ISG ZSM PoC Proposal: Automation of Intent-based cloud leased line service

1 PoC Project Details

1.1 PoC Project

PoC Number:	3
PoC Project Name:	Automation of Intent-based cloud leased line service
PoC Project Host:	China Telecom
Short Description:	This PoC demonstrates the automation of the Intent-based cloud leased line (CLL) use-case. The use-case is developed on ONAP, and its implementation complies with the ZSM standards. The PoC will demonstrate management services (defined in ZSM 002), cross-domain orchestration (ZSM 008), closed-loop (ZSM 009), and Intent-based networking (ZSM 011).

Note: This document uses the term Cloud Leased Line (CLL) and Cloud Private Line (CPL) interchangeably.

1.2 PoC Team Members

	Organisation name	ISG ZSM participant (yes/no)	Contact (Email)	PoC Point of Contact (*)	Role (**)	PoC Components
1	China Telecom	Yes	wangd5@chinatelecom.cn	X	Network operator	(1) ONAP development; (2) provide lab facilities to host ONAP for the PoC
2	China Mobile	No	hekeguang@chinamobile.com		Network operator	ONAP development
3	China Unicom	Yes	zhengyanlei@chinaunicom.cn		Network operator	(1) Contribute to technical details of data-plane operations in the Transport Domain (2) Provide lab facilities to host the network equipment for the PoC
4	Huawei Technologies	Yes	henry.yu1@huawei.com	X	Network supplier	(1) ONAP development; (2) Provide domain controller(s) and network equipment for the PoC
5	AsiaInfo Technologies	No	shilei8@asiainfo.com		ONAP project partner	ONAP development
6	Xidian University	No	cgyang@xidian.edu.cn		University research partner	Research on Intent translation algorithms to improve the translation accuracy
(*) Identify the PoC Point of Contact with an X. (**) The Role will be network/service provider, supplier, or other (universities, research centers, test labs, Open Source projects, integrators, etc…).						

All the PoC Team members listed above declare that the information in this proposal is conformant to their plans at this date and commit to inform ETSI timely in case of changes in the PoC Team, scope or timeline.

1.3 PoC Project Scope

1.3.1 PoC Topics

PoC Topics identified in this clause need to be taken for the PoC Topic List identified by ISG ZSM and publicly available in the ZSM WIKI. PoC Teams addressing these topics commit to submit the expected contributions in a timely manner.

PoC Topic Code	PoC Topic Description	Related WI	Expected Contribution	Target Date
Topic 3 (Intent-driven Closed-loop automation)	Automation of the Intent-based cloud leased line service deployment and the closed-loop operations for service assurance	ZSM009 and ZSM011	Demos	Final December 2022
Topic 4 (Cross-domain user-driven E2E services)	Demonstration of the cross-domain orchestration and automation between the E2E MD and the Transport MD	ZSM002 and ZSM008	Demos	Final December 2022

1.3.2 Other topics in scope

List here any additional topic for which the PoC plans to provide input/feedback to the ISG ZSM.

PoC Topic Code	PoC Topic Description	Related WG/WI	Expected Contribution	Target Date
A				
B				
C				
D				

1.4 PoC Project Milestones

PoC Milestone	Milestone description	Target Date	Additional Info
P.S	PoC Project Start	Jan 2022	
P.D1	PoC Demo 1	May 2022	Automated CPL service creation and modification using ZSM framework (ZSM 002) (simulated hardware)
P.D2	PoC Demo 2	May 2022	Closed-loop in Transport MD (ZSM 009) (simulated hardware). Please note that the ONAP software and setup used in Demo 1 will also be used in Demo 2. In other words, Demo 2 will be built upon Demo 1.
P.C1	Contribution on lessons learned from Demo 1 & 2	July 2022	From Demo 1 & 2, collect feedback about the ONAP design and lessons learned about the PoC, in order to make improvements in Demo 3
P.D3	PoC Demo 3	Nov 2022	Demo with real hardware and real data traffic
P.C2	Feedback to ISG ZSM on potential improvements of the ZSM standards tested by the PoC (Demo 1 – 3)	Dec 2022	This PoC relates to ZSM 002, ZSM 008, ZSM 009, and ZSM 011. Potential improvements of these standards, if any, might be discovered by the PoC, and will be documented in the PoC Report.
P.C3	Contribution on lessons learned from Demo 3	Dec 2022	Lessons learned and potential improvements of the PoC will be documented in the PoC Report.
P.R	PoC Report	Dec 2022	
P.E	PoC Project End	Dec 2022	

NOTE: Milestones need to be entered in chronological order.

