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ENI requirements

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Foreword

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

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**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 specifies the requirements of how intelligence is applied to the network and applications in different scenarios to improve experience of service provision and network operation. Also, how intelligence enables dynamic autonomous behaviour and adaptive policy driven operation in a changing context. The ENI requirements are based on the ENI use case document and identified requirements from other SDOs. These requirements will form the base for the architecture design work.

In Release 3 the present document that is a specification will add:

- Requirements derived from API descriptions.

- Requirements derived from System Architecture.

- Requirements derived from new use cases.

# 2		References

## 2.1		Normative 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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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 necessary for the application of the present document.

[1]		ETSI GS ENI 001: "Experiential Networked Intelligence (ENI); ENI use cases".

[2]		ETSI GS ENI 005: "Experiential Networked Intelligence (ENI); System Architecture".

[3]		ETSI TS 102 165-1 (V5.2.5): "CYBER; Methods and protocols; Part 1: Method and pro forma for Threat, Vulnerability, Risk Analysis (TVRA)".

[4]		ETSI GS NFV 006 (V4.4.1): "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Architectural Framework Specification".

[5]		ETSI TS 101 158: "Telecommunications security; Lawful Interception (LI); Requirements for network functions".

## 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.

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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 GR ENI 004: "Experiential Networked Intelligence (ENI); Terminology for Main Concepts in ENI".

[i.2] Service Operations Specification MEF 55: "Lifecycle Service Orchestration (LSO): Reference Architecture and Framework".

[i.3] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GR ENI 004 [i.1] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AI	Artificial Intelligence
API	Application Programming Interface
BP	Back Propagation
BSS	Business Support System
CAP	Context Aware related Policy
CAPEX	CAPital EXpenditure
DC	Data Collection

NOTE: Used in the context of servers.

DCA	Data Collection and Analysis
DSL	Domain-Specific Language
EMS	Element Management System
ENI	Experiential Networked Intelligence
GDPR	General Data Protection Regulation
GPM	General Policy Management
IoT	Internet of Things
IP	Internet Protocol
IT	Information Technology
KPI	Key Performance Indicator
LI	Lawful Interception
LLC	Last Level Cache
LSO	Lifecycle Service Orchestration
LSO RA	Lifecycle Service Orchestration - Reference Architecture
MANO	MANagement and Orchestration
MEC	Multi-access Edge Computing
MEF	Metro Ethernet Forum
MOP	Mode Of Operations
NFV	Network Functions Virtualisation
NM	Network Model
NPD	Network Planning & Deployment
OPEX	OPerational EXpenditure
OR	Operational Requirements
OSS	Operational Support System
PINet	Polymorphic Network
PR	Performance Requirements
RA	Reference Architecture

RR	Resilience and Reliability
SDN	Software Defined Networking
SLA	Service Level Agreement
SOM	Service Orchestration and Management
SP	Security and Privacy
SP.2A	Security and Privacy 2A
SP.2B	Security and Privacy 2B
SVM	Support Vector Machine
TCO	Total Cost of Ownership
TVRA	Threat, Vulnerability and Risk Analysis
VNF	Virtualised Network Function

4   Introduction

4.1   Categorization of the requirements

The present document structure addresses the requirements in the following areas:

1) Service and network requirements:

   - General requirements

   - Service orchestration and management

   - Network planning and deployment

   - Network optimization

   - Resilience and reliability

   - Security and privacy

2) Functional requirements:

   - Data collection and analysis

   - Policy management

   - Data learning

   - Interworking with other systems

   - Mode of operations

   - Model training and iterative optimization

   - Mode of deployments

   - API requirements

3) Non-functional requirements:

   - Performance requirements

   - Operational requirements

   - Regulatory requirements

5   Service and network requirements

5.1   Overview

The requirements in this clause are addressed from service and network point of view and are derived directly from the related use cases.

