functional modules and interfaces of the CN-Agent, and the key technologies required.	2025, in force	[D1-C1] [D1-C1-1] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-1] Ddefinitions [D/T-2] Use cases [D/T-3] Requirements
ETSI ISG ENI	GR ENI 018 Experiential Networked Interlligence (ENI); Introduction to Artificial Intelligence Mechanisms for Modular Systems	The present document has provided an introduction for how artificial intelligence is used in the ENI System Architecture. Different types of learning and model training were defined, and a generic overview of bias and ethical decision-making was given. The present document concluded with an introduction to natural language processing principles.	2021, in ofrce	[D1-C1]	[D/T-10] Ethics

ETSI ISG ENI	GR ENI 010 Experiential Networked Intelligence (ENI); Evaluation of categories for AI application to Networks	The present document investigates quantitative evaluation criteria of network autonomicity categories, performs a deeper research of more quantitative factors that determine those categories, defines an accurate scoring criteria that complies with the evolution ofthe ENI architecture and defines a data model covering an entire operator's network or just a specific domain.	2024, in force	[D1-C1] [D1-C1-2] [D1-C3] [D1-C3-1] [D1-C3-3] [D2-C1]	[D/T-8] Data model
ETSI ISG ENI	GR ENI 008 Experiential Networked Intelligence (ENI); InTent Aware Network Autonomicity (ITANA)	The present document will discuss various design options, in terms of a set of new stand-alone and/or nested Functional Blocks, for using intent with the ENI System Architecture. This includes accepting, translating and validating intent statements, determining how intent affects the goals and operation of the ENI system, and how it is used by business users, application developers and network administrators.	2021, in force	[D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3]	[D/T-2] Use cases [D/T-5] Architecture
ETSI ISG ENI	GR ENI 007 Experiential Networked Intelligence (ENI); ENI Definition of Categories for AI Application to Networks	The present document defines various categories for the level of application of Artificial Intelligence (AI) techniques to the management of the network, going from basic limited aspects, to the full use of AI techniques for performing network management.	2019, in ofrce	[D1-C1] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D2-C1]	[D/T-2] Applications
ETSI ISG ENI	GS ENI 005 Experiential Networked Intelligence (ENI); System Architecture	The present document specifies the functional architecture of an ENI System, which is a high-level decomposition of an ENI System into its major components, along with a characterization of the externally visible behaviour (e.g. as defined by a set of reference points) of the components.	2023, in ofrce	[D1-C1] [D1-C1-2] [D1-C2] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-3] Requirement s [D/T-5] Architecture [D/T-6] Protocols and APIs
ETSI ISG ENI	GR ENI 004 Experiential Networked Intelligence (ENI); Terminology	The present document provides terms and definitions used within the scope of the ETSI ISG ENI. The purpose is to define a common lexicon for use across all deliverables of ENI.	2023, in force	/	[D/T-1] Terminology /vocabularly and definitions
ETSI ISG ENI	GS ENI 002 Experiential Networked Intelligence (ENI); ENI requirements	The present document specifies the requirements of how intelligence is applied to the network and applications in different scenarios to improve experience of service provision and network operation. Also, how intelligence enables dynamic autonomous behaviour and adaptive policy driven operation in a changing context.	2023, in force	[D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-3] Requirement s
ETSI ISG ENI	GS ENI 001 Experiential Networked Intelligence (ENI); ENI Use Cases	The present document identifies and describes additional use cases and scenarios and gives the baseline on how the studies in ENI can be applied	2023, in force	[D1-C1] [D1-C2] [D1-C3] [D1-C3-1]	[D/T-2] Use cases

		as solutions of some identified use cases in accordance with the ENI Reference Architecture and will substantially benefit the operators and other stakeholders.		[D1-C3-2] [D1-C3-3] [D1-C3-4]	