1.5 PoC Demonstration Plan

We propose to conduct this PoC in two phases. The first phase (Demo 1 and 2), which is scheduled in May 2022, will demonstrate the Intent-based CPL service automation using simulated network controllers and simulated physical networks. Although this phase might be adequate to validate and demonstrate the service automation aspect of the use-case, real network traffic flows, however, cannot be performed due to the lack of the real data-plane. Please note that the ONAP software and setup used in Demo 1 will also be used in Demo 2. In other words, Demo 2 will be built upon Demo 1.

In the second phase (Demo 3), which is scheduled in November 2022, we will improve the demo procedures, scope, and content based on the feedback received from the first phase. Then the use-case will be demonstrated using real commercial network controllers and real network equipment. Thus, a complete use-case realization, including network traffic flows, will be demonstrated.

The reason why we propose to perform the PoC in two phases is that the complete solution, which consists of both the software (e.g., ONAP and domain SDN controllers) and the hardware (e.g., NEs), may take a long time to develop (It will be completed in November 2022). So, instead of a waterfall development style (which shows the final result at the end of the implementation), we would like to propose a more agile approach of showing the demos in two phases. This way, we can receive and collect feedback from the first phase (e.g., suggestions to improve our ONAP implementation), and use it to improve our final demo.

China Telecom and China Unicom will provide lab facilities to host each phase of the PoC, respectively. Both labs are located in Beijing, China, and are remotely accessible via VPN connections. Huawei will provide necessary network equipment for the PoC (i.e., to be used in the 2nd phase), and they will be installed in the China Unicom's lab.

We prefer to perform the demonstrations at ZSM's face-to-face meetings (via remote access to the labs), so that we can receive direct interactions and feedback. However, should face-to-face meetings not be available, we will perform the demonstrations in the virtual meetings.

1.6 Additional Details

The ONAP use-case information about Intent-based cloud leased line is available at the following links:

- https://wiki.onap.org/display/DW/Smart+Intent+Guarantee+based+on+IBN+-+R9+Intent+Instance
- https://wiki.onap.org/display/DW/R9+CCVPN+Support+for+Intent-Based+Networking

2 PoC Technical Details

2.1 PoC Overview

2.1.2 Use-case Description

Cloud private line (CPL) services connect cloud service users to edge or cloud data centres, and edge or cloud data centres to each other, with deterministic connection performance. They may represent point-to-point, point-to-multipoint, multipoint-to-point, or multipoint-to-multipoint connectivity service topologies, and may be implemented using connected or connection-oriented paradigm-supporting technologies. Data flow mapping to CPL services is port, packet- or frame-oriented and CPL services may or may not include inspection and differential mapping of frames to connection services at connection service ingress ports. Service and/or supporting technology types include Ethernet, MPLS (Multi-Protocol Label Switching), OTN (Optical Transport Network) and DWDM (Dense Wavelength Division Multiplexing), solely or in combination. Collections of CPL services may be considered as Transport "Slices" and defined and provisioned collectively; here, we consider CPL services as defined and provisioned individually.

Fig. 1 illustrates an example of a CPL service infrastructure that uses EOO (Ethernet-over-OTN) technology. User data (e.g., IP packets or Ethernet frames) are carried by Carrier Ethernet Services, which operate over Ethernet Virtual Connections

(EVCs). The EVCs provide service OAM (Operations, Administration and Maintenance), while service isolation and traffic protection are offered by the underlay OTN services. Right-sizing and topological configuration of service tunnels, and groups of tunnels, is provided by reconfigurable ODUFlex and DWDM technologies.

