



ONAP PNF Plug and Play for Casablanca (R3, 4Q 2018)







- ONAP and PNF Plug and Play for 5G RAN
- 5G Use Case Team



PNF Plug and Play CASABLANCA IMPROVEMENTS OVERVIEW

- ONAP and PNF Plug and Play for 5G RAN
- 5G Use Case Team

Casablanca Summary Overview

| TOPIC | ICON | DESCRIPTION |
|--|---|---|
| PNF Registration Handler (PRH) Improvements |  | New VES Event domain for PNF registration with corresponding support in VES collector, DMaaP and PRH. |
| SO Workflow enhancements |  | Introduction of dedicated 5G use case work-flow |
| Service Configuration Improvement |  | Service configuration improvements from APP-C/SDN-R to PNF after PNF registration to PRH |
| Security Enhancements |  | Authentication, Certificates, User name & password and intra-ONAP security. |
| Modeling enhancements |  | Modeling enhancements to support 5G PNF in ONAP. Inheritance, and PNF characteristics for sharing. Focusing on PNF connectivity. PNF-SDK. |
| PNF Onboarding / Package |  | Defining <i>PNF Onboarding Package</i> . Extending framework to work with PNFs. Defining PNF Package framework. |

PRH Enhancements

DESCRIPTION

PNF Registration Handler (PRH) Enhancements.

(1) New VES Event domain for PNF Registration

– Create new VES event domain for PNF registration with corresponding support in VES collector, DMaaP and PRH. PnP Use case was using the “other” domain to register VES events. For Casablanca, we propose using a dedicated domain. VES separation of events. VES agent update in PNF.

(2) VES EXTENSIONS - As a result, VES collector and VES agent content will change with field updates using the new domain. Extensions for PNF registration fields. Corresponding VES Schema change (requires approval and coordination from ONAP community).

(3) PNF REGISTRATION EXCHANGE UPDATE –

The registration VES event used by the DU Simulator (or actual PNF) will need to update its JSON payload to match the changes above.



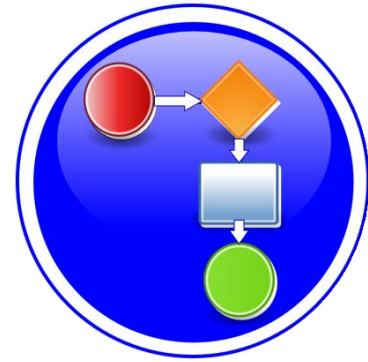
PROJECTS

PNF Registration Handler, DMaaP, DCAE

PNF PnP: SO Workflow Enhancements

DESCRIPTION

- (1) SO WORKFLOW ENHANCEMENTS** –
Dedicated 5G BTS Workflow in SO.
- (2) 5G PNF WORKFLOW** – Extensions to Beijing
SO Workflow (part of VCPE workflow)



PROJECTS

SO

SERVICE CONFIGURATION ENHANCEMENT

DESCRIPTION

- (1) Service configuration Enhancements** to ONAP Controller to PNF *service configuration* exchange with PNF.
- (2) PROTOCOL DEFINITION** – Better definition around the Protocols supported (and/or support more protocols). What ONAP controller supports what PNF and what protocols are supported. NetConf, Ansible, Chef. (SDN-R = NetConf)(?)
- (3) Configuration Extensions** – New parameters needed for Casablanca use cases. Vid script to pushing data, ID config, ID where data comes from. Generic configuration support.
- (4) PNF PnP Config** – Finishing PNF PnP by sending down config data.
- (5) (OPTIONAL) Vendor Data** – Extensions to Service Configuration with Vendor specific configuration data can be developed (vendor dependent).



PROJECTS

ONAP Controller (SDN-R), VID, SO,
SDC/CDT

SECURITY ENHANCEMENTS

DESCRIPTION

- (1) PNF AUTHENTICATION** – DCAE must authenticate the HTTP/TLS connection from the PNF. DCAE to integrate the HTTP and TLS authentication functionality by AAF.
- (2) VENDOR CERTIFICATES** – Handling Vendor Certificates for TLS/SSH for PNFs.
- (3) USER NAME & PASSWORDS** – Provisioning. DCAE & PNF management of *User Name & Passwords*.
- (4) SECURITY BETWEEN COMPONENTS** – DMaaP & PRH to authenticate w/ other ONAP components.



PROJECTS

PNF Registration Handler, DCAE, AAF,
ONAP Controller, DMaaP

PNF PnP: MODELING ENHANCEMENTS

DESCRIPTION

- (1) PNF MODELING** – Modeling enhancements to support 5G PNF in ONAP. Model Inheritance definitions for PNF. SDC modeling improvements from Beijing PnP use case.
- (2) PNF SHARING** – SDC model updates for PNF characteristics focusing on PNF inter-connectivity.
- (3) PNF-SDK** – SDK provided from Vendors. This will help modeling the Physical “Box” (PNF) and network functions.
- (4) CDT ENHANCEMENTS** - Improving CDT to handle complex config templates, multiple templates per PNF, identify different sources for template data, integrating CDT into SDC, expanding CDT usage to other controllers.



PROJECTS

SDC, CDT, PNF-SDK

PNF ONBOARDING / PNF PACKAGE

DESCRIPTION

PNF Onboarding and PNF Package

(1) PNF PACKAGE DEFINITION – Defining *PNF Onboarding Package*. Extending framework to work with PNFs. Defining PNF Package framework.

- A. **PNF ARTIFACTS DEFINITION** – Vendor specific/provided artifacts to add to the (new PNF) package.
- B. **PNF ARTIFACTS DISTRIBUTION**



PROJECTS:
SDC, APP-C



PNF Plug and Play IN CASABLANCA (R3)

- ONAP and PNF Plug and Play for 5G RAN
- 5G Use Case Team

PNF Plug and Play Stages

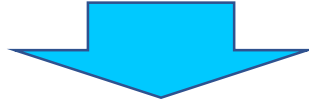
Design Time

A



PNF Modeling

Resources Definition/Services Definition
SDC: PNF (physical element) Modeling
Distribution of types



B



PNF Instance Declaration

PNF Infrastructure Service Declaration
First part of PNF instantiation
DCAE & AAI Entry with PNF ID (e.g. MAC address)



C



PNF Boot-strapping

PNF Powers up and Boot-straps
PNF performs a "Plug and Play" procedure
Equipment vendor proprietary steps

D



PNF Contacts ONAP

PNF connects to ONAP via a Registration Event
PNF Registration Handler (PRH) processes the event
Generic (not vendor proprietary)

E



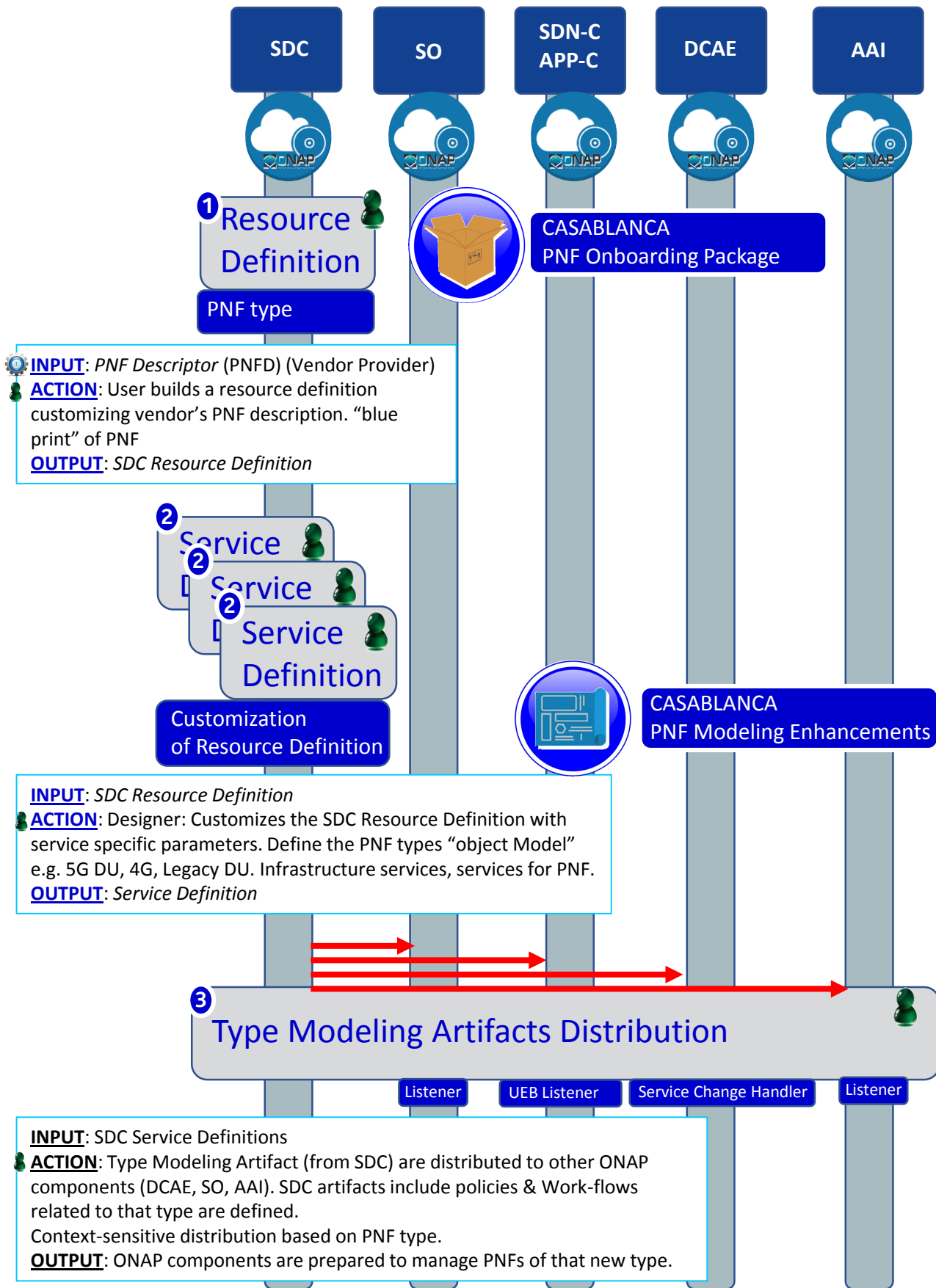
PNF Activation

Connection points configured
Second part of PNF service instantiation
PNF configured and ready to provide service

