1st mWT Plugtest;
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Contents

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1 Executive Summary

ETSI has organized the first Millimetre Wave Transmission (mWT) Plugtests™ event. This event was hosted by ETSI, from 21 to 24 Jauary 2019 in Sophia Antipolis, France.

The aim of the event was to trial the SDN solutions for Microwave and Millimetre-wave transport applications. The goal of the test was to demonstrate interoperability of the Northbound Interface (NBI) of the SDN Domain Controllers of each participant, both individually and all connected together. The Test Cases covered network and Ethernet topology discovery and end-to-end creation and deletion of a L2 E-LINE service. Validation of the service definition was performed with a data traffic generator.

One key aspect of the tested scenarios was the adoption of a Standard NBI definition based on Restconf and IETF Data Models, including both general network- and service level models, and the recent Microwave Topology Model.

The main highlights of this event are:

1. 100% interoperability was demonstrated
2. Seven Manufacturers participated, representing 90% of the market solutions providers from around the world, including Asia and Europe
3. Four Global Telecommunications Operators attend the event as observers
4. Suitability of this architecture to reduce to zero interoperability testing among Domains
5. Great ease and efficiency of converging through active collaboration to a unified and powerful NBI definition
6. A fully functional (and publicly available) test suite is produced, as a byproduct of the adopted test architecture

The results of the Plugtest, and especially the commonly agreed models, will be provided to ETSI ISG mWT to create a profile of SDN for Microwave and Millimetre-wave transport applications.

2 References

[i.1] I2RS Topology Model: https://tools.ietf.org/html/rfc8345

[i.2] TE Topology Model: https://tools.ietf.org/html/draft-ietf-teas-yang-te-topo

[i.3] MW Topology Model: https://tools.ietf.org/html/draft-ye-ccamp-mw-topo-yang

[i.4] Ethernet Topology Model: https://tools.ietf.org/html/draft-zheng-ccamp-client-topo-yang

[i.5] Ethernet Service Model: https://tools.ietf.org/html/draft-zheng-ccamp-otn-client-signal-yang

[i.6] Restconf protocol: https://tools.ietf.org/html/rfc8040

[i.7] YANG Module Library: https://tools.ietf.org/html/rfc7895

[i.8] FORGE Repository: https://forge.etsi.org/gitlab/sdn/mwt/mwt-plu-postman-collections

[i.9] Test Plan: https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/mWT_Plugtest1_TestPlan_v1.0.pdf

3 Abbreviations

DC	Domain Controller
DUT	Device Under Test
GE	Gigabit Ethernet
IFS	Interoperability Feature Statement
mmW	Millimetre wave
MW	Microwave
NBI	Northbound Interface
NE	Network Element
NMS	Network Management System
SBI	Southbound Interface
SDN	Software Defined Network
TD	Test Description

4 Participants

The teams which executed tests during the Plugtest are listed in the table below.