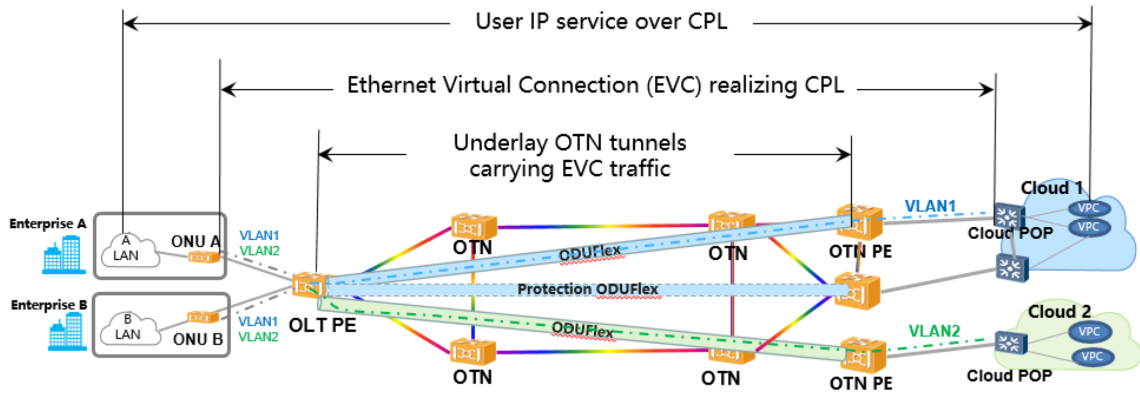

Figure 1. Illustration of a CPL service infrastructure based on EOO (Ethernet-over-OTN) technology.

Data centres may be operated by the CPL service customer, by the CPL services provider, by some other service provider(s), or by any combination of these. CPL service traffic consists in machine-to-machine data flows with a range of characteristics. Some data flows are essentially continuous, may require low or medium bandwidths, and may be anywhere from relatively latency-insensitive to highly latency-sensitive (e.g., synchronous data mirroring). Other data flows may comprise block data transfers, of varying sizes and completion time requirements, may occur on varying schedules, and may require small to very large bandwidths; they may also have varying latency sensitivities. The application drivers of individual data flows may depend on a range of application circumstances that may vary in time. Even CPL service availability and restoration requirements are variable and derive from application requirements associated with particular data flows.

There is demand, in multiple market segments, for dynamically user-driven mass-customized CPL services, having deterministic connection performance when in operation, to serve these requirements. Such a paradigm would replace both static port-to-port "large pipe" private line service, and statically-configured services that rely on statistically-based sharing of transport resources among data flows that require - perhaps significant - overprovisioning of resources to prevent service performance degradation under unfavourable aggregate data flow conditions. This new paradigm is useful to both service consumers and service providers, as: services may be closely matched to specific needs; service performance is deterministic in operation, providing e.g., determinism in block data transfer times; service delivery is network resource-efficient, as resources may be allocated to closely match the minimum detailed needs of every service; and services may be better-monetized, as no service parameter needs to be "given away free". Obviously, however, a dynamically mass-customized service paradigm, operated at any reasonable scale, requires a high degree of automation of service delivery and maintenance processes.

Dynamically mass-customized CPL services are driven operationally by CPL service consumers, either semi-manually (e.g., through a user-facing provisioning portal) or – more usefully – directly by consumer scheduling software systems. Intent is – obviously - a useful API and service-driving paradigm to support such capability.

2.1.3 Scope and Content of the PoC

This PoC demonstrates the service automation of the Intent-based CPL. The design architecture of the use-case follows the ZSM framework (ZSM 002) and other relevant ZSM standards (ZSM 009 and ZSM 011). Figure 2 depicts the use-case realization using the ZSM framework.

