9 December 2021

The Standards People

ETSI ISG ENI**

Creating an intelligent service optimization solution

Presented by:

Chair:	Dr. Raymond Forbes (Huawei Technologies)
Vice-Chair:	Mrs. Haining Wang (Intel)
Vice-Chair:	Mr. Antonio Gamelas (Portugal Telecom)
Technical Officer:	Mrs. Christine Mera (ETSI)

***Experiential Networked Intelligence*

ENI Leadership Team

Role	Name (Organization)
Chair	**Dr. Raymond Forbes** (Huawei)
Vice Chair	**Ms. Haining Wang** (Intel)
Second Vice Chair	**Mr. Antonio Gamelas** (Portugal Telecom)
Support Officer	**Mrs. Christine Mera** (ETSI)
ENI ISG PoC Review Team	**Raymond Forbes** (Huawei) **Christine Mera** (ETSI Support Officer) **Ultan Mulligan** (ETSI CTI Director) **Bill Wright** (Redhat) **Haining Wang** (Intel) **Luca Pesando** (Telecom Italia) **Yu Zeng** (China Telecom) **Antonio Gamelas** (Portugal Telecom)

ENI Members and Participants

Source: https://portal.etsi.org/TBSiteMap/ENI/ListOfENIMembers.aspx
Members signed the ENI Member agreement and are ETSI members
Participants signed the ENI Participant agreement but are not ETSI members

ENI Vision

Network technology evolution

- Rapidly changing network conditions
- More services, more users

Network intelligence

Network mgmt. and operation evolution

- Human decisions
- Complex manual configuration

Orchestration and operation intelligence

ENI

- Network perception and analysis
- Data driven policy
- AI-based closed-loop control

Enhanced network experience

Better customer experience

Improved QoE of service

Increased service value

Improved business efficiency

Reduced OPEX

Increased profit

5G/IoT automation

Better QoE service delivery

Source: ETSI ENI White Papers,
http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp22_ENI_FINAL.pdf
http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp44_ENI_FINAL.pdf

ENI Mission/Scope (1)

⇨ **ETSI ISG ENI starting in Release 1 & 2 (2017–2019 + 2019–3Q2021):**

- The ISG ENI has focused on improving the operator experience, adding closed-loop artificial intelligence mechanisms based on context-aware, metadata-driven policies. Enabling quick recognition and incorporation of new and changed knowledge, and hence, make actionable decisions.
- In particular, ENI has specified a set of use cases, and the functional architecture, for a network supervisory assistant system based on the 'observe-orient-decide-act' control loop model.
- This model can assist decision-making systems, such as network control and Interact with the domain orchestration systems, to adjust services and resources offered based on changes in user needs, environmental conditions and business goals.

⇨ Release 1 defined big data-analysis functionality

ENI Mission/Scope (2)

⇨ **ETSI ISG ENI starting in Release 1 & 2 (2017–2019 + 2019–3Q2021) (cont.):**

- Definition of AI Categories into levels 0-5 regarding autonomicity.
- Evaluation criteria for Categorization and methods of measuring.
- Use of the API broker for non-capable signaling systems.
- Specification of external reference points, implementation, PoCs, data mechanisms
- Definition of closed control loops in the real-time network.

ENI Mission/Scope (or just Mission?) (3)
Future expected issues

⇨ ENI Release 3 starting 3Q2021:

- Revision of the Use cases & Requirements + Evaluation & Measurement of Categorization + Data Management
  - Priority Use Cases demonstrated in PoCs
  - Measurement Criteria
  - Data Handling related with format and flow between FBs
  - Transformer architecture
- Further deployment and specification of the system architecture
  - Interface definitions and information models
  - Data models and APIs
  - Handling of Policy Management Model
  - Handling of Intent-based concept

ENI Published Reports, Specifications & Work plan

Published ENI deliverables:

- ETSI GS ENI 001 V3.1.1 (2020-12) Published Use Cases
- ETSI GS ENI 002 V3.1.1 (2020-12) Published Requirements
- ETSI GR ENI 003 V1.1.1 (2018-05) Published Context-Aware Policy Man.
- ETSI GR ENI 004 V2.2.1 (2021-12) Newly Published General Terminology
- ETSI GS ENI 005 V2.1.1 (2021-12) Newly Published System Architecture
- ETSI GS ENI 006 V2.1.1 (2020-05) Published PoC Framework
- ETSI GR ENI 007 V1.1.1 (2019-11) Published Definition of Categories
- ETSI GR ENI 008 V1.1.1 (2021-03) Published Intent Aware Net. Autonomicity
- ETSI GR ENI 009 V1.1.1 (2021-06) Published Data Mechanisms
- ETSI GR ENI 010 V1.1.1 (2021-03) Published Evaluation of categories
- ETSI GR ENI 016 V2.1.1 (2021-07) Published Functional Concepts
- ETSI GR ENI 017 V2.1.1 (2021-08) Published Control Loop Archit.
- ETSI GR ENI 018 V2.1.1 (2021-08) Published AI Mechanisms

Ongoing ENI Work Items and Rapporteurs:

- ENI 001 (WI RGS/ENI-001v321) – Target for approval Mar. 2023
  Use Cases (Release 3) – Da Wang (Asia Info)
- ENI 002 (WI RGS/ENI-002v321) – Target for approval Mar. 2023
  Requirements (Release 3) – Haining Wang (Intel)
- ENI 004 (WI RGR/ENI-004v311) – Target for approval Mar. 2023
  General Terminology (Release 3) – Yu Zeng (China Telecom)
- ENI 005 (WI RGS/ENI-005v311) – Target for approval Mar. 2023
  System Architecture (Release 3) – John Strassner (FutureWei)
- ENI 009 (WI RGR/ENI-009v121) –draft in progress
  Data processing mechanisms – Hongden Ren (China Telecom)
- ENI 010 (WI RGR/ENI-0010v121) –draft in progress
  Measurement of Evaluation Categories for AI application to Networks – Yu Zeng (China Telecom)
- ENI 012 (WI DGR/ENI-0022) – draft in progress – ISG approval ongoing
  Reactive In-situ flow information Telemetry – Yali Wang (Huawei)
- ENI 013 (WI DGR/ENI-0023) – draft in progress
  ENI Intent Policy Model – Jiachen Zheng (China Mobile)
- ENI 015 (WI DGR/ENI-0025) – draft in progress
  Processing and Management of Intent Policy – Ziting Zhang (China Telecom)
- ENI 019 (WI DGS/ENI-0029) – draft in progress
  Representing, Inferring in interfaces – John Strassner (Futurewei)
- ENI 030 (WI DGS/ENI-0030) – WI Form in approval
  Transformer Architecture – John Strassner (Futurewei)

 Accessible via Work Item Monitoring - ENI

Main concepts: Use Cases

Infrastructure Management
Policy-driven IDC traffic steering
Handling of peak planned occurrences
Energy optimization using AI

Network Assurance
Network fault identification and prediction
Assurance of Service Requirements
Network Fault Root-cause Analysis and Intelligent Recovery

Network Operations
Policy-driven IP managed networks
Radio coverage and capacity optimization
Intelligent software rollouts
Intelligent fronthaul management and orchestration
Elastic Resource Management and Orchestration
Application Characteristic based Network Operation
AI enabled network traffic classification
Automatic service and resource design framework for cloud service
Intelligent time synchronization of network
Intelligent Content-Aware Real-Time Gaming Network

Service Orchestration and Management
Context aware VoLTE service experience optimization
Intelligent network slicing management
Intelligent carrier-managed SD-WAN
Intelligent caching based on prediction of content popularity

Network Security
Policy-based network slicing for IoT security
Limiting profit in cyber-attacks

Source: ETSI GS ENI 001 ; ENI Use Cases

Main concepts: Requirements

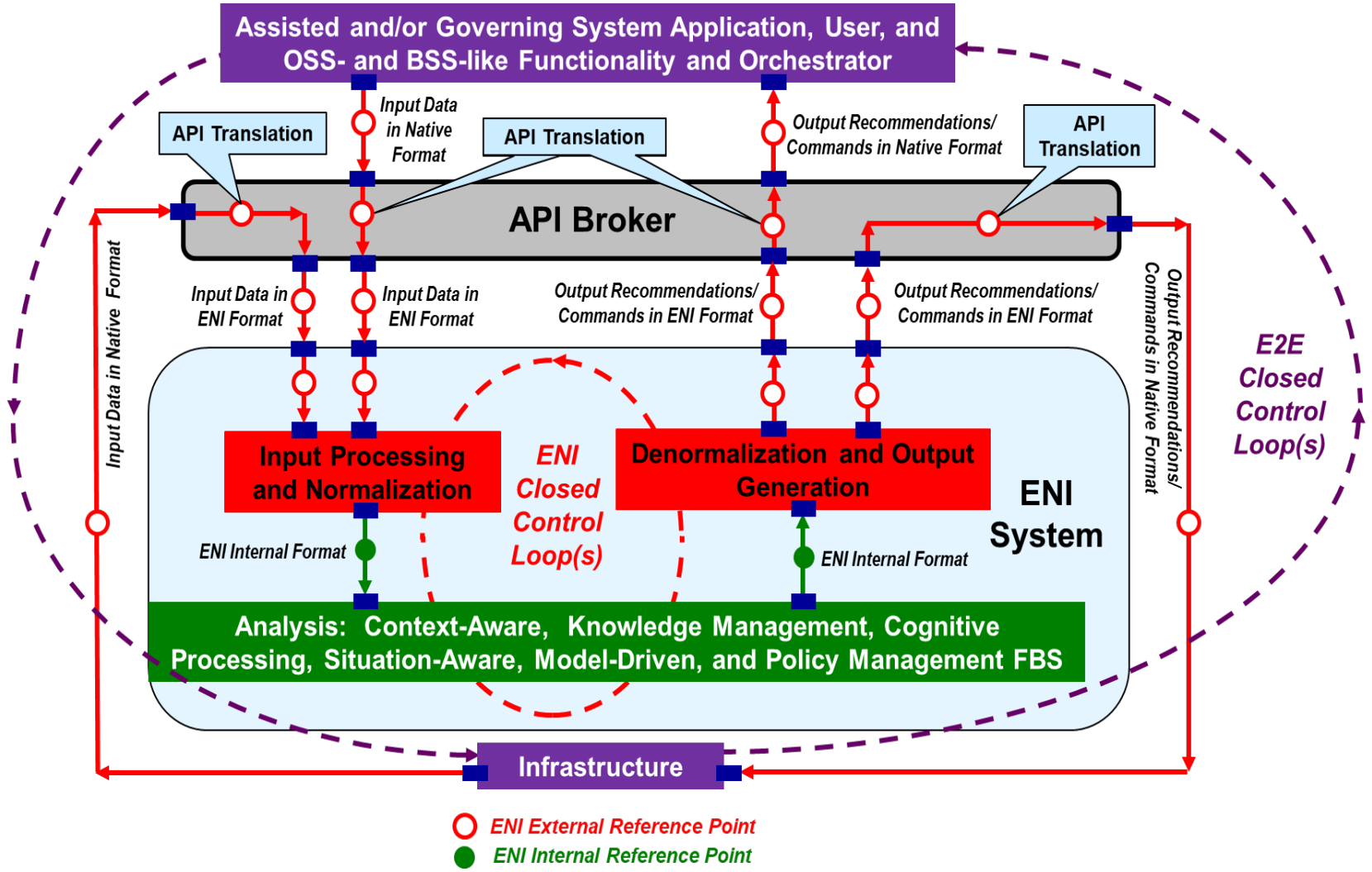
Level 1	Level 2
Service and network requirements	General requirements
	Service orchestration and management
	Network planning and deployment
	Network optimization
	Resilience and reliability
	Security and privacy

