ETSI GR ENI 004 V2.2.1 (2021-12)

Experiential Networked Intelligence (ENI); Terminology for Main Concepts in ENI

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Experiential Networked Intelligence (ENI).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

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.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI GS NFV 003 (V1.3.1): "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

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[i.3] MEF 55.0.3: "Amendment to MEF 55: Service Orchestration Functionality", January 2018.

[i.4] MEF 55: "Lifecycle Service Orchestration (LSO): Reference Architecture and Framework", March 2016.

[i.5] MEF 78.1: "MEF Technical Specification: MEF Core Model", Strassner, J., editor, July 2020.

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[i.6] Gamma E., Helm R. Johnson R. and Vlissides J.: "Design Patterns: Elements of Reusable Object-Oriented Software", Addison-Wesley, November 1994. ISBN 978-0201633610.

[i.7] ISO/IEC 2382-28: "Information technology -- Vocabulary".

[i.8] ISO/IEC/IEEE 42010: "Systems and software engineering -- Architecture description".

[i.9] The Atlan Data wiki definition of structured data.

[i.10] ETSI GR ENI 007 (V1.1.1): "Experiential Networked Intelligence (ENI); ENI Definition of Categories for AI Application to Networks".

[i.11] IETF RFC 8321: "Alternate-Marking Method for Passive and Hybrid Performance Monitoring".

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[i.12] Mitchell, Tom M.: "Machine Learning", McGraw-Hill, 978-0070428072.

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[i.16] ETSI TR 103 240 (V1.1.1) (2014-01): "Powerline Telecommunications (PLT); Powerline communication recommendations for smart metering and home automation".

[i.17] Strassner. J.: "Knowledge Representation, Processing, and Governance in the FOCALE Autonomic Architecture", chapter 11 of Autonomic Network Management Principles, 2011, Elsevier.

3 Definition of terms, symbols and abbreviations

3.1 Terms

0 to 9

Void.

A

abstraction: hiding of unnecessary details to focus on data and information that is relevant for defining a particular concept or process

action: set of operations that may be performed on a set of managed entities, it represents a transformation or processing in the system being modelled

NOTE: An Action either maintains the state, or transitions to a new state, of the targeted managed entities. The execution of an Action may be influenced by applicable attributes and metadata. As defined in MEF PDO CfC [i.2].

actor: role, played by an external entity (human or machine), which interacts with the subject of a use case

NOTE: An actor is always a type of stakeholder (but not vice versa). See stakeholder.

agent: computational process that implements the autonomous, communicating functionality of an application:

- **software agent:** software that acts on behalf of a user or another program
- **software autonomous agent:** software agent that acts on behalf of the entity that owns it without any communication from the owning entity
- **software intelligent agent:** software agent that reasons about its environment and take the best set of actions to satisfy a set of goals

NOTE: This has the connotation of containing AI mechanisms to provide the reasoning and decision-making capabilities.

- **software multi-agent:** set of software agents that are physically separate that work together to satisfy a set of goals

anomaly: measurable consequences of an unexpected change in state of a datum, or set of data, which is outside of its local or global norm

API: set of communication protocols, code and tools that enable one set of software components to interact with either a human or a different set of software components

NOTE: This is also known as an Application Programming Interface.

API Broker: software entity that mediates between two systems with different APIs, enabling the two different systems to communicate transparently with each other

architecture: set of rules and methods that describe the functionality, organization, and implementation of a system

- **cognitive architecture:** system that learns, reasons, and makes decisions in a manner resembling that of a human mind

NOTE: Specifically, the learning, reasoning, and decision-making is performed using software that makes hypotheses and proves or disproves them using non-imperative mechanisms that typically involve constructing new knowledge dynamically during the decision-making process.

- **deliberative architecture:** symbolic world model that enables problem-solving components to be built using a sense-plan-act paradigm
- **functional architecture:** model of the architecture that defines the major functions of each module and how each module interacts with each other
- **hybrid architecture:** system made up of reactive and deliberative components that are combined into a hierarchy of interacting layers, where each layer reasons at a different level of abstraction
- **reactive architecture:** system that is aware of changes that affect its computations and adjusts accordingly

NOTE: The adjustment is made by reacting to an event in real-time without centralized control. The availability of new information drives program logic execution.

- **software architecture:** high-level structure and organization of a software-based system. This includes the objects, their properties and methods and relationships between objects.

Artificial Intelligence (AI): computerized system that uses cognition to understand information and solve problems

NOTE 1: ISO/IEC 2382-28 [i.7] defines AI as "an interdisciplinary field, usually regarded as a branch of computer science, dealing with models and systems for the performance of functions generally associated with human intelligence, such as reasoning and learning".

NOTE 2: In computer science AI research is defined as the study of "intelligent agents": any device that perceives its environment and takes actions to achieve its goals.

NOTE 3: This includes pattern recognition and the application of machine learning and related techniques.

NOTE 4: Artificial Intelligence is the whole idea and concepts of machines being able to carry out tasks in a way that mimics the human intelligence and would be considered "smart".

assisted system: system that the ENI system is providing recommendations and/or management commands to is referred to as the "assisted system"

autonomous network: network with increasing level of autonomous decisions and delegation of responsibilities from Human Operators

Autonomous Network Responsibility Index (ANRI): set of self-governing programmable and explainable systems that seamlessly deliver secure, context-aware, business-driven services that are created and maintained using model-driven engineering and administered by using policies

NOTE: Some of the dimensions can be tailored or merged in line with actual conditions.

axiom: statement that is assumed to be true, in order to serve as a starting point for further reasoning

B

bias: systematic difference in treatment of certain objects, ideas, or people in comparison to others:

- **algorithmic bias:** algorithm that possesses systematic and repeatable errors that create unfair outcomes
- **emergent bias:** reliance on an algorithm that has not been adjusted to evaluate new forms of data
- **inductive bias:** set of assumptions that are used in a machine learning algorithm used to predict outputs for inputs that it has not encountered

bidirectional encoder representations from transformers: unsupervised deep learning strategy that utilizes bidirectional models that considers all words of the input sentence simultaneously and then uses an attention mechanism to develop a contextual meaning of the words

blackboard: architecture that uses a shared workspace that a set of independent agents contribute to, which contains input data along with partial, alternative and completed solutions

BSS-like functionality: functionality supporting customer-facing activities for the operator

NOTE: Examples include customer service, rating, order management, billing and settlement.

C

capability: type of metadata that represents a set of features that are available to be used from a managed entity

NOTE: These features may, but do not have to, be used. These features may represent all or a subset of the functionality provided by a managed entity. Since a Functional Block is a type of managed entity, Capabilities can be defined for Functional Blocks as well. A Capability provides information about the functionality of a managed entity that enables management entities to decide whether that managed entity is useful for a given task.

case-based reasoning: use of existing experiences and knowledge to understand and solve new problems

catastrophic forgetting: tendency of an artificial neural network to forget previously learned information when learning new information

choreography: set of processes that define how entities interact from a global point-of-view

NOTE: That is without a single point of control. Compare this definition to Orchestration.

class: template for defining a specific type of object that exhibits a common set of characteristics and behaviour:

- **abstract class:** class that cannot be directly instantiated
- **concrete class:** class that can be directly instantiated

classifier: procedure that predicts which elements of a set belong to which (pre-defined) classes

NOTE: The classification is done using training data whose category membership is known, and can be thought of as a function that assigns a new observation a class label.