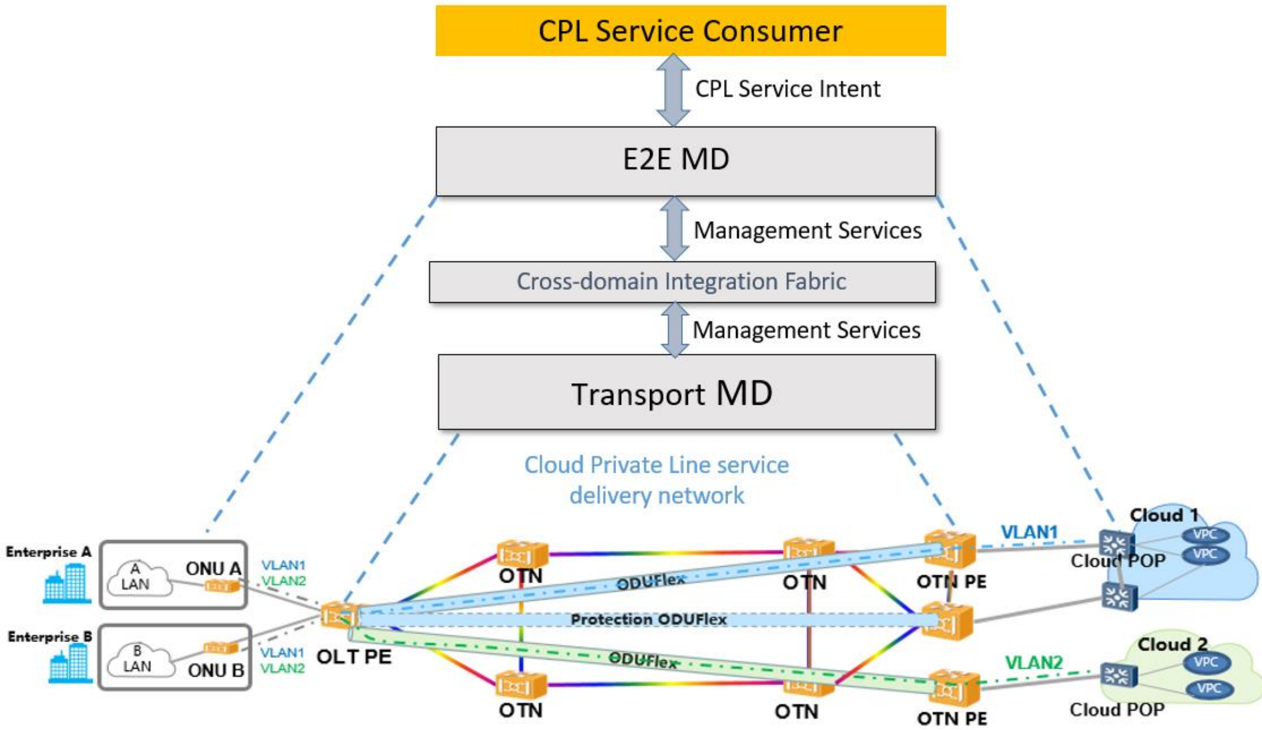

Figure 2 CPL use-case realization using ZSM framework

The service consumer expresses and sends the requests of a CPL service to the E2E MD via its Intent interface. The E2E MD is responsible for the E2E service orchestration. It translates the consumer's Intent into corresponding Management Services which are offered by the Transport MD(s). The cross-domain integration fabric facilitates the communication between the E2E and the Transport MD. The Transport MD registers its Management Services to the cross-domain integration fabric. The E2E MD then discovers and consumes these services.

The Transport MD is responsible for the service provisioning and network configurations of the physical network. Its northbound interfaces (i.e., Management Service APIs) are intent-like (in the case of this PoC), model-driven, technology agnostic, and open standard-based. Furthermore, the MD also implements the closed-loop defined in ZSM 009-1.

The PoC will demonstrate management services (defined in ZSM 002), cross-domain orchestration (ZSM 002), closed-loop (ZSM 009-1), and Intent-based networking (ZSM 011). Table 1 summaries the content of the PoC.

