
HUAWEI
Experiential Networked Intelligence

Agenda

- State of the Art
- Experiential Networked Intelligence
- Evolution
- Use Case
- Discussion

Inspired by the Development of Technology

AlphaGo

The game of Go is complex because of the huge number of possible states. So is the operator's network management: many types of devices/protocols, complex connection topology, different configuration options and languages from different vendors, etc. Manual management is costly and error-prone.

How can ALPHAGO's success inspires us to improve the operator's network management experience?

Inspired by the Development of Technology (2)

- Mobile： Feature phone → 1st Gen Smart Phone → Smart Phone
- Automobile： MT → AT → Self-driving
- Network： Traditional → SDN / NFV / ? → ***Autonomic Operation and Behavior***

The ultimate goal of development of science and technology, is to improve the human experience, more suitable for human to use, simplify the human-machine interaction by improving the AI of machine

Operator Experience?

UX is so popular in IT, what is OPX for CT?

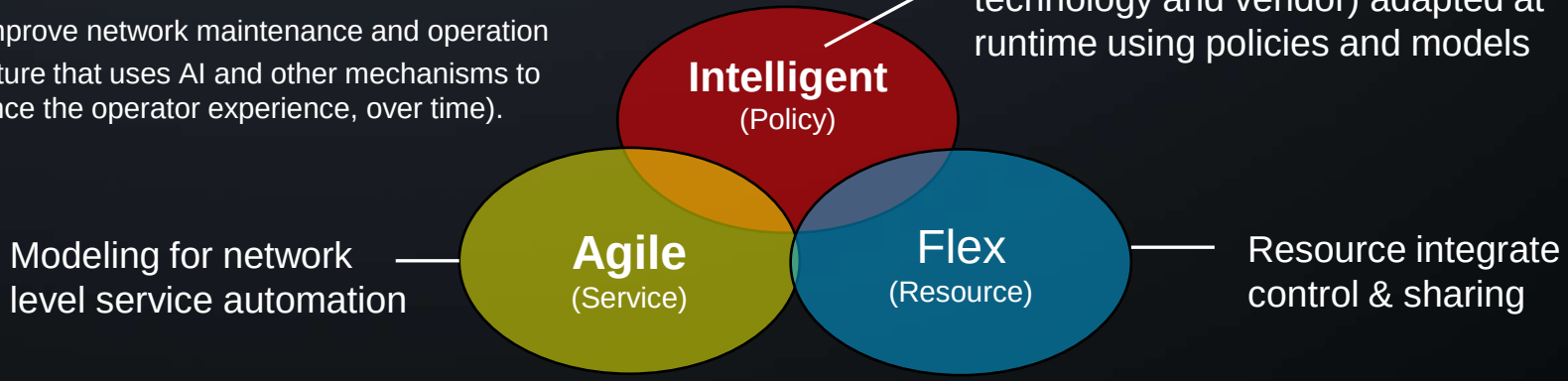
- **User experience** (**UX**) refers to a person's emotions and attitudes about using a particular product, system or service,… includes a person's perceptions of system aspects such as utility, ease of use and efficiency. - from wikipedia
- *If* network = cell phone, *then* the experience of its owner(operator) is still barely satisfactory:
  - Human-dependent decision, complex manual config, low resource utilization
- OPX for SDN/NFV/Legacy operation depends on three concepts

Ideal UX example

- Intelligent Decision-Making
- Agile & Auto Config
- Flex Resource Allocation

Challenges

- Automating human-dependent decision-making processes
- Determining services status
- Defining how best to visualize network services and improve network maintenance and operation
- Providing an experiential architecture (i.e., an architecture that uses AI and other mechanisms to improve its understanding of the environment, and hence the operator experience, over time).



Network should be provisioned based on improving OPX. This is done by using policy-driven orchestration and model-driven engineering to enable offered services to adapt to user, business, and environmental changes.

