DEFENSE INFORMATION SYSTEMS AGENCY
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IN REPLY REFER TO: Joint Interoperability Test Command (JTE) 10 October 2012

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Special Interoperability Test Certification of the CIENA Government Solutions, Inc., ActivFlex (AF) 6500, an Optical Transport System (OTS) and a Fixed-Network Element (F-NE), with Software Release 7.01

References: (a) Department of Defense Directive 4630.05, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," 5 May 2004
(b) Department of Defense Instruction 8100.04, "DoD Unified Capabilities (UC)," 9 December 2010
(c) through (e), see Enclosure 1

1. References (a) and (b) establish the Joint Interoperability Test Command (JITC) as the responsible organization for interoperability test certification.

2. The CIENA Government Solutions, Inc., AF 6500 with Software Release 7.01, is hereinafter referred to as the System Under Test (SUT). The SUT solution is a family of products with models submitted for testing that includes the corresponding slot shelf numbers for each chassis: 7-slot, 14-slot, and 32-slot. The SUT meets all its critical interoperability requirements, and JITC certifies the SUT for joint use in the Defense Information Systems Network (DISN) as an OTS and an F-NE. The Defense Information Systems Agency (DISA) adjudicated all Test Discrepancy Reports open at the completion of testing to have a minor operational impact. The operational status of the SUT will be verified during deployment. Any new discrepancies that are discovered in the operational environment will be evaluated for impact and adjudicated to the satisfaction of DISA via a vendor Plan of Action and Milestones to address the concern(s) within 120 days of identification. JITC conducted testing using OTS and F-NE requirements within the Unified Capabilities Requirements (UCR) 2008, Change 2, Reference (c). JITC tested the SUT using DISN OTS and F-NE test procedures, Reference (d). JITC does not certify any other configurations, features, or functions, except those cited within this memorandum. This certification expires on 8 August 2014 based on previous placement on the Approved Products List.

3. This finding is based on interoperability testing conducted by JITC and DISA Transport Division, Network Service Engineering (NSE) 11, review of the vendor's Letter of Compliance (LoC) and Information Assurance (IA) Certification Authority (CA) approval of the IA configuration. JITC conducted interoperability testing at its Indian Head, Maryland, facility from 18 April through 15 July 2011; NSE completed bit error rate testing for the 100 Gigabit

Ethernet interface from 13 January to 18 May 2011 at its Skyline 7 Facility. JITC completed review of vendor's LoC on 10 January 2012. The DISA IA CA reviewed the JITC published IA Assessment Report for the SUT, Reference (e), and provided a positive recommendation of the IA configuration on 24 June 2011. The acquiring agency or site will be responsible for the Department of Defense Information Assurance Certification and Accreditation Process accreditation. DISA, as a DISN service provider, requested JITC evaluate the SUT as a DISN OTS under UCR 2008, Change 2, Section 5.5. In addition, the United States Army, as a sponsor, requested JITC evaluate the SUT as an F-NE under UCR 2008, Change 2, Section 5.9. Enclosure 2 documents test results and describes the tested network and system configurations. Enclosure 3 lists the DISN OTS and F-NE Capability Requirements (CR) and Functional Requirements (FR).

4. Sections 5.5 and 5.9 of the UCR establish interfaces and threshold CRs/FRs used to evaluate interoperability of the SUT as a DISN OTS and F-NE. Tables 1 through 4 list the OTS and the F-NE interfaces, CRs, FRs, and the component status of the SUT.

Table 1. SUT DISN OTS Interface Interoperability Status

Interface	Critical	Reference (UCR 2008, Change 2)	Threshold CR/FR Requirements (See note 1.)	Status	Remarks
OTS					
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/STM-16.
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 GbE	Yes	5.5.3.2.5.1	1, 2, 4, 5, and 8	Certified	Met threshold CRs/FRs.
10 GbE LAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs.
10 GbE 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, 7 and 8	Not Tested	Met requirement based on vendor's LoC. (See note 2.)
OTN 100G	No	5.5.3.2.5.1	1, 2, 4, 5, 6, 7 and 8	Certified	Met requirement based on vendor's LoC. (See note 3.)
OSC	Yes	5.5.3.2.8	7 and 8	Certified	Met threshold CRs/FRs.
Other					
10 x 10 GbE LAN	No	IEEE 802.3ae	9	Certified	See note 4.
10 x 10 GbE WAN	No	IEEE 802.3ae	9	Certified	See note 4.
10 x OC-192	No	GR-253	9	Certified	See note 4.
1 x 100 GbE	No	IEEE 802.3ba	9	Not Tested	See note 4.

Table 1. SUT DISN OTS Interface Interoperability Status (continued)

NOTES:
1. The threshold CRs/FRs provide a high-level overview of applicable UCR requirements. For detailed applicability of UCR requirements, refer to Enclosure 3.
2. Due to the lab limitation of JITC test facility at Indian Head, Maryland, the following OTN rates: ODU1, ODU2, and ODU3 did not undergo testing. However, according to vendor's LoC, the SUT meets the corresponding UCR requirement.
3. This is a conditional requirement that requires the vendor to have a plan for the future to support an OTN 100G interface. The vendor has claimed that the SUT supports a 100G user-side interface. However, due to unavailability, JITC did not test the 100G client interface.
4. JITC tested 10 x 10 GbE LAN/WAN and 10 x OC-192 interfaces at the client side and 100G DWDM at the network side. The SUT supports a 1 x 100 GbE interface, but the SUT tested configuration did not have 1 x 100 GbE client interface; therefore, JITC did not test it.

LEGEND:

CR	Capability Requirement	LoC	Letters of Compliance
DISN	Defense Information Systems Network	OC	Optical Carrier
DWDM	Dense Wavelength Division Multiplexing	ODU	Optical Data Unit
FR	Functional Requirement	OSC	Optical Supervisory Channel
G	Gigabit	OTN	Optical Transport Network
GbE	Gigabit Ethernet	OTS	Optical Transport System
GR	Generic Requirement	STM	Synchronous Transport Module
IEEE	Institute of Electrical and Electronic Engineers	SUT	System Under Test
JITC	Joint Interoperability Test Command	UCR	Unified Capabilities Requirements
LAN	Local Area Network	WAN	Wide Area Network

Table 2. SUT DISN OTS CRs and FRs Status

CR/FR ID	Capability/Function	Applicability (See notes 1 and 2.)	Reference (UCR 2008, Change 2)	Status	Remarks (See note 3.)
OTS CR/FR					
1	**Requirements Applicable to all OTS Elements**				
	Overall Requirements	Required	5.5.3.2.2.1	Partially Met	See note 4.
	Performance Requirements	Required	5.5.3.2.2.2	Met	
	Reliability and Quality Assurance	Required	5.5.3.2.2.2.1	Partially Met	See note 5.
	Common Physical Design Requirements	Required	5.5.3.2.2.3	Partially Met	See note 6.
	Protection and Restoration	Required	5.5.3.2.2.4	Met	
2	**Optical Amplifier Requirements**				
	Optical Amplifier Requirements	Required	5.5.3.2.3	Partially Met	See note 7.
	OLA Physical Design Requirements	Required	5.5.3.2.3.1	Partially Met	See note 8.
3	**Muxponder Requirements**				
	Muxponder	Required	5.5.3.2.4	Met	
4	**Transponder Requirements**				
	Transponder Requirements	Required	5.5.3.2.5	Partially Met	See note 9.
	Interface Requirements	Required	5.5.3.2.5.1	Partially Met	See note 10.
5	**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	Met	
6	**Requirements Common to Transponder and ROADM**				
	Framed Formats	Required	5.5.3.2.7.1	Partially Met	See note 12.
	Unframed Formats	Required	5.5.3.2.7.2	Met	
7	**Optical Supervisory Channel Requirements**				
	Optical Supervisory Channel	Required	5.5.3.2.8	Partially Met	See note 4.

Table 2. SUT DISN OTS CRs and FRs Status (continued)

CR/FR ID	Capability/Function	Applicability (See notes 1 and 2.)	Reference (UCR 2008, Change 2)	Status	Remarks (See note 3.)
8	**OTS Standards Compliance Requirements**				
	OTS Standards Compliance	Required	5.5.3.2.9	Met	See note 13.
Other CR/FR					
9	**100G Sponsor Requirements**				
	100G IP Transport	Conditional	IEEE 802.3ae/ba GR-253	Met	See note 10.

NOTES:
1. Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.
2. The DISA requested the SUT be assessed against UCR 2008, Section 5.5, as an OTS device.
3. Notes 4 through 13 contain details of discrepancies that have been adjudicated by the DISA Adjudication Board and the Sponsor.
4. The UCR requires 150 km/50 dB span loss but the SUT only supports 150 km/44 dB span loss.
5. The SUT software development process does not comply directly with the Reliability and Quality Acceptance Criteria.
6. The SUT does not support capability to roll back to the previous operational version of software, required altitude, interoperability with deployed GIG-BE operational software versions, software upgraded in a modular fashion, and a fully accessible file system.
7. The SUT's internal OSA does not support 25 GHz ITU grid spacing and reporting of Noise level, Q-Factor, OSNR for each wavelength, and Optical Eye Diagram. The Unified Capabilities adjudication panel recommended changing all the internal OSA requirements in UCR to conditional. In addition, the SUT does not support automatic monitoring and reporting on the operation of the Raman pumping lasers, including power on, off, optical output power, operating current and total Optical Return Loss, but it supports Raman pump failure alarm. Also, Raman output power and line power can be monitored from two external monitor ports.
8. A fully configured SUT OLA site may consume more than the specified 2000 watts.
9. The SUT does not support Built-in self-BER test function and not all transponders support user-selectable FEC.
10. JITC tested 10 x 10 GbE LAN/WAN and 10 x OC-192 interfaces at the client side and 100G DWDM at the network side. The SUT supports a 1 x 100 GbE interface, but the SUT tested configuration did not have a 1 x 100 GbE client interface; therefore, JITC did not test it.
11. The SUT ROADM did not support colorless wavelength routing at the time of testing.
12. The SUT does not support Alien wavelength regeneration.
13. This section is verifying SUT compliance to a list of industry standards via vendor's LoC. JITC reviewed and accepted the vendor's LoC.

LEGEND:

BER	Bit Error Rate	IP	Internet Protocol
CR	Capability Requirement	ITU	International Telecommunication Union
dB	Decibel	JITC	Joint Interoperability Test Command
DISA	Defense Information Systems Agency	km	kilometer
DISN	Defense Information Systems Network	LAN	Local Area Network
DWDM	Dense Wavelength Division Multiplexing	LoC	Letter of Compliance
FEC	Forward Error Correction	OC	Optical Carrier
FR	Functional Requirement	OLA	Optical Line Amplifier
G	Gigabit	OSA	Optical Spectrum Analyzer
GbE	Gigabit Ethernet	OSNR	Optical Signal to Noise Ratio
GHz	Gigahertz	OTS	Optical Transport System
GIG-BE	Global Information Grid – Bandwidth Expansion	Q-Factor	Quality Factor
GR	Generic Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexer
ID	Identification	SUT	System Under Test
IEEE	Institute of Electrical and Electronic Engineers	UCR	Unified Capabilities Requirements
		WAN	Wide Area Network

Table 3. SUT F-NE Interface Interoperability Status

Interface	Critical (See note.)	Reference (UCR 2008, Change 2)	Threshold CR/FR Requirements	Status	Remarks
NE					
Analog	No	5.9.3.2.1	1, 2, and 4	NA	Not supported by the SUT.
Serial	No	5.9.2.3.2	1, 2, and 4	NA	Not supported by the SUT.
BRI ISDN	No	5.9.2.3.3	1, 2, and 4	NA	Not supported by the SUT.

Table 3. SUT F-NE Interface Interoperability Status (continued)

Interface	Critical (See note.)	Reference (UCR 2008, Change 2)	Threshold CR/FR Requirements	Status	Remarks
DS1	No	5.9.2.3.4	1, 2, 3, and 4	Certified	SUT met requirements for specified interfaces.
E1	No	5.9.2.3.5	1, 2, 3, and 4	NA	Not supported by the SUT.
DS3	No	5.9.2.3.6	1, 2, 3, and 4	Certified	SUT met requirements for specified interfaces.
OC-X	No	5.9.2.3.8	1, 2, 3, and 4	Certified	SUT met requirements for OC-3/12/48/192/768 interfaces. SUT also met requirements for STM-1/4/16/64/256 interfaces.
IP (Ethernet)	No	5.9.2.3.9	1, 2, 4, and 7	Certified	SUT met requirements for 10/100/1000, 1 GbE, and 10 GbE.
NM					
10Base-X	Yes	5.3.2.4.4	8	Certified	SUT met NM requirements for specified interfaces.
100Base-X	Yes	5.3.2.4.4	8	Certified	

NOTE: UCR does not specify any minimum interfaces. The SUT must minimally provide one of the listed ingress and egress interfaces specified.

LEGEND:

10Base-X	10 Mbps Ethernet generic designation	IP	Internet Protocol
100Base-X	100 Mbps Ethernet generic designation	ISDN	Integrated Services Digital Network
BRI	Basic Rate Interface	Mbps	Megabits per second
CR	Capability Requirement	NA	Not Applicable
DS1	Digital Signal Level 1 (1.544 Mbps)	NE	Network Element
DS3	Digital Signal Level 3 (44.736 Mbps)	NM	Network Management
E1	European Interface Standard (2.048 Mbps)	OC	Optical Carrier
F-NE	Fixed Network Element	STM	Synchronous Transport Module
FR	Functional Requirement	SUT	System Under Test
GbE	Gigabit Ethernet	UCR	Unified Capabilities Requirements

Table 4. SUT F-NE CRs and FRs Status

CR/FR ID	Capability/Function	Applicability (See note.)	Reference (UCR 2008, Change 2)	Status	Remarks
F-NE CR/FR					
1	**General NE Requirements**				
	General Requirements	Required	5.9.2.1	Met	
	Alarms	Required	5.9.2.1.1	Met	
	Congestion Control & Latency	Required	5.9.2.1.2	Met	
2	**Compression**				
	G.726	Conditional	5.9.2.2	NA	Not supported by the SUT.
	G.728	Conditional	5.9.2.2	NA	Not supported by the SUT.
	G.729	Conditional	5.9.2.2	NA	Not supported by the SUT.
3	**Interface Requirements**				
	Timing	Required	5.9.2.3.7	Met	
4	**Device Management**				
	Management Options	Required	5.9.2.4.1	Met	
	Fault Management	Conditional	5.9.2.4.2	Met	
	Loop-Back Capability	Conditional	5.9.2.4.3	Met	
	Operational Configuration Restoral	Required	5.9.2.4.4	Met	
5	**DLoS**				
	DLoS Transport	Conditional	5.9.2.4.5	NA	Not supported by the SUT.

Table 4. SUT F-NE CRs and FRs Status (continued)

CR/FR ID	Capability/Function	Applicability (See note.)	Reference (UCR 2008, Change 2)	Status	Remarks
6	**IPv6 Requirements**				
	Product Requirements	Required	5.3.5.4	Met	SUT is a Layer-2 device and transports IPv4 and IPv6 traffic transparently.
7	**NM Requirements**				
	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	
	General Management Requirements	Required	5.3.2.17.2	Met	

NOTE: Annotation of "required" refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.

LEGEND:

ADPCM	Adaptive Differential Pulse Code Modulation	IPv6	Internet Protocol version 6
CR	Capability Requirement	ITU-T	International Telecommunication Union – Telecommunication
CS-ACELP	Conjugate Structure-Algebraic Code Excited Linear Prediction	kbps	kilobits per second
DLoS	Direct Line of Sight	LD-CELP	Low Delay-Code Excited Linear Prediction
F-NE	Fixed-Network Element	NA	Not Applicable
FR	Functional Requirement	NE	Network Element
G.726	ITU-T speech codec for ADPCM (32 kbps)	NM	Network Management
G.728	ITU-T speech codec for LD-CELP (16 kbps)	NMS	Network Management System
G.729	ITU-T speech codec for CS-ACELP (8 kbps)	SUT	System Under Test
ID	Identification	UCR	Unified Capabilities Requirements
IPv4	Internet Protocol version 4	VVoIP	Voice and Video over Internet Protocol

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 Unclassified-But-Sensitive 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 Approved Products List (APL) testing is available on the DISA APL Testing and Certification website located at http://www.disa.mil/Services/Network-Services/UCCO. All associated test information is available on the DISA Unified Capability Certification Office APL Integrated Tracking System (APLITS) website located at https://aplits.disa.mil.

JITC Memo, JTE, Special Interoperability Test Certification of the CIENA Government Solutions, Inc., ActivFlex (AF) 6500, an Optical Transport System (OTS) and a Fixed-Network Element (F-NE), with Software Release 7.01

6. JITC testing point of contact is Ms. Fanny Lee-Linnick, commercial (301) 743-4259. Her email address is Fanny.Lee-Linnick.civ@mail.mil, mailing address: 3341 Strauss Avenue, Suite 236, Indian Head, MD 20640-5149. The tracking number for the SUT is 1023101.

FOR THE COMMANDER:

3 Enclosures a/s

RICHARD A. MEADOR
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Distribution (electronic mail):
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ADDITIONAL REFERENCES

(c) Office of the Assistant Secretary of Defense Document, "Department of Defense Unified Capabilities Requirements 2008, Change 2," December 2010
(d) Joint Interoperability Test Command Document, "Unified Capabilities Interoperability Test Plan," 4 February 2010
(e) Joint Interoperability Test Command, "Information Assurance Findings and Mitigations Summary for CIENA ActivFlex 6500 Packet Optical Platform, Software Release 7.01 (TN 1023101)," 7 June 2011

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CERTIFICATION TESTING SUMMARY

1. SYSTEM TITLE. CIENA Government Solutions, Inc., ActivFlex (AF) 6500, an Optical Transport System (OTS) and a Fixed-Network Element (F-NE), with Software Release 7.01

2. SPONSORS. 1) Mr. Gary Steele, Defense Information Systems Agency, Chief, Unified Capabilities Certification Office, Post Office Box 549, Fort Meade, MD 20755; email: Gary.Steele2.civ@mail.mil.

