



DEFENSE INFORMATION SYSTEMS AGENCY
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IN REPLY
REFER TO: Joint Interoperability Test Command (JTE)

MEMORANDUM FOR DISTRIBUTION

10 Mar 11

SUBJECT: Special Interoperability Test Certification of the Fujitsu FLASHWAVE 7500
Optical Transport System with Software Release 6.1.2

- References:
- (a) Department of Defense Directive 4630.05, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," 5 May 2004
 - (b) Chairman, Joint Chiefs of Staff Instruction 6212.01E, "Interoperability and Supportability of Information Technology and National Security Systems," 15 December 2008
 - (c) through (f) see enclosure 1

1. References (a) and (b) establish the Joint Interoperability Test Command (JITC) as the responsible organization for Interoperability Certification.
2. The following Fujitsu hardware and software items will hereinafter be referred to as the System Under Test (SUT).
 - a. FLASHWAVE 7500 Two-Degree Reconfigurable Optical Add-Drop Multiplexer (ROADM) 40-Channel Software Release 6.1.2.
 - b. FLASHWAVE 7500 Two-Degree Wavelength Selective Switch ROADM 40-Channel Software Release 6.1.2.
 - c. FLASHWAVE 7500 Fixed Optical Add-Drop Multiplexer and or ROADM 40-Channel Software Release 6.1.2.
 - d. Multi-degree Hub node scalable in-service to a 12-degree hub configuration 40-Channel Software Release 6.1.2.

The SUT is certified for joint use in the Defense Information System Network as an Optical Transport System (OTS). The Defense Information Systems Agency (DISA) adjudicated all Test Discrepancy Reports (TDR) open at the completion of testing to have a minor operational impact. JITC will verify the certification status of the SUT by evaluating any new discrepancies noted in the operational environment for impact on the existing certification. These discrepancies will be adjudicated to the satisfaction of DISA via a vendor Plan of Actions and Milestones (PoAM) that will address all new critical TDRs within 120 days of identification. JITC conducted Testing using OTS product requirements derived from the Unified Capabilities

JITC Memo, JTE, Special Interoperability Test Certification of the Fujitsu FLASHWAVE 7500 with Software Release 6.1.2

Requirements (UCR), Reference (c). The SUT includes additional models and capabilities not covered by this certification. No other configurations, features, or functions, except those cited in this memorandum, are certified by JITC. This certification expires upon changes that affect interoperability, but no later than three years from the date of this memorandum.

3. The extension of this certification is based upon Desktop Review (DTR). The original certification is based on interoperability testing conducted by JITC, review of the vendor’s Letters of Compliance (LoC), and Defense Information Assurance (IA)/Security Accreditation Working Group (DSAWG) accreditation. JITC conducted interoperability testing at the JITC Advanced Technology Test Facility, Indian Head, Maryland during August and September 2009. Review of the vendor’s LoC was completed during July 2009 reference (e). A review of the current changes in the SUT in Reference (d) and comparison with the new requirements in Reference (c) was conducted in July 2010 to certify the SUT for interoperability within the Defense Information System Network without additional interoperability testing. DSAWG granted accreditation on 14 June 2010 based on the security testing completed by DISA-led IA test teams and published in a separate report, Reference (f). This DTR was requested to include FW7500 Lambda Access Module 7, FW7500 Lambda Access Shelf for 19-inch shelf, FW7500 LS OLC-B (SR) 1554.13 - 1556.55 Transponder Module, FW7500 LS OLC-B (SR) 1560.61 - 1563.05 Transponder Module, Network Element (NE) shelf management unit, and the correction of the FNC-7500-0061-020 documentation Compact Disk part number. JITC determined, through analysis, that there is low risk in approving this DTR because this change is unlikely to affect the interoperability functionality of the certified OTS. Therefore, JITC approves this DTR. The DSAWG accreditation for this DTR was granted on 5 October 2010 reference (f). A detail description of changes and correction for this DTR is listed in Table 3-2 of enclosure 3.

4. The interface, Capability Requirements (CR), Functional Requirements (FR), and component status of the SUT are listed in Tables 1 and 2. JITC evaluated the interoperability status of the SUT based on the corresponding applicable threshold of CRs/FRs in UCR 2008 Change 1, Section 5.5.3.

Table 1. SUT Interface Interoperability Status

Interface	Critical	UCR Reference	Threshold CR/FR Requirements	Status	Remarks
OC-48/STM-16	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs for OC-48 but not for STM-16 (See note 1).
OC-192/STM-64	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs for OC-192/STM-64.
OC-768/STM-256	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs for OC-768/STM-256.
1 Gigabit Ethernet	Yes	5.5.3.2.5.1	1, 2, 4, 5, and 8	Certified	Met threshold CRs/FRs.
10 Gigabit Ethernet LAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs.
10 Gigabit Ethernet-WAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs.
OTN ODU1/ODU2/ODU3	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met requirement based on vendor’s LoC (See note 2).
OTN 100 Gbps	Yes	5.5.3.2.5.1	7	Not-Certified	SUT does not support OTN 100 Gbps (See note 3).
OSC	Yes	5.5.3.2.8	8	Certified	Met threshold CRs/FRs.

Table 1. SUT Interface Interoperability Status (continued)

NOTES:	
1. The SUT does not support STM-16. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement STM-16 interface.	
2. Based on vendor's LoC, the SUT meets the corresponding UCR requirements. JITC did not test the OTN rates including ODU1/ODU2/ODU3 (See Enclosure 2 test limitations for more details).	
3. The SUT does not support 100 Gbps. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement 100 Gbps interface.	
LEGEND:	
CR	Capability Requirements
FR	Functional Requirement
Gbps	Gigabits per second
JITC	Joint Interoperability Test Command
LAN	Local Area Network
LoC	Letters of Compliance
OC	Optical Carrier
ODU	Optical Channel Data Unit
OSC	Optical Supervisory Channel
OTN	Optical Transport Network
STM	Synchronous Transport Module
SUT	System Under Test
UCR	Unified Capabilities Requirements
WAN	Wide Area Network

Table 2. SUT Capability Requirements and Functional Requirements Status

CR/FR ID	Capability/Function	Applicability (See note 1.)	UCR Reference	Status	Remarks
1	Requirements Applicable to all OTS Elements				
	Overall Requirements	Required	5.5.3.2.2.1	Partially Met	See note 2.
	Performance Requirements	Required	5.5.3.2.2.2	Met	
	Reliability and Quality Assurance	Required	5.5.3.2.2.2.1	Met	
	Common Physical Design Requirements	Required	5.5.3.2.2.3	Met	
2	Protection and Restoration	Required	5.5.3.2.2.4	Partially Met	See note 3.
	Optical Amplifier Requirements				
3	OLA Physical Design Requirements	Required	5.5.3.2.3.1	Met	
	Muxponder Requirements				
4	Muxponder	Required	5.5.3.2.4	Met	
	Transponder Requirements				
	Transponder	Required	5.5.3.2.5	Met	
5	Interface Requirements	Required	5.5.3.2.5.1	Partially Met	See notes 4 and 5.
	ROADM Requirements				
6	ROADM Requirements	Required	5.5.3.2.6	Met	
	ROADM Specific Physical Design Requirements	Required	5.5.3.2.6.1	Met	
7	Requirements Common to Transponder and ROADM				
	Framed Formats	Required	5.5.3.2.7.1	Met	
8	Unframed Formats	Required	5.5.3.2.7.2	Met	
	Optical Supervisory Channel Requirements				
9	Optical Supervisory Channel	Required	5.5.3.2.8	Met	
	OTS Standards Compliance Requirements				
10	OTS Standards Compliance	Required	5.5.3.2.9	Met	

Table 2. SUT Capability Requirements and Functional Requirements Status (continued)

NOTES:			
1. Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in enclosure 2.			
2. The SUT only supports 40 wavelengths not the 80 wavelengths specified by the UCR. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement 80 wavelengths.			
3. Quad 10 Gigabit Module QMC1, 40 Gigabit Regen Module QRC1, and 10 Gigabit Regen Module RGC1 did not meet the 50-millisecond switch time requirement. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement any 40 Gigabit configurations.			
4. The SUT does not supports STM-16 and 100 Gigabit interface. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement STM-16 and 100 Gigabit interface.			
5. The SUT met all the UCR OTN interface requirements based on vendor's LoC.			
LEGEND:			
CR	Capability Requirements	OTS	Optical Transport System
FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexer
ID	Identification	STM	Synchronous Transport Module
LoC	Letter of Compliance	SUT	System Under Test
OLA	Optical Line Amplifier	UCR	Unified Capabilities Requirements
OTN	Optical Transport Network		

5. In accordance with the Program Manager's request, JITC did not develop a detailed test report. JITC distributes interoperability information via the JITC Electronic Report Distribution system, which uses Non-secure Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program, which .mil/gov users can access on the NIPRNet at <https://stp.fhu.disa.mil>. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool at <http://jit.fhu.disa.mil> (NIPRNet). Information related to (Defense Switched Network (DSN) testing is on the Telecom Switched Services Interoperability website at <http://jitc.fhu.disa.mil/tssi>. All associated data is available on the DISA Unified Capability Coordination Office website located at <http://www.disa.mil/ucco/>.

6. The JITC testing point of contact is Mr. Son Pham, commercial (301) 744-2636, or DSN 354-2636. His e-mail address is Son.Pham@disa.mil. The JITC mailing address is 3341 Strauss Avenue, Suite 236, Indian Head, Maryland 20640-5149. The SUT System tracking number is TN 0915503.

FOR THE COMMANDER:

3 Enclosures a/s


for BRADLEY A. CLARK
Acting Chief
Battlespace Communications Portfolio

JITC Memo, JTE, Special Interoperability Test Certification of the Fujitsu FLASHWAVE 7500 with Software Release 6.1.2

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ADDITIONAL REFERENCES

- (c) Office of Assistant Secretary of Defense for Networks and Information Integration Document, "Department of Defense Unified Capabilities Requirements 2008, Change 1," 22 January 2010
- (d) Fujitsu Desk Top Review (DTR) Reference Document, "FLASHWAVE 7500, R6.1.2 DTR1," July 2010
- (e) Fujitsu Document, "Letter of Compliance," July 2009
- (f) Joint Interoperability Test Command Document, "Information Assurance (IA) Assessment of Fujitsu FLASHWAVE 7500 with Software Release 6.1.2 (TN 0915503), for APL" 1 October 2009 and for DTR" 5 October 2010

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CERTIFICATION TESTING SUMMARY

- 1. SYSTEM TITLE.** The Fujitsu FLASHWAVE 7500 Optical Transport System with Software Release 6.1.2.
- 2. SPONSOR.** United States Army, Mr. Gary Kitsmiller, Address: AMSEL-IE-IS, Bldg 53301, Fort Huachuca, Arizona, 85613-5300, e-mail: gary.kitsmiller@us.army.mil.
- 3. SYSTEM POINT OF CONTACT.** Ms. Cathy Simon, Address: 2801 Telecom Parkway, Richardson, TX 75082, e-mail: cathy.simon@us.fujitsu.com.
- 4. TESTER.** Joint Interoperability Test Command (JITC), Indian Head, Maryland.
- 5. SYSTEM UNDER TEST (SUT) DESCRIPTION.** The SUT is based on advanced Wavelength Selective Switch technology that enables optical mesh and hub network architectures that are key components for building an all-optical high-capacity backbone network in the Department of Defense (DoD). It is a transport network element that offers capacity of 1.6 terabit per second, provides up to 40 wavelengths services, features transmission paths exceeding 1000 kilometers, and supports up to 24 intermediate add/drop nodes. Fujitsu designed the system to add value to the DoD networks by enabling the DoD to aggregate and transport traffic efficiently.