Table 1: List of teams

#	Team
1	Ceragon Networks
2	Ericsson
3	Huawei
4	Intracom Telecom
5	NEC
6	Nokia
7	SIAE

Table 2: List of observers

#	Observer
1	BT
2	Deutsche Telekom
3	Orange
4	Vodafone

5 Architecture

5.1 Reference SDN Architecture

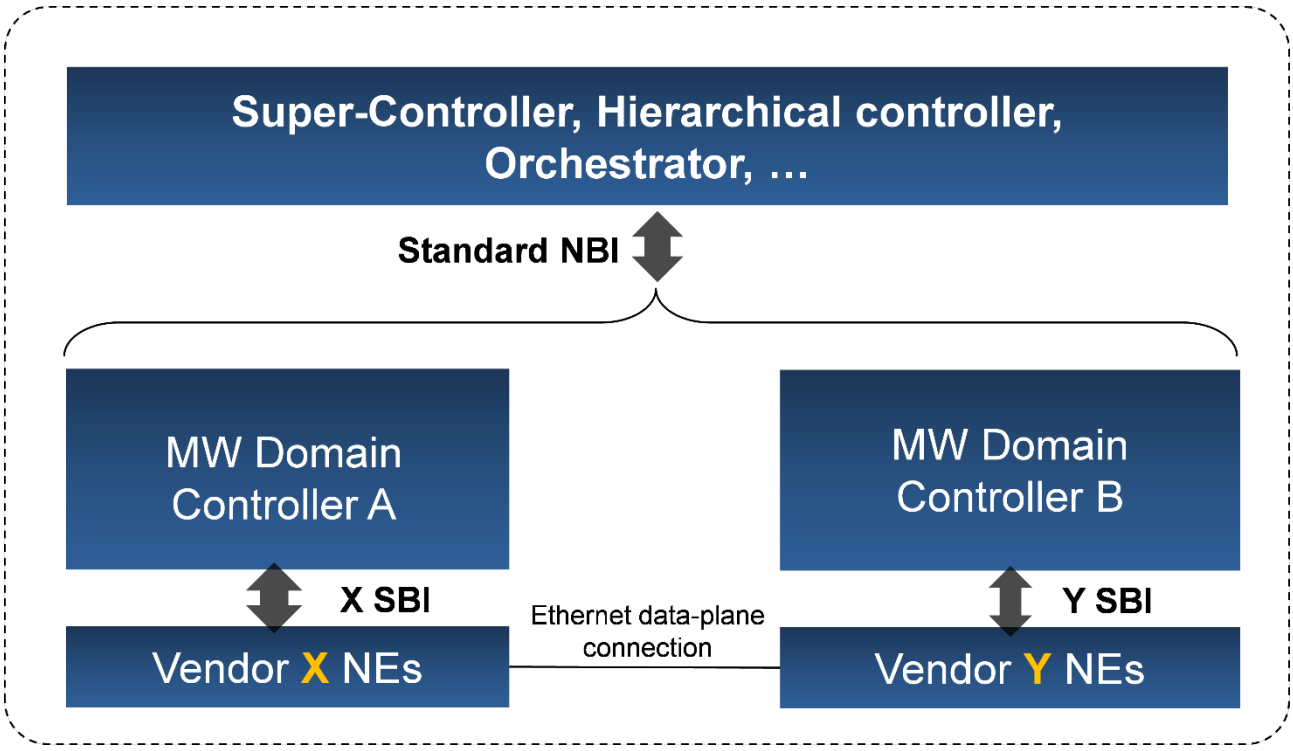

Figure 1 Generic Multi-Domain, Multi-Vendor SDN Architecture

With reference to Figure 1, this Plugtest focused on the DC's NBI, regardless of the specific overall architecture choices made in layers above the Domain Controller.

Also, as an explicit choice, nothing was specified or required regarding the DC's SBI (i.e. the interface between a DC and its managed NEs), regarding protocols, data models etc.

The basis for the definition of the NBI whose interoperability was tested by this Plugtest was the use of the Restconf protocol (RFC 8040) and the YANG DM library provided by IETF (RFCs and relevant drafts.

As depicted in Figure 2, in order to simplify the test specification and implementation, the interoperability testing was by unanimous agreement of the mWT ISG performed by using an API Development and Testing environment, namely the Postman system.

Tests were performed by exploiting the automation (scripting) capability of Postman, with a single set of scripts being jointly developed specifically for this Plugtest by the Participants and stored in the Plugtest's Forge code repository [i.8].

Specifying a single set of scripts and the expected format and content of the related responses by the DCs, it was possible to univocally determine the compliance of the DCs to the relevant standards and confirm the multi-domain interoperability of the systems under test and the specified NBI.

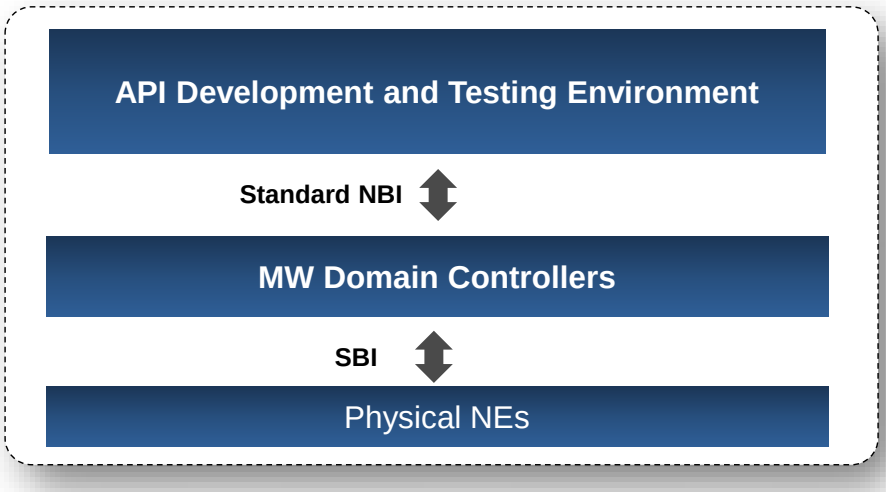

Figure 2 Plugtest SDN Architecture

5.2 Test Network Architecture

5.2.1 Logical Topology

Figure 3 shows the logical topology of the Plugtest network.

