



The Standards People

• 20-January-2020

ETSI ISG ENI**

Creating an intelligent service
optimization solution

Presented by:

- Chairman: Dr. Raymond Forbes (Huawei Technologies)
- Vice-Chairman: Mrs. Haining Wang (Intel)
- Vice-Chairman: Dr. Luca Pesando (Telecom Italia)
- Secretary: Dr. Yue Wang (Samsung)
- Technical Officer: Mrs. Korycinska Sylwia (ETSI)
- Technical Manager: Dr. Shucheng Liu "Will" (Huawei Technologies)

Outline

- ETSI ISG ENI Progress
- Vision & Background
- Introduce the Status of ETSI ISG ENI (Experiential Networked Intelligence)
- Network Intelligence Activities in 2016 - 2019
- WI Progress

ENI Published Reports, Specifications & Workplan



Published ENI deliverables:

- [ETSI GS ENI 001 V2.1.1 \(2019-09\)](#) **Published**
Use Cases
- [ETSI GS ENI 002 V2.1.1 \(2019-09\)](#) **Published**
Requirements
- [ETSI GR ENI 003 V1.1.1 \(2018-05\)](#) **Published**
Context-Aware Policy Management Gap Analysis
- [ETSI GR ENI 004 V2.1.1 \(2019-10\)](#) **Published**
General Terminology
- [ETSI GS ENI 005 V1.1.1 \(2019-09\)](#) **Published**
System Architecture
- [ETSI GS ENI 006 V1.1.1 \(2018-05\)](#) **Published**
Proof of Concept (PoC) Framework
- [ETSI GR ENI 007 V1.1.1 \(2019-11\)](#) **Published**
Definition of Categories for AI Application to Networks

Accessible via [Work Item Monitoring - ENI](#)

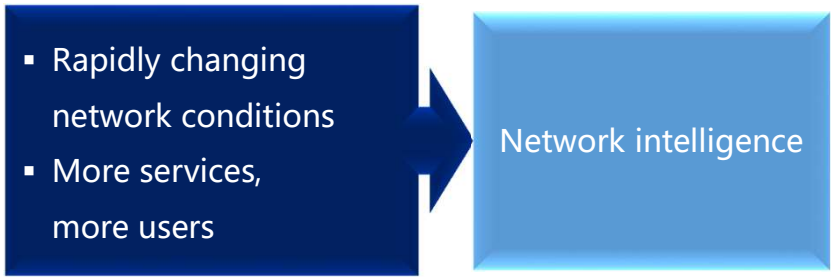
Ongoing ENI Work Items and Rapporteurs:

- ENI 001 (WI RGS/ENI-0014)
Use Cases (Release 2) – Yue Wang (Samsung)
- ENI 002 (WI RGS/ENI-0015)
Requirements (Release 2) – Haining Wang (Intel)
- ENI 004 (WI RGR/ENI-0018)
General Terminology (Release 2) – Yu Zeng (China Telecom)
- ENI 005 (WI DGS/ENI-0016)
System Architecture (Release 2) – John Strassner (FutureWei)
- ENI 006 (WI RGS/ENI-0012)
PoC Framework (Release 2) – Bill Wright (Redhat/IBM)
- ENI 008 (WI DGR/ENI-0013)
Intent Aware Network Autonomicity – Yannan Bai (China Telecom)
- ENI 009 (WI DGR/ENI-0017)
Definition of data processing mechanisms - Weiyuan Li (China Mobile)
- ENI 010 (WI DGR/ENI-0020)
Evaluation of categories for AI application to Networks - Bingming Huang (China Unicom)
- ENI 011 (WI DGS/ENI-0021)
Mapping between ENI architecture and operational systems– Yannan Bai (China Telecom)

Business Value

• Network : Traditional → SDN & NFV → Autonomic Network

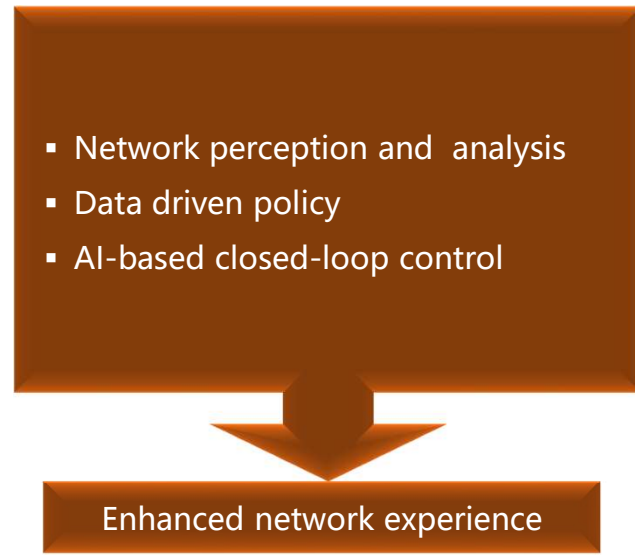
Network technology evolution



Network mgmt. and operation evolution



ENI



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 Paper, http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp22_ENI_FINAL.pdf



ENI Goals and Leadership Team

Core idea: Network perception analysis, data-driven policy, AI based closed-loop control

ETSI ISG ENI founded at 17Q1, Release 1 (2017-2019)

- The ISG ENI focuses on improving the operator experience, adding closed-loop artificial intelligence mechanisms based on context-aware, metadata-driven policies to more quickly recognize and incorporate new and changed knowledge, and hence, make actionable decisions.
- In particular, ENI will specify a set of use cases, and the 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

Extended at 19Q1 into Release 2(2019-2021)

- New Terms of reference included: external reference points, implementation, PoC, plug-tests and open-source relationships.
- Release 2 defines loop control in the real-time network.

The ISG ENI Leadership team

Role	Name (Organization)
Chairman	Dr. Raymond Forbes (Huawei)
Vice Chairman	Mrs. Haining Wang (Intel)
Second Vice Chairman	Dr. Luca Pesando (Telecom Italia)
Secretary	Dr. Yue Wang (Samsung)
Technical Officer	Mrs. Sylwia Korycinska (ETSI)
Technical Manager	Dr. Shucheng Liu "Will" (Huawei)
ENI ISG PoC Review Team	Raymond Forbes (Huawei) Sylwia Korycinska (ETSI Technical Officer) Michele Carignani (ETSI CTI) Bill Wright (Redhat) Haining Wang (Intel) Luca Pesando (Telecom Italia) Mostafa Essa (Vodafone) 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

