

TM Forum Introductory Guide

Autonomous Networks Industry Standards

IG1230B

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Notice

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Direct inquiries to the TM Forum office:

181 New Road, Suite 304
Parsippany, NJ 07054 USA
Tel No. +1 862 227 1648
TM Forum Web Page: www.tmforum.org

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1 Industry and Standardization Efforts

1.1 Towards a shared vision of Autonomous Networks

Autonomous Network initiatives are being progressed in multiple standards developing organizations (SDOs), such as ETSI, 3GPP, and GSMA to name but a few. An alignment on Autonomous Network concepts, a shared vision and framework would help the industry to progress in a coordinated way on this important initiative.

Autonomous Networks evolution, standardization, and deployment will require an industry- wide consensus and each stakeholder will need to learn how to collaborate better to create the right approach. For standards work, SDOs will need to “share early and often”, align better and avoid duplication of effort.

Autonomous Networks will evolve over a longer-term timeline and real solution deployments using AI that delivers a high level of network automation (AN Level 4) are expected in the next 5 years. However, it is the next 2 years that will prove crucial to its success. Concrete, tangible elements of the AN framework, generating the initial benefits and return, will deliver partially autonomous systems. These returns when reinvesting into the initiatives will bring bigger savings and the value behind AN. Standards should move fast to prepare the conditions of interoperability and commercial deployment of these autonomous systems.

1.2 SDO Landscape Summary

The challenges and opportunities of AN are significant, and no single stakeholder or SDO is capable to cover the entire end-to-end perspectives of AN. The cross-SDO, industry-level collaboration to achieve consensus of key concepts and terminologies (e.g., AN definition, framework, autonomous networks levels) and the development of key capabilities, mechanisms, interfaces (e.g., control loops, autonomous domains, intent) is essential to the success of AN.



Figure 1. Industry and Standards Landscape

Figure 1, Industry and Standards Landscape, shows a simplified ¹view of the key organizations that are active in the area of AN – from standards to open source implementations such as ONAP. The table below defines the objectives of this SDO projects and groups. Table 1 below lists the objectives of some relevant projects in AN space.

Table 1. SDO Projects or Specification Groups

Project	Objective
ETSI ENI	Experiential Networked Intelligence Industry Specification Group (ENI ISG) is defining a Cognitive Network Management architecture, using Artificial Intelligence (AI) techniques and context-aware policies to adjust offered services based on changes in user needs, environmental conditions and business goals. ISGENI is focused on improving the experience of the operator in managing any type of network
ETSI GANA	The main goal of the GANA reference model is prescribing design and operational principles for Decision Elements (DEs) as the drivers for cognitive, self-managing and self-adaptive network behaviors that enable to achieve OPEX reduction and other benefits "Artificial Intelligence/Cognition in AMC (autonomics)" bring to Network Operators and End User Customers, and to Enterprise Networks as well, such as: Dynamic and Analytics-Driven Service Fulfilment and Closed-Loop Service Assurance, Predictive, Proactive and Advanced Customer Experience.
ETSI ZSM	Defines and describes the reference architecture for the end-to-end Zero-touch network and Service Management (ZSM) framework based on a set of user scenarios and requirements documented in ETSI GS ZSM 001. The overarching design goal of ZSM is to enable zero-touch automated network and service management in a multivendor environment.
ETSI F5G	The ETSI ISG F5G aims at studying the fixed-network evolution required to match and further enhance the benefits that 5G has brought to mobile networks and communications. It will define improvements with respect to previous solutions and the new characteristics of the fifth-generation fixed network.
ITU-T SG13	Specifies an architectural framework for machine learning (ML) in future networks: a set of architectural requirements, specific architectural components needed to satisfy these requirements (components include, but are not limited to, a ML pipeline as well as ML management and orchestration functionalities), integration of such components into future networks and guidelines for applying this architectural framework in a variety of technology-specific underlying networks.
3GPP SA5	Within the 3GPP Technical Specification Group Service and System Aspects (TSGSA), the main objectives of 3GPP TSG SA WG5 (SA5) are Management, Orchestration and Charging for 3GPP systems. Both functional and service perspectives are covered.

Project	Objective
IETF NMRG	The Network Management Research Group (NMRG) provides a forum for researchers to explore new technologies for the management of the Internet. In particular, the NMRG will work on solutions for problems that are not yet considered well understood enough for engineering work within the IETF. The focus of the NMRG will be on management services that interface with the current Internet management framework.
CCSA TC7	TC7 is a technical committee supporting Network Management and Operation. WG1 focuses on Wireless communication management. WG2 focuses on Transport, Bearer, and Access Network Management. WG3 focuses on ICT Service Management and Operation.