Run-Time (Instances)

| ACTORS | DESCRIPTION |
|--------------------------|--|
| PNF | PHYSICAL NETWORK FUNCTION (PNF) – A Network Function that is hosted on a physical hardware device, not in the cloud infrastructure. |
| DHCP | DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) – Protocol to assign IP addresses to a network element (NE). The IP address can be dynamically assigned or static based on MAC address of PNF. |
| SEGW | SECURITY GATEWAY – Used to set up IPSec tunnels to protect against unsecured traffic entering an internal network of an operator; used by enterprises to protect their users from accessing and being infected by malicious traffic. |
| CA/RA | CERTIFICATE AUTHORITY / REGISTRATION AUTHORITY – Used to generate a service provider certificate for the PNF. |
| Initial EM | INITIAL EM – Provides basic configuration and software download services to the PNF. This might be a equipment vendor specific solution. Also, responsible for identifying a PNF. |
| SDN-C | SOFTWARE DEFINED NETWORK CONTROLLER (SDN-C) – A controller for Layer 0 to 3 devices. Manages transport and network connections. |
| DCA&E | DATA COLLECTION, ANALYTICS AND EVENTS (DCAE) – Gathers performance, usage, and configuration data from the managed environment. Collect, store data and provides a basis for analytics within ONAP. For PNF Plug and Play can potentially perform analytics on the Plug and Play process, statistics, logs. |
| A&AI | ACTIVE & AVAILABLE INVENTORY – The PNF is identified as available inventory and tracked through a key which is the PNF ID. When onboarded the PNF gets an entry in A&AI and can then be tracked, requested, and seen by the ONAP components for service requests or other queries. |
| SO | SERVICE ORCHESTRATOR – Serves as a mediator and coordinator of service requests. |
| APP-C | APPLICATION CONTROLLER (APP-C) - A controller for Layer 4 to 7 applications. Manages the life cycle of virtual applications, virtual network functions (VNFs), and components. APP-C manages the 5G DU & 4G DU. |
| PNF Registration Handler | PNF Infrastructure Manager – A microservice in DCAE used during PNF Plug-n-Play to process the PNF Registration event. |

Design Time (ONAP)



PNF PnP: MODELING ENHANCEMENTS

DESCRIPTION

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PROJECTS

SDC, CDT

PNF ONBOARDING / PNF PACKAGE

DESCRIPTION

PNF Onboarding and PNF Package

(1) PNF PACKAGE DEFINITION – Defining *PNF Onboarding Package*. Extending framework to work with PNFs. Defining Package framework.

A. PNF ARTIFACTS DEFINITION – Vendor specific/provided artifacts to add to the (new PNF) package.

B. PNF ARTIFACTS DISTRIBUTION

VNF Package – basis for PNF package.

PNF package.

Meta data file, main service template, TOSCA template.

Artifact Package. Separated by types of artifacts. Separations by folder for different types. Place artifacts in categories. Anyone can choose which artifacts to receive.

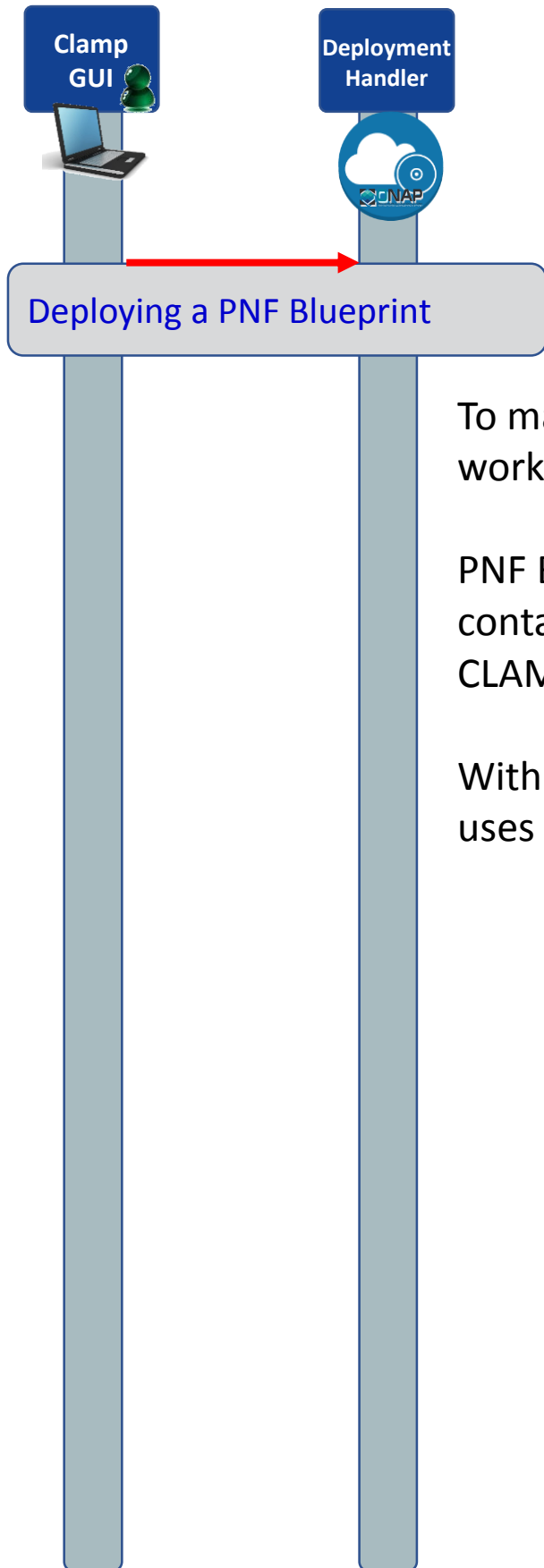


PROJECTS:

SDC, APP-C

| STEP | DESCRIPTION |
|------|---|
| 1 | <p>RESOURCE DECLARATION – A user on the VID performs a Resource Declaration. This uses the Service definition created in SDC. The user on the VID can define known information about the PNF. The user can (optional) provide the following information</p> <p>PNF RESOURCE Definition</p> <ul style="list-style-type: none"> Resource Type – Type of Resource. NEW type: PNF (pre-defined in SDC) NAME – Name of the PNF type CATEGORY – e.g. Infrastructure TAGS – User-definable tags (default name of the PNF) DESCRIPTION – Textual description CONTACT ID – Designer (user of ONAP) VENDOR – PNF Vendor (e.g. Nokia) VENDOR RELEASE – Vendor release VENDOR MODEL NUMBER – PNF Model value (link to A&AI) EVENTS – Monitoring Event definitions. Define design-time templates. CLAMP (runtime monitoring), DCAD (design time design template attach to VNF). Define templates & attach them. <p>Note: The user may provide whatever information in the above fields they know. Note: Consumer vs Enterprise deployments. Consumer systems pre-registered, distributed throughout a region. For a consumer deployment you might not know the MAC address/Serial number (PND IF) until the PNF connects to ONAP.</p> |
| 2 | <p>SERVICE Definition (uses a PNF)</p> <ul style="list-style-type: none"> NAME – Name of the Service (mandatory) CATEGORY – e.g. Network L1...L4, VOIP call Control, Mobility TAGS – User-definable tags (default name of the PNF) DESCRIPTION – Textual description of service (mandatory) CONTACT ID – Designer (user of ONAP) (mandatory) PROJECT CODE – ID (mandatory) Ecomp-Generated Naming – Name Naming Policy – Policy to be used to assign a name to a service by SO/SDNC SERVICE TYPE – Type of service SERVICE ROLE – The Role of this service. ENVIRONMENTAL CONTEXT – distributed environments Specific Service(?) – PNF, allotted resource from a CU Service <p>The “basic” model are extended. Inherit (OO) from existing model. Vendor takes standard node types and creates their own extension. CDT (Configuration Design Tool) (GUI) to build artifacts to be used by APP-C (Tosca models) for a configure Template.</p> |
| 3 | <p>DISTRIBUTION – Event Monitoring Templates distributed. (?)</p> |

Deployment Handler (VES Collector)



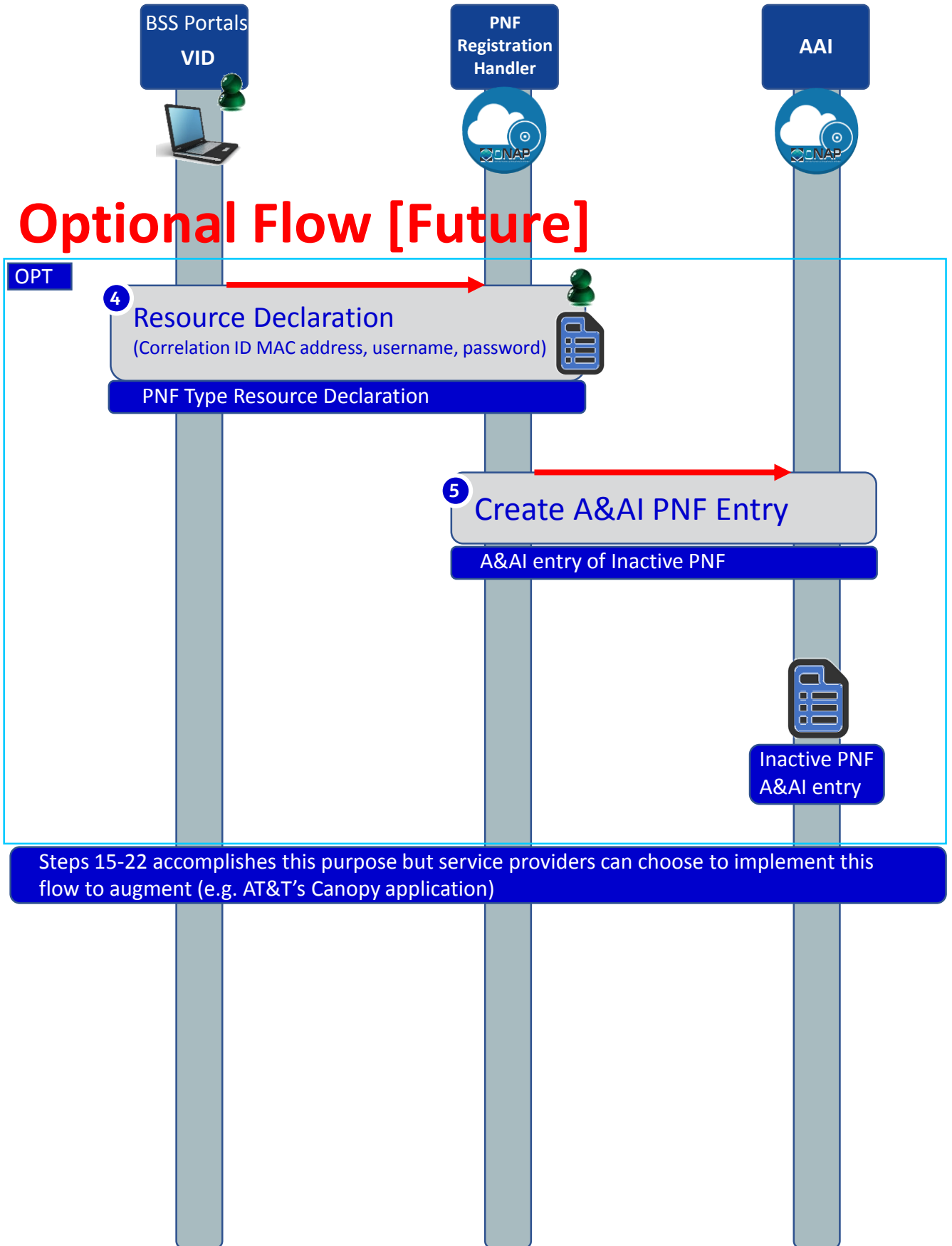
To make a VES Collector in DCAE work properly