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

Requirements

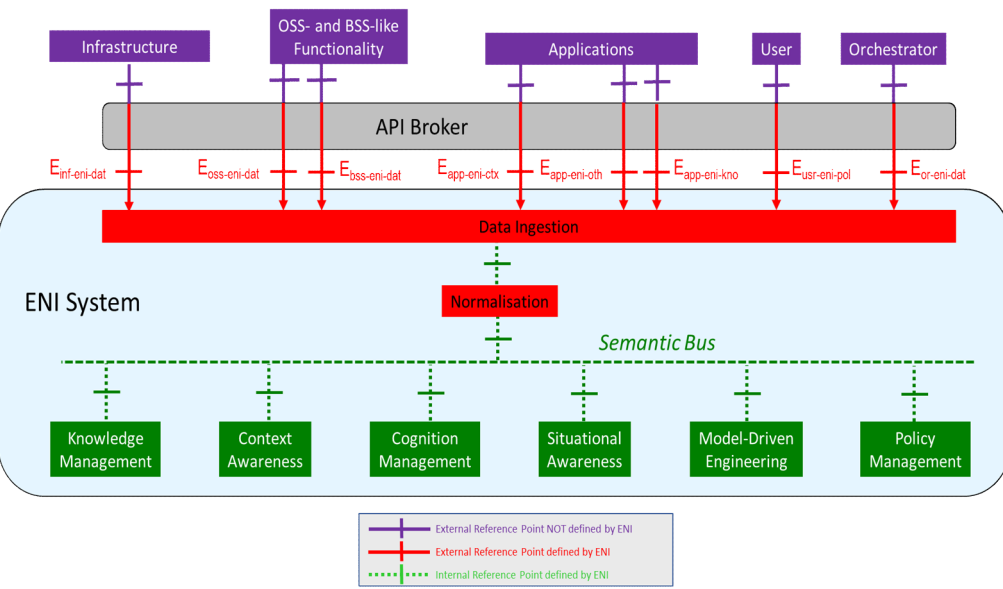


Level 1	Level 2
Service and network requirements	General requirements
	Service orchestration and management
	Network planning and deployment
	Network optimization
	Resilience and reliability
	Security and privacy

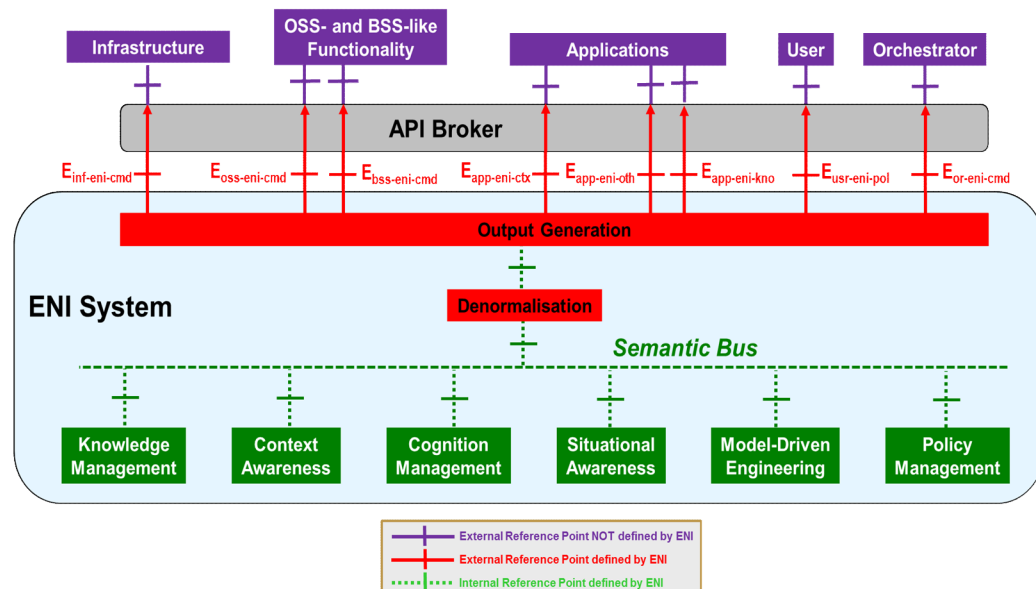
Level 1	Level 2
Functional requirements	Data Collection and Analysis
	Policy Management
	Data Learning
	Interworking with Other Systems
	Mode of Operations
	Model training and iterative optimization

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

Architecture External reference points (Inputs & Outputs)

