ACTN (Abstraction and Control of TE networks)

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Overview

ACTN refers to the set of virtual network operations needed to orchestrate, control and manage large-scale multi-domain TE networks so as to facilitate network programmability, automation, efficient resource sharing, and end-to-end virtual service aware connectivity and network function virtualization services.

These operations are summarized as follows:

- Abstraction and coordination of underlying network resources to higher-layer applications and customers, independent of how these resources are managed or controlled, so that these higher-layer entities can dynamically control virtual networks. Where control includes creating, modifying, monitoring, and deleting virtual networks.

- Multi-domain and multi-tenant virtual network operations via hierarchical abstraction of TE domains that facilitates multi-administration, multi-vendor, and multi-technology networks as a single virtualized network. This is achieved by presenting the network domain as an abstracted topology to the customers via open and programmable interfaces. Which allows for the recursion of controllers in a customer-provider relationship.
- Orchestration of end-to-end virtual network services and applications via allocation of network resources to meet specific service, application and customer requirements.

- Adaptation of customer requests (made on virtual resources) to the physical network resources performing the necessary mapping, translation, isolation and, policy that allows conveying, managing and enforcing customer policies with respect to the services by the network to said customer.

- Provision of a computations scheme and virtual control capability via a data model to customers who request virtual network services. Note that these customers could, themselves, be service providers.

ACTN solutions build on, and extend, existing TE constructs and TE mechanisms wherever possible and appropriate.

Framework

- CNC - Customer Network Controller -
- MDSC - Multi Domain Service Coordinator -
- PNC - Physical Network Controller -

Customer Network Controller

A Virtual Network Service is instantiated by the Customer Network Controller via the CMI (CNC-MDSC Interface). As the Customer Network Controller directly interfaces the application stratum, it understands multiple application requirements and their service needs. It is assumed that the Customer Network Controller and the MDSC have a common knowledge on the end-point interfaces based on their business negotiation prior to service instantiation. End-point
interfaces refer to customer-network physical interfaces that connect customer premise equipment to network provider equipment. In addition to abstract networks, ACTN allows to provide the CNC with services. Example of services include connectivity between one of the customer's end points with a given set of resources in a data center from the service provider.

**Multi Domain Service Coordinator**

The MDSC (Multi Domain Service Coordinator) sits between the CNC (the one issuing connectivity requests) and the PNCs (Physical Network Controllers - the ones managing the physical network resources). The MDSC can be collocated with the PNC, especially in those cases where the service provider and the network provider are the same entity.

The MDSC is the only building block of the architecture that is able to implement all the four ACTN main functionalities, i.e. multi domain coordination function, virtualization/abstraction function, customer mapping function and virtual service coordination. The key point of the MDSC and the whole ACTN framework is detaching the network and service control from underlying technology and help customer express the network as desired by business needs. The MDSC envelopes the instantiation of right technology and network control to meet business criteria. In essence it controls and manages the primitives to achieve functionalities as desired by CNC. A hierarchy of MDSCs can be foreseen for scalability and administrative choices. In order to allow for a hierarchy of MDSC, the interface between the parent MDSC and a child MDSC must be the same as the interface between the MDSC and the PNC. This does not introduce any complexity as it is transparent from the perspective of the CNCs and the PNCs and it makes use of the same interface model and its primitives as the CMI and MPI.

A key requirement for allowing recursion of MDSCs is that a single interface needs to be defined both for the north and the south bounds. In order to allow for multi-domain coordination a 1:N relationship must be allowed between MDSCs and between MDSCs and PNCs (i.e. 1 parent MDSC and N child MDSC or 1 MDSC and N PNCs). In addition to that it could be possible to have also a M:1 relationship between MDSC and PNC to allow for network resource partitioning/sharing among different customers not necessarily connected to the same MDSC (e.g. different service providers).

**Physical Network Controller**

The Physical Network Controller is the one in charge of configuring the network elements, monitoring the physical topology of the network and passing it, either raw or abstracted, to the MDSC.

The PNC, in addition to being in charge of controlling the physical network, is able to implement two of the four ACTN main functionalities: multi domain coordination function and virtualization/abstraction function.

A hierarchy of PNCs can be foreseen for scalability and administrative choices.

**IETF ACTN architecture, YANG models and PCE-P protocols for NBI**


**ACTN Project Development Overview**

**New Work in ONOS**

1. IETF YANG NBI/SBI
2. ACTN MDSC (Super Controller)
3. PCEP as NBI/SBI
4. ACTN PNC (Domain Controller)

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**Hierarchical Topology Abstractions via Standard NBIs**

**Abstract (Customized) TE Topology 1**

**Abstract (Customized) TE Topology 2**

**Merged Native TE Topology**

**Domain Abstract TE Topology**

**Domain Native TE Topology**

**VN (Virtual Network) Creation via PCEP**
1. VN (assume 2 endpoints for simplicity) requested at MDSC (parent PCE) via CNC

2. MDSC computes end to end path either by itself or by using child PCE. MDSC further breaks the path into per-domain LSP segments

3. PCInitiate (A-C)

3. PCInitiate (C-E)

3. PCInitiate (E-F)
Supporting VN operations in PCEP

* P-PCE computes paths and determines each domain paths and associate VNI with LSPs for each Domain
  * For each LSP Initiate, Use: Association Object to associate VNI ID with LSPs

JIRA Tickets

- IETF YANG NBI/SBI - [ONOS-4840](https://github.com/onos-project/onos/issues/4840)
- ACTN MDSC Controller - [ONOS-4874](https://github.com/onos-project/onos/issues/4874)