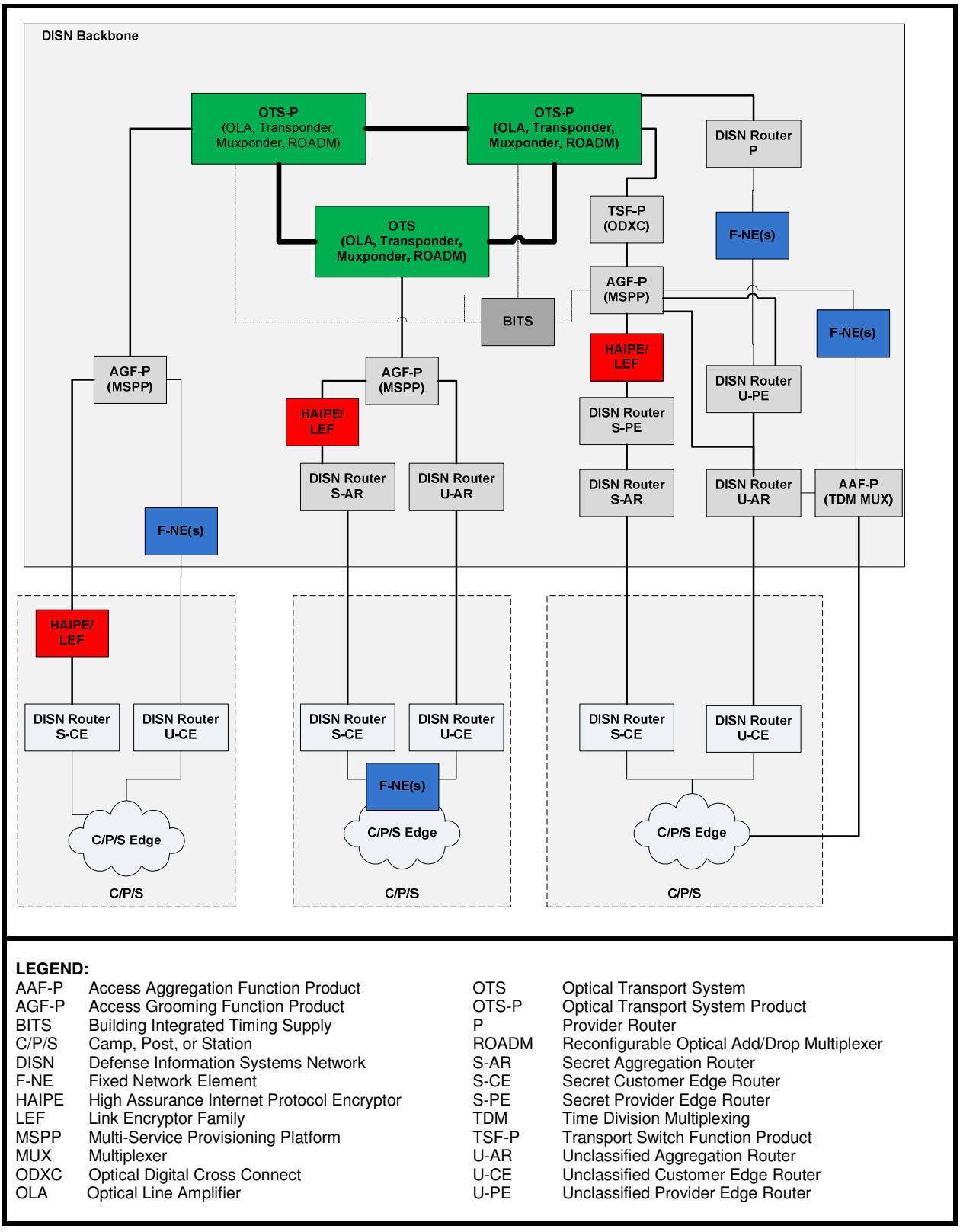
2) Mr. Jordan Silk, Program Manager, HQUSAISEC, AMSEL-IE-IS, Building 53302, Fort Huachuca, AZ 85613; e-mail: Jordan.R.Silk.civ@mail.mil.

3. SYSTEM POC. Mr. Kevin Lawrence, CIENA Government Solutions, Inc. 900 Elkridge Landing Road, Linthicum, MD 21090; e-mail: klawrenc@ciena.com.

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

5. SYSTEM DESCRIPTION. The CIENA Government Solutions, Inc., AF 6500 with software release 7.01, hereinafter referred to as the System Under Test (SUT). The SUT is a family of Packet-Optical Transport products that consist of the following models with corresponding slot shelf numbers for each chassis: 7-slot, 14-slot, and 32-slot. The SUT is designed to provide traditional Time Division Multiplexing (TDM), Optical Multi-service Provisioning, and Reconfigurable Optical Add/Drop Multiplexer (ROADM) functionalities, while at the same time evolving into a full multifunction switch platform that provides Optical Data Unit packet encapsulation, Layer-2 Carrier Ethernet transport and switching for E-line, E-Local Area Network (LAN), and E-tree functionalities. In addition, the platform's E-Spring functionality is designed to support the distributed edge with transport speed capabilities of 10 Gigabit (Gb), to 40 Gb, and extend it to 100 Gb. The product portfolio submitted for testing supports transport speeds up to 100 Gb.

6. OPERATIONAL ARCHITECTURE. JITC tested the SUT under the Defense Information Systems Network (DISN) OTS and F-NE of the Unified Capabilities Requirements (UCR) product categories. A high-level DISN node architecture, as depicted in Figure 2-1, shows the role of the SUT providing core transport for the following DISN components: Access Grooming Function, Transport Switch Function, and Routers. In addition, the figure illustrates the SUT as a F-NE provided to extend DISN services in the Wide Area Network (WAN) and on a camp, post, or station within the Local Area Network (LAN) infrastructure. The SUT meets both UCR 2008, Change 2, Section 5.5 (DISN OTS) and Section 5.9 (F-NE) requirements and can be deployed to augment core transport, LAN, and WAN infrastructures.



LEGEND:

AAF-P	Access Aggregation Function Product	OTS	Optical Transport System
AGF-P	Access Grooming Function Product	OTS-P	Optical Transport System Product
BITS	Building Integrated Timing Supply	P	Provider Router
C/P/S	Camp, Post, or Station	ROADM	Reconfigurable Optical Add/Drop Multiplexer
DISN	Defense Information Systems Network	S-AR	Secret Aggregation Router
F-NE	Fixed Network Element	S-CE	Secret Customer Edge Router
HAIPE	High Assurance Internet Protocol Encryptor	S-PE	Secret Provider Edge Router
LEF	Link Encryptor Family	TDM	Time Division Multiplexing
MSPP	Multi-Service Provisioning Platform	TSF-P	Transport Switch Function Product
MUX	Multiplexer	U-AR	Unclassified Aggregation Router
ODXC	Optical Digital Cross Connect	U-CE	Unclassified Customer Edge Router
OLA	Optical Line Amplifier	U-PE	Unclassified Provider Edge Router

Figure 2-1. DISN Architecture

7. INTEROPERABILITY REQUIREMENTS. The interface, Capability Requirements (CR), Functional Requirements (FR), Information Assurance (IA), and other requirements for OTS products are established by Department of Defense (DoD) UCR 2008, Change 2, Sections 5.4 and 5.5.3.

7.1 Interfaces. The OTS products use its interfaces to interconnect the DISN WAN infrastructure. Table 2-1 lists the threshold requirements for interfaces specific to the OTS products. The OTS and the F-NE products use interfaces to connect to LAN or DISN WAN infrastructure. The threshold requirements for interfaces specific to the F-NE products are listed in Table 2-2.

Table 2-1. OTS Interface Requirements

Interface	Critical	Reference (UCR 2008, Change 2)	Threshold CR/FR Requirements	Criteria
OC-48/STM-16	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Meet minimum CR/FR 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 GbE	Yes	5.5.3.2.5.1	1, 2, 4, 5, and 8	
10 GbE LAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	
10 GbE -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, 7, and 8	
OTN 100G	No	5.5.3.2.5.1	1, 2, 4, 5, 6, 7, and 8	
OSC	Yes	5.5.3.2.8	7 and 8	

LEGEND:

CR	Capability Requirement	OSC	Optical Supervisory Channel
FR	Functional Requirement	OTN	Optical Transport Network
G	Gigabit	OTS	Optical Transport System
GbE	Gigabit Ethernet	STM	Synchronous Transport Module
LAN	Local Area Network	UCR	Unified Capabilities Requirements
OC	Optical Carrier	WAN	Wide Area Network
ODU	Optical Channel Data Unit		

Table 2-2. F-NE Interface Requirements

Interface	Critical (See note 1.)	Reference (UCR 2008, Change 2)	Threshold CR/FR (See note 2.)	Criteria	Remarks
NE					
Analog	No	5.9.3.2.1	1, 2, and 4	Meet minimum CR/FRs and interface standards.	Provides access to local infrastructure.
Serial	No	5.9.2.3.2	1, 2, and 4		
BRI ISDN	No	5.9.2.3.3	1, 2, and 4		
DS1	No	5.9.2.3.4	1, 2, 3, and 4		
E1	No	5.9.2.3.5	1, 2, 3, and 4		
DS3	No	5.9.2.3.6	1, 2, 3, and 4		
OC-X	No	5.9.2.3.8	1, 2, 3, and 4		
IP (Ethernet)	No	5.9.2.3.9	1, 2, 4, and 7		
NM					
10Base-X	Yes	5.3.2.4.4	8	Meet minimum CR/FRs and interface standards.	Provides access to local infrastructure.
100Base-X	Yes	5.3.2.4.4	8		

Table 2-2. F-NE Interface Requirements (Continued)

NOTES:
1. UCR does not specify any minimum interfaces.
2. CR/FR requirements are contained in Table 2-3. CR/FR numbers represent a roll-up of UCR requirements.

LEGEND:

10Base-X	10 Mbps Ethernet generic designation	FR	Functional Requirement
100Base-X	100 Mbps Ethernet generic designation	IP	Internet Protocol
BRI	Basic Rate Interface	ISDN	Integrated Services Digital Network
CR	Capability Requirement	Mbps	Megabits per second
DS1	Digital Signal Level 1 (1.544 Mbps)	NE	Network Element
DS3	Digital Signal Level 3 (44.736 Mbps)	NM	Network Management
E1	European Interface Standard (2.048 Mbps)	OC	Optical Carrier
F-NE	Fixed Network Element	UCR	Unified Capabilities Requirements

7.2 CRs and FRs. The OTS products have required and conditional features and capabilities established by UCR 2008, Change 2, 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 2-3 lists the features and capabilities and their associated requirements for OTS products. Table 3-1 of Enclosure 3 provides detailed CR/FR requirements.

The F-NE products have required and conditional features and capabilities established by UCR 2008, Change 2, Section 5.9. The SUT, with respect to the F-NE, 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 2-4 lists the features and capabilities and their associated requirements for the SUT products. Table 3-2 of Enclosure 3 provides detailed CR/FR requirements.

Table 2-3. OTS CRs and FRs

CR/FR ID	Capability/Function	Applicability (See note.)	Reference (UCR 2008, Change 2)	Criteria
1	**Requirements Applicable to all OTS Elements**			
	Overall Requirements	Required	5.5.3.2.2.1	Meet UCR Applicable to all OTS Elements 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	
2	**Optical Amplifier Requirements**			
	Optical Amplifier Requirements	Required	5.5.3.2.3	Meet UCR OLA requirements. See Table 3-1 in Enclosure 3.
	OLA Physical Design Requirements	Required	5.5.3.2.3.1	
3	**Muxponder Requirements**			
	Muxponder	Required	5.5.3.2.4	Meet UCR muxponder requirements. See Table 3-1 in Enclosure 3.

Table 2-3. OTS CRs and FRs (continued)

CR/FR ID	Capability/Function	Applicability (See note.)	Reference (UCR 2008, Change 2)	Criteria
4	**Transponder Requirements**			
	Transponder Requirements	Required	5.5.3.2.5	Meet UCR transponder requirements. See Table 3-1 in Enclosure 3.
	Interface Requirements	Required	5.5.3.2.5.1	
5	**ROADM Requirements**			
	ROADM Requirements	Required	5.5.3.2.6	Meet UCR ROADM requirements. See Table 3-1 in Enclosure 3.
	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 to Transponder and ROADM requirements. See Table 3-1 in Enclosure 3.
	Unframed Formats	Required	5.5.3.2.7.2	
7	**Optical Supervisory Channel Requirements**			
	Optical Supervisory Channel	Required	5.5.3.2.8	Meet UCR OSC requirements. See Table 3-1 in Enclosure 3.
8	**OTS Standards Compliance Requirements**			
	OTS Standards Compliance	Required	5.5.3.2.9	Meet UCR standards compliance requirements. See Table 3-1 in Enclosure 3.

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

LEGEND:

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

Table 2-4. F-NE CRs and FRs

CR/FR ID	Capability/Function	Applicability (See note.)	Reference (UCR 2008, Change 2)	Criteria	Remarks
F-NE CR/FR					
1	**General NE Requirements**				
	General Requirements	Required	5.9.2.1	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 in Enclosure 3.	
	Alarms	Required	5.9.2.1.1		
	Congestion Control & Latency	Required	5.9.2.1.2		
2	**Compression**				
	G.726	Conditional	5.9.2.2	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 in Enclosure 3.	
	G.728	Conditional	5.9.2.2		
	G.729	Conditional	5.9.2.2		

Table 2-4. F-NE CRs and FRs (continued)

CR/FR ID	Capability/Function	Applicability (See note.)	Reference (UCR 2008, Change 2)	Criteria	Remarks
3	**Interface Requirements**				
	Timing	Required	5.9.2.3.7	Meet UCR requirements.	Applicable to TDM interfaces.
4	**Device Management**				
	Management Options	Required	5.9.2.4.1	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 of Enclosure 3.	
	Fault Management	Conditional	5.9.2.4.2		
	Loop-Back Capability	Conditional	5.9.2.4.3		
	Operational Configuration Restoral	Required	5.9.2.4.4		
5	**DLoS**				
	DLoS Transport	Conditional	5.9.2.4.5	Meet UCR DLoS requirements.	
6	**IPv6 Requirements**				
	Product Requirements	Required	5.3.5.4	Meet UCR IPv6 requirements.	
7	**NM Requirements**				
	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 of Enclosure 3.	
	General Management Requirements	Required	5.3.2.17.2		

NOTE: Annotation of "required" refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.

LEGEND:

ADPCM	Adaptive Differential Pulse Modulation	IPv6	Internet Protocol version 6
CR	Capability Requirement	ITU-T	International Telecommunication Union - Telecommunication
CS-ACELP	Conjugate Structure-Algebraic Code-Excited Linear Prediction	kbps	kilobits per second
DLoS	Direct Line of Sight	LD-CELP	Low Delay-Code Excited Linear Prediction
F-NE	Fixed Network Element	NE	Network Element
FR	Functional Requirement	NM	Network Management
G.726	ITU-T speech codec for ADPCM (32 kbps)	NMS	Network Management System
G.728	ITU-T speech codec for LD-CELP (16 kbps)	TDM	Time Division Multiplexing
G.729	ITU-T speech codec for CS-ACELP (8 kbps)	UCR	Unified Capabilities Requirements
ID	Identification	VVoIP	Voice and Video over Internet Protocol

7.3 Other. The Sponsor requested additional interfaces be tested, including 10 x 10 Gigabit Ethernet (GbE) LAN, 10 x 10 GbE WAN, 10 x Optical Carrier (OC)-192, and 1 x 100 GbE. Table 2-5 lists the other SUT interface requirements.

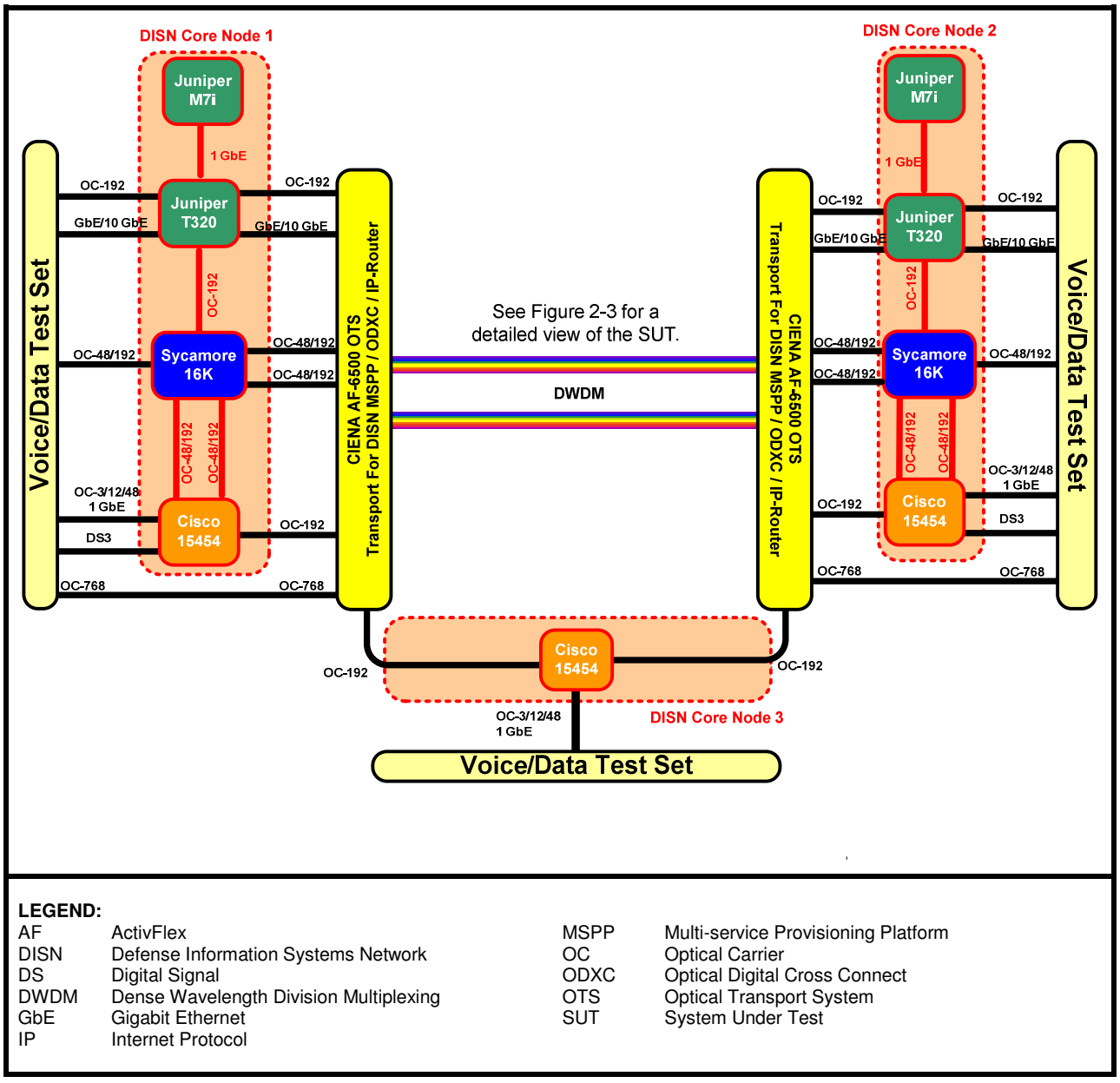
Table 2-5. Other SUT Interface Requirements

