Intelligence lies in simplicity

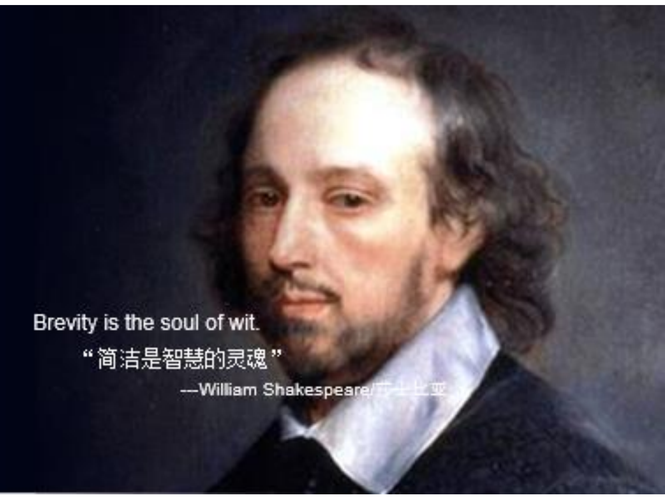
智慧源于简单，智慧为了简单

Black + White + Simple Rules = Infinite Strategy

黑与白，最简规则，却蕴含博大的智慧

0 + 1 = Infinite Computation

0与1，有限元素，却产生无尽的智慧



Brevity is the soul of wit.

“简洁是智慧的灵魂”

---William Shakespeare/莎士比亚

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

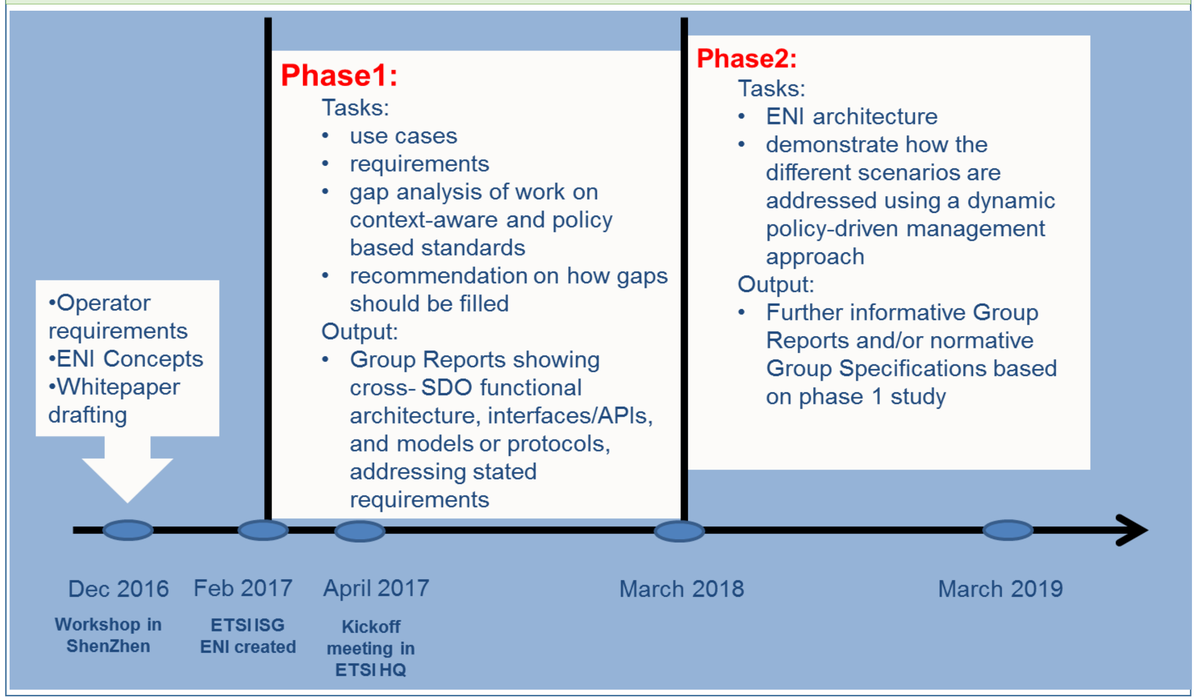
(Experiential Networked Intelligence)

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.

Phase 1 focus on use case & requirements, phase 2 design function & architecture. 4 meetings per year: Q3 - Beijing (hosted by CT), Q4 - UK (hosted by Samsung)



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

Role	Company
Chairman	**Huawei** (Dr. Raymond Forbes)
Vice Chairman	**China Telecom** (Haining Wang)
Second Vice Chairman	**Verizon** (Dr. Farid Feisullin "Fred")
Technical Officer	**ETSI** (Sylwia Korycinska)
Technical Manager	**Huawei** (Dr. Shucheng Liu "Will")
Other Main Players	**Samsung, PT, SKT, Changhwa Tel, Intel, ZTE, Xilinx, Layer123, WINGS, HKUST, UniLU, CATR, Convida, MeadowCom, Cadzow…**

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

Contact Details:

Yue Wang

(Samsung R&D UK)

yue2.wang@samsung.com

ENI Requirements – ENI-002

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

Contact Details:

Haining Wang

(China Telecommunications)

wanghn.bri@chinatelecom.cn

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

Contact Details:

John Stassner

(Huawei Technologies Co. Ttd. UK)

John.sc.Strassner@huawei.com

ENI Terminology – ENI-004

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

Contact Details:

Yu Zeng

(China Telecommunications)

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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)

ETSI Supporters: Verizon, Huawei, ZTE, China Telecommunications, Portugal Telecoms.