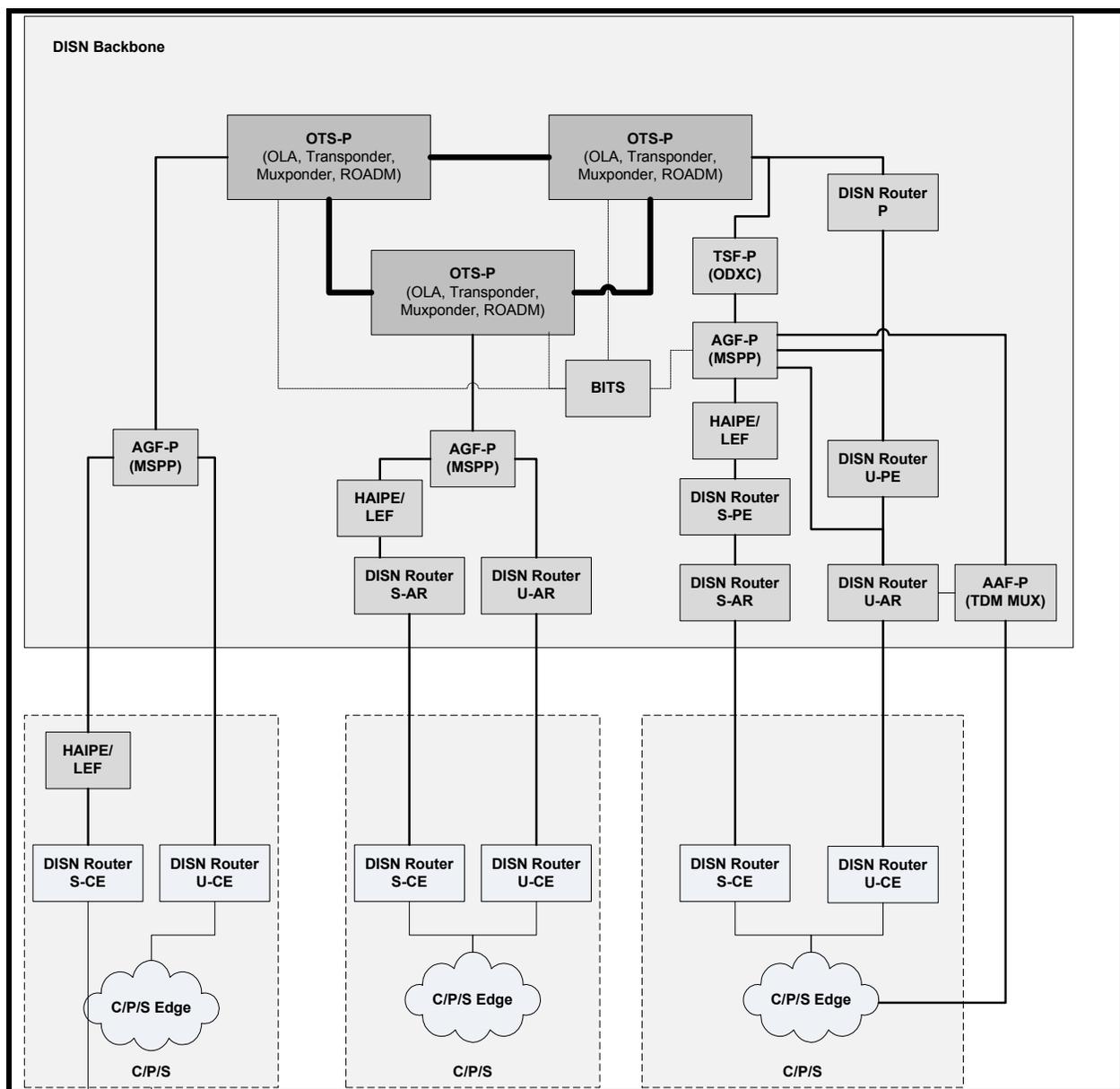
The following is a brief description of SUT's hardware and software platforms:

- a. FLASHWAVE 7500 Two-Degree ROADM 40-Channel Software Release 6.1.2.
- b. FLASHWAVE 7500 Two-Degree Wavelength Selective Switch ROADM 40-Channel Software Release 6.1.2.
- c. FLASHWAVE 7500 Fixed Optical Add-Drop Multiplexer and ROADM 40-Channel Software Release 6.1.2.
- d. Multi-degree hub node scalable in-service to a 12-degree hub configuration 40-Channel Software Release 6.1.2.
- e. NetSmart 500 Element Management System Software Release 3.12.0 is a Windows-based craft interface tool. The NetSmart 500 software supports graphical shelf views, equipment and facility provisioning, alarm surveillance, software download, remote memory backup, and remote memory restore capabilities, and cross-connect provisioning. Only used for configuration purposes and is not certified as a part of the SUT.
- f. NetSmart 1500 Network Management System Software Release 6.0 provides a full suite of network and element management features, enabling turn up of Ethernet, Wavelength Division Multiplexing, Synchronous Digital Hierarchy (SDH), and

Synchronous Optical Network (SONET) services. Only used for configuration purposes and is not certified under the SUT.

Although the SUT supports the SDH standard, the SUT does not support Synchronous Transport Module (STM)-16 interfaces; therefore, JITC did not test this interface and the Defense Information System Network (DISN) Program Management Office has not authorized it for use with the DISN.

6. OPERATIONAL ARCHITECTURE. As defined in the Unified Capabilities Requirements (UCR), the SUT is an Optical Transport System (OTS). Figure 2-1 shows the role of the SUT providing core transport for the Sycamore 16K, Cisco 15454, Juniper T320 routers, client Ethernet, client SONET, and client STM signals.



LEGEND:			
AAF-P	Access Aggregation Function Product	OLA	Optical Line Amplifier
AGF-P	Access Grooming Function Product	OTS-P	Optical Transport System Product
AR	Aggregation Router	ROADM	Reconfigurable Optical Add and Drop Multiplexer
ATM	Asynchronous Transfer Mode	S-AR	Secret Aggregation Router
CE	Customer Edge Router	S-CE	Secret Customer Edge Router
C-PE	Classified Provider Edge Router	S-PE	Secret Provider Edge Router
C/P/S	Camp, Post, or Station	TDM	Time Division Multiplexing
DISN	Defense Information System Network	T-PE	Transport Provider Edge Router
HAIPE	High Assurance Internet Protocol Encryptor	TSF-P	Transport Switch Function Product
MSPP	Multi-Service Provisioning Platform	U-AR	Unclassified Aggregation Router
MUX	Multiplexer	U-CE	Unclassified Customer Edge Router
P	Provider Router	U-PE	Unclassified Provider Edge Router
ODXC	Optical Digital Cross Connect		

Figure 2-1. DISN Backbone Architecture

7. INTEROPERABILITY REQUIREMENTS. The interface, Capability Requirements (CR), Functional Requirements (FR), Information Assurance (IA), and other requirements for OTS products are established by Sections 5.4 and 5.5.3 of the DoD Unified Capabilities UCR 2008, Change 1.

7.1 Interfaces. The OTS products use its interfaces to interconnect the DISN Wide Area Network (WAN) infrastructure. Table 2-1 lists the threshold requirements for interfaces specific to the OTS products.

Table 2-1. OTS Interface Requirements

Interface	Critical	UCR Reference	Threshold CR/FR Requirements	Criteria	Remarks
OC-48/STM-16	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Meet minimum CR/FRs and interface standards.	
OC-192/STM-64	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8		
OC-768/STM-256	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8		
1 Gigabit Ethernet	Yes	5.5.3.2.5.1	1, 2, 4, 5, and 8		
10 Gigabit Ethernet LAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8		
10 Gigabit Ethernet-WAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8		
OTN ODU1/ODU2/ODU3	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8		
OTN 100 Gbps	Yes	5.5.3.2.5.1	7		
OSC	Yes	5.5.3.2.8	8		

LEGEND:			
CR	Capability Requirements	OSC	Optical Supervisory Channel
FR	Feature Requirements	OTN	Optical Transport Network
Gbps	Gigabits per second	OTS	Optical Transport System
LAN	Local Area Network	STM	Synchronous Transport Module
OC	Optical Carrier	UCR	Unified Capabilities Requirements
ODU	Optical Channel Data Unit	WAN	Wide Area Network

7.2 Capability Requirements (CR) and Functional Requirements (FR). The OTS products have required and conditional features and capabilities that are established by UCR Section 5.5.3. The SUT does not need to provide non-critical (conditional) features and capabilities. If they are present, however, they must function according to the specified requirements. Table 2-2 lists the features and capabilities and their

associated requirements for OTS products. Table 3-1, in Enclosure 3, provides detailed CR/FR requirements.

Table 2-2. OTS Capability Requirements and Functional Requirements

CR/FR ID	Capability/Function	Applicability (See note.)	UCR Reference	Criteria	Remarks																								
1	Requirements Applicable to all OTS Elements																												
	Overall Requirements	Required	5.5.3.2.2.1	SUT must meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 in Enclosure 3.																									
	Performance Requirements	Required	5.5.3.2.2.2																										
	Reliability and Quality Assurance	Required	5.5.3.2.2.1																										
	Common Physical Design Requirements	Required	5.5.3.2.2.3																										
Protection and Restoration	Required	5.5.3.2.2.4																											
2	Optical Amplifier Requirements																												
	OLA Physical Design Requirements	Required	5.5.3.2.3.1	SUT must meet UCR OLA requirements. See table 3-1.																									
3	Muxponder Requirements																												
	Muxponder	Required	5.5.3.2.4	SUT must meet UCR muxponder requirements. See table 3-1.																									
4	Transponder Requirements																												
	Transponder	Required	5.5.3.2.5	SUT must meet UCR transponder requirements. See table 3-1.																									
Interface Requirements	Required	5.5.3.2.5.1																											
5	ROADM Requirements																												
	ROADM Requirements	Required	5.5.3.2.6	SUT must meet UCR ROADM requirements. See table 3-1.																									
ROADM Specific Physical Design Requirements	Required	5.5.3.2.6.1																											
6	Requirements Common to Transponder and ROADM																												
	Framed Formats	Required	5.5.3.2.7.1	SUT must meet UCR common requirements. See table 3-1.																									
Unframed Formats	Required	5.5.3.2.7.2																											
7	Optical Supervisory Channel Requirements																												
	Optical Supervisory Channel	Required	5.5.3.2.8	SUT must meet UCR OSC requirements. See table 3-1.																									
8	OTS Standards Compliance Requirements																												
	OTS Standards Compliance	Required	5.5.3.2.9	SUT must meet UCR standards compliance requirements. See table 3-1.																									
<p>NOTE: Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in this table.</p> <p>LEGEND:</p> <table> <tr> <td>CR</td> <td>Capability Requirements</td> <td>OTS</td> <td>Optical Transport System</td> </tr> <tr> <td>FR</td> <td>Functional Requirement</td> <td>ROADM</td> <td>Reconfigurable Optical Add Drop Multiplexer</td> </tr> <tr> <td>ID</td> <td>Identification</td> <td>STM</td> <td>SYNCHRONOUS TRANSPORT MODULE</td> </tr> <tr> <td>LoC</td> <td>Letter of Compliance</td> <td>SUT</td> <td>System Under Test</td> </tr> <tr> <td>OLA</td> <td>Optical Line Amplifier</td> <td>UCR</td> <td>Unified Capabilities Requirements</td> </tr> <tr> <td>OTN</td> <td>OPTICAL TRANSPORT NETWORK</td> <td></td> <td></td> </tr> </table>						CR	Capability Requirements	OTS	Optical Transport System	FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexer	ID	Identification	STM	SYNCHRONOUS TRANSPORT MODULE	LoC	Letter of Compliance	SUT	System Under Test	OLA	Optical Line Amplifier	UCR	Unified Capabilities Requirements	OTN	OPTICAL TRANSPORT NETWORK		
CR	Capability Requirements	OTS	Optical Transport System																										
FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexer																										
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OLA	Optical Line Amplifier	UCR	Unified Capabilities Requirements																										
OTN	OPTICAL TRANSPORT NETWORK																												