¹ It is not an exhaustive list of all SDOs in AN

1.3 SDO Deliverables Summary

Table 2 gives an overview of the objectives and published deliverables for the respective SDOs.

Table 2. Review of ongoing AN activities in relevant SDOs

SDO	Objectives	Planned Deliverables	Published Deliverables
TM Forum	E2E perspective User stories Business requirements/Business architecture Technical architecture Catalysts / PoCs	IG1260 AN Project Guide IG1251 (ANF Reference Architecture) IG1252 (AN Levels Evaluation Methodology) IG1253 Intent in Autonomous Networks IG1259 Study of Telecom Industry Intent Meta-Modeling Approaches	AN Whitepapers R19 and R20 IG1193 (Vision & Roadmap) IG1218 (BA 1.0) IG1229 (Guiding Principles) IG1230 (TA 1.0)
3GPP SA5	Autonomous Network levels 5G Service-Level Agreement Closed loop assurance Intent-driven management Self-organizing network Management data analytics	Autonomous Network levels: TS 28.100 Intent-driven management: TS 28.312 1. Management data analytics: TS 28.104	Architecture: TS 28.533 closed loop automation: TS 28.535/536 Self-organizing network: TS 28.313 5G Service-Level Agreement TS 28.541

SDO		Objectives	Planned Deliverables	Published Deliverables
ETSI	ZSM	Closed loop of Network operations automation; Cross-domain E2E Service LCM; Intent-driven AN; AI Enablers	GS ZSM 009-1 Closed-loop automation; Enablers. GS ZSM 009-2 Closed-loop automation; Solutions GS ZSM 009-3 Closed-loop automation; Advanced topics . GS ZSM 008 Cross-domain E2E service LCM GS ZSM 011 Intent-driven autonomous networks GS ZSM 012 AI Enablers	ZSM002 v1.1.1 ZSM004 v1.1.1 ZSM005 v1.1.1.
	ENI	Closed loop of AI for Network operations automation	Rel 2	Rel 1 on Use cases, architecture, Context-Aware Policy Management
	F5G	transport networks with AN capabilities		
GSMA		Future Networks; Automation in Network evolution.		Whitepaper: AI & Automation: An Overview
ITU-T	SG13	Machine learning in future network		Y.3170-Y.3179
	FG-AN	Initial proposal on study of AN is now a new focus group called FG-AN (Feb 2021)		
CCSA TC7		Network Management and Operation		
IETF NMRG		Concepts; Intent classification; Service assurance; policy	draft-irtf-nmrg-ibn-concepts-definitions-03 draft-irtf-nmrg-ibn-intent-classification-03 draft-zhou-nmrg-digitaltwin-network-concepts-03 draft-claise-opsawg-service-assurance-architecture-03 draft-ietf-netmod-eca-policy-01	RFC7575, RFC7576

2 SDO Landscape

The following sub-sections list some of the *recent* contributions to the AN topic from various SDO organizations.

2.1 European Telecommunications Standards Institute (ETSI)

ETSI have a number of standards activities relating to Autonomous Networks:

- *F5G (5th Generation Fixed Network)*,
- *ENI (Improve operator Experience through closed loop AI)*,
- *NFV (Network Function Virtualization)*,
- *ZSM (Management/Automation of emerging and future networks and services)*.