Interface	Criteria	Remarks
10 x 10 GbE LAN	Meet commercial interface standards and sponsor information exchange requirements.	Met commercial interface standards and sponsor information exchanges.
10 x 10 GbE WAN		
10 x OC-192		
1 x 100 GbE		

LEGEND:

GbE	Gigabit Ethernet	SUT	System Under Test
LAN	Local Area Network	WAN	Wide Area Network
OC	Optical Carrier		

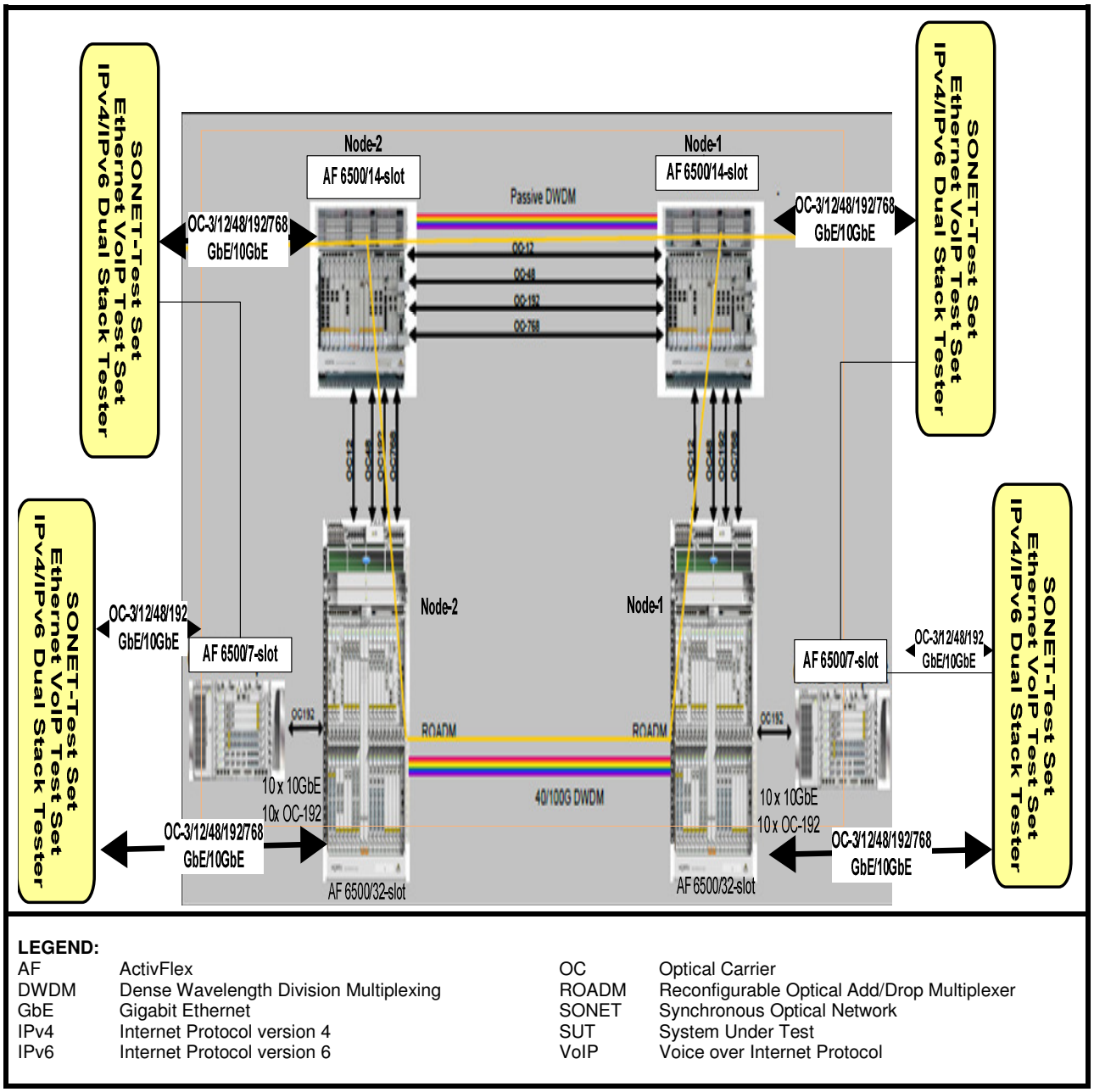
8. TEST NETWORK DESCRIPTION. JITC tested the SUT at its test facility at Indian Head, Maryland. Figure 2-2 depicts the DISN OTS Interoperability Test Configuration. Figure 2-3 shows the Detailed View of the SUT's Test Configuration. Figure 2-4 illustrates the SUT's Secure Communication Facsimile (Fax) and Modem Configuration.



LEGEND:

AF	ActivFlex	MSPP	Multi-service Provisioning Platform
DISN	Defense Information Systems Network	OC	Optical Carrier
DS	Digital Signal	ODXC	Optical Digital Cross Connect
DWDM	Dense Wavelength Division Multiplexing	OTS	Optical Transport System
GbE	Gigabit Ethernet	SUT	System Under Test
IP	Internet Protocol		

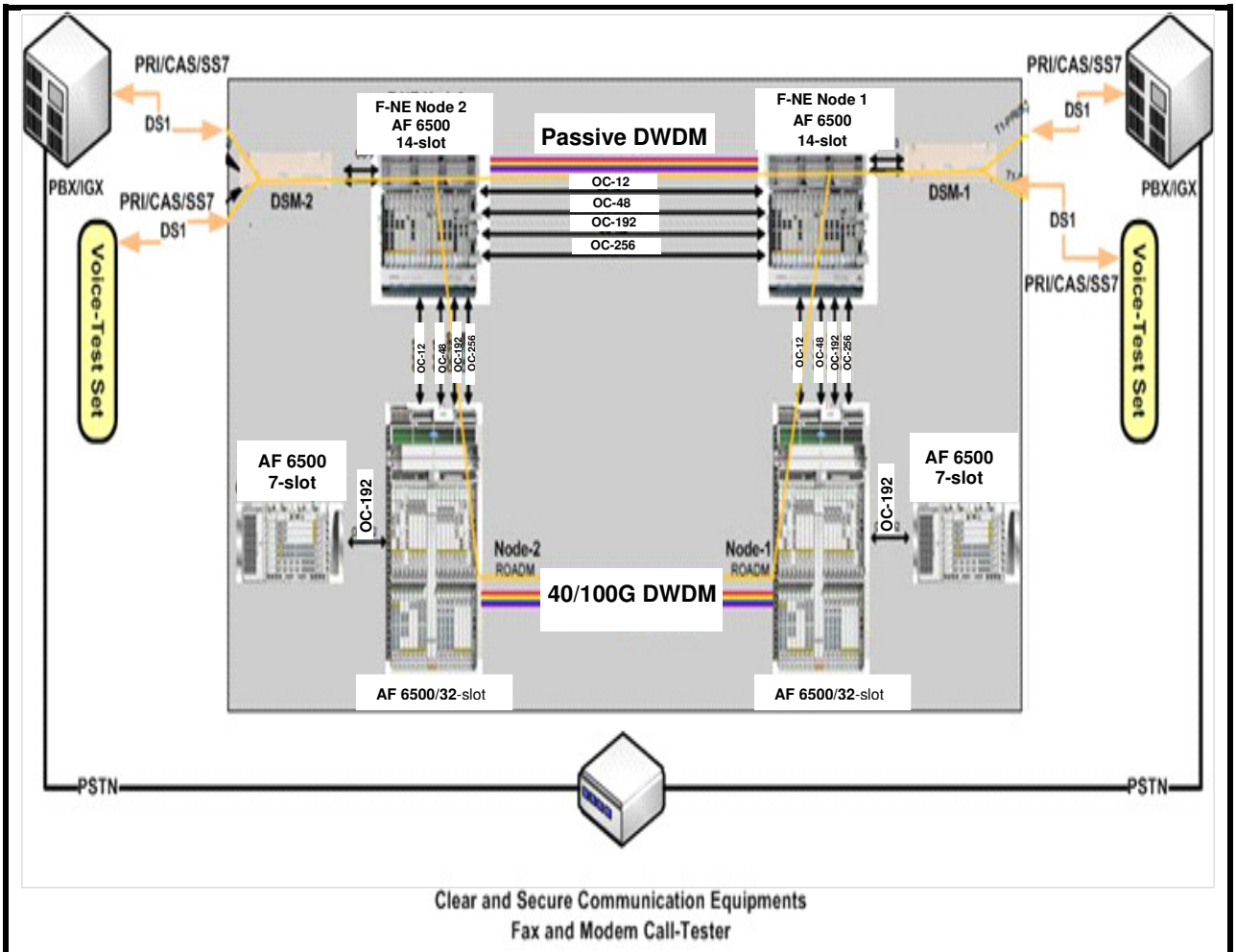
Figure 2-2. DISN OTS Interoperability Test Configuration



LEGEND:

AF	ActivFlex	OC	Optical Carrier
DWDM	Dense Wavelength Division Multiplexing	ROADM	Reconfigurable Optical Add/Drop Multiplexer
GbE	Gigabit Ethernet	SONET	Synchronous Optical Network
IPv4	Internet Protocol version 4	SUT	System Under Test
IPv6	Internet Protocol version 6	VoIP	Voice over Internet Protocol

Figure 2-3. Detailed View of the SUT's Test Configuration



LEGEND:

AF	ActivFlex	IGX	Integrated Gateway Exchange
CAS	Channel Associated Signaling	OC	Optical Carrier
DS1	Digital Signal 1	PBX	Private Branch Exchange
DSM	DS1 Service Module	PRI	Primary Rate Interface
DWDM	Dense Wavelength Division Multiplexing	PSTN	Public Switch Telephone Network
F-NE	Fixed-Network Element	ROADM	Reconfigurable Optical Add/Drop Multiplexer
G	Gigabit	SS7	Signaling System Seven

Figure 2-4. CIENA F-NE Secure Communication Fax and Modem Configuration

9. SYSTEM CONFIGURATION. Table 2-7 lists the tested SUT equipment shown in Figure 2-2, Table 2-8 lists the non-SUT equipment used to test the SUT, and Table 2-9 lists the test equipment used to generate voice, synchronous Optical Network, and Internet Protocol (IP) traffic.

Table 2-6. Hardware/Software Tested SUT Equipment

Platform		Software Release		UC Product Type
AF 6500		7.01		OTS/F-NE
Hardware	**QTY**	**Component Description**		**Part Number**
AF 6500 F-NE Node 1	1	AF 6500 Converged / 40 G Optical / Rear Electrical Shelf Assembly		NTK503CDE5
	2	HF Front Venting Cooling Module		NTK507LDE5
	1	Shelf Front Cover - Main Shelf - (Captive Mechanism)		NTK509CBE6
	1	Access Panel (SONET/JSDH) - Release 1.1		NTK505MA
	2	60 AMP Power Interface Card (breaker)		NTK505CAE5
	1	Maintenance Interface Card - Dual/Split Return		NTK505FB
	1	AF 6500 Rel. 7.0 Shelf Processor (SP-2) Kit		NTZF03GAE5
	2	Cross-Connect – 160 G with STS-1/VC-3 Granularity - Rel. 1.0		NTK557BAE5
	2	Cross-Connect – 80 G / 80 G VT1.5 / VC-12 Granularity - Rel. 1.1		NTK557NAE5
	1	1 x OC-192 Short Reach 1310 nm (Low Order - VT1.5 granularity) - Rel. 1.1		NTK524BA
	1	Tunable 1 x OC-192/STM-64 VT1.5/LO DWDM C-Band AM1/AM2 Circuit Pack		NTK527JAE5
	2	2 x OC-48 Interface (LO - VT1.5 granularity) - Rel. 1.1		NTK517BA
	2	OC-48 SR 1310 nm (SR-1 / I-16.1 XCT Enhanced SFP Module) – Rel. 2.0		NTTP03BF
	2	eDC40G OCLD 1 x OTU3+ DWDM with Enhanced PMD Compensation Circuit Pack (1800 km reach & 25 PMD limit)		NTK539PAE5
	2	40 G XCIF STS-1		NTK525FAE5
	2	8 x OC-3 / 12 Interface (LO - VT1.5 granularity) - Rel. 1.1		NTK513DA
	2	OC-3/12 SR 1310 nm (SR-1/1-I4 XCT) Enhanced SFP Module - Rel. 1.2		NTTP04BF
	2	OC-3/12 IR 1310 nm (IR-1 XCT) Enhanced SFP Module – Rel. 1.0		NTTP04CF
	1	4 x GbE EPL Interface - Rel. 1.0		NTK535LBE5
	1	4 x GbE 10 G RPR / 802.17 Optical Circuit Pack - Rel. 3.0		NTK534BAE5
	4	GbE 1000Base-SX 850 nm XCT Enhanced SFP Module - Rel. 1.0		NTTP01AFE6
	2	GbE 1000Base-LX 1310 nm XCT Enhanced SFP Module - Rel. 1.0		NTTP01CFE6
	1	24 x 10/100BT EPL Electrical interface card - Rel. 2.1		NTK548BA
	1	24 x DS-3/E-3 Mapper (Working) Circuit Pack - Rel. 3.0		NTK543CA
	1	24 x DS-3/E-3 Mapper (1:N Protection) Circuit Pack - Rel. 3.0		NTK544CA
	1	48 Channel Trans Mux (5G - Portless) Circuit Pack - Rel. 3.0		NTK558DA
	1	48 x DS-3/E-3/EC-1 1:N Rear I/O Panel - Rel. 1.2		NTK572QAE5
	1	DSM Breaker Interface Panel (1 Unit)		NTN458RAE5
	1	DSM shelf without the circuit packs		NTN407MA
	2	DSM DS 1 x 84 Pack (LC Connector)		NTN313AC
	1	DSM Fan Module		NTN355AA
	1	DSM Adapter Module		NTN356AA
	3	DSM 28 DS1 I/O Pack		NTN312AA
AF 6500 F-NE Node 2	1	AF 6500 Converged / 40 G Optical / Rear Electrical Shelf Assembly		NTK503CDE5
	2	HF Front Venting Cooling Module		NTK507LDE5
	1	Shelf Front Cover - Main Shelf - (Captive Mechanism)		NTK509CBE6
	1	Access Panel (SONET/JSDH) - Rel. 1.1		NTK505MA
	2	60AMP Power Interface Card (breaker)		NTK505CAE5
	1	Maintenance Interface Card - Dual/Split Return		NTK505FB
	1	AF 6500 Rel. 7.0 SP-2 Kit		NTZF03GAE5
	2	Cross-Connect – 160 G with STS-1/VC-3 Granularity – Rel. 1.0		NTK557BAE5
	2	Cross-Connect – 80 G / 20 G VT1.5 / VC-12 Granularity - Rel. 1.1		NTK557PAE5
	1	1 x OC-192 SR 1310 nm (Low Order - VT1.5 granularity) - Rel. 1.1		NTK524BA
	1	Tunable 1 x OC-192/STM-64 VT1.5/LO DWDM C-Band AM1/AM2 Circuit Pack		NTK527JAE5
	2	2 x OC-48 Interface (LO - VT1.5 granularity) - Rel. 1.1		NTK517BA
	2	OC-48 SR 1310 nm (SR-1 / I-16.1 XCT Enhanced SFP Module) – Rel. 2.0		NTTP03BF
	2	eDC40 GbE OCLD 1 x OTU3+ DWDM with Enhanced PMD Compensation Circuit Pack (1800 km reach & 25 PMD limit)		NTK539PAE5
	2	40 G XCIF (STS-1)		NTK525FAE5
	2	8 x OC-3 / 12 Interface (LO - VT1.5 granularity) - Rel. 1.1		NTK513DA
	2	OC-3/12 SR 1310 nm (SR-1 /1-I4 XCT) Enhanced SFP Module - Rel. 1.2		NTTP04BF
	2	OC-3/12 IR 1310 nm (IR-1 XCT) Enhanced SFP Module - Rel. 1.0		NTTP04CF
	1	4 x GbE EPL Interface - Rel. 1.0		NTK535LBE5

Table 2-6. Hardware/Software Tested SUT Equipment (continued)

