ETSI ISG ENI**

Creating an intelligent service

optimization solution

Chair:	Dr. Raymond Forbes (Huawei Technologies)
Vice-Chair:	Mrs. Haining Wang (Intel)
Presented by: Vice-Chair:	Miss Ziting Zhang (China Telecommunications)
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	**Miss Ziting Zhang** (China Telecommunications)
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) **Yu Zeng** (China Telecom) **Antonio Gamelas** (Portugal Telecom)

ENI Members and Participants

Netmagic Associates LLC

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

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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

❖ **Core concepts: Network perception analysis, data-driven policy, AI based closed-loop control**

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 (3)
Current Issues

⇨ **ENI Release 3 3Q2021 - 1Q2023:**

- 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 (22 publications):

- 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) Published General Terminology

- ETSI GS ENI 005 V2.1.1 (2021-12) 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 V2.1.1 (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 012 v1.1.1 (2022-03) Published Reactive In-situ flow information Telemetry

- ETSI GR ENI 013 v1.1.1 (2023-01) Published ENI Intent Policy Model

- 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) – Chao Wu (NTT)

- ENI 002 (WI RGS/ENI-002v321) – Target for approval Mar. 2023 stable draft
  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 015 (WI DGR/ENI-0025) – draft in progress
  Processing and Management of Intent Policy – Ziting Zhang (China Telecom)

- ENI 017 (WI RGR/ENI-0017v221) – draft in progress
  Overview of Prominent Control Loop Architectures – Sen Bian (AsiaInfo)

- ENI 019 (WI DGS/ENI-0029) – draft in progress
  Representing, Inferring and Proving Knowledge in ENI – John Strassner (Futurewei)

- ENI 030 (WI DGS/ENI-0030v311) – Target for approval Mar. 2023 draft in progress
  Transformer Architecture – John Strassner (Futurewei)

- ENI 031 (WI DGR/ENI-0031v311) – draft in progress
  fault maintenance network knowledge graphs – Bingming Huang (China Unicom)

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
Intelligent Optimization for Transmission Network
Energy saving in radio network

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
Service experience optimization of E2E slicing involving both OSS and BSS
Intent-based Cloud Management for VDI service
Intelligent vehicle diversified service fulfillment based on polymorphic network
AI based family broadband network user experience optimization