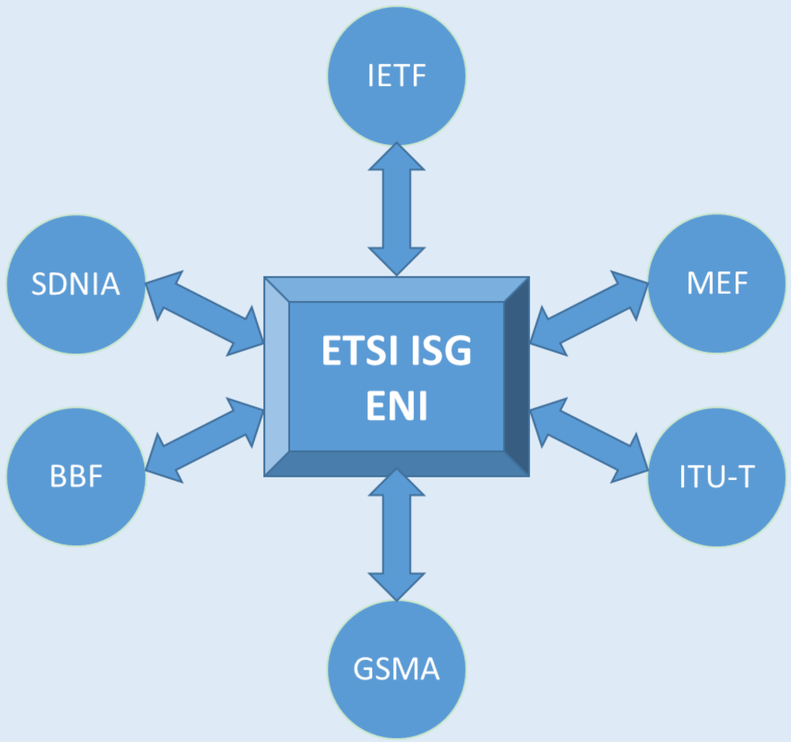
ENI Use Case: Summary Proposed by Operators & Vendors

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

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

ENI Ecosystem

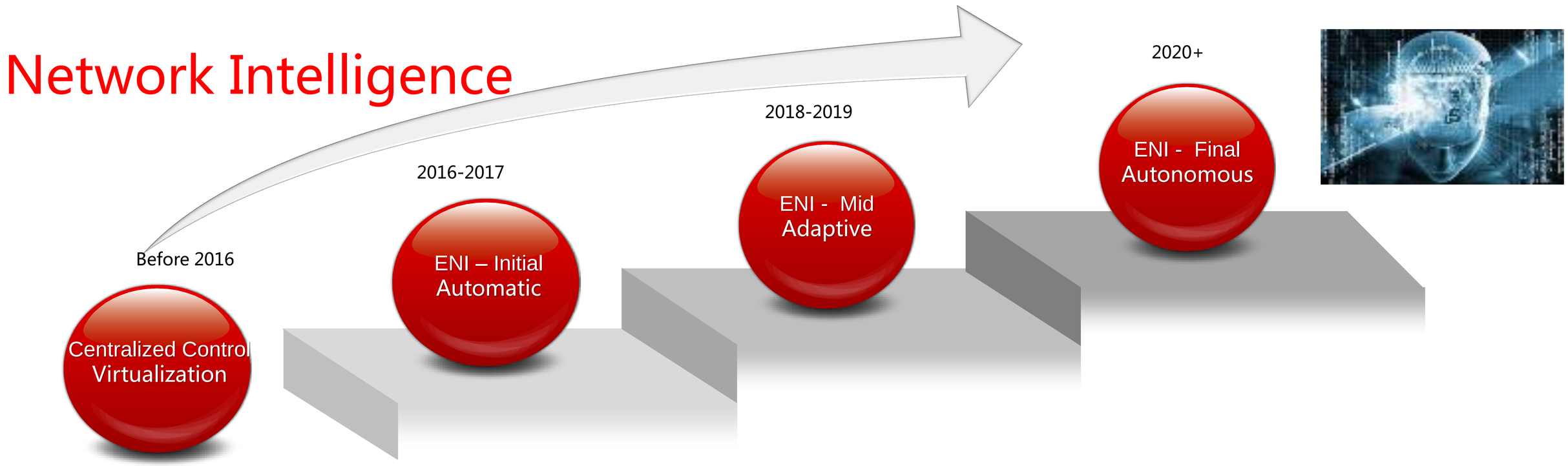
•Network Intelligence standard and industry layout