Table 1 Content of the PoC

Use-case scenario to be demonstrated	Demonstration of the ZSM features and capabilities which support the use-case scenario
The CPL service capability, offered by the Transport MD, is automatically discovered by the service discovery mechanism.	• Transport MD registers its management services to the cross-domain integration fabric • E2E MD discovers Transport services via the cross-domain integration fabric
The user (or Intent consumer) expresses an Intent of creating (or terminating) a CPL service. This Intent is then automatically fulfilled by provisioning (or	• E2E MD interacts with the user (or Intent consumer) to fulfil the Intent and manages the Intent life cycle

deprovisioning) the corresponding services and allocating (or deallocating) the required resources on the physical network.	• E2E MD consumes the management services of the Transport MD in order to create (or terminate) the CPL services • Transport MD provides three management services, including control, orchestration, and data collection. They are necessary for the delivery of the CPL service
The Intent-based system monitors the SLA parameters of the CPL service (e.g., bandwidth usage), and automatically triggers the closed-loop actions (e.g., increase max bandwidth) in order to guarantee the SLA.	• Transport MD implements the closed-loop defined in ZSM 009-1. The PoC will demonstrate control flow consisting of monitoring, analysis, decision, and execution.

2.2 PoC Architecture

Figure 3 depicts the PoC architecture. The transport network in this demo is a multi-domain (2-domain), multi-vendor (2-vendor) optical network. Each network domain is managed by a network controller. The network controllers, as well as their managed network equipment, may be supplied by different vendors, yet the northbound interface (NBI) of the controllers comply with the IETF/ACTN standards, in order to assure interoperability.

