



Juniper PTX 100G Coherent Test

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Reference Documents

Abbreviations

BFD	Bi-directional Forwarding Detection
BGP	Border Gateway Protocol
BRAS	Broadband Remote Access Server
CE	Customer Edge
DNS	Domain Name System
DOS	Denial of Service
EMS	Element Management System
FPC	Flexible PIC Concentrator
FTP	File Transfer Protocol
HLD	High Level Design
ICMP	Internet Control Message Protocol
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Protocol
IP	Internet Protocol
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
IQ	Intelligent Queuing
IS-IS	Intermediate System to Intermediate System
LDP	Label Distribution Protocol
LSP	Label Switched Path
MLD	Multicast Listener Discovery
MPLS	Multi Protocol Label Switching
MSE	Multi Service Edge
MTU	Maximum Transmission Unit
MVPN	Multicast Virtual Private Network
NA	Neighbour Advertisement
NAT	Network Address Translation
ND	Neighbour Discovery
NGN	Next Generation Network
NLRI	Network Layer Reachability Information
NMS	Network Management System
NTP	Network Time Protocol
RADIUS	Remote Authentication Dial-in User Service
RE	Routing Engine
RSVP	Resource Reservation Protocol
SD	Service Design
SNMP	Simple Network Management Protocol
SSH	Secure Shell
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VPN	Virtual Private Network
VRF	Virtual Routing and Forwarding
VRR	Virtual Route Reflector

1. Introduction

Telekom Malaysia has embarked on a project to expand the current IP Core converge network services and operations that is based on PTX and MX platforms. To optimize operational cost, network function virtualization is also explored, including virtualizing route reflector. This document is an ATP for PTX 100G coherent interface test with Fibrehome DWDM systems.

1.1. Document Purpose

This document is an ATP for the proof-of-concept for PTX 100G Coherent interface.

1.2. Audience

This document is intended to be used by Telekom Malaysia business groups (and its contractors) involved in the design, implementation, testing, and troubleshooting of IP Core infrastructure and services.

The document assumes that the reader has an understanding of TCP/IP, routing, routing protocols, MPLS, and related services. This document is intended to be read in conjunction with the JUNOS hardware and software documents, available at the following URL: <http://www.juniper.net/support>.

1.3. Scope

The scope of this document is to provide an ATP for PTX5000 100G coherent interface. The 100G interfaces are tested with features to support hypercore functionality with connectivity into Fibrehome DWDM systems. The qualification of other IP Core routers is not within the scope of this document.

1.4. Comments

It is assumed that all comments and inputs from the stakeholders have been taken into account. For further comments and inputs, the reader is required to contact the author of this document and/or ST.

2. Test Equipment Requirements

The following test equipment is recommended for the execution of this ATP.

- PTX5000
- 2 port 100G coherent interface for PTX5000
- Traffic generator
- Optical spectrum analyser (OSA)
- Variable Optical Attenuator (VOA)
- Optical power meter

3. New Feature Tests

100G coherent interface is a new network element in TM IP Core and in POC stage.

5. PTX5000 100G coherent interface test

5.1. Power measurement

Test No.	5.1
Test Synopsis	The test is to certify power transmit and receive sensitivity specification of PTX5000 transponders.
Test Diagram	 The diagram illustrates a cross-connection setup for power measurement. Two PTX 5000 transponders are shown as blue circles. The left transponder has a TX port at the top and an RX port at the bottom. The right transponder has an RX port at the top and a TX port at the bottom. A blue rectangular block labeled 'VOA' is positioned between them. Four lines connect the ports: from the left TX to the right RX, from the left RX to the right TX, and two additional lines crossing in the center, representing the optical paths through the VOA.
Test Objective:	The purpose of this test is for certify : 1) To measure maximum transmitted power of transponders 2) To measure sensitivity of the minimum receiving power
Test Requirements:	• Setup network as per test diagram.

	Test Instruction
Test Procedure	1. Connect 100G on PTX1 in a back-to-back configuration. Verify link is operational from CLI. Connect receive cable of port 1 to a power meter. 2. Observe the reading on power meter to show transmit power. 3. Insert a step VOA in between the connection. 4. Set VOA to full-pass. Observe the power meter to baseline the attenuation. 5. Step up the attenuation on the VOA. Increase the attenuation until port is status is down, and decrease the attenuation 1 step down. Observe the port status is up. 6. Observe reading on power meter and interface CLI for SNR.

