ETSI GR ENI 009 V1.2.1 (2023-05)

Experiential Networked Intelligence (ENI); Definition of data processing mechanisms

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Reference

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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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Introduction

The present document outlines a high-level reference framework that describes technical methods for producing high-quality actionable data efficiently and in a timely manner.

The organization of the present document is as follows:

- Clause 1 defines the scope of the present document.
- Clauses 2 and 3 provide informative references, terms, symbols and abbreviations.
- Clause 4 describes an overview of the data mechanism, including its motivation and challenges.
- Clause 5 defines components in the high-level framework of the data mechanism in terms of data acquiring and data processing.
- Clause 6 presents the data mechanisms in some example scenarios proposed in ETSI GR ENI 001 [i.1], Use Case specification.

- Clause 7 presents example requirements for data format, interface and data security.
- Clause 8 concludes possible contributions to other ENI group specifications of the present document.

Data Telemetry is used as an example for data mechanisms description and analysis.

1 Scope

The present document revises ETSI GR ENI 009 [i.30] (V1.1.1). The realization of intelligent network depends on the use of mechanisms related with: processing of the big data, AI algorithms and computing resources. Therefore, effective data management and operation is extremely important.

The present document is purposed to enhance the ETSI GR ENI 009 [i.30] (V1.1.1) on data operation requirements and mechanisms to better serve ENI system, especially within the following technical areas:

1) data format among the Functional Block of ENI system and towards the external world (internal Functional Blocks, Knowledge Representation);

2) data conversion and possibility to translate AI data model to be adapted to/from external system (external trained model imported into ENI);

3) consistency of data format and interface to accelerate the Autonomous Network (AN) evolution process; and

4) ensure that customer privacy is not disclosed in the entire lifecycle of data collection, processing and utilization (Federated Learning).

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 GR ENI 001 (V3.2.1): "Experiential Networked Intelligence (ENI); ENI use cases".

[i.2] ETSI GR ENI 004 (V3.1.1): "Experiential Networked Intelligence (ENI); Terminology".

[i.3] ETSI GS ENI 005 (V3.1.1): "Experiential Networked Intelligence (ENI); System Architecture".

[i.4] IETF RFC 7011: "Specification of the IP Flow Information Export (IPFIX) Protocol for the Exchange of Flow Information".

[i.5] IETF RFC 7950: "The YANG 1.1 Data Modeling Language".

[i.6] IETF RFC 4656: "A One-way Active Measurement Protocol (OWAMP)".

[i.7] IETF RFC 5357: "A Two-Way Active Measurement Protocol (TWAMP)".

[i.8] IETF RFC 9197: "Data Fields for In-situ OAM".

[i.9] IETF RFC 8321: "Alternate-Marking Method for Passive and Hybrid Performance Monitoring".

[i.10] IETF RFC 8889: "Multipoint Alternate Marking method for passive and hybrid performance monitoring".

[i.11] IETF RFC 7799: "Active and Passive Metrics and Methods (with Hybrid Types In-Between)".

[i.12] Recommendation ITU-T Y.1731: "OAM functions and mechanisms for Ethernet based networks".

[i.13] IETF RFC 6241: "Network Configuration Protocol (NETCONF)".

[i.14] IETF RFC 4271: "A Border Gateway Protocol 4 (BGP-4)".

[i.15] IETF RFC 7854: "BGP Monitoring Protocol (BMP)".

[i.16] IETF I-D.draft-kumar-rtgwg-grpc-protocol-00: "gRPC Protocol".

[i.17] IETF I.D.draft-zhou-ippm-enhanced-alternate-marking-12: "Enhanced Alternate Marking Method".

[i.18] IETF I.D.draft-song-ippm-postcard-based-telemetry-15: "Postcard-based On-Path Flow Data Telemetry using Packet Marking".

[i.19] IETF RFC 793: "Transmission Control Protocol (TCP)".

[i.20] IETF RFC 768: "User Datagram Protocol (UDP)".