Hardware	QTY	Component Description	Part Number
AF 6500 F-NE Node 2 (cont)	1	4 x GbE L2SS Optical Circuit Pack - Rel. 2.0	NTK531BAE6
	4	4 x GbE 10G RPR / 802.17 Optical Circuit Pack - Rel. 3.0	NTK534BAE5
	2	GbE 1000Base-SX 850 nm XCT Enhanced SFP Module - Rel. 1.0	NTTP01AFE6
	1	GbE 1000Base-LX 1310 nm XCT Enhanced SFP Module - Rel. 1.0	NTTP01CFE6
	1	24 x 10/100Base-T EPL Electrical interface card - Rel. 2.1	NTK548BA
	1	48 x 10/100Base-T Rear Unprotect I/O Module - Rel. 2.1	NTK574QAE5
	1	24 x DS-3/E-3 Mapper (Working) Circuit Pack - Rel. 3.0	NTK543CA
	1	24 x DS-3/E-3 Mapper (1:N Protection) Circuit Pack - Rel. 3.0	NTK544CA
	1	48 Channel Trans Mux (5 G - Portless) Circuit Pack - Rel. 3.0	NTK558DA
	1	48 x DS-3/E-3/EC-1 1:N Rear I/O Panel - Rel. 1.2	NTK572QAE5
	1	DSM Breaker Interface Panel (1 Unit)	NTN458RAE5
	1	DSM Shelf Without the Circuit Packs	NTN407MA
	2	DSM DS1 x 84 Pack (LC Connector)	NTN313AC
	1	DSM Fan Module	NTN355AA
	1	DSM Adapter Module	NTN356AA
	3	DSM 28 DS1 I/O Pack	NTN312AA
AF 6500 ROADM OTS Node 1	1	AF 6500 32-Slot Optical Shelf Assembly	NTK603AAE5
	2	AF 6500 32-Slot Shelf Front Cooling Tray	NTK607AAE5
	1	AF 6500 32-Slot Shelf Front Air Filter	NTK603ZAE6
	1	AF 6500 Rel. 7.0 Shelf Processor (SP-2 with Dual CPU) Kit	NTZF06GAE5
	1	AF 6500 32-Slot Shelf Access Panel	NTK605MAE5
	2	AF 6500 32-Slot Shelf 3 x 60 AMP Power Input Card (Breaker)	NTK605CAE5
	2	AF 6500 32-Slot Shelf XCT 640 G+ STS-1/VC-3 Sync-ST3 Circuit Pack	NTK610BBE5
	re-use existing	eDC40 G OCLD 1 x OTU3+ DWDM with Enhanced PMD Compensation Circuit Pack (1800 km reach & 25 PMD limit)	NTK539PAE5
	1	4 x 10G Mux OCI (OC-192/STM-64/10Gb/OTU2/FC) XFP Circuit Pack	NTK525CFE5
	2	2 x 10G XFP, 8 x GbE SFP, FLEX MOTR Circuit Pack	NTK531YAE5
	2	Multirate 1528.38 - 1568.77 50 GHz DWDM XFP	NTK583AAE6
	4	OC-192 SR-1: I-64.1,10 G Base-LR/LW, OTU2/10GFC 1200-SM-LL-L, 1310 nm, XFP, LC	NTTP84BA
	1	20G L2SS with the I/O Panel Support	NTK531HAE5
	2	GbE 1000Base-SX 850 nm XCT Enhanced SFP Module - Rel. 1.0	NTTP01AFE6
	11	GbE 1000Base-LX 1310 nm XCT Enhanced SFP Module – Rel. 1.0	NTTP01CFE6
	4	OC-192 SR-1, STM-64 I-64.1, 10G Base-LW/LR, OTU2 (1310 nm, SMF, 100 m), 0-70C XFP Module	NTTP83BA
	2	SuperMux 10 x SFP 24 x SFP I/O 10 G XFP	NTK535FAE5
	4	155M/622M SR 1310 nm (SR-1 /1-I4 XCT) Enhanced SFP Module - Rel. 1.2	NTTP04BFE6
	2	2.5 G SR 1310 nm (SR-1 / I-16.1 XCT Enhanced SFP Module) - Rel. 2.0	NTTP03BFE6
	2	100Base-FX FTM-3401C-SL2iCG-NT (-40 to + 85°C)	NTTP12ACE6
	2	100Base-T ABCU-5710RZ-NT6 (0 to 70°C)	NTTP61BAE6
	2	FC100 SM-L/FC200 SM-L/FC400 SM-L 1310nm SFP	NTTP11CFE6
	2	CMD 44 x 100 GHz ITU spaced wavelengths in the C-Band	NTT862AAE5
	2	SLA Circuit Pack C-Band	NTK552AAE5
	2	MLA Circuit Pack C-Band	NTK552BAE5
	2	WSS 100 GHz with OPM C-Band	NTK553EAE5
	1	OSC with WSC 2 Port SFP 2 Port 10Base-T (Requires 1 or 2 pluggable)	NTK554BAE5
	2	OC-3/STM-1 CWDM 1511 nm SFP Module (0 - 15 dB span loss)	NTK592NPE6
	2	eDC100 G OCLD C-Band 1 x OTU4 DWDM Circuit Pack	NTK539TBE5
	2	10 x 10G OCI CP (for 100 G OTR)	NTK529BAE5
	2	10 x 10G SONET/OTN/GbE Mux 10 x XFP Circuit Pack	NTK529BBE5
AF 6500 ROADM OTS Node 2	1	AF 6500 32-Slot Optical Shelf Assembly	NTK603AAE5
	2	AF 6500 32-Slot Shelf Front Cooling Tray	NTK607AAE5
	1	AF 6500 32-Slot Shelf Front Air Filter	NTK603ZAE6
	1	AF 6500 Rel. 7.0 Shelf Processor (SP-2 with Dual CPU) Kit	NTZF06GAE5
	1	AF 6500 32-Slot Shelf Access Panel	NTK605MAE5
	2	AF 6500 32-Slot Shelf 3 x 60 AM Power Input Card (Breaker)	NTK605CAE5
	2	AF 6500 32-Slot Shelf X-CONN 640 G+ STS-1/VC-3 Sync-ST3 Circuit Pack	NTK610BBE5

Table 2-6. Hardware/Software Tested SUT Equipment (continued)

Hardware	QTY	Component Description	Part Number
AF 6500 ROADM OTS Node 2 (cont)	1	eDC40 G OCLD 1 x OTU3+ DWDM with Enhanced PMD Compensation Circuit Pack (1800 km reach & 25 PMD limit)	NTK539PAE5
	1	4 x 10G Mux OCI (OC-192/STM-64/10 GbE/OTU2/FC) XFP Circuit Pack	NTK525CFE5
	2	2 x 10G XFP, 8 x GbE SFP, FLEX MOTR Circuit Pack	NTK531YAE5
	2	Multirate 1528.38-1568.77 50 GHz DWDM XFP	NTK583AAE6
	4	OC-192 SR-1: I-64.1, 10G BASE-LR/LW,OTU2/10GFC 1200-SM-LL-L, 1310 nm, XFP, LC	NTTP84BA
	1	20 G L2SS with the I/O Panel Support	NTK531HAE5
	2	GbE 1000Base-SX 850 nm XCT Enhanced SFP Module - Rel. 1.0	NTTP01AFE6
	11	GbE 1000Base-LX 1310 nm XCT Enhanced SFP Module - Rel. 1.0	NTTP01CFE6
	4	OC-192 SR-1, STM-64 I-64.1, 10 G Base-LW/LR, OTU2 (1310 nm, SMF, 100 m), 0-70C XFP Module	NTTP83BA
	2	SuperMux 10 x SFP 24 x SFP I/O 10 G XFP	NTK535FAE5
	4	155M/622M SR 1310 nm (SR-1 /1-I4 XCT) Enhanced SFP Module - Rel. 1.2	NTTP04BFE6
	2	2.5 G SR 1310 nm (SR-1 / I-16.1 XCT Enhanced SFP Module) - Rel. 2.0	NTTP03BFE6
	2	100Base-FX FTM-3401C-SL2iCG-NT (-40 to +85℃)	NTTP12ACE6
	2	100Base-T ABCU-5710RZ-NT6 (0 to70℃)	NTTP61BAE6
	2	FC100 SM-L/FC200 SM-L/FC400 SM-L 1310 nm SFP	NTTP11CFE6
	2	CMD 44 x 100 GHz ITU spaced wavelengths in the C-Band	NTT862AAE5
	2	SLA Circuit Pack C-Band	NTK552AAE5
	2	MLA Circuit Pack C-Band	NTK552BAE5
	2	WSS 100 GHz with OPM C-Band	NTK553EAE5
	1	OSC with WSC 2-port SFP 2-port 10Base-T (Requires 1 or 2 pluggable)	NTK554BAE5
	2	OC-3/STM-1 CWDM 1511 nm SFP Module (0 - 15 dB span loss)	NTK592NPE6
	2	eDC100 G OCLD C-Band 1 x OTU4 DWDM Circuit Pack	NTK539TBE5
	2	10 x 10G OCI CP (for 100 G OTR)	NTK529BAE5
	2	10 x 10G SONET/OTN/GbE Mux 10 x XFP Circuit Pack	NTK529BBE5
AF 6500 7-Slot	1	AF 6500 7-Slot Shelf Assembly	NTK505PAE5
	1	AF 6500 7-Slot Shelf Cooling Module (4-Fan)	NTK507PAE5
	1	AF 6500 7-Slot Shelf Front Cover	NTK509CPE6
	1	Interface Filler Card - Rel. 1.0	NTK505YAE5
	1	OTSC 1 x 10 - 11.3G DWDM - Rel. 5.0	NTK528AAE5
	1	2 x 10G OTR with strong FEC and FC800/FC1200	NTK530PME5
	1	NGM WT OTU-2 10.7 G DWDM Pack - Premium Reach (1600 km) - Rel. 5.0	NTK530ACE5
	1	Multirate 1528.38 - 1568.77 50 GHz DWDM XFP	NTK583AAE6
	4	OC-192 SR-1: I-64.1,10 G Base-LR/LW, OTU2/10GFC 1200-SM-LL-L, 1310 nm, XFP, LC	NTTP84BA
	1	Serial 4-Channel Mux/Demux Group 2 (1534-1537 nm)	NTK508ABE5
	1	Line Interface Module circuit Pack (LIM)	NTK552DAE5
	1	AF 6500 7-Slot Shelf Assembly	NTK505PAE5
	1	AF 6500 7-Slot Shelf Cooling Module (4-Fan)	NTK507PAE5
	1	AF 6500 7-Slot Shelf Front Cover	NTK509CPE6
	1	Interface Filler Card - Rel. 1.0	NTK505YAE5
	1	OTSC 1 x 10 - 11.3G DWDM - Rel. 5.0	NTK528AAE5
	1	2 x 10G OTR with strong FEC and FC800/FC1200	NTK530PME5
	1	NGM WT OTU-2 10.7G DWDM Pack - Premium Reach (1600 km) - Rel. 5.0	NTK530ACE5
	1	Multirate 1528.38 - 1568.77 50 GHz DWDM XFP	NTK583AAE6
	4	OC-192 SR-1: I-64.1,10 G BASE-LR/LW, OTU2/10GFC 1200-SM-LL-L, 1310 nm, XFP, LC	NTTP84BA
	1	Serial 4-Channel Mux/Demux Group 2 (1534 - 1537 nm)	NTK508ABE5
	1	LIM Circuit Pack	NTK552DAE5

Table 2-6. Hardware/Software Tested SUT Equipment (continued)

LEGEND:

10Base-T	10 Mbps (Baseband Operation, Twisted Pair) Ethernet	LO	Low Order
100Base-T	100 Mbps (Baseband Operation, Twisted Pair) Ethernet	LR	Long Reach
1000Base-SX	1000 Mbps Fiber Optic GbE Over Multi-mode Fiber	LW	Light Weight
1000Base-LX	1000 Mbps Fiber Optic GbE Standard	m	meter
AF	ActivFlex	Mbps	Megabits per second
AM	Amplitude Modulation	NGM	Next Generation Modulation
AMP	Ampere	MLA	Mid-Stage Line Amplifier
BT	Base-T Ethernet standard - transmits at 100 Mbps	MOTR	Monitoring
CMD	Channel Mux Demux	Mux	Multiplexer
Cont	Continued	nm	nanometer
CP	Circuit Pack	OC	Optical Carrier
CPU	Central Processing Unit	OCI	Optical Channel Interface
CWDM	Coarse wavelength division multiplexing	OCLD	Optical Channel Laser Detector
dB	Decibel	OPM	Optical Power Management
Demux	De-Multiplexer	OSC	Optical Supervisory Channel
DS	Digital Signal	OTN	Optical Transport Network
DSM	DS1 Service Module	OTR	Optical Transponder
DWDM	Dense Wavelength Division Multiplexing	OTS	Optical Transport System
E-3	European Interface Standard	OTSC	Optical Transport System (CIENA)
EC	Electrical interface card	OTU	Optical Transport Unit
EPL	Ethernet Private Line	PMD	Power Management Device
FC	Fiber-optic Connector	QTY	Quantity
FEC	Forward Error Correction	Rel.	Release
F-NE	Fixed-Network Element	ROADM	Reconfigurable Optical Add/Drop Multiplexer
FLEX	Flexible	RPR	Resilient Packet Ring
FX	Fast Ethernet over Fiber Optics	SFP	Small Form-Factor
G	Gigabit	SLA	Single Line Amplifier
GbE	Gigabit Ethernet	SM	Software Module
GFC	Generic Flow Control	SMF	Small Module Form Factor
GHz	Gigahertz	SONET	Synchronous Optical Network
HF	High Flow	SP	Shelf Processor
I/O	Input/output	SR	Short Reach
IR	Intermediate Reach	STM	Synchronous Transmission Mode
ITU	International Telecommunication Union	STS	Synchronous Transport Signal
JSDH	Junction Synchronous Digital Hierarchy	SUT	System Under Test
km	Kilometer	VC	Virtual Concatenation
L2SS	Layer 2 Service Switch	VT	Voice Terminal
LC	Line Connection	XCIF	Cross Connect Interface
LIM	Line Interface Module	XCT	Cross Connect
LL	Long Line	XFP	Small Form Factor Pluggable
		WSC	Wavelength Selective Connector
		WSS	Wavelength Selective Switching
		WT	Web Technology

Table 2-7. Non-SUT Equipment

Component	Software Version	Function	Subcomponent
Cisco 15454	09.00-008I-17.17	MSPP	ETH 100T-12-G, OC-3IR-STM-1 SH-1310-8, OC-12IR-STM-4-1310-4, 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	ODXC	GPIC2 2 x OC-192/STM-64, GPIC 24 x OC-3-12/STM-1-4IR, GPIC2 8 x OC-48/STM-16, USC - OC-192 LR 2c LIM 1
Juniper T320 Router	9.2.R2.15	DISN Router	4 x FE 100Base-X, 10 x GbE LAN 1000Base-TX, 1 x OC-192 SM SR2, 1 x 10 GbE LAN, XENPAK
Cisco Catalyst 6500	12.1 (13)	DISN Router	48 Ethernet ports, 8 ports GbE, 2 ports 10 GbE

Table 2-7. Non-SUT Equipment (continued)

LEGEND:

100Base-X	100 Mbps Ethernet generic designation	LR	Long Reach
1000Base-TX	1000 Mbps GbE over Category 6, 7 twisted-pair cabling	Mbps	Megabits per second
		MSPP	Multi-Service Provisioning Platform
DISN	Defense Information System Network	OC	Optical Carrier
DS	Digital Signal	ODXC	Optical Digital Cross Connect
ETH	Ethernet	R	Revision
FE	Fast Ethernet	SM	Single Mode
GbE	Gigabit Ethernet	SR	Short Reach
GPIC	Gigabit Port Interface Controller	STM	Synchronous Transport Module
IR	Intermediate Reach	SUT	System Under Test
LAN	Local Area Network	USC	Universal Services Card
LIM	Line Interface Module	X	Place holder for FX or TX

Table 2. Test Equipment

Manufacturer	Type	Port Type	Software Version
Agilent	Optical Tester	1550 nm	A.06.01
		1310 nm	
	Router Tester 900	OC-3/OC-12/POS	6.11
		OC-48 Multilayer	
		1000Base-X	
Agilent	Rack Mounted Router Tester 900	10 GbE LAN/WAN	6.11
		10/100/1000Base-X	
		1000Base-X	
		OC-48c POS	
		OC-3/12/POS	
JDSU	T-Berd 8000	OC-192 POS	6.11
		DSU	6.4
		10/100/1000Base-X	
		OC-3-12	
		DS-3	
		OC-192	

LEGEND:

10/100/1000Base-X	10/100/1000 Mbps Ethernet generic designation	LAN	Local Area Network
		Mbps	Megabits per second
DS	Digital Signal	nm	nanometer
DSU	Data Services Unit	OC	Optical Carrier
GbE	Gigabit Ethernet	POS	Packet Over Synchronous Optical Network
JDSU	Vendor name	WAN	Wide Area Network

10. TEST LIMITATIONS. JITC's test facility at Indian Head, Maryland, does not have the capability to test Optical Transport Network (OTN) data rates. Vendor has provided letter of compliance (LoC) for the corresponding UC requirements.

11. INTEROPERABILITY EVALUATION RESULTS. The SUT meets the critical interoperability requirements for an OTS and an F-NE, and JITC certifies its joint use within the DISN. Additional discussion regarding specific testing results is contained in subsequent paragraphs.

11.1 Interfaces. The SUT's interface status is provided in Tables 2-10 and 2-11.

Table 2-9. SUT DISN OTS Interface Interoperability Status

Interface	Critical	Reference (UCR 2008, Change 2)	Threshold CR/FR Requirements (See note 1.)	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/STM-16.
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 GbE	Yes	5.5.3.2.5.1	1, 2, 4, 5, and 8	Certified	Met threshold CRs/FRs.
10 GbE LAN	Yes	5.5.3.2.5.1	1, 2, 4, 5, 6, and 8	Certified	Met threshold CRs/FRs.
10 GbE 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 100G	No	5.5.3.2.5.1	7 and 8	Certified	Met requirement based on vendor's LoC. (See note 3.)
OSC	Yes	5.5.3.2.8	7 and 8	Certified	Met threshold CRs/FRs.
Other					
10 x 10 GbE LAN	No	IEEE 802.3ae	9	Certified	See note 4.
10 x 10 GbE WAN	No	IEEE 802.3ae	9	Certified	See note 4.
10 x OC-192	No	GR-253	9	Certified	See note 4.
1 x 100 GbE	No	IEEE 802.3ba	9	Not Tested	See note 4.

NOTES:
1. The threshold CRs/FRs provide a high-level overview of applicable UCR requirements. For detailed applicability of UCR requirements, refer to Enclosure 3.
2. Due to the lab limitation of JITC test facility at Indian Head, Maryland, following OTN rates: ODU1, ODU2, and ODU3 did not undergo testing. However, according to vendor's Loc, the SUT meets the corresponding UCR.
3. This is a conditional requirement which requires the vendor to have a plan to support an OTN 100G interface. The vendor has claimed it supports a 100G user-side interface; however, due to unavailability, JITC did not test the 100G client interface.
4. JITC tested 10 x 10 GbE LAN/WAN and 10 x OC-192 interfaces at the client side and 100G DWDM at the network side. The SUT supports a 1 x 100 GbE interface, but the SUT tested configuration did not have 1 x 100 GbE client interface; therefore, JITC did not test it.

LEGEND:

CR	Capability Requirement	ODU	Optical Data Unit
DISN	Defense Information Systems Network	OSC	Optical Supervisory Channel
FR	Functional Requirement	OTN	Optical Transport Network
GbE	Gigabit Ethernet	OTS	Optical Transport System
IEEE	Institute of Electrical and Electronic Engineers	PMO	Program Management Office
JITC	Joint Interoperability Test Command	STM	Synchronous Transport Module
LAN	Local Area Network	SUT	System Under Test
LoC	Letters of Compliance	UCR	Unified Capabilities Requirements
OC	Optical Carrier	WAN	Wide Area Network

Table 2-10. SUT F-NE Interface Requirements Status

Interface	Critical (See note.)	Reference (UCR 2008, Change 2)	Threshold CR/FR	Status	Remarks
NE					
Analog	No	5.9.3.2.1	1, 2, and 4	NA	Not supported by the SUT.
Serial	No	5.9.2.3.2	1, 2, and 4	NA	Not supported by the SUT.
BRI ISDN	No	5.9.2.3.3	1, 2, and 4	NA	Not supported by the SUT at egress.
DS1	No	5.9.2.3.4	1, 2, 3, and 4	Certified	SUT met requirements for specified interfaces.
E1	No	5.9.2.3.5	1, 2, 3, and 4	NA	Not supported by the SUT.

Table 2-10. SUT F-NE Interface Requirements Status (Continued)

Interface	Critical (See note)	Reference (UCR 2008, Change 2)	Threshold CR/FR	Status	Remarks
NE (cont)					
DS3	No	5.9.2.3.6	1, 2, 3, and 4	Certified	SUT met requirements for specified interfaces.
OC	No	5.9.2.3.8	1, 2, 3, and 4	Certified	SUT met requirements for OC-3/12/48/192/768 interfaces. SUT also met requirements for STM-1/4/16/64/256 interfaces.
IP (Ethernet)	No	5.9.2.3.9	1, 2, 4, 6, and 7	Certified	SUT met requirements for 10/100/1000 and 10 GbE.
NM					
10Base-X	Yes	5.3.2.4.4	8	Certified	SUT met NM requirements for specified interfaces
100Base-X	Yes	5.3.2.4.4	8	Certified	

NOTE: UCR does not specify any minimum interfaces. The SUT must minimally provide one of the listed ingress and egress interfaces specified.

