ADN Introduction

Why Autonomous Network

Telecom networks are becoming more and more complex. Network O&M in this case is dominated by manual operations, which therefore results in error prone, time consuming and high costs operations. One survey by Huawei technical support team found that manual intervention is required for 95% of the process and job nodes.

As the number of connections increases, the bandwidth grows rapidly, and the construction of telecom infrastructure accelerates. This in turn poses stringent requirements on balancing asset utilization and improving energy efficiency to obtain the optimal TCO.

Although the business scale and data availability in the telecom industry are extensive, its business monetization capability is poor. The industry lacks differentiated products and customer service capabilities. It also struggles to implement network SLA assurance. Service freezing, intermittent disconnection, and poor quality caused by network congestion frequently occur, and user complaints cannot be handled promptly or accurately.

The convergence and innovation of new services is slow. For example, the telecom industry takes more than 12 months on average to roll out a new service.

Facing these challenges, the telecom industry needs to leverage intelligent technologies to promote the evolution of network architecture and O&M. It also needs to move towards the autonomous driving network (ADN) era of man-machine collaboration, and continuously drive the intelligent upgrade in the industry.

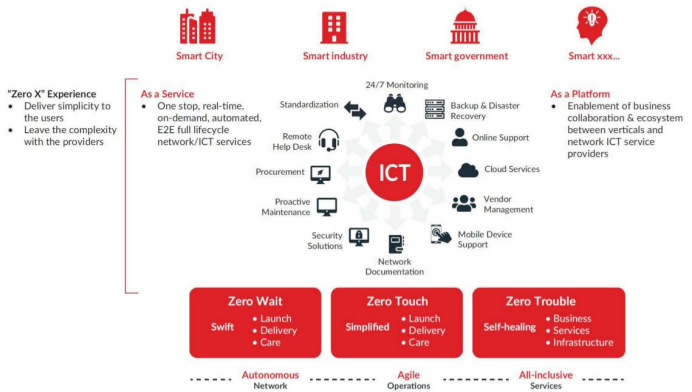
Autonomous Networks

What is autonomous networks

Autonomous networks aim to provide

- Fully automated zero wait, zero touch, zero trouble innovative network/ICT services for vertical industries users and consumers.
- Support self-configuration, self-healing, self-optimizing and self-evolving telecom network infrastructures for telecom internal users: planner, service/marketing, operations and management.

The Autonomous Networks comprises simplified network architecture/autonomous domains and automated intelligent business/network operations for the closed-loop of digital business, which offer the best-possible user experience, full lifecycle operations automation/autonomy and maximum resource utilization.



The ultimate goal for autonomous network is to enable telecommunication system (including management system and network) to be governed by itself with minimal to no human intervention by utilizing the autonomy mechanisms (3GPP TS28.100)

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Levels of Autonomous Networks

Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience†	P	P	P	P	P/S	S
Applicability	N/A	Selected Scenarios				All Scenarios

P People (manual)

S Systems* (autonomous)

* **Note 1:** Systems including management system, O&M tools and network.

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Autonomous Networks Framework

3-layers: Represent a group of common capabilities and business logics that can be utilized to support all scenarios, as well as business relationships between the groups of atomic capabilities.

Business operations layer: Including customer lifecycle management processes and product/offering lifecycle management processes.

Network operations layer/Service Layer: Including the flows of resource-facing services planning, deployment, maintenance, optimization and inventory management. Also, includes the flows of customer-facing services planning, deployment, service providing, maintenance, and optimization.

Network resources layer: Including the processes of resource/network planning, deployment, maintenance ,optimization and inventory management.

4-closed-loops: represent the execution/fulfilment of the full lifecycle of the operations that can use the select capabilities of above layers upon corresponding business process.
- Network resource closed loop
- Network operations closed loop
- Business operations closed loop
- Cross layer user service closed loop