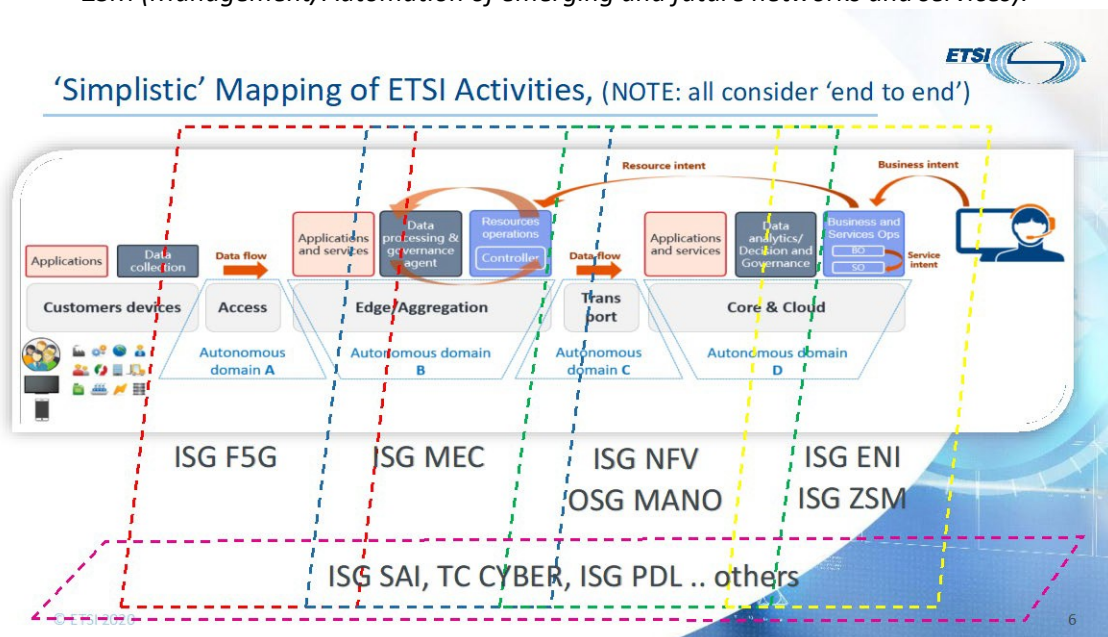


Figure 2. ETSI ISGs relating to AN (Source: ETSI 2020)

Figure 2 shows the ISGs working in areas related to autonomous networks and identifies areas of contribution and convergence of scope of the various ETSI ISGs. ETSI plans to publish a whitepaper on Autonomous Networks that shows the importance of coordination and knowledge sharing between the ISGs and all involved in the extended ecosystem, including SDOs, cross-vertical organizations, open-source alliances and research groups.

2.2 3rd Generation Partnership Project (3GPP)

3GPP SA5 has progressed the following specifications in the general area of AN:

Architecture Framework

- In Release 16, 3GPP SA5 took the architectural framework specified in GS ZSM 002 (ZSM Reference Architecture) into account. The related description has been captured in TS 28.533 clause 5.3 "Management service deployment based on ZSM framework".

Closed Loop Assurance

- In 3GPP Release 16, 3GPP SA5 has specified the concept for open control loop and closed control loop, as well as use cases, requirements and a model for communication service assurance closed control loop. Corresponding contents are captured in TS 28.535 and TS 28.536.
- In 3GPP Release 17, 3GPP SA5 has started a new work item on enhanced closed loop SLS assurance.

Classification of Network Autonomy for Fault recovery (28.810)

In addition, SA5 is currently working on the following Rel-17 topics that are relevant to AN:

- Intent driven management service for mobile networks (see TR 28.812/TS 28.312),
- Management Data Analytics Service (see TR 28.809),
- Autonomous Network Levels (see TR 28.810/TS 28.100).

3GPP has also established the NWDAF (network data analytics function) working group to work on 5G slicing and intelligent application research of 5G Core.

2.3 International Telecommunication Union Telecommunication (ITU-T)

The ITU-T approved ITU-T Y.3172 in June 2019 to define the network AI framework, including the intelligence level, data processing standards, and cases. The Focus group on Machine Learning for Future Networks including 5G (FG-ML5G) has developed an Architectural framework for machine learning in future networks including IMT-2020. The topics are related to Autonomous Networks but differ in focus and emphasis to the TM Forum work. The group has published deliverables on architectural framework, high-level architecture, requirements and discussed topics such as intent, machine learning, orchestrator, ML pipeline, and the need for ML sandboxes. Four important areas are shown in the callouts in Figure 3.