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

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

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

ENI System Reference Architecture
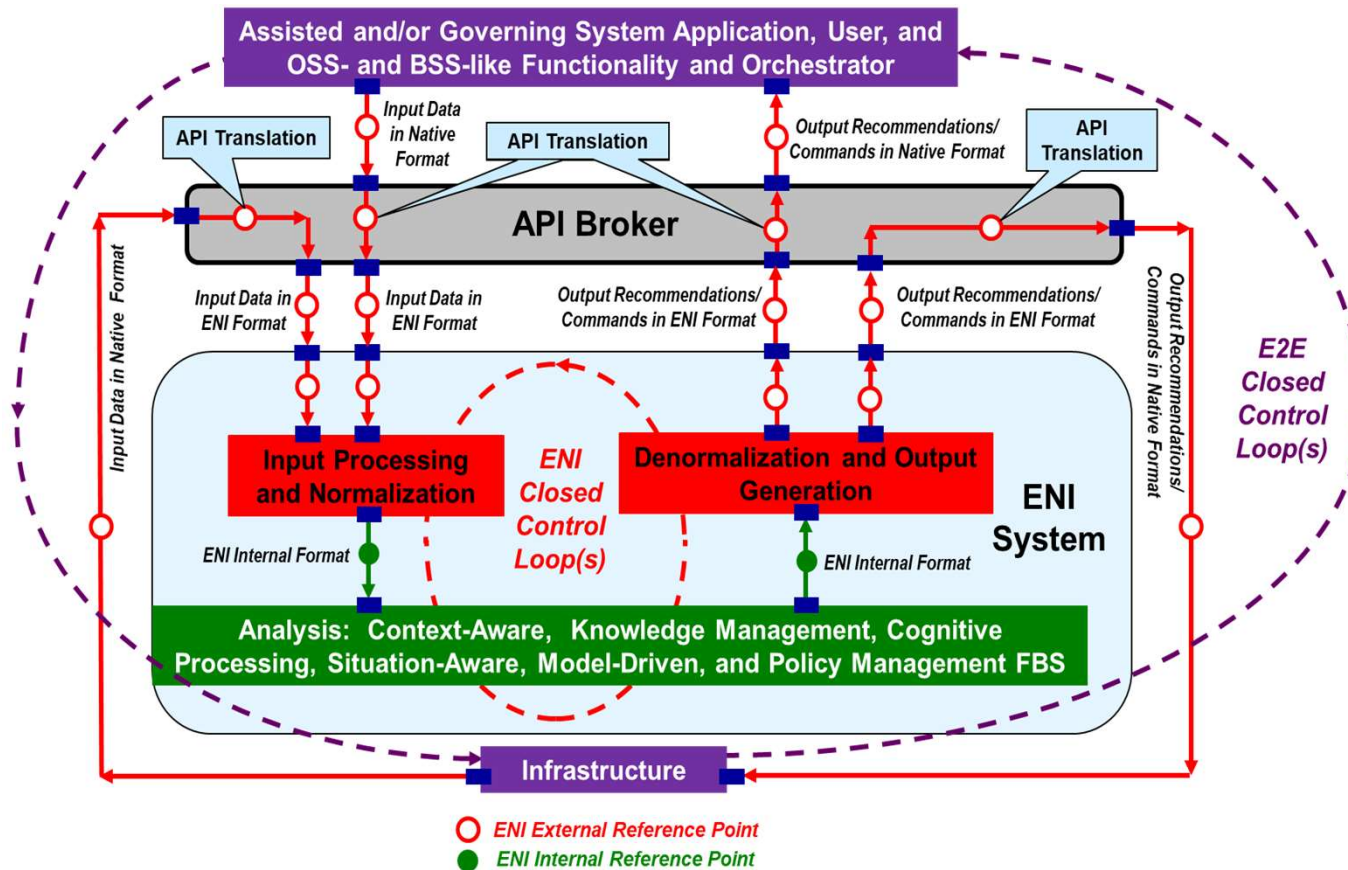
High-Level Functional Architecture Diagram in GS ENI 005 v2.1.1 Published in Dec. 2021, ETSI GS ENI 005 V2.1.1 (2021-12)

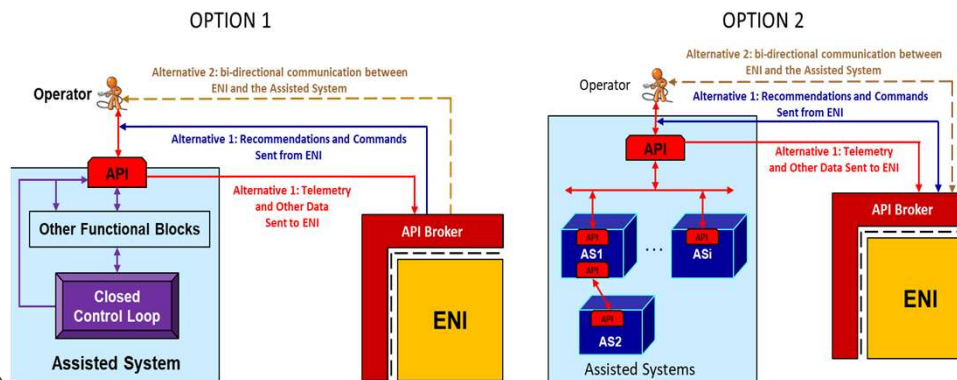# ENI System Architecture - Mode of Operation and Class