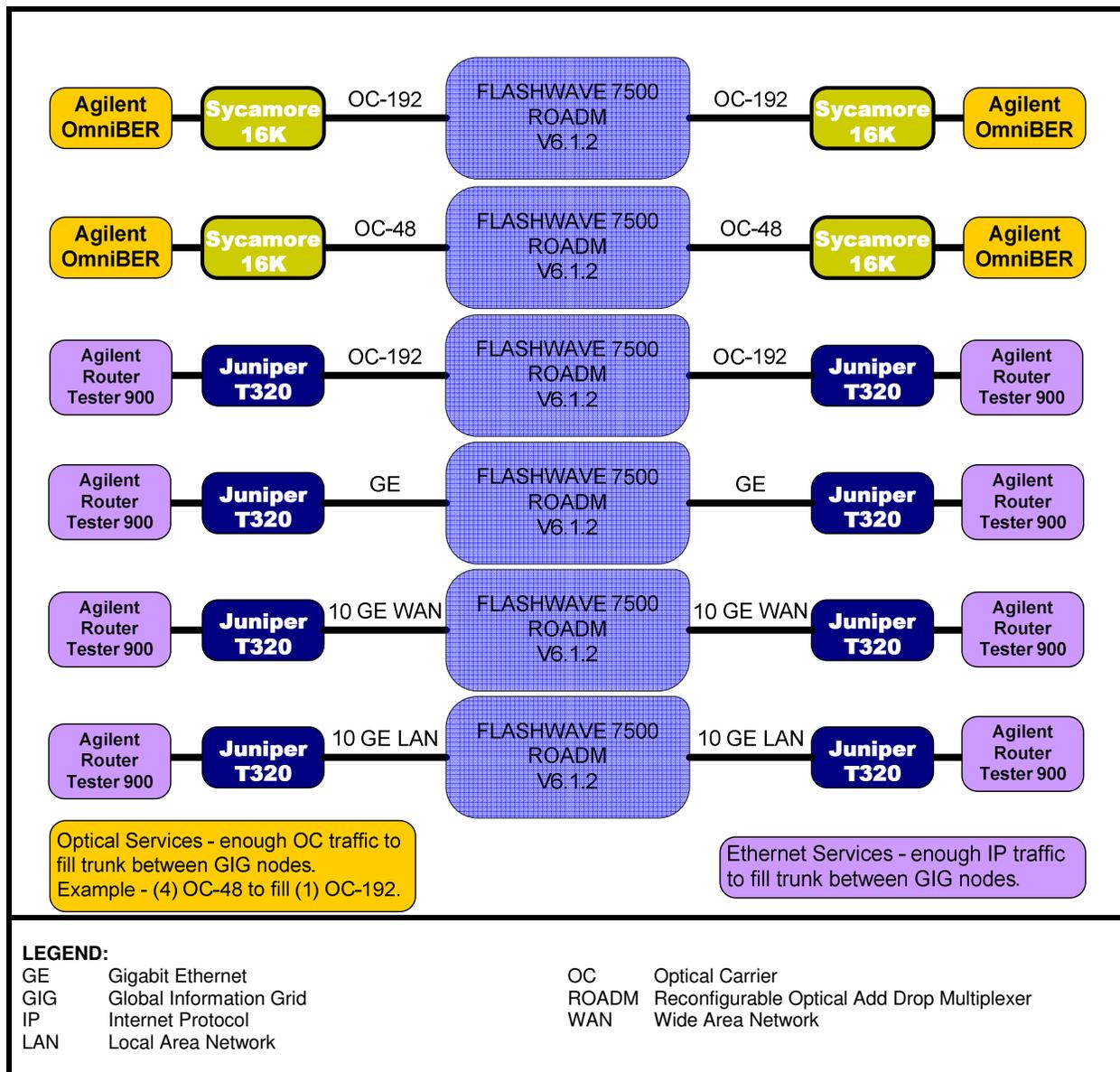


Figure 2-2. Interoperability Test Configuration 1

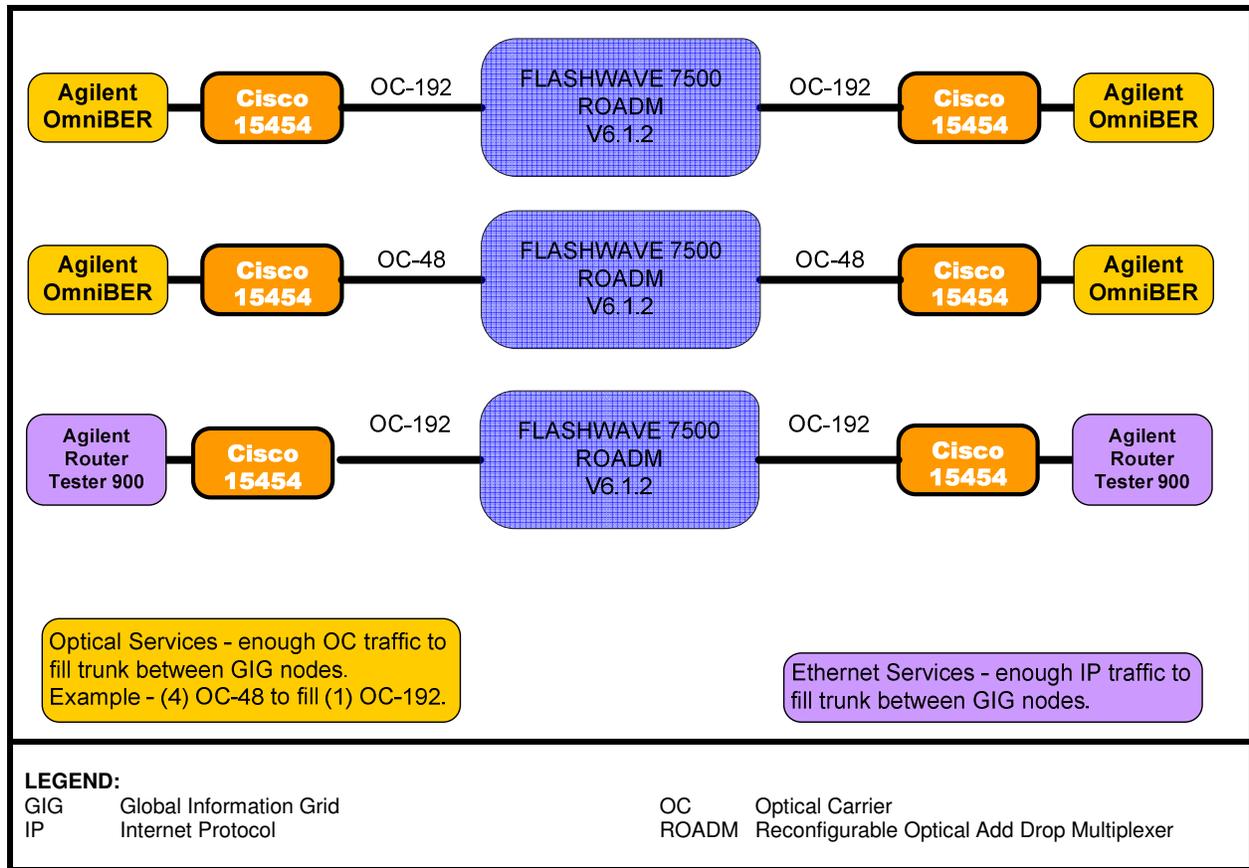


Figure 2-3. Interoperability Test Configuration 2

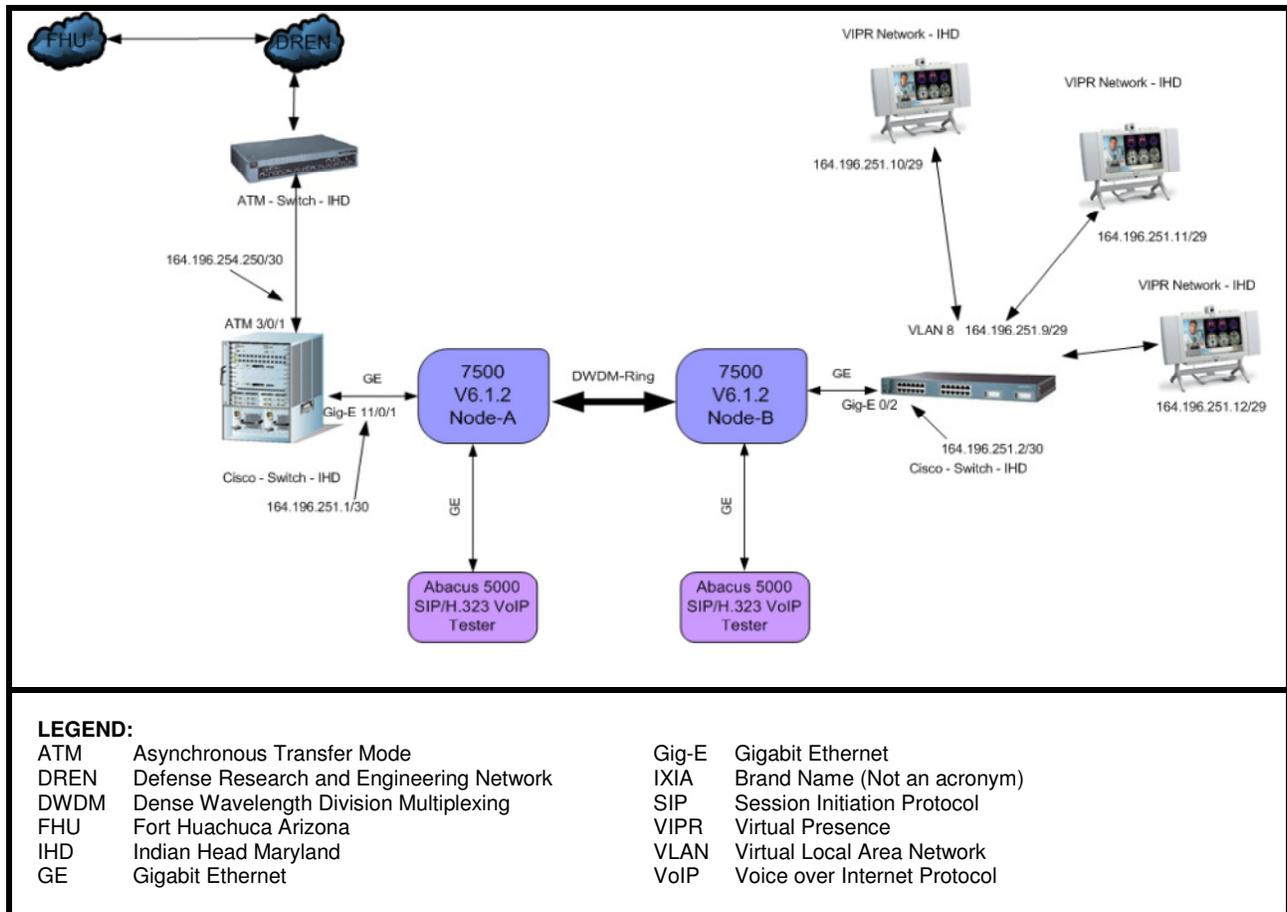


Figure 2-4. Interoperability Test Configuration 3

9. SYSTEM CONFIGURATIONS. Table 2-4 lists the tested SUT hardware/software equipments, Table 2-5 lists the Non-SUT equipments, and Table 2-6 lists the test equipments used in the test.

Table 2-4. Tested System Equipment

System Name	Software Release	
FLASHWAVE 7500 Two-Degree ROADM 40-Channel.	Release 6.1.2.	
FLASHWAVE 7500 Two-Degree Wavelength Selective Switch ROADM 40-Channel.	Release 6.1.2.	
FLASHWAVE 7500 Fixed Optical Add-Drop Multiplexer and ROADM 40-Channel.	Release 6.1.2.	
Multi-degree Hub node scalable in-service to a 12-degree hub configuration 40-Channel.	Release 6.1.2.	
NetSmart 500 EMS. Only used for configuration purposes and is not certified under the SUT. (See note.)	Release 3.12.0.	
NetSmart 1500 NMS. Only used for configuration purposes and is not certified under the SUT. (See note.)	Release 6.0.0.	
Card Name	Part Number	Number of Items
OC-3 Intermediate Reach	FC95700021	2
OC-12, Intermediate Reach SFP	FC95700051	2
OC-48 Short Reach	FC95700080	2

Table 2-4. Tested System Equipment (continued)

Card Name	Part Number	Number of Items
STM-1 Enhanced	FC95700200	2
OC-48 SFP - 1530.33nm, 195.9THz, ITU Channel 59	FC95704AAC	2
OC-48 SFP - 1560.61nm, 192.1THz, ITU Channel 21	FC95704ABS	2
OC-3 1310nm Intermediate Reach SFP	FC95700051	4
OC-12 Short Reach / Intermediate Reach SFP	FC95700080	4
OC-48 Short Reach-1 SFP Transceiver	FC9580C9B1	10
OC-192, 1310nm Short Reach	FC9580FP11	2
OC-48 Muxponder	FC9682BXC1	2
OC-192, 1310nm Short Reach	FC9580FP11	2
Enhanced 10 Gigabit Flexponder	FC9682GUC1	4
Gigabit Ethernet Muxponder	FC9682SB13	2
OLC-B (Short Reach) 1541.35 - 1543.73	FC9682LLC1	1
10 Gigabit Line Card 40 channel Long Reach	FC9682HGC1	1
10 Gigabit Line Card 40 channel Short Reach -1	FC9682U1C1	2
Universal 10 Gigabit	FC9503LAM1	2
GBE 1000 BaseSX SFP Transceiver	FC95705010	8
1000 Base - Long Reach SFP	FC9682SHU2	2
10 Gigabit Regenerator Unit	FC9682QUC1	2
40 Gigabit Transponder	FC9682QRC1	1
40 Gigabit Unidirectional Regenerator	FC9682SHP4	2
Enhanced 40 Gigabit Muxponder	FC9682QMC1	1
OC-192 Short Reach 1/10 Gigabit Base -Long Reach /10 Gigabit Base XFP	FC9573D410	4
OC192 Intermediate Reach /10 Gigabit Base-Extended Reach/10 Gigabit Base XFP	FC9573D420	4
NETSMART 1500, v5.0 server. (See note.)	PWR-QNUM-75132-1	1

NOTE: The UCR does not stipulate a minimum network-management system requirement for an Optical Transport System.

