



H2020 5G-TRANSFORMER Project
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5GT-SO USER GUIDE

Abstract

This document provides the user guide for the 5GT-SO reference implementation, including a description of features and functionality accessible through its GUI.

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Disclaimer

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List of Acronyms

Acronym	Description
5GT-SO	Service Orchestrator
5GT-VS	Vertical Slicer
API	Application Programming Interface
AppD	Application Descriptor
CRUD	Create-Read-Delete-Update
DB	Database
DF	Deployment Flavour
eMBB	Enhanced Mobile BroadBand
ETSI	European Telecommunication Standardization Institute
GUI	Graphical User Interface
IFA	Interfaces and Architecture
IL	Instantiation Level
LC	Lifecycle
LCM	Lifecycle Management
mlIoT	Massive Internet of Things
MEC	Multi-access Edge Computing
NBI	Northbound Interface
NF	Network Function
NFV	Network Function Virtualization
NFVI	Network Functions Virtualisation Infrastructure
NFV-NS	NFV Network Service
NFVO	NFV Orchestrator
NS	Network Slice
NSD	Network Service Descriptor
REST	Representational State Transfer
SBI	Southbound Interface
SLA	Service Level Agreement
URLLC	Ultra-Reliable Low-Latency Communication
VNF	Virtual Network Function
VNFD	VNF Descriptor
VSB	Vertical Service Blueprint
VSD	Vertical Service Descriptor
VSI	Vertical Service Instance

1 Service Orchestrator Reference Implementation

The 5G-TRANSFORMER Service Orchestrator (5GT-SO) reference implementation is an open source software prototype developed in python, which provides all the major 5GT-SO functionalities required by 5G-TRANSFORMER use cases [4] . It can be downloaded from the 5G-TRANSFORMER website and github [3] and its design, operation, and implementation is described in deliverables D4.3 [1] and D4.4 [2].

1.1 5GT-SO functionalities

The list of 5GT-SO functionalities and features implemented in the 5GT-SO is reported in Table 1 (for further details about the 5GT-SO architecture and functionalities see Deliverable D4.3 [1]).

TABLE 1: 5GT-SO FUNCTIONALITIES

Functionality	Description
IFA013-based REST-based NBI	Integration with 5GT-VS Catalogue and lifecycle management functions: <ul style="list-style-type: none"> • NFV-NS scaling • NFV-NS lifecycle management (ID creation, instantiation, operation status, NS info, termination) • on-boarding, removal, queries of descriptors/packages stored in catalogues
Service Orchestration	Support for: <ul style="list-style-type: none"> • management functions (on-boarding) for descriptors and packages of NFV-NS, Virtual Network Function (VNF), AppD stored in catalogues • NFV-NS scaling and NFV-NS lifecycle management • Service composition and federation support for deployment of NFV-NSs in one or multiple domains (involving different 5GT-SOs) • service assurance through NFV-NS auto-scaling leveraging SLA manager and monitoring manager
Resource Orchestration	Extended Resource Orchestration functions: <ul style="list-style-type: none"> • placement decisions based on vertical service requirements and abstracted infrastructure information provided by 5GT-MTP, including single Point of Presence (PoP) deployments and multi-PoP deployments through Wide Area Network (WAN) • triggering and coordination of resource allocation and release operations triggered by NFV-NS instantiation, termination, auto-scaling • interworking with multiple orchestration platforms (OSM and Cloudify) • composite NFV-NS resource management (for service composition and federation) • collection of resource topological and capacity information • allocation and release of networking (also for inter-domain communication) and computing resource operations
Placement Algorithm (PA) REST API	Easy support for external placement logic based on resources exposed by 5GT-MTP and vertical requirements coming from 5GT-VS
Cloudify Wrapper	Automation in NFV-NS operations while involving the Cloudify orchestrator for all the 5GT-SO workflows
Open Source MANO (OSM) Wrapper	Automation in NFV-NS operations while involving the OSM orchestrator for all the 5GT-SO workflows

Monitoring platform	Integrated monitoring platform supporting lifecycle management through configuration of monitoring jobs and service assurance operations through the Service Level Agreement (SLA) manager
Extended IFA005-based REST SBI	Integration with new Mobile and Transport Platform (5GT-MTP) features: <ul style="list-style-type: none">• allocation/release of computing and networking resources in both cloud and WAN• advertisement of resource information (e.g., capacity, topology)
5GT-SO Graphical user interface	5GT-SO graphical user interface (GUI) to visualize NFV-NSs, placement, database content, NBI ...

1.2 5GT-SO user guide

This section provides a brief guideline about how to use the 5GT-SO from its web Graphical User Interface (GUI) for administrative actions. As such, it is an interface used by the 5GT Service Provider to manage the service.

It should be noted that the 5GT-SO GUI interacts with the 5GT-SO core using its REST APIs. It is thus possible to use the same REST APIs in order to interact with the system from external components.

In the following, we assume that the 5GT-SO has been deployed, installed and correctly configured with both its core system and its GUI, with the GUI accessible at a generic X.X.X.X IP address. Installation and usage instructions are described in the HOW_TO_WORK_WITH_5GT-SO.txt file for 5GT-SO core part, and in this file for the GUI. Both files are present at the github repository under [5GT-SO/documentation](#) folder.

5GT-SO GUI can be accessed from a web browser at the following link: <http://X.X.X.X:8080>. At the beginning, the GUI will initially visualize the authentication page where the user can enter its username and password.

1.2.1 5GT-SO GUI

The 5GT-SO GUI is used by the 5GT service provider to manage the service orchestrator, including visualization of all relevant data related with service offerings, instantiated services, and resources used. It also allows manually onboarding and translating NSDs and VNFDs to the Service Manager (SM) and the MANO platform in use (functionality currently supported for OSM). It also allows manually instantiating NFV-NSs from the GUI and visualization of NFV-NS structure, and its placement in domains (in case of service federation) and in local PoPs.

In order to enter 5GT-SO administration GUI, the user should insert “test” and “test” as username and password in the authentication page (admin credentials can be modified through the GUI, in the Users Database Page). The main page shown in Figure 1 will be visualized.

