SolCon Guide

Version 0.0

Summary

This document outlines how to use the TOSCA (SOL001) to SOL006 converter, known as SolCon.

Introduction

An external tool to convert TOSCA YAML files to SOL006 JSON files that can then be load merged into NCS in rel3 with the SOL6 VNFD model.

Downloads: https://stash.tail-f.com/users/aasteele/repos/nfvo-converter-tosca-sol6/browse/builds

Installing Compiled Binary

Step 1

Download the most recent version of solcon for your operating system (either Mac or Linux) from the above download link.

Note: For the example commands we are going to download solcon-OSX-0.6. Substitute the "-OSX-0.6" for whatever OS and version you have downloaded.

Step 2

Ensure the executable is runnable

```
chmod +x solcon-OSX-0.6
```

The program is now installed.

Step 3

Ensure the input and configuration files are present:

- Input files are TOSCA specified YAML files, such as altiostar_vCU.yaml
- Configuration files are in TOML format
  - TOSCA configuration for ESC VNFDs: config-esc.toml
  - SOL6 output configuration: config-sol6.toml

Note: The configuration files determine how the YAML VNFD is read, and also how the JSON SOL6 VNFD is outputted. config-esc.toml specifies how the TOSCA YAML file is read, and config-sol6.toml specifies exactly how the data is output. There is no need to change these files by default.

Step 4

Run the compiled program. The argument "-o output_altiostar.json" determines where the output JSON file is located and what it is named.

```
./solcon-OSX-0.6 -f altiostar_vCU.yaml -o output_altiostar.json -c config-esc.toml -s config-sol6.toml
```

Note: If the program does not run for some reason with the frozen package, try downloading and running from the source code (instructions below.)

Step 5

Load merging JSON into NCS can be done, but it's slightly more complicated than normal load merging via CLI.

Instead of entering NCS, run the following command

```
ncs_load -lm -F o altiostar_vCU.json
```

- -lm stands for load merge
- -F is the format
- o is the flag for JSON format

If the file to be load merged is not properly formatted, or is missing some required fields, the ncs_load program will give the same error message as load merging from inside NCS.

Installing + Running from Source

Step 1: Installing pre-requisites/dependencies

Download and install Python3 based on your OS. Once python3 is installed, run tool/setup-script.sh:

```
sh tools/setup-script.sh
```

This will install the following python packages

- PyYAML
- toml

Step 2: Setup PYTHONPATH variable

Running without a bash script requires that with every unique terminal instance, the following command be run from inside the repository directory

```
PYTHONPATH=python/nfvo_solcon_tosca
```

This can be automated by using a bash script (check the bottom of this document to see how.)

Step 3: Running the program

Run the program with the following command

```
python3 solcon.py -f altiostar_vCU.yaml -o output_altiostar.json -c config-esc.toml
-s config-sol6.toml
```

Step 4: Load merging output

Load merging JSON into NCS can be done, but it's slightly more complicated than normal load merging via CLI.

Instead of entering NCS, run the following command:

```
ncs_load -lm -F o altiostar_vCU.json
```

- -lm stands for load merge
- -F is the format
- o is the flag for JSON format

If the file to be load merged is not properly formatted, or is missing some required fields, the ncs_load program will give the same error message as load merging from inside NCS.

Troubleshooting and Diagnostics

All log messages are captured in a file in the folder 'logs/' for review after the program has been run.

Running the program with log-level set to debug will provide considerably more information than running in "info" mode.

```
./solcon-OSX-0.6 (...) --log-level DEBUG
```

Automating PYTHONPATH Variable

A bash script can be created with the following contents:

```
#!/usr/bin/env bash
export PYTHONPATH=python/nfvo_solcon_tosca

python3 solcon.py -f altiostar_vCU.yaml -o output_altiostar.json -c config-esc.toml -s config-sol6.toml
```

This will set the PYTHONPATH and run the program at the same time.