LEGEND:

10Base-X	10 Mbps Ethernet generic designation	IP	Internet Protocol
100Base-X	100 Mbps Ethernet generic designation	ISDN	Integrated Services Digital Network
BRI	Basic Rate Interface	Mbps	Megabits per second
CR	Capability Requirement	NA	Not Applicable
DS1	Digital Signal Level 1 (1.544 Mbps)	NE	Network Element
DS3	Digital Signal Level 3 (44.736 Mbps)	NM	Network Management
E1	European Interface Standard (2.048 Mbps)	OC	Optical Carrier
F-NE	Fixed Network Element	SUT	System Under Test
FR	Functional Requirement	STM	Synchronous Transport Module
GbE	Gigabit Ethernet	UCR	Unified Capabilities Requirements

11.2 CR and FR. Tables 2-12 and 2-13 list the SUT's CR/FR status. Tables 3-1 and 3-2 of Enclosure 3 provide the detailed CR/FR requirements.

Table 2-11. SUT DISN OTS CRs and FRs Status

CR/FR ID	Capability/Function	Applicability (See notes 1 and 2.)	Reference (UCR 2008, Change 2)	Status	Remarks (See note 3.)
1	**Requirements Applicable to all OTS Elements**				
	Overall Requirements	Required	5.5.3.2.2.1	Partially Met	See note 4.
	Performance Requirements	Required	5.5.3.2.2.2	Met	
	Reliability and Quality Assurance	Required	5.5.3.2.2.2.1	Partially Met	See note 5.
	Common Physical Design Requirements	Required	5.5.3.2.2.3	Partially Met	See note 6.
	Protection and Restoration	Required	5.5.3.2.2.4	Met	
2	**Optical Amplifier Requirements**				
	Optical Amplifier Requirements	Required	5.5.3.2.3	Partially Met	See note 7.
	OLA Physical Design Requirements	Required	5.5.3.2.3.1	Partially Met	See note 8.
3	**Muxponder Requirements**				
	Muxponder	Required	5.5.3.2.4	Met	
4	**Transponder Requirements**				
	Transponder	Required	5.5.3.2.5	Partially Met	See note 9.
	Interface Requirements	Required	5.5.3.2.5.1	Partially Met	See note 10.

Table 2-11. SUT DISN OTS CRs and FRs Status (continued)

CR/FR ID	Capability/Function	Applicability (See notes 1 and 2.)	Reference (UCR 2008, Change 2)	Status	Remarks
5	**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	Met	
6	**Requirements Common to Transponder and ROADM**				
	Framed Formats	Required	5.5.3.2.7.1	Partially Met	See note 12.
	Unframed Formats	Required	5.5.3.2.7.2	Met	
7	**Optical Supervisory Channel Requirements**				
	Optical Supervisory Channel	Required	5.5.3.2.8	Partially Met	See note 13.
8	**OTS Standards Compliance Requirements**				
	OTS Standards Compliance	Required	5.5.3.2.9	Met	See note 14.
9	**100G Sponsor Requirements**				
	100G IP Transport	Conditional	IEEE 802.3ae/ba GR-253	Met	See note 10.

NOTES:
1. Annotation of "required" refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.
2. DISA requested the SUT be assessed against UCR 2008, Section 5.5, as an OTS device.
Notes 4 through 13 contain details of discrepancies have been adjudicated by the DISA Adjudication Board and the Sponsor.
4. The UCR requires 150 km/50 dB span loss, but the SUT only supports 150+ km/44 dB span loss.
5. The SUT software development process does not comply directly with the Reliability and Quality Acceptance Criteria.
6. The SUT does not support capability to roll back to the previous operational version of software, required operating altitude, interoperability with deployed GIG-BE operational software versions, software upgraded in a modular fashion, and a fully accessible file system.
7. The SUT's internal OSA does not support 25 GHz ITU grid spacing and reporting of Noise level, Q-Factor, OSNR for each wavelength, and Optical Eye Diagram. The Unified Capabilities adjudication panel recommended changing all the internal OSA requirements in UCR to conditional. In addition, the SUT does not support automatic monitoring and reporting on the operation of the Raman pumping lasers, including power on, off, optical output power, and operating current and total Optical Return Loss, but it supports Raman pump failure alarm. Also, Raman output power and line power can be monitored from two external monitor ports.
8. A fully configured SUT OLA site may consume more than the specified 2000 watts.
9. The SUT does not support built-in self-BER test function and not all transponders support user-selectable FEC.
10.JITC tested 10 x 10 GbE LAN/WAN and 10 x OC-192 interfaces at the client side and 100G DWDM at the network side. The SUT supports a 1 x 100 GbE interface, but the SUT tested configuration did not have a 1 x 100 GbE client interface; therefore, JITC did not test it.
11. The SUT ROADM did not support colorless wavelength routing at the time of testing.
12. The SUT does not support alien wavelength regeneration.
13. This section is verifying SUT compliance to a list of industry standards via vendor's LoC. JITC reviewed and accepted the vendor's LoC.

LEGEND:

BER	Bit Error Rate	ITU	International Telecommunication Union
CR	Capability Requirement	JITC	Joint Interoperability Test Command
dB	Decibel	km	kilometer
DISA	Defense Information Systems Agency	LAN	Local Area Network
DISN	Defense Information System Network	LoC	Letter of Compliance
DWDM	Dense Wavelength Division Multiplexing	OC	Optical Carrier
FEC	Forward Error Correction	OLA	Optical Line Amplifier
FR	Functional Requirement	OSA	Optical Spectrum Analyzer
G	Gigabit	OSNR	Optical Signal to Noise Ratio
GbE	Gigabit Ethernet	OTS	Optical Transport System
GHz	Gigahertz	Q-Factor	Quality Factor
GIG-BE	Global Information Grid – Bandwidth Expansion	ROADM	Reconfigurable Optical Add/Drop Multiplexer
GR	Generic Requirement	SUT	System Under Test
ID	Identification	UCR	Unified Capabilities Requirements
IEEE	Institute of Electrical and Electronics Engineers	WAN	Wide Area Network
IP	Internet Protocol		

Table 2-12. SUT F-NE CRs and FRs Status

CR/FR ID	Capability/ Function	Applicability (See note.)	Reference (UCR 2008, Change 2)	Status	Remarks
F-NE CR/FR					
1	**General NE Requirements**				
	General Requirements	Required	5.9.2.1	Met	
	Alarms	Required	5.9.2.1.1	Met	
	Congestion Control & Latency	Required	5.9.2.1.2	Met	
2	**Compression**				
	G.726	Conditional	5.9.2.2	NA	Not supported by the SUT
	G.728	Conditional	5.9.2.2	NA	Not supported by the SUT
	G.729	Conditional	5.9.2.2	NA	Not supported by the SUT
3	**Interface Requirements**				
	Timing	Required	5.9.2.3.7	Met	
4	**Device Management**				
	Management Options	Required	5.9.2.4.1	Met	
	Fault Management	Conditional	5.9.2.4.2	Met	
	Loop-Back Capability	Conditional	5.9.2.4.3	Met	
	Operational Configuration Restoral	Required	5.9.2.4.4	Met	
5	**DLoS**				
	DLoS Transport	Conditional	5.9.2.4.5	NA	Not supported by the SUT
6	**IPv6 Requirements**				
	Product Requirements	Required	5.3.5.4	Met	SUT is a Layer-2 device and transports IPv4 and IPv6 traffic transparently
7	**NM Requirements**				
	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	
	General Management Requirements	Required	5.3.2.17.2	Met	

NOTE: Annotation of "required" refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.

LEGEND:

ADPCM	Adaptive Differential Pulse Code Modulation	IPv6	Internet Protocol version 6
CR	Capability Requirement	ITU-T	International Telecommunication Union – Telecommunication
CS-ACELP	Conjugate Structure-Algebraic Code Excited Linear Prediction	kbps	kilobits per second
DLoS	Direct Line of Sight	LD-CELP	Low Delay-Code Excited Linear Prediction
F-NE	Fixed-Network Element	NA	Not Applicable
FR	Functional Requirement	NE	Network Element
G.726	ITU-T speech codec for ADPCM (32 kbps)	NM	Network Management
G.728	ITU-T speech codec for LD-CELP (16 kbps)	NMS	Network Management System
G.729	ITU-T speech codec for CS-ACELP (8 kbps)	SUT	System Under Test
ID	Identification	UCR	Unified Capabilities Requirements
IPv4	Internet Protocol version 4	VVoIP	Voice and Video over Internet Protocol

a. DISN OTS CRs and FRs Status.

(1) Requirements Applicable to all OTS Elements

(a) Overall Requirements. In Accordance With (IAW) UCR 2008, Change 2, paragraph 5.5.3.2.2.1, an OTS must provide generally accepted commercial requirements. Within this section, there are 15 required and 2 conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted Letter of Compliance (LoC), with the following exception: The 50 Decibel (dB) span loss requirement is not supported by the SUT; however, the SUT supports 44 dB span loss. Defense Information Systems Agency (DISA) Adjudication Board and sponsor adjudicated this Test Deficiency Report (TDR) as having a minor operational impact.

(b) Performance Requirements. IAW UCR 2008, Change 2, paragraph 5.5.3.2.2.2, an OTS must provide generally accepted commercial requirements. Within this section, there are seven required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC.

(c) Reliability and Quality Assurance. IAW UCR 2008, Change 2, paragraph 5.5.3.2.2.2.1, an OTS must provide generally accepted commercial requirements. Within this section, there are two required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC, with the following exception: The SUT software development process does not comply directly with the reliability and quality acceptance criteria. The DISA Adjudication Board and sponsor adjudicated this TDR as having a minor operational impact.

(d) Common Physical Design Requirements. IAW UCR 2008, Change 2, paragraph 5.5.3.2.2.3, an OTS must provide generally accepted commercial requirements. Within this section, there are 46 required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC. However, the SUT had the following exceptions: the SUT does not support capability to roll back to the previous operational version of software, required altitude, interoperability with deployed Global Information Grid – Bandwidth Expansion operational software versions, software upgraded in a modular fashion, and a fully accessible file system. The DISA Adjudication Board and sponsor adjudicated this TDR as having a minor operational impact.

(e) Protection and Restoration. IAW UCR 2008, Change 2, paragraph 5.5.3.2.2.4, an OTS must provide generally accepted commercial requirements. Within this section, there are two required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC.

(2) Optical Amplifier Requirements

(a) Optical Amplifier. IAW UCR 2008, Change 2, paragraph 5.5.3.2.3, an OTS must provide generally accepted commercial requirements. Within this section, there are 27 required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC. However, the SUT had the following exceptions: The SUT's internal Optical Spectrum Analyzer (OSA) does not support 25 Gigahertz International Telecommunication Union grid spacing and reporting of noise level, Quality-Factor, Optical Signal to Noise Ratio for each wavelength, and Optical Eye Diagram. The Unified Capabilities adjudication panel recommended changing all the internal OSA requirements in the UCR to conditional. In addition, the SUT does not support automatic monitoring and reporting on the operation of the Raman pumping lasers, including power on, off, optical output power, and operating current and total Optical Return Loss, but it supports Raman pump failure alarm. Also, Raman output power and line power can be monitored from two external monitor ports. The DISA Adjudication Board and sponsor adjudicated this TDR as having a minor operational impact.

(b) Optical Line Amplifier (OLA) Physical Design Requirements. IAW UCR 2008, Change 2, paragraph 5.5.3.2.3.1, an OTS must provide generally accepted commercial requirements. Within this section, there are six required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC, with the following exceptions: The SUT OLA site in full configuration may consume more than 2000 watts of power. The DISA Adjudication Board and Sponsor adjudicated this TDR as having a minor operational impact.

(3) Muxponder Requirements. IAW UCR 2008, Change 2, Section 5.5.3.2.4, an OTS must provide generally accepted commercial requirements. Within this section, there are 12 required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC.

(4) Transponder Requirements

(a) Transponder Requirements. IAW UCR 2008, Change 2, paragraph 5.5.3.2.5, an OTS must provide generally accepted commercial requirements. Within this section, there are 13 required and 2 conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC, with the following exceptions: The SUT does not support Built-in self-Bit Error Rate (BER) test function, and not all transponders support user-selectable Forward Error Corrections. The DISA Adjudication Board and Sponsor adjudicated this TDR as having a minor operational impact.

(b) Interface Requirements. IAW UCR 2008, Change 2, paragraph 5.5.3.2.5.1, an OTS must provide generally accepted commercial requirements. Within

this section, there are 10 required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC, with the following exceptions: JITC tested 10 x 10 GbE LAN/WAN and 10 x OC-192 interfaces at the client side and 100 Gigabit Dense Wave Division Multiplexing at the network side. The SUT supports a 1 x 100 GbE interface, but the SUT tested configuration did not have a 1 x 100 GbE client interface; therefore, JITC did not test it. The DISA Adjudication Board and Sponsor adjudicated this TDR as having a minor operational impact.

(5) ROADM

(a) ROADM Requirements. IAW UCR 2008, Change 2, paragraph 5.5.3.2.6, an OTS must provide generally accepted commercial requirements. Within this section, there are 32 required and no conditional/desired requirements. The SUT met all the corresponding UCR requirements except colorless wavelength routing; JITC verified via interoperability testing and a vendor-submitted LoC, with the following exceptions: The SUT ROADM did not support colorless wavelength routing at the time of testing. The DISA Adjudication Board and Sponsor adjudicated this TDR as having a minor operational impact.

(b) ROADM Specific Physical Design Requirements. IAW UCR 2008, Change 2, paragraph 5.5.3.2.6.1, an OTS must provide generally accepted commercial requirements. Within this section, there are eight required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC.

(6) Requirements Common to Transponder and ROADM

(a) Framed Formats. IAW UCR 2008 Change 2, paragraph 5.5.3.2.7.1, an OTS must provide generally accepted commercial requirements. Within this section, there are eight required and one conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC, with the following exception: The SUT does not support alien wavelength regeneration. The DISA Adjudication Board and sponsor adjudicated this TDR as having a minor operational impact.

(b) Unframed Formats. IAW UCR 2008 Change 2, paragraph 5.5.3.2.7.2, an OTS must provide generally accepted commercial requirements. Within this section, there are two required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted LoC.

(7) Optical Supervisory Channel. IAW UCR 2008 Change 2, Section 5.5.3.2.8, an OTS must provide generally accepted commercial requirements. Within this section, there are 12 required and no conditional/desired requirements. The SUT met all the UCR requirements; JITC verified via interoperability testing and a vendor-submitted

LoC, with the following exception: The 50 dB span loss requirement is not supported by the SUT; however, the SUT supports 44 dB span loss. The DISA Adjudication Board and Sponsor adjudicated this TDR as having a minor operational impact.

(8) OTS Standards Compliance Requirements. IAW UCR 2008 Change 2, paragraph 5.5.3.2.9, an OTS must provide generally accepted commercial requirements. Within this section, there are 27 required and no conditional/desired requirements. This section is verifying SUT compliance to a list of industry standards via vendor's LoC. JITC has reviewed and accepted the vendor's LoC.

b. SUT F-NE CRs and FRs Status

(1) General Network Elements (NE) Requirements

(a) General Requirements. IAW UCR 2008, Change 2, Section 5.9.2.1, all NEs shall meet the following general requirements and conditions:

1. The introduction of an NE(s) shall not cause the End-to-End (E2E) average Mean Opinion Score (MOS) to fall below 4.0 as measured over any 5-minute time interval. The SUT met the MOS requirement as measured using test equipment and simulated voice information exchanges.

2. The introduction of an NE(s) shall not degrade the E2E measured BER to no more than .03 percent from the baseline minimum E2E digital BER requirement, which is not more than one error in $1x10^9$ bits (averaged over a 9-hour period). The SUT met the requirement as measured using test equipment and simulated information exchanges.

3. The introduction of an NE(s) shall not degrade secure transmission for secure end devices as defined by UCR 2008, Change 2, Section 5.2.12.6, and DoD Secure Communications Devices. JITC tested secure information exchanges by using DoD Secure Communications Devices such as Secure Telephone Unit/Secure Terminal Equipment devices with no noted issues.

4. The NE(s) shall support a minimum modem transmission speed of 9.6 kilobits per second (kbps) across the associated NE(s). JITC tested this information exchange by using a modem and simulated information exchange with no noted issues.

5. The NE(s) shall support a minimum facsimile transmission speed of 9.6 kbps across the associated NE(s). JITC tested this information exchange by using a facsimile and simulated information exchanges with no noted issues.

6. The NE shall transport all call control signals transparently on an E2E basis. JITC tested this information exchange by using an actual call control signals via a Private Branch Exchange T-Carrier calls and simulated information exchanges with no noted issues.

(b) Alarms. The NE shall provide the capability of detecting a Carrier Group Alarm (CGA). NEs that support IP ingress/egress traffic either as inbound or outbound NE traffic and/or transport between NE(s) shall support one or more of the following routing protocols. The Link-State and/or Distance-Vector, such that the NE can notify the IP network (e.g., LAN, Metropolitan Area Network) the condition of its link state for transporting ingress IP traffic, namely operational or down. The SUT is a Layer-2 device and it passes all the routing protocols and IP link states transparently between connecting end equipments, and it propagates all CGA with no noted issues. In addition, it provides loss of signal alarm in case of loss of connectivity events for connecting end equipment.

(c) Congestion Control and Latency. IAW UCR 2008, the NE shall ensure that congestion and latency between paired NEs does not affect DISN calls in progress or subsequent calls. Call congestion and latency requirements are as follows:

1. TDM Transport. The SUT is a Layer-2 device and the SUT provides transparent TDM Transport. Therefore, the following TDM transport requirements are not applicable to the SUT. These requirements are the responsibility of connecting end equipment.

a. A dynamic load control signal (e.g., contact closure) shall be provided to the DISN switch.

b. Congestion is not possible in the NE by nature of its functioning (e.g., a TDM multiplexer or transcoder).

c. A software capability in limiting the provisioning the ingress and egress interfaces making congestion impossible even under the worst congestion scenario. This can be done by limiting the bearer or aggregate provisioning.

d. TDM Transport Latency. The addition of NEs with TDM transports shall not increase the one-way latency per NE pair when measured from E2E over any 5-minute period specified as follows:

(1) TDM ingress G.711 (nonsecure calls) to non-transcoding G.711 TDM egress shall not increase delay more than 10 milliseconds (ms) per NE pair as measured E2E.

(2) TDM ingress G.711 (nonsecure calls) to transcoding TDM egress with compression codes shall not increase delay by more than 100 ms per NE pair as measured E2E.