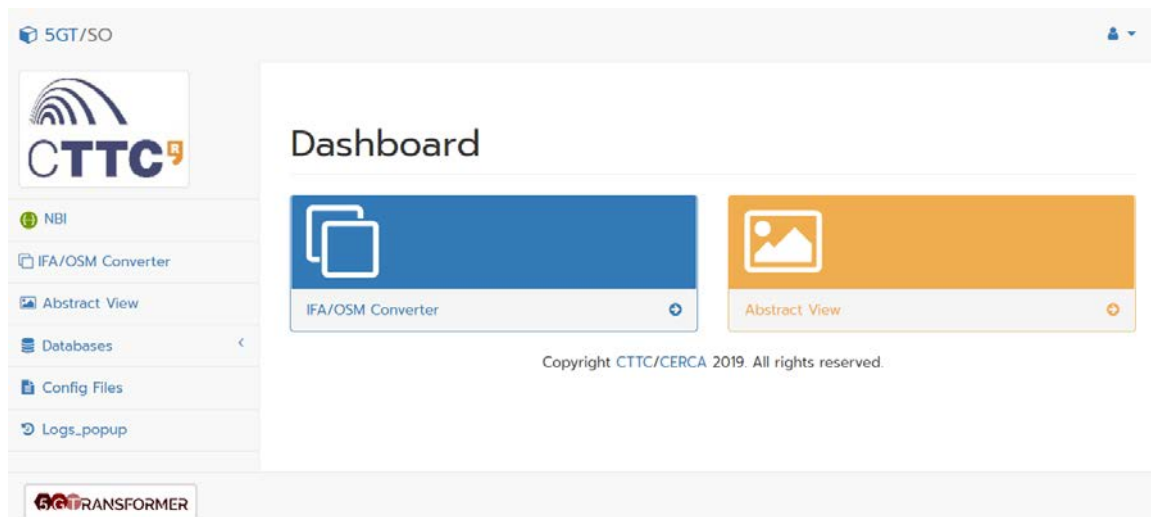


FIGURE 1: 5GT-SO ADMIN GUI - MAIN PAGE

From 5GT-SO admin GUI the following actions can be performed:

- Exploration of the 5GT-SO NBI swagger API
- Exploration of the content of all databases (NSD; VFND catalogues, MTP resources, Instantiated NSs, Resources associated with instantiated NSs, Operation IDs)
- Graphical visualization of instantiated NSs, their components (VLs and VNFs) and the placement of the VNFs in different PoPs. For composite NSs, visualization of placement of NSs in domains (local and federated).
- Onboarding of NSD in the catalogue and translation to NSDs for OSM
- Onboarding of VNFD
- Instantiation of NS from the GUI
- IFA-to-OSM NSD and VNFD converter
- Inspection of main 5GT-SO configuration files
- Inspection of 5GT-SO log

1.2.1.1 Exploration of the 5GT-SO NBI swagger API

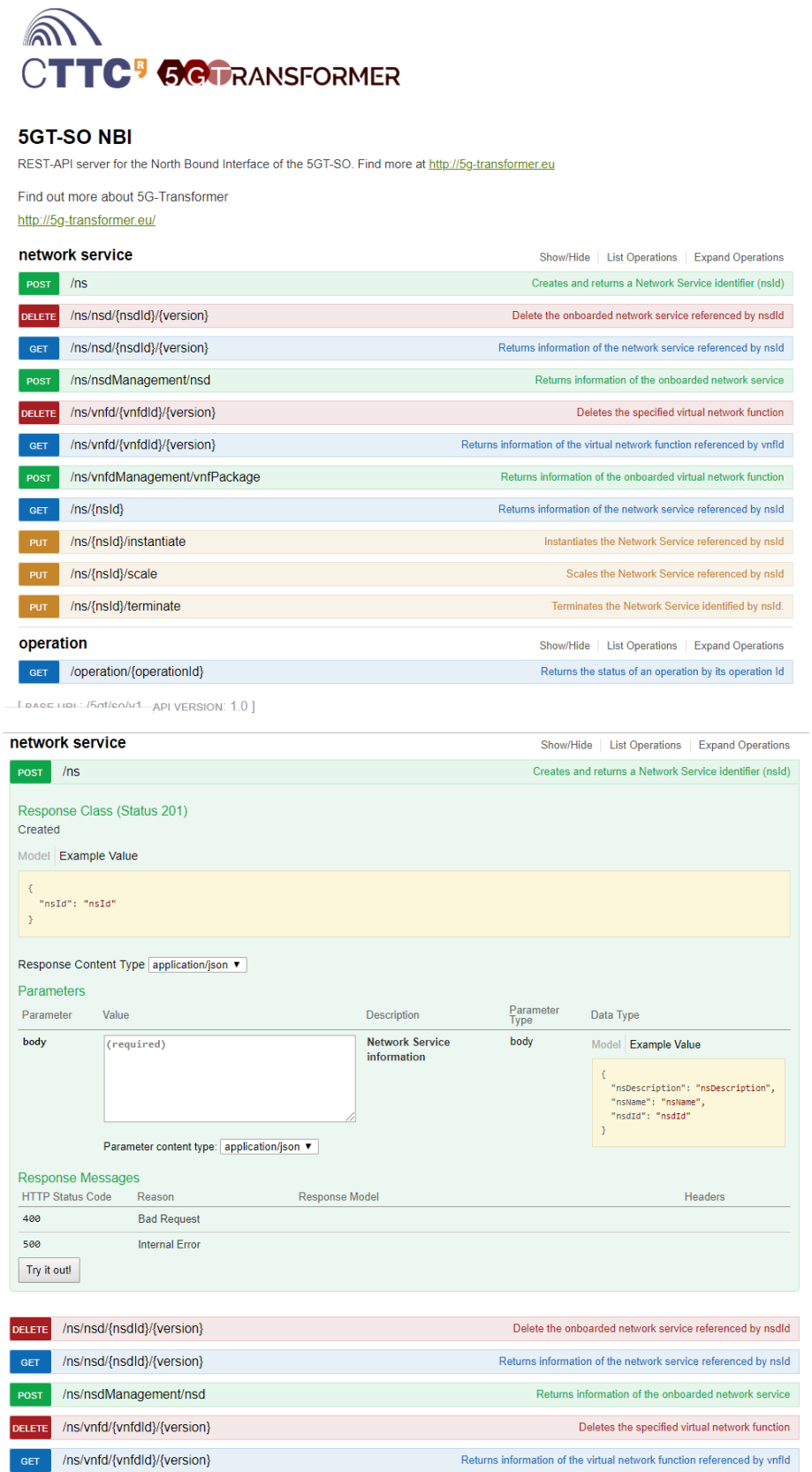


FIGURE 2: 5GT-SO ADMIN GUI - SWAGGER OF THE 5GT-SO NBI (E.G., POST NS)

1.2.1.2 IFA-to-OSM NSD and VNFD converter

An NSD or VNFD can be pasted in the window or a JSON file can be uploaded to the converter. The descriptor is converted into yaml format ready to be onboarded to OSM.