ENI - Experiential Networked Intelligence

Intelligent Service Deployment

- Intent based service management
- Service mapping
- Service atom

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

Intelligent Monitoring

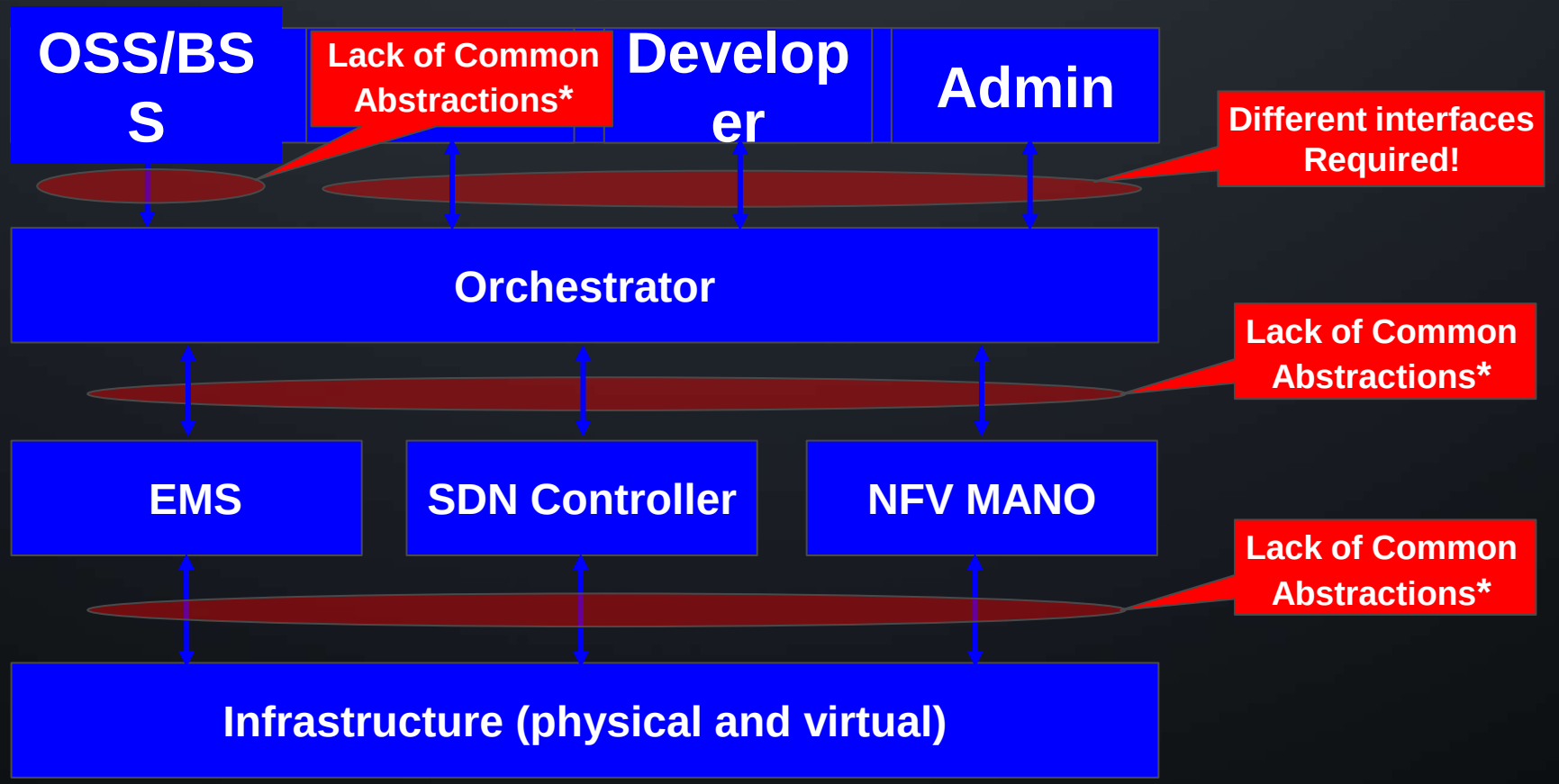
- SDN Telemetry
- Network event & state collection
- Network performance collection

Intelligent Analyzing and Prediction

- Network analyzing
- Utilization/inventory Prediction
- Fault Prediction

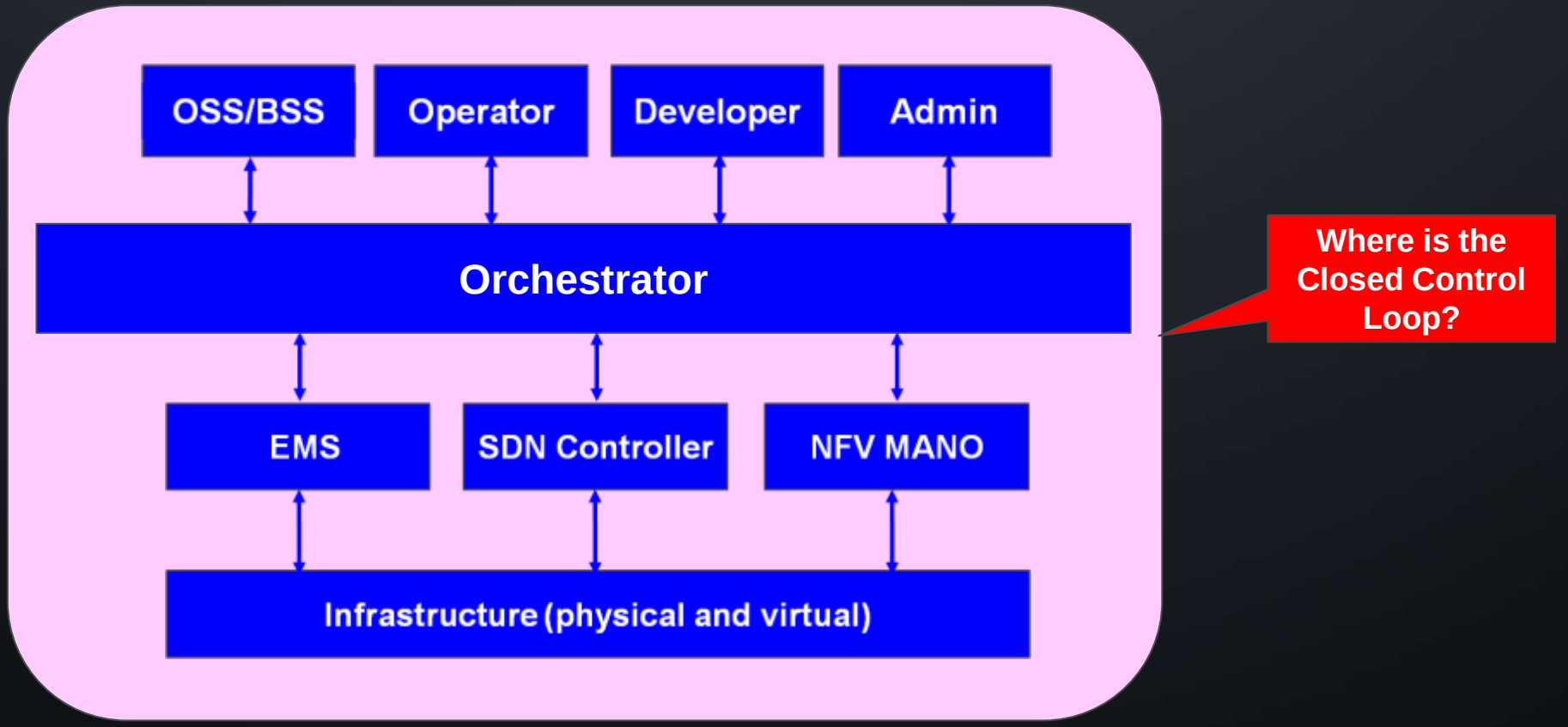
Missing from Current SDO Work (1)