A. Sources

https://stash.tail-f.com/users/aasteele/repos/nfvo-converter-tosca-sol6/browse

B. ESC TOML Config File

```
# These must match with 'provider-identifiers.{}'
# If the given provider for a VNFD matches with one of these, then it will automatically
# take the identifiers from this file
providers=["cisco"]

version = "0.1.0"

# All of the identifiers must be the same for all instances of that object,
# multiple IDs for a single type are not supported
[provider_identifiers.cisco]
    vdu                     = ["type", "cisco.nodes.nfv.Vdu.Compute"]
    int_cpd                 = ["type", "cisco.nodes.nfv.VduCp"]
    int_cpd_mgmt            = ["type", "cisco.nodes.nfv.VduCp"]
```

```
    instantiation_level     = ["type", "tosca.policies.nfv.VduInstantiationLevels"]
    scaling_aspects         = ["type", "tosca.policies.nfv.ScalingAspects"]
    scaling_aspects_deltas   = ["type", "tosca.policies.nfv.VduScalingAspectDeltas"]
    virtual_storage         = ["type", "cisco.nodes.nfv.Vdu.VirtualBlockStorage"]
    security_group          = ["type", "cisco.policies.nfv.SecurityGroupRule"]
    anti_affinity_rule      = ["type", "tosca.policies.nfv.AntiAffinityRule"]
    affinity_rule           = ["type", "tosca.policies.nfv.AffinityRule"]
    placement_group         = ["type", "tosca.groups.nfv.PlacementGroup"]

# Note: If there is a variable with "path_VAL", that means it will not be parsed for the path
# heirarchy, but will instead just be set with the value
# The structure of the TOSCA file, in paths
[tosca]
    topology_template       = "topology_template"
    node_templates          = ["topology_template", "node_templates"]
    substitution_map        = ["topology_template", "substitution_mappings"]
    substitution_req        = ["substitution_map", "requirements"]
    policies                = ["topology_template", "policies"]
    groups                  = ["topology_template", "groups"]
    inputs                  = ["topology_template", "inputs"]
    desc                    = "description"
    input_key               = "get_input"

    # ** VNF Metadata **
    vnf                     = ["node_templates", "vnf"]
    vnf_prop                = ["vnf", "properties"]
    vnf_desc_id             = ["vnf_prop", "descriptor_id"]
    vnf_desc_ver            = ["vnf_prop", "descriptor_version"]
    vnf_provider            = ["vnf_prop", "provider"]
    vnf_product_name        = ["vnf_prop", "product_name"]
    vnf_software_ver        = ["vnf_prop", "software_version"]
    vnf_product_info_name   = ["vnf_prop", "product_info_name"]
    vnf_vnfm_info           = ["vnf_prop", "vnfm_info"]
    vnf_conf_props          = ["vnf_prop", "configurable_properties"]
    vnf_conf_autoheal       = ["vnf_conf_props", "is_autoheal_enabled"]
    vnf_conf_autoscale      = ["vnf_conf_props", "is_autoscale_enabled"]
    vnf_lcm_conf            = ["vnf_prop", "lcm_operations_configuration"]
    vnf_lcm_heal            = ["vnf_lcm_conf", "heal"]
    vnf_lcm_heal_item       = ["vnf_lcm_heal", "{}"]
    # Additional configurable parameters
    vnf_interfaces          = ["vnf", "interfaces"]
    vnf_vnflcm              = ["vnf_interfaces", "Vnflcm"]
    vnf_instantiate         = ["vnf_vnflcm", "instantiate"]
    vnf_inst_inputs         = ["vnf_instantiate", "inputs"]
    vnf_additional_param_list= ["vnf_inst_inputs", "additional_parameters"]
    vnf_add_parameter       = ["vnf_additional_param_list", "parameters"]
    vnf_add_param_elem      = ["vnf_add_parameter", "{}"]
    # These are the variables that will be taken from parameters_list and put into the sol6 VNFD
    ADD_PARAMS_VAL          = ["BOOTUP_TIME_SF", "BOOTUP_TIME_CF", "CHASSIS_KEY"]

    # ** VDU **
    vdu                     = ["node_templates", "{}"]
    vdu_props               = ["vdu", "properties"]
    vdu_name                = ["vdu_props", "name"]
    vdu_boot                = ["vdu_props", "boot_order"]
    vdu_desc                = ["vdu_props", "description"]
```

```
vdu_conf_props_base     = ["vdu_props", "configurable_properties"]
vdu_conf_props          = ["vdu_conf_props_base", "additional_vnfc_configurable_properties"]

vdu_vim_flavor          = ["vdu_conf_props", "vim_flavor"]
vdu_cap                 = ["vdu", "capabilities"]
vdu_cap_vc              = ["vdu_cap", "virtual_compute"]
vdu_cap_props           = ["vdu_cap_vc", "properties"]
vdu_virt_cpu            = ["vdu_cap_props", "virtual_cpu"]
vdu_virt_cpu_num        = ["vdu_virt_cpu", "num_virtual_cpu"]
vdu_virt_mem            = ["vdu_cap_props", "virtual_memory"]
vdu_virt_mem_size       = ["vdu_virt_mem", "virtual_mem_size"]

vdu_profile             = ["vdu_props", "vdu_profile"]
vdu_prof_inst_min       = ["vdu_profile", "min_number_of_instances"]