[i.21] VNF Event Stream (VES).

[i.22] IETF RFC 3416: "Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP)".

[i.23] IETF RFC 959: "File Transport Protocol (FTP)".

[i.24] The Atlan Data wiki definition of structured data.

[i.25] The Atlan Data wiki definition of unstructured data.

[i.26] IETF RFC 4560: "Definitions of Managed Objects for Remote Ping, Traceroute, and Lookup Operations".

[i.27] Prometheus open source.

[i.28] NoSQL.

[i.29] Data model.

[i.30] ETSI GR ENI 009 (V1.1.1): "Experiential Networked Intelligence (ENI); Definition of data processing mechanisms".

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.2], ETSI GS ENI 005 [i.3] and the following apply:

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 optimized for reading and computing on columnar data. Examples include Snowflake and BigQuery.

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 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.

ENI AI data model: AI data model refers to the data involved in AI modeling process

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

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.

Principal Component Analysis (PCA): data dimensionality reduction algorithm

NOTE: The central idea of principal PCA is to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set.

prometheus: open-source systems monitoring and alerting toolkit

NOTE: This open source is originally built at SoundCloud. Since its inception in 2012, many companies and organizations have adopted Prometheus, and the project has a very active developer and user community. It is now a standalone open source project and maintained independently of any company. To emphasize this, and to clarify the project's governance structure, Prometheus joined the Cloud Native Computing Foundation in 2016 as the second hosted project, after Kubernetes.

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

reinforcement learning: See ETSI GR ENI 004 [i.2] and ETSI GS ENI 005 [i.3].

row-oriented database: database that organizes 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.

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

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

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.24].

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

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.

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

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR ENI 004 [i.2], ETSI GS ENI 005 [i.3] and the following apply:

5G	Fifth Generation
AI	Artificial Intelligence
AS	Autonomous System
BGP	Border Gateway Protocol
BMP	BGP Monitoring Protocol
BSS	Business Support Systems
CPU	Central Processing Unit
CRM	Customer Relationship Management
EAM	Explicit Address Mapping
ENI	Experiential Networked Intelligence
FTP	File Transport Protocol
gNMI	gRPC Network Management Interface
IETF	Internet Engineering Task Force
IMS	Integrated Management System
IOAM	In-band OAM
IP	Internet Protocol
IPFIX	IP Flow Information eXport
IPFPM	IP Flow Performance Measurement
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication standardization sector
JSON	JavaScript Object Notation
KPI	Key Performance Indicator
MS	Monitoring System
NE	Network Element
NMS	Network Management System
OAM	Operation, Administration and Maintenance
OMC	Operations and Maintenance Centre
OSS	Operations Support Systems
OWAMP	One-Way Active Measurement Protocol
PBT	Postcard-Based Telemetry
PCA	Principal Component Analysis
QoS	Quality of Service
SDK	Software Development Kit
SDN	Software-Defined Networking
SLA	Service Level Agreement
SNMP	Simple Network Management Protocol
SQL	Structured Query Language
SR-IOV	Single Root I/O Virtualization
TCP	Transmission Control Protocol
TWAMP	Two-Way Active Measurement Protocol
UDP	User Datagram Protocol
VES	VNF Event Stream
VNF	Virtual Network Function
XML	eXtensible Markup Language
YAML	Yet Another Markup Language
YANG	Yet Another Next Generation

4 Overview

4.1 Background

Exploiting network data for intelligent network applications and use has been increasing in recent years. By combining AI and machine learning algorithms, network data is able to provide insights that help network operators better manage and optimize the network. Therefore, the quality of available sample data, for instance, time validity, diversity, volume, accuracy, plays an important role in learning from data. One challenge is that large amounts of data as well as data that meets the demands is able to be acquired. Additionally, the data collected from network equipment's from different vendors varies in the aspect of name, format, calculation rules, etc. Thus a large amount of time is often be spent to do the data normalizing, cleansing, and engineering before those data could be used to train the model. This blocks the deployment of actionable decisions, which are meant to improve ENI System performance and User Experience.