AnnexF.8 ONAP

The following table identifies a set of collected ONAP standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F8 - Existing ONAP (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps analysis (delimiting characteristics with AI-native networks)	Domains /topics
ONAP	Open Network Automation Platform—Ecosystem—Architecture	This document provides the architecture of ONAP. ONAP is a collection of Network Automation functions, including orchestration, management, and automation of network and edge computing services for network operators, cloud providers, and enterprises. The capabilities of ONAP are enhanced by genAI/ML. This document mainly focuses on the AI for network operations management.	/	[D1-C1] [D1-C1-1] [D1-C3] [D1-C3-1] [D1-C3-2] [D1-C3-3]	[D/T-5] Architecture

AnnexF.9 3GPP

The following table identifies a set of collected 3GPP standards for the selection of relevant candidates for_AI-native for telecommunication network gaps analysis.

Table F9 - Existing 3GPP (published and ongoing) standards relating to AI-native telecommunication networks

SDO	Standards reference and title	Short description	Publication year (if applicable); Status (in force /under study)	Essential set of information for conducting gaps	Domains /topics (according to legend in clause 9.2)

				analysis (delimiting characteristics with AI-native networks)	
3GPP RAN 3	37.817: Study on enhancement for data collection for NR and ENDC	This document provides descriptions of principles for RAN intelligence enabled by AI, the functional framework (e.g., the AI functionality and the input/output of the component for AI enabled optimization) and use cases and solutions of AI enabled RAN. The study is based on the current architecture and interfaces.	Under change control	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-2]	[D/T-5] Architecture
3GPP RAN 1	38.843: Study on Artificial Intelligence (AI)/Machine Learning (ML) for NR air interface	This study focuses on an AI-native air-interface, based on the 3GPP framework for AI/ML application to target use cases. The document idenfities a common AI/ML framework impacting multiple parts of the network system, including functional requirements of AI/ML architecture. Evaluations are provided to show the attainable gains of AI/ML based techniques, as well as to understand the impact of those solutions onto a future network architecture.	Under change control	[D1-C1] [D1-C1-1] [D1-C1-2] [D1-C3] [D1-C3-2] [D1-C3-3] [D1-C3-4]	[D/T-5] Architecture
3GPP SA5	28.908: Study on Artificial Intelligence/Machine Learning (AI/ ML) management	This document studies the Artificial Intelligence / Machine Learning (AI/ML) management capabilities and services for 5GS where AI/ML is used, including management and orchestration (e.g. MDA), 5GC (e.g. NWDAF) and NG-RAN.	Under change control	[D1-C1] D1-C1-1] [D1-C1-2] [D2-C2]	[D/T-4] Capabilities, Protocols and APIs
3GPP SA5	28.105: Management and orchestration; Artificial Intelligence/ Machine Learning (AI/ML) management	This document specifies the Artificial Intelligence / Machine Learning (AI/ML) management capabilities and services for 5GS where AI/ML is used, including management and orchestration (e.g., MDA) and 5G networks (e.g. NWDAF) and NG-RAN.	Under change control	[D1-C1] D1-C1-1] [D1-C1-2] [D2-C2]	[D/T-3] Requirements [D/T-4] Capabilities [D/T-6] Protocols and APIs

Annex G Use case analysis process and results

Editor's note: The content of this Annex will be excerpted from Clause 4.2 of Document Supp-FG-AINN-I-152. For specific details, please refer to that document.

Appendix I Overview of Artificial Intelligence Native Telecommunication Networks practice, studies and research

Editor's note: *It is considered hard to develop this clause correctly, as we should ensure appropriate and correct summary of every piece of existing activities across different SDOs (handled by experts not necessarily involved in the FG-AINN). It is also not clear for now the mandatory value of such clause. It is proposed to (consider to) delete it, or, alternatively, to move it to a specific Appendix (Appendix I - Overview of Artificial Intelligence Native for Telecommunication Networks practice, studies and research). The draft agreement of the 28th April WG1 ad-hoc meeting is to keep this clause here as simple introduction, with background general information only (including linkage with the aim of the document)*
Action for the post-14 May WG1 meetings: to develop text for this introduction clause according to the draft agreement of the 28th April WG1 ad-hoc meeting.

