DEFENSE INFORMATION SYSTEMS AGENCY
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IN REPLY
REFER TO: Joint Interoperability Test Command (JTE) **10 Feb 11**

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Special Interoperability Test Certification of Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform with Software Release 7.2.0 Optical Transport System

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 Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform with Software Release 7.2.0, hereinafter referred to as the System Under Test (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. The 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) which addresses all new critical TDRs within 120 days of identification. Testing was conducted using OTS product requirements derived from the Unified Capabilities Requirements (UCR), Reference (c). The Ciena ActivSpan CN 4200 series includes additional models and capabilities not covered by this certification. No other configurations, features, or functions, except those cited within 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. This finding 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 Indian Head, Maryland test facility from December 2009 through April 2010 and completed review of the vendor's LoCs on 14 December 2010. DSAWG grants accreditation based on the security testing completed by DISA-led IA test teams that is published in a separate report, Reference (e). The DSAWG accreditation was granted on 4 November 2010. The JITC certifies

the Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform with Software Release 7.2.0 as meeting the UCR for OTS requirements. Enclosure 2 documents the test results and describes the test network and system configurations.

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 Capability/Functional requirements in UCR 2008 Change 1, Sections 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.
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.
OC-768/STM-256	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8	Certified	Met requirement based on vendor's LoC. (See note 1.)
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	Certified	Met requirement based on vendor's LoC. (See note 3.)
OSC	Yes	5.5.3.2.8	8	Certified	Met threshold CRs/FRs.

NOTES:
1. Based on vendor's LoC, the CN 4200 supports 40 Gbps channels; however, OC-768/STM-256 was not tested.
2. Based on vendor's LoC, the CN 4200 meets the corresponding UCR requirements. The JITC did not test the OTN rates including ODU1/ODU2/ODU3.
3. Based on vendor's LoC, the CN 4200 supports mixed bit rate signals including 100 Gbps. The JITC did not test the OTN 100 Gbps.

LEGEND:

CR	Capability Requirements	OSC	Optical Supervisory Channel
DS	Digital Signal	OTN	Optical Transport Network
FR	Functional Requirement	STM	Synchronous Transport Module
Gbps	Gigabits per second	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		

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	See note 3.
	Reliability and Quality Assurance	Required	5.5.3.2.2.2.1	Partially Met	See note 4.
	Common Physical Design Requirements	Required	5.5.3.2.2.3	Partially Met	See note 5.
	Protection and Restoration	Required	5.5.3.2.2.4	Met	See note 6.
2	**Optical Amplifier Requirements**				
	OLA Physical Design Requirements	Required	5.5.3.2.3.1	Partially Met	See note 7.
3	**Muxponder Requirements**				
	Muxponder	Required	5.5.3.2.4	Met	See note 8.
4	**Transponder Requirements**				
	Transponder	Required	5.5.3.2.5	Partially Met	See note 9.
	Interface Requirements	Required	5.5.3.2.5.1	Met	See note 10.
5	**Reconfigurable Optical Add Drop Multiplexor (ROADM) Requirements**				
	ROADM Requirements	Required	5.5.3.2.6	Partially Met	See note 11.
	ROADM Specific Physical Design Requirements	Required	5.5.3.2.6.1	Partially Met	See note 7.
6	**Requirements Common to Transponder and ROADM**				
	Framed Formats	Required	5.5.3.2.7.1	Met	
	Unframed Formats	Required	5.5.3.2.7.2	Met	See note 3.
7	**Optical Supervisory Channel Requirements**				
	Optical Supervisory Channel	Required	5.5.3.2.8	Partially Met	See note 12.
8	**OTS Standards Compliance Requirements**				
	OTS Standards Compliance	Required	5.5.3.2.9	Met	See note 3.

