ETSI CTI Plugtests Report V1.1 (2026-02)

TECHNICAL REPORT

5th mWT SDN Plugtests
Sophia Antipolis, France
10 – 14 November 2025

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1 Executive summary

ETSI organised the fifth mWT (millimetre Wave Transmission) SDN (Software Defined Network) Plugtests™ event from 10 to 14 November 2025. The event took place at the ETSI headquarters, in Sophia Antipolis, France.

This event marked a significant milestone in advancing multi-vendor interoperability and automation for Software-Defined Networking (SDN) in Wireless Backhaul (W-BH) and X-Haul transport networks. Building on outcomes from the previous Plugtests, the event validated and further matured NETCONF/YANG-based Southbound Interface (SBI) implementations across microwave (MW) and millimetre-wave (mmW) equipment under realistic deployment scenarios.

The Plugtests event exercised and verified real-world implementations of open, standardised YANG models across key automation use cases, including:

- Network and Service Auto-Discovery
- End-to-End Service Provisioning
- Performance Analysis and Prediction
- Smart Alarm Analysis and Fault Prediction

Based on the concepts outlined in ETSI GR mWT 016 "Applications and use cases of Software Defined Networking (SDN) as related to microwave and millimetre wave transmission" [i.1] and ETSI GR mWT 025 - “Wireless Backhaul Network and Services Automation: SDN SBI YANG models” [i.2], these use cases demonstrated tangible progress in enabling programmable, scalable, and efficient transport network operations, aligned with the industry’s evolution towards 5G and beyond.

Automated and repeatable testing, supported by open-source tools (such as the Robot Framework), provided transparency and objective insight into SBI maturity, compliance, and gaps.

This edition also addressed areas identified during the 4th Plugtests, notably refinements to IETF microwave YANG modules and enhanced multi-vendor alignment, while expanding automation capabilities through both enhanced and new use cases. Furthermore, the test activities were aligned with the ongoing work in ETSI mWT, particularly the development of the new standardized YANG data models profile defined in “SDN SBI Wireless Transport – Profiles for HW Inventory Use Cases” [i.3], ensuring consistency between Plugtests findings and standardization progress.

Key Outcomes for the Industry

- **Increased Interoperability:** Demonstrated consistent SBI behaviour across multi-vendor environments
- **Operational Advancements:** Validated automated provisioning, monitoring, and fault workflows *supporting OPEX reduction*
- **Standardization Support:** Provided feedback to refine IETF/IEEE YANG models and contributed to ETSI mWT profile work (“SDN SBI Wireless Transport – Profiles for HW Inventory Use Cases” [i.3])
- **Future-Network Enablement:** Strengthened foundation for AI-assisted operation and real-time orchestration in next-generation transport networks

Five organizations participated alongside three network operator observers. The event was highly successful: a final success rate of 90,7% was achieved over the 183 tests executed. A number of observations and opportunities for improvement were identified and are being fed back into ETSI ATTM TM_mWT.

Overall, the 5th SDN Plugtests contributed practical validation, implementation feedback, and measurable progress towards open, programmable, and intelligent transport networks, supporting operators and vendors in the journey towards fully automated network environments.

2 References

The following referenced documents apply:

[i.1] ETSI GR mWT 016 (July 2017): "Applications and use cases of Software Defined Networking (SDN) as related to microwave and millimetre wave transmission". https://www.etsi.org/deliver/etsi_gr/mWT/001_099/016/01.01.01_60/gr_mwt016v010101p.pdf [i.2] ETSI GR mWT 025 (March 2021): " Wireless Backhaul Network and Services Automation: SDN SBI YANG models ". https://www.etsi.org/deliver/etsi_gr/mWT/001_099/025/01.01.01_60/gr_mWT025v010101p.pdf

[i.3] ETSI Draft : SDN SBI Wireless Transport – Profiles for HW Inventory Use Cases https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=74377

[i.4] ETSI mWT SDN Test Plan https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/ETSI_mWT_SDN_TestPlan_v1.0.zip

3 Abbreviations

For the purposes of the present document, the abbreviations from the mWT SDN Test Plan [i.4] apply.

4 Participants

All the participating companies had team members present on site at ETSI and were supported by their back-office teams. Two observers were present on site at ETSI, and one observer attend remotely the daily wrap-up sessions.

The table below shows the list of all the organizations along with their role.

Table 1: Participants

Company Name	Role
CNIT	Test tool provider
Ericsson	Vendor
Huawei	Vendor
Nokia	Vendor
SIAE Microelettronica	Vendor
ZTE	Vendor
Deutsche Telekom	Observer
Vodafone	Observer
Orange	Observer

Appreciation is extended to the vendor Intracom Telecom for their contributions during the preparation phase of the event, despite their inability to attend.

5 Details about the event

5.1 Test Network Architecture

5.1.1 Overview

The figure below shows the Network Architecture.