Expected result:	The interface is operational within technical specification: TX power: -2dBm RX power: -18 to -5dBm
Actual Result:	① Low power warning alarm is notified when VOA step is on 140 ② Link down is notified when step of VOA is on 147. - Please refer to the result table for details.
Remarks	- VOA step used / range from (0 - 147) - Tools are used to measure transmitted and received power ① Power Meter (optical : Adapter is used between CFP and Power meter). ② Command line interface (CLI). ③ Traffic Generator

Test Conducted By:	Name	Signature	Company	Date
	MD. SHAFIUL RAHMAN B. MD. LATIF		AIKSTAR	2
	MUHAMMAD FAIZ MUHAMMAD NAJIB		MCSB	
	Han Yiping		Fiberhome	
Test Verified By: I hereby verify that the test has been conducted according to the test plan. Refer to Actual Result for the outcome of the test.	Name	Signature	Company	Date

Table 1: Power measurement

5.2. Verification of Alien Wavelength (Juniper) with Fiberhome DWDM

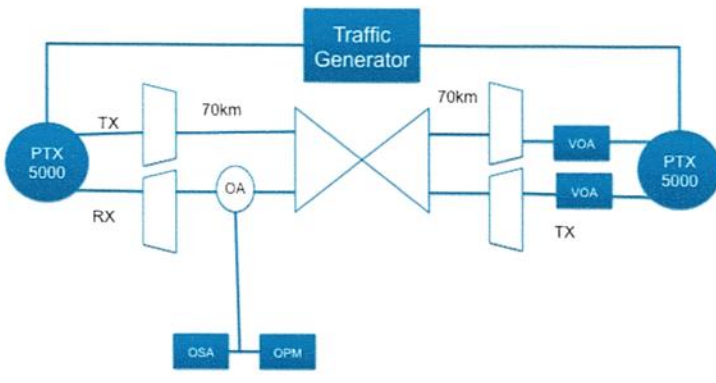
Test No.	5.2
Test Synopsis	The test is to verify the Juniper 100G coherent is able to interwork with Fiberhome DWDM systems within TM 50Ghz spacing specifications.
Test Diagram	
Test Objective:	The purpose of this test is to qualify the PTX5000 100G coherent interface to support: 1) To verify the new wavelength for the new channel. 2) To test wavelength lower frequency with 50GHz spacing 3) To test wavelength higher frequency with 50GHz spacing 4) PTX5000 is able to be tuned to support 96 DWDM channels
Test Requirements:	• Setup network as per test diagram.

	Test Instruction												
Test Procedure	1. Configure at FH DWDM, channel 1 (low) and channel 96 (high) and connect to Juniper transponders. 2. On both PTX5000 configure port-1 on channel 1 and port-2 3. Configure channel 2, 3, 94 and 95 on Fibrehome DWDM systems to transmit other types of traffic. 4. Connect FH DWDM to Juniper transponder on PTX1 and PTX2. 5. Observe OSNR on OSA and compare against Fibrehome OPM readings. 6. Capture 100G interface statistics from CLI.												
Expected result:	The 100G DP-QPSK coherent router interface can successfully be tuned across the extended C-band. The following parameters are measure and conform to TM specifications: Result from OSA 1) Nominal Frequency for both low and high frequencies 2) Nominal Wavelength 3) Wavelength 4) Power 5) OSNR better than 18dB Result from OPM (Optical performance monitoring) 1) Nominal Frequency 2) Nominal Wavelength 3) Wavelength 4) Power 5) OSNR												
Actual Result:	<u>Lower frequency</u>. - Result captured from Optical Spectrum Analyzer (OSA) ① CH 1 : Fibrehome wavelength - 1529.16 CH 2 : Juniper wavelength - 1529.55 CH 3 : Fibrehome Wavelength - 1529.93 ② OSNR measurement <table><tr><th></th><th>OSA</th><th>OPM</th></tr><tr><td>CH 1</td><td>20.59</td><td>24.66</td></tr><tr><td>CH 2</td><td>20.28</td><td>23.89</td></tr><tr><td>CH 3</td><td>23.46</td><td>25.91</td></tr></table>		OSA	OPM	CH 1	20.59	24.66	CH 2	20.28	23.89	CH 3	23.46	25.91
	OSA	OPM											
CH 1	20.59	24.66											
CH 2	20.28	23.89											
CH 3	23.46	25.91											
Remarks													

	- 3 wavelength generated (combination of Juniper and fiberhome wavelength). - opm fiberhome unable to monitor osnr that higher than CH88. - Please refer report from OSA / screen captured for detail table.			
Test Conducted By:	Name	Signature	Company	Date
	MD. SHAFU L RAHMAN S. MD LATIF		RIKSTON	
	MOHD FAIZ MOHD NADIB		MSB	
	Han Yiping		Fiberhome	
Test Verified By: I hereby verify that the test has been conducted according to the test plan. Refer to Actual Result for the outcome of the test.	Name	Signature	Company	Date