Note: other important elements, such as Applications, are not shown to keep this diagram (and the next 2) simple

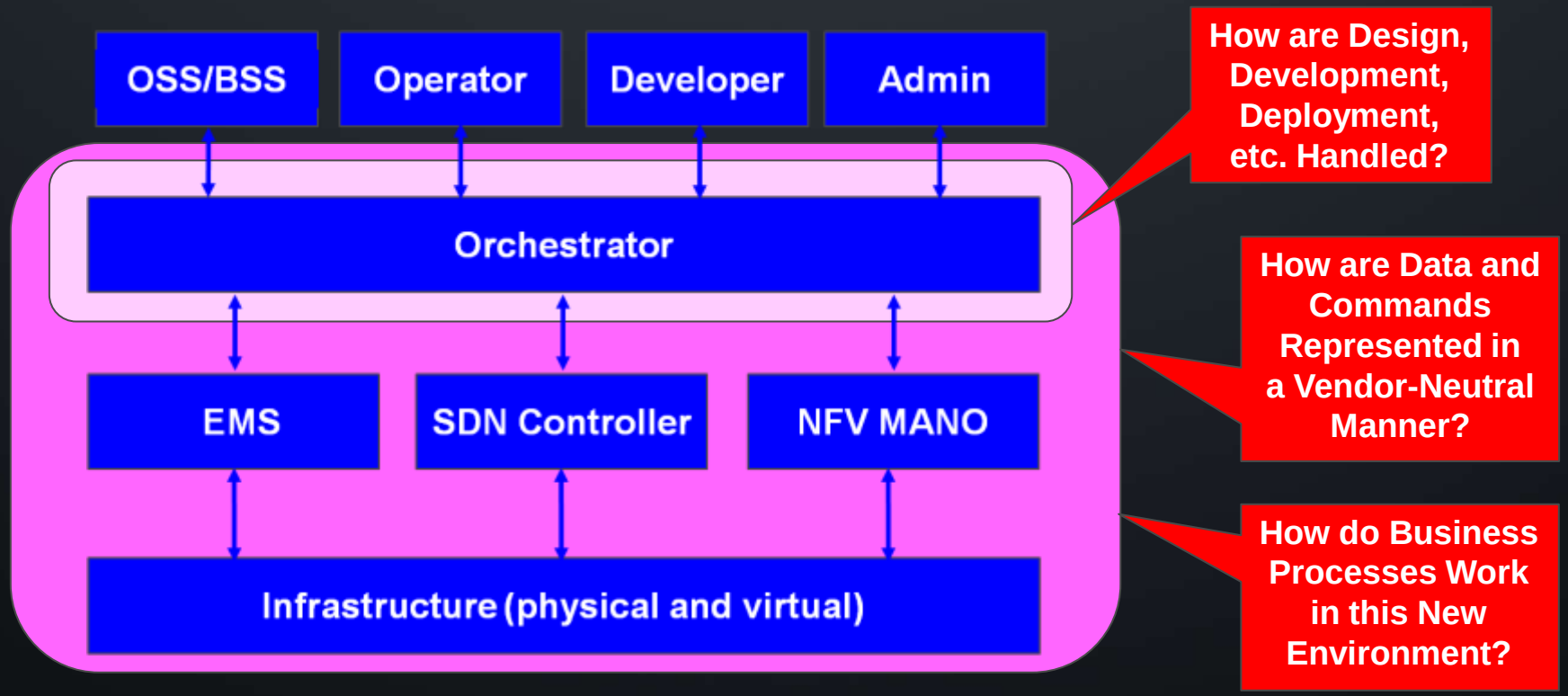


** Other than MEF Services, of course ☺*

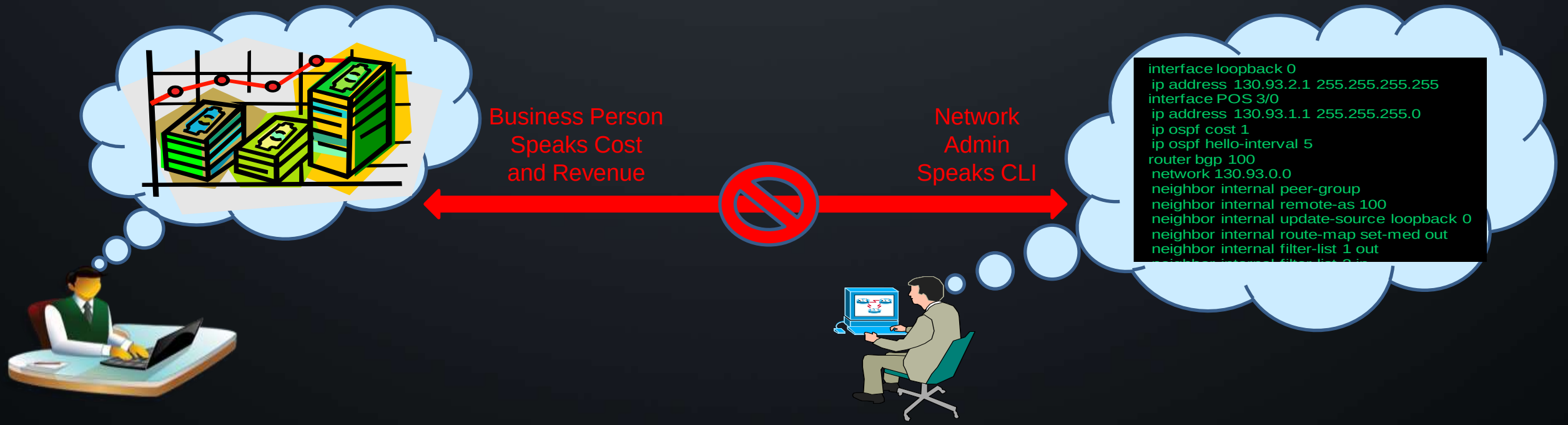
Missing from Current SDO Work (2)



Missing from Current SDO Work (3)



Missing from Current SDO Work (4)



This SHOULD be one of the main problems solved by Intent!