5.2   General requirements

This clause captures the requirements that are general and independent from other requirements categorized in other specific clauses.

[GR.1]   The ENI System shall use history data, context, and decisions taken to learn, process and provide responses to events, whether generated from devices or from management systems.

[GR.2]   The ENI System shall use context information as part of the computations that result in recommendations, advisement, predictions, and decisions that are used to assist other network systems, e.g. orchestration and management systems.

NOTE: As an example, MANO (from ETSI GS NFV 006 [4]) or the LSO RA (from MEF [i.2]) are different types of orchestration and management systems.

[GR.3]   The ENI architecture shall be flexible enough to support extensibility.

5.3   Service orchestration and management

This clause captures requirements related to the ENI System service provisioning, e.g. how to compile the service intent and orchestrate the service atoms and workflows, as well as automatic service on boarding.

[SOM.1]   The ENI System shall invoke policies based on models that describe and/or define traffic behaviour, such as SLAs (e.g. past or current telemetry).

[SOM.2]   The ENI System shall support the closed loop control model when different orchestration and management systems are used.

NOTE 1:   As an example, MANO (from ETSI GS NFV 006 [4]) and LSO RA (from MEF [i.2]) are different types of orchestration and management systems.

[SOM.3]   The ENI System should not directly manage, control or orchestrate physical or virtual entities, either at the infrastructure level or service level.

NOTE 2:   ENI System may interact with the Orchestration system, EMS or OSS/BSS to influence the state of the resources or services.

5.4   Network planning and deployment

This clause captures requirements related to network planning and deployment, e.g. how to allocate network resources to VNFs, or automatic VNF on boarding.

NOTE 1:   The network resources that can be managed are not limited to the requirements addressed in this clause.

[NPD.1]   The ENI System shall recommend allocation or retrieval of network resources, e.g. virtual machines, bandwidth, IPv4 addresses and IPv6 prefixes to end users or service flows, in an intelligent way to improve the efficiency of resource utilization. This ENI System function may be implemented in a centralized and/or distributed manner, according to what is defined in ETSI GR ENI 004 [i.1] and according to ETSI GS ENI 005 [2].

[NPD.2]   The ENI System shall assist the network equipment or network function to use the resource pools
                 that are used for resource allocation (e.g. virtual machines, network bandwidth, IP addresses, CPU
                 cores, CPU frequencies, memory, memory bandwidth), in an intelligent way in order to improve
                 the efficiency of resource utilization and user experiences.

[NPD.3]   The ENI System should dynamically and intelligently compute and recommend the required
                 network resources, including both IPv4 and IPv6 resources as well as other resources.

[NPD.4]   The ENI System shall compute the network resources required to dynamically and intelligently
                 deploy a given network service efficiently.

[NPD.5]   IT resources to enable network services shall be managed within the ENI System.

NOTE 2:   Similar capabilities within the data centre are outside the network scope of this phase of ENI.

[NPD.6]   The ENI System shall be capable of understanding the context that a set of devices is operating
                 within.

[NPD.7]   The ENI System shall be capable of performing the proper planning and deployment of resources
                 to ensure that applicable deployed policies are not violated.

[NPD.8]   The ENI System shall identify different types of rollouts for different types of resources that lead
                 to the upgrade of virtualised software-based resources.

[NPD.9]   The ENI System shall, in an efficient and dynamic manner, combine network slices, slice/service
                 prioritization and resource allocation concepts, e.g. in order to resolve resource allocation conflicts
                 between competing network slices deployed on top of a shared infrastructure.

[NPD.10]   The ENI System shall support cross-domain and global resource management, e.g. cross-domain
                 node content resource aggregation and integration, as well as cross-domain permissions
                 management of unified user identity.

5.5   Network optimization

This clause captures requirements related to network optimization, e.g. how to adjust the network configurations to
improve its efficiency and performance, as well as the user experience of the service.

[NO.1]   The ENI System shall collect and process the necessary data according to specific algorithms in
                 order to achieve network optimization.