PNF Blueprint will be docker container. May be deployed from CLAMP or Cloudify Orchestrator.

Within VES Collector schema uses "Adder" (existing)

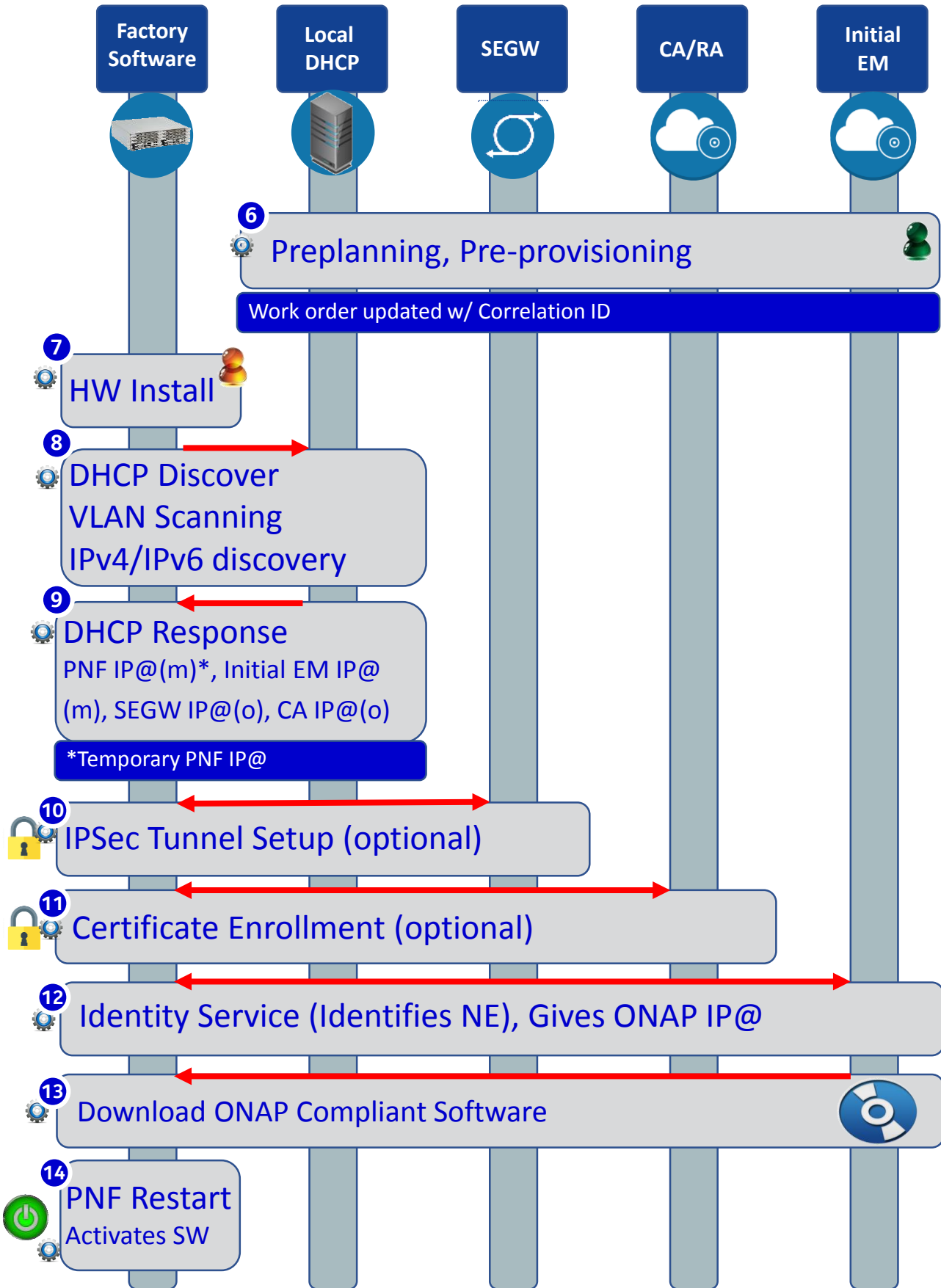
| STEP | DESCRIPTION |
|------|--|
| 1 | <p>DEPLOYMENT HANDLER PNF BLUEPRINT – The Deployment handler is necessary to use, to give it the PNF blueprint so that later on in the Plug and Play flow, DCAE will recognize the PNF. The PNF Blueprint will be docker container. The PNF blueprint May be deployed from CLAMP or Cloudify Orchestrator to DCAE. Within VES Collector schema uses “Adder” (existing).</p> |










PNF Resource Declaration (future)



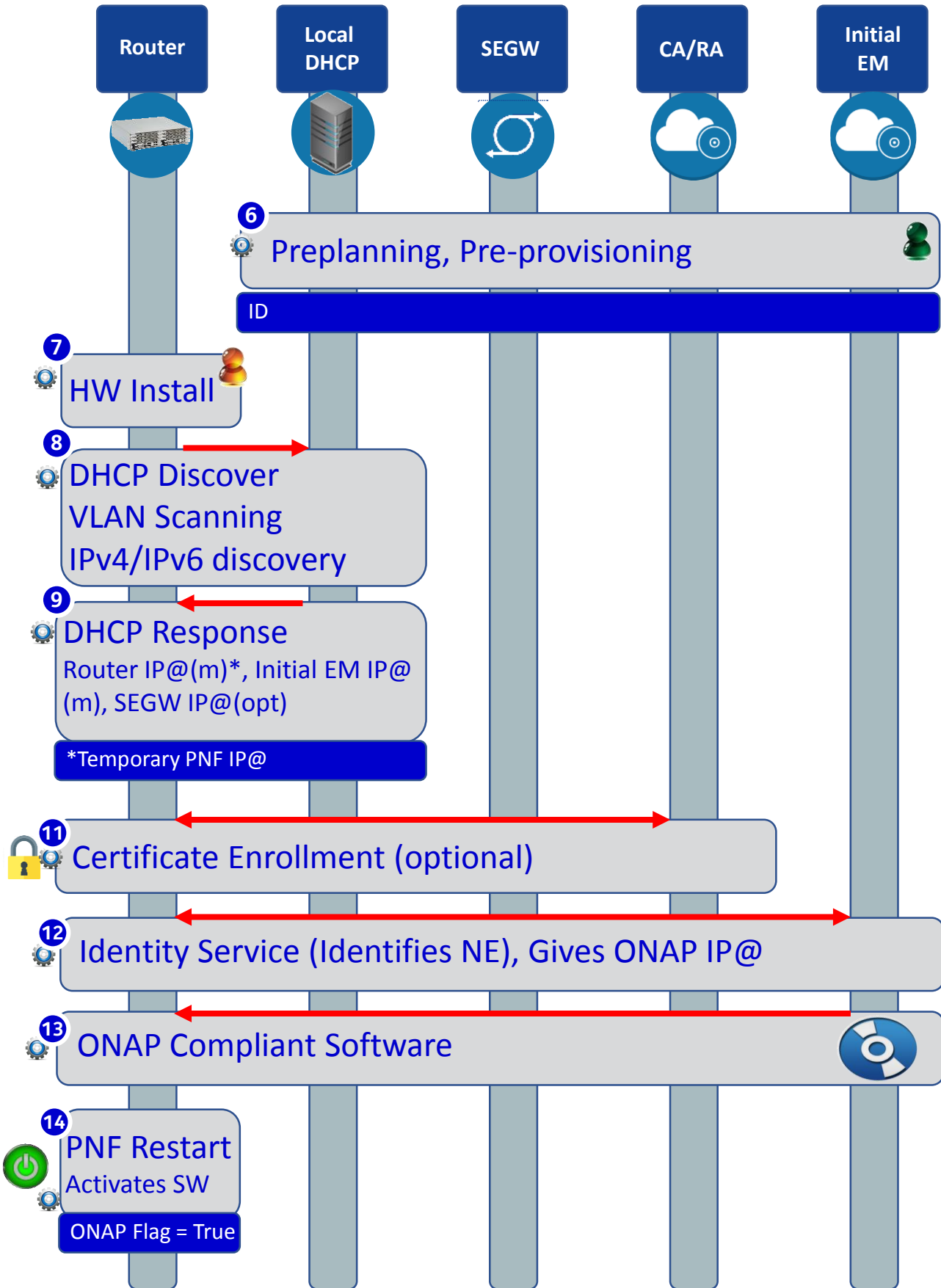
| STEP | DESCRIPTION |
|------|--|
| 4 | <p>RESOURCE DECLARATION – A user on the VID performs a Resource Declaration. This uses the Service definition created in SDC. The user on the VID can define known information about the PNF. The user can (optional) provide the following information</p> <p>PNF RESOURCE Definition</p> <ul style="list-style-type: none"> Resource Type – Type of Resource. NEW type: PNF (pre-defined in SDC) NAME – Name of the PNF type CATEGORY – e.g. Infrastructure TAGS – User-definable tags (default name of the PNF) DESCRIPTION – Textual description CONTACT ID – Designer (user of ONAP) VENDOR – PNF Vendor (e.g. Nokia) VENDOR RELEASE – Vendor release VENDOR MODEL NUMBER – PNF Model value (link to A&AI) EVENTS – Monitoring Event definitions. Define design-time templates. . |
| 5 | <p>PNF Registration Handler (PRH) creates an A&AI Entry:</p> <p>The PNF entry in AAI is created by the PRH with the PNF ID (or correlation ID) address. After this step, the PNF is considered to be created but inactive within ONAP. It can then be later used in the second part of service instantiation. See Step 28.</p> |