vdu_prof_inst_max       = ["vdu_profile", "max_number_of_instances"]

vdu_vendor              = ["vdu_props", "vendor_section"]
vdu_cisco_esc           = ["vdu_vendor", "cisco_esc"]
vdu_day0_list           = ["vdu_cisco_esc", "config_data"]
vdu_day0                = ["vdu_day0_list", "{}"]
vdu_day0_file           = ["vdu_day0", "file"]
vdu_day0_variables      = ["vdu_day0", "variables"]
vdu_day0_variable       = ["vdu_day0_variables", "{}"]

# ** Do not modify **
vdu_day0_custom_id      = ["vdu_day0", "custom_id"]
# ** End **

# ** Internal Connection Points **
int_cpd                 = ["node_templates", "{}"]
int_cpd_props           = ["int_cpd", "properties"]
int_cpd_req             = ["int_cpd", "requirements"]
int_cpd_virt_binding    = ["int_cpd_req", "virtual_binding"]
int_cpd_virt_link       = ["int_cpd_req", "virtual_link"]
int_cpd_layer_prot      = ["int_cpd_props", "layer_protocols"]
int_cpd_allowed_pair    = ["int_cpd_props", "allowed_address_pairs"]
int_cpd_ip_allowed_addr = ["int_cpd_allowed_pair", "ip_address"]
int_cpd_ip_addr         = ["int_cpd_props", "ip_address"]
int_cpd_vl_profile      = ["int_cpd_props", "vl_profile"]
int_cpd_virt_prot_data  = ["int_cpd_vl_profile", "virtual_link_protocol_data"]
int_cpd_l3_data         = ["int_cpd_virt_prot_data", "l3_protocol_data"]
int_cpd_cidr            = ["int_cpd_l3_data", "cidr"]
int_cpd_dhcp            = ["int_cpd_l3_data", "dhcp_enabled"]



virt_storage            = ["node_templates", "{}"]

virt_props              = ["virt_storage", "properties"]
virt_artifacts          = ["virt_storage", "artifacts"]
virt_vsb                = ["virt_props", "virtual_block_storage_data"]
virt_size               = ["virt_vsb", "size_of_storage"]
virt_storage_req        = ["virt_vsb", "vdu_storage_requirements"]
virt_type               = ["virt_storage_req", "type"]

sw_image_data           = ["virt_props", "sw_image_data"]
```

```
sw_name                 = ["sw_image_data", "name"]
sw_version              = ["sw_image_data", "version"]
sw_checksum             = ["sw_image_data", "checksum"]
sw_container_fmt        = ["sw_image_data", "container_format"]
sw_disk_fmt             = ["sw_image_data", "disk_format"]
sw_min_disk             = ["sw_image_data", "min_disk"]
sw_size                 = ["sw_image_data", "size"]
sw_image                = ["virt_artifacts", "sw_image"]
sw_image_file           = ["sw_image", "file"]

# ** Deployment Flavor **
df_id                   = ["vnf_prop", "flavour_id"]
df_desc                 = ["vnf_prop", "flavour_description"]


def_inst_level          = ["policies", "instantiation_levels"]
def_inst_key            = "default"
def_inst_prop           = ["def_inst_level", "properties"]
def_inst_p_levels       = ["def_inst_prop", "levels"]
def_inst_def            = ["def_inst_p_levels", "default"]
def_inst_desc           = ["def_inst_def", "description"] # Matches def_inst_key
inst_level              = ["policies", "{}"]
inst_level_targets      = ["inst_level", "targets"]
inst_level_props        = ["inst_level", "properties"]
inst_level_levels       = ["inst_level_props", "levels"]
inst_level_def          = ["inst_level_levels", "default"]
inst_level_num_instances = ["inst_level_def", "number_of_instances"]

# ** Scaling Aspects **
scaling_aspects         = ["policies", "{}"]
scaling_props           = ["scaling_aspects", "properties"]
scaling_aspect_item_list = ["scaling_props", "aspects"]
scaling_aspect_item     = ["scaling_aspect_item_list", "{}"]
scaling_aspect_name     = ["scaling_aspect_item", "name"]
scaling_aspect_desc     = ["scaling_aspect_item", "description"]
scaling_aspect_level    = ["scaling_aspect_item", "max_scale_level"]
scaling_aspect_deltas   = ["scaling_aspect_item", "step_deltas"]

# For use in the deltas definition block
deltas_aspects          = ["policies", "{}"]
deltas_props            = ["deltas_aspects", "properties"]
deltas_list             = ["deltas_props", "deltas"]
deltas_elem             = ["deltas_list", "{}"]
deltas_num_instances    = ["deltas_elem", "number_of_instances"]
deltas_targets          = ["deltas_aspects", "targets"]
deltas_target           = ["deltas_targets", "{}"]

# ** Security Groups **
security_group          = ["policies", "{}"]
security_group_name     = ["security_group", "group_name"]
security_group_targets  = ["security_group", "targets"]

# ** Affinity/Anti Groups **
affinity_group          = ["policies", "{}"]
affinity_group_props    = ["affinity_group", "properties"]
affinity_group_scope    = ["affinity_group_props", "scope"]
```

```
    affinity_group_targets  = ["affinity_group", "targets"]

    placement_group         = ["groups", "{}"]
    placement_members       = ["placement_group", "members"]

[tosca.input_values]
    VIM_FLAVOR = "VIM_FLAVOR_INPUT"
```