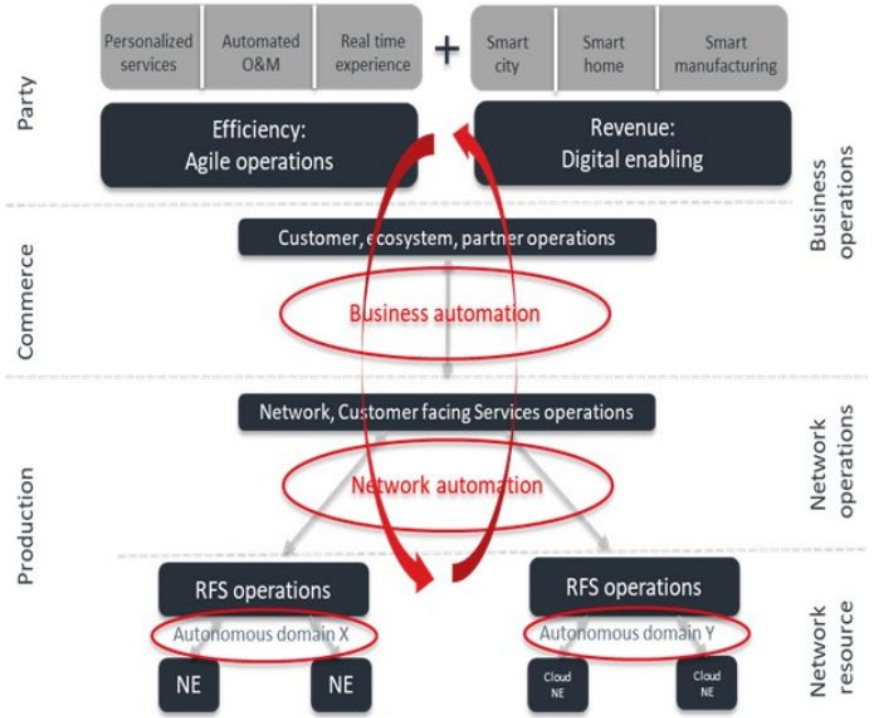

Figure 2. Overarching framework: 3-layer + 4-closed-loop

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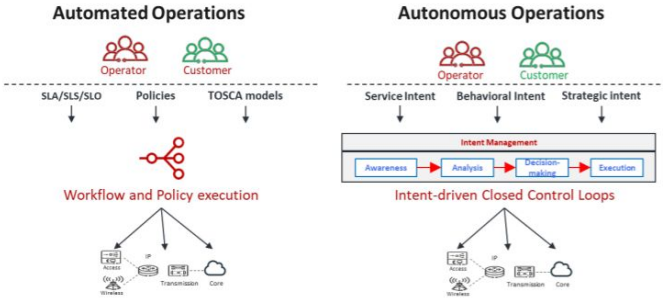
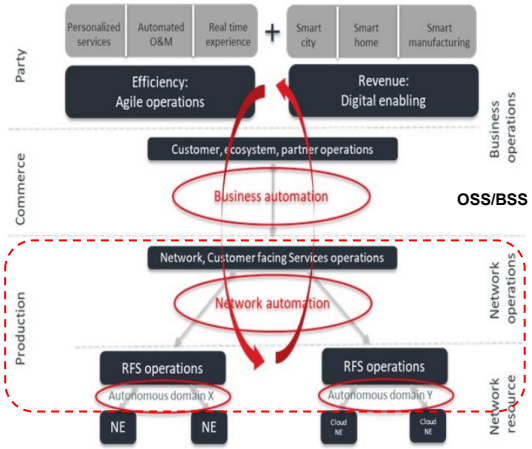
Automatic vs Autonomous

Automatic means working by itself with little or no direct human control. An automatic task is not manually performed as no humans are involved. Automated systems typically run within a well-defined set of parameters and are very restricted in what tasks they can perform. **The decisions made or actions taken by an automated system are based on predefined rules.**

Autonomous means having the freedom to act independently. Having the freedom to govern itself or control its own affairs and **making its own decision. It can learn and adapt.**