PNF Plug and Play Steps (for 5G DU)



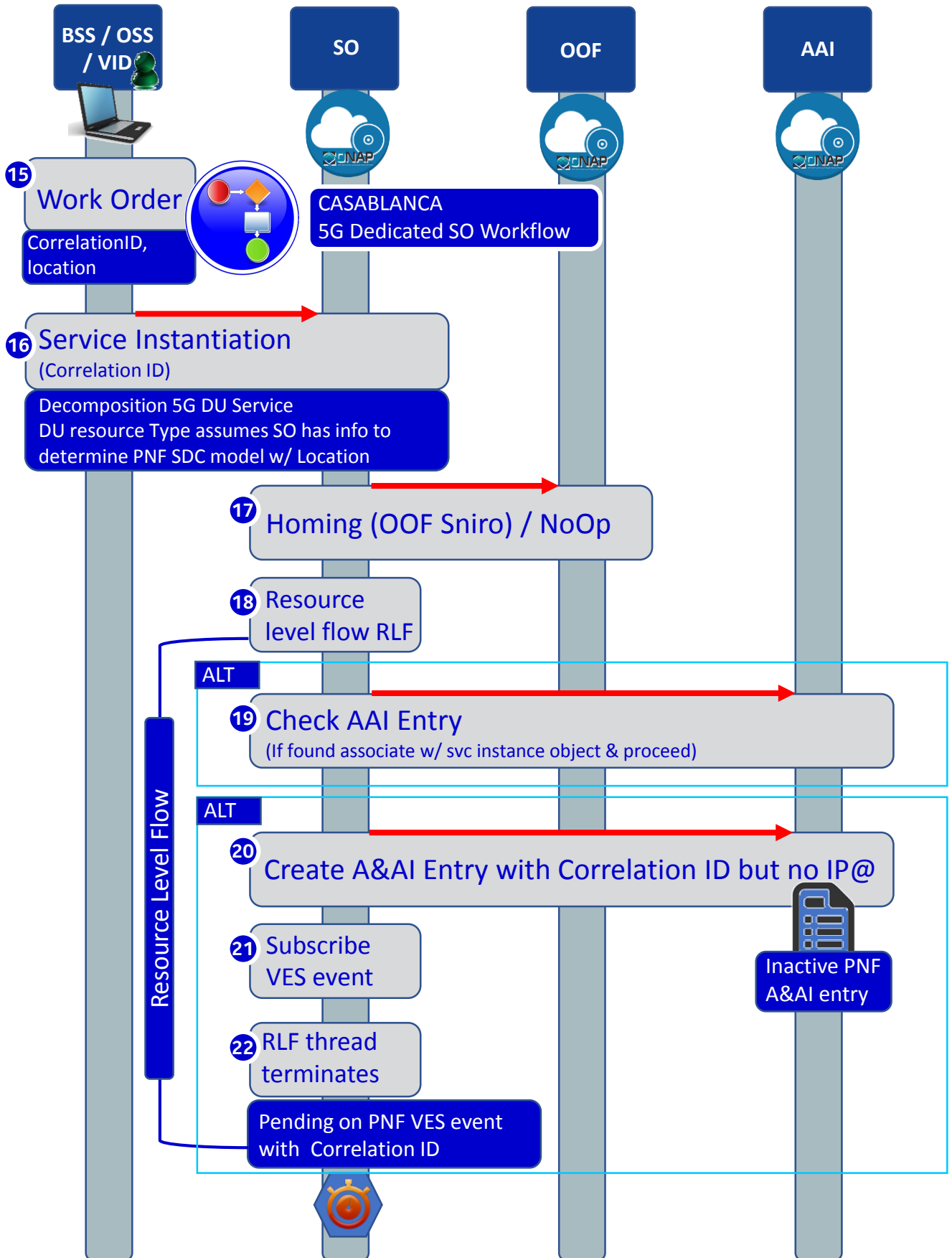
| STEP | DESCRIPTION (Plug and Play Vendor steps for Infrastructure components) |
|---|---|
| 6  | <p>PRE-PLANNING, PRE-PROVISIONING – There is data which is programmed into the system for the PNF Plug and Play operation. The user programs the local DHCP IP address(@), the Security Gateway IP@, the CA/RA certificate information, the management plane IP address (the ONAP IP@), the software service IP@ for use by the PNF during the onboarding process.</p> <p>Note: <i>The CU is instantiated ahead of time with the expected DUs that it should be connected to (that is outside the scope of this flow).</i></p> <p>Note: The user name & password which the PNF needs to know to contact and get through the vAAA server before it contacts ONAP.</p> |
| 7  | <p>HW INSTALL – The physical hardware is installed at the site. Site licensing, real estate contacts, zoning, and physical hardware of the PNF is installed by technicians. Power, backhaul, and antennas are installed and connected.</p> |
| 8  | <p>INITIAL NETWORK ACCESS – A DHCP Discover procedure is executed when the PNF powers on, VLAN Scanning is performed, and IPv4/IPv6 discovery is done. The DHCP Discover message exchange provides an entryway into the network and is designed as an procedure for a network element to be able to find connection to the network from “scratch”. VLAN Scanning and IPv4 vs IPv6 discovery is done as well.</p> |
| 9  | <p>DHCP RESPONSE – The DHCP response returns a PNF IP address, the initial EM IP address, Security Gateway IP address (optional), and certificate authority IP address (opt). It is possible the PNF IP address is a temporary IP address used for initial connectivity purposes, and that a permanent PNF IP address will be granted later.</p> |
| 10  | <p>IPSEC TUNNEL – An IP Sec Tunnel is established which uses cryptography to provides a secure connection. IPSec has two security services: Authentication header and an encapsulating security payload with tunnel and transport modes.</p> |
| 11  | <p>CERTIFICATE ENROLLMENT – The process where the PNF gets a service provider certificate from the Certificate authority. The certificate is then used to authenticate and verify the PNF.</p> |
| 12  | <p>IDENTITY SERVICE – The identity service is there to identify the PNF. It also returns the ONAP (DCAE) IP address.</p> |
| 13  | <p>ONAP COMPLIANT SOFTWARE – The PNF contacts the initial EM and downloads the ONAP Bootstrap software. This is a software package that is meant to perform the remaining steps of PNF registration and activation onto ONAP</p> |
| 14  | <p>PNF RESET – The PNF is reset so that the downloaded ONAP Bootstrap software becomes activated and is then ready to continue to PNF registration</p> |

PNF Bootstrapping Steps (for Routers)



| STEP | DESCRIPTION (Plug and Play Vendor steps for Infrastructure components) |
|---|---|
| 6  | <p>PRE-PLANNING, PRE-PROVISIONING – There is data which is programmed into the system for the PNF Plug and Play operation. The user programs the local DHCP IP address(@), the Security Gateway IP@, the CA/RA certificate information, the management plane IP address (the ONAP IP@), the software service IP@ for use by the PNF during the onboarding process.</p> <p>Note: <i>The CU is instantiated ahead of time with the expected DUs that it should be connected to (that is outside the scope of this flow).</i></p> <p>Note: The user name & password which the PNF needs to know to contact and get through the vAAA server before it contacts ONAP.</p> |
| 7  | <p>HW INSTALL – The physical hardware is installed at the site. Site licensing, real estate contacts, zoning, and physical hardware of the PNF is installed by technicians. Power, backhaul, and antennas are installed and connected.</p> |
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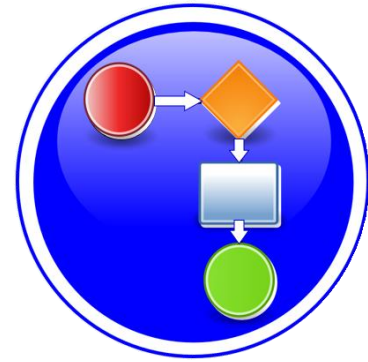
Service Instantiation Process (Part 1)



PNF PnP: SO Workflow Enhancements


DESCRIPTION

- (1) SO WORKFLOW ENHANCEMENTS** –
Dedicated 5G BTS Workflow in SO.
- (2) 5G PNF WORKFLOW** – Extensions to Beijing
SO Workflow (part of VCPE workflow)