- **binary classifier:** classifier that decides whether or not an input belongs to one of two groups (i.e. classes) based on a classification function
- **discriminative classifier:** classifier that differentiates an object using class labels

NOTE: This directly estimates the conditional probability of P(Y|X). An example is logistic regression.

- **generative classifier:** classifier that learns a model of the joint probability of an input x and the label y, uses Bayes rules to calculate p(Y|X), and then assigns the most likely label

NOTE: This estimates P(Y|X) by estimating P(Y) and P(X|Y). An example is Naïve Bayes classifier.

- **hierarchical classifier:** classifier that maps input data into a tree-like set of output categories by first, classifying at a low level, and then iterating each lower-level classification into a higher-level classification

- **linear classifier:** classifier that assigns a label based on a linear combination of its features
- **probabilistic classifier:** classifier that assigns a label to an object based on a (conditional) probability distribution

closed loop control: self-regulating mechanism in which outputs of a system are provided to a system that compares the current state to a desired state (or set of states); the comparison is then used to adjust the behaviour of the system

NOTE 1: Positive feedback increases the correction value, while negative feedback reduces the correction value.

NOTE 2: Positive and negative feedback can be combined to achieve the needs of a system. In addition, more complex forms of closed loop control exist, such as Proportional-Integral-Derivative (PID) control. See control theory.

clustering: grouping of a set of objects such that objects in the same group are more similar to each other, by one or more measures, than to other objects in other groups

cognition: process of understanding data and information and producing new data, information and knowledge

- **cognition model:** computer model of how cognitive processes, such as comprehension, action and prediction are performed and influence decisions.

collaborating: two or more managed entities cooperate to accomplish a given task

column-oriented database: database that organizes data by field

NOTE: This type of database keeps all of the data associated with a field next to each other in memory, and is optimized for online analytical processing. They are optimizes for reading and computing on columnar data.

compiler: computer program that translates the content of a source programming language into a different, or target, programming language

component: part of a System that has operational and/or management significance

NOTE: A Software Component is an encapsulation of a set of related functions and/or data that perform a set of specific purposes and have a set of associated semantics and behaviour.

compute node: object that performs a set of calculations according to a set of algorithms

concept drift: not taking changing data and its meanings into account when training an ML model [i.12]

condition: set of attributes, features and/or values that are to be compared with a set of known attributes, features, and/or values in order to determine what decision to make

container: object that stores collections of other objects in an organized manner

context: collection of measured and inferred knowledge that describe the environment in which an entity exists or has existed

control loop: mechanism that senses the performance of an object or process being controlled to achieve desired behaviour:

- **adaptive closed control loop:** closed control loop whose controlling function adapts to the object or process being controlled using parameter that are either unknown and/or vary over time
- **closed control loop:** control loop whose controlling action is dependent on feedback from the object or process being controlled

NOTE: This type of control loop measures the difference between the actual and desired values of a set of variables to adjust a set of parameters to change the behaviour of the system to bring the actual value closer to that of the desired value.

- **cognitive closed control loop:** closed control loop that selects data and behaviours to monitor that can help assess the status of achieving a set of goals, and produce new data, information, and knowledge to facilitate the attainment of those goals
- **distributed closed control loop:** closed control loop whose components are physically distributed among different locations
- **federated closed control loop:** set of semi-autonomous closed control loops that use formal agreements to govern their interaction and behaviour
- **hierarchical closed control loop:** closed control loop that is organized in the form of a tree
- **open control loop:** control loop whose controlling action is independent of the output of the object or process being controlled

  NOTE: This type of control loop does not link the control action to the object or process being controlled (it simply continues to apply the control action).

- **peer closed control loop:** two or more closed control loops that may interact, but are independent of each other

control plane: communication between entities that enables forwarding and routing of traffic to work

NOTE: Control plane packets are destined to or locally originated, by entities themselves (e.g. they go to a network entity and direct how traffic flows). Compare to Data Plane.

control theory: application of mechanisms to regulate the behaviour of a target system

NOTE: Control theory includes linear and nonlinear control mechanisms.

coupling: amount of interdependence between two components, modules or systems

D

data: facts and statistics collected together for reference or analysis:

database: structured set of data held in a computer, especially one that is accessible in various ways

data lake: centralized storage repository that stores raw data that are in the form of structured, semi-structured and unstructured format

data mart: subset of a data warehouse focused on a particular line of business, department or subject area

data mining: procedure that discovers patterns in, and extracts knowledge from, data sets

NOTE: For the purposes of ENI, these patterns are of two principal types:

1) patterns that cause the generation of data; and
2) patterns that relate data (typically in a semantic manner).

data model: representation of concepts of interest to an environment that is dependent on data repository, data definition language, query language, implementation language and/or protocol (typically, but not necessarily, all five)

NOTE: As defined in MEF PDO CfC [i.2].

data plane: path that the end-user traffic takes through a network

NOTE It is made up of traffic that goes through network entities, not to a network entity. Compare to Control Plane.

data warehouse: repository used to connect, analyse, and report on historical and current data from heterogeneous sources

NOTE: A data warehouse is designed for query and analysis as opposed to transaction processing. It analyses and reports on data from operational systems as used in decision-support systems.

decidable: procedure that determines, by a mathematical formal means in a finite amount of time, whether a formula is valid

decision making: set of processes that result in the selection of a set of actions to take from among several alternative possible actions

declarative policy: type of policy that uses statements to express the goals of the policy, but not how to accomplish those goals

NOTE 1: State is not explicitly manipulated, and the order of statements that make up the policy is irrelevant.

NOTE 2: In the present document, Declarative Policy will refer to policies that execute as theories of a formal logic.

NOTE 3: As defined in MEF PDO CfC [i.2].

denormalization: process of changing information from a canonical form to one specialized for a particular actor and/or domain

design pattern: general, reusable solution in a given context to a commonly occurring software problem

NOTE: This type of design pattern is not an architecture and not even a finished design; rather, it describes how to build the elements of a solution that commonly occurs. It may be thought of as a reusable template.

- **design pattern, architecture:** general, reusable solution in a given context to a commonly occurring problem in the design of the software architecture of a system
- **design pattern, software:** general, reusable solution in a given context to a commonly occurring problem in the design of a software system

designated entity: operator, nms, ems, controller or orchestrator acting on behalf of the assisted system

NOTE: The Designated Entity is a trusted entity.

digital twin: virtual representation of a physical object or system across its lifecycle, using real-time data to enable understanding, learning and reasoning

domain: collection of entities that share a common purpose

NOTE: Each constituent Entity in a Domain is both uniquely addressable and uniquely identifiable within that Domain. This is based on the definition of an MCMDomain in [i.5].

- **administrative domain:** domain that employs a set of common administrative processes to manage the behaviour of its constituent Entities
- **management domain:** domain that uses a set of common Policies to govern its constituent Entities

NOTE: A Management Domain refines the notion of a Domain by adding three important behavioural features:

1) it defines a set of administrators that govern the set of Entities that it contains;
2) it defines a set of applications that are responsible for different governance operations, such as monitoring, configuration, and so forth;
3) it defines a common set of management mechanisms, such as policy rules, that are used to govern the behaviour of MCMManagedEntities contained in the MCMManagementDomain.

