



DEFENSE INFORMATION SYSTEMS AGENCY

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IN REPLY
REFER TO: Joint Interoperability Test Command (JTE)

25 Jun 12

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Special Interoperability Test Certification of the Nokia Siemens Networks (NSN) hiT7300, Dense Wavelength Division Multiplexing (DWDM), Fixed Network Element (F-NE), with Software Release Version 4.30

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 NSN hiT7300, DWDM, with Software Release Version 4.30, is hereinafter referred to as the System Under Test (SUT). 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 F-NE. The SUT provides additional optical transport interfaces and functional capabilities. JITC evaluated and certifies the SUT for optical transport for the Optical Carrier interfaces detailed in Table 1. Additional sponsor functional capabilities are addressed in Table 2. 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 the Defense Information Systems Agency (DISA) via a vendor Plan of Action and Milestones to address the concern(s) within 120 days of identification. JITC conducted testing using F-NE requirements within the Unified Capabilities Requirements (UCR) 2008, Change 1, Reference (c), and other sponsor requested requirements. The JITC tested the SUT using F-NE test procedures, Reference (d) and test procedures developed to address the sponsor unique requirements. JITC does not certify any other configurations, features, or functions, except those cited within this memorandum. This certification expires upon changes that affect interoperability, but no later than three years from the date of this memorandum.
3. This finding is based on interoperability testing conducted by JITC, review of the Vendor's Letter of Compliance and Information Assurance (IA) Certification Authority (CA) approval of the IA configuration. JITC conducted Interoperability testing at the Indian Head, Maryland, Test Facility from 30 August through 19 November 2010. 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 5 April 2011. The acquiring agency or site will be

JITC Memo, JTE, Special Interoperability Test Certification of the Nokia Siemens Networks (NSN) hiT7300, Dense Wavelength Division Multiplexing (DWDM), Fixed Network Element (F-NE), with Software Release Version 4.30

responsible for the DoD Information Assurance Certification and Accreditation Process (DIACAP) accreditation. The Army originally submitted the SUT as a DISN Optical Transport System under UCR 2008 Section 5.5. Based on DISA guidance received 18 January 2012, this product was re-evaluated as an F-NE. Enclosure 2 documents the test results and describes the tested network and system configurations. Enclosure 3, System Functional and Capability Requirements, lists the F-NE Capability Requirements (CR) and Functional Requirements (FR).

4. Section 5.9 of the UCR establishes the interfaces and threshold CRs/FRs used to evaluate the interoperability of the SUT as a F-NE. Tables 1 and 2 list the F-NE, sponsor requested interfaces, CRs, FRs, and the component status of the SUT.

Table 1. SUT Interface Interoperability Status

Interface		Critical (See note)	UCR Ref (UCR 2008, Change 1)	Threshold CR/FR	Status	Remarks
NE	Analog	No	5.9.2.3.1	1,2,4	NA	Not supported by the SUT
	Serial	No	5.9.2.3.2	1,2,4	NA	Not supported by the SUT
	BRI ISDN	No	5.9.2.3.3	1,2,4	NA	Not supported by the SUT
	DS1	No	5.9.2.3.4	1,2,3,4	NA	Not supported by the SUT
	E1	No	5.9.2.3.5	1,2,3,4	NA	Not supported by the SUT
	DS3	No	5.9.2.3.6	1,2,3,4	NA	Not supported by the SUT
	OC-X	No	5.9.2.3.8	1,2,3,4	Certified	SUT met requirements for the following interfaces: OC-48/STM-16; OC-192/STM-64; and OC-768/STM-256
IP (Ethernet) GbE and 10GbE	No	5.9.2.3.9	1,2,4,7	Certified	SUT met requirements for specified interfaces	
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	
OTHER	10 GbE-LAN	No	5.9.2.3.9	1,2,4,7	Certified	SUT met requirements for specified interfaces.
	10 GbE-WAN	No	5.9.2.3.9	1,2,4,7	Certified	SUT met requirements for specified interfaces
	OSC	No	5.9.2.3.9	1,2,3,4,5	Certified	SUT met requirements for specified interfaces
NOTE: UCR does not specify any minimum interfaces. The SUT must minimally provide one of the listed ingress and egress interfaces specified.						
LEGEND:						
100Base-X	100 Mbps Ethernet generic designation	LAN	Local Area Network			
10Base-X	10 Mbps Ethernet generic designation	Mbps	Megabits per second			
BRI	Basic Rate Interface	NA	Not Applicable			
CR	Capability Requirement	NE	Network Element			
DS1	Digital Signal Level 1 (1.544 Mbps)	NM	Network Management			
DS3	Digital Signal Level 3 (44.736 Mbps)	OC-X	Optical Carrier - X (OC-3, OC-12, etc.,)			
E1	European Interface Standard (2.048 Mbps)	OSC	Optical Supervisory Channel			
F-NE	Fixed Network Element	SONET	Synchronous Optical Network			
FR	Functional Requirement	STM	Synchronous Transport Module			
GbE	Gigabit Ethernet	SUT	System Under Test			
IP	Internet Protocol	UCR	Unified Capabilities Requirements			
ISDN	Integrated Services Digital Network	WAN	Wide Area Network			

Table 2. SUT CRs and FRs Status

CR/FR ID	Capability/Function	Applicability (See notes 1 and 2.)	UCR Ref (UCR 2008, Change 1)	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	SUTs are a layer 2 device and transports IPv4 and IPv6 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	
Other Tested Requirements					
8	Requirements Applicable to all OTS Elements				
	Overall Requirements	Conditional	5.5.3.2.2.1	Partially Met	Certified based on sponsor requirements. See note 3.
	Performance Requirements	Conditional	5.5.3.2.2.2	Met	
	Reliability and Quality Assurance	Conditional	5.5.3.2.2.2.1	Met	
	Common Physical Design Requirements	Conditional	5.5.3.2.2.3	Partially Met	Certified based on sponsor requirements. See note 4.
	Protection and Restoration	Conditional	5.5.3.2.2.4	Met	
	Optical Amplifier Requirements				
	Optical Amplifier	Conditional	5.5.3.2.3	Partially Met	Certified based on sponsor requirements. See note 5.
	OLA Physical Design Requirements	Conditional	5.5.3.2.3.1	Partially Met	Certified based on sponsor requirements. See note 6.
	Muxponder Requirements				
	Muxponder	Conditional	5.5.3.2.4	Met	
	Transponder Requirements				
	Transponder	Conditional	5.5.3.2.5	Partially Met	Certified based on sponsor requirements. See note 7.
	Interface Requirements	Conditional	5.5.3.2.5.1	Met	
	ROADM Requirements				

Table 2. SUT CRs and FRs Status (continued)

CR/FR ID	Capability/Function	Applicability (See notes 1 and 2.)	UCR Ref (UCR 2008, Change 1)	Status	Remarks
8 (cont)	ROADM Requirements	Conditional	5.5.3.2.6	Partially Met	Certified based on sponsor requirements. See note 8.
	ROADM Specific Physical Design Requirements	Conditional	5.5.3.2.6.1	Partially Met	Certified based on sponsor requirements. See note 9.
	Other Tested Requirements				
	Requirements Common to Transponder and ROADM				
	Framed Formats	Conditional	5.5.3.2.7.1	Partially Met	Certified based on sponsor requirements. See note 10.
	Unframed Formats	Conditional	5.5.3.2.7.2	Not Met	Certified based on sponsor requirements. See note 11.
	Optical Supervisory Channel Requirements				
	Optical Supervisory Channel	Conditional	5.5.3.2.8	Met	
	OTS Standard Compliance	Conditional	5.5.3.2.9	Met	
NOTES:					
1. Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.					
2. The sponsor requested the SUT be assessed against UCR 2008, Section 5.5 as an OTS device.					
3. The SUT does not support 100 Gbps					
4. The SUT equipment complies with ETS 300 019-1-3 Class 3.1E, which has a normal max temperature of 40° C and max humidity of 85%, with exceptional conditions of +45° C and 90% RH. The SUT does not support software upgraded in a modular fashion, UC adjudication panel recommended for deleting all the environmental and climate control requirements in UCR 2008, paragraph 5.5.3.2.2.3, because all OTS products are considered as COTS products and COTS are designed to use in climate control environments, also recommended to change the "modular software upgrade" requirement to conditional.					
5. The SUT does not meet requirement For Laser Status Monitoring and Reporting, the SUT does not meet required reporting of Gain On Channel, does not meet requirement for Ability to Report Q Factor, the SUT does not support requirement to Show Eye Diagram, and does not support requirement for OSNR.					
6. The SUT control processors are not in 1+1 redundant configuration, but distributed amongst shelves and modules, and two management interfaces are provided on each NE Controller card. There is 1 fan shelf supporting multiple fans according to NSN POA&M Redundant control processors are planned to be introduced with SW Release 5.25 in the second half of 2013.					
7. The SUT does not support Built-in self-BER test function, Tuneable lasers for regional and metro transponders, and near end loop back for 2.5G transponder, UC adjudication panel recommended to change the requirements to "conditional" and "condition of fielding". The SUT does not support Unframed 100 Gbps					
8. The SUT does not support directionless wavelength routing, color-less wavelength routing, and optical multicasting capability, according to NSN POA&M Directionless wavelength routing for ROADMs for 80 channels will be available with SW release 5.10 EP2, available in the second half of 2012.					
9. The SUT's control processors are not in 1+1 redundant configuration, but distributed amongst shelves and modules, and 2 management interfaces are provided on each NE Controller card. There is one fan shelf supporting multiple fans, and fully configured PCX will require more than one full 84" rack, according to NSN POA&M alternative variety of fan tray is available (SRS-S or SRS-19) supporting four separate fan trays each with two fans are planned to be introduced with SW Release 5.25 in the second half of 2013. UC adjudication panel recommended to delete 84" rack requirement.					
10. The SUT does not meet required 10:1 Muxponder, and does not support 100 Gbps (STD TBD) Signals.					
11. The SUT does not support Unframed Wavelength Services and does not support Mixed Framed and Unframed Wavelength Services.					