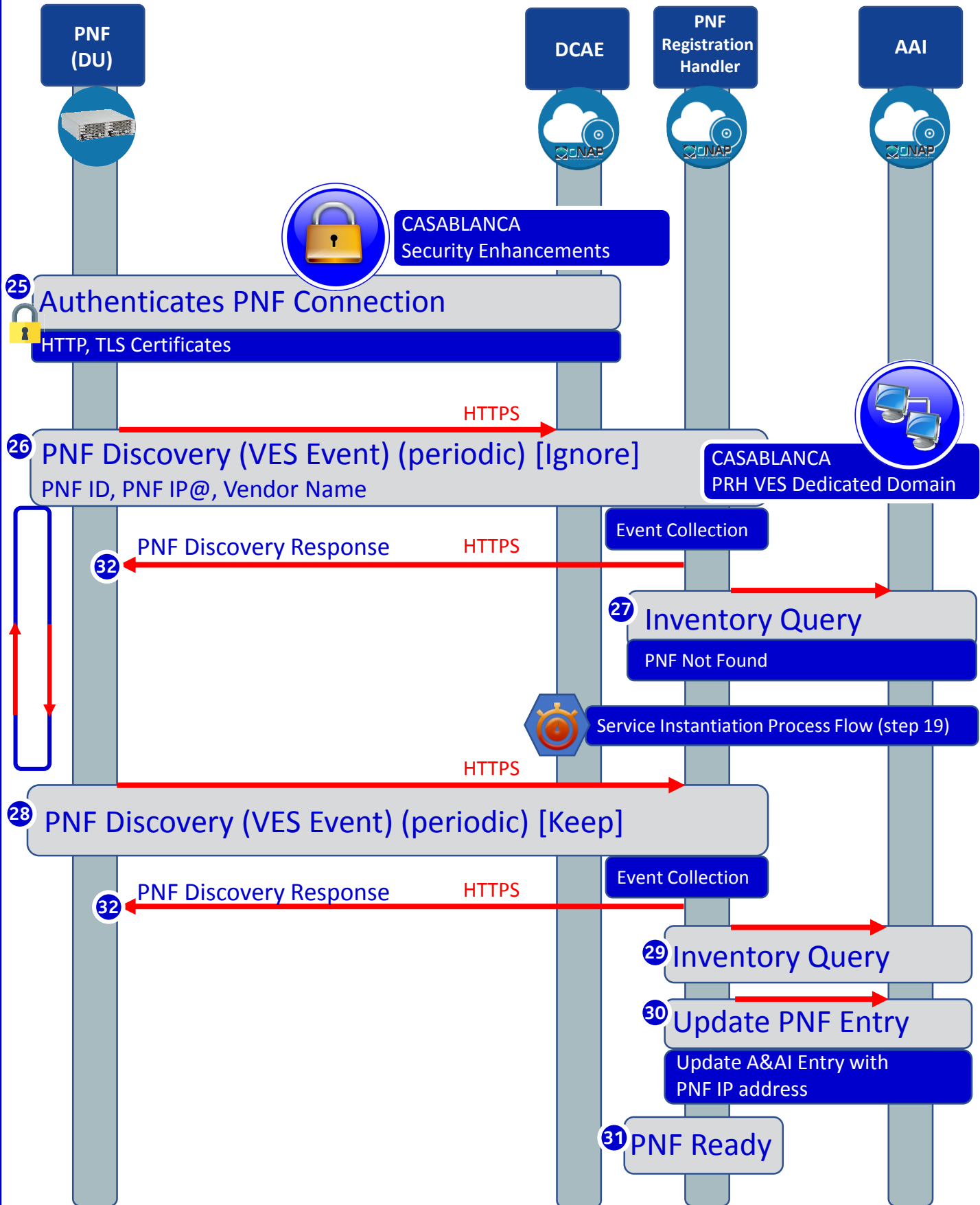


PROJECTS

SO

| # | DESCRIPTION |
|----|---|
| 15 | WORK ORDER – The work order (AT&T work order process) determines which PNF to use for this Service/work order. BSS is told the correlation ID. Typically, the PNF will be known before the PNF comes on-line. Orchestrated with a equipment order (to vendor) and location value for the PNF. |
| 16 | SERVICE INSTANTIATION – The user on the VID creates a service instantiation providing a correlation ID. The service is decomposed for a 5G DU PNF. The DU resource types assumes that there is enough information to determine the PNF SDC model. The configuration parameter is provided manually (as part of service instantiation data). |
| 17 | HOMING – The SO instantiation is homed with the OOF. Dependencies stated on PNF. The homing latency constraints are based on CPE address (location). As part of the service definition a latency needs to be less than [x]. This is a service constraint. Homing dependencies should come from SDC or VID. PNF homes to a CU. [FUTURE] Homing identifies the place where a VNF is instantiated. For PNF there is no “cloud” resources needed (CU); ONAP instantiations/data-centers want to define which ONAP instantiation takes care of a PNF [FUTURE]. |
| 18 | RESOURCE LEVEL FLOW (RLF) - The resource level flow thread starts. This thread is responsible for carrying out the creation of an A&AI entry in the following steps (steps 18 through 21). |
| 19 | CHECK A&AI ENTRY – The RLF thread in SO checks the A&AI entry for the PNF. If SO discovers that there is an A&AI entry with both the correlationID and the PNF IP@ then it can continue. If found it can associate it with the service instance. |
| 20 | CREATE A&AI ENTRY – A&AI entry created by SO for PNF using the available information and the correlation ID. This is done in anticipation of the PnP PNF VES event. |
| 21 | CREATE DMaaP TOPIC LISTENER – The RLF thread (process) subscribes to the DMaaP Topic that will complete the service instantiation. It allows ONAP to intercept the VES event that will eventually come from the PNF when it reaches a point in the PNF Plug and Play process that it is ready to contact ONAP. The RLF specific resource thread indicates that it cares about the VES event with this correlation ID. Essentially it activates a “listener” of the PNF VES event. DCAE is the normal VES event Listener which creates a DMaaP Topic. SO saves the state information looks and sees if it is one of the DMaaP topics it is waiting for. |
| 22 | RLF THREAD TERMINATES – The Resource Level Flow (RLF) thread in SO terminates. When the VES event is received at a later point in time, it can be processed accordingly. Additionally, these steps 15-22 prepare ONAP with the pre-requisite information so that when the VES event comes from the PNF it will not be discarded. This is denoted by stopwatch icon  . At a later step in the PNF Plug and Play this thread becomes relevant again at the other stopwatch icon. The RLF thread/process stops processing and wait for an asynchronous event (to avoid a long running event). Writes a process, kamunda handler for an event that rehydrates it. (this reuses the SO rainy day handling) |

PNF Registration Steps



PRH Enhancements

DESCRIPTION

PNF Registration Handler (PRH) Enhancements.

(1) New VES Event domain for PNF Registration

– Create new VES event domain for PNF registration with corresponding support in VES collector, DMaaP and PRH. PnP Use case was using the “other” domain to register VES events. For Casablanca, we propose using a dedicated domain. VES separation of events. VES agent update in PNF.

(2) VES EXTENSIONS - As a result, VES collector and VES agent content will change with field updates using the new domain. Extensions for PNF registration fields. Corresponding VES Schema change (requires approval and coordination from ONAP community).

(3) PNF REGISTRATION EXCHANGE UPDATE –

The registration VES event used by the DU Simulator (or actual PNF) will need to update its JSON payload to match the changes above.



PROJECTS

PNF Registration Handler, DMaaP, DCAE

SECURITY ENHANCEMENTS


DESCRIPTION

- (1) PNF AUTHENTICATION** – DCAE must authenticate the HTTP/TLS connection from the PNF. DCAE to integrate the HTTP and TLS authentication functionality by AAF.
- (2) VENDOR CERTIFICATES** – Handling Vendor Certificates for TLS/SSH for PNFs.
- (3) USER NAME & PASSWORDS** – Provisioning. DCAE & PNF management of *User Name & Passwords*.
- (4) SECURITY BETWEEN COMPONENTS** – DMaaP & PRH to authenticate w/ other ONAP components.