Editor's note: the following revision-marked text in italic (from FG-AINN-I-106) has not been reviewed and has been copied here only for promoting future discussion on the expected content of this clause.

AI-native networks are designed with AI integrated from the beginning rather than being added later as an afterthought. This approach allows networks to be more adaptive, efficient and capable of being better managed. So, unlike the traditional networks, AI-native systems can learn from data, make decisions to adjust operations in real-time to meet changing demands.

It is evident that AI is being used to optimize the performance of telecom networks. This includes managing traffic, reducing latency, and improving overall user experience. Telecom service provider companies may be interested in developing networks that can automatically adjust to provide the best service, using AI to manage resources and predict issues before they occur. Technology stakeholders may be interested in creating platforms that can integrate AI with cloud and edge computing to help faster data processing and improved network performance. Some key focus areas include customer experience enhancement with chat bots and virtual assistants; security and fraud detection by advanced analytics and augmented operational efficiency by automating tasks.

Academic and Research Developments

- ***Toward Native Artificial Intelligence in 6G [i]:*** *In order to meet the challenges brought by 5G "plug-in" network intelligence and meet the requirements of the ultimate performance, new AI service, and high-level network autonomy, native AI is listed as one of the important features in 6G. This paper first reviews the related research on network intelligence of various organizations, and then provides the viewpoint on the native AI in 6G and three features, including hierarchical and distributed intelligence, in-depth convergence of connection and intelligence, and collaborative exposure of connection and intelligence capabilities. At last, the 6G network architecture outlook with native AI is also provided.*
- ***Toward Native Artificial Intelligence in 6G Networks: System Design, Architectures, and Paradigms [ii]:*** *In the 6G era, networks are envisioned to transcend traditional communication roles by integrating Artificial Intelligence (AI) as a foundational element, enabling ubiquitous access to AI services for all users. This paradigm shift necessitates a comprehensive redesign of network architecture, introducing dedicated data and intelligent planes to facilitate end-to-end AI workflow orchestration and management. Such advancements aim to transform 6G networks into versatile platforms offering "Everything as a Service" (XaaS), thereby enhancing service delivery and business opportunities.*
- ***Beyond XAI for trustworthy federated learning in 6G zero-touch network slicing [iii]:*** *In the evolving landscape of 6G networks, AI-driven zero-touch automation is essential to manage*

diverse network slices catering to various use cases. Traditional centralized data control faces challenges in scalability and efficiency. Federated Learning (FL) offers a decentralized approach, enhancing security, reducing data exchange, and enabling swift local decision-making. Integrating Explainable AI (XAI) ensures transparency and trust in AI decisions, crucial for complex resource management and anomaly detection. Together, these technologies aim to optimize resource allocation, uphold fairness, and meet stringent service requirements in 6G networks.

- ***Large Generative AI Models for Telecom: The Next Big Thing?[iv]:*** *Generative AI (GenAI) is revolutionizing wireless networks by enabling autonomous, self-evolving systems that adapt to dynamic conditions without manual intervention. By leveraging multi-modal GenAI models trained on diverse telecom data, networks can perform various tasks—such as traffic prediction and resource optimization—without the need for task-specific models, paving the way for Artificial General Intelligence (AGI)-empowered networks. In the context of 6G, integrating on-device GenAI models fosters a collective intelligence paradigm, enhancing real-time decision-making and adaptability in wireless communications.*
- ***Distributed Intelligence in Wireless Networks[v] :*** *Edge computing, combined with Artificial Intelligence (AI), addresses the inefficiencies of cloud-based solutions by processing data closer to its source, thereby reducing latency, power consumption, and privacy concerns. This integration enables intelligent decision-making at the network edge, supporting advanced applications like real-time surveillance and personalized recommendations. Furthermore, distributed Machine Learning (ML) techniques, such as federated learning, enhance data privacy by eliminating the need to transmit large datasets to centralized servers, making AI a native and ubiquitous component of future wireless networks.*

[i] https://ieeexplore.ieee.org/abstract/document/9828649
[ii] https://arxiv.org/abs/2103.02823
[iii] https://upcommons.upc.edu/handle/2117/428758
[iv] https://arxiv.org/abs/2306.10249?
[v] https://arxiv.org/abs/2208.00545?