- **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



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**
  - https://portal.etsi.org/tb.aspx?tbid=857&SubTB=857#5069-meetings

Date	Meeting	Location
14 Nov	Rapporteur's call#27: Terminology TBC	Online
21 Nov	Rapporteur's call#28: Requirements&Terminology	Online
21 Nov	Rapporteur's call#29: Use cases	Online
22 Nov	Rapporteur's call#30: Context Aware Policy Modelling	Online
28 Nov	Rapporteur's call#31: Context Aware Policy Modelling	Online
28 Nov	Rapporteur's call#32: Requirements&Terminology	Online
11-13 Dec	ENI#4	Staines GB
14 Dec	ENI workshop	Staines GB
05-08 Mar	ENI#5	Sophia Antipolis FR
14-17 May	ENI#6	Sophia Antipolis FR

- **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**

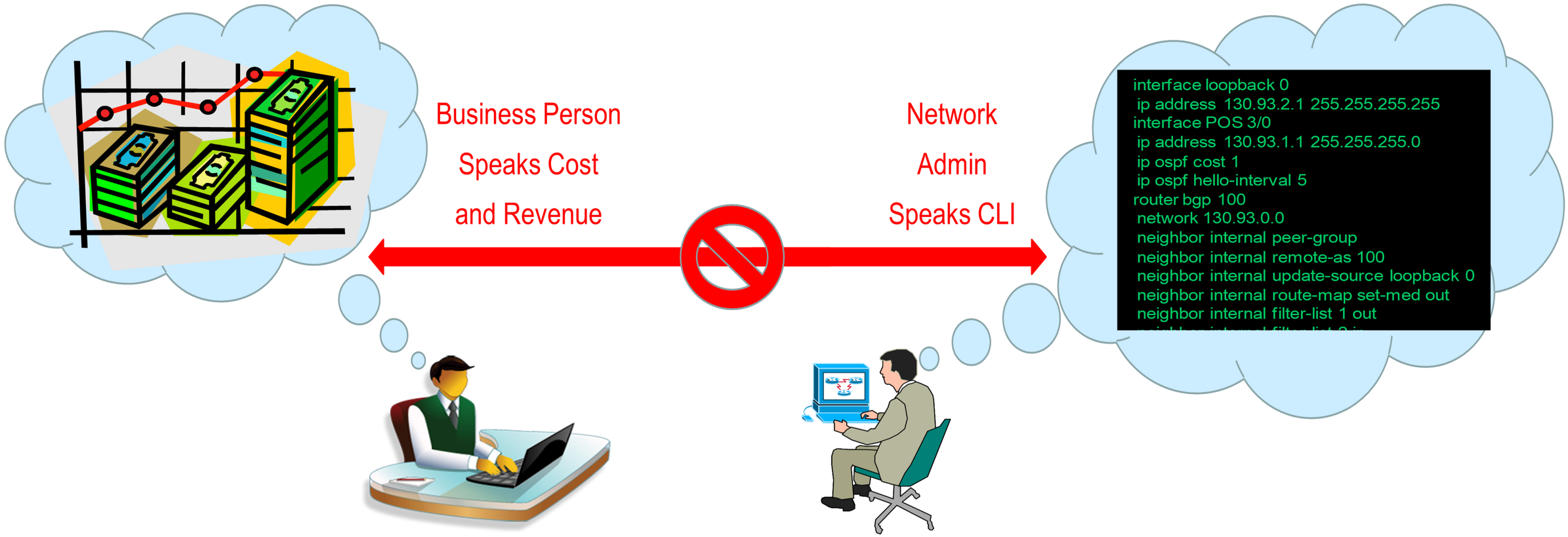
Agenda