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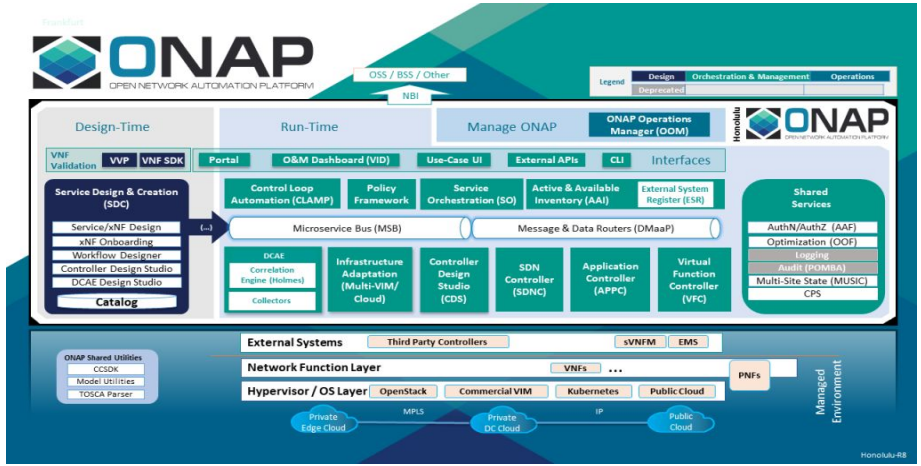
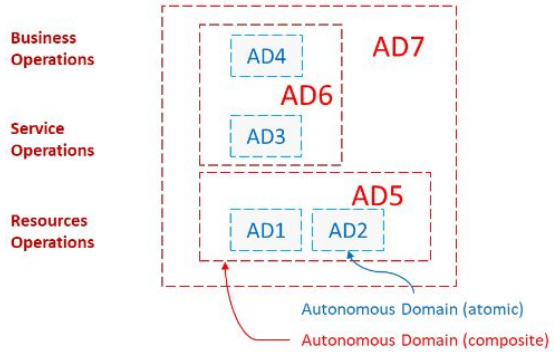


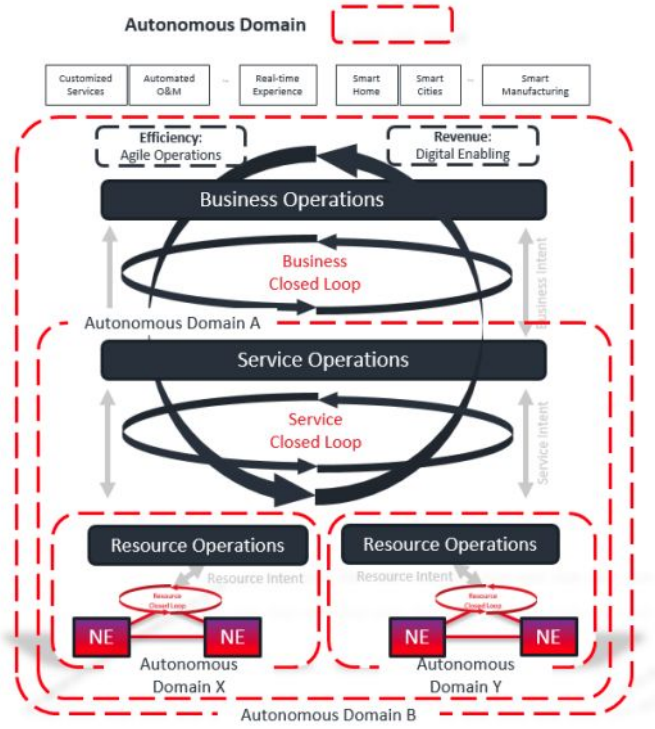
Automatic ++ (ADN Level 2)

Key ingredients of AN capabilities: Autonomous domains

An Autonomous Domain is an operational management domain that defines the scope of encapsulated autonomous behavior. It is the ‘building block’ (i.e., unit) of autonomous behavior that when federated together form a complete Autonomous Network. It serves as the basic unit that can fulfill closed-loop automation of specific network operations.

The examples of autonomous domain instances can be the closed loops of access, metro backbone, core, edge, customer network from infrastructure perspective, or SD-WAN, VoLTE, CDN etc. from service perspective.





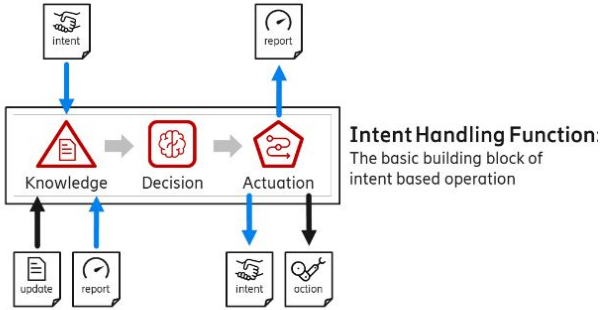
Key ingredients of AN capabilities: Intent driven interaction