This is based on the definition of an MCMDomain in [i.5].

domain technical expert: technical expert that has authority within a domain

E

ENI application programming interface: set of communication mechanisms applied between two or more software components

NOTE: It consists of tools, object methods, and other elements of a model and/or code. APIs simplify producing programs, since they abstract the underlying implementation and only expose objects and flow of information, and the characteristics and behaviour of those objects. This prevents the unnecessary exposure of objects.

ENI external reference point: reference point that is used to communicate between an ENI Functional Block and an external functional block (e.g. a functional block of the OSS, BSS or assisted system)

NOTE: Where an ENI External Reference Point crosses between two organizational entities is not specified in this release.

ENI framework: set of abstractions that provide reusable and extensible mechanisms to provide generic functionality

NOTE 1: The ISO/IEC/IEEE 42010 [i.8] defines the term **architecture framework** as: "An architecture framework establishes a common practice for creating, interpreting, analysing and using architecture descriptions within a particular domain of application or stakeholder community".

NOTE 2: The ENI Framework also uses its abstractions to enable the ENI System to dynamically adapt to changing business goals, user needs, and environmental conditions. The ENI Framework hence provides a standard way to build and deploy applications and application components.

ENI hardware interface: point across which electrical, mechanical, and/or optical signals are conveyed from a sender to one or more receivers using one or more protocols

NOTE: A hardware interface decouples the hardware from other functional blocks in a system.

ENI interface: point across which two or more components exchange information

- **ENI API interface:** ENI interface set of communication mechanisms through which a developer constructs a computer program
- **ENI hardware interface:** ENI interface across which electrical, mechanical, and/or optical signals are conveyed from a sender to one or more receivers using one or more protocols
- **ENI software interface:** ENI interface point through which communication with a set of resources (e.g. memory or CPU) of a set of objects is performed

ENI internal reference point: reference point that is used to communicate between two or more ENI Functional Blocks

NOTE: This relationship stays within the ENI framework, and cannot be addressed by systems that are external to the ENI framework.

ENI ISG PoC proposal: initial description of a PoC Project, submitted as a contribution for review and acceptance by the ENI ISG before the PoC Project starts

ENI ISG PoC report: detailed description of the results and findings of a PoC project, submitted once the PoC Project has finished

ENI Reference Point: logical point of interaction between specific Functional Blocks

- **ENI External Reference Point:** ENI Reference Point that is used to communicate between an ENI Functional Block and an external Functional Block of an external system
- **ENI Internal Reference Point:** ENI Reference Point that is used to communicate between two or more Functional Blocks that belong to the ENI System

ENI software interface: point through which communication with a set of resources (e.g. memory or CPU) of a set of objects is performed

NOTE: This decouples the implementation of a software function from the rest of the system.

ENI system: set of entities, based on the "observe-orient-decide-act" control loop model, that produces commands, recommendations, and knowledge to assist or direct the management of another system

NOTE: The ENI system is an innovative, policy-based, model-driven entity that uses artificial intelligence and other mechanisms to provide intelligent service operation and management. It is the enabler of intelligent Infrastructure management, Network Operations Service Operation and Management, and Assurance. It automates complex human-dependent decision-making processes. It also provides the ability to ensure that automated decisions taken by the system are correct and are made to increase the reliability, security and maintenance of the network and the applications that it supports. It also includes hardware and software components, programs, and system and user documentation.

entity: object in the environment being managed that has a set of unique characteristics and behaviour

NOTE: Objects are represented by classes in an information model.

ethics: set of principles that govern the moral behaviour of a person or machine

- **consequentialist ethics:** agent is ethical if and only if it considers the consequences of each decision and chooses the decision that has the most moral outcome
- **deontological ethics:** agent is ethical if and only if it respects obligations, duties, and rights appropriate for a given situation
- **ethical dilemma:** situation in which any available decision leads to infringing on one or more ethical principles
- **virtue ethics:** agent is ethical if and only if it acts according to a set of moral values

evaluation dimension: viewpoint that can be divided into five dimensions such as ManMachine Interface

NOTE: This can be subdivided into Decision Making Participation, Data Collection and Analysis, Degree of Intelligence and Environment Adaptability, as defined in ETSI ENI 007 [i.10].

evaluation object: AI application or a part of Network Lifecycle, defined from two dimensions: the subsystems and the network lifecycle

Event-Condition-Action (ECA): type of imperative policy in which actions can only execute if the event and condition clauses are true

NOTE: An ECA policy rule is activated when its event clause is true; the condition clause is then evaluated and, if true, enables the execution of one or more actions in the action clause. This type of policy explicitly defines the current and desired states of the system being managed.

Experiential Networked Intelligence (ENI): processes associated with assimilating and understanding knowledge and learning through experience

NOTE: Adding closed-loop artificial intelligence mechanisms based on context-aware, metadata-driven policies enables the network to more quickly recognize and incorporate new and changed knowledge, and hence, make actionable decisions. This enables the network functionality to evolve and become better able to meet the demands of its operators with continued usage.

F

feature: (traditionally), individually measurable property of an object under observation

feature: (for ENI), individually measurable characteristic or behaviour of an object being observed:

NOTE: Traditionally, individually measurable characteristics were assigned numerical values. For ENI, these individually measurable characteristics or behaviours may be allowed to be numeric or other types of data.

- **feature construction:** feature that creates higher-level features from lower-level features (see feature hierarchy)

- **feature engineering:** process of transforming raw data into features that better represent the underlying problem to the predictive models, resulting in improved model accuracy on unseen data

NOTE: Feature engineering is concerned with determining the best representation of the sample data to learn a solution for a given problem.

- **feature hierarchy:** tree-like structure of features, where a higher-level object represents the composition of its lower-level objects

flow-oriented on-path telemetry: specific class of network forwarding-plane telemetry techniques, including IOAM (In-situ OAM), EAM (Enhanced Alternate Marking), PBT (Postcard-based Telemetry) and HTS (Hybrid Two Steps)

formal: study of (typically linguistic) meaning of an object by constructing formal mathematical models of that object and its attributes and relationships

- **formal grammar:** set of structural rules that define how to form valid strings from a language's alphabet that obey the syntax of the language

- **formal logic:** use of inference applied to the form, or content, of a set of statements

NOTE: The logic system is defined by a grammar that can represent the content of its sentences, so that mathematical rules may be applied to prove whether the set of statements is true or false. Refer to MEF PDO CfC [i.2].

- **formal methods:** set of mathematical theories, such as logic, automata, graph or set theory, that provide associated notations for describing and analysing systems

NOTE: As used in MEF PDO CfC [i.2].

formula: finite sequence of symbols from an alphabet that is part of a formal language

- **atomic formula:** formula that does not have logical connectives

- **first-order logic formula:** well-formed formula that has a subject and a predicate that can have quantifiers

NOTE: First-order logic restricts the predicate to refer to a single subject. Both the universal and existential quantifiers may be used in constructing a first-order logic formula.

- **propositional formula:** well-formed formula that has a unique truth value

- **well-formed formula:** formula used in logic that obeys the grammatical rules of its formal language

NOTE: Feature engineering is concerned with determining the best representation of the sample data to learn a solution for a given problem.

functional block: modular unit that defines the properties, behaviour, and relationships of a part of a system

NOTE: With respect to ENI, functional blocks may be categorized as external (meaning that other systems external to ENI can see them) and internal (meaning that the functional block is only visible to other ENI functional blocks). External functional blocks use Reference Points to provide access to their functionality. Internal functional blocks use private interfaces to provide access to their functionality. As used in MEF 55.0.3 [i.3].