Class 1: An Assisted System that has No AI-based Capabilities
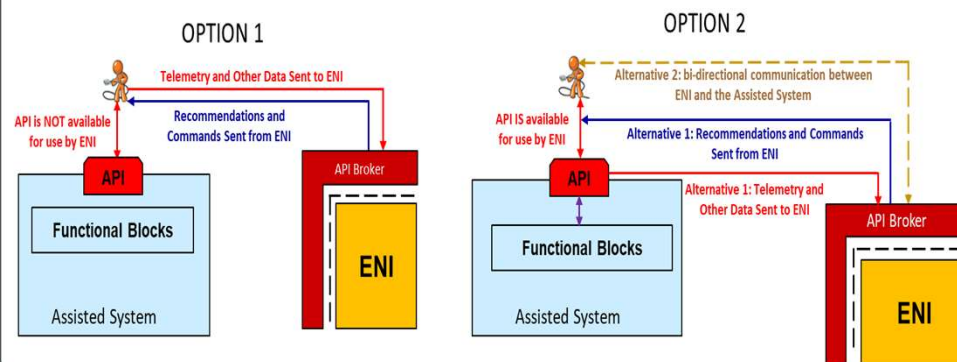
Class 2: An Assisted System with AI that is Not in the Control Loop
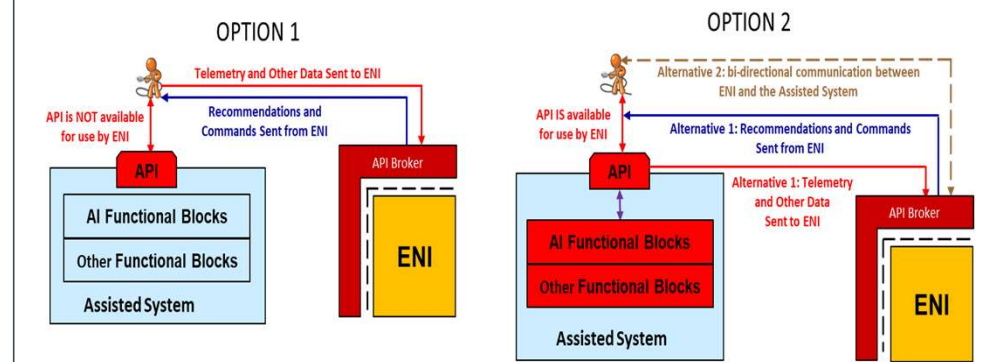
Class 3: An Assisted System with AI Capabilities in its Control Loop