Table 2: 50Ghz DWDM channel spacing verification

5.3. OSNR Verification

Test No.	5.3
Test Synopsis	The test is to verify the Juniper 100G coherent is able to interwork with Fibrehome DWDM systems within TM 18dB OSNR specifications.
Test Diagram	 The diagram illustrates the test setup for OSNR verification. It features two PTX 5000 devices. The left PTX 5000 has a TX port connected to a 70km fiber link and an RX port connected to an OA (Optical Amplifier). The right PTX 5000 has a TX port connected to a 70km fiber link and two VOA (Variable Optical Attenuator) ports. A Traffic Generator is connected to both PTX 5000 devices. The two 70km fiber links are connected to a central optical switch. The OA is connected to the output of the optical switch. The two VOA ports are connected to the output of the optical switch. The OA is also connected to an OSA (Optical Spectrum Analyzer) and an OPM (Optical Power Meter).
Test Objective:	The purpose of this test is to qualify the PTX5000 100G coherent interface to support: 1) To verify the new wavelength for the new channel. observer noise, OSNR
Test Requirements:	• Setup network as per test diagram.

	Test Instruction			
Test Procedure	Continue test setup from 5.2 and measure OSNR from OSA			
Expected result:	OSNR is better than 18dB.			
Actual Result:	Lower frequency (OSNR) CH1 (F) : 22.59 CH2 (J) : 20.28 CH3 (F) : 23.46 Higher frequency (OSNR) CH94 (F) : 22.84 CH95 (F) : 26.07 CH96 (J) : 20.89 OSA			
Remarks	- Refer to screen captured / OSA report for detail result. - 3 wavelength is generated. Combination of jumper and fiberhome wavelength.			
Test Conducted By:	Name	Signature	Company	Date
	Han Yinding		Fiberhome	
	MUHAMMAD FAIZ MUHAMMAD NAJIB		MSB	
	MOSHAIFUZZ RAHMAN B. MD LATIF		AIES7A R	
Test Verified By: I hereby verify that the test has been conducted according to the test plan. Refer to Actual Result for the outcome of the test.	Name	Signature	Company	Date

Table 3: Verification of 18dB OSNR

5.4. Sensitivity For Transponder

Test No.	5.4
Test Synopsis	The test is baseline nominal FEC rate for PTX5000 coherent interface.
Test Diagram	
Test Objective:	In TM transmission network, pre-FEC BER between transponders is specified as 10^{-12}. This test is to baseline the pre-FEC BER between PTX5000 transponders when connected to Fibrehome DWDM systems.
Test Requirements:	Setup network as per test diagram.
Test Instruction	
Test Procedure	- Continue setup from 5.3 - From CLI, issue "show interface et-xxx extensive" and observe the pre-FEC BER. - Observe the uncorrected error counter to ensure error free operations.
Expected result:	- PTX5000 nominal pre-FEC BER is around 10^{-8}. 100G link is error free.
Actual Result:	Please refer to attachment.

Remarks	- Noise is added on the line (Fiberhome) by adapting optical amplifier (OA) and creating noise signal.			
Test Conducted By:	Name	Signature	Company	Date
	Wan Yiping		Fiberhome	
	MR. SIBIRAL KARAN & ADLTP		PIESTAR	
	MOTD FAN MOTD NASIB		MSB	
Test Verified By:	Name	Signature	Company	Date
I hereby verify that the test has been conducted according to the test plan. Refer to Actual Result for the outcome of the test.				

Table 4: Nominal pre-FEC BER

- Before test. (Sensitivity for Transponder)

① hco1 ~~error~~ corrected error ratio = ~~$5.95e-07$~~ ^{$5.85e-07$} , Rx Power = -10.97

hco2 corrected error ratio = $1.73e-06$, Rx Power = -10.00

② OSNR from URA, CH94 (F) = 24.84

CH95 (F) = 26.07

CH96 (J) = 20.89

③ Jumper setting. - ber-threshold clear $1e-04$

ber-threshold-signal degrade $1e-03$

- After Test. (OA = -5) @ 10^{-5}

① OA is set -5 at fiberhome. (Rx side at hco1).

② hco1 = $6.40e-07$, Rx Power = -10.97

hco2 = $4.15e-03$, Rx Power = -13

③ Link down.

} with threshold setting.