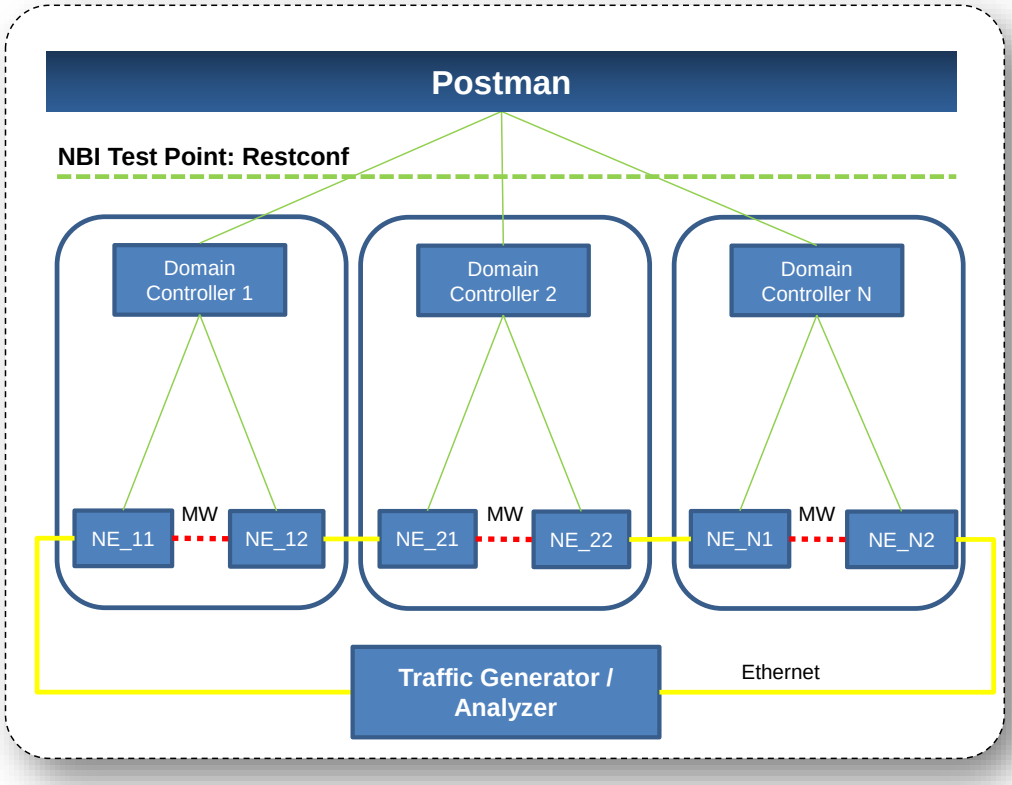

Figure 3 Logical Topology of the Test Network

- Each Domain contains exactly one MW (mmW) link. The physical connection between the two RF units of the radio link within one domain shall be realized with coaxial cable or waveguide plus attenuators, no antenna and no free space radiation is allowed
- MW links are arranged in a linear topology
- Each link is connected to the adjacent one via an Ethernet cable, the first and the last NE in the total chain are connected to a packet traffic generator / analyzer via Ethernet cables
- The connection between the Domain controller and its MW link is internal to the domain and completely taken care for by the respective Participant
- All naming of attributes is indexed to the Domain "number" (1 to N for a total of N Domains) in order to simplify the script execution

Figure 4 and Figure 5 show the general and detailed physical structure of the test network.