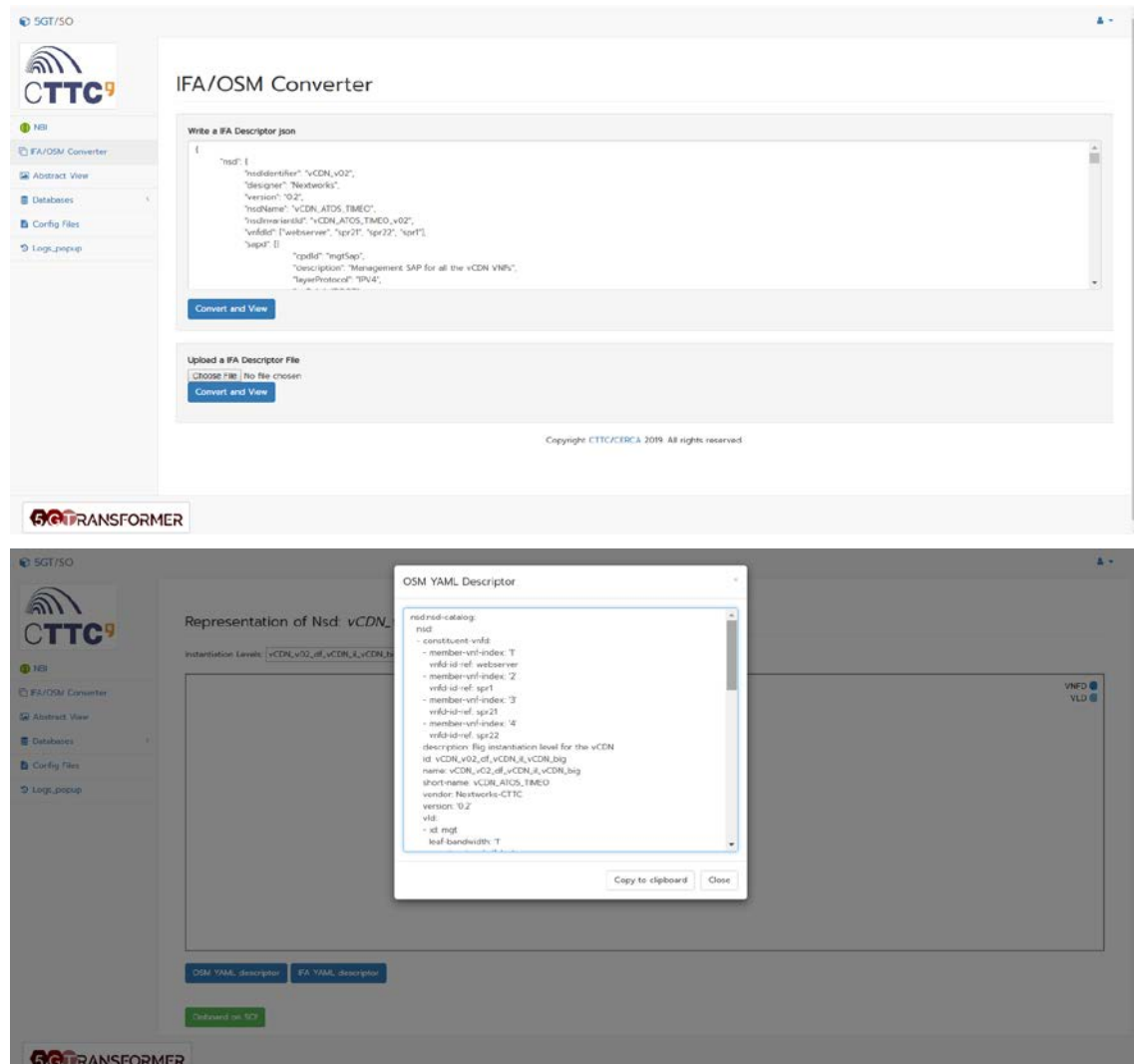
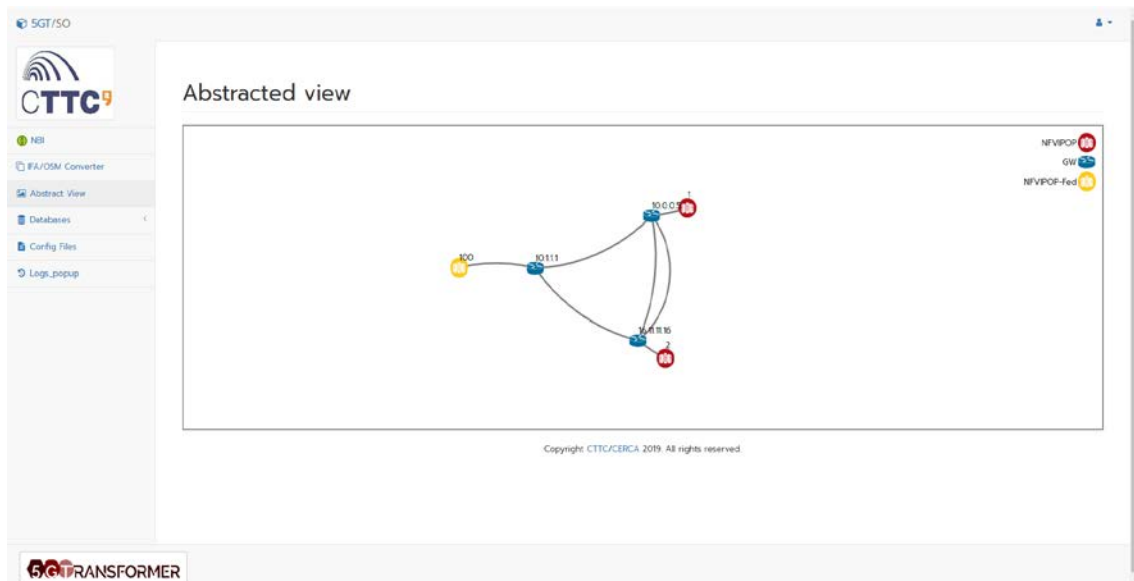


FIGURE 3: 5GT-SO ADMIN GUI - IFA-TO-OSM CONVERTER

1.2.1.3 Visualization of resources exposed by the 5GT-MTP

Visualization of resources as exposed by the 5GT-MTP (PoPs and Logical Links). Red PoPs correspond to local PoPs and yellow ones to virtual PoPs, which represent federated domains as seen from the 5GT-MTP.

**FIGURE 4: 5GT-SO ADMIN GUI - 5GT-MTP RESOURCES**


1.2.1.4 Databases

Exploration of the content of all databases (NSD, VFND catalogues, MTP resources, Instantiated NSs, Resources associated with instantiated NSs, Operation IDs). Notice that the NS DB GUI also presents the instantiated composite NSs (table with yellow heading).

