**APP NOTE**

# CloudCO-APPN-441: Converged Core-as-a-Service (with PNF based User Plane)

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# 1 Summary/Objective

This application note describes the establishment of Converged Core service provided by the Cloud CO Operator within a Cloud CO domain. The Converged Core service is consumed by various Service Provider tenants. Each Service Provider tenant takes control of its Converged Core exclusive resources, i.e., dedicated UP PNF and CP VNF allocated by the Cloud CO Operator. After that, Service Provider tenant manages and operates, in an independent way, its own services offered to the end customers.

The Converged Core can serve both wireline and wireless services by providing the functionalities such as BNG, EPC and etc. In this application node, the Converged Core is only offering the BNG functionality.

In this application note, the control plane of the Converged Core is implemented as centralized VNF and hosted in NFVI, while its user plane still remains as distributed PNFs in order to obtain high packet processing performance. If any existing PNF, such as BNG, hopes to support this migration model, its northbond API must be upgraded to support the interactions with CP VNF as well as the Edge SND M&C.

# 2 Assumptions and Preconditions

1. The Cloud CO Domain instance is already fully bootstrapped.

2. All Controllers are applications running inside the NFVI, Controllers can talk to the elements they manage. This was all deployed in the previous bootstrapping stage (See CLOUDCO-APPN-000).

3. The Converged Core User Plane PNFs have been deployed to fulfill the Converged Core user plane. The Converged Core User Plane PNFs have IP addresses to communicate with Edge SDN M&C.

4. The Converged Core User Plane PNFs support the standard northbound $M_{inf}$ and $M_{fc}$ interfaces.

5. The physical connectivity between Switch Fabric, Converged Core User Plane PNFs, and Network I/O has been established.

# 3 Description of the System

The Service Provider accesses E2E SO issues a Converged Core Service request to the CCO DO via the CCO NBI.

CCO DO orchestrates the establishment of appropriate network service by requesting the:

VIM to create a connectivity from Edge SDN M&C to the Converged Core User Plane PNF.

- Edge SDN M&C to configure the Converged Core User Plane PNF.

- VNFM to manage the lifecycle of the Converged Core Control Plane VNF.

- Edge SDN M&C to configure the Converged Core Control Plane VNF.

- Leveraging Edge, DC SDN M&C Controllers, as well as the VIM to establish connectivity between Switch Fabric, Converged Core User Plane PNF, Converged Core Control Plane VNF and Network I/O.
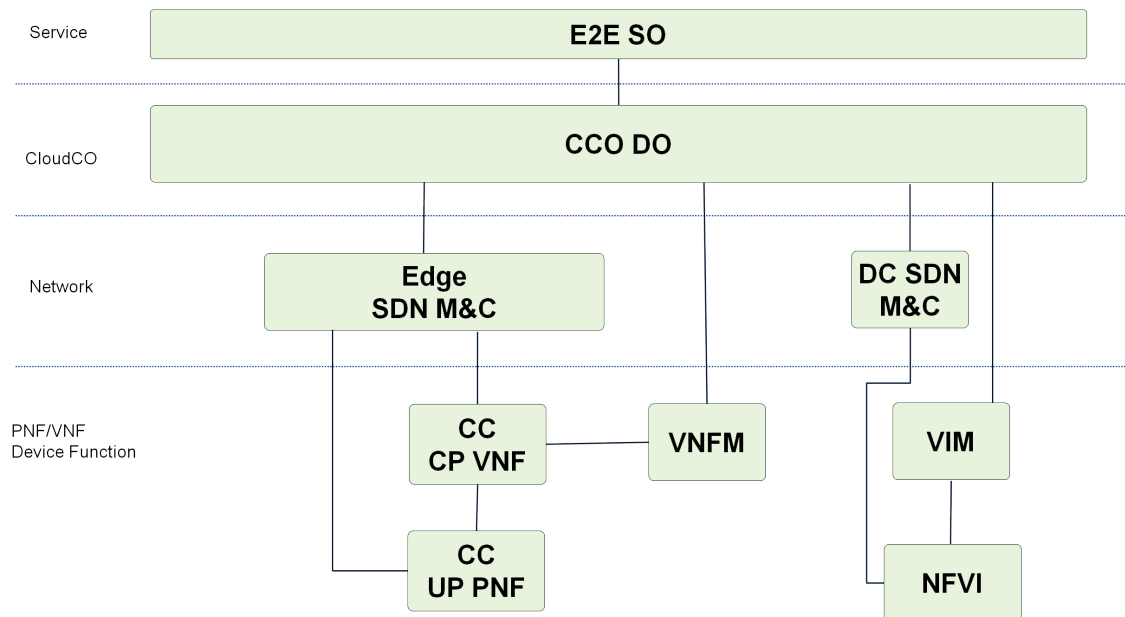
# 4 Components