LEGEND:

EMS	Element Management System	SFP	Small Form Factor Pluggable
GBE	Gigabit Ethernet	STM	Synchronous Transport Module
ITU	International Telecommunication Union	SUT	System Under Test
nm	Nanometer	UCR	Unified Capabilities Requirements
OC	Optical Carrier	XFP	10 Gigabit Small Form Factor Pluggable
ROADM	Reconfigurable Optical Add-Drop Multiplexer		

Table 2-5. Non-SUT Equipment

Test Sets	Software Version	Interface Cards
Cisco 15454	09.00-008I-17.17	ETH 100T-12-G, OC-3IR-STM1 SH-1310-8, OC-12IR-STM4-1310-4, DS-1N-14, G1K-4, OC-192SR/STM-64, OC-48 AS-IR-1310, DS-3N-12E
Sycamore ODXC	7.6.21 Build 0562.26.27.57.14	GPIC2 2 X OC-192/STM-64, GPIC 24 x OC-3-12/STM1-4IR, GPIC2 8 x OC-48/STM16, USC - OC-192 LR 2c LIM 1
Juniper T320 Router	9.2.R2.15	4 x FE 100 Base Tx, 10 x GigE LAN 1000 Base, 1x OC-192 SM SR2, 1 x 10GigE LAN, XENPAK

LEGEND:

DS	Digital Signal	R	Revision
ETH	Ethernet	SM	Single Mode
GigE	Gigabit Ethernet	SR	Short Reach
LAN	Local Area Network	STM	Synchronous Transport Module
LIM	Line Interface Module	SUT	System under Test
OC	Optical Carrier	Tx	Transmit
ODXC	Optical Digital Cross-Connect	USC	Universal Services Card

Table 2-6. Test Equipment

Manufacture	Type	Port Type	Software Version
Anritsu	Tunics Plus – Tunable Laser	C-Band	1.00
Agilent	Optical Tester	1550 nm	A.06.01
		1310 nm	
	Router Tester 900	OC-3/OC-12 /POS OC-48 Multilayer 1000 Base X	6.11
Ixia	Traffic generator	10 Gig LM1000STX	5
Digital Lightwave	Optical Wavelength Manager	Monitor Ports	2.4.0
Agilent	Rack Mounted Router Tester 900	10 Gig LAN/WAN	6.11
		10/100/1000 Base-T	
		1000 Base-X	
		OC-48c POS OC-3/12/POS	
Agilent JDSU	T-Berd 8000	OC-192 POS	6.11
		DSU	6.4
		10/100/1000	
		OC-3-12	
		OC-192 STM-1/STM-4/STM-16/STM-64	

LEGEND:

DSU	Data Services Unit	OC	Optical Carrier
Gig	Gigabit	POS	Packet Over Synchronous Optical Network
LAN	Local Area Network	STM	Synchronous Transport Module
nm	nanometer	WAN	Wide Area Network

10. TEST LIMITATIONS. The JITC Advanced Technologies Testbed laboratory does not have Optical Transport Network (OTN) interface test capability. Therefore, JITC did not test OTN rates including Optical Channel Data Unit (ODU)1/ODU2/ODU3. The Program Manager adjudicated this test limitation as having a minor operational impact because the current fielding does not implement ODU1, ODU2, and ODU3 interfaces.

11. INTEROPERABILITY EVALUATION RESULTS. The SUT meets the critical OTS interoperability requirements and is certified for joint use within the DISN. Additional discussion regarding specific test results is contained in subsequent paragraphs.

11.1 Interfaces. Table 2-7 describes the SUT’s interface status. In accordance with (IAW) the UCR 2008 Change 1 requirements, the SUT transports and restores traffic in a reliable, timely, and secure manner. The SUT interoperates with other transport systems comprising the DoD Global Information Grid. The SUT did not interfere with the protection switching of the Sycamore 16K.

Table 2-7. SUT Interface Requirements Status

Interface	Critical	UCR Reference	Threshold CR/FR Requirements	Status	Remarks
OC-48/STM-16	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs for OC-48 but not for STM-16 (See note 1).
OC-192/STM-64	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs for OC-192/STM-64.
OC-768/STM-256	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs for OC-768/STM-256.
1 Gigabit Ethernet	Yes	5.5.3.2.5.1	1, 2, 4, 5, and 8	Certified	Met threshold CRs/FRs.
10 Gigabit Ethernet LAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs.
10 Gigabit Ethernet-WAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs.
OTN ODU1/ODU2/ODU3	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met requirement based on vendor's LoC (See note 2).
OTN 100 Gbps	Yes	5.5.3.2.5.1	7	Not-Certified	SUT does not support OTN 100 Gbps (See note 3).
OSC	Yes	5.5.3.2.8	8	Certified	Met threshold CRs/FRs.

NOTES:

1. The SUT does not support STM-16. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement STM-16 interface.
2. Based on vendor's LoC, the SUT meets the corresponding UCR requirements. JITC did not test the OTN rates including ODU1/ODU2/ODU3 (See Enclosure 2 test limitations for more details).
3. The SUT does not support 100 Gbps. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement 100 Gbps interface.

LEGEND:

CR	Capability Requirements	OSC	Optical Supervisory Channel
FR	Functional Requirement	OTN	Optical Transport Network
Gbps	Gigabits per second	STM	Synchronous Transport Module
JITC	Joint Interoperability Test Command	SUT	System Under Test
LAN	Local Area Network	UCR	Unified Capabilities Requirements
LoC	Letters of Compliance	WAN	Wide Area Network
OC	Optical Carrier		
ODU	Optical Channel Data Unit		

11.2 Capability Requirements (CR) and Functional Requirements (FR). Table 2-8 lists the SUT's CR/FR status. The detailed CR/FR requirements are provided in Table 3-1 of the System Functional and Capability Requirements (Enclosure 3).

Table 2-8. SUT Capability Requirements and Functional Requirements Status

CR/FR ID	Capability/Function	Applicability (See note 1.)	UCR Reference	Status	Remarks																								
Requirements Applicable to all OTS Elements																													
1	Overall Requirements	Required	5.5.3.2.2.1	Partially Met	See note 2.																								
	Performance Requirements	Required	5.5.3.2.2.2	Met																									
	Reliability and Quality Assurance	Required	5.5.3.2.2.2.1	Met																									
	Common Physical Design Requirements	Required	5.5.3.2.2.3	Met																									
	Protection and Restoration	Required	5.5.3.2.2.4	Partially Met	See note 3.																								
Optical Amplifier Requirements																													
2	OLA Physical Design Requirements	Required	5.5.3.2.3.1	Met																									
Muxponder Requirements																													
3	Muxponder	Required	5.5.3.2.4	Met																									
Transponder Requirements																													
4	Transponder	Required	5.5.3.2.5	Met																									
	Interface Requirements	Required	5.5.3.2.5.1	Partially Met	See notes 4 and 5.																								
ROADM Requirements																													
5	ROADM Requirements	Required	5.5.3.2.6	Met																									
	ROADM Specific Physical Design Requirements	Required	5.5.3.2.6.1	Met																									
Requirements Common to Transponder and ROADM																													
6	Framed Formats	Required	5.5.3.2.7.1	Met																									
	Unframed Formats	Required	5.5.3.2.7.2	Met																									
Optical Supervisory Channel Requirements																													
7	Optical Supervisory Channel	Required	5.5.3.2.8	Met																									
OTS Standards Compliance Requirements																													
8	OTS Standards Compliance	Required	5.5.3.2.9	Met																									
<p>NOTES:</p> <p>1. Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in enclosure 2.</p> <p>2. The SUT only supports 40 wavelengths not the 80 wavelengths specified by the UCR. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement 80 wavelengths.</p> <p>3. Quad 10 Gigabit Module QMC1, 40 Gigabit Regen Module QRC1, and 10 Gigabit Regen Module RGC1 did not meet the 50-millisecond switch time requirement. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement any 40 Gigabit configurations.</p> <p>4. The SUT does not supports STM-16 and 100 Gigabit interface. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement STM-16 and 100 Gigabit interface.</p> <p>5. The SUT met all the UCR OTN interface requirements based on vendor's LoC.</p> <p>LEGEND:</p> <table> <tr> <td>CR</td> <td>Capability Requirements</td> <td>OTS</td> <td>Optical Transport System</td> </tr> <tr> <td>FR</td> <td>Functional Requirement</td> <td>ROADM</td> <td>Reconfigurable Optical Add Drop Multiplexer</td> </tr> <tr> <td>ID</td> <td>Identification</td> <td>STM</td> <td>Synchronous Transport Module</td> </tr> <tr> <td>LoC</td> <td>Letter of Compliance</td> <td>SUT</td> <td>System Under Test</td> </tr> <tr> <td>OLA</td> <td>Optical Line Amplifier</td> <td>UCR</td> <td>Unified Capabilities Requirements</td> </tr> <tr> <td>OTN</td> <td>Optical Transport Network</td> <td></td> <td></td> </tr> </table>						CR	Capability Requirements	OTS	Optical Transport System	FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexer	ID	Identification	STM	Synchronous Transport Module	LoC	Letter of Compliance	SUT	System Under Test	OLA	Optical Line Amplifier	UCR	Unified Capabilities Requirements	OTN	Optical Transport Network		
CR	Capability Requirements	OTS	Optical Transport System																										
FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexer																										
ID	Identification	STM	Synchronous Transport Module																										
LoC	Letter of Compliance	SUT	System Under Test																										
OLA	Optical Line Amplifier	UCR	Unified Capabilities Requirements																										
OTN	Optical Transport Network																												

a. Requirements Applicable to all OTS Elements

(1) Overall Requirements. IAW UCR 2008 Change 1, Section 5.5.3.2.2.1, an OTS must provide generally accepted commercial requirements. The SUT met all the UCR requirements, verified via combination of interoperability testing and a vendor submitted Letter of Compliance (LoC), with the following exceptions. The SUT provides

40 grid wavelengths not 80 as specified. The Program Manager has stipulated that this test discrepancy report (TDR) has a minor operational impact because the DISN currently only implements up to 40 wavelengths.

(2) Performance Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.2.2 the SUT must meet performance requirements for: jitter, data rates, deterioration, reliability, and quality assurance. The SUT met all UCR requirements verified via combination of interoperability testing and a vendor submitted LoC.

(3) Reliability and Quality Assurance. IAW UCR 2008 Change 1 Section 5.5.3.2.2.2.1 the SUT must meet Reliability and Quality Assurance requirements. Based on vendor's LoC.

(4) Common Physical Design Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.2.3 the SUT must meet requirements for common physical design. These requirements were verified via combination of interoperability testing and a vendor submitted LoC.

(5) Protection and Restoration. IAW UCR 2008 Change 1, Section 5.5.3.2.2.4 the SUT must provide 1+1 wavelength protection and restoration. The SUT met the UCR requirements as verified via combination of interoperability testing and a vendor submitted LoC, except SUT's Quad 10 Gigabit Module QMC1, 40 Gigabit Regen Module QRC1, and 10 Gigabit Regen Module RGC1 did not meet the 50-millisecond switch time requirement. The Program Manager adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement any 40 Gigabit configurations.

b. Optical Amplifier Requirements

(1) Optical Amplifier. IAW UCR 2008 Change 1 Section 5.5.3.2.3, the SUT must meet optical amplifier requirements. The SUT met all requirements as verified via combination of interoperability testing and a vendor submitted LoC.