SO Databases									
NS List									
NS Name	NS id	Status	NSD id	Sap info	NS Instantiation Level id	Flavour id	Used by		
MFV-NS-vCDN	fst-d574648-105e-46f0-9601-9558af9a5f2	NOT_INSTANTIATED	vCDN_v02						
vCDN_ATOS_TIMEO	a50ea57b1e4b40d47ac-ba0bc0c9524e997b9	INSTANTIATED	vCDN_v07	[videoSap: [webserver: "10.112.0.1", [sqrT: "10.112.14"], mgidSap: [TsrT: "10.112.5]]]	il_vCDN_small	dl_vCDN			
test	a0d2d1c7-a0ce-44f7-8bcb-e9f062217450	INSTANTIATING	eHealth-vEPC		eHealth-vEPC_J_default	eHealth-vEPC_of			
vEPC for eHealth	fst-89f5f81-a0ce-4992-a5f5-e699bab3ac38	TERMINATED	eHealth-vEPC	[mgmt_vpcp_sap: [TMBE_VNF: "10.112.14"], [PGW_VNF: "10.112.40"], [SOFW_VNF: "10.112.15"], [HSS_VNF: "10.112.5]]]	eHealth-vEPC_J_default	eHealth-vEPC_of			
vEPC for eHealth	fst-a5c8464-638a-44d3-0d8f-20e46235204a	INSTANTIATED	eHealth-vEPC	[mgmt_vpcp_sap: [PGW_VNF: "10.112.40"], [TMBE_VNF: "10.112.14"], [HSS_VNF: "10.112.5"], [SOFW_VNF: "10.112.15]]]	eHealth-vEPC_J_default	eHealth-vEPC_of	[Tgr-562b95-15c8-4bcb-9889-121708b41930]		
test	a527035c-cc40-43a3-adec-c9ea015a50cf	INSTANTIATING	vCDN_v02		il_vCDN_small	dl_vCDN			
lte	a9eaacdc-6a11-4a7a-a81b-c080c7e307d2	INSTANTIATING	eHealth-Mon-NS		eHealth-Mon-NS_il_small	eHealth-Mon-NS_of			
vEPC for eHealth	fst-a0483d1-d95c-4369-962b-19036f9cd6d	INSTANTIATED	eHealth-vEPC	[mgmt_vpcp_sap: [SOFW_VNF: "10.112.15"], [PGW_VNF: "10.112.40"], [TMBE_VNF: "10.112.14"], [HSS_VNF: "10.112.5]]]	eHealth-vEPC_J_default	eHealth-vEPC_of	[Tgr-6b0bce1-68cd-4a66-82cd-e41c3a0a6600]		
Monitoring backend for eHealth	fst-056745a-30a7-49f9-a570-a2597a265cd0	INSTANTIATED	eHealth-BE	[mgmt_health_mon_be_sap: [TLB_VNF: "10.0.0.0.20"], [SERVER_VNF: "10.0.0.0.15]]]	eHealth-BE_il_small	eHealth-BE_of	[Tgr-1959791-8479-4729-a147-1a2acae3f552]		

[illegible]
















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- NSD
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NSD List

Nsd Id	Nsd Name	Version	Shareable	Domain			
eHealth-vEPC	vEPC for eHealth	01	True	local			
vCDN_v02	vCDN_ATOS_TME0	02	True	local			
eHealth-Mon-NS	eHealth Monitoring service	01	False	Composite			
eHealth-BE	Monitoring backend for eHealth	01	True	local			
vCDN_v02_65	vCDN_ATOS_TME0	02	True	local			

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NSR List

NS Id	Placement Info	Network Mapping	Remaning Mapping	VL
45de87b-b460-47ac-bc0b-0c05c4a47b93	[{usedVls: [{mappedVls: [VideoData], lld: 75b7b}], usedVls: [{mappedVls: [VideoDistribution], NFVPID: 1}], [mappedVls: [mgmt, NFVPID: 2], totalLatency: 15, usedVFPops: [NFVPID: 1, mappedVNFs: [webserver, spr1], NFVPID: 2, mappedVNFs: [spr1]], totalCost: 0}], [mappedVNFs: [NFVPID: 1, mappedVNFs: [webserver, spr1, spr2]]]			No
45de87b-b460-47ac-bc0b-0c05c4a47b93	[{usedVls: [{totalLatency: 0.0, usedVls: [{mappedVls: [VideoData, VideoDistribution], mgmt, NFVPID: 1}], totalCost: 0.0, usedVFPops: [NFVPID: 1, mappedVNFs: [webserver, spr1, spr2]]]			No
1gt-562b165-15c3-4bc8-989-12708b41930	[{usedVls: [{usedVls: [{mappedVls: [mgmt, ehwh_mon_be_vf, data, ehwh_mon_be_vf], NFVPID: 2}], totalLatency: 0.0, usedVFPops: [NFVPID: 2, mappedVNFs: [SERVER, VNF, LB, VNF]], totalCost: 0.0}]			[7e, 2b, 75, 9b]
1gt-4da3b04-004b-47c9-ab57-76b76da165		[{nestedVirtualLinkConnectivity: [ehwh-vfpc: [mgmt, vesp_vf, mgmt, ehwh_mon_vf, data, ehwh_mon_vf, ehwh-be: [mgmt, ehwh_mon_be_vf, mgmt, ehwh_mon_vf, [data, ehwh_mon_be_vf, data, ehwh_mon_vf], vsp: 1gt-4da3b04-004b-47c9-ab57-76b76da165, nsid: ehwh-mon-NS]}]		
1gt-56c55-043b-4950-86a2-10990a22c025		[{nestedVirtualLinkConnectivity: [ehwh-vfpc: [mgmt, vesp_vf, 1gt-56882ab-40c1-60a0-ef4c7967b54f, mgmt, vesp_vf, [mgmt, vesp_vf, 1gt-56882ab-40c1-60a0-ef4c7967b54f, mgmt, vesp_vf], ehwh-be: [mgmt, ehwh_mon_be_vf, 1gt-56882ab-40c1-60a0-ef4c7967b54f, mgmt, vesp_vf]		