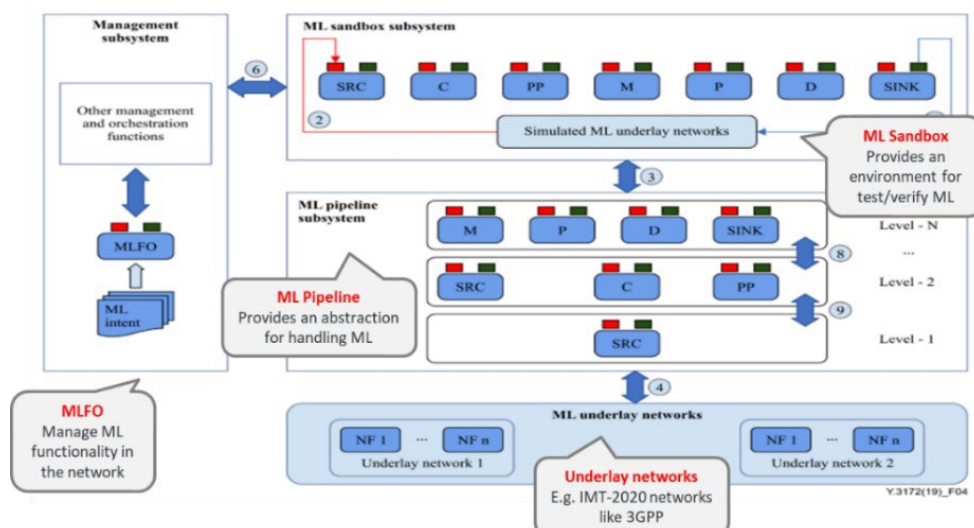


Figure 3. Overview of ML work in FG ML5G [Y3172] (Callouts added)

3 Intent in Autonomous Networks

3.1 Intent Standardization Efforts

Many standard-developing organizations (SDO) are actively working on the topic of autonomous networks and associated intent-driven management. One of the key building blocks of intent-driven management is the intent meta-model which provides an abstract representation of the schema and rules of the intent model, irrespective of the management domain or specific management layer, and enables the extension of such a model wherever necessary, depending on the context of usage. This is critical because the meta-model of the intent is one of the architectural considerations that can influence the functional blocks required for the autonomous network system to derive the semantic meaning and context of the intent as well as helps to map intent to internal actions without ambiguities or conflicts.

Table 3 lists some of the key standards in the area of intent-driven networking and categorizes the standards by the following dimensions: conception definition, model, architecture, classification (types, taxonomy), domain (scopes), and lastly, the relevant TM Forum AN Intent Category (Business Intent, Service Intent, Resource Intent).

Table 3. Intent Standards Classification

	Concept Definition	Model	Architecture	Classification	Domains	Intent Category
TM Forum	IG 1230	IG1253	IG1251 and IG1253	IG1253A	FFS in IG1253E	Business, Service Resource
ZSM/ENI	ZSM005/ ZSM011 (in 2021)	ENI PoC8	ENI005, ITANA			Service, Resource
3GPP	TR 28.812 /TS 28.312	TR 28.812	28.312	TR 28.812 / TS 28.312	TR 28.812 TS 28.312	Network / Domain Specific
IETF	RFC7575 draft-irtf-nmrg-ibn-concepts-definitions-03	RFC 8049 RFC 8466 RFC 8969 draft-ietf-opsawg-l3sm-l3nm-09 draft-yang-nmrg-network-measurement-intent-01	draft-ietf-opsawg-service-assurance-architecture-00	draft-irtf-nmrg-ibn-intent-classification-03		Network / Domain Specific
Other	MEF071	MEF071	ITU SG13 Q2 Y.IBN Reqs	CCSA		

TM Forum's AN Project has also published a suite of guides on 'Intent in Autonomous Networks'. See below for the complete list of guides.

1. IG1253 is a set of documents in which each document defines a separate aspect of intent-driven operation:
2. IG1253 - Intent in Autonomous Networks
This is the main overview document. It contains a description of general definitions and operation principles. The documents A-E contain and deeper views into some key topics.
3. IG1253A - Intent Modeling
This document defines the modeling of intent objects as ontology graphs. It introduces the concept of model federation based on a central intent meta-model and separate domain-specific extensions and information models. This document then defines the central and domain-independent intent meta-model.
4. IG1253B - Intent Information Models (future release)
This document adds to the model federation as defined in IG1253A and propose domain-specific extensions and information models.
5. IG1253C - Intent life cycle management and Interface
This document defines the life cycle of intent including the [roles](#) and responsibilities within the life-cycle. It then defines the interface and API used to execute the life-cycle management operations. This includes methods for communicating, modifying and removing intent objects, as well as negotiating intent content.
6. IG1253D - Intent handler scope and capability management (future release)
This document defines a registration and discovery mechanism about the capabilities and scope of operation of distinct intent handler interfaces.
7. IG1253E - Use cases and examples (future release)
This document is a collection of use cases with detailed examples that demonstrate how to apply the principles and use the models and interfaces defined in the IG1253 set of documents.

Separate to the Intent specification work above, TM Forum has also published a study called IG1259 Study of Telecom Industry Intent Meta-Modeling Approaches that examines the various approaches to intent modeling and intent expression languages from across SDOs and open source communities [IG1259].