- **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**

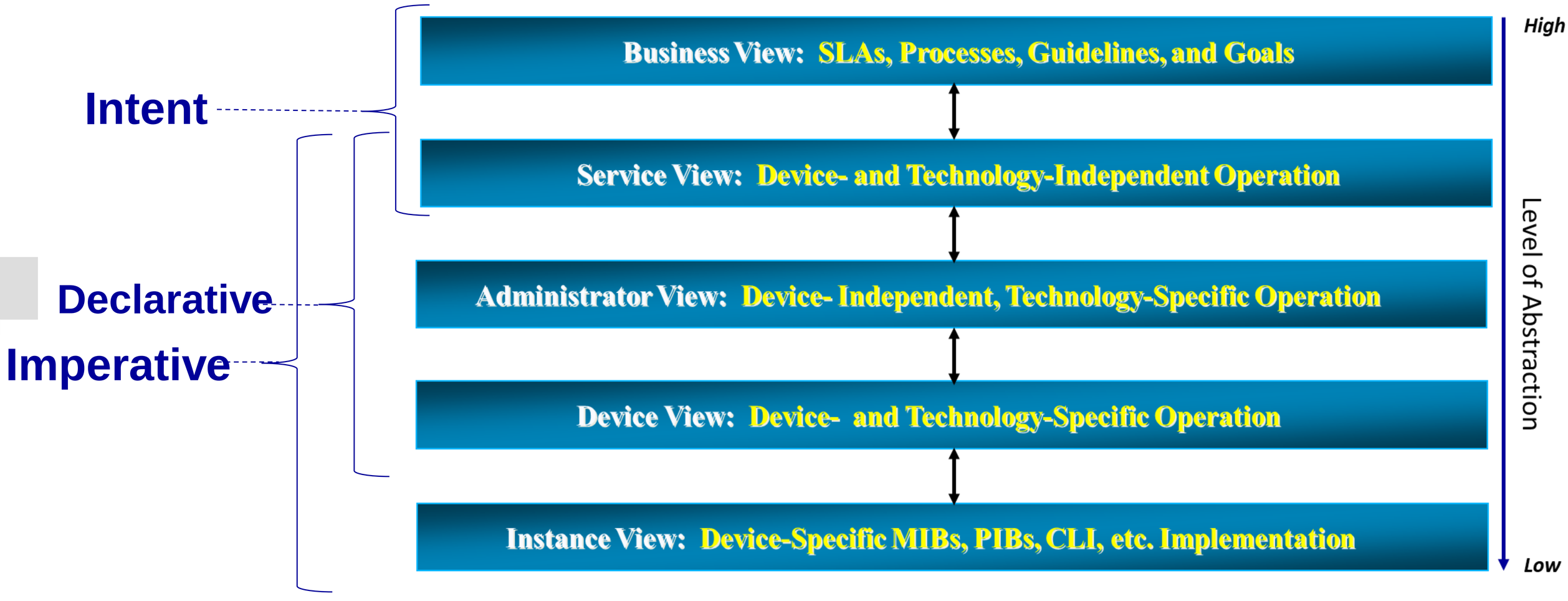
MEF Policy Summary

- **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



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

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

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

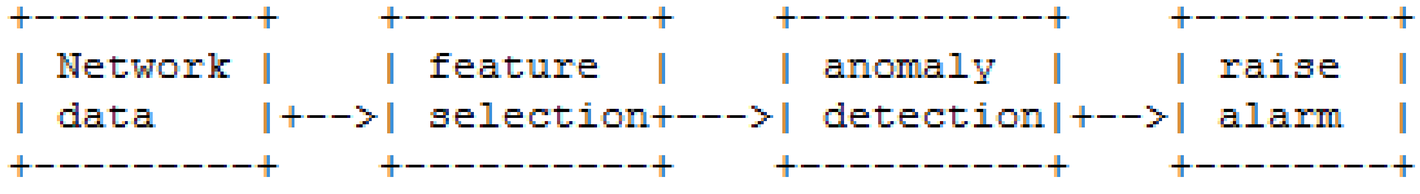
- **Network data is a series of data points indexed in time order. It taken over time may have an internal structure (such as, trend, seasonal variation, or outliers).**
- **Network data mainly consists several major characteristics:**
  - **Subject**
  - **Measured values**
  - **Timestamp**

timestamp	cluster	hostname	cpu	iops
2015-04-28T17:50:00Z	Cluster-A	host-a	10	10
2015-04-28T17:50:10Z	Cluster-A	host-b	20	30
2015-04-28T17:50:20Z	Cluster-A	host-a	5	8