| Component Framework Name | Component Description |
|---|---|
| CCO DO | TR-384, WT-411 |
| Edge SDN M&C | Edge SDN Management and Control: TR-384, WT-411, WT-413 - Provides SDN Management and Control of the Converged Core Control Plane VNF as well as CCO awareness Converged Core User Plane PNF. |
| DC SDN M&C | Data Center SDN Management and Control: WT-411 - Provides SDN Management and Control of the NFVI , in this case the physical network fabric. |
| VIM | Virtualized Infrastructure Manager: WT-411, ETSI NFV - Controls the NFVI, deploys VNFs and interconnects them. |
| Converged Core Control Plane VNF | The virtualized control plane functions, including Address Allocation & Management, Subscriber Access Management, AAA, Subscriber Management, and Service Control (See section 5.2.5.1 of TR-384) |
| Converged Core User Plane PNF | The routing functions of BNG, including Routing Forwarding Plane and Routing Control (See Option 1 of section 5.2.5.3 of TR-384) |
| VNFM | VNF Manager: ETSI NFV: Manages the lifecycle of the Converged Core Control Plane VNF. |
| NFVI | NFV Infrastructure: WT-411, ETSI NFV – The physical network fabric and servers |

# 5  Actors

| Actor Name | Actor Description | Actions at CCO Perimeter (CCO DO NBI, User action) |
|---|---|---|
| Cloud CO Domain Operator | The wholesale service provider offers the CCO infrastructure to Service Provider. | 1. Create Converged Core Service for the Service Provider. |
| Service Provider | The Service Provider is the user of the Converged Core Service. It provides its own services to the end users. | 1. Offer the services to the end customers on the top of the rented Converged Core resources. |

# 6 Interactions

## 6.1 Interaction 1: Create Converged Core Service

1. CCO DO receives a Converged Core Service creation request from the Service Provider tenant.

2. CCO DO requests VIM to deploy a Converged Core Control Plane VNF instance and establish the connectivity between the Converged Core Control Plane VNF and the Edge SDN M&C. the CC CP VNF includes multiple functional components, like DHCP Server, AAA, Service Control etc. Alternatively, above functions can be a set of independent VNFs.

3. CCO DO requests VNFM to manage the lifecycle of the Converged Core Control Plane VNF.

4. CCO DO requests Edge SDN M&C to configure the Converged Core Control Plane VNF. For example, configuring DHCP server with the available IP address pools, AAA with the RADIUS server information and Service Control with the policy server information.

5. CCO DO requests Edge SDN M&C to configure the Converged Core User Plane PNF assigned for the Service Provider tenant as well. For example, configuring User Plane to forward the subscriber access control related messages (e.g., PPPoE, IPoE, DHCP) to Control Plane.

6. CCO DO requests the VIM to establish L3 connectivity between the Converged Core Control Plane VNF and dedicated Converged Core User Plane PNF.