- After test (OA = -8) @ 10^{-8} [without threshold setting]

① hco1 = $5.06e-07$

② hco2 = $6.63e-05$

③ Link up, no error.

- After Test (OA = -7) @ 10^{-7} [without threshold setting]

① hco1 = $6.75e-07$

hco2 = $1.94e-04$

③ Link up.

- After test (OA = -6) 8.89×10^{-6} [without threshold setting]

① hco1 = $6.83e-07$

hco2 = $1.38e-03$

③ Link up.

* VOA : 1.99×10^{-5}

• hc01 : 5.34×10^{-7}

• hc02 : 3.08×10^{-3}

• Link up

• OSA OSNR CH94 (F) : 19.46

CH95 (F) : 20.67

CH96 (J) : 15.75

* VOA : 2.09×10^{-5}

• hc01 : 6.04×10^{-7}

• hc02 : 4.26×10^{-3}

• Link up ✓

• OSA OSNR CH94 (F) : 19.15

CH95 (F) : 20.35

CH96 (J) : 15.47

* VOA : 4.07×10^{-5}

• hc01 : 7.33×10^{-7}

• hc02 : ~~4.8~~ 4.6×10^{-3}

~~OSA OSNR~~

• Link ~~intermittent~~ up

• OSA OSNR CH94 (F) : 18.95

CH95 (F) : 20.17

CH96 (J) : 15.27

* VOA : 5.5×10^{-5}

• hc01 : 4.97×10^{-7}

• hc02 : 5.46×10^{-3}

• Link up

• OSA OSNR CH94 (F) : 18.77

CH95 (F) : 19.99

CH96 (J) : 15.08

5.5. Bit Error Rate Link Test

Test No.	5.2
Test Synopsis	The test is to verify the Juniper 100G coherent is able to interwork with Fibrehome DWDM systems error free for 72 hours.
Test Diagram	
Test Objective:	The purpose of this test is to qualify the PTX5000 100G coherent interface to support error free transmission for 72 hours.
Test Requirements:	Setup network as per test diagram.

	Test Instruction
Test Procedure	- Configure at FH DWDM, channel 1 (low) and channel 96 (high) and connect to Juniper transponders. - On both PTX5000 configure port-1 on channel 1 and port-2 - Configure channel 2, 3, 94 and 95 on Fibrehome DWDM systems to transmit other types of traffic. - Connect FH DWDM to Juniper transponder on PTX1 and PTX2. - Observe OSNR on OSA and compare against Fibrehome OPM readings. - Capture 100G interface statistics from CLI. - Run traffic generator to generate traffic at 100G and verify traffic is routed over 100G interface. - Continue running the test for 72 hours. - Verify error free for CLI "show interface et-xxx extensive"

Expected result:	Error free transmission for 72 hours			
Actual Result:				
Remarks	- snate configuration . - traffic profile 8G0 - 8G5 . - As Please refer attachment for detail .			
Test Conducted By:	Name	Signature	Company	Date
	Man Yaping		Fiberhome	
	MO. SHAIFUL RAHMAN & MD. LATIF		PLES-TAR	
	MOTIP FARZ MOTIB NAJIB		MSB	
Test Verified By:	Name	Signature	Company	Date
I hereby verify that the test has been conducted according to the test plan. Refer to Actual Result for the outcome of the test.				

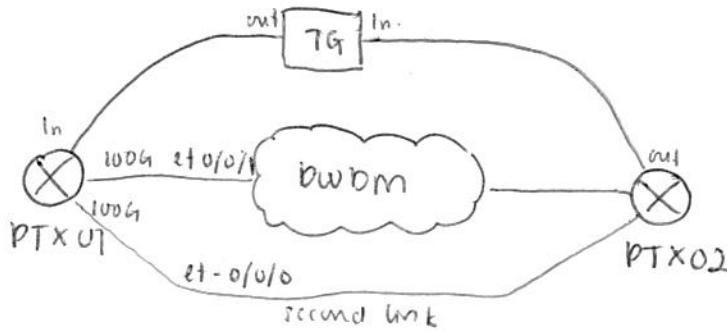
Table 5: 72 hours error free transmission

5.6. Link Protection Test

Test No.	5.2
Test Synopsis	The test is to verify the Juniper 100G coherent is able to protect traffic in fibre-cut scenario and signal degraded environment.
Test Diagram	
Test Objective:	The purpose of this test is to qualify the PTX5000 100G coherent interface to support 50ms failover time for the following scenarios: 1. Catastrophic fibre-cut 2. Signal degradation
Test Requirements:	• Setup network as per test diagram.

