DEFENSE INFORMATION SYSTEMS AGENCY
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IN REPLY REFER TO: Joint Interoperability Test Command (JTE) **12 mar 12**

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Special Interoperability Test Certification of the Cisco Aggregation Services Router (ASR) 9000 Series (selected models) with Internetwork Operating System (IOS) XR 4.1.1

References: (a) DoD Directive 4630.05, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," 5 May 2004
(b) CJCSI 6212.01E, "Interoperability and Supportability of Information Technology and National Security Systems," 15 December 2008
(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 Cisco ASR 9010 Customer Edge Router with IOS XR4.1.1 hereinafter referred to as the System Under Test (SUT). The SUT meets all the critical interoperability requirements as a High Availability Customer Edge Router (CER) and is certified for joint use within the Defense Information System Network (DISN). When a CER meets the High Availability CER requirements, it is also certified as a Medium Availability with System Quality Factors (SQF), Medium Availability without SQF, and Low Availability CER. The SUT met the critical interoperability requirements set forth in Reference (c), using the test procedures derived from Reference (d). The SUT met the critical interoperability requirements for the following interfaces: Institute of Electrical and Electronics Engineers (IEEE) 802.3i (10Base-T), IEEE 802.3u (100Base-T), IEEE 802.3ab and 802.3z (1000Base-X), IEEE 802.3ae (10000Base-X), Digital Signal Level (DS)1, DS3, European Carrier (E)3, Packet over Synchronous Optical Network (SONET) (POS) Optical Carrier (OC)-3, OC-12 POS, OC-48 POS, and OC-192 POS. The Cisco ASR 9006 employs the same software and similar hardware as the SUT. The JITC analysis determined these systems to be functionally identical to the SUT for interoperability certification purposes, and they are also certified for joint use. Per the vendor's Letter of Compliance (LoC), the SUT met all IPv6 requirements for a CER with following exceptions: The SUT partially met RFC 1981, Path Maximum Transmission Unit (MTU) Discovery (PMTUD) for IPv6. The PMTUD is supported for Transmission Control Protocol (TCP) only and does not comply with RFCs 2473 and 4301. On 10 January 2012, DISA adjudicated these deficiencies as minor, and established a target date for addressing these RFCs for 31 December 2012. Per the vendor's LoC, the copper SFPs do not support auto-negotiation. On 14 February 2012, DISA adjudicated this discrepancy as minor, with the following condition of fielding: The speed and duplex must be manually configured. No other configurations, features, or functions, except those cited within

this memorandum are certified by JITC. This certification expires upon changes that affect interoperability, but no later than three years from the date of the Approved Products List (APL) memorandum.

3. This finding is based on interoperability testing conducted by the United States Army Information Systems Engineering Command, Technology Integration Center (USAISEC TIC), review of the vendor's LoC and DISA Certification Authority (CA) approval of the SUT IA configuration. Interoperability testing was conducted by the USAISEC TIC, Fort Huachuca, Arizona, from 24 October 2011 through 22 November 2011. Review of the vendor's LoC was completed on 20 January 2012. The DISA CA has reviewed the IA Assessment Report for the SUT, Reference (e), and based on the findings in the report has provided a positive recommendation on 10 February 2012. The acquiring agency or site will be responsible for the DoD Information Assurance Certification and Accreditation Process (DIACAP) accreditation. Enclosure 2 documents the test results and describes the tested network and system configurations including specified patch releases. Enclosure 3 provides a detailed list of the interface, capability, and functional requirements.

4. The interface, Capabilities Requirements (CRs) and Functional Requirements (FRs), and component status of the SUT are listed in Tables 1 and 2. The threshold Capability/Functional requirements for CERs are established by Section 5.3.2.14 of Reference (c) and were used to evaluate the interoperability of the SUT.

Table 1. SUT Interface Interoperability Status

Interface	Critical	UCR Reference	Threshold CRs/FRs (see note 1)	Status	Remarks
ASLAN Interfaces					
10Base-T	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	Not provided by the test facility for testing (see note 2 & 3).
100Base-T	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100Base-T) interface.
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (1000Base-X) interface.
10GbE	No	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (10GbE) interface.

Table 1. SUT Interface Interoperability Status (continued)

Interface	Critical	UCR Reference	Threshold CRs/FRs (see note 1)	Status	Remarks
WAN Interfaces					
10Base-T	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	Not provided by the test facility for testing (see notes 2, 3 & 4).
100Base-T	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100Base-T) interface (see notes 2, 3 & 4).
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (1000Base-X) interface.
10GbE	No	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (1000Base-X) interface.
DS1	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for the DS1 interface.
DS3	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for the DS3 interface.
E1	No	5.3.2.14.9	1-2	Not Certified	Because of test configuration limitations, the E1 interface was not tested in a heterogeneous environment.
E3	No		1-2	Certified	The SUT met all critical CRs and FRs for the E3 interface.
POS (OC-3)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this ANSI T1.105 (SONET) interface
POS (OC-12)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this ANSI T1.105 (SONET) interface
POS (OC-48)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this ANSI T1.105 (SONET) interface
POS (OC-192)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this ANSI T1.105 (SONET) interface
Network Management Interfaces					
10Base-T	Yes	5.3.2.4.4	4	Certified[3]	Not provided by the test facility for testing (see notes 2 & 3).
100Base-T	Yes	5.3.2.4.4	4	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100Base-T) interface. This was met by vendor's Letters of Compliance and evaluation.