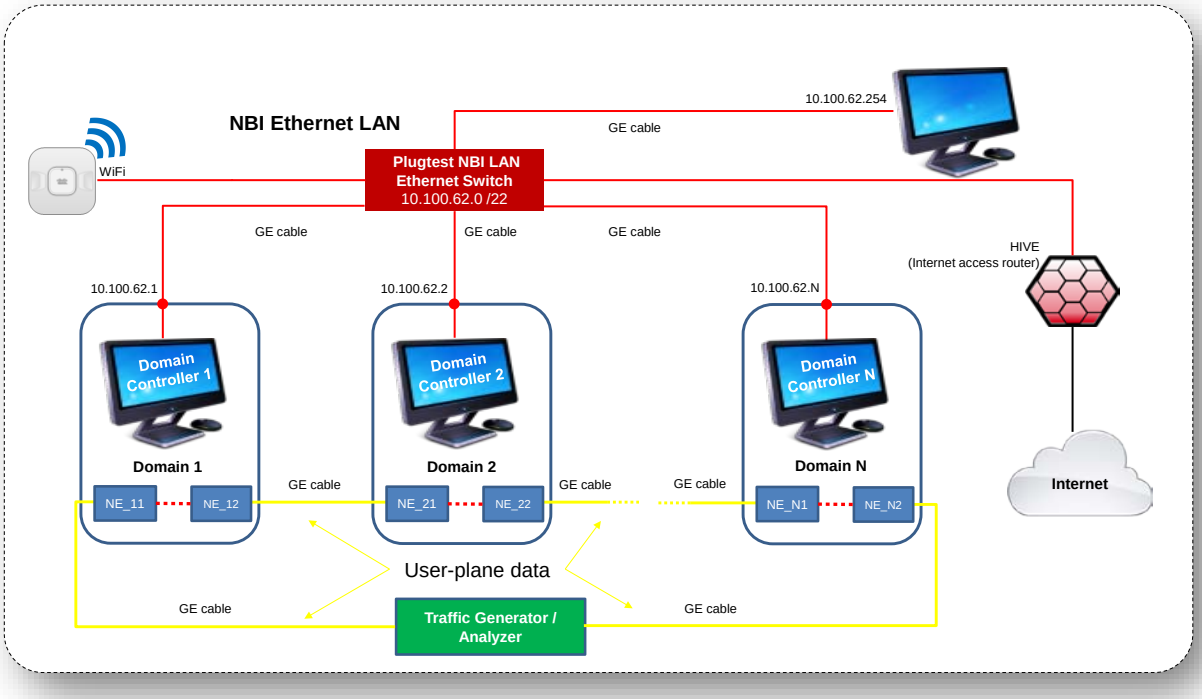

Figure 4 Physical Structure of the Test Network (All Domains Connected)

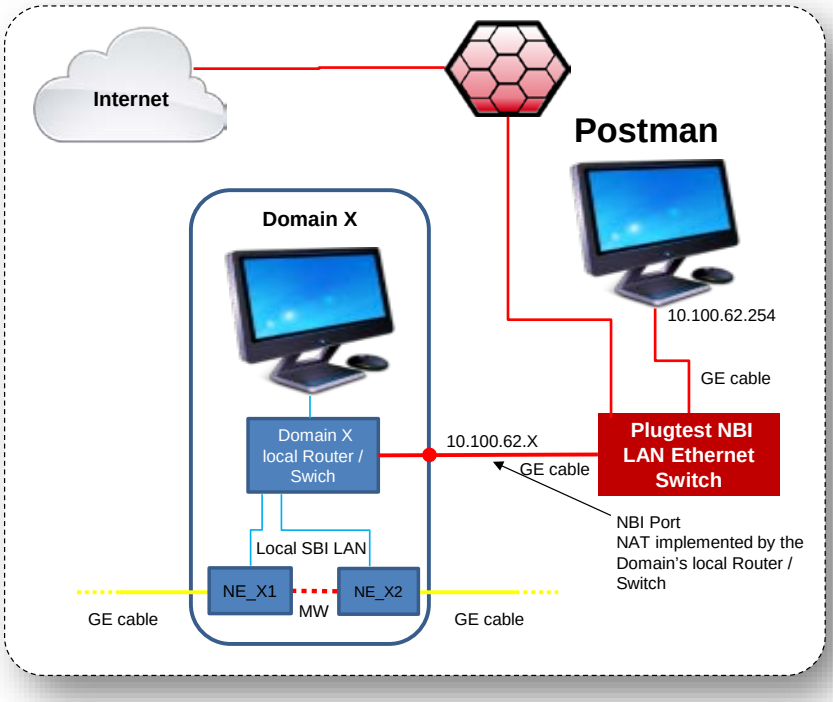

Figure 5 Physical Structure of the Test Network (Detail of one Domain)