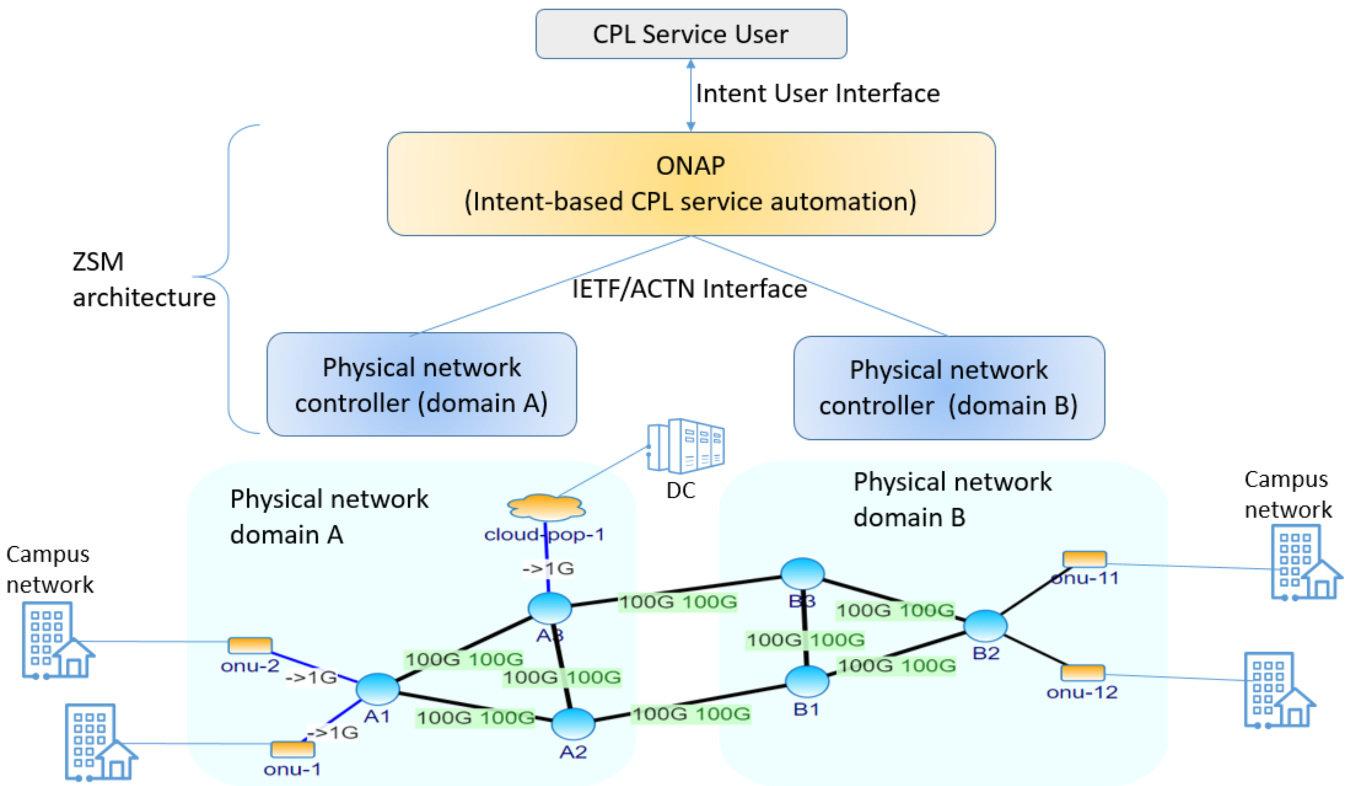

Figure 3 PoC Architecture. The network automation framework follows the ZSM standards, and the interfaces of the network controllers (which serve as Management Functions) follow the IETF/ACTN standards

The network controllers are controlled and orchestrated by ONAP. The overall architecture of this system follows the ZSM framework. More precisely, the E2E MD and the cross-domain integration fabric is implemented on ONAP. The Transport MD is implemented on both ONAP and network controllers.

ONAP is a cloud-based platform. It consists of a collection of microservices, each of which has a dedicated network management responsibility and performs specific tasks. The Intent-based CPL use-case, therefore, is developed on multiple

ONAP microservices. Table 2 provides a list of the ONAP microservices on which new features/code are developed in order to realize the use-case.

Table 2 List of ONAP microservices which implement E2E MD, Cross-domain integration fabric, and Transport MD

ZSM component	ONAP microservices which implement the ZSM component
E2E MD	• UUI (Use-case UI) • DCAE (Data Collection, Analytics, and Events) • AAI (Active and Available Inventory)
Cross-domain integration fabric	• MSB (Microservices Bus) • SO (Service Orchestrator)
Transport MD	• SO • SDNC (SDN Controller) • AAI • DCAE • Policy • Network controllers (Note 1)

Note 1: Network controllers are outside of ONAP. But they are part of the Transport MD, serving as the Management Functions (MF).

Figure 4 depicts the implementation of the ZSM architecture on ONAP. ONAP's cloud-based architecture has many advantages. However, its distributed nature also introduces challenges on service management, discovery, orchestration, and deployment. This PoC shows how the adoption of the ZSM framework on ONAP may help overcome these challenges while still keeping the advantages of a cloud-based system.