NOTES:
1. The annotation of 'required' refers to a high-level requirement category. The applicability of each sub-requirement is provided in Enclosure 3.
2. The UCR states the minimum interface requirement for a CER ASLAN and WAN interface is Ethernet 10Base-T or 100Base-T.
3. All interfaces were tested with the exception of 10Base-T and 100Base-T. Analysis determined 10Base-T and 100Base-T are low risk for certification based on the vendor's Letter of Compliance to comply with IEEE 802.3i, IEEE 802.3u, and testing data collected at all other rates.
4. The copper SFPs do not support auto-negotiation, a requirement in the UCR, Change 3, Paragraph 5.3.1.3.1. DISA adjudicated this discrepancy as having a minor operational impact, provided that the following condition of fielding is met: The speed and duplex must be manually configured.

LEGEND:

802.3i	10 Megabits Per Second Base Band over Twisted Pair	E3	European Carrier 3 (34 Mbps)
802.3u	Standard for carrier sense multiple access with collision detection at 100 Megabits per Second	FR	Functional Requirement
		GbE	Gigabit Ethernet
ASLAN	Assured Services Local Area Network	IEEE	Institute of Electrical and Electronics Engineers
CER	Customer Edge Router	Mbps	Megabits per second
CR	Capability Requirement	SUT	System Under Test
DISA	Defense Information Systems Agency	SFP	Small Form-Factor Pluggable
DS1	Digital Signal Level 1 (1.544 Mbps)	UCR	Unified Capabilities Requirements
DS3	Digital Signal Level 3	WAN	wide area network
E1	European Carrier 1 (2.048 Mbps)		

Table 2. SUT Capability Requirements and Functional Requirements Status

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Status	Remarks
Product Interface Requirements					
1	Internal Interface Requirements	Required	5.3.2.4.1	Met	The SUT met all critical CRs and FRs.
	External Physical Interfaces between Network Components	Required	5.3.2.4.2	Met	The SUT met all critical CRs and FRs.
	IP Queue Control Capabilities	Required	5.3.2.17.3.4.2 .12, Para. 1	Met	The SUT met all critical CRs and FRs.
	Differentiated Services Code Point	Required	5.3.3.3.2	Met	The SUT met all critical CRs and FRs.
	VVoIP Per-Hop Behavior Requirements	Required	5.3.3.3.3	Met	The SUT met all critical CRs and FRs.
	Traffic Conditioning Requirements	Required	5.3.3.3.4	Met	The SUT met all critical CRs and FRs.
Customer Edge Router Requirements					
2	Traffic Conditioning	Required	5.3.2.14.1	Met	The SUT met all critical CRs and FRs.
	Differentiated Services Support	Required	5.3.2.14.2	Met	The SUT met all critical CRs and FRs.
	Per-Hop Behavior Support	Required	5.3.2.14.3	Met	The SUT met all critical CRs and FRs.
	Interface to the LSC/MFSS for Traffic Conditioning	Conditional	5.3.2.14.4	Not Tested	The SUT does not support this feature and it is not required.
	Interface to the LSC/MFSS for Bandwidth Allocation	Conditional	5.3.2.14.5	Not Tested	The SUT does not support this feature and it is not required.
	Availability	Required	5.3.2.14.7	Met	The SUT met all critical CRs and FRs. The SUT met High Availability CER requirements.[2]
	Packet Transit Time	Required	5.3.2.14.8	Met	The SUT met all critical CRs and FRs.
	CER Interfaces and Throughput Support	Required	5.3.2.14.9	Met	The SUT met all critical CRs and FRs.
	Assured VVoIP Latency	Required	5.3.3.4	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Latency	Required	5.3.3.4.2	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Latency	Required	5.3.3.4.4	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Jitter	Required	5.3.3.5.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Jitter	Required	5.3.3.5.4	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Packet Loss	Required	5.3.3.6.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Packet Loss	Required	5.3.3.6.4	Met	The SUT met all critical CRs and FRs.[3]
	End-to-End Availability	Required	5.3.3.12.1	Met	The SUT met all critical CRs and FRs.[4]
	Availability Design Factors	Required	5.3.3.12.2	Met	The SUT met all critical CRs and FRs.[4]
	Product Quality Factors	Required	5.3.3.12.3	Met	The SUT met all critical CRs and FRs.
	Layer 1 – Physical Layer	Required	5.3.3.12.4.1	Met	The SUT met all critical CRs and FRs.
	Layer 2 – Data Link Layer	Required	5.3.3.12.4.2	Met	The SUT met all critical CRs and FRs.
	Provisioning	Required	5.3.3.13	Met	The SUT met all critical CRs and FRs.[3]

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

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Status	Remarks
Customer Edge Router Requirements					
2	Interchangeability	Required	5.3.3.14	Met	The SUT met this requirement with Static Routing, BGP-4, IS-IS, OSPFv2, and OSPFv3.
	Voice Grade of Service	Required	5.3.3.15	Met	The SUT met all critical CRs and FRs.[3]
	Survivability	Required	5.3.3.16	Not Tested	This is an E2E engineering requirement and is not testable in a lab environment.[3]
Internet Protocol Version 6 Requirements					
3	IPv6	Required	5.3.3.10	Partially Met[5]	The SUT met all critical CRs and FRs.[5]
	Product Requirements	Required	5.3.5.4	Met	The SUT met all critical CRs and FRs.
Network Management Requirements					
4	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	SUT met all critical CRs and FRs for the 802.3u (100Base-T) interface.
	NM Requirements for CERs	Required	5.3.2.18.1	Met	SUT met all critical CRs and FRs for the 802.3u (100Base-T) interface.
	Network Management	Required	5.3.2.14.6	Met	SUT met all critical CRs and FRs for the 802.3u (100Base-T) interface.