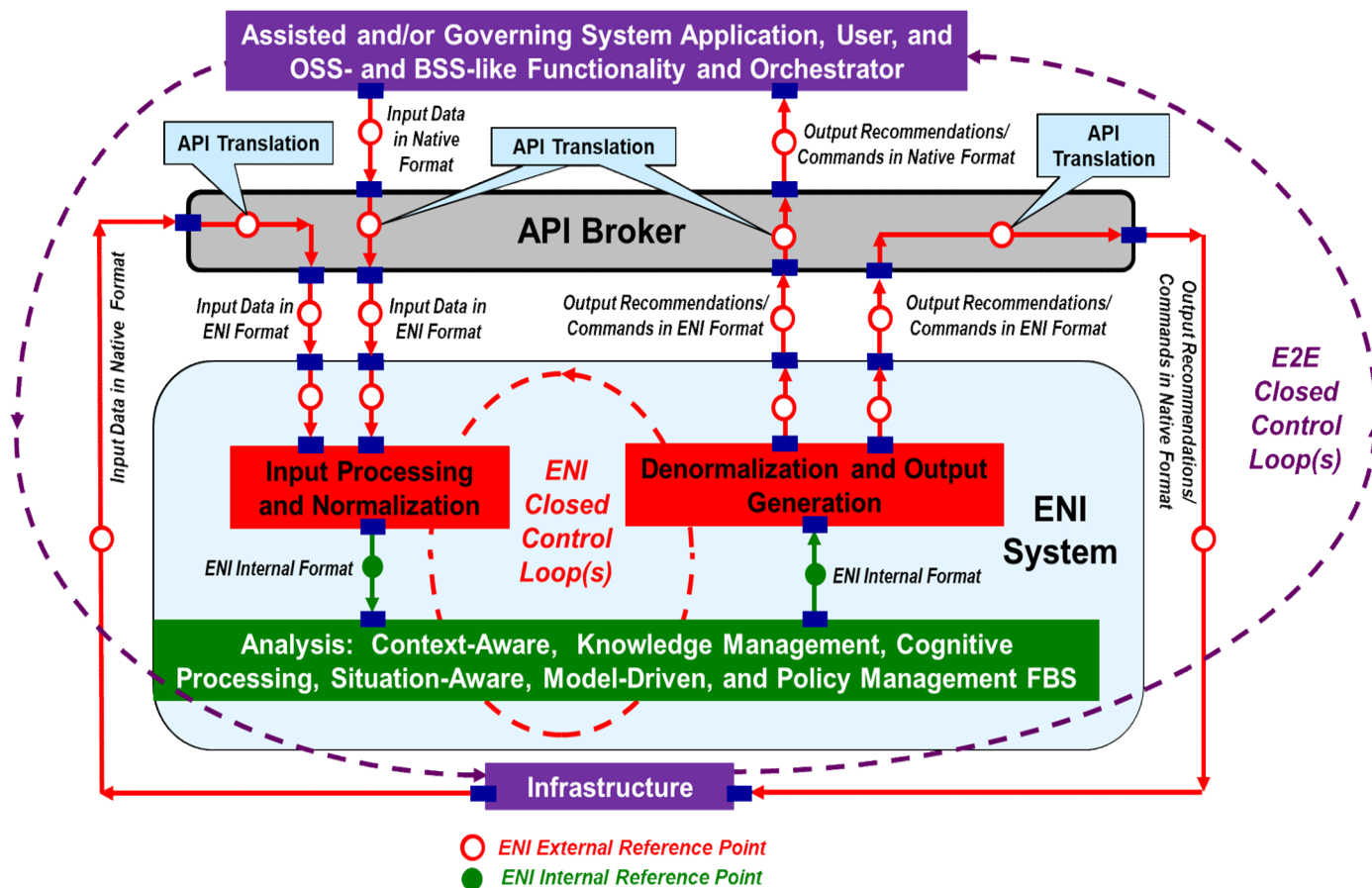


Functional Architecture with its Input Reference Points



Functional Architecture with its Output Reference Points

ENI High-Level Functional Architecture

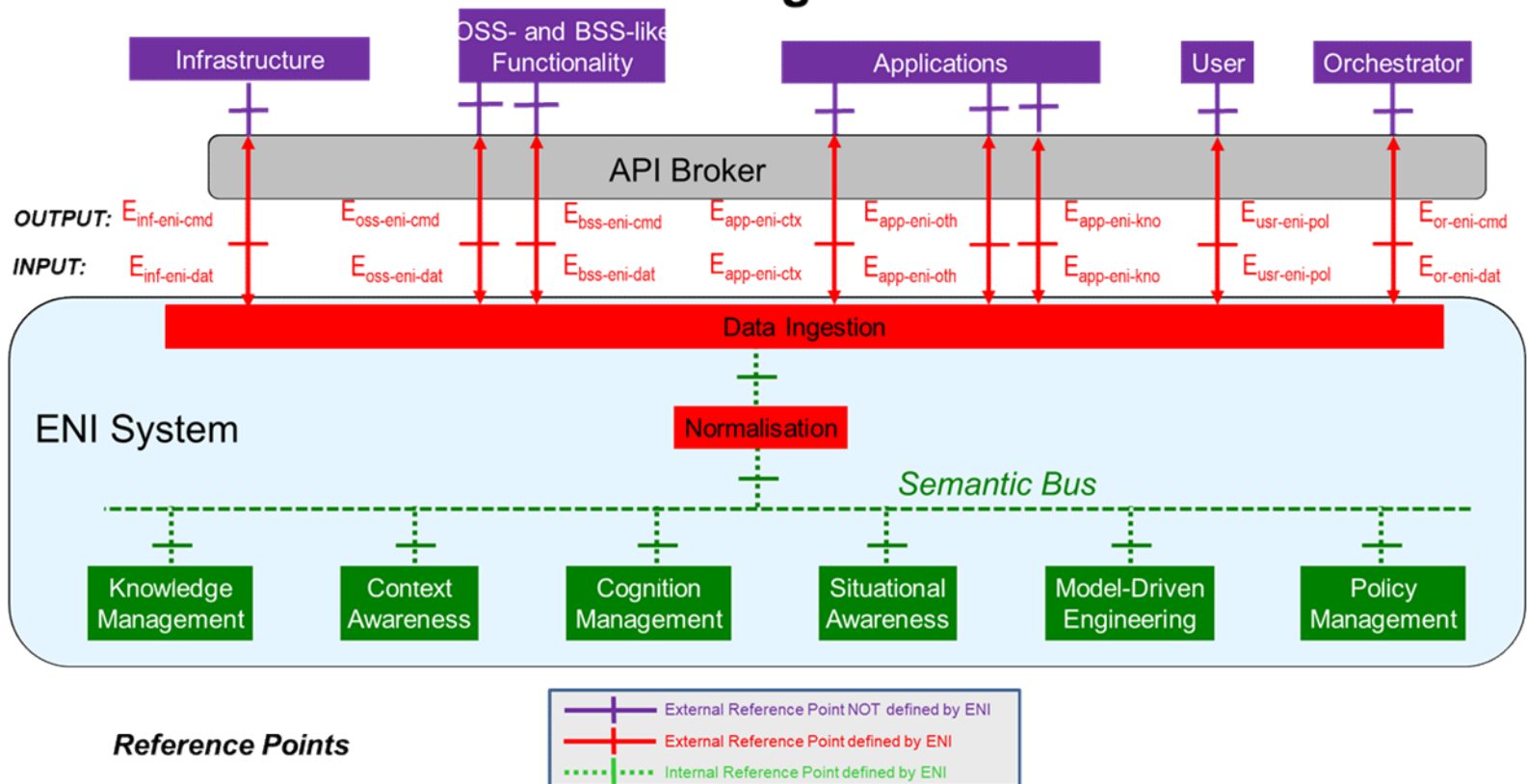


High-Level Functional Architecture Diagram in GS ENI 005 (GS ENI 005)

Architecture External reference points (Inputs & Outputs)



Reference Points: interacting with ENI



Definition of Categories for AI Application to Networks

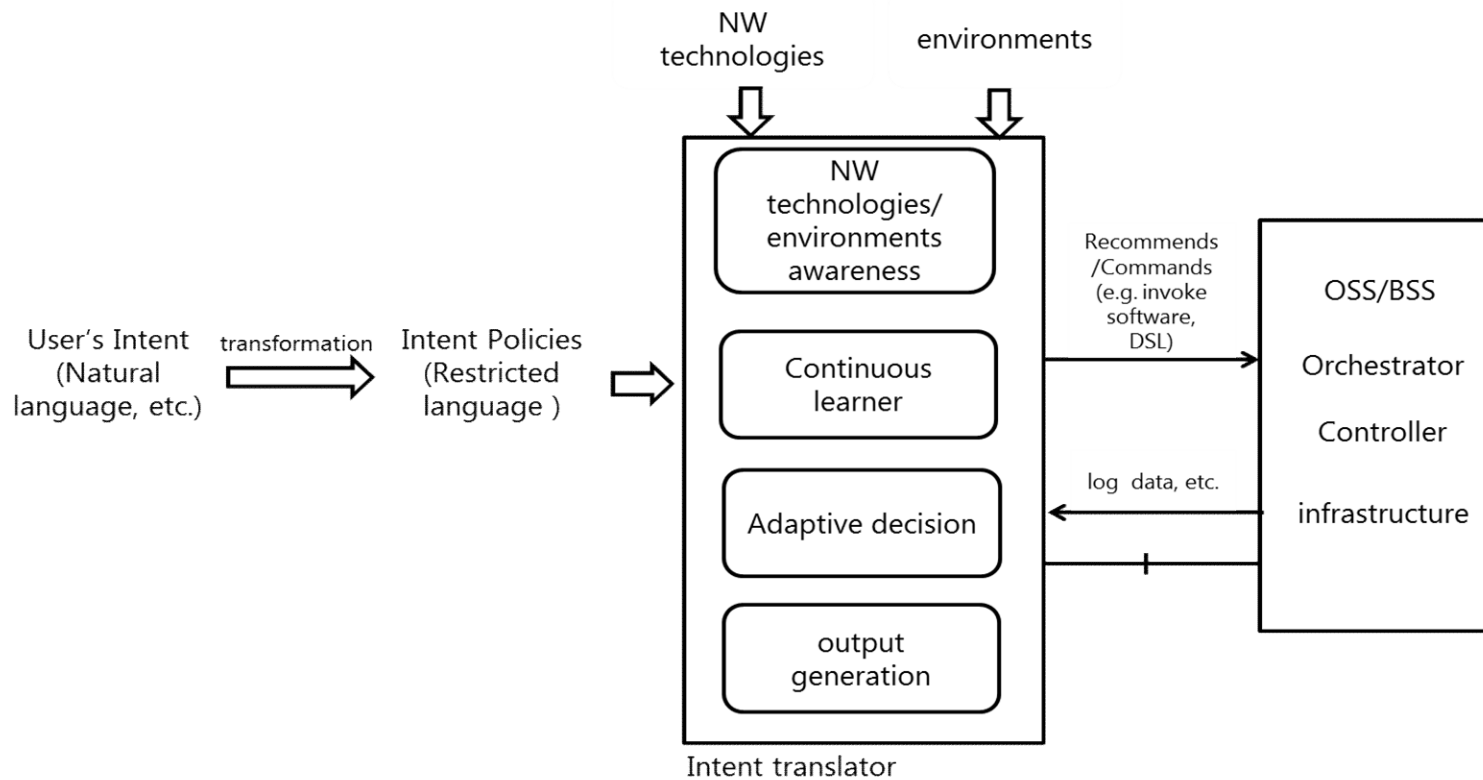
Category	Name	Definition	Man-Machine Interface	Decision Making Participation	Data Collection and Analysis	Degree of Intelligence	Environment Adaptability	Supported Scenario
Category 0	Manual O&M	O&M operators manually control the network and obtain network alarms and logs	How (command)	All-manual	Single 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 autonomy	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 autonomy	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