Level 1	Level 2
Functional requirements	Data collection and analysis
	Policy management
	Data learning
	Interworking with other systems
	Mode of operations
	Model training and iterative optimization
	API requirements

Level 1	Level 2
Non-functional requirements	Performance requirements
	Operational requirements
	Regulatory requirements

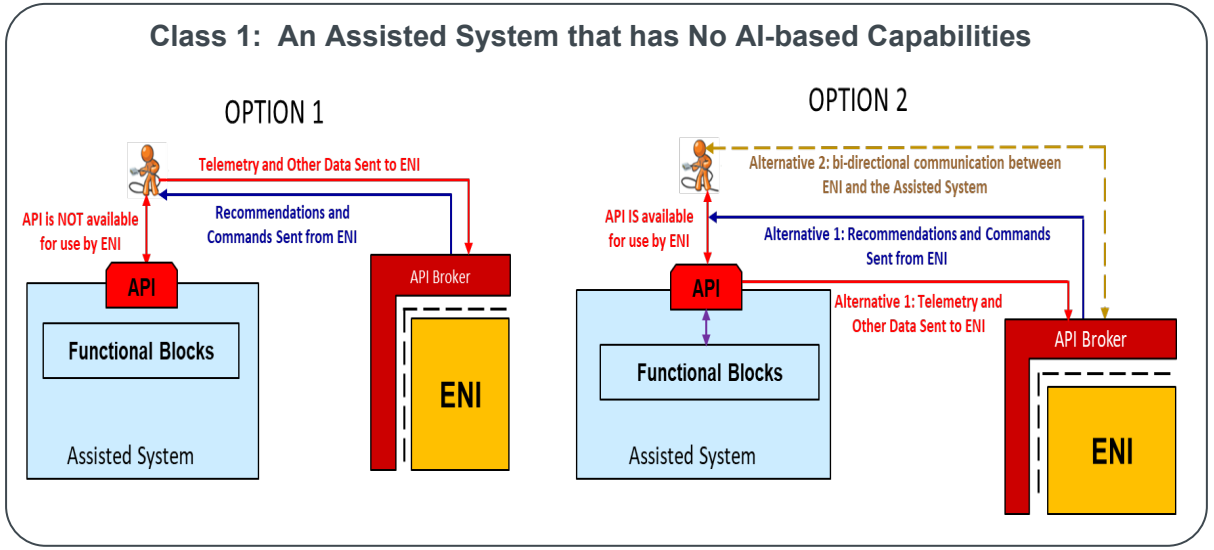
Source: ETSI GS ENI 002 , ENI Requirement