- 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

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Architecture External Reference Points (Inputs & Outputs)
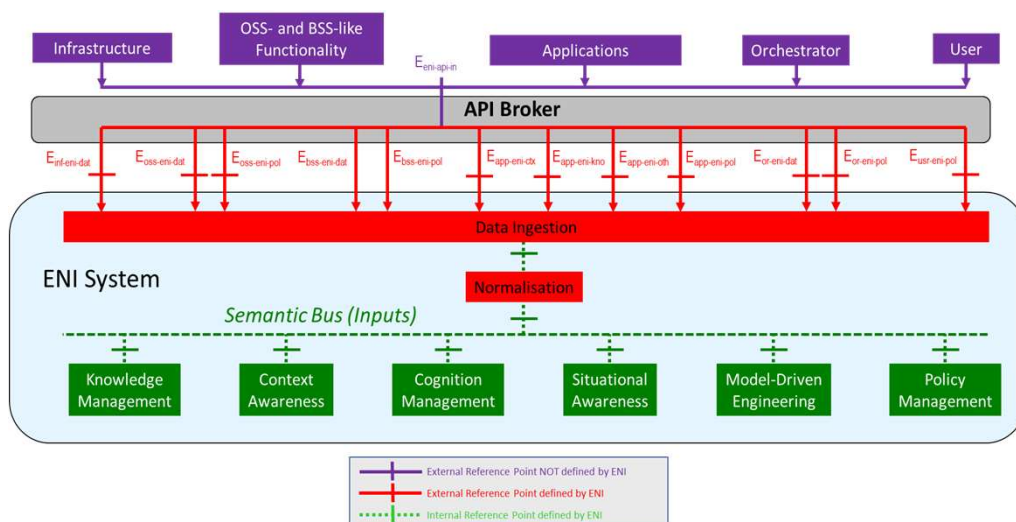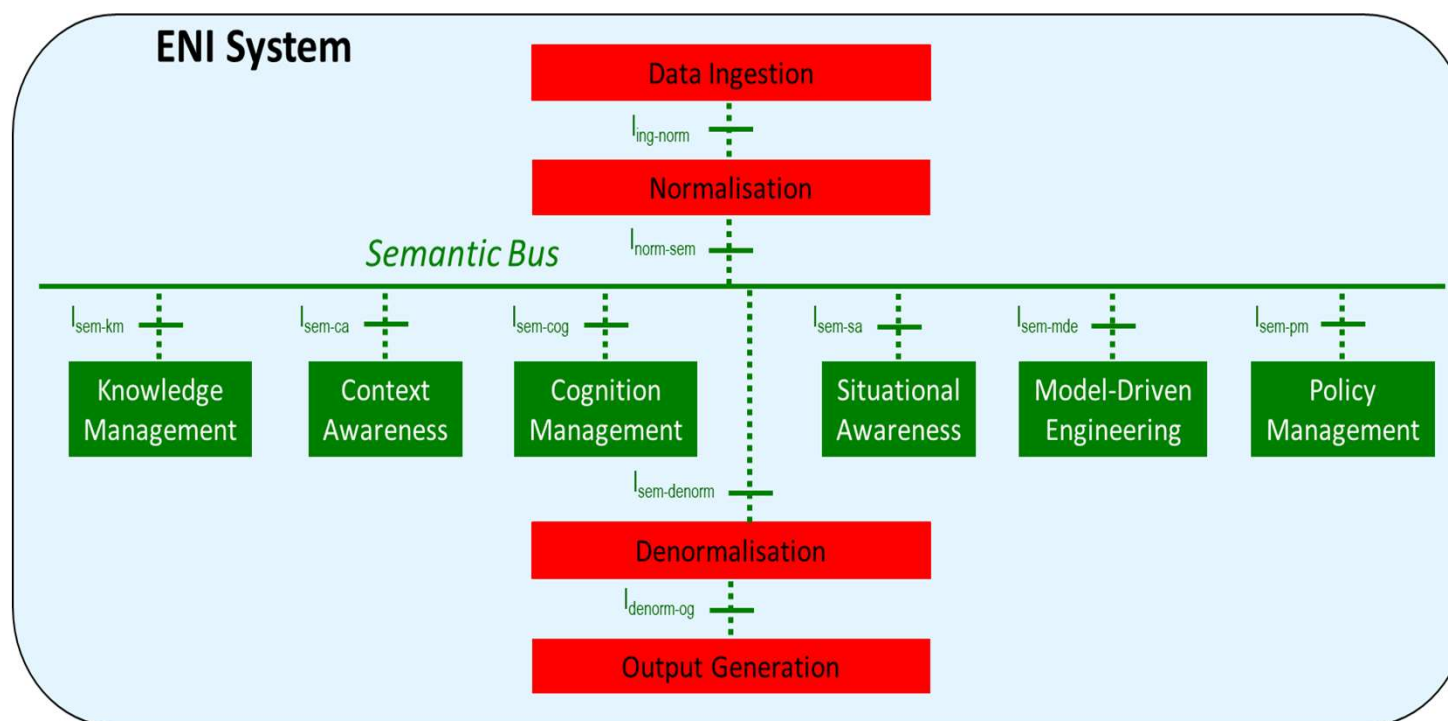

Functional Architecture with its Input Reference Points
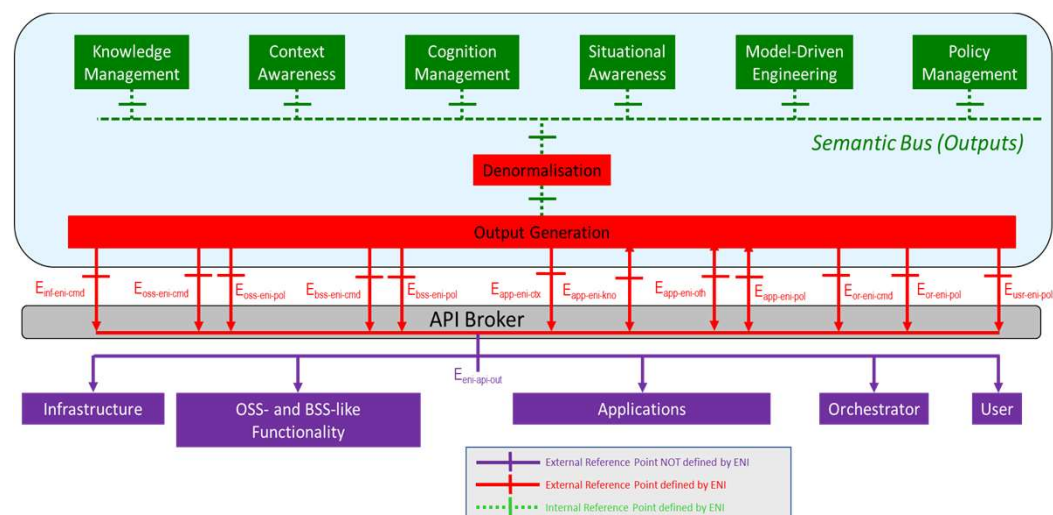
Functional Architecture with its Output Reference Points