(3) TDM ingress G.711 (secure calls) to non-transcoding TDM egress G.711 shall not increase delay by more than 50 ms per NE pair as measured E2E.

(4) TDM ingress G.711 (secure calls) to transcoding TDM egress with compression codes shall not increase delay by more than 250 ms per NE pair as measured E2E.

2. IP Transport. The NE(s) using IP transport shall implement IP congestion control. Congestion may be controlled by using Differentiated Services, which shall be capable of providing preferential treatment for call congestion over other media types and a capability to limit the provisioning of input, and output interfaces so that congestion is impossible under the worst transport congestion scenario. The IP interface parameters subject to ingress/egress requirements shall be met. The SUT is a Layer-2 device and it passes all IP traffic transparently. Therefore, none of the above IP transport requirement is applicable to the SUT; instead, those are responsibility of connecting end equipment.

3. Direct Line of Sight (DLoS) Transport. The SUT does not provide DLoS Transport.

(2) Compression. The SUT does not support compression.

(3) Interface Requirements. The NE shall be able to derive timing signal from an internal source, an incoming digital signal, or an external source. This requirement applies to TDM interfaces only; IP interfaces do not need to meet this requirement.

(4) Device Management. The SUT shall provide the following device management functions:

(a) Management Options. The NE devices are to be managed by at least one of the following:

(1) A front or back panel and/or external console control capability shall be provided for local management, and SUT supports only external console control capability. The SUT provides an external console capability.

(2) Remote monitoring and management by the Advanced DISN Integrated Management Support System (ADIMSS). JITC did not verify management of the SUT by ADIMSS.

(b) Fault Management. The SUT may (conditional) report any failure of self-test diagnostic function on non-active and active channels on a noninterference basis to the assigned Network Management System (NMS). JITC verified this conditional capability via Network Management (NM) testing.

(c) Loop-Back Capability. This requirement applies to TDM interfaces only; the SUT does provide loop-back capabilities via its all interfaces.

(d) Operational Configuration Restoral. Loss of power should not remove configuration settings. The SUT shall restore to the last customer-configured state before the power loss, without intervention when power is restored. JITC verified this capability via NM testing.

(5) DLoS. DLoS Transport. The SUT does not provide DLoS Transport.

(6) Internet Protocol version 6 (IPv6) Requirements. Product Requirements. The SUT must meet UCR 2008, Change 2, Section 5.3.5.4, IPv6 requirements for Network Appliance/Simple Server. The SUT is a Layer-2 device and transports IPv4 and IPv6 traffic transparently so requirements relating to Layer-3 do not apply.

(7) NM Requirements. JITC verified the following NM requirements by connecting the NMS to the SUT via all required interfaces and verified via utilization of NMS for performing test configurations, for performing alarms monitoring, and for performing fault management.

(a) Voice and Video over Internet Protocol (VVoIP) NMS Interface Requirements. The physical interface between the DISA VVoIP Element Management System (EMS) and the network components (i.e., Local Session Controller, Multifunction Soft Switch, Edge Boundary Controller, Customer Edge Router is a 10/100 Megabits per second Ethernet interface. The interface will work in either of the two following modes using auto-negotiation: Institute of Electrical and Electronics Engineers (IEEE), Ethernet Standard 802.3, 1993; or IEEE, Fast Ethernet Standard 802.3u, 1995.

(b) General Management Requirements. The SUT must support Simple Network Management Protocol version 3 format. A network appliance shall have Operations interfaces that provide a standard means by which management systems can directly or indirectly communicate with and, thus, manage the various network appliances in the DISN. The physical interface between the Local EMS and the VVoIP network components shall be an Ethernet connection IAW UCR 2008, Change 2, paragraph 5.3.2.4.4, VoIP NMS Interface Requirements. The physical interface between the VVoIP EMS and the VVoIP network components shall also be an Ethernet connection IAW UCR 2008, Change 2, paragraph 5.3.2.4.4. There shall be a local craftsperson interface (Craft Input Device for Operations Administration and Management) for all VVoIP network components.

11.3 Other. JITC conducted additional tests on the SUT. Table 2-14 shows the Additional Interface Requirements under IEEE 802.3ae.

Table 2-13. Other SUT Interface Requirements

Interface	Critical	Reference (UCR 2008, Change 2)	Threshold CR/FR Requirements (See note 1.)	Status	Remarks
Other					
10 x 10 GbE LAN	No	IEEE 802.3ae	9	Certified	See note 2.
10 x 10 GbE WAN	No	IEEE 802.3ae	9	Certified	See note 2.
10 x OC-192	No	GR-253	9	Certified	See note 2.
1 x 100 GbE	No	IEEE 802.3ba	9	Not Certified	See note 2.

NOTES:
1. The threshold CRs/FRs provide a high-level overview of applicable UCR requirements. For detailed applicability of UCR requirements, refer to Enclosure 3.
2. JITC tested 10 x 10 GbE LAN/WAN and 10 x OC-192 interfaces at client side and 100 GbE DWDM at the network side. The SUT supports 1 x 100 GbE interface, but the SUT tested configuration did not have a 1 x 100 GbE client interface; therefore, JITC did not test it.

LEGEND:

CR	Capabilities Requirement	JITC	Joint Interoperability Test Command
DWDM	Dense Wavelength Division Multiplexing	LAN	Local Area Network
FR	Functional Requirement	OC	Optical Carrier
GbE	Gigabit Ethernet	SUT	System Under Test
GR	Generic Requirement	UCR	Unified Capabilities Requirements
IEEE	Institute of Electrical and Electronics Engineers	WAN	Wide Area Network

12. TEST AND ANALYSIS REPORT. IAW the Program Manager's request, no detailed test report was developed. JITC distributes interoperability information via the JITC Electronic Report Distribution system, which uses Unclassified-But-Sensitive Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program (STP). The STP is accessible by .mil/gov users 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 APL testing is available on the APL Testing and Certification website at http://www.disa.mil/Services/Network-Services/UCCO.

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OPTICAL TRANSPORT SYSTEM (OTS) FUNCTIONAL AND CAPABILITY REQUIREMENTS

The OTS has required and conditional features and capabilities established by the Unified Capabilities Requirements. The SUT need not provide conditional requirements; however, If they are provided, they must function according to the specified requirements. The detailed Functional requirements and Capability Requirements for OTS are listed in Table 3-1. Detailed information assurance requirements included in Reference (e) are not listed below.

Table 3-1. OTS Capability/Functional Requirements Table

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
1	The OTS family of equipment shall be currently available, COTS equipment.	5.5.3.2.2.1 (1)	R
2	The OTS shall support a minimum of 80 ITU-T Recommendation 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 Recommendation 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: 10 Gbps, 40 Gbps, and 100 Gbps.	5.5.3.2.2.1 (4)	R
5	The OTS shall use the ITU-T specified OSC for out of-band management communication.	5.5.3.2.2.1 (5)	C
6	The OTS shall support all specified wavelengths for all specified bit rate and signal format.	5.5.3.2.2.1 (6)	R
7	The OTS shall support at least standard single mode fiber (ITU-T Recommendation G.652), non-zero dispersion shifted fibers C (ITU-T Recommendation G.655) such as TrueWave-RS®, TrueWave Classic (TWC, TW+), E-LEAF or LEAF.	5.5.3.2.2.1 (7)	R
8	The OTS shall support the ability of 80, 10 Gbps wavelengths to traverse a minimum of five ROADM using fibers specified previously for a minimum reach of 2,000 km without regeneration (OEO conversion) at a BER less than 1×10^{-15}.	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 previously for a minimum reach of 1,500 km without regeneration (OEO conversion) at a BER less than 1×10^{-15}.	5.5.3.2.2.1 (9)	R
1	The OTS shall support the ability of 80, 100G wavelengths to traverse a minimum of five ROADM using fibers specified previously for a minimum reach of 1,200 km without regeneration (OEO conversion) at a BER less than 1×10^{-15}.	5.5.3.2.2.1 (10)	R
2	The OTS shall support span length up to 150 km and span loss up to 50 dB. The reach shall not be limited by OSC performance.	5.5.3.2.2.1 (11)	R
12	The OTS shall allow the remote configuration of wavelengths added or dropped from the system.	5.5.3.2.2.1 (12)	R
13	Client interfaces available on the OTS shall meet the accepted standards or specifications for the interface (e.g., OC-192 Telcordia Technologies GR-253-CORE standards, STM-16 and STM-64 ITU-T Recommendations G.707 standards, and GbE and 10 GbE IEEE 802.3 standards).	5.5.3.2.2.1 (13)	R
14	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 (14)	R
15	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 (15)	R
16	The OTS shall enable pre- and post-dispersion compensation options, at all nodes (terminals, ROADMs, and OLAs).	5.5.3.2.2.1 (16)	R
17	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 (17)	R
18	Jitter tolerance shall comply with Telcordia Technologies GR-253 Type II and ITU-T G.958.	5.5.3.2.2.2 (1)	R

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

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
19	Jitter transfer shall comply with Telcordia Technologies GR-253 and ITU-T G.958.	5.5.3.2.2.2 (2)	R
20	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
21	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
22	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
23	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
24	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
25	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
26	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
27	All equipment to be deployed in the central office environment, regardless of application, must comply with the requirements of this section. Mission criticality or presence of network traffic bring other criteria into play, but this set must always be present to protect the people working inter-facility and the other more critical equipment.		
28	Each OTS element shall meet requirements addressed in this document and shall have met EC or 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
29	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
30	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
31	Equipment racks' weight shall be within generally acceptable standards defined for raised floor application.	5.5.3.2.2.3 (4)	R
32	Equipment racks shall allow cable installation above and below each rack.	5.5.3.2.2.3 (5)	R
33	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
34	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
35	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 Reference (UCR 2008 CH 2)	R/C
36	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
37	A and B power cables shall have physically diverse routing within the bay/cabinet.	5.5.3.2.2.3 (10)	R
38	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
39	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
40	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
41	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
42	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
43	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
44	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
45	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
46	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
47	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
48	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
49	All OTS elements shall be fully NEBS, Level 3 compliant.	5.5.3.2.2.3 (22)	R
50	All OTS elements shall meet the environmental conditions described in Telcordia Technologies GR-63-CORE.	5.5.3.2.2.3 (23)	R
51	All OTS elements shall meet the environmental conditions described in ETSI ETS-300-019.	5.5.3.2.2.3 (24)	R
52	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
53	All OTS elements shall meet the EMC/EMI requirements defined in: Telcordia Technologies GR-1089-CORE EMC and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.	5.5.3.2.2.3 (26)	R
54	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 Reference (UCR 2008 CH 2)	R/C
55	All OTS elements shall meet the EMC/EMI requirements defined in ETS EN 50082.	5.5.3.2.2.3 (28)	R
56	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
57	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
58	All OTS elements shall be designed to operate continuously in the following environment ranges without degradation. Temperature: 0 to +50℃, Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.3 (31)	R
59	All OTS elements shall be designed to be operational after transportation and/or storage in the following environment ranges: Temperature: –40 to +70℃, Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.3 (32)	R
60	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
61	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
62	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
63	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
64	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
65	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
66	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
67	The OTS shall provide the capability to roll back to the previous operational version of software.	5.5.3.2.2.3 (40)	R
68	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
69	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
70	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
71	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
72	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
73	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
74	OTS shall support 1+1 wavelength protection and restoration	5.5.3.2.2.4 (1)	R
75	The "Active" and "Standby" wavelengths shall be diversely routed.	5.5.3.2.2.4 (2)	R
76	The system shall support the use of an optical connector for connecting 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

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

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
77	The total optical power emitted from the OTS to be coupled into the fiber, shall not exceed the power limit of IEC Class 3B (+27 dBm).	5.5.3.2.3 (2)	R
78	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
79	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
80	(Reserved)	5.5.3.2.3 (5)	R
81	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
82	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
83	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
84	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
85	The power management algorithm shall cause no interruptions in OSC communications at any time.	5.5.3.2.3 (10)	R
86	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
87	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
88	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
89	Chromatic dispersion compensation shall be able to fully compensate a 150 km span for each fiber type, as specified in Section 5.5.3.1, Fiber Plant.	5.5.3.2.3 (14)	R
90	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
91	The OTS shall enable pre- and post- dispersion compensation options.	5.5.3.2.3 (16)	R
92	A secured external monitor port is required at each OA. For devices that contain a full-featured internal OSA, an external monitor port shall still be required.	5.5.3.2.3 (17)	R
93	Internal OSA functionality shall support 25 GHz ITU grid spacing with minimum 5 percent wavelength accuracy.	5.5.3.2.3 (18)	C
94	Internal OSA functionality shall provide a minimum accuracy of 0.2 dB for each wavelength.	5.5.3.2.3 (19)	R
95	Internal OSAs shall provide sweep times of less than 1 second.	5.5.3.2.3 (20)	R
96	Internal OSAs shall provide the ability to display all wavelengths simultaneously.	5.5.3.2.3 (21)	R
97	Internal OSAs shall provide the ability to retrieve data to be stored at a remote storage site.	5.5.3.2.3 (22)	R
98	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
99	Internal OSAs shall provide the ability to report Quality factor (not critical).	5.5.3.2.3 (24)	R
100	Internal OSAs shall have the ability to estimate OSNR for each wavelength.	5.5.3.2.3 (25)	R
101	All measurements made available at the internal OSA shall be available at the external OSA port (not critical).	5.5.3.2.3 (26)	R
102	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
103	The OLA shall support redundant Fans management interfaces power supplies control processors	5.5.3.2.3.1 (2)	R
104	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

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

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
105	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
106	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
107	The vendor shall identify their OLA power and space requirements for all specified configurations.	5.5.3.2.3.1 (6)	R
108	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
109	The OTS shall support a 4:1 40G 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
110	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
111	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
112	The 4:1 40G MUX shall transfer the OC-192/STM-64 signals through the system transparently.	5.5.3.2.4 (5)	R
113	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
114	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
115	An OC-48/STM-64 through the OTS that is MUXed and DEMUXed 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, ES, SES, and Availability.	5.5.3.2.4 (8)	R
116	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
117	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
118	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
119	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
120	Transponders shall comply with the DWDM wavelength grid as specified in ITU-T G.694.1.	5.5.3.2.5 (1)	R
121	Transponders shall support tunable lasers, which are tunable over whole band.	5.5.3.2.5 (2)	R
122	All transponders shall support built-in self BER test function	5.5.3.2.5 (3)	R
123	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
124	All transponders shall support total E2E signal propagation delay (at transponder ingress to egress) reporting function.	5.5.3.2.5 (5)	C
125	All transponders shall support user selectable line side FEC; 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
126	Transponders shall support ITU-T G.709 specifications for OTN services.	5.5.3.2.5 (7)	R
127	Transponders shall support switching of framing protocols (OTN, SONET, 10 GbE, etc.) without requiring downloading or switching firmware/software and physical removal of the transponder from the slot.	5.5.3.2.5 (8)	R
128	Transponders shall have non-intrusive SONET/SDH B1 monitoring capability	5.5.3.2.5 (9)	R

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

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
129	Transponder shall have integrated EDC for all specified fiber types to support minimum un-regenerated reach of 2000 km.	5.5.3.2.5 (10)	C
130	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
131	The vendor shall provide a transponder to interface with 10/40/100Gbps unframed wavelength services.	5.5.3.2.5 (12)	R
132	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
133	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
134	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
135	Transponders shall support an OC-48/STM-16 interface.	5.5.3.2.5.1 (1)	R
136	Transponders shall support an OC192/STM64 interface.	5.5.3.2.5.1 (2)	R
137	Transponders shall support a GbE interface.	5.5.3.2.5.1 (3)	R
138	Transponders shall support a 10 GbE WAN PHY interface.	5.5.3.2.5.1 (4)	R
139	Transponders shall support a 10 GbE LAN PHY interface.	5.5.3.2.5.1 (5)	R
140	The transponders shall support OC-768/STM-256 interfaces.	5.5.3.2.5.1 (6)	R
141	The transponder shall support all OTN rates including ODU1/ODU2/ODU3 and 100 Gbps in future.	5.5.3.2.5.1 (7)	R
142	The transponders shall support SR, LR-1, LR-2, LR-3, and IR-1, IR-2, client interface types per Telcordia Technologies GR-253-CORE.	5.5.3.2.5.1 (8)	R
143	The transponders shall support client interfaces at 1310 and 1550 nm.	5.5.3.2.5.1 (9)	R
144	The transponders shall support client interface at 850 and 1310 nm for GbE signals.	5.5.3.2.5.1 (10)	R
145	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
146	The ROADM shall support direction-less wavelength routing.	5.5.3.2.6 (2)	R
147	The ROADM shall be capable of colorless wavelength routing.	5.5.3.2.6 (3)	R
148	The system shall support cascading of minimum eight ROADMs for a total un-regenerated reach of 2000 km.	5.5.3.2.6 (4)	R
149	Any wavelength not explicitly dropped or added shall be passed through the ROADM.	5.5.3.2.6 (5)	R
150	It shall be possible to reuse wavelength at ROADM.	5.5.3.2.6 (6)	R
151	There shall be no restrictions on ADD/DROP and EXPRESS (pass through) wavelengths at ROADM site.	5.5.3.2.6 (7)	R
152	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
153	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
154	The ROADM shall be capable of supporting dynamic wavelength selection without pre-cabling being required.	5.5.3.2.6 (10)	R
155	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
156	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
157	The ROADM shall be capable of dropping any specific wavelength, independent of other wavelengths to be dropped.	5.5.3.2.6 (13)	R
158	The ROADM shall be capable of adding any specific wavelength, independent of other wavelengths to be added.	5.5.3.2.6 (14)	R

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

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
159	The ROADM shall support wavelength hair-pinning capability.	5.5.3.2.6 (15)	R
160	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
161	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
162	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
163	Hardware upgrades of the ROADM to support higher tributary interface density shall not disrupt operational traffic.	5.5.3.2.6 (19)	R
164	Hardware upgrades of the ROADM to support higher line interface density shall not disrupt operational traffic.	5.5.3.2.6 (20)	R
165	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
166	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
167	The ROADM shall support dynamic per-wavelength power leveling.	5.5.3.2.6 (23)	R
168	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
169	The ROADM shall not incur increased bit errors associated with wavelength provisioning or line equalization.	5.5.3.2.6 (25)	R
170	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
171	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
172	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
173	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
174	The ROADM shall support redirection of light paths via the EMS/NMS.	5.5.3.2.6 (30)	R
175	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 (31)	R
176	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 (32)	R
177	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
178	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
179	The ROADM shall support redundant: Fans Switching Fabrics Power Supplies Control Processors.	5.5.3.2.6.1 (3)	R
180	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
181	The fully configured ROADM (excluding the transponder shelves) shall not exceed two full 84" racks.	5.5.3.2.6.1 (5)	R
182	The fully configured ROADM shall not exceed one full 84" rack.	5.5.3.2.6.1 (6)	R
183	The ROADM shall not require contiguous rack locations.	5.5.3.2.6.1 (7)	R

