11-April-2019

The Standards People

ETSI ISG ENI**

Creating an intelligent service management solution

Presented by:

Chairman:	Dr. Raymond Forbes (Huawei Technologies)
Vice-Chairman:	Mrs. Haining Wang (China Telecom)
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)

***Experiential Networked Intelligence*

Outline

ETSI ISG ENI progress

- Vision & background
- Introduce the status of the ETSI ISG on Experiential Networked Intelligence (ENI)
- Network intelligence activities in 2016, 2017 & 2018
- Other related SDOs and industry consortia
- WI progress

ENI Published Deliverables & Workplan

Published ENI deliverables:

- ETSI GR ENI 001 V1.1.1 (2018-04) Published
  Use Cases – Yue Wang (Samsung)
- ETSI GS ENI 002 V1.1.1 (2018-04) Published
  Requirements – Haining Wang (China Telecom)
- ETSI GR ENI 003 V1.1.1 (2018-05) Published
  Context-Aware Policy Management Gap Analysis – John Strassner (Huawei)
- ETSI GR ENI 004 V1.1.1 (2018-05) Published
  Terminology – Yu Zeng (China Telecom)
- ETSI GS ENI 006 V1.1.1 (2018-05) Published
  Proof of Concept (PoC) Framework - Luca Pesando (TIM)

Ongoing ENI Work Items and Rapporteurs:

- ENI 001 (WI RGS/ENI-008)
  Use Cases (Release 2) – Yue Wang (Samsung)
- ENI 002 (WI RGS/ENI-007)
  Requirements (Release 2) – Haining Wang (China Telecom)
- ENI 004 (WI RGR/ENI-010)
  Terminology (Release 2) – Yu Zeng (China Telecom)
- ENI 005 (WI DGS/ENI-005)
  System Architecture – John Strassner (Huawei)
- ENI 006 (WI RGS/ENI-012)
  PoC Framework (Release 2) – Bill Wright (Redhat/IBM)
- ENI 007 (WI RGR/ENI-011)
  Definition of Networked Intelligence Categorization – Luca Pesando (TIM)

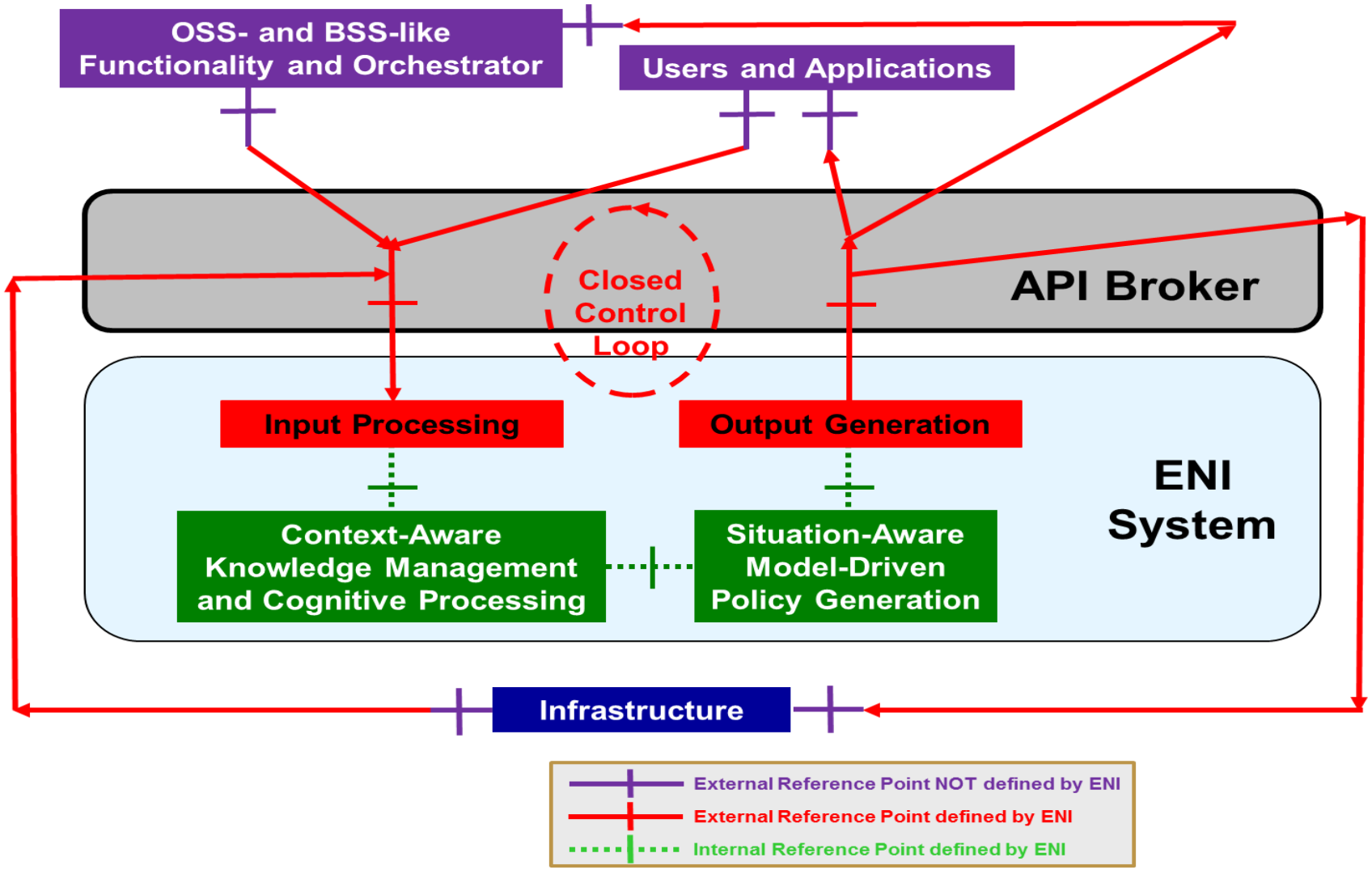
Accessible via Work Item Monitoring - ENI

ENI Members and Participants

- operators, vendors and research institutes from across Europe, USA and Asia

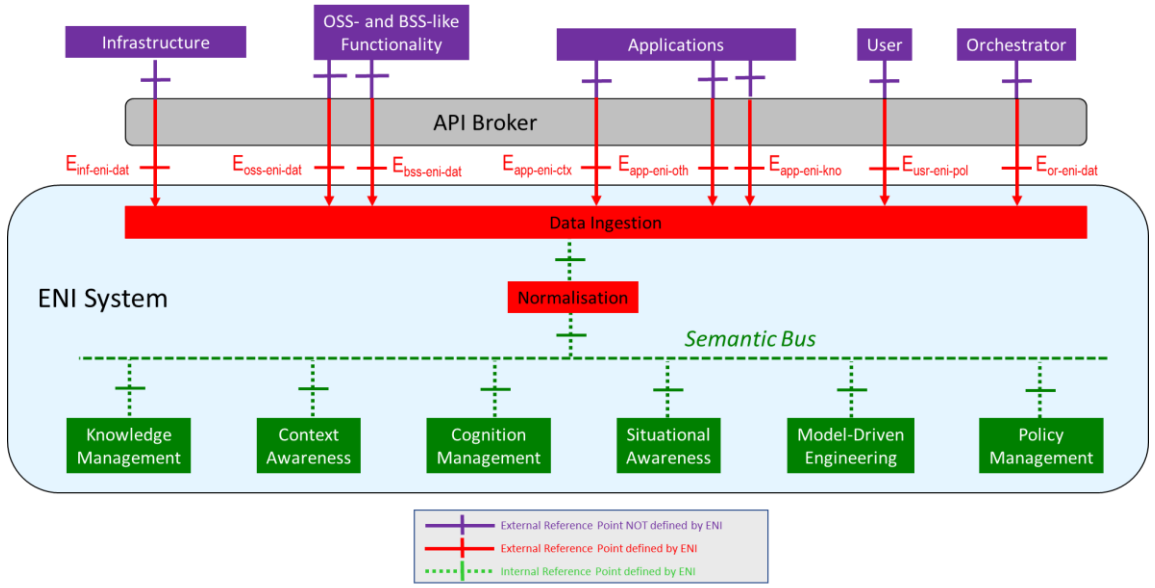
Source: https://portal.etsi.org/TBSiteMap/ENI/ListOfENIMembers.aspx
Members signed the ENI Member agreement and are ETSI members
Participants signed the ENI Participant agreement but are not ETSI members

ENI High-Level Functional Architecture

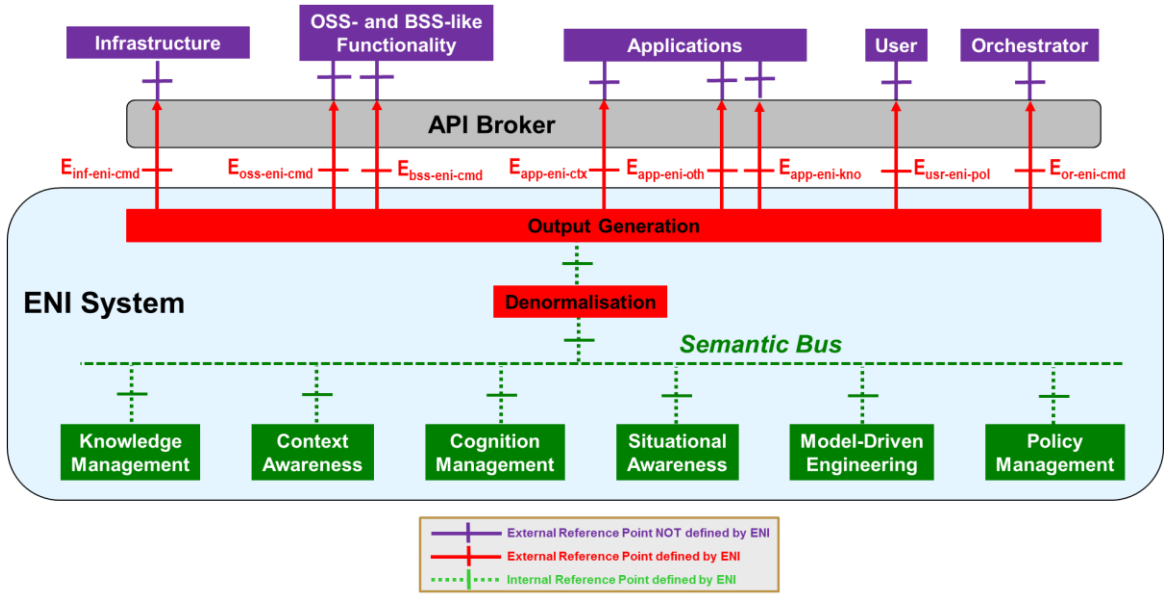


High-Level Functional Architecture Diagram in DGS/ENI-005 (GS ENI 005) v0.0.21

Initial Thoughts on Reference Architecture

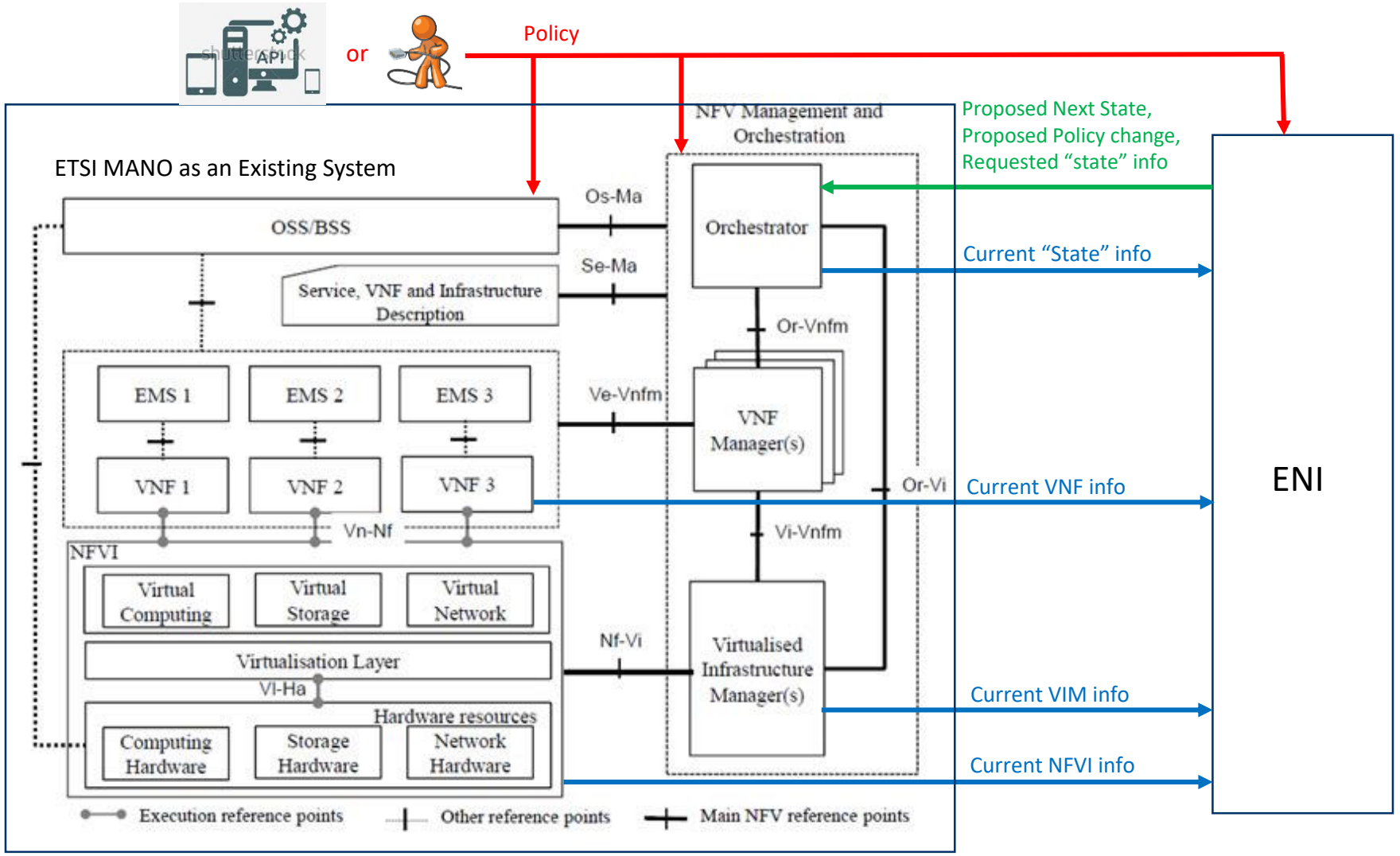


Functional Architecture with its Input Reference Points



Functional Architecture with its Output Reference Points

ENI Assisting MANO



- For MANO to take full advantage of ENI, existing interfaces extension or in some cases, new interfaces may be required
- Physical Network interaction, e.g. with SDN Controller explicitly depicted through NFVI interaction (OOB possible too)

ENI Assisting MEF LSO RA

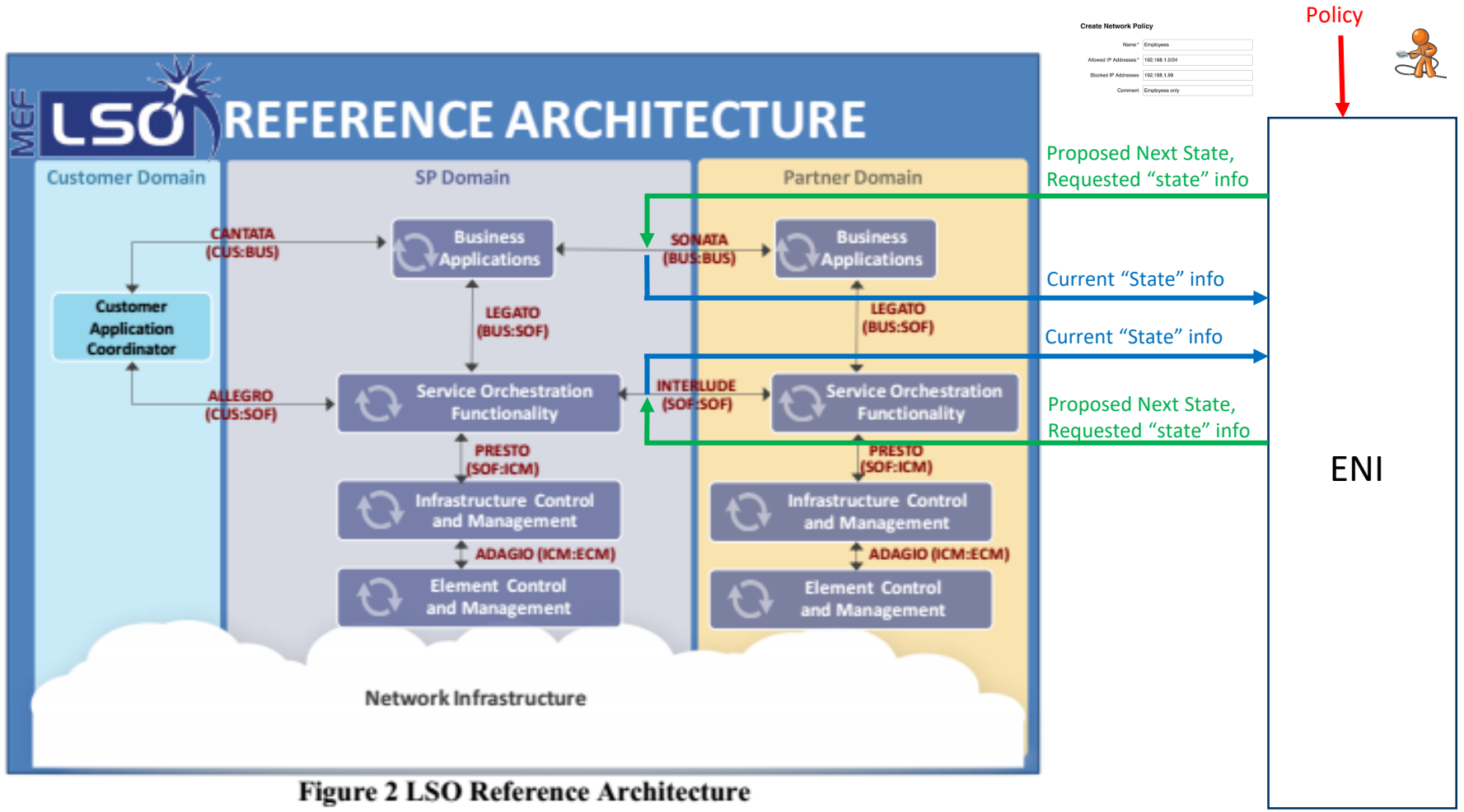


Figure 2 LSO Reference Architecture

- ENI ISG collaborates with MEF on liaison basis
- ENI insights can improve the consumer experience by improving the inter-operator interaction
- Of potential interest can also be LSO extensions to include ENI ⇔ ENI interaction and collaboration

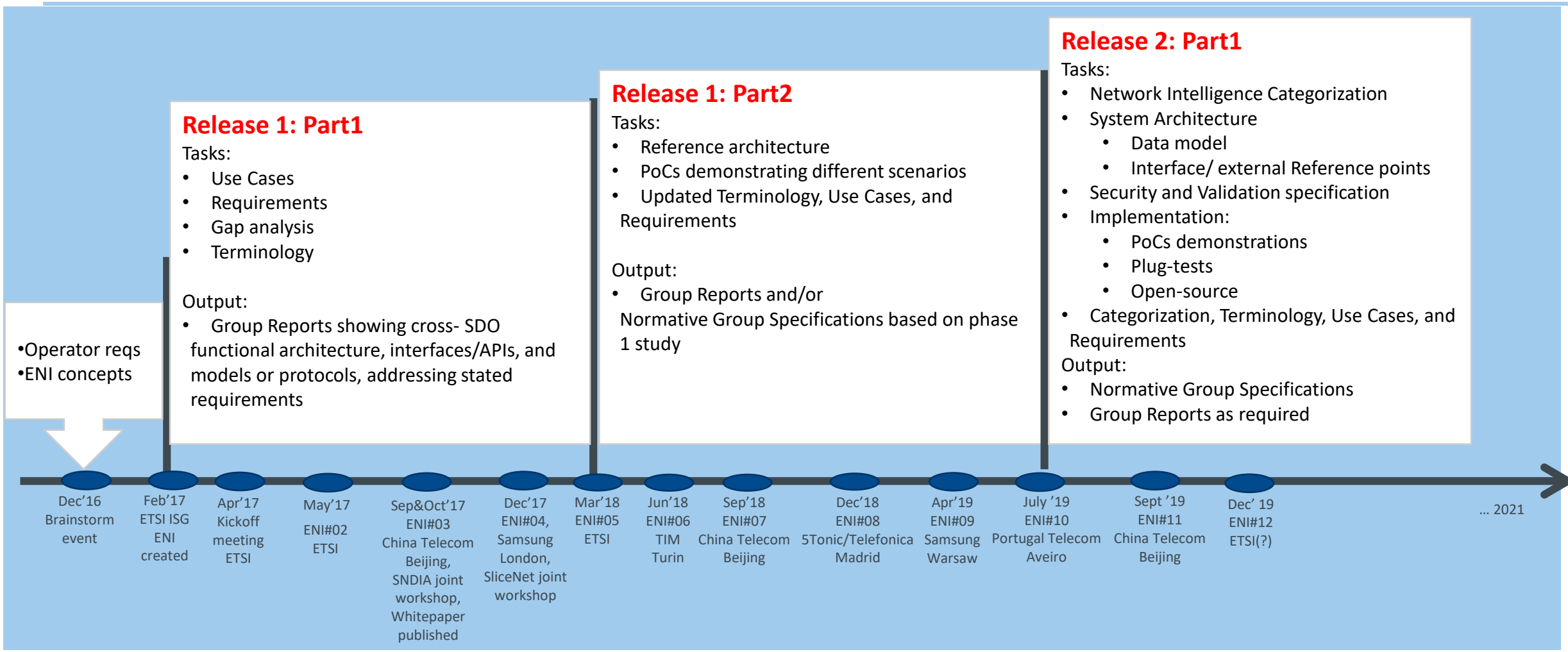
Categorization of Network Intelligence

Autonomous capability
Continuous improvement

Category	Name	Definition	Man-Machine Interface	Decision Making Participation	Decision Making and Analysis	Degree of Intelligence	Environment Adaptability	Supported Scenario
Level 0	Traditional manual network	O&M personnel manually control the network and obtain network alarms and logs	How (command)	All-manual	Single and shallow awareness (SNMP events and alarms)	Lack of understanding (manual understanding	Fixed	Single scenario
Level 1	Partially automated network automated diagnostics	Automated scripts are used in service provisioning, network deployment, and maintenance. Shallow perception of network status and decision making suggestions of machine	How (command)	Provide suggestions for machines or humans and help decision making	Local awareness (SNMP events, alarms, KPIs, and logs)	A small amount of analysis	Little change	Few scenarios
Level 2	Automated network	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 a small decision	Comprehensive awareness (Telemetry basic data)	Powerful analysis	Little change	Few scenarios
Level 3	Self-optimization network	Deep awareness of network status and automatic network control, meeting users' network intentions	HOW (declarative)	Most of the machines make decisions	Comprehensive and adaptive sensing (such as data compression and optimization technologies)	Comprehensive knowledge Forecast	Changeable	Multiple scenarios and combinations
Level 4	Partial autonomous network	In a limited environment, people do not need to participate in decision-making and adjust themselves	WHAT (intent)	Optional decision-making response (decision comments of the challenger)	Adaptive posture awareness (edge collection + judgment)	Comprehensive knowledge Forward forecast	Changeable	Multiple scenarios and combinations
Level 5	Autonomous network	In different network environments and network conditions, the network can automatically adapt to and adjust to meet people's intentions	WHAT (intent)	Machine self-decision	Adaptive deterioration optimization (edge closed-loop, including collection, judgment, and optimization)	Self-evolution and knowledge reasoning	Any change	Any scenario & combination

Example of categorization report

Work Plan



Release 1 focus on use case & requirements, started designing architecture and PoCs.
The ETSI Director-General advised by the ETSI Board approved in Feb. 2019 that ISG ENI is mandated to work on ENI release 2 for 2019-2021.
Four F2F meetings per year: 19Q2 Hosted by Portugal Telecom in Aveiro, 19Q3 Hosted by China Telecom in Beijing.
Online meeting every week https://portal.etsi.org/tb.aspx?tbid=857&SubTB=857#5069-meetings

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:

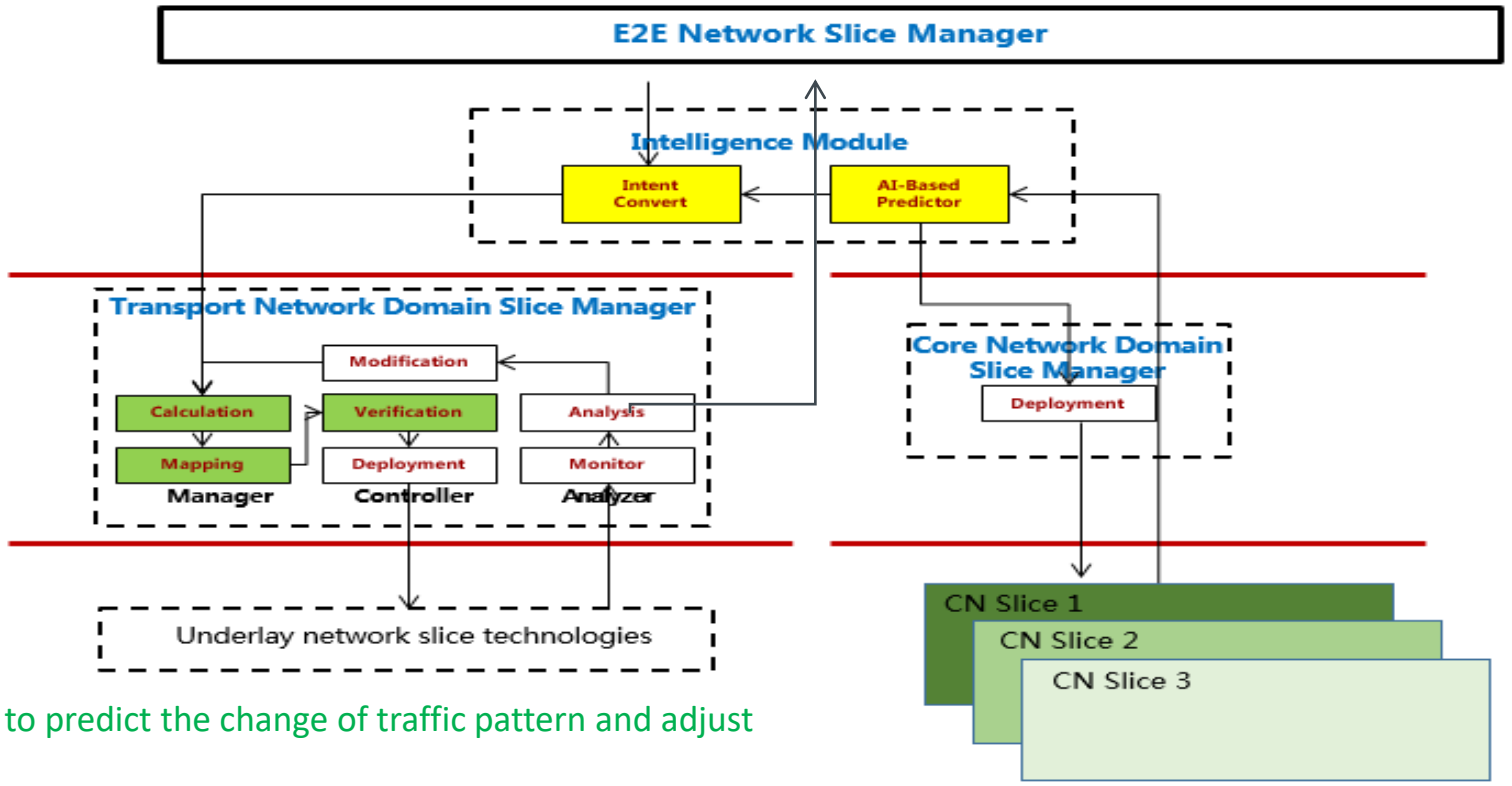
- Provides underlay network control to satisfy the network slice requests.
- FlexE and a FlexE-based optimization algorithm are used for underlay network slice creation and modification.

CNSM:

- Provides core network control to satisfy the network slice requests

Host/Team Leader: 中国电信 CHINA TELECOM

Team members: HUAWEI, intel, 国家电网 STATE GRID 中国电力科学研究院有限公司, DTT 大唐电信, DAHO 大河云联



✓ 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.

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

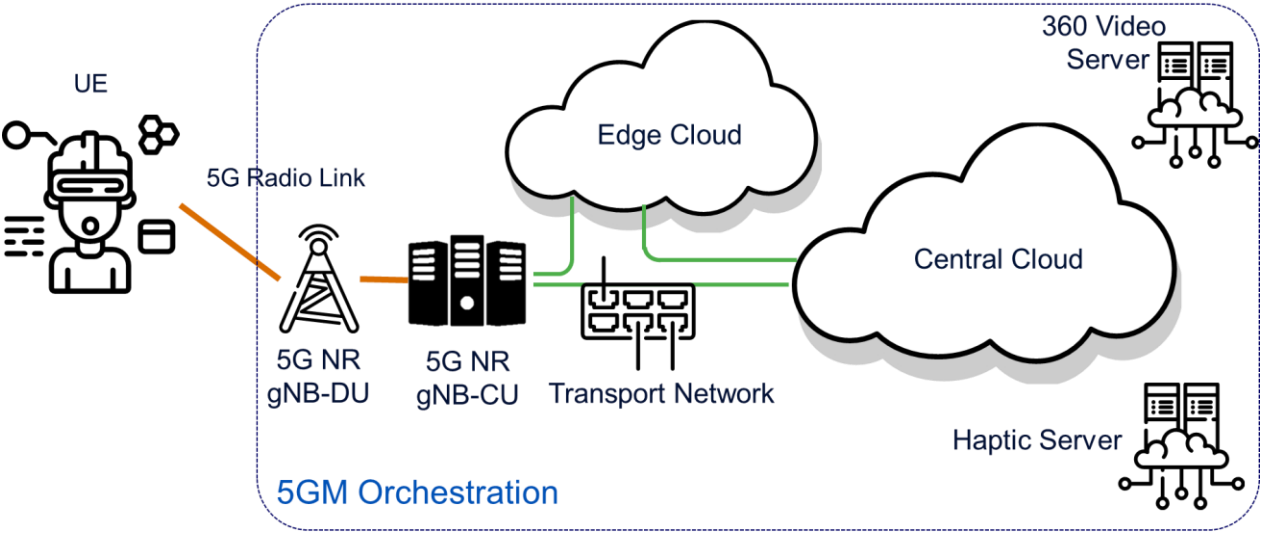
Network Slice Blueprinting & Onboarding

Elastic Intelligent Features:

- Horizontal and Vertical VNF Scaling
- Intelligent Admission Control

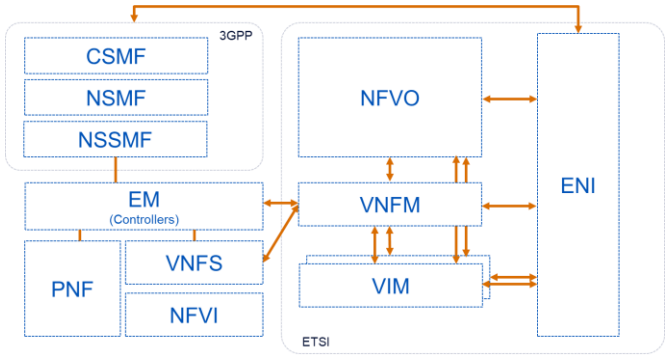
One innovative service through 2 network slices

- Virtual Reality application
- One eMBB slice for 360 video
- One URLLC slice for haptic interaction



Hardware and Software Setup

PoC Team



Orchestration Architecture

VR Service

Goals:

- Provide enhanced AI-based mechanisms to provide novel 5G Services
- Design, test and validate new interfaces with MANO

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, ATOS

SHIELD
https://www.shield-h2020.eu/

Goals

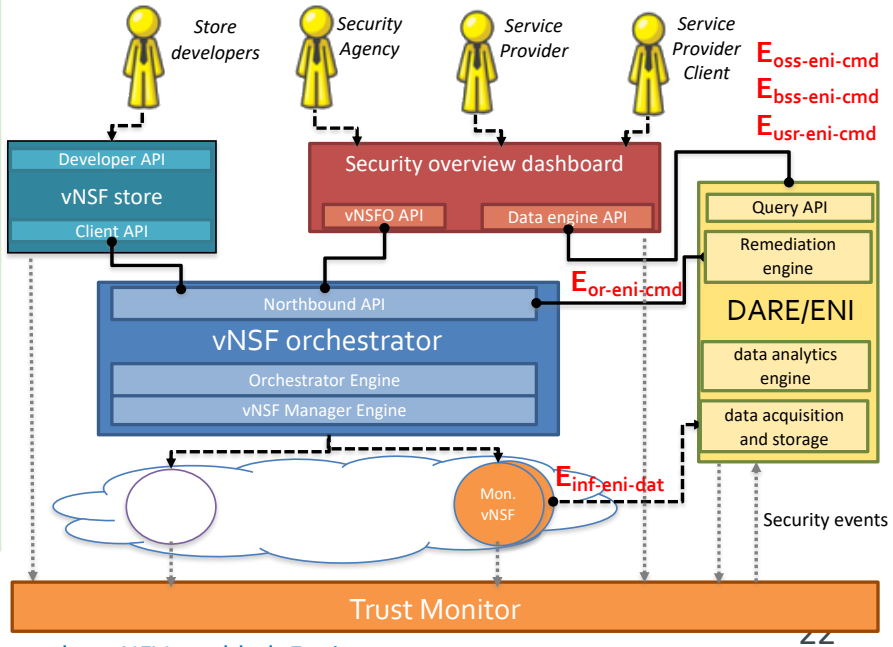
- PoC Goal #1: Demonstrate an AI framework able to detect network attacks over NFV network combining several ML algorithms
- PoC Goal #2: Recommend intent-based security policy
- PoC Goal #3: Remote attestation for data collectors.

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

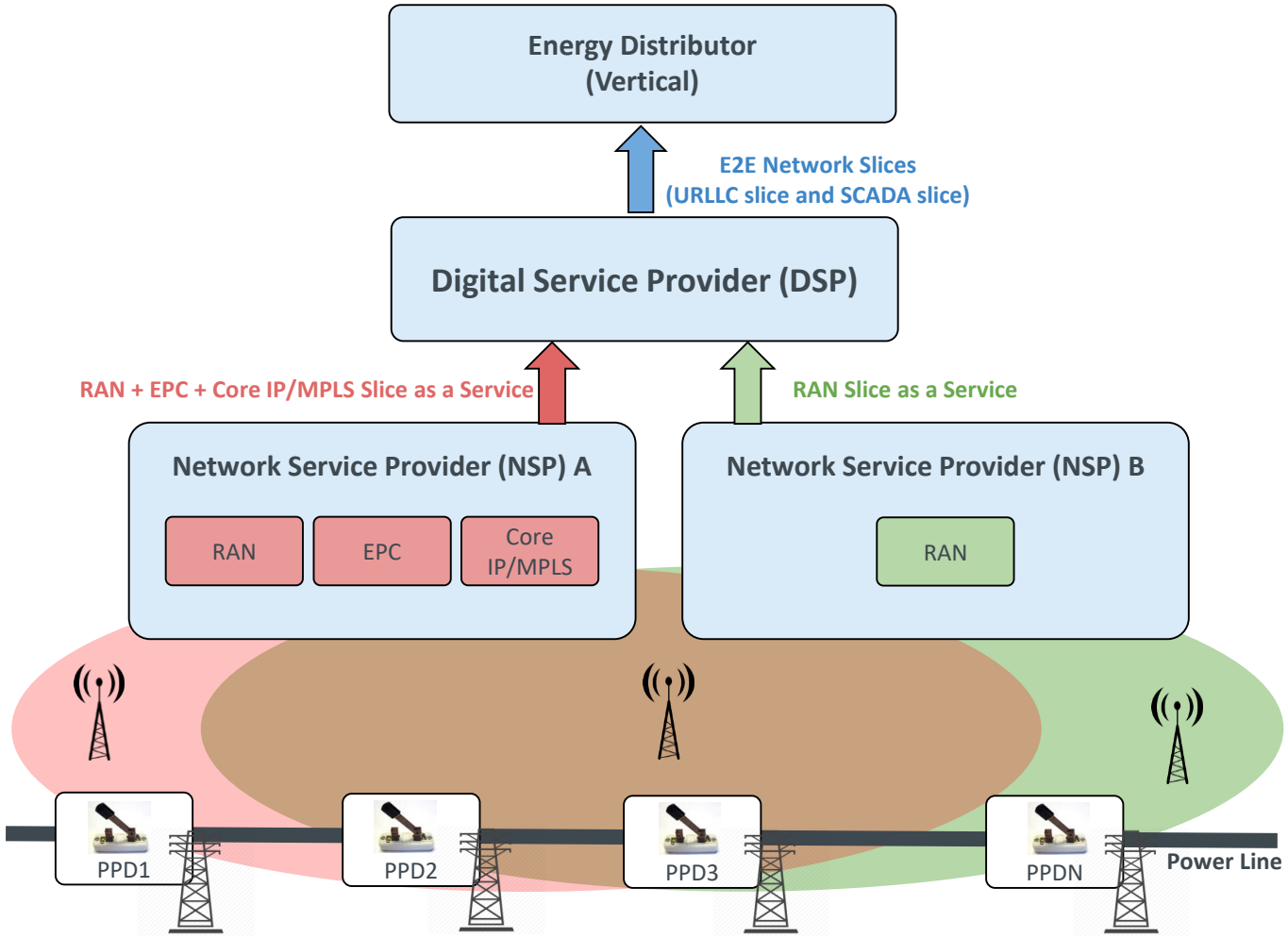
Contribution

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



https://eniwiki.etsi.org/index.php?title=PoC#PoC.233:_Securing_against_Intruders_and_other_threats_through_a_NFV-enabled_Environment

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



https://slicenet.eu/

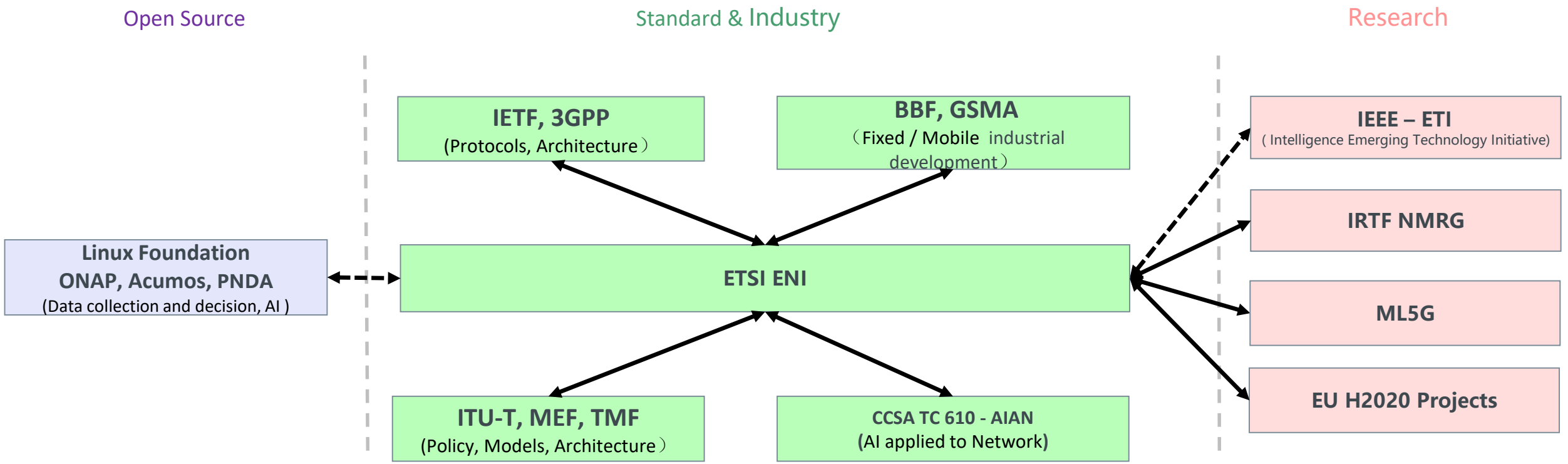
- PoC is focused on the **DSP** functions
  - NSPs provide Sub-slices
  - DSP monitors all Sub-slices behaviour
  - DSP predicts Sub-slice failure
  - DSP decides best failover sub-slice alternative
  - DSP triggers Subslice/NSP switching

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

Ecosystem



- 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.

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

ENI
Use Cases

Dr. Yue Wang (Samsung), Rapporteur, Use Cases

Overview of the Use Case Work Item

Identify and describe appropriate use cases

First phase (April 2017 – April 2018)

- Scope - use cases and scenarios that are enabled with enhanced experience, through the use of network intelligence.
- Group report (GR) produced: **ETSI GR ENI 001 V1.1.1**
  - Details where intelligence can be applied in the fixed and/or mobile network
  - Gives the baseline on how the studies in ENI will substantially benefit the operators and other stakeholders.

Second phase (started April 2018)

- Gives baseline on how the studies in ENI can be applied as solutions of the identified use cases in accordance with the ENI Reference Architecture, and will substantially benefit the operators and other stakeholders.
- Group Specification to be produced

Use Cases

Network Operations
Policy-driven IP managed networks
Radio coverage and capacity optimization
Intelligent software rollouts
★ Policy-based network slicing for IoT security
★ Intelligent fronthaul management and orchestration
Elastic Resource Management and Orchestration
Application Characteristic based Network Operation
AI enabled network traffic classification

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

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

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

Source: ETSI RGS/ENI-008 , Experiential Networked Intelligence (ENI); ENI use cases; – Wang, Yue (Samsung)

★ = examples shown in the next slides

ENI Requirements and Terminology

Haining Wang (China Telecom), Rapporteur, Requirements

Yu Zeng (China Telecom), Rapporteur, Terminology

Categorization of the 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

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

Overview of ENI Work Item - Terminology

General information:

Creation Date:	2018-06-29	**Type:**	Group Report
Work Item Reference:	RGR/ENI-010	**Latest version:**	2.0.1
Rapporteur:	Yu Zeng	**Technical Officer:**	Sylwia Korycinska

Scope:

The WI will provide terms and definitions used within the scope of the ISG ENI, in order to achieve a "common language" across all the ISG ENI documentation. This work item will be updated with the general terminology required as the ENI specifications develop.

ENI Intelligent Policy Management

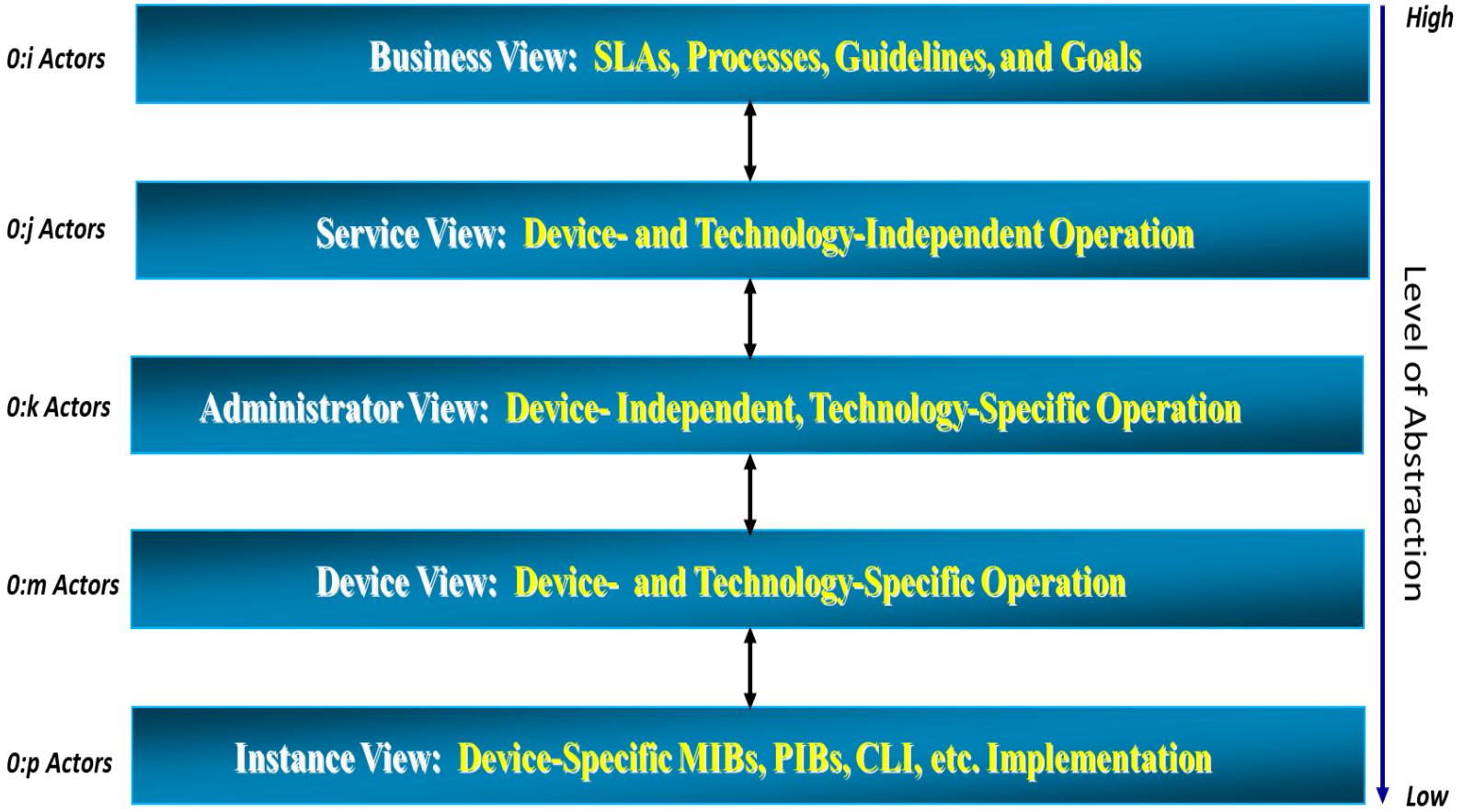
Dr. John Strassner, (Huawei), Rapporteur, Context-Aware Policy Management

Main Contents of the Context-Aware Policy Management WI

Content

- Introduction and Approach
  - Including Introduction to Policy Management, The Policy Continuum, Types of Policy Paradigms, etc.
- Analysis of the MEF PDO Model
  - Including Characteristics, Supported Policy Paradigms, Imperative/Declarative/Intent Policy, etc.
- Analysis of the IETF SUPA policy Model
  - Characteristics, Supported Policy Paradigms, etc.
- Analysis of the TM Forum SID Policy Model
  - Characteristics, Supported Policy Paradigms, etc.

The Policy Continuum



The number of continua in the Policy Continuum should be determined by the applications using it. There is no fixed number of continua.

Work Plan and Next Steps

The report had been published:
GR ENI 003 v1.1.1 “Experiential Networked Intelligence (ENI); Context-Aware Policy Management Gap Analysis”

Contact: Dr. John Strassner (Huawei)
strazpdj@gmail.com

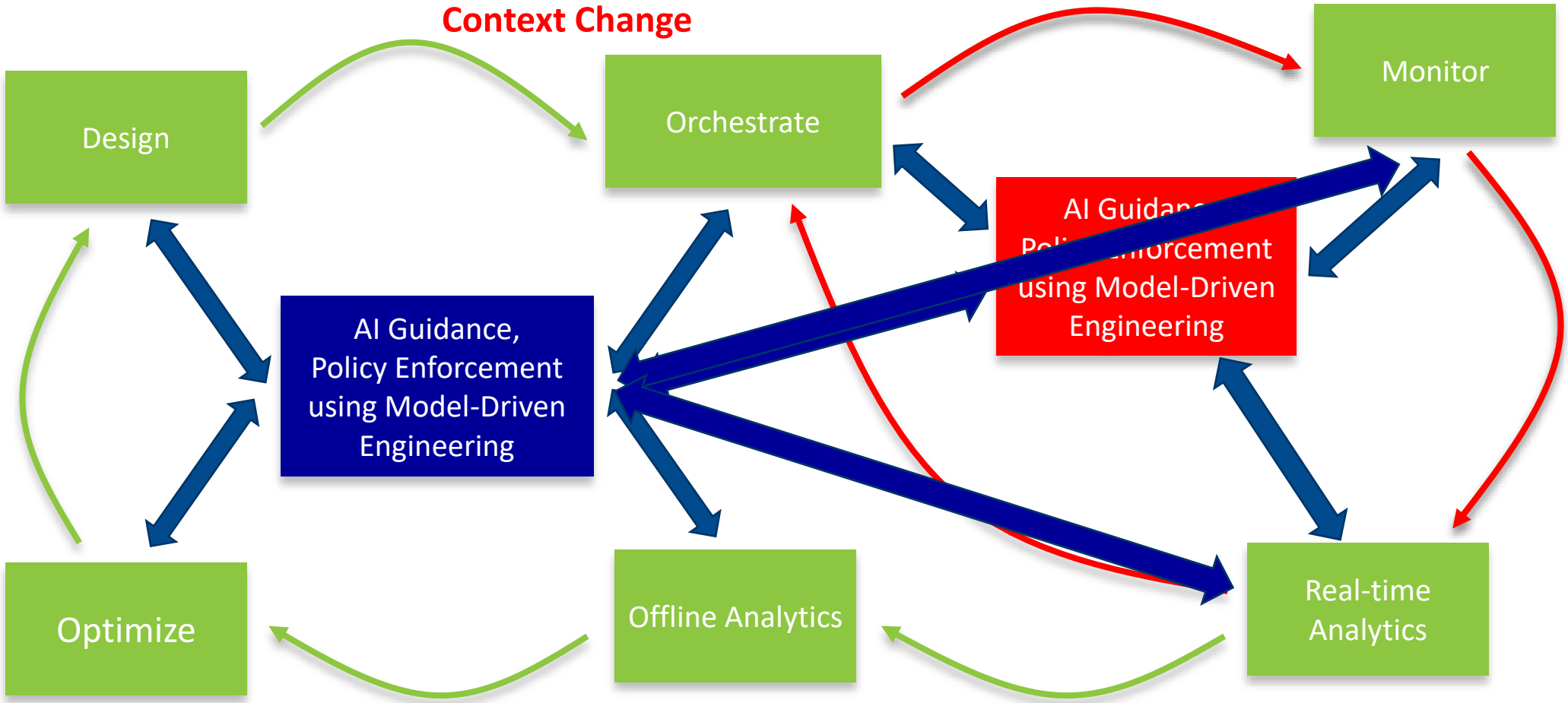
Thank you!

Experiential Networked Intelligence *System Architecture*

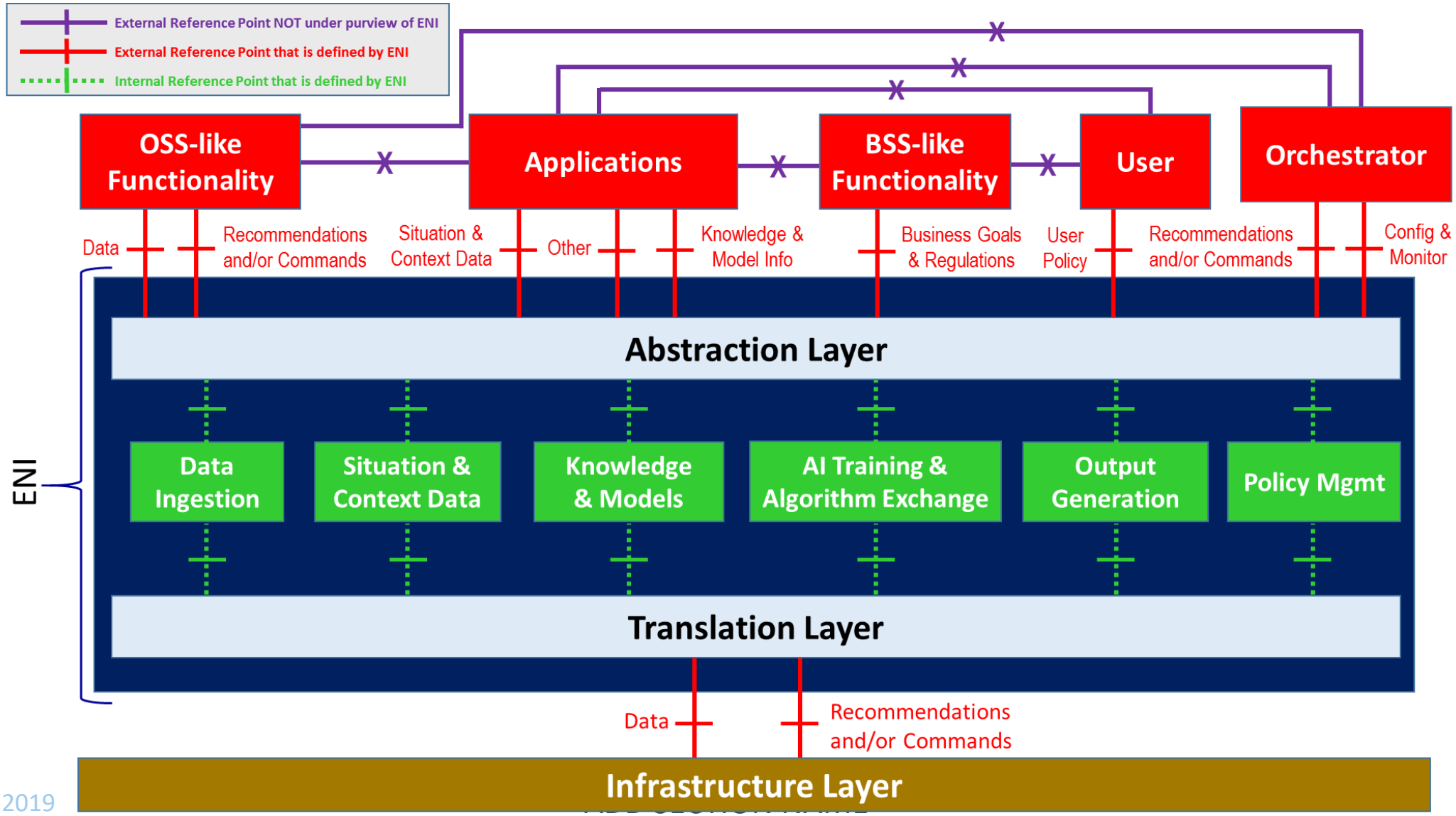
Dr. John Strassner (Huawei, Rapporteur)

Closed Loop Control in FOCALE

1. **Outer Closed Control Loop for a Given Context and Long-Term Optimization**
2. **Inner Closed Control Loop Triggered by Context Change**



Initial Thoughts on Reference Architecture



Knowledge Management

Functional Block

The purpose of the Knowledge Management Functional Block is to represent information about both the ENI System as well as the system being managed. Knowledge representation is fundamental to all disciplines of modelling and AI. It also enables machine learning and reasoning – without a formal and consensual representation of knowledge, algorithms cannot be defined that reason (e.g., perform inferencing, correct errors, and derive new knowledge) about the knowledge. Knowledge representation is a substitute for the characteristics and behaviour of the set of entities being modelled; this enables the computer system to plan actions and determine consequences by reasoning using the knowledge representation, as opposed to taking direct action on the set of entities.

There are many examples of knowledge representation formalisms, ranging in complexity from models and ontologies to semantic nets and automated reasoning engines.

Context-Aware Management

Functional Block

The purpose of the Context-Aware Management Functional Block is to describe the state and environment in which an entity exists or has existed. Context consists of measured and inferred knowledge, and may change over time. For example, a company may have a business rule that prevents any user from accessing the code server unless that user is connected using the company intranet. This business rule is context-dependent, and the system is required to detect the type of connection of a user, and adjust access privileges of that user dynamically.

Situation-Awareness Management

Functional Block

The purpose of the Situation Awareness Functional Block is for the ENI system to be aware of events and behaviour that are relevant to the environment of the system that it is managing or assisting. This includes the ability to understand how information, events, and recommended commands given by the ENI system will impact the management and operational goals and behavior, both immediately and in the near future. Situation awareness is especially important in environments where the information flow is high, and poor decisions may lead to serious consequences (e.g., violation of SLAs).
The working definition of situation awareness for ENI is:

The perception of data and behaviour that pertain to the relevant circumstances and/or conditions of a system or process ("the situation"), the comprehension of the meaning and significance of these data and behaviours, and how processes, actions, and new situations inferred from these data and processes are likely to evolve in the near future to enable more accurate and fruitful decision-making.

Policy-based Management

Functional Block

The purpose of the Policy Management Functional Block is to provide decisions to ensure that the system goals and objectives are met. Formally, the definition of policy is:

Policy is a set of rules that is used to manage and control the changing and/or maintaining of the state of one or more managed objects.

There are three different types of policies that are defined for an ENI system:

- **Imperative policy:** a type of policy that uses statements to explicitly change the state of a set of targeted objects. Hence, the order of statements that make up the policy is explicitly defined.
  In this document, Imperative Policy will refer to policies that are made up of Events, Conditions, and Actions.
- **Declarative policy:** a type of policy that uses statements to express the goals of the policy, but not how to accomplish those goals. Hence, state is not explicitly manipulated, and the order of statements that make up the policy is irrelevant.
  In this document, Declarative Policy will refer to policies that execute as theories of a formal logic.
- **Intent policy:** a type of policy that uses statements to express the goals of the policy, but not how to accomplish those goals. Each statement in an Intent Policy may require the translation of one or more of its terms to a form that another managed functional entity can understand.
  In this document, Intent Policy will refer to policies that do not execute as theories of a formal logic. They typically are expressed in a restricted natural language, and require a mapping to a form understandable by other managed functional entities.

An ENI system MAY use any combination of imperative, declarative, and intent policy to express recommendations and commands to be issued to the system that it is assisting.

Cognition Management

Functional Block

Cognition, as defined in the Oxford English Dictionary, is “the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses”.
The purpose of the Cognition Framework Functional Block is to enable the ENI system to understand ingested data and information, as well as the context that defines how those data were produced; once that understanding is achieved, the cognition framework functional block then provides the following functions:

- change existing knowledge and/or add new knowledge corresponding to those data and information
- perform inferences about the ingested information and data to generate new knowledge
- use raw data, inferences, and/or historical data to understand what is happening in a particular context, why the data were generated, and which entities could be affected
- determine if any new actions should be taken to ensure that the goals and objectives of the system will be met.

A cognition framework uses existing knowledge and generates new knowledge.

A cognition framework uses multiple diverse processes and technologies, including linguistics, computer science, AI, formal logic, neuroscience, psychology, and philosophy, along with others, to analyse existing knowledge and synthesise new knowledge

ENI PoC Framework

Bill Wright (Redhat/IBM)

ENI PoC List

Title	PoC Team Members	Main Contact	Proposal	Start Time	Current Status (Apr-2019)
PoC #1: Intelligent Network Slice Lifecycle Management	**China Telecom** Huawei, Intel, CATT, DAHO Networks, China Electric Power Research Institute	Haining Wang	ENI(18)000104r2	Jun-2018	Stage 2 finished
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	ENI(18)000175r4	Nov-2018	Ongoing
PoC #3: Securing against Intruders and other threats through a NFV-enabled Environment (SHIELD)	**Telefonica** Space Hellas, ORION, Demokritos (NCSR)	Diego R. Lopez Antonio Pastor	ENI(18)000234r1	Jan-2019	Finished
PoC #4: Predictive Fault management of E2E Multi-domain Network Slices	**Portugal Telecom/Altice Labs** SliceNet Consortium (Eurescom,University of the West Scotland,Nextworks S.R.L,Ericsson Telecomunicazioni SpA,IBM,Eurecom,Universitat Politècnica de Catalunya ,RedZinc Service Ltd.,OTE – The Hellenic Telecommunications Organisation, SA,Orange Romania / Orange France,EFACEC,Dell EMC,Creative Systems Engineering,Cork Institute of Technology)	António Gamelas Rui Calé	ENI(19)000055	Mar-2019	Ongoing
PoC #5: AI Enabled Network Traffic Classification	**China Mobile** Huawei, Intel, Tsinghua University	Weiyuan Li	ENI(19)009_004r5	Proposed in Apr 2019	Proposed

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

Definition of Networked Intelligence Categorization

Luca Pesando (TIM), Rapporteur