Appendix II Version control of this document

Version Control	Changes	Comments by experts at WG1 meetings and reasons of changes
R0 FG level	FG-AINN-047 (Jan 8th 2025 by Xiaomi and Marco): (1) The template was co-proposed by Xiaomi An and Marco Carugi. The document develops the standardization gap analysis (focusing on non-radio aspects) for AI native for telecommunication and networks with respect to existing technologies and the studies under the standardization organizations, industry bodies, and open-source bodies.	WG1 meeting 2 held on Jan 8th 2025: (1) Vishnu Ram: In alignment with Supplement A.SupplSGA to ITU-T A-series Recommendations “Guidelines for the development of a standardization gap analysis” . (2) Yi Zhang: What does semantic considerations mean? (3) Antonio De Domenico: Gap analysis could go beyond semantic considerations and include performance considerations and service considerations.
R1	FG-AINN-WG1-047-R1 (Jan 15th 2025 by Xiaomi): (1) Modified Clause 6 “Concepts of AI-native networks, their characteristics and concept relations for standardization” (2) Adding NOTE 2: “Semantic interoperability considerations, performance considerations and service considerations” in section 10.	WG1 meeting 3 held on Jan 15th 2025: (1) Vishnu Ram suggested adding a reference in Clause 2 of FG-AINN-I-047 Standardization Gap Analysis Template for WG1 of the FG-AINN. He pointed out the lack of clarity regarding the guidelines used and requested clarification on which parts of the document were aligned with the guidelines. He also recommended adding in-square-bracket citations wherever the guidelines were applied in the document to indicate the alignment. (2) Minrui Shi provided a document as a supplement to 8.7 of FG-AINN-I-047 Standardization Gap Analysis Template for WG1 of the FG-AINN. (3) WG1 ultimately reached consensus on FG-AINN-I-047 Standardization Gap Analysis Template for WG1 of the FG-AINN.
R2	FG-AINN-WG1-047-R2 (Jan 22nd 2025 by Xiaomi): (1) Clause 6 has been simplified to “Concepts of AI-native networks, their characteristics and concept relations for standardization”. (2) Clause 7 is related to the environment with the Use Case Template from WG2, using their work to analyze existing standards. (3) Clause 9 has a coding taxonomy with tagging based on the	WG1 meeting 4 held on Jan 22nd 2025: (1) Vishnu Ram wanted to know what the main deliverable was planned to be and asked if FG-AINN-I-047 was the primary planned document for that meeting. (2) Antonio De Domenico suggested limiting the number of output documents from the working group. FG-AINN-I-038 and FG-AINN-I-047 for WG1 of the FG-AINN. (3) Vishnu Ram agreed with Antonio’s comments and suggested 2 main documents. He pointed out that there are papers and