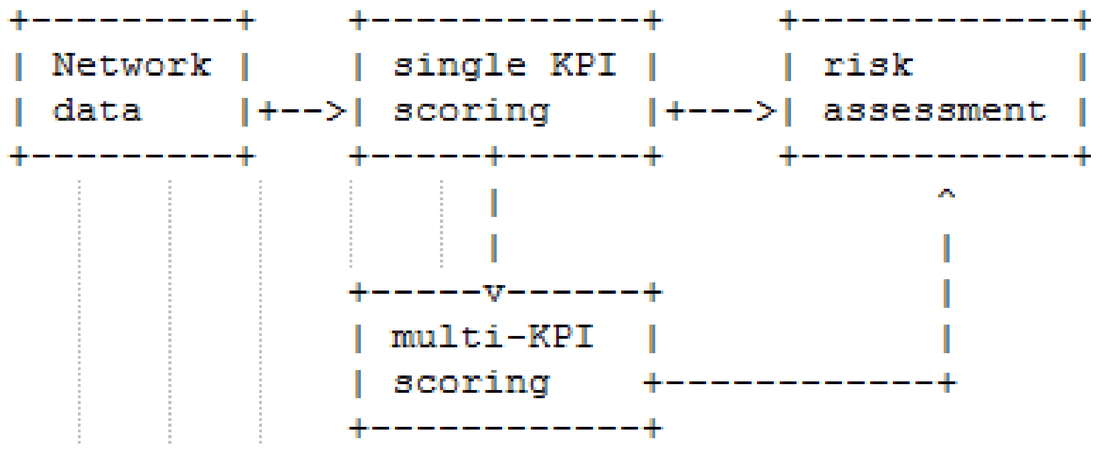
Timestamp Subject Measured values

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**

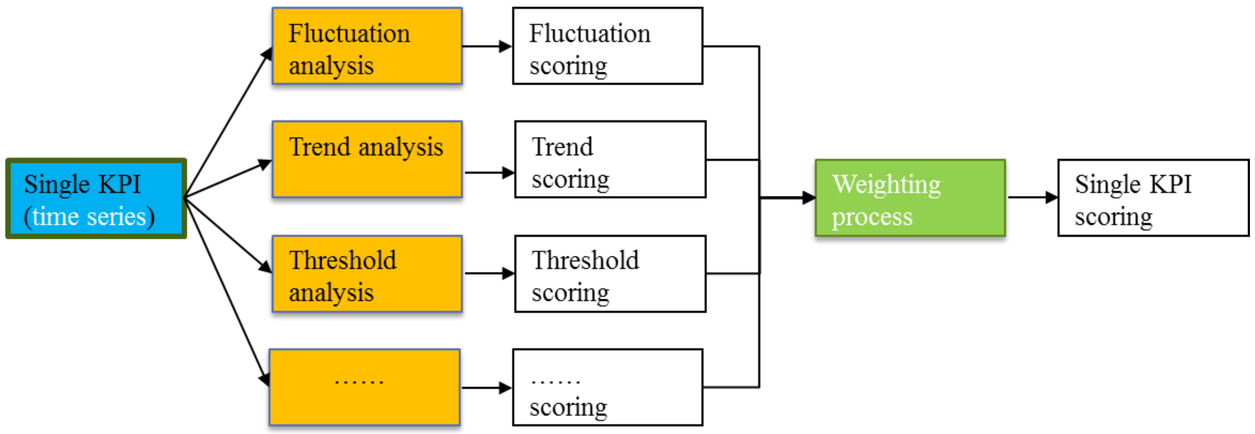


- **Risk assessment:**
  - **Single KPI scoring: The scoring strategy for single KPI. In this case, different dimensions of a KPI should be examined to score a KPI;.**
  - **Multi-KPI scoring: The scoring strategy for assessing the network risk using values of many KPIs. If a device or a service is monitored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



Risk assessment

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



- **FEC_bef KPI scoring**

FEC_score (5×169,236)

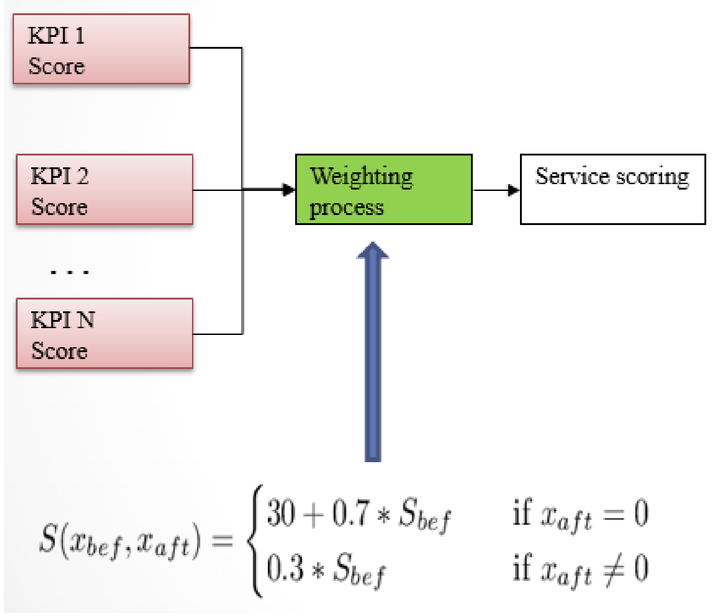
time	rid	befjitterscore	befdeviationscore	befthresholdscore
2017-07-01 00:00:00	r1	50.0073	87.7848	12.5
2017-07-01 00:00:00	r10	100	100	100
2017-07-01 00:00:00	r100	100	100	100
2017-07-01 00:00:00	r1000	100	100	100
2017-07-01 00:00:00	r1001	100	100	100
2017-07-01 00:00:00	r1002	83.0047	85.7769	37.5
2017-07-01 00:00:00	r1003	77.2716	100	25
2017-07-01 00:00:00	r1004	100	100	100
2017-07-01 00:00:00	r1005	100	100	100
2017-07-01 00:00:00	r1006	100	100	100
2017-07-01 00:00:00	r1007	100	90.3659	12.5
2017-07-01 00:00:00	r1008	79.8173	87.1236	0
2017-07-01 00:00:00	r1009	87.3081	95.2853	12.5
2017-07-01 00:00:00	r101	100	100	12.5
2017-07-01 00:00:00	r1010	100	100	100
2017-07-01 00:00:00	r1011	100	100	100
2017-07-01 00:00:00	r1012	100	100	100
2017-07-01 00:00:00	r1013	100	100	100
2017-07-01 00:00:00	r1014	100	100	100
2017-07-01 00:00:00	r1015	34.575	100	100
2017-07-01 00:00:00	r1016	100	100	100
2017-07-01 00:00:00	r1017	100	100	100
2017-07-01 00:00:00	r1018	100	100	100
2017-07-01 00:00:00	r1019	100	100	100
2017-07-01 00:00:00	r102	100	99.8157	12.5
2017-07-01 00:00:00	r1020	84.8477	100	100
2017-07-01 00:00:00	r1021	71.1991	100	100
2017-07-01 00:00:00	r1022	100	99.9679	0
2017-07-01 00:00:00	r1023	100	100	0
2017-07-01 00:00:00	r1024	100	100	100
2017-07-01 00:00:00	r1025	100	100	100
2017-07-01 00:00:00	r1026	100	100	100
2017-07-01 00:00:00	r1027	100	100	100
2017-07-01 00:00:00	r1028	81.1454	87.5456	37.5
2017-07-01 00:00:00	r1029	34.575	87.3236	62.5
2017-07-01 00:00:00	r103	100	100	100
2017-07-01 00:00:00	r1030	100	100	37.5