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 DISA PM adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement 80 wavelengths.
3. The SUT met the corresponding UCR requirements based on vendor's LoC.
4. Based on vendor's LoC, the SUT has not yet been certified to meet Telcordia Technologies GR-282-CORE, Software Reliability, and Quality Acceptance Criteria. The DISA PM adjudicated this test discrepancy as having a minor operational impact because no known outages have been reported on previous software versions.
5. Based on vendor's LoC, the SUT does not yet meet the EMC/EMI requirements defined in ETS EN 50082. The DISA PM adjudicated this test discrepancy as having a minor operational impact because no known issues exist with fielded systems.
6. This requirement was verified via vendor's submitted LoC. The SUT did not provide protection. Protect will have to be provided by a Transport Switch or router.
7. The SUT does not support redundant control processors (the SUT has a single control processor only). The DISA PM adjudicated this test discrepancy as having a minor operational impact because the control processor is just for communicating with the management network and pushing configurations to the other cards. The system and all services continue to run as normal during a control processor card failure/replacement.
8. This requirement was verified via vendor's submitted LoC. JITC did not test all the Muxponder capabilities.
9. The SUT does not support built-in self Bit Error Rate test. The DISA PM adjudicated this test discrepancy as having a minor operational impact because there are other ways to measure errors through the system.
10. This requirement was verified via JITC test and vendor's submitted LoC. The JITC did not test the interface OC-768/STM-256 and OTN rates including ODU1/ODU2/ODU3.
11. The SUT does not support multicasting. The DISA PM adjudicated this test discrepancy has a minor operational impact because in an operational environment multicasting may be performed on the IP layer until optical multicasting is available.
12. The SUT's OSC supports a span loss of up to only 35 dB not 50 dB as specified in the UCR. The DISA PM adjudicated this test discrepancy as having a minor operational impact because no fielding issues have been noted with span loss detection.

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

LEGEND:

CR	Capability Requirements	IP	Internet Protocol
dB	Decibel	LoC	Letter of Compliance
EMC	Electromagnetic Compatibility	OLA	Optical Line Amplifier
EMI	Electromagnetic Interference	OSC	Optical Supervisory Channel
ETS	Electromagnetic Telecommunication Standard	OTS	Optical Transport System
FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexor
GR	Generic Requirement	SUT	System Under Test
ID	Identification	UCR	Unified Capabilities Requirements

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 Ms. Fanny Lee-Linnick, commercial (301) 744-2731, or DSN 354-2731. Her e-mail address is Fanny.Lee-Linnick@disa.mil. The JITC mailing address is 3341 Strauss Avenue, Suite 236, Indian Head, Maryland 20640-5149. The SUT System tracking number is 0921701.

FOR THE COMMANDER:

3 Enclosures a/s

BRADLEY A. CLARK
Acting Chief
Battlespace Communications Portfolio

Distribution (electronic mail):
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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) Ciena Document, "Letter of Compliance," 21 July 2010
(e) Ciena Document, "Software Release Document, Software Release 7.1.0," 16 April 2010
(f) Ciena Document, "Software Release Document, software Release 7.2.0," 3 September 2010

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CERTIFICATION TESTING SUMMARY

1. SYSTEM TITLE. Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform with Software Release 7.2.0 Optical Transport System (OTS)

2. PROPONENTS. Defense Information Systems Agency (DISA) Network Services

3. PROGRAM MANAGER. Dr. Leon J. Nicely, Sr., Terrestrial Transport Lifecycle Management Manager, NS11, 5275 Leesburg Pike, Falls Church, Virginia 22042, e-mail: Leon.Nicely@disa.mil

4. TESTER. Joint Interoperability Test Command (JITC), Indian Head, Maryland

5. SYSTEM UNDER TEST (SUT) DESCRIPTION. The Defense Information Systems Network (DISN) OTS multiplexes optical signals from various sources (e.g., router, transport switch function, Channel Access Grooming) at the optical core layer. The OTS consists of the following components: Terminal, Reconfigurable Optical Add and Drop Multiplexer (ROADM), and Optical Line Amplifier (OLA). An Optical Supervisory Channel (OSC) runs between these components. The terminal is composed of two elements: the transponder and the muxponder. The Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform, hereinafter referred to as the SUT, is a Dense Wavelength Division Multiplexer with ROADM capabilities. The SUT is a 17-slot chassis capable of supporting multiple functions. The Ciena 4200 series also provide a 400 MC and 4200 chassis. These configurations are not addressed in this certification because of dissimilarities in the system's capabilities and performance. The SUT uses ROADM technology to allow control over the optical path that network operators use to provision transport services. The ROADM architecture enables networks to maximize available system bandwidth by adding dynamic reconfiguration options on each individual wavelength. The four key modules in the SUT are the Dynamic Wavelength Router (DWR), Optical Channel Monitor (OCM-8), Variable Gain (Rx) Amplifier (OAV-VS-U-C), and Fixed Gain (Tx) Amplifier (OAF-BC-B).