7. CCO DO reports 'Service Ready'.
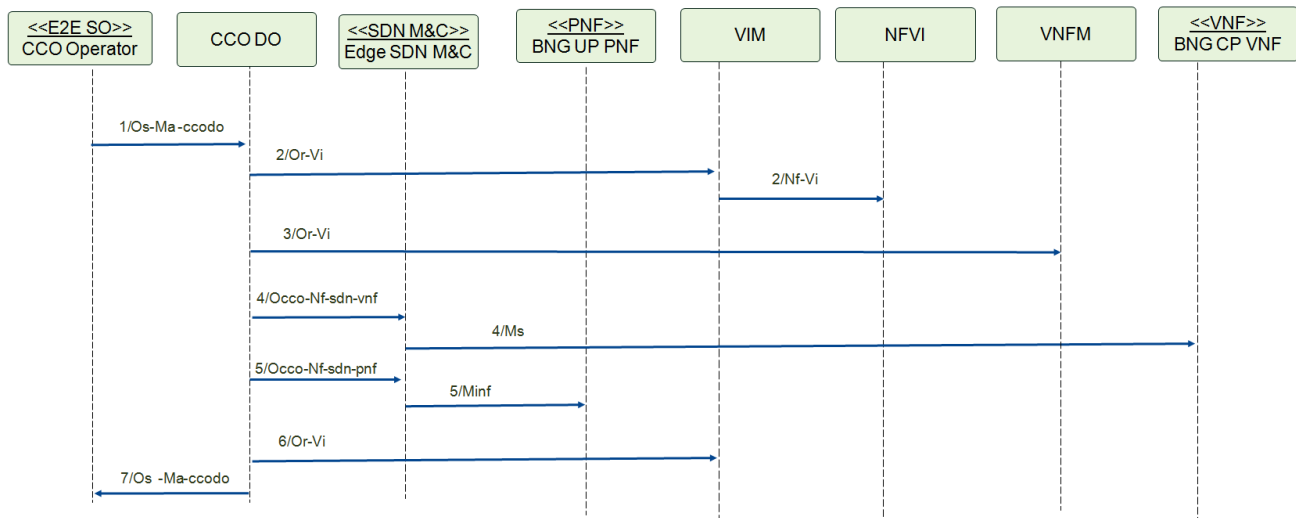
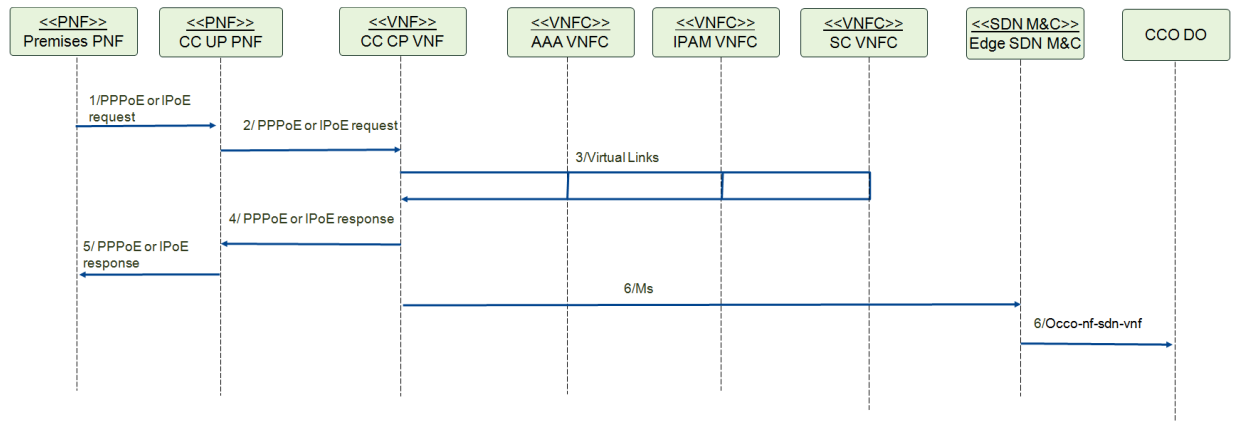## 6.2  Interaction 2: Create Converged Core Service User

1. CCO DO receives a Converged Core Service User request with enduser information, e.g., the quality of service, user credentials.