- The LAN used to connect the Domain Controllers to the Postman is a simple Ethernet LAN with a single Ethernet switch
- The NBI IP addressing plan is static, based on private IP (e.g. 10.100.62.X, where X is the given Domain unique assigned number – from 1 to N if there is a total of N Domains)
- NAT is used at the Domains' NBI Port, in order to completely isolate the Postman NBI LAN
- The Domain's own Router / Switch is complete responsibility of the Domain's owner
- The single Postman instance used for all testing is running on a common, dedicated computer. This computer is connected via Ethernet cable to the NBI LAN (with internet access for Plugtest's Forge [i.8] etc.)

5.2.2 Data Plane Network

The test cases that create and delete a L2 service required the use of a Test Instrument (Spirent TestCenter C1) to generate the traffic, and to confirm that it is flowing correctly when the circuit is set up.

This data-plane network was closed, i.e. not connected to any other network (test network, internet etc.)

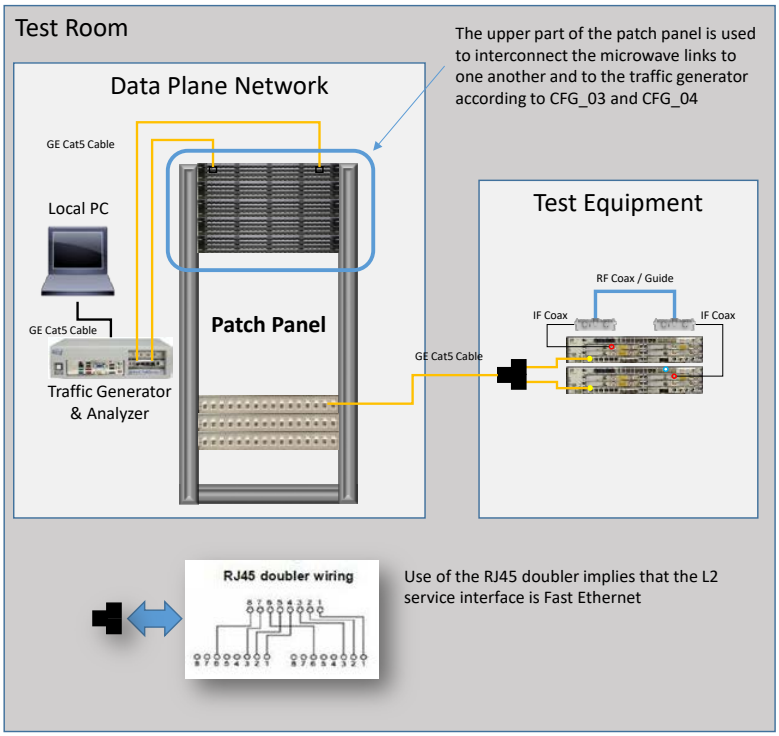

Figure 6 Data Plane Physical Interconnections

The use of the RJ-45 doubler, needed to connect to the portable patch panel provided by ETSI CTI, meant that the physical interface type had to be 100Base-T.