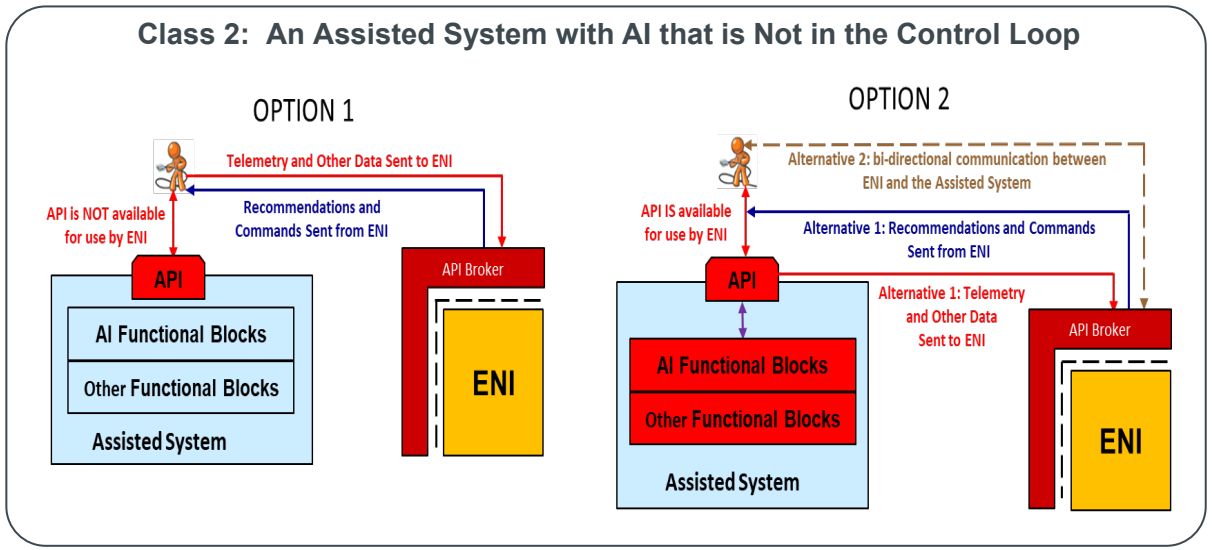
ENI System Reference Architecture

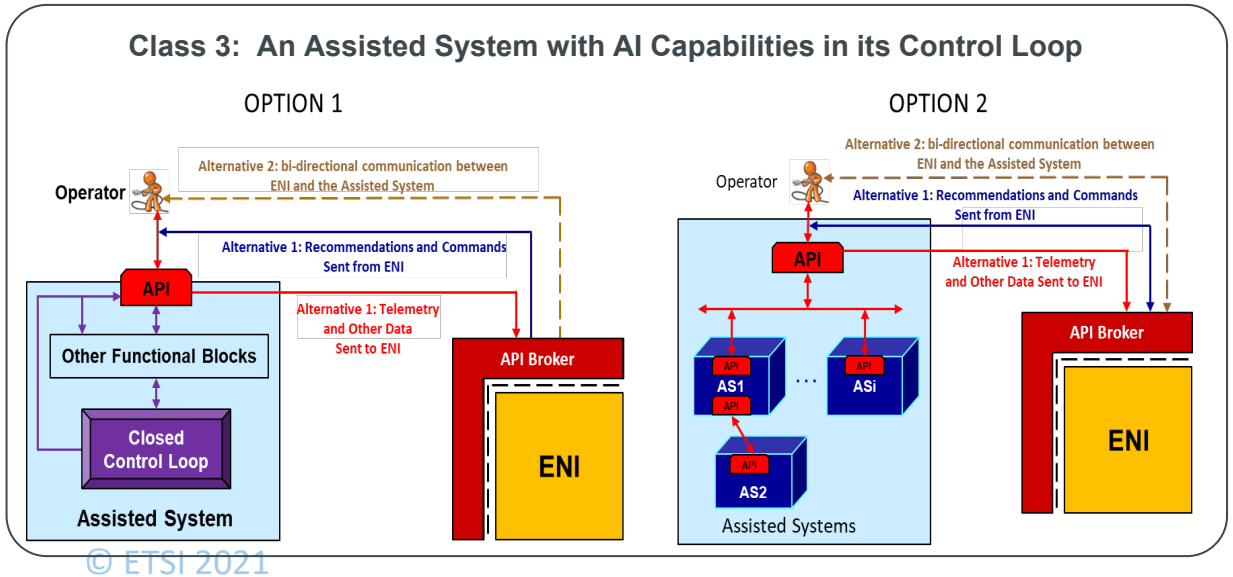


High-Level Functional Architecture Diagram in GS ENI 005 (GS ENI 005) v2.1.1 to be published in Dec. 2021, ETSI GS ENI 005 V2.1.1 (2021-12)