NOTES:

1. Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.
2. To meet the High and Medium Availability requirements with SQF, the SUT must be deployed with dual Embedded Service Processors, dual RPs, and dual interface modules.
3. This requirement was verified in an operational emulated environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.
4. This is an End-to-End engineering requirement, and due to variations in network architectures, it could not be accurately tested in a lab environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.
5. The SUT met all IPv6 requirements for a CER through testing and vendor LoC with following exceptions: The SUT partially met RFC 1981, Path MTU Discovery for IPv6. The PMTUD is supported for TCP only, and does not comply with RFCs 2473 and 4301. On 10 January 2012, DISA adjudicated these deficiencies as minor, and accepted the vendor POA&Ms for 31 December 2012.

LEGEND:

BGP	Border Gateway Protocol
CE	Customer Edge
CER	Customer Edge Router
CR	Capability Requirement
DISA	Defense Information Systems Agency
E2E	End-to-End
EBC	Edge Boundary Controller
FR	Functional Requirement
ID	Identification
IP	Internet Protocol
IPv6	Internet Protocol version 6
IS-IS	Intermediate System-Intermediate System
LoC	Letters of Compliance
LSC	Local Session Controller
MFSS	Multifunction Soft Switch
MTU	Maximum Transmission Unit
NM	Network Management
NMS	Network Management System
PMTDU	Path Maximum Transmission Unit Discovery
POA&M	Plan of Actions and Milestones
OSPFv2	Open Shortest Path First version 2
OSPFv3	Open Shortest Path First version 3
RFC	Request For Comment
RP	Route Processor
SQF	System Quality Factors
SUT	System Under Test
TCP	Transmission Control Protocol
UCR	Unified Capabilities Requirements
VVoIP	Voice and Video over Internet Protocol

5. No detailed test report was developed in accordance with the Program Manager's request. JITC distributes interoperability information via the JITC Electronic Report Distribution (ERD) system, which uses Unclassified-But-Sensitive Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program (STP). The STP is accessible by .mil/gov users on the NIPRNet at https://stp.fhu.disa.mil. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool (JIT) at http://jit.fhu.disa.mil (NIPRNet). Information related to DSN testing is on the Telecom Switched Services Interoperability (TSSI) website at http://jitc.fhu.disa.mil/tssi. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool (JIT) at http://jit.fhu.disa.mil (NIPRNet), or http://199.208.204.125 (SIPRNet). Information related to DSN testing is on the Telecom Switched Services Interoperability (TSSI) website at http://jitc.fhu.disa.mil/tssi. Due to the sensitivity of the information, the Information Assurance Accreditation Package (IAAP) that contains the approved configuration and deployment guide must be requested directly through government civilian or uniformed military personnel from the Unified Capabilities Certification Office (UCCO), e-mail: ucco@disa.mil.

6. The JITC point of contact is Mr. Edward Mellon, DSN 879-5159, commercial (520) 538-5159, FAX DSN 879-4347, or e-mail to edward.mellon@disa.mil. The JITC's mailing address is P.O. Box 12798, Fort Huachuca, AZ 85670-2798. The Tracking Number for the SUT is 1116705.

FOR THE COMMANDER:

3 Enclosures a/s

for BRADLEY A. CLARK
Chief
Battlespace Communications Portfolio

Distribution (electronic mail):
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U.S. Joint Forces Command, Net-Centric Integration, Communication, and Capabilities Division, J68
Defense Information Systems Agency, GS23

ADDITIONAL REFERENCES

(c) Office of the Assistant Secretary of Defense, "Department of Defense Unified Capabilities Requirements 2008, Change 3" September 2011
(d) Joint Interoperability Test Command, "Unified Capabilities Test Plan (UCTP)"
(e) Joint Interoperability Test Command, "Information Assurance (IA) Assessment of Cisco ASR 9000 with IOS XR 4.1.1 (Tracking Number 1116705)" 10 February 2012

CERTIFICATION TESTING SUMMARY

1. SYSTEM TITLE. The Cisco Aggregation Services Router (ASR) 9010 with Internetworking Operating System (IOS) XE XR 4.1.1, hereinafter referred to as the System Under Test (SUT).

2. PROPONENT. Headquarters, U.S. Army Information Systems Engineering Command (HQUSAISEC).

3. PROGRAM MANAGER Installation Information Infrastructure Modernization Program (I3MP), Point of Contact: Mr. Jordan Silk, United States Army Information Systems Engineering Command, Technology Integration Center (USAISEC-TIC), Building 53302, Fort Huachuca, AZ 85613; e-mail: jordan.r.silk.civ@mail.mil.

4. TESTER. The USAISEC-TIC, Fort Huachuca, Arizona.

5. SYSTEM DESCRIPTION. The Unified Capabilities Requirements (UCR) defines a Customer Edge Router (CER) as a router located at the boundary between the Edge Segment and the Access Segment in the Real Time Services (RTS) Information Assurance (IA) Architecture. The CER provides traffic conditioning, bandwidth management on a granular service class (i.e., voice, video) basis, and quality of service (QoS) based on the RTS requirements. A base/post/camp/station (B/P/C/S) may have a single CER or multiple CERs based on the local architecture.