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SO Databases

Operation List

Operation Id	Status	NS Id	Operation Type
1e54dc05-c34e-420-9263-d0dc76e4818	PROCESSING	4ab24fc7-ecf0-4878-b8c8-e9f02171660	INSTANTIATION
1e6c61a1-f30d-4736-bc3b-3efbf4e1c08	CANCELLED	a3025d5d-28cc-4092-6d32-25e4f8c8a0f	INSTANTIATION
1f5524c6-26d9-6465-9037-24f9c3947e	PROCESSING	a3025d5d-28cc-4092-6d32-25e4f8c8a0f	TERMINATION
5f20d379-f24e-48de-af39-ba205233dc9f	CANCELLED	ac189955-6060-4577-9705-9f6bb60d038	INSTANTIATION
5c9ab8b5-612f-435e-abda-6385e2baa056	PROCESSING	ac189955-6060-4577-9705-9f6bb60d038	TERMINATION
1b87c7f1-2a80-4427-b18c-1265304bec37	CANCELLED	ac1853af-ec29-4743-af18-30837920c38	INSTANTIATION
86aee089-a07c-41c1-b83f-e240c0788203	PROCESSING	ac1853af-ec29-4743-af18-30837920c38	TERMINATION
85d0e90e-d35d-4da3-99ec-3655dea966a9	PROCESSING	ab4e48b5-4c94-40a0-ba89-df45e23eca9	INSTANTIATION
12d4eb6-b3ce-4c71-5db2-3c7f0c0d85e	PROCESSING	a2a38f-2-5d33-48f-a70c-aa74c74debe	INSTANTIATION
1b9f09b1-9501-4216-ba45-969f083a7e7e	PROCESSING	a534dca0-72a0-442b-8818-0964e7e78372	INSTANTIATION
50d3c309-e819-4ba5-ef40-928c5a2bc0ff	PROCESSING	ae3e363-08b8-4742-aa2e-7630366a8a9	INSTANTIATION
0f910c-10b2-43be-ba79-2343c08674c	PROCESSING	ad93999-45fa-48a0-bd29-430a83478a6f	INSTANTIATION
1e489e12-68db-483f-89f2-f2e2b33009ae	PROCESSING	ac12056-1726-4a77-514c-6c5a648a4956	INSTANTIATION
96a75c79-afbe-4727-bf86-0a22c2a08ba5	PROCESSING	a5d9504-403f-4a49-8aef-8a6b6f8c3ca	INSTANTIATION

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VNF List

VNF Id	VNF Version	VNF Name	VNF Icon
spr1	0.2	CDN origin server	
spr21	0.2	CDN cache	

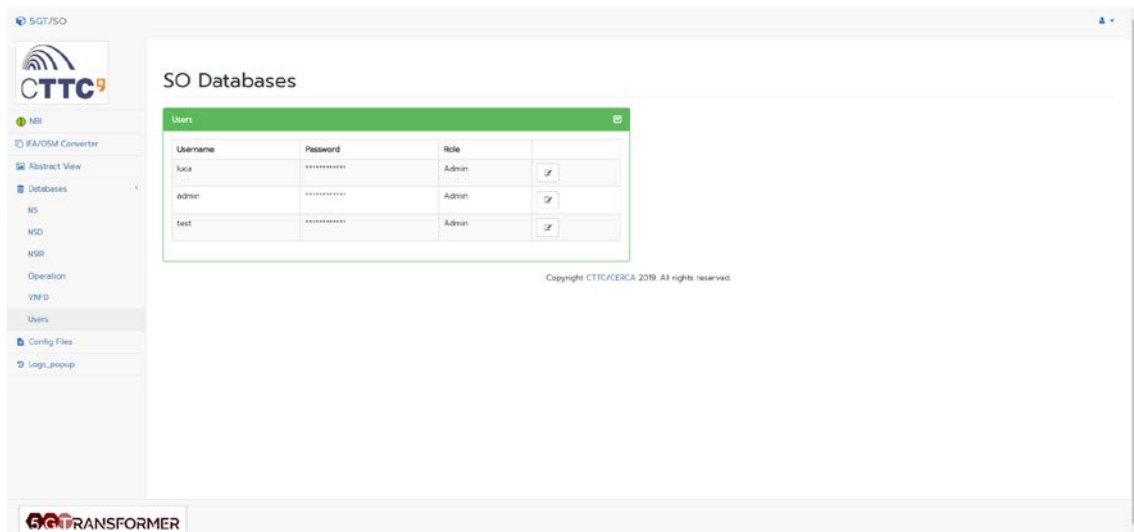
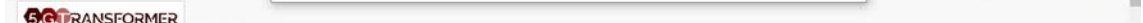
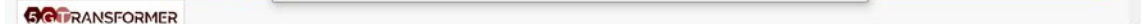


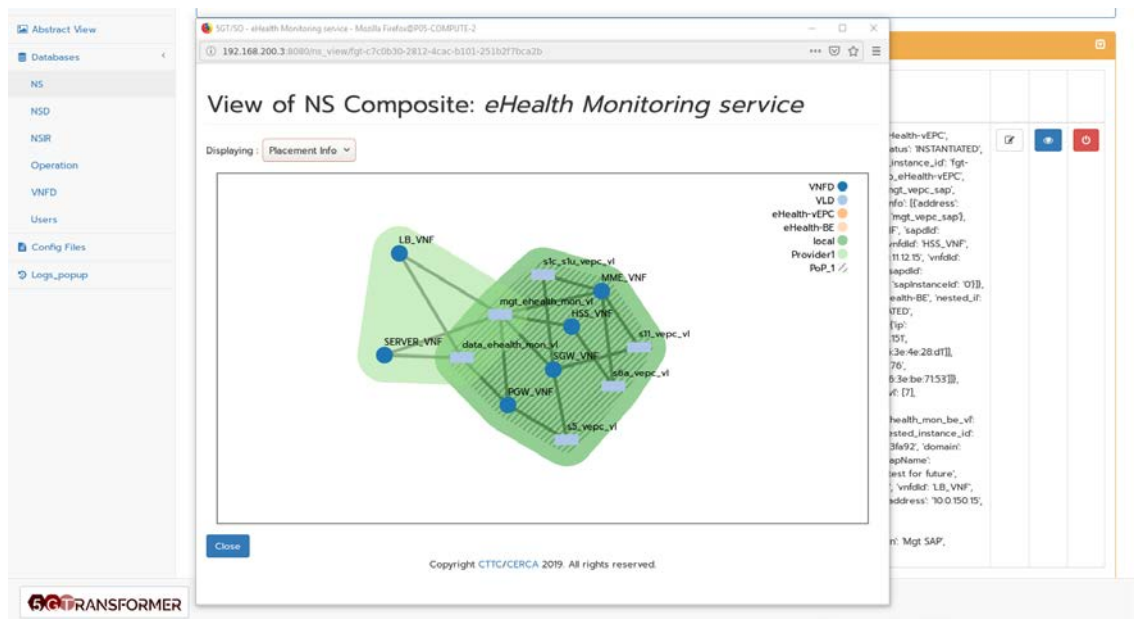
FIGURE 5: 5GT-SO ADMIN GUI - DATABASES

1.2.1.5 Graphical visualization of instantiated NSs

Graphical visualization of instantiated NSs, their components (VLs and VNFs) and the placement of the VNFs in different PoPs can be opened by clicking on the eye icon next to the corresponding entry in the DB. For composite NSs, visualization of placement of NSs in domains (local and federated). Background bubbles in different colors correspond to different PoPs. Blue rectangles represent VLs and dark blue dots represent VNFs. In case of composite NSs, background bubbles circle nested NSs (“nested NS” selected in the “Displaying” drop-down menu), placement in PoPs (“placement info” selected in the “Displaying” drop-down menu), or placement in different administrative domains in case of federation or different administrative domains (“federation info” selected in the “Displaying”

By clicking on the pencil icon next to each entry, some of the fields of the DB entry can be updated, or the whole entry can be deleted from the DB by clicking on the “Delete” button at the bottom of the “Modify NS List fields” window.