(2) OLA Physical Design Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.3.1, the SUT must meet OLA physical design requirements. The SUT met all requirements as verified via combination of interoperability testing and a vendor submitted LoC.

c. Muxponder Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.4, the SUT must meet muxponder requirements. The SUT met all requirements as verified via combination of interoperability testing and a vendor submitted LoC.

d. Transponder Requirements

(1) Transponder. IAW UCR 2008 Change 1 Section 5.5.3.2.5, the SUT must meet all transponder requirements specified. The SUT met all requirements as verified via combination of interoperability testing and a vendor submitted LoC.

(2) Interface Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.5.1, the SUT must meet applicable interface requirements. The SUT interface status is provided in Table 2-7.

e. Reconfigurable Optical Add Drop Multiplexer (ROADM) Requirements

(1) ROADM. IAW UCR 2008 Change 1 Section 5.5.3.2.6, the SUT must meet all the specified ROADM requirements. The SUT does not support multicasting. This has a minor operational impact because, in an operational environment, multicasting may be performed on the IP layer until optical multicasting is available.

(2) ROADM Specific Physical Design Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.6.1, the SUT must meet applicable ROADM requirements. The SUT met all ROADM requirements as verified via combination of interoperability testing and a vendor submitted LoC.

f. Requirements Common to Transponder and ROADM

(1) Framed Formats. IAW UCR 2008 Change 1 Section 5.5.3.2.7.1, the SUT must support applicable framed formats. The SUT met the UCR requirements as verified via combination of interoperability testing and a vendor submitted LoC.

(2) Unframed Formats. IAW UCR 2008 Change 1 Section 5.5.3.2.7.2, the SUT must meet the unframed format requirements. The SUT met the corresponding UCR requirements verified via combination of interoperability testing and a vendor submitted LoC.

g. Optical Supervisory Channel Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.8, the SUT must meet the specified OSC requirements. The SUT met all requirements as verified via combination of interoperability testing and a vendor submitted LoC.

h. OTS Standards Compliance Requirements. IAW UCR 2008 Change 1 Section 5.5.3.2.9, the SUT must comply with the specified OTS standards. The SUT met the requirements as verified via vendor submitted LoC.

11.3 Information Assurance. The IA Assessment Report is published separately.

11.4 Other. None.

12. TEST AND ANALYSIS REPORT. IAW the Program Manager's request, JITC did not prepare a detailed test report. JITC distributes interoperability information via the JITC Electronic Report Distribution system, which uses Non-secure Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program, which .mil/gov users can access on the NIPRNet at <https://stp.fhu.disa.mil>. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool at <http://jit.fhu.disa.mil> (NIPRNet). Information related to Defense Switched Network testing is on the Telecom Switched Services Interoperability website at <http://jitc.fhu.disa.mil/tssi>.

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SYSTEM FUNCTIONAL AND CAPABILITY REQUIREMENTS

The Optical Transport System (OTS) have required and conditional features and capabilities that are established by the Unified Capabilities Requirements (UCR). The System Under Test (SUT) need not provide conditional requirements. If they are provided, they must function according to the specified requirements. The detailed Functional requirements (FR) and Capability Requirements for NEs are listed in Table 3-1. Detailed Information Assurance (IA) requirements are included in Reference (e) and are not listed below.

Table 3-1. OTS Capability/Functional Requirements Table

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
	5.5.3.2.2.1 Overall Requirements		
1	The OTS family of equipment shall be currently available, commercial-off-the-shelf (COTS) equipment.	5.5.3.2.2.1 (1)	R
2	The OTS shall support a minimum of 80 ITU-T G.694.1 grid wavelengths per line-side optical fiber.	5.5.3.2.2.1 (2)	R
3	The OTS shall support a minimum of 160 ITU-T G.694.1 grid wavelengths per line-side optical fiber	5.5.3.2.2.1 (3)	C
4	The OTS shall support mixed bit rate signals: 2.5 Gbps, 10 Gbps, and 40 Gbps.	5.5.3.2.2.1 (4)	R
5	The OTS shall support mixed bit rate signals: 2.5 Gbps, 10 Gbps, 40 Gbps, and 100 Gbps.	5.5.3.2.2.1 (5)	C
6	The OTS shall utilize the ITU-T specified Optical Supervisory Channel (OSC) for in-band management communication.	5.5.3.2.2.1 (6)	R
7	The OTS shall support all specified wavelengths for all specified bit rate and signal format.	5.5.3.2.2.1 (7)	R
8	The OTS shall support at least SSMF (ITU-T G.652), ELEAF, TW-RS, and TW-C (ITU-T G.655).	5.5.3.2.2.1 (8)	R
9	The OTS shall support the ability of 80, 40G wavelengths to traverse a minimum of five ROADM using fibers specified above for a minimum reach of 1,500 km without regeneration (O-E-O conversion) at BER less than 1×10^{-15} .	5.5.3.2.2.1 (9)	R
10	The OTS shall support the ability of 80, 40G wavelengths to traverse a minimum of five ROADM using fibers specified above for a minimum reach of 1,500 km without regeneration (O-E-O conversion) at BER less than 1×10^{-15} .	5.5.3.2.2.1 (10)	R
11	The OTS shall support the ability of 80, 100G wavelengths to traverse a minimum of five ROADM using fibers specified above for a minimum reach of 1,200 km without regeneration (O-E-O conversion) at BER less than 1×10^{-15} .	5.5.3.2.2.1 (11)	R
12	The OTS shall support span length up to 150 km and span loss up to 50 dB. The reach shall not be limited by optical supervisory channel performance.	5.5.3.2.2.1 (12)	R
13	The OTS shall allow the remote configuration of wavelengths added or dropped from the system.	5.5.3.2.2.1 (13)	R
14	Client interfaces available on the OTS shall meet the generally accepted standards or specifications for the interface (e.g., OC-192) Telcordia Technologies GR-253 standards, Synchronous Transport Module (STM)-16 and STM-64 International Telecommunications Union (ITU)-T G.707 standards, and Gigabit Ethernet (GE) and 10 GE IEEE 802.3 standards).	5.5.3.2.2.1 (14)	R
15	The OTS shall support remote shelf location with up to 6 dB optical power budget between terminal and remote locations.	5.5.3.2.2.1 (15)	R
16	The OTS shall support universal (or single part code) MUX/DEMUX circuit-packs at all Terminals and ROADM nodes.	5.5.3.2.2.1 (16)	R
17	The OTS shall enable pre- and post- dispersion compensation options.	5.5.3.2.2.1 (17)	R
18	The OTS T&S requirements are defined in Section 5.5.4.2.3, General DISN NE Requirements, and Section 5.5.4.2.4, Optical Transport System.	5.5.3.2.2.1 (18)	
	5.5.3.2.2.2 Performance Requirements		
1	Jitter tolerance shall comply with Telcordia Technologies GR-253 Type II and ITU-T G.958.	5.5.3.2.2.2 (1)	R
2	Jitter transfer shall comply with Telcordia Technologies GR-253 and ITU-T G.958.	5.5.3.2.2.2 (2)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
3	In a single vendor environment, a wavelength shall traverse up to at least 20 transponders before termination of the signals is required at a terminal site. This shall be true for all data rates specified.	5.5.3.2.2.2 (3)	R
4	The OTS shall tolerate a persistent input channel signal timing deviation of at least +/- 20 ppm. This implies that the OTS must (1) operate properly in normal condition (i.e., without alarms) when any one or all of the tributaries have long-term frequency offsets of up to +/- 20 ppm and (2) maintain the system performance objectives for concatenated OTS systems.	5.5.3.2.2.2 (4)	R
5	When a signal passes through concatenated OTS sections, the output jitter shall not exceed the network interface limits of ITU-T G.825.	5.5.3.2.2.2 (5)	R
6	When one or more channels (up to 90 percent) fail or are removed (either instantaneously or sequentially), the remaining channels shall not experience increasing bit errors or loss of operating margin. In addition, when failed channels are restored or new channels are added, the existing channels shall not experience any transient or long-term performance deterioration.	5.5.3.2.2.2 (6)	R
7	Maximum uncompensated PMD the system can tolerate at 40/100 Gbps shall not exceed that tolerated at 10 Gbps.	5.5.3.2.2.2 (7)	R
5.5.3.2.2.2.1 Reliability and Quality Assurance			
1	The OTS equipment shall meet the following quality program requirements, unless specifically overridden or modified by another requirement in this document: <ul style="list-style-type: none"> • Telcordia Technologies GR-282-CORE, Software Reliability and Quality Acceptance Criteria • Telcordia Technologies GR-2911-CORE, Software Inventory for Network Element Software Management • Telcordia Technologies TR-NWT-000179, Software Quality Program Generic Requirements • Telcordia Technologies TR-NWT-000418, Generic Reliability Assurance for Fiber Optic Transport Systems • Telcordia Technologies SR-NWT-002419, Software Architecture Review Checklists 	5.5.3.2.2.2.1 (1)	R
2	A list shall be available of country of origin of the critical components as well as final assembly location of the system.	5.5.3.2.2.2.1 (2)	R
5.5.3.2.2.3 Common Physical Design Requirements			
1	Each OTS element shall meet requirements addressed in this document and shall have met European Community (EC) or Pacific (PAC) Host Nation approvals required for foreign countries. Provide information on the countries that the equipment is currently approved, including equipment part numbers and other applicable documentation.	5.5.3.2.2.3 (1)	R
2	The vendor shall have a program underway to obtain approvals and permits for connection and operation of the equipment to the public networks in the EC and PAC areas. A list of countries where such approval has been obtained or is actively being worked toward approval is also required. (Note that this list will change with time.)	5.5.3.2.2.3 (2)	R
3	Each network element shall meet requirements addressed in this section and shall be compliant, at a minimum, without future hardware and/or memory upgrades or replacements.	5.5.3.2.2.3 (3)	R
4	Equipment racks' weight shall be within generally acceptable standards defined for raised floor application.	5.5.3.2.2.3 (4)	R
5	Equipment racks shall allow cable installation above and below each rack.	5.5.3.2.2.3 (5)	R
6	Each OTS element shall be able to receive all types of cables from the top or bottom of the bay/cabinets. When receiving from the bottom, it shall be able to accommodate a raised floor environment.	5.5.3.2.2.3 (6)	R
7	All inter-bay cabling shall be routed above and below each rack allowing various different cable lengths up to 100 m. If the equipment cannot support 100 m, the vendor shall state the maximum cable length supported.	5.5.3.2.2.3 (7)	R
8	Within an OTS element, all intra-system cabling shall maximize separation of redundant cables and fibers (i.e., working/protection, east/west, timing cables, switch cables, etc.).	5.5.3.2.2.3 (8)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
9	All working signal cables shall be routed on separate physical paths from the protection cables within the system. Between systems, all separations shall be maintained. All inter-system connections shall be able to support a minimum distance of 100m.	5.5.3.2.2.3 (9)	R
10	A and B power cables shall have physically diverse routing within the bay/cabinet.	5.5.3.2.2.3 (10)	R
11	Current drain information shall be provided to outline current draws in both normal and worst case voltage scenarios. (The latter information shall also address impacts of failed feeds and temperature where variable speed fans or other factors make such considerations appropriate). When multiple configurations are possible because of card variety, test data on several "generic" configurations shall be provided with a table of power numbers to help the user interpolate the approximate values of other configurations.	5.5.3.2.2.3 (11)	R
12	Each OTS element/shelf/circuit pack, whichever is the smallest independent load device of the OTS element, shall obtain power from two completely independent power units. Furthermore, the return path from the power units shall remain completely independent (Telcordia Technologies TR-NWT-000295). If one of the power units fails, an alarm shall be generated and the load shall be carried by the other unit without manual intervention and without interruption of service or functionality. The other power unit shall support the operation of the element/shelf/circuit pack until the problem with the faulty unit is corrected.	5.5.3.2.2.3 (12)	R
13	All OTS elements shall conform to the spatial and environmental criteria specified in Telcordia Technologies FR 796 and Telcordia Technologies GR-63-CORE.	5.5.3.2.2.3 (13)	R
14	All OTS elements, along with its power distribution panel and all associated/ancillary hardware, shall be capable of being mounted in standard EIA 310C 23" inches relay rack, 84" in height.	5.5.3.2.2.3 (14)	R
15	All OTS elements shall be capable of being operated and maintained with access only to the front of the unit.	5.5.3.2.2.3 (15)	R
16	All OTS elements shall be capable of being mounted in a back-to-back arrangement or directly against a building wall	5.5.3.2.2.3 (16)	R
17	All OTS elements, along with its power distribution panel and all associated/ancillary hardware, shall be capable of being mounted in standard EIA 310C 23" relay rack, 78" in height.	5.5.3.2.2.3 (17)	R
18	All OTS elements, along with its power distribution panel and all associated/ancillary hardware, shall be capable of being mounted in standard EIA 19" relay rack, 78" in height.	5.5.3.2.2.3 (18)	R
19	All OTS elements, along with its power distribution panel and all associated/ancillary hardware, shall be capable of being mounted in X-Mark/CDT Cabinets, part number XSL78-4-1S0002, size 78" x 23" x 30".	5.5.3.2.2.3 (19)	R
20	All OTS elements shall demonstrate an operational availability of all functions and services of 99.9997 percent.	5.5.3.2.2.3 (20)	R
21	All OTS elements shall comply with the earthquake, office vibration, and transportation vibration criteria specified in Telcordia Technologies GR-63, section 4.4.	5.5.3.2.2.3 (21)	R
22	All OTS elements shall be fully Network Equipment Building System (NEBS), Level 3 compliant.	5.5.3.2.2.3 (22)	R
23	All OTS elements shall meet the environmental conditions described in Telcordia Technologies GR-63-CORE.	5.5.3.2.2.3 (23)	R
24	All OTS elements shall meet the environmental conditions described in ETSI ETS-300-019.	5.5.3.2.2.3 (24)	R
25	All OTS elements shall be designed to operate in a communication equipment environment, adjacent to or in the vicinity of others types of equipment which may include digital radio equipment, fiber optic terminal equipment, FDM analog microwave, VHF/UHF base stations, satellite ground terminals, transfer trip and power line carrier equipment, and telephone signaling equipment.	5.5.3.2.2.3 (25)	R
26	All OTS elements shall meet the EMC/EMI requirements defined in: Telcordia Technologies GR-1089-CORE Electromagnetic Compatibility (EMC) and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.	5.5.3.2.2.3 (26)	R
27	All OTS elements shall meet the EMC/EMI requirements defined in FCC Part 15 Class A.	5.5.3.2.2.3 (27)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
28	All OTS elements shall meet the EMC/EMI requirements defined in ETS EN 50082.	5.5.3.2.2.3 (28)	R
29	All OTS elements shall meet the EMC/EMI requirements defined in ETS EN 55022 Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement.	5.5.3.2.2.3 (29)	R
30	All OTS elements shall meet the EMC/EMI requirements defined in ETS EN 300-386 EMC and Radio Spectrum Matters (ERM); Telecommunication OTS element; EMC Requirements.	5.5.3.2.2.3 (30)	R
31	All OTS elements shall be designed to operate continuously in the following environment ranges without degradation. Temperature: 0 to +50°C, Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.3 (31)	R
32	All OTS elements shall be designed to be operational after transportation and/or storage in the following environment ranges: Temperature: -40 to +70°C, Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.3 (32)	R
33	All OTS elements shall be designed to operate continuously in the following environment range without degradation. Altitude: -100 to 15,000 feet AMSL.	5.5.3.2.2.3 (33)	R
34	All OTS elements shall be designed to be operational after transportation and/or storage in the following environment range: Transport Altitude: -100 feet to +40,000 feet AMSL.	5.5.3.2.2.3 (34)	R
35	All OTS elements shall adhere to NEBS level 3 compliance standards for acceptable voltage ranges, EMI, and ESD safety, and shall be operable using standard 48V DC power as well as having redundant isolated power input feeds. For certain sites, an alternative AC/DC rectifier may need to be supplied to power the system and shall be able to switch 110/220 V with redundant isolated power modules.	5.5.3.2.2.3 (35)	R
36	All OTS elements shall be operational throughout the battery voltage range of: -41.5 to -56 VDC.	5.5.3.2.2.3 (36)	R
37	All OTS elements shall not be damaged and recover to normal performance following application of the following maximum transient voltages for the duration's given (nominal voltage 48 VDC): 75 Vp-p for 1 msec, 60Vp-p for 500 msec.	5.5.3.2.2.3 (37)	R
38	All OTS elements in the transport layer primary OS interface shall provide the capability for reporting alarms of external equipment and general housekeeping alarms. A minimum of 16 user-defined alarms shall be provided, with the option to expand to 32 user-defined alarm points. Capability shall be provided for minimum of eight user-defined remote control points for external functions. This capability shall be provided by relays, not TTL.	5.5.3.2.2.3 (38)	R
39	The OTS shall support having all data cross connects stored locally and redundantly; and automatically restored without user intervention, in the case of failure, within a period of five minutes.	5.5.3.2.2.3 (39)	R
40	The OTS shall provide the capability to roll back to the previous operational version of software.	5.5.3.2.2.3 (40)	R
41	The OTS shall conform to memory administration, and system administration and security standards as documented. Telcordia Technologies GR-472 and GR-253.	5.5.3.2.2.3 (41)	R
42	All future software for the OTS shall interoperate with the previous deployed GIG-BE system operational software version/release.	5.5.3.2.2.3 (42)	R
43	The OTS shall support software upgrades that directly use or translate the previous version's configuration database.	5.5.3.2.2.3 (43)	R
44	The software of the OTS shall be designed and upgraded in a modular fashion so that an entire code does not have to be replaced when a portion is upgraded.	5.5.3.2.2.3 (44)	R
45	The OTS shall be designed with an accessible file system to allow for multiple versions of software, logs, and file manipulation/integrity checks to be performed prior to upgrading or downgrading software and/or firmware.	5.5.3.2.2.3 (45)	R
46	All equipment shall have been tested and register as compliant to the following Electrical Safety standards: UL-1950, EN60950, and IEC 60950.	5.5.3.2.2.3 (46)	R
5.5.3.2.2.4 Protection and Restoration			
1	OTS shall support 1+1 wavelength protection and restoration	5.5.3.2.2.4 (1)	R
2	The "Active" and "Standby" wavelengths shall be diversely routed.	5.5.3.2.2.4 (2)	R
5.5.3.2.3 Optical Amplifier			