Table 2. SUT CRs and FRs Status (continued)

LEGEND:			
ADPCM	Adaptive Differential Pulse Code Modulation	Kbps	Kilobits per second
BER	Bit Error Rate	LD-CELP	Low Delay-Code Excited Linear Prediction
C	Celsius	NA	Not Applicable
COTS	Commercial off the Shelf	NE	Network Element
CR	Capabilities Requirement	NM	Network Management
CS-ACELP	Conjugate Structure Algebraic Code-Excited Linear Prediction	NMS	Network Management System
DLoS	Direct Line of Sight	NSN	Nokia Siemens Networks
EP2	Expansion Pack 2	OLA	Optical Line Amplifier
ETS	European Telecommunication Standard	OSNR	Optical Signal-To-Noise Ratio
F-NE	Fixed-Network Element	OTS	Optical Transport System
FR	Functional Requirement	PCX	Photonic Cross-Connect
G	Gigabit	POA&M	Plan of Action and Milestones
G.726	ITU-T speech codec for ADPCM (32 Kbps)	RH	Relative Humidity
G.728	ITU-T speech codec for LD-CELP (16 Kbps)	ROADM	Reconfigurable Optical Add-Drop Multiplexor
G.729	ITU-T speech codec for CS-ACELP (8 Kbps)	SRS	Vendor Specific Acronym
Gbps	Gigabits per second	STD	Standard
ID	Identification	SUT	System Under Test
IPv4	Internet Protocol version 4	SW	Software
IPv6	Internet Protocol version 6	TBD	To Be Determined
ITU-T	International Telecommunications Union - Telecommunications	UC	Unified Capability
		UCR	Unified Capabilities Requirements
		VVoIP	Video and Voice over IP

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

6. JITC testing point of contact is Mr. Son Pham, commercial (301) 743-4258. His e-mail address is Son.M.Pham2.civ@mail.mil, mailing address: 3341 Strauss Avenue, Suite 236, Indian Head, Maryland 20640-5149. The UCCO Tracking Number (TN) is 1006001.

FOR THE COMMANDER:

3 Enclosures a/s


for RICHARD A. MEADOR
Chief
Battlespace Communications Portfolio

Distribution (electronic mail):
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Joint Interoperability Test Command, Liaison, TE3/JT1

JITC Memo, JTE, Special Interoperability Test Certification of the Nokia Siemens Networks (NSN) hiT7300, Dense Wavelength Division Multiplexing (DWDM), Fixed Network Element (F-NE), with Software Release Version 4.30

Office of Chief of Naval Operations, CNO N6F2

Headquarters U.S. Air Force, Office of Warfighting Integration & CIO, AF/XCIN (A6N)

Department of the Army, Office of the Secretary of the Army, DA-OSA CIO/G-6 ASA (ALT),
SAIS-IOQ

U.S. Marine Corps MARCORSYSCOM, SIAT, MJI Division I

DOT&E, Net-Centric Systems, and Naval Warfare

U.S. Coast Guard, CG-64

Defense Intelligence Agency

National Security Agency, DT

Defense Information Systems Agency, TEMC

Office of Assistant Secretary of Defense (NII)/DoD CIO

U.S. Joint Forces Command, Net-Centric Integration, Communication, and Capabilities
Division, J68

HQUSAISEC, AMSEL-IE-IS

ADDITIONAL REFERENCES

- (c) Office of the Assistant Secretary of Defense, "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 (IA) Assessment of Nokia Siemens Networks hiT7300, Software Release version 4.30, (TN1006001)," February 2010

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CERTIFICATION TESTING SUMMARY

- 1. SYSTEM TITLE.** Nokia Siemens Networks (NSN) hiT7300, Dense Wavelength Division Multiplexing (DWDM) platform, Fixed Network Element (F-NE) with Software Release Version 4.30.
- 2. SPONSOR.** Mr. Jordan Silk, Program Manager, HQUSAISEC, AMSEL-IE-IS, Building 53302, Fort Huachuca, AZ 85613, Email: Jordan.R.Silk.civ@mail.mil.
- 3. SYSTEM POC.** Mr. Paul Shrubshall, NSN, 6000 Connection Drive, Building 4, Irving, TX 75039, e-mail: paul.shrubshall@nsn.com.
- 4. TESTER.** Joint Interoperability Test Command (JITC), Indian Head, Maryland.
- 5. SYSTEM DESCRIPTION.** The Defense Information Systems Network (DISN) Optical Transport System (OTS) multiplexes optical signals from various sources (e.g., router, transport switch function, Channel Access Grooming) at the optical core layer. The OTS consists of the following components: Terminal, Reconfigurable Optical Add and Drop Multiplexer (ROADM), and Optical Line Amplifier. An Optical Supervisory Channel runs between these components. The terminal is composed of two elements: the transponder and the muxponder. The SUT with Software Release Version 4.30 is a DWDM-based ROADM OTS.

The NSN Telecommunication Network Management System (NMS) with Software Release Version 12.6 and NSN TransNet DWDM System Network Planning Tool, with Software Release Version 7.0 are used for configuration purposes and therefore are not certified under the SUT.

- 6. OPERATIONAL ARCHITECTURE.** JITC tested the SUT under the F-NE Unified Capabilities Requirements (UCR) product category. A high-level Defense Information System Network (DISN) node architecture, as depicted in Figure 2-1, displays the F-NE devices. The SUT as F-NE can be deployed to transport DISN services in the Wide Area Network (WAN) and on a camp, post, or station within the Local Area Network (LAN) infrastructure. The SUT solution meets the UCR requirements and can be used to augment WAN or LAN infrastructures.

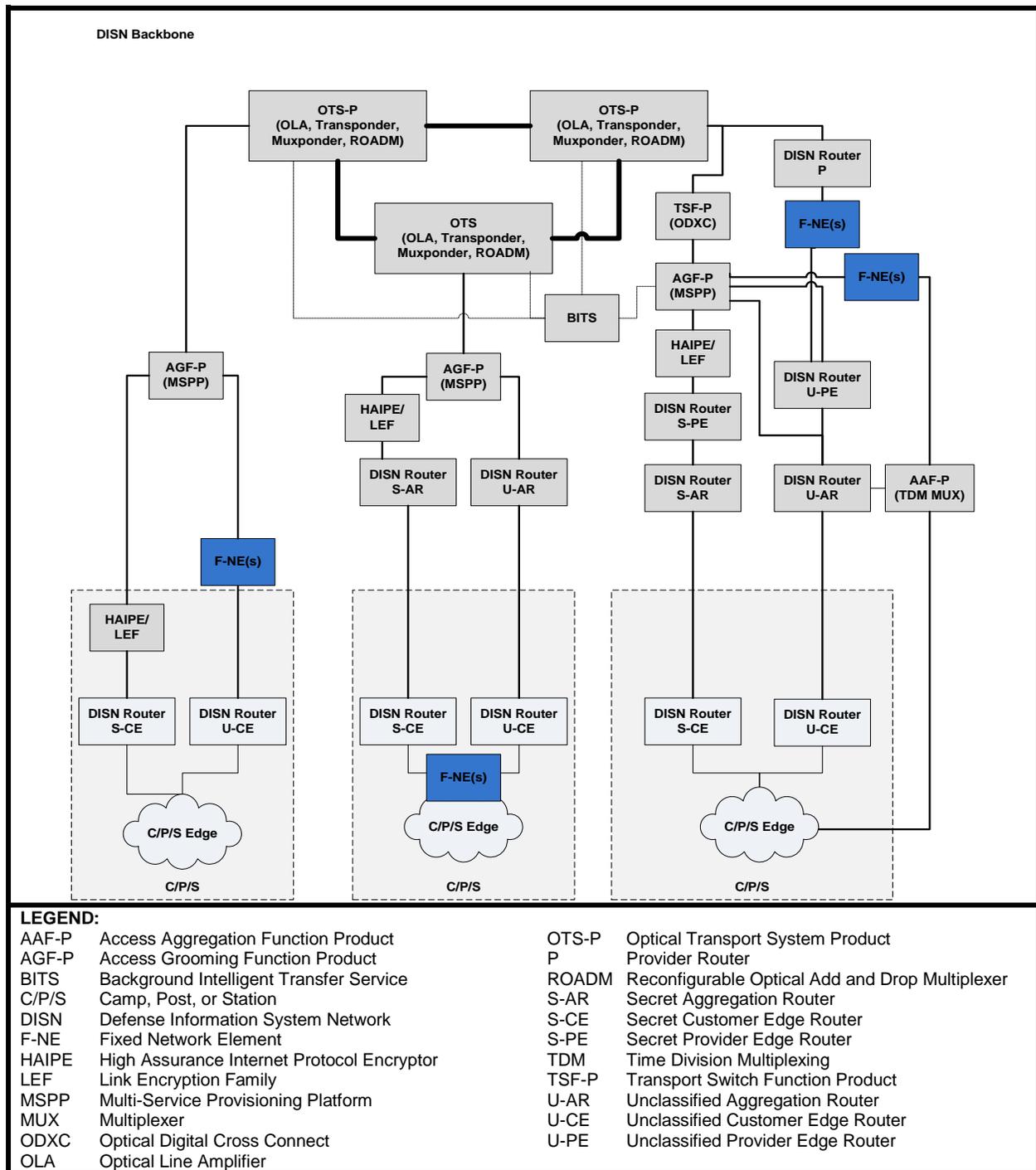


Figure 2-1. DISN Architecture

7. INTEROPERABILITY REQUIREMENTS. The interface, Capability Requirements (CR), Functional Requirements (FR), Information Assurance ((IA), and other requirements for F-NE products are established by Sections 5.4 and 5.9 of the Department of Defense (DoD) UCR 2008, Change 1.

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

Table 2-1. F-NE Interface Requirements

Interface	Critical (See note 1)	UCR Ref (UCR 2008, Change 1)	Threshold CR/FR (See note 2)	Criteria	Remarks
Ingress (LAN side)					
Analog	No	5.9.2.3.1	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		
Egress (WAN side)					
Serial	No	5.9.2.3.2	1, 2, 3, and 4	Meet minimum CR/FRs and interface standards.	Provides access to local infrastructure.
DS1	No	5.9.2.3.4	1, 2, 3, and 4		
E1	No	5.9.2.3.6	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		
DLoS	No	5.9.2.3.9	1, 2, 3, 4, and 5		
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		
NOTES:					
1. UCR does not specify any minimum interfaces.					
2. CR/FR requirements are contained in Table 2-2. CR/FR numbers represent a roll-up of UCR requirements.					
LEGEND:					
100Base-X	100 Mbps Ethernet generic designation		FR	Functional Requirement	
10Base-X	10 Mbps Ethernet generic designation		IP	Internet Protocol	
BRI	Basic Rate Interface		ISDN	Integrated Services Digital Network	
CR	Capability Requirement		LAN	Local Area Network	
DLoS	Direct Line of Sight		Mbps	Megabits per second	
DS1	Digital Signal Level 1 (1.544 Mbps)		NM	Network Management	
DS3	Digital Signal Level 3 (44.736 Mbps)		OC-X	Optical Carrier - X (OC-3, OC-12, etc.)	
E1	European Interface Standard (2.048 Mbps)		UCR	Unified Capabilities Requirements	
F-NE	Fixed Network Element		WAN	Wide Area Network	

7.2 CR and FR. The F-NE products have required and conditional features and capabilities that are established by Section 5.9 of the UCR. The SUT does not need to provide non-critical (conditional) features and capabilities. If they are present, however, they must function according to the specified requirements. Table 2-2 lists the features and capabilities and their associated requirements for the SUT products. Table 3-1 of Enclosure 3 provides detailed CR/FR requirements.