The DWR is a Dynamic Wavelength Router module capable of dropping and adding any of the wavelengths supported by the 44-channel CN 4200 RS. The DWR module is the primary wavelength routing component for the CN 4200 ROADM configuration. The DWR module is a two slot wide module that users can install in any slot other than slot 1 of the RS chassis. The DWR module is in the CN 4200 ROADM configurations and provides the following functions:

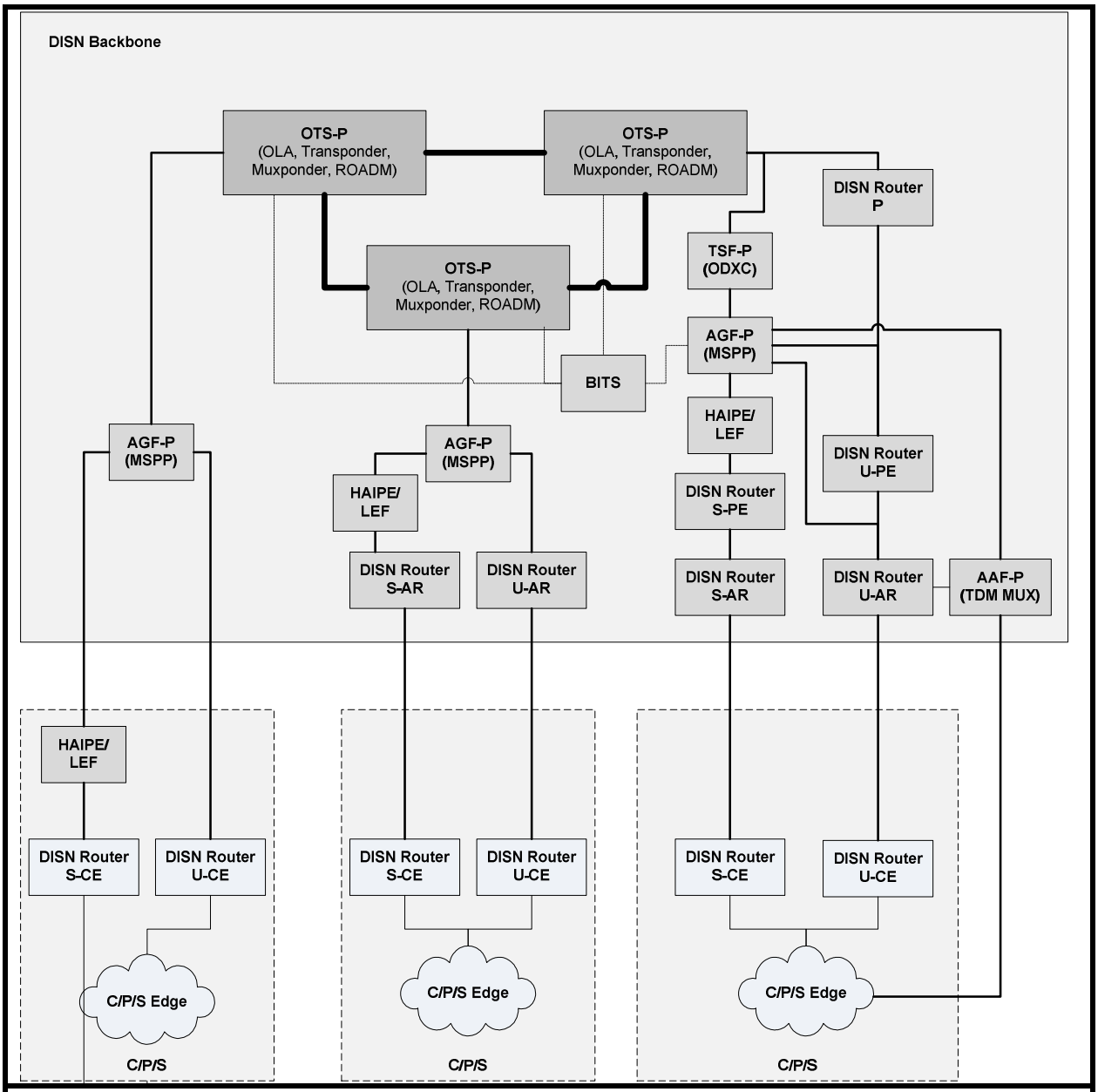
- Selection of from 1 to 9 wavelengths from the received network wavelength
- Automatic power management
- Provisioning (module level)
- Alarm and fault reporting
- Maintenance and Diagnostics