NOTE 1:   Data collection and processing algorithms for systems will be specified in the functional architecture.

[NO.2]   The ENI System shall meet or exceed all performance requirements when improving the target
                 performance.

[NO.3]   The ENI System shall support central optimization, local optimization and distributed joint
                 optimization, according to what is defined in ETSI GR ENI 004 [i.1].

[NO.4]   The ENI System shall support an adaptive optimization process where changes in the environment
                 are reflected in the results of the optimization.

[NO.5]   The ENI System shall use prioritization and other scheduling and traffic shaping techniques to
                 prevent SLA violations related with priority services.

[NO.6]   The ENI System shall use AI (e.g. Machine Learning) to identify traffic type and support traffic
                 handling and QoS assurance for specific type of traffic.

[NO.7]   The ENI System shall support traffic type identification in different granularity levels, including
                 application types, action types (e.g. sending pictures, voice calls, etc.).

[NO.8]   The ENI System shall support dynamic policy adjustment, i.e. to select or re-select and enforce a
                 policy dynamically, for a specific flow based on traffic identification results.

NOTE 2:   Applying policies to specific flows may lead to hundreds of thousands of policies.

5.6   Resilience and reliability

This clause captures requirements related to resilience and reliability of the network, including fault diagnosis and prediction, high availability and back up, conflict detection, and rolling back to previous policies and status.

[RR.1]   The ENI System shall intelligently recommend allocation or retrieval of IP addresses without causing route oscillation.

[RR.2]   The ENI System shall intelligently recommend allocation or retrieval of IP addresses without causing any interruption in the offered services.

[RR.3]   The ENI System shall support root cause analysis to diagnose existent faults and potential faults caused by new cases, according to what is defined in ETSI GS ENI 005 [2].

[RR.4]   The ENI System shall support the use of one or more AI algorithms to perform network service fault prediction.

[RR.5]   The ENI System shall learn and predict the pattern of resource requirements of services.

[RR.6]   When optimization of energy consumption is required, which implies a switch of servers, the ENI System shall trigger the reallocation of services to appropriate resources in another server.

[RR.7]   The ENI System shall wake up an appropriate number of servers in time to meet the growing resource needs required by services, after learning and predicting the pattern of resource requirement of those services.

[RR.8]   The ENI System shall provide the operators with the ability to define services that are critical or prioritized.

[RR.9]   The ENI System shall allow the on-going services in a server to be moved from this server to another without interruption, e.g. during reallocation for energy saving purposes.

[RR.10]   The ENI System shall not interrupt the on-going services on the target servers, e.g. when reallocation of services from other servers takes place for energy saving purposes.

[RR.11]   Energy saving need not be the only criterion for moving a service.

[RR.12]   The ENI System shall calculate and propose proper backup actions to the operators in order to prevent or to mitigate a service degradation or disruption when a planned operation occurs.

[RR.13]   The ENI System shall support the use of one or more intelligent methods to perform network anomaly (fault, error and unusual behaviour) prediction and prevention.

[RR.14]   The ENI System shall be aware of the impact of adjustment on services and guarantee seamless adjustment of network slice and high valued services.

5.7   Security and privacy

This clause captures requirements related to security and privacy issues (e.g. it is recommended that data collection shall be captured in a secure way and not add more security risks). In addition, it is recommended that the collected data shall be accessible by authorized accounts, and that the privacy of both subscribers and operators are protected.

The requirements indicated in the present document have been derived from application of the ETSI TVRA method defined in ETSI TS 102 165-1 [3], the details of the analysis leading to the requirements have been examined with respect to the use cases defined in ETSI GS ENI 001 [1] and with respect to the terminology defined in ETSI GR ENI 004 [i.1].

[SP.1]   The ENI System shall use AI (e.g. Machine Learning) to detect abnormal traffic patterns that can lead to service disruptions or security threats as well as to carry out the identification of abnormally operating devices.