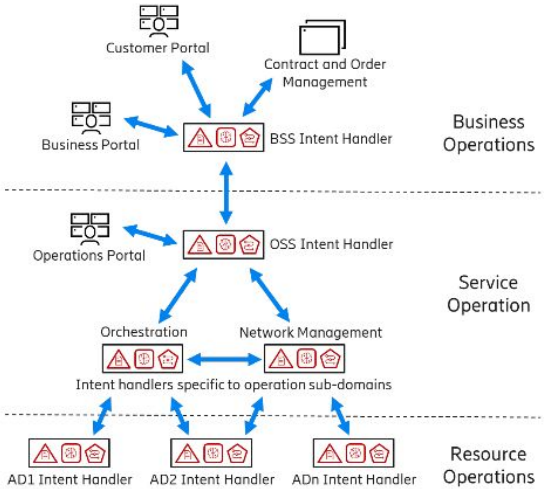
Intent defines what Autonomous Networks are expected to achieve, but it leaves the details of how a network is designed and operated to the internal operations of the network platform. This means that the smart software in the platform can constantly optimize how the service is delivered and we can incrementally add new technologies like Analytics and Machine Learning to constantly improve the implementation.

Business intent represents the objectives of a business user. Operators expect their Autonomous Networks to operate service contracts while meeting revenue targets. Their customers expect a good user experience.

Service intent represents the objectives of a service user. A service is expected to deliver functional as well as non-functional attributes. This includes targets for example on connectivity, bandwidth, latency or availability.

Resource intent represents the objectives of resource users. Resources are expected to be allocated so that performance and quality of service targets are met.





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Key ingredients of AN capabilities: Closed loops

4-closed loops: to fulfill the full lifecycle of the inter-layer interaction

User closed loop: the interaction across above three layers and three closed loops to support the user service fulfillment. The interactions across the different layers should be based on simple, intent based API interfaces.

Business closed loop: the interaction between business and service operations. The operations need to be upgraded from isolated business to on demand, automated business collaboration and ecosystem, which enables the closed loop for customer/business/ ecosystem operations, normally requiring collaboration across multiple service providers globally.

Service closed loop: the interaction between service and network resource operations. The operations need to be upgraded from legacy customized project-centric approach to a data/knowledge driven platform based on full lifecycle operations automation.

Resource closed loop: the interaction of network resource operations in the granularity of autonomous domains.