C. SOL6 TOML Config File

```
# Sol6 Path configurations
[sol6]
    # **********
    # ** VNFD **
    # **********
    vnfd                        = "vnfd"
    vnfd_id                     = ["vnfd", "id"]
    vnfd_provider               = ["vnfd", "provider"]
    vnfd_product                = ["vnfd", "product-name"]
    vnfd_software_ver           = ["vnfd", "software-version"]
    vnfd_ver                    = ["vnfd", "version"]
    vnfd_info_name              = ["vnfd", "product-info-name"]
    vnfd_info_desc              = ["vnfd", "product-info-description"]
    vnfd_vnfm_info              = ["vnfd", "vnfm-info"]

    vnfd_config_props           = ["vnfd", "configurable-properties"]
    vnfd_config_autoheal        = ["vnfd_config_props", "is-auto-heal-enabled"]
    vnfd_config_autoscale       = ["vnfd_config_props", "is-auto-scalable-enabled"]
    vnfd_config_additional      = ["vnfd_config_props", "additional-configurable-property"]
    vnfd_config_add_elem        = ["vnfd_config_additional", "{}"]
    vnfd_config_add_key         = ["vnfd_config_add_elem", "key"]
    vnfd_config_add_value       = ["vnfd_config_add_elem", "value"]


    PROTOCOLS_PREFIX_VAL        = "etsi-nfv-descriptors:"
    VALID_PROTOCOLS_VAL         = ["ethernet", "ipv4", "ipv6", "mpls", "odu2", "pseudo-wire"]
    VALID_DISK_FORMATS_VAL      = ["qcow2", "raw", "vmdk"]
    VALID_CONTAINER_FORMATS_VAL = ["aki", "ami", "ari", "bare", "docker", "ova", "ovf"]
    VALID_AFF_SCOPES_VAL        = ["nfvi-node", "nfvi-pop", "zone", "zone-group"]
    VALID_STORAGE_TYPES_VAL     = ["ephemeral-storage", "root-storage", "swap-storage", "cisco-etsi-nfvo:volume-storage"]

    # ********************************
    # ** Virtual Compute Descriptor **
    # ********************************
    vnfd_virt_compute_desc_base = ["vnfd", "virtual-compute-desc"]
    vnfd_virt_compute_desc      = ["vnfd_virt_compute_desc_base", "{}"]
    vnfd_vcd_id                 = ["vnfd_virt_compute_desc", "id"]
    vnfd_vcd_flavor_name        = ["vnfd_virt_compute_desc", "cisco-etsi-nfvo-sol1-vnfd-extensions:flavour-name-variable"
    vnfd_virtual_cpu            = ["vnfd_virt_compute_desc", "virtual-cpu"]
    vnfd_vcd_cpu_num            = ["vnfd_virtual_cpu", "num-virtual-cpu"]
    vnfd_vcd_cpu_clock          = ["vnfd_virtual_cpu", "clock"]
    vnfd_vcd_cpu_arch           = ["vnfd_virtual_cpu", "cpu-architecture"]
    vnfd_vcd_cpu_oversub        = ["vnfd_virtual_cpu", "oversubscription-policy"]
    vnfd_vcd_vdu_cpu_req        = ["vnfd_virtual_cpu", "vdu-cpu-requirements"]
    vnfd_vcd_mem                = ["vnfd_virt_compute_desc", "virtual-memory"]
    vnfd_vcd_mem_size           = ["vnfd_vcd_mem", "size"]
```

```
# ********************************
# ** Virtual Storage Descriptor **
# ********************************
vnfd_virt_storage_desc_base = ["vnfd", "virtual-storage-desc"]
vnfd_virt_storage_desc      = ["vnfd_virt_storage_desc_base", "{}"]
vnfd_virt_storage_id        = ["vnfd_virt_storage_desc", "id"]
vnfd_virt_storage_type      = ["vnfd_virt_storage_desc", "type-of-storage"]
VIRT_STORAGE_DEFAULT_VAL    = "root-storage"
vnfd_virt_storage_size      = ["vnfd_virt_storage_desc", "size-of-storage"]