2. CCO DO requests Edge SDN M&C to configure the Converged Core Control Plane VNF, including the AAA VNF component with the enduser credentials, the IPAM VNF component with the enduser IP address pool and Service Control VNF component with the enduser policies, like bandwidth, QoS etc.
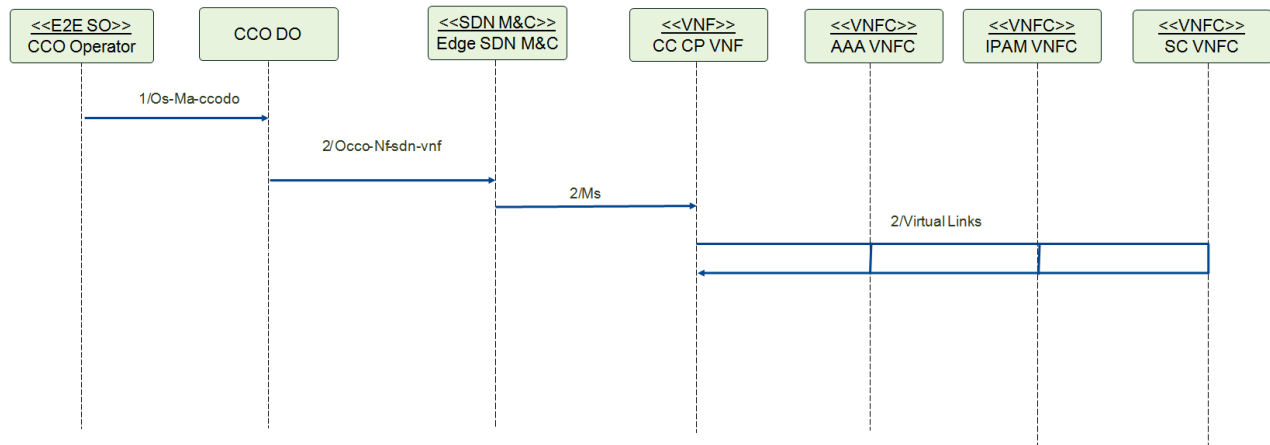


## 6.3  Interaction 3: Activate Converged Core Service

1. The Premises PNF (RG) sends a subscriber access control related message (e.g., IPoE or PPPoE request message).

2. Converged Core User Plane PNF intercepts the request message and forwards it to the Converged Core Control Plane VNF via the connectivity created in the step 6 of Interaction 1.

3. Converged Core Control Plane VNF handles the request with its components (AAA VNFC, IPAM VNFC, SC VNFC and etc.) inside itself.

4. Upon the successful authentication, IP address allocation and policies enforcement, Converged Core Control Plane VNF sends a response downstream to the Converged Core User Plane PNF.