ENI System Architecture - Mode of Operation and Class

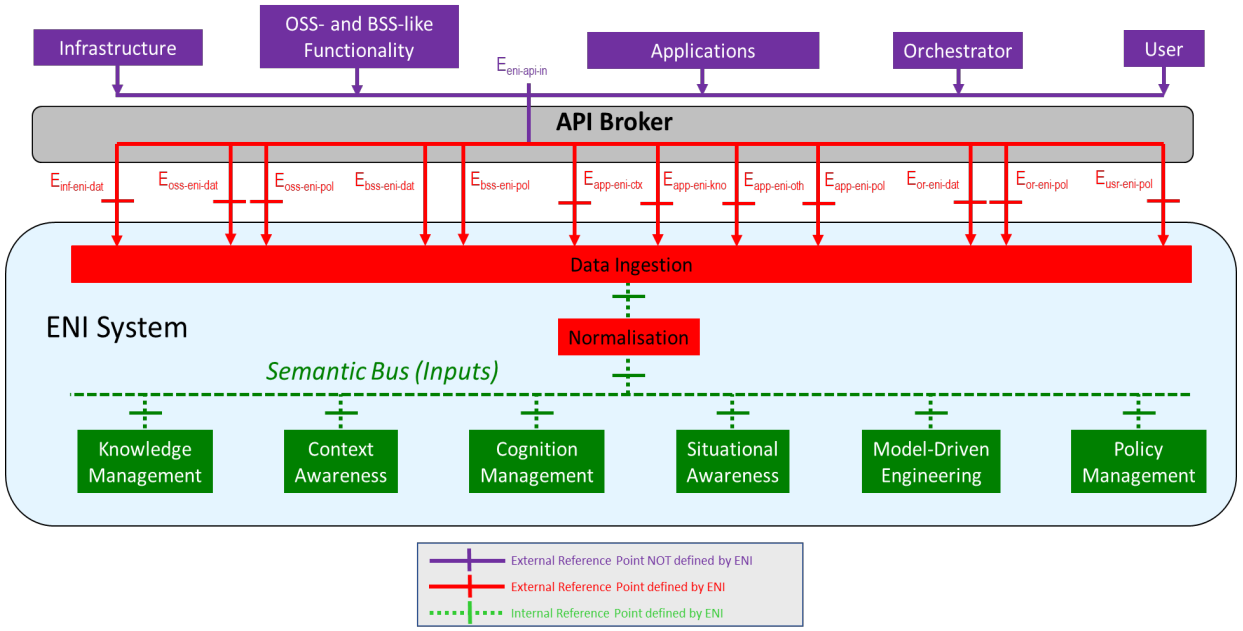




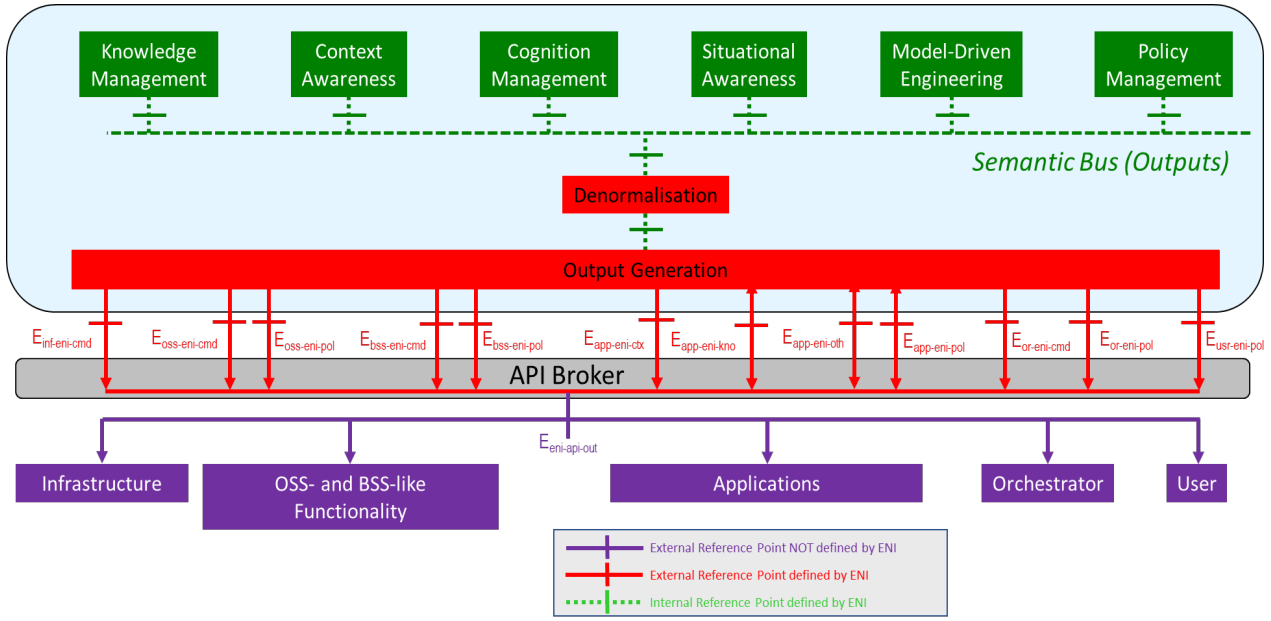


- In each case, ENI requires data from the Assisted System.
- Changes to the Assisted System are not required for any class of Assisted System, shown here
- This facilitates the use and rapid adoption of ENI.
- ENI shall use the API Broker to mediate between ENI and the Assisted System
- ENI provides actionable decisions back to the assisted system (autonomous or recommendatory)
- ENI monitors the effect

Architecture External Reference Points (Inputs & Outputs)