5.3 Data Model Architecture

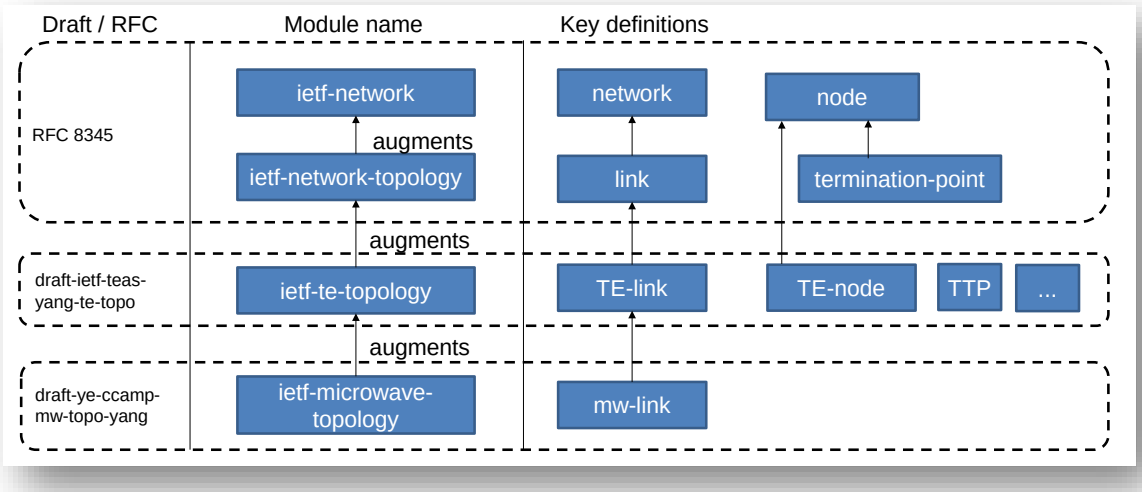

Figure 7, Figure 8 and Figure 9 depict a simplified DM topology overview as it was used in this Plugtest.