[SP.2]   The ENI System shall provide means to detect a corrupted device.

[SP.2A]   The ENI System shall provide means to identify a corrupted device.

[SP.2B]   The ENI System shall provide means to isolate and remove a corrupted device from the system.

[SP.3]   The ENI System should provide means to indicate to authorized parties the occurrence of potential and confirmed security threats by using appropriate mechanisms, (e.g. via dedicated interfaces).

[SP.4]   The ENI System shall provide means to invoke policies to isolate threats.

[SP.5]   The ENI System shall be designed in such a way that it complies to the provisions of the GDPR [i.3], when processing of data (traffic or signalling).

[SP.6]   The ENI System shall allow entities that are involved in services that are subject to LI processing to be designed in such a manner that they comply with the general provisions of LI as defined in ETSI TS 101 158 [5].

[SP.7]   Processing for security functions (e.g. access control, user authentication, privacy protection mechanism) should always be enabled.

[SP.8]   The addition of any processing in the ENI System to comply with provisions arising from LI compliance shall not be visible to an external observer.

NOTE: The consequence of the above is that an external observer should not assert that an LI operation is taking place by observation of the processing load of the ENI System.

6 Functional requirements

6.1 Overview

The requirements in this clause are addressed from the architecture point of view.

6.2 Data collection and analysis

This clause captures requirements related to how data is collected and analysed by the ENI System.

[DCA.1]   The ENI System shall gather network status data (e.g. related to connection or routing protocols in use) as well as network operational, administrative, and state information (e.g. network configuration, network topology of data link, network node working status, resource storage information).

[DCA.2]   The ENI System shall store the data either as raw data or aggregated data for further analysis, according to what is defined in ETSI GR ENI 004 [i.1].

[DCA.3]   The ENI System shall provide data analysis functionalities, which make use of collected data in order to produce intermediate information that will support further analysis.

NOTE 1: Examples of information related to this requirement include network context information (such as time of the day, device/link state, and location of users).

[DCA.4]   The ENI System shall collect and analyse the necessary data in order to determine traffic patterns.

NOTE 2: This requirement can be governed by national and international regulations on Data Protection and Privacy.

[DCA.5]   The ENI System shall collect information from the infrastructure, e.g. massive-MIMO array antenna information such as geometrical configuration of overall array, relative power pattern of the individual element and relative displacement of the elements, RF parameters or code book with corresponding antenna power pattern.

[DCA.6]   The ENI System shall collect, store and pre-process the history data, and extract features from it, to be used for e.g. further analysis, learning process, real time prediction of future business requirement and network status, etc.

[DCA.7]   The ENI System shall collect and store required run-time data in order to e.g. determine the policy.

[DCA.8]   The ENI System shall provide data collection methods for network KPI status data (e.g. packet loss rate, latency, throughput) in different granularities (e.g. physical interface, logical interface, flow).

[DCA.9]   The ENI System may perform analysis on the combination of data, collected from various relevant infrastructure elements, to generate an overall view of network status.

[DCA.10]   The ENI System shall be capable of requesting or retrieving certain kind of data from the Assisted System.

[DCA.11]   The ENI System shall be capable of extracting configuration information from the collected data to generate policies intelligently (e.g. avoiding adjust DC servers that are unavailable or inaccessible).

[DCA.12]   The ENI System shall automatically assign labels to new samples.

[DCA.13]   The ENI System shall be able to collect service data e.g. service performance log data, service workload data and resource configuration of services for further analysis and policy making.

[DCA.14]   The ENI System shall be able to collect fine grained telemetry data to provide enhanced visibility into how the infrastructure is operating and how the application is using its resources, e.g. how shared resources such as Last Level Cache (LLC) and memory bandwidth are used.