Ref [4][7][11]

Intelligent Policy

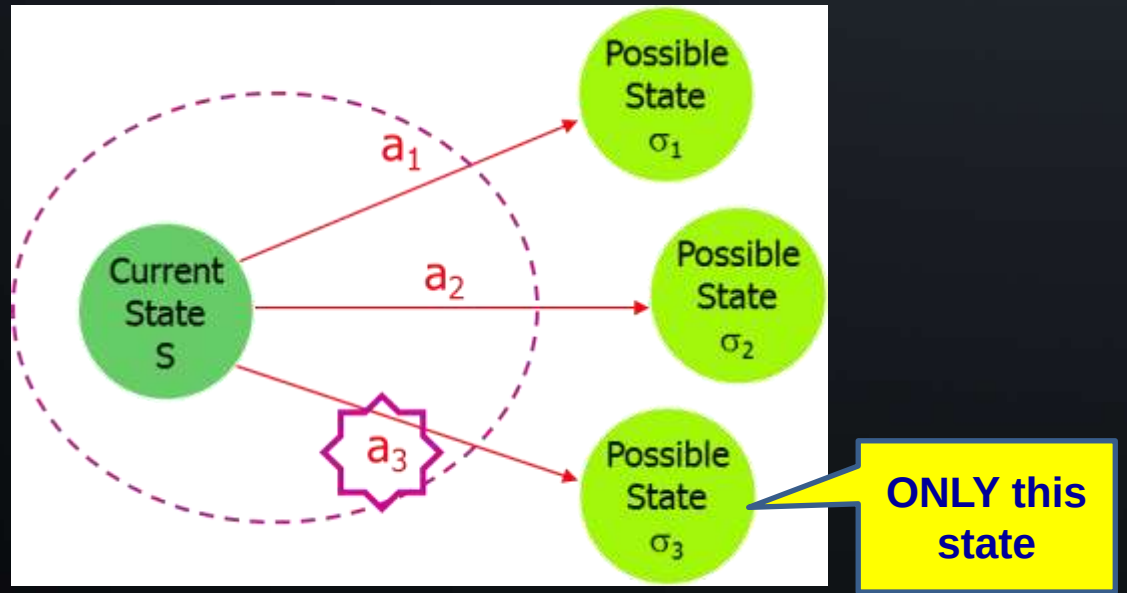
Imperative: Event-Condition-Action (ECA)

IF the Event clause evaluates to TRUE
IF the Condition clause evaluates to TRUE
THEN Execute Actions in Action Clause
ENDIF
ENDIF

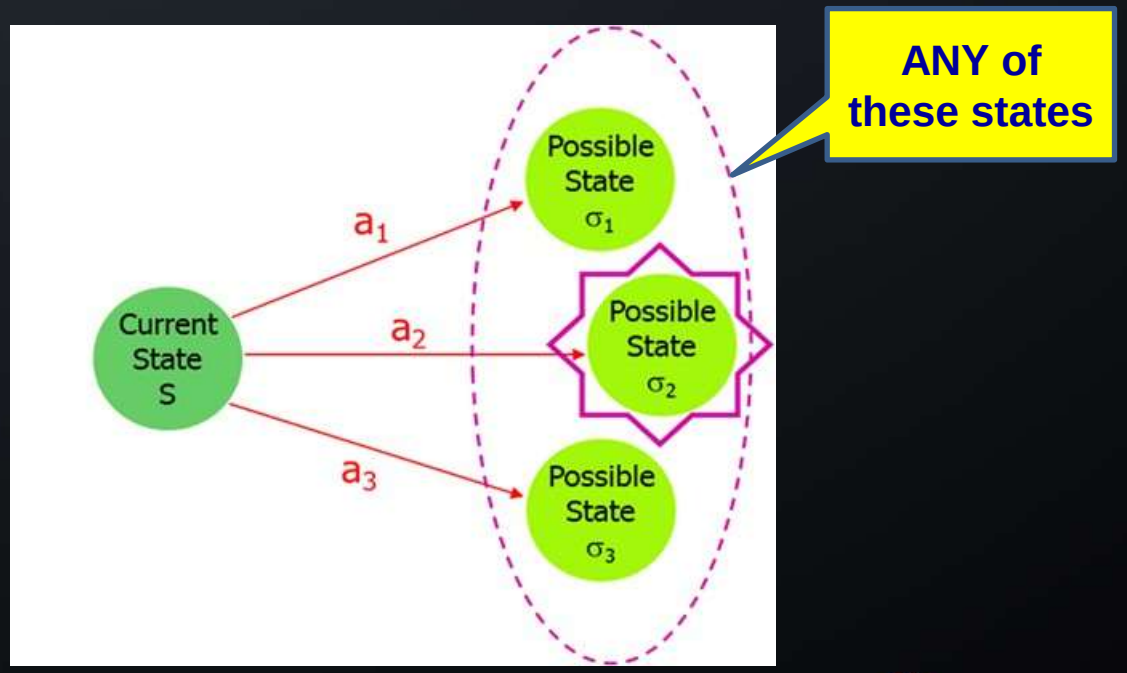
Declarative: Goal- or Intent-based

Express **What** should be done.
not **How** to do it
Specifies criteria for choosing acceptable states, each of which has a binary value