The SUT is an intelligent, unified communications, network border element. Perimeter routers are components used for scaling unified communications networks from being "Internet Protocol (IP) islands" within a single customer network to becoming an End-to-End (E2E) IP community.

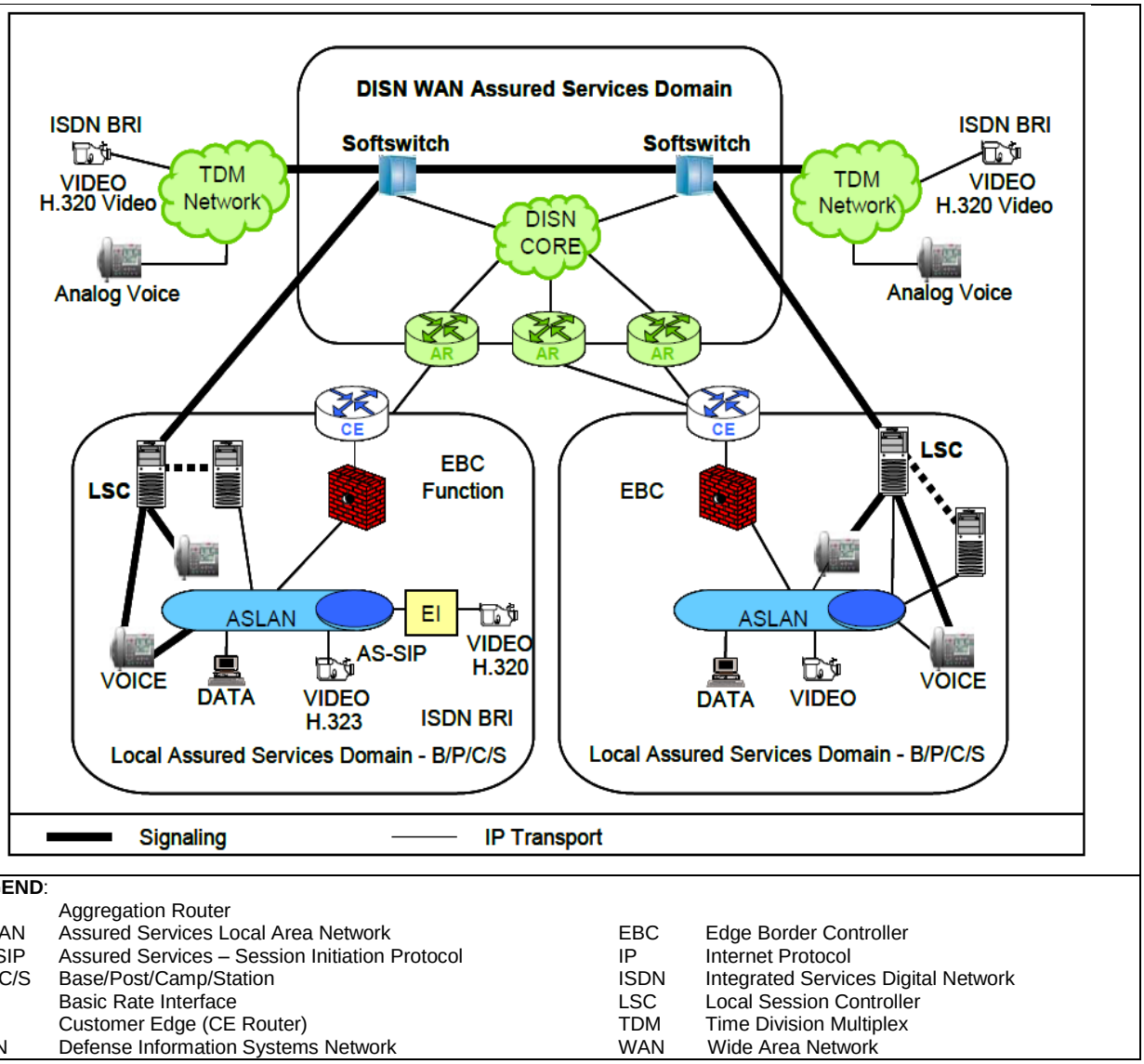
The SUT is a solution that provides a network-to-network demarcation interface for signaling interworking, media interworking, address and port translations, billing, security, QoS, and bandwidth management. The SUT ASR platform embeds virtual private network, multicast and other IOS software services, as well as security functions directly inside the router.

a. SUT (High and Medium Availability with System Quality Factors [SQF]). The SUT must be deployed with dual Embedded Service Processors (ESPs), dual Route Processors (RPs), and dual Shared Port Adapter (SPA) Interface Processor (SIP) cards. It meets all of the lesser requirements (i.e., Medium Availability with and without SQF, and Low Availability).

b. SUT (Medium Availability). The Cisco ASR 9010 is certified as a Medium Availability CER when it is deployed with the following hardware: a single RP, a single ESP, and dual SIPs. The ASR 9006 employs the same software and similar hardware as the SUT, and is certified as a Medium Availability CER when deployed with the following hardware: The ASR 9006 CER with a single ESP, a single RP, and dual SIPs.

c. SUT (Low Availability). The low availability solution does not require redundancy. The SUT is certified in a single chassis configuration for low availability.

6. OPERATIONAL ARCHITECTURE. Figure 2-1 depicts the Defense Information System Network (DISN), Unified Capabilities, notional operational architecture that the SUT may be used in.