The present document describes data acquisition, sharing and processing mechanisms, as well as supports for data privacy in AI-enabled network Operation, Administration and Management (OAM). The present document identifies the sources and data to be extracted, however it does not intend to explain how the mechanisms work, or how data is processed in order to became used. This could be addressed in a later release.

4.2 Data Precondition

Different types of data are able to be analysed only and interpreted correctly in particular contexts. The following are examples of some of the types of data that the present document focuses on.

Real-time data: Typically, network data has to be continually monitored and dynamically processed in real-time. Example processing includes filtering, correlation, and cleansing. This is typically down locally and then aggregated results are distributed for further processing.

Continuous data: In some cases, continuous data over a long time span is required for analysis or model training. For example, historical traffic data are used to predict future traffic trends. In general, the longer the time span, the more representative it is, but the larger the data volume. Therefore, a way of efficiently processing and managing continuous data is needed.

NOTE: More consideration on "historical data" will be described in a future version in a later release.

5 Data Mechanism

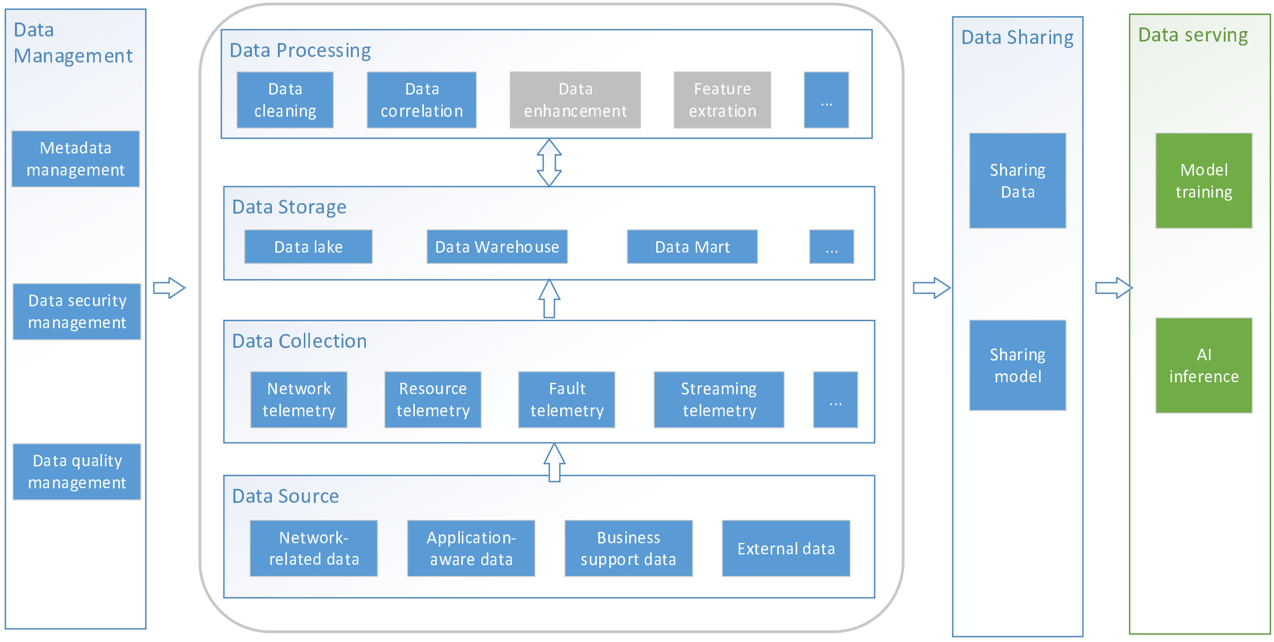
5.1 Introduction

5.1.1 Data Mechanism Overview

This clause defines components in a high-level overview for data acquisition and processing. Furthermore, this clause classifies different types of data in terms of their data sources, as well as describes data processing mechanisms, in order to support AI enabled network OAM and service management.