Rationality is defined by the developer



Rationality generated by compiler



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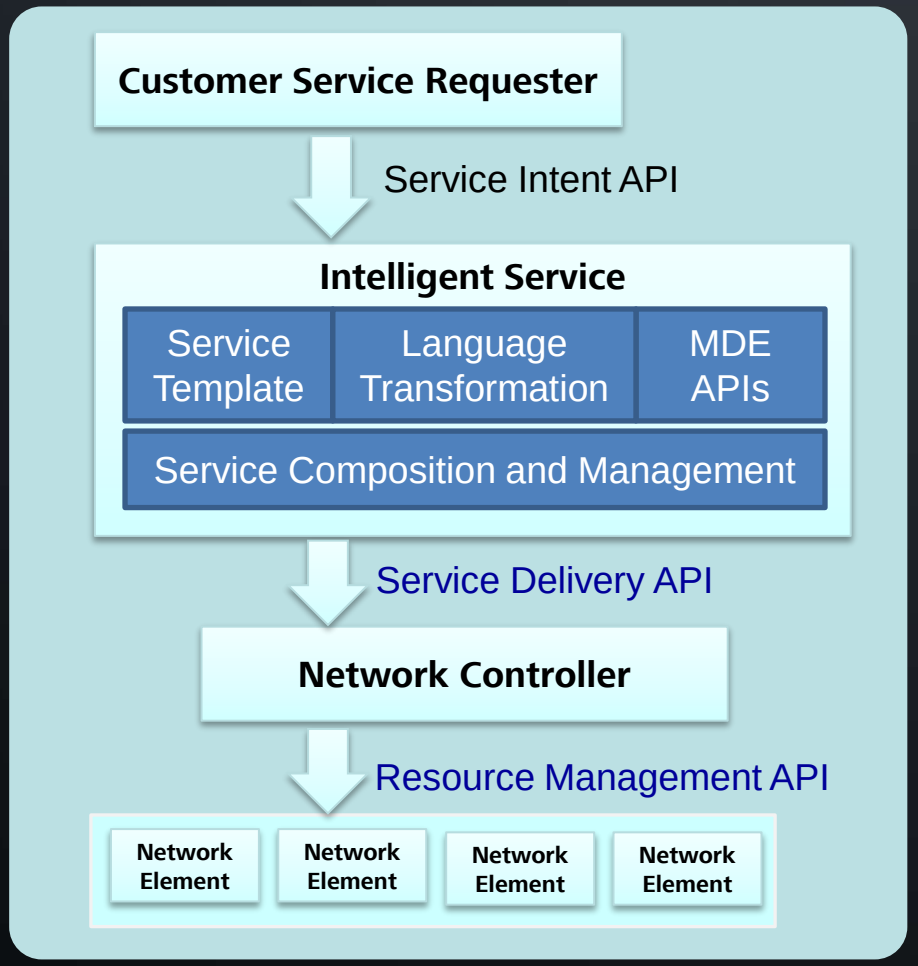
Intelligent Service Management



Intent Service API:

- Independent of technology and vendor
- Specify what customer wants, but not how to implement it, using business-friendly concepts

Intelligent Service:

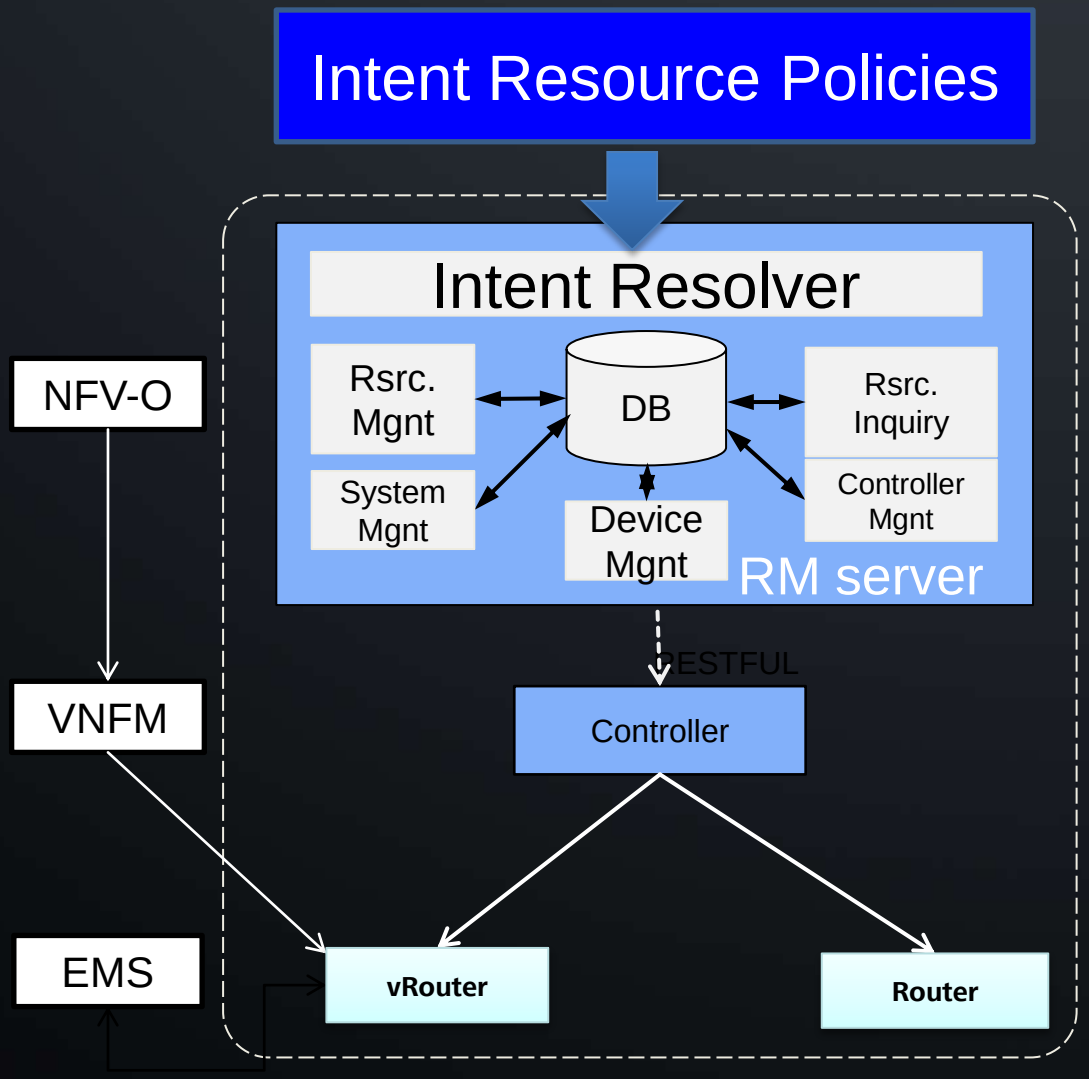
- Model-driven service API
- Service composition supports new services without having to recompile and redeploy
- Customized service template according to the scenario, based upon the model