	characteristics in Clause 6 and the Use Case Template variables.	research findings from industry and academia that are not in the form of standards but could potentially provide valuable insights. He suggested that useful published materials from these sources, whether related to definitions, terminology, or other relevant aspects, should be taken into account as inputs for the gap analysis. (4) Riccardo asked for clarification on whether the document is about “GAP analysis” or “STATE OF THE ART analysis”. Vishnu and Antonio agreed with his opinion, the focus should be standardization gap analysis.
R3	FG-AINN-WG1-047-R3 (Jan 29th 2025 by Fuquan): (1) Adding concept diagram of AI-native for telecommunication networks in Annex A. (2) Adding Table 1 – Standards mapping with use case template for specific domain/topic. (3) Update Table 2 – Existing SDOs and the standards relating to AI-native for telecommunication networks (Examples provided & columns modified: Relating to AI-native for telecommunication networks. At the same time, we have included suggested principles for the selection of relevant standards.) (4) Adding Table 3 – Standards in alignment with AI-native for telecommunication networks concept system	WG1 meeting 5 held on Jan 29th 2025: (1) Marco Carugi expressed confusion about the numerical coding system, in particular questioning the meaning of the expression “[2-5-2]” and whether it referred to a coding that would be used in the future. He suggested that a simple legend would be helpful at this stage, at least at the first level. He noted that the coding system could evolve based on further discussion and input from members. (2) Vishnu Ram provided an update on the outputs from WG1 for the FG AINN 2nd meeting in April. He highlighted that WG1 is producing two types of outputs: “Vocabulary, terminology, and definitions” and “Meta-information that could be useful to other WGs”. (3) Vishnu also emphasized the importance of collating all inputs towards these outputs, as Antonio had just mentioned. He pointed out that two main documents would be consolidated to contribute to the FG deliverable: “Terminology and definitions” and “Inputs for the gap analysis”.
R4	FG-AINN-WG1-047-R4 (Feb 5th 2025 by Fuquan): (1) Adding novel value added service as a key characteristic of AI-native for telecommunication networks. (2) Adding definition of AI-native telecommunication networks and its characteristics with coding scheme, shareable with AI-native for telecommunication networks. (3) Adding objects and characteristics mapping table between AI-native for telecommunication network and	WG1 meeting 5 held on Feb 19th 2025: (1) Vishnu Ram suggested renaming the document as a “vocabulary study” or “vocabulary scratch pad”. He suggested that WG1 focus on gathering this information and work towards an “agreed” output in collaboration with the other WGs. (2) Thomas recommended renaming the document to follow the format “Output_WG_19_February_2025_Gap_Analysis”.

	AI-native telecommunication network in Table 1 and Table 2. (4) Reset table numbering from Table 2 to Table 4, and name to Existing SDOs and the standards relating to AI-native for telecommunication networks and AI-native telecommunication networks. (5) Adding table of reverse alignment with the objects and characteristics of AI-native telecommunication networks between existing standards to Table 5, Table6, Table 7, Table 8 and Table 9. (6) Update Annex A: "The UML concept system of AI-native for Telecommunication Network" with new code mapping.	(3) The meeting suggested that the gap analysis could explore the addition of new models beyond semantic analysis.
R5	FG-AINN-WG1-047-R5 (Mar 27th 2025 by Fuquan): (1) Optimize the presentation of the analytical framework for the introduction of definitions from FG-AINN-I-038 in Section 6. (2) Remove the table comparing the definitions of AI-native for networks and AI-native networks that was added in R4 in Section 6, as the presentation is duplicative of the addition. (3) To simplify the presentation of overlay mapping relationships, tables 5, 6, 7, 8, 9 have been deleted. (4) Heat maps have been added as a new presentation tool in section 9 to better visualize the gaps. (5) A completed analysis of the existing standards for SG13 has been added to section 8 (domain analysis) and section 9 (semantic mapping analysis).	
R6	FG-AINN-WG1-047-R6 (April 2nd 2025 by Fuquan):	**To be completed**
R7 (R1 FG level)	FG-AINN-WG1-047-R7 (April 9th 2025 by Marco) – resubmitted as FG-AINN-047-R1 by WG1:	Some comments for consideration with respect to the future development of this document; enhancements in terms of ITU-T SG13 relevant standards