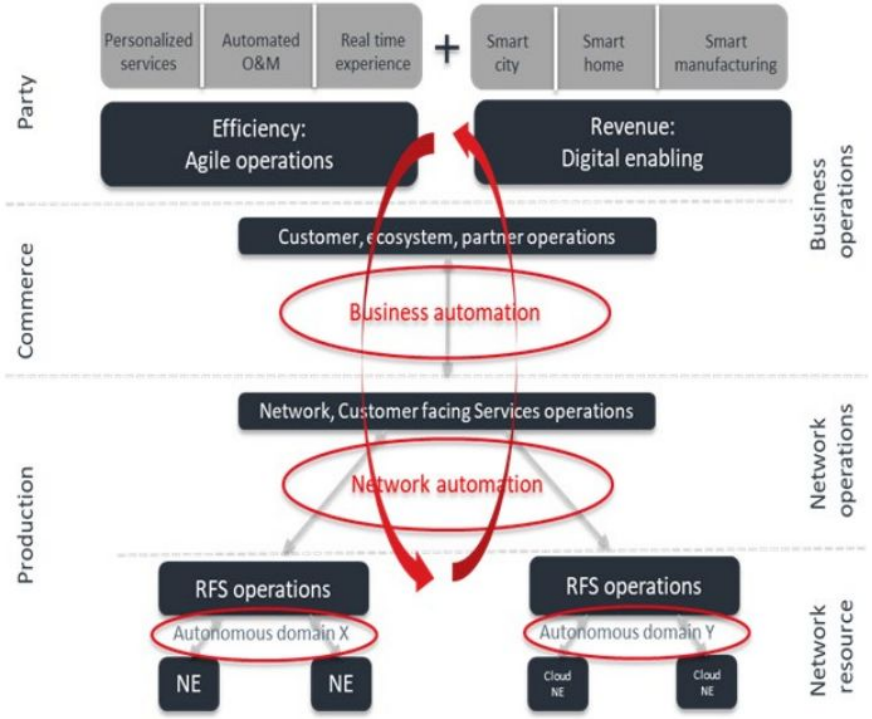

Figure 2. Overarching framework: 3-layer + 4-closed-loop

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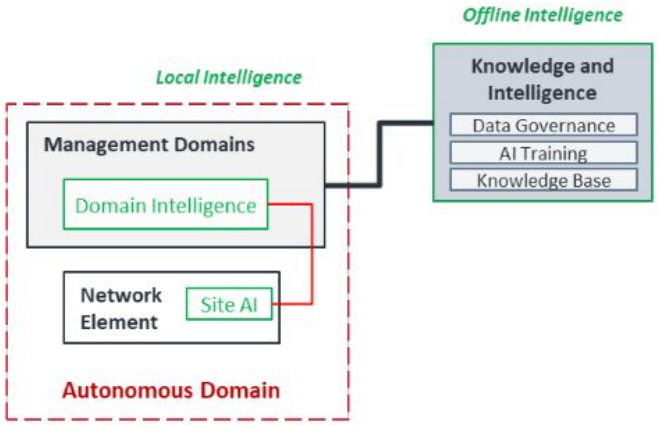
AI in Autonomous Networks

In the Autonomous Networks, AI can be used anywhere as needed.

AI capabilities need to be provided at different layers of Autonomous Networks. This will support AI-based automated closed-loop network operations, implement intelligent automation in different service scenarios for meeting autonomous levels of Autonomous Networks.



Four key telecom AI use case categories :

1. Prediction
2. Detection and identification
3. Control optimization
4. Process optimization

Three Layered Intelligence

"Cloud + AI"– an open Knowledge and Intelligence platform, accelerate network AI innovation and development.

"Management layer + AI" − involving AI Inference framework, promote intelligent analysis and decision capability in the management layer.

"NE + AI" − Make the network real-time perceptible with built-in AI chips and sensors, enabling data collection acceleration and rapid inference at the edge.

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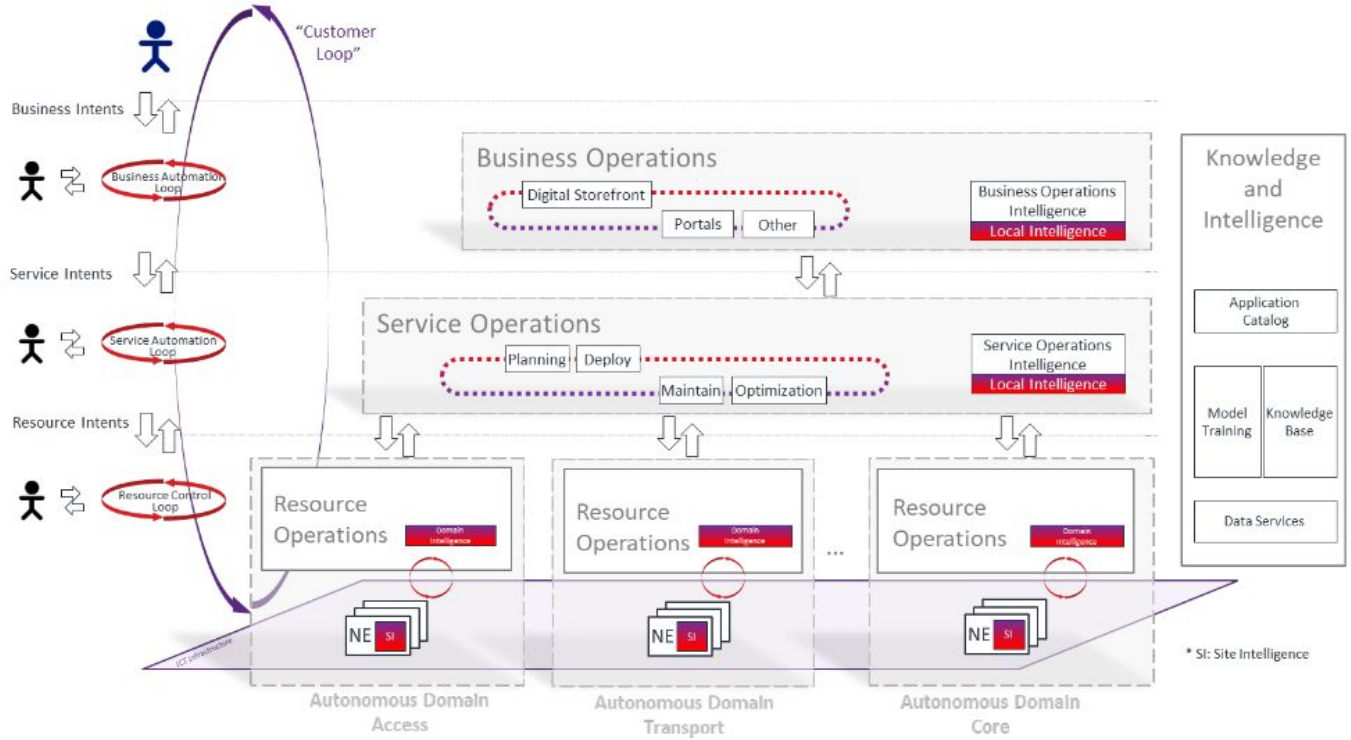
ADN Technical Architecture