G

graph: collection of nodes, where some subset of the nodes is connected

NOTE: Visually, a node is a "point" and a connection is a "line", called an "edge". For the purposes of ENI, any graph may be directed, weighted or both.

- **directed graph:** graph where each connection, or edge, has an associated direction

- **graph loop:** edge of a graph that joins a vertex to itself

NOTE: For ENI, graph loops are not applicable.

- **hypergraph:** graph in which generalized edges may connect more than two nodes
- **multigraph:** graph in which multiple edges between nodes are permitted
- **weighted graph:** graph where each connection, or edge, has an associated weight

H

hadoop distributed file system: distributed fault-tolerant file system that stores data on commodity machines and provides high throughput access

hyperparameter: learning parameter that is set before the learning process is started

- **algorithm hyperparameter:** hyperparameter that affects only the speed and/or quality of the learning process, and does not affect the mathematical or statistical model used in the learning process (e.g. learning rate)
- **model hyperparameter:** hyperparameter that selects the mathematical or statistical model used in the learning process (e.g. size and topology of the ANN)

hypothesis: set of statements for explaining an observation that is not yet known to be true

I

imperative policy: type of policy that uses statements to explicitly change the state of a set of targeted objects

NOTE 1: The order of statements that make up the policy is explicitly defined.

NOTE 2: In the present document, Imperative Policy will refer to policies that are made up of Events, Conditions, and Actions. As defined in MEF PDO CfC [i.2].

information model: representation of concepts of interest to an environment in a form that is independent of data repository, data definition language, query language, implementation language and protocol

NOTE: As defined in MEF PDO CfC [i.2].

In-situ Flow Information Telemetry（IFIT): network OAM data plane on-path telemetry techniques

NOTE: This includes In-situ OAM (IOAM), Direct Exporting (DEX) IOAM (IOAM-DEX), Postcard-based Telemetry (PBT) and Alternate Marking [i.11]. It can provide flow information on the entire forwarding path on a per-packet basis in real time. "In-situ" is Latin which can be translated as "in the original place".

intent knowledge: knowledge that is used in the process of Intent Translation

NOTE: It contains the relevant policyMetadata (e.g. a time period that this intent policy is valid, as well as version information, including a minimum version that can be used) and the generated new knowledge (e.g. rules for the specific domain, the corresponding actions to meet certain requirement). It is stored in the model repository and knowledge repository defined in MEF PDO CfC [i.2] within the Repository Management Functional Block.

intent policy: type of policy that uses statements to express the goals of the policy, but not how to accomplish those goals

NOTE 1: Each statement in an Intent Policy may require the translation of one or more of its terms to a form that another managed functional entity can understand. As defined in MEF PDO CfC [i.2].

NOTE 2: In the present document, Intent Policy will refer to policies that do not execute as theories of a formal logic. They typically are expressed in a restricted natural language and require a mapping to a form understandable by other managed functional entities.

intent translation functional block: new functional block that takes part in the process of Intent Translation. It performs lexical analysis, syntactic analysis, semantic analysis and augmentation, compiling of the Intent Policy

interpreter: computer program that directly executes code from a programming language without requiring the code to have been compiled into a machine language program

lSO reference architecture: layered abstraction architecture that characterizes the management and control domains and entities, and the interfaces among them, to enable cooperative orchestration of Connectivity Services

NOTE: As defined in MEF 55 [i.4].

J

Void.

K

knowledge: analysis of data and information, resulting in an understanding of what the data and information mean

NOTE: Knowledge represents a set of patterns that are used to explain, as well as predict, what has happened, is happening, or is possible to happen in the future; it is based on acquisition of data, information, and skills through experience and education.

- **inferred knowledge:** knowledge that was created based on reasoning, using evidence provided
- **measured knowledge:** knowledge that has resulted from the analysis of data and information that was measured or reported
- **propositional knowledge:** knowledge of a proposition, along with a set of conditions that are individually necessary and jointly sufficient to prove (or disprove) the proposition

knowledge reasoning: field of artificial intelligence that uses a set of knowledge bases and a given knowledge representation to reason about the information available

NOTE: Typically, this is used to validate data as well as predict or infer new information from existing information.

knowledge representation: field of artificial intelligence that represents data and information in a form that a computerized system can use

L

label: identification of an output value for a given input

NOTE: Supervised learning uses labelled data; semi-supervised learning uses labels for a portion of the training data (the remaining training data are not labelled); unsupervised learning is based on training data that are not labelled.

language: structured and well-defined system of communication

- **controlled language:** restricted version of a single Natural Language that uses a subset of the grammar of the Natural Language
- **Domain Specific Language (DSL):** small human-understandable language that uses a higher level of abstraction to communicate and configure software systems for a particular application domain
  - **external DSL:** DSL that has its own custom syntax

NOTE: External DSL is not dependent on another language.

  - **internal DSL:** DSL that defines a specific way to use a host language to give it a different feel

NOTE: Internal DSL does not require a custom compiler or interpreter, because it is embedded into its base language.

- **general purpose language:** programming language that can address a wide variety of problems and domains
- **natural language:** human-understandable language that is used to interact with a computer program

learning: process that acquires new knowledge and/or updates existing knowledge to optimize a function using sample observations

NOTE: The learning process adjusts parameters to minimize observed errors; if the error rate becomes too high, then the ANN needs to be redesigned.

- **active learning:** learning algorithm that can query a user interactively to label data with the desired outputs

NOTE: The algorithm proactively selects the subset of examples to be labelled next from the pool of unlabelled data. The idea is that an ML algorithm could potentially reach a higher level of accuracy while using a smaller number of training labels if it were allowed to choose the data it wants to learn from.

- **batch learning:** type of offline learning algorithm that is updated (i.e. retrained) periodically

- **deep learning:** use of hierarchical computational models, which are composed of multiple processing layers, to learn representations of data with multiple levels of abstraction

NOTE: This replaces manually-intensive processes, and enables a machine to both learn features and use them to perform a task. Deep learning can be applied to almost any of the other algorithms defined here, as long as there are at least two hidden layers.

- **dictionary learning:** use of sparse matrices to represent input data using a linear combination of elements from a dictionary learned from training data

- **distributed learning:** distribution of machine learning applications to multiple computing nodes

- **distributed data learning:** sets of data that are used to train multiple instances of the same model on different subsets of the training data set in parallel

NOTE: The same model is available to all computational nodes, so that a single coherent output emerges naturally by combining each of the model updates.

- **distributed model learning:** multiple exact copies of the same data sets are processed by working nodes that operate on different parts of the model; the resulting model is an aggregate of each of these operations

- **ensemble learning:** use of multiple learning algorithms to obtain better performance in predicting results than is possible from using any single learning algorithm

- **explanation-based learning:** explanation-driven approach that enables a search procedure, constrained by general domain knowledge related to the context of the actual problem, to be used to provide more accurate and efficient learning in knowledge-intensive systems

- **feature learning:** learning representations of data that make it easier to discover information from raw data when building different types of predictors (e.g. classifiers)

NOTE: This replaces manually-intensive processes, and enables a machine to both learn features and use them to perform a task.

- **federated learning:** approach that trains an algorithm across multiple decentralized entities holding local data samples, without exchanging their data samples

NOTE: Each device trains the model on their own local data set, and then each client sends a model or model update to a centralized service, which aggregates each client's contribution into one global model. The centralized service then distributes the global model back to the clients.