Table 2-2. SUT CRs and FRs

CR/FR ID	Capability/Function	Applicability (See note)	UCR Ref (UCR 2008, Change 1)	Criteria	Remarks																																								
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 of 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 of Enclosure 3.																																									
	G.728	Conditional	5.9.2.2																																										
G.729	Conditional	5.9.2.2																																											
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																																											
<p>NOTE: Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.</p> <p>LEGEND:</p> <table border="0"> <tr> <td>ADPCM</td> <td>Adaptive Differential Pulse Code Modulation</td> <td>IPv6</td> <td>Internet Protocol version 6</td> </tr> <tr> <td>CR</td> <td>Capabilities Requirement</td> <td>Kbps</td> <td>Kilobits per second</td> </tr> <tr> <td>CS-ACELP</td> <td>Conjugate Structure Algebraic Code-Excited Linear Prediction</td> <td>LD-CELP</td> <td>Low Delay-Code Excited Linear Prediction</td> </tr> <tr> <td>DLoS</td> <td>Direct Line of Sight</td> <td>NE</td> <td>Network Element</td> </tr> <tr> <td>FR</td> <td>Functional Requirement</td> <td>NM</td> <td>Network Management</td> </tr> <tr> <td>G.726</td> <td>ITU-T speech codec for ADPCM (32 Kbps)</td> <td>NMS</td> <td>Network Management System</td> </tr> <tr> <td>G.728</td> <td>ITU-T speech codec for LD-CELP (16 Kbps)</td> <td>SUT</td> <td>System Under Test</td> </tr> <tr> <td>G.729</td> <td>ITU-T speech codec for CS-ACELP (8 Kbps)</td> <td>TDM</td> <td>Time Division Multiplexing</td> </tr> <tr> <td>ID</td> <td>Identification</td> <td>UCR</td> <td>Unified Capabilities Requirements</td> </tr> <tr> <td></td> <td></td> <td>VVoIP</td> <td>Voice and Video over Internet Protocol</td> </tr> </table>						ADPCM	Adaptive Differential Pulse Code Modulation	IPv6	Internet Protocol version 6	CR	Capabilities Requirement	Kbps	Kilobits per second	CS-ACELP	Conjugate Structure Algebraic Code-Excited Linear Prediction	LD-CELP	Low Delay-Code Excited Linear Prediction	DLoS	Direct Line of Sight	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)	SUT	System Under Test	G.729	ITU-T speech codec for CS-ACELP (8 Kbps)	TDM	Time Division Multiplexing	ID	Identification	UCR	Unified Capabilities Requirements			VVoIP	Voice and Video over Internet Protocol
ADPCM	Adaptive Differential Pulse Code Modulation	IPv6	Internet Protocol version 6																																										
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ID	Identification	UCR	Unified Capabilities Requirements																																										
		VVoIP	Voice and Video over Internet Protocol																																										

7.3 Other. The SUT was originally submitted as an Optical Transport System (OTS) via the Unified Capabilities Certification Office process but based on Defense Information Systems Agency (DISA) guidance received 18 January 2012, this product was re-evaluated as a F-NE. The SUT also supports OTS features. JITC tested the

SUT's functionalities and capabilities. Table 2-3 and 2-4 lists these requirements on the Other Requirements Section. The OTS products with the designated interfaces can be used to interconnect the DISN WAN infrastructure.

Table 2-3. Other SUT Interface Requirements

Interface	Criteria	Remarks	
10 GbE-LAN	Meet Commercial interface standards and sponsor information exchange requirements.	UCR specifies minimum requirements. These requirements represent the sponsors additional; interfaces desired for fielding in US and Europe.	
10 GbE-WAN			
OSC			
LEGEND:			
GbE	Gigabit Ethernet	UCR	Unified Capabilities Requirements
LAN	Local Area Network	US	United States
OSC	Optical Supervisory Channel	WAN	Wide Area Network
SUT	System Under Test		

Table 2-4. Other CR/FR Requirements

CR/FR ID	Capability/Function	Applicability	UCR Ref (UCR 2008, Change 1)	Criteria	Remarks
Other Requirements					
8	Requirements Applicable to all OTS Elements				
	Overall Requirements	Conditional	5.5.3.2.2.1	Meet Sponsor requirements	
	Performance Requirements	Conditional	5.5.3.2.2.2		
	Reliability and Quality Assurance	Conditional	5.5.3.2.2.2.1		
	Common Physical Design Requirements	Conditional	5.5.3.2.2.3		
	Protection and Restoration	Conditional	5.5.3.2.2.4		
	Optical Amplifier Requirements				
	OLA Physical Design Requirements	Conditional	5.5.3.2.3.1	Meet Sponsor requirements	
	Muxponder Requirements				
	Muxponder	Conditional	5.5.3.2.4	Meet Sponsor requirements	
	Transponder Requirements				
	Transponder	Conditional	5.5.3.2.5	Meet Sponsor requirements	
	Interface Requirements	Conditional	5.5.3.2.5.1		
	ROADM Requirements				
	ROADM Requirements	Conditional	5.5.3.2.6	Meet Sponsor requirements	
	ROADM Specific Physical Design Requirements	Conditional	5.5.3.2.6.1		
	Requirements Common to Transponder and ROADM				
	Framed Formats	Conditional	5.5.3.2.7.1	Meet Sponsor requirements	
	Unframed Formats	Conditional	5.5.3.2.7.2		
	Optical Supervisory Channel Requirements				
Optical Supervisory Channel	Conditional	5.5.3.2.8	Meet Sponsor requirements		

Table 2-4. Other CR/FR Requirements (continued)

LEGEND:			
CR	Capabilities Requirement	OTS	Optical Transport System
FR	Functional Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexor
ID	Identification	UCR	Unified Capabilities Requirements
OLA	Optical Line Amplifier		

8. TEST NETWORK DESCRIPTION. JITC tested the SUT at its Indian Head, Maryland Advanced Technologies Test bed. Figure 2-2 shows the SUT’s Test Configuration.

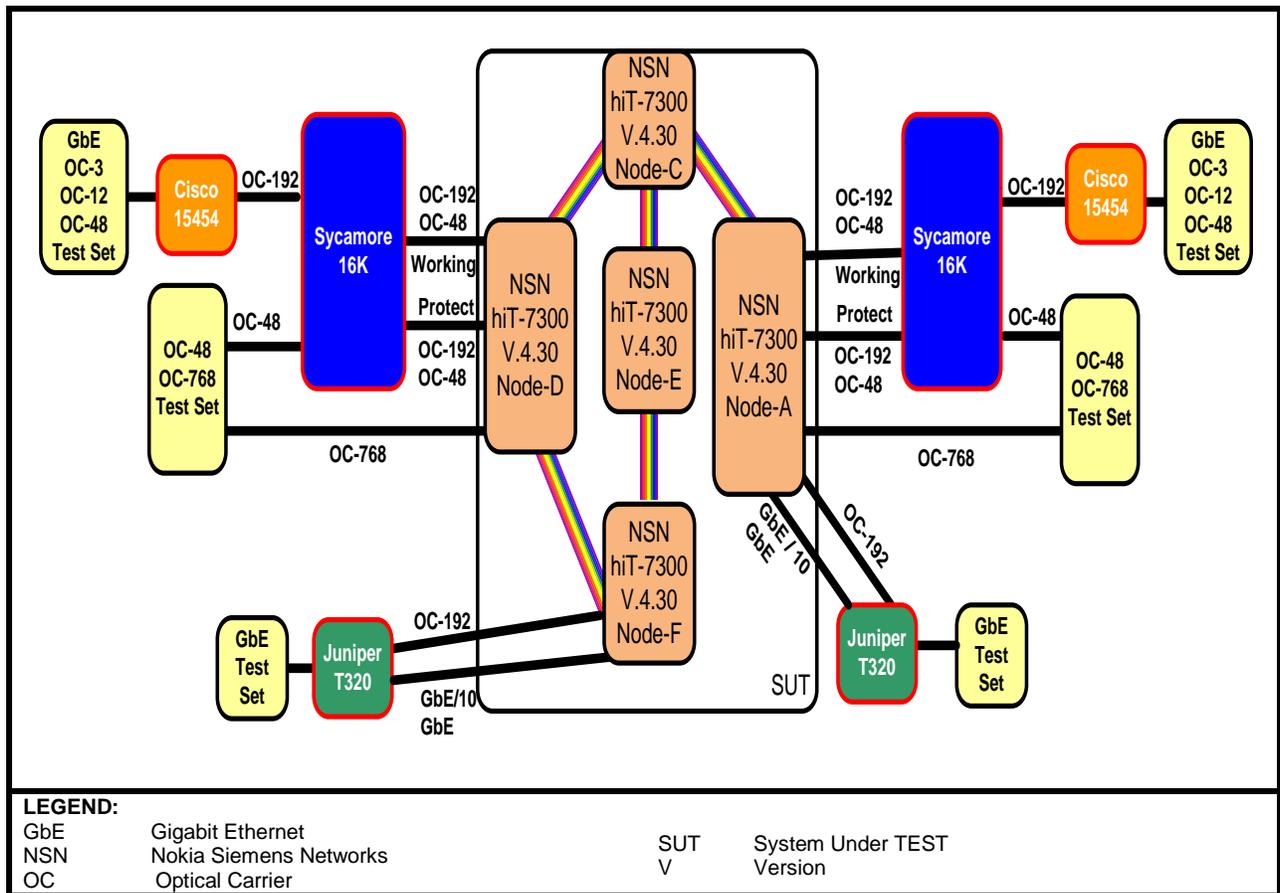


Figure 2-2. SUT’s Test Configuration

9. SYSTEM CONFIGURATION. Table 2-5 lists the Tested SUT equipment shown in Figure 2-2, Table 2-6 lists the Non-SUT equipment used to test the SUT, and Table 2-7 lists the test equipment used to generate voice, Synchronous Optical Network, and Internet Protocol (IP) traffic.

