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GROUP REPORT

Experiential Networked Intelligence (ENI); ENI use cases

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Experiential Networked Intelligence (ENI).

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1 Scope

The present document includes a collection of use cases from a variety of stakeholders, where the use of an Experiential Networked Intelligence (ENI) system can be applied to the fixed network, the mobile network, or both, to enhance the operator experience through the use of network intelligence.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] NGMN Alliance, Description of Network Slicing Concept, Version 1.0, January 13, 2016.

NOTE: Available at https://www.ngmn.org/fileadmin/user_upload/160113_Network_Slicing_v1_0.pdf.

[i.2] 3GPP TR 23.799: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on Architecture for Next Generation System, 3GPP TR 23.799, V14.0.0, Release 14", December 2016.

[i.3] 5G Service-Guaranteed Network Slicing White Paper, Issue 1, March 2017.

NOTE: Available at http://www-file.huawei.com/~/media/CORPORATE/PDF/white%20paper/5g-service-guaranteed-network-slicing-whitepaper.pdf.

[i.4] A. Morton, AT&T Labs: "Considerations for Benchmarking Virtual Network Functions and Their Infrastructure", July 2017.

[i.5] ETSI TS 132 101 (V11.4.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Principles and high level requirements (3GPP TS 32.101 version 11.4.0 Release 11)".

[i.6] ETSI GS ENI 002 (V1.1.1): "Experiential Networked Intelligence (ENI); Requirements".

[i.7] ETSI GS ENI 005: "Experiential Networked Intelligence (ENI); Architecture".

[i.8] ETSI GR ENI 004: "Experiential Networked Intelligence (ENI); Terminology".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI GR ENI 004 [i.8] apply.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AI	Artificial Intelligence
AP	Access Point
API	Application Programming Interface
BBU	Baseband Unit
BRAS	Broadband Remote Access Server
BSS	Business Support System
CCO	Capacity and Coverage Optimization
CGN	Carrier Grade Network address translation
CPRI	Common Public Radio Interface
CPU	Computing Processing Unit
C-RAN	Centralized RAN
DC	Data Centre
DDOS	Distributed Denial Of Service
DHCP	Dynamic Host Configuration Protocol
D-RAN	Distributed RAN
E2E	End-to-End
ENI	Experiential Networked Intelligence
FTP	File Transfer Protocol
IDC	Internet Data Centre
INFP	Intelligent Network Failure Prevention
IP	Internet Protocol
KPI	Key Performance Indicator
MANO	Management and Orchestration
MEC	Multi-access Edge Computing
MIMO	Multiple Input Mutliple Output
MPLS	Multi-Protocol Label Switching
NFV	Network Function Virtualisation
NFVI	NFV Infrastructure
NGFI	Next Generation Fronthaul interface
NGMN	Next Generation Mobile Networks
NSI	Network Slice Instances
OPEX	OPerational EXpenditure
OS	Operating Systems
OSS	Operations Support System
PHY	PHYsical layer
QoE	Quality-of-Experience
QoS	Quality-of-Service
RAM	Random Access Memory
RAN	Radio Access Network
RAU	Remote Aggregation Unit
RCC	Radio Cloud Centre
RF	Radio Frequency
RRU	Remote Radio Units
RSRP	Reference Signal Received Power
SDN	Software Defined Networking
SD-WAN	Software-Defined Wide Area Network
SLA	Service-Level Agreement
TCP	Transmission Control Protocol
UE	User Equipment
VM	Virtual Machines
VNF	Virtualised Network Functions
WAN	Wireless Access Network
WLAN	Wireless Local Area Network

4 Overview

4.1 Background

Operators see human-machine interaction as slow, error-prone, expensive, and cumbersome. For example, operators are worried about the increasing complexity of integration of different standardization platforms in their network and operational environment; this is due to the vast differences inherent in programming different devices as well as the difficulty in building agile, personalized services that can be easily created and torn down. These human-machine interaction challenges are considered by operators as barriers to reducing the time to market of innovative and advanced services. Moreover, there is no efficient and extensible standards-based mechanism to provide contextually-aware services (e.g. services that adapt to changes in user needs, business goals, or environmental conditions).

These and other factors contribute to a very high OPerational EXpenditure (OPEX) for network management. Operators need the ability to automate their network configuration and monitoring processes to reduce OPEX. More importantly, operators need to improve the use and maintenance of their networks. In particular, this requires the ability to visualize services and their underlying operations so that the proper changes can be applied to protect offered services and resources (e.g. ensure that their Quality-of-Service (QoS) and Quality-of-Experience (QoE) requirements are not violated). If such visualization could be provided, then operators would be better able to maintain their networks.

The associated challenges may be stated as:

a) automating complex human-dependent decision-making processes;

b) determining which services should be offered, and which services are in danger of not meeting their Service-Level Agreement (SLA)s, as a function of changing context;

c) defining how best to visualize how network services are provided and managed to improve network maintenance and operation; and

d) providing an experiential architecture (i.e. an architecture that uses various mechanisms to observe and learn from the experience an operator has in managing the network) to improve its understanding of the operator experience, over time.

The aforementioned challenges will require advances in network telemetry, big data mechanisms to gather appropriate data at speed and scale, machine learning for intelligent analysis and decision making, and applying innovative, policy-based, model-driven functionality to simplify and scale complex device configuration and monitoring.

4.2 Overview of the ENI System

4.2.1 Brief Description

The ENI system is an innovative, policy-based, model-driven functional entity that understands the configuration and takes actions in accordance with changes in context, such as the environment, the dynamic demand of the resources, and the varying service requirements. By exploiting emerging technologies, such as big data analysis and artificial intelligence mechanisms, and also by automating (where possible) complex human-dependent decision-making processes, the ENI system enables intelligent service operation and management, and provides the ability to ensure that automated decisions taken by the system are correct and are made to increase the stability and maintainability of the network and the applications that it supports.

Examples of the possible functionalities of an ENI system are given in figure 4-1.

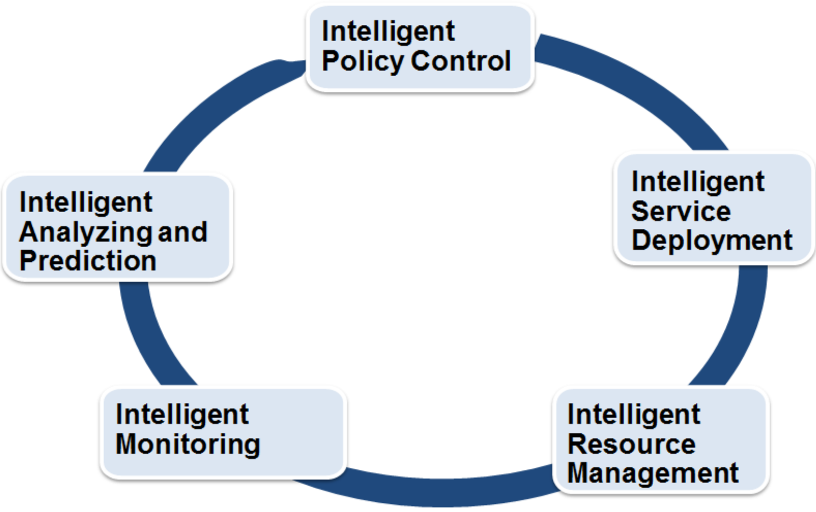

Figure 4-1: Example of functionalities of ENI system

4.2.2 Expected Benefits

ENI system delivers enhanced customer experience by allowing operators to understand the operating status of their network and networked applications in near-real-time, and reconfigure their network. The ENI system automatically collects network status and associated metrics, faults, and errors, and then uses artificial intelligence to ensure network performance and quality of service are met at the highest possible efficiency (e.g. with the minimum required resources). An ENI system can also be used to find bottlenecks of service and/or failure of network. Both of these benefits are done on-demand, in response to changing contextual information.

The ENI system helps to increase the value of services provided by an operator to its customers by rapidly on-boarding new services, enabling the creation of a new ecosystem of cloud consumer and enterprise services, reducing Capital and Operational Expenditures, and providing efficient operations.

5 General use cases

5.1 Introduction

This clause describes the use cases and scenarios identified by the ENI ISG. Each use case includes a description of how an ENI system can be applied, and the benefits it provides.

A list of the use cases included in the present document are categorized into the following four categories (table 5-1):

1) Infrastructure Management: This category of use cases covers the processes related to the management of the network infrastructure (e.g. adjustment of allocated and provided services, maintenance, capability specification, and planning). In particular, it is about using policies for managing the network infrastructure, enabled by placing analytics in the control loop and using the results of the analytics as part of the input to policy-based management of the infrastructure.

2) Network Operations: Use cases described in this category are concerned with running the network, where the runtime contexts of the network are extracted and analysed, and the management operations are performed and optimized dynamically at runtime.

3) Service Orchestration and Management: This category of use cases relates to the service and order management, covering processes such as activation using the operator's business channels or customer portals. It is about providing differentiated SLAs for different applications, including vertical applications, through the application of machine learning in an intelligent entity, i.e. ENI. For example, services can be differentiated based on level (e.g. gold vs. silver vs. bronze classes of service) as well as based on the type of application within a level (e.g. a video streaming service has a different service than FTP, even though both are applications that a particular customer has).

4) Assurance: Use cases described in this category are concerned with the functionality of network monitoring, trending, and prediction, as well as taking policy-based actions using knowledge learned from the network to facilitate network maintenance. This includes service runtime operations dedicated to guarantee continuous service delivery.

Table 5-1: Summary of ENI Use Cases

Category					
1 - Infrastructure Management	Use Case #1-1: Policy-driven IDC Traffic Steering	Use Case #1-2: Handling of Peak Planned Occurrences	Use Case #1-3: DC Energy Saving using AI		
2 - Network Operations	Use Case #2-1: Policy-driven IP Managed Networks	Use Case #2-2: Radio Coverage and Capacity Optimization	Use Case #2-3: Intelligent Software Rollouts	Use Case #2-4: Policy-based Network Slicing for IoT Security	Use Case#2-5: Intelligent Fronthaul Management and Orchestration
3 - Service Orchestration and Management	Use Case #3-1: Context-Aware VoLTE Service Experience Optimization	Use Case #3-2: Intelligent Network Slicing Management	Use Case #3-3: Intelligent Carrier-Managed SD-WAN		
4 - Assurance	Use Case #4-1: Network Fault Identification and Prediction	Use Case #4-2: Assurance of Service Requirements			

5.2 Infrastructure Management

5.2.1 Use Case #1-1: Policy-driven IDC Traffic Steering

5.2.1.1 Use case context

This use case relates to intelligent link load balancing and bandwidth allocation between Internet Data Centres (IDCs). The tenants of IDCs include enterprises that have requirements that dynamically adjust service and/or resource behaviour (e.g. reliable network connectivity and changes to an offered service based on network load).

There are a number of problems with how current traffic steering is performed between IDCs. These include the use of multiple possible links between IDCs (e.g. which link is the best to use at a given time). Currently, the link for a tenant is normally determined as the shortest path between the IDC that the tenant resides in and the IDC that the tenant is connecting to. in addition, the link load is not considered when calculating the traffic path. Furthermore, the bandwidth allocated to a tenant is not always fully used.

5.2.1.2 Description of the use case

5.2.1.2.1 Overview

Operators are deploying IDCs in Metropolitan Area Networks (MANs) to provide network access with load-balancing and resiliency. Current network configuration practices include:

- In order to provide service assurance for important tenants, network administrators typically schedule the traffic in specific periods. Traditional network management is usually complex, with a long cycle caused by manual actions, so it is difficult to meet the requirement of real-time traffic optimization.

- Large service provider's traffic usually is sensitive to the events of a day. For example, online big sales and usage of social media with video steaming cause a significant increase in traffic. This means that the network administrator cannot provide bandwidth assurance for some important tenants.

- The bandwidth requirements of tenants tend to change dynamically. Traditional static bandwidth allocation leads to low bandwidth utilization and redundancy.
- The imbalance across multiple links leads to inefficient resource utilization. For example, it is possible that the utilization of a link reaches a certain threshold, while other links' loads remain low.

5.2.1.2.2 Motivation

The ENI system can be used to achieve intelligent link load balancing and intelligent bandwidth allocation. In ENI, policies can be modified by using machine learning to fill in important parameters, such as available links, link bandwidth, real-time link utilization, and other predefined constraints. Three examples of the predefined constraints to be considered before modifying the policies are:

1) each link is predefined with a threshold of the maximum bandwidth and cannot be exceeded;
2) flow of a client at a specific service level (e.g. gold) cannot be switched;
3) the maximum times of switching specific service from one link to another link is predefined and cannot be exceeded.

Such policies can be used to better manage the network and achieve autonomous service traffic monitoring and network resource optimization. It can also be used to adjust the service along different links of an IDC, thus improving the operator's experience through enhanced network resilience and service QoS and QoE.

The ENI system also:

- predicts changes by using AI in the tenant's service requirements based on historical data (e.g. the type of QoS to be provided for a given service based on the type of application and metadata);
- collects and analyses real-time data, given the service adjustment recommendations (e.g. which metadata and metrics to monitor based on the type of service and the type of changes applied);
- corrects the prediction result according to the adjustment recommendations, and converges to an ideal service management policy;
- analyses QoS and other applicable data and metadata to make the final service policy modifications; this is then stored as a reusable set of objects.

By using the above intelligent service adjustment policy provided by the ENI system, real-time, dynamic, and automated resource allocation and adjustment to the service can be achieved. The bandwidth utilization is improved. Meanwhile, it provides bandwidth assurance for important tenants according to the service level.

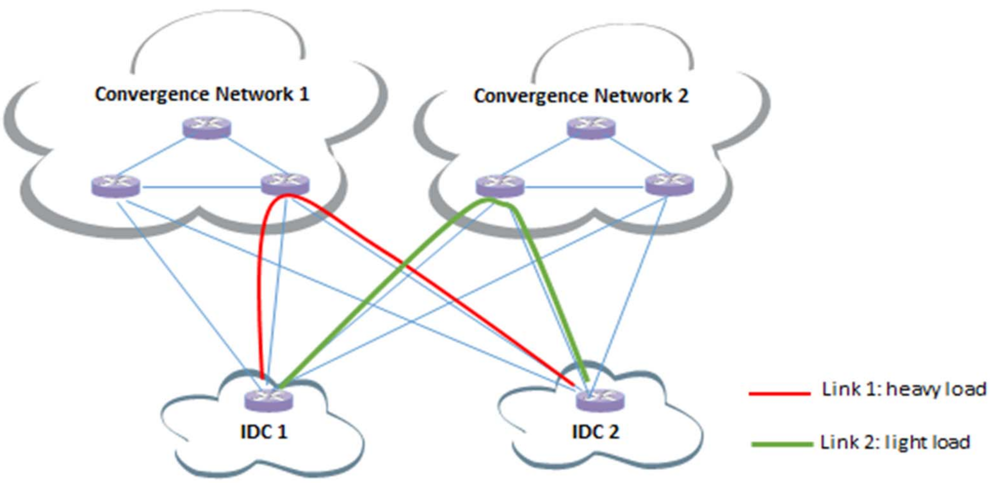

Figure 5-1: Policy-driven, automatic IDC traffic steering

As shown in left portion of figure 5-1, two IDCs can connect to each other via two different paths. There are multiple links between the two IDCs. When link 1 is heavily loaded, as much traffic as necessary can be moved to link 2.