Figure 7 IETF Microwave Topology Models

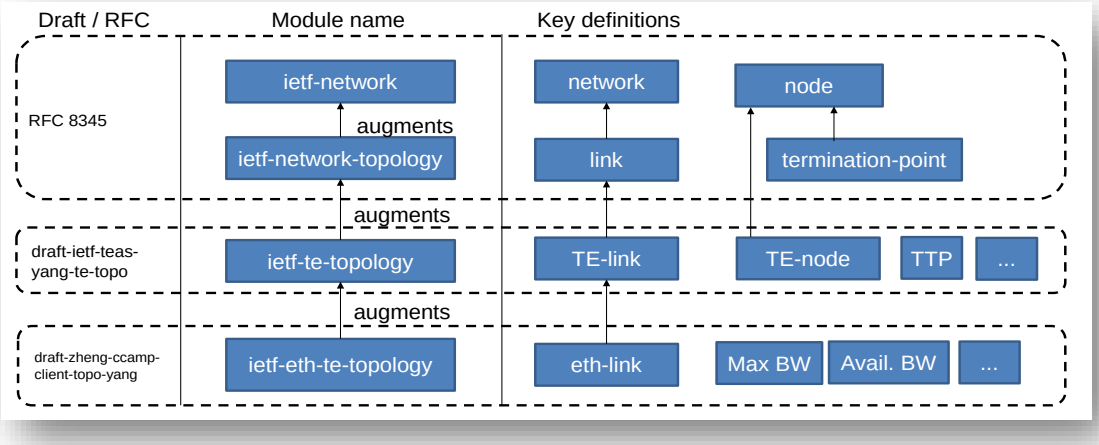

Figure 8 IETF Ethernet Topology Models

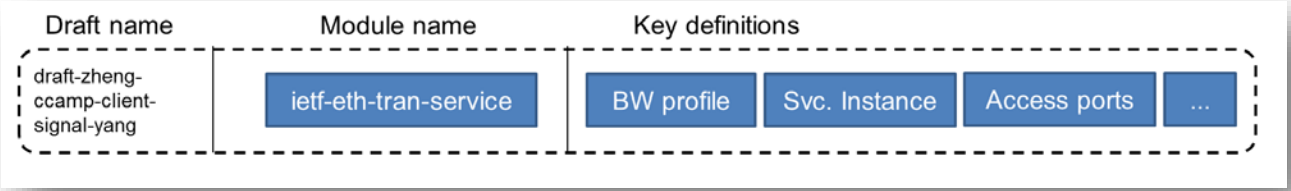

Figure 9 IETF Ethernet Service Model

5.4 Reference Topology Models

5.4.1 Single Domain Topology Exposed on NBI

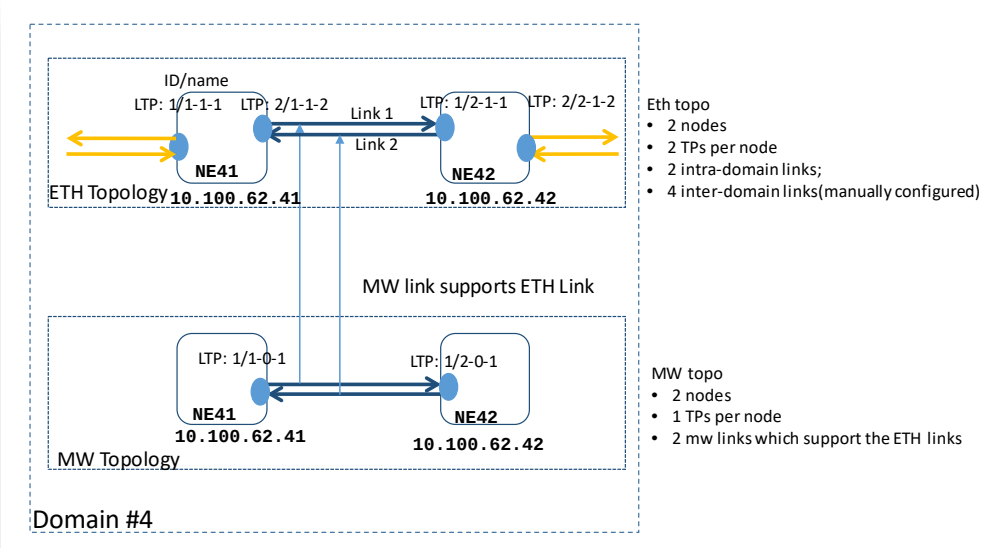

Figure 10 Single Domain Topology Exposed on NBI

Note 1: The inter-domain links' information is not requested to be published across the NBI for this Plugtest.

6 Achieved Interoperability Results

For the full description of the Test Plan document that can be found at https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/mWT_Plugtest1_TestPlan_v1.0.pdf.

The Postman scripts that were used can be found at https://forge.etsi.org/gitlab/sdn/mwt/mwt-plu-postman-collections.

Below are the screenshots proving the successful result of each individual test.

The test and the domain involved in each can be found in the screenshots.

6.1 Discovery Tests

The results can be found in the accompanying document "Plugtest Report - Network Discovery.pdf".

Notes:
The second screenshot for TD_SDN_SNSD_03, available for other Domains, is missing for Intracom Telecom's Domain. The test was nonetheless fully Pass.

6.2 Service Provisioning Tests

The results can be found in the accompanying document "Plugtest Report - Service Provisioning.pdf"".

Notes:
The indicated throughput measured by the Spirent TestCenter instruments, and shown as a tachometer graph in the screenshots from the instrument's management software, show a value for "Aggregate Port L1 Rx Rate" around 25.6Mb/s. this is due to the fact that the requested L2 service specified 6.4Mbps CIR and 6.4Mbps EIR, so the theoretical aggregate throughput (both directions) in absence of congestion is 25.6 Mb/s.

7 Lessons Learned

- The IETF Data Model library provides a very rich set of standards, including micro- / millimetre-wave dedicated models
- Only a subset of the defined models is needed for the MW/mmW applications
- It is extremely easy and backward-compatible to extend the standards (now and in the future) to cover specific and new features and applications of MW/mmW
- Being compliant to common standards, the Domain Controller implementtions are ready for production deployment in real networks
- Using an API development platform like Postman has many important advantages:
    - It is very easy to quickly converge to a common and compliant implementation of the NBI among different manufacuters by using the very same code and comparing results and behaviours directly. This step took only a few weeks from when the Domain Controllers' implementations were available
    - There is no ambiguity in describing the expected behaviour for each test case
    - There is no troubleshooting required in case of behaviour divergence among domains, as there may be by using a third-party "Application"
    - Compliance is determined by the tool itself in a clear Pass/Fail manner
    - The code developed to be used in the Postman platform turns out to be – as it is – the complete and unified test suite to certify any product for compliance to the NBI definition
- The ETSI Plugtests™ framework provides a productive, collaborative and fair collaboration environment among different parties across the industry

8 Conclusions

This interoperability test campaign was a complete success, of great significance given the almost universal participation of the MW/mmW industry.

A clear NBI defined based on the huge amount of IETF Data Models and protocols and frameworks allows to quickly achieve complete and provable interoperability, without need of extensive and extremely resource-intensive prior interoperability testing among any combination of Domain Controller implementations.

This allows not only orders of magnitude cost savings, but also ensures extreme ease and speed of development and convergence, as was demonstrated that the actual time required to complete all the tests took less time than what was initially planned; instead of 4 testing days, the test campaign could be accomplished withon two days.

History

Document history		
V_internal0.1	25.01.2019	First draft
V_internal1.1	30.01.2019	Notes added to 6.1 and 6.2
V1.0	18.02.2019	Made available