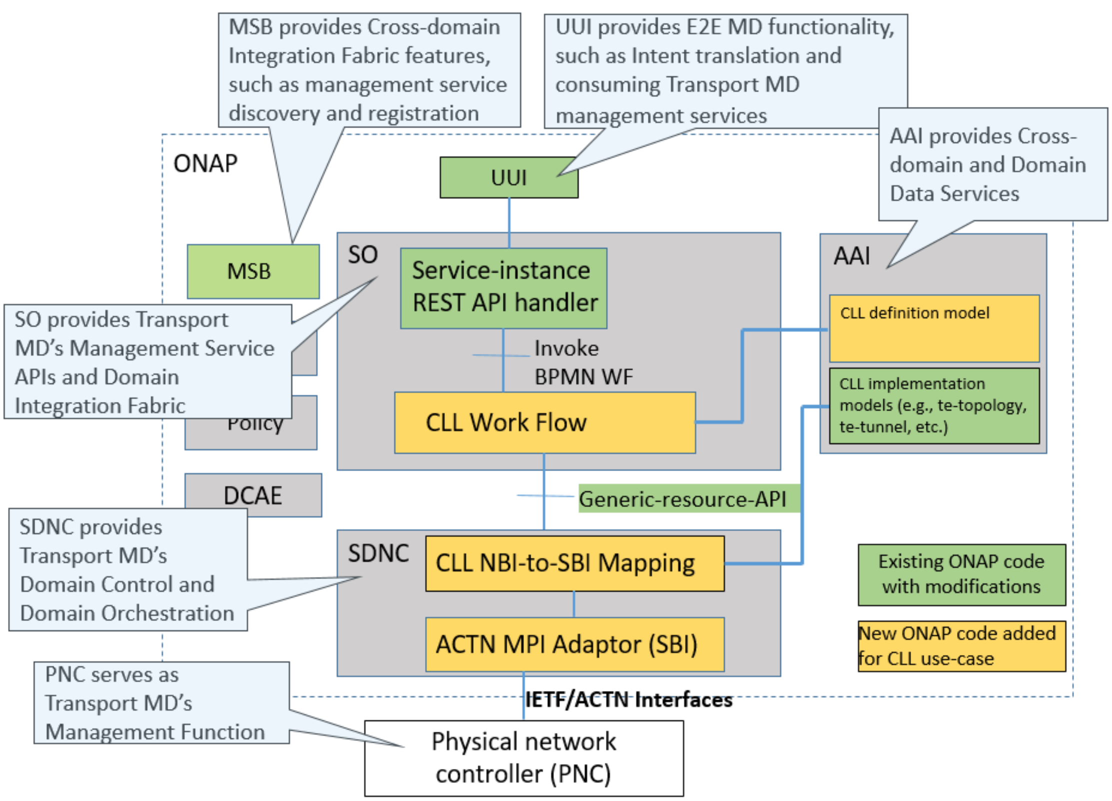

Figure 4 ONAP implementation of ZSM architecture

Another aspect of the PoC is to demonstrate the closed-loop capability of the Transport MD. Figure 5 depicts the closed-loop implementation on ONAP. The features are built top of the ZSM framework depicted in Figure 4, and the implementation follows ZSM 009-1.