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
1	The system shall support the use of an optical connector for connecting optical amplifier (OA) to the OSP fiber; Raman amplifiers may not be directly spliced to the transmission fiber and must be field-replaceable, without the need for special equipment.	5.5.3.2.3 (1)	R
2	The total optical power emitted from the OTS to be coupled into the fiber, shall not exceed the power limit of IEC Class 3B (+27dBm).	5.5.3.2.3 (2)	R
3	The OTS shall monitor and report on the operation of the Raman pumping lasers including power on, off, optical output power, operating current, and total ORL.	5.5.3.2.3 (3)	R
4	Once detecting the failure of Raman pumping lasers, the OTS shall generate an alarm, but shall not shut off the system.	5.5.3.2.3 (4)	R
5	The Raman pumping lasers shall automatically shut off if a fiber is broken or a connector disconnected in the span pumped by the Raman amplifier.	5.5.3.2.3 (5)	R
6	The OTS shall have an integrated power management algorithm, which invokes power monitoring and adjustment devices to compensate for power variations across the optical wavelengths.	5.5.3.2.3 (6)	R
7	The OLA system shall be able to balance individual wavelengths so that power output levels exhibit less than 0.5 dB variance from the mean output level without remote or direct intervention from a network operator.	5.5.3.2.3 (7)	R
8	When one or more channels fail or are removed, the remaining channels shall not experience increased bit errors or loss of operating margin.	5.5.3.2.3 (8)	R
9	When failed channels are restored or new channels are added, the existing channels shall not experience any transient or long-term performance deterioration.	5.5.3.2.3 (9)	R
10	The power management algorithm shall cause no interruptions in OSC communications at any time.	5.5.3.2.3 (10)	R
11	OSC signals shall experience no increased errors at any time up to EOL, including during wavelength provisioning or line equalization.	5.5.3.2.3 (11)	R
12	Amplifiers shall require less than 1 ms to return all wavelength power output levels to within 1 dB of pre-insertion/drop levels – transient suppression statistics shall be provided for OLA systems.	5.5.3.2.3 (12)	R
13	The OA shall maintain safe (Hazard level 1) system operation in the event of input signal loss or fiber cut.	5.5.3.2.3 (13)	R
14	Chromatic dispersion compensation shall be able to fully compensate a 150 km span for each fiber type, as specified in the fiber requirements section.	5.5.3.2.3 (14)	R
15	Chromatic dispersion compensation shall be provided for different fiber lengths in 10, 20, or 30 km increments, if the technique requires the compensation to be periodically dispersed.	5.5.3.2.3 (15)	R
16	The OTS shall enable pre- and post- dispersion compensation options.	5.5.3.2.3 (16)	R
17	A secured external monitor port is required at each OA. For devices that contain a full-featured internal Optical Spectrum Analyzer (OSA), an external monitor port shall still be required.	5.5.3.2.3 (17)	R
18	Internal OSA functionality shall support 25 GHz ITU grid spacing with minimum 5 percent wavelength accuracy.	5.5.3.2.3 (18)	C
19	Internal OSA functionality shall provide a minimum accuracy of 0.2 dB for each wavelength.	5.5.3.2.3 (19)	R
20	Internal OSAs shall provide sweep times of less than 1 second.	5.5.3.2.3 (20)	R
21	Internal OSAs shall provide the ability to display all wavelengths simultaneously.	5.5.3.2.3 (21)	R
22	Internal OSAs shall provide the ability to retrieve data to be stored at a remote storage site.	5.5.3.2.3 (22)	R
23	Internal OSAs shall provide the ability to view various calculated data such as gain tilt, output tilt, gain variation, gain difference, noise level, total received power, total launched power, etc.	5.5.3.2.3 (23)	R
24	Internal OSAs shall provide the ability to report Q factor (not critical).	5.5.3.2.3 (24)	R
25	Internal OSAs shall have the ability to show eye diagrams (not critical).	5.5.3.2.3 (25)	R
26	Internal OSAs shall have the ability to estimate Optical Signal to Noise Ratio (OSNR) for each wavelength.	5.5.3.2.3 (26)	R
27	All measurements made available at the internal OSA shall be available at the external OSA port (not critical).	5.5.3.2.3 (27)	R
	5.5.3.2.3.1 OLA Physical Design Requirements		