The OCM-8 is an Optical Channel Monitor module capable of monitoring the optical power levels of up to 44 different wavelengths on eight different inputs. The OCM-8 module is a single slot wide RS form-factor module that users can install in any slot other than slot 1 of the RS chassis. The OCM-8 module is in the CN 4200 ROADM configurations and provides the following functions:

- Simultaneously monitoring the optical power level of 44 channels (16 through 59) on any of eight ports
- Provisioning (module level)
- Alarm and fault reporting
- Maintenance and Diagnostics

The Variable Gain Amplifier Receive (Rx) and Fixed Gain Amplifier Transmit (Tx) use Ciena's SmartGain™ Technology. Using SmartGain technology, the CN 4200 fixed and variable gain Optical Amplifiers (OA) monitor the incoming signal power and automatically adjust the pump lasers to maintain consistent signal gain when the number of optical wavelength channels changes. This feature eliminates the need to reconfigure the amplifiers manually when channels are added, removed, or redirected through a network. SmartGain responds to optical load changes in less than 1 millisecond and enables the amplifiers to maintain their performance across the transport spectrum, even in the event of an optical fiber break. In such an event, the OA detects the drop in optical power at its input and adjusts the pump power to maintain the gain of the surviving channel. (Protected channels upstream of the fiber break undergo a protection switch.) Later, when the fiber continuity is regained and services are redirected to their former path, the OA again detects the change in optical power (an increase) and re-adjusts the amplifier pumps to preserve gain characteristics of the channels. (Reference: Ciena Technical Description, January 2010)

6. OPERATIONAL ARCHITECTURE. As defined in the Unified Capabilities Requirements (UCR), the Ciena 4200 RS ROADM is an 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 Synchronous Optical Transport Network (SONET), and client Synchronous Transport Module (STM) signals.



LEGEND:

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

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 Department of Defense 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 Section 5.5.3 of the UCR. 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	Partially 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	5.5.3.2.2.2.1		
	Common Physical Design Requirements	Required	5.5.3.2.2.3		
	Protection and Restoration	Required	5.5.3.2.2.4		

Table 2-2. OTS Capability Requirements and Functional Requirements (continued)

CR/FR ID	Capability/Function	Applicability (See note.)	UCR Reference	Criteria	Remarks
2	**Optical Amplifier Requirements**				
	OLA Physical Design Requirements	Required	5.5.3.2.3.1	Partially meet UCR OLA requirements. See table 3-1.	
3	**Muxponder Requirements**				
	Muxponder	Required	5.5.3.2.4	Partially meet UCR muxponder requirements. See table 3-1.	
4	**Transponder Requirements**				
	Transponder	Required	5.5.3.2.5	Partially meet UCR transponder requirements. See table 3-1.	
	Interface Requirements	Required	5.5.3.2.5.1		
5	**Reconfigurable Optical Add Drop Multiplexor (ROADM) Requirements**				
	ROADM Requirements	Required	5.5.3.2.6	Partially 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	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	Partially meet UCR OSC requirements. See table 3-1.	
8	**OTS Standards Compliance Requirements**				
	OTS Standards Compliance	Required	5.5.3.2.9	Meet UCR standards compliance requirements. See table 3-1.	

NOTE: Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in this table.

LEGEND:

CR	Capability Requirements	OSC	Optical Supervisory Channel
FR	Feature Requirements	OTS	Optical Transport System
ID	Identification	ROADM	Reconfigurable Optical Add Drop Multiplexor
OLA	Optical Line Amplifier	UCR	Unified Capabilities Requirements

7.3 Information Assurance. Table 2-3 lists the IA requirements for OTS products. The IA requirements were derived from the UCR Section 5.4, IA Requirements.

Table 2-3. OTS Products IA Requirements

Requirement	Critical (See note.)	UCR Reference
General Requirements	Yes	5.4.6.2
Authentication	Yes	5.4.6.2.1
Integrity	Yes	5.4.6.2.2
Confidentiality	Yes	5.4.6.2.3
Non-repudiation	Yes	5.4.6.2.4
Availability	Yes	5.4.6.2.5

NOTE: Not all IA requirements from the referenced UCR section apply. Detailed IA requirements are provided in the separately published IA report.

LEGEND:

IA	Information Assurance	UCR	Unified Capabilities Requirements
OTS	Optical Transport System		

7.4 Other. None.

8. TEST NETWORK DESCRIPTION. JITC conducted the CN 4200 RS testing at its Indian Head, Maryland Advanced Technology Testing Laboratory. Figure 2-2 illustrates the test configurations.