Functional Architecture with its Input Reference Points

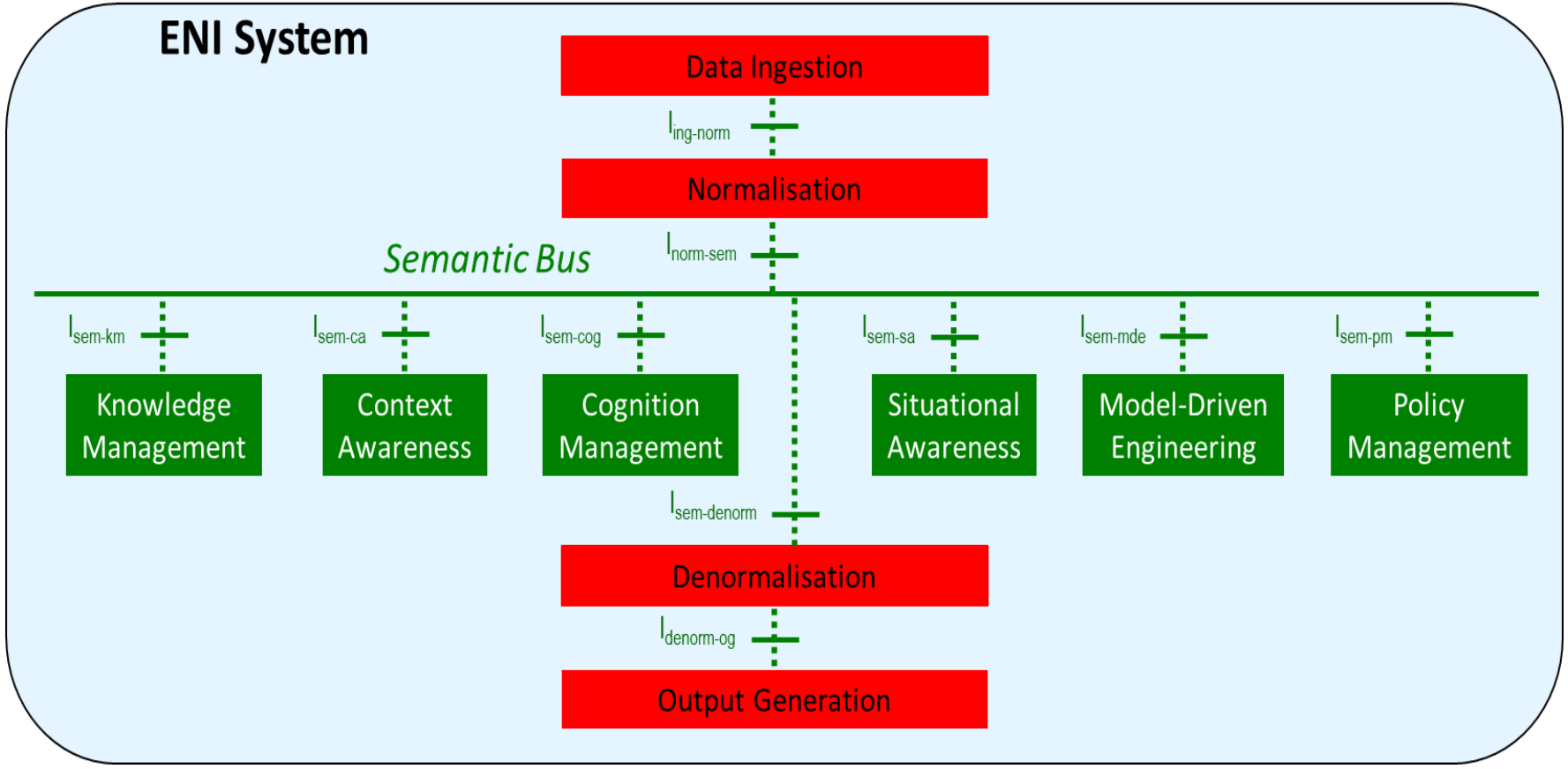


Functional Architecture with its Output Reference Points

Imperative, Declarative, and Intent Policies *are handled within the same architecture, with no additional RP or FB needed*

Source: ETSI GS ENI 005 , ENI System Architecture

Architecture Internal Reference Points



Source: ETSI GS ENI 005 , ENI System Architecture

Definition of Categories for AI Application to Networks

Autonomicity capability
Continuous improvement

Category	Name	Definition	Man-Machine Interface	Decision Making Participation	Data Collection and Analysis	Degree of Intelligence	Environment Adaptability	Supported Scenario
Category 0	Manual O&M	O&M operators manually control the network and obtain network alarms and logs	How (command)	All-manual	Single and shallow awareness (SNMP events and alarms)	Lack of AI based understanding (manual management and control)	Fixed	Single scenario
Category 1	Assisted O&M	Automated scripts are used in service provisioning, network deployment, and maintenance. Shallow perception of network status and machine suggestions for decision making	How (command)	Provide suggestions for machines or humans and help decision making	Local awareness (SNMP events, alarms, KPIs, and logs)	Limited analysis capability	Limited adaptability to changes	Selected scenarios
Category 2	Partial automation	Automation of most service provisioning, network deployment, and maintenance Comprehensive perception of network status and local machine decision making	How (declarative)	The machine provides multiple opinions, and the machine makes limited decisions	Comprehensive awareness (basic telemetry data)	Deep analysis capability	Limited adaptability to changes	Selected scenarios
Category 3	Conditional automation	In specific environmental and network conditions there is automatic network control and adaptation	How (declarative)	Most of the machines make decisions	Comprehensive and adaptive sensing (such as data compression and optimization technologies)	Comprehensive analysis and knowledge; Short-term forecast capability	Adaptability to significant changes	Multiple scenarios
Category 4	Partial autonomicity	Deep awareness of network status; in most cases the network performs autonomic decision-making and operation adjustment	What (intent)	Optional decision-making response	Adaptive posture awareness	Comprehensive analysis and knowledge Long-term forecast capability	Adaptability to significant changes	Multiple scenarios
Category 5	Full autonomicity	In all environmental and network conditions, the network can automatically adapt	What (intent)	Machine autonomous decision	Adaptive optimization as a consequence of quality of service deterioration	Autonomic evolution and knowledge reasoning	Adaptability to any change	Any scenario

Categories of network autonomicity from a technical point of view

Source: ETSI GR ENI 007 , ENI Definition of Categories for AI Application to Networks