Autonomy capability
Continuous improvement

Categories of network autonomy from a technical point of view

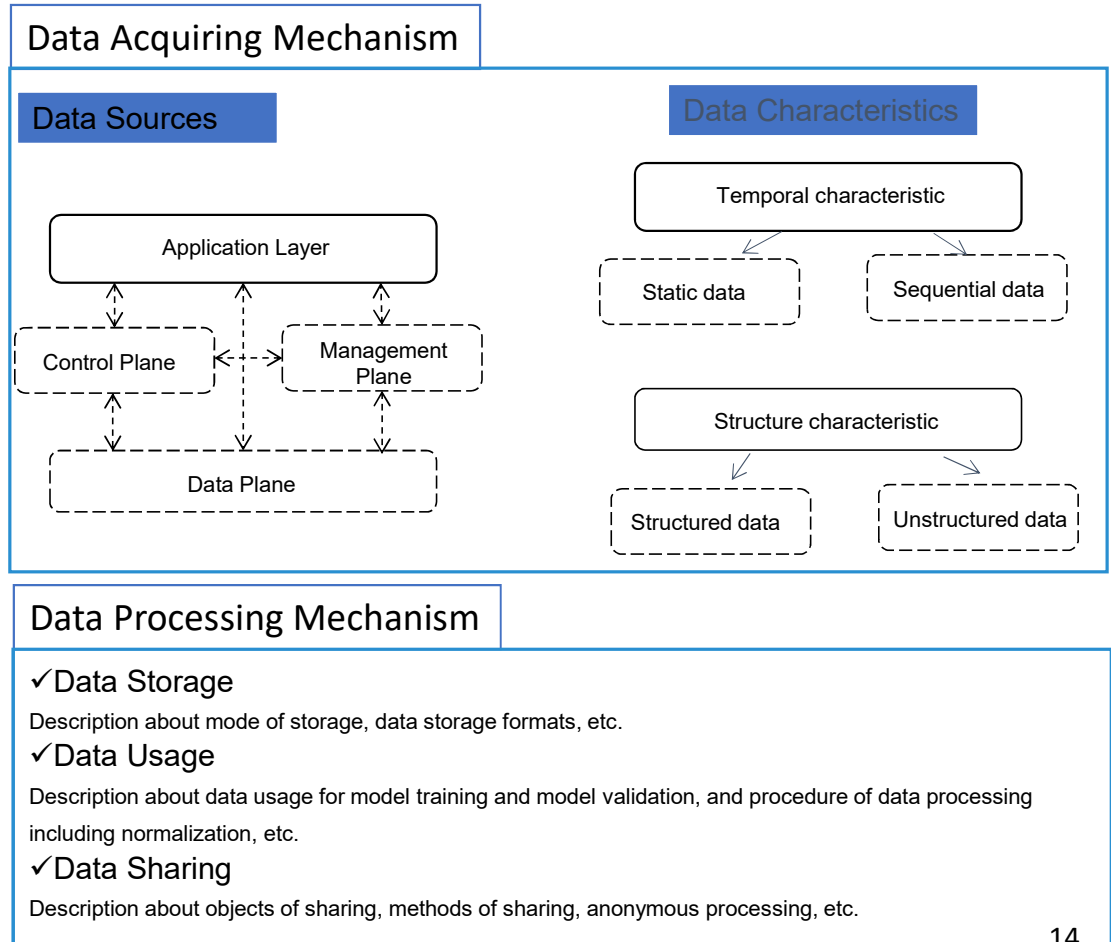
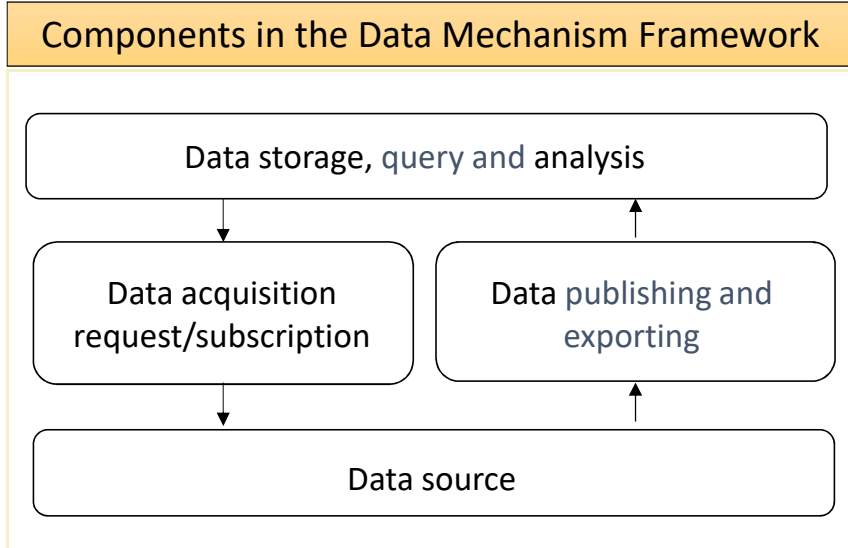
Source: ETSI GR ENI 007 , ENI Definition of Categories for AI Application to Networks

Process of Intent Policy Translation and Implementation



Main Contents of the Data Mechanisms

WI



PoC Team and ENI Work-Flow proposal

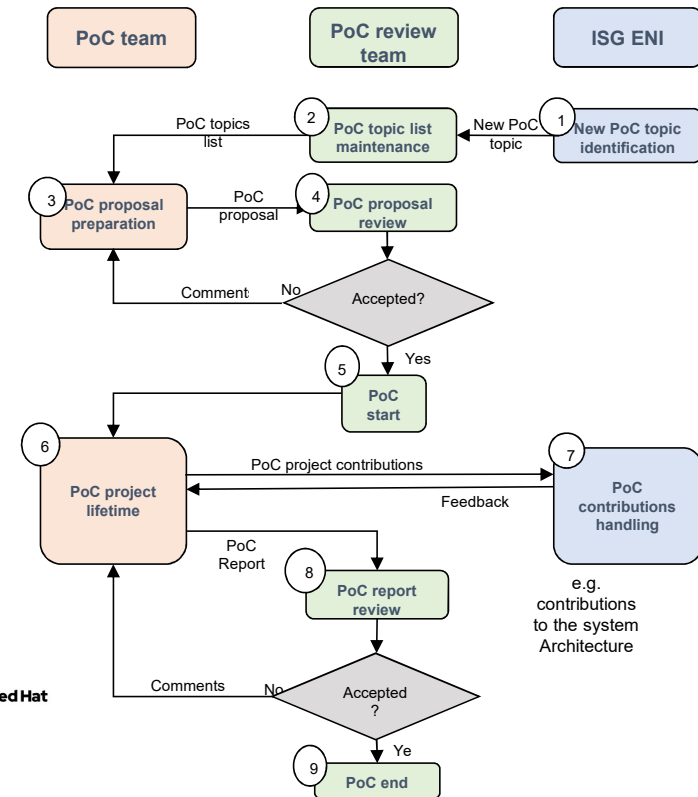


using the process under definition in ETSI

- Procedures:
 - ISG ENI draft and approve a PoC framework
 - Form a PoC review group to receive and review PoC proposals with formal delegation from ISG
 - Publish the framework (e.g. ENI has set up a wiki)
 - 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 – use the process and template of the ISG – Choose a POC Team Leader and draft the proposal

- ENI PoC review team:

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



ENI PoC List



Title	PoC Team Members	Main Contact	Start Time	Current Status (Feb-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 Multi-domain Network Slices	Portugal Telecom/Altice Labs SliceNet Consortium	António Gamelas Rui Calé	Mar-2019	Ongoing
PoC #5: AI Enabled Network Traffic Classification	China Mobile Huawei, Intel, Tsinghua University	Weiyuan Li	Jun- 2019	Ongoing
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	Ongoing
PoC #7: Intelligent time synchronization of network	China Unicom Beijing University of Posts and Telecommunications, Samsung, Cambricon, Huawei	Bingming Huang	Sep-2019	Ongoing
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	Started
PoC #9: Autonomous Network Slice Management for 5G Vertical Services	Nextworks TIM, Nextworks, Samsung, WINGS, UC3M	Gino Carrozzo	Jan-2020	Started
PoC #10: Intelligent Telecom Network Energy Optimization	China Mobile China Mobile Research Institute, Intel, Quanta Cloud Technology, Hong Kong ASTRI (Applied Science and Technology Research Institute)	Yan Yang	Jan-2020	Started

ENI PoC project #1: Intelligent Network Slice Lifecycle Management

AI-based predictor:

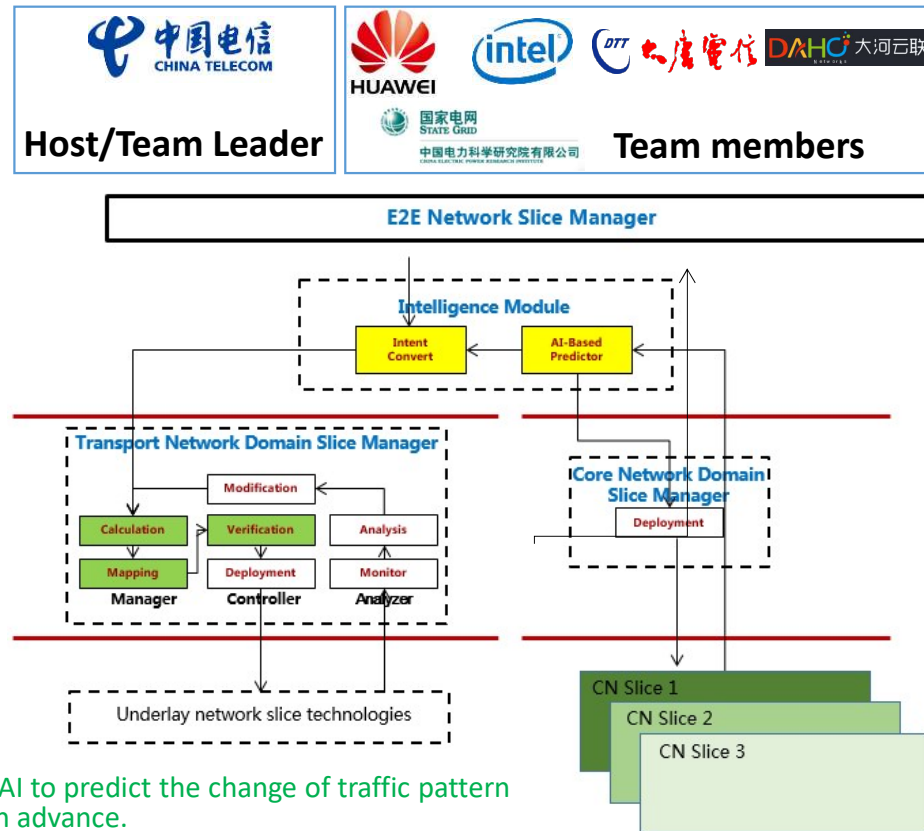
- For generating new scale up/down and converting the intent to suggested configuration.
- LSTM is used for traffic prediction.

TNSM:

- Provides underlay network control to satisfy the network slice requests.
- FlexE and a FlexE-based optimization algorithm are used for underlay network slice creation and modification.

CNSM:

- Provides core network control to satisfy the network slice requests
- ✓ PoC Project Goal #1: Demonstrate the use of AI to predict the change of traffic pattern and adjust the configuration of network slice in advance.
 - ✓ PoC Project Goal #2: Demonstrate the use of intent based interface to translate tenant requirements to network slice configuration and intelligent network slice lifecycle management on demand.



Showcases:

- Beijing, Sep 19-20, 2018
- Nanjing, Nov 14-16, 2018
- Warsaw, Apr 10, 2019

<https://eniwiki.etsi.org/index.php?title=PoC#PoC.231>
: Intelligent Network Slice Lifecycle Management

ENI PoC project #2: Elastic Network Slice Management



Main Features

Network Slice Blueprinting & Onboarding

One innovative service through 2 network slices

✔ Virtual Reality application

Elastic Intelligent Features:

✔ One eMBB slice for 360 video

✔ Horizontal and Vertical VNF Scaling

✔ One URLLC slice for haptic interaction

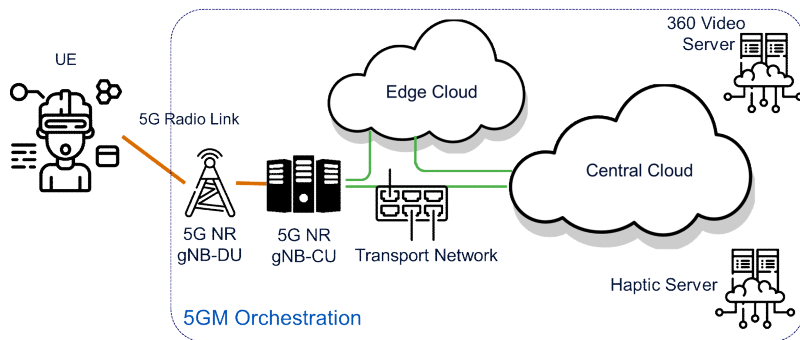
✔ Intelligent Admission Control



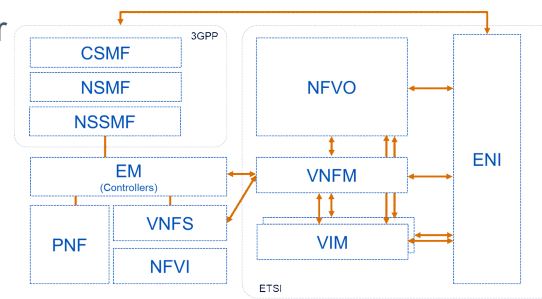
PoC Team



VR Service



Hardware and Software Setup



Orchestration Architecture

Goals:

✔ Provide enhanced AI-based mechanisms to provide novel 5G Services

✔ Design, test and validate new interfaces with MANO

Showcases:

✔ Turin: May 20th-24th 2019

✔ Valencia: June 17th-21st 2019

✔ <https://youtu.be/L-5XzBvAZyY> 18

https://eniwiki.etsi.org/index.php?title=PoC#PoC.232: Elastic_Network_Slice_Management

ENI PoC project #3: Securing against Intruders and other threats through a NFV-enabled Environment (SHIELD)



Status: PoC public demo 23-25th Feb. 2019, and finished.

Host/Team Leader: *Telefonica*

Team members:: **SPACE** **ORION** 



Goals

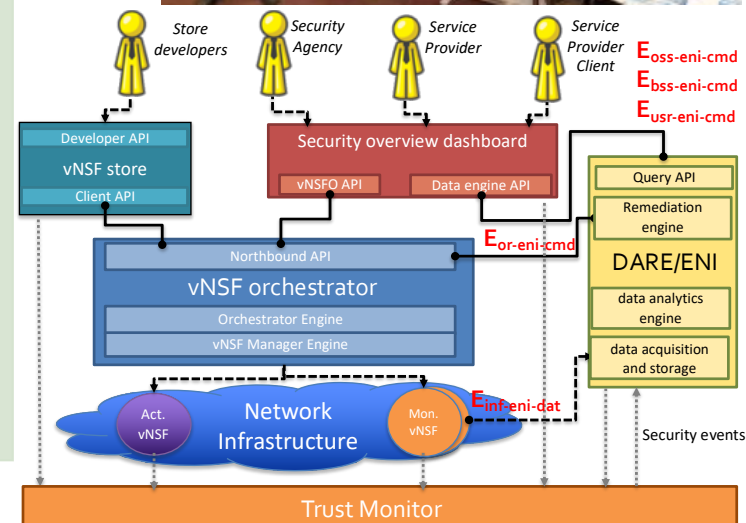
- PoC Goal #1: Demonstrate an AI framework able to detect network attacks over NFV network combining several ML algorithms
- PoC Goal #2: Recommend intent-based security policy
- PoC Goal #3: Remote attestation for data collectors.

Gaps identified

- Coordination between AI models / ENI systems.
 - Support 3rd party AI models
 - Information sharing between ENI systems
- Data collection integrity and security with Trust Monitoring
- Synchronization between intent-based and configuration policies API

Contribution

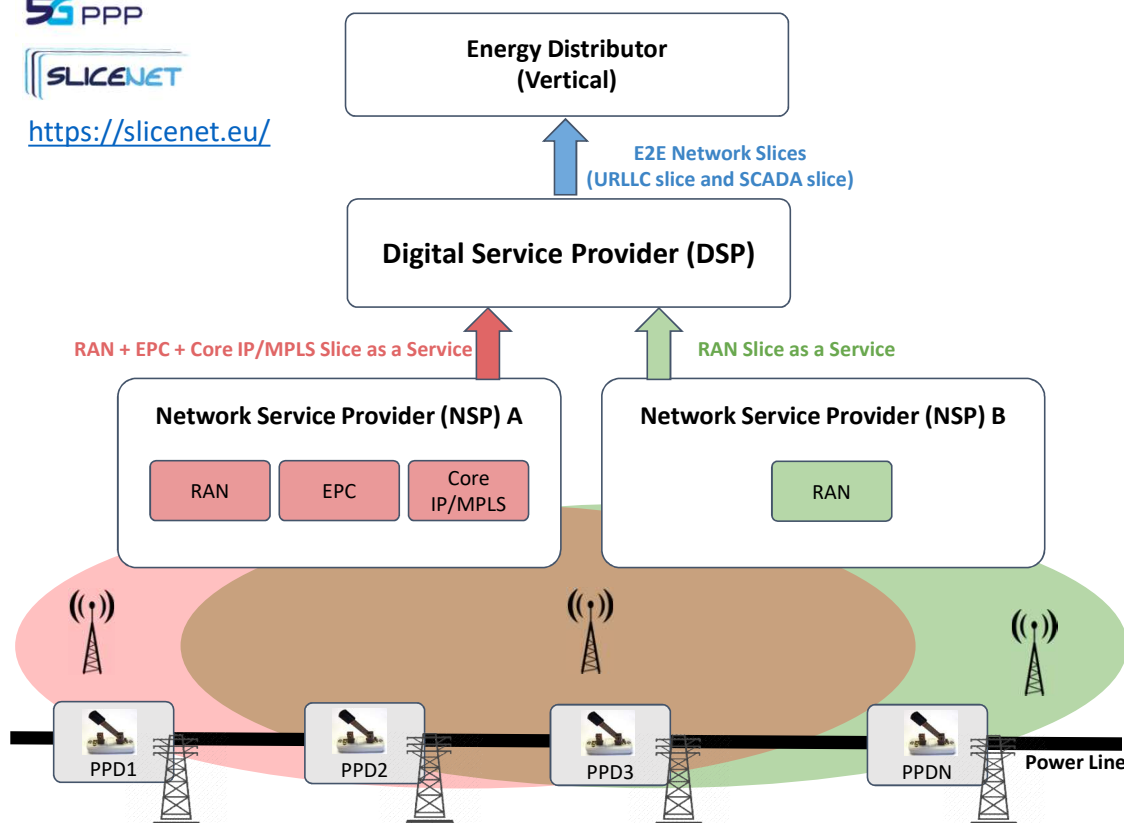
- New type of use cases related with malware in ENI 001



ENI PoC project #4: Predictive Fault management of E2E Multi-domain Network Slices



<https://slicenet.eu/>



- PoC scenario is a power grid vertical, that uses 5G to provide time sensitive communications for grid protection mechanisms. A Network Slice is provided by a DSP for that effect.
- PoC is focused on the **DSP** functions
 - NSPs provide Sub-slices
 - DSP monitors all Sub-slices behaviour
 - DSP predicts Sub-slice failure
 - DSP decides best failover sub-slice alternative
 - DSP triggers Subslice/NSP switching

PoC Project Goal #1: Network Slice Fault Prediction. Demonstrate the use of AI on performance data to be able to accurately predict failure situations on Network Slices and estimate their impact on an E2E multi-domain slice performance.

PoC Project Goal #2: Policy-based Network Slice Management. Evaluate the use of a policy-based structure for slice composition decisions, as well as the mechanisms for policy definition on that same context.

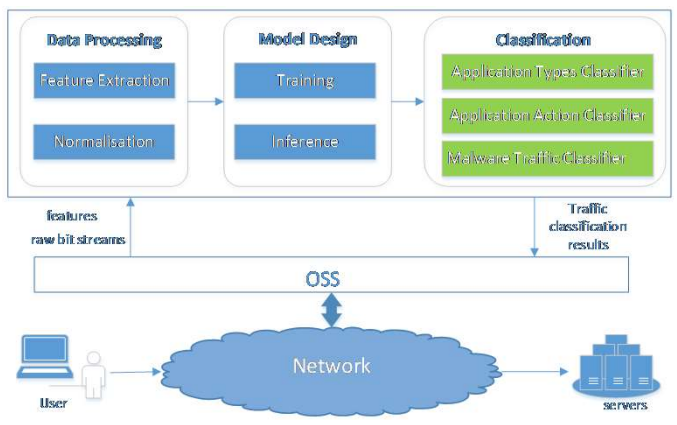
https://eniwiki.etsi.org/index.php?title=PoC#PoC.234:_Predictive_Fault_management_of_E2E_Multi-domain_Network_Slices

ENI PoC project #5: Intelligent Traffic Profiling

Host/Team Leader:



Team members:

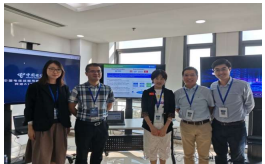


This PoC aims to verify the feasibility and the benefits of the use of AI/ML for network traffic classification, including the encrypted traffic, and demonstrate in a testbed environment that how ENI system can support intelligent traffic profiling and mechanism generalization.

This PoC consists of three scenarios:

- ✓ **The first scenario** demonstrates that the AI/ML-based technique enables network traffic to be categorized into classes of application types, e.g. high-throughput data, real-time interactive, multimedia streaming, low-priority data.
- ✓ **The second scenario** shows that traffic flows generated by a specific application can be classified into classes of subactions types , e.g. query action, call action etc.
- ✓ **The third scenario** shows that the malware traffic and normal traffic can be identified based on the AI/ML algorithms.

- Showcases:
- Beijing, Sep 27, 2019
 - Guangzhou, Nov 14-16, 2019
 - Sophia Antipolis France, Dec9-10, 2019

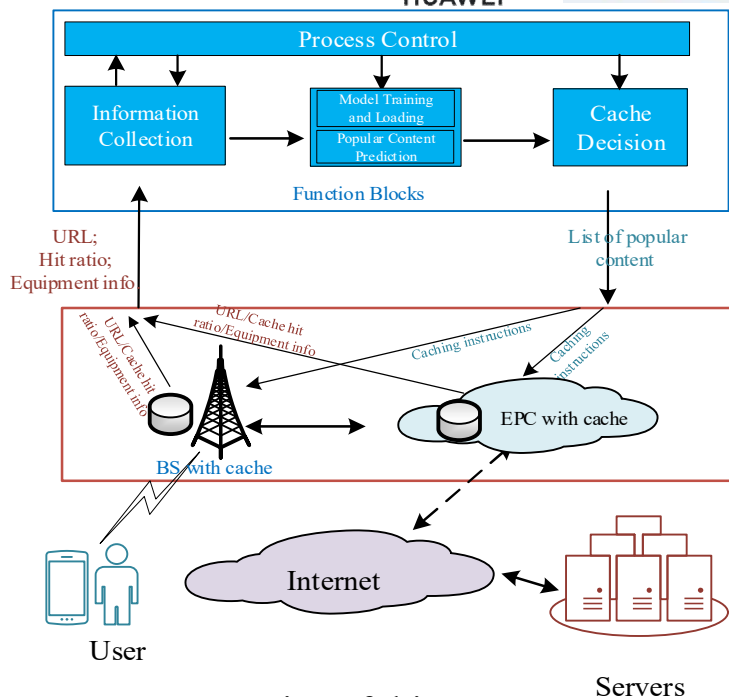


https://eniwiki.etsi.org/index.php?title=PoC_05:_Intelligent_Traffic_Profiling

ENI PoC project #6: Intelligent caching based on prediction of content popularity



PoC Team



Scenarios of this PoC

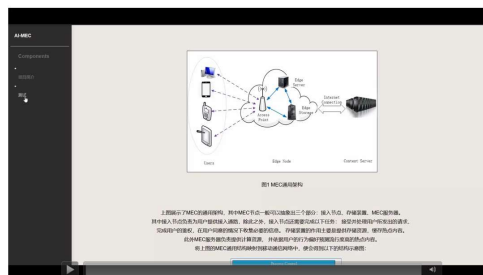
This PoC is meant to show the feasibility and the benefits of an intelligent mobile edge cache, especially when there are large amount users request the same content, and demonstrate in a testbed environment that how ENI system can support intelligent caching based on prediction of content popularity.

Goal #1:

- ✓ The first scenario demonstrates how the system, which is called intelligent caching based on prediction of content popularity, predicts popular content.

Goal #2:

- ✓ The second scenario shows the functionality of this system in the network, specifically to reduce the latency and reduce the core network load.



Showcases:
Sophia Antipolis
France, December 9-10,
2019

https://eniwiki.etsi.org/index.php?title=PoC_06:_Intelligent_caching_based_on_prediction_of_content_popularity

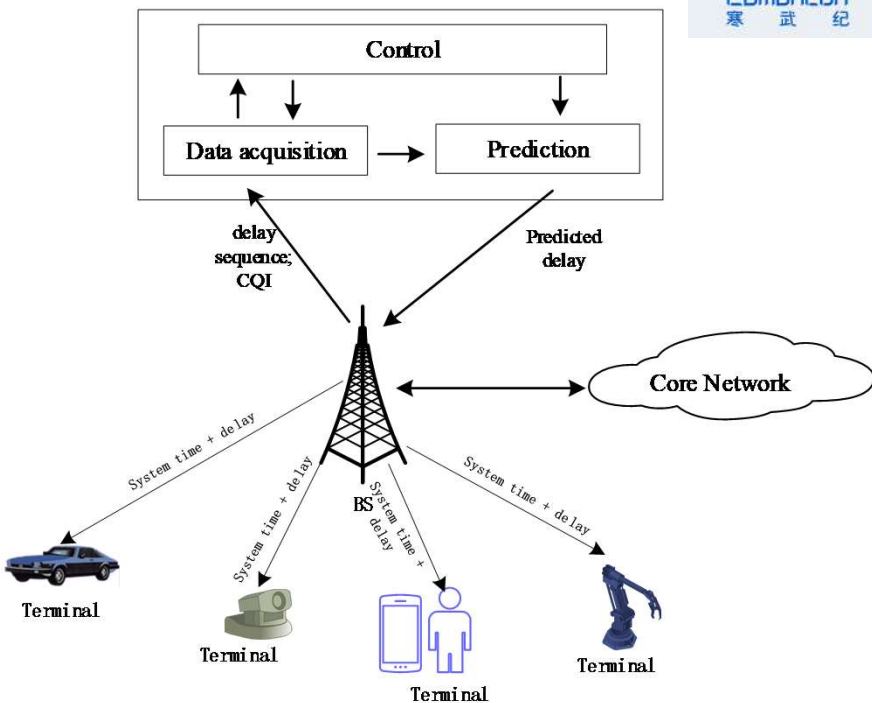
ENI PoC project #7: Intelligent time synchronization of network



Host/Team Leader:



Team members:



This PoC is meant to Demonstrate the use of ML algorithms to be able to predict future delays based on past delays. Achieve time synchronization accuracy of network on the order of hundreds of ns



Goal #1:

✓ Design the structure of the hardware and algorithms. Analyze the feasibility and improve it.

Goal #2:

✓ Build the hardware platform and design software system, then propose the detection methods

Goal #3:

✓ Deploy software and hardware to get test data. Analyze the experimental results and improve the algorithm

Showcases:
Sophia Antipolis
France, December 9-10,
2019



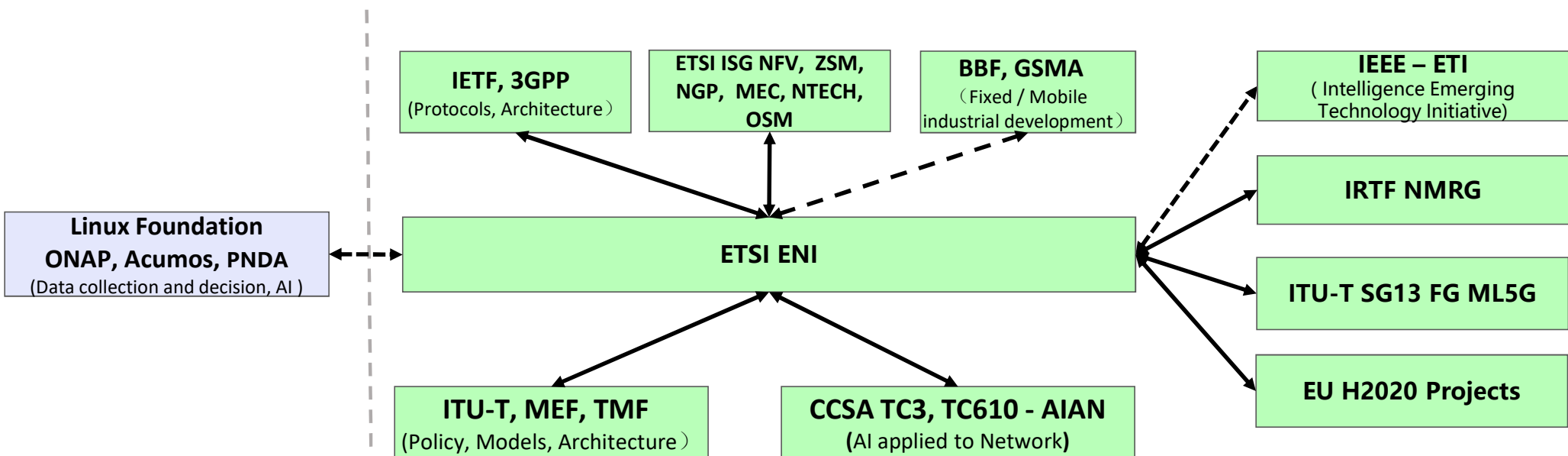
https://eniwiki.etsi.org/index.php?title=PoC_07:_Intelligent_time_synchronization_of_network

Ecosystem



Open Source

Standard & Industry & Research



- Cooperate with mainstream operators, vendors and research institutes in Europe, USA and Asia
- Collaborate with other SDOs and industry ad-hocs
 - Liaisons exchanged with IETF, BBF, MEF, ITU-T
 - Liaisons with other ETSI groups: NFV, NGP, MEC, NTECH, OSM, ZSM
- Position ETSI ENI as the home of network intelligence standards
- Guide the industry with consensus on evolution of network intelligence
- Boarder between different categories are becoming vague.

Network Intelligence Activities in 2016 - 2019



Past 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



Forum on Network Intelligence, Dec'16



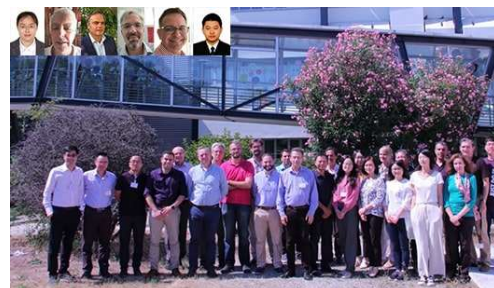
ENI & SDNIA Joint Forum on Network Intelligence, Sep'17



ENI & SliceNet workshop, Dec'17



ENI & Samsung Workshop, Apr'19



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



ENI & China telecom Labs, Sept'19

Other related SDOs, Industry Consortia and EU Projects



ORGANIZATION	ACTIVITY
ITU-T SG13 FG ML5G	Focus Group on Machine Learning for Future Networks including 5G
IETF/IRTF ANIMAWG , NMRG	IETF Working Group on Autonomic Networking Integrated Model and Approach IRTF Research Group on Network Management
CCSA TC610 (was SDNIA)	AIAN (Artificial Intelligence Applied in Network) industry group
H2020 & 5G-PPP	SliceNet, SelfNet, 5G-MoNArch, Shield
BBF SDN&NFV WA	CloudCO Project Stream focusing on the CloudCO reference architectural framework
MEF	Lifecycle Service Orchestration Committee, Service Committee, Applications Committee
OASIS	Advanced systems interworking – Open intelligent protocols
Linux Foundation	ONAP, Acumos, PNDA
OTHER RELEVANT BODIES	
Telecom Infra Project (TIP)	Artificial Intelligence (AI) and Applied Machine Learning (ML) Project Group
TMForum	Telecommunication Management Forum
IEEE ETI NI	Network Intelligence Emerging Technology Initiative (ETI)

Other 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 OSG OSM	Open Source Group on MANO
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



Please Contribute

ETSI ENI#13 meeting will be hosted by ETSI online, on Mar 17-20, 2020.
You are welcome to join us!

Contact Details:

Chair: Dr. Raymond Forbes

Raymond.Forbes@huawei.com

+44 771 851 1361

• Useful links:

[ENI Terms of Reference](#)
[ENI Member Agreement](#)
[ENI Participant Agreement](#)
[ENI Activity Report](#)

[ENI membership list](#)
[ENI Published Deliverables](#)
[ENI Presentation](#)
[ENI Wiki and PoC info](#)

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[ENI White Paper](#)
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[ENI Webpage](#)

Acknowledge the assistance of

Dr. LIU Shucheng (Will) liushucheng@huawei.com

Thank you!