R2 FG level (as well as FG-AINN-O-003)	FG-AINN-047-I-R2 (April 15th 2025 by WG1 Editors):	Based on FG-AINN-I-047-R1 (WG1 input to the Istanbul FG-AINN meeting) and results of the 14th April WG1 session of the Istanbul FG-AINN meeting (resolution of some open points contained in FG-AINN-I-047-R1, high-level agreement on the focus of the new update of the Standardization gap analysis document, high-level agreement on FG-AINN-I-053 (updates shown with "MC2" revision marks). NOTE 1 – Focus of the new update: a lot of details could be moved to Appendix, and the body could concentrate on the collection of relevant activities (from SDOs, industry bodies and open-source bodies) and the identification of gaps. This action has been implemented only partially in FG-AINN-I-47-R2. NOTE 2 – The Istanbul FG-AINN meeting also agreed on the development of an action plan to proactively solicit contributions from different ITU-T SGs, other SDOs, industry bodies and open-source bodies (collection of relevant activities) – this action has to be fully implemented.
FG-AINN-O-003-R1	FG-AINN-O-003-R1 (April 16th 2025 by WG1 Editors):	Minor updates based on comments on O-003 from Istanbul meeting participants, inclusion of other content based on 15th April FG-AINN plenary high-level agreement on FG-AINN-I-048, I-49, I-50. This version constitutes the agreed official output of the Istanbul FG-AINN meeting,
FG-AINN-WG1-047-R8	FG-AINN-WG1-047-R8 (May 7th April 2025 by WG1 co-Editor Marco Carugi):	Updates over the clean version of FG-AINN-O-003-R1, considering the results of the 28th April WG1 ad-hoc meeting (which has discussed the inputs "FG-AINN-O-03-R1-submitted-clean", "FG-AINN-O-03-R1-submitted-suggestion-FQ-WEN-26Apr2025" and considered other 28th April meeting comments) and subsequent proposals from WG1 co-Editor Marco Carugi according the 28th April meeting agreements. FG-AINN-WG1-047-R8-14052025 has been agreed at the 14th May WG1 meeting as the version to be used for future contributions to the "Standardization Gap Analysis of the FG-AINN" document.
FG-AINN-WG1-047-R9	FG-AINN-WG1-047-R8 (May 26th 2025 by WG1 Fuquan): (1) Based on the previous meeting discussions, the AI-native network's delimiting characteristics-based analysis framework was recoded.	WG1 meeting 15 held on May 28th 2025: Due to time running out, there was no detailed discussion. It was agreed that this document or a proposed additional update of it will be discussed at the 4th June WG meeting.

	(2) Margo provided a list of new, relevant standards. Meanwhile, Jing and Kewei updated their coverage features and fields. (3) Heatmap remapping by Fuquan.	
FG-AINN-WG1-047-R10	FG-AINN-WG1-047-R8 (Jun 2nd 2025 by WG1 Fuquan): (1) Based on the issues encountered in the current work, seven discussion points (as contributor's notes) have been added at the beginning of the document for discussion at the 4th June WG1 meeting. (2) Add heatmap mapping for clause 9 (domain/topics) (3) Add a description of the method for the preliminary screening of the labelling of standards using an AI-based LLM in Clause 9.2. This method is based on a subset of the current manually annotated SG13 data, and the study currently only includes domain topics. The placement of this clause requires further discussion at the conference. (4) Based on the existing mapping results of SG13, conduct a preliminary analysis of the gaps in current standard research and draw up a draft conclusion. This section is located in clause 7 and its placement needs to be discussed further at the meeting. (5) Two distinct gaps proposed by Jing Yin, placed in clause 10.	WG1 meeting 15 held on 4th Jun 2025: Meeting conclusion: After detailed discussion of all proposed updates and related modifcations, plus agreements on additional amendments, an informal ouput of the 4th June WG1 meeting is agreed. Its cleaned-up version (essentially an editorial clean-up) has been submitted to the 3rd FG-AINN meeting as formal ouput of the 4th June WG1 meeting (FG-AINN-I-**XX**) for consideration by the 3rd FG-AINN meeting. NOTE – There was no time to review (1), the discussion points added at the beginning of the document: those points were kept in the output as contributor's notes for future consideration.
FG-AINN-O-06		3rd FG-AINN meeting, New Delhi, 11-13 June 2025: Meeting conclusion: After detailed discussion of all received relevant inputs, this document is agreed as the output of the 3rd FG-AINN meeting, New Delhi, 11-13 June 2025. It uses the clean version of FG-AINN-I-107 (output of the 4th June WG1 meeting) as baseline, and has revision-marked amendments according to the New Delhi meeting discussion and agreements on inputs FG-AINN-I-107, FG-AINN-I-106, FG-AINN-I-92, FG-AINN-I-100 and FG-AINN-I-101, as well as according to the 12 June final review of
FG-AINN-006R1		the proposed output (FG-AINN-I-107-R1). Main amendments: initial draft list of gaps in clause 10.2, initial text for new clause 11,