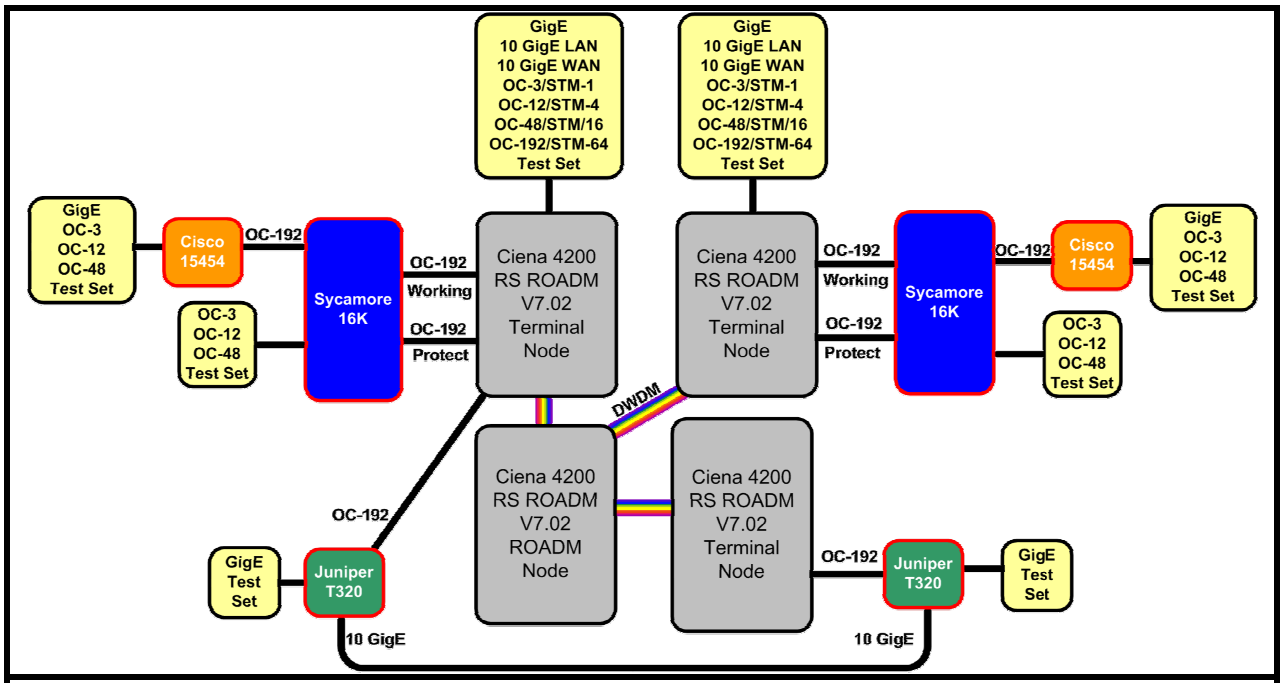


Figure 2-2. Ciena 4200 RS Test Bed Architecture

9. SYSTEM CONFIGURATIONS. Table 2-4 lists the tested software configuration for the Ciena equipment shown in Figure 2-2. The DISN Core Equipment used in Figure 2-2 is listed Table 2-5.

Table 2-4. Tested SUT Equipment

Platform	Software Release	Application/Function
Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform	7.2.0 (See note.)	OTS
Components		
Dynamic Wavelength Router (DWR)		
Optical Channel Monitor (OCM-8)		
Variable Gain (Rx) Amplifier (OAV-VS-U-C)		
Fixed Gain (Tx) Amplifier (OAF-BC-B)		

NOTE: JITC originally tested version 7.0.2. This version did not meet IA requirements. The vendor applied patches to meet IA requirements; the DSAWG approved software version was 7.2.0. JITC assessed the IO impact and determined that the new versions did not affect the IO certification. The IA report for this system provides additional information.

LEGEND:

DSAWG	Defense Information Assurance (IA)/Security Accreditation Working Group	OAV	
DWR	Dynamic Wavelength Router	OCM	Optical Channel Monitor
IA	Information Assurance	OTS	Optical Transport System
IO	Interoperability	Rx	Receive
JITC	Joint Interoperability Test Command	SUT	System under Test
OAF		Tx	Transmit
		VS	

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	6.11
		OC-48 Multilayer	
		1000 Base X	
Ixia	Traffic generator	10 Gig	5
		LM1000STX	
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 tested the Ciena products using the configuration depicted in Figure 2-2. The JITC used a combination of Letters of Compliance (LoC) and functional testing to verify requirements. The JITC's test lab had some limitations in its ability to verify the OC-768 interface and its ability to measure persistent input channel signal timing deviations. The limitation to verify the interface and offered performance poses a low risk to interoperability because the OC-768 interface is a requirement for future deployment and the persistent input channel signal timing capability is widely commercially offered and deployed worldwide.