Table 2-5. Hardware/Software Tested SUT Equipment

Platform	Software Release	UC Product Type
NSN hiT7300, F-NE, DWDM platform	4.30	F-NE
Sub-Components		
Component Name	Software Release	Function
NSN TNMS software	12.6	Graphical Craft Interface
NSN TransNet software	7.0	DWDM System Network Planning Tool.
SUT-Equipments List		
Item/Card Name	Part Number	Number of Items
HIT7300 ANSI SHELF AND ACCESSORIES	TNX:A4B0000008890	1
hiT 7300 FlatPack, ANSI, DC, accessories	TNX:A4B0000009918	1
Filler Panel	C50117-A29-B84	2
NE-CONTROLLER R4.2 W/O TIF, CCMP-1 (40mm)	TNX:A4B0000009953	4
NE-CONTROLLER R4.25 W/ TIF, CCEP-1 (70mm)	TNX:A4B0000011141	1
SHELF-CONTROLLER CCSP-1 (40mm)	TNX:A4B0000008953	9
40CH MX(DX)(UNIDIR.)	TNX:A4B0000009426	11
40CH MX(DX)(UNIDIR.)+VOAS	TNX:A4B0000009927	3
40CH ROADM W/ SPLITTER	TNX:A4B0000009427	2
8-CHANNEL VOA	TNX:A4B0000009751	2
WSS, 50GHz 9X1, DROP-PATH	TNX:A4B0000011133	3
WSS, 100GHz 8x1, add-path	TNX:A4B0000009929	2
WSS, 50GHz 9X1, ADD-PATH	TNX:A4B0000011132	4
INTERLEAVER 80CH W/ DROP-PATH (UNIDIR.)	TNX:A4B0000009933	1
Power Distribution Unit (GMT)	TNX:A4B0000009903	6
LAMPC-1, MEDIUM SPAN PRE-AMPLIFIER, INTERSTAGE ACCESS, NO EXT. PUMP	TNX:A4B0000008905	4
LAMIC-1, MEDIUM SPAN INLINE-AMPLIFIER, INTERSTAGE ACCESS, NO EXT. PUMP	TNX:A4B0000008906	8
LASBC-1, SHORT SPAN BOOSTER-AMPLIFIER, NO INTERSTAGE ACCESS, NO EXT. PUMP	TNX:A4B0000008907	3
RAMAN PUMP CARD, C-BAND, 4 PUMPS, 2 PUMP WAVELENGTHS, 2 SLOTS	TNX:A4B0000008909	2
EXTERNAL PUMP CARD	TNX:A4B0000008910	3
LALBC-1, LONG SPAN BOOSTER AMPL. (R4.1)	TNX:A4B0000009794	2
LALPC-1, LONG SPAN PRE-AMPLIFIER (R4.1), INTERSTAGE ACCESS, UPGRADABLE WITH RAMAN, 2 SLOTS	TNX:A4B0000009796	4
80-CHANNEL 4-PT POWER MONITOR (2.5G-40G)	TNX:A4B0000009934	6
DCM (DCF), 50km SSMF, 850ps/nm, 1 slot	TNX:A4B0000011010	2
DCM (DCF), 90km SSMF, 1530ps/nm, 2 slot	TNX:A4B0000011014	2
DCM (DCF), 100km SSMF, 1700ps/nm, 2 slot	TNX:A4B0000011015	2
DCM (DCF), 130km SSMF, 2210ps/nm, 2 SLOT	TNX:A4B0000011018	2
DCM (DCF), 30km SSMF, 510ps/nm, 1 SLOT	TNX:A4B0000011008	6
DCM (DCF), 40km SSMF, 680ps/nm, 1 slot	TNX:A4B0000011009	2
2.5G TRANSPONDER/REGENERATOR, 2X LINE	TNX:A4B0000009750	2
10G TRANSPONDER LH TUNABLE, 1X LINE, 1X CLIENT (XFP), C-BAND	TNX:A4B0000008949	4
10G MUXPONDER LH TUNABLE, 1X LINE, 8X CLIENT (SFP), C-BAND	TNX:A4B0000009431	2
10G TRANSPONDER LH TUN./DISPCOMP, 1X LINE, 1X CLIENT (XFP), C-BAND (195.75 THz)	TNX:A4B0000009430	2

Table 2-5. Tested SUT Equipment (continued)

Item/Card Name	Part Number	Number of Items
40G TRANSPONDER, DPSK, 1X LINE, 1X CLIENT	TNX:A4B0000009941	2
40G REGENERATOR, DPSK, UNIDIR. (194.0 THz)	TNX:A4B0000009942	2
40G MUXPONDER, DPSK, 1X LINE, 4X CLIENT	TNX:A4B0000009943	2
SFP STM-16/OC-48, I-16/SR/P111-1D1, SMF, 1300nm, 2km, LC	TNX:A4B0000008959	29
XFP MODULE I64.1/P111-2D1/10GBASE-L, SMF, 1300nm, 2km FOR STM64, 10Km FOR 10GBASE-L, LC	TNX:A4B0000008970	6
SFP DWDM 2.5G, 1546,917 nm (193,8 THz) (193.8 THz)	TNX:A4B0000010387	2
SFP DWDM 2.5G, 1546,119 nm (193,9 THz) (193.9 THz)	TNX:A4B0000010386	2
OPT. CHANNEL PROTECTION (3PORT)	TNX:A4B0000009428	2
FILLER PANEL	TNX:A4B0000008900	62
FO ATTENUATOR LC/PC, 3dB	C39195-Z202-D203	25
FO ATTENUATOR LC/PC, 2dB	C39195-Z202-D202	6
FO ATTENUATOR LC/PC, 4dB	C39195-Z202-D204	5
FO ATTENUATOR LC/PC, 6dB	C39195-Z202-D206	2
FO PATCH CORD LC/PC - LC/PC, 3.0M	TNX:A4B0000006030	130
FO PATCH CORD LC/PC - LC/PC, 6.0M	TNX:A4B0000006031	22
LEGEND:		
ANSI	American National Standards Institute	MX Multiplexor
CCEP	Nokia Siemens specific card	NE Network Element
CCMP	Nokia Siemens specific card	nm nanometer
CCSP	Nokia Siemens specific card	NSN Nokia Siemens Network
CH	Channel	PC Power Control
dB	Decibel	PS Peco Second
DC	Direct Current	PT Point
DCF	Dispersion Compensating Fiber	ROADM Reconfigurable Optical Add Drop Multiplexer
DCM	Data Communication Module	SFP Small Form-Factor
DPSK	Dual Phase Shift Keying	SR Short Reach
DWDM	Dense Wavelength Division Multiplexing	SSMF Standard Single Mode Fiber
DX	Demultiplexor	STM Synchronous Transmission Mode
F-NE	Fixed-Network Element	SUT System Under Test
FO	Fiber Optics	THz Terahertz
G	Gigabit	TIF Telemetry Interface
GHz	Gigahertz	TNMS Transport Network Management System
GMT	Generic Mapping Tools	UNIDIR Unidirectional
km	kilometer	VOA Vertically Oriented Antenna
LC	Line Conditioner	VOAS Vertically Oriented Antenna Surface
M	Meter	WSS Wavelength Selective Switching
mm	millimeter	XFP X-Form Factor Pluggable

Table 2-6. Non-SUT Equipment

Component	Software Version	Function
Cisco 15454	09.00-008I-17.17	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 16K	7.6.21 Build 0562.26.27.57.14	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	4 x FE 100 Base TX, 10 x GbE LAN 1000 Base, 1x OC-192 SM SR2, 1 x 10GbE LAN, XENPAK

Table 2-6. Non-SUT Equipment (continued)

LEGEND:			
100 Base-TX	100 Mbps Ethernet generic designation	Mbps	Megabit per second
1000 Base	1000 Mbps Ethernet generic designation	OC	Optical Carrier
DS	Digital Signal	ODXC	Optical Digital Cross Connect
ETH	Ethernet	R	Revision
FE	Fast Ethernet	SM	Single Mode
FX	Fast Ethernet over Fiber Cable	SR	Short Reach
GbE	Gigabit Ethernet	STM	Synchronous Transport Module
GIPC	Group Primary Interexchange Carrier	SUT	System Under Test
IR	Immediate Reach	TX	Fast Ethernet Twisted Wires
LAN	Local Area Network	USC	Universal Services Card
LIM	Line Interface Module	X	Place holder for FX or TX
LR	Long Reach		

Table 2-7. Test Equipment

Manufacture	Type	Port Type	Software Version
Anritsu	Tunics Plus – Tunable Laser	C-Band	1.00
Agilent	Optical Tester	1550 nm	A.06.01
		1310 nm	
	Router Tester 900	OC-3/OC-12 /POS	6.11
	OC-48 Multilayer		
Ixia	Traffic generator	10 GbE	5
		LM1000STX	
Digital Lightwave	Optical Wavelength Manager	Monitor Ports	2.4.0
Agilent	Rack Mounted Router Tester 900	10 GbE LAN/WAN	6.11
		10/100/1000 Base-T	
		1000 Base-X	
		OC-48c POS	
Agilent JDSU	T-Berd 8000	OC-3/12/POS	6.11
		OC-192 POS	
		DSU	6.4
		10/100/1000	
OC-3-12			
	OC-192		
	STM-1/STM-4/STM-16/STM-64		
LEGEND:			
10/100/1000 Base-X	10/100/1000 Mbps Ethernet generic designation	Nm	nanometer
DSU	Data Services Unit	OC	Optical Carrier
FX	Fast Ethernet	POS	Packet Over Synchronous Optical Network
GbE	Gigabit Ethernet	STM	Synchronous Transport Module
JDSU	Vendor Name	TX	Fast Ethernet over Twisted Wires
LAN	Local Area Network	WAN	Wide Area Network
Mbps	Megabits per second	X	Place holder for FX or TX

10. TEST LIMITATIONS. None

11. INTEROPERABILITY EVALUATION RESULTS. The SUT meets the critical interoperability requirements for 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 Table 2-8.

Table 2-8. SUT F-NE Interface Requirements Status

Interface	Critical (See note)	UCR Ref (UCR 2008, Change 1)	Status	Remarks	
NE	Analog	No	5.9.2.3.1	NA	Not supported by the SUT.
	Serial	No	5.9.2.3.2	NA	Not supported by the SUT.
	BRI ISDN	No	5.9.2.3.3	NA	Not supported by the SUT.
	DS1	No	5.9.2.3.4	NA	Not supported by the SUT.
	E1	No	5.9.2.3.5	NA	Not supported by the SUT.
	DS3	No	5.9.2.3.6	NA	Not supported by the SUT.
	OC-X	No	5.9.2.3.8	Certified	SUT met requirements for the following interfaces: OC-48/STM-16; OC-192/STM-64; AND OC-768/STM-256
IP (Ethernet) 10/100/1000 and 10GbE	No	5.9.2.3.9	Certified	SUT met requirements for specified interfaces.	
NM	10Base-X	Yes	5.3.2.4.4	Certified	SUT met requirements for specified interfaces.
	100Base-X	Yes	5.3.2.4.4	Certified	SUT met requirements for specified interfaces.
NOTE: UCR does not specify any minimum interfaces.					
LEGEND:					
100Base-X	100 Mbps Ethernet generic designation	Mbps	Megabits per second		
10Base-X	10 Mbps Ethernet generic designation	NA	Not Applicable		
BRI	Basic Rate Interface	NE	Network Element		
DS1	Digital Signal Level 1 (1.544 Mbps)	NM	Network Management		
DS3	Digital Signal Level 3 (44.736 Mbps)	OC-X	Optical Carrier - X (OC-3, OC-12, etc.)		
E1	European Interface Standard (2.048 Mbps)	STM	Synchronous Transport Module		
F-NE	Fixed Network Element	SUT	System Under Test		
FX	Fast Ethernet	TX	Fast Ethernet over Twisted Wires		
GbE	Gigabit Ethernet	UCR	Unified Capabilities Requirements		
IP	Internet Protocol	X	Place holder for FX or TX		

11.2 CR and FR. SUT’s CR/FR statuses are listed in Table 2-9. The detailed CR/FR requirements are provided in Table 3-1 of the System FRs and CRs (Enclosure 3).