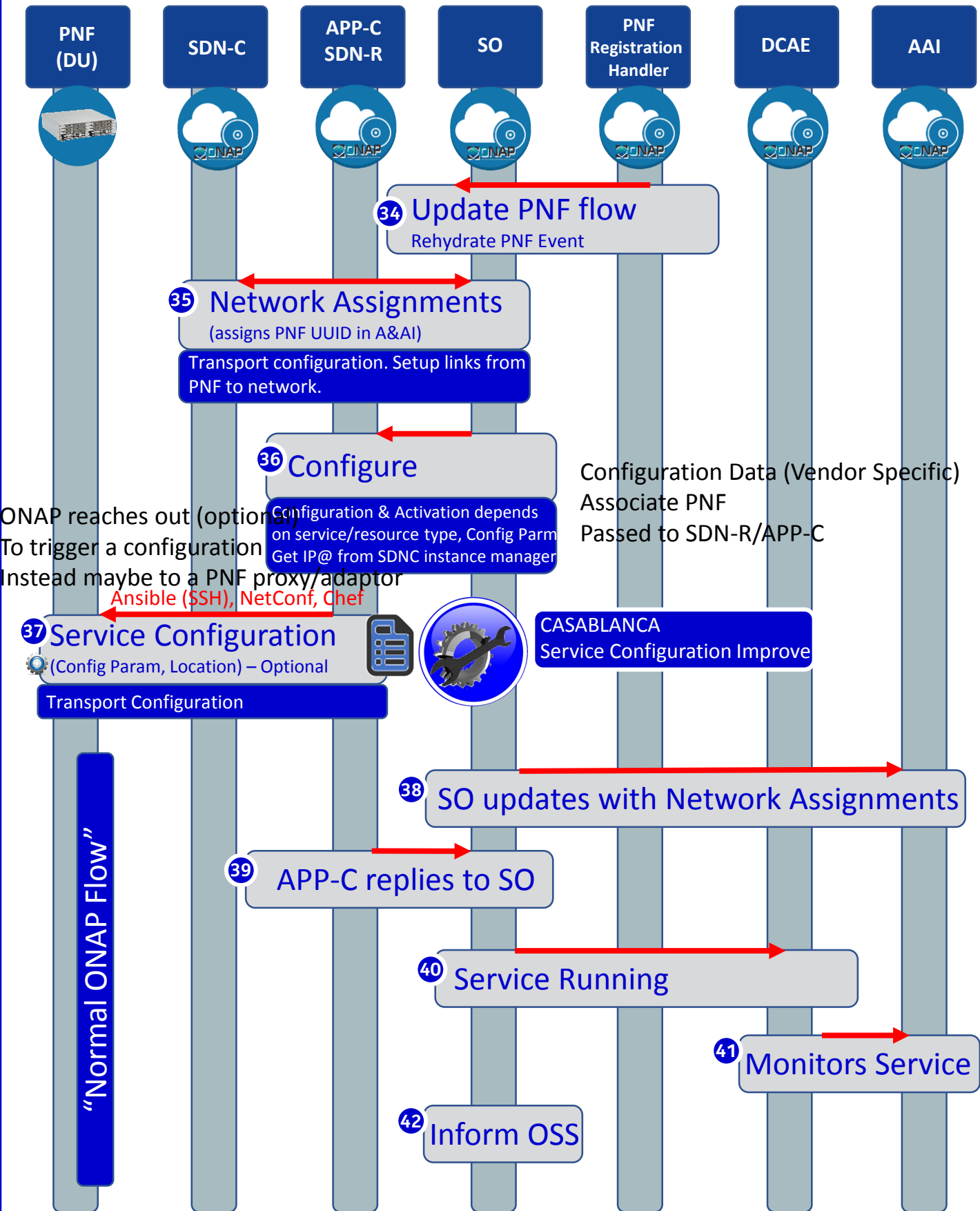


PROJECTS

PNF Registration Handler, DCAE, AAF,
ONAP Controller, DMaaP

| STEP | DESCRIPTION |
|---------|---|
| 23 | DHCP Request –ONAP Onboarding S/W performs a DHCP procedure with vDHCP |
| 24 | DHCP Response – DHCP response returns a ONAP IP address |
| 25 | Authenticate PNF – The PNF is authenticated through a vAAA. |
| 26 & 28 | PNF DISCOVERY – The PNF periodically generates a VES Event (json schema extend for discovery event) to DCAE which is the “triggering” event that tells ONAP that the PNF is trying to register. This event contains the Correlation ID (PNF ID), which will serve as an identifying key within A&AI to seek for that particular PNF instance. The event also contains the PNF OAM IP address and the vendor name. PNF sends the Event over an HTTPS connection which may be authenticated with a username and password. The Event is “standardized” and is the same for all hardware (PNF) irrespective of equipment vendor, thus there needs to be ONAP compliant software. The PNF must natively support or have an adapter to be ONAP capable. Note [FUTURE]: A (new) “ <i>PNF Infrastructure Manager</i> ” may evolve in the future to include other management functions, as there may be a need for an entity that owns the interactions with device interactions w.r.t. ONAP. Management of devices vs containers. I/F manages & consumes services. VIM/Multi-Cloud. Multi-VIM PNF plugin. Multi-VIM would call the PNF infrastructure manager. |
| 27 & 29 | INVENTORY QUERY – PNF Registration Handler performs an inventory Query to A&AI using the Correlation ID (based on the PNF ID) as the key. The AAI instance for this PNF ID must have already been created. If it has, then this is a valid, expected PNF. If not, then this is not a valid or not found a response is given to the PNF. In Step 32, PNF A&AI entry is found. |
| 30 | UPDATE PNF ENTRY IN AAI – The PNF entry in AAI is updated with the PNF IP address. After this step, the PNF is considered to be active in ONAP and becomes available as an network element to fulfill service requests. |
| 31 | PNF READY - PRH publishes a PNF Ready event on the DMaaP bus to which SO subscribes. SO receives the PNF Ready event, determines that it is an event it is waiting for and rehydrates the appropriate RLF to restart the Service Instantiation |
| (15-22) | SERVICE INSTANTIATION PROCESS (PART 1) – Steps 15-22, the Service Instantiation Process (part 1) occurs in parallel to these steps. When that process reaches the pending point (denoted by ) it rejoins the flow here. PNF previously declared. |
| 32 | PNF DISCOVERY RESPONSE - The PRH responds to the PNF discovery event of the PNF with a response. |

PNF Activation Steps (ONAP)



SERVICE CONFIGURATION ENHANCEMENT

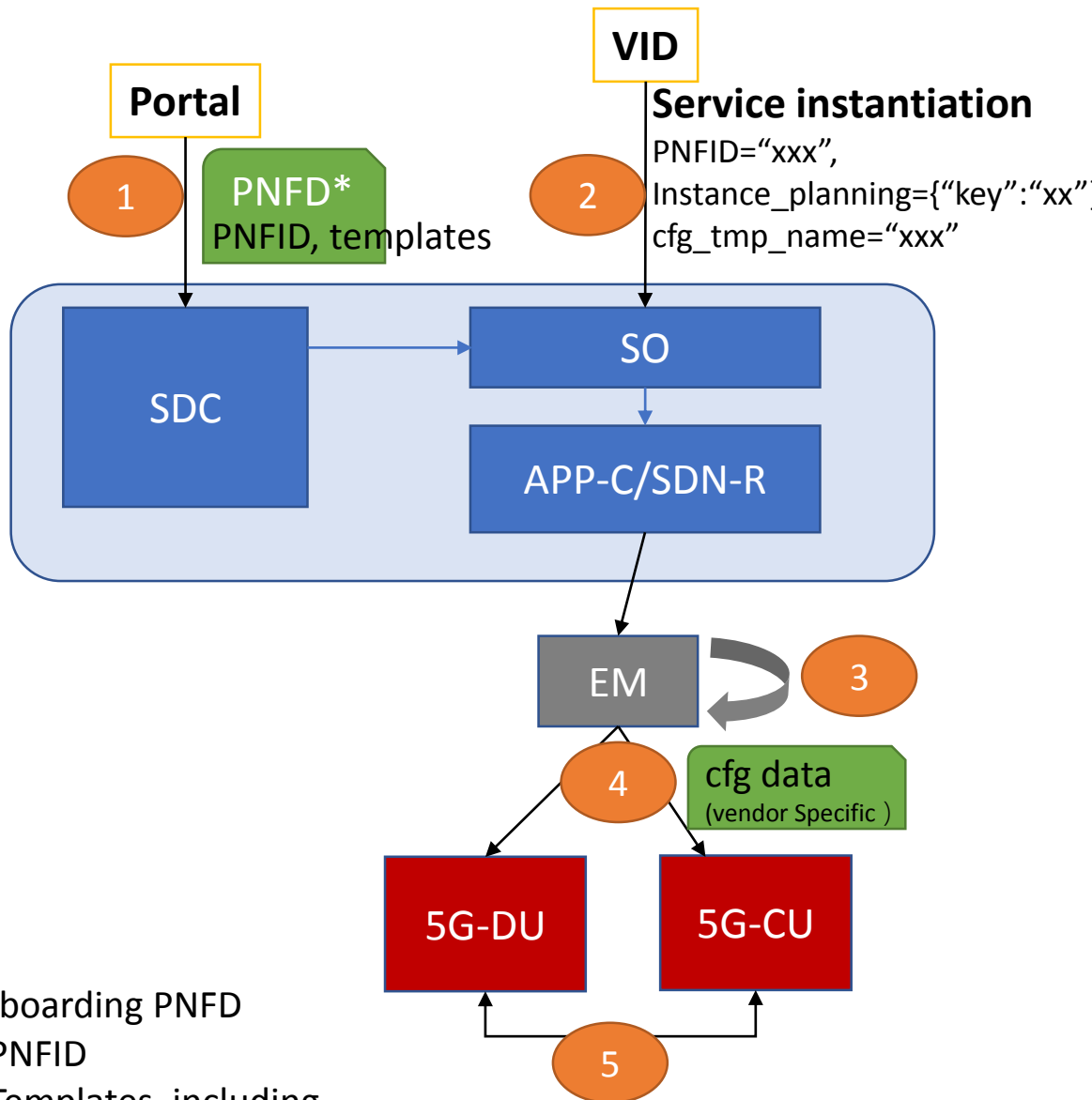
DESCRIPTION

- (1) Service configuration Enhancements** to ONAP Controller to PNF *service configuration* exchange with PNF.
- (2) PROTOCOL DEFINITION** – Framework for how SDN-R will support NetConf, Ansible, Chef. All 3 are expected to be supported with PNFs. How is the protocol agreement done?
- (3) Configuration Extensions** – New parameters needed for Casablanca use cases. Vid script to pushing data, ID config, ID where data comes from. Generic configuration support.
- (4) PNF PnP Config** – Finishing PNF PnP by sending down config data.
- (5) (OPTIONAL) Vendor Data** – Extensions to Service Configuration with Vendor specific configuration data can be developed (vendor dependent).



PROJECTS

ONAP Controller (SDN-R), VID, SO,
SDC/CDT



Design time

- (1) Onboarding PNFD
 - PNFID
 - Templates, including PNF/VNF templates,
 - Configuration templates

Run time

- (2) service instantiation
- (3) generate configuration data
- (4) configure PNF/VNF via EM
- (5) CU-DU inter-connect

| STEP | DESCRIPTION |
|------|---|
| 34 | SO NOTIFIED - PNF Infrastructure Manager Notifies SO. SO listens to the DMaaP hook. A trigger. Wait for PNF onboarded. Calls SDN-C. |
| 35 | NETWORK ASSIGNMENTS – SDN-C assigns an IP Address for PNF. The IP @ assigned to the PNF is drawn either from the DHCP server, IP address Pool, or a Static IP@. Managing physical/virtual links to PNF. Between CU & DU. Transport connectivity setup. SDNC makes assignments, the resource model have external/internal connection points (named). For each point, attributes say L1/L2 connection. If L3 who assigns the IP address. Each point, SDNC knows if and what to assign. Set either through SDNC (L0-L3) or APP-C (L4-L7). Driven by TOSCA Model. |
| 36 | ACTIVATE – Configuration & Activation of the PNF Depends on the resource type. The controller requires input data based on PNF type. Either VF-C or APP-C orchestrate with SO. The IP@ is retrieved SDNC instance manager for PNF and the DHCP server may be updated. Pass on configuration parameter(s). (Future) retrieve VNF a configuration parameter. |
| 37 | <p>SERVICE CONFIGURATION – APP-C calls Ansible to configure PNF’s (Configuration Parameter) NetConf messages from SDN-C to PNF.</p> <p>(1) Configuration Parameter (mandatory) - VF-C/APP-C gives the Controller IP@ to the DU. In R2 for the 5G DU, this will also give a configuration parameter (e.g. CU IP@) which will allow the DU to contact the CU to be configured for service. Eventually when the DU is managed directly from ONAP, this would be the APP-C, SDN-C or VF-C IP@ as appropriate.</p> <p>(2) OAM IP@ (optional) - The permanent OAM IP address is given to the PNF. The PNF would receive this IP address and use it. The IP address assigned from SDN-C may come from the vAAA, or it may draw from a local pool of IP addresses. SDN-C performs the IP address selection. It knows if a permanent IP address should be assigned to the PNF. Note: this IP@ assignment <i>optional</i>.</p> <p>(3) Transport configuration (optional) – Transport configuration is given to the PNF.</p> <p>(4) Location – the Location configuration is given to the PNF.</p> <p>http://onap.readthedocs.io/en/latest/submodules/appc.git/docs/APPC%20LCM%20API%20Guide/APPC%20LCM%20API%20Guide.html</p> |
| 38 | SDN-C Updates A&AI – SO updates A&AI with Network Assignments (from step 35) |
| 39 | SDN-C replies to SO – SDN-C replies to SO are the service configuration step. |
| 40 | Service Running – SO publishes a “Service running” event to which DCAE subscribes. |
| 41 | Monitors Service - DCAE reads A&AI entry and sets up monitoring for the new service. DCAE publishes “Service monitored” event to which SO subscribes. For monitoring events, the DU will be managed by the CU (in the FUTURE an M-Plane will be setup to ONAP to DU |