Intelligent Resource Management:

- Model-driven translation to resource allocation, *transparent to the end-user* (see next slide)

The Service Intent API reduces the user's network knowledge requirements, and enhances the network operator's experience

Intelligent Resource Management

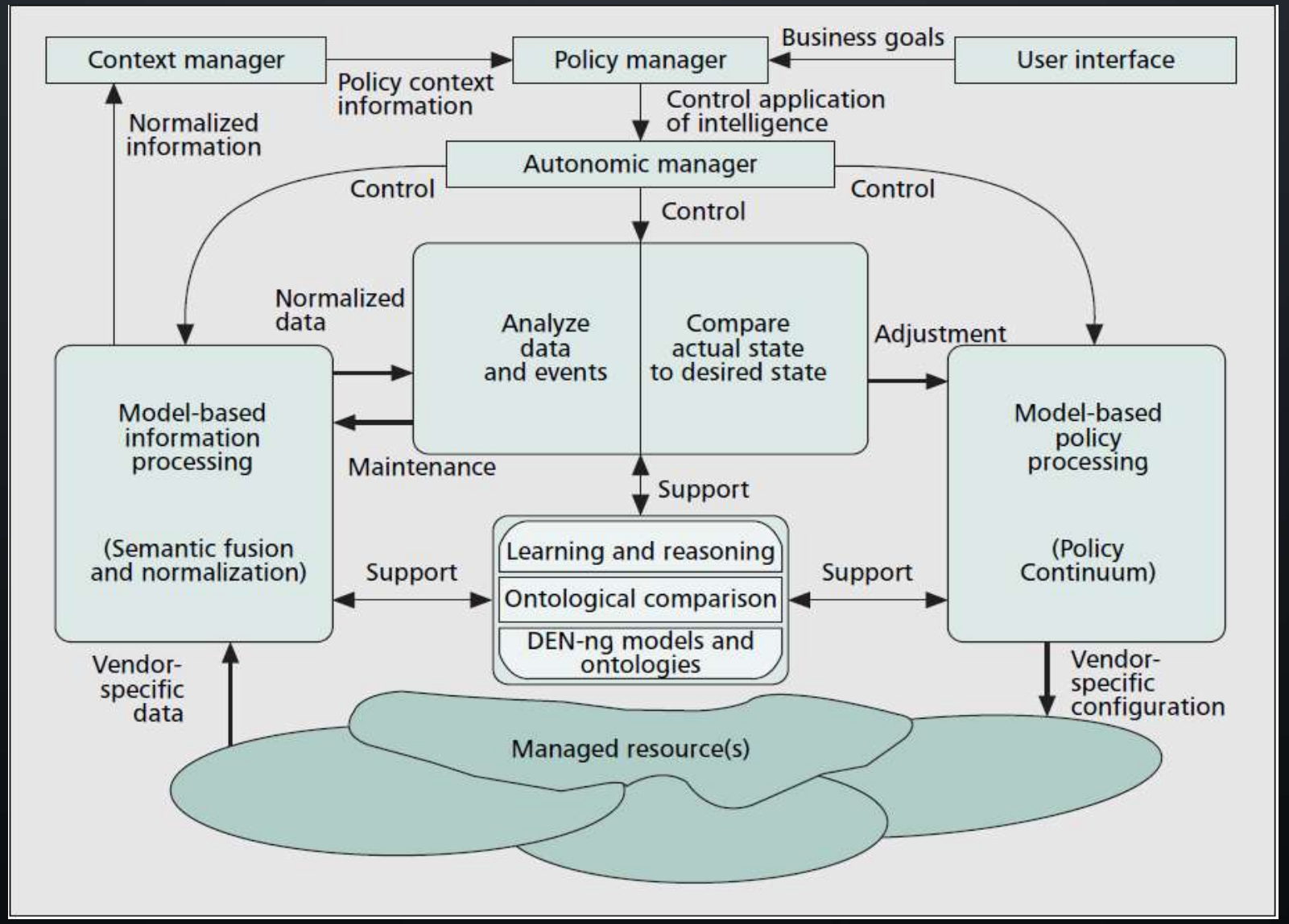


Intelligent Resource Management:
Logically centralized (but physically distributed) management, Dynamic allocation of resources