weighting

FEC_score (6×169,236)

time	rid	befjitterscore	befdeviationscore	befthresholdscore	befscore
2017-07-01 00:00:00	r1	50.0073	87.7848	12.5	55.7685
2017-07-01 00:00:00	r10	100	100	100	100
2017-07-01 00:00:00	r100	100	100	100	100
2017-07-01 00:00:00	r1000	100	100	100	100
2017-07-01 00:00:00	r1001	100	100	100	100
2017-07-01 00:00:00	r1002	83.0047	85.7769	37.5	68.4641
2017-07-01 00:00:00	r1003	77.2716	100	25	70.3407
2017-07-01 00:00:00	r1004	100	100	100	100
2017-07-01 00:00:00	r1005	100	100	100	100
2017-07-01 00:00:00	r1006	100	100	100	100
2017-07-01 00:00:00	r1007	100	90.3659	12.5	64.558
2017-07-01 00:00:00	r1008	79.8173	87.1236	0	55.5344
2017-07-01 00:00:00	r1009	87.3081	95.2853	12.5	65.1139
2017-07-01 00:00:00	r101	100	100	12.5	69.375
2017-07-01 00:00:00	r1010	100	100	100	100
2017-07-01 00:00:00	r1011	100	100	100	100
2017-07-01 00:00:00	r1012	100	100	100	100
2017-07-01 00:00:00	r1013	100	100	100	100
2017-07-01 00:00:00	r1014	100	100	100	100
2017-07-01 00:00:00	r1015	34.575	100	100	90.1862
2017-07-01 00:00:00	r1016	100	100	100	100
2017-07-01 00:00:00	r1017	100	100	100	100
2017-07-01 00:00:00	r1018	100	100	100	100
2017-07-01 00:00:00	r1019	100	100	100	100
2017-07-01 00:00:00	r102	100	99.8157	12.5	69.2828
2017-07-01 00:00:00	r1020	84.8477	100	100	97.7272
2017-07-01 00:00:00	r1021	71.1991	100	100	95.6799
2017-07-01 00:00:00	r1022	100	99.9679	0	64.984
2017-07-01 00:00:00	r1023	100	100	0	65
2017-07-01 00:00:00	r1024	100	100	100	100
2017-07-01 00:00:00	r1025	100	100	100	100
2017-07-01 00:00:00	r1026	100	100	100	100
2017-07-01 00:00:00	r1027	100	100	100	100
2017-07-01 00:00:00	r1028	81.1454	87.5456	37.5	69.0696
2017-07-01 00:00:00	r1029	34.575	87.3236	62.5	70.7231
2017-07-01 00:00:00	r103	100	100	100	100
2017-07-01 00:00:00	r1030	100	100	37.5	78.125

- **Multi - KPI**



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

- **Multi - KPI scoring**

FEC_score (5×169,236)