[DCA.15]   The ENI System shall be able to support the pre-processing, integration, analysis and storage of multi-source and heterogeneous data (e.g. compatibility of data from different Network Model (NM) e.g. IP based NM, Identity based NM, Content based NM and Location based NM in Polymorphic Network (PINet)).

NOTE 3:   Heterogeneous data pre-processing may include heterogeneous data discrimination, sampling and cleaning. Heterogeneous data integration may include heterogeneous data label fusion, heterogeneous data fusion analysis, and heterogeneous data feature extraction. Clustering analysis, association analysis and classification prediction algorithms can realize the fusion analysis of structured data and unstructured heterogeneous data from multiple sources.

6.3   Policy management

6.3.1   General policy management requirements

This clause captures requirements related to how policies are managed by the ENI System.

The ENI System enforces policies. Policies should be used to manage the behaviour and operation of the Assisted System. The actions may be either a set of commands or recommendations, depending on the mode that the ENI System is operating in. The ENI System may use any combination of imperative, declarative and intent policies to form the actions, see ETSI GS ENI 005 [2].

[GPM.1]   The content of the recommendations and/or commands may be changed through the execution of policies that affect the ENI System.

[GPM.2]   Pre-defined policies that are triggered by one or more events should be executed by the ENI System while complying with any metadata or other policies that govern their operation.

[GPM.3]   When an event indicates that a policy violation is detected, the ENI System should be aware and then take appropriate remediation, or stop execution and ask the policy author what to do.

[GPM.4]   The ENI System shall be capable of performing policy conflict resolution in order to ensure that the overall system behaviour complies with all policies.

[GPM.5]   The ENI System shall use all relevant external information, including but not limited to metadata, business rules, context, and regulatory requirements, to achieve the goals of the Assisted System.

[GPM.6]   The ENI System shall detect changing conditions in the network and adapt the behaviour and operation of the Assisted System using policies.

[GPM.7]   The ENI System shall send policies to external entities by using dedicated External Reference Points.

6.3.2   Context aware related policy requirements

This clause is based on policy related functional requirements defined in ETSI GS ENI 005 [2].

[CAP.1]   In the ENI System, a single information model shall be used to represent the structure and semantics of policies.

[CAP.2]   Multiple data models may be derived from the (single) information model.

[CAP.3]   The Policy information model shall be integrated into the system's information model. This facilitates relating policies to Services, Resources, Functional Blocks, and other managed entities of the system.

[CAP.4]   The information model shall be used in constructing APIs and DSLs.

[CAP.5]   In the ENI System, different types of policies may be supported in the same system.

[CAP.6]   Policy within a domain shall act as a mechanism to define and manage the behaviour of entities contained within that domain. This includes entities in a sub-domain contained in a higher-level domain.

[CAP.7]   Policy defined in peer domains may act as a mechanism to negotiate mutually acceptable behaviour between the domains.

[CAP.8]   Situations shall be used to select active policies (and deactivate policies that are no longer appropriate). This enables the ENI System to adjust its goals and behaviours accordingly to changes in context.

[CAP.9]   The ENI System, based on contextual changes, may construct new policies to address problems found and/or improve system behaviour by using operator intervention if no suitable policies currently exist.

NOTE 1:   According to what is defined in ETSI GR ENI 004 [i.1], a policy may be cloned and modified by an applicable functional block, such as policy engine (as opposed to the policy itself being self-modified). The changes allowed by this process will be limited according to parameters defined in the ENI architecture. Self-modifying policies are still in the early research stage; in this stage of ENI, self-modifying policies are not specified.

NOTE 2:   This requirement is to be supported in a future release.

[CAP.10]   Policy may be augmented by metadata.

[CAP.11]   Policy metadata should be used to describe and/or prescribe functionality.

[CAP.12]   Policy may be realized by using centralized and/or distributed architectures, according to what is defined in ETSI GS ENI 005 [2].

[CAP.13]   The (single) information model, and each data model, should use a set of software design patterns to provide extensibility and consistency.