LEGEND:

AR	Aggregation Router		
ASLAN	Assured Services Local Area Network	EBC	Edge Border Controller
AS-SIP	Assured Services – Session Initiation Protocol	IP	Internet Protocol
B/P/C/S	Base/Post/Camp/Station	ISDN	Integrated Services Digital Network
BRI	Basic Rate Interface	LSC	Local Session Controller
CE	Customer Edge (CE Router)	TDM	Time Division Multiplex
DISN	Defense Information Systems Network	WAN	Wide Area Network

Figure 2-1. DISN Unified Capabilities Notional Operational Architecture

7. INTEROPERABILITY REQUIREMENTS. The interface, Capability Requirements (CRs), Functional Requirements (FRs), IA, and other requirements for CERs are established by Section 5.3.2.14 of Reference (c).

7.1 Interfaces. The SUT uses the interfaces shown in Table 2-1 to connect to the Global Information Grid (GIG) network. This table shows the physical interfaces supported by the SUT and the associated standards.

Table 2-1. Customer Edge Router Interface Requirements

Interface	Critical	UCR Reference	Criteria[1]
ASLAN Interfaces			
10Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE 802.3i.[3]
100Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE802.3u.[3]
1000Base-X 1000Base-T	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE 802.3z and 802.3ab.
10 GbE	No	5.3.2.4.2	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE 802.3ae.
WAN Interfaces			
10Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE 802.3i.[3]
100Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE802.3u.[3]
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE 802.3z.
10GbE	No	5.3.2.4.2	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for IEEE 802.3ae.
DS1	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ANSI T1.102
DS3	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ANSI T1.102-1993.
E1	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ITU-T G.703.
E3	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ITU-T G.703.
POS (OC-3)	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ANSI T1.105-2001.
POS (OC-12)	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ANSI T1.105-2001.
POS (OC-48)	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ANSI T1.105-2001
POS (OC-192)	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3), and meet interface criteria for ANSI T1.105-2001.
Network Management Interfaces			
10Base-T	Yes	5.3.2.4.4	Support minimum threshold CRs/FRs (4), and meet interface criteria for IEEE 802.3i.
100Base-T	Yes	5.3.2.4.4	Support minimum threshold CRs/FRs (4), and meet interface criteria for IEEE802.3u.

Table 2-1. Customer Edge Router Interface Requirements (continued)

NOTES:
1. The CRs/FRs are contained in Table 2-2. The CR/FR numbers represent a roll-up of the UCR. Enclosure 3 provides a list of more detailed requirements for CER products.
2. Must provide a minimum of one of the listed interfaces.
3. All interfaces were tested with the exception of 10Base-T and 100Base-T. Analysis determined 10Base-T and 100Base-T are low risk for certification based on the vendor's Letter of Compliance to comply with IEEE 802.3i, 802.3u, and testing data collected at all other rates.

LEGEND:

802.3ab	1000BASE-T Gbit/s Ethernet over Twisted Pair at 1 Gbit/s
802.3i	10 Megabits/s Base Band over Twisted Pair
802.3u	Standard for carrier sense multiple access with collision detection at 100 Megabits per Second
802.3z	1000BASE-X Gbit/s Ethernet over Fiber Optic at 1 Gbit/s
ANSI	American National Standard Institute
ASLAN	Assured Services Local Area Network
CER	Customer Edge Router
CR	Capability Requirement
DS1	Digital Signal Level1
DS3	Digital Signal Level 3
FR	Functional Requirement
E1	European Carrier 1 (2.048 Mbps)
E3	European Carrier 3 (34 Mbps)
GbE	Gigabit Ethernet
Gbits/s	Gigabits per second
IEEE	Institute of Electrical and Electronics Engineers
ITU-T	International Telecommunication Union – Telecommunications Standardization Sector
MBPS	Megabits Per Second
OC	Optical Carrier
POS	Packet over SONET
SONET	Synchronous Optical Network
UCR	Unified Capabilities Requirements
WAN	Wide Area Network

7.2 Capability Requirements and Functional Requirements. The CERs have required and conditional features and capabilities that are established by Section 5.3.2.14 of the UCR. The SUT does not need to provide non-critical (conditional) requirements. If they are provided, they must function according to the specified requirements. The SUT's features and capabilities, and its aggregated requirements in accordance with (IAW) the CER requirements, are listed in Table 2-2. Detailed CRs/FRs are provided in Table 3-1 of Enclosure 3.

Table 2-2. Customer Edge Router Capability Requirements and Functional Requirements

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Remarks
Product Interface Requirements				
1	Internal Interface Requirements	Required	5.3.2.4.1	
	External Physical Interfaces between Network Components	Required	5.3.2.4.2	
	IP Queue Control Capabilities	Required	5.3.2.17.3.4.2. 12, Para. 1	
	Differentiated Services Code Point	Required	5.3.3.3.2	
	VVoIP Per-Hop Behavior Requirements	Required	5.3.3.3.3	
	Traffic Conditioning Requirements	Required	5.3.3.3.4	

Table 2-2. Customer Edge Router Capability Requirements and Functional Requirements (continued)