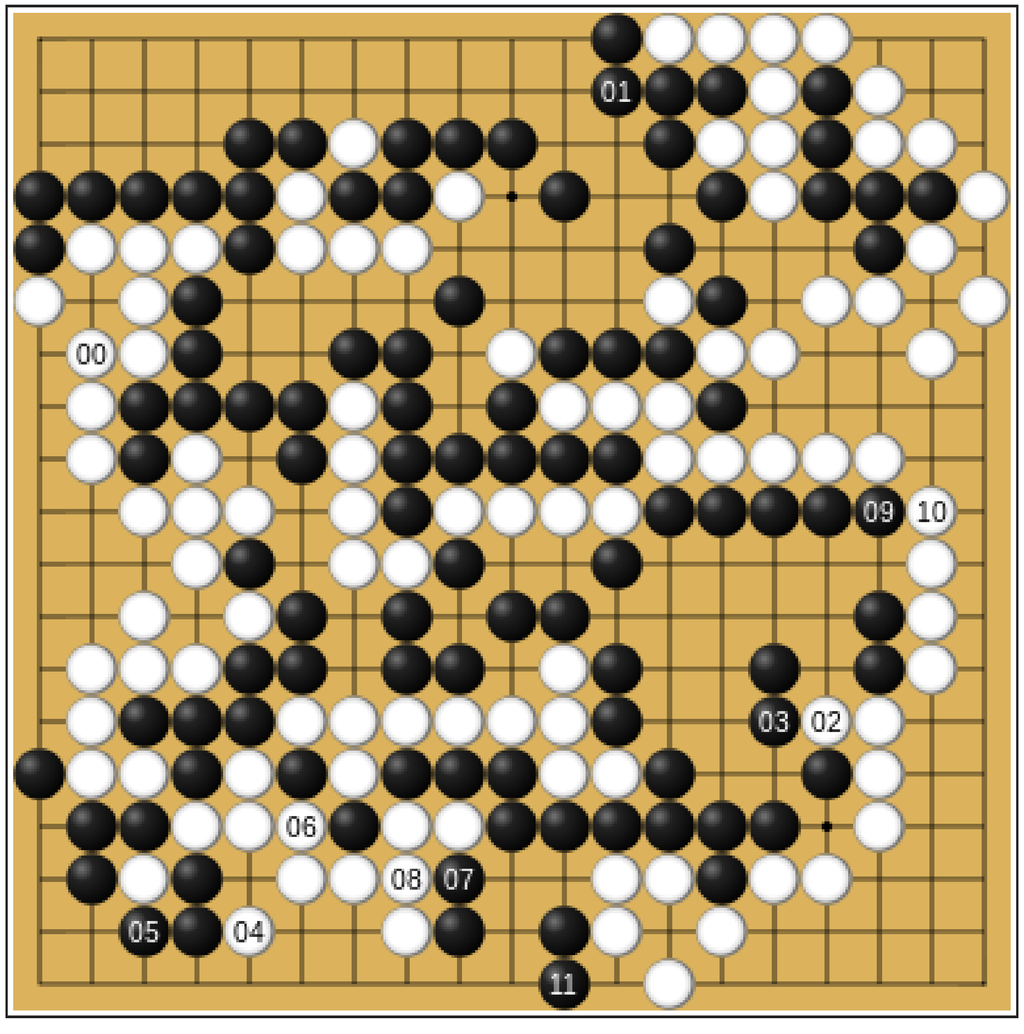
time	rid	aftcorrected	befscore	finalscore
2017-07-01 00:00:00	r1	0	55.7685	69.0379
2017-07-01 00:00:00	r10	0	100	100
2017-07-01 00:00:00	r100	0	100	100
2017-07-01 00:00:00	r1000	0	100	100
2017-07-01 00:00:00	r1001	0	100	100
2017-07-01 00:00:00	r1002	0	68.4641	77.9249
2017-07-01 00:00:00	r1003	0	70.3407	79.2385
2017-07-01 00:00:00	r1004	0	100	100
2017-07-01 00:00:00	r1005	0	100	100
2017-07-01 00:00:00	r1006	0	100	100
2017-07-01 00:00:00	r1007	0	64.558	75.1906
2017-07-01 00:00:00	r1008	0	55.5344	68.8741
2017-07-01 00:00:00	r1009	0	65.1139	75.5797
2017-07-01 00:00:00	r101	0	69.375	78.5625
2017-07-01 00:00:00	r1010	0	100	100
2017-07-01 00:00:00	r1011	0	100	100
2017-07-01 00:00:00	r1012	0	100	100
2017-07-01 00:00:00	r1013	0	100	100
2017-07-01 00:00:00	r1014	0	100	100
2017-07-01 00:00:00	r1015	0	90.1862	93.1304
2017-07-01 00:00:00	r1016	0	100	100
2017-07-01 00:00:00	r1017	0	100	100
2017-07-01 00:00:00	r1018	0	100	100
2017-07-01 00:00:00	r1019	0	100	100
2017-07-01 00:00:00	r102	0	69.2828	78.498
2017-07-01 00:00:00	r1020	0	97.7272	98.409
2017-07-01 00:00:00	r1021	0	95.6799	96.9759
2017-07-01 00:00:00	r1022	0	64.984	75.4888
2017-07-01 00:00:00	r1023	0	65	75.5
2017-07-01 00:00:00	r1024	0	100	100
2017-07-01 00:00:00	r1025	0	100	100
2017-07-01 00:00:00	r1026	0	100	100
2017-07-01 00:00:00	r1027	0	100	100
2017-07-01 00:00:00	r1028	0	69.0696	78.3487
2017-07-01 00:00:00	r1029	0	70.7231	79.5061
2017-07-01 00:00:00	r103	0	100	100
2017-07-01 00:00:00	r1030	0	78.125	84.6875

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?**

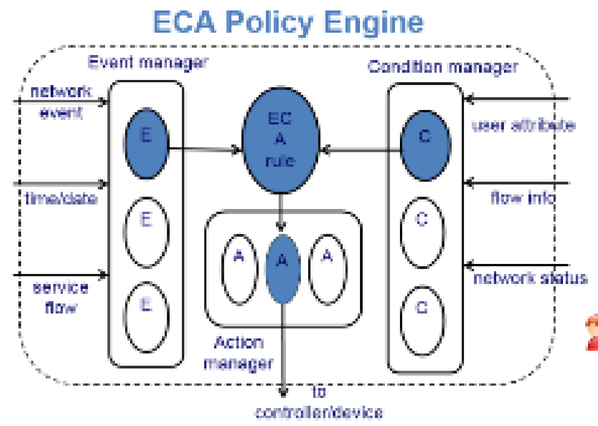
Thank you!