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. In addition, the acceptance of security enhancement features in software release 7.2.0, all other new features and capabilities introduced in the software release 7.1.0 (Reference: Ciena "Software Release Document, Software Release 7.1.0", 16 April 2010, Page 5) and 7.2.0 (Reference: Ciena "Software Release Document, Software Release 7.2.0", 3 September 2010, page 7) listed in the following are not a part of the current testing:

a. Release 7.0.0 to 7.1.0 New Features.

(1) EM6 GbE (ETHP) and FCHP Support Aggregation.

(2) ESOM/EM6 Expanded Client Interoperability.

(3) Fault Propagation and Consequence Actions with Electrical SFPS.

(4) 2RS Provisioning Extensions.

(5) Quad-10T Forward Error Correction (FEC) Selection.

(6) Auto-Negotiation added for X9/X4 Modules.

b. Release 7.0.0 to 7.1.0 Enhancements/Improvements to Existing Features.

(1) Enhanced Protected Fiber Channel Operations.

(2) NDP High Byte Deprecation Enhancement.

c. Release 7.1.0 to 7.2.0 New Features

(1) ACPC Enhancement.

(2) ACPC Suspension Condition.

(3) G10/G10X Features and Enhancements. New features and enhancements for the G10/G10X include:

(a) Hitless EPL/EVPL Warm Reset.

(b) Layer 2 Cross-Connect Scaling.

(c) Increased Supported Size of Ethernet Virtual Connections (EVC) (or Layer 2 Cross-Connects) from 2.5G to 10G.

(d) Alarm Support.

(e) Layer 2 SNMP Trap Support.

(f) Bridging SNMP.

(g) Bridging/LAG Behavior on Controller Reset.

(h) IGMP Performance Improvement.

(i) Timeslot (TS) Compaction and Persistent timeslots allocation.

(j) Master Elections.

(k) Layer 1 Pre-provisioning Available for Packet Mode.

(l) L1/L2 Awareness.

(m) L1 PM Improvements (OTNCG ports).

(n) OTNCG L1 shaping (10/100/1000 Mbps) support to inter-operate with legacy client ports.

(4) Low Latency Modules and Low Latency MAN-OS, MAN-OAF and MANRaman as part of the product solution to minimize latency within the network OPS/OPS-2 Subnetwork Connection Protection (SNCP) forced switch priority.

(5) Process Health Monitoring Updates.

(6) QUAD-10T, ITU standard Generic Framing Protocol (GFP) mapping.

(7) ROADM Expansion to 8 Degrees.

(8) User interface enhancements.

(9) MIB Changes in R7.2.0.

d. Release 7.1.0 to 7.2.0 Enhancements/Improvements to Existing Features

(1) CLI Embedded Data Capture.

(2) System Initialization Improvements.

Therefore, these new features and capabilities in release 7.1.0 and 7.2.0 are not a part of this certification.

11.1 Interfaces. The SUT's interface status is provided in Table 2-7. In accordance with the UCR 2008 Change 1 requirements, the Ciena CN 4200 RS transports and restores traffic in a reliable, timely, and secure manner. The Ciena CN 4200 RS ROADM interoperates with other transport systems comprising the Department of Defense Global Information Grid. The Ciena CN 4200 RS 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.
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.
OC-768/STM-256	Yes	5.5.3.2.5.1	1, 2, 3, 4, 5, 6, and 8	Certified	Met requirement based on vendor's LoC. (See note 1.)

Table 2-7. SUT Interface Requirements Status (continued)

Interface	Critical	UCR Reference	Threshold CR/FR Requirements	Status	Remarks
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/ODU 3	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	Certified	Met requirement based on vendor's LoC (See note 3.)
OSC	Yes	5.5.3.2.8	8	Certified	Met threshold CRs/FRs.

NOTES:
1. Based on vendor's LoC, the CN 4200 supports 40 Gbps channels; however, OC-768/STM-256 was not tested.
2. Based on vendor's LoC, the CN 4200 meets the corresponding UCR requirements. The JITC did not test the OTN rates including ODU1/ODU2/ODU3.
3. Based on vendor's LoC, the CN 4200 supports mixed bit rate signals including 100 Gbps. The JITC did not test the OTN 100 Gbps.