PNF Final Download & Activation (Vendor Specific)

PNF (DU)



EM CU (VNF)



Step 37a
S/W download




42 Connection to Controller (DU or EM contacts CU)

43 PNF configured

Before CU/DU Split

44 DU Restart

45 Ready for Service

| STEP | DESCRIPTION |
|---|---|
| 42  | <p>CONNECTION TO CONTROLLER – Using the CU IP@ from the previous step, the DU makes contact with the CU. If the CU cannot be reached, the DU shall periodically retry.</p> <p>Note: The CU has already been previously deployed and “plug & play” onboarded procedure before the DU wants to register. This is outside the scope of this use case.</p> <p>Note: After the 3GPP CU/DU split, the signaling interfaces between the gNB CU and DU will be standardized by 3GPP RAN3 (which supports that ability to mix CU and DU PNFs from different vendors).</p> |
| 44  | <p>CU CONFIGURES DU – The configuration information is downloaded to the DU. This information provides operational configurations and settings which are vital for service. They would be pre-provisioned and allow the PNF to operate with specified configurations, optimizations, RF settings, connectivity, and L1/L2 algorithmic settings.</p> |
| 45  | <p>DU RESTART – The PNF (DU) is reset, which allows the new configuration parameters to take hold. And the DU is ready to provide service using the configuration provided to it. Typically, a test call is performed to verify service is working end-to-end.</p> |

VNF vs PNF Comparison

| TOPIC | VNF | PNF |
|---|--|--|
| Concept | Application fulfills the role of a network function. | It is a network element, a physical entity, which can implement the role of a network function. |
| Physical Characteristic | Application without dedicated hardware; Virtualized applications require specific capabilities; Run on different vendor servers. SRIOV, Inter-DPDK. Hardware capabilities. | Has an actual physical asset that is deployed and associated directly with the PNF. |
| On-boarding | To onboard a VNF is to “bring it into ONAP” i.e. the VNF images, component VNF-C provide descriptors of these NFs. Deployment model, # components, functions. Configuration parameters. VNF is not tied or optimized for a specific hardware, only requiring perhaps some capability to be supported. | For PNF provide the descriptors. Only provide the meta-data. PNF S/W specifically optimized to run on dedicated hardware. (Now) Not the software image. (Future) ONAP will provide the software image repository. |
| Plug and Play | The model triggers the orchestration. | (See this slide package for PNF Plug and Play) at the end of PnP the PNF can provide service. |
| Characteristics | 5G CU could be a VNF since there is no need to have an association to a physical environment. | 5G DU must be PNF. PNFs are Elements which may need to interact with the physical environment. PNF is “High-Touch” technology. E.g. Emit radio waves in a geographical area. |
| Configurability & Deployment | Easily adaptable to functions that you expect. E.g. Packet gateway to reconfigure as different NFs. Services easily create instances reconfigures including deployments (for different applications). Use a different instances of the VNF to provide a new service. For a VNF you can easily “delete” and “create” a new VNF to perform a new function. Configured dynamically. | PNF has a “fixed” set of capabilities but can’t easily reconfigure it. One PNF in multiple services. Different capabilities exposed by the PNF. Reuse the same PNF with different services configuration. For a PNF you would not “destroy” a PNF but rather re-configure it. Can be configured dynamically. |
| ONAP Interaction | ONAP is started with VNF. VNF is “deployed” on-demand. Control from the ONAP perspective when a deployment of a VNF happens. DCAE – same Configure – Chef, Ansible | PNF do not “deploy” application. Do not use multi-VIM. Only “configure” the application, the PNF is deployed. A technician goes to site and “deploys” a PNF. DCAE – same Configure –Implementation of PNF client. Communication protocol, Client |
| Design Time Modeling | Model VNF. Templates. Onboarded before. In Run-time. Make sure properly identify specific PNF instance already deployed. Vs a dynamically created instances. VNF instances could be created & instantiated dynamically. SDC may assumed instantiation of network function. | PNF cannot be instantiated, a PNF is only instantiated when it “powers up” and connects to ONAP. Service Orchestration. PNF is instantiated by nature of a PNF installation & commission procedure. |
| Service Orchestration | VNF cloud, #VM resources consumption, define components implement different functions. Where & What will be deployed. | Physical location, pre-provisioned capabilities, performance monitoring. Components installed. RUs for specific functions. |
| Resources | VNF dynamically assigned resources. | PNF statically associated (hardware) resources. |
| Capacity | VNF Capacity can be dynamically changed | PNF is static (number of cells supported) |



PNF Plug and Play Project Impacts

- ONAP and PNF Plug and Play for 5G RAN
- 5G Use Case Team

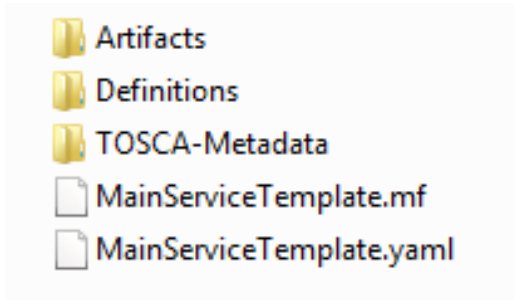
PROJECT IMPACTS FROM ONBOARDING

| ONAP Project | IMPACT |
|-------------------------------------|---|
| SDC/ Modeling | Modeling Project - (No License management impact – See Futures Section) [See follow-on Slides “MODELING”] |
| VNF-SDK (PNF-SDK) Validation | <p><u>PNF PACKAGE DEFINITION</u></p> <p>PNF packages similar to VNF packages. PNF Descriptors, artifacts. In PNF not doing deployment process in SDC. Only PNF configuration. Model a PNF. Onboard PNFs (create templates service configuration). Orchestrate a service on a PNF. Service provisioning. Life cycle: Template/service orchestrated. For PNF every PNF vendor makes this package. Need specific PNF properties. Image details. ONAP updates the image.</p> <p><u>VALIDATION OF A SDK PACKAGE</u></p> <p>VNF-SDK (validation, Package definition, verification tool) – package compliant. Allows creation/validation of packages. PNF-SDK <i>validates</i> the package.</p> |
| WORK FLOW (SDC) | Create work-flow for PNF (Srini) SDC Impacts related to work-flow. ACTION: Sample Work-flow for PNF. |
| MONITORING (SDC) | <p>Monitoring definitions – SDC has a side monitoring template designer. Way to define monitoring alarms etc; In AT&T there is a project; IN ONAP code is there finalizing code; pluggable modeler for monitoring. DCAE as part of onboarding specify what VES template. DCAD define microservices for monitoring. How is PNF monitored & correlated. If [x] goes down how is this correlated. SDC would define the Modeling what needs to be monitored and how they would correlated with other events from other NE. Thresholds. [Baby step to process get an alarm from PNF, YAML file describes fault VES event, Fault meta-data; alarms generate].</p> <p>Alarms raises are documented in SDC. Upload an “Artifact” file (Alarm Dictionary / Fault Meta-data / YAML, YANG). Vendor Specific. Demo and separate discussion.</p> <p>How monitored – processing in DCAE-D (Design time). Based on design time data DCAE is done in.</p> |

MODELING IMPACTS

PNF has no onboarding package.

Just model the PNF from the modeling screens.



CSAR – decompile info stored in SDC model.

In VNF flow. Onboard the VNF. VNF cataloged as a version to be used. Check-in/check-out. After onboarding can add more artifacts and certify the VNF. A “building block” to be used in different services. Generic, the structure will be the same. E.g. 2000 ports vs 10 ports. “Ports”. How to comm w/ PNF what to do w/ PNF. Specific work-flow or configuration. PNF & VNF similar. SO will orchestrate, already exists in ecosystem.

ARTIFACTS

DEFINITIONS

PNF – 5G Base Stations

Backhaul Ports – PNF & VNF and want to communicate. In a VNF can describe a port a TOSCA. Model onboarded understand what can connect to what. CP connections. Can see they can connect. Model needs to capture info for modeling parts representing connections. Model allow someone designing service to connections. Or requirements from VNF/PNF from the model. A virtual link. One VNF & PNF connected via virtual network/link.

PNF Work-flows – initialization, triggered when connecting to PNF. Configuration/registration that needs to be done. DNS pre-loaded. Location. Policies attached to PNF, High volume # of PNF deployments, port-allocation. *Capabilities. Triggered by orchestrator as part of the instantiation.*

PNF Policies -

Tilt – (Antenna Tilt - RF) – not related to PNF / VNF communicate.

Modeling Project, VNF-SDK (validation, Package definition, verification tool) – package compliant

PROJECT IMPACTS FROM ONBOARDING

| ONAP Project | IMPACT |
|--------------------------|--|
| Management Design | (After modeling, and instantiation) “in the middle” Policy Design changes? (check w/ Policy Project) CDT (APPC) - Networking Design – SDN-C design tool for networking design. Creates Yang files. Config Design |
| VID | |

PNF REGISTRATION HANDLER IMPACTS

PNF Registration Handler (PRH) Project Impacts

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ACTIVE INVENTORY (A&AI) IMPACTS

ACTIVE & AVAILABLE INVENTORY (A&AI) PROJECT IMPACTS

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DCAE IMPACTS

DCAE PROJECT IMPACTS

**Security
Validation**

Authenticate Connection

MONITORING

Monitoring definitions – SDC has a side monitoring template designer. Way to define monitoring alarms etc; In AT&T there is a project; IN ONAP code is there finalizing code; pluggable modeler for monitoring. DCAE as part of onboarding specify what VES template. DCAD define microservices for monitoring. How is PNF monitored & correlated. If [x] goes down how is this correlated. SDC would define the Modeling what needs to be monitored and how they would correlated with other events from other NE. Thresholds. [Baby step to process get an alarm from PNF, YAML file describes fault VES event, Fault meta-data; alarms generate].