[CAP.14]   The derivation of a data model should be done by defining formal transformations from the (single) information model to each different data model. This facilitates the development of associated software tooling.

[CAP.15]   Different entities may be represented by different roles being mapped to different levels in the Policy Continuum.

[CAP.16]   Different entities have different concepts and terminologies for their policies. Therefore, the notion of a Policy Continuum, where each continuum corresponds to a given set of entities, should be realized.

[CAP.17]   Formal mathematical transformations between each level of the Policy Continuum and its entities should be defined, which facilitates the development of APIs and DSLs.

[CAP.18]:   The ENI System should be prepared to modify the role of outside systems.

NOTE 3:   Considering that entities operate in a changeable context throughout the lifecycle of the system. Therefore, the context of an entity may be used to map the activities of the entity to a particular level in the Policy Continuum. In this context, the above requirement applies.

NOTE 4:   An end-user is always an end-user, and is defined by that particular MCMPartyRole. If that same end-user wants to be a Developer, then that end-user will assume a new MCMPartyRole. (This behaviour is fundamental to the role-object pattern, and is defined in ETSI GS ENI 005 [2]).

[CAP.19]   The ENI System should use historical data about contextual changes along with other collected data to perform analysis and generate policies.

6.4   Data learning

This clause captures requirements related to data learning in ENI System.

[DL.1]   The ENI System shall provide basic data learning functionalities, such as classification, regression, and clustering.

NOTE: The ENI System may contain common algorithms to support these functionalities, such as SVM for classification, BP for regression and K-Means for clustering.

[DL.2]   The ENI System shall provide feature analysis functionalities, which can rank all features of the data in the order of their importance and provide suggestions to operators for their further feature weighting.

[DL.3]   The ENI System shall provide big data mining and analysis functionalities, which can find the hidden patterns, correlations and knowledge and reveal the relationship between correlation rules and events through mining and analysing large amounts of data.

[DL.4]   The ENI System shall provide data annotation functionality, which can classify and organize the data to be standardized, and provide data coding to meet data analysis requirements.

6.5   Interworking with other systems

This clause captures requirements related to how the ENI System interworks with other systems.

[IWOS.1]   The ENI System shall interwork with other systems, e.g. NFV, MEC, SDN, MEF LSO, DC Dynamic Environment System, OSS, and others that may show up in a 5G-Network context, by reusing existing functions and interfaces as much as possible.

[IWOS.2]   The failure of ENI System shall not interrupt the services provided by other systems.

6.6   Mode of operations

This clause captures requirements on the mode of operations of the ENI System.

[MOP.1]   The ENI System shall support a recommendation mode.

[MOP.2]   The ENI System may support a management mode of operation.

[MOP.3]   The ENI System may support a mixed mode of operation for different sets of decision classes (e.g. some types of decisions are made using one mode of operation, and other sets of decisions are made using the other mode of operation).

[MOP.4]   The ENI System shall discover (and/or be told) the capabilities of the Assisted System in supporting the desired mode of operation.

[MOP.5]   The ENI System shall support and adapt to external inputs for each mode of operation.

[MOP5.A]   The ENI System shall support and adapt to changes in the context and/or situation of the Assisted System.

[MOP5.B]   The ENI System shall support external input of regulatory policies and operator goals.

[MOP.6]   The ENI System shall use the above two factors in [MOP5] to select its mode of operation.

[MOP.7]   The ENI System shall ask permission from the Operator or Designated Entity to change modes of operation using an agreed External Reference Point.

[MOP.8]   The Assisted System, or its Designated Entity shall ask the ENI System to change modes of operation using an agreed External Reference Point.

[MOP.9]   The ENI System shall confirm through the agreed External Reference Point to the Operator or Designated Entity of the Assisted System when it has successfully switched modes of operation.

[MOP.10]   The ENI System may suggest that a particular mode of operation is used when a class of decision is reached that is not specified by the Assisted System.