LEGEND:

CR	Capability Requirements	OSC	Optical Supervisory Channel
DS	Digital Signal	OTN	Optical Transport Network
FR	Functional Requirement	STM	Synchronous Transport Module
Gbps	Gigabits per second	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). The SUT's CR/FR status is listed in Table 2-8. 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
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	See note 3.
	Reliability and Quality Assurance	Required	5.5.3.2.2.2.1	Partially Met	See note 4.
	Common Physical Design Requirements	Required	5.5.3.2.2.3	Partially Met	See note 5.
	Protection and Restoration	Required	5.5.3.2.2.4	Met	See note 6.
2	**Optical Amplifier Requirements**				
	OLA Physical Design Requirements	Required	5.5.3.2.3.1	Partially Met	See note 7.
3	**Muxponder Requirements**				
	Muxponder	Required	5.5.3.2.4	Met	See note 8.

Table 2-8. SUT Capability Requirements and Functional Requirements Status (continued)

CR/FR ID	Capability/Function	Applicability (See note 1.)	UCR Reference	Status	Remarks
4	**Transponder Requirements**				
	Transponder	Required	5.5.3.2.5	Partially Met	See note 9.
	Interface Requirements	Required	5.5.3.2.5.1	Met	See note 10.
5	**Reconfigurable Optical Add Drop Multiplexor (ROADM) Requirements**				
	ROADM Requirements	Required	5.5.3.2.6	Partially Met	See note 11.
	ROADM Specific Physical Design Requirements	Required	5.5.3.2.6.1	Partially Met	See note 7.
6	**Requirements Common to Transponder and ROADM**				
	Framed Formats	Required	5.5.3.2.7.1	Met	
	Unframed Formats	Required	5.5.3.2.7.2	Met	See note 3.
7	**Optical Supervisory Channel Requirements**				
	Optical Supervisory Channel	Required	5.5.3.2.8	Partially Met	See note 12.
8	**OTS Standards Compliance Requirements**				
	OTS Standards Compliance	Required	5.5.3.2.9	Met	See note 3.

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 DISA PM adjudicated this test discrepancy as having a minor operational impact because the current fielding does not implement 80 wavelengths. .
3. The SUT met the corresponding UCR requirements based on vendor's LoC.
4. Based on vendor's LoC, the SUT has not yet been certified to meet Telcordia Technologies GR-282-CORE, Software Reliability and Quality Acceptance Criteria. The DISA PM adjudicated this test discrepancy as having a minor operational impact because no known outages have been reported on previous software versions.
5. Based on vendor's LoC, the SUT does not yet meet the EMC/EMI requirements defined in ETS EN 50082. The DISA PM adjudicated this test discrepancy as having a minor operational impact because no known issues exist with fielded systems.
6. This requirement was verified via vendor's submitted LoC. The SUT did not provide protection. Protect will have to be provided by a Transport Switch or router.
7. The SUT does not support redundant control processors (the SUT has a single control processor only). The DISA PM adjudicated this test discrepancy as having a minor operational impact because the control processor is just for communicating with the management network and pushing configurations to the other cards. The system and all services continue to run as normal during a control processor card failure/replacement.
8. This requirement was verified via vendor's submitted LoC. JITC did not test all the muxponder capabilities.
9. The SUT does not support built-in self Bit Error Rate test. The DISA PM adjudicated this test discrepancy as having a minor operational impact because there are other ways to measure errors through the system.
10. This requirement was verified via JITC test and vendor's submitted LoC. The JITC did not test the interface OC-768/STM-256 and OTN rates including ODU1/ODU2/ODU3.
11. The SUT does not support multicasting. The DISA PM adjudicated this test discrepancy has a minor operational impact because in an operational environment multicasting may be performed on the IP layer until optical multicasting is available.
12. The SUT's OSC supports a span loss of up to only 35 dB not 50 dB as specified in the UCR. The DISA PM adjudicated this test discrepancy as having a minor operational impact because no fielding issues have been noted with span loss detection.
10. This requirement was verified via JITC test and vendor's submitted LoC. The JITC did not test the interface OC-768/STM-256 and OTN rates including ODU1/ODU2/ODU3.
11. The SUT does not support multicasting. The DISA PM adjudicated this test discrepancy has a minor operational impact because in an operational environment multicasting may be performed on the IP layer until optical multicasting is available.
12. The SUT's OSC supports a span loss of up to only 35 dB not 50 dB as specified in the UCR. The DISA PM adjudicated this test discrepancy as having a minor operational impact because no fielding issues have been noted with span loss detection.