4 Administrative

4.1 References

#	Title	Organization
EAI34	ETSI White Paper No. #34, "Artificial Intelligence and Future Directions for ETSI," 1st Edition, Jun 2020.	ETSI
EAN40	ETSI White Paper No. #40, "Autonomous Networks, supporting tomorrow's ICT business," 1st edition, Oct 2020.	ETSI
ENI005	ETSI ENI, "Experiential Networked Intelligence (ENI); System Architecture," GS ENI 005, v2.0.23, Mar 2021.	ETSI
ENI44	ETSI Whitepaper No. #44, "ENI Vision: Improved Network Experience using Experiential Networked Intelligence," 1st Edition, Mar 2021.	ETSI
GAN44	ETSI White Paper No. #4, "ETSI GANA as Multi-Layer Artificial Intelligence (AI) Framework for Implementing AI Models for Autonomic Management & Control (AMC) of Networks and Services; and Intent-Based Networking (IBN) via GANA Knowledge Planes (KPs)," Released on 27 Aug 2019.	ETSI
IG1190	AI Ops Service Management - a guide of best practices on redesigning complex service management operations processes to handle and govern AI software at scale.	TM Forum
IG1193	Autonomous Networks Vision	TM Forum
IG1218	Autonomous Networks Business Requirements and Framework v1.1	TM Forum
IG1230	Autonomous Networks Technical Architecture v1.1	TM Forum
IG1230A	Autonomous Networks Scenarios Realizations v1.1	TM Forum
IG1253	Intent in Autonomous Networks (Suite of guides)	TM Forum
IG1259	Study of Telecom Industry Intent Meta-Modeling Approaches v1.0.0	TM Forum
IG1260	Autonomous Networks Project Deliverable Guide	TM Forum
Y.3172	ITU-T, "Architectural framework for machine learning in future networks including IMT-2020," Recommendation ITU-T Y.3172, Jun 2019.	ITU-T
Y.3174	ITU-T, "Framework for data handling to enable machine learning in future networks including IMT-2020," Recommendation ITU-T Y.3174, Feb 2020.	ITU-T
ZSM002	ETSI ZSM, "Zero-touch network and Service Management (ZSM); Reference Architecture," GS ZSM 002, v1.1.1, Aug 2019.	ETSI
ZSM005	ETSI ZSM, "Zero-touch network and Service Management (ZSM); Means of Automation" GR ZSM 005, v1.1.1, May 2020.	ETSI

4.2 Document History

4.2.1 Version History

Version Number	Date Modified	Modified by:	Description of changes
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4.3.1 Guide Lead & Author

Member	Title	Company
Kevin McDonnell	Senior Director, Intelligent Automation	Huawei

4.3.2 Main Contributors

Member	Title	Company
Wang Lei	Systems Expert	Huawei
Wang Xu	Systems Expert	Huawei
Xie Yuan	Systems Expert	Huawei
Zheng Guangying	Systems Expert	Huawei

4.3.3 Additional Inputs

Member	Title	Company
Abdul Majid Hussain	Solutions Architect	Telstra
Abinash Vishwakarma	Lead Business Analyst	Netcracker
Andy Corston-Petrie	Senior Research Manager	BT Group plc
Brad Peters	Architect	NBNCo Ltd
Christian Maître	VP Smart City	Orange

Member	Title	Company
Dong Sun	Chief Business Strategist, Digital Transformation	Futurewei Technologies
Emmanuel A. Otchere	Chief Technical Expert VP, Standards & Industry Development	Huawei
Joe Isaac	Principal Architect	Wipro Technologies
Johanne Mayer	Consultant	Ciena
Liu Hongbo	Deputy General Manager, Intelligent Network Center	China Unicom
Luigi Licciardi	Consultant, Executive Advisor	Huawei
Manoj Nair	Senior Solutions Architect, CTO Office	Netcracker
Min He	Chief Architect	Futurewei Technologies
Qiao Zizhi	Senior Engineer, Intelligent Network Center	China Unicom
Steve Iatropoulos	Client & Industry CTO	Microsoft
Tayeb Ben Meriem	Senior Standardization Manager	Orange
Thierry Reynard	OSS Consulting Manager	ETIYA
Vance Shipley	CEO	Sigscale

4.3.4 TM Forum Staff

TM Forum	Title	Company
Aaron Boasman-Patel	Vice President, AI, Customer Experience & Data	TM Forum
Alan Pope	Collaboration Manager	TM Forum
David Milham	Chief Architect	TM Forum
Ian Turkington	VP, Architecture & APIs	TM Forum
W. George Glass	CTO	TM Forum