SDN-R (Controller) IMPACTS [APP-C]

SDN-R APP-C PROJECT IMPACTS



CC-SDK (SDN-R)

Artifacts from CC-SDK, APP-C

Mobility controller

Artifacts “borrowed” will become part of CC-SDK

Available for all controller persona.

QUESTION: moving towards CC-SDK & common foundation is there anything

On top of that planned for SDN-R.

Some thing specific to wireless, ... perhaps they do not belong in CC-SDK.

Things borrowed from CC-SDK and libraries that are common.

SERVICE ORCHESTRATOR (SO) IMPACTS

SERVICE ORCHESTRATOR (SO) PROJECT IMPACTS

**WORK FLOW
(SO
executor)**

Create work-flow for PNF (Srini)
For configuration for SO





PNF Plug and Play INTEGRATION & SHOWCASING

- ONAP and PNF Plug and Play for 5G RAN
- 5G Use Case Team

INTEGRATION TEAM IMPACTS

INTEGRATION TEAM IMPACTS

SHOWCASING

DEMO CONTENT – [Closed] What will be **showcased**? Test send registration event. Instantiation Pt1/Pt2 (Update A&AI). PRH service request (VES event & DMaaP topic). APP-C Ansible configure. PNF sends event, receives ansible event. Start with R1 use case (VoLTE / vCPE) upgraded w/ mechanisms of R2. DU Emulator (for registration).

ACTUAL PNF, DU Emulator

DU EMULATOR – [Closed] Nokia will provide a simple DU emulator [Mar 16 2018]. Capable of sending PNF registration request (Step 26, 28). Capable of receive configuration command from APP-C via Ansible (Step 37) and recording result of successful reception (or failure) in a log.

Test Case Description (Demo Document) [Open Point]

(1) **Demo Document** – Document describing demo (use case group?) <https://wiki.onap.org/display/DW/vCPE+Use+Case+Tutorial%3A+Design+and+Deploy+based+on+ONAP+Amsterdam+Release>
 (2) **Test case description** – Documenting the test case. Start with VoltE and modify it.

LOGISTICS (Open Point)

(1) **DEMO ANNOUNCEMENT** – “come see this demo” – Integration ONAP Wiki. Video. Schedule ONAP Wiki Events Calendar. Integration project. (SME = x).
 (2) **LOGISTICS** – *Contacts* Helen Chen, Yang Xu. Intel Windriver Lab, T-Lab (AT&T Lab, Bedminster), and/or use CMCC Lab. ONAP “Open Lab”. ONAP installed in a lab. Demo shown via conference. Virtual Demo (dial in).
 (3) **RELEASE MANAGER** – Coordinate w/ Joe Gildas. Joe Gildas release manager (status of project). M4 Voting.

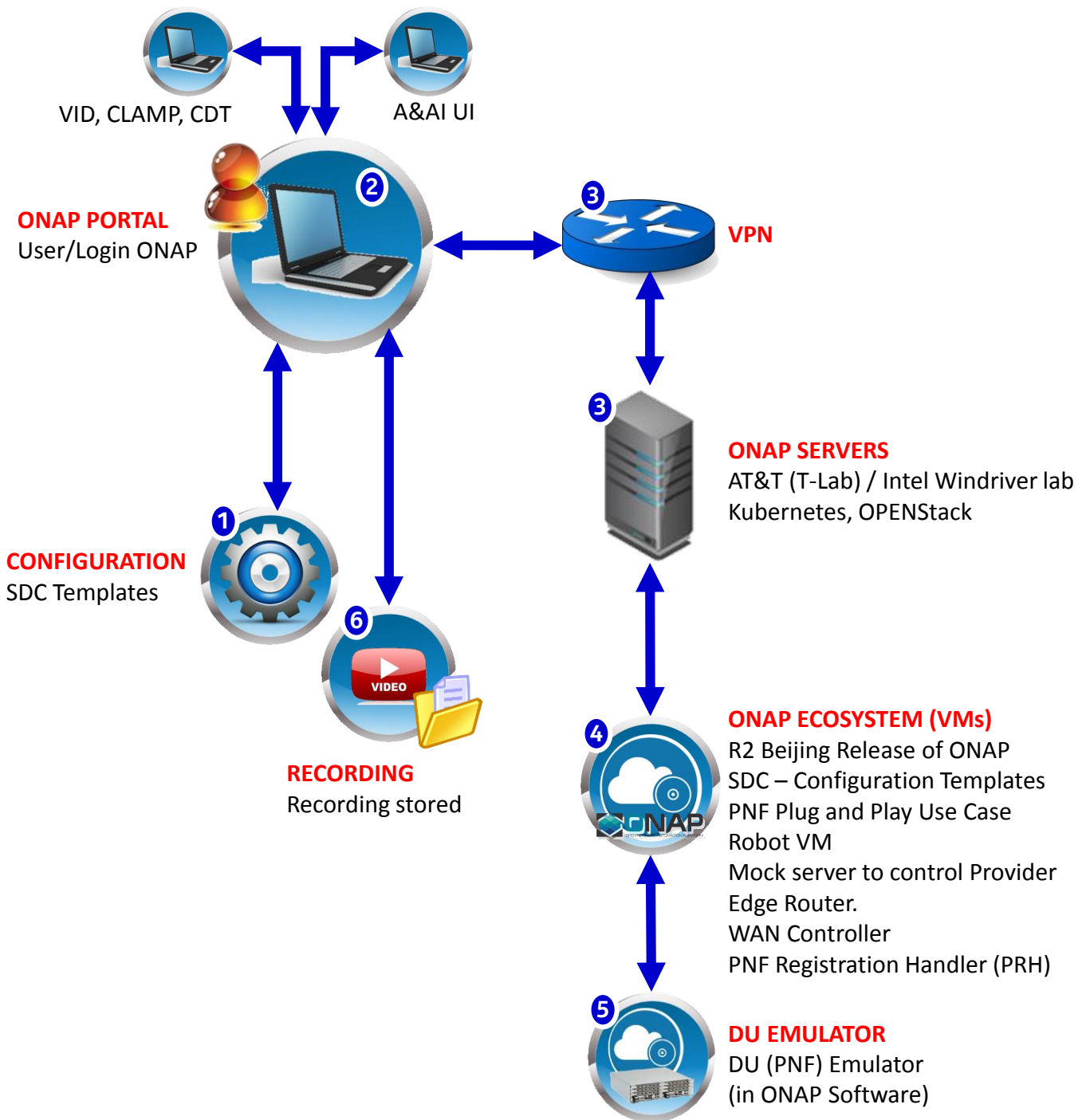
AUTHENTICAT ION

AUTHENTICATION – Authentication is optional, and for R2 Demo we will not have any authentication. Could be considered for Casablanca (R3). Amsterdam authentication flow not useful for PNFs. Not use second vDHCP & vAAA.

CONTROLLER CONFIGURATI ON

CONFIGURATION: IP address (from DHCP). Username & Password. Configured in controller (manually added to ONAP). VES configuration (do not need username & password to be configured on VES)

DEMO ARCHITECTURE



| STEP | DESCRIPTION |
|------|--|
| 1 | <p>CONFIGURATION – SDC Design templates need to be configured in preparation of the Demo & Showcasing. The appropriate PNF and VNF designs are designed, validated and exported to the other components of ONAP.</p> |
| 2 | <p>PORTAL & GUIS – The ONAP Portal is used to access the appropriate GUIs and interfaces necessary to operate and configure ONAP. The VID and CLMAP GUI are used to configure the appropriate information for the showcase. The A&AI GUI are used to show the created entries in A&AI for the PNF.</p> |
| 3 | <p>VPN – The appropriate security gateways and/or VPN networks are configured. The appropriate security setups are authenticated against. Passwords and IP addresses that are needed to connect to the ONAP servers go through this VPN or security gateway (as appropriate)</p> <p>ONAP SERVERS – The ONAP Servers that host the ONAP ecosystem are connected to</p> |
| 4 | <p>ONAP ECOSYSTEM (VM) – The ONAP ecosystem has all of the appropriate Virtual Machines necessary to operate. This has the R2 Beijing Release of ONAP. All of the PNF Plug and Play Use Case updated software is available in the ONAP Ecosystem. The Robot VM, Mock server to control Provider Edge Router, and WAN Controller are established.</p> <p>The PNF Registration Handler a new DCAE plug-in are available in this ONAP ecosystem which is used to register the PNF into ONAP.</p> |
| 5 | <p>DU EMULATOR – The DU Emulator is used to emulate the responses and connection to ONAP. The DU emulator establishes a VES HTTPS connection with the PRH during the registration process and receives a APP-C response back via ansible.</p> |
| 6 | <p>RECORDING – A recording is made of the showcase and demo for later upload/download and playback for demonstration purposes.</p> |



PNF Plug and Play ROADMAP (After Casablanca)

- ONAP and PNF Plug and Play for 5G RAN
- 5G Use Case Team

FUTURE FUNCTIONS

| ONAP Project | IMPACT |
|-----------------------------|--|
| Licensing Management | Licensing Impact – meta-data managing licensing. PNF (DU#55) – Service on DU (5G) [feature xyz] Licensing Management (FUTURE) |
| | |
| | |
| | |



APPENDIX & Meeting Notes



DISCUSSION MAY 03, 2018

SDN-R supports all 3

CC-SDK controller

Should support all 3

How does that get implemented

PNF agnostic/future-proof

PNFs will support one

ADAPTORS/MEDIATORS

Adaptor – No adaptor

PNF talks directly to ONAP

Adap/transl/mediators

For embedded base.

5G “going native”

PNF – Descriptor

Protocols supports

PNF Package defines

The Meta-models Tbsupported

mm microwave PNF unchanged

ID PNF

PNF #62

SDN-C
UUID

PNF #62

A&AI

Mac Address
IP Address

Correlation ID
(UUID)
PNF #62

Gets Assigned a UUID

Just like any VNFID

From then on processes of ONAP

Work on UUID

CorrelationID is no longer used.

UUID assigned by SDN-C (rules how UUIDs assigned)