LEGEND:

CR	Capability Requirements	IP	Internet Protocol
dB	Decibel	LoC	Letter of Compliance
EMC	Electromagnetic Compatibility	OLA	Optical Line Amplifier
EMI	Electromagnetic Interference	OSC	Optical Supervisory Channel
ETS	Electromagnetic Telecommunication Standard	OTS	Optical Transport System
FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexor
GR	Generic Requirement	SUT	System Under Test
ID	Identification	UCR	Unified Capabilities Requirements

a. Requirements Applicable to all OTS Elements

(1) Overall Requirements. In accordance with (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 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 DISA NS 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 as verified via 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, the SUT has not yet been certified to meet Telcordia Technologies GR-282-CORE, Software Reliability and Quality Acceptance Criteria.

(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 vendor submitted LoC. Based on vendor's LoC, the SUT does not yet meet the EMC/EMI requirements defined in ETS EN 50082.

(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 vendor submitted LoC.

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 interoperability test and 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 vendor submitted LoC. The SUT does not support redundant control processors (the SUT has a single control processor only). This has been adjudicated as a minor operational impact because the control processor is just for communicating with the management network and pushing configurations to the other cards. The system and all services continue to run as normal during a control processor card failure/replacement.

(3) The control microprocessor is not the main microprocessor and will not affect day-today operation if it fails.

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 vendor submitted LoC.

d. Transponder Requirements

(1) Transponder. IAW UCR 2008 Change 1 Section 5.5.3.2.5, the SUT must met all transponder requirements specified. The SUT does not support built-in self Bit Error Rate test. This is deemed to have a minor operational impact since there are other ways to measure error functionality through the system.

(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 Multiplexor (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 with the exception that the SUT does not support redundant control processors (the SUT has a single control processor only). This has been adjudicated as a minor operational impact because the microprocessor is not the main microprocessor and will not affect day-today operation if it fails.

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 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 based on vendor's 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's OSC supports a span loss of up to 35 dB only. The PM adjudicated this as having a minor operational impact.

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 as a separate report.

12. TEST AND ANALYSIS REPORT. In accordance with 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 1x 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 1x 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 1x 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: • 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" × 23" × 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 ROADM, 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 ROADM		
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

LEGEND:

BER	Bit Error Rate	msec	millisecond
dB	Decibel	MSPP	Multiservice Provisioning Platform
C	Conditional	NE	Network Element
DC	Direct Current	NEBS	Network Equipment-Building System
DCN	Data Communications Network	nm	nanometer
DISN	Defense Information Systems Network	OA	Optical Amplifier
DWDM	Dense Wavelength Division Multiplexing	OC	Optical Carrier
EDC	Electronic Dispersion Compensation	ODU	Optical Channel Data Unit
EIA	Electronic Industries Alliance	ODXC	Optical Digital Cross Connect
EMC	Electromagnetic Compatibility	OLA	Optical Line Amplifier
EMI	Electromagnetic Interference	ORL	Optical Return Loss
EOL	End of Life	OSC	Optical Supervisory Channel
FCC	Federal Communications Commission	OSP	Open Shortest Path
FDM	frequency-division multiplexing	OTS	Optical Transport System
GIG-BE	Global Information Grid-Bandwidth Expansion	OXC	Optical Cross Connect
GigE	Gigabit Ethernet	R	Required
GR	Generic Requirement	ROADM	Reconfigurable Optical Add/Drop Multiplexer
IEC	International Electrotechnical Commission	SDH	Synchronous Digital Hierarchy
IEEE	Institute of Electrical and Electronic Engineers	SONET	Synchronous Optical Transport Network
IR	Intermediate Reach	STM	Synchronous Transport Module
ITU	International Telecommunication Union	SUT	System Under Test
ITU-T	International Telecommunication Union-Telecommunication	TTL	Transistor-transistor logic
		UCR	Unified Capabilities Requirement
JITC	Joint Interoperability Test Command	UHF	Ultra high frequency
km	Kilometer	UNI	User Network Interface
LAN	Local Area Network	VHF	Very High Frequency
LoC	Letter of Compliance	WAN	Wide Area Network
Mbps	Megabits per second		

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