vnfd_virt_storage_sw_image  = ["vnfd_virt_storage_desc", "sw-image-desc"]

# ***********************
# ** Deployment Flavor **
# ***********************
deployment_flavor           = ["vnfd", "df"]
df_id                       = ["deployment_flavor", "id"]
df_desc                     = ["deployment_flavor", "description"]
df_inst_level_default       = ["deployment_flavor", "default-instantiation-level"]
df_vdu_profile_list         = ["deployment_flavor", "vdu-profile"]
df_vdu_profile              = ["df_vdu_profile_list", "{}"]
df_vdu_prof_id              = ["df_vdu_profile", "id"]
df_vdu_prof_inst_min        = ["df_vdu_profile", "min-number-of-instances"]
df_vdu_prof_inst_max        = ["df_vdu_profile", "max-number-of-instances"]
df_vdu_prof_aff_group_list  = ["df_vdu_profile", "affinity-or-anti-affinity-group"]
df_vdu_prof_aff_group       = ["df_vdu_prof_aff_group_list", "{}"]
df_vdu_prof_aff_group_id    = ["df_vdu_prof_aff_group", "id"]

# -- Instantiation Level
df_inst_level_base          = ["deployment_flavor", "instantiation-level"]
df_inst_level               = ["df_inst_level_base", "{}"]
df_inst_level_id            = ["df_inst_level", "id"]
df_inst_level_desc          = ["df_inst_level", "description"]
df_inst_level_vdu_level_lst = ["df_inst_level", "vdu-level"]
df_inst_level_vdu_level     = ["df_inst_level_vdu_level_lst", "{}"]
df_inst_level_vdu_vdu       = ["df_inst_level_vdu_level", "vdu-id"]
df_inst_level_vdu_num       = ["df_inst_level_vdu_level", "number-of-instances"]
# -- Scaling Info
df_inst_scaling_info_list   = ["df_inst_level", "scaling-info"]
df_inst_scaling_info        = ["df_inst_scaling_info_list", "{}"]
df_inst_scaling_aspect      = ["df_inst_scaling_info", "id"]
df_inst_scaling_level       = ["df_inst_scaling_info", "scale-level"]

df_scale_aspect_list        = ["deployment_flavor", "scaling-aspect"]
df_scale_aspect             = ["df_scale_aspect_list", "{}"]
df_scale_aspect_id          = ["df_scale_aspect", "id"]
df_scale_aspect_name        = ["df_scale_aspect", "name"]
df_scale_aspect_desc        = ["df_scale_aspect", "description"]
df_scale_aspect_max_level   = ["df_scale_aspect", "max-scale-level"]
df_scale_aspect_delta_det   = ["df_scale_aspect", "aspect-delta-details"]
df_scale_aspect_deltas_list = ["df_scale_aspect_delta_det", "deltas"]
df_scale_aspect_deltas      = ["df_scale_aspect_deltas_list", "{}"]
df_scale_aspect_deltas_id   = ["df_scale_aspect_deltas", "id"]
df_scale_aspect_vdu_delta_lst = ["df_scale_aspect_deltas", "vdu-delta"]
df_scale_aspect_vdu_delta   = ["df_scale_aspect_vdu_delta_lst", "{}"]
df_scale_aspect_vdu_id      = ["df_scale_aspect_vdu_delta", "id"]
```

```
df_scale_aspect_vdu_num     = ["df_scale_aspect_vdu_delta", "number-of-instances"]
df_scale_aspect_no_delta_VAL = "unknown"

df_affinity_group_list      = ["deployment_flavor", "affinity-or-anti-affinity-group"]
df_affinity_group           = ["df_affinity_group_list", "{}"]
df_affinity_id              = ["df_affinity_group", "id"]
df_affinity_type            = ["df_affinity_group", "type"]
df_affinity_scope           = ["df_affinity_group", "scope"]
affinity_VAL                = "affinity"
anti_affinity_VAL           = "anti-affinity"