Table 2-9. SUT CRs and FRs Status

CR/FR ID	Capability/Function	Applicability (See note)	UCR Ref (UCR 2008, Change 1)	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				

Table 2-9. SUT CRs and FRs Status (continued)

	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																																													
<p>NOTE: Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.</p> <p>LEGEND:</p> <table> <tr> <td>ADPCM</td> <td>Adaptive Differential Pulse Code Modulation</td> <td>IPv4</td> <td>Internet Protocol version 4</td> </tr> <tr> <td>CR</td> <td>Capabilities Requirement</td> <td>IPv6</td> <td>Internet Protocol version 6</td> </tr> <tr> <td>CS-ACELP</td> <td>Conjugate Structure Algebraic Code-Excited Linear Prediction</td> <td>Kbps</td> <td>Kilobits per second</td> </tr> <tr> <td>DLoS</td> <td>Direct Line of Sight</td> <td>LD-CELP</td> <td>Low Delay-Code Excited Linear Prediction</td> </tr> <tr> <td>F-NE</td> <td>Fixed Network Element</td> <td>NA</td> <td>Not Applicable</td> </tr> <tr> <td>FR</td> <td>Functional Requirement</td> <td>NE</td> <td>Network Element</td> </tr> <tr> <td>G.726</td> <td>ITU-T speech codec for ADPCM (32 Kbps)</td> <td>NM</td> <td>Network Management</td> </tr> <tr> <td>G.728</td> <td>ITU-T speech codec for LD-CELP (16 Kbps)</td> <td>NMS</td> <td>Network Management System</td> </tr> <tr> <td>G.729</td> <td>ITU-T speech codec for CS-ACELP (8 Kbps)</td> <td>SUT</td> <td>System Under Test</td> </tr> <tr> <td>ID</td> <td>Identification</td> <td>UCR</td> <td>Unified Capabilities Requirements</td> </tr> <tr> <td>ITU-T</td> <td>ITU Telecommunications Union - Telecommunications</td> <td>VVoIP</td> <td>Voice and Video over Internet Protocol</td> </tr> </table>						ADPCM	Adaptive Differential Pulse Code Modulation	IPv4	Internet Protocol version 4	CR	Capabilities Requirement	IPv6	Internet Protocol version 6	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	ITU-T	ITU Telecommunications Union - Telecommunications	VVoIP	Voice and Video over Internet Protocol
ADPCM	Adaptive Differential Pulse Code Modulation	IPv4	Internet Protocol version 4																																														
CR	Capabilities Requirement	IPv6	Internet Protocol version 6																																														
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																																														
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G.726	ITU-T speech codec for ADPCM (32 Kbps)	NM	Network Management																																														
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ID	Identification	UCR	Unified Capabilities Requirements																																														
ITU-T	ITU Telecommunications Union - Telecommunications	VVoIP	Voice and Video over Internet Protocol																																														

a. General NE Requirements

(1) General Requirements. In accordance with (IAW) UCR 2008, Change 1, Section 5.9.2.1 all NEs shall meet the following general requirements and conditions:

(a) 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.

(b) The introduction of an NE(s) shall not degrade the E2E measured Bit Error Rate (BER) to no more than .03 percent from the baseline minimum E2E digital BER requirement, which is not more than one error in 1×10^9 bits (averaged over a 9-hour period). The SUT met the requirement as measured using test equipment and simulated information exchanges.

(c) The introduction of an NE(s) shall not degrade secure transmission for secure end devices as defined by UCR 2008, Change 1, 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.

(d) 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.

(e) 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.

(f) 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 Transmission Link Level 1 calls and simulated information exchanges with no noted issues.

(2) Alarms. The NE shall provide the capability of detecting a Carrier Group Alarm (CGA). NEs that support IP ingress/egress traffic as either inbound or outbound NE traffic and/or transport between NEs shall support one or more of the following routing protocols: Link-State and/or Distance-Vector. Therefore, the NE can notify the Internet Protocol (IP) network (e.g., LAN and 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, 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 equipments.

(3) 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:

(a) Time Division Multiplexer/Multiplexing (TDM) Transport. The SUT is a Layer-2 device and 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 equipments.

(b) 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 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 equipments.

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

b. Compression. The SUT does not support Compression.

c. Interface Requirements. Timing. 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.

d. Device Management. The SUT shall provide the following device management functions:

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

(a) 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.

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

(2) 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.

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

(4) 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.

e. DLoS. DLoS Transport. The SUT does not provide DLoS Transport.

f. Internet Protocol version 6 (IPv6) Requirements. The SUT must meet UCR 2008, Change 1, Section 5.3.5.4 IPv6 requirements for Network Appliance/Simple Server. The SUT is a Layer-2 device and transports IP version 4 and IPv6 traffic transparently so requirements specific relating to layer 3 do not apply.

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

(1) 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.

(2) General Management Requirements. The SUT must support Simple Network Management Protocol v3 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 1, 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 & Management) for all VVoIP network components.

11.3 Other. JITC has conducted additional tests on the SUT. Table 2-10 shows the Additional Interface Requirements under UCR 2008, Change 1, Section 5.5.3.4, and the results. The SUT's CR/FR status under OTS requirements are listed in Table 2-11. The SUT met the minimum standards for the following UCR 2008, Change 1, Section 5.5.3.2, with the following exceptions:

- (a) Requirements Applicable to all OTS Elements/Overall Requirements – Sub-Paragraph: (5.5.3.2.) 2.1.7.
- (b) Requirements Applicable to all OTS Elements/Common Physical Design Requirements – Sub-Paragraphs: (5.5.3.2.) 2.3.32, 2.3.33, 2.3.34, 2.3.38, 2.3.44.
- (c) Optical Amplifier Requirements/Optical Amplifier – Sub-Paragraphs: (5.5.3.2.) 3.3, 3.23, 3.24, 3.25, 3.26.
- (d) Optical Amplifier Requirements/OLA Physical Design Requirements – Sub-Paragraph: (5.5.3.2.) 3.1.2.
- (e) Transponder Requirements/Transponder – Sub Paragraphs: (5.5.3.2.) 5.2, 5.3, 5.4, 5.12.
- (f) ROADM Requirements/ROADM Requirements – Sub-Paragraphs: (5.5.3.2.) 6.1, 6.2, 6.3, 6.22.
- (g) ROADM Requirements/ROADM Specific Physical Design Requirements – Sub-Paragraphs: (5.5.3.2.) 6.1.3, 6.1.6.
- (h) Requirements Common to Transponder and ROADM/Framed Formats – Sub-Paragraphs: (5.5.3.2.) 7.1.2, 7.1.7.
- (i) Requirements Common to Transponder and ROADM/Unframed Formats – Sub-Paragraphs: (5.5.3.2.) 7.2.1, 7.2.2.

Table 2-11. Other CRs and FRs

CR/FR ID	Capability/Function	UCR Ref (UCR 2008, Change 1)	Status	Remarks
8	Requirements Applicable to all OTS Elements			
	Overall Requirements	5.5.3.2.2.1	Partially Met	See note 1.
	Performance Requirements	5.5.3.2.2.2	Met	
	Reliability and Quality Assurance	5.5.3.2.2.2.1	Met	
	Common Physical Design Requirements	5.5.3.2.2.3	Partially Met	See note 2.
	Protection and Restoration	5.5.3.2.2.4	Met	
	Optical Amplifier Requirements			
	Optical Amplifier	5.5.3.2.3	Partially Met	See note 3.
	OLA Physical Design Requirements	5.5.3.2.3.1	Partially Met	See note 4.
	Muxponder Requirements			
	Muxponder	5.5.3.2.4	Met	
	Transponder Requirements			
	Transponder	5.5.3.2.5	Partially Met	See note 5.
	Interface Requirements	5.5.3.2.5.1	Met	
	ROADM Requirements			
	ROADM Requirements	5.5.3.2.6	Partially Met	See note 6.
	ROADM Specific Physical Design Requirements	5.5.3.2.6.1	Partially Met	See note 7.
	Requirements Common to Transponder and ROADM			
	Framed Formats	5.5.3.2.7.1	Partially Met	See note 8.
	Unframed Formats	5.5.3.2.7.2	Not Met	See note 9.
Optical Supervisory Channel Requirements				
Optical Supervisory Channel	5.5.3.2.8	Met		
OTS Standards Compliance	5.5.3.2.9	Met		
NOTES:				
<p>1. The SUT does not support 100 Gbps.</p> <p>2. The SUT equipment complies with ETS 300 019-1-3 Class 3.1E, which has a normal max temperature of 40° C and max humidity of 85%, with exceptional conditions of +45° C and 90% RH. The SUT does not support software upgraded in a modular fashion, UC adjudication panel recommended for deleting all the environmental and climate control requirements in UCR 2008, paragraph 5.5.3.2.2.3, because all OTS products are considered as COTS product and COTS are designed to for use in climate controlled environments, also recommended to change the “modular software upgrade” requirement to conditional.</p> <p>3. The SUT does not meet requirement For Laser Status Monitoring and Reporting, the SUT does not meet required reporting of Gain On Channel, does not meet requirement for Ability to Report Q Factor, the SUT does not support requirement to Show Eye Diagram, and does not support requirement for OSNR.</p> <p>4. The SUT control processors are not in 1+1 redundant configuration, but distributed amongst shelves and modules, and two management interfaces are provided on each NE Controller card. There is one fan shelf supporting multiple fans according to NSN POA&M Redundant control processors are planned to be introduced with SW Release 5.25 in the second half of 2013.</p> <p>5. The SUT does not support Built-in self-BER test function, Tunable lasers for regional and metro transponders, and near end loop back for 2.5G transponder, UC adjudication panel recommended to change the requirements to “conditional” and “condition of fielding”. The SUT does not support Unframed 100 Gbps.</p>				

Table 2-11. Other CRs and FRs (continued)

NOTES (continued):			
6. The SUT does not support direction-less wavelength routing, color-less wavelength routing, and optical multicasting capability, according to NSN POA&M Directionless wavelength routing for ROADMs for 80 channels will be available with SW release 5.10 EP2, available in the second half of 2012.			
7. The SUT's control processors are not in 1+1 redundant configuration, but distributed amongst shelves and modules, and two management interfaces are provided on each NE Controller card. There is one fan shelf supporting multiple fans, and fully configured PCX will require more than one full 84" rack, according to NSN POA&M alternative variety of fan tray is available (SRS-S or SRS-19) supporting four separate fan trays each with 2 fans are planned to be introduced with SW Release 5.25 in the second half of 2013. UC adjudication panel recommended deleting 84" rack requirement.			
8. The SUT does not meet required 10:1 Muxponder, and does not support 100 Gbps (STD TBD) Signals.			
9. The SUT does not support Unframed Wavelength Services, and does not support Mixed Framed and Unframed Wavelength Services.			
LEGEND:			
BER	Bit Error Rate	OSNR	Optical Signal-To-Noise Ratio
C	Celsius	OTS	Optical Transport System
CH	Change	PCX	Photonic Cross-Connect
COTS	Commercial off the Shelf	POA&M	Plan of Action and Milestones
CR	Capabilities Requirement	RH	Relative Humidity
ETS	European Telecommunication Standard	ROADM	Reconfigurable Optical Add-Drop Multiplexor
EP2	Expansion Pack 2	SRS	Vendor Specific Acronym
FR	Functional Requirement	STD	Standard
G	Gigabit	SUT	System Under Test
Gbps	Gigabits per second	SW	Software
ID	Identification	TBD	To Be Determined
NE	Network Element	UC	Unified Capability
NSN	Nokia Siemens Networks	UCR	Unified Capabilities Requirements
OLA	Optical Line Amplifier		

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

SYSTEM FUNCTIONAL AND CAPABILITY REQUIREMENTS

The Network Elements (NE) and Fixed Network Elements (F-NE) have required and conditional features and capabilities that are established by the Unified Capabilities Requirements (UCR). The System Under Test (SUT) does not need to meet conditional requirements. If they are provided, they must function according to the specified requirements. The detailed Functional requirements (FR) and Capability Requirements for NEs are listed in Table 3-1.