Main Contents of the Data Processing Mechanisms

Data Collection Techniques

Data carried out in functional planes protocols

✓Data carried out in the Forwarding/User Plane

✓Data carried out in the Control Plane

✓Data carried out in the Management Plane

Specific data used to deploy telemetry

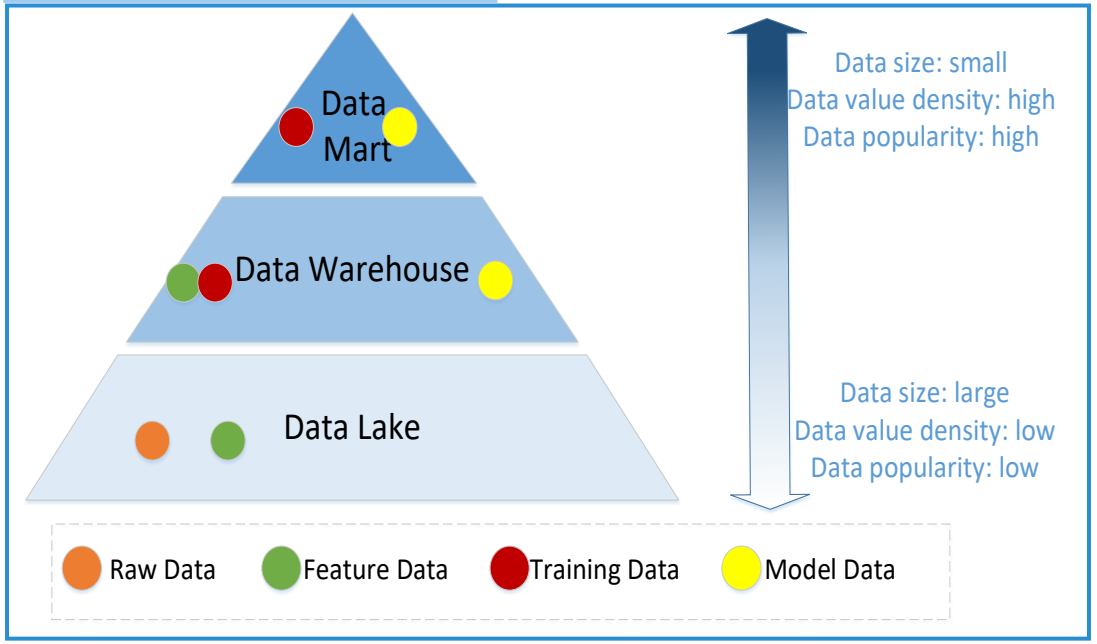
✓Network Telemetry

✓Resource Telemetry

✓Fault Telemetry

✓Streaming Telemetry

Hierarchical Data Storage



Example Scenarios to Illustrate Data Mechanisms

Description of data processing in the selected use cases proposed in ENI 001, supporting analysis in ENI System, e.g., data cleansing.

✓AI-enabled Traffic Classification

✓Network Fault Root-Cause Analysis and Intelligent

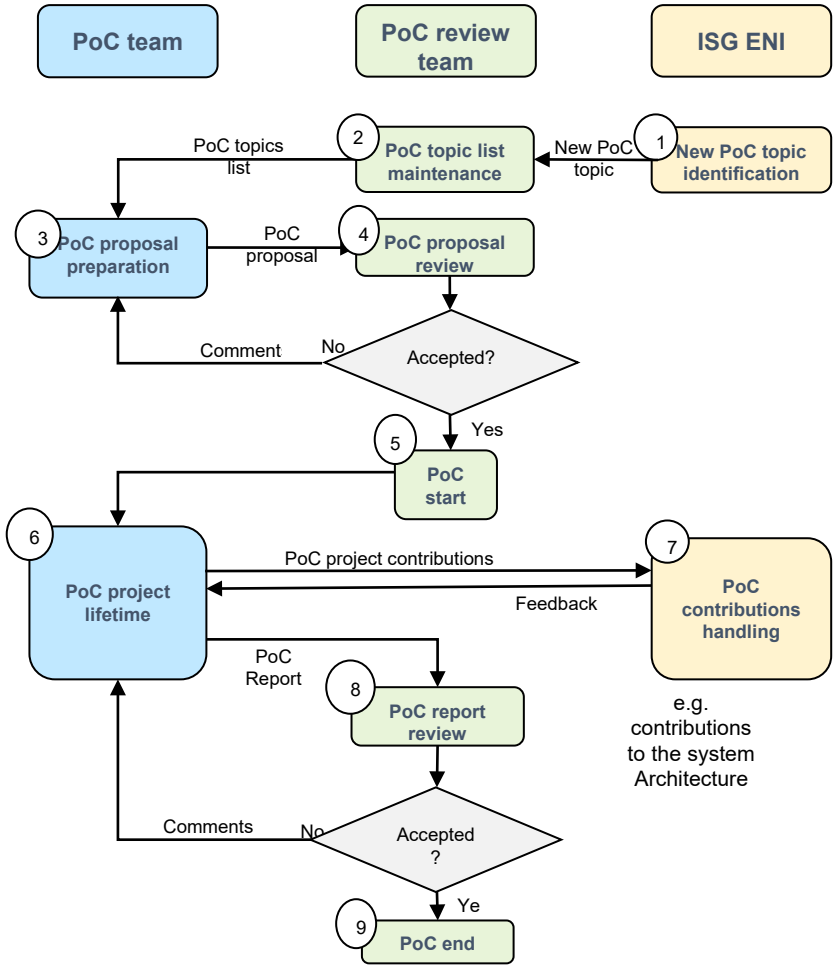
✓Intelligent Service Experience Evaluation

PoC Team and ENI Work-Flow proposal

Using the process defined in ETSI

Procedures:

- ISG ENI approved & published a PoC framework (2nd version)
- PoC review group to receive and review PoC proposals with formal delegation from ISG
- Publish the PoC proposals (on ETSI Portal wiki) according to the PoC framework
- PoC teams (the proposers – which may include non-members) shall present an initial proposal and a final report, according to the templates given by ISG for review
- PoC Team(s) are independent of the ISG, must choose a POC Team Leader and draft the proposal according to the process and templates defined by the ISG



ENI PoC review team:

PoC project wiki: https://eniwiki.etsi.org/index.php?title=Ongoing_PoCs

ENI PoC List (1)