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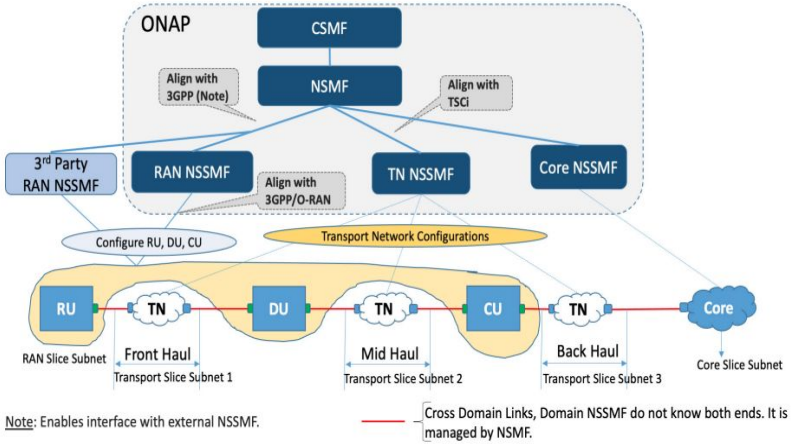
ADN Gaps with ONAP Slicing as an Example

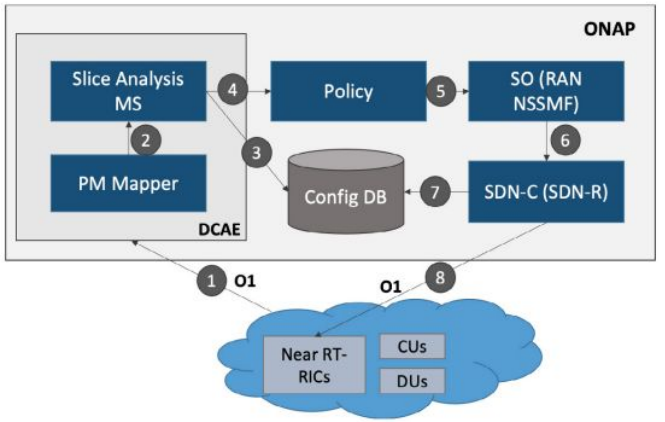
Features Supported

- Cross Domain/ Cross Vendor Automated Service Provisioning
- Analytics & Rule based Closed Loop (Majorly within Domain, not at Service layer)
- Moving towards Intent.

GAPS

- AI Driven Closed Loop
  - Network optimization
  - Predictive Maintenance
- Intent driven cross domain service provisioning with SLA Assurance
- Cross domain Fault co-relations
- Knowledge Graphs