df_lcm_config               = ["deployment_flavor", "lcm-operations-configuration"]
df_lcm_heal_config          = ["df_lcm_config", "heal-vnf-op-config"]
df_heal_param_base          = ["df_lcm_heal_config", "parameter"]
df_heal_param               = ["df_heal_param_base", "{}"]
df_heal_param_key           = ["df_heal_param", "key"]
df_heal_param_value         = ["df_heal_param", "value"]

# ***************************
# ** Virtual/External Links **
# ***************************
virt_link_desc_base         = ["vnfd", "int-virtual-link-desc"]
virt_link_desc              = ["virt_link_desc_base", "{}"]
virt_link_desc_id           = ["virt_link_desc", "id"]
virt_link_desc_desc         = ["virt_link_desc", "description"]
virt_link_desc_conn         = ["virt_link_desc", "connectivity-type"]
virt_link_desc_protocol     = ["virt_link_desc_conn", "layer-protocol"]
virt_link_desc_flow         = ["virt_link_desc_conn", "flow-pattern"]
virt_link_desc_add_params   = ["virt_link_desc", "cisco-etsi-nfvo-sol1-vnfd-extensions:additional-sol1-parameters"]
virt_link_desc_cidr         = ["virt_link_desc_add_params", "cidr-variable"]
virt_link_desc_dhcp         = ["virt_link_desc_add_params", "dhcp-enabled-variable"]

ext_cpd_base                = ["vnfd", "ext-cpd"]
ext_cpd                     = ["ext_cpd_base", "{}"]
ext_cpd_id                  = ["ext_cpd", "id"]
ext_cpd_protocol            = ["ext_cpd", "layer-protocol"]
ext_cpd_virt_link           = ["ext_cpd", "int-virtual-link-desc"]
ext_cpd_role                = ["ext_cpd", "role"]
ext_cpd_vdu                 = ["ext_cpd", "int-cpd"]
ext_cpd_vdu_id              = ["ext_cpd_vdu", "vdu-id"]
ext_cpd_int_cpd_id          = ["ext_cpd_vdu", "cpd"]


#ext_cpd_int_cpd             = ["ext_cpd", "int-cpd"]
#ext_cpd_icp_vdu             = ["ext_cpd_int_cpd", "vdu"]
#ext_cpd_icp_cpd             = ["ext_cpd_int_cpd", "cpd"]


# *********
# ** VDU **
# *********
vdus                        = ["vnfd", "vdu"]
vdu                         = ["vdus", "{}"]
vdu_name                    = ["vdu", "name"]
vdu_desc                    = ["vdu", "description"]
vdu_id                      = ["vdu", "id"]
```

```
vdu_boot_order_list         = ["vdu", "boot-order"]
vdu_boot_order              = ["vdu_boot_order_list", "{}"]
vdu_boot_key                = ["vdu_boot_order", "key"]
vdu_boot_value              = ["vdu_boot_order", "value"]
vdu_vc_desc_list            = ["vdu", "virtual-compute-desc"]
vdu_vc_desc                 = ["vdu_vc_desc_list", "{}"]
vdu_vs_desc_list            = ["vdu", "virtual-storage-desc"]
vdu_vs_desc                 = ["vdu_vs_desc_list", "{}"]
vdu_sw_image_desc_list      = ["vdu", "sw-image-desc"]
vdu_sw_image_desc           = ["vdu_sw_image_desc_list", "{}"]

vdu_artifact                = ["vdu", "cisco-etsi-nfvo:artifact"]

# ******************************
# ** Internal Connection Points **
# ******************************
int_cpd_list                = ["vdu", "int-cpd"]
int_cpd                     = ["int_cpd_list", "{}"]
int_cpd_id                  = ["int_cpd", "id"]
int_cpd_layer_prot          = ["int_cpd", "layer-protocol"]
int_cpd_virt_link_desc      = ["int_cpd", "int-virtual-link-desc"]