SO Databases

NS Name	NS Id	Status
RFV-NS-vCDN_test	fgt-cd34b48-9b5a-4ab0-9b01-953ba9a9f92	NOT INSTANTIATED
vCDN_ATOS_TMO	a5de9b7b-b4b0-47ac-bc0b-0c9524a97b9	INSTANTIATED
test	aa2a9c7-ac10-44f7-80c8-e90b207460	NOT INSTANTIATED
vEPC for eHealth	fgt-59508-a0ce-4992-ac05-6899a63ac3a8	INSTANTIATED
vEPC for eHealth	fgt-45c8f4-835a-44d3-80f8-28a4235204a	NOT INSTANTIATED
test	a537b35c-c040-43a3-adec-c99a031a580f	NOT INSTANTIATED
rtb	fgt9acde-d471-4a7a-e8b8-00807a01012	NOT INSTANTIATED
vEPC for eHealth	fgt-648504-d86c-45a9-902b-1903619a6ad	NOT INSTANTIATED
Monitoring backend for eHealth	fgt-05875de-30e7-4919-a570-a2597a285c0d	NOT INSTANTIATED

Modify NS List Fields

NS Name: vCDN_ATOS_TMO

NS Description: Virtual Content Delivery Network

NS Id: a5de9b7b-b4b0-47ac-bc0b-0c9524a97b9

Status: INSTANTIATED

NSD Id: vCDN_v02

Sap Info: [vcdsap: [webserver: 10.11.12.40], [ipr2: 10.11.12.14], mgtsap: [ipr2: 10.11.12.14]]

NS Instantiation Level Id: i_vCDN_small

Flavour Id: i_vCDN

Used by:

Modify NS List Fields

NS Name: eHealth Monitoring service

NS Description: eHealth Monitoring Network Service

NS Id: fgt-c99354-b479-472a-a4c7-b2ac6195f2

Status: INSTANTIATED

NSD Id: eHealth-Mon-NS

Sap Info: [vcdsap: [webserver: 10.11.12.40], [ipr2: 10.11.12.14], mgtsap: [ipr2: 10.11.12.14]]

NS Instantiation Level Id: eHealth-Mon-NS_i_small

Flavour Id: eHealth-Mon-NS_i

Nested NS Id: fgt-05875de-30e7-4919-a570-a2597a285c0d

FIGURE 6: 5GT-SO ADMIN GUI - NS VISUALIZATION AND MODIFICATION/DELETION OF DB ENTRIES

1.2.1.6 NSD visualization

The structure of the NSD (before instantiation) can also be explored from the NSD catalogue by clicking on the eye icon next to each DB entry.

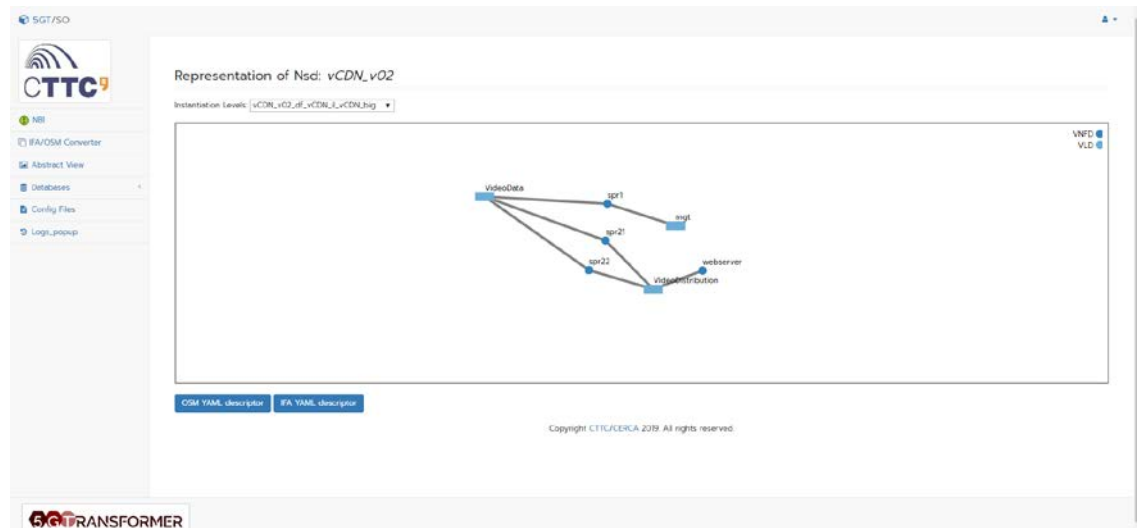
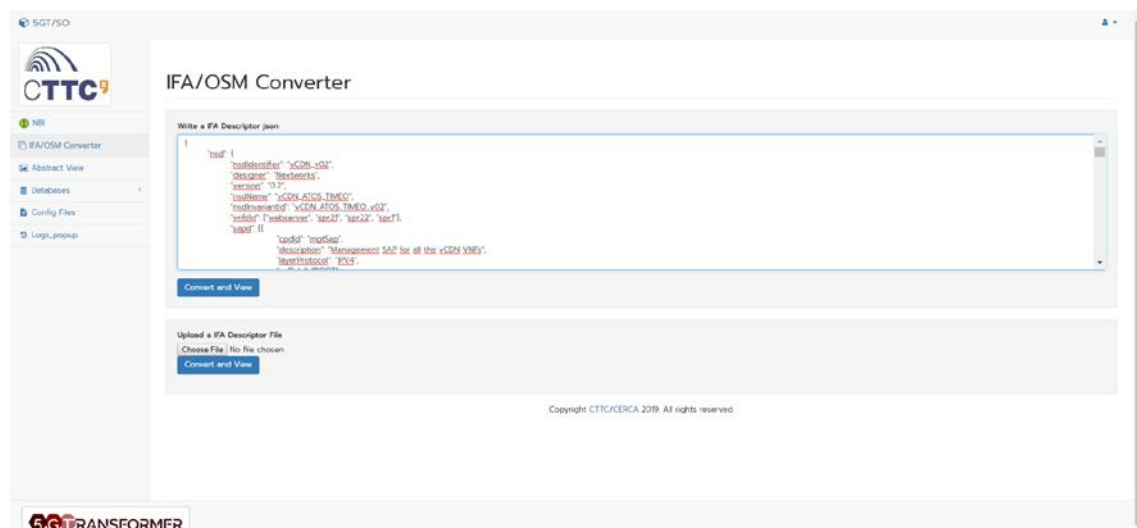


FIGURE 7: 5GT-SO ADMIN GUI - NSD VISUALIZATION

1.2.1.7 Onboarding of NSD in the catalogue and translation to NSDs for OSM

The process starts as described for the IFA/OSM converter above. If the NSD or VNFD is already onboarded, the system returns an error. Otherwise, it returns a message showing the successful onboarding. Again, entries can be modified from the pencil icon.