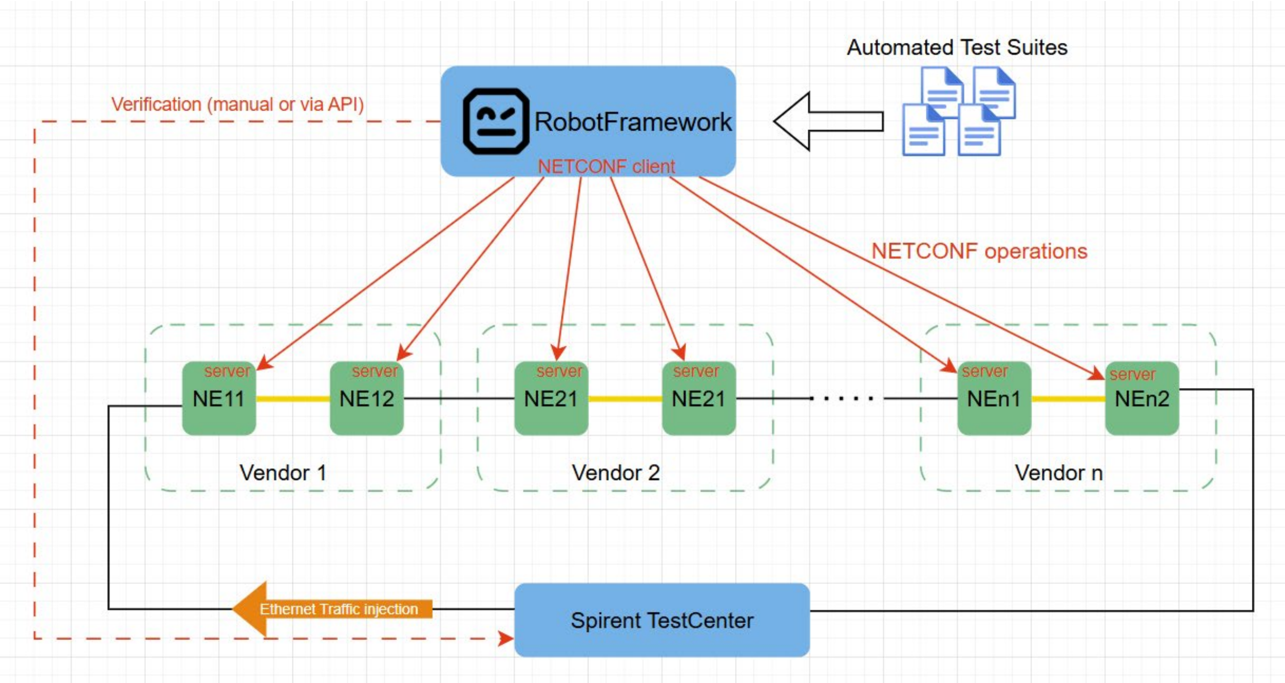

Figure 1: Test Network Architecture

Each network equipment vendor provided a pair of network elements, representing both ends of a millimetre wave or microwave link. The physical connection between the two RF units of the radio link was realized with coaxial cable or waveguide plus attenuators; no antenna and no free space radiation was allowed.

The links were arranged in a linear topology to enable an end-to-end service to be configured.

Each network element was connected to the adjacent one via an optical fibre connection through a patch panel. The first and the last network elements in the total chain were connected to a packet traffic generator/analyzer, also via optical fibre connections.

5.1.2 Data Plane

The test cases that create and delete a L2 service required the use of a Traffic Generator (Spirent N4U TestCenter, see clause 5.5.3) to generate the traffic, and to confirm that the traffic was flowing correctly when the circuit was set up.

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

5.1.3 mWT Robot Framework

The mWT Robot Framework is an automated testing framework specifically designed to support API testing of the mWT devices. It is capable of executing a wide range of test cases to verify whether a NETCONF server behaves according to the established mWT YANG profile. By simulating various API calls and validating responses against expected outputs, the Robot Framework played a key role in ensuring the correctness, consistency, and reliability of the mWT YANG implementations. For more details refer to clause 4 of the mWT SDN Test Plan [i.4].

The mWT Robot Framework is accessible with an ETSI Online Account at https://forge.etsi.org/rep/mwt/mwt-test-scripts.

5.2 Logical Topology of the Test Network

The figure below shows the Logical Topology of the Test Network. The patch panel, as well as the traffic generator, were part of the test network.

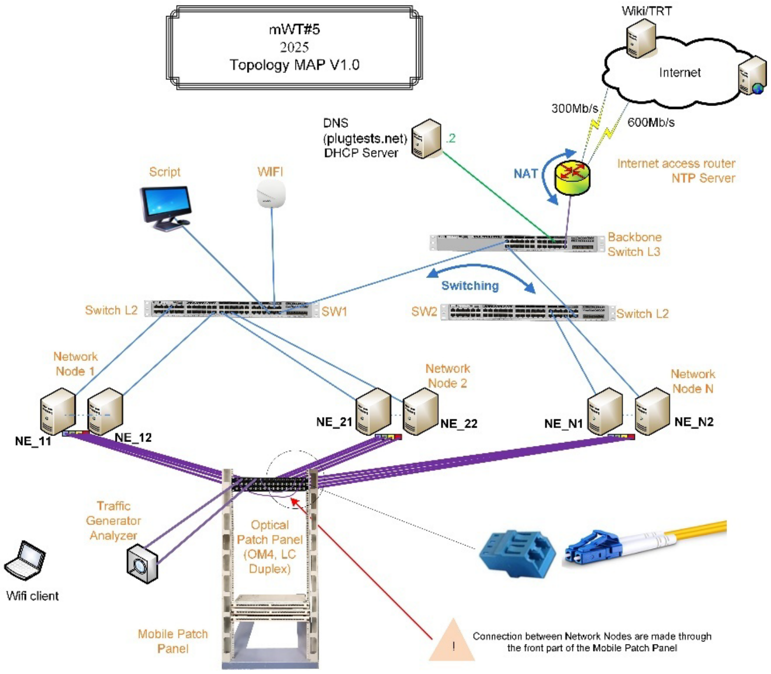

Figure 2: Test Network

5.3 Timeline

The figure below summarises the different phases in the preparation of the Plugtests Event.

	June	July	Aug	Sept				Oct					Nov	
				wk 36	wk 37	wk 38	wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46
Conf Calls	X	X	X	X	X	X	X	X	X	X	X	X	X	
Company Registration	17/06 - 15/09													
Equipment Registration							18/09 - 09/10							
Test Script Validation							18/09 - 30/10							
Plugtests Event														10/11 - 14/11

Figure 3: Timeline of the event

Conference calls: Regular conference calls were held to allow every participant to collaborate and review drafts. Especially the Test Plan and the YANG Profile were developed and consolidated in an iterative way, considering input and feedback received from all the participants.