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

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
184	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
185	The OTS shall support the transport of the following SONET/SDH services: OC-192/STM-64, OC-48/STM-16, and OC-768/STM-256.	5.5.3.2.7.1 (1)	R
186	The OTS shall support the transport of the following Ethernet services: GigE (via 10:1 Muxponder), 10 GbE WAN PHY, and 10 GbE LAN PHY.	5.5.3.2.7.1 (2)	R
187	The OTS shall support the transport of the following OTN services: OTU1, OTU2, and OTU3.	5.5.3.2.7.1 (3)	C
188	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
189	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
190	Framed wavelength services shall be supported for GbE/10 GbE signals, and signals formatted for OTN transport (ITU-T G.709).	5.5.3.2.7.1 (6)	R
191	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
192	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
193	Alien wavelength” regeneration shall be supported.	5.5.3.2.7.1 (9	R
194	The OTS shall support unframed wavelength services.	5.5.3.2.7.2 (1)	R
195	The OTS shall support Mixed Framed Service Unframed Wavelength Service	5.5.3.2.7.2 (2)	R
196	The OTS shall include an OSC linking the two OTS GNEs, with access at each OTS OLA site. All telemetry, data, and voice traffic originating at OTS OLA sites shall be routed over this service channel. A diagram of the OSC appears in Figure 5.5.3-2, Optical Supervisory Channel. The optical line rate, the optical format, and interface partitioning internal to the OTS may be a proprietary implementation.		
197	The OLA, ROADM, ET elements shall terminate/insert an OSC with a wavelength that adheres to ITU-T specifications.	5.5.3.2.8 (1)	R
198	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
199	The OLA, ROADM, and ET elements shall use the same OSC wavelength.	5.5.3.2.8 (3)	R
200	The internal diagnostics for OLA, ROADM, and ET elements shall report OSC failure.	5.5.3.2.8 (4)	R
201	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
202	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
203	The OLA, ROADM, and ET elements shall report any OSC channel BER threshold violation.	5.5.3.2.8 (7)	R
204	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
205	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
206	The OSC circuit-pack shall report optical span-loss between two adjacent nodes.	5.5.3.2.8 (10)	R
207	The OSC shall operate at 2 Mbps or higher data rates.	5.5.3.2.8 (11)	R
208	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

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

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
209	The standards in effect when the equipment was first acquired are listed. Updates to the standards since that point in time are identified in brackets. When the manufacturer provides new components for the COTS items to the same device that satisfy updated standards, DISA will often purchase and install those components to accommodate growth, but will not replace existing components unless there is another reason to do so. As such, components will be operational within DISN that satisfy multiple versions of the standards. Testing will need to be undertaken using the standard release that applied to that component, where the revised standard cannot be satisfied by the original component.		
210	ITU-T Recommendation G.652 (10/2000) (2005)	5.5.3.2.9 (1)	R
211	ITU-T Recommendation G.655 (10/2000) (2006)	5.5.3.2.9 (2)	R
212	ITU-T Recommendation G-694.1 (2002)	5.5.3.2.9 (3)	R
213	ITU-T Recommendation G.709/Y.1331	5.5.3.2.9 (4)	R
214	ITU-T Recommendation G.825 (2000)	5.5.3.2.9 (5)	R
215	ITU-T Recommendation G.958 (1994), Digital Sections and Digital Line Systems	5.5.3.2.9 (6)	R
216	Telcordia Technologies GR-63-CORE, Issue 1, October 1995 (Issue 3, March 2006)	5.5.3.2.9 (7)	R
217	Telcordia Technologies TR-NWT-000179, Issue 2, June 1993	5.5.3.2.9 (8)	R
218	Telcordia GR-253-CORE, Issue 3, September 2000 (Issue 4, December 2005)	5.5.3.2.9 (9)	R
219	Telcordia Technologies GR-282-CORE, December 1997 (Issue 4, July 2006)	5.5.3.2.9 (10)	R
220	Telcordia Technologies TR-NWT-000295, Issue 2, July 1992	5.5.3.2.9 (11)	R
221	Telcordia Technologies NWT-000418, December 1999	5.5.3.2.9 (12)	R
222	Telcordia Technologies GR-472-CORE, Issue 2, November 1996	5.5.3.2.9 (13)	R
223	Telcordia Technologies FR-796, Reliability and Quality Generic Requirements, Issue 5, April 2008	5.5.3.2.9 (14)	R
224	Telcordia Technologies GR-1089-CORE, Issue 2, Revision 1, February 1999 (Issue 4, June 2006)	5.5.3.2.9 (15)	R
225	Telcordia Technologies SR-NWT-002419, Issue 1, 1992	5.5.3.2.9 (16)	R
226	Telcordia Technologies GR-2911-CORE, 1995	5.5.3.2.9 (17)	R
227	ETSI ETS 300 019, 1994	5.5.3.2.9 (18)	R
228	ETSI ETS-FN-50022	5.5.3.2.9 (19)	R
229	ETSI EN 50082	5.5.3.2.9 (20)	R
230	ETSI EN 300 386	5.5.3.2.9 (21)	R
231	British Standards Institute BS EN 60950-1, August 6, 2006	5.5.3.2.9 (22)	R
232	IEC 60950-1, 2006	5.5.3.2.9 (23)	R
233	CFR FCC Part 15, Class A	5.5.3.2.9 (24)	R
234	NEBS, Level 3	5.5.3.2.9 (25)	R
235	UL-1950, Standard for Safety, Information Technology Equipment Including Electrical Business Equipment, First Edition 1989	5.5.3.2.9 (26)	R
236	EIA 310C	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
dB	Decibel
C	Conditional
C	Celsius
CFR	Code of Federal Regulations
CH	Change
COTS	Commercial Off-the-Shelf
DC	Direct Current
DCN	Data Communications Network
DEMUX	demultiplexer
DISA	Defense Information Systems Agency
DISN	Defense Information Systems Network
DWDM	Dense Wavelength Division Multiplexing
E2E	End-To-End
E-LEAF	Enhanced Large Effective Area
EDC	Electronic Dispersion Compensation
EC	European Community
EIA	Electronic Industries Alliance
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMS	Element Management System
EOL	End of Life
ES	Errored Seconds
ESD	Electrostatic Discharge
ET	End Terminal
ETS	Electronic Tandem Switching
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDM	frequency-division multiplexing
FEC	Forward Error Correction
Gbps	Gigabits per Second
GHz	Gigahertz
GIG-BE	Global Information Grid-Bandwidth Expansion
GbE	Gigabit Ethernet
GNE	Gateway Network Element
GR	Generic Requirement
ID	Identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IR	Intermediate Reach
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union-Telecommunication
km	Kilometer
LAN	Local Area Network
LEAF	Large Effective Area
LoC	Letter of Compliance
LR	Long Reach
m	Meter
Mbps	Megabits per second
ms	Microsecond
msec	millisecond
MSPP	Multiservice Provisioning Platform
MUX	Multiplexer
NE	Network Element
NEBS	Network Equipment-Building System
nm	nanometer
NMS	Network Management System
OA	Optical Amplifier
OC	Optical Carrier
ODU	Optical Channel Data Unit
ODXC	Optical Digital Cross Connect
O/E	Optical/Electrical
O-E-O	Optical-to-Electrical-to-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
OXC	Optical Cross Connect
PAC	Pacific
PMD	Polarization Mode Dispersion
PHY	Physical Layer
ppm	parts per million
R	Required
ROADM	Reconfigurable Optical Add/Drop Multiplexer
SDH	Synchronous Digital Hierarchy
SES	Severely Errored Seconds
SONET	Synchronous Optical Transport Network
SR	Short Reach
STD	Standard
STM	Synchronous Transport Module
TBD	To Be Determined
T&S	Timing and Synchronization
TTL	Transistor-transistor logic
UCR	Unified Capabilities Requirement
UHF	Ultra high frequency
UL	Underwriters Laboratories, Inc.
V	Volt
VDC	Volt Direct Current
VHF	Very High Frequency
VP-P	Volts Peak-to-Peak
WAN	Wide Area Network

SYSTEM FUNCTIONAL AND CAPABILITY REQUIREMENTS

The Network Elements (NE) and Fixed Network Elements have required and conditional features and capabilities established by the Unified Capabilities Requirements. The SUT does not need to meet conditional requirements; however, if they are provided, they must function according to the specified requirements. The detailed functional requirements and capability requirements for NEs are listed in Table 3-2.

Table 3-2. NE Capability/Functional Requirements Table

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
1	The introduction of an NE(s) shall not cause the E2E average MOS to fall below 4.0 as measured over any 5-minute time interval.	5.9.2.1 (1)	R
2	The introduction of an NE(s) shall not degrade the E2E measured BER to no more than .03 percent from the baseline minimum E2E digital BER requirement which is not more than one error in $1x10^9$ bits (averaged over a 9-hour period).	5.9.2.1 (2)	R
3	The introduction of an NE(s) shall not degrade secure transmission for secure end devices as defined by UCR 2008, Section 5.2.2, DoD Secure Communications Devices.	5.9.2.1 (3)	R
4	The NE(s) shall support a minimum modem transmission speed of 9.6 kbps across the associated NE(s).	5.9.2.1 (4)	R
5	The NE(s) shall support a minimum facsimile transmission speed of 9.6 kbps across the associated NE(s).	5.9.2.1 (5)	R
6	The NE shall transport all call control signals transparently on an E2E basis.	5.9.2.1 (6)	R
7	[Conditional] The NEs that support a P2N capability shall meet the following additional requirements when deployed in a P2N architectural configuration:	5.9.2.1 (7)	C
7A	The aggregate egress from all NEs in the P2NP architecture must be identical to the aggregate ingress of all NEs in the same P2N architecture. However, if all or part of the P2N is operating in a P2MP mode that is applying multicast from a centrally designated NE to one or more of the associated peripheral NEs, the aggregate of the additional multicast traffic must be accounted for in the egress sum total.	5.9.2.1 (7A)	R
7B	Excluding latency, the P2N AP shall be measured as though it is a P2P architecture at the P2N AP NE endpoints ingress and egress points. As such, the P2N AP must meet all the other stated requirements of a P2P.	5.9.2.1 (7B)	R
7C	For a given P2N AP, the maximum latency allowed E2E, as measured over any 5-minute period at the P2N AP NE ingress and egress points, shall be 5 ms or less, when added in addition to the expected P2P latency. Hence, as an example, if the expected P2P latency requirement for a P2N AP is 50 ms, then P2N AP maximum latency, regardless of the number of NE hops between the ingress and egress NEs, the measured value shall not exceed 55 ms.	5.9.2.1 (7C)	R
8	The NE shall be able to propagate CGAs upon physical loss of the TDM interface. The NE shall provide the capability of detecting a CGA. When this alarm is detected, all associated outgoing trunks shall be made busy automatically to subsequent customer call attempts. Call attempts on associated incoming trunks shall not be processed. When possible, the Reverse Make Busy feature shall be exercised on incoming trunks. Voice switching systems using a TDM connection to an NE shall receive the proper CGAs from the NE upon loss of the transport link between NEs, regardless of whether the transport link is TDM, IP, or DLoS between the NEs. The NEs that support IP ingress or egress traffic either as inbound or outbound NE traffic and/or transport between NE(s) shall support one or more of the following routing protocols: Link-State and/or Distance-Vector, so the NE can notify the IP network (e.g., LAN, MAN), using one of these routing protocols, the condition of its link state for transporting ingress IP traffic, namely operational or down.	5.9.2.1.1	R

Table 3-2. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
9	The NE shall assure that congestion between paired NEs does not affect DSN calls in progress or subsequent calls. Call congestion handling shall be met in one or more of the following ways.	5.9.2.1.2	R
9A	The NE shall implement TDM congestion control via one of the following methods: A. A dynamic load control signal (e.g., contact closure) shall be provided to the DSN switch per the following requirements: (1) The NE shall provide the capability to handle CGA indications from the carrier systems/equipment using the E-telemetry interface (scan points) for the TDM interfaces provided (e.g., DS0, DS1, and/or OC-X), and, comply to the Telcordia Technologies GR-303-CORE, System Generic Requirements, Objectives, and Interface, December 2000, Issue 4 and Telcordia Technologies TR-NWT-000057 that specifies the use of an COT generated DC contact closure alarm to indicate an "all-accessible-channels busy" condition.	5.9.2.1.2.1 (1A1)	C
9B	(2) The NE when interfaced to the network that provides an E-telemetry interface type (scan points) for alarm management shall be capable of CGA management that is used to minimize the effects of carrier failures on switching systems and on service. CGA scan point (binary condition, i.e., "closed" contact for active and "opened" for inactive states) when "closed" should busy out the failed circuits, release customers from the failed circuits, and prevent the failed circuits from seizing the DSN trunk equipment and prevent the NE from seizing the failed circuits.	5.9.2.1.2.1 (1A2)	C
9C	(3) The DSN CGA System Operation can be divided into three parts, i.e., detection of the carrier failure, conditioning the failed trunk, and reaction of the switching equipment to the processing of the failure. Requirements for scan point CGA are: (a) Sense Point Interface: The switching system shall provide sense points to which external CGAs can be interfaced to, so that failure of the carrier equipment shall cause the trunks to be removed from service. (b) Call Processing Actions: Receipt of a CGA shall cause call processing to be aborted on associated trunks that are not in the talking state. (c) Trunk Conditioning: Receipt of a CGA shall cause the following actions on the affected trunks: (i) Idle trunks shall be removed from the idle list. Subsequent calls for service must be ignored for the duration of the CGA. Busy-back shall be returned on those incoming trunks, which are optioned for busy-back while in the out-of-service state and proper MLPP treatment shall be applied. (ii) Trunks in the talking state shall be monitored for disconnect, after which they are to be placed in the same state as described above for idle trunks.	5.9.2.1.2.1 (1A3)	C
9D	(4) Restoration of Service: All trunks affected shall be returned to their previous state after the CGA is removed. B. Congestion is not possible in the NE by nature of its functioning (e.g., a TDM multiplexer or transcoder). C. A software capability in limiting the provisioning of the ingress and egress interfaces making congestion impossible even under the worst congestion scenario. This can be done by limiting the bearer or aggregate provisioning.	5.9.2.1.2.1 (1A4, 1B, 1C)	C
10	2. The addition of NEs with TDM transports shall not increase the one-way latency per NE pair when measured from end to end over any 5-minute period specified as follows: a. TDM ingress G.711 (non-secure calls) to non-transcoding G.711 TDM egress shall not increase delay more than 10 ms per NE pair as measured E2E. b. TDM ingress G.711 (non-secure calls) to transcoding TDM egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 100 ms per NE pair as measured E2E. c. TDM ingress G.711 (secure calls) to non-transcoding TDM egress G.711 shall not increase delay by more than 50 ms per NE pair as measured E2E. d. TDM ingress G.711 (secure calls) to transcoding TDM egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 250 ms per NE pair as measured E2E.	5.9.2.1.2.1 (2A, 2B, 2C, 2D)	C
11	The NE(s) using IP transport shall implement IP congestion control. Congestion may be controlled by using DiffServ, which shall be capable of providing preferential treatment for call congestion over other media types IAW Section 5.3.3, Network Infrastructure End-to-End Performance Requirements, and a capability to limit the provisioning of input and output interfaces so congestion is impossible under the worst transport congestion scenario. The IP interface parameters subject to ingress or egress requirements shall be met IAW Section 5.9.2.3.9, IP Interface. The NE shall implement DLoS congestion control based on the DSN traffic and signaling type to be transported. (Please see Following).	5.9.2.1.2.2	C

Table 3-2. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
12	The NE shall implement DLoS congestion control based on the DSN traffic and signaling type to be transported. (Please see Following)	5.9.2.1.2.3	C
13	The NE transporting only TDM bearer and signaling traffic shall implement DLoS congestion control via one or more of the following methods: a. A dynamic load control signal (e.g., contact closure). b. Congestion is not possible in the NE so the maximum ingress throughput into the NE is configured so it does not exceed the DLoS link maximum egress transport capability to include all DLoS overhead control traffic between the transport devices. c. A software capability in limiting the provisioning of the ingress and egress interfaces making congestion impossible even under the worst congestion scenario. This can be done by limiting the bearer or aggregate provisioning.	5.9.2.1.2.3 (1A, 1B, 1C)	C
14	The NE transporting only ingress IP traffic, and using a DLoS transport, excluding 802.11, and/or 802.16 series standards, -shall implement DLoS IP congestion control per Section 5.9.2.1.2.2, For IP Transport. Additionally, IP congestion control may include a standards-based or proprietary protocol between the NEs that will adjust the QoS of the NE based on DLoS transport monitoring feedback to the NE to accommodate for changing environmental link conditions.	5.9.2.1.2.3 (2)	C
15	The NE transporting both TDM and IP ingress traffic simultaneously over the same DLoS transport link shall meet the following requirements: a. [Required] The NE shall provide congestion control so it provides the same level of capability, respectively, for the appropriate traffic type, TDM and IP, per the requirements for single traffic type ingress or egress to the NE. Additionally, the congestion control may include a standards-based or proprietary protocol between the NEs that will adjust the QoS of the NE based on DLoS transport monitoring feedback to the NE to accommodate for changing environmental link conditions. b. [Conditional] The use of DLoS transport shall not increase the one-way latency or packet delay per the requirements for TDM ingress and TDM or IP egress interfaces per the appropriate Section 5.9.2.1.2.1, For TDM Transport, and Section 5.9.2.3.9, IP Interface, respectively.	5.9.2.1.2.3 (3A, 3B)	C
16	The NE used for voice compression shall support at least one of the following standards: • ITU-T Recommendation G.726 • ITU-T Recommendation G.728 • ITU-T Recommendation G.729	5.9.2.2	C
17	If provided, the NE shall provide for a 2-wire and/or 4-wire analog trunk circuit(s) interface that interfaces using industry standard signaling and facility arrangements per one or more of the following:	5.9.2.3.1	C
18A	1. E&M Trunk Circuits: The NE shall interface with exchange carriers using industry standard E&M signaling. The switching system shall interface with Type I and Type II E&M signaling in accordance with paragraph 9 and subparagraphs of GR-506-CORE. The switching system shall interface with Type V E&M signaling as defined in Paragraphs 6.8.5, 6.8.6, 6.8.7.2, 6.8.8.2, and 6.8.8.3 of Telcordia Technologies Document SR-2275. The DSN switch analog trunk interface shall always originate on the M-lead.	5.9.2.3.1 (1)	C
18B	2. Single Frequency Trunk Circuits: The NE will interface with external SF equipment using a 4-wire E&M trunk circuit, either Type I or II. The DSN in-band signaling equipment utilizing SF will place a 2600 Hz tone on the circuit to indicate the idle state (on-hook) and the tone will be removed from the circuit to indicate the busy state (off-hook). Signaling states will be conveyed via E and M leads (Type I or II) to the telephone equipment terminating the circuit on the equipment side of the interface. The SF trunk interface consists of only the voice path conductors (T, R, T1, R1), but at a point between this transmission facility interface and the switching function the SF signal will be translated back to the two-state DC signals.	5.9.2.3.1 (2)	C
18C	3. Dual Frequency Trunk Circuits: The DFSU equipment used in the DSN operates in much the same way as an SF unit, except that whenever the 2600 Hz tone is removed from the circuit a 2800 Hz tone is applied for a short period (175 ms maximum). The 2800 Hz tone burst will serve as a confirmation tone; the receiving signaling unit will only transition from on-hook to off-hook if the loss of the 2600 Hz tone is followed by the 2800 Hz tone. This prevents false on-hook to off-hook transitions from occurring due to a break in the communications circuit. Like the SF	5.9.2.3.1 (3)	C