Table 3-1. NE Capability/Functional Requirements Table

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE
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

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

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE
8	The NE shall be able to propagate Carrier Group Alarms (CGAs) upon physical loss of the TDM interface. The NE shall provide the capability of detecting a carrier group alarm (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
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 Carrier Group Alarm (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

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

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE
10	<p>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:</p> <p>a. Time Division Multiplexing 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 end-to-end.</p> <p>b. Time Division Multiplexing 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 end-to-end.</p> <p>c. Time Division Multiplexing 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 end-to-end.</p> <p>d. Time Division Multiplexing 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 end-to-end.</p>	5.9.2.1.2.1 (2A, 2B, 2C, 2D)	C
11	<p>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.</p>	5.9.2.1.2.2	C
12	<p>The NE shall implement DLoS congestion control based on the DSN traffic and signaling type to be transported. (Please see Following)</p>	5.9.2.1.2.3	C
13	<p>The NE transporting only TDM bearer and signaling traffic shall implement DLoS congestion control via one or more of the following methods:</p> <p>a. A dynamic load control signal (e.g., contact closure).</p> <p>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.</p> <p>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.</p>	5.9.2.1.2.3 (1A, 1B, 1C)	C
14	<p>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.</p>	5.9.2.1.2.3 (2)	C
15	<p>The NE transporting both TDM and IP ingress traffic simultaneously over the same DLoS transport link shall meet the following requirements:</p> <p>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.</p> <p>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.</p>	5.9.2.1.2.3 (3A, 3B)	C
16	<p>The NE used for voice compression shall support at least one of the following standards:</p> <ul style="list-style-type: none"> • ITU-T Recommendation G.726 • ITU-T Recommendation G.728 • ITU-T Recommendation G.729 	5.9.2.2	C
17	<p>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:</p>	5.9.2.3.1	C
18A	<p>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</p>	5.9.2.3.1 (1)	C

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

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE
	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.		
18B	2. Single Frequency Trunk Circuits: The NE will interface with external switching facility (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 Dual Frequency Signaling Unit (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 trunk interface, the DF trunk interface will consist of only the voice path conductors (T, 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: <ul style="list-style-type: none"> • 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 Extended Superframe (ESF) framing format. D5 is also referred to as Extended Frame (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) pulse code modulation (PCM) encoding law. Supervisory and dial pulse (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 1-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, dial pulse digits (DPs), 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 and the "B" bit = 0 as on-hook, and the combination bit = 1 and "B" bit = 1 as an off-hook indication. When signaling on Voice Frequency (VF) channels using the PCM-24 format, the least significant bit of each channel, every six frames, shall	5.9.2.3.4 (2)	C

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

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE
	<p>carry signaling information.</p> <p>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.</p> <p>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.</p> <p>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.</p>		
22B	3. Clear Channel Capability: The NE shall be capable of transmitting and receiving B8ZS line coding in accordance with 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 digital interface unit (DIU) as defined in Table 5.9.2.3.4-4, PCM-24 Alarm and Restoral Requirements. (Please see UCR 2008, Change 1-Page 1901)	5.9.2.3.4 (4)	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 1-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 1-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 in accordance with ANSI T1.107-2002.	5.9.2.3.6.1 (2)	C
26	The line coding shall be bipolar 3 zero substitution (B3ZS) in accordance with ANSI T1.102-1993.	5.9.1.5.3.6.2	R
27	<p>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):</p> <p>[Required: Media Gateway (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</p> <p>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.</p> <p>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.</p> <p>5.3.2.12.14.1.1.2 Internal Clock Requirements</p> <p>5.3.2.12.14.1.1.2.1 General - [Required: MG] The MGs shall provide internal clock</p>	5.9.2.3.7	R

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

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE
	requirements as described in the Telcordia Technologies GR-518-CORE, Paragraph 18.2. 5.3.2.12.14.1.1.2.2 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		
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) Time Division Multiplexing 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 end-to-end. (2) Time Division Multiplexing 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 end-to-end. (3) Time Division Multiplexing ingress G.711 (secure calls) to non-transcoding G.711 IP egress shall not increase delay by more than 50 ms per NE pair as measured end-to-end. (4) Time Division Multiplexing 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 end-to-end.	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 National Institute of Standards and Technology (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 Advanced DSN Integrated Management Support System (ADIMSS) or similar Network Management (NM) systems developed by DoD Components. The following requirements apply:	5.9.2.4.1	R

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

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE
	<p>(1) [Required: Data Interface] The NE shall provide network management (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)</p> <p>(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</p> <p>(3) [Required: Configuration Management] Requirements for this feature shall be in accordance with Telcordia Technologies GR-472-CORE, Section 4.</p>		
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	<p>The NEs using DLoS transport shall support the following:</p> <p>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.</p> <p>b. [Required] The minimum acceptable maximum transmission range (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.</p> <p>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.</p> <p>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.</p>	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

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

ID	Requirement	UCR Ref (UCR 2008 CH 2)	F-NE																																																																																								
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																																																																																								
<p>LEGEND:</p> <table border="0"> <tr> <td>ADIMSS</td> <td>Advanced DSN Integrated Management Support System</td> <td>IP</td> <td>Internet Protocol</td> </tr> <tr> <td>ANSI</td> <td>American National Standards Institute</td> <td>ISDN</td> <td>Integrated Services Data Network</td> </tr> <tr> <td>APL</td> <td>Approved Product List</td> <td>ITU</td> <td>International Telecommunications Union</td> </tr> <tr> <td>ASLAN</td> <td>Assured Services LAN</td> <td>ITU-T</td> <td>ITU Telecommunications Union - Telecommunications Sector</td> </tr> <tr> <td>BER</td> <td>Bit Error Rate</td> <td>LAN</td> <td>Local Area Network</td> </tr> <tr> <td>BRI</td> <td>Basic rate Interface</td> <td>MAN</td> <td>Metropolitan Area Networks</td> </tr> <tr> <td>C</td> <td>Conditional</td> <td>MLPP</td> <td>Multi-Level Precedence and Preemption</td> </tr> <tr> <td>CE</td> <td>Customer Edge</td> <td>MOS</td> <td>Mean Opinion Score</td> </tr> <tr> <td>CGA</td> <td>Carrier Group Alarm</td> <td>Ms</td> <td>Millisecond</td> </tr> <tr> <td>CH</td> <td>Change</td> <td>NMS</td> <td>Network Management System</td> </tr> <tr> <td>D-NE</td> <td>Deployed-Network Element</td> <td>NSA</td> <td>National Security Agency</td> </tr> <tr> <td>DAA</td> <td>Designated Approving Authority</td> <td>PCM</td> <td>Pulse Code Modulation</td> </tr> <tr> <td>DISR Profile</td> <td>DoD Information technology Standards and Registry</td> <td>PRI</td> <td>Primary rate Interface</td> </tr> <tr> <td>DoD</td> <td>Department of Defense</td> <td>R</td> <td>Required</td> </tr> <tr> <td>DoDI</td> <td>DoD Instruction</td> <td>SCIP</td> <td>Secure Communication Interoperability Protocol</td> </tr> <tr> <td>DSN</td> <td>Defense Switched Network</td> <td>SONET</td> <td>Synchronous Optical Network</td> </tr> <tr> <td>DVX</td> <td>Deployed Voice Exchange</td> <td>STIG</td> <td>Security Technical implementation Guide</td> </tr> <tr> <td>E1</td> <td>European 1 (2048 bps, 30-channel PCM)</td> <td>T1</td> <td>Trunk 1 (1544 bps, 24-channel PCM)</td> </tr> <tr> <td>E2E</td> <td>End to End</td> <td>TDM</td> <td>Time Division Multiplexing</td> </tr> <tr> <td>F-NE</td> <td>Fixed-Network Element</td> <td>UCCO</td> <td>Unified Capabilities Certification Office</td> </tr> <tr> <td>FIPS</td> <td>Federal Information Processing Standard</td> <td>UCR</td> <td>Unified Capabilities Requirements</td> </tr> <tr> <td>IAW</td> <td>In Accordance With</td> <td>VVoIP</td> <td>Voice and Video over Internet Protocol</td> </tr> </table>				ADIMSS	Advanced DSN Integrated Management Support System	IP	Internet Protocol	ANSI	American National Standards Institute	ISDN	Integrated Services Data Network	APL	Approved Product List	ITU	International Telecommunications Union	ASLAN	Assured Services LAN	ITU-T	ITU Telecommunications Union - Telecommunications Sector	BER	Bit Error Rate	LAN	Local Area Network	BRI	Basic rate Interface	MAN	Metropolitan Area Networks	C	Conditional	MLPP	Multi-Level Precedence and Preemption	CE	Customer Edge	MOS	Mean Opinion Score	CGA	Carrier Group Alarm	Ms	Millisecond	CH	Change	NMS	Network Management System	D-NE	Deployed-Network Element	NSA	National Security Agency	DAA	Designated Approving Authority	PCM	Pulse Code Modulation	DISR Profile	DoD Information technology Standards and Registry	PRI	Primary rate Interface	DoD	Department of Defense	R	Required	DoDI	DoD Instruction	SCIP	Secure Communication Interoperability Protocol	DSN	Defense Switched Network	SONET	Synchronous Optical Network	DVX	Deployed Voice Exchange	STIG	Security Technical implementation Guide	E1	European 1 (2048 bps, 30-channel PCM)	T1	Trunk 1 (1544 bps, 24-channel PCM)	E2E	End to End	TDM	Time Division Multiplexing	F-NE	Fixed-Network Element	UCCO	Unified Capabilities Certification Office	FIPS	Federal Information Processing Standard	UCR	Unified Capabilities Requirements	IAW	In Accordance With	VVoIP	Voice and Video over Internet Protocol
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OPTICAL TRANSPORT SYSTEM (OTS) SYSTEM FUNCTIONAL AND CAPABILITY REQUIREMENTS

The OTS product has required and conditional features and capabilities that are established by the Unified Capabilities Requirements (UCR). The System Under Test (SUT) need not provide conditional requirements. If they are provided, they must function according to the specified requirements. The detailed Functional Requirements (FR) and Capability Requirements (CR) for OTS are listed in Table 3-2. Detailed Information Assurance (IA) requirements are included in Reference (e) and are not listed below.