Reduces manual planning and configuration

- Intent Resolver receives policies from the Intelligent Service Manager and translates them into policies that govern resource behavior
- Resource Manager automatically determines resource allocations according to the resource state reported by each affected device, the appropriate policies set by the organization, topology, traffic, and the selected resource tuning mechanism
- Resource Manager chooses the appropriate tuning mechanism according to policy

Intelligent Monitoring, Analyzing, and Prediction



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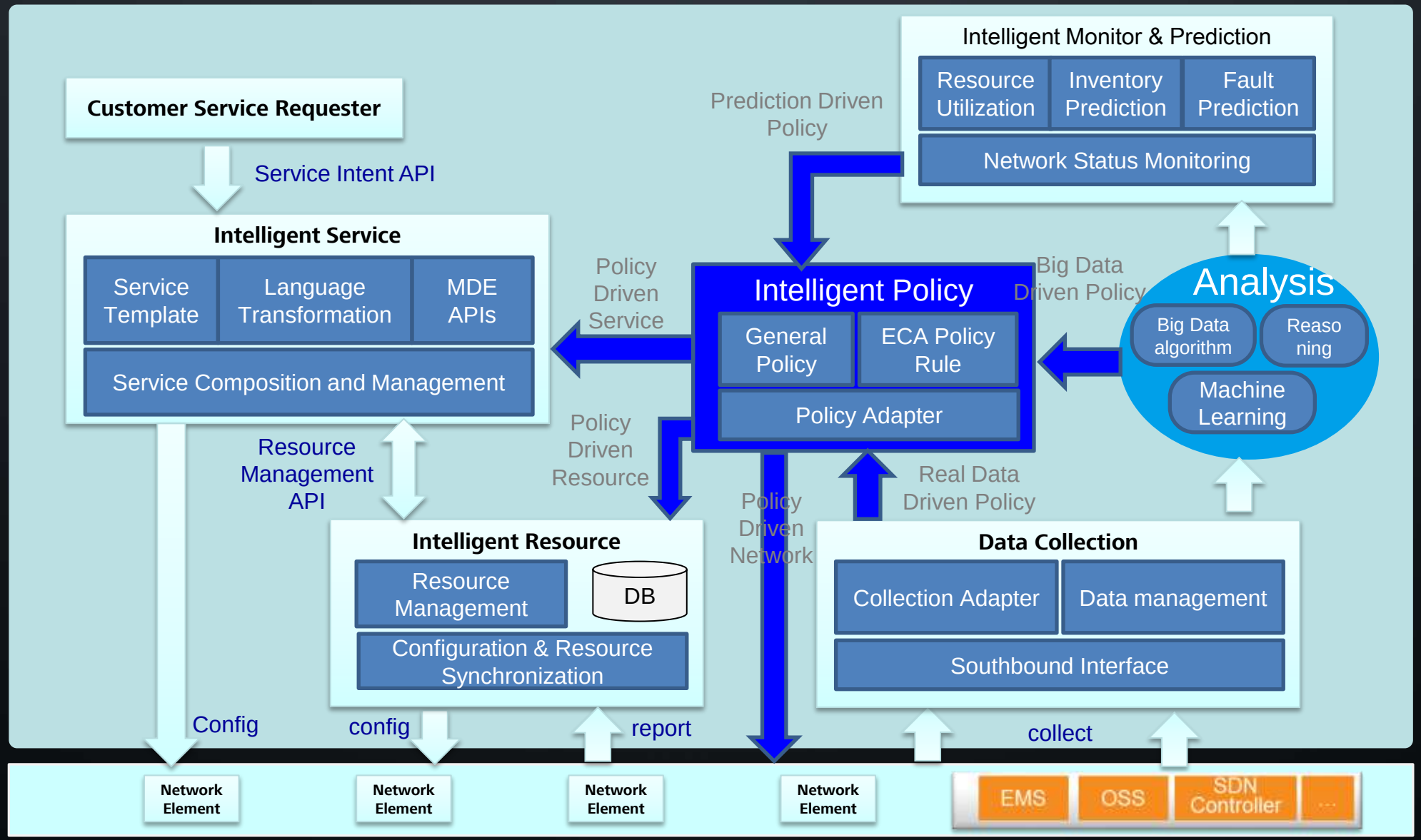
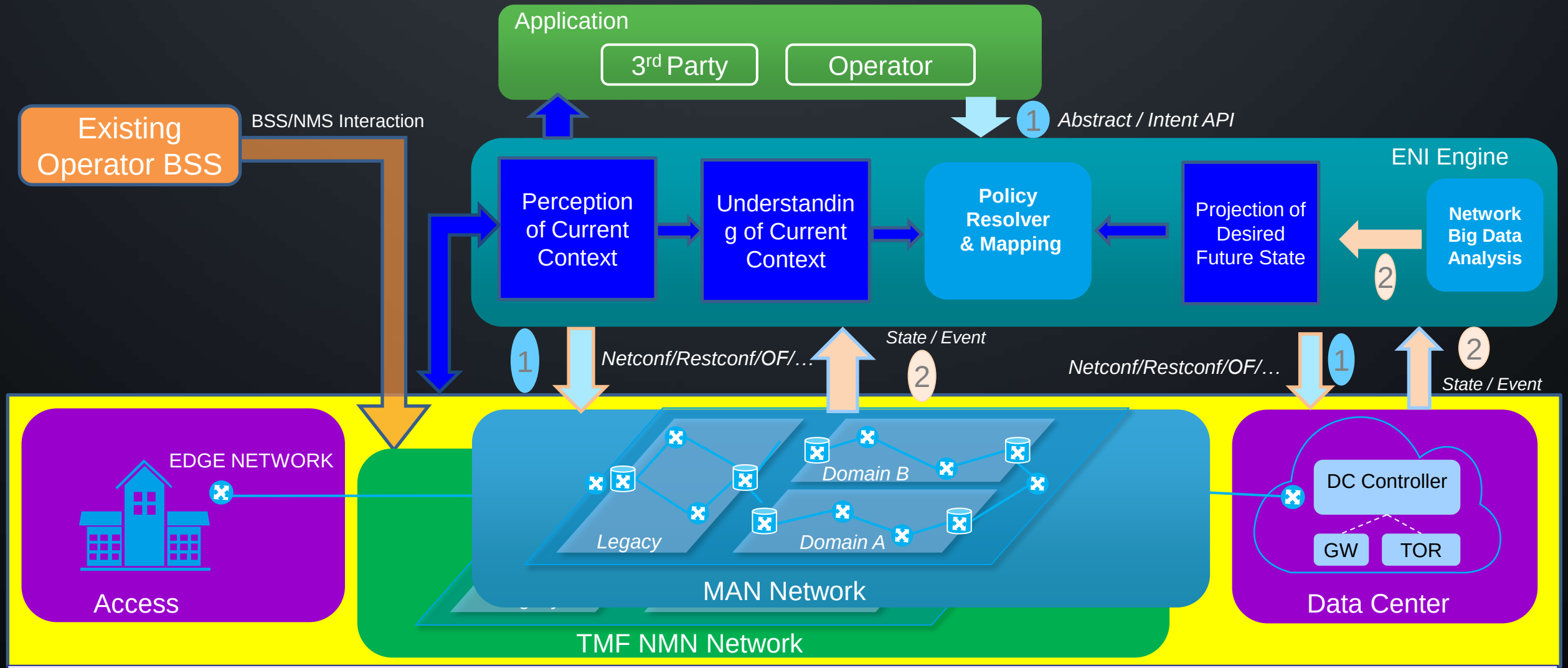
Example of Possible Architecture of ENI engine