	Test Instruction
Test Procedure	Configure the pre-FEC BER parameters as follows: <pre> interfaces { et-0/0/0 { mtu 9500; optics-options { wavelength 1550.12; } otn-options { laser-enable; signal-degrade { interval 2; ← BER collection window in ms ber-threshold-clear 5; ← BER 1.0E-5 ber-threshold-signal-degrade 4; ← BER 1.0E-4 } preemptive-fast-reroute { signal-degrade-monitor-enable; backward-frr-enable; ← Notifying Remote End } } } } </pre>

1.1 Fiber cut (10G traffic)



- Frame size
1500 bytes.
- Traffic profile
840 - 845

a) Fiber cut at Juniper Tx.

Actual result : - traffic is divert from et-0/0/1 into et-0/0/0

$$\text{- switching time} = \frac{(\text{frame drop}) (\text{frame size}) (8)}{\text{total T/put}}$$

$$= \frac{(63491)(1500)(8)}{9664000000 \text{ bps}}$$

$$= 0.0788 \text{ s} = 78.8 \text{ ms}$$

b) Fiber cut at line (fiberhome bwdm)

Actual Result : - Traffic is divert from et-0/0/1 into et-0/0/0.

$$= \frac{(73889)(1500)(8)}{9664000000 \text{ bps}}$$

$$= 0.0911 : 91.1 \text{ ms}$$

	Signal-degrade environment: 1) Start with the end-to-end configuration of the 100G DP-QPSK coherent router interface across the FIBREHOME line system. 2) Without Pre-FEC BER signal degrade detection configured, reducing the received optical power level of the 100G DP-QPSK coherent interface on port et-4/1/0 such that the pre-FEC BER exceeds $1e-4$. 3) Capture the CLI output showing detected BER before FEC and zero errors after FEC. 4) Increase the received optical power level of the 100G DP-QPSK coherent interface on port et-4/1/0 such that the pre-FEC BER is below $1e-4$. 5) Stop traffic and set the signal degrade threshold as in the configuration below. 6) Start traffic and increase the BER to above the configured BER threshold of $1e-4$ but below the FEC threshold to trigger the detection event. 7) Measure traffic throughput with external tester to show no packet loss occurred. 8) Capture CLI output showing detected BER, interface status and alarms. Capture remote router interface status and alarms. 9) Reduce error rate to below configured clear BER threshold of $1e-5$ and trigger LSP back to the primary link using "clear mpls lsp optimize-aggressive". 10) Measure traffic throughput with external tester to show no packet loss occurred. Capture CLI output showing detected BER, interface status and alarms. Capture remote router interface status and alarms. Fibre-cut: 1. Physically remove the patch cable from PTX5000 to Fibrehome DWDM systems. 2. Measure traffic throughput with external tester to show packet loss.
--	--

Expected result:	Minimal packet loss in signal degrade and fibre-cut scenarios. Failover time is around 50ms.
Actual Result:	Please refer to attachment for detail information / result.

- After test ($OA = -8$) $4.18 e-08$

Hc 01 :

Hc 02 : $1.1 e-04$

Link up (Restore after reach the clean threshold)

* ~~the~~ Restart the step to reach the signal degrade threshold.
(Increase the noise back).

- After test (OA) -07 : $1.3 e-07$

Hc 01 :

Hc 02 : $7.27 e-04$

Link up .

~~the~~

- After test ($OA = -07$) $3.09 e-07$

Hc 01

Hc 02 : $1.14 e-03$

Link down . Traffic is FRR to secondary link

Switching time = 0 (Zero packet drop) .

default value for threshold

clean = ~~$7.5 e-03$~~ 7.5

signal-degrade = $7.5 e-03$

Remarks	-Default PRE-FEC : SD = XE-02. Chan = XE-03 -			
Test Conducted By:	Name	Signature	Company	Date
	Han Yaping		Fiber-home	
	MD. SHAFIUL RAHMAN MD LATP		ARRIS TAP	
	MOHD FAIZ MOHD NASIR		MSB	
Test Verified By:	Name	Signature	Company	Date
I hereby verify that the test has been conducted according to the test plan. Refer to Actual Result for the outcome of the test.				

Table 6: Link Protection test

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6. Appendix – Issue Register

Known issues in the TM IP Core production network are to be documented within the Appendix of this document. The information should contain the affected JUNOS release, JUNOS release the fix will be available, and the current work around within the production network.

Note. All work-arounds proposed should be backed out when the router is upgraded to a JUNOS version with the available fix for the issue.

Date	Items	JUNOS Release		Note
		Affected In	Fixed In	

Table 7: IP Core TM Marvel Project