The Data Mechanism supports different data acquisition and processing mechanisms for data from different sources and for use by different network applications.

As shown in figure 5-1, the data mechanism overview is able to be partitioned into the following components.



NOTE: The content in grey box will be described in a future version in a later release.

Figure 5-1: Data Mechanism Overview

The main components above are thoroughly described and explained in the next clauses. However, before doing that, some information will be provided on the data contents characteristics, i.e. on the types of data that are able to be used to classify data as well as on the parameters that encompass each type and the scenarios where they could be found.

Telemetry is a service/application related to the collection of measurements, statistics, or other related data at pre-determined points, and the subsequent and automatic transmission of those data to appropriate devices. It will be used throughout this clause as an example of data source in order to provide some practical application to the descriptions presented in the main text.

5.2 Data Characteristics

5.2.1 Configuration Data

Configuration data are used to identify the context in which measurements are made. Table 5-1 lists some examples of configuration data that are required to be made per-user, per-service telemetry measurements, see clause 5.4.1.

Table 5-1: Exemplary Configuration Data Characteristics

Configuration Data	Brief Description	Source	Scenario
Network device attribute information	Device ID, location, device model/version	Network Management Systems --> OSS	Network device alarm root cause analysis
Network device configuration information	Device IP, port, Vlan ID, IP Route Protocol	Network Management Systems	Intelligent traffic steering
Customer information	IMEI, IMSI, Terminal type, user name, user level (e.g. VIP user), register time, subscription service information	Network Management Systems --> BSS	Content Recommendation

5.2.2 Sequential Data

Sequential data are a series of data recorded in time order. Table 5-2 shows some examples of sequential data.

Table 5-2: Exemplary Temporal Data Characteristics

Sequential Data	Brief Description	Source	Scenario
Fault data	Alarm, log	Network Management Systems	Network device alarm root cause analysis
Performance data	CPU, memory, and I/O usage memory	Network infrastructure --> servers	KPI anomaly analysis
Network traffic data	Throughput, rate, delay	Network infrastructure --> switches, routers	Traffic prediction
External environment data	Temperature, humidity	External sources --> sensors	Device equipment energy saving

5.2.3 Data Representation

Data is able to be classified into structured, semi-structured, and unstructured data formats according to whether the data can be expressed in a uniform structure.

Structured data is information organized in a predetermined way (a fixed format, data model or schema) within a record or a file [i.24]. Structured data enables all elements to be individually addressable, and conform to a data model. Table 5-3 shows some examples of structured data in the network.

Table 5-3: Exemplary Structured Data Characteristics

Structured Data	Brief Description	Source	Scenario
Relational Data	Data structured that adheres to a pre-defined data model	SQL database	Customer information

Semi-structured data is 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.

Table 5-4: Exemplary Semi-structured Data Characteristics

Semi-Structured Data	Brief Description	Source	Scenario
XML Data	Data that has some organizational properties	XML Data Store	Some types of Network Data

Unstructured data is information that does not have a pre-defined data model, and does not contain properties that provide any organization or structure to its elements. It will be pre-processed in order to find information by domain-specific applications [i.25]. Table 5-5 shows some examples of unstructured data in the network.

Table 5-5: Exemplary Unstructured Data Characteristics

Unstructured Data	Brief Description	Source	Scenario
Word®, PDF®, or Text Documents, Media Files	Data that does not have a pre-defined data model	BSS	Content (e.g. streaming media)

5.2.4 Data Exchange Formats

When using interfaces for data exchange between functional blocks, according to what is defined in ETSI GR ENI 004 [i.2] three data formats are usually used: JSON, XML and YAML:

- **JSON:** It is a lightweight text data exchange format, which is syntactically the same as the code for creating JavaScript objects and consists of key&value.
- **XML:** It is an extensible markup language, a subset of the standard universal markup language, and a markup language used to mark electronic files to make them structured.
- **YAML:** It is an intuitive data serialization format that can be recognized by the computer.