[MOP.11]   The Assisted System and/or its Designated Entity need not accept the recommendations offered by the ENI System when in recommendation mode. This includes those decisions that apply to recommendations when the Assisted System is in a mixed mode of operation.

[MOP.12]   The Assisted System and/or its Designated Entity need not accept the recommendations offered by the ENI System when in management mode. This includes those decisions that apply to commands when the Assisted System is in a mixed mode of operation.

[MOP.13]   Decisions and commands in management mode are subject to the approval of the Assisted System (or its Designated Entity).

[MOP.14]   The Assisted System (or its Designated Entity) may tell the ENI System that it approves all commands sent to it when it is in management mode.

[MOP.15]   The Assisted System may revoke the above setting at any time, in which case [MOP.13] then applies (once acknowledged by the ENI System).

[MOP.16]   If the Assisted System (or its Designated Entity) rejects a command set to it by the ENI System when it is in recommendation mode, it shall send a notification to the ENI System.

[MOP.17]   If the Assisted System (or its Designated Entity) rejects a command set to it by the ENI System when it is in management mode, it shall send a notification to the ENI System.

6.7   Model training and iterative optimization

[MTIO.1]   The ENI System shall be able to support the selected algorithms according to the types of problems, e.g. classification, regression, etc., and support the initialization of model parameters and structure based on data features and task objectives.

[MTIO.2]   The ENI System shall support the ability to adjust a model's hyperparameters or choose a new model.

[MTIO.3]   The ENI System shall re-train the model using various learning techniques and algorithms through continuously extending the existing model's knowledge according to input data.

NOTE: Learning techniques may include Online Learning and Offline Learning techniques, including Incremental Learning, Transfer Learning with their associated algorithms, etc.

[MTIO.4]   The ENI System may solve related problems based on knowledge gained while solving one or more previous problems.

6.8   Mode of deployments

[MOD.1]   The ENI System shall support centralized deployment and distributed deployment.

[MOD.2]   Information exchange shall be supported between distributed ENI Systems located in the same network domain.

[MOD.3]   Information exchange shall be supported between distributed ENI Systems located in different network domains.

[MOD.4]   Information exchange shall be supported between distributed ENI Systems and one or more centralized ENI Systems.

6.9   API requirements

[API.1]   The ENI System shall support API based programming mode.

NOTE 1: If [API.1] is used then the following corollaries follow:

[API.1A]   The ENI System shall provide a set of common APIs in driver level to support AI development across a range of data parallel accelerators.

[API.1B]   The ENI System shall provide a set of APIs to support AI development across different AI frameworks.

[API.1C]   The ENI System shall reuse the APIs provided by an existing external system as external ENI APIs, if these APIs can meet the requirement of interworking between ENI System and the external system.

[API.2]   The ENI System should support direct programming mode if the API based programming mode cannot meet the required needs.

NOTE 2: [API.1] and [API.2] can be used in combination.

NOTE 3: API based programming mode is the way that programmers produce code to achieve particular function by calling existing APIs. Direct programming mode is the way that the programmers use programming language to produce code to achieve particular function without calling existing APIs.

[API.3]   The ENI System shall be able to communicate with external systems by a single set of ENI APIs directly or via an optional API Broker.

7   Non-functional requirements

7.1   Overview

The requirements in this clause are addressed from non-functional point of view.

7.2   Performance requirements

This clause captures requirements related to system performance, e.g. latency, accuracy, efficiency.

[PR.1]   The ENI System shall be capable of analysing real-time data collected from a large number of devices, common in IoT environments, in order to ensure a proper performance according to SLA contracts.

7.3 Operational requirements

This clause captures operational requirements.

[OR.1]   When using the ENI System to provide intelligent network operation and management, it shall be possible to minimize the Total Cost of Ownership (TCO), including Operating Expenses (OPEX) and Capital Expenses (CAPEX) of the network infrastructure. Existing network infrastructure shall be reused as much as possible to build or interwork with the ENI System.