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
1	The OLA shall support hot swappable modular components, including but not limited to fans, amplifier modules, in-band/out-of-band management interfaces, power supplies, and control processor.	5.5.3.2.3.1 (1)	R
2	The OLA shall support redundant Fans management interfaces power supplies control processors	5.5.3.2.3.1 (2)	R
3	The OA shall be able to fit into either a 19" or a 23" rack with depth no greater than 30" and height no more than 84".	5.5.3.2.3.1 (3)	R
4	The OLA overall dimensions shall be no more than one 7.2-foot standard Telco rack for a full 80 wavelengths bi-directionally, or two racks for 160 wavelengths, including out-of-band management functions.	5.5.3.2.3.1 (4)	R
5	The OLA power consumption shall be kept below 2,000 watts for all equipment at an OLA site.	5.5.3.2.3.1 (5)	R
6	The vendor shall identify their OLA power and space requirements for all specified configurations.	5.5.3.2.3.1 (6)	R
5.5.3.2.4 Muxponder Requirements			
1	Transponders shall support a four-to-one muxponder (4-10G signals multiplexed into one 40G signal). If the vendor equipment supports this functionality, the equipment shall meet the requirements listed in this section (3.2.1.3).	5.5.3.2.4 (1)	R
2	The OTS shall support a 4:1 40G multiplexer (MUX). The 4:1 40G MUX shall receive four standards compliant OC-192/STM-64 signals, from one to four sources, and multiplex them onto a signal for transport over a 40G wavelength on the system.	5.5.3.2.4 (2)	R
3	The 4:1 40G MUX shall transmit a 40G channel in each of the operating bands specified by the vendor. The vendor shall indicate any excluded band.	5.5.3.2.4 (3)	R
4	The 4:1 40G MUX shall occupy no more physical space than an OC-192/STM-64 transmit/receive pack.	5.5.3.2.4 (4)	R
5	The 4:1 40G MUX shall transfer the OC-192/STM-64 signals through the system transparently.	5.5.3.2.4 (5)	R
6	The engineering rules for the 4:1 40G MUX configuration shall be the same as the standard OC-768/STM-256 configuration without the need to change any system components, including dispersion compensation.	5.5.3.2.4 (6)	R
7	The OC-192/STM-64 interface (i.e., SR, etc.) for a 4:1 40G MUX shall have identical compliance to all of the requirements for an OC-192/STM-64 interface to an OC-192/STM-64 standard transponder as specified in this document.	5.5.3.2.4 (7)	R
8	An OC-48/STM-64 through the OTS that is multiplexed and demultiplexed through the 4:1 10G MUX shall meet the same performance requirements as an OC-192/STM-64 signal through the OTS using OC-192/STM-64 transponders. Performance requirements include, but are not limited to BER, Errored Seconds (ES), Severely Errored Seconds (SES), and Availability.	5.5.3.2.4 (8)	R
9	An OC-192/STM-64 through multiple concatenated systems containing 4:1 10G MUX shall meet the same performance requirements as an OC-192/STM-64 signal through concatenated OTSs using OC-192/STM-64 transponders. The same number of concatenated 4:1 10G MUX shall be supported as the number of concatenated OC-192/STM-64 transponders. Performance requirements include, but are not limited to Jitter Generation and Tolerance.	5.5.3.2.4 (9)	R
10	The maximum number of 40G channels equipped with 4:1 40G MUX in an OTS must be equal to the maximum number of OC-768/STM-256 channels supported in an OTS.	5.5.3.2.4 (10)	R
11	The 4:1 10G MUX shall operate without degradation if less than four of the OC-192/STM-64s have a valid OC-192/STM-64 signal.	5.5.3.2.4 (11)	R
12	The loss of one or more provisioned OC-192/STM-64 inputs to a 4:1 10G MUX shall not affect the performance of any other provisioned OC-192/STM-64 on that multiplexed channel.	5.5.3.2.4 (12)	R
5.5.3.2.5 Transponder Requirements			
1	Transponders shall comply with the DWDM wavelength grid as specified in ITU-T G.694.1.	5.5.3.2.5 (1)	R
2	Transponders shall support tunable lasers, which are tunable over whole band.	5.5.3.2.5 (2)	R
3	All transponders shall support built-in self BER test function	5.5.3.2.5 (3)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
4	All transponders shall support local and remote loop-back capability on the line side for built-in self-BER test.	5.5.3.2.5 (4)	R
5	All transponders shall support total end-to-end (E2E) signal propagation delay (at transponder ingress to egress) reporting function.	5.5.3.2.5 (5)	C
6	All transponders shall support user selectable line side FEC (Forward Error Correction), i.e., no FEC, ITU-T G.709 compliant standard FEC, and enhanced FEC SFEC or EFEC modes.	5.5.3.2.5 (6)	R
7	Transponders shall support ITU-T G.709 specifications for OTN services.	5.5.3.2.5 (7)	R
8	Transponders shall support switching of framing protocols (OTN, SONET, 10GBE, etc.) without requiring downloading or switching firmware/software and physical removal of the transponder from the slot.	5.5.3.2.5 (8)	R
9	Transponders shall have non-intrusive SONET/SDH B1 monitoring capability	5.5.3.2.5 (9)	R
10	Transponder shall have integrated EDC (Electronic Dispersion Compensation) for all specified fiber types to support minimum un-regenerated reach of 2000 kms.	5.5.3.2.5 (10)	C
11	The vendor shall supply through-transponder(s) to eliminate unnecessary O/E conversions for wavelength regeneration at ROADMs, OXC, and regenerator sites.	5.5.3.2.5 (11)	R
12	The vendor shall provide a transponder to interface with 10/40/100Gbps unframed wavelength services.	5.5.3.2.5 (12)	R
13	A transponder shelf shall support all types of transponders, or a combination of them. No slot shall be bit-rate specific.	5.5.3.2.5 (13)	R
14	There shall be no human (manual) tuning or intervention (such as power or wavelength adjustment) involved after adding transponders.	5.5.3.2.5 (14)	R
15	A transponder shall support all wavelengths and required transmission rates with a minimum reach of 2000 kilometers without O-E-O regeneration on all specified fiber types (e.g., ITU-T G.652, G.655).	5.5.3.2.5 (15)	R
5.5.3.2.5.1 Interface Requirements			
1	Transponders shall support an OC-48/STM-16 interface.	5.5.3.2.5.1 (1)	R
2	Transponders shall support an OC192/STM64 interface.	5.5.3.2.5.1 (2)	R
3	Transponders shall support a GigE interface.	5.5.3.2.5.1 (3)	R
4	Transponders shall support a 10GigE WAN PHY interface.	5.5.3.2.5.1 (4)	R
5	Transponders shall support a 10GigE LAN PHY interface.	5.5.3.2.5.1 (5)	R
6	The transponders shall support OC768/STM256 interfaces.	5.5.3.2.5.1 (6)	R
7	The transponder shall support all OTN rates including ODU1/ODU2/ODU3 and 100Gbs in future.	5.5.3.2.5.1 (7)	R
8	The transponders shall support Short Reach (SR), Long Reach (LR-1, LR-2, LR-3), and Intermediate Reach (IR-1, IR-2), client interface types per Telcordia Technologies GR-253-CORE.	5.5.3.2.5.1 (8)	R
9	The transponders shall support client interfaces at 1310 and 1550 nm.	5.5.3.2.5.1 (9)	R
10	The transponders shall support client interface at 850 and 1310 nm for GigE signals.	5.5.3.2.5.1 (10)	R
5.5.3.2.6 ROADMs			
1	The ROADM shall be capable of supporting a minimum of eight network-side interfaces, perform both optical bypass, and add/drop functions.	5.5.3.2.6 (1)	R
2	The ROADM shall support direction-less wavelength routing.	5.5.3.2.6 (2)	R
3	The ROADM shall be capable of colorless wavelength routing.	5.5.3.2.6 (3)	R
4	The system shall support cascading of minimum eight ROADMs for a total un-regenerated reach of 2000 kms.	5.5.3.2.6 (4)	R
5	Any wavelength not explicitly dropped or added shall be passed through the ROADM.	5.5.3.2.6 (5)	R
6	It shall be possible to reuse wavelength at ROADM.	5.5.3.2.6 (6)	R
7	There shall be no restrictions on ADD/DROP and EXPRESS (pass through) wavelengths at ROADM site.	5.5.3.2.6 (7)	R
8	It shall be possible to add/drop, or pass express, any of the optical channels at an ROADM site in any order.	5.5.3.2.6 (8)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
9	If a wavelength is dropped at an ROADM site, then the same wavelength shall be able to be added at that site. However, there shall be no requirement that the wavelength that is dropped must be matched by a corresponding wavelength that is added, and vice versa, implying wavelength translation capability at the ROADM. At a ROADM it shall be possible to drop an incoming wavelength and not add a new corresponding outgoing wavelength including the following: a. Accepting a non-provisioned incoming wavelength and adding a new outgoing wavelength. b. Dropping an incoming wavelength and adding a new corresponding outgoing wavelength	5.5.3.2.6 (9)	R
10	The ROADM shall be capable of supporting dynamic wavelength selection without pre-cabling being required.	5.5.3.2.6 (10)	R
11	The ROADM shall be capable of dropping all wavelengths from each of eight line-side fiber connections to tributary side optics.	5.5.3.2.6 (11)	R
12	The ROADM shall be capable of adding all wavelengths to each of eight line-side fiber connections from tributary side optics	5.5.3.2.6 (12)	R
13	The ROADM shall be capable of dropping any specific wavelength, independent of other wavelengths to be dropped.	5.5.3.2.6 (13)	R
14	The ROADM shall be capable of adding any specific wavelength, independent of other wavelengths to be added.	5.5.3.2.6 (14)	R
15	The ROADM shall support wavelength hair-pinning capability.	5.5.3.2.6 (15)	R
16	The ROADM shall support wavelength regeneration, including wavelength conversion, using back-to-back transponders or through-transponders via hair pinning.	5.5.3.2.6 (16)	R
17	The activation of additional services on interfaces in the ROADM shall be non-service affecting to existing traffic and shall not cause any increase in bit-errors.	5.5.3.2.6 (17)	R
18	The deletion of active services on interfaces in the ROADM shall be non-service affecting to the remaining traffic and shall not cause any increase in bit-errors.	5.5.3.2.6 (18)	R
19	Hardware upgrades of the ROADM to support higher tributary interface density shall not disrupt operational traffic.	5.5.3.2.6 (19)	R
20	Hardware upgrades of the ROADM to support higher line interface density shall not disrupt operational traffic.	5.5.3.2.6 (20)	R
21	The ROADM shall provide latching capability. (Latching is the ability of the ROADM to maintain its current state in the event of power failure.)	5.5.3.2.6 (21)	R
22	The ROADM shall provide optical multicasting capability. (Multicasting is the ROADM's ability to allow one input wavelength to be duplicated on multiple outputs tributary and line ports).	5.5.3.2.6 (22)	R
23	The ROADM shall support dynamic per-wavelength power leveling.	5.5.3.2.6 (23)	R
24	The addition or deletion of a wavelength service on the ROADM shall not cause an increase in BER or data loss on other wavelengths.	5.5.3.2.6 (24)	R
25	The ROADM shall not incur increased bit errors associated with wavelength provisioning or line equalization.	5.5.3.2.6 (25)	R
26	The failure of an upstream line system shall not cause the ROADM to increase in BER or lose data on the remaining active wavelengths.	5.5.3.2.6 (26)	R
27	The OSNR (optical signal to noise ratio) penalty for any signal passing thru a ROADM shall be < 0.5 dB.	5.5.3.2.6 (27)	R
28	The system is required to automatically redirect working paths to available spare fibers/wavelengths in the event of a primary path failure. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (28)	R
29	The ROADM shall support 1+1 protection functionality with fully diverse routing. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (29)	R
30	The switching time for 1+1 protection shall be ≤ 50 ms. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (30)	R
31	The switching time for 1+1 protection shall be ≤ 20 ms. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (31)	R
32	The ROADM shall support redirection of light paths via the EMS/NMS.	5.5.3.2.6 (32)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
33	The ROADM shall support linear protection topologies. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (33)	R
34	The ROADM shall support ring protection topologies. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (34)	R
5.5.3.2.6.1 ROADM Specific Physical Design Requirements			
1	The vendor shall comply with all requirements listed in General Physical Requirements of this document. The vendor shall list all discrepancies.	5.5.3.2.6.1 (1)	R
2	The ROADM shall support hot swappable modular components, including but not limited to: Fans switch fabric interface ports power supplies control processor.	5.5.3.2.6.1 (2)	R
3	The ROADM shall support redundant: fans switching fabrics power supplies control processors.	5.5.3.2.6.1 (3)	R
4	The ROADM equipment shall be able to fit in either a 19" or a 23" rack with depth no greater than 32" and height no more than 84".	5.5.3.2.6.1 (4)	R
5	The fully configured ROADM (excluding the transponder shelves) shall not exceed two full 84" racks.	5.5.3.2.6.1 (5)	R
6	The fully configured ROADM shall not exceed one full 84" rack.	5.5.3.2.6.1 (6)	R
7	The ROADM shall not require contiguous rack locations.	5.5.3.2.6.1 (7)	R
8	The ROADM weight shall be such that the device can be mountable in a standard Telco™ rack or secure cabinet with standard rack screws and not require unusual hardware.	5.5.3.2.6.1 (8)	R
5.5.3.2.7 Requirements Common to Transponder and ROADM			
5.5.3.2.7.1 Framed Formats			
1	The OTS shall support the transport of the following SONET/SDH services: OC-192/STM-64, OC-48/STM-16, and OC-768/STM256.	5.5.3.2.7.1 (1)	R
2	The OTS shall support the transport of the following Ethernet services: GigE (via 10:1 Muxponder), 10GigE WAN PHY, and 10GigE LAN PHY.	5.5.3.2.7.1 (2)	R
3	The OTS shall support the transport of the following OTN services: OTU1, OTU2, and OTU3.	5.5.3.2.7.1 (3)	C
4	The OTS shall be transparent to the bit pattern of all optical channels (i.e., the OTS shall not modify the payload bit pattern of any signal that traverses it).	5.5.3.2.7.1 (4)	R
5	Framed wavelength services shall be supported for 2.5, 10, and 40 Gbps SONET/SDH and OTN transport (ITU-T G.709).	5.5.3.2.7.1 (5)	R
6	Framed wavelength services shall be supported for GigE/10 GigE signals, and signals formatted for OTN transport (ITU-T G.709).	5.5.3.2.7.1 (6)	R
7	Framed wavelength services shall be supported for 40 (ITU-T G.709) and 100 Gbps (STD TBD) signals.	5.5.3.2.7.1 (7)	R
8	The OTS shall support, in hardware and in software, the possibility to feed a specified ITU-T grid wavelength, with undefined framing, directly into the multiplexer through a "colored interface" that shall verify the wavelength and power levels (commonly known as ALIEN wavelength). Identify other characteristics of the tributary signal required to be known and monitored for proper OTS system operation with such tributary signals.	5.5.3.2.7.1 (8)	R
9	Alien wavelength" regeneration shall be supported.	5.5.3.2.7.1 (9)	R
5.5.3.2.7.2 Unframed Formats			
1	The OTS shall support unframed wavelength services.	5.5.3.2.7.2 (1)	R
2	The OTS shall support mixed framed service unframed wavelength service	5.5.3.2.7.2 (2)	R
5.5.3.2.8 Optical Supervisory Channel			
1	The OLA, ROADM, end terminal (ET) elements shall terminate/insert an Optical Supervisory Channel (OSC) with a wavelength that adheres to ITU-T specifications.	5.5.3.2.8 (1)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
2	The OLA, ROADM, and ET elements shall utilize the ITU-T specified OSC for out-of-band management communications.	5.5.3.2.8 (2)	R
3	The OLA, ROADM, and ET elements shall use the same OSC wavelength.	5.5.3.2.8 (3)	R
4	The internal diagnostics for OLA, ROADM, and ET elements shall report OSC failure.	5.5.3.2.8 (4)	R
5	It shall be possible to turn-up and sustain transmission between two nodes in the absence of an OSC.	5.5.3.2.8 (5)	R
6	The OLA, ROADM, and ET elements shall report any OSC channel input/output failure (via out-of-band DCN).	5.5.3.2.8 (6)	R
7	The OLA, ROADM, and ET elements shall report any OSC channel BER threshold violation.	5.5.3.2.8 (7)	R
8	The OLA, ROADM, and ET elements shall provide OSC interfaces that allow for interoperability with all adjacent equipment within the optical network (wavelength, modulation, protocol, etc) from the same vendor.	5.5.3.2.8 (8)	R
9	The OSC shall be able to operate error-free across 150 km of each specified fiber type with a span loss of 50 dB at the OSC frequency/wavelength. The span loss shall not be inclusive of the OSC insertion loss.	5.5.3.2.8 (9)	R
10	The OSC circuit-pack shall report optical span-loss between two adjacent nodes.	5.5.3.2.8 (10)	R
11	The OSC shall operate at 2 Mb/s or higher data rates.	5.5.3.2.8 (11)	R
12	Architecturally, the OSC shall be passively and optically separated from the transport optical signals immediately after input connection of the OTS.	5.5.3.2.8 (12)	R
5.5.3.2.9 OTS Standards Compliance Requirements			
1	ITU-T G.652, "Characteristics of a single-mode optical fiber and cable."	5.5.3.2.9 (1)	R
2	ITU-T G.655, "Characteristics of a non-zero dispersion-shifted single-mode optical fiber and cable."	5.5.3.2.9 (2)	R
3	ITU-T 694.1, "Spectral grids for WDM applications: DWDM frequency grid."	5.5.3.2.9 (3)	R
4	ITU-T G.709/Y.1331, "Network node interface for the optical transport network (OTN)."	5.5.3.2.9 (4)	R
5	ITU-T G.958, "Digital line systems based on the synchronous digital hierarchy for use on optical fiber cables." [Withdrawn]	5.5.3.2.9 (5)	R
6	ITU-T G.8251 (G.otnjit), "The control of jitter and wander within the optical transport network (OTN)."	5.5.3.2.9 (6)	R
7	Telcordia Technologies GR-63-CORE, Network Equipment-Building System (NEBS™) Generic Equipment Requirements.	5.5.3.2.9 (7)	R
8	Telcordia Technologies TR-NWT-000179, Quality Systems Generic Requirements for Software.	5.5.3.2.9 (8)	R
9	Telcordia Technologies GR-253-CORE, Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria.	5.5.3.2.9 (9)	R
10	Telcordia Technologies GR-282-CORE, Software Reliability and Quality Acceptance Criteria (SRQAC).	5.5.3.2.9 (10)	R
11	Telcordia Technologies TR-NWT-000295, Isolated Ground Planes: Definition and Application to Telephone Central Offices.	5.5.3.2.9 (11)	R
12	Telcordia Technologies NWT-000418, Reliability Assurance for Fiber Optic Systems.	5.5.3.2.9 (12)	R
13	Telcordia Technologies GR-472-CORE, Network Element Configuration Management.	5.5.3.2.9 (13)	R
14	Telcordia Technologies FR-796, Reliability and Quality Generic Requirements (RQGR).	5.5.3.2.9 (14)	R
15	Telcordia Technologies GR-1089-CORE, Electromagnetic Compatibility, and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.	5.5.3.2.9 (15)	R
16	Telcordia Technologies SR-NWT-002419, Software Architecture Review Checklists.	5.5.3.2.9 (16)	R
17	Telcordia Technologies GR-2911-CORE, Software Inventory for Network Element Software Management.	5.5.3.2.9 (17)	R
18	ETSI ETS 300 019, "Equipment Engineering (EE); Environmental Conditions and Environmental Tests for Telecommunications Equipment."	5.5.3.2.9 (18)	R
19	ETSI ETS EN 50022, "Specification for low voltage switchgear and control gear for industrial use."	5.5.3.2.9 (19)	R
20	ETSI EN 50082, "Electromagnetic compatibility. Generic immunity standard. Residential, commercial and light industry."	5.5.3.2.9 (20)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
21	ETSI EN 300 386, "Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; Electromagnetic Compatibility (EMC) requirements."	5.5.3.2.9 (21)	R
22	BS EN 60950-1 Information Technology Equipment – Safety – Part 1: General Requirements.	5.5.3.2.9 (22)	R
23	IEC 60950-1 Information Technology Equipment – Safety – Part 1: General Requirements.	5.5.3.2.9 (23)	R
24	CFR FCC Part 15, Class A.	5.5.3.2.9 (24)	R
25	NEBS, Level 3.	5.5.3.2.9 (25)	R
26	Underwriters Laboratories, Inc. UL-1950, Standard for Safety, Information Technology Equipment Including Electrical Business Equipment.	5.5.3.2.9 (26)	R
27	EIA 310C, 19-inch rack mounting equipment specification.	5.5.3.2.9 (27)	R