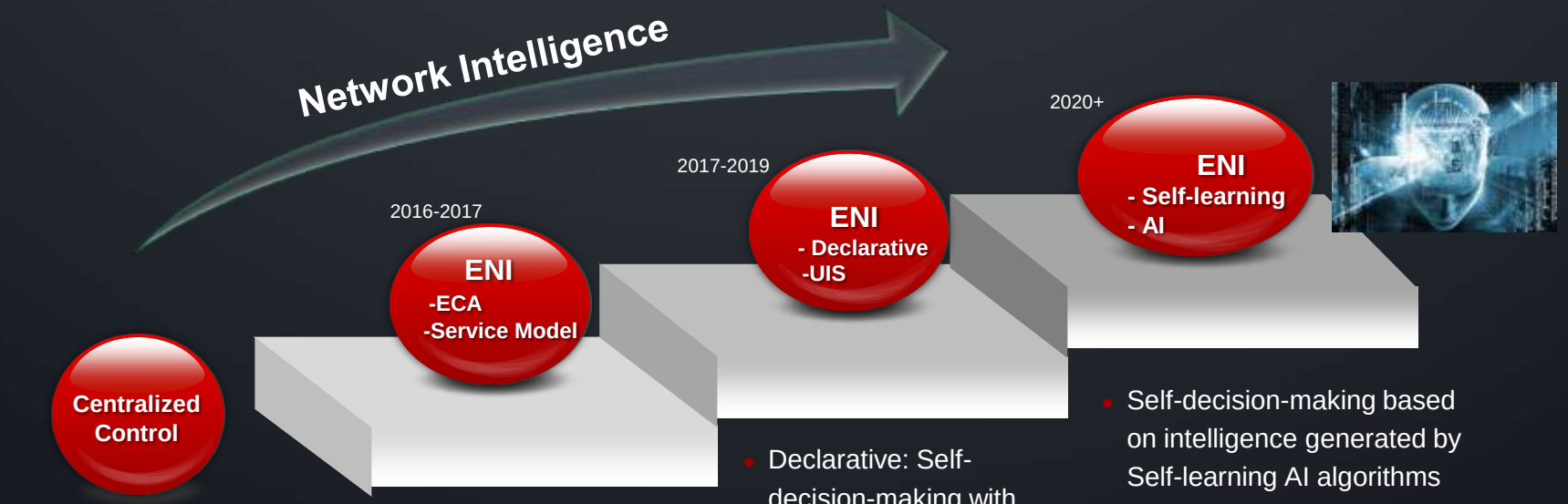


Example of Possible Types of Intelligent Flows



Top-down: Intent based network deployment, open API ecosystem
Bottom-up: Self-adaptive network, control plane adjusts network automatically based on network status

Grow Path of Networked Intelligence



- Decouple the forwarding and controlling plane by SDN technology
- Best Efforts

- ECA: Self-decision-making using Event – Condition-Action policy rules
- Service Model enables dynamic service automation

- Declarative: Self-decision-making with declarative policy statements
- Translation of user intent to service and resource management

- Self-decision-making based on intelligence generated by Self-learning AI algorithms
- Integrate all available resources to achieve high performance and improved OPX with low cost (OPEX and CAPEX), like self-driving car and AlphaGo from Google

Data → Information → Knowledge → Wisdom

The future network grow path will be just like the mobile phone or automobile: from processing data, to learning to recognize information, to processing knowledge, to developing wisdom

Thank You

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