		enhancements of some clauses 8.X (collection of standards). Changes made in alignment with delimiting characteristics of AI-native telecommunication networks identified in FG-AINN-I-038R18 agreed at July 2, WG1 meeting. “AI-native telecommunication networks” is taking place of “ AI-native for telecommunication networks in the whole document.
FG-AINN-I-152-R1	FG-AINN-WG1-047-R8 (July 22nd 2025 by WG1 JingYin): 1) Added Table 8.X Overview of SDO’s work and selection status related to AI-native networks, to determine which SDOs should be retained.	WG1 meeting 22 held on July 30th 2025: Meeting conclusion: Tne selection criteria in Caluse 8 should be further supplemented and improved to clarify the reason why SDOs are selected or not, and the subjects of the standards in SDOs should be further checked.
FG-AINN-I-152-R2	August 5th 2025 by Francisco and WG1 Jing Yin: 1) Adding the analysis of standards related to AINN collected from 3GPP in Clause 8.2.10. 2) Adjusting the structure of clause 8: adding new subclauses 8.1 and 8.2, and adding brief explanatory text below them to clarify the purpose of this subsection. 3) Supplementing the last two columns of Table 8-1 and adding the reasons for selecting or not selecting SDOs in the last column. 4) Updating the heat map in Clause 9.3.1. 5) Adding a new Clause 10.2 and proposing five gaps.	
FG-AINN-I-152-R3	August 15th 2025 by Fuquan: (1) Adjust the document structure in accordance with FG-AINN-I-WG1-005.	
FG-AINN-I-152-R6	(1) Based on the heat map, three additional gaps have been identified; The future work section has been refined from macro-level concepts into specific measures.	
FG-AINN-I-152-R7	(1) Collect and add 23 standards related to AINN: 4 standards from SG21, 3 standards from SG17 and 16 standards from SG20 (Seen Annex F). (2) Map the characteristics and domains of standards collected from SG21, SG17 and SG20 (Seen Annex F).	

	(2) (3) Add the tables of characteristic mapping result for SG17, SG20 and SG21 in Clause 7.1, and add the heat maps for SG17, SG20 and SG21 in Clause 7.2.	
FG-AINN-I-157-R8	October 22nd 2025 by Fuquan, Jing Yin, Kewei and Zhiying: 1) Map the characteristics and domains of standards collected from SG2, ETSI ISGs and ONAP (See Annex F). 2) Add the tables of characteristic mapping result and domain mapping result for SG2, IETF/IRTF, ETSI ISGs, ONPP and 3GPP (See Clause 7.1 and 7.2). 3) Update the two heatmaps in Clause 7. 4) Based on the analysis of Clause 7, add a new gap (Gap 9) in Clause 8.1.	
FG-AINN-I-157-R9	November 26th 2025 by Fuquan, Jing Yin: 1) Add and analyze 7 standards from SG20 based on the Document FG-AINN-I-202-LS (Seen Annex F.5); 2) Conduct the gap analysis based on 12 use cases from WG2, and generate an analysis report (seen Supp-FG-AINN-I-152).	
FG-AINN-I-157-R10	February 3rd 2026 by Jing Yin: 1) Add Clause 6.2 Gap analysis process and methodology and Clause 6.4 Use case analysis method for gaps; 2) Add Annex G Use case analysis process and results.	The gap analysis process established by WG1 has completed expert review, with broad consensus reached on its key elements. The bottom-up use case analysis method is currently under development and requires subsequent approval and consensus at WG1 meetings in the furture.

Bibliography

NOTE- the authors can indicate here state of the art references, etc.

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