Table 3-2. OTS Capability/Functional Requirements Table

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

20	Jitter transfer shall comply with Telcordia Technologies GR-253 and ITU-T G.958.	5.5.3.2.2.2 (2)	R
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Table 3-2. OTS Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
21	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
22	The OTS shall tolerate a persistent input channel signal timing deviation of at least +/- 20 parts per million (ppm). This implies that the OTS must (1) operate properly in normal condition (i.e., without alarms) when any or all 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
23	When a signal passes through concatenated OTS sections, the output jitter shall not exceed the network interface limits of ITU-T Recommendation G.825.	5.5.3.2.2.2 (5)	R
24	When one or more channel (up to 90 percent) fails or is 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
25	The 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
	Reliability and Quality Assurance	5.5.3.2.2.2.1	
26	The OTS equipment shall meet the following quality program requirements, unless specifically overridden or modified by another requirement in this document: <ul style="list-style-type: none"> • Telcordia Technologies GR-282-CORE • Telcordia Technologies GR-2911-CORE • Telcordia Technologies TR-NWT-000179 • Telcordia Technologies TR-NWT-000418 • Telcordia Technologies SR-NWT-002419 	5.5.3.2.2.2.1 (1)	R
27	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
28	Each OTS element shall meet requirements addressed in this document and shall have met European Community (EC) or Pacific Host Nation approvals required for foreign countries. Provide information on the countries that currently approve the equipment, 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 Pacific areas. A list of counties where such approval has been obtained or where it is actively working toward approval. (Note: this list will change with time.)	5.5.3.2.2.3 (2)	R
30	Each NE 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 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 or 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 interbay cabling shall be routed above and below each rack allowing various different cable lengths up to 100 meters. If the equipment cannot support 100 meters, the vendor shall state the maximum cable length supported.	5.5.3.2.2.3 (7)	R
35	Within a OTS element, all intrasystem cabling shall maximize separation of redundant cables and fibers (i.e., working/protection, east/west, timing cables, switch cables).	5.5.3.2.2.3 (8)	R
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 intersystem connections shall be able to support a minimum distance of 100 meters.	5.5.3.2.2.3 (9)	R

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
37	A and B power cables shall have physically diverse routing within the bay or 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, or 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, or 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 GR-63-CORE.	5.5.3.2.2.3 (13)	R
41	All OTS elements, along with its power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in a standard EIA 310C 23-inch relay rack, 84-inch 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 their power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in a standard EIA 310C 23-inch relay rack, 78 inches in height.	5.5.3.2.2.3 (17)	R
45	All OTS elements, along with their power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in standard EIA 19-inch relay rack, 78 inches in height.	5.5.3.2.2.3 (18)	R
46	All OTS elements, along with their power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in X-Mark/CDT cabinets, part number XSL78-4-1S0002, size 78 inches x 23 inches x 30 inches.	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-CORE, Section 4.4, Earthquake, Office Vibration, and Transportation Vibration.	5.5.3.2.2.3 (21)	R
49	All OTS elements shall be fully Network Equipment-Building System (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 European Telecommunications Standards Institute (ETSI) ETSI 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 that may include digital radio equipment, fiber optic terminal equipment, frequency-division multiplexing (FDM) analog microwave, very high frequency (VHF)/ultra high frequency (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 Electromagnetic Compatibility (EMC)/electromagnetic interference (EMI) requirements defined in Telcordia Technologies GR-1089-CORE.	5.5.3.2.2.3 (26)	R
54	All OTS elements shall meet the EMC/EMI requirements defined in Federal Communications Commission (FCC) Part 15 Class A.	5.5.3.2.2.3 (27)	R
55	All OTS elements shall meet the EMC/EMI requirements defined in ETSI EN 50082.	5.5.3.2.2.3 (28)	R

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
56	All OTS elements shall meet the EMC/EMI requirements defined in ETSI EN 55022.	5.5.3.2.2.2.3 (29)	R
57	All OTS elements shall meet the EMC/EMI requirements defined in ETSI EN 300-386.	5.5.3.2.2.2.3 (30)	R
58	All OTS elements shall be designed to operate continuously in the following environment ranges without degradation: Temperature: 0 to +50°C; Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.2.3 (31)	R
59	All OTS elements shall be designed to be fully operational after transportation and/or storage in the following environment ranges: Temperature: -40 to +70°C; Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.2.3 (32)	R
60	All OTS elements shall be designed to operate continuously in the following environment range without degradation: Altitude: -100 to 15,000 ft above mean sea level (AMSL).	5.5.3.2.2.2.3 (33)	R
61	All OTS elements shall be designed to be fully operational after transportation and/or storage in the following environment range: Transport Altitude: -100 ft to +40,000 ft AMSL.	5.5.3.2.2.2.3 (34)	R
62	All OTS elements shall adhere to NEBS Level 3 compliance standards for acceptable voltage ranges, EMI, and electrostatic discharge (ESD) safety, and shall be operable using standard 48V direct current (dc) power as well as having redundant isolated power input feeds. For certain sites, an alternative alternating current (ac)/dc rectifier may need to be supplied to power the system and shall be able to switch 110/220V with redundant isolated power modules.	5.5.3.2.2.2.3 (35)	R
63	All OTS elements shall be fully operational throughout the battery voltage range of -41.5 to -56 volts direct current (VDC).	5.5.3.2.2.2.3 (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, 60 VP-P for 500 msec.	5.5.3.2.2.2.3 (37)	R
65	All OTS elements in the transport layer primary operating system 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 a minimum of eight user-defined remote control points for external functions. This capability shall be provided by relays, not Transistor-Transistor Logic	5.5.3.2.2.2.3 (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 5 minutes.	5.5.3.2.2.2.3 (39)	R
67	The OTS shall provide the capability to roll back to the previous operational version of software.	5.5.3.2.2.2.3 (40)	R
68	The OTS shall conform to memory administration, and system administration and security standards as documented. (Telcordia Technologies GR-472-CORE and GR-253-CORE (issue 4, December 2005).	5.5.3.2.2.2.3 (41)	R
69	All future software for the OTS shall interoperate with the previous deployed GIG-Bandwidth Expansion (GIG-BE) system operational software version/release.	5.5.3.2.2.2.3 (42)	R
70	The OTS shall support software upgrades that directly use or translate the previous version's configuration database.	5.5.3.2.2.2.3 (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.	5.5.3.2.2.2.3 (44)	R
72	The OTS shall be designed with an accessible file system to allow for multiple versions of software, logs, and file manipulation or integrity checks to be performed before upgrading or downgrading software and/or firmware.	5.5.3.2.2.2.3 (45)	R
73	All equipment shall have been tested and registered as compliant to the following electrical safety standards: UL-1950, EN60950, and International Electrotechnical Commission (IEC) 60950.	5.5.3.2.2.2.3 (46)	R
Protection and Restoration		5.5.3.2.2.4	
74	The 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
Optical Amplifier		5.5.3.2.3	

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
76	The system shall support the use of an optical connector for connecting an optical amplifier (OA) to the outside plant 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
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	The Raman pumping lasers shall automatically shut off if a fiber is broken or a connector disconnected in the span pumped by the Raman amplifier.	5.5.3.2.3 (5)	R
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 the fiber requirements section.	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 Optical Spectrum Analyzer (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 Q factor (not critical).	5.5.3.2.3 (24)	R
100	Internal OSAs shall have the ability to show eye diagrams (not critical).	5.5.3.2.3 (25)	R
101	Internal OSAs shall have the ability to estimate Optical Signal to Noise Ratio (OSNR) for each wavelength.	5.5.3.2.3 (26)	R
102	All measurements made available at the internal OSA shall be available at the external OSA port (not critical).	5.5.3.2.3 (27)	R
	OLA Physical Design Requirements	5.5.3.2.3.1	

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
103	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
104	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
105	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
106	The OLA shall support redundant Fans Management Interfaces Power Supplies Control Processors	5.5.3.2.3.1 (2)	R
107	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
108	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
109	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
110	The vendor shall identify their OLA power and space requirements for all specified configurations.	5.5.3.2.3.1 (6)	R
	Muxponder Requirements	5.5.3.2.4	
111	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
112	The OTS shall support a 4:1 40G multiplexer (MUX). The 4:1 40G MUX shall receive four standards compliant OC-192/STM-64 signals, from one to four sources, and multiplex them onto a signal for transport over a 40G wavelength on the system.	5.5.3.2.4 (2)	R
113	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
114	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
115	The 4:1 40G MUX shall transfer the OC-192/STM-64 signals through the system transparently.	5.5.3.2.4 (5)	R
116	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
117	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
118	An OC-48/STM-64 through the OTS that is multiplexed and demultiplexed through the 4:1 10G MUX shall meet the same performance requirements as an OC-192/STM-64 signal through the OTS using OC-192/STM-64 transponders. Performance requirements include, but are not limited to BER, Errored Seconds (ES), Severely Errored Seconds (SES), and Availability.	5.5.3.2.4 (8)	R
119	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
120	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
121	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