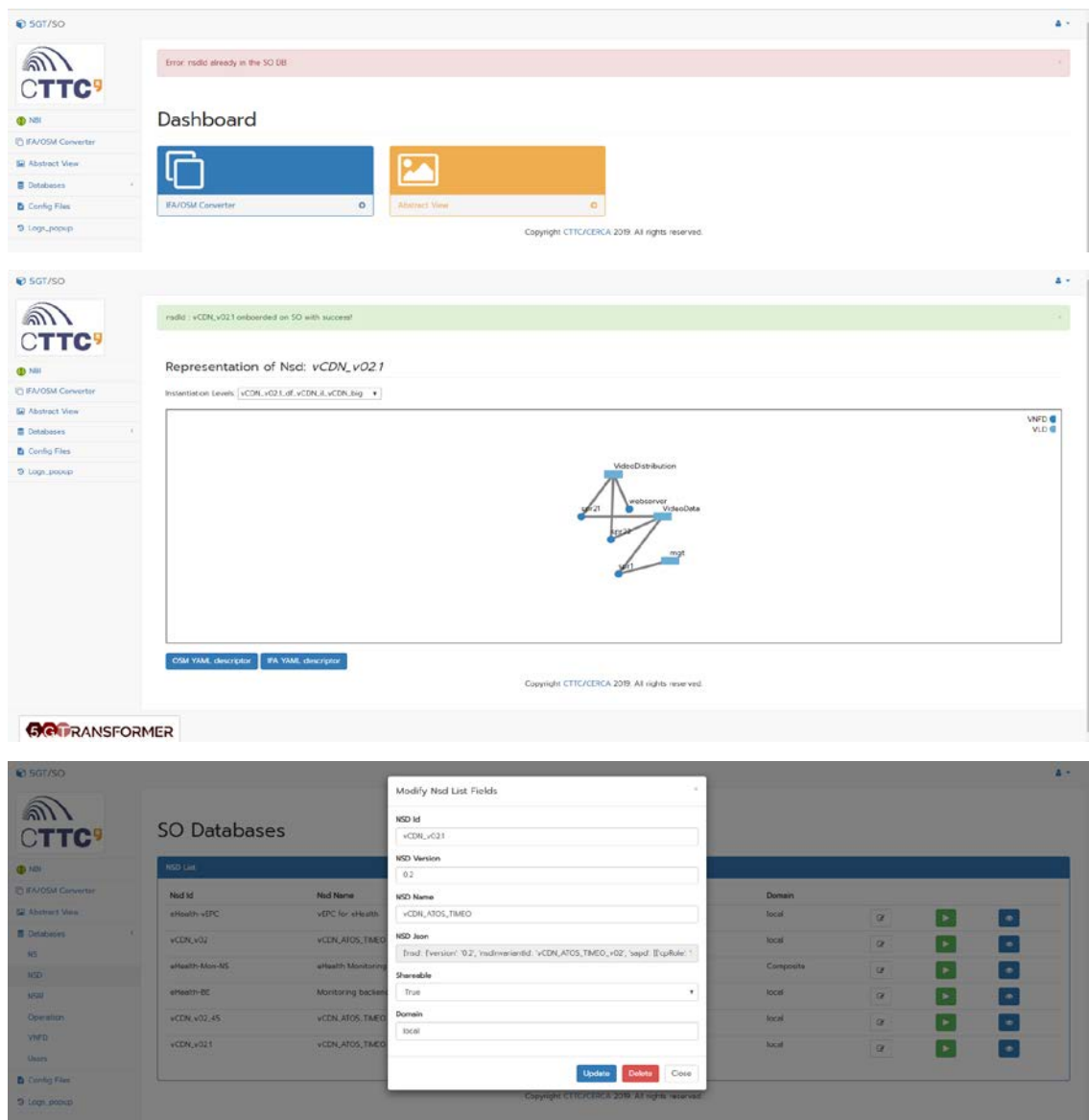


FIGURE 8: 5GT-SO ADMIN GUI - WIZARD TO ONBOARD AN NSD

1.2.1.8 Onboarding of VNFD

Onboarding of VNFDs follows exactly the same steps as NSDs, but update/delete is done from the VNFD catalogue DB visualization page instead.

1.2.1.9 Instantiation/Termination of NS from the GUI

From the NSD catalogue, one can instantiate a service by clicking on the triangle icon next to the corresponding NSD. A window opens to introduce the name, a description, the deployment flavour, and the instantiation level. A message with green background appear after successful instantiation (red otherwise) and the new entry appears in the NS database. From there, once the status pass to INSTANTIATED, the service can be

visualized, clicking on the blue “eye” icon. Also the service can be terminated by clicking in the red switch off button next to the corresponding DB entry.

The screenshot shows the 5GT-SO Admin GUI. On the left is a sidebar with navigation options: NS, NSR, Operation, VNF, Users, Config Files, and Logs. The main area is titled 'SO Databases' and contains a table of NS instances. A modal window titled 'Instantiate NS: eHealth-Mon-NS' is open, showing fields for NS ID, NS Name, NS Description, Flavour ID, NS Instantiation Level ID, and Nested NS Instance ID. The 'Instantiate' button is highlighted in green.