- **incremental learning:** learning from a continuously changing source of data (e.g. streaming data) that arrives over time

NOTE: This is a form of online learning.

- **machine learning:** use of a series of inputs to build a model, followed by the use of that model to create a representation, a decision, a prediction or an answer

NOTE: Decisions are made without explicit instructions (e.g. through inferencing or other types of logical actions). A more formal definition is "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E" [i.12]. It is a subset of Artificial Intelligence genre.

- **offline learning:** data set being worked on does not change

NOTE: This means that parameters defined during the training depend on the entire training data set (e.g. are global).

- **online learning:** learning when data is not previously available

NOTE: In this approach, data arrives over time, and a model is first inferred, and then refined after each subsequent time step. It is similar to incremental learning, except that it is bounded in time (and possibly other factors, such as model complexity and resources).

- **reinforcement learning:** use of software agents to take actions in an environment in order to maximize a cumulative reward

NOTE: The learning agent is not told which actions to take, but can instead discover which actions yield the highest reward.

- **rule-based learning:** use of rules to represent the knowledge of a system

NOTE: This type of system learns rules to make decisions, instead of using a model. These rules are different than other types of rule-based systems because this set of rules are learned, while rules in other types of systems are defined.

- **semi-supervised learning:** hybridization of supervised and unsupervised learning, where the training data consists of both labelled and unlabelled data

- **supervised learning:** learning a function that maps an input to an output based on example pairs of labelled inputs and outputs

- **unsupervised learning:** learning a function that maps an input to an output without the benefit of the data being classified or labelled

lexeme: linguistic unit of meaning, consisting of a word or group of words

NOTE: A lexeme is an abstract unit that can have many different forms. For example, in inflectional languages, a lexeme will have many forms (e.g. present and past). Idioms, as well as expressions, are also lexemes.

lexicon: collection of all words, phrases and symbols used in a language, along with their definition(s) and meaning(s)

NOTE: More formally, a lexicon is the complete set of morphemes in a language, along with their definitions and grammatical rules, that enables a complete vocabulary to be defined.

Lifecycle management of Intent Policy: management of basic CRUD (Create Read Update Delete) operations and other operations of state management on Intent Policies, which comes from ENI System or Intent Policy Creator

Lifecycle Service Orchestration (LSO): open and interoperable automation of management operations over the entire lifecycle of Layer 2 and Layer 3 Connectivity Services

NOTE: This includes fulfilment, control, performance, assurance, usage, security, analytics and policy capabilities, over all the network domains that require coordinated management and control, in order to deliver the offered Service. As defined in MEF 55 [i.4].

location: physical geographic location (e.g. a geocode or a bounding polygon) of an entity (e.g. a server)

NOTE: Contrast this with Placement.

logic: formal or informal language that evaluates a conclusion based on a set of premises

- **alethic logic:** representation, using mathematical formalisms, expressions involving necessity, possibility, and contingency
- **defeasible logic:** representation, using mathematical formalisms, weak rules that are not necessarily justified by the fact, and could thus be proven incorrect

NOTE: Defeasible logic (and reasoning) uses three types of rules: strict rules that are TRUE, weak rules that may be true if no evidence can be found to contradict them, and "defeaters" that represent contradictory evidence to prove that a weak rule is incorrect.

- **deontic logic:** representation, using mathematical formalisms, expressions involving obligation, permission, and the concept of being forbidden
- **description logic:** family of formal languages that are subsets of first-order logic to ensure decidability and efficiency
- **doxastic logic:** representation, using mathematical formalisms, expressions involving the belief of a particular entity or set of entities
- **first-order logic:** extension of propositional logic to include predicates and quantification
- **fuzzy logic:** type of many-valued logic that allows a truth value to be any real number between 0 and 1 inclusive

NOTE: Fuzzy logic is most often used to reason about the degree of truth, or probability, in a system.

- **modal logic:** representation, using mathematical formalisms, expressions involving necessity and possibility
- **propositional logic:** manipulation of a set of propositions, possibly with logical connectives, to prove or disprove a conclusion

NOTE: Propositional logic does not deal with logical relationships and properties that involve the parts of a statement smaller than the statement itself. It is also called sentential logic, zeroth-order logic, and propositional (or sentential) calculus.

- **temporal logic:** representation, using mathematical formalisms, expressions involving time (e.g. it will be, it will always be, it was, and it has always been)

logic clause: expression made up of a finite set of literals (i.e. literals), including the negation of literals

NOTE: In propositional logic, a literal is a variable. In predicate logic, a literal is an atomic formula.

- **boolean clause:** expression that, when evaluated, produces a value of either true or false
- **fact (clause):** horn clause with no negative literals
- **horn clause:** disjunction of literals that contains at most one positive literal

NOTE: This is also called a definite clause. This is used in some types of automated theorem proving.

- **goal clause:** horn clause without a positive literal

M

machine learning: set of processes that enables computers to understand data and enhance its knowledge; said knowledge is used to learn new information without being explicitly programmed

NOTE 1: ISO/IEC 2382-28 [i.7] defines machine learning as "a process by which a functional unit improves its performance by acquiring new knowledge or skills, or by reorganizing existing knowledge or skills".

NOTE 2: Mitchell's book (Machine Learning) defines this as: "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E".

NOTE 3: Machine Learning is a subsidiary ongoing application of AI based around the idea that it should give machines access to data and let them learn for themselves.

management: set of procedures that are responsible for describing, organizing, controlling access to, and managing the lifecycle needs of information and entities of an organization

NOTE: As defined in MEF PDO CfC [i.2].

management abstraction: abstraction used for management purposes

NOTE: As defined in MEF PDO CfC [i.2].

management plane: collection of services that enable authorized roles to change entity settings in a domain

NOTE: Traditionally, the Management Plane configures, monitors, and provides management of the network stack and associated logic. In contrast, the Control Plane is concerned with the configuration and monitoring of routing and forwarding information.

manufacturer: company having a substantial capacity to develop and/or produce and/or install and/or maintain products to be used in, or directly or indirectly connected to, an electronics communications network

NOTE: An association or organization of such manufacturers also falls within this category. (Member categories from Rules of procedure in ETSI Directives [i.13]).

massively parallel processing: use of a large number of processing nodes that perform a set of coordinated tasks in parallel using a high-speed network

NOTE: The processing nodes typically are independent, and do not share memory, and typically each node runs its own instance of an operating system.

measurement: set of operations having the object of determining a Measured Value or Measurement Result

NOTE 1: The actual instance or execution of operations leading to a Measured Value.

NOTE 2: See ETSI GS NFV 003 [i.1].

message system: system that transfers data between components

meta-policy: policy that governs that operation, administration, and/or management of another set of policies

NOTE: As defined in MEF PDO CfC [i.2].

metadata: set of objects that contains prescriptive and/or descriptive information about the object(s) to which it is attached

NOTE: As defined in MEF MCM CfC [i.5].

metric: standard definition of a quantity, produced in an assessment of performance and/or reliability of the entity being measured, which has an intended utility and is specified to convey a measured value or set of values

model: representation of the entities of a system, including their relationships and dependencies, using an established set of rules and concepts

- **data model:** representation of concepts of interest to an environment in a form that is dependent on data repository, data definition language, query language, implementation language, and/or protocol

NOTE: This definition is taken from MEF MCM CfC [i.5].