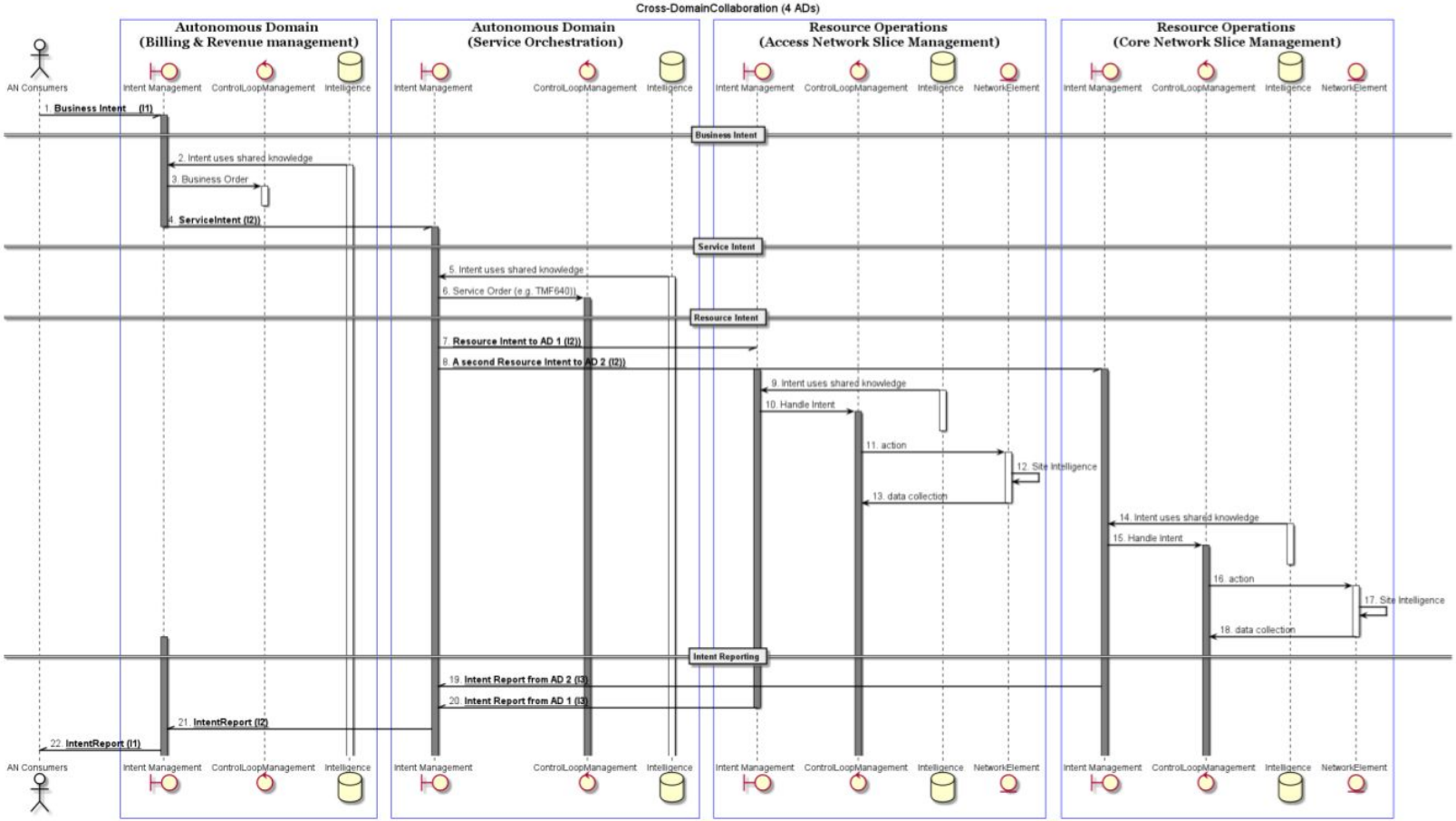




Sample closed loop

Gaps to implement ADN

- Various Building blocks Need to be mature:
  - Digital Twin/KAAS: The scaling of resource and service operations requires retrieving knowledge from each applicable Autonomous Domain for a given context. Each Autonomous Domain has different users with different needs, defined by different concepts and vocabularies. The integration of the needs of these different constituencies and their associated knowledge, create different viewpoints that define the business and system architectures. Knowledge-as-a-Service (KaaS), delivers knowledge from a viewpoint to a set of users as needed.
  - Explainable AI: One of the biggest challenges to the wide-scale adoption of AI, is the need to fully address the trust issues related to the technology i.e. how human can trust decision taken by machine. Without explanations behind an AI model's internal functionalities and the decisions it makes, there is a risk that the model would not be considered trustworthy or legitimate.
  - Standard Intent: A key challenge for building this layer is the lack of industry alignment on intent-driven languages and data models. Several standardization efforts exist; for example, TOSCA is being widely used for service modeling, but the industry is divided in terms of the support and adoption of these standards, which is leading to slow progress, fragmentation and incompatibility issues.
- Multi Domain multi vendor Support: An autonomous network solution must span the entire network for all domains, including the campus, WAN, data center, branch and IoT edge. ADN should always have the consistent responses across the managed entities across the domains. This becomes critical for the the operators to remove any vendor lock in. Also Limited Standards are available for APIs, implementations.



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Backup Slides

Q & A

1. How many levels are there of an autonomous network?
2. What is intent?
3. How many layers are there in autonomos network framework?
4. Difference between automatic and autonomous?