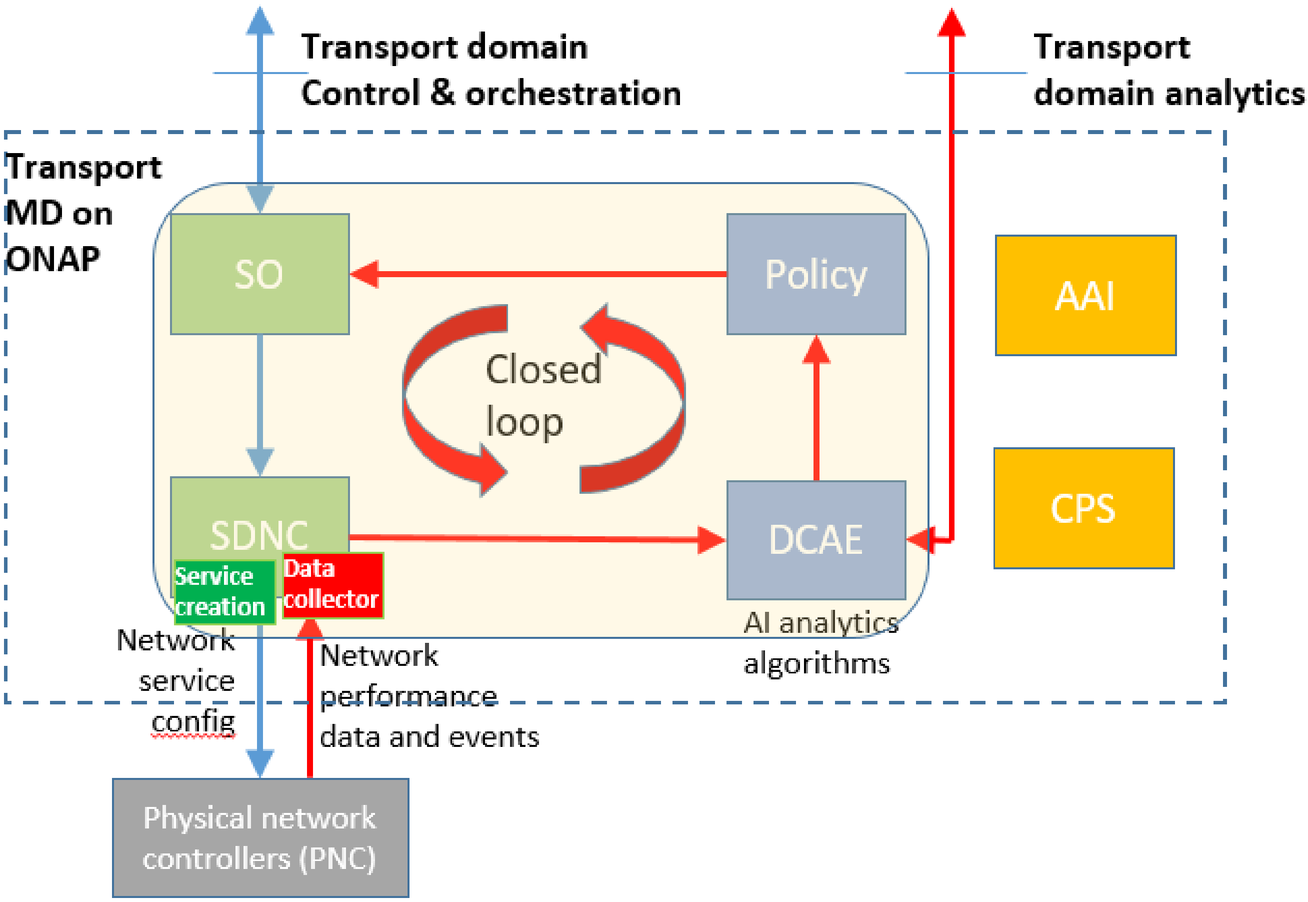

Figure 5 ONAP implementation of the closed-loop in the Transport MD

As specified in ZSM 009-1, the closed-loop control flow contains four stages: Monitoring, Analysis, Decision, and Execution. The Monitoring stage collects the performance data from the physical network, and then generates and sends data events to the Analysis stage for further processing. The Monitory stage is implemented on ONAP SDNC and physical network controllers (PNC).

The Analysis stage processes the incoming data events and generates and sends insights to the Decision stage. The Analysis stage is implemented on ONAP's DCAE.

The Decision stage creates the action plans based in the insights received from the Analysis stage, and then triggers the Execution stage to execute the actions. The Decision stage is implemented on ONAP's Policy microservice.

The Execution stage is realized by the domain control and domain orchestration management services, which are implemented on ONAP's SO and SDNC.

2.3 PoC Demonstration Procedure

The demo's physical network topology is a two-domain network, and, thus, two physical network controllers (PNC) are deployed for the demo. Before the demo begins, the system needs to be initialized. At the initialization phase, ONAP is the first to power up, followed by the two PNCs. When the PNCs are up, they register themselves to ONAP's External Service Register (ESR) service (which plays a role in Transport MD's Integration Fabric). The ESR registration then triggers ONAP's SDNC to discover the physical network topology and network resources from the PNCs, and store the information in AAI. All these initialization procedures are automated.

The physical network of the demo contains several access ports (UNIs) to enterprise/campus networks, and also contains several ports to cloud POPs. The PoC is demonstrated in the following steps.

1. On the ONAP UUI portal, a list of enterprises and clouds are displayed. The user expresses, in a natural language, an Intent to connect one (or more) enterprises to one (or more) clouds, as well as his/her expectation for the quality of the service.
2. The ONAP UUI translates the user Intent into more specific Service Intent parameters (e.g., UNI ports, SLA parameters) and displays them to the user for the confirmation. The user may optionally modify the Service Intent parameters before the confirmation.
3. Once the user confirms the Intent, the E2E MD and Transport MD will start to deliver the CPL service. For example, create an Ethernet Virtual Connection (EVC) between an enterprise network to a cloud POP over the underlay OTN tunnels.
4. During the CPL service delivery, the ONAP UUI displays its progress (e.g, completion percentage) and the final status (e.g., success or failure) at the end. This display is useful to inform the user if the Intent is fulfilled.
5. After the CPL service is delivered, the ONAP UUI displays the services provisioned on the physical network (e.g., E-Trees and OTN tunnels). This display is useful for the operator to exam whether the service is provisioned correctly on the network.
6. After the CPL service is delivered, the closed-loop in the Transport MD starts automatically to provide Intent assurance. The closed-loop monitors network telemetry data, aggregates and transforms them into data notification events, and analyses these events using the SLA parameters derived from the user's Intent. In this PoC, we demonstrate the live monitoring of the CPL's bandwidth usage, and the automatic increase of the allocated bandwidth of the CPL when the actual bandwidth usage reaches a certain threshold.

2.4 Additional information

N/A