- **information model:** representation of concepts of interest to an environment in a form that is independent of data repository, data definition language, query language, implementation language and protocol

NOTE: This definition is taken from MEF MCM CfC [i.5].

- **machine learning model:** representation of a deterministic system using mathematical and/or logical formalisms

NOTE: A deterministic system is a system in which successive states of a system are determined by its preceding state; this means that an algorithm, given a particular input, will always produce the same output.

- **statistical model:** representation of a non-deterministic system using a set of statistical assumptions that describe how system data are generated

NOTE: In this model, randomness is introduced via defining some variables as stochastic (i.e. their values depend on the outcome of a random phenomenon). This is typically represented using probability distributions.

Model-Driven Behaviour (MDB): approach in which the behaviour of components, modules of systems are managed using MDE

NOTE: For ENI, this applies to Functional Blocks, not components within a Functional Block.

Model-Driven Engineering (MDE): approach in which models are central to all phases of the development and implementation processes

morpheme: the smallest unit of meaning in a language

N

negotiation: set of communications that is intended to reach a beneficial outcome for a set of conflicting issues

- **distributive negotiation:** zero-sum game, in which each participant assumes that there is a fixed amount of value to be divided between the (winning) bidders

- **integrative negotiation:** win-win (or non-zero-sum) game, in which all collaborating participants receive optimal value

network controller: functional block that provides configuration, monitoring, and management functionality for entities in its domain

NOTE: It may provide an abstract view of its domain to other functional blocks via Reference Points.

Network Digital Twin (NDT): Virtual Digital Twin of telecom network, including its own Network lifecycle

network intelligence categories: network classification, in terms of the advantages that intelligence and automation bring into the management and operation processes, by using capabilities of adaptation and optimization

network lifecycle: work-flow of activities including network planning, network deployment, network maintenance, network optimization in real-time, network service providing

network operator (aka network carrier): operator of an electronics communications network or part thereof

NOTE: An association or organization of such network operators also falls within this category. (Member categories from Rules of procedure in ETSI Directives [i.13]).

network supervisory controller/network supervisory assistant: roles played by an ENI System

NOTE: The former sends commands and information, while the latter sends recommendations and information. A single ENI System may play both roles, reflecting the confidence in different sets of operations by the Network Operator.

neural network: network of nodes that communicate with other nodes via specialized connections

NOTE: The above technically refers to the biological concept, where a node is a neuron (i.e. nerve cell). ENI will use the term artificial neural network, or ANN, to refer to the artificial intelligence concept.

- **artificial neural network:** computing system that learns to perform functions by using artificial neurons that take the form of a directed, weighted graph

NOTE: An ANN learns to perform a function by analysing examples (i.e. training data) instead of being programmed to perform a task.

- **artificial neuron:** node in an ANN that receives weighted input data, adds the data, and produces an output using a non-linear output function

NOTE: The output function is also called a transfer function or activation function, and represents what portion of the potential action is transmitted.

- **feedforward neural network:** ANN whose inter-nodal connections do not form a cycle

NOTE: Put another way, information always moves forward and never backwards. In general, any directed acyclic graph is a type of feedforward neural network.

- **recurrent neural network:** ANN that is connected between nodes form a directed graph across a temporal sequence

NOTE: RNNs contain cyclic connections that make them effective in storing history and state. This is done by using feedback loops in the processing of an output.

normalization: process of changing ingested information to a canonical form

O

object: instance of a concrete class

one-cold vector: 1 × N matrix (vector) used to distinguish each word in a vocabulary from every other word in the vocabulary, where the vector consists of 1 s in all cells with the exception of a single 0 in a cell used uniquely to identify the word

one-hot vector: 1 × N matrix (vector) used to distinguish each word in a vocabulary from every other word in the vocabulary, where the vector consists of 0 s in all cells with the exception of a single 1 in a cell used uniquely to identify the word

ontology (traditionally): explicit specification of a conceptualization

NOTE 1: As defined in [i.14].

NOTE 2: This definition is the basis for definitions in OneM2M and SmartM2M.

ontology (for ENI): language, consisting of a vocabulary and a set of primitives, that enable the semantic characteristics of a domain to be modelled

operational system: physical and virtual system that is used by operators to maintain and manage the network/resources or provide the network service

NOTE: ENI System can be deployed independently to assist the operational system or as an integrated part of the operational system, by mapping some or all of its functionalities to the corresponding components of the operational system.

optimization: set of mechanisms that select a best solution (with respect to a set of criteria) from a set of available alternatives

NOTE: Optimization may be implemented by a centralized and/or distributed architecture.

orchestration: set of processes that coordinates the interaction among, and behaviour of, a set of entities, from the point of view of a set of entities that perform the orchestration function

NOTE: That is the "Orchestrator". Compare this definition to Choreography.

OSS-like functionality: functionality used to support back-office activities that configures and operates a network for the operator

NOTE: Examples include inventory, configuration management, service assurance and service activation.

P

parser: computer program that creates one or more data structures from an input programming language using an associated formal grammar

pattern: named, generic, reusable solution to a problem that applies to a particular context

NOTE 1: A pattern is not a finished design, but rather, is a reusable template that defines a set of objects, and their interactions, that can be adapted to meet the context-specific needs required to solve a problem.

NOTE 2: As defined in MEF MCM CfC [i.5] and [i.6].

perceptron: supervised learning algorithm for binary classifiers, where the classification function is based on a linear function that combines the weighted sum of inputs with the feature vector

NOTE: Since a linear function is used, a perceptron can only distinguish data that is linearly separable (compare to multi-layer perceptron).

- **multi-layer perceptron:** type of feedforward ANN that consists of an input layer, an output layer, and one or more hidden layers

NOTE: Since a non-linear function is used, a multi-layer perceptron can distinguish data that is not linearly separable (compare to perceptron).

placement: logical location of an entity (e.g. a virtual machine) on or in another entity (e.g. a server)

NOTE: Contrast this with Location.

PoC demo objective: detailed description of one particular aspect that the PoC Team intends to demonstrate and how it will be achieved

PoC project: activity oriented to perform a PoC according to the framework described in the present document

PoC review team: entity in charge of administering the PoC activity process

PoC scenario report: collection of PoC Demo Objectives

PoC team: organizations participating in the PoC Project

policy: set of rules that is used to manage and control the changing and/or maintaining of the state of one or more managed objects

NOTE: This is defined in MEF 55 [i.4], but also see MEF PDO CfC [i.2] and [i.15].

- **declarative policy:** type of policy that uses statements from a formal logic to describe a set of computations that need to be done without defining how to execute those computations
- **ENI Policy Rules:** set of imperative, declarative, and/or intent policy rules
- **imperative policy:** type of policy that uses statements to explicitly change the state of a set of targeted objects

NOTE: The canonical form of an imperative policy is a triple, consisting of a set of Event, Condition, and Action Boolean clauses. Conceptually, it is evaluated as: When the Event Clause occurs, IF the Condition Clause is TRUE, THEN a set of actions may be executed.

- **intent policy:** type of policy that uses statements from a restricted natural language to express the goals of the policy, but not how to accomplish those goals

NOTE: In particular, formal logic syntax is not used. Therefore, each statement in an Intent Policy may require the translation of one or more of its terms to a form that another managed functional entity can understand.