Table 3-2. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
18C cont	R, T1, R1). The NE shall interface an external DFSU using a 4-wire E&M trunk circuit with Type I or II E&M signaling. This connection is on the equipment-side of a DF trunk interface.	5.9.2.3.1 (3)	C
19	The NE used for serial interface connections shall be in accordance with one of the following standards: • ITU-T Recommendation V.35 • TIA-232-F • EIA-449-1 • TIA-530-A	5.9.2.3.2	C
20	The ISDN BRI interface shall meet the requirements and conditions IAW Section 5.3.2.31.2, National ISDN 1/2 Basic Access.	5.9.2.3.3	C
21	If provided, the NE shall meet the following DS1 (T1) interface requirements and conditions of a PCM-24 Digital Trunk Interface. PCM-24 Digital Trunk Interface: An NE shall provide a PCM-24 channel digital interface with a 1.544 Mbps T1 bit stream configured in either the D3/D4 (Superframe) framing format or the D5 ESF framing format. D5 is also referred to as EF. The same framing format shall be used in both directions of transmission. Voice signals shall be encoded in the 8-bit μ (255 quantized values) PCM encoding law. Supervisory and DP signals shall utilize the A and B bits of the D3/D4 format or the A, B, C, and D bits of the D5 format for pre-CCS7 configurations. Voice channel address in-band signaling shall be provided on individual channels. The D5 format shall be the preferred and system "goal" digital framing format and shall be provided in accordance with MIL-STD-187-700. 1. Interface Characteristics: The NE shall use the DS1 24 channel standard interface as specified in ANSI T1.102, "Digital Hierarchy – Electrical Interfaces." Table 5.9.2.3.4-1, PCM-24 Electrical Interface Characteristics, provides the electrical characteristics at the interface. Table 5.9.2.3.4-2 and Table 5.9.2.3.4-3 provide a listing of the framing characteristics. (Please see UCR 2008, Change 2, Pages 1898 thru 1900)	5.9.2.3.4	C
22A	2. Supervisory Channel Associated Signaling: On-hook and off-hook status of each channel is transmitted and derived from the coding of the "A" and "B" signaling bits. Trunk seizure, answer supervision, DP digits, preemption signals, and all other trunk supervisory information shall be sent and received on a per-channel basis using this scheme. Per-trunk signaling in the DSN switching system shall control the value of the "A" and "B" bits to indicate an on-hook ("A" = 0, "B" = 0) or an off-hook ("A" = 1, "B" = 1) condition. When receiving supervisory status on digital trunks using the PCM-24 format, the DSN switching system shall interpret the combination of the "A" bit = 0 andthe "B" bit = 0 as on-hook, and the combination bit = 1 and "B" bit = 1 as an off-hook indication. When signaling on VF channels using the PCM-24 format, the least significant bit of each channel, every six frames, shall carry signaling information. Utilizing the four-state signaling option of the Superframe (D3) format, frame 6 shall contain the "A" channel signaling information and frame 12 shall contain the "B" channel signaling information. The switching system shall also interpret the combination of "A" bit = 1, "B" bit = 0, with bit position 2 in all 24 channels in the Superframe (D3) format equal to "0" as a channel alarm indication and shall also interpret the combination of "A" bit = 1, "B" bit = 0 as a remote make busy. In the ESF format ANSI defines a sixteen-state signaling option that labels the signaling bits "A" (frame 6), "B" (frame 12), "C" (frame 18), and "D" (frame 24). Because DSN does not require the "C" and "D" signaling channels the four-state option shall be used to allow changes in "A" and "B" signaling states to be transmitted twice as often. Utilizing Frames 6 and 18 in the 24-frame Extended Superframe shall contain the "A" channel signaling information; frames 12 and 24 shall contain the "B" channel signaling information.	5.9.2.3.4 (2)	C
22B	3. Clear Channel Capability: The NE shall be capable of transmitting and receiving B8ZS line coding IAW MIL-STD-187-700.	5.9.2.3.4 (3)	C
22C	4. Alarm and Restoral Requirements: The NE shall provide the alarm and restoral features on the DIU as defined in Table 5.9.2.3.4-4, PCM-24 Alarm and Restoral Requirements. (Please see UCR 2008, Change 2, Page 1901)	5.9.2.3.4 (4)	C

Table 3-2. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
23	If provided, the NE shall meet the following E1 interface requirements and conditions of a PCM-30 Digital Trunk Interface: PCM-30 Digital Trunk Interface: The NE shall provide PCM-30 digital interfaces at a data rate of 2.048 Mbps. The PCM-30 interfaces shall meet the requirements of ITU-T Recommendation G.703 and ITU-T Recommendation G.732. Voice signals in the PCM-30 framing format shall utilize the A-law encoding technique in accordance with ITU-T Recommendation G.772 (REV), "Protected Monitoring Points on Digital Transmission Systems." The pertinent requirements for the PCM-30 interface are summarized in Table 5.9.2.3.5-1, PCM-30 Electrical Interface Characteristics. (Please see UCR 2008, Change 2, Page 1902)	5.9.2.3.5	C
23A	1. Supervisory Channel Associated Signaling: When receiving supervisory status on digital trunks using the PCM-30 format, the DSN switching system shall interpret the combination of the "A" signaling channel bit = 1 and the "B" signaling channel bit = 1 as on-hook, and shall interpret the combination of the "A" signaling channel bit = 0 and the "B" signaling channel bit = 1 as an off-hook indication. The DSN switching system shall also interpret the combination of "A" bit = 1 and "B" bit = 0 as a channel alarm indication and a remote make busy. Bits "C" and "D" are not used in the DSN for signaling or control and therefore shall be set to the values "C" = 0 and "D" =1 in accordance with ITU-T Recommendation G.704.	5.9.2.3.5 (1)	C
23B	2. Alarm and Restoral Requirements: The NE shall provide the alarm and restoral features on the DIU in order to be compatible with PCM-30 facilities and terminal equipment, as shown in Table 5.9.2.3.5-3, PCM-30 Alarm and Restoral Requirements. (Please see UCR 2008, Change 2, Page 1903)	5.9.2.3.5 (2)	C
24	The DS3 interface shall meet the following requirements and conditions. Frame structure shall include M13 framing in accordance with ANSI T1.107-2002.	5.9.2.3.6.1 (1)	R
25	Frame structure may include C-bit parity application IAW ANSI T1.107-2002.	5.9.2.3.6.1 (2)	C
26	The line coding shall be bipolar 3 zero substitution (B3ZS) IAW ANSI T1.102-1993.	5.9.1.5.3.6.2	R
27	The NE shall be able to derive a timing signal from an internal source, an incoming digital signal, or an external source IAW Section 5.3.2.12.14.1.1, Timing Modes (5.3.2.12.14.1.1 Timing Modes): [Required: MG] The MGs shall meet the external timing mode requirements specified in the Telcordia Technologies GR-518-CORE, Paragraph 18.1. Most SMEOs and PBX1s will only support line timing 5.3.2.12.14.1.1.1 External Timing Mode - [Required: MG] The MGs shall support external timing modes as defined in Telcordia Technologies TR-NWT-001244. 5.3.2.12.14.1.1.2 Line Timing Mode - [Required: MG] The MGs shall support line timing modes as defined in Telcordia Technologies TR-NW-001244. 5.3.2.12.14.1.2 Internal Clock Requirements 5.3.2.12.14.1.2.1 General - [Required: MG] The MGs shall provide internal clock requirements as described in the Telcordia Technologies GR-518-CORE, Paragraph 18.2. 5.3.2.12.14.1.2.2 Stratum 4 Clock - [Required: MG] The MGs shall provide a stratum 4 or better internal clock. 5.3.2.12.14.1.2 Synchronization Performance Monitoring Criteria - [Required: MG] The MGs shall meet the synchronization performance monitoring criteria as described in Telcordia Technologies GR-518-CORE, Paragraph 18.3	5.9.2.3.7	R
28	The OC-X interface shall be IAW Section 5.5.3.2, Optical Transport System Interface, and/or appropriate SONET commercial standards. (NOTE: X stands for the capacity (e.g., 3, 48, 192 and higher)	5.9.2.3.8	C
29	The NE having an IP interface and using DLoS transport comprised of 802.11 and/or 802.16 series standards shall instead meet the requirements for a WAB contained in Section 5.3.1.7.2, Wireless. All other IP configurations shall meet the following:	5.9.2.3.9	C
29A	a. Delay. The addition of NEs with IP transports shall not increase the one-way latency per NE pair when measured from end to end over any 5-minute period specified as follows: (1) TDM ingress G.711 (non-secure calls) to non-transcoding G.711 IP egress shall not increase delay more than 50 ms per NE pair as measured E2E. (2) TDM ingress G.711 (non-secure calls) to transcoding IP egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 100 ms per NE pair as measured E2E. (3) TDM ingress G.711 (secure calls) to non-transcoding G.711 IP egress shall not	5.9.2.3.9	C

Table 3-2. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
29A cont	increase delay by more than 50 ms per NE pair as measured E2E. (4) TDM ingress G.711 (secure calls) to transcoding IP egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 250 ms per NE pair as measured E2E.	5.9.2.3.9	C
29B	b. Jitter. The addition of an NE shall not cause jitter measured from ingress to egress to increase by more than 5 ms averaged over any 5-minute period.	5.9.2.3.9	C
29C	c. Packet Loss. The addition of an NE shall not cause packet loss measured from ingress to egress to increase by more than 0.05 percent averaged over any 5-minute period.	5.9.2.3.9	C
29D	d. [Required: F-NE, D-NE] For VVoIP systems, if the system decrypts the VVoIP traffic and applies a proprietary encryption approach before transmittal between the two components of the single vendor system, then the system proprietary encryption approach shall be one of the encryption and integrity-approved approaches defined in Section 5.4, Information Assurance Requirements NOTE: For example, if the NE decrypts the AS-SIP with TLS packets between the NEs and re-encrypts it using NE proprietary encryption methods, then the proprietary method must be one of the cryptographic methods defined in Section 5.4, Information Assurance Requirements, (e.g., IPSec with AES-128 bit encryption, HMAC-SHA1 for integrity, and DoD PKI for authentication). All Section 5.4, Information Assurance Requirements, approved encryption and integrity approaches use FIPS PUB 140-2 cryptographic modules (or have been granted a formal waiver by NIST). Importantly, proprietary only refers to the lack of interoperability with a different vendor's NE and all cryptographic approaches used in Section 5.4, Information Assurance Requirements, are standards based.	5.9.2.3.9	R
29E	e. [Required: F-NE, D-NE] The VVoIP systems that use proprietary encryption approaches within the system shall restore the VVoIP packets to their original format (e.g., AS-SIP with TLS and SRTP) upon exiting from the system to ensure the VVoIP session can complete successfully.	5.9.2.3.9	R
29F	2. [Conditional] The IP interface shall meet the IP requirements detailed in the DISR and Section 5.3, IP-Based Capabilities and Features, inclusive.	5.9.2.3.9	C
30	The NE devices are to be managed by at least one of the following: A front or back panel and/or external console control capability shall be provided for local management. Remote monitoring and management by the ADIMSS or similar Network Management (NM) systems developed by DoD Components. The following requirements apply: (1) [Required: Data Interface] The NE shall provide NM data/monitoring via one or more of the following physical interfaces: ** Ethernet/TCP/IP (IEEE 802.3) ** Serial (RS-232)/Asynchronous ** Serial/Synchronous (X.25 and/or BX.25 variant) All data that is collected shall be accessible through these interfaces. For NM purposes, the NE must provide no less than two separate data channels. They may be physically separate (e.g., two distinct physical interface points) or logically separate (e.g., two user sessions through a single Ethernet interface). The data may be sent in ASCII, binary, or hexadecimal data or ASCII text designed for screen/printer display. The data channels shall be used for and, as such, must be capable of providing: ** Alarm/Log Data ** Performance Data (e.g., traffic data) ** NE access (to perform NE data fill administration and network controls) (2) [Required: Fault Management] The DSN telephone switching systems shall detect fault (alarm) conditions and generate alarm notifications. The alarm messages must be sent to the assigned NM Alarm channel in near-real time. No alarm restriction/filtering is necessary. In addition to the data formats in Section 5.3.2.17, Management of Network Appliances, alarms may be sent as Simple Network Management Protocol (SNMP) traps. If this channel is also used to output switch administrative log information, the alarm messages must be distinguishable from an administrative log message (3) [Required: Configuration Management] Requirements for this feature shall be IAW Telcordia Technologies GR-472-CORE, Section 4.	5.9.2.4.1	R

Table 3-2. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Reference (UCR 2008 CH 2)	R/C
31	The NE shall report any failure of self-test diagnostic function on non-active and active channels on a noninterference basis to the assigned NMS.	5.9.2.4.2	C
32	The NE shall provide loopback capability on each of the trunk-side interfaces IAW ITU-T Recommendation V.54.	5.9.2.4.3	C
33	Loss of power should not remove configuration settings. Unit should be restored to the last customer-configured state before the power loss, without intervention when power is restored.	5.9.2.4.4	R
34	The NEs using DLoS transport shall support the following: a. A minimum MOS score as defined in Section 5.9.2.1, General Requirements, performance requirement or better as measured in any 5-minute interval using ITU-T Recommendation P.862 testing standard. b. [Required] The minimum acceptable MTR shall be 300 feet based on operating in an open air-minimal obstruction, clear line-of-sight environment with the DLoS transport device operating at or near full power mode. Based on the testing results, the estimated maximum performance range while still maintaining MOS requirements, as required in item a, shall hereby be referred to as the NE DLoS transport MTR. The MTR baseline-testing environment shall be while operating in an open air-minimal obstruction, clear line-of-sight environment with the DLoS transport device operating at or near full power mode. The NE shall be tested at a minimum operating height of 25 feet with a clear unobstructed line of sight between NEs at a minimum range of 150 feet. The NEs may be tested with attenuation inserted to simulate the actual NE DLoS transport capability from which the maximum MOS performance range MTR can be extrapolated. The value determined shall be included in the APL report. Refer to Section 5.9.2.5.3, Submission of DLoS Transport NEs to UCCO for DSN Connection Request, concerning guidelines on submitting the DLoS transport NE engineering analysis package.	5.9.2.4.5	R
35	The DLoS transport NEs shall be engineered properly so that the DLoS transport transmitting or receiving devices achieve the required performance requirements in their specific deployed environment. The user shall submit a network design and engineering performance analysis with supporting calculations to meet minimum MOS performance with the request for DSN connection. Included is the calculation and data required for determining the MDR, as defined in Section 5.9.2.5.1, DLoS Transport NE Maximum Deployment Range. For certification procedures, the UCCO submittal shall also include wireless security compliancy as identified in Section 5.9.2.6, Security.	5.9.2.5.3	C
36	All components of the NE shall meet security requirements, for each supported mode, as outlined in DoDI 8510.01 and the applicable STIG(s).	5.9.2.6	R
37	1. If a DoD-approved WIDS exists for the DLoS transport technology used, the NE DLoS transport link(s) shall be monitored in according with the appropriate STIG(s).	5.9.2.7	C

Table 3-2. NE Capability/Functional Requirements Table (continued)

LEGEND:

ADIMSS	Advanced DSN Integrated Management Support System
AES	Advanced Encryption Standard
ANSI	American National Standards Institute
AP	Approved Product
ASCII	American Standard Code for Information Interchange
AS-SIP	Assured Services Session Initiation Protocol
BER	Bit Error Rate
BRI	Basic Rate Interface
C	Conditional
CGA	Carrier Group Alarm
CH	Change
cont	continued
COT	Continuity Testing
D-NE	Deployed-Network Element
DAA	Designated Approving Authority
DC	Direct Current
DF	Dual Frequency
DFSU	Dual Frequency Signaling Unit
DISR	DoD Information technology Standards and Registry
DIU	Digital Interface Unit
DLoS	Direct Line of Sight
DoD	Department of Defense
DP	Dial Pulse
DS	Digital Signal
DSN	Defense Switched Network
E&M	Ear and Mouth
E1	European 1 (2048 Mbps, 30-channel PCM)
E2E	End to End
EF	Extended Frame
ESF	Extended Superframe
F-NE	Fixed-Network Element
FIPS	Federal Information Processing Standard
GR	Generic Regulations
Hz	Hertz
IA	Information Assurance
IAW	In Accordance With
IEEE	Institute of Electrical and Electronic Engineers
ID	Identification
IP	Internet Protocol
IPSec	Internet Protocol Security
ISDN	Integrated Services Data Network
ITU	International Telecommunications Union
ITU-T	ITU Telecommunications Union - Telecommunications Sector
kbps	kilobits per Second
LAN	Local Area Network
MAN	Metropolitan Area Networks
Mbps	Megabits per second
MG	Media Gateway
MLPP	Multi-Level Precedence and Preemption
MOS	Mean Opinion Score
ms	millisecond
MTR	Maximum Transmission Range
NE	Network Element
NIST	National Institute of Standards and Technology
NM	Network Management
NMS	Network Management System
OC	Optical Carrier
OS	Operations System
P2MP	Point-to-Multipoint
P2N	Point-to-Network
P2P	Point-to-Point
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PKI	Public Key Infrastructure
QoS	Quality of Service
R	Required
RS	Remote Switching
SCIP	Secure Communication Interoperability Protocol
SF	Switching Facility
SMEO	Small End Office
SNMP	Secure/Simple Network Management Protocol
SONET	Synchronous Optical Network
SRTP	Secure Real-Time Protocol
STIG	Security Technical implementation Guide
T1	Trunk 1 (1544 Mbps, 24-channel PCM)
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TLS	Transport Layer Security
UCCO	Unified Capabilities Certification Office
UCR	Unified Capabilities Requirements
VF	Video Frequency
VVoIP	Voice and Video over Internet Protocol
WIDS	Wireless Intrusion Detection System