Company Registration: Registration to the Plugtests Event was open from mid-June to mid-September to any organisation willing to participate in testing the mWT Ecosystem.

Equipment Registration: This was a necessary step for the room plan and the test schedule. Every vendor provided a pair of network elements.

Test Scrip Validation: The test scripts evolved together with the Test Plan. The test scripts were accessible via a git repository and every vendor could execute the test script locally. The validation allowed every vendor to assess their level of compliance and helped to debug the script.

Plugtests Event: From 10 to 14 November 2025, participants connected their equipment with the test network to collaboratively run the Interoperability Test Sessions onsite at ETSI.

5.4 Tools

5.4.1 Event WIKI

The WIKI provided information for the event. Access to the WIKI was restricted to participating companies. The main technical information provided in the WIKI was organised as follows:

- Event Information – Logistics aspects of the Plugtests event
- Host Information – Information about the equipment available
- Shipment of Equipment – Information regarding shipment of equipment
- Visa Information – Visa related information was provided for vendors require visa for travel
- Schedule – Complete schedule of the event
- Test Network Information

5.4.2 Test Reporting Tool

The Test Reporting Tool guided participants through the Test Plan test cases during the Test Sessions. It allowed creating Test Session Reports compiling detailed results for the individual scheduled Test Sessions.

Only the companies providing the EUTs for each specific Test Session combination had access to their Test Session Reports contents and specific results. All companies involved in a specific session and who have entered the test results were required to verify and approve the reported results at the end of each session.

Another interesting feature of this tool was the ability to generate real-time stats (aggregated data) of the reported results, per test case, test group, test session or overall results. These stats were available to all participants and organisers and allowed tracking the progress of the testing with different levels of granularity, which was useful to analyse the results.

5.4.3 Spirent N4U TestCenter

The traffic generator deployed was a SPIRENT N4U TestCenter, an end-to-end test solution to measure and validate the data connections. The setup of the SPIRENT N4U TestCenter was:

- 4 Gigabit Ethernet ports
- SFP 1000-BASE_SX
- Streams configuration
- Independent stream evaluation
    - TX/RX rate
    - Dropped frames
    - Latency

5.5 mWT Hardware Profiles

The mWT SDN Test Plan defines five hardware profiles, see clause 5 of the mWT SDN Test Plan [i.4]. The following hardware profiles were implemented by the vendors:

- HW_CFG_02
- HW_CFG_03
- HW_CFG_04

5.6 Test Configurations

Not all defined test configurations defined in clause 5 of the mWT SDN Test Plan [i.4], were deployed during the event. The table below show how the mapping of use cases to the configurations. The main considerations were:

- The Single Mode configuration can be considered as a typical Conformance test setup, with a single vendor testing against a test system, and thus it was a gating criterion to enter the more advanced testing of Dual Mode and Chain Mode.
    - Use cases 1, 3 and 4 contain API tests which are independent of any neighbor/chain behaviour and thus were run only in Single Mode. This isolation allowed to simplify the detection of potential API issues.

- Use Case 02 was the most complex use case with service provisioning, modification and deletion and traffic flow.
    - Use Case 2 was executed in all three configurations.

Table 2: Test Configurations used during the event

	Single Mode	Dual Mode	Chain Mode
Use Case 1	Yes (CB, PB, PEB)	No	No
Use Case 2	Yes (CB, PB, PEB)	Yes (E2E + Cascade)	Yes (E2E + Cascade)
Use Case 3	Yes (CB, PB, PEB)	No	No
Use Case 4	Yes (CB, PB, PEB)	No	No

6 Achieved Results

6.1 Use Case 1

6.1.1 Motivation

The use case area of network and service discovery can be broken down into two logical applications.

Auto-Discovery: Traditional microwave NE deployment procedures can often be more complex than other transport technology domains due to the detailed planning, coordination, spectrum license applications and configuration of physical layer radio attributes before commissioning can take place. In addition, the initial installation procedure typically requires significant time and effort from expert resource before higher layer protocols can be established for further configuration and service provisioning. A standardized and interoperable SBI has the potential for near real-time integration of multi-vendor NE with centralized network planning tools to automate or assist commissioning, optimization and validation of new radio links.

NE Capabilities and Domain Characteristics: The ability to track and query configuration capabilities and active topology of the network underpin the management ability of the operator. An SDN ambition for the operator is the ability to provision end to end services regardless of the underlying transport technology. This can only be realized with effective technology domain abstraction where technology specific automation (based on NE capabilities and topology) can be handled by domain controllers. A standardized super-set of technology specific capabilities (e.g. physical links, ports, HW profile and services) would allow network services to be implemented in multi-vendor, multi-technology domain.

6.1.2 Expected Value

The most significant benefit for operators of automatic discovery of NE (which in turn facilitates automated or semi-automated commissioning and inventory systems) is through OPEX cost savings. Deployment of microwave transmission equipment is a particularly costly and time-consuming procedure where standardized interfaces and data models can enable faster time to market and enable greater flexibility of suppliers and supplier equipment without the (often cost prohibitive) proprietary NMS/OSS/BSS integration.

Auto-discovery of network equipment topology and capabilities also could enable seamless integration of new applications for near real-time visualization of microwave link information relevant to planning and operational teams. New applications could permit accurate and frequent asset and inventory management tasks, track upgrades and their impacts, re-configuration and security patching across all domains. Where such procedures are currently manual or part-manual processes there is significant scope for error and inaccuracy which could be removed through automated configuration audits and automatic correction against the target/desired configuration.

6.1.3 Achieved Results

The table below shows the summary of the UC 01 tests.

Table 3: UC 01, Single Mode, Test Overview

Test ID	Status	Test Objective
INV_HW_01	M	HW Inventory
INV_SW_01	M	SW Inventory
INV_CAR_01	M	Microwave Carrier Inventory
INV_ETH_CAR_01	M	Ethernet Carrier Inventory
INV_SRV_01	M	Customer Bridge Mode Inventory
INV_NET_01	M	LLDP Neighbor Inventory

The testing and test setup were structured in different test sessions. The table below shows the UC 01 test sessions. All test sessions used the same configuration: Single Mode, Customer Bridge, Tagged Traffic. Each vendor executed the tests individually against the test system and traffic generator. No chain mode or dual mode was used.

Table 4: UC 01, Single Mode, Test sessions

Test session
Test System + Traffic Generator+ Ericsson
Test System + Traffic Generator+ Huawei
Test System + Traffic Generator+ Nokia
Test System + Traffic Generator+ SIAE
Test System + Traffic Generator+ ZTE

The table below shows the results of the UC 01 tests.

Table 5: UC 01, Single Mode, Results

	Interoperability		Not Executed	Totals	
	OK	NO	NA	Run	Run + NA
UC 01	30 (100%)	0 (0%)	0 (0%)	30	30

6.2 Use Case 2

6.2.1 Motivation

The process of creating new backhaul services is currently separated mainly between IP and MW teams. IP service provisioning is usually done using command line interface by IP teams while MW services creation (usually Layer2) is performed on the Element Management System which implies laborious configuration on each NE. Thus, service provisioning is time consuming and could likely encounter human errors.

Another scenario met in operators' networks is the provisioning of a single service over a multi-vendor MW network which requires multiple configurations on different Element Managers, automation based on standardized equipment interfaces would significantly improve the efficiency of such operations.

Moreover, the emergence of 5G and specifically the E2E network slicing will require "on the fly" bandwidth provisioning between two nodes in a transport network according to several criteria (e.g. Latency, Bandwidth, physical routing constraints, etc.), this can be enabled by automating the services creation.

6.2.2 Expected Value

The target eventually will be to have a seamless and automated service provisioning over IP+MW networks which will bring OPEX savings thanks to time-effective operation and more reliable networks because no human errors. The focus in this work item will be on the automation of the services provisioning on the MW segment only.

6.2.3 Achieved Results

6.2.3.1 Single Mode

The table below shows the summary of the UC 02 – Single Mode tests.

Table 6: UC 02, Single Mode, Test Overview

Test ID	Status	Test Objective
PRO_CUS_CRE_01	M	C-VLAN Customer Bridge Mode - Creation
PRO_CUS_DEL_01	M	C-VLAN Customer Bridge Mode - Deletion
PRO_BRD_CRE_01	M	S-VLAN Provider Bridge Mode - Creation
PRO_BRD_DEL_01	M	S-VLAN Provider Bridge Mode – Deletion
PRO_EDG_CRE_01	M	S-VLAN Provider Edge Bridge Mode - Creation
PRO_EDG_DEL_01	M	S-VLAN Provider Edge Bridge Mode - Deletion

The testing and test setup were structured in different test sessions. A single mode test session was executed as shown in the table below. All test sessions used the same configuration: Single Mode, Customer Bridge, Tagged Traffic. Each vendor executed the tests individually against the test system and traffic generator. No chain mode or dual mode was used.

Table 7: UC 02, Single Mode, Test sessions

Test session
Test System + Traffic Generator+ Ericsson
Test System + Traffic Generator+ Huawei
Test System + Traffic Generator+ Nokia
Test System + Traffic Generator+ SIAE
Test System + Traffic Generator+ ZTE

The table below shows the results.

Table 8: UC 02, Single Mode, Results

	Interoperability		Not Executed	Totals	
	OK	NO	NA	Run	Run + NA
UC 02 Single Mode	30 (100%)	0 (0%)	0 (0%)	30 (100%)	30

6.2.3.2 Chain Mode

After the Single Mode configuration, the test sessions focused on the Chain Mode configuration. Separate tests were defined for the E2E and Cascade configuration as shown in the tables below. It was decided to include the LLDP test, and to execute it as a preamble, before starting with the service provisioning tests.

Table 9: UC 02, Chain Mode, E2E, Test Overview

Test ID	Status	Test Objective
INV_NET_01	M	LLDP Neighbor Inventory
PRO_CHX_E2E_CRE_01	M	S-VLAN – E2E - Creation
PRO_CHX_E2E_DEL_01	M	S-VLAN - E2E – Deletion

Table 10: UC 02, Chain Mode, Cascade, Test Overview

Test ID	Status	Test Objective
INV_NET_01	M	LLDP Neighbor Inventory
PRO_CHX_CAS_CRE_01	M	S-VLAN – Cascade - Creation
PRO_CHX_CAS_DEL_01	M	S-VLAN - Cascade – Deletion

The test sessions shown in the figures below were executed in E2E as well as in Cascade configuration.

The chain was built in a stepped approach as shown in the following figures. In a first step, the chain was built with three vendors. **Ericsson** and **Nokia** were positioned on the edge of the chain, and **Huawei** in the middle.

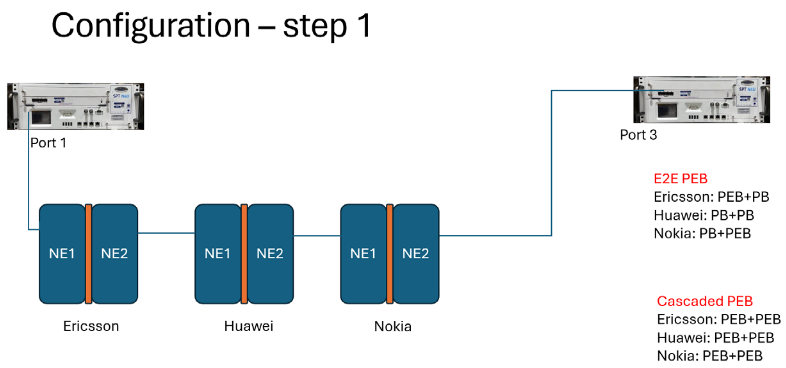

Figure 4: Step 1, Chain Mode 3

Then, **SIAE** was added to the end of the chain.

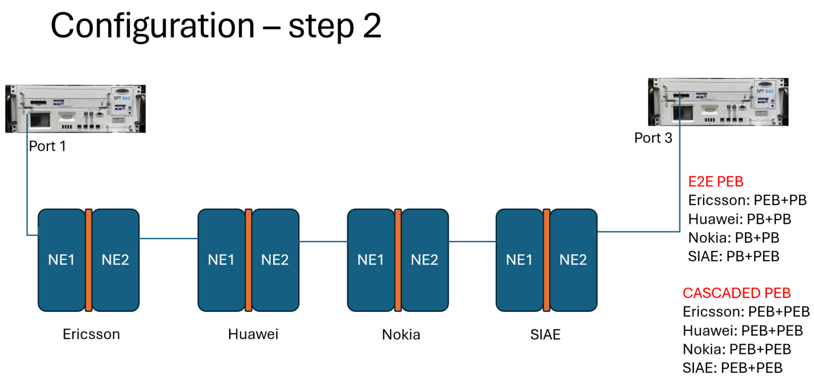

Figure 5: Step 2, Chain Mode 4

Then, **ZTE** was added to the end of the chain.

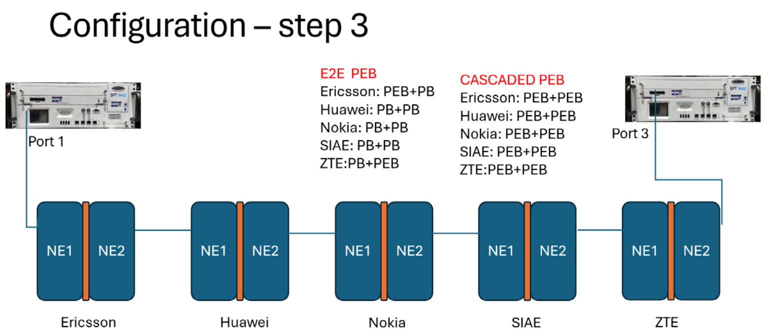

Figure 6: Step 3, Chain Mode 5

In step 4, **Huawei** was positioned on the edge, and **ZTE** moved to the inner chain.

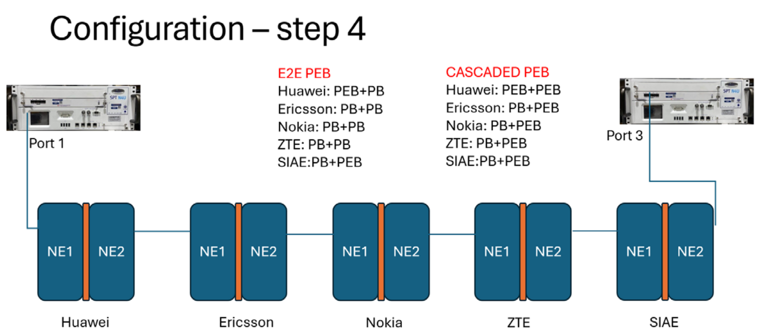

Figure 7: Step 4, Chain Mode 5

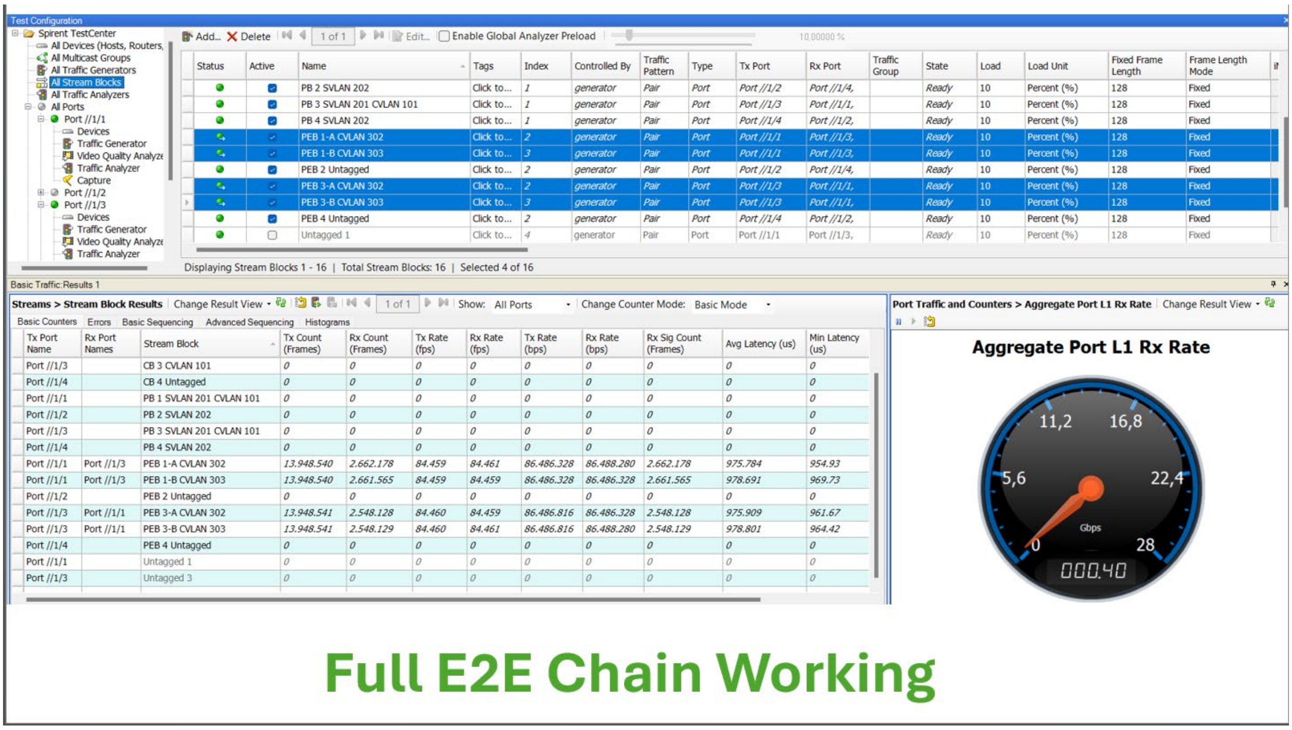

Figure 8: Full E2E Chain Mode Result

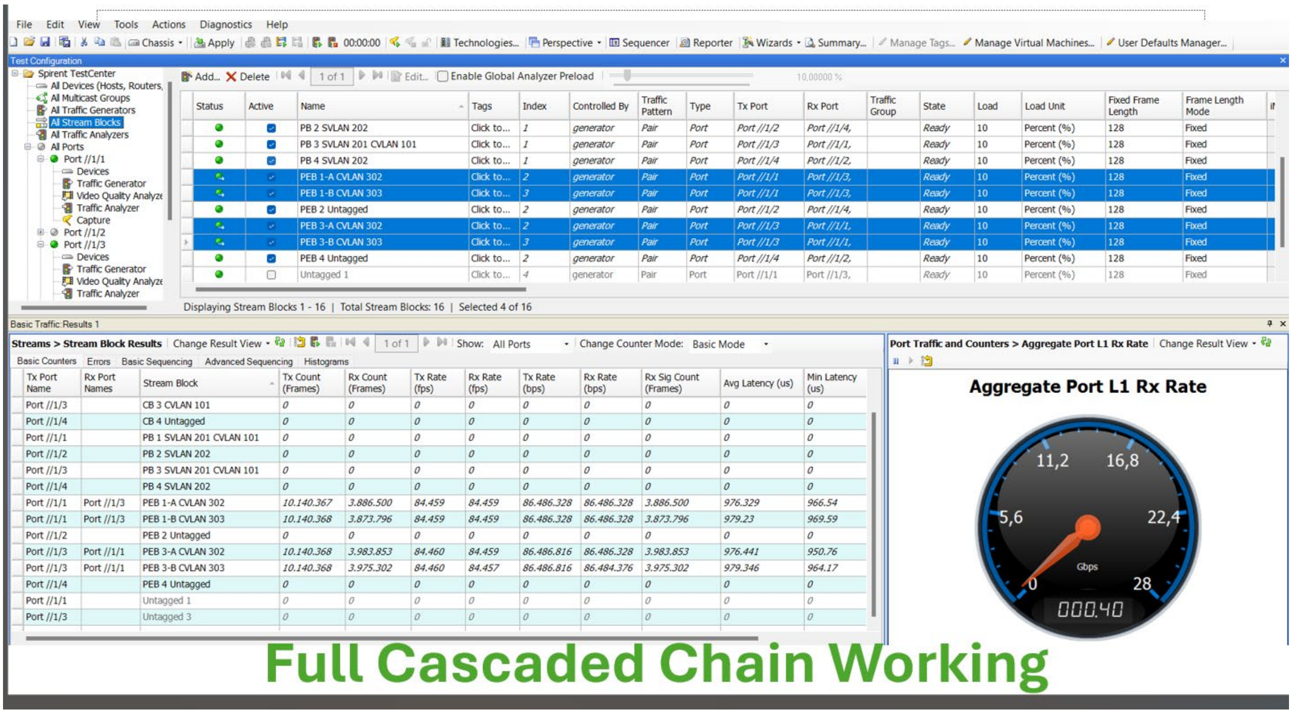

Figure 9: Full Cascade Chain Mode Result

The table below show the results.

Table 11: UC 02, Chain Mode, Results

	Interoperability		Not Executed	Totals	
	OK	NO	NA	Run	Run + NA
Chain Mode 3 E2E	2 (66,7%)	1 (33,3%)	0 (0%)	3 (100%)	3
Chain Mode 3 CAS	2 (66,7%)	1 (33,3%)	0 (0%)	3 (100%)	3
Chain Mode 4 E2E	2 (66,7%)	1 (33,3%)	0 (0%)	3 (100%)	3
Chain Mode 4 CAS	2 (66,7%)	1 (33,3%)	0 (0%)	3 (100%)	3
Chain Mode 5 E2E	4 (66,7%)	2 (33,3%)	0 (0%)	6 (100%)	6
Chain Mode 5 CAS	6 (66,7%)	3 (33,3%)	0 (0%)	9 (100%)	9

The NO result is due to some vendors not having implemented the mandatory LLDP Neighbor Inventory feature.

6.2.3.3 Dual Mode

With the execution of the Chain Mode test sessions, the dual mode configuration was tested implicitly. For example, in the chain **Huawei – Ericsson – Nokia**, the dual mode configurations **Huawei – Ericsson** and **Ericsson – Nokia** were covered and recorded. To cover all possible dual mode permutations, some more chain mode permutations were executed. The test sessions of the dual mode configuration are shown in the table below.

Table 12: UC 02, Dual Mode, E2E and Cascade, Test sessions

	Huawei	**Nokia**	**SIAE**	**ZTE**
Ericsson	E2E Cascade	E2E Cascade	E2E Cascade	E2E Cascade
Huawei		E2E Cascade	E2E Cascade	E2E Cascade
Nokia			E2E Cascade	E2E Cascade
SIAE				E2E Cascade

Table 13: UC 02, Dual Mode, Results

	Interoperability		Not Executed	Totals	
	OK	NO	NA	Run	Run + NA
Dual Mode E2E	26 (86,7%)	4 (13,3%)	0 (0%)	30 (100%)	30
Dual Mode CAS	26 (86,7%)	4 (13,3%)	0 (0%)	30 (100%)	30

The NO result is due to some vendors not having implemented the mandatory LLDP Neighbor Inventory feature.

6.3 Use Case 3

6.3.1 Motivation

Network performance analysis based on intelligent algorithms and network built-in automated processes is considered as a fundamental path to serve end-users requirements in an agile approach, achieve optimum network resources utilization, minimize risks of network failures and increase operational efficiency and productivity, whilst keeping OPEX at acceptable levels. In the context of wireless backhaul/X-Haul domain, intelligent algorithms can be applied to perform smart performance analysis (in the first place) and prediction (at subsequent stages).

With respect to the wireless backhaul/X-haul, there are largely three layers to focus:

- Equipment layer
- Radio link layer

- Service layer (IP/Ethernet)

6.3.2 Expected Value

The proposal is to introduce a use case, where radio performance data is tracked and collected in real-time, i.e. get radio status data by polling (get-requests) or notifications for preconfigured threshold crossing, that can help take an action.

In the mid/long- term, the above actions could be used for AI/ML-powered prediction algorithms that can recognize the causes of any radio impairments and failures, create timely notifications, propose and/or enable the most appropriate mitigation techniques.

6.3.3 Achieved Results

The table below shows the summary of the UC 03 tests.

Table 14: UC 03, Single Mode, Test Overview

Test ID	Status	Test Objective
PER_CAR_01	M	Query performance metrics
PER_CAR_02	M	Operation with minimum Tx power
PER_CAR_03	O	Threshold Alarm Notification
PER_CAR_04	O	Re-establish degraded link

The testing and test setup were structured in different test sessions. The table below shows the UC 03 test sessions. All test sessions used the same configuration: Single Mode, Customer Bridge, Tagged Traffic. Each vendor executed the tests individually against the test system and traffic generator. No chain mode or dual mode was used.

Table 15: UC 03, Single Mode, Test sessions

Test session
Test System + Traffic Generator+ Ericsson
Test System + Traffic Generator+ Huawei
Test System + Traffic Generator+ Nokia
Test System + Traffic Generator+ SIAE
Test System + Traffic Generator+ ZTE

The table below shows the result of the UC 03 tests.

Table 16: UC 03, Single Mode, Results

	Interoperability		Not Executed	Totals	
	OK	NO	NA	Run	Run + NA
UC 03	18 (100%)	0 (0%)	2 (10%)	18 (90%)	20

6.4 Use Case 4

6.4.1 Motivation

Fault management is one of the most critical operational aspects of the network. Typically, there may be small supervision teams overseeing the end-to-end network who utilize or aggregate proprietary EMSs of different networks and vendors, this may generate thousands of alarms every day. Reliable troubleshooting, prioritization and escalation are often a highly manual and time-consuming process. The area of fault management and fault prediction is one of the most promising areas for the application of machine learning where the aim is to realize a proactive fault prediction and mitigation solution based on current and historical alarm patterns.

6.4.2 Expected Value

Automating fault management or preventative maintenance through the introduction of machine learning has the potential for huge OPEX cost saving, improved network availability and quality of service to the end customer. Standardized fault definitions and classifications relevant to wireless transport solutions would allow an SDN domain controller real time information about the radio interface and associated hardware which could be stored, analysed and correlated with equivalent information in the wider SDN solution. Such information could be used to actively predict and prevent future network issues. A robust, cross technology domain root-cause analysis capability would underpin an 'ultra-reliable' network of the future.

6.4.3 Achieved Results

The table below shows the summary of the UC 04 tests.

Table 17: UC 04, Single Mode, Test Overview

Test ID	Status	Test Objective
ALA_CAR_01	M	Query alarm list
ALA_CAR_02	M	New alarm in alarm list due to broken link
ALA_CAR_03	O	Alarm Notification due to broken link
ALA_CAR_04	O	Re-establish broken link

The testing and test setup were structured in different test sessions. The table below shows the UC 04 test sessions. All test sessions used the same configuration: Single Mode, Customer Bridge, Tagged Traffic. Each vendor executed the tests individually against the test system and traffic generator. No chain mode or dual mode was used.

Table 18: UC 04, Single Mode, Test sessions

Test session
Test System + Traffic Generator+ Ericsson
Test System + Traffic Generator+ Huawei
Test System + Traffic Generator+ Nokia
Test System + Traffic Generator+ SIAE
Test System + Traffic Generator+ ZTE

The table below shows the overall result of the UC 04 tests.

Table 19: UC 04, Single Mode, Results

	Interoperability		Not Executed	Totals	
	OK	**NO**	**NA**	**Run**	**Run + NA**
UC 04	18 (100%)	0 (0%)	2 (10%)	18 (90%)	20

6.5 Overall Results

During the Plugtests event, a total of 85 Test Sessions were run: that is, 183 different tests based on different configurations were executed.

The table below provides the overall results (aggregated data) from all the tests run during all the Test Sessions.

Table 20: Overall Results

Interoperability		Not Executed	Totals	
OK	**NO**	**NA**	**Run**	**Run + NA**
166 (90,7%)	17 (8,3%)	4 (2,0%)	183 (98,0%)	187

An overall interoperability success rate of 90,7 % was achieved, which indicates a very high degree of compatibility among the participating implementations (EUTs) in the areas of the Test Plan where features were widely supported, and the test cases could be executed in most of the Test Sessions. This high rate is also a consequence of the good preparation and involvement of participants during the test plan development and the pre-testing phase.

The 4th mWT Plugtests event demonstrated that selected YANG models and attributes matched the desired use cases, setting a profile of standard YANG modules to enable the implementation of automation use cases on Microwave networks. It focused on cross-domain YANG modules, prioritized two of the most beneficial use cases - service provisioning and topology discovery - and highlighted improvement needs in the ietf-microwave-radio-link model. Several vendor-specific adjustments were required, indicating that while interoperability had progressed, there was still room for improvement.

The 5th mWT Plugtests event deepened the SBI implementations by reusing the successful elements of the previous Plugtests event and explored successfully two additional use cases.

The use of the Robot Framework helped to automate the testing.

7 Common Issues Observed

7.1 Introduction

During the interoperability testing event, a number of observations and opportunities for improvement were identified and were fed back into ETSI ATTM TM_mWT.

7.2 Automation between the Robot Framework and the Traffic Generator

- **Problem:** The final verification that data was flowing correctly through the configured chain of NEs, required a manual step on the traffic generator. The tests could be executed in a smoother way, if this step would be automated.
- **Decision:**
    - Make a study to evaluate if an API with the traffic generator can be implemented

7.3 Define the chain permutations in advance

- **Problem:** There are many possible permutations to build the chain of NEs. At the start of the interoperability tests the decision was taken which permutations to run. Knowing this decision in advance (before the event) would help to reduce configuration time.
- **Decision:**
    - Define the chain permutations in advance of the next event.

7.4 Harmonise the test scripts

- **Problem:** The test script development started shortly before the event, not allowing every vendor to validate the test scripts. This resulted in some hot fixes during the event.
- **Decision:**
    - The current test script plus any additional new tests shall we validated well in advance of a next event.

7.5 Reorganisation of the bridge-mode UC 01 tests

- **Problem:** The Provider Edge Bridge and Provider Bridge Mode Inventory vendor APIs can only be fully checked when a traffic service is deployed. Hence, it makes no sense to run the corresponding tests in UC01, and it is deleted from UC01. For consistency, the Provider Bridge Mode test is deleted in UC01.
- **Decision:**
    - Keep the Customer Bridge test in the UC 01 test list.
    - Move the Provider Edge Bridge and Provider Bridge tests to the UC02 test list.

7.6 Reorganisation of the WIKI Event Information

- **Problem:** In the preparation of the event a WIKI was used to provide specific event related information (see clause 5.5.1). However, the test plan was developed in a collaborative manner, using a gitlab repository. The WIKI was located in another domain than the gitlab repository, and it was confusing for the participants to have multiple different web locations.
- **Decision:**
    - The gitlab repository provides a WIKI as well. For a next event only use the gitlab repository WIKI to ensure that all information is at a single web location.
    - Make a study to evaluate whether the current Plugtest 5 WIKI could be merged to the gitlab repository WIKI.

8 Scope of future Plugtests

The following new features could be evaluated in future Plugtests to strengthen the successful adoption and interoperability of mWT implementations.

- IETF RFC 8561 draft version
    - Enables more complex configurations
- QoS
    - Requires further study to understand if cross-vendor applicable tests can be derived
    - Shaping, Policy, WRED,
- Synchronisation
    - E.g. Precision Time Protocol (PTP)
    - Requires further study to understand if cross-vendor applicable tests can be derived
- Add an Open-Source Controller + NBI (vertical expansion of scope)
    - Versus horizontal expansion of scope (new use cases)
- Carrier Terminals at protection mode
- Aggregated Carrier Terminals
- Aggregated Carrier Terminals at Dual Band configuration
- Carrier Terminals at XPIC-pair
- LinkId check at the Carrier Terminals communication
- AI topics
    - AI based controller
    - Use AI to run fault prediction

Annex A: Interoperability Implementation Guide

A.1 Introduction

This guide has been developed as a non-normative annex to support implementers of mWT specifications by capturing lessons learned, clarifications, and best practices identified during the interoperability testing event. The goal is to improve the consistency and correctness of implementations across different platforms.

A.2 Scope

This guide addresses the practical aspects of implementing the mWT standard, based on findings and experiences gathered during the ETSI Plugtests event.

A.3 Best Practices

A.3.1 Foreword

The following best practices are derived from lessons learned during the interoperability event and are intended to promote reliable and semantically consistent mWT implementations. These guidelines should be considered by both platform developers and data providers to ensure correct behavior and compatibility.

A.3.2 Follow Consistent VLAN Naming

- **Why:** Uniform naming helps humans and machines understand and process data more effectively.
- **Practice:**
    - Consistent VLAN IDs were introduced
- **Benefit:** Simplifies debugging, reduces schema mismatches, and promotes clarity.

A.3.3 Consistent Test Configurations Naming

- **Why:** Uniform naming helps humans and machines understand and process data more effectively.
- **Practice:**
    - The different modes (Single, Dual, Chain) were defined and mapped to the different possible setups, such as Customer Bridge (CB), Provider Bridge (PB) and Provider Edge Bridge (PEB) were clarified.
- **Benefit:** Reduces test configuration mismatches and promotes clarity.

A.4 Recommendations for Implementers

A.4.1 Foreword

To ensure successful adoption and interoperability of mWT implementations, developers and integrators should follow the practices outlined below. These recommendations are based on real-world issues observed during the event and reflect a consensus on how to reduce integration friction and improve conformance with the mWT specification.

A.4.2 Run the mWT Robot Framework

- The mWT Robot Framework is available as a git repository
- Run the tests to assess your level of compliance
- Run the tests prior to a Plugtests event

A.4.3 Bring the appropriate power adapters

- The ETSI lab does not provide hardware specific power adapters. It only provides 230 V AC.
- If your hardware requires, for example, a power input of 48 V DC, 12,4 A and power consumption of 600 W, bring this specific power adapter

A.4.4 Bring the appropriate power plugs

- The ETSI lab provides power plugs and sockets (outlets) of type E. The ETSI lab does not provide any adapters.
- If you have a different power plug system, for example, power plugs and sockets (outlets) of type F and type L (used in Italy), bring the appropriate adapters.

History

Document history		
V1.0	December 2025	Publication
V1.1	February 2026	Correction of the Overall Result Addition of the link to the mWT Robot Framework