Imperative, Declarative, and Intent Policies are handled within the same architecture, with no additional RP or FB needed
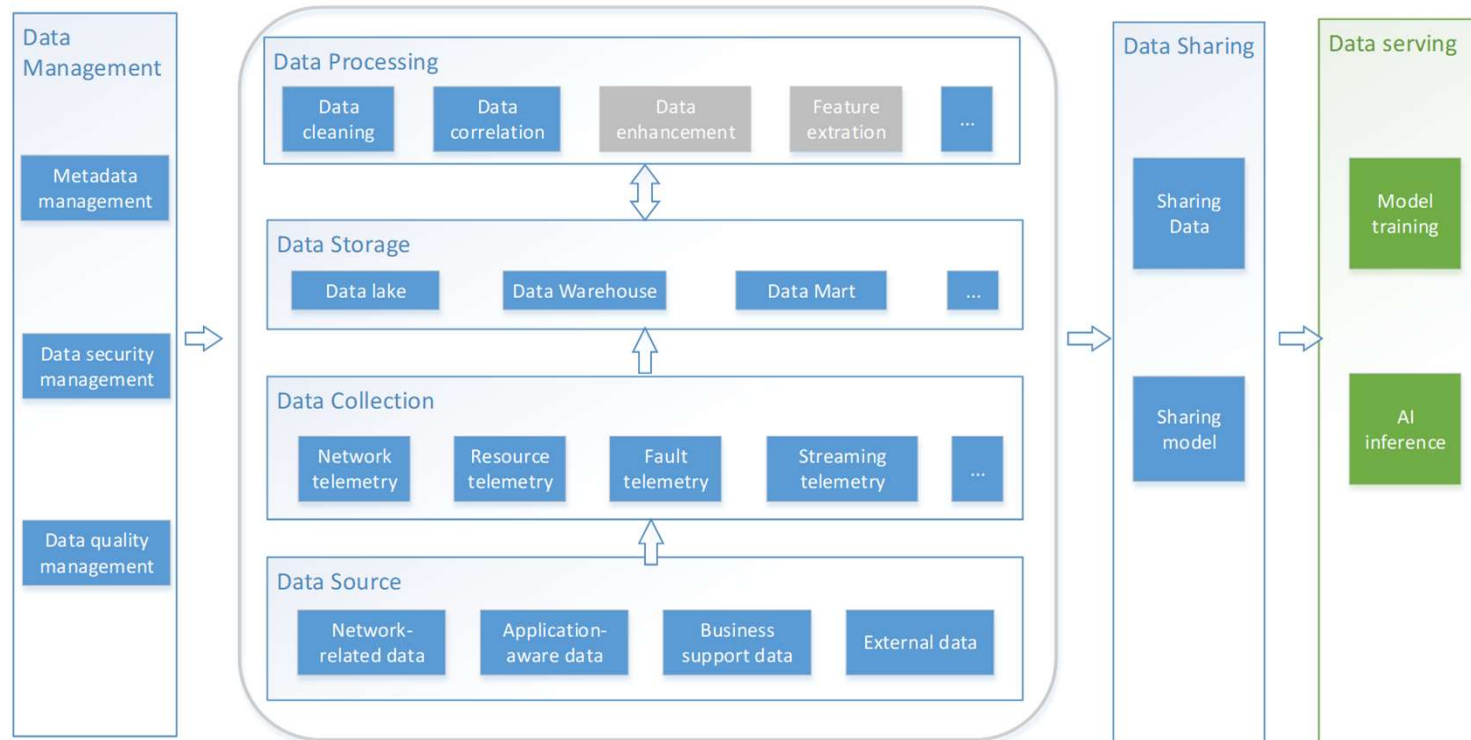
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Source: ETSI GS ENI 005 , ENI System Architecture