Title	PoC Team Members	Main Contact	Start Time	Current Status (Dec.-2020)
PoC#1: Intelligent Network Slice Lifecycle Management	**China Telecom** Huawei, Intel, CATT, DAHO Networks, China Electric Power Research Institute	Haining Wang	Jun-2018	Completed
PoC#2: Elastic Network Slice Management	**Universidad Carlos III de Madrid** Telecom Italia S.p.A., CEA-Leti, Samsung R&D Institute UK, Huawei	Marco Gramaglia	Nov-2018	Completed
PoC#3: SHIELD, security through NFV	**Telefonica** Space Hellas, ORION, Demokritos (NCSR)	Diego R. Lopez Antonio Pastor	Jan-2019	Completed
PoC#4: Predictive Fault management of E2E Network Slices	**Portugal Telecom/Altice Labs** SliceNet Consortium	António Gamelas Rui Calé	Mar-2019	Completed
PoC#5: AI Enabled Network Traffic Classification	**China Mobile** Huawei, Intel, Tsinghua University	Weiyuan Li	Jun- 2019	Completed
PoC#6: Intelligent caching based on prediction of content popularity	**China Unicom** Beijing University of Posts and Telecommunications, Samsung, Cambricon, Huawei	Bingming Huang	Sep-2019	Completed
PoC#7: Intelligent time synchronization of network	**China Unicom** Beijing University of Posts and Telecommunications, Samsung, Cambricon, Huawei	Bingming Huang	Sep-2019	Completed
PoC#8: Intent-based user experience optimization	**China Telecom/Huawei Technologies** China Telecom, Huawei Technologies, AsiaInfo, Beijing University of Posts and Telecommunications	Dong Li	Jan-2020	Completed

More info can be found https://eniwiki.etsi.org/index.php?title=Ongoing_PoCs

ENI PoC List (2)

Title	PoC Team Members	Main Contact	Start Time	Current Status (Jan.2022)
PoC#9: Autonomous Network Slice Management for 5G Vertical Services	**Nextworks** TIM, Nextworks, Samsung, WINGS, UC3M	Gino Carrozzo / Marco Gramaglia	Jan-2020	Completed
PoC#10: Intelligent Telecom Network Energy Optimization	**China Mobile** China Mobile Research Institute, Intel, Quanta Cloud Technology, Hong Kong ASTRI	Liexiang Yue	Jan-2020	Completed
PoC#11: Intelligent Energy Management of DC	**China Telecom:** China Telecom, Intel, AsiaInfo, Samsung, Huawei	Yu Zeng	April-2020	Completed
PoC #12: Intelligent Transmission Network Optimization	**China Mobile** China Mobile Research Institute, China Mobile Group Zhejiang Co., Ltd., Huawei, Intel	Chen Shaofan	Sept.-2020	Completed
PoC#13: Intelligent Coverage Optimization of 5G Massive MIMO BS	**China Telecom** China Telecom, Intel, Inspur	Xueqi Yuan	October-2020	Ongoing
PoC #14: Intent-based Cloud Management	**NTT Labs** NTT labs, Intracom Telecom, NTT-AT, Intel	Chao Wu	June-2021	Ongoing
PoC#15: PINet—Polymorphic Intelligent Network	**China Telecom** China Telecommunications, China Mobile Research Institute, AsiaInfo Technologies Inc., Maipu Communication Technology Co., Ltd.	Ziting Zhang	Nov.-2022	In review

More info can be found https://eniwiki.etsi.org/index.php?title=Ongoing_PoCs

Network Intelligence Activities between 2016 and 2021

Activities:

- **Forum on Network Intelligence, Dec'16, Shenzhen, China**
- **ENI & SDNIA Joint Forum, Sep'17, Beijing, China**
- **ENI & H2020-SliceNet Workshop, Dec'17, London, UK**
- **ENI & 5GPPP MoNArch Workshop, Jun'18, Turin Italy**
- **ENI presentation to ITU workshop, Aug'18, San Jose, CA, USA**
- **ENI & CCSA TC610 AIAN Joint Forum, Sep'18, Beijing, China**
- **ENI & 5Tonic Joint Workshop, Dec'18, Madrid, Spain**
- **ENI & Samsung joint Workshop, Apr'19, Warsaw, Poland**
- **ENI & Altice Lab / Portugal Telecom joint Workshop, Jul'19, Aveiro, Portugal**
- **ENI & China Telecom Research labs, workshop with CCSA TC 610 SNIA, September 2019**
- **ENI in the pandemic 4 plenaries online remote, Release 2 progressed to near completion**
- **In 2020 – 6 deliverables approved**
- **Early 2021 ENI Release 3 start: 4 Work-items started initially**
- **Summer 2021 complete ENI Release 2; more Release 3 Work-items started**
- **End of 2021 Release 2 finalized, Release 3 underway**

Forum on Network Intelligence, Dec'16

ENI & SDNIA Joint Forum on Network Intelligence, Sep'17

ENI & SliceNet workshop, Dec'17

ENI & Samsung Workshop, Apr'19

ENI & Altice Lab / Portugal Telecom Workshop, Jul'19

ENI & China telecom Labs, Sept'19

Please Contribute

Contact Details:
Chair: Dr. Raymond Forbes Raymond.Forbes@huawei.com

+44 771 851 1361

Useful links:

ENI Terms of Reference	ENI membership list	ENI High Level Notice
ENI Member Agreement	ENI Published Deliverables	ENI White Paper
ENI Participant Agreement	ENI Presentation	ENI Blog
ENI Activity Report	ENI Wiki and PoC info	ENI Webpage

Acknowledge the assistance of: Dr. Yu Zeng zengyu@chinatelecom.cn

Thank you!