int_cpd_role                = ["int_cpd", "role"]
int_cpd_interface_id        = ["int_cpd", "cisco-etsi-nfvo:interface-id"]
int_cpd_management          = ["int_cpd", "cisco-etsi-nfvo:management"]
int_cpd_management_VAL      = "[null]"
int_cpd_additional_params   = ["int_cpd", "cisco-etsi-nfvo-sol1-vnfd-extensions:additional-sol1-parameters"]
int_cpd_allowed_addr        = ["int_cpd_additional_params", "allowed-address-variable"]
int_cpd_ip_addr             = ["int_cpd_additional_params", "ip-address-variable"]
int_cpd_security            = ["int_cpd_additional_params", "security-group-variable"]

KEY_VIRT_LINK_MGMT_VAL      = "VIM_NETWORK_MANAGEMENT-VL"
KEY_VIRT_LINK_MGMT_PROT_VAL = "etsi-nfv-descriptors:ipv4"
KEY_VIRT_LINK_ORCH_VAL      = "VIM_NETWORK_ORCHESTRATION-VL"
KEY_VIRT_LINK_ORCH_PROT_VAL = "etsi-nfv-descriptors:ipv4"
KEY_EXT_CP_MGMT_VAL         = "VIM_NETWORK_MANAGEMENT"
KEY_EXT_CP_MGMT_PROT_VAL    = "etsi-nfv-descriptors:ipv4"
KEY_EXT_CP_ORCH_VAL         = "VIM_NETWORK_ORCHESTRATION"
KEY_EXT_CP_ORCH_PROT_VAL    = "etsi-nfv-descriptors:ipv4"

# ******************************
# ** Software Image Descriptor **
# ******************************
sw_img_desc_base            = ["vnfd", "sw-image-desc"]
sw_img_desc                 = ["sw_img_desc_base", "{}"]
sw_id                       = ["sw_img_desc", "id"]
sw_name                     = ["sw_img_desc", "name"]
sw_image_name_var           = ["sw_img_desc", "cisco-etsi-nfvo-sol1-vnfd-extensions:image-name-variable"]
sw_version                  = ["sw_img_desc", "version"]
sw_checksum                 = ["sw_img_desc", "checksum"]
sw_checksum_hash            = ["sw_checksum", "hash"]
sw_checksum_algorithm       = ["sw_checksum", "algorithm"]
sw_checksum_algorithm_VAL    = "sha-256"
sw_container_format         = ["sw_img_desc", "container-format"]
sw_disk_format              = ["sw_img_desc", "disk-format"]
sw_min_disk                 = ["sw_img_desc", "min-disk"]
sw_min_ram                  = ["sw_img_desc", "min-ram"]
```

```
sw_size                    = ["sw_img_desc", "size"]
sw_image                   = ["sw_img_desc", "image"]
sw_operating_sys           = ["sw_img_desc", "operating-system"]
sw_supp_virt_environ       = ["sw_img_desc", "supported-virtualization-environment"]

# **************
# ** Artifact **
# **************
artifact_base              = ["vnfd", "cisco-etsi-nfvo:artifact"]
artifact                   = ["artifact_base", "{}"]
artifact_id                = ["artifact", "id"]
artifact_dest              = ["artifact", "destination-name"]
artifact_url               = ["artifact", "url"]
artifact_variable_list     = ["artifact", "variable"]
artifact_variable          = ["artifact_variable_list", "{}"]
artifact_variable_id       = ["artifact_variable", "id"]
artifact_variable_desc     = ["artifact_variable", "description"]
artifact_checksum          = ["artifact", "checksum"]
artifact_hash              = ["artifact_checksum", "hash"]
artifact_algorithm         = ["artifact_checksum", "algorithm"]
artifact_hash_DUMMY_VAL    = "9af30fce37a4c5c831e095745744d6d2"
artifact_algorithm_DUMMY_VAL = "etsi-nfv-descriptors:sha-256"
```


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