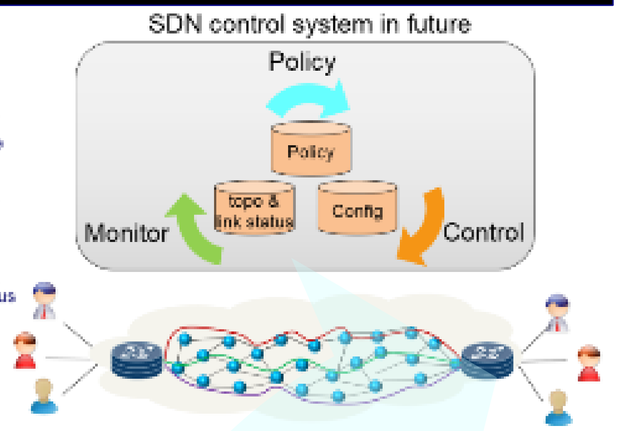


Backup slides

ThinkNET: Demo the idea of network intelligence

Sub-Demo A: Imperative policy

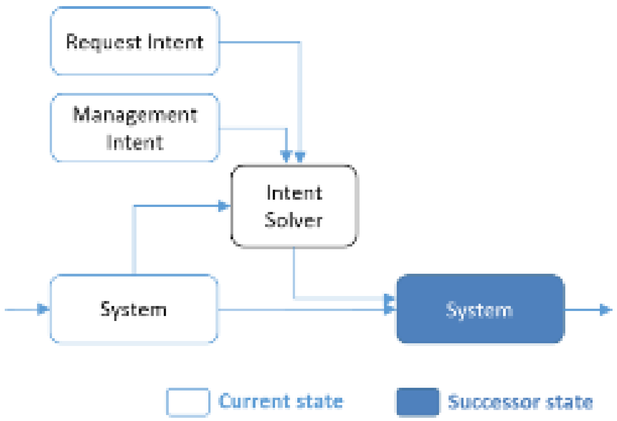




- **Imperative policy： ECA**
- **Close loop control based on pre-defined policy**

Sub-Demo B: Declarative policy

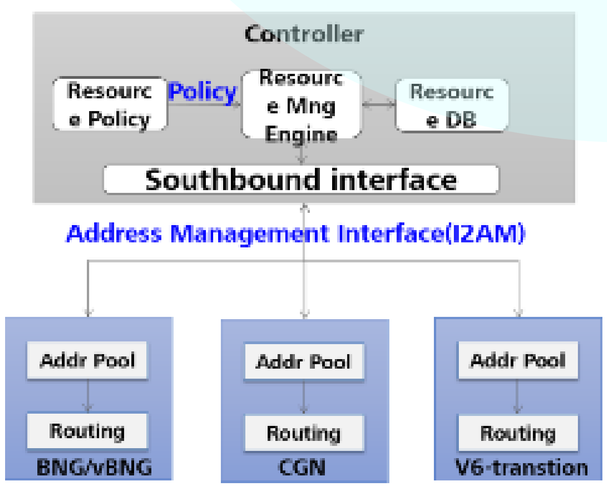
- **Intent based API**
- **The system automatically generates the solution according to the intent and status of network**



overall intelligent control mechanism on the whole process

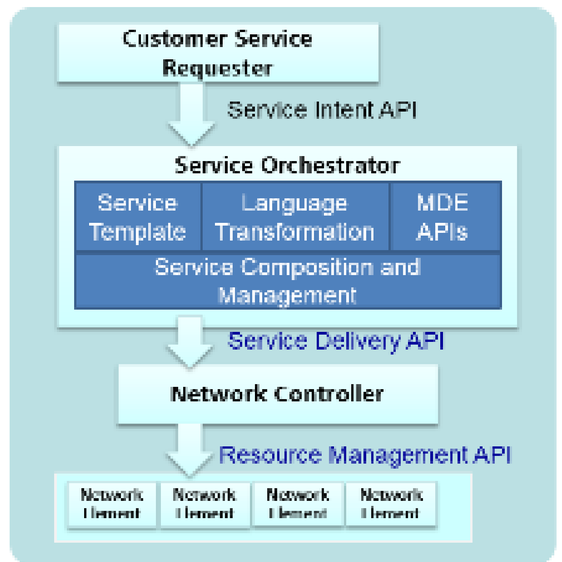
Sub-Demo C: intelligent resource mngt

- **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 Policy Control
- Imperative policy
- Declarative policy
- Policy driven service/resource management

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

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