NS Name	NS ID	Status	NSD ID	Sap Info	NS Instantiation Level ID	Flavour ID	Used by
NFV-NS-vCDN-test	fgt-0d74648-9f5a-5af5-9801-9558b9f9d52	NOT_INSTANTIATED	vCDN_v03				
vCDN_ATOS_TMEO	a5d487b-b4d0-47ac-8c0b-0c923a6b709	INSTANTIATED	vCDN_v02	[vcdsap: {webserver: '10.112.40', fip2: '10.112.151', mg5ap: {fip2: '10.112.151}}	eHealth-vEPC_d1	d1_vCDN	
test	ac02dc7-ac10-4487-8bdc-a9062107460	INSTANTIATING	eHealth-vEPC		eHealth-vEPC_d1	eHealth-vEPC_d1	
vEPC for eHealth	fgt-09508f-9c0e-4992-ac5-4899eb3ec3e8	TERMINATED	[mg5_vpc_sap: {VME_VNF: '10.112.141', PGW_VNF: '10.112.40', SGW_VNF: '10.112.151', HSS_VNF: '10.112.151}		eHealth-vEPC_d1	eHealth-vEPC_d1	
vEPC for eHealth	fgt-c5a0f4-03b-44d3-8d7f-2844235264a	INSTANTIATED	eHealth-vEPC	[mg5_vpc_sap: {PGW_VNF: '10.112.401', VME_VNF: '10.112.141', HSS_VNF: '10.112.151', SGW_VNF: '10.112.151}	eHealth-vEPC_d1	eHealth-vEPC_d1	[fip: 502/05-05-0-4x6-989-52708b4f930]
test	a527b35c-cc40-43a3-adec-c990319580f	INSTANTIATING	vCDN_v02		eHealth-vEPC_d1	d1_vCDN	
rtb	ef0eacdc-5af1-4a7a-af8b-0080c701012	INSTANTIATING	eHealth-Mon-NS		eHealth-Mon-NS_d1	eHealth-Mon-NS_d1	
vEPC for eHealth	fgt-04808f-d86c-45a9-9f26-19036193c6d	INSTANTIATED	eHealth-vEPC	[mg5_vpc_sap: {SGW_VNF: '10.112.151', PGW_VNF: '10.112.40', VME_VNF: '10.112.151', HSS_VNF: '10.112.151}	eHealth-vEPC_d1	eHealth-vEPC_d1	[fip: 502/05-05-0-4x6-989-52708b4f930]

FIGURE 9: 5GT-SO ADMIN GUI - NS INSTANTIATION PROCESS

1.2.1.10 Inspection of main 5GT-SO configuration files

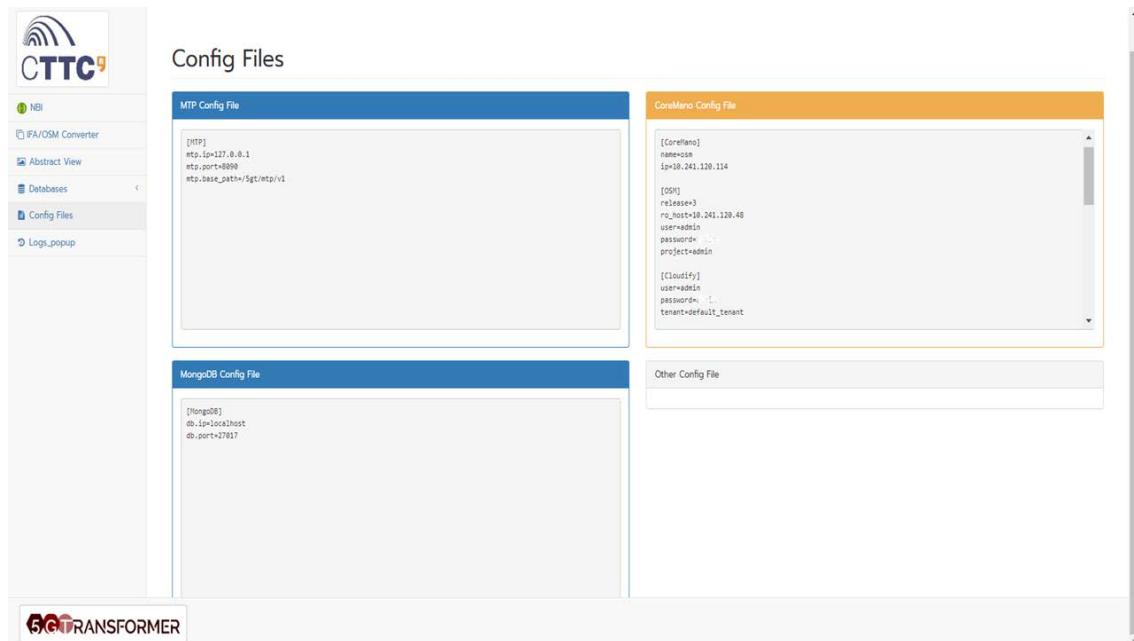


FIGURE 10: 5GT-SO ADMIN GUI - INSPECTION OF 5GT-SO CONFIG FILES

1.2.1.11 Inspection of 5GT-SO log

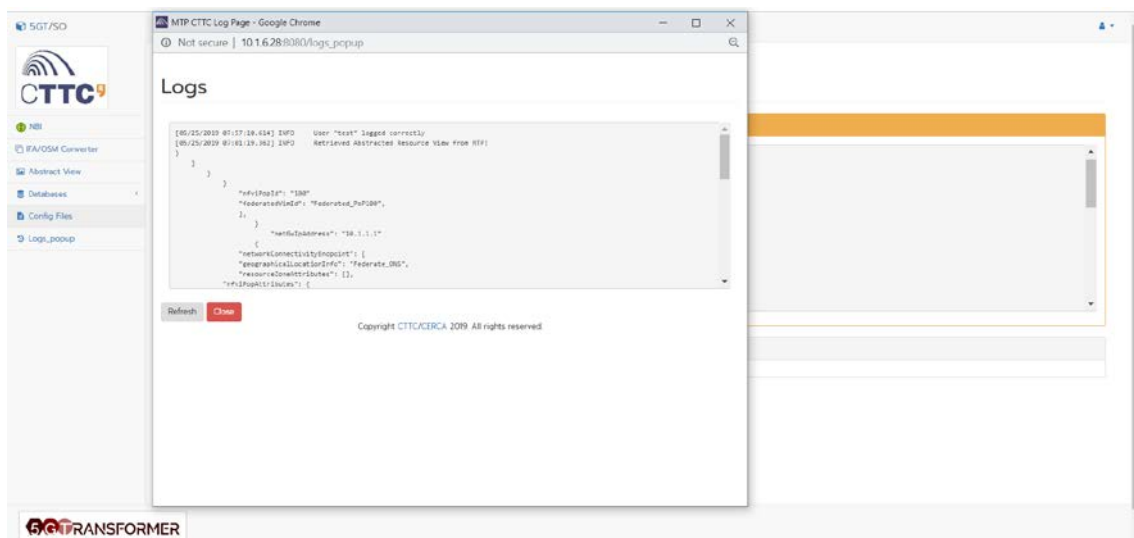


FIGURE 11: 5GT-SO ADMIN GUI - INSPECTION OF 5GT-SO LOGS

2 References

- [1] 5G-TRANSFORMER, D4.3, Final design and implementation report on service orchestration, federation and monitoring platform, May 2019.
- [2] 5G-TRANSFORMER, D4.4, Final design and implementation report on service orchestration, federation and monitoring platform (reference implementation), May 2019.
- [3] 5GT-SO github repository available at the public github: <https://github.com/5g-transformer/5gt-so/>
- [4] 5G-TRANSFORMER, D1.1, Report on vertical requirements and use cases, 2017.