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Remarks
Customer Edge Router Requirements[2]				
2	Traffic Conditioning	Required	5.3.2.14.1	
	Differentiated Services Support	Required	5.3.2.14.2	
	Per Hop Behavior Support	Required	5.3.2.14.3	
	Interface to the LSC/MFSS for Traffic Conditioning	Conditional	5.3.2.14.4	
	Interface to the LSC/MFSS for Bandwidth Allocation	Conditional	5.3.2.14.5	
	Availability	Required	5.3.2.14.7	
	Packet Transit Time	Required	5.3.2.14.8	
	CER Interfaces and Throughput Support	Required	5.3.2.14.9	
	Assured VVoIP Latency	Required	5.3.3.4	
	Assured VVoIP CE Latency	Required	5.3.3.4.2[3]	
	Assured VVoIP CER-to-CER Latency	Required	5.3.3.4.4[3]	
	Assured VVoIP CER-to-CER Jitter	Required	5.3.3.5.3[3]	
	Assured VVoIP CE Jitter	Required	5.3.3.5.4[3]	
	Assured VVoIP CER-to-CER Packet Loss	Required	5.3.3.6.3[3]	
	Assured VVoIP CE Packet Loss	Required	5.3.3.6.4[3]	
	End-to-End Availability	Required	5.3.3.12.1[3]	
	Availability Design Factors	Required	5.3.3.12.2[3]	
	Product Quality Factors	Required	5.3.3.12.3	
	Layer 1 – Physical Layer	Required	5.3.3.12.4.1	
	Layer 2 – Data Link Layer	Required	5.3.3.12.4.2	
	Provisioning	Required	5.3.3.13[3]	
	Interchangeability	Required	5.3.3.14	
	Voice Grade of Service	Required	5.3.3.15[3]	
	Survivability	Required	5.3.3.16	This is an E2E engineering requirement and is not testable in a lab environment.[4]
Internet Protocol Version 6 Requirements				
3	IPv6	Required	5.3.3.10	
	Product Requirements	Required	5.3.5.4	
Network Management Requirements				
4	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	
	NM Requirements for CERs	Required	5.3.2.18.1	
	Network Management	Required	5.3.2.14.6	

Table 2-2. Customer Edge Router Capability Requirements and Functional Requirements (continued)

NOTES:
1. The annotation of 'required' refers to a high-level requirement category. The applicability of each sub-requirement is provided in Enclosure 3. The SUT does not need to provide conditional requirements. However, if a capability is provided, it must function according to the specified requirements.
2. If a CER meets the High Availability CER requirements, it meets all of the lesser requirements for Medium Availability with and without SQF and Low Availability.
3. This requirement was verified in an operational, emulated environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.
4. This is an E2E engineering requirement and, due to variations in network architectures, it could not be accurately tested in a lab environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.

LEGEND:

BGP	Border Gateway Protocol		
CE	Customer Edge	LSC	Local Session Controller
CER	Customer Edge Router	MFSS	Multifunction Softswitch
CR	Capability Requirement	NM	Network Management
E2E	End-to-End	NMS	Network Management System
EBC	Edge Boundary Controller	Para.	Paragraph
FR	Functional Requirement	SQF	System Quality Factors
ID	Identification	SUT	System Under Test
IP	Internet Protocol	UCR	Unified Capabilities Requirements
IPv6	Internet Protocol version 6	VVoIP	Voice and Video over Internet Protocol

7.3 Information Assurance. Table 2-3 details the IA requirements applicable to the CER products.

Table 2-3. CER IA Requirements

Requirement	Applicability (See note)	UCR Reference	Criteria
General Requirements	Required	5.4.6.2	Detailed requirements and associated criteria for CERs are listed in the IATP, Reference (e).
Authentication	Required	5.4.6.2.1	
Integrity	Required	5.4.6.2.2	
Confidentiality	Required	5.4.6.2.3	
Non-Repudiation	Required	5.4.6.2.4	
Availability	Required	5.4.6.2.5	

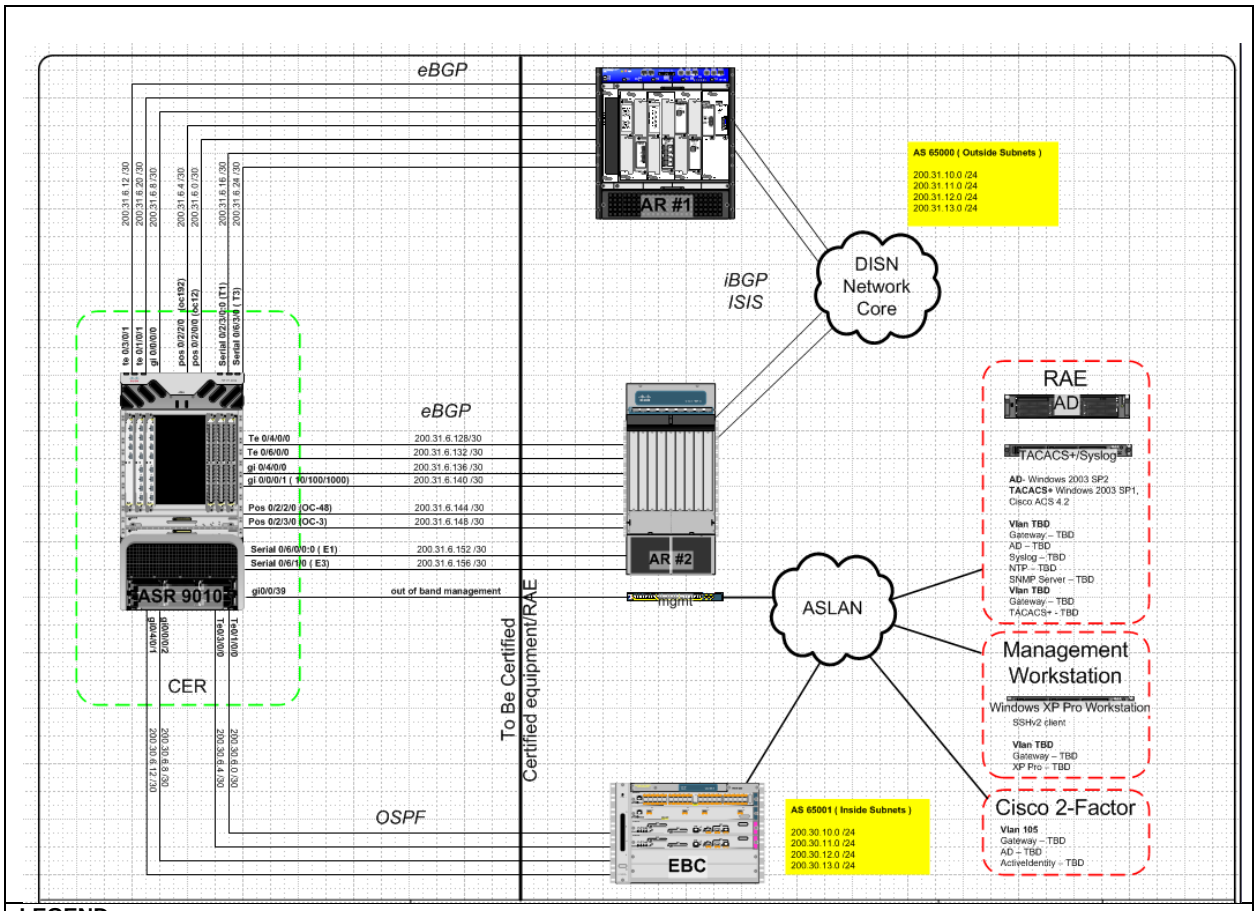
NOTE: The annotation of 'required' refers to a high-level requirement category of IA requirements from the UCR 2008, Change 3, Section 5.4. The detailed IA requirements are included in Reference (e).