- **policy conflict:** two policies that, when executed, cause contradictory and otherwise incompatible results within a given execution time window

policy-driven orchestration: use of different types of policies, in conjunction with an object-oriented information model, to guide orchestration and choreography

NOTE: As defined in MEF PDO CfC [i.2].

policy enforcement: set of processes that ensure that a set of policies was successfully executed on a set of target entities

policyMetadata: data that provides information about policy

NOTE: It helps ENI System find relevant information and discover resources Examples of policyMetadata include a time period that this intent policy is valid, as well as version information, including a minimum version that can be used.

predicate: statement that can be true or false depending on the value of its variables

probability: numerical value defining the likelihood of an occurrent occurring

- **probability distribution:** mathematical function that defines the probability of occurrence of all possible outcomes of the random phenomenon being observed
- **conditional probability distribution:** probability of an event occurring given that another event already occurred

process: execution of a set of instructions that produce a result

proposition: statement that can be true or false

protocol buffers (Protobuf): language-neutral, platform-neutral, extensible mechanism for serializing structured data

Q

quantifier: specification of the number of objects in a given domain that satisfy a formula with at least one variable

- **existential quantifier:** assertion that a property or relation holds for at least one member of a domain
- **universal quantifier:** assertion that a property or relation holds for all members of a domain

quantitative evaluation criteria: score given to specific network intelligent application(s) or system(s) considering multiple dimensions

R

Reference Point (RP): logical point of interaction between specific functional blocks

NOTE: Each Reference Point defines a set of related interfaces that define how the functional blocks communicate.

repository: centralized location of a set of storage devices that enable different Functional Blocks to store and retrieve information

- **active repository:** repository that pre- and/or post-processes information that is stored or retrieved

NOTE: It may contain dedicated (typically internal) Reference Points that provide the loading, activation, deactivation, and unloading of specialized functions that change the pre- and/or post-processing functionality according to the needs of the application.

- **passive repository:** repository that stores or retrieves information without pre- or post-processing

resiliency: ability of the ENI System to limit disruption and return to normal or at a minimum acceptable service delivery level in the face of a fault, failure, or an event that disrupts the normal operation of the system being managed or assisted by the ENI System

resource allocation: process of assigning and managing assets in a manner that supports an agreed process or commitment

resource reservation: action to reserve resources across a network for a service according to an agreed commitment

resource sharing: different customers to sharing the same resource within the same time window

row-oriented database: database that organize data by record

NOTE: This type of database keeps all of the data associated with a record next to each other in memory, and is optimized for online transaction processing. An example is MySQL.

S

sample: set of objects selected or collected from a statistical population using a procedure

SDO System: part of an Assisted System that is defined by another SDO

NOTE: Examples include NFV MANO and MEF LSO.

semantic bus: type of message bus used to orchestrate and filter communications between ENI Functional Blocks based on the meaning, attributes and metadata of a message using a shared set of interfaces

semantics: study of the meaning of something (e.g. a sentence or a relationship in a model)

semantic closeness: measure of how similar the semantics of two different sets of concepts are

NOTE: The types of semantic relationships may be changed to achieve a closer amount of semantic closeness. This is one important mechanism in the knowledge discovery and alignment processes.

semi-structured data: information that does not conform to a formal data model, but does have some organizational properties that define key data (e.g. tags) that enable data to be *self-describing*

service continuity: continuous delivery of service in conformance with a Service's functional and behavioural specification and SLA requirements

NOTE 1: This is both in the control and data planes, for any initiated transaction or session till its full completion even in the events of intervening exceptions or anomalies, whether scheduled or unscheduled, malicious, intentional or unintentional.

NOTE 2: From an end-user perspective, service continuity implies continuation of ongoing communication sessions with multiple media traversing different network domains (access, aggregation and core network) or different user equipment.

NOTE 3: End to end service continuity requires that the service is delivered with service quality defined by an SLA. This is true regardless if the service is delivered via a non-virtual network, virtual network or a combination.

Service Level Agreement (SLA): negotiated agreement between two or more parties, recording a common understanding about the service and/or service behaviour

NOTE: This covers availability, performance, service continuity, responsiveness to anomalies, security, serviceability, operation offered by one party to another and the measurable target values characterizing the level of services

Service Orchestration Functionality (SOF): set of service management layer functionality supporting an agile framework to streamline and automate the service lifecycle

NOTE 1: This is carried out in a sustainable fashion for coordinated management supporting design, fulfilment, control, testing, problem management, quality management, usage measurements, security management, analytics, and policy-based management capabilities providing coordinated end-to-end management and control of Layer 2 and Layer 3 Connectivity Services

NOTE 2: As defined in MEF 55 [i.4].

service provider: company or organization, making use of an electronics communications network or part thereof to provide a service or services on a commercial basis to third parties

NOTE: An association or organization of such service providers also falls within this category. (Member categories from Rules of procedure in ETSI Directives [i.13]).

situation: set of circumstances and conditions at a given time that may influence decision-making

- **situation awareness:** perception of data and behaviour that pertain to the relevant circumstances and/or conditions of a system or process, the comprehension of the meaning and significance of these data and behaviours, and how processes, actions, and new situations inferred from these data and processes are likely to evolve in the near future

NOTE: This definition is based on the material in [i.17] and MEF 55 [i.4].

software defined hardware: software programmable hardware that is able to be reconfigured at runtime to enable near ASIC performance without sacrificing programmability for data-intensive algorithms

stakeholder: set of individuals and/or organizations that may affect, be affected by, or perceive themselves to be affected by a decision, activity, or outcome of a process

structured data: information organized in a predetermined way (a fixed format, data model or schema) within a record or a file

NOTE 1: As defined in [i.9].

NOTE 2: Structured data enables all elements to be individually addressable, and conform to a data model.

subsystem: network element, management system, network platform

syntax: set of rules that govern how elements of a statement are structured, including what element goes where in a statement

T

technical expert: person in charge of defining or supporting Operational Procedures within a CSP Network (e.g. in charge of Capacity Planning, Engineering and Designing, Troubleshooting)

telemetry: automated process of recording and transmitting data to receiving equipment for monitoring purposes

NOTE: The process is typically automated, and the data transfer may include wireless, cellular, optical and other mechanisms.

- **reactive telemetry:** telemetry operation in a dynamic and interactive fashion

theorem: set of statements that has been mathematically proven to be true, based on a set of axioms and/or (previously proven) theorems

training: process of teaching an entity a set of knowledge, skills, processes and/or behaviours

- **online training:** phase in machine learning that is used to perform inferences in real-time (i.e. when the model is actively being used)
- **offline training:** phase in machine learning that is used to create a model when the algorithm is not currently being executed

U

unstructured data: information that does not have a pre-defined data model, and does not contain properties that provide any organization or structure to its elements

NOTE: Unstructured data needs to be processed in order to find information by domain-specific applications.

use case (from Teddi): description of a specific configuration/deployment scenario of a system from the user point of view

NOTE: As defined in ETSI TR 103 240 [i.16].

use case (for ENI): list of actions defining the interactions between a set of actors and the system in order to achieve a goal that has an observable result beneficial to a set of stakeholders

NOTE: The above definition of use case is more applicable for ENI modelling activities. In addition, the list of actions may consist of different sets of actions to accomplish a goal.

user service: component of the portfolio of choices offered by Service Providers to the End-Users/Customers/Subscribers

V

video stalling: process during the video playback, the video is paused and waits for the buffer due to dragging or other reasons

W to Z

Void.

3.2 Symbols

Void.