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
122	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
	Transponder Requirements	5.5.3.2.5	
123	Transponders shall comply with the DWDM wavelength grid as specified in ITU-T G.694.1.	5.5.3.2.5 (1)	R
124	Transponders shall support tunable lasers, which are tunable over whole band.	5.5.3.2.5 (2)	R
125	All transponders shall support built-in self BER test function	5.5.3.2.5 (3)	R
126	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
127	All transponders shall support total end-to-end (E2E) signal propagation delay (at transponder ingress to egress) reporting function.	5.5.3.2.5 (5)	C
128	All transponders shall support User selectable line side FEC (Forward Error Correction), i.e., no FEC, ITU-T G.709 compliant standard FEC, and enhanced FEC SFEC or EFEC modes.	5.5.3.2.5 (6)	R
129	Transponders shall support ITU-T G.709 specifications for OTN services.	5.5.3.2.5 (7)	R
130	Transponders shall support switching of framing protocols (OTN, SONET, 10GBE, etc.) without requiring downloading or switching firmware/software and physical removal of the transponder from the slot.	5.5.3.2.5 (8)	R
131	Transponders shall have non-intrusive SONET/SDH B1 monitoring capability	5.5.3.2.5 (9)	R
132	Transponder shall have integrated EDC (Electronic Dispersion Compensation) for all specified fiber types to support minimum un-regenerated reach of 2000 kms.	5.5.3.2.5 (10)	C
133	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
134	The vendor shall provide a transponder to interface with 10/40/100Gbps unframed wavelength services.	5.5.3.2.5 (12)	R
135	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
136	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
137	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
	Interface Requirements	5.5.3.2.5.1	
138	Transponders shall support an OC-48/STM-16 interface.	5.5.3.2.5.1 (1)	R
139	Transponders shall support an OC- 192/STM64 interface.	5.5.3.2.5.1 (2)	R
140	Transponders shall support a GigE interface.	5.5.3.2.5.1 (3)	R
141	Transponders shall support a 10GigE WAN PHY interface.	5.5.3.2.5.1 (4)	R
142	Transponders shall support a 10GigE LAN PHY interface.	5.5.3.2.5.1 (5)	R
143	The transponders shall support OC- 768/STM256 interfaces.	5.5.3.2.5.1 (6)	R
144	The transponder shall support all OTN rates including ODU1/ODU2/ODU3 and 100Gbs in future.	5.5.3.2.5.1 (7)	R
145	The transponders shall support Short Reach (SR), Long Reach (LR-1, LR-2, LR-3), and Intermediate Reach (IR-1, IR-2), client interface types per Telcordia Technologies GR-253-CORE.	5.5.3.2.5.1 (8)	R
146	The transponders shall support client interfaces at 1310 and 1550 nm.	5.5.3.2.5.1 (9)	R
147	The transponders shall support client interface at 850 and 1310 nm for GigE signals.	5.5.3.2.5.1 (10)	R
	ROADM	5.5.3.2.6	
148	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
149	The ROADM shall support direction-less wavelength routing.	5.5.3.2.6 (2)	R
150	The ROADM shall be capable of colorless wavelength routing.	5.5.3.2.6 (3)	R
151	The system shall support cascading of minimum eight ROADMs for a total un-regenerated reach of 2000 kms.	5.5.3.2.6 (4)	R
152	Any wavelength not explicitly dropped or added shall be passed through the ROADM.	5.5.3.2.6 (5)	R
153	It shall be possible to reuse wavelength at ROADM.	5.5.3.2.6 (6)	R

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
154	There shall be no restrictions on ADD/DROP and EXPRESS (pass through) wavelengths at ROADM site.	5.5.3.2.6 (7)	R
155	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
156	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
157	The ROADM shall be capable of supporting dynamic wavelength selection without pre-cabling being required.	5.5.3.2.6 (10)	R
158	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
159	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
160	The ROADM shall be capable of dropping any specific wavelength, independent of other wavelengths to be dropped.	5.5.3.2.6 (13)	R
161	The ROADM shall be capable of adding any specific wavelength, independent of other wavelengths to be added.	5.5.3.2.6 (14)	R
162	The ROADM shall support wavelength hair-pinning capability.	5.5.3.2.6 (15)	R
163	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
164	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
165	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
166	Hardware upgrades of the ROADM to support higher tributary interface density shall not disrupt operational traffic.	5.5.3.2.6 (19)	R
167	Hardware upgrades of the ROADM to support higher line interface density shall not disrupt operational traffic.	5.5.3.2.6 (20)	R
168	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
169	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
170	The ROADM shall support dynamic per-wavelength power leveling.	5.5.3.2.6 (23)	R
171	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
172	The ROADM shall not incur increased bit errors associated with wavelength provisioning or line equalization.	5.5.3.2.6 (25)	R
173	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
174	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
175	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
176	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

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
177	The switching time for 1+1 protection shall be ≤ 50 ms. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (30)	R
178	The switching time for 1+1 protection shall be ≤ 20 ms. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (31)	R
179	The ROADM shall support redirection of light paths via the EMS/NMS.	5.5.3.2.6 (32)	R
180	The ROADM shall support linear protection topologies. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (33)	R
181	The ROADM shall support ring protection topologies. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (34)	R
ROADM Specific Physical Design Requirements		5.5.3.2.6.1	
182	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
183	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
184	The ROADM shall support redundant: Fans Switching Fabrics Power Supplies Control Processors.	5.5.3.2.6.1 (3)	R
185	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
186	The fully configured ROADM (excluding the transponder shelves) shall not exceed two full 84" racks.	5.5.3.2.6.1 (5)	R
187	The fully configured ROADM shall not exceed one full 84" rack.	5.5.3.2.6.1 (6)	R
188	The ROADM shall not require contiguous rack locations.	5.5.3.2.6.1 (7)	R
189	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
Requirements Common to Transponder and ROADM		5.5.3.2.7	
Framed Formats		5.5.3.2.7.1	
190	The OTS shall support the transport of the following SONET/SDH services: OC-192/STM-64, OC-48/STM-16, and OC-768/STM256.	5.5.3.2.7.1 (1)	R
191	The OTS shall support the transport of the following Ethernet services: GigE (via 10:1 Muxponder), 10GigE WAN PHY, and 10GigE LAN PHY.	5.5.3.2.7.1 (2)	R
192	The OTS shall support the transport of the following OTN services: OTU-1, OTU-2, and OTU-3.	5.5.3.2.7.1 (3)	C
193	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
194	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
195	Framed wavelength services shall be supported for GigE/10 GigE signals, and signals formatted for OTN transport (ITU-T G.709).	5.5.3.2.7.1 (6)	R
196	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
197	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
198	Alien wavelength" regeneration shall be supported.	5.5.3.2.7.1 (9)	R
Unframed Formats		5.5.3.2.7.2	
199	The OTS shall support unframed wavelength services.	5.5.3.2.7.2 (1)	R

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
200	The OTS shall support mixed framed service unframed wavelength service	5.5.3.2.7.2 (2)	R
	Optical Supervisory Channel	5.5.3.2.8	
201	The OLA, ROADM, end terminal (ET) elements shall terminate/insert an Optical Supervisory Channel (OSC) with a wavelength that adheres to ITU-T specifications.	5.5.3.2.8 (1)	R
202	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
203	The OLA, ROADM, and ET elements shall use the same OSC wavelength.	5.5.3.2.8 (3)	R
204	The internal diagnostics for OLA, ROADM, and ET elements shall report OSC failure.	5.5.3.2.8 (4)	R
205	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
206	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
207	The OLA, ROADM, and ET elements shall report any OSC channel BER threshold violation.	5.5.3.2.8 (7)	R
208	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
209	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
210	The OSC circuit-pack shall report optical span-loss between two adjacent nodes.	5.5.3.2.8 (10)	R
211	The OSC shall operate at 2 Mb/s or higher data rates.	5.5.3.2.8 (11)	R
212	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
	OTS Standards Compliance Requirements	5.5.3.2.9	
213	ITU-T G.652, "Characteristics of a single-mode optical fiber and cable."	5.5.3.2.9 (1)	R
214	ITU-T G.655, "Characteristics of a non-zero dispersion-shifted single-mode optical fiber and cable."	5.5.3.2.9 (2)	R
215	ITU-T 694.1, "Spectral grids for WDM applications: DWDM frequency grid."	5.5.3.2.9 (3)	R
216	ITU-T G.709/Y.1331, "Network node interface for the optical transport network (OTN)."	5.5.3.2.9 (4)	R
217	ITU-T G.958, "Digital line systems based on the synchronous digital hierarchy for use on optical fiber cables." [Withdrawn]	5.5.3.2.9 (5)	R
218	ITU-T G.8251 (G.otnjit), "The control of jitter and wander within the optical transport network (OTN)."	5.5.3.2.9 (6)	R
219	Telcordia Technologies GR-63-CORE, Network Equipment-Building System (NEBS™) Generic Equipment Requirements.	5.5.3.2.9 (7)	R
220	Telcordia Technologies TR-NWT-000179, Quality Systems Generic Requirements for Software.	5.5.3.2.9 (8)	R
221	Telcordia Technologies GR-253-CORE, Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria.	5.5.3.2.9 (9)	R
222	Telcordia Technologies GR-282-CORE, Software Reliability and Quality Acceptance Criteria (SRQAC).	5.5.3.2.9 (10)	R
223	Telcordia Technologies TR-NWT-000295, Isolated Ground Planes: Definition and Application to Telephone Central Offices.	5.5.3.2.9 (11)	R
224	Telcordia Technologies NWT-000418, Reliability Assurance for Fiber Optic Systems.	5.5.3.2.9 (12)	R
225	Telcordia Technologies GR-472-CORE, Network Element Configuration Management.	5.5.3.2.9 (13)	R
226	Telcordia Technologies FR-796, Reliability and Quality Generic Requirements (RQGR).	5.5.3.2.9 (14)	R
227	Telcordia Technologies GR-1089-CORE, Electromagnetic Compatibility, and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.	5.5.3.2.9 (15)	R
228	Telcordia Technologies SR-NWT-002419, Software Architecture Review Checklists.	5.5.3.2.9 (16)	R

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

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C																																																																																																												
229	Telcordia Technologies GR-2911-CORE, Software Inventory for Network Element Software Management.	5.5.3.2.9 (17)	R																																																																																																												
230	ETSI ETS 300 019, "Equipment Engineering (EE); Environmental Conditions and Environmental Tests for Telecommunications Equipment."	5.5.3.2.9 (18)	R																																																																																																												
231	ETSI ETS EN 50022, "Specification for low voltage switchgear and control gear for industrial use."	5.5.3.2.9 (19)	R																																																																																																												
232	ETSI EN 50082, "Electromagnetic compatibility. Generic immunity standard. Residential, commercial and light industry."	5.5.3.2.9 (20)	R																																																																																																												
233	ETSI EN 300 386, "Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; Electromagnetic Compatibility (EMC) requirements."	5.5.3.2.9 (21)	R																																																																																																												
234	BS EN 60950-1 Information Technology Equipment – Safety – Part 1: General Requirements.	5.5.3.2.9 (22)	R																																																																																																												
235	IEC 60950-1 Information Technology Equipment – Safety – Part 1: General Requirements.	5.5.3.2.9 (23)	R																																																																																																												
236	CFR FCC Part 15, Class A.	5.5.3.2.9 (24)	R																																																																																																												
237	NEBS, Level 3.	5.5.3.2.9 (25)	R																																																																																																												
238	Underwriters Laboratories, Inc. UL-1950, Standard for Safety, Information Technology Equipment Including Electrical Business Equipment.	5.5.3.2.9 (26)	R																																																																																																												
239	EIA 310C, 19-inch rack mounting equipment specification.	5.5.3.2.9 (27)	R																																																																																																												
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