LEGEND:

CER	Customer Edge Router	IATP	IA Test Plan
IA	Information Assurance	UCR	Unified Capabilities Requirements

7.4 Other. None.

8. TEST NETWORK DESCRIPTION. The SUT was tested at the TIC, Fort Huachuca, Arizona, in a manner and configuration similar to that of a notional operational environment. Testing the system's required functions and features was conducted using the test configuration depicted in Figure 2-2. Figure 2-2 depicts the SUT High Availability test configuration.



LEGEND:

ACS	Access Control Server	Pro	professional
AD	Active Directory	RAE	Required Ancillary Equipment
AR	Aggregation Router	SNMP	Simple Network Management Protocol
AS	Autonomous System	SSHv2	Secure Shell Protocol version 2
ASLAN	Assured Service Local Area Network	SONET	Synchronous Optical Network
ASR	Aggregation Services Router	SP	Service Pack
eBGP	external Border Gateway Protocol	T1	Digital Transmission Link Level 1
iBGP	internal Border Gateway Protocol	T3	Digital Transmission Link Level 3
CER	Customer Edge Router	TACACS+	Terminal Access Controller Access-Control System
DISN	Defense Information Systems Network		
EBC	Edge Boundary Controller	TBD	to be determined
Gi	Gigabit Ethernet	Te	Ten Gigabit Ethernet
Mgmt	management	VLAN	virtual local area network
NTP	Network Time Protocol	XP	experience
POS	Packet over SONET		
OC	Optical Carrier		
OSPF	Open Shortest Path First		

Figure 2-2. SUT High Availability Test Configuration

9. SYSTEM CONFIGURATIONS. Table 2-4 provides the system configurations and hardware and software components tested with the SUT. The SUT was tested in an operationally realistic environment to determine its interoperability capability with associated network devices and network traffic.

Table 2-4. Tested System Configurations

System Name		Software	
Cisco 7609-S		12.2(33)SRE2	
Cisco 7606		12.2(33)SRE2	
Cisco 6506		12.2(33)SXI4	
Juniper M120		11.2R2.4	
Required Ancillary Equipment		**Equipment**	
		Active Directory	
		SysLog	
		Terminal Access Controller Access Control System Plus	
		Site-Provided Management PC	
Component (See note 1)	**Release**	**Sub-Component (See note 1,2)**	**Description**
ASR-9010-AC, ASR-9010-DC, ASR-9006-AC, ASR-9006-DC	IOS XR 4.1.1	**A9K-RSP-8G**	**Route Switch Processor with 8G memory**
		A9K-RSP-4G	Route Switch Processor with 4G memory
		A9K-40GE-E	**40-Port GE High Queue Line Card, requires SFPs**
		A9K-40GE-B	40-Port GE Medium Queue Line Card, requires SFPs
		A9K-40GE-L	40-Port GE Low Queue Line Card, requires SFPs
		A9K-2T20GE-E	**2-Port 10GE, 20-Port GE High Queue Combo Line Card, requires XFPs for 10GE, SFPs for GE**
		A9K-2T20GE-B	2-Port 10GE, 20-Port GE Medium Queue Combo Line Card, requires XFPs for 10GE, SFPs for GE
		A9K-2T20GE-L	2-Port 10GE, 20-Port GE Medium Queue Combo Line Card, requires XFPs for 10GE, SFPs for GE
		A9K-8T-E	**8-Port 10GE High Queue Line Card, requires XFPs**
		A9K-8T-B	8-Port 10GE Medium Queue Line Card, requires XFPs
		A9K-8T-L	8-Port 10GE Low Queue Line Card, requires XFPs
		A9K-16/8T-B	**16-Port 10GE Medium Queue Oversubscribed Line Card, requires XFPs**
		A9K-8T/4-E	**8-Port 10GE Oversubscribed Extended Line Card, requires XFPs**
		A9K-8T/4-B	8-Port 10GE Medium Queue Oversubscribed Line Card, requires XFPs
		A9K-8T/4-L	8-Port 10GE Low Queue Oversubscribed Line Card, requires XFPs
		A9K-4T-E	4-Port 10GE Extended Line Card, requires XFPs
		A9K-4T-B	4-Port 10GE Medium Queue Line Card, requires XFPs
		A9K-4T-L	4-Port 10GE Low Queue Line Card, requires XFPs
		A9K-SIP-700	**Cisco ASR 9000 SPA Interface Processor-700**
		SPA-2XOC48POS/RPR	**2-port OC-48/STM-16 POS/RPR Shared Port Adapters**
		SPA-8XOC3-POS	**8-port OC-3/STM-1 POS Shared Port Adapters**
		SPA-4XOC3-POS-V2	4-port OC-3/STM-1 POS Shared Port Adapters
		SPA-8XOC12-POS	**8-port OC-12/STM-4 POS Shared Port Adapters**
		SPA-OC192POS-XFP	**1-port OC-192/STM-64 POS/RPR XFP Optics**
		SPA-8XCHT1/E1	**8-port Channelized T1/E1 to DS0 Shared Port Adapter**
		SPA-4XT3/E3	**4-port Clear Channel T3/E3 Shared Port Adapter**
		SPA-2XT3/E3	2-port Clear Channel T3/E3 Shared Port Adapter