3.3 Abbreviations

0 to 9

5G	Fifth Generation

A

ACL	Access Control List
ACNO	Application Characteristic based Network Operation
AI	Artificial Intelligence
AMM	enhanced Alternate Marking Method
AN	Access Network
ANN	Artificial Neural Network
AP	Access Point
API	Application Programming Interface
APN	APplication-aware Network
AS	Autonomous System

B

BBU	BaseBand Unit
BERT	Bidirectional Encoder Representations from Transformers
BGP	Border Gateway Protocol
BFD	Bidirectional Forwarding Detection
BMP	BGP Monitoring Protocol
BOSS	Business Operations Support System
BP	Back Propagation
BRAS	Broadband Remote Access Server
BSS	Business Support System

C

C-RAN	Centralized RAN
CAP	Content Aware related Policy
CAPEX	CAPital EXpenditure
CCO	Capacity and Coverage Optimization
CGN	Carrier Grade Network address translation
CMD	Command
CN	Core Network
COM	Control, Orchestration, and Management
COMPA	Control, Orchestration, Management, Policy and Analytics
CPRI	Common Public Radio Interface
CPU	Central Processing Unit
CRM	Customer Relationship Management
CSMF	Communication Service Management Function
CSC	Communication Service Customer
CSP	Communication Service Provider
CSV	Comma Separated Values

D

D-RAN	Distributed RAN
DC	Data Centre
DCA	Data Collection and Analysis
DDoS	Distributed Denial of Service
DE	Decision Element
DevOps	Development and Operations
DHCP	Dynamic Host Configuration Protocol
DIKW	Data Information Knowledge Wisdom
DNP	Dynamic Network Probes
DSL	Domain Specific Language

E

EAM	Enhanced Alternate Marking
EDP	Eventmonitor Data Processing
E2E	End-to-End
ECA	Event Condition Action
EG	Expert Group
EMS	Element Management System
ENI	Experiential Networked Intelligence
ESB	Enterprise Service Bus

F

FB	Functional Block
FIB	Forwarding Information Base
FPGA	Field Programmable Gate Array
FOCALE	Foundation Observe Compare Act Learn rEason
FOL	First Order Logic
FSM	Finite State Machine
FTP	File Transfer Protocol

G

GANA	Generic Autonomic Networking Architecture
GDPR	General Data Protection Regulation
gNMI	gRPC Network Management Interface
GPM	General Policy Management
GPT	Generative Pre-trained Transformer

H

HTML	HyperText Markup Language
HTS	Hybrid Two Steps

I

ICM	Infrastructure Control and Management
IDC	Internet Data Centre
IDMS	Intent Driven Management Service
IFIT	In-situ Flow Information Telemetry
IETF	Internet Engineering Task Force
IMS	Integrated Management System
INFP	Intelligent Network Failure Prevention
IOAM	In-situ OAM
IoT	Internet of Things
IP	Internet Protocol
IPFIX	IP Flow Information eXport
IPFPM	IP Flow Performance Measurement
IPPM	IP Performance Metrics
IT	Information Technology
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector

J

Void.

K

KP	Knowledge Plane
KPI	Key Performance Indicator
KQI	Key Quality Indicator
KSQL	Streaming SQL engine for Apache Kafka

L

LI	Lawful Interception
LSO	Lifecycle Service Orchestration
LSO RA	LSO Reference Architecture
LSTM	Long Short-Term Memory
LTE	Long Term Evolution

M

MAN	Metropolitan Area Network
MANO	MANagement and Orchestration
MAPE	Model-Analyse-Plan-Execute
MAPE-K	Model-Analyse-Plan-Execute-Knowledge
MCP	Multi-vendor Command Platform
MDE	Model-Driven Engineering
ME	Managed Element
MEC	Multi-access Edge Computing
MEF	Metro Ethernet Forum

NOTE: An industry association.

MIMO	Multiple Input Multiple Output
ML	Machine Learning
MOP	Mode of Operation
MOS	Mean Opinion Score
MPLS	Multi-Protocol Label Switching

MS	Monitoring System

N

N-PoP	Network Point of Presence
NAT	Network Address Translation
NE	Network Element
NF	Network Function
NFV	Network Functions Virtualisation
NFVI	NFV Infrastructure
NGFI	Next Generation Fronthaul Interface
NGMN	Next Generation Mobile Networks
NIC	Network Interface Controller
NLP	Natural Language Processing
NMI	Network Management Interface
NMS	Network Management System
NOC	Network Operation Centres
NOP	Network OPerator
NP	Network Processor
NPD	Network Planning & Deployment
NS	Network Service
NSI	Network Slice Instance
NSMF	Network Service Management Function
NSSMF	Network Sub-Slicing Management Function

O

OAM	Operation, Administration and Maintenance
ONIX	Overlay Network for Information eXchange
OM	Operation and Maintenance
OMC	Operations and Maintenance Centre
OODA	Observe Orient Decide Act
OPEX	OPerational EXpenditure
OR	Operational Requirements
OS	Operating System
OSS	Operations Supporting System
OTT	Over The Top
OWAMP	One-Way Active Measurement Protocol

P

PBM	Policy-Based Management
PBT	Postcard-Based Telemetry
PDO	Policy-Driven Orchestration
PHY	PHYsical layer
PM	Policy Management
PNF	Physical Network Function
PoC	Proof of Concept
PoP	Point of Presence
PR	Performance Requirements

Q

QoE	Quality of Experience
QoS	Quality of Service

R

RA	Reference Architecture
RAM	Random Access Memory
RAN	Radio Access Network

RAU	Remote Aggregation Unit
RCC	Radio Cloud Centre
RCP	Remote Procedure Calls
RF	Radio Frequency
RP	Reference Point
RR	Resilience and Reliability
RRU	Remote Radio Units
RSRP	Reference Signal Received Power

S

S3	Simple Storage Service
SD-WAN	Software-Defined Wide Area Network
SDK	Software Development Kit
SDN	Software Defined Networking
SLA	Service Level Agreement
SLO	Service Level Objective
SNMP	Simple Network Management Protocol
SOF	Service Orchestration Functionality
SOM	Service Orchestration and Management
SP	Security and Privacy
SP.2A	Security and Privacy 2A
SP.2B	Security and Privacy 2B
SQL	Structured Query Language
SR-IOV	Single Root I/O Virtualization
SVM	Support Vector Machine

T

TCO	Total Cost of Ownership
TCP	Transmission Control Protocol
TM	Traffic Manager
TN	Transport Network
TVRA	Threat, Vulnerability and Risk Analysis
TWAMP	Two-Way Active Measurement Protocol

U

UDP	User Datagram Protocol
UE	User Equipment
UML	Unified Modelling Language

V

VA	Virtual Application
vCPU	virtualised CPU
VES	VNF Event Stream
VIM	Virtualised Infrastructure Manager
VM	Virtual Machine
VNF	Virtualised Network Function
VNFC	Virtualised Network Function Component
VNFD	Virtualised Network Function Descriptor
VNF FG	VNF Forwarding Graph
VNFM	Virtualised Network Function Manager
vNIC	virtualised NIC
VoIP	Voice over IP
VoLTE	Voice over LTE
URL	Universal Resource Location
vStorage	virtualised Storage
vSwitch	virtualised Switch

W

WAN	Wide Area Network
WG	Working Group
WI	Work Item
WLAN	Wireless Local Area Network

X

XML	eXtensible Markup Language

Y

YANG	Yet Another Next Generation

Y to Z

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