Table 3-1. OTS Capability/Functional Requirements Table (continued)

LEGEND:	
AC	Alternating Current
AMSL	Above Mean Sea Level
BER	Bit Error Rate
C	Conditional
CFR	Codified Federal Regulation
CH	Change
COTS	Commercial Off-The-Shelf
dB	decibel
DC	Direct Current
DCN	Data Communications Network
DEMUX	Demultiplex
DISN	Defense Information Systems Network
DWDM	Dense Wavelength Division Multiplexing
E2E	End to End
EC	European Community
EDC	Electronic Dispersion Compensation
EE	Equipment Engineering
EIA	Electronic Industries Alliance
ELEAF	Enhanced Large Effective Area Fiber
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMS	Element Management System
EN	Equipment Number
EOL	End of Life
ERM	Radio Spectrum Matters
ES	Errored Seconds
ESD	Electrostatic Discharge
ET	End Terminal
ETS	European Telecommunications Standard
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDM	Frequency-Division Multiplexing
FEC	Forward Error Correction
GBE	Gigabit Ethernet
Gbps	Gigabits Per Second
GHz	Gigahertz
GIG-BE	Global Information Grid-Bandwidth Expansion
GigE	Gigabit Ethernet
GR	Generic Requirement
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IR	Intermediate Reach
ITU-T	International Telecommunication Union- Telecommunication
km	kilometer
LAN	Local Area Network
LR	Long Reach
m	meter
msec	millisecond
MSPP	Multiservice Provisioning Platform
MUX	Multiplex
NE	Network Element
NEBS	Network Equipment-Building System
nm	nanometer
NMS	Network Management System
O/E	Optical/Electrical Converter
OA	Optical Amplifier
OC	Optical Carrier
ODU	Optical Channel Data Unit
ODXC	Optical Digital Cross Connect
O-E-O	Optical-Electronic-Optical
OLA	Optical Line Amplifier
ORL	Optical Return Loss
OS	Operating System
OSA	Optical Spectrum Analyzer
OSC	Optical Supervisory Channel
OSNR	Optical Signal to Noise Ratio
OSP	Open Shortest Path
OTN	Optical Transport Network
OTS	Optical Transport System
OTU	Optical Transport Unit
OXC	Optical Cross Connect
PAC	Pacific
PHY	Physical
PMD	Polarization Mode Dispersion
R	Required
Ref	Reference
ROADM	Reconfigurable Optical Add/Drop Multiplexer
RQGR	Reliability and Quality Generic Requirement
SDH	Synchronous Digital Hierarchy
SONET	Synchronous Optical Transport Network
SR	Short Reach
SRQAC	Software Reliability and Quality Acceptance Criteria
SSMF	Standard Single Mode Fiber
STD	Standard
STM	Synchronous Transport Module
TBD	To Be Determined
TTL	Transistor-Transistor Logic
UCR	Unified Capabilities Requirement
UHF	Ultra high frequency
UL	Underwriters Laboratory
V	Volt
VDC	Volt Direct Current
VHF	Very High Frequency
WAN	Wide Area Network
WDM	Wavelength Division Multiplexing

Table 3-2. Detail Description of DTR Changes and Corrections

Approved Units - TN 0915503		Comparable Units for Approval		Reason for Change	Description of Change
FNC Part Number	Description	FNC Part Number	Description		
FC9503LAM1	FW7500S Lambda Access Module	FC9682LAM7	FW7500 Lambda Access Module	Certify the FC9682LAM7 unit for use in the FLASHWAVE 7500 network element.	The FC9682LAM7 is comparable to the FC9503LAM1 that was tested and approved in Release 6.1.2 of the NE. They are both 16-channel cards, and only differ in size. The LAM1 was designed for the 19" shelf and the LAM7 was designed for the 23" shelf. Both are passive (non-powered) units.
FC9503LAS2	FW7500S Lambda Access Shelf for 19" shelf	FC9682SDL1	FW7500 Lambda Access Shelf for 19" shelf	Certify the FC9682SDL1 unit for use in the FLASHWAVE 7500 network element.	The FC9682SDL1 is comparable to the FC9503LAS2 that was tested and approved in Release 6.1.2 of the NE. Both of these are 19" shelves and only differ in capacity. The LAS2 houses quantity 2 16-channel cards and the SDL1 houses quantity 10 4-channel cards. Both are passive (non-powered) units.
FC9682SB13	FW7500 LS OLC-B (SR) 1541.35 - 1543.73	FC9682SB29	FW7500 LS OLC-B (SR) 1554.13 - 1556.55	Certify the FC9682SB29 unit for use in the FLASHWAVE 7500 network element.	The FC9682SB29 is comparable to the FC9682SB13 that was tested and approved in Release 6.1.2 of the NE. They are both short reach cards and only differ by which channel each covers.
		FC9682SB37	FW7500 LS OLC-B (SR) 1560.61 - 1563.05	Certify the FC9682SB37 unit for use in the FLASHWAVE 7500 network element.	The FC9682SB37 is comparable to the FC9682SB13 that was tested and approved in Release 6.1.2 of the NE. They are both short reach cards and only differ by which channel each covers.
FC9682SHP4	Enhanced NE shelf management unit	FC9682SHP3	NE shelf management unit	Certify the FC9682SHP3 unit for use in the FLASHWAVE 7500 network element.	The FC9682SHP3 is comparable to the FC9682SHP4 that was tested and approved in Release 6.1.2 of the NE. They use the same software and only differ in that the SHP4 has a higher memory capacity. The SHP3 has 640MB of SDRAM, 8MB Flash Memory, and 256MB Compact Flash Memory Card, and the SHP4 has 2GB of SDRAM, 32MB Flash Memory, and 1GB Compact Flash Memory Card.
FNC-7500-0061-010	FW7500 R6.1, Issue 01 Documentation CD	FNC-7500-0061-020	FW7500 R6.1, Issue 02 Documentation CD	Correct the FLASHWAVE 7500, R6.1.2 certification with this correct FNC-7500-0061-020 documentation CD part number.	The incorrect part number is listed in the current certification. This request simply corrects existing documentation to ensure the proper part number is referenced in the list of approved units.

Table 3-2. Detail Description of DTR Changes and Corrections (continued)

LEGEND:			
CD	Compact Disk	MB	Megabyte
DTR	Desktop Review	NE	Network Element
FNC	Fujitsu Network Communication	SUT	System Under Test
LAM	Lambda Access Module		