Table 2-4. Tested System Configurations (continued)

NOTES:
1. Components in bold were tested by the USAISEC TIC. The other components in the family series were not tested; however, they utilize the same software and similar hardware as the SUT, JITC analysis determined them to be functionally identical for interoperability certification purposes, and they are also certified for joint use.
2. The High Availability and Medium Availability with SQF solutions include the SUT as a fully redundant chassis (redundant RP, fabric, and power supplies) with no single point of failure. The Medium Availability without SQF and Low Availability solutions do not require redundancy.

LEGEND:

ASR	Aggregation Services Router
DS0	Digital Signal Level 0
E1	European Carrier 1 (2.048 Mbps)
E3	European Carrier 3 (34 Mbps)
G	Gigabit
GE	Gigabit Ethernet
IOS	Internetworking Operating System
JITC	Joint Interoperability Test Command
Mbps	Megabits Per Second
OC	Optical Carrier
PC	Personal Computer
POS	Packet over SONET
RP	Route Processor
RPR	Route Processor Redundancy
SFP	Small Form-factor Pluggable
SONET	Synchronous Optical Network
SPA	Shared Port Adapter
SQF	System Quality Factors
STM	Synchronous Transmission Mode
SUT	System Under Test
T1	Digital Transmission Link Level 1
T3	Digital Transmission Link Level 3
TIC	Technology Integration Center
USAISEC	U.S. Army Information Systems Engineering Command
XFP	10 Gigabit Small Form Factor Pluggable Module

10. TESTING LIMITATIONS. Test lab did not have the ability to test the E1 Interface in a heterogeneous environment. Due to variations in network architectures, the E2E engineering requirements were verified in an operational emulated environment. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines in the UCR, Section 5.3.3.

11. INTEROPERABILITY EVALUATION RESULTS. The SUT meets the critical interoperability requirements for a CER IAW UCR 2008, Change 3, Section 5.3.2.14, and is certified for joint use with other network infrastructure products listed on the Unified Criteria Approved Products List (UC APL). Additional discussion regarding specific testing results is located in subsequent paragraphs.

11.1 Interfaces. The interface status of the SUT is provided in Table 2-5.

Table 2-5. SUT Interface Interoperability Status

Interface	Critical	UCR Reference	Threshold CRs/FRs (see note 1)	Status	Remarks
ASLAN Interfaces					
10Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	1-3	Certified	Not provided by the test facility for testing [2, 3 & 4]
100Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100Base-T) interface. [2, 3 & 4]
1000Base-X 1000Base-T	No[2]	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3z (1000Base-X) and 802.3ab (1000Base-T) interface.
10GbE	No	5.3.2.4.2	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ae (10GbE) interface.

Table 2-5. SUT Interface Interoperability Status (continued)

Interface	Critical	UCR Reference	Threshold CRs/FRs (see note 1)	Status	Remarks
WAN Interfaces					
10Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	1-3	Certified	Not provided by the test facility for testing[2, 3 & 4]
100Base-T	Yes[2]	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100Base-T) interface.[2, 3 & 4]
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3z (1000Base-X) interface.
10GbE	No	5.3.2.4.2	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ae (10GbE) interface.
DS1	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this interface.
DS3	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this interface.
E1	No	5.3.2.14.9	1-3	Not Certified	Because of test configuration limitations, the E1 interface was not tested in a heterogeneous environment.
E3	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this interface.
POS (OC-3)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this interface.
POS (OC-12)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this interface.
POS (OC-48)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this interface.
POS (OC-192)	No	5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for this interface.
Network Management Interfaces					
10Base-T	Yes[2]	5.3.2.4.4	4	Certified[3]	Not provided by the test facility for testing [2 & 3]
100Base-T	Yes[2]	5.3.2.4.4	4	Certified	The SUT met all critical CRs and FRs for this interface.

NOTES:

1. The CRs/FRs are contained in Table 2-2. The CR/FR ID numbers represent a roll-up of the UCR. Enclