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Abstract

This deliverable presents functional tests on G^2MPLS Control Plane prototype, which were performed in some local test-bed deployed in Phosphorus project (specifically , PSNC and UESSEX local test-beds). These tests validate the whole G^2MPLS software stack acting the role of network core controller, network border controller and provider edge controller. They also check the expected functionalities of every software component implemented into the stack.

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0 Executive Summary

This document reports the G^{2}MPLS Control Plane prototype functional tests. The purpose of these tests is to verify the Grid and network functionalities implemented in software prototype.

The actual scope of the document is stated in section 1, which provides the guiding information on how to read and use the whole document.

Section 2 introduces into the used terminology and refers to the acronyms list in section 8.

Section 3 describes the testing environment in terms of both transport plane resources and Control Plane configurations to control these resources.

Section 4 introduces testing methodology that has been used for tests descriptions.

Sections 5 presents functional tests and it is divided in three main areas of G^{2}MPLS functionalities:

- LSP signalling, mainly aimed to verify G^{2}MPLS signalling protocol behaviours and related transport network configurations,
- single-domain and inter-domain G^{2}MPLS call signalling, mainly focused on higher level G^{2}MPLS signalling controllers (NCC, CCC) and related interfaces,
- single-domain and inter-domain G^{2}MPLS routing, mainly aimed to check the Grid and Network information advertisement by routing module.

Finally, in section 6 some concluding remarks are provided.

1 Objectives and Scope

This deliverable only provides the information and the results with regards to functional testing on the different modules implemented for the GMPLS and G^{2}MPLS Control Plane. The work reported here is supported by WP2 design documents concerning the G^{2}MPLS architecture [PH-WP2-D2.1] and deployment models [PH-WP2-D2.6], the protocol extensions [PH-WP2-D2.2], the interfaces [PH-WP2-D2.7] and the high-level software design [PH-WP2-D2.3].

This document reports on the specific functional tests conducted to identify and confirms the proper operation of the various G^{2}MPLS modules (developed from scratch or modified with respect to the Quagga software baseline) on real equipments deployed in some Phosphorus local test-beds (fiber and wavelength switches). The deliverable includes:

- The testing environment used to check the performance of the G^{2}MPLS Control Plane software, which focuses on the Transport Plane including equipment and physical topology, as well as on the Control Plane with its G^{2}MPLS stack configuration.
- The methodology for all the conducted tests, introduced to help the reader in following the testing. This methodology is based on a table representing the test-card model used for each test. It describes the objectives of the test and its relationships with other tests carried out. Each test is performed in a step by step basis, checking the correct functioning with the expected results. Finally, a test status confirmation is added to report the test result.
- The actual G^{2}MPLS Control Plane functional tests are been logically reported under three main sections; the LSP signalling tests, the call signalling tests and the routing tests.

This deliverable provides also a general reference to any potential user of the G^{2}MPLS software, in terms of network environment to be created (both physical and logical topologies) and tests to be run for the early checking of the G^{2}MPLS functionalities. The reference to the specific Transport Plane hardware used in the used local Phosphorus test-bed (i.e. ADVA FSP 3000RE-II wavelength switches and Calient Diamondwave Fiber Connect switches) does not limit the scope of the test suite described in this document, but rather suggests a testing methodology for any possible further development by G^{2}MPLS users.

2 Terminology

No specific terminology is introduced by this document. Please refer to Deliverable [PH-WP2-D2.1], [PH-WP2-D2.2], [PH-WP2-D2.3], [PH-WP2-D2.6] and [PH-WP2-D2.7] for any specific terms used.

A full list of the abbreviations used in this document is provided in Section 8.

3 Testing environment

This section describes the testing environment used to test the functionalities of the G^2MPLS Control Plane software, focusing on the physical topology, the Control Plane and the G^2MPLS stack configuration.

3.1 Transport Plane

This section reports the details of the PSNC and UESSEX test-beds used for the G^2MPLS Control Plane test. One fibre switched test-bed from UESSEX, one fibre switched test-bed from PSNC and one wavelength switched test-bed from PSNC were involved in the test. Details of the test-beds and the involved equipments are described in the following sections.

3.1.1 Equipment

Table 3.1 shows equipment inventory in PSNC and UESSEX local test-beds.

EQUIPMENT					
PSNC			UESSEX		
Type/Make/ Model	No.	Attrib.	Type Make/Model	No.	Attrib.
ADVA FSP 3000RE-II (Lambda Switch)	3	15 Pass through ports 6 Local ports	CalientDiamondWave (Fibre Switch)	1 (4 after partitioning)	96 ports total
CalientDiamond Wave (Fibre Switch)	1 (4 after partitioning)	144 ports total	VLAN capable GE switch (FastIronFoundry)	1	24 ports optical
VLAN capable GE switch (XMR Foundry)	1	60 ports	VPN Gateway	1	----
Equipment controller	7	Virtualized PC	Equipment Controller	4	PCs

Client nodes	2	HP IA64 2xIntel Itanium2 servers	Client nodes	2	Intel dual core processor servers
Traffic Analyser/Generator (Agilent)	1	2X10GE 2x1GE	Traffic Analyser/Generator (Anritsu)	1	10GE network analyser

Table 3.1 Summary of available equipments in PSNC and UESSEX domains for G^2MPLS functional tests.

3.1.1.1 LSC equipment - ADVA FSP 3000RE-II

There are three ADVA FSP 3000RE-II switches available in PSNC domain test-bed. They are lambda switches with add/drop capability through their local I/O (ROADM) as indicated in the following picture.

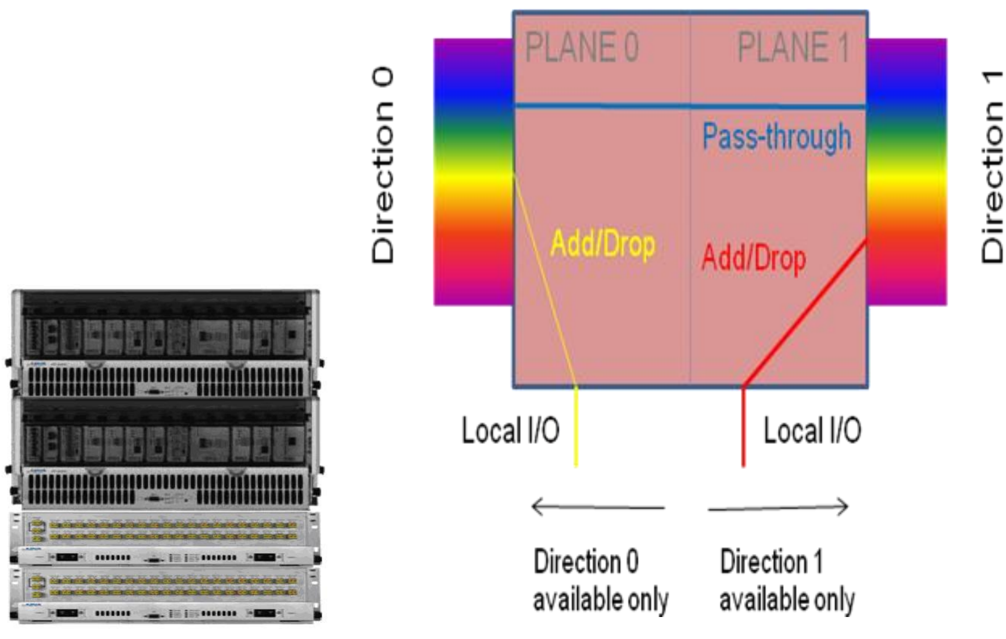


Figure 3.1: Adva FSP 3000RE-II.

3.1.1.2 FSC equipment - Calient Diamond Wave Fibre Connect

There is one Calient switch available in PSNC domain test-bed and one Calient switch in UESSEX domain. They are both a fiber switch and have been configured in a similar way. Each fiber swicth has been partitioned as four individual sub-switches. Therefore each test-bed and domain resulted in four individual fibre switches.

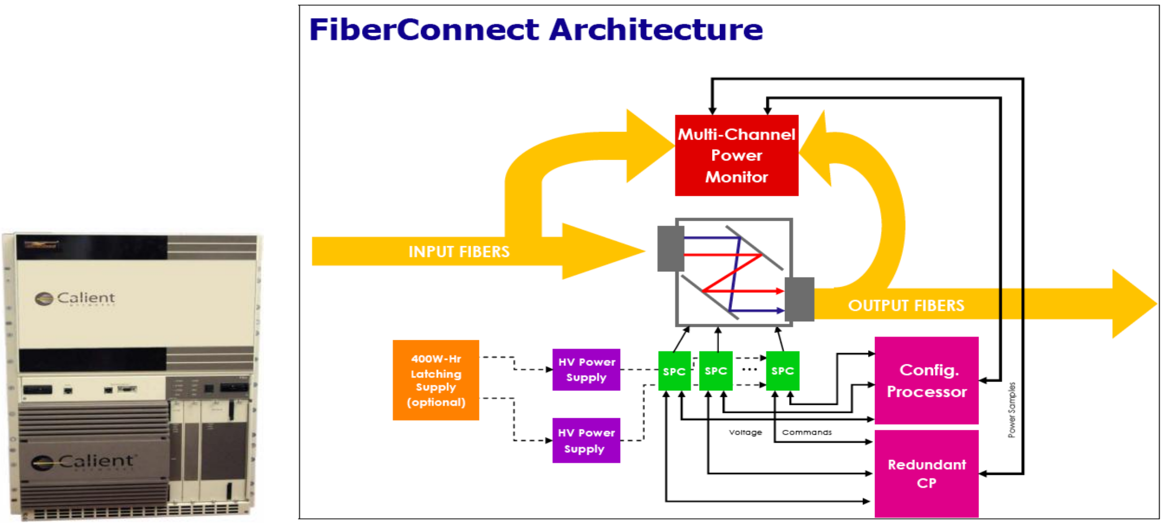


Figure 3.2: Calient Diamond Wave Fiber Connect.

3.1.1.3 VLAN capable GE switches

Transport Plane in UESSEX and PSNC domains is supported by two Foundry GE switches (Foundry FastIron in UESSEX and Foundry XMR in PSNC). These switches facilitate the VLAN inter-domain connectivity between UESSEX and PSNC (through GEANT). Furthermore the provide connectivity between test-clients and traffic generators with the test-bed in each domain. Therefore, they are completely transparent for the G^{2}MPLS Control Plane and are used just to emulate connectivity to the main switching domains (LSC and FSC).

3.1.2 Physical topology

The aforementioned equipments and facilities were used to build two test-beds in PSNC and UESSEX for the Control Plane functionality test. Topologies of these test-beds are described below:

3.1.2.1 UESSEX fibre switched test-bed topology

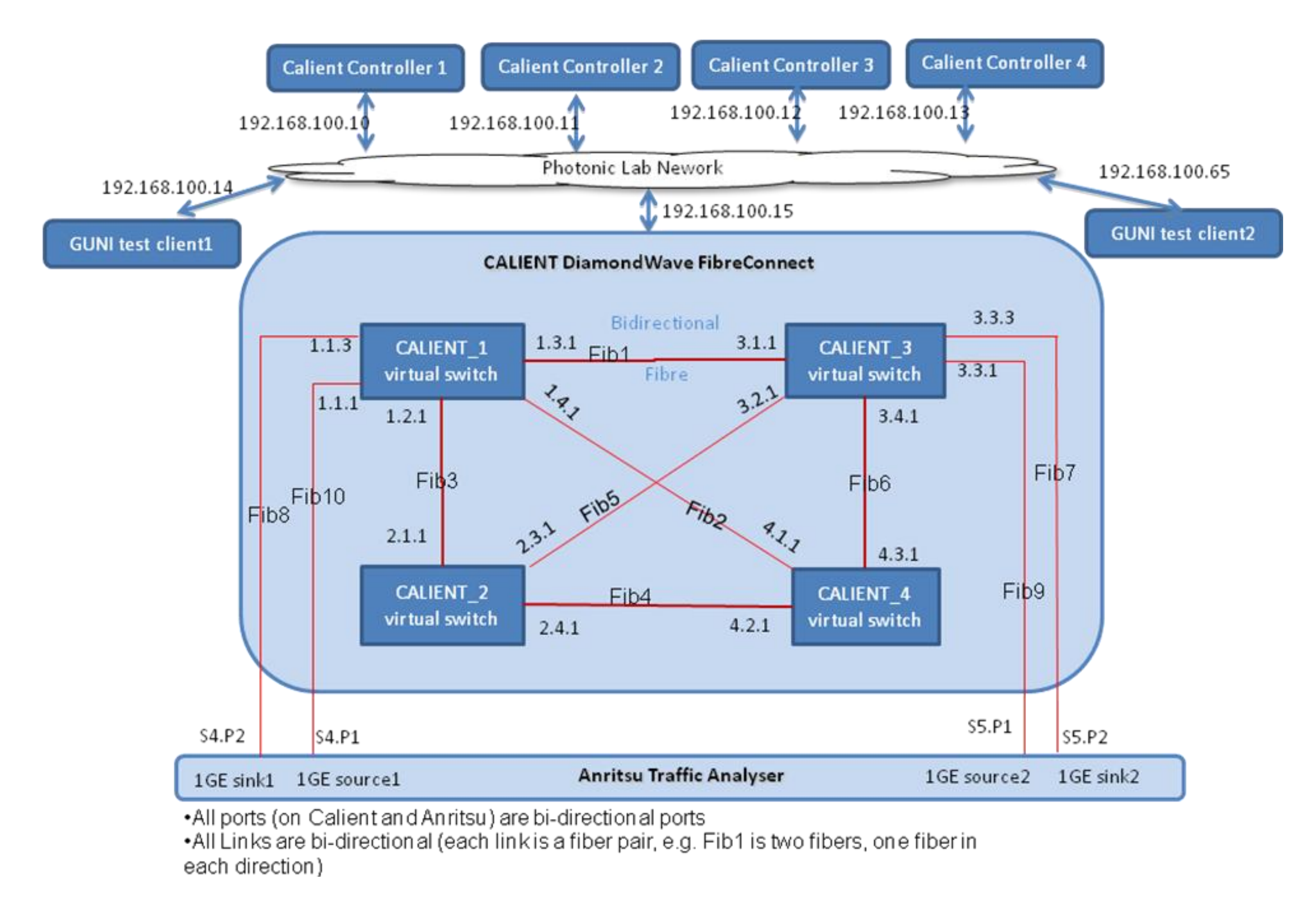


Figure 3.3: UESSEX fibre switching test-bed topology.

The test-bed comprises one Calient Diamondwave Fiber Connect as the optical fibre-switching node. To emulate functionality of a realistic network with multiple optical switching nodes, the Calient switch has been partitioned into four independent sub- switches (i.e. Calient_1, Calient_2, Calient_3 and, Calient_4). This has been done through a proprietary software interface jointly developed by UESSEX and PSNC. Through the software interface, the Control Plane interfaces to four switches that can be communicated and operated independently. The four switches are interconnected with bi-directional optical fibres in a fully meshed topology. As shown in Figure 3.3, there is one direct bi-directional path between each two nodes. In the test-bed, each switch is controlled by a G^2MPLS node controller, which is an Intel quad core server and runs an instance of the G^2MPLS Control Plane. These four nodes are connected through the 1GE local area network, which constitute the Signalling Control Network (SCN) for the G^2MPLS Control Plane. In this test-bed, the user's Transport Plane is emulated by an Anritsu traffic analyser/generator. Each user uses one sink-source port of the traffic generator to transmit-receive data with optical 10GE format. For each user, there is an Inter dual core server that runs the G.UNI signalling and is connected to the SCN. Figure 3.3 shows topology of the test-bed and its physical layer connectivity together with associated IP addresses, port numbers and fibre numbers.

Virtual Switch Name	interface ID	Equip ID	Board ID	Port ID	TN direction	Remote interface ID
Calient_1	1.1.1	0x1	0x1	0x1101	Local I/O	S4.P1
	1.1.3	0x1	0x1	0x1103	Local I/O	S4.P2
	1.2.1	0x1	0x1	0x1201	To Calient_2	2.1.1
	1.3.1	0x1	0x1	0x1301	To Calient_3	3.1.1
	1.4.1	0x1	0x1	0x1401	To Calient_4	4.1.1
Calient_2	2.1.1	0x1	0x1	0x2101	To Calient_1	1.2.1
	2.3.1	0x1	0x1	0x2301	To Calient_3	2.3.2
	2.4.1	0x1	0x1	0x2401	To Calient_4	2.4.1
Calient_3	3.1.1	0x1	0x1	0x3101	To Calient_1	1.3.1
	3.2.1	0x1	0x1	0x3201	To Calient_2	2.3.1
	3.3.1	0x1	0x1	0x3301	Local I/O	S5.P1
	3.3.3	0x1	0x1	0x3303	Local I/O	S5.P2
Calient_4	4.1.1	0x1	0x1	0x4101	To Calient_1	1.3.1
	4.2.1	0x1	0x1	0x4201	To Calient_2	2.3.1
	4.3.1	0x1	0x1	0x4301	To Calient_3	3.4.1

Figure 3.4 Calient interfaces and G^2MPLS identifiers in UESSEX testbed.

3.1.2.2 PSNC fibre switched test-bed topology

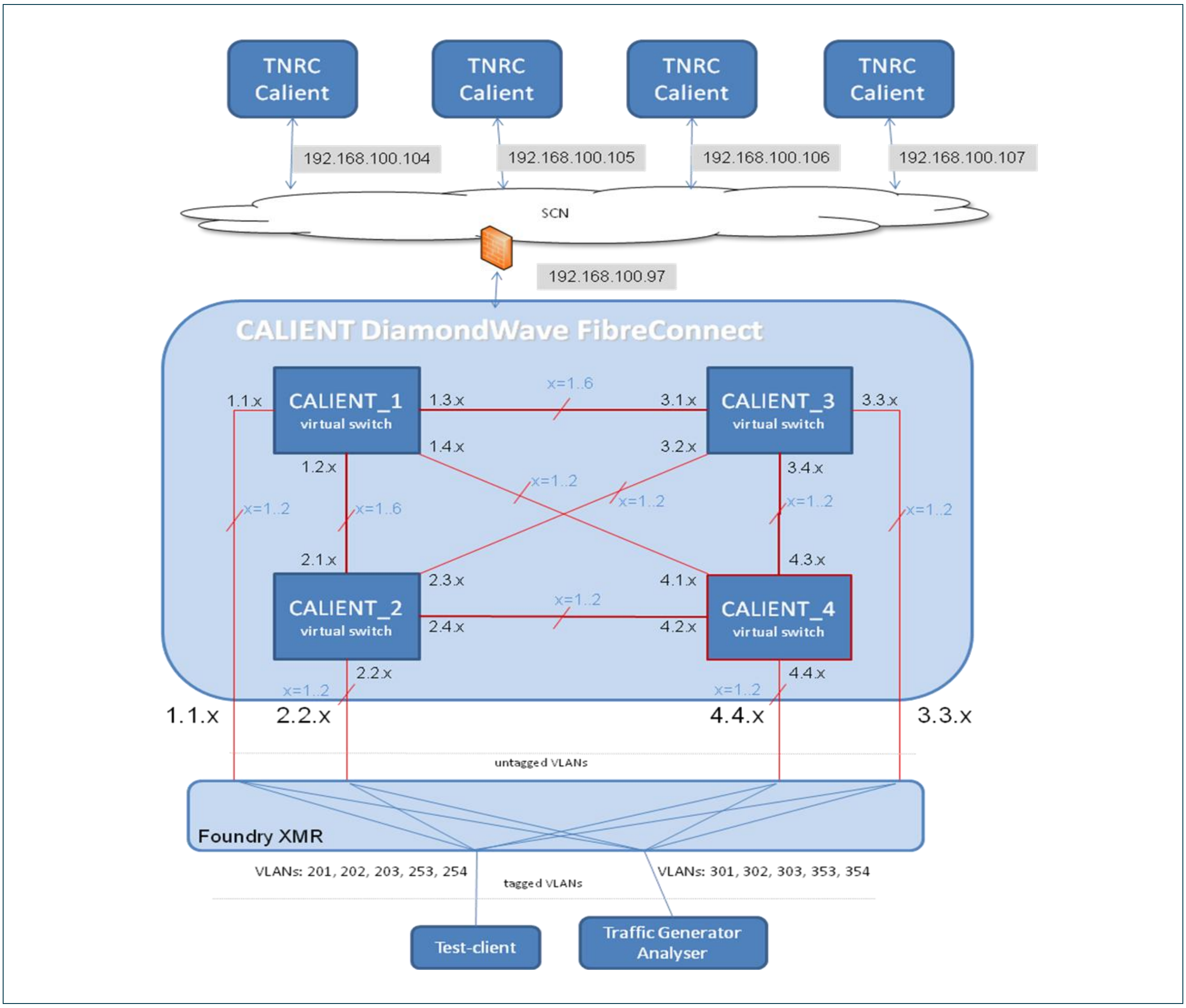


Figure 3.5 PSNC fibre switching test-bed topology.

The test-bed comprises one Calient Diamondwave Fiber Connect as the optical fibre-switching node. To emulate functionality of a realistic network with multiple optical switching nodes, the Calient switch was partitioned into four independent sub-switches, as in the UESSEX case. The four switches are connected with bi-directional optical fibres in a fully meshed topology. As shown in Figure 3.5, there is 2-6 direct bi-directional path between each two virtual nodes. More data links between virtual nodes give great possibility to setup a set of LSPs going through the same transport plane node or setup LSPs using two or more data links as component links. In the test-bed, each switch is controlled by a G^{2}MPLS node controller (i.e. Calient controller 1..4), which is an Intel Itanium2 core server and runs an instance of the G^{2}MPLS stack These four nodes are connected through the local area network implememting the SCN. In this test-bed client nodes are emulated by a test client and a traffic analyser/generator. The client nodes are connected to the optical switches through a foundry XMR switch. Each client uses a range of VLAN tags as shown in Figure 3.5 to transmit-receive data with optical 1GEtherent format. Each VLAN tag is associated with fibre connectivity to one switching node. Each client also runs the client signalling or G.UNI and is connected to Control Plane network. Figure 3.4 and Table 3.2 shows topology of the test-bed and its physical layer connectivity together with associated IP addresses, port numbers, fibre numbers and its G^2MPLS identifiers.

Virtual Switch Name	interface ID	Equip ID	Board ID	Port ID	TN direction	Remote interface ID
Calient_1	1.1.1	0x1	0x1	0x1101	Local I/O	VLAN 201
	1.1.2	0x1	0x1	0x1102	Local I/O	VLAN 301
	1.2.1	0x1	0x1	0x1201	To Calient_2	2.1.1
	1.2.2	0x1	0x1	0x1202	To Calient_2	2.1.2
	1.2.3	0x1	0x1	0x1203	To Calient_2	2.1.3
	1.2.4	0x1	0x1	0x1204	To Calient_2	2.1.4
	1.2.5	0x1	0x1	0x1205	To Calient_2	2.1.5
	1.2.6	0x1	0x1	0x1206	To Calient_2	2.1.6
	1.3.1	0x1	0x1	0x1301	To Calient_3	3.1.1
	1.3.2	0x1	0x1	0x1302	To Calient_3	3.1.2
	1.3.3	0x1	0x1	0x1303	To Calient_3	3.1.3
	1.3.4	0x1	0x1	0x1304	To Calient_3	3.1.4
	1.3.5	0x1	0x1	0x1305	To Calient_3	3.1.5
	1.3.6	0x1	0x1	0x1306	To Calient_3	3.1.6
	1.4.1	0x1	0x1	0x1401	To Calient_4	4.1.1
	1.4.2	0x1	0x1	0x1402	To Calient_4	4.1.2

Virtual Switch Name	interface ID	Equip ID	Board ID	Port ID	TN direction	Remote interface ID
Calient_2	2.1.1	0x1	0x1	0x2101	To Calient_1	1.2.1
	2.1.2	0x1	0x1	0x2102	To Calient_1	1.2.2
	2.1.3	0x1	0x1	0x2103	To Calient_1	1.2.3
	2.1.4	0x1	0x1	0x2104	To Calient_1	1.2.4
	2.1.5	0x1	0x1	0x2105	To Calient_1	1.2.5
	2.1.6	0x1	0x1	0x1206	To Calient_1	1.2.6
	2.2.1	0x1	0x1	0x2201	Local I/O	VLAN 202
	2.2.2	0x1	0x1	0x2202	Local I/O	VLAN 302
	2.3.1	0x1	0x1	0x2301	To Calient_3	2.3.2
	2.3.2	0x1	0x1	0x2302	To Calient_3	2.3.2
	2.4.1	0x1	0x1	0x2401	To Calient_4	2.4.1
	2.4.2	0x1	0x1	0x2402	To Calient_4	2.4.2

Virtual Switch Name	interface ID	Equip ID	Board ID	Port ID	TN direction	Remote interface ID
Calient_3	3.1.1	0x1	0x1	0x3101	To Calient_1	1.3.1
	3.1.2	0x1	0x1	0x3102	To Calient_1	1.3.2
	3.1.3	0x1	0x1	0x3103	To Calient_1	1.3.3
	3.1.4	0x1	0x1	0x3104	To Calient_1	1.3.4
	3.1.5	0x1	0x1	0x3105	To Calient_1	1.3.5
	3.1.6	0x1	0x1	0x3206	To Calient_1	1.3.6
	3.2.1	0x1	0x1	0x3201	To Calient_2	2.3.1
	3.2.2	0x1	0x1	0x3202	To Calient_2	2.3.2
	3.3.1	0x1	0x1	0x3301	Local I/O	VLAN 251
	3.3.2	0x1	0x1	0x3302	Local I/O	VLAN 353
	3.4.1	0x1	0x1	0x3401	To Calient_4	4.3.1
	3.4.2	0x1	0x1	0x3402	To Calient_4	4.3.2

Virtual Switch Name	interface ID	Equip ID	Board ID	Port ID	TN direction	Remote interface ID
Calient_4	4.1.1	0x1	0x1	0x4101	To Calient_1	1.3.1
	4.1.2	0x1	0x1	0x4102	To Calient_1	1.3.2
	4.2.1	0x1	0x1	0x4201	To Calient_2	2.3.1
	4.2.2	0x1	0x1	0x4202	To Calient_2	2.3.2
	4.3.1	0x1	0x1	0x4301	To Calient_3	3.4.1
	4.3.2	0x1	0x1	0x4302	To Calient_3	3.4.2
	4.4.1	0x1	0x1	0x4401	Local I/O	VLAN 252
	4.4.2	0x1	0x1	0x4402	Local I/O	VLAN 354

Table 3.2 Calient interfaces and G^2MPLS identifiers in PSNC test-bed.

3.1.2.3 PSNC wavelength switched test-bed topology

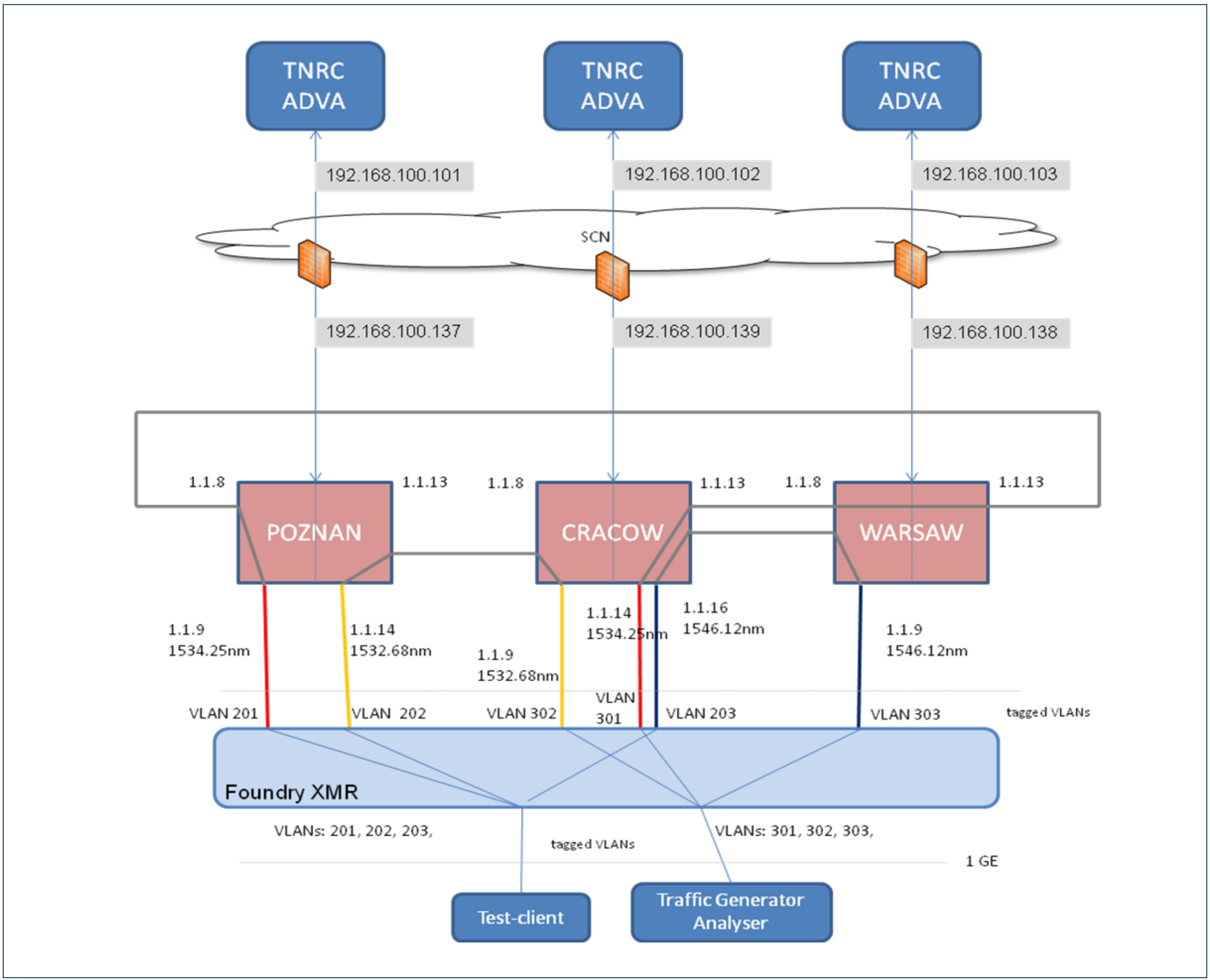


Figure 3.6: PSNC wavelength switching test-bed topology.

The test-bed comprises three ADVA FSP 3000RE-II wavelength switches as the optical wavelength-switching nodes (POZNAN, CRACOW, WARSAW). The ROADMs are connected with bi-directional optical fibres in a ring topology. In the test-bed, each optical switch is controlled by a G^2MPLS node controller, which is an Intel quad core server. These three nodes are connected through the local area network implementing the SCN. In this test-bed client nodes are emulated by a test client and a traffic analyser/generator. The client nodes are connected to the optical switches through a foundry XMR switch. Each client uses a range of VLAN tags as shown in Figure 3.6 to transmit-receive data with optical 1GE format. Each VLAN tag is associated to a specific fibre connectivity to one switching node. Each client also runs the G.UNI signalling and is connected to the

SCN. Figure 3.6 and Table 3.3 show topology of the test-bed and its physical layer connectivity together with associated IP addresses, port numbers, fibre numbers and its G^{2}MPLS identifiers.

Device Name	Management address	TN interface ID	TN interface type	TN direction
Poznan	192.168.100.137	1.1.8	40λ-DWDM	To Warsow
		1.1.9	λ-1534.25nm	VLAN 201
		1.1.13	40λ-DWDM	To Cracow
		1.1.14	λ-1532.68nm	VLAN 202
Cracow	192.168.100.139	1.1.8	40λ-DWDM	To Poznan
		1.1.9	λ-1532.68nm	VLAN 302
		1.1.13	40λ-DWDM	To Warsow
		1.1.14	λ-1534.25nm	VLAN 301
		1.1.16	λ-1546.12nm	VLAN 203
Warsaw	192.168.100.138	1.1.8	40λ-DWDM	To Cracow
		1.1.9	λ-1546.12nm	VLAN 303
		1.1.13	40λ-DWDM	To Poznan

Device Name	TN interface ID	Equip ID	Board ID	Port ID	Label ID(s)
Poznan	1.1.8	0x1	0x1	0x1108	All ADVA labels
	1.1.9	0x1	0x1	0x1109	0x28000017
	1.1.13	0x1	0x1	0x110D	All ADVA labels
	1.1.14	0x1	0x1	0x110E	0x28000019
Cracow	1.1.8	0x1	0x1	0x1108	All ADVA labels
	1.1.9	0x1	0x1	0x1109	0x28000019
	1.1.13	0x1	0x1	0x110D	All ADVA labels
	1.1.14	0x1	0x1	0x110E	0x28000017
	1.1.16	0x1	0x1	0x1110	0x28000008
Warsaw	1.1.8	0x1	0x1	0x1108	All ADVA labels
	1.1.9	0x1	0x1	0x1109	0x28000008
	1.1.13	0x1	0x1	0x110D	All ADVA labels

Table 3.3 ADVA interfaces capabilities, configuration and G^{2}MPLS identifiers.

3.2 Control Plane

The Control Plane is implemented by G^{2}MPLS node controllers. Each controller operates exclusively (i.e. without concurrency with/of other control entities) on a Transport Network element (real or derived from partitioning) inside the boundaries of the G^{2}MPLS domain. G^{2}MPLS controllers run over i386 32bit platforms with Gentoo Linux distributions.

Each G^{2}MPLS exposes at least an interface on the Signalling Communication Network (SCN) over which the G^{2}MPLS protocol messages flow. In the single domain case IP tunnelling is used for out of band connectivity between controllers. Moreover, each G^{2}MPLS controller is interfaced to the Transport Network equipment (Southbound interface for the Calient and ADVA devices) through TL1 connections across the same SCN. This choices is not a requirement of the G^{2}MPLS stack, but rather a simplification of addressing spaces in small sized domains in order to focus configuration and tests on the fundamental issues of the protocol behaviours.

3.3 G^{2}MPLS Control Plane configuration

The configuration of the G^{2}MPLS Control Plane for the testing environment requires the mapping of the actual physical topology into the proper configuration files associated with each of the G^{2}MPLS processes. The default location of the configuration files is /usr/local/etc/.

Configuration files contain information like the vty login credentials or location of the log files. Moreover, the lrmd configuration file (lrmd.conf) sets the initial configuration of the node. Specifically, it configures the control interfaces, control channels, te-links and data-links, setting addresses and initial state. Figure 3.7 shows the network configuration example used for the tests described in the next sections.

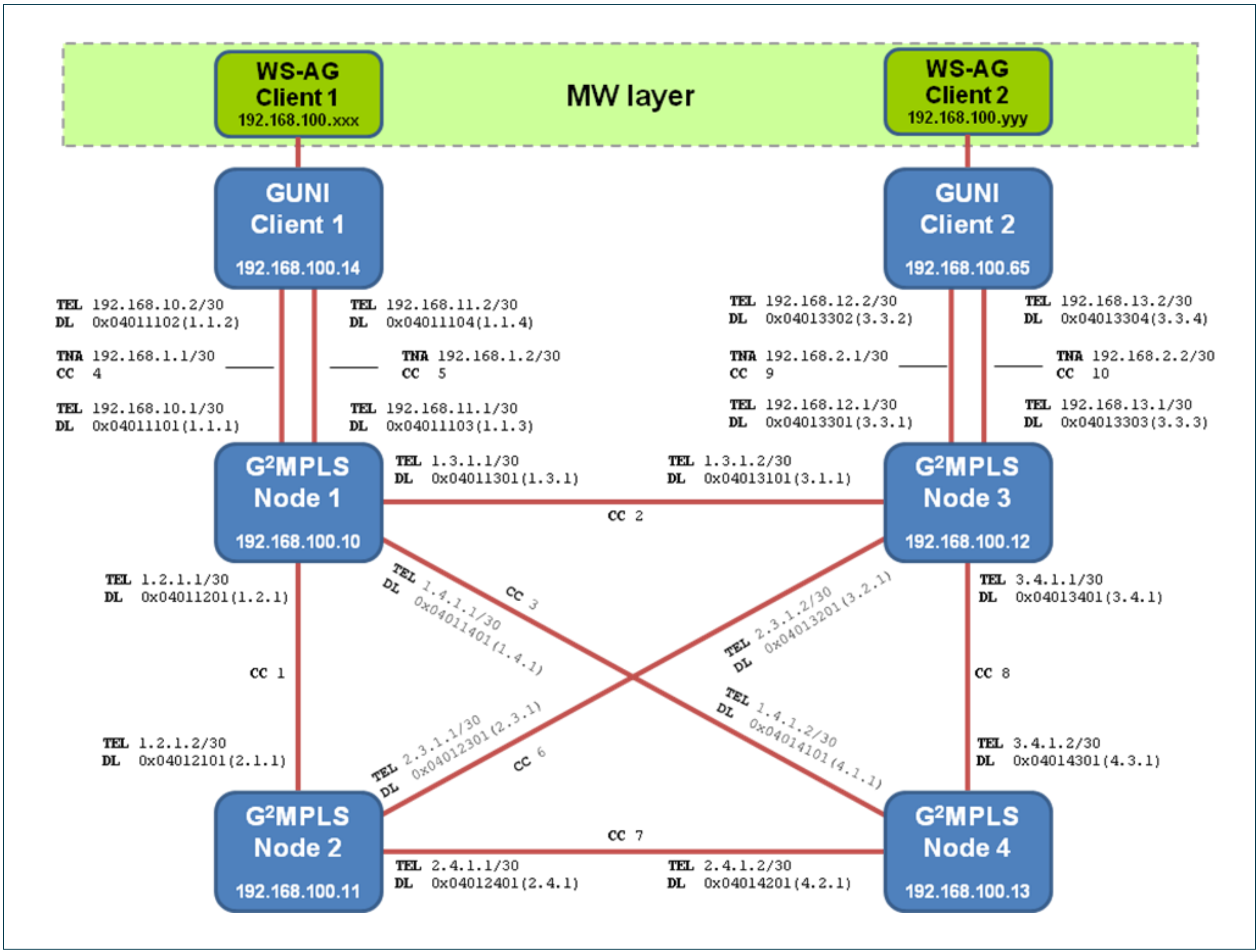


Figure 3.7: A G^2MPLS Control Plane configuration

The SCN in the test-bed is IP-based with private addressing. Router Ids and interfaces IP addresses are private IPv4 addresses as well.

4 Testing methodology

The following table is the test-card model used for each test. Each of the cards has a set of fields to identify and describes the tests.

- *Test Card Name*, which briefly identifies the test;
- Authors, which identifies the team which has executed the test;
- *Objective*, which exposes the expected results of the performed test;
- *Related Test Cards*, which provides a list of the test cards that are related with the current test in terms of pre-requisite or imported common steps;
- *Topology and DUT details*, which depicts the topology and configuration used for the test;
- *Test description*, which reports the test in a step by step basis, checking the correct functioning and the results achieved are captured in the “Outcome” column;
- *Additional comments*, which reports any pre- and post-conditions of the test not previously included in the “Test description”;
- *Test status*, which provides a test status confirmation to report if the test has been successful;

Test Card #	GMPLS-01	**Authors**	
Test Card Name	SPC test		
Objective			
Related Test Cards	*<put a list here if it make sense >*		
Topology and DUT details	*<Insert a picture with the topology and the details for DUT configuration, pre-requisites>*		

Test description		
Step	**Description**	**Outcome**
1.		
1.1.		
1.1.1.		
1.1.2.		

2.		
3.		
4.		

Additional comments
Some remarks, notes, but not configuration issues

Test status
Passed/Not passed

5 G²MPLS Control Plane functional tests

5.1 Overview of the tests

The functionality of G²MPLS Control Plane was tested using 35 test-cards divided into three main areas. Each test-card verifies a set of G²MPLS features expressed as set of objectives to be achieved in the fixed environment conditions. All the test-cards have been successfully executed and thus the current state of the G²MPLS Control Plane prototype development fulfil the main expected functionalities as per Milestone M2.4.

LSP signalling tests			
	LSP signalling tests in LSC domain		
No	**Test Card**	**Test name**	**Status**
1	G²MPLS-TC-1.1	LSC node initialization	Passed
2	G²MPLS-TC-1.2	Transport Plane notifications from LSC node	Passed
3	G²MPLS-TC-1.3	Setup of one bidirectional LSC LSP	Passed
4	G²MPLS-TC-1.4	Tear down of one bidirectional LSC LSP from HEAD node	Passed
5	G²MPLS-TC-1.5	Tear down of one bidirectional LSC LSP from TAIL node	Passed
6	G²MPLS-TC-1.6	Unsuccessful bidirectional LSC LSP setup (failure in HEAD node)	Passed
7	G²MPLS-TC-1.7	Unsuccessful bidirectional LSC LSP setup (failure in intermediate node)	Passed
8	G²MPLS-TC-1.8	Unsuccessful bidirectional LSC LSP setup (failure in TAIL node)	Passed
9	G²MPLS-TC-1.9	Setup of one bidirectional LSC LSP with advance reservation	Passed
10	G²MPLS-TC-1.10	Tear down of one bidirectional LSC LSP with advance reservation from HEAD node	Passed
	LSP signalling tests in FSC domain		
No	**Test Card**	**Test name**	**Status**
11	G²MPLS-TC-2.1	FSC node initialization	Passed
12	G²MPLS-TC-2.2	Transport Plane notifications from FSC node	Passed
13	G²MPLS-TC-2.3	Setup of one bidirectional FSC LSP	Passed
14	G²MPLS-TC-2.4	Tear down of one bidirectional FSC LSP from HEAD node	Passed
15	G²MPLS-TC-2.5	Tear down of one bidirectional FSC LSP from TAIL node	Passed
16	G²MPLS-TC-2.6	Unsuccessful bidirectional FSC LSP setup (failure in HEAD node)	Passed
17	G²MPLS-TC-2.7	Unsuccessful bidirectional FSC LSP setup (failure in intermediate node)	Passed
18	G²MPLS-TC-2.8	Unsuccessful bidirectional FSC LSP setup (failure in TAIL node)	Passed
19	G²MPLS-TC-2.9	Setup of one bidirectional FSC LSP with advance reservation	Passed
20	G²MPLS-TC-2.10	Tear down of one bidirectional FSC LSP with advance reservation from HEAD node	Passed
G²MPLS call signalling tests			

	Single-domain call signalling tests		
No	**Test Card**	**Test name**	**Status**
21	G^{2}MPLS-TC-3.1	Setup of one bidirectional single-domain FSC LSP by G2.NCC module	Passed
22	G^{2}MPLS-TC-3.2	Teardown of the one bidirectional single-domain FSC LSP by G2.NCC module	Passed
23	G^{2}MPLS-TC-3.3	Setup of one bidirectional single-domain FSC LSP by G2.CCC module	Passed
24	G^{2}MPLS-TC-3.4	Teardown of the one bidirectional single-domain FSC LSP by G2.CCC module	Passed
25	G^{2}MPLS-TC-3.5	Setup of one bidirectional single-domain FSC LSP by G.UNI-GW module	Passed
26	G^{2}MPLS-TC-3.6	Teardown of the one bidirectional single-domain FSC LSP by G.UNI-GW module	Passed
27	G^{2}MPLS-TC-3.7	Setup of one bidirectional single-domain FSC LSP by Middleware WS-Agreement client	Passed
28	G^{2}MPLS-TC-3.8	Teardown of the one bidirectional single-domain FSC LSP by Middleware WS-Agreement client	Passed
	Inter-domain call signalling tests		
No	**Test Card**	**Test name**	**Status**
29	G^{2}MPLS-TC-4.1	Setup of one bidirectional inter-domain FSC LSP by G2.CCC	Passed
30	G^{2}MPLS-TC-4.2	Teardown of the one bidirectional single-domain FSC LSP by G2.CCC	Passed
G^{2}MPLS routing tests			
	Single-domain routing test-cases		
No	**Test Card**	**Test name**	**Status**
31	G^{2}MPLS-TC-5.1	I-NNI G2.OSPF-TE instance initialization	Passed
32	G^{2}MPLS-TC-5.2	Distribution of TE information through the G.I-NNI interfaces	Passed
33	G^{2}MPLS-TC-5.3	Distribution of Grid information through the G.UNI and G.I-NNI interfaces	Passed
	Inter-domain routing test cases		
No	**Test Card**	**Test name**	**Status**
34	G^{2}MPLS-TC-6.1	Routing information exchange between adjacent RAs	Passed
35	G^{2}MPLS-TC-6.2	Grid information exchange between adjacent RAs	Passed

Table 5.1 Overview of the executed test-cards.

5.2 LSP signalling tests

The G^{2}MPLS LSP signalling tests have been executed in two separate sessions:

- LSC LSP signalling tests
- FSC LSP signalling tests

The LSC LSP signalling tests have been used to verify the proper work and interaction of modules involved in the LSP signalling in LSC domain and LSC equipment configuration (G^2.RSVP-TE, LRM, TNRC with Adva TNRC SP plugin, SCNGW).
Similarly, The FSC LSP signalling tests have been used to verify the proper work and interaction of modules involved in the LSP signalling in FSC domain and FSC equipment configuration (G^2.RSVP-TE, LRM, TNRC with Calient TNRC SP plugin, SCNGW).

5.2.1 LSP signalling tests in LSC domain

In this section the results of the tests regarding the single-domain LSP signalling are presented. As shown in Figure 5.1, in the test-bed there are 3 G^{2}MPLS controllers with just I-NNI interfaces between them.

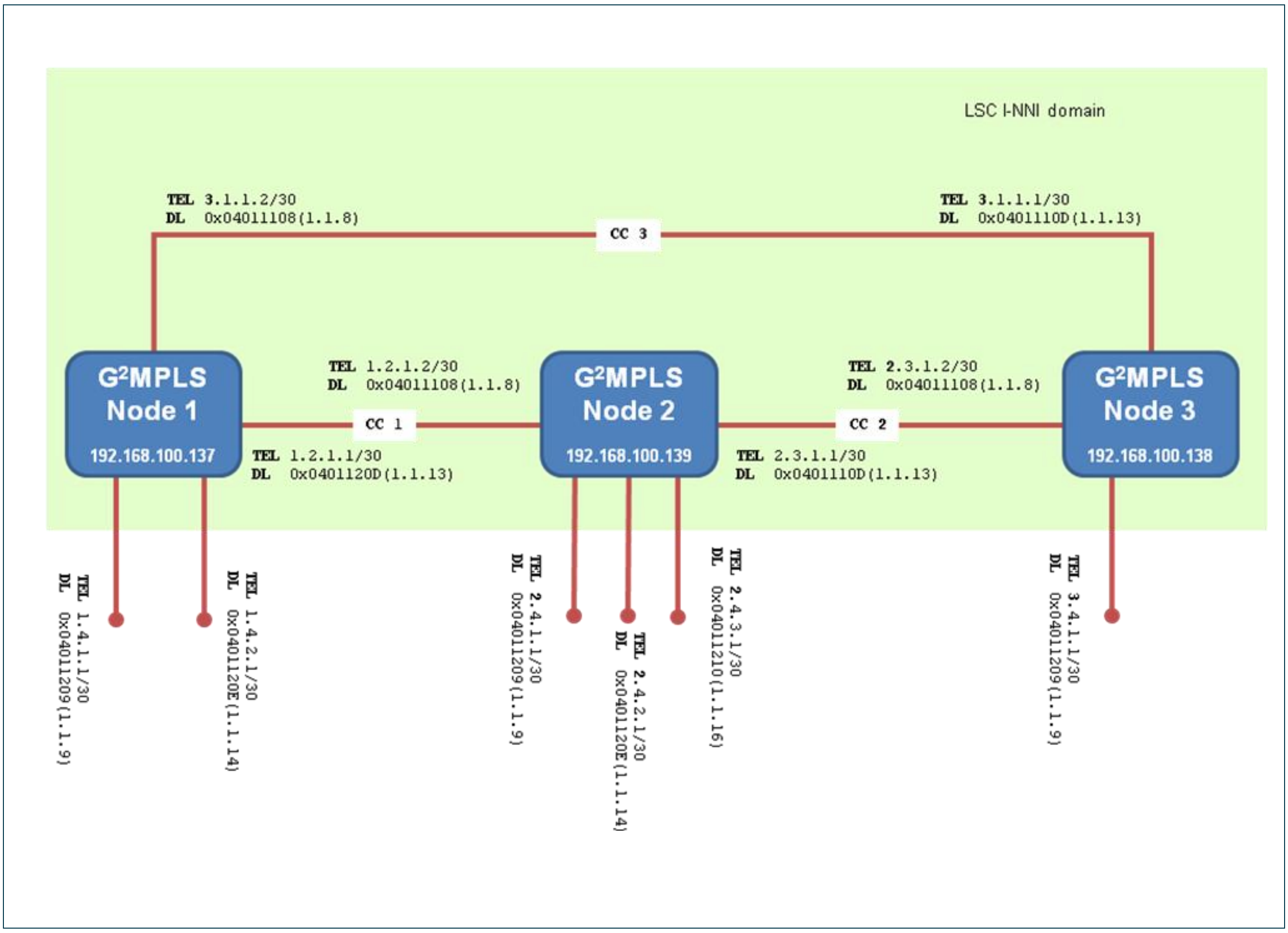
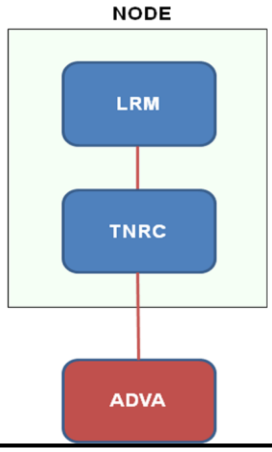


Figure 5.1: Logical topology of the single-domain LSC test-bed.

5.2.1.1 LSC node initialization

Test Card #	G^{2}MPLS-TC-1.1	Authors	NXW, PSNC
Test Card Name	LSC node initialization		
Objectives	Proper configuration of TNRC and LRM modules: • Configuration files reading • Resource and states retrieving from TN equipment via Adva FSP 3000RE		

	TNRC SP plugin • Information passing from TNRC to LRM • Information presenting in VTY
Related Test Cards	None
Topology and DUT details	

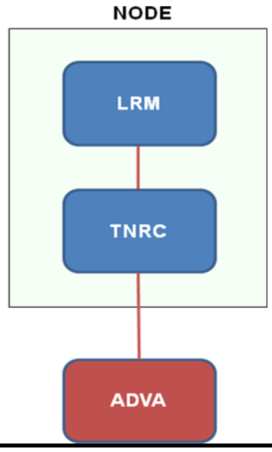
Test description		
Step	**Description**	**Outcome**
1.	Run TNRCD process	✓ TNRCD is up and working ○ There is TNRCD process on the system processes list ○ The configuration file was read successfully ○ TNRCD VTY is accessible
1.1.	TNRC AP data model is loaded	✓ There are proper equipment and boards information available in TNRCD VTY
1.2.	TNRC SP retrieved information from equipment	✓ There are ports and resources available in TNRCD VTY ○ Ports operational statuses are UP ○ The port bandwidth values are equal to configured in TNRCD equipment configuration file ○ Resources operational statuses are UP ○ Bitmaps show no lambda in use.
2.	Run LRM process	✓ LRMD is up and working ○ There is LRMD process on the system processes list ○ The configuration file was read successfully ○ LRMD VTY is accessible
2.1.	LRM data model is loaded	✓ There are proper SCN interfaces, Control Channels, adjacencies, data links and TE-links information available in LRMD VTY ○ The information about data-links are the same as in TNRCD ○ The SCN and TE-link information correspond to data-links and LRMD configuration file

Additional comments
• Preconditions ◦ Before the test there should be no already existing cross-connections on equipment. If there will be some existing cross-connection (for example: created by Management Plane) then operational statuses related to the cross-connection resources will be in down state and cannot be used by G^2MPLS Control Plane.

Test status
Passed

5.2.1.2 *Transport Plane notifications from LSC node*

Test Card #	G^2MPLS-TC-1.2	**Authors**	NXW, PSNC
Test Card Name	Transport Plane notifications from LSC node		
Objectives	Notification of TNRC and LRM modules in LSC node in case of resource operational state change or in case of wavelength external usage (by Network Management System or Network Operator): • States change retrieving from TN equipment via Adva FSP 3000RE TNRC SP plugin • Information passing from TNRC to LRM • Data Model information updating		
Related Test Cards	G^2MPLS-TC-1.1		

Topology and DUT details	

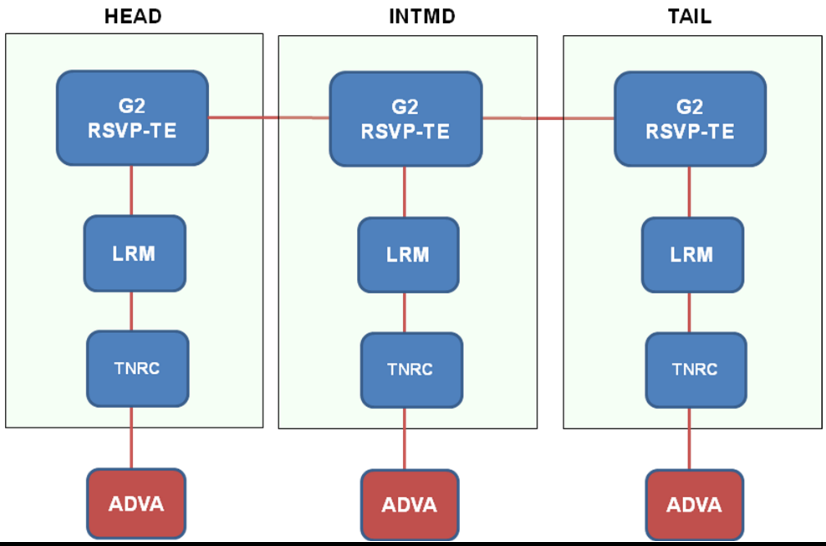
Test description		
Step	**Description**	**Outcome**
1.	TNRCD and LRMD processes are running on all nodes	✓ TNRCD VTY and LRMD VTY are accessible ✓ See G^{2}MPLS-TC-1.1 Step 1 and 2
2.	Operational state of a port is set down on Equipment	✓ TNRC SP retrieves information about port operation state change
2.1.	Notification from TNRC SP is issued to TNRC AP	✓ There is the port state down information in TNRCD VTY
2.2.	Notification from TNRC AP is issued to upper protocols (LRMD)	✓ Changes in LRMD VTY ○ The data-link operational state is DOWN ○ related TE-link has operation state DOWN
3.	Status of a free wavelength is set to busy on Equipment via NE management interface	✓ TNRC SP retrieve information about active cross-connections on equipment
3.1.	Notification from TNRC SP is issued to TNRC AP	✓ There is port state down information present in TNRCD VTY
3.2.	Notification from TNRC AP is issued to upper protocols (LRMD)	✓ Changes in LRMD VTY ○ The data-link operational state is DOWN ○ related TE-link has operation state DOWN

Additional comments
• Preconditions ○ Free wavelength is set to busy via selected wavelength cross-connection configuring using NE management interface.

Test status

Passed

5.2.1.3 Setup of one bidirectional LSC LSP

Test Card #	G^{2}MPLS-TC-1.3	**Authors**	NXW, PSNC
Test Card Name	Setup of one bidirectional LSC LSP		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of LSC LSP setup: • LSP setup signalling through 3 LSC nodes via RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^{2}MPLS-TC-1.1		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^{2}MPLS-TC-1.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP is created and signalled up
2.1.	HEAD node: cross-connection setup request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized to intermediate node
2.2.	HEAD node: TNRC AP	✓ There is cross-connection information in TNRCD VTY

	notification is issued to upper protocols on cross-connection setup	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is less available port bandwidth (port, data-link, TE-link)
2.3.	Intermediate node: cross-connection setup request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized to TAIL node
2.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ There is cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ There is less available port bandwidth (port, data-link, TE-link)
2.5.	TAIL node: cross-connection setup request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized back to HEAD node via intermediate node
2.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ There is cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ There is less available port bandwidth (port, data-link, TE-link)

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the created LSP is up and running. There are related cross-connections on TN equipment.

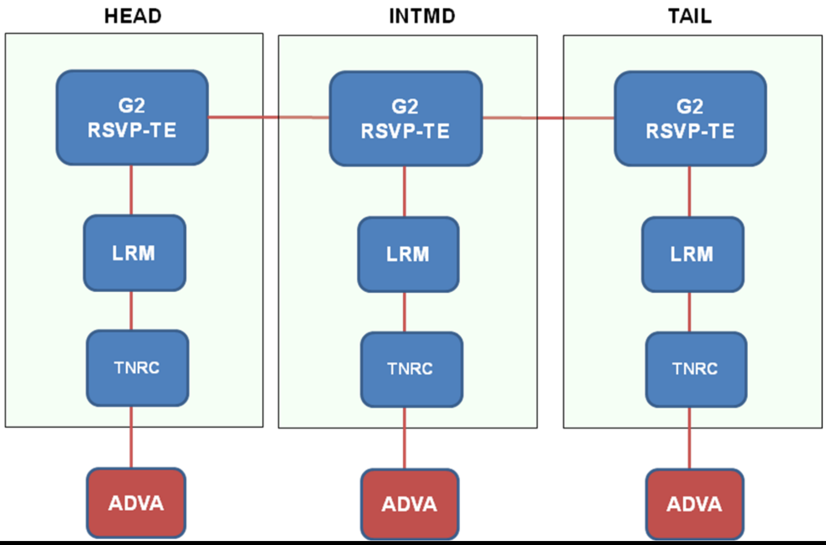
Test status
Passed

5.2.1.4 *Tear down of one bidirectional LSC LSP from HEAD node*

Test Card #	G^{2}MPLS-TC-1.4	**Authors**	NXW, PSNC
Test Card Name	Tear down of one bidirectional LSC LSP from HEAD node		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of LSC LSP teardown: • LSP teardown signalling through 3 LSC nodes via RSVP-TE from the ingress node • TN equipments cross-connect deletion • Data model information updating		
Related	G^{2}MPLS-TC-1.1, G^{2}MPLS-TC-1.3		

Test Cards

Topology and DUT details



Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-1.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP is created and signalled up ✓ See G^2MPLS-TC-1.3 Step 2
3.	Destroy LSP from HEAD node	✓ LSP is signalled down from HEAD node and destroyed
3.1.	HEAD node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to intermediate node
3.2.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY o Max available port bandwidth is back (port, data-link, TE-link)
3.3.	Intermediate node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to TAIL node
3.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY o Max available port bandwidth is back (port, data-link, TE-link)
3.5.	TAIL node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized back to HEAD node via intermediate node

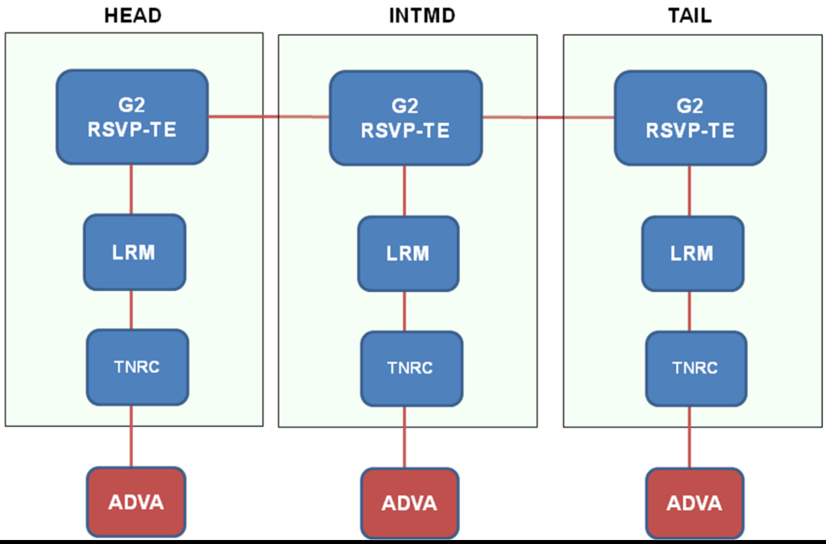
3.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRC VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.2.1.5 Tear down of one bidirectional LSC LSP from TAIL node

Test Card #	G^2MPLS-TC-1.5	**Authors**	NXW, PSNC
Test Card Name	Tear down of one bidirectional LSC LSP from TAIL node		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of LSC LSP teardown: • LSP teardown signalling through 3 LSC nodes via RSVP-TE from the egress node • TN equipments cross-connect deletion • Data model information updating		
Related Test Cards	G^2MPLS-TC-1.1, G^2MPLS-TC-1.3		

Topology and DUT details	

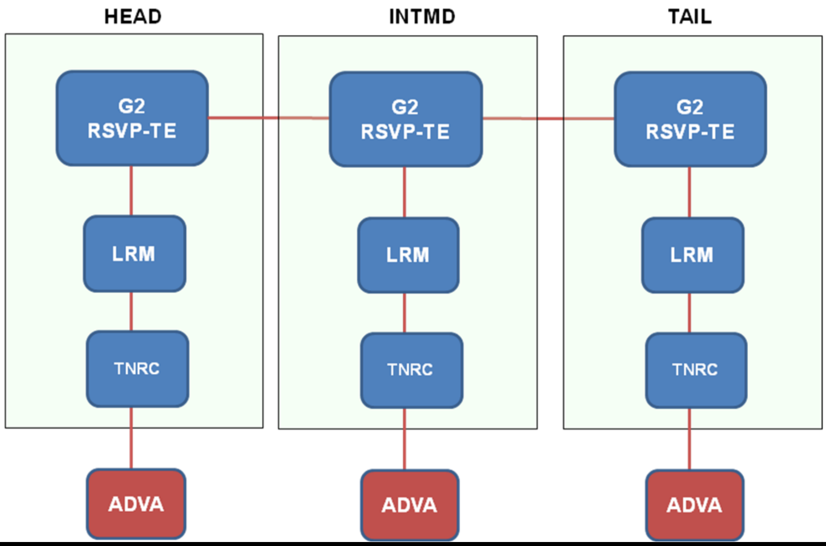
Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-1.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP is created and signalled up ✓ See G^2MPLS-TC-1.3 Step 2
3.	Destroy LSP from TAIL node	✓ LSP is signalled down from HEAD node and destroyed
3.1.	TAIL node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to intermediate node
3.2.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)
3.3.	Intermediate node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to HEAD node
3.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)
3.5.	HEAD node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized back to TAIL node via intermediate node
3.6.	HEAD node: TNRC AP	✓ There is no cross-connection information in TNRC VTY

	notification is issued to upper protocols on cross-connection deletion	✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.2.1.6 *Unsuccessful bidirectional LSC LSP setup (failure in HEAD node)*

Test Card #	G^2MPLS-TC-1.6	**Authors**	NXW, PSNC
Test Card Name	Unsuccessful bidirectional LSC LSP setup (failure in HEAD node)		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of LSC LSP setup failure in HEAD node		
Related Test Cards	G^2MPLS-TC-1.1, G^2MPLS-TC-1.3		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-1.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP creation is unsuccessful ✓ See G^2MPLS-TC-1.3 Step 2.1, 2.2
2.1.	Outgoing TE-link is not present in HEAD node	✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.2.	Outgoing TE-link is down in HEAD node	✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.3.	Outgoing data-link is not present in HEAD node	✓ Selection of data-link in TE-link fails ✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.4.	Outgoing data-link is down in LRMD in HEAD node	✓ Selection of data-link in TE-link fails ✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.5.	Outgoing label is not present in HEAD node	✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.6.	Outgoing label is not free in TNRCD in HEAD node	✓ Selection of label in data-link fails ✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.7.	Cross-connection fails in TNRCD in HEAD node	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized to intermediate node ✓ Notification of unsuccessful cross-connection setup is issued to upper protocols ○ PathTear is issued to intermediate node and LSP is in "Down" state

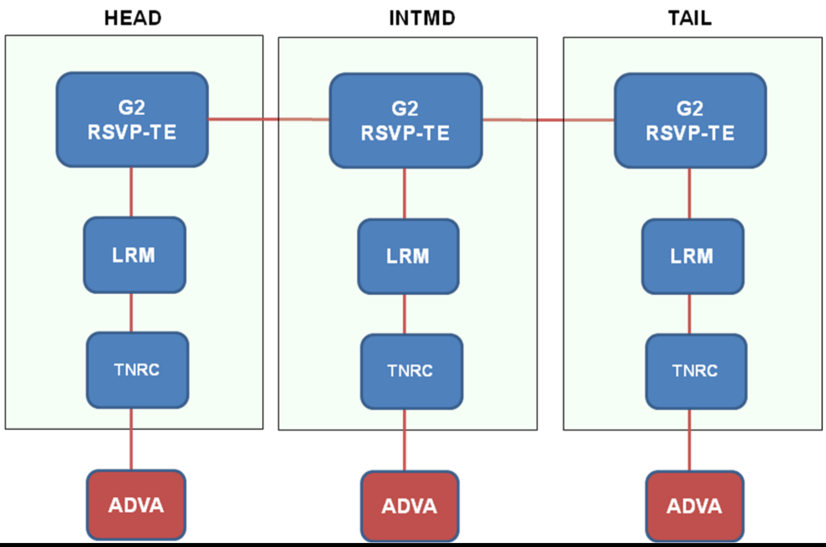
Additional comments

- Preconditions
  - Before the test all needed resources by the LSP should be available and free.
- Postconditions
  - After the test the situation is the same as before the test.

Failure conditions related to a lack of resource presence (label, data-link, TE-link) can be achieved by incorrect LSP request configuration in G2.RSVP-TE.
Failure conditions related to down state of label can happen when there is existing cross-connection using the label.
Failure conditions related to down state of data-link and TE-link can happen when TN equipment port is set to down.
Cross-connection fails in TNRC during setup when alarms appear on TN equipment because of TN equipment mis-configuration or lack of light.

Test status
Passed

5.2.1.7 *Unsuccessful bidirectional LSC LSP setup (failure in intermediate node)*

Test Card #	G²MPLS-TC-1.7	**Authors**	NXW, PSNC
Test Card Name	Unsuccessful bidirectional LSC LSP setup (failure in intermediate node)		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of LSC LSP setup failure in intermediate node		
Related Test Cards	G²MPLS-TC-1.1, G²MPLS-TC-1.3		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G²MPLS-TC-1.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP creation is unsuccessful ✓ See G²MPLS-TC-1.3 Step 2.1, 2.2, 2.3, 2.4
2.1.	Outgoing TE-link is not present in intermediate node	✓ Intermediate node: ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node:

		○ LSP is in "Down" ○ Cross-connection is destroyed
2.2.	Outgoing TE-link is down in intermediate node	✓ Intermediate node: ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.3.	Outgoing data-link is not present in intermediate node	✓ Intermediate node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.4.	Outgoing data-link is down in LRMD in intermediate node	✓ Intermediate node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.5.	Outgoing label is not present in intermediate node	✓ Intermediate node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.6.	Outgoing label is not free in TNRCD in intermediate node	✓ Intermediate node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.7.	Cross-connection fails in TNRCD in intermediate node	✓ Intermediate node: ○ notification of unsuccessful cross-connection setup is issued to upper protocols ○ ERO process fails ○ PathErr is sent upstream ○ PathTear is send downstream ○ LSP is in "Down" and no Path is issued

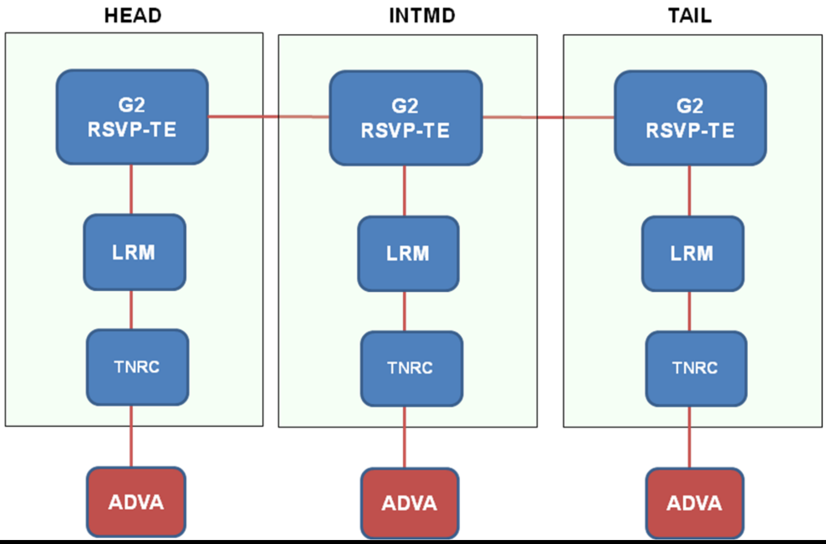
		downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test. Failure conditions related to a lack of resource presence (label, data-link, TE-link) can be achieved by incorrect LSP request configuration in G2.RSVP-TE. Failure conditions related to down state of label can happen when there is existing cross-connection using the label. Failure conditions related to down state of data-link and TE-link can happen when TN equipment port is set to down. Cross-connection fails in TNRC during setup when alarms appear on TN equipment because of TN equipment misconfiguration or lack of light.

Test status
Passed

5.2.1.8 Unsuccessful bidirectional LSC LSP setup (failure in TAIL node)

Test Card #	G^2MPLS-TC-1.8	**Authors**	NXW, PSNC
Test Card Name	Unsuccessful bidirectional LSC LSP setup (failure in TAIL node)		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of LSC LSP setup failure in TAIL node		
Related Test Cards	G^2MPLS-TC-1.1, G^2MPLS-TC-1.3		

Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^{2}MPLS-TC-1.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP creation is unsuccessful ✓ See G^{2}MPLS-TC-1.3 Step 2.1, 2.2, 2.3, 2.4, 2.5, 2.6
2.1.	Outgoing TE-link is not present in TAIL node	✓ TAIL node: ○ TNA resolving process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.2.	Outgoing TE-link is down in TAIL node	✓ TAIL node: ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.3.	Outgoing data-link is not present in TAIL node	✓ TAIL node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down"

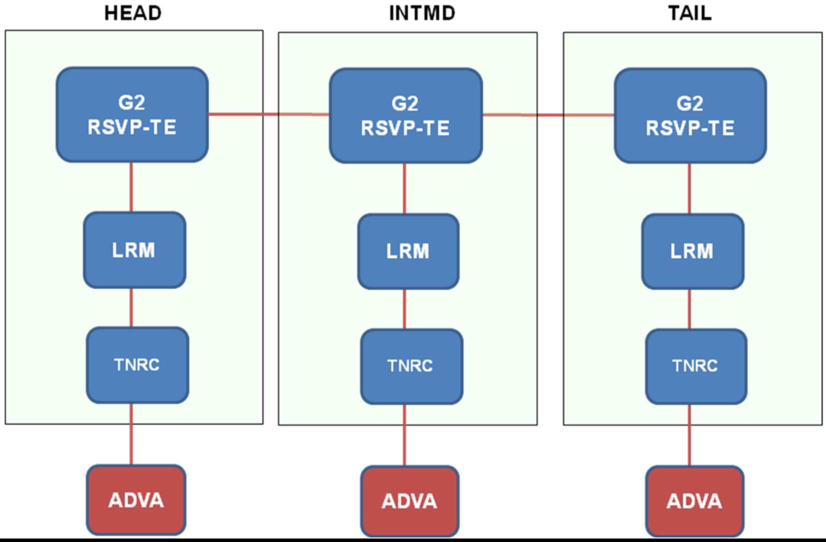
		○ Cross-connection is destroyed
2.4.	Outgoing data-link is down in LRMD in TAIL node	✓ TAIL node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.5.	Outgoing label is not present in TAIL node	✓ TAIL node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.6.	Outgoing label is not free in TNRCD in TAIL node	✓ TAIL node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.7.	Cross-connection fails in TNRCD in TAIL node	✓ TAIL node: ○ notification of unsuccessful cross-connection setup is issued to upper protocols ○ ERO process fails ○ PathErr is sent upstream ○ PathTear is send downstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test. Failure conditions related to a lack of resource presence (label, data-link, TE-link) can be achieved by incorrect LSP request configuration in G2.RSVP-TE. Failure conditions related to down state of label can happen when there is existing cross-connection using the label.

Failure conditions related to down state of data-link and TE-link can happen when TN equipment port is set to down. Cross-connection fails in TNRC during setup when alarms appear on TN equipment because of TN equipment mis-configuration or lack of light.

Test status
Passed

5.2.1.9 Setup of one bidirectional LSC LSP with advance reservation

Test Card #	G^2MPLS-TC-1.9	**Authors**	NXW, PSNC
Test Card Name	Setup of one bidirectional LSC LSP with advance reservation		
Objectives	verification of proper work of modules TNRC, LRM, SCNGWS and G2.RSVPTE in case of LSC LSP advance reservation: • LSP setup with advance reservation signalling through 3 LSC nodes via RSVP-TE • LSP activation after reservation start time • LSP teardown after reservation end time • TN equipment reconfiguration • Data model information updating		
Related Test Cards	G^2MPLS-TC-1.1, G^2MPLS-TC-1.4		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G²MPLS-TC-1.1 Step 1 and 2
2.	Create LSP with advance reservation from HEAD node	✓ Advance LSP is created and activated
2.1.	HEAD node: cross-connection reservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ LSP setup with advance reservation is signalized to intermediate node
2.2.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ Changes in LRMD VTY and in TNRCD VTY o There is new advance reservation (resource, port, data-link, TE-link)
2.3.	Intermediate node: cross-connection reservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED o LSP setup with advance reservation is signalized to intermediate node
2.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ Changes in LRMD VTY and in TNRCD VTY o There is new advance reservation (resource, port, data-link, TE-link)
2.5.	TAIL node: cross-connection reservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED o LSP setup with advance reservation is signalized to intermediate node
2.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ Changes in LRMD VTY and in TNRCD VTY o There is new advance reservation (resource, port, data-link, TE-link)
3.	LSP is activated	✓ LSP up and running
3.1.	HEAD node: TNRC AP issues cross-connection setup	✓ Cross-connection configured on equipment ✓ Upper protocols notification
3.2.	Intermediate node: TNRC AP issues cross-connection setup	✓ Cross-connection configured on equipment ✓ Upper protocols notification
3.3.	HEAD node: TNRC AP issues cross-connection setup	✓ Cross-connection configured on equipment ✓ Upper protocols notification
3.4.	LSP is teardown	✓ LSP is destroyed ✓ See G²MPLS-TC-1.4 Step 3
3.5.	HEAD node: TNRC AP issues cross-connection deletion	✓ Cross-connection destroyed on equipment ✓ Upper protocols notification ✓ G2.RSVP-TED initiate LSP TearDown ✓ LSP goes "down" and is destroyed
3.6.	Intermediate node: TNRC AP issues cross-connection	✓ Cross-connection destroyed on equipment ✓ Upper protocols notification

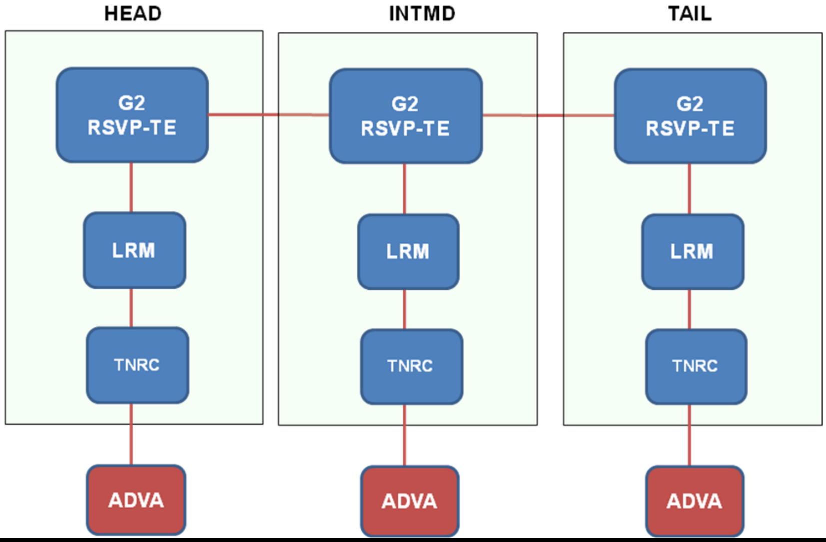
	deletion	
3.7.	TAIL node: TNRC AP issues cross-connection deletion	✓ Cross-connection destroyed on equipment ✓ Upper protocols notification

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.2.1.10 *Tear down of one bidirectional LSC LSP with advance reservation from HEAD node*

Test Card #	G^2MPLS-TC-1.10	**Authors**	NXW, PSNC
Test Card Name	Tear down of one bidirectional LSC LSP with advance reservation from HEAD node		
Objectives	verification of proper work of modules TNRC, LRM, SCNGWS and G2.RSVPTE in case of LSC LSP advance reservation teardown: • LSP setup with advance reservation signalling through 3 LSC nodes via RSVP-TE • LSP teardown before reservation activation time • Data model information updating		
Related Test Cards	G^2MPLS-TC-1.1, G^2MPLS-TC-1.9		

Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^{2}MPLS-TC-1.1 Step 1 and 2
2.	Create LSP with advance reservation from HEAD node	✓ Advance LSP is created and activated ✓ See G2MPLS-TC-1.9 Step 2 and 3
3.	Destroy LSP before reservation START_TIME	✓ LSP is signalled down from HEAD node and destroyed
3.1.	HEAD node: cross-connection unreservation request is send from G2.RSVP-TED to TNRC	✓ LSP is "down" in G2.RSVP-TED ✓ LSP teardown is signalized to intermediate node
3.2.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection unreserve	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no advance reservation (resource, port, data-link, TE-link)
3.3.	Intermediate node: cross-connection unreservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ○ LSP teardown is signalized to TAIL node
3.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection unreserve	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no advance reservation (resource, port, data-link, TE-link)
3.5.	TAIL node: cross-connection unreservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ○ LSP teardown is signalized back to HEAD node via intermediate node

3.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection unreserve	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no advance reservation (resource, port, data-link, TE-link)

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.2.2 LSP signalling tests in FSC domain

In this section are presented the results of the tests regarding the single-domain LSP signalling with FSC switching capability. As shown in Figure 5.2, in the test-bed there are 4 I-NNI G^2MPLS controllers.

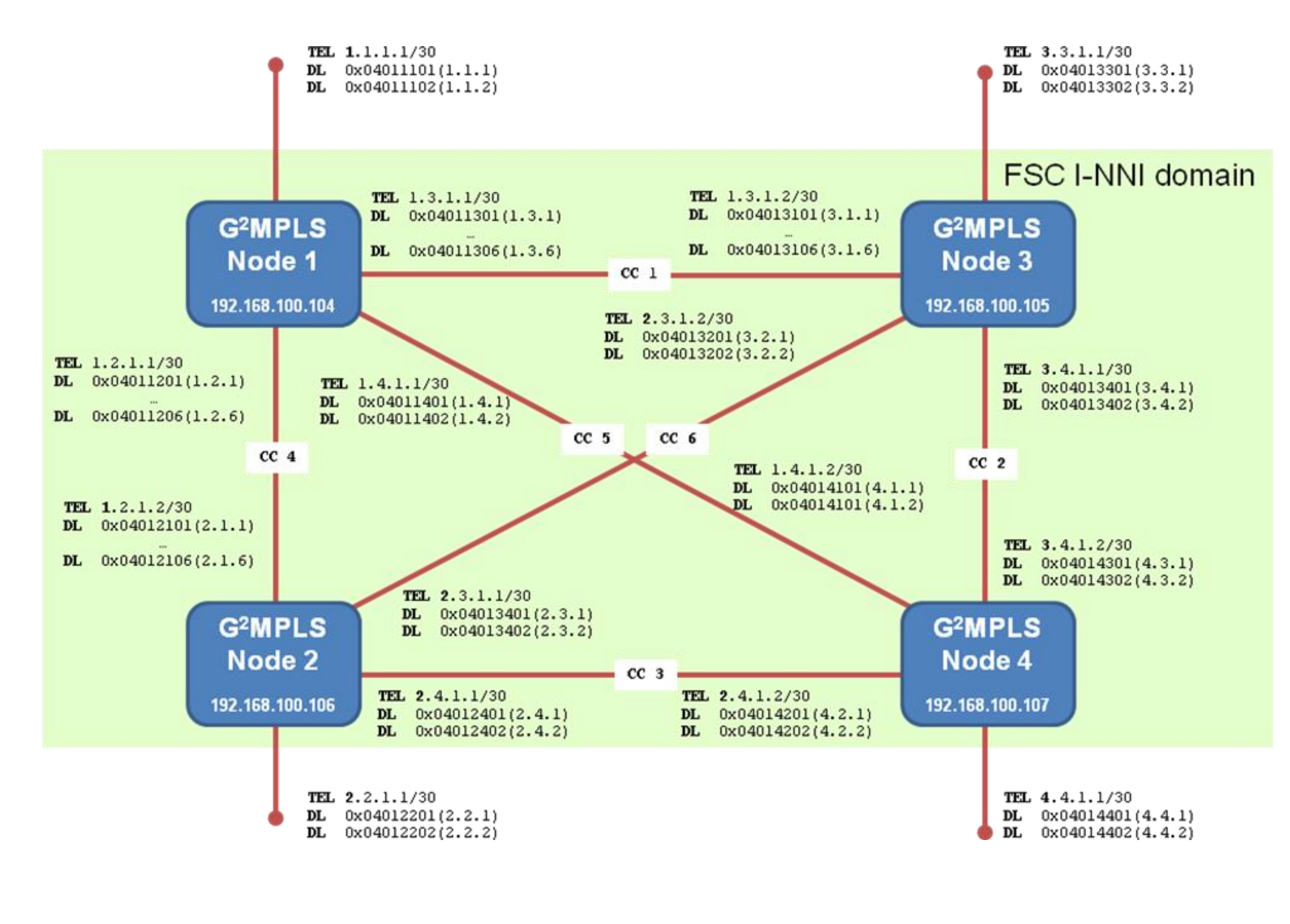
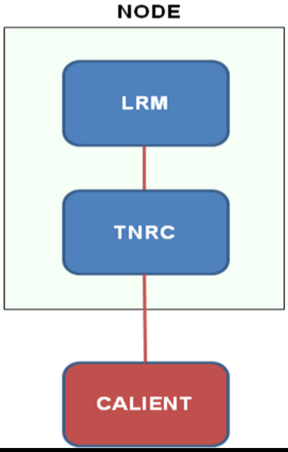


Figure 5.2: Logical topology of the single-domain FSC test-bed.

5.2.2.1 FSC node initialization

Test Card #	G^2MPLS-TC-2.1	**Authors**	NXW, PSNC
Test Card Name	FSC node initialization		
Objectives	Proper configuration of TNRC and LRM modules: • Configuration files reading • Resource and states retrieving from TN equipment via Calient DiamondWave FiberConnect TNRC SP plugin • Information passing from TNRC to LRM • Information presenting in VTY		
Related Test Cards	None		

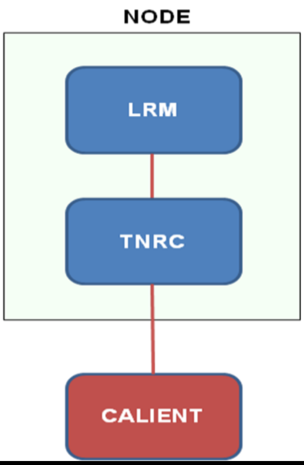
Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	Run TNRCD process	✓ TNRCD is up and working ○ There is TNRCD process on the system processes list ○ The configuration file was read successfully ○ TNRCD VTY is accessible
1.1.	TNRC AP data model is loaded	✓ There are proper equipment and boards information available in TNRCD VTY
1.2.	TNRC SP retrieved information from equipment	✓ There are ports and resources available in TNRCD VTY ○ Ports operational statuses are UP ○ The port bandwidth values are equal to configured in TNRCD equipment configuration file
2.	Run LRMD process	✓ LRMD is up and working ○ There is TNRCD process on the system processes list ○ The configuration file was read successfully ○ LRMD VTY is accessible
2.1.	LRMD data model is loaded	✓ There are proper SCN interfaces, Control Channels, adjacencies, data links and TE-links information available in LRMD VTY ○ The information about data-links are the same as in TNRCD ○ The SCN and TE-link information correspond to data-links and LRMD configuration file ○ The bundling operation on TE-Links containing more than one data-link is correct

Additional comments
• Preconditions   ○ Before the test there should be no already existing cross-connections on equipment. If there will be some existing cross-connection (for example: created by Management Plane) then operational statuses related to the cross-connection resources will be in down state and cannot be used by G^2MPLS Control Plane.

Test status
Passed

5.2.2.2 *Transport Plane notifications from FSC node*

Test Card #	G^2MPLS-TC-2.2	**Authors**	NXW, PSNC
Test Card Name	Transport Plane notifications from FSC node		
Objectives	Notification of TNRC and LRM modules in FSC node in case of resource operational state change or in case of wavelength external usage (by Network Management System or Network Operator): • States change retrieving from TN equipment via Calient DiamondWave FiberConnect TNRC SP plugin • Information passing from TNRC to LRM • Data Model information updating		
Related Test Cards	G^2MPLS-TC-2.1		
Topology and DUT details			

Test description

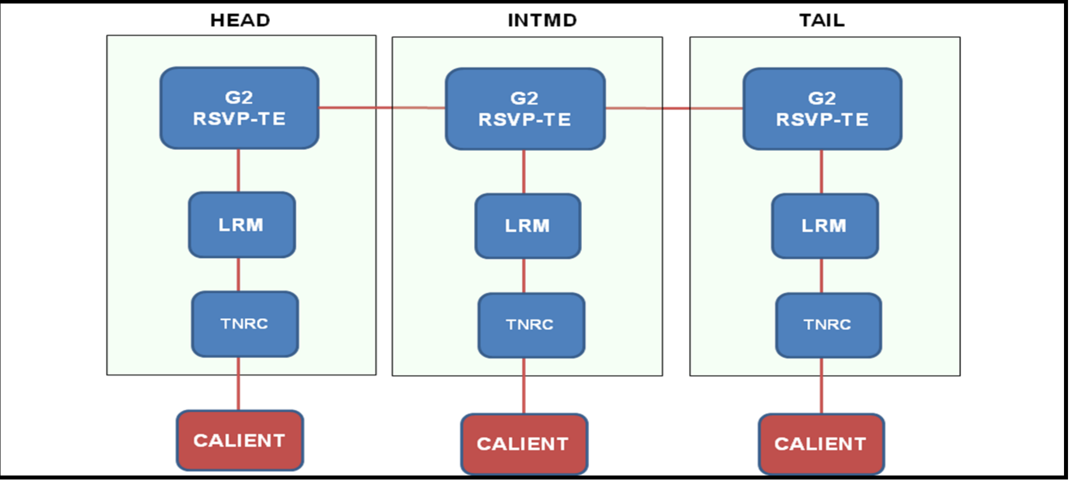
Step	Description	Outcome
1.	TNRCD and LRMD processes are running on all nodes	✓ TNRCD VTY and LRMD VTY are accessible ✓ See G^{2}MPLS-TC-2.1 Step 1 and 2
2.	Operational state of a port is set down on Equipment	✓ TNRC SP retrieve information about port operation state change
2.1.	Notification from TNRC SP is issued to TNRC AP	✓ There is the port state down information present in TNRCD VTY
2.2.	Notification from TNRC AP is issued to upper protocols (LRMD)	✓ Changes in LRMD VTY o The data-link operational state is DOWN o related TE-link has operation state DOWN

Additional comments
None.

Test status
Passed

5.2.2.3 *Setup of one bidirectional FSC LSP*

Test Card #	G^{2}MPLS-TC-2.3	**Authors**	NXW, PSNC
Test Card Name	Setup of one bidirectional FSC LSP		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of FSC LSP setup: • LSP setup signalling through 3 FSC nodes via RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^{2}MPLS-TC-2.1		

Topology and DUT details	
Topology and DUT details	

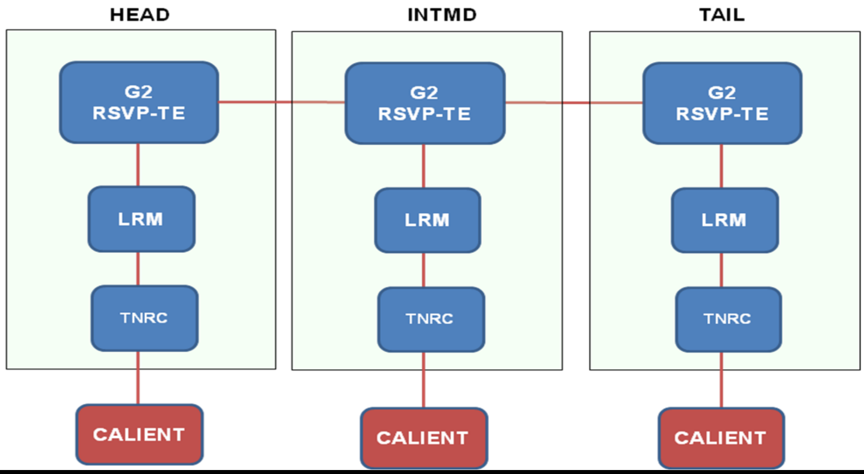
Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^{2}MPLS-TC-2.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP is created and signalled up
2.1.	HEAD node: cross-connection setup request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized to intermediate node
2.2.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ There is cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no available port bandwidth (port, data-link, TE-link)
2.3.	Intermediate node: cross-connection setup request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized to TAIL node
2.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ There is cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no available port bandwidth (port, data-link, TE-link)
2.5.	TAIL node: cross-connection setup request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized back to HEAD node via intermediate node
2.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ There is cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no available port bandwidth (port, data-link, TE-link)

Additional comments

• Preconditions
  ○ Before the test all needed resources by the LSP should be available and free.
• Postconditions
  ○ After the test the created LSP is up and running. There are related cross-connections on TN equipment.

Test status
Passed

5.2.2.4 Tear down of one bidirectional FSC LSP from HEAD node

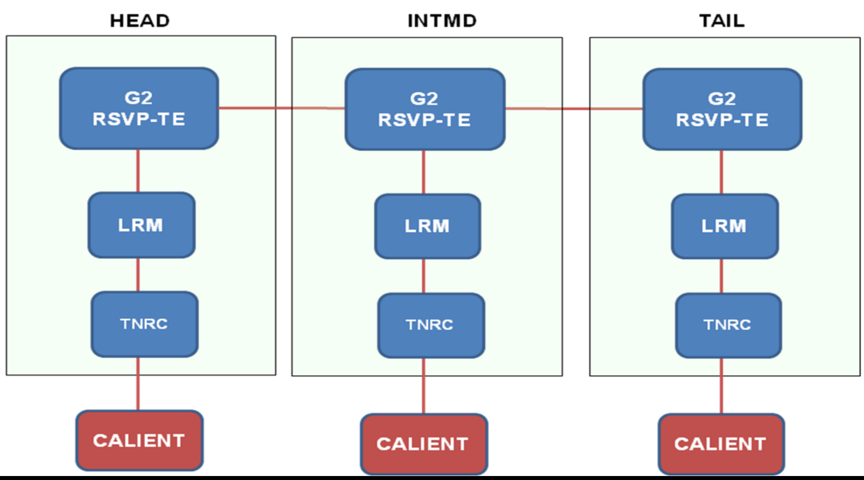
Test Card #	G^2MPLS-TC-2.4	**Authors**	NXW, PSNC
Test Card Name	Tear down of one bidirectional FSC LSP from HEAD node		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of FSC LSP teardown: • LSP teardown signalling through 3 FSC nodes via RSVP-TE from the ingress node • TN equipments cross-connect deletion • Data model information updating		
Related Test Cards	G^2MPLS-TC-2.1, G^2MPLS-TC-2.3		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-2.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP is created and signalled up ✓ See G^2MPLS-TC-2.3 Step 2
3.	Destroy LSP from HEAD node	✓ LSP is signalled down from HEAD node and destroyed
3.1.	HEAD node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to intermediate node
3.2.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRC VTY ✓ Changes in LRMD VTY and in TNRC VTY ○ Max available port bandwidth is back (port, data-link, TE-link)
3.3.	Intermediate node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to TAIL node
3.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)
3.5.	TAIL node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized back to HEAD node via intermediate node
3.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRC VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.2.2.5 Tear down of one bidirectional FSC LSP from TAIL node

Test Card #	G^{2}MPLS-TC-2.5	**Authors**	NXW, PSNC
Test Card Name	Tear down of one bidirectional FSC LSP from TAIL node		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of FSC LSP teardown: • LSP teardown signalling through 3 FSC nodes via RSVP-TE from the egress node • TN equipments cross-connect deletion • Data model information updating		
Related Test Cards	G^{2}MPLS-TC-2.2, G^{2}MPLS-TC-2.3		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^{2}MPLS-TC-2.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP is created and signalled up ✓ See G^{2}MPLS-TC-2.3 Step 2
3.	Destroy LSP from TAIL node	✓ LSP is signalled down from HEAD node and destroyed
3.1.	TAIL node: cross-connection deletion request is send from G2.RSVP-TED to TNRC	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to intermediate node
3.2.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)

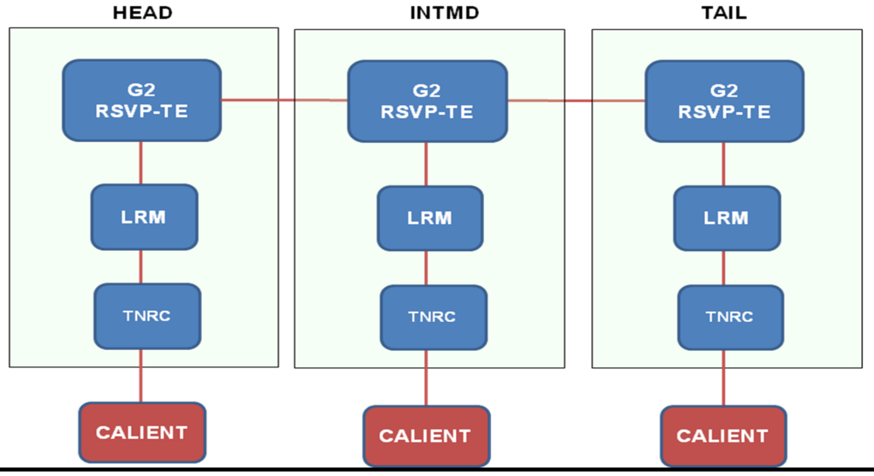
3.3.	Intermediate node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized to HEAD node
3.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRC VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)
3.5.	HEAD node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ LSP is "down" in G2.RSVP-TED ✓ Cross-connection deletion on equipment ✓ LSP teardown is signalized back to TAIL node via intermediate node
3.6.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ There is no cross-connection information in TNRCD VTY ✓ Changes in LRMD VTY and in TNRCD VTY ○ Max available port bandwidth is back (port, data-link, TE-link)

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.2.2.6 *Unsuccessful bidirectional FSC LSP setup (failure in HEAD node)*

Test Card #	G^2MPLS-TC-2.6	**Authors**	NXW, PSNC
Test Card Name	Unsuccessful bidirectional FSC LSP setup (failure in HEAD node)		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of FSC LSP setup failure in HEAD node		
Related Test Cards	G^2MPLS-TC-2.1, G^2MPLS-TC-2.3		

Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVPTED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^{2}MPLS-TC-2.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP creation is unsuccessful ✓ See G^{2}MPLS-TC-2.3 Step 2.1, 2.2
2.1.	Outgoing TE-link is not present in HEAD node	✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.2.	Outgoing TE-link is down in HEAD node	✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.3.	Outgoing data-link is not present in HEAD node	✓ Selection of data-link in TE-link fails ✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.4.	Outgoing data-link is down in LRMD in HEAD node	✓ Selection of data-link in TE-link fails ✓ LSP is in "Down" state and no Path signalling and cross-connection is issued
2.5.	Cross-connection fails in TNRCD in HEAD node	✓ LSP is "installed" in G2.RSVP-TED ✓ Cross-connection setup on equipment ✓ LSP setup is signalized to intermediate node ✓ Notification of unsuccessful cross-connection setup is issued to upper protocols ○ PathTear is issued to intermediate node and LSP is in "Down" state

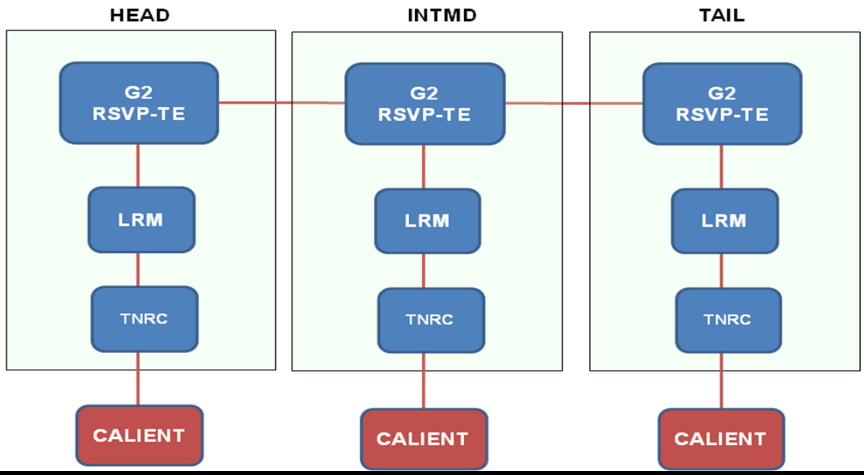
Additional comments

- Preconditions
  - Before the test all needed resources by the LSP should be available and free.
- Postconditions
  - After the test the situation is the same as before the test.

Failure conditions related to a lack of resource presence (data-link, TE-link) can be achieved by incorrect LSP request configuration in G2.RSVP-TE.
Failure conditions related to down state of data-link and TE-link can happen when TN equipment port is set to down or there is already existing cross-connection.
Cross-connection fails in TNRC during setup when alarms appear on TN equipment because of TN equipment mis-configuration or lack of light.

Test status
Passed

5.2.2.7 *Unsuccessful bidirectional FSC LSP setup (failure in intermediate node)*

Test Card #	G^2MPLS-TC-2.7	**Authors**	NXW, PSNC
Test Card Name	Unsuccessful bidirectional FSC LSP setup (failure in intermediate node)		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of FSC LSP setup failure in intermediate node		
Related Test Cards	G^2MPLS-TC-2.1, G^2MPLS-TC-2.3		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVPTED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-2.1 Step 1 and 2
2.	Create LSP from HEAD	✓ LSP creation is unsuccessful

	node	✓ See G^2MPLS-TC-2.3 Step 2.1, 2.2, 2.3, 2.4
2.1.	Outgoing TE-link is not present in intermediate node	✓ intermediate node: ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.2.	Outgoing TE-link is down in intermediate node	✓ intermediate node: ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.3.	Outgoing data-link is not present in intermediate node	✓ intermediate node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.4.	Outgoing data-link is down in LRMD in intermediate node	✓ intermediate node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.5.	Cross-connection fails in TNRCD in intermediate node	✓ intermediate node: ○ notification of unsuccessful cross-connection setup is issued to upper protocols ○ ERO process fails ○ PathErr is sent upstream ○ PathTear is send downstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD node: ○ LSP is in "Down" ○ Cross-connection is destroyed

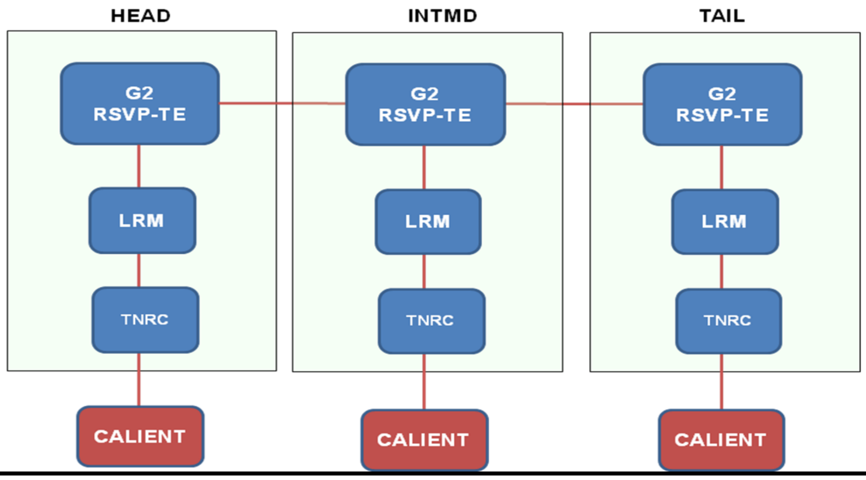
Additional comments

- Preconditions
  - Before the test all needed resources by the LSP should be available and free.
- Postconditions
  - After the test the situation is the same as before the test.

Failure conditions related to a lack of resource presence (data-link, TE-link) can be achieved by incorrect LSP request configuration in G2.RSVP-TE.
Failure conditions related to down state of data-link and TE-link can happen when TN equipment port is set to down or there is already existing cross-connection.
Cross-connection fails in TNRC during setup when alarms appear on TN equipment because of TN equipment mis-configuration or lack of light.

Test status
Passed

5.2.2.8 Unsuccessful bidirectional FSC LSP setup (failure in TAIL node)

Test Card #	G^{2}MPLS-TC-2.8	**Authors**	NXW, PSNC
Test Card Name	Unsuccessful bidirectional FSC LSP setup (failure in TAIL node)		
Objectives	Verification of proper work of modules TNRC, LRM, SCNGW and G2.RSVP-TE in case of FSC LSP setup failure in TAIL node		
Related Test Cards	G^{2}MPLS-TC-2.1, G^{2}MPLS-TC-2.3		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVPTED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-2.1 Step 1 and 2
2.	Create LSP from HEAD node	✓ LSP creation is unsuccessful ✓ See G^2MPLS-TC-2.3 Step 2.1, 2.2, 2.3, 2.4, 2.5, 2.6
2.1.	Outgoing TE-link is not present in TAIL node	✓ TAIL node: ○ TNA resolving process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.2.	Outgoing TE-link is down in TAIL node	✓ TAIL node: ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.3.	Outgoing data-link is not present in TAIL node	✓ TAIL node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.4.	Outgoing data-link is down in LRMD in TAIL node	✓ TAIL node: ○ data-link selection from TE-link fails ○ ERO process fails ○ PathErr is sent upstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down" ○ Cross-connection is destroyed
2.5.	Cross-connection fails in TNRCD in TAIL node	✓ TAIL node: ○ notification of unsuccessful cross-connection setup is issued to upper protocols ○ ERO process fails ○ PathErr is sent upstream ○ PathTear is send downstream ○ LSP is in "Down" and no Path is issued downstream ✓ HEAD and intermediate node: ○ LSP is in "Down"

		○ Cross-connection is destroyed

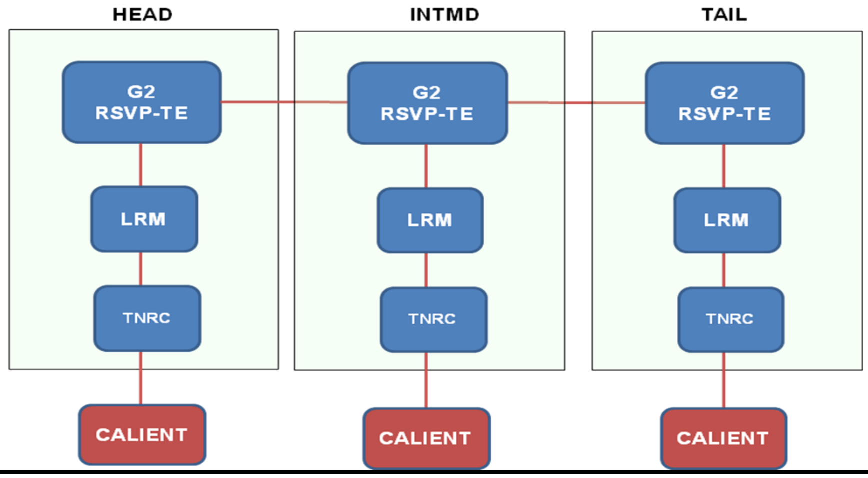
Additional comments

• Preconditions
  ○ Before the test all needed resources by the LSP should be available and free.
• Postconditions
  ○ After the test the situation is the same as before the test.
 	
Failure conditions related to a lack of resource presence (data-link, TE-link) can be achieved by incorrect LSP request configuration in G2.RSVP-TE.
Failure conditions related to down state of data-link and TE-link can happen when TN equipment port is set to down or there is already existing cross-connection.
Cross-connection fails in TNRC during setup when alarms appear on TN equipment because of TN equipment misconfiguration or lack of light.

Test status
Passed

5.2.2.9 Setup of one bidirectional FSC LSP with advance reservation

Test Card #	G^2MPLS-TC-2.9	**Authors**	NXW, PSNC
Test Card Name	Setup of one bidirectional FSC LSP with advance reservation		
Objectives	verification of proper work of modules TNRC, LRM, SCNGWS and G2.RSVP-TE in case of FSC LSP advance reservation: • LSP setup with advance reservation signalling through 3 FSC nodes via RSVP-TE • LSP activation after reservation start time • LSP teardown after reservation end time • TN equipment reconfiguration • Data model information updating		
Related Test Cards	G^2MPLS-TC-2.1, G^2MPLS-TC-2.4		

Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVPTED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-2.1 Step 1 and 2
2.	Create LSP with advance reservation from HEAD node	✓ Advance LSP is created and activated
2.1.	HEAD node: cross-connection reservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ✓ LSP setup with advance reservation is signalized to intermediate node
2.2.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is new advance reservation (resource, port, data-link, TE-link)
2.3.	Intermediate node: cross-connection reservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ○ LSP setup with advance reservation is signalized to intermediate node
2.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is new advance reservation (resource, port, data-link, TE-link)
2.5.	TAIL node: cross-connection reservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is "installed" in G2.RSVP-TED ○ LSP setup with advance reservation is signalized to intermediate node
2.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection setup	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is new advance reservation (resource, port, data-link, TE-link)
3.	LSP is activated	✓ LSP up and running

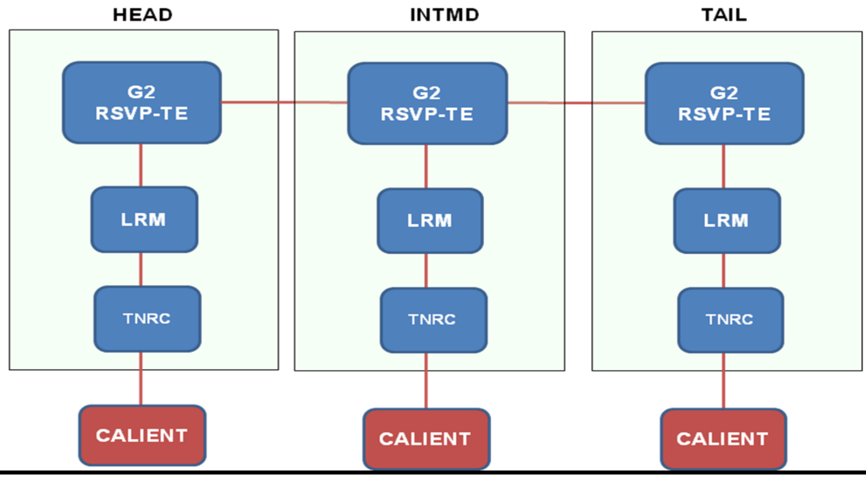
3.1.	HEAD node: TNRC AP issues cross-connection setup	✓ Cross-connection configured on equipment ✓ Upper protocols notification
3.2.	Intermediate node: TNRC AP issues cross-connection setup	✓ Cross-connection configured on equipment ✓ Upper protocols notification
3.3.	HEAD node: TNRC AP issues cross-connection setup	✓ Cross-connection configured on equipment ✓ Upper protocols notification
3.4.	LSP is teardown	✓ LSP is destroyed ✓ See G^{2}MPLS-TC-2.4 Step 3
3.5.	HEAD node: TNRC AP issues cross-connection deletion	✓ Cross-connection destroyed on equipment ✓ Upper protocols notification ✓ G2.RSVP-TED initiate LSP TearDown ✓ LSP goes "down" and is destroyed
3.6.	Intermediate node: TNRC AP issues cross-connection deletion	✓ Cross-connection destroyed on equipment ✓ Upper protocols notification
3.7.	TAIL node: TNRC AP issues cross-connection deletion	✓ Cross-connection destroyed on equipment ✓ Upper protocols notification

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.2.2.10 *Tear down of one bidirectional FSC LSP with advance reservation from HEAD node*

Test Card #	G^{2}MPLS-TC-2.10	**Authors**	NXW, PSNC
Test Card Name	Tear down of one bidirectional FSC LSP with advance reservation from HEAD node		
Objectives	verification of proper work of modules TNRC, LRM, SCNGWS and G2.RSVP-TE in case of FSC LSP advance reservation teardown: • LSP setup with advance reservation signalling through 3 FSC nodes via RSVP-TE • LSP teardown before reservation activation time		

	• Data model information updating
Related Test Cards	G^2MPLS-TC-2.1, G^2MPLS-TC-2.09
Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVPTED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent ✓ See G^2MPLS-TC-2.1 Step 1 and 2
2.	Create LSP with advance reservation from HEAD node	✓ Advance LSP is created and activated ✓ See G2MPLS-TC-2.9 Step 2 and 3
3.	Destroy LSP before reservation START_TIME	✓ LSP is signalled down from HEAD node and destroyed
3.1.	HEAD node: cross-connection unreservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is “down” in G2.RSVP-TED ✓ LSP teardown is signalized to intermediate node
3.2.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection unreserve	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no advance reservation (resource, port, data-link, TE-link)
3.3.	Intermediate node: cross-connection unreservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is “down” in G2.RSVP-TED ○ LSP teardown is signalized to TAIL node
3.4.	Intermediate node: TNRC AP notification is issued to upper protocols on cross-connection unreserve	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no advance reservation (resource, port, data-link, TE-link)
3.5.	TAIL node: cross-connection unreservation request is send from G2.RSVP-TED to TNRCD	✓ LSP is “down” in G2.RSVP-TED ○ LSP teardown is signalized back to HEAD node via intermediate node

3.6.	TAIL node: TNRC AP notification is issued to upper protocols on cross-connection unreserve	✓ Changes in LRMD VTY and in TNRCD VTY ○ There is no advance reservation (resource, port, data-link, TE-link)

Additional comments
• Preconditions ○ Before the test all needed resources by the LSP should be available and free. • Postconditions ○ After the test the situation is the same as before the test.

Test status
Passed

5.3 G²MPLS call signalling tests

The G²MPLS call signalling tests have been executed in two separate sessions:

- single-domain call signalling tests
- Inter-domain call signalling tests

The single-domain tests have been used to verify the proper work and interaction of that modules involved in just one G²MPLS domain signalling (mainly G2.NCC, RC and G².RSVP-TE).
The inter-domain tests, instead, have been used to verify the proper work and interaction of those modules involved in the multi-domain signalling (mainly G2.NCC and G.ENNI-RSVP).
In the next two sessions the results of the two sessions of tests are shown.

5.3.1 Single-domain call signalling tests

In this section the results of the tests regarding the single-domain call signalling are presented. As shown in Figure 5.3**Błąd! Nie można odnaleźć źródła odwołania.**, in the test-bed there are 6 different G²MPLS controllers: 4 of them (Node 1, 2, 3 and 4) have been used as INNI nodes, and the other 2 as G.UNI-GW clients.

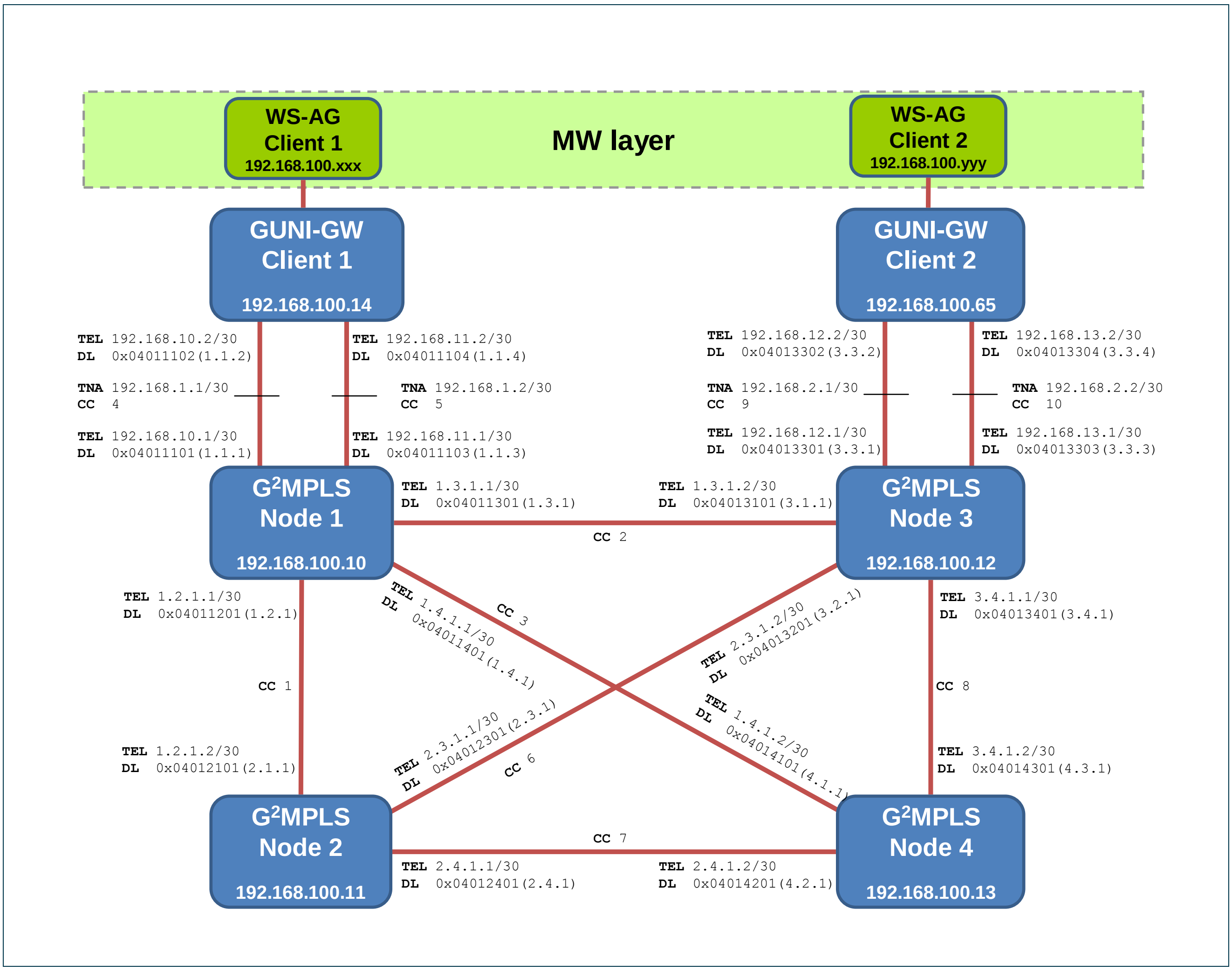
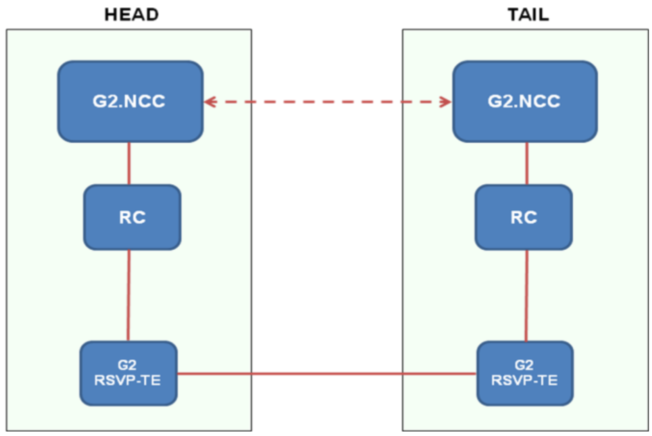


Figure 5.3: Logical topology of the single-domain FSC test-bed for G2MPLS Call signalling tests.

5.3.1.1 *Setup of one bidirectional single-domain FSC LSP by G2.NCC module*

Test Card #	G^2MPLS-TC-3.1	**Authors**	NXW, PSNC, UESSEX
Test Card Name	Setup of one bidirectional single-domain FSC LSP by G2.NCC module		
Objectives	Verification of proper work of modules G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP setup: • Call setup signalling through 2 G2.NCC instances (HEAD and TAIL node) • LSP setup signalling through 2 FSC nodes via RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^2MPLS-TC-1.3		

Topology and DUT details	

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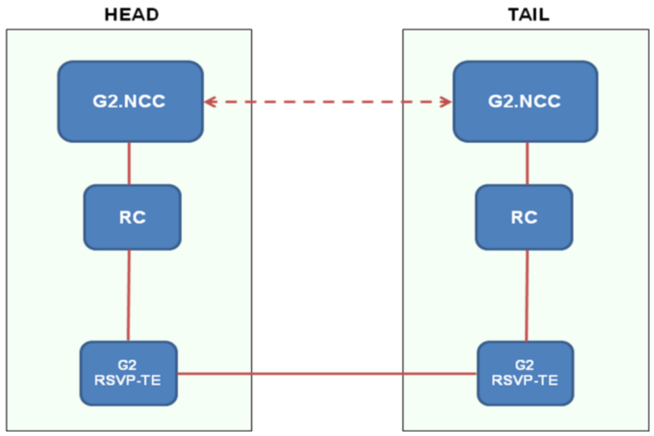
Test description		
Step	**Description**	**Outcome**
1.	G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G2.NCC	✓ Call is created and signalled up
2.1.	HEAD node: Setup request is sent from G2.NCC to TAIL node	✓ Setup Indication is received from TAIL node G2.NCC ✓ Setup Confirm is sent from G2.NCC to TAIL node ✓ Call is "active" in G2.NCC ✓ Recovery bundle is created by RC
2.2.	TAIL node: Setup request is received from HEAD node G2.NCC	✓ Setup Indication is sent from G2.NCC to HEAD node ✓ Setup Confirm is received from TAIL node G2.NCC ✓ Call is "active" in G2.NCC ✓ Recovery bundle is created in RC
3.	Create LSP from HEAD node RC	✓ LSP is created and signalled up by RC
3.1.	HEAD node: LSP and cross-connection setup	✓ See G^2MPLS-TC-1.3: steps 2.1. and 2.2.
3.2.	TAIL node: LSP and cross-connection setup	✓ See G^2MPLS-TC-1.3 steps 2.5. and 2.6.

Additional comments

- Pre-conditions:
  - all needed resources by the LSP should be available and free on the equipments
  - the persistency files (*.pdb) related to G2.NCC should be removed
- Post-conditions:
  - new persistency files are created for G2.NCC

Test status
Passed

5.3.1.2 Teardown of the one bidirectional single-domain FSC LSP by G2.NCC module

<table>
<tr><td>Test Card #</td><td>G^{2}MPLS-TC-3.2</td><td rowspan="2">Authors</td><td rowspan="2">NXW, PSNC, UESSEX</td></tr>
<tr><td>Test Card Name</td><td>Teardown of the one bidirectional single-domain FSC LSP by G2.NCC module</td></tr>
<tr><td>Objectives</td><td colspan="3">Verification of proper work of modules G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP teardown:
• Call teardown signalling through 2 FSC nodes G2.NCC instances (HEAD and TAIL node)
• LSP teardown signalling through 2 FSC nodes via G2.RSVP-TE
• TN equipments cross-connect deletion
• Data model information updating</td></tr>
<tr><td>Related Test Cards</td><td colspan="3">G^{2}MPLS-TC-1.4, G^{2}MPLS-TC-3.1</td></tr>
<tr><td>Topology and DUT details</td><td colspan="3">
</td></tr>
</table>

Test description		
Step	**Description**	**Outcome**

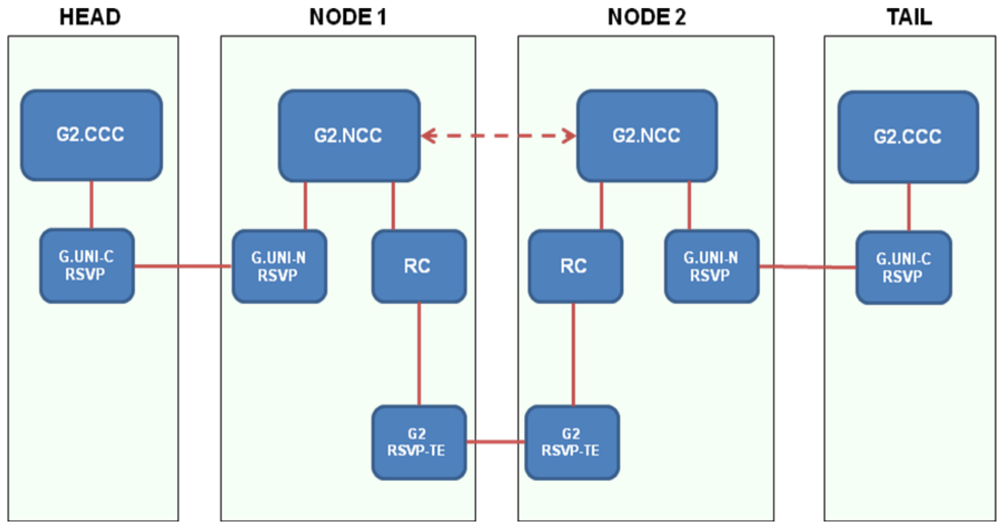
1.	G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G2.NCC	✓ See G^{2}MPLS-TC-3.1: step 2.
3.	Create LSP from HEAD node RC	✓ See G^{2}MPLS-TC-3.1: step 3.
4.	Destroy Call from HEAD node G2.NCC	✓ Call is signalled down from HEAD node G2.NCC and destroyed
4.1.	HEAD node: Release Request is sent from G2.NCC to TAIL node	✓ Release Indication is received from TAIL node G2.NCC ✓ Call is “idle” in G2.NCC and is destroyed ✓ Recovery bundle is destroyed in RC
4.2.	TAIL node: Release Request is received from HEAD node G2.NCC	✓ Release Indication is sent from G2.NCC to HEAD node ✓ Call is “idle” in G2.NCC and is destroyed ✓ Recovery bundle is destroyed in RC
5.	Destroy LSP from HEAD node RC	✓ LSP is signalled down from HEAD node RC and destroyed
5.1.	HEAD node: TNRC AP notification is issued to upper protocols on cross-connection deletion	✓ See G^{2}MPLS-TC-1.4: steps 3.1. and 3.2.
5.2.	TAIL node: cross-connection deletion request is send from G2.RSVP-TED to TNRCD	✓ See G^{2}MPLS-TC-1.4: steps 3.5. and 3.6.

Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.NCC

Test status
Passed

5.3.1.3 Setup of one bidirectional single-domain FSC LSP by G2.CCC module

Test Card #	G^{2}MPLS-TC-3.3	**Authors**	NXW, PSNC, UESSEX

Test Card Name	Setup of one bidirectional single-domain FSC LSP by G2.CCC module		
Objectives	Verification of proper work of modules G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP setup: • UNI LSP setup signalling through HEAD node and Node1 via G.UNI-RSVP • UNI LSP setup signalling through Node2 and TAIL node via G.UNI-RSVP • Call setup signalling through 2 G2.CCC instances (HEAD and TAIL node) and 2 G2.NCC instances (Node1 and Node2) • INNI LSP setup signalling through 2 FSC nodes (Node1 and Node2) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^2MPLS-TC-1.3, G^2MPLS-TC-3.1		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
1.	G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G2.CCC	✓ Call is created and signalled up
2.1.	HEAD node: Setup request is sent from G2.CCC to Node1	✓ UNI LSP is created and signalled up by G2.CCC ✓ Setup Indication is received from Node1 G2.NCC via G.UNI-RSVP signalling ✓ Setup Confirm is sent from G2.NCC to Node1 via G.UNI-RSVP signalling

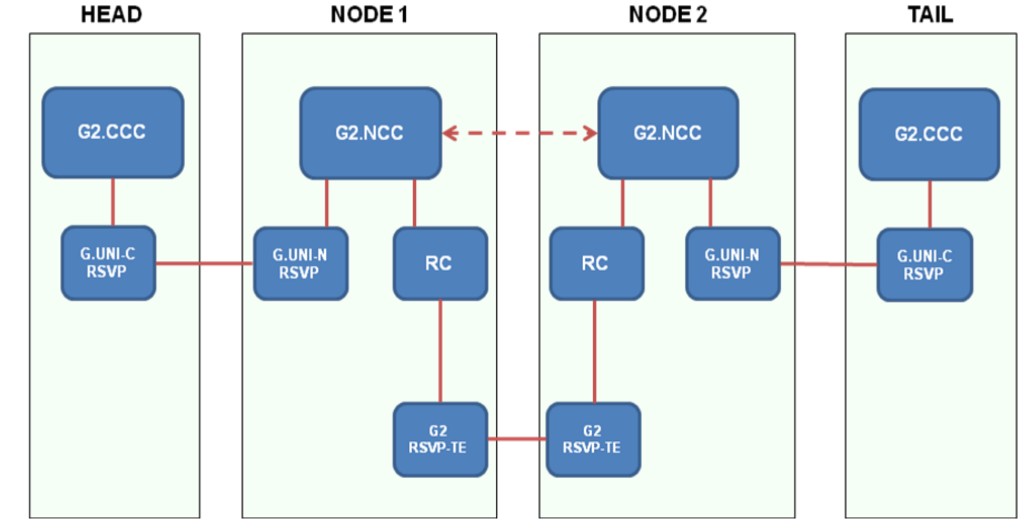
		✓ Call is "active" in G2.CCC ✓ UNI LSP is "installed" in G.UNI-RSVP
2.2.	Node1: Setup Request is received from HEAD node G2.CCC via G.UNI-RSVP signalling	✓ Setup Request is sent from G2.NCC to Node2 ✓ Setup Indication is received from Node2 G2.NCC and forwarded to HEAD node via G.UNI-RSVP signalling ✓ Setup Confirm is received from HEAD node G2.NCC and forwarded by G2.NCC to Node2 ✓ Call is "active" in G2.NCC ✓ UNI LSP is "installed" in G.UNI-RSVP ✓ Recovery bundle is created in RC
2.3.	Node2: Setup Request is received from Node1 G2.NCC	✓ Setup Request is forwarded to TAIL node via G.UNI-RSVP signalling ✓ Setup Indication is received from TAIL node and forwarded by G2.NCC to Node1 ✓ Setup Confirm is received from Node1 G2.NCC and forwarded by G2.NCC to TAIL node ✓ Call is "active" in G2.NCC ✓ UNI LSP is "installed" in G.UNI-RSVP ✓ Recovery bundle is created in RC
2.4.	TAIL node: Setup Request is received from Node2 G2.NCC via G.UNI-RSVP signalling	✓ Setup Indication is sent from G2.CCC to Node2 via G.UNI-RSVP signalling ✓ Setup Confirm is received from Node2 G2.NCC ✓ Call is "active" in G2.CCC ✓ UNI LSP is "installed" in G.UNI-RSVP
3.	Create INNI LSP from Node1 RC	✓ See G^2MPLS-TC-3.1 step 3. and G^2MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.

Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to and G:CCC and G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.CCC and G2.NCC

Test status
Passed

5.3.1.4 Teardown of the one bidirectional single-domain FSC LSP by G2.CCC module

Test Card #	G^2MPLS-TC-3.4	**Authors**	NXW, PSNC, UESSEX
Test Card Name	Teardown of the one bidirectional single-domain FSC LSP by G2.CCC module		

Objectives	Verification of proper work of modules G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP teardown: • UNI LSP teardown signalling through HEAD node and Node1 via G.UNI-RSVP • UNI LSP teardown signalling through Node2 and TAIL node via G.UNI-RSVP • Call teardown signalling through 2 G2.CCC instances (HEAD and TAIL node) and 2 G2.NCC instances (Node1 and Node2) • INNI LSP teardown signalling through 2 FSC nodes (Node1 and Node2) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating
Related Test Cards	G^2MPLS-TC-1.3, G^2MPLS-TC-3.1, G^2MPLS-TC-3.3
Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G2.CCC	✓ See G^2MPLS-TC-3.3:step 2.
3.	Create INNI LSP from Node1 RC	✓ See G^2MPLS-TC-3.1 step 3. and G2MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.
4.	Destroy Call from HEAD node G2.CCC	✓ Call is signalled down from HEAD node G2.CCC and destroyed
4.1.	HEAD node: Release Request is sent from G2.CCC to TAIL node via G.UNI-RSVP signalling	✓ Release Indication is received from Node1 G2.NCC ✓ Call is “idle” in G2.CCC and is destroyed

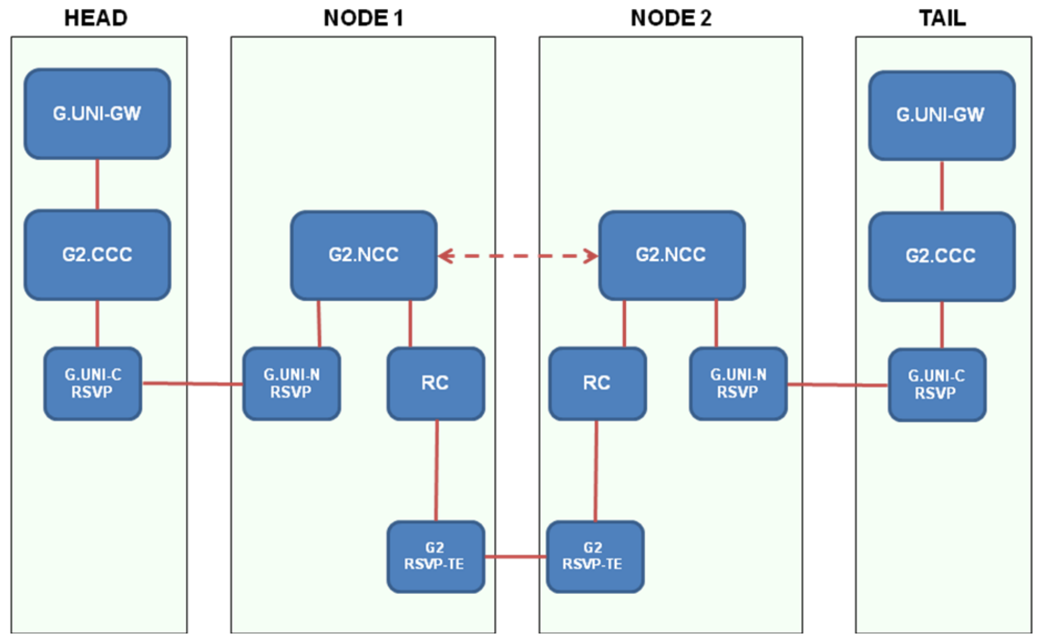
4.2.	Node1: Release Request is received from HEAD node G2.CCC via G.UNI-RSVP signalling	✓ Release Request is forwarded by G2.NCC to Node2 G2.NCC ✓ Release Indication is received from Node2 G2.NCC and forwarded to HEAD node G2.CCC ✓ Call is “idle” in G2.NCC and is destroyed ✓ Recovery bundle is destroyed in RC
4.3.	Node2: Release Request is received from Node1 G2.NCC	✓ Release Request is forwarded by G2.NCC to TAIL node G2.CCC via G.UNI-RSVP signalling ✓ Release Indication is received from TAIL node G2.CCC via G.UNI-RSVP signalling and forwarded by G2.NCC to Node1 ✓ Call is “idle” in G2.NCC and is destroyed ✓ Recovery bundle is destroyed in RC
4.4.	TAIL node: Release Request is received from Node2 G2.NCC via G.UNI-RSVP signalling	✓ Release Indication is sent from G2.CCC to Node2 via G.UNI-RSVP signalling ✓ Call is “idle” in G2.CCC and is destroyed
5.	Destroy INNI LSP from Node1 RC	✓ See G^{2}MPLS-TC-3.1:step 5.

Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to and G.CCC and G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.CCC and G2.NCC

Test status
Passed

5.3.1.5 *Setup of one bidirectional single-domain FSC LSP by G.UNI-GW module*

Test Card #	G^{2}MPLS-TC-3.5	**Authors**	NXW, UESSEX, PSNC
Test Card Name	Setup of one bidirectional single-domain FSC LSP by G.UNI-GW module		
Objectives	Verification of proper work of modules G.UNI-GW, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP setup: • UNI LSP setup signalling through HEAD node and Node1 via G.UNI-RSVP • UNI LSP setup signalling through Node2 and TAIL node via G.UNI-RSVP • Call setup signalling through 2 G.UNI-GW instances, 2 G2.CCC instances (HEAD and TAIL node) and 2 G2.NCC instances (Node1 and Node2)		

	• INNI LSP setup signalling through 2 FSC nodes (Node1 and Node2) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating
Related Test Cards	G^{2}MPLS-TC-1.3, G^{2}MPLS-TC-3.1, G^{2}MPLS-TC-3.3
Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	G.UNI-GWD, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY, SCNGWD VTY, and G.UNI-GWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G.UNI-GW	✓ Call is created and signalled up
2.1.	HEAD node: Call Create request is sent from G.UNI-GW to G2.CCC	✓ Setup Request is sent from G2.CCC to Node 1via G.UNI-RSVP signalling ✓ See G^{2}MPLS-TC-3.3: step 2.1. ✓ Call is “installed” in G.UNI-GW
2.2.	Node1: Setup Request is received from HEAD node G2.CCC via G.UNI-RSVP signalling	✓ See G^{2}MPLS-TC-3.3: step 2.2.
2.3.	Node2: Setup Request is received from Node1 G2.NCC	✓ See G^{2}MPLS-TC-3.3: step 2.3.

2.4.	TAIL node: Setup Request is received from Node2 G2.NCC via G.UNI-RSVP signalling	✓ See G^2MPLS-TC-3.3: step 2.4.
3.	Create INNI LSP from Node1 RC	✓ See G^2MPLS-TC-3.1 step 3. and G^2MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.

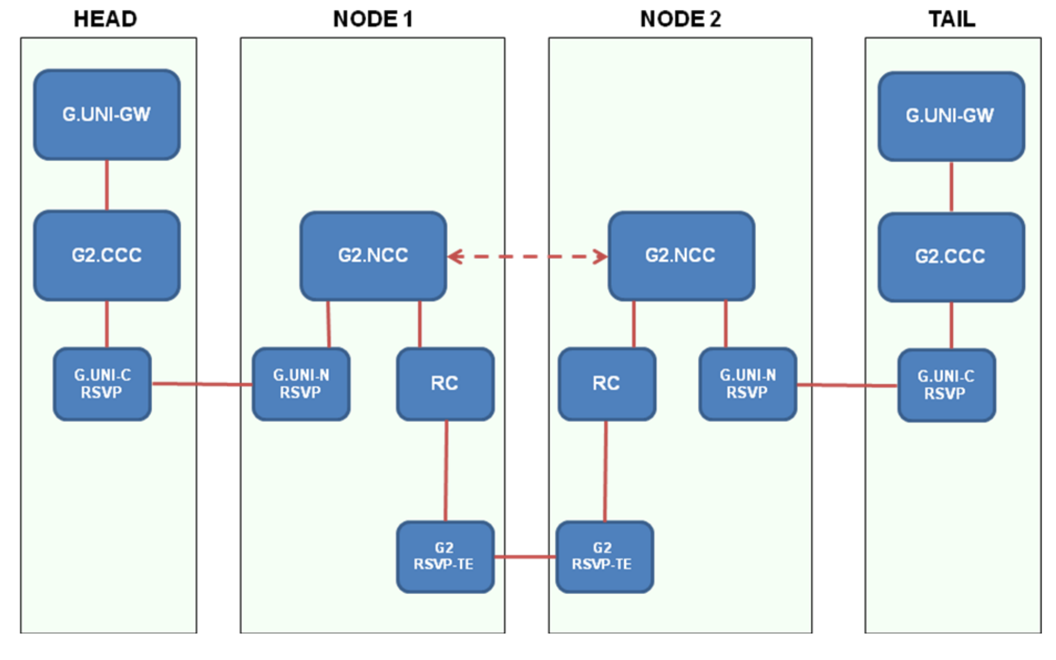
Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to and G:CCC and G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.CCC and G2.NCC

Test status
Passed

5.3.1.6 Teardown of the one bidirectional single-domain FSC LSP by G.UNI-GW module

Test Card #	G^2MPLS-TC-3.6	**Authors**	NXW, UESSEX, PSNC
Test Card Name	Teardown of the one bidirectional single-domain FSC LSP by G.UNI-GW module		
Objectives	Verification of proper work of modules G.UNI-GW, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP teardown: • UNI LSP teardown signalling through HEAD node and Node1 via G.UNI-RSVP • UNI LSP teardown signalling through Node2 and TAIL node via G.UNI-RSVP • Call teardown signalling through 2 G.UNI-GW instances, 2 G2.CCC instances (HEAD and TAIL node) and 2 G2.NCC instances (Node1 and Node2) • INNI LSP teardown signalling through 2 FSC nodes (Node1 and Node2) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^2MPLS-TC-1.3, G^2MPLS-TC-3.1, G^2MPLS-TC-3.4, G^2MPLS-TC-3.5		

Topology and DUT details



Test description		
Step	**Description**	**Outcome**
1.	G.UNI-GWD, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY, SCNGWD VTY and G.UNI-GWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G.UNI-GW	✓ See G^{2}MPLS-TC-3.5:step 2.
3.	Create INNI LSP from Node1 RC	✓ See G^{2}MPLS-TC-3.1 step 3. and G^{2}MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.
4.	Destroy Call from HEAD node G.UNI-GW	✓ Call is signalled down from HEAD node G.UNI-GW and destroyed
4.1.	HEAD node: Call Destroy request is sent from G.UNI-GW to G2.CCC	✓ Release Request is sent from G2.CCC to TAIL node via G.UNI-RSVP signalling ✓ See G^{2}MPLS-TC-3.4: step 4.1. ✓ Call is destroyed in G.UNI-GW
4.2.	Node1: Release Request is received from HEAD node G2.CCC via G.UNI-RSVP signalling	✓ See G^{2}MPLS-TC-3.4: step 4.2.
4.3.	Node2: Release Request is received from Node1 G2.NCC	✓ See G^{2}MPLS-TC-3.4: step 4.3.
4.4.	TAIL node: Release Request is received from	✓ See G^{2}MPLS-TC-3.4: step 4.4.

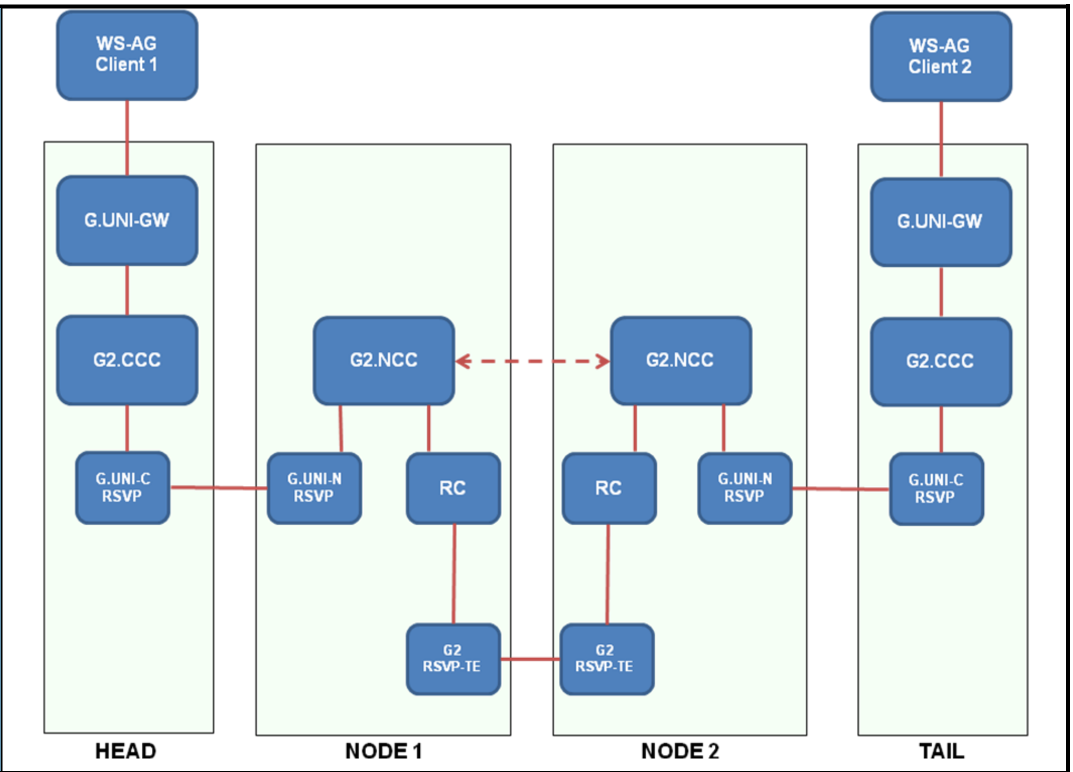
	Node2 G2.NCC via G.UNI-RSVP signalling	
5.	Destroy INNI LSP from Node1 RC	✓ See G^{2}MPLS-TC-3.1:step 5.

Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to and G:CCC and G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.CCC and G2.NCC

Test status
Passed

5.3.1.7 Setup of one bidirectional single-domain FSC LSP by Middleware WS-Agreement client

Test Card #	G^{2}MPLS-TC-3.7	**Authors**	NXW, UESSEX, FHG, PSNC
Test Card Name	Setup of one bidirectional single-domain FSC LSP by Middleware WS-Agreement client		
Objectives	Verification of proper work of modules WS-AG client, G.UNI-GW, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP setup: • UNI LSP setup signalling through HEAD node and Node1 via G.UNI-RSVP • UNI LSP setup signalling through Node2 and TAIL node via G.UNI-RSVP • Call setup signalling through WS-AG client, 2 G.UNI-GW instances, 2 G2.CCC instances (HEAD and TAIL node) and 2 G2.NCC instances (Node1 and Node2) • INNI LSP setup signalling through 2 FSC nodes (Node1 and Node2) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^{2}MPLS-TC-1.3, G^{2}MPLS-TC-3.1, G^{2}MPLS-TC-3.3, G^{2}MPLS-TC-3.5		
Topology and DUT details			



Test description		
Step	**Description**	**Outcome**
1.	WS-AG client, G.UNI-GWD, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY, SCNGWD VTY, and G.UNI-GWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from WS-AG client	✓ Call is created and signalled up
2.1.	WS-AG client: Call Create request is sent to HEAD node G.UNI-GW	✓ Connection to the web service server success and Call is created
2.2.	HEAD node: Call Create request is received from WS-AG client	✓ Call Create request is sent from G.UNI-GW to G2.CCC ✓ See G^{2}MPLS-TC-3.5: step 2.1.
2.3.	Node1: Setup Request is received from HEAD node G2.CCC via G.UNI-RSVP signalling	✓ See G^{2}MPLS-TC-3.3: step 2.2.
2.4.	Node2: Setup Request is received from Node1 G2.NCC	✓ See G^{2}MPLS-TC-3.3: step 2.3.
2.5.	TAIL node: Setup Request	✓ See G^{2}MPLS-TC-3.3: step 2.4.

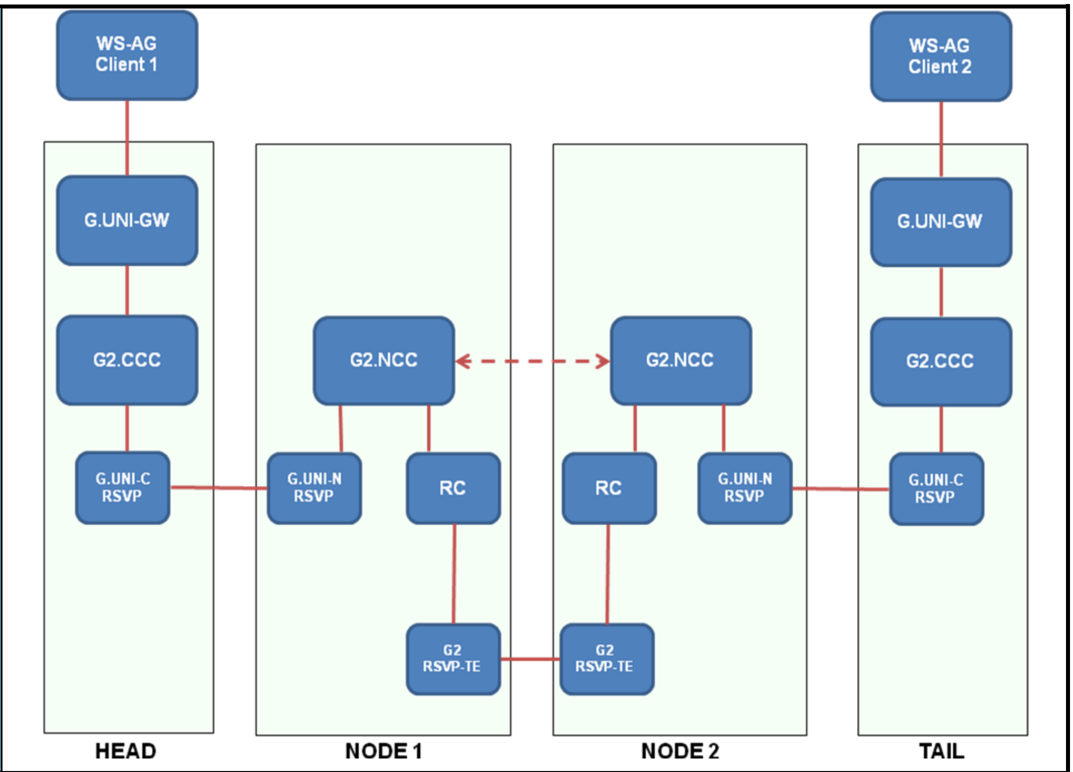
	is received from Node2 G2.NCC via G.UNI-RSVP signalling	
3.	Create INNI LSP from Node1 RC	✓ See G^{2}MPLS-TC-3.1 step 3. and G^{2}MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.

Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to and G:CCC and G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.CCC and G2.NCC

Test status
Passed

5.3.1.8 Teardown of the one bidirectional single-domain FSC LSP by Middleware WS-Agreement client

Test Card #	G^{2}MPLS-TC-3.8	**Authors**	NXW, UESSEX, FHG, PSNC
Test Card Name	Teardown of the one bidirectional single-domain FSC LSP by Middleware WS-Agreement client		
Objectives	Verification of proper work of modules WS-AG client, G.UNI-GW, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP teardown: • UNI LSP teardown signalling through HEAD node and Node1 via G.UNI-RSVP • UNI LSP teardown signalling through Node2 and TAIL node via G.UNI-RSVP • Call teardown signalling through WS-AG client, 2 G.UNI-GW instances, 2 G2.CCC instances (HEAD and TAIL node) and 2 G2.NCC instances (Node1 and Node2) • INNI LSP teardown signalling through 2 FSC nodes (Node1 and Node2) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^{2}MPLS-TC-1.3, G^{2}MPLS-TC-3.1, G^{2}MPLS-TC-3.4, G^{2}MPLS-TC-3.5, G^{2}MPLS-TC-3.7		
Topology and DUT details			



Test description		
Step	**Description**	**Outcome**
1.	G.UNI-GWD, G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY, SCNGWD VTY and G.UNI-GWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from WS-AG client	✓ See G^2MPLS-TC-3.7:step 2.
3.	Create INNI LSP from Node1 RC	✓ See G^2MPLS-TC-3.1 step 3. and G^2MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.
4.	Destroy Call from WS-AG client	✓ Call is signalled down from WS-AG client and destroyed
4.1.	WS-AG client: Call Destroy request is sent to HEAD node G.UNI-GW	✓ Connection to the web service server success and Call is destroyed
4.2.	HEAD node: Call Destroy request is received from WS-AG client	✓ Call Destroy request is sent from G.UNI-GW to G2.CCC ✓ See G^2MPLS-TC-3.6: step 4.1.
4.3.	Node1: Release Request is received from HEAD node G2.CCC via G.UNI-RSVP signalling	✓ See G^2MPLS-TC-3.4: step 4.2.

4.4.	Node2: Release Request is received from Node1 G2.NCC	✓ See G^2MPLS-TC-3.4: step 4.3.
4.5.	TAIL node: Release Request is received from Node2 G2.NCC via G.UNI-RSVP signalling	✓ See G^2MPLS-TC-3.4: step 4.4.
5.	Destroy INNI LSP from Node1 RC	✓ See G^2MPLS-TC-3.1:step 5.

Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to and G:CCC and G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.CCC and G2.NCC

Test status
Passed

5.3.2 Inter-domain call signalling tests

In this section the results of the tests regarding the single-domain call signalling are presented. For this purpose 6 G^2MPLS controllers have been deployed, in order to setup 2 different I-NNI domains (each one with 2 controllers) reachable by a G.UNI-GW client each.

In Figure 5.4 the logical topology of the test-bed for the inter-domain tests is described.

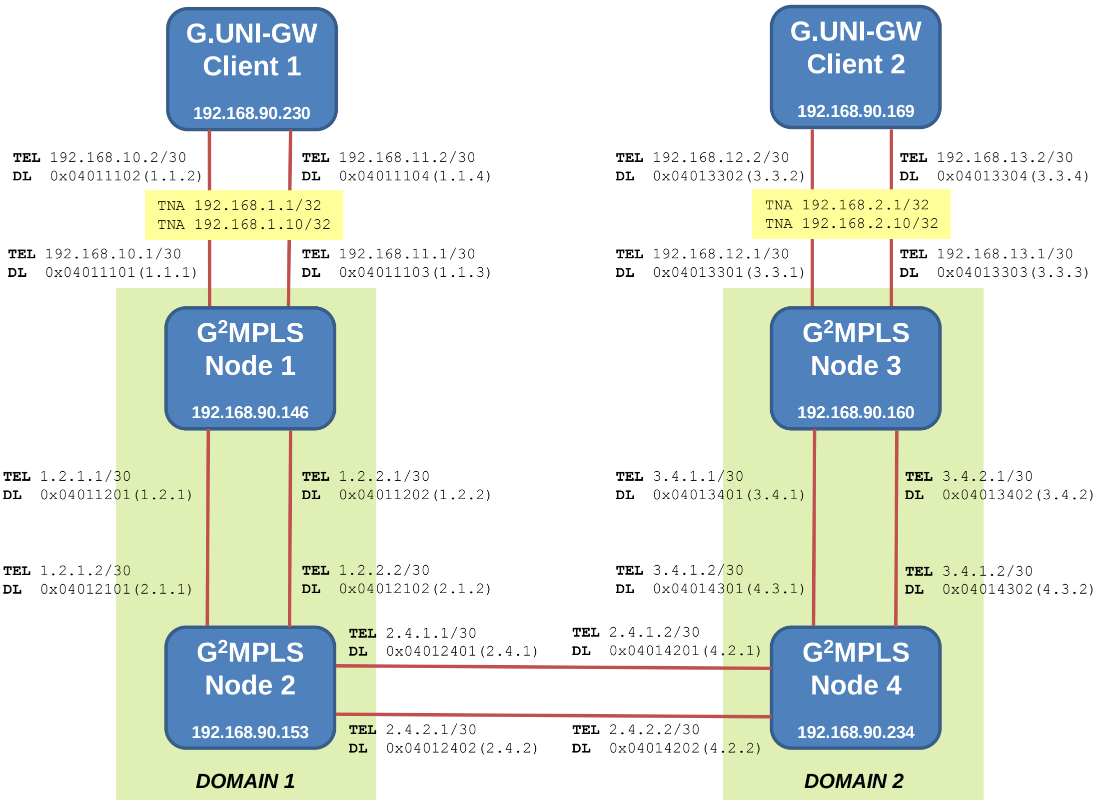
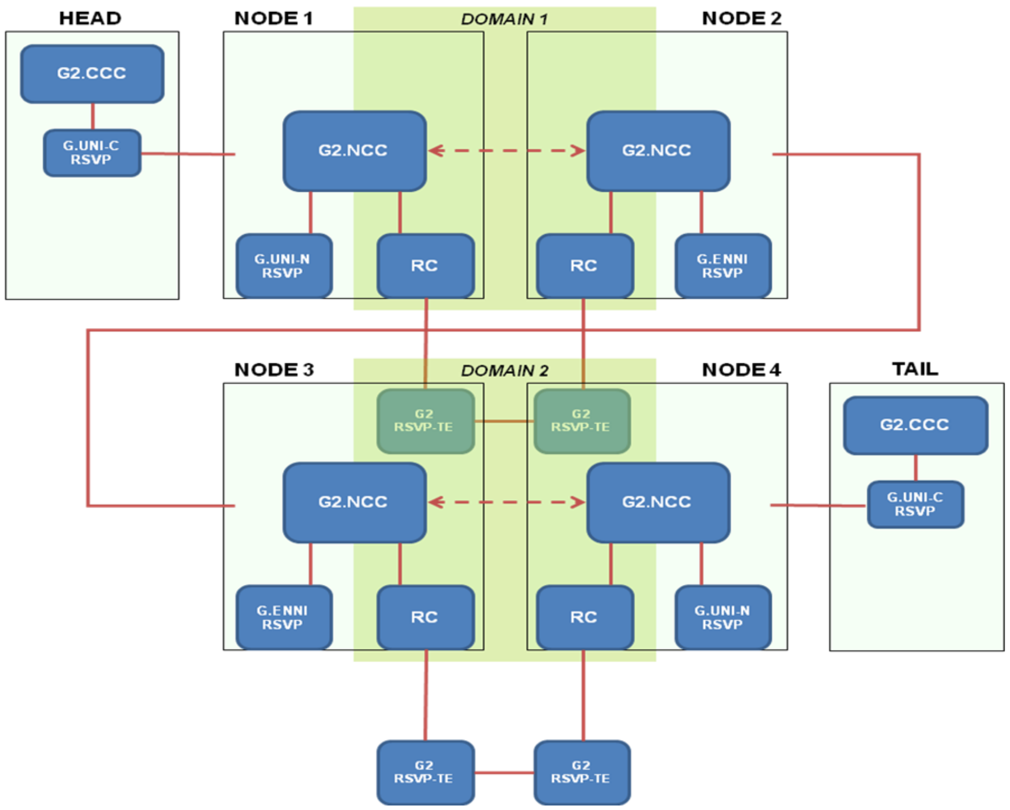


Figure 5.4: Logical topology of the inter-domain FSC test-bed for G^{2}MPLS Call signalling tests.

5.3.2.1 Setup of one bidirectional inter-domain FSC LSP by G2.CCC

Test Card #	G^{2}MPLS-TC-4.1	**Authors**	NXW
Test Card Name	Setup of one bidirectional inter-domain FSC LSP by G2.CCC		
Objectives	Verification of proper work of modules G2.CCC, G.UNI-RSVP, G.ENNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP setup: • UNI LSP setup signalling through HEAD node and Node1 via G.UNI-RSVP • ENNI LSP setup signalling through Node2 and Node3 via G.ENNI-RSVP • UNI LSP setup signalling through Node4 and TAIL node via G.UNI-RSVP • Call setup signalling through 2 G2.CCC instances (HEAD and TAIL node) and 2 couples of G2.NCC instances (Node1-Node2 and Node3-Node4) • Domain1 INNI LSP setup signalling through 2 FSC nodes (Node1 and Node2)		

	via G2.RSVP-TE • Domain2 INNI LSP setup signalling through 2 FSC nodes (Node3 and Node4) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating
Related Test Cards	G^2MPLS-TC-1.3, G^2MPLS-TC-3.1, G^2MPLS-TC-3.2
Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	G2.CCC, G.UNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G2.CCC	✓ Call is created and signalled up
2.1.	HEAD node: Setup request is sent from G2.CCC to Node1	✓ See G^2MPLS-TC-3.2: step 2.1.

2.2.	Node1: Setup Request is received from HEAD node G2.CCC via G.UNI-RSVP signalling	✓ See G^{2}MPLS-TC-3.2: step 2.2.
2.3.	Node2: Setup Request is received from Node1 G2.NCC	✓ Setup Request is forwarded to Node3 via G.ENNI-RSVP signalling ✓ Setup Indication is received from Node3 via G.ENNI-RSVP signalling and forwarded by G2.NCC to Node1 ✓ Setup Confirm is received from Node1 G2.NCC and forwarded by G2.NCC to Node3 via G.ENNI-RSVP signalling ✓ Call is “active” in G2.NCC ✓ ENNI LSP is “installed” in G.ENNI-RSVP ✓ Recovery bundle is created in RC
2.4.	Node3: Setup Request is received from Node2 G2.NCC via G.ENNI-RSVP signalling	✓ Setup Request is forwarded from G2.NCC to Node4 ✓ Setup Indication is received from Node4 G2.NCC and forwarded to Node2 via G.ENNI-RSVP signalling ✓ Setup Confirm is received from Node2 via G.ENNI-RSVP and forwarded by G2.NCC to Node4 ✓ Call is “active” in G2.NCC ✓ ENNI LSP is “installed” in G.ENNI-RSVP ✓ Recovery bundle is created in RC
2.5.	Node4: Setup Request is received from Node3 G2.NCC	✓ See G^{2}MPLS-TC-3.2: step 2.3.
2.6.	TAIL node: Setup Request is received from Node2 G2.NCC via G.UNI-RSVP signalling	✓ See G^{2}MPLS-TC-3.2: step 2.4.
3.	Create INNI LSP in Domain1 from Node1 RC	✓ See G^{2}MPLS-TC-3.1 step 3. and G^{2}MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.
4.	Create INNI LSP in Domain2 from Node3 RC	✓ See G^{2}MPLS-TC-3.1 step 3. and G^{2}MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.

Additional comments

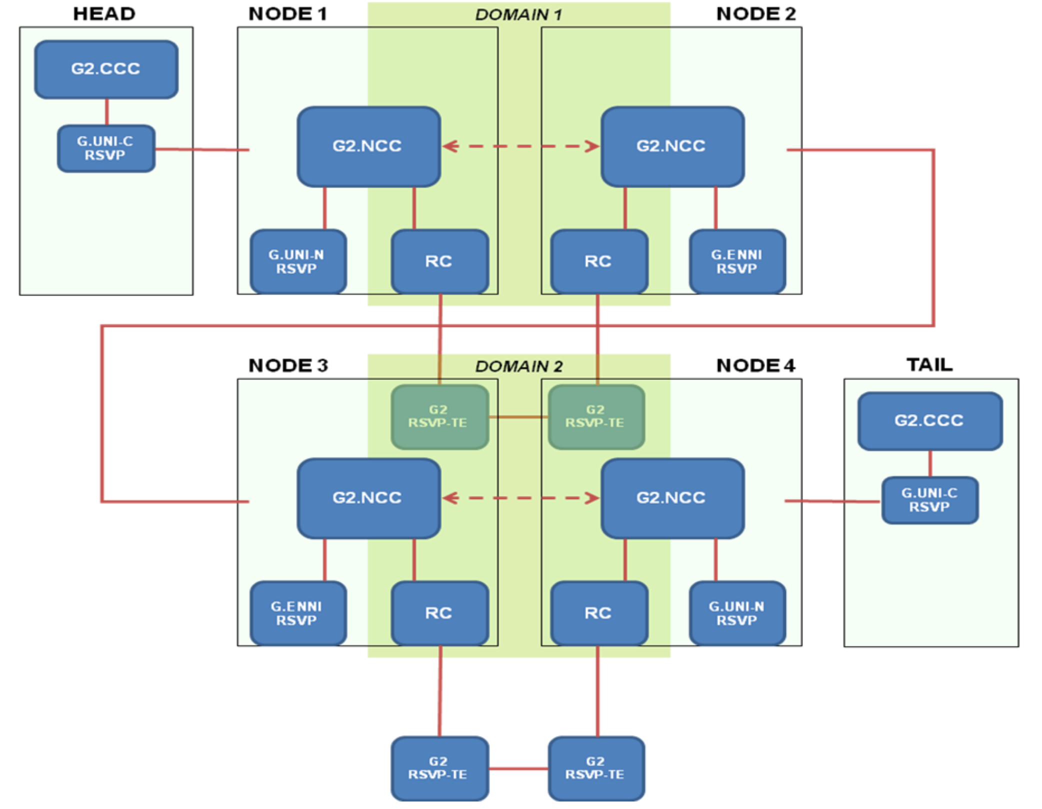
- Pre-conditions:
  - all needed resources by the LSP should be available and free on the equipments
  - the persistency files (*.pdb) related to and G:CCC and G2.NCC should be removed
- Post-conditions:
  - new persistency files are created for G2.CCC and G2.NCC

Test status

Passed

5.3.2.2 Teardown of one bidirectional inter-domain FSC LSP by G2.CCC

Test Card #	G^2MPLS-TC-4.2	**Authors**	NXW
Test Card Name	Teardown of the one bidirectional single-domain FSC LSP by G2.CCC		
Objectives	Verification of proper work of modules G2.CCC, G.UNI-RSVP, G.ENNI-RSVP, G2.NCC, RC, TNRC, LRM, SCNGW and G2.RSVP-TE in case of SPC Call and FSC LSP teardown: • UNI LSP teardown signalling through HEAD node and Node1 via G.UNI-RSVP • ENNI LSP teardown signalling through Node2 and Node3 via G.ENNI-RSVP • UNI LSP teardown signalling through Node4 and TAIL node via G.UNI-RSVP • Call teardown signalling through 2 G2.CCC instances (HEAD and TAIL node) and 2 couples of G2.NCC instances (Node1-Node2 and Node3-Node4) • Domain1 INNI LSP teardown signalling through 2 FSC nodes (Node1 and Node2) via G2.RSVP-TE • Domain2 INNI LSP teardown signalling through 2 FSC nodes (Node3 and Node4) via G2.RSVP-TE • TN equipments cross-connect configuration • Data model information updating		
Related Test Cards	G^2MPLS-TC-1.3, G^2MPLS-TC-3.1, G^2MPLS-TC-3.3, G^2MPLS-TC-4.1		

Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	G2.CCC, G.UNI-RSVP, G.ENNI-RSVP, G2.NCC, RC, TNRCD, LRMD, SCNGWD and G2.RSVP-TED processes are running on nodes	✓ TNRCD VTY, LRMD VTY, G2.RSVP-TED VTY and SCNGWD VTY are accessible ✓ TE-link/CC/SCN-if bindings are consistent
2.	Create Call from HEAD node G2.CCC	✓ See G^2MPLS-TC-4.1:step 2.
3.	Create INNI LSP in Domain1 from Node1 RC	✓ See G^2MPLS-TC-3.1 step 3. and G^2MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.
4.	Create INNI LSP in Domain3 from Node3 RC	✓ See G^2MPLS-TC-3.1 step 3. and G^2MPLS-TC-1.3: steps 2.1., 2.2., 2.5. and 2.6.
5.	Destroy Call from HEAD node G2.CCC	✓ Call is signalled down from HEAD node G2.CCC and destroyed
5.1.	HEAD node: Release Request is sent from G2.CCC to TAIL node via G.UNI-RSVP signalling	✓ See G^2MPLS-TC-3.3: step 4.1.
5.2.	Node1: Release Request is	✓ See G^2MPLS-TC-3.3: step 4.2.

	received from HEAD node G2.CCC via G.UNI-RSVP signalling	
5.3.	Node2: Release Request is received from Node1 G2.NCC	✓ Release Request is forwarded by G2.NCC to Node3 via G.ENNI-RSVP signalling ✓ Release Indication is received from Node3 via G.ENNI-RSVP signalling and forwarded by G2.NCC to Node1 ✓ Call is “idle” in G2.NCC and is destroyed ✓ ENNI LSP is “down” and is destroyed ✓ Recovery bundle is destroyed in RC
5.4.	Node3: Release Request is received from Node2 via G.ENNI-RSVP signalling	✓ Release Request is forwarded by G2.NCC to Node4 G2.NCC ✓ Release Indication is received from Node4 G2.NCC and forwarded to Node2 via G.ENNI-RSVP signalling ✓ Call is “idle” in G2.NCC and is destroyed ✓ ENNI LSP is “down” and is destroyed ✓ Recovery bundle is destroyed in RC
5.5.	Node4: Release Request is received from Node1 G2.NCC	✓ See G^{2}MPLS-TC-3.3: step 4.3.
5.6.	TAIL node: Release Request is received from Node2 G2.NCC via G.UNI-RSVP signalling	✓ See G^{2}MPLS-TC-3.3: step 4.4.
6.	Destroy INNI LSP in Domain1 from Node1 RC	✓ See G^{2}MPLS-TC-3.1:step 5.
7.	Destroy INNI LSP in Domain2 from Node3 RC	✓ See G^{2}MPLS-TC-3.1:step 5.

Additional comments
• Pre-conditions: ○ all needed resources by the LSP should be available and free on the equipments ○ the persistency files (*.pdb) related to and G:CCC and G2.NCC should be removed • Post-conditions: ○ new persistency files are created for G2.CCC and G2.NCC

Test status
Passed

5.4 G²MPLS routing tests

The G²MPLS routing advertisement tests have been executed in two separate sessions:

- G²MPLS single-domain routing tests
- G²MPLS Inter-domain routing tests

The single-domain tests have been used to verify the proper work and interaction of that modules involved in the single-domain routing (mainly G2.OSPF-INNI, G2.OSPF-UNI, LRM, SCNGW).
The inter-domain tests instead have been used to verify the proper operation and interaction of those modules involved in the multi-domain routing (mainly G2.OSPF-INNI, G2.OSPF-ENNI (referred also as ENNI-RC), G2.OSPF-UNI, LRM, SCNGW).
In the next two sessions the results of the two sessions of tests are shown.

The G²MPLS routing tests are divided also regarding network/grid functionalities:

- Routing network resources advertisement tests
- Routing Grid&Network resources advertisement tests

Routing network resources advertisement tests check the single-domain and multi-domain advertisement of router addresses, TE-links and TNA addresses. These test verify compatibility with standard GMPLS.
Routing Grid&Network resources advertisement tests check the single-domain and multi-domain advertisement of Grid resources in parallel to network resource advertisement.

5.4.1 Single-domain routing test-cases

In this section are presented the results of the tests regarding the single-domain routing advertisement. As shown in Figure 5.5, in the test-bed there are 6 different G²MPLS controllers: 4 of them (Node 1, 2, 3 and 4) have been used as INNI nodes, and the other 2 as G.UNI-C clients.

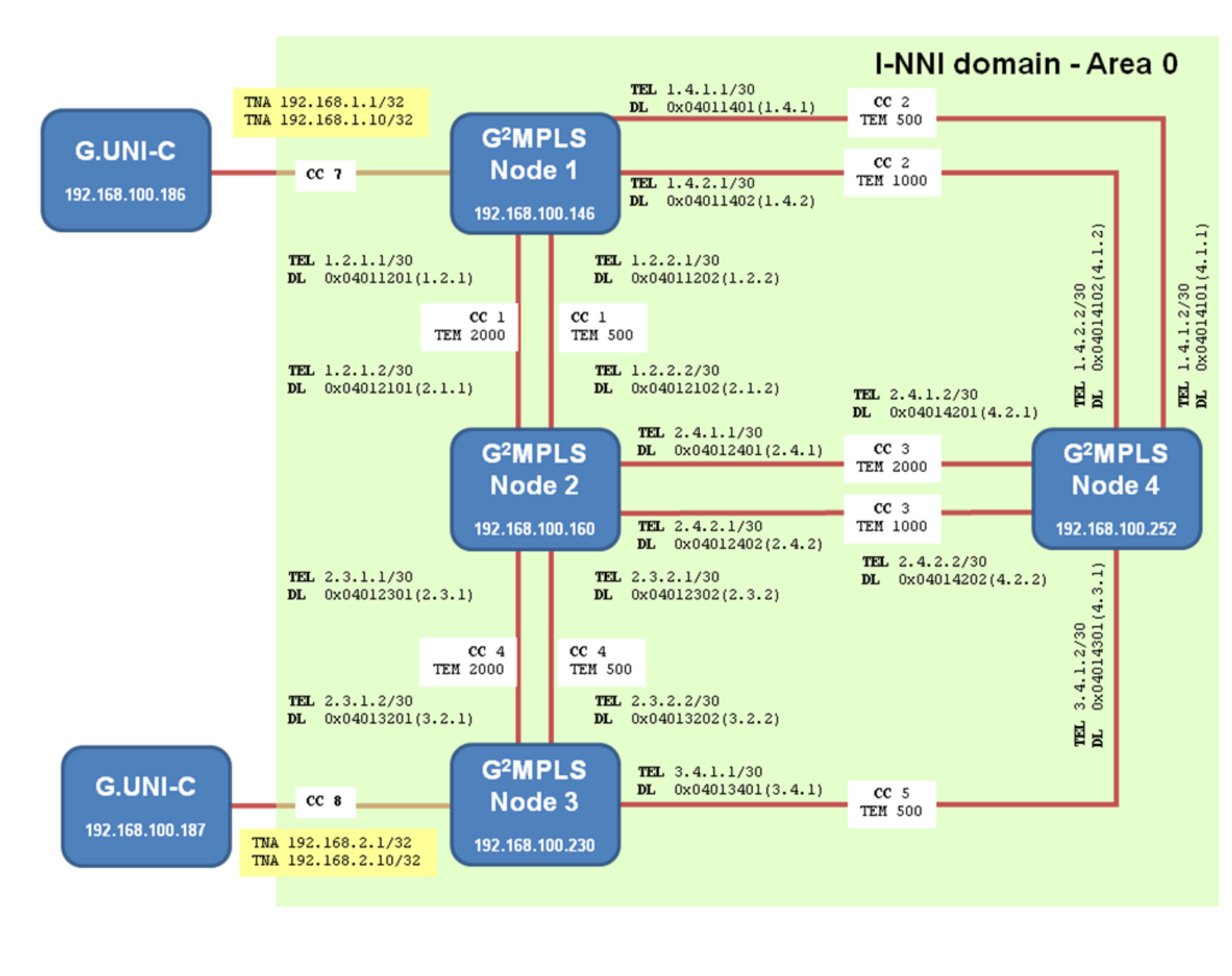
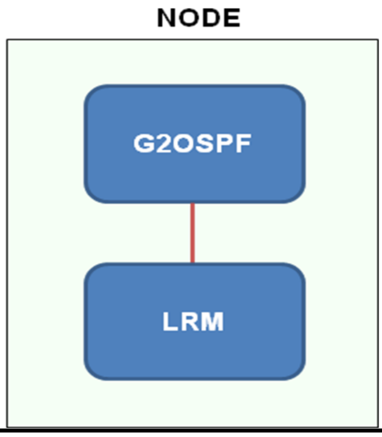


Figure 5.5: Single-domain logical topology for routing tests.

5.4.1.1 Single node initialization test case

Test Card #	G^2MPLS-TC-5.1	**Authors**	PSNC, NXW
Test Card Name	I-NNI G2.OSPF-TE instance initialization		
Objectives	Proper configuration of G2.OSPF-TE and LRM modules: • Configuration files reading • Information passing from LRMD to G2.OSPF-TED • Information presenting in VTY		
Related Test Cards	None		

Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	Run TNRCD, LRMD and SCNGWD processes	✓ TNRCD VTY, LRMD VTY and SCNGWD VTY are accessible
2.	Run G2.OSPF-TED process	✓ G2.OSPF-TED is up and working o There is G2.OSPF-TED process on the system processes list o The configuration file was read successfully o G2.OSPF-TED VTY is accessible ✓ There is no routing neighbours available ✓ The opaque capability is enabled
2.1.	I-NNI Router ID is loaded in G2.OSPF-TED from LRMD	✓ Router ID is available in G2.OSPF-TED VTY I-NNI instance
2.2.	Single-domain TE-link interfaces are loaded in G2.OSPF-TED from LRMD	o There are proper single-domain TE-link interfaces information available in G2.OSPF-TED VTY in I-NNI instance which are equivalent to information stored in LRMD o TE-link identifiers (Link ID, Local/Remote Interface IP or Local/Remote Link ID), o TE-link technology details (Link Type, Switching Capability) o TE-link bandwidths (Max Bandwidth, Max Reservable Bandwidth, Unreserved Bandwidth) o TE-link administration (TE Metric, SRLG, Administrative Group)
2.3.	Inter-domain TE-link interfaces are loaded in G2.OSPF-TED from LRMD	o There are proper inter-domain TE-link interfaces information available in G2.OSPF-TED VTY in I-NNI instance which are equivalent to information stored in LRMD o TE-link identifiers (Link ID, Local/Remote Interface IP or Local/Remote Link ID, Local/Remote Node ID), o TE-link technology details (Link Type, Switching Capability) o TE-link bandwidths (Max Bandwidth, Max

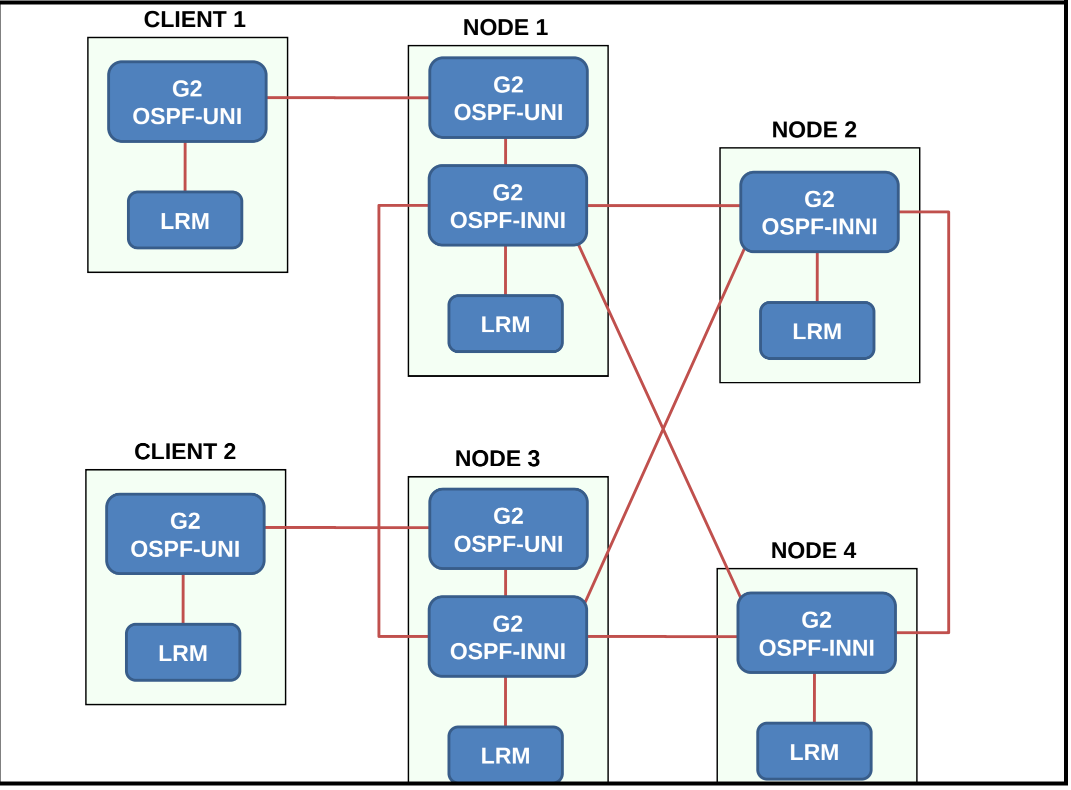
		Reservable Bandwidth, Unreserved Bandwidth) ○ TE-link administration (TE Metric, SRLG, Administrative Group)
2.4.	TNA addresses are loaded in G2.OSPF-TED from LRMD	✓ There are proper TNA addresses information available in G2.OSPF-TED VTY in G.UNI-N instance which are equivalent to information stored in LRMD ○ TNA addresses ○ Node ID hosting the TNA ✓ G.UNI-N router ID is read from G2.OSPF-TED configuration file

Additional comments
Single-domain TE-links are loaded if there are configured I-NNI TE-links in LRMD configuration. Inter-domain TE-links are loaded if there are configured E-NNI TE-links in LRMD configuration. TNA addresses are loaded if there are configured UNI TE-links in LRMD configuration. G.UNI-N router ID is loaded if there are configured UNI TE-links in LRMD configuration. If there is no G.UNI-Crouting node, then TNA address are not passed from G.UNI-N routing instance to G.I-NNI routing instance.

Test status
Passed

5.4.1.2 Network functionalities test case

Test Card #	G^2MPLS-TC-5.2	**Authors**	PSNC, NXW
Test Card Name	Distribution of TE information through the G.I-NNI interfaces		
Objectives	• checking TE database for neighbours list and states • verifying incoming opaque list • checking TNA address pushing from G.UNI-Crouting instance to G.I-NNI routing instance • checking dynamic topology changes (e.g. bandwidth changes)		
Related Test Cards	G^2MPLS-TC-5.1		

Topology and DUT details	

Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD SCNGWD and G2.OSPF-TED processes are running on all G.I-NNI nodes	✓ TNRCD VTY, LRMD VTY, SCNGWD VTY and G2.OSPF-TED VTY are accessible ✓ See G2MPLS-TC-5.1 Step 1 and 2
2.	Routing information are advertised inside the local domain	✓ The same set of information about Router addresses, TE-links and TNAs is available in every node LSDB of the local domain
2.1.	Routing adjacencies are established	✓ G2.OSPF-TED VTY presents a list of neighbour G.I-NNI routers ○ All neighbours are in 'full' state of OSPF Interface State Machine (ISM)
2.2.	I-NNI topology information are exchanged	✓ Router address is originated as TE opaque LSA ✓ Intra- and inter-domain TE-links information are originated as TE opaque LSAs ✓ TE opaque LSAs from other nodes containing Router addresses and TE-links are present in local node LSDB
2.3.	Change TE-link available bandwidth	✓ The value of TE-link available bandwidth is advertised and updated on every node LSDB in the network via flooding of an opaque LSA with new sequence number
2.4.	Change TE-link metric	✓ The value of TE-link metric is advertised and updated on every node LSDB in the network via flooding of an opaque LSA with new sequence number

3.	Run G.UNI-Cnodes	✓ TNA addresses are originated by G.UNI-N instance in form of TE opaque LSAs ✓ TE opaque LSAs from other nodes containing TNA addresses are present in every node G.I-NNI LSDB ✓ TNA addresses are read by G.UNI-N instances from G.I-NNI LSDB ✓ TNA address are send to G.UNI-C instances from G.UNI-N instances

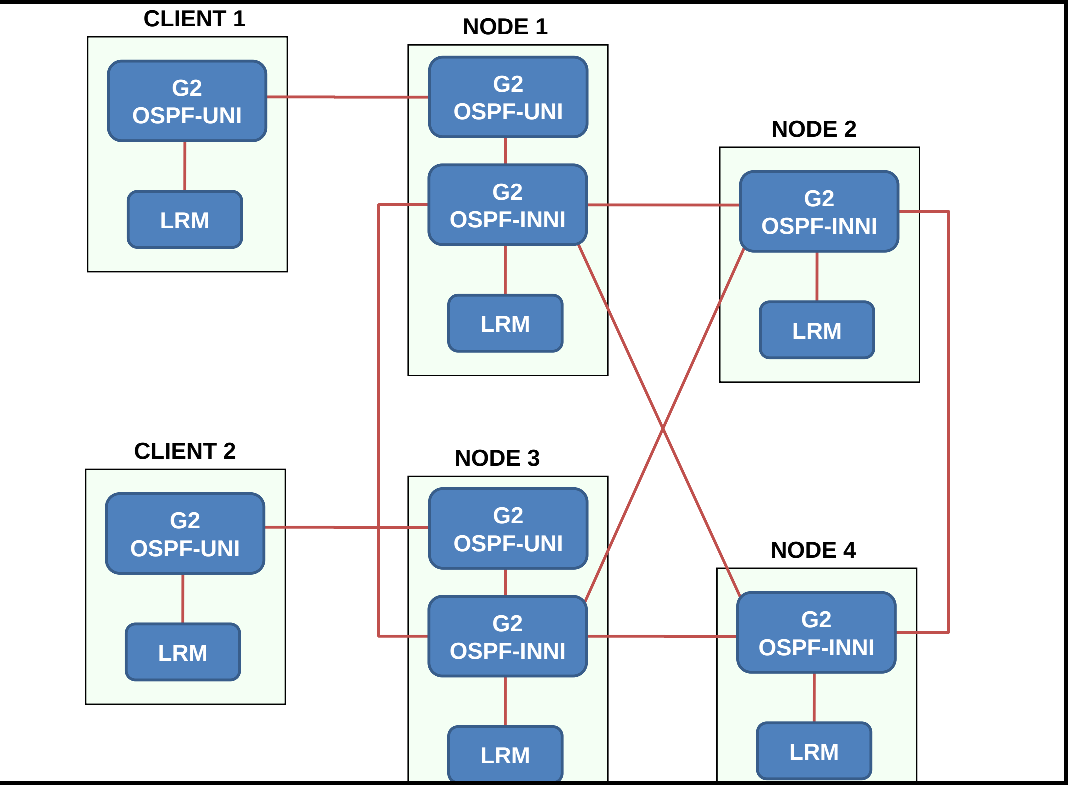
Additional comments
After the test all nodes in the RA have the same and the up-to-date knowledge about Router addresses, TE-links and TNAs present in the domain. Each client node has list of all available TNA addresses in the domain. G.UNI-Chas no knowledge about Grid information yet.

Test status
Passed

5.4.1.3 Grid&Network functionalities test case

Test Card #	G^{2}MPLS-TC-5.3	**Authors**	PSNC, NXW
Test Card Name	Distribution of Grid information through the G.UNI and G.I-NNI interfaces		
Objectives	• validation of Grid information exchange between G.UNI and G.I-NNI instances • checking the availability of Grid information at the network nodes • checking the availability of Grid information at the client nodes • checking dynamic grid information changes		
Related Test Cards	G^{2}MPLS-TC-5.1, G^{2}MPLS-TC-5.2		

Topology and DUT details



Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD SCNGWD and G2.OSPF-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, SCNGWD VTY and G2.OSPF-TED VTY are accessible ✓ See G2MPLS-TC-5.1 Step 1 and 2
2.	Routing information are advertised inside the local domain	✓ See G2MPLS-TC-5.2 Step 2 ✓ The same set of information about TE-links and TNAs is available in every node LSDB of the local domain
3.	Run G.UNI-Cnodes	✓ See G2MPLS-TC-5.2 Step 3 ✓ TNA addresses are originated by G2.OSPF-TED UNI-N instance in form of TE opaque LSAs ✓ TE opaque LSAs from other nodes containing TNA addresses are present in every node LSDB
4.	Configure Grid Site at one of G.UNI-C • ID • Name • Provider Edge router ID • Latitude and Longitude	✓ Grid Site TLV in Grid opaque LSA is originated from G.UNI-C to G.UNI-N ✓ The Grid Site TLV is pushed to G.I-NNI instance LSDB ✓ The Grid Site TLV is flooded to all domain nodes ✓ All G.UNI-N instances (except of the originating G.UNI-N) read the Grid Site TLV from G.I-NNI LSDB and send it to its G.UNI-C
5.	Configure Grid Service at the G.UNI-C	✓ Grid Service TLV in Grid opaque LSA is originated from G.UNI-C to G.UNI-N

	• ID • Parent Site ID • IPv4 address • Service Info • Status	✓ The Grid Service TLV is pushed to G.I-NNI instance LSDB ✓ The Grid Service TLV is flooded to all domain nodes ✓ All G.UNI-N instances (except of the originating G.UNI-N) read the Grid Service TLV from G.I-NNI LSDB and send it to its G.UNI-C
6.	Configure Grid Computing at the G.UNI-C • ID • Parent Site ID • IPv4 Host Name • LRMS Info • Gatekeeper port • Job Manager • Data Dir • Job States • Job Stats • Job Time Performance • Job Time Policy • Jobs Load Policy • CE calendar	✓ Grid Computing TLV in Grid opaque LSA is originated from G.UNI-C to G.UNI-N ✓ The Grid Computing TLV is pushed to G.I-NNI instance LSDB ✓ The Grid Computing TLV is flooded to all domain nodes ✓ All G.UNI-N instances (except of the originating G.UNI-N) read the Grid Computing TLV from G.I-NNI LSDB and send it to its G.UNI-C
7.	Configure two Grid Sub-Clusters at the G.UNI-C • ID • Parent Site ID • CPU Info • OS Info • Memory Info • Software Package • Sub-Cluster calendar	✓ Grid Sub-Cluster TLVs in Grid opaque LSA is originated from G.UNI-C to G.UNI-N ✓ The Grid Sub-Cluster TLVs are pushed to G.I-NNI instance LSDB ✓ The Grid Sub-Cluster TLVs are flooded to all domain nodes ✓ All G.UNI-N instances (except of the originating G.UNI-N) read the Grid Sub-Cluster TLVs from G.I-NNI LSDB and send them to its G.UNI-C
8.	Change Grid Computing information at G.UNI-C • Job States • Job Stats • Job Time • CE calendar	✓ The new values of Grid Computing are originated by G.UNI-C as an opaque LSA with new sequence number and updates the G.UNI-N LSDB ✓ G.UNI-N push the new Grid Computing TLV opaque LSA to G.I-NNI LSDB ✓ update on every node LSDB in the network via flooding of an opaque LSA with new sequence number ✓ G.UNI-N update the new Grid Computing TLV in its LSDB from G.I-NNI LSDB ✓ G.UNI-C send the new Grid Computing TLV opaque LSA to G.UNI-C
9.	Change Grid Sub-Cluster information at G.UNI-C • Sub-Cluster calendar	✓ The new values of Grid Sub-Cluster are originated by G.UNI-C as an opaque LSA with new sequence number and updates the G.UNI-N LSDB ✓ G.UNI-N push the new Grid Sub-Cluster TLV opaque LSA to G.I-NNI LSDB ✓ update on every node LSDB in the network via flooding of an opaque LSA with new sequence number ✓ G.UNI-N update the new Grid Sub-Cluster TLV in its LSDB from G.I-NNI LSDB

		✓ G.UNI-C send the new Grid Sub-Cluster TLV opaque LSA to G.UNI-C

Additional comments
After the test all nodes in the RA and all client nodes have the same and up-to-date knowledge about Grid resources available in the domain.

Test status
Passed

5.4.2 Inter-domain routing test cases

In this section the results of the tests regarding the inter-domain routing advertisement are presented. For this purpose we need at least 6 G^2MPLS controllers, to have 2 different INNI domains (each one with 2 controllers) reachable by a G.UNI-C each.

In Figure 5.4 the logical topology of the test-bed for the inter-domain tests is described.

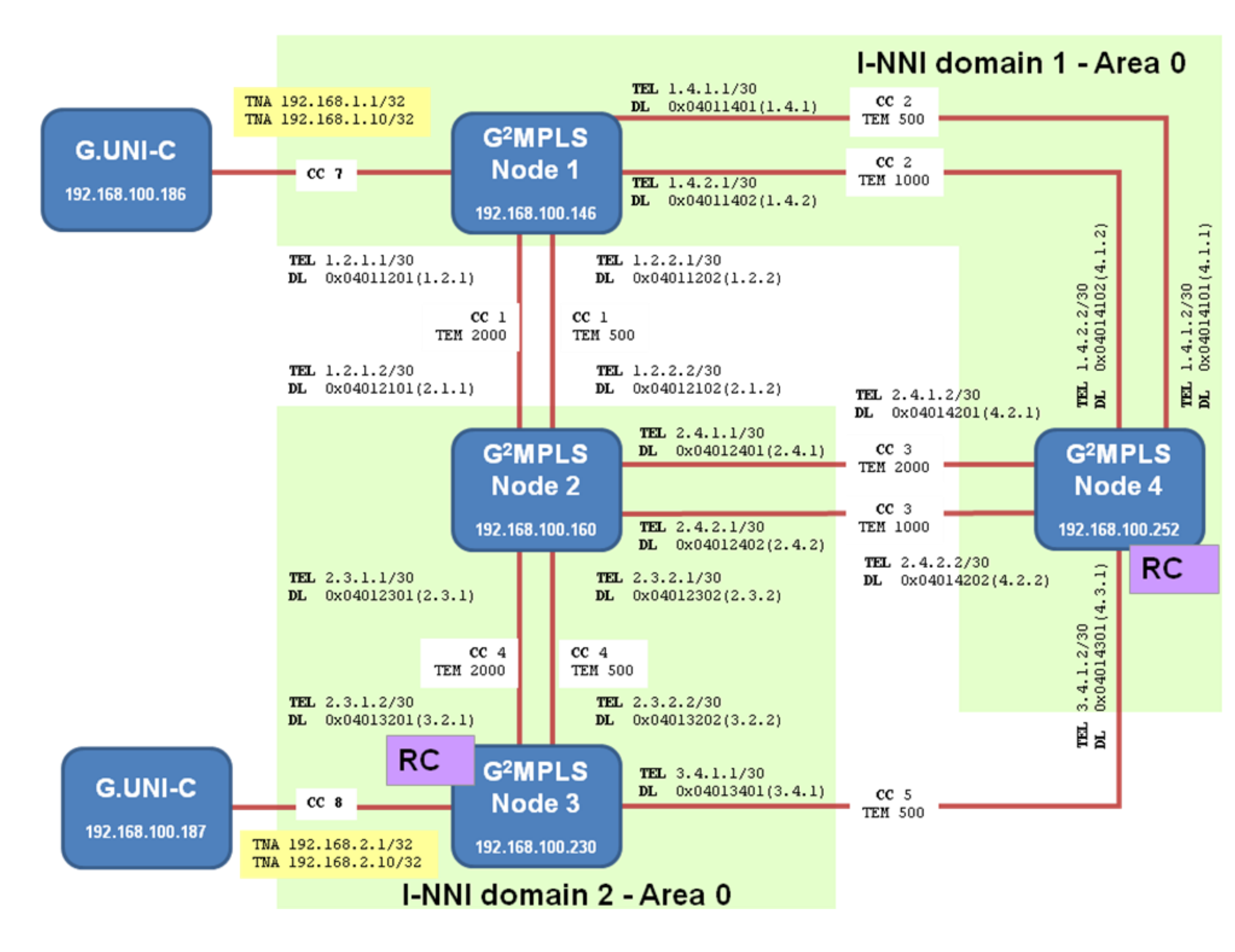
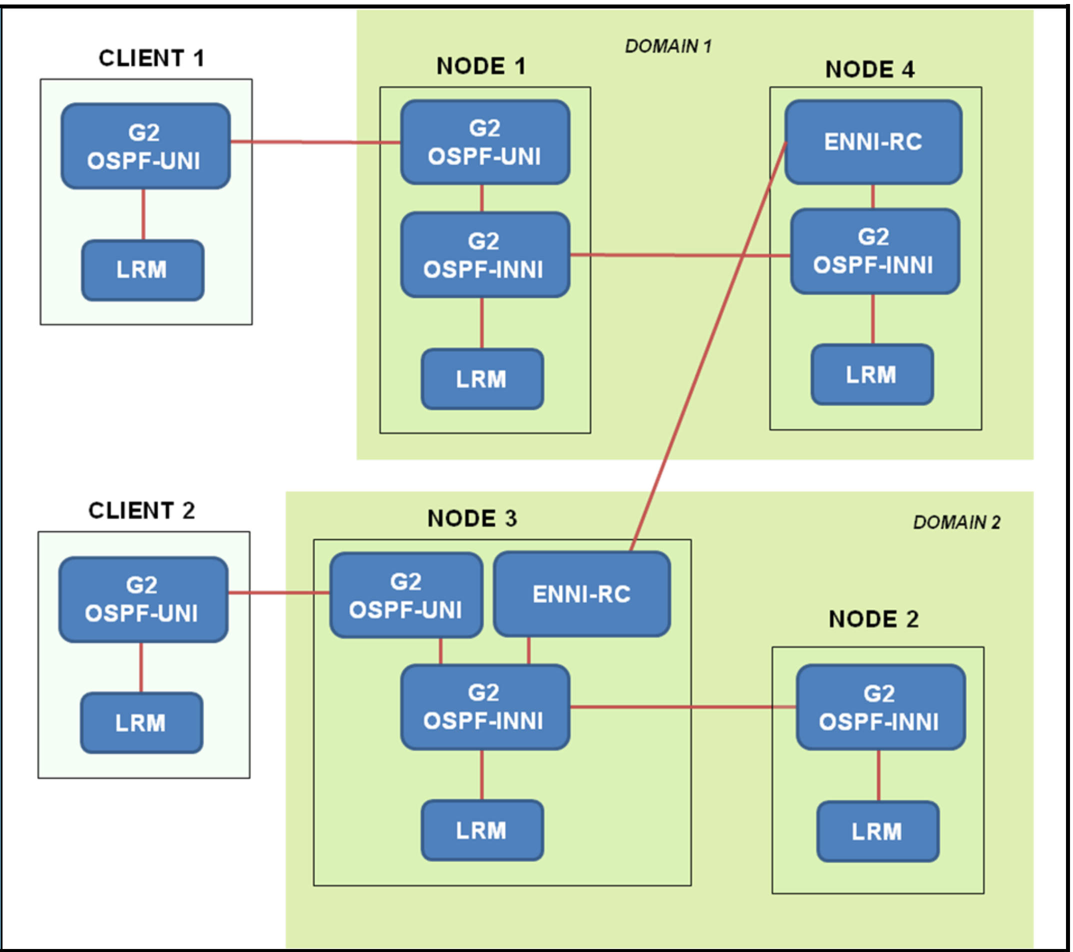


Figure 5.6: Inter-domain logical topology for routing tests.

5.4.2.1 Network functionalities test case

Test Card #	G²MPLS-TC-6.1	Authors	PSNC, NXW
Test Card Name	Routing information exchange between adjacent RAs		
Objectives	• Checking feed-up from I-NNI (RA level 0) to ENNI-RC (RA level 1) • Checking routing information advertising between ENNI-RC (in RA level 1) • Checking feed-down from ENNI-RC (RA level 1) to I-NNI (RA level 0)		
Related Test Cards	G²MPLS-TC-5.1, G²MPLS-TC-5.2		

Topology and DUT details



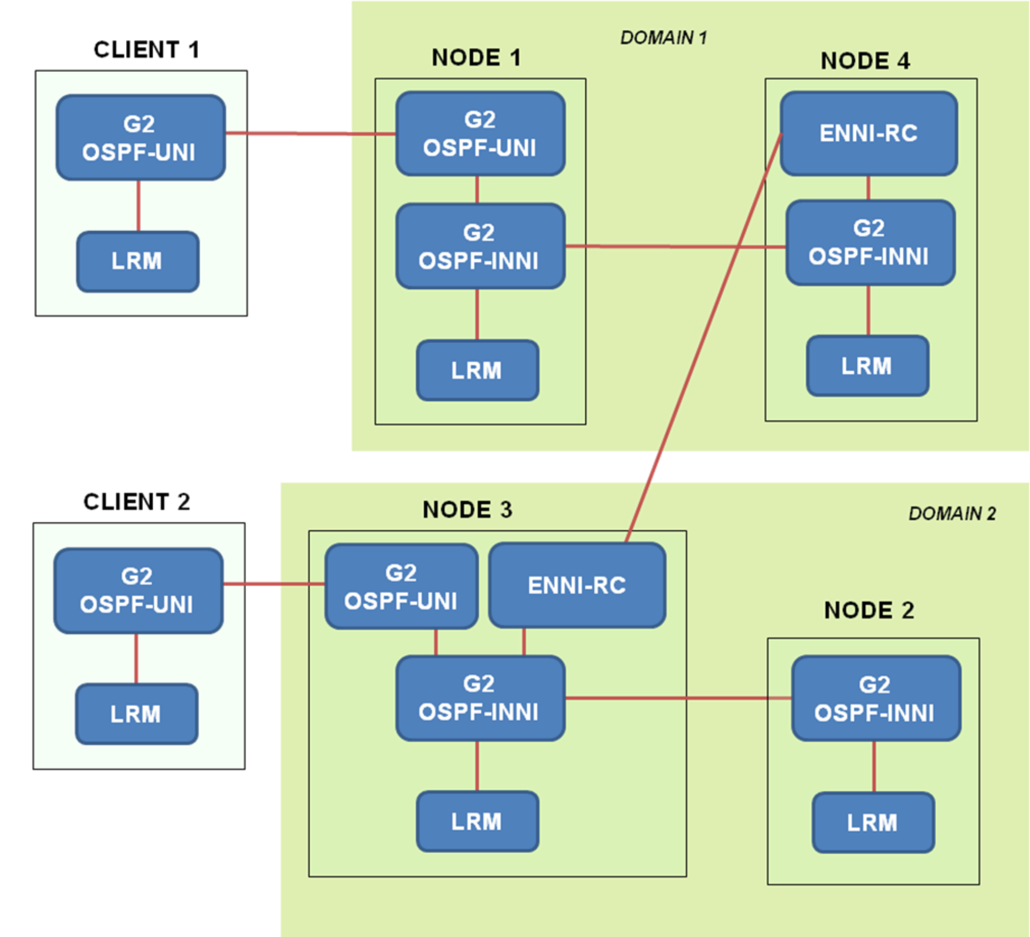
Test description		
Step	**Description**	**Outcome**
1.	TNRCD, LRMD SCNGWD and G2.OSPF-TED processes are running on all nodes	✓ TNRCD VTY, LRMD VTY, SCNGWD VTY and G2.OSPF-TED VTY are accessible ✓ See G2MPLS-TC-5.1 Step 1 and 2 ✓ G.E-NNI router ID is read from configuration file in case of RC
2.	Routing information are advertised inside the local domain	✓ See G2MPLS-TC-5.2 Step 2 and 3 ✓ The same set of information about Router addresses, TE-links and TNAs is available in every node LSDB of the local domain
3.	ENNI-RC appear in the domain	✓ Routing information are feed up to ENNI-RC ○ Inter-domain TE-links opaque LSAs are present in ENNI-RC LSDB ○ TNA addresses opaque LSAs are present in ENNI-RC LSDB
4.	Running the second domain with its own ENNI-RC	✓ Routing information are flooded to other ENNI-RC and populate in RA level 0 domain by feed down process

4.1.	Routing information are advertised on RA level 1	✓ The same set of information about ENNI-RC addresses, inter-domain TE-links and TNAs is available in every node LSDB of the RA level 1 domain
4.2.	Routing adjacencies at level 1 are established	✓ G2.OSPF-TED VTY presents a list of neighbours E-NNI routers ✓ All neighbours are in 'full' state of OSPF Interface State Machine (ISM)
4.3.	E-NNI topology information are exchanged	✓ Inter-domain TE-links information are originated as TE opaque LSAs ✓ TE opaque LSAs from other nodes containing inter-domain TE-links are present in ENNI-RC LSDB ✓ TNA addresses are originated in form of TE opaque LSAs ✓ TE opaque LSAs from other nodes containing TNA addresses are present in ENNI-RC LSDB
4.4.	Routing information are feed down from RC	✓ Inter-domain TE-links opaque LSAs from other domains are present in RA level 0 domain nodes LSDB ✓ TNA addresses opaque LSAs are present in RA level 0 domain node LSDB
5.	Change inter-domain TE-link available bandwidth	✓ The new information about TE-link available bandwidth is updated in local domain, RA level 1 and in other RA level 0 domains ✓ new opaque LSA is flooded inside the RA level 0 local domain ✓ the LSA is feed up to local domain RC ✓ the LSA is advertised between ENNI-RCs (in RA level 1 domain) ✓ the LSA is feed down in ENNI-RC of the second domain ✓ the LSA is flooded inside the second RA level 0 domain
6.	Change inter-domain TE-link metric	✓ The new information about TE-link metric is updated in local domain, RA level 1 and in other RA level 0 domains ✓ new opaque LSA is flooded inside the RA level 0 local domain ✓ the LSA is feed up to local domain ENNI-RC ✓ the LSA is advertised between ENNI-RCs (in RA level 1 domain) ✓ the LSA is feed down in ENNI-RC of the second domain ✓ the LSA is flooded inside the second RA level 0 domain

Additional comments
After the test all nodes in every RA have the same and the newest knowledge about inter-domains TE-links and TNAs present in each domain. Each client node has list of all available TNA addresses in all domains.

Test status
Passed

5.4.2.2 Grid&Network functionalities test case

Test Card #	G^2MPLS-TC-6.2	**Authors**	PSNC, NXW
Test Card Name	Grid information exchange between adjacent RAs		
Objectives	• Checking Grid information feed-up from I-NNI (RA level 0) to ENNI-RC (RA level 1) • Checking Grid information advertising between RC (in RA level 1) • Checking Grid information feed-down from ENNI-RC (RA level 1) to I-NNI (RA level 0)		
Related Test Cards	G^2MPLS-TC-5.1, G^2MPLS-TC-5.2, G^2MPLS-TC-5.3, G^2MPLS-TC-6.1		
Topology and DUT details			

Test description		
Step	**Description**	**Outcome**
7.	TNRCD, LRMD SCNGWD	✓ TNRCD VTY, LRMD VTY, SCNGWD VTY and G2.OSPF-

	and G2.OSPF-TED processes are running on all nodes	TED VTY are accessible ✓ See G2MPLS-TC-5.1 Step 1 and 2 ✓ G.E-NNI router ID is read from configuration file in case of ENNI-RC
8.	Grid information are advertised inside the local domain	✓ The same set of Grid information is available in every node LSDB of the local domain ✓ G^2MPLS-TC-5.3 Step 2, 3, 4, 5, 6 and 7
9.	ENNI-RC appear in the domain	✓ Grid information are feed up to ENNI-RC o Grid opaque LSAs are present in RC LSDB
10.	Running the second domain with its own ENNI-RC	✓ Gird information are flooded to other ENNI-RC and populate in RA level 0 domain by feed down process
10.1.	Grid information are advertised on RA level 1	✓ The same set of information about Grid information is available in every node LSDB of the RA level 1 domain
10.2.	Routing adjacencies at level 1 are established	✓ G2.OSPF-TED VTY presents a list of neighbours E-NNI routers ✓ All neighbours are in 'full' state of OSPF Interface State Machine (ISM) ✓ See G2MPLS-TC-5.2 Step 2.1 ✓ See G2MPLS-TC-6.1 Step 4
10.3.	E-NNI Grid information are exchanged	✓ Grid information are originated as Grid opaque LSAs ✓ Grid opaque LSAs from other nodes containing Grid information from other domains are present in ENNI-RC LSDB
10.4.	Grid information are feed down from ENNI-RC	✓ Grid opaque LSAs from other domains are present in RA level 0 domain nodes LSDB
11.	Change Grid Computing information at G.UNI-C • Job States • Job Stats • Job Time • CE calendar	✓ The new information about Grid Computing is updated in local domain, RA level 1 and in other RA level 0 domains ✓ new opaque LSA is flooded inside the RA level 0 local domain ✓ the LSA is feed up to local domain RC ✓ the LSA is advertised between ENNI-RCs (in RA level 1 domain) ✓ the LSA is feed down in ENNI-RC of the second domain ✓ the LSA is flooded inside the second RA level 0 domain
12.	Change Grid Sub-Cluster information at G.UNI-C • Sub-Cluster calendar	✓ The new information about Grid Sub-Cluster is updated in local domain, RA level 1 and in other RA level 0 domains ✓ new opaque LSA is flooded inside the RA level 0 local domain ✓ the LSA is feed up to local domain ENNI-RC ✓ the LSA is advertised between ENNI-RCs (in RA level 1 domain) ✓ the LSA is feed down in ENNI-RC of the second domain ✓ the LSA is flooded inside the second RA level 0 domain

Additional comments

After the test all nodes in every RA have the same and the newest knowledge about Grid resources present in each domain.

6 Conclusions

This document reports the functional tests executed on the G^2MPLS Control Plane built in the framework of Phosphorus WP2. Most of these tests comprised the single module and functionality verification, as well as the integrated operation of protocols and network controllers in meshed topologies. The software modules constituting the G^2MPLS stack under test resulted from the integration of the delivered WP2 outputsat the passed milestones M2.1, M2.2, M2.3, M2.5.1 and M2.5.2.

This deliverable and its companion deliverable D2.5 on the preliminary G^2MPLS Control Plane prototype contribute to the first official and public release of the G^2MPLS Control Plane. They represent a first step of G^2MPLS integration in the Phosphorus test-beds, an activity that will be progressed and finalized by WP6 team. In the PSNC and UESSEX local test-beds two switching technologies have been deployed, i.e. the fiber and the lambda switching, and proper mediation modules have been developed between the G^2MPLS protocols and the Calient Diamond Wave Fibre Connect and the ADVA FSP-3000RE-II switches.

All the planned tests have been concluded successfully, both in the single-domain and in the inter-domain cases. They can be used as a test-suite for testing G^2MPLS prototypes in different deployment scenarios., e.g. other G^2MPLS test-beds installed in Phosphorus framework or externally. The same test-suite can help the validation phase of new developments on the stack, e.g. in case of addition of other mediation functions towards other equipments or switching technologies.

7 References

As explained in section 2, the references listed here are only those directly functional to this document. For a list of the references to standards appearing in this document, please point to [PH-WP2-D2.1], [PH-WP2-D2.2] and [PH-WP2-D2.7].

[PH-WP2-D2.1] Phosphorus deliverable D2.1, "The Grid-GMPLS Control Plane architecture".

[PH-WP2-D2.2] Phosphorus deliverable D2.2, "Routing and Signalling Extensions for the Grid-GMPLS Control Plane".

[PH-WP2-D2.3] Phosphorus deliverable D2.3, "Grid-GMPLS high level system design".

[PH-WP2-D2.6] Phosphorus deliverable D2.6, "Deployment models and solutions of the Grid-GMPLS Control Plane".

[PH-WP2-D2.7] Phosphorus deliverable D2.7, "Grid-GMPLS network interfaces".

[PH-WP6-D6.1] Phosphorus deliverable D6.1, "Test-bed design".

[PH-WP6-D6.6] Phosphorus deliverable D6.6, "Plan of testing".

8 Acronyms

CC	Control Channel
CCC	Client Call Controller
CP	Control Plane
DWDM	Dense Wavelength Division Multiplexing
E-NNI	Exterior NNI
ENNI-RC	E-NNI Routing Controller
ERO	Explicit Route Object
FSC	Fiber Switching Capability
G.E-NNI	Grid E-NNI
G.I-NNI	Grid I-NNI
G2.CCC	Grid-GMPLS CCC
G2.NCC	Grid-GMPLS NCC
G2.OSPF-TE	Grid-GMPLS OSPF-TE
G2.OSPF-TED	G2.OSPF-TE Daemon
G2.RSVP-TE	Grid-GMPLS RSVP-TE
G2.RSVP-TED	G2.RSVP-TE Daemon
G²MPLS	Grid-GMPLS (enhancements to GMPLS for Grid support)
GE	Gigabit Ethernet
GMPLS	Generalized MPLS
G.UNI	Grid UNI
G.UNI-C	G.UNI Client Site
G.UNI-GW	G.UNI Gateway
G.UNI-GWD	G.UNI-GW Daemon
G.UNI-N	G.UNI Network Site
I-NNI	Interior NNI
IP	Internet Protocol
IPv4	Internet Protocol Version 4
LAN	Local Area Network
LSA	Link State Advertisement
LSC	Lambda Switching Capability
LSDB	Link State Database

LSP	Label Switched Path
LRM	Link Resource Manager
LRMD	LRM Daemon
MPLS	Multi Protocol Label Switching
NCC	Network Call Controller
NNI	Network to Network Interface
OSPF	Open Shortest Path First protocol
OSPF-TE	OSPF with Traffic Engineering extensions
P2MP	Point to Multi Point
RA	Routing Area
RC	Recovery Controller
RSVP	Resource reSerVation Protocol
RSVP-TE	RSVP with Traffic Engineering extensions
SCN	Signalling Control Network
SCNGW	SCN Gateway
SCNGWD	SCNGW Daemon
TE	Traffic Engineering
TE-link	Traffic Engineering link
TL-1	Transaction Language 1
TLV	Type-Length-Value protocol fields
TN	Transport Network
TNA	Transport Network Address
TNRC	Transport Network Resource Controller
TNRCD	TNRC Daemon
TNRC AP	TNRC Abstract Part
TNRC SP	TNRC Specific Part
TP	Transport Plane
UNI	User to Network Interface
VLAN	Virtual LAN
VPN	Virtual Private Network
VTY	Virtual TeletYpe interface
WAN	Wide Area Network
WP	Work Package
WS-AG	WebService Agreement

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