Network, All Intelligent.

ENI introduction
Experiential Networked Intelligence

LIU Shucheng(Will), John Strassner, DING Xiaojian
Agenda

- Intro of the progress of ETSI ISG ENI
- Intro of the progress of MEF
- One typical use case: network data use case for wavelength division service
  - draft-ding-nmrg-wavelength-use-case-00
ETSI ENI - a Standards Group Network Focusing on Network Intelligence Established in 2017Q1

(Experiential Networked Intelligence)

The core idea of network intelligence defined by ENI:
Network perception analysis, data-driven policy, AI based closed-loop control

17Q1: ETSI ISG ENI (Experiential Networked Intelligence)
- 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 management systems, to adjust services and resources offered based on changes in user needs, environmental conditions and business goals.

<table>
<thead>
<tr>
<th>Phase 1 focus on use case &amp; requirements, phase 2 design function &amp; architecture. 4 meetings per year: Q3 - Beijing (hosted by CT), Q4 - UK (hosted by Samsung)</th>
</tr>
</thead>
</table>
| Phase1: Tasks:  
- use cases  
- requirements  
- gap analysis of work on context-aware and policy based standards  
- recommendation on how gaps should be filled  
- Group Reports showing cross-SDO functional architecture, interfaces/APIs, and models or protocols, addressing stated requirements |
| Phase2: Tasks:  
- ENI architecture  
- demonstrate how the different scenarios are addressed using a dynamic policy-driven management approach  
- Further informative Group Reports and/or normative Group Specifications based on phase 1 study |

<table>
<thead>
<tr>
<th>ENI players including operators and vendors from Europe, US and Asia. As ENI was founded this year, some operators and vendors are in their internal progress to join ENI</th>
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<tbody>
<tr>
<td>Role</td>
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<tr>
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</tr>
<tr>
<td>Chairman</td>
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<tr>
<td>Vice Chairman</td>
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<tr>
<td>Second Vice Chairman</td>
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<tr>
<td>Technical Officer</td>
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<tr>
<td>Technical Manager</td>
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<tr>
<td>Other Main Players</td>
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</tbody>
</table>

Phase 1: Dec 2016 Workshop in Shenzhen  
Phase 2: Feb 2017 ETSI/ISG ENI created  
Kickoff meeting in ETSI HQ  
March 2018  
March 2019
ETSI ENI Work-items

ENI Use Cases – ENI-00

- Early draft: May 2017
- 14 Use cases to date
- Stable draft: December 2017
- Draft for approval: February 2018

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ENI Requirements – ENI-002

- Early draft: May 2017
- Stable draft: December 2017
- Draft for approval: February 2018

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ENI Context Aware Modelling Gap Analysis – ENI-003

- Early draft: September 2017
  - Comparison in MEF PO, IETF SUPA & TMF SID
- Stable draft: December 2017
- Draft for approval: February 2018

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ENI Terminology – ENI-004

- Early draft: September 2017
- Stable draft: December 2017
- Draft for approval: February 2018

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ENI Architecture GS – ENI-005

- Early draft: February 2018
- Stable draft: February 2019
- Draft for approval: March 2019
  - To be agreed

Contact Details:
To be confirmed (Verizon tbc)
## ENI Use Case: Summary Proposed by Operators & Vendors

### Use case

<table>
<thead>
<tr>
<th>Use case</th>
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<tbody>
<tr>
<td>Policy-driven IDC traffic steering</td>
</tr>
<tr>
<td>Awareness of Dedicated Resources with Network Slicing</td>
</tr>
<tr>
<td>Policy-driven IP managed networks</td>
</tr>
<tr>
<td>Radio Coverage and capacity optimization</td>
</tr>
<tr>
<td>Intelligent Software Rollouts</td>
</tr>
<tr>
<td>Policy-based network slicing for IoT security</td>
</tr>
<tr>
<td>Context aware VoLTE service experience optimization</td>
</tr>
<tr>
<td>Intelligent network slicing management</td>
</tr>
<tr>
<td>Intelligent carrier-managed SD-WAN</td>
</tr>
<tr>
<td>Dynamic Service Prioritization and Resource Sharing Infrastructures</td>
</tr>
<tr>
<td>Network fault prediction</td>
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<tr>
<td>Fault localization and diagnosis</td>
</tr>
</tbody>
</table>

14+ Use cases summarized in 3 categories: resource management and optimization, service experience optimization and assurance, fault detection and prediction
ENI Ecosystem

- Network Intelligence standard and industry layout

- ETSI ENI - Concept, use case and requirement, framework
- IETF / 3GPP - Protocol / data model / architecture
- ITU-T / MEF - Big data / policy
- BBF / GSMA - Fixed/Mobile international industrial development
- SDNIA AIAN - China - Asia industry alliance

- Cooperate with industry mainstream players - operators and vendors from Europe, US and Asia have joined ENI
- Work with other SDOs and industry development organization - Liaisons exchanged with IETF, BBF, MEF, ETSI NFV / NGP / MEC / NTECH, etc
- ETSI ENI as the home/core of intelligent network standards - guiding the industry on the consensus of evolution of intelligence in the network
Future evolution of network intelligence

Network Intelligence

Automatic: refers to the automation of service distribution, network deployment and maintenance, through the integration of network management and control unit, to achieve automation of service distribution processes

Adaptive: refers to the further introduction of intelligent analysis unit based on the first stage, real-time acquisition of network data, perception of network status, based on service and network SLA promised to generate optimization strategies to enable the network from open-loop configuration to closed-loop optimization

Autonomous (self-decision) - Long-term exploration: To further enhance the "intelligence" level of the unit of analysis, introduce artificial intelligence and machine learning algorithms to make the network self-learning ability, evolve from a given static strategy to a dynamic strategy based on self-realize and learn network autonomy.

From “Network, All Intelligent.” speech from Mr. Wang Tao in UBBF.
Next Steps

- All ICT Industry companies are welcome to join us!

- **Online meetings every week, 20+meetings already held**

<table>
<thead>
<tr>
<th>Date</th>
<th>Meeting</th>
<th>Location</th>
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<tbody>
<tr>
<td>14 Nov</td>
<td>Rapporteur's call#27: Terminology TBC</td>
<td>Online</td>
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<tr>
<td>21 Nov</td>
<td>Rapporteur's call#28: Requirements&amp;Terminology</td>
<td>Online</td>
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<td>21 Nov</td>
<td>Rapporteur's call#29: Use cases</td>
<td>Online</td>
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<td>22 Nov</td>
<td>Rapporteur's call#30: Context Aware Policy Modelling</td>
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<td>28 Nov</td>
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<td>28 Nov</td>
<td>Rapporteur's call#32: Requirements&amp;Terminology</td>
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<td>11-13 Dec</td>
<td>ENI#4</td>
<td>Staines GB</td>
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<td>14 Dec</td>
<td>ENI workshop</td>
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<tr>
<td>05-08 Mar</td>
<td>ENI#5</td>
<td>Sophia Antipolis FR</td>
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<tr>
<td>14-17 May</td>
<td>ENI#6</td>
<td>Sophia Antipolis FR</td>
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- **Next F2F meeting:**
  - ENI#04 meeting will be held in Staines, UK, on 11-13 Dec.
  - Meetings in 2018 planned

- **Need to cooperate with many SDO and Technical bodies within ETSI**
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MEF Policy Summary

• **Comprehensive Info Model Defined**
  - Extension of IETF SUPA Framework
  - Defines declarative and intent policies in addition to imperative policies

• **Info Model Used as a Grammar**
  - Syntax and semantics used to define APIs and DSLs

• **Three DSLs with Mappings between Each**
  - Imperative: *Block-structured, keyword-based*
  - Declarative: *FOL-based*
  - **Intent:** *Natural language*
How Do Different Constituencies Interact?
Constituencies: The Policy Continuum and Intent

Intent

- Declarative
- Imperative

Level of Abstraction

High

Low

Business View: SLAs, Processes, Guidelines, and Goals

Service View: Device- and Technology-Independent Operation

Administrator View: Device- Independent, Technology-Specific Operation

Device View: Device- and Technology-Specific Operation

Instance View: Device-Specific MIBs, PIBs, CLI, etc. Implementation
Generic Observations About Policy

• A Policy could be used to build and modify ACLs (access control lists)
• A Policy is typically NOT thought of as the ACL itself
• For North-South, or hierarchies in general:
  – Policies *manage* behavior
• For East-West:
  – Policies *negotiate* (e.g., request and offer, but not *control*) behavior