5. The Converged Core User Plane PNF forwards the response to the Premises PNF (RG).

6. Converged Core Control Plane VNF reports an enduser activation to the CCO DO via the Edge SDN M&C.
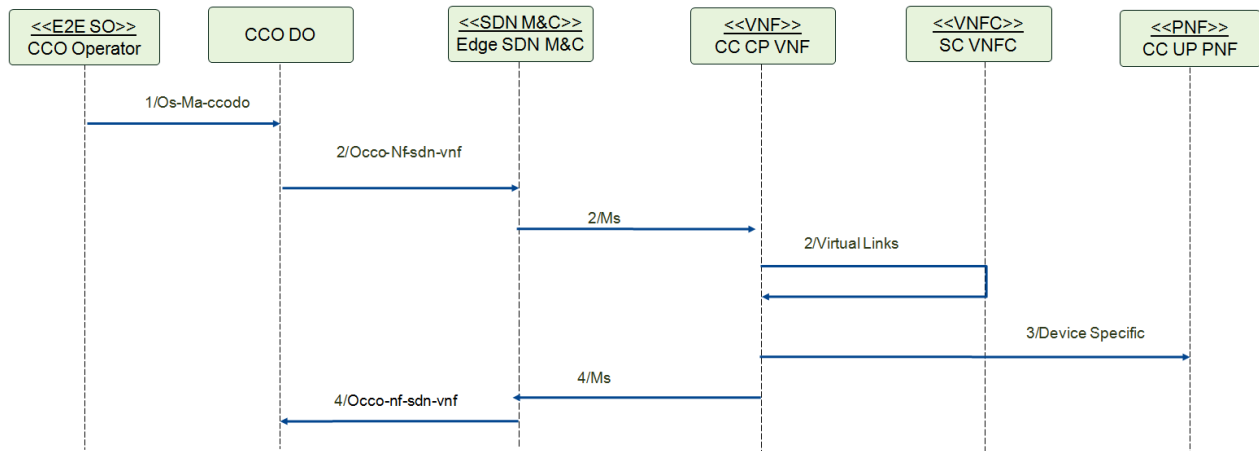
**Note:** There may be multiple message exchanges between the Premises PNF (RG), CC CP VNF and CC UP PNF, for example, DHCP messages in IPoE, PAD messages and LCP/PAP CHAP/NCP messages in PPPoE, during the Interaction 3.

```
<<PNF>>        <<PNF>>         <<VNF>>        <<VNFC>>       <<VNFC>>        <<VNFC>>        <<SDN M&C>>       CCO DO
Premises PNF   CC UP PNF       CC CP VNF      AAA VNFC       IPAM VNFC      SC VNFC         Edge SDN M&C

   1/PPPoE or IPoE
   request
            2/ PPPoE or IPoE request

                            3/Virtual Links

            4/ PPPoE or IPoE response
   5/ PPPoE or IPoE
   response

                            6/Ms
                                                                                            6/Occo-nf-sdn-vnf
```

## 6.4  Interaction 4: Change Bandwidth Service based on CC

1.  CCO DO receives a request to change the bandwidth for the enduser.

2.  CCO DO requests Edge SDN M&C to configure the Service Control VNF component of the Converged Core Control Plane VNF with the enduser's bandwidth on-demand.

3.  Converged Core Control Plane VNF instructs the Converged Core User Plane PNF to enforce the bandwidth modification for the enduser.

4.  Converged Core Control Plane VNF reports a bandwidth change acknowledge to the CCO DO via the Edge SDN M&C.

**Note:** The bandwidth change request may be initiated by a RADIUS CoA-Request message from RADIUS Server located in E2E SO.

```
<<E2E SO>>     CCO DO          <<SDN M&C>>       <<VNF>>        <<VNFC>>        <<PNF>>
CCO Operator                   Edge SDN M&C      CC CP VNF      SC VNFC         CC UP PNF

   1/Os-Ma-ccodo

            2/Occo-Nf-sdn-vnf

                            2/Ms

                                        2/Virtual Links

                                                        3/Device Specific

                            4/Ms
            4/Occo-nf-sdn-vnf
```

# 7 Success Criteria

**Interaction 1:**

1. CCO DO maintains the Converged Core Service request.
2. Converged Core resources, i.e., VNF and PNF, have been allocated to the Service Provider tenant.

**Interaction 2:**

1. Converged Core Service User is created.
2. AAA VNFC is configured with the enduser credentials.
3. IPAM VNFC is configured with the enduser IP address pool.
4. SC VNFC is configured with the enduser policies.

**Interaction 3:**

1. Converged Core Service is established for the enduser.

**Interaction 4:**

1. The bandwidth of the enduser has been changed on demand.