[OR.2]   The ENI System shall help to improve the energy efficiency of the whole network, where the information is available.

[OR.3]   The ENI System shall provide, by using a functional block architecture, the support for multiple applications as used in different use cases.

7.4 Regulatory requirements

This clause captures regulatory requirements.

[RegR.1]   The privacy of the users shall be properly protected during the collection, storage and analysis of the data.

NOTE: In Europe, the GDPR [i.3] applies.

[RegR.2]   It shall be possible to analyse the network data without exposing its users.

[RegR.3]   The provider of an ENI System shall comply with the provisions of the Lawful Interception regulations.

[RegR.4]   The provider of an ENI System shall comply with the provisions of the data protection regulations.

[RegR.5]   The provider of an ENI System shall comply with the provisions of the information security regulations.

Annex A (informative):
Change History

Date	Version	Information about changes
2017-05	v0.0.1	Initial early draft with skeleton
2017-06	v0.0.2	Combine ENI(17)000012r1
2017-07	v0.0.3	Combine ENI(17)000028r1
2017-08	v0.0.4	Combine ENI(17)000039r1, ENI(17)000044r1
2017-09	v0.0.5	Combine ENI(17)000079r1, ENI(17)000080r1
2017-10	v0.0.6	Combine ENI(17)003_029r1, ENI(17)003_031r1, ENI(17)003_032r1, ENI(17)003_035r1
2017-10	v0.0.7	Combine ENI(17)000086r1
2017-11	v0.0.8	Adding requirements from clause 4.12 of ETSI GR ENI 003
2017-11	v0.0.9	Change GR to GS, revise requirements in clauses 6 & 7
2017-12	v0.1.0	Combine ENI(17)004_007r1, ENI(17)004_020r1, ENI(17)004_021r1
2018-02	v0.1.1	Combine ENI(18)000042r1, ENI(18)000043r1
2018-03	v0.1.2	Combine ENI(18)005_019, ENI(18)005_020r1, ENI(18)005_022r3
2018-04	v1.1.1	Publication
2018-05	v2.0.0	Combine ENI(18)000105r1, ENI(18)000106r1
2018-06	v2.0.1	Combine ENI(18)006_024r2, ENI(18)006_027, ENI(18)006_026r4
2018-11	v2.0.2	Combine ENI(18)000186r1
2019-02	v2.0.3	Combine ENI(19)000021r1
2019-03	v2.0.4	Combine ENI(19)000046r1
2019-05	v2.0.5	Combine ENI(19)000121, ENI(19)000125r1
2019-07	V2.0.6	Combine ENI(19)000100r1 and changes agreed during ENI#10
2019-09	V2.1.1	Publication
2019-09	V3.0.1	Combine ENI(19)011_026r1 and new scope agreed during ENI#11
2019-12	V3.0.2	Combine ENI(19)012_028
2020-03	V3.0.3	Combine ENI(20)000041
2020-03	V3.0.4	Combine ENI(20)013_032r1
2020-04	V3.0.5	Combine ENI(20)000_008r1
2020-06	V3.0.6	Combine ENI(20)014_037r1
2020-12	V3.1.1	Publication
2021-11	V3.1.2	Combine ENI(21)000_214r1
2021-12	V3.1.3	Combine ENI(21)000_251
2022-03	V3.1.4	Combine ENI(22)021_009
2022-05	V3.1.5	Combine ENI(22)000_106r1
2022-06	V3.1.6	Combine ENI(22)000_133r1
2022-08	V3.1.7	Combine ENI(22)000_142
2022-09	V3.1.8	Combine agreed changes in ENI(22)023_029r3 and alignments

History

Document history		
V1.1.1	April 2018	Publication
V2.1.1	September 2019	Publication
V3.1.1	December 2020	Publication
V3.2.1	April 2023	Publication