• How we can build a common abstraction for these two different policies?
  – Policies are selected based on a 3-tuple: {Context, Capabilities, Constraints}
  – Metadata can be used to describe and prescribe each of the elements in the above 3-tuple
  – Context selects policies based on applicability
  – Capabilities describe what the policy does
  – Constraints restrict the capabilities offered and/or the behavior of the policy
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Background, Motivation and Goal

● **Background:**
  - Wavelength-division multiplexing (WDM)
  - WDM system
  - wavelength division network data

● **Motivation:**
  - Traditional passive strategy is inefficient, and easily leads to long service interruption.
  - Statistical characteristics of network data can help operator to judge the time point at which the service is abnormal or normal, or the service is risky or healthy.

● **Goal:**
  - illustrate the requirements of network data used to evaluate the performance of wavelength division service.
  - demonstrate the different application scenarios of network data in wavelength division service.
  - present the existing problem of learning network data.
Characteristics of network data

- Network data is a series of data points indexed in time order. It taken over time may have an internal structure (such as, trend, seasonal variation, or outliers).
- Network data mainly consists several major characteristics:
  - Subject
  - Measured values
  - Timestamp

<table>
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<tr>
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<th>cpu</th>
<th>iops</th>
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<td>Cluster-A</td>
<td>host-a</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>
Use cases

- **Anomaly detection:**
  - **anomaly detection** is the identification of items, events or observations which do not conform to an expected pattern or other items in data
  - **Network data:** FEC_bef, input optical power, laser bias current and other key factors can be selected to keep track of wavelength division service over time

```
+--------+ +--------+ +--------+ +--------+
| Network | feature | anomaly | raise |
| data    | +-->    | selection | +--> | detection | +--> | alarm |
+--------+ +--------+ +--------+ +--------+
```

- **Risk assessment:**
  - **Single KPI scoring:** The scoring strategy for single KPI. In this case, different dimensions of a KPI should be examined to score a KPI;
  - **Multi-KPI scoring:** The scoring strategy for assessing the network risk using values of many KPIs. If a device or a service is monitored by several key KPIs, the risk should be analyzed by the integration of these KPI scores.

```
+--------+ +--------+ +--------+
| Network | single KPI | risk |
| data    | +-->    | scoring | +--> | assessment |
+--------+ +--------+ +--------+
```

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Risk assessment

- Single KPI
  - Fluctuation analysis
  - Trend analysis
  - Threshold analysis

- Multi-KPI
  - FECbef KPI scoring

- Multi-KPI scoring

\[ S(x_{bef}, x_{aft}) = \begin{cases} 
30 + 0.7 * S_{bef} & \text{if } x_{aft} = 0 \\
0.3 * S_{bef} & \text{if } x_{aft} \neq 0
\end{cases} \]
Open issues

• Merge data from different time periods?

  ❑ For example, for a multi-domain deployment service, there are many different collection periods for network devices, such as 30s, 5min, 15min, and so on.
  ❑ How these data sets are stored and assessed with high efficiency?
Thank you!
Backup slides
ThinkNET: Demo the idea of network intelligence

Sub-Demo A: Imperative policy

- Imperative policy: ECA
- Close loop control based on pre-defined policy

Sub-Demo B: Declarative policy

- Intent based API
- The system automatically generates the solution according to the intent and status of network

Sub-Demo C: intelligent resource mngt

- Centrally controlled address management
- Real-time collect & analyze data, adjust resource based on that without manual configuration
- Improve IP address utilization and reduce OPEX

Sub-Demo D: Intelligent service deployment

- Simplify the manual configuration
- Based on service model
- Orchestrator implements the network configuration details
ENI Standards for Experiential Networked Intelligence Improving Experience

Intelligent Service Deployment
• Intent based service management
• Service mapping
• Service atom

Intelligent Analyzing and Prediction
• Network analyzing
• Utilization/inventory Prediction
• Fault Prediction

Intelligent Monitoring
• SDN Telemetry
• Network event & state collection
• Network performance collection

Intelligent Policy Control
• Imperative policy
• Declarative policy
• Policy driven service/resource management

Intelligent Resource Management
• On-demand resource allocation
• 3rd party resource API
• Intent based resource management