Architecture Internal Reference Points

Definition of Categories for AI Application to Networks

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

Autonomicity capability
Continuous improvement

Categories of network autonomicity from a technical point of view

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Data Mechanism Framework

The Data Mechanism supports different data acquisition and processing mechanisms for data from different sources and for use by different network applications. This makes it possible to assemble a comprehensive data mechanism supporting AI enabled network OAM and service management.

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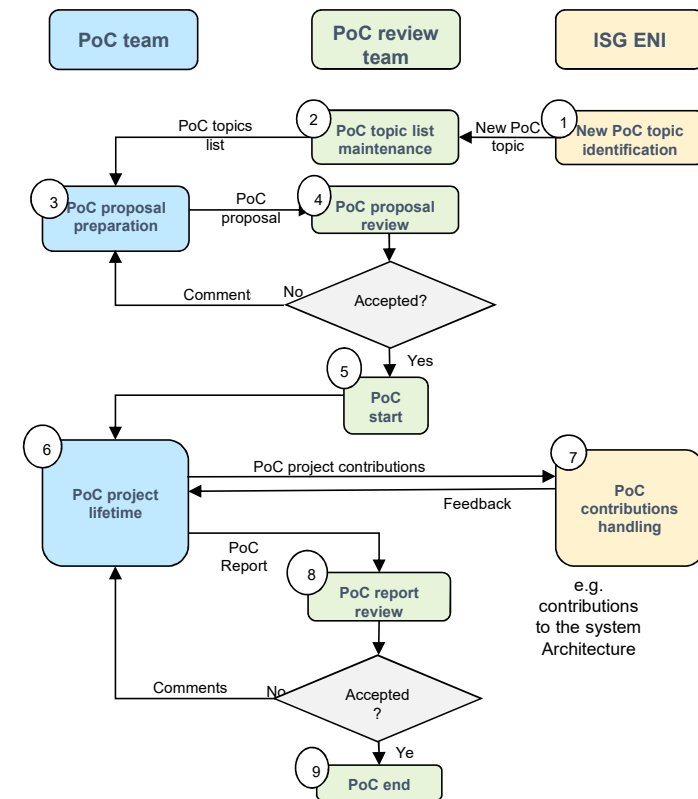
PoC project wiki: https://eniwiki.etsi.org/index.php?title=Ongoing_PoCs

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

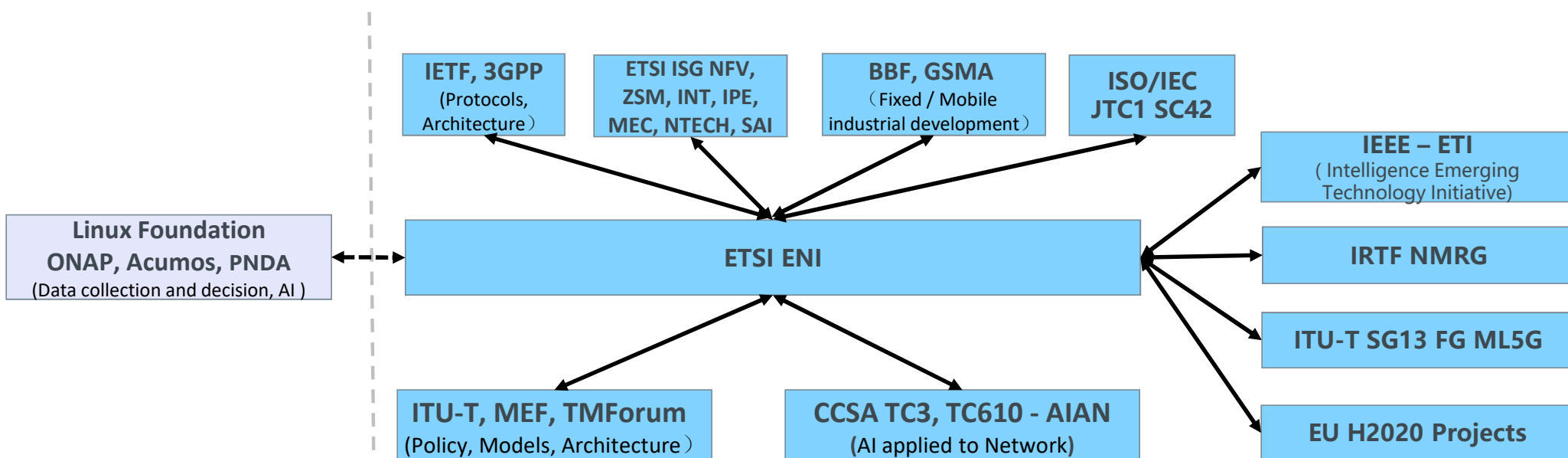More info can be found https://eniwiki.etsi.org/index.php?title=Ongoing_PoCs

ENI PoC List (2)

Title	PoC Team Members	Main Contact	Start Time	Current Status (Dec.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	Completed
PoC#14: Intent-based Cloud Management	**NTT Labs** NTT labs, Intracom Telecom, NTT-AT, Intel	Chao Wu	June-2021	Completed
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.-2021	Completed
PoC#16: AI based family broadband network user experience optimization	**China Mobile** China Mobile Research Institute, AsiaInfo Inc., Intel	Bian Sen	October - 2022	Ongoing

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

ENI Value Proposition and Synergy with Other SDOs

Open Source

Standard & Industry & Research

IETF, 3GPP (Protocols, Architecture)	
ETSI ISG NFV, ZSM, INT, IPE, MEC, NTECH, SAI	
BBF, GSMA (Fixed / Mobile industrial development)	
ISO/IEC JTC1 SC42	

Linux Foundation ONAP, Acumos, PNDA (Data collection and decision, AI)

ETSI ENI

IEEE – ETI (Intelligence Emerging Technology Initiative)

IRTF NMRG

ITU-T SG13 FG ML5G

EU H2020 Projects

ITU-T, MEF, TMForum (Policy, Models, Architecture)

CCSA TC3, TC610 - AIAN (AI applied to Network)

- Cooperate with mainstream operators, vendors and research institutes in Europe, USA and Asia
- Collaborate with other SDOs and industry Forums
    - Liaisons exchanged with IETF, BBF, MEF, ITU-T, ISO/IEC
    - Liaisons with other ETSI groups: NFV, INT, IPE, MEC, NTECH, ZSM, SAI
- Position ETSI ENI as the home of network intelligence standards
- Guide the industry with consensus on the evolution of network intelligence
- Ccooperate with TMForum on Autonomous networks

ETSI internal Technical Bodies (TCs/ISGs)

ETSI TECHNICAL BODY ACTIVITY	
ETSI ISG NFV	Industry Standardization Group on Network Functions Virtualization
ETSI ISG MEC	Industry Standardization Group on Mobile-access Edge Computing
ETSI ISG ZSM	Industry Standardization Group on Zero touch network and Service Management
ETSI ISG SAI	Industry Standardization Group on Securing AI
ETSI ISG IPE	IPv6 Evolution
ETSI TC INT - AFI	Technical Committee Core Network and Interoperability Testing - Evolution of Management towards Autonomic Future Internet
ETSI TC CYBER	CYBER security centre of expertise
3GPP SA2 3GPP SA5	Mobile standardization specification global partnership project
OCG AI OCG AN	Operational coordination subgroup on Artificial Intelligence Operational coordination subgroup on Autonomous Network

Network Intelligence Events & Milestones between 2016 and 2022

- **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**
- **2022 Release 3 definition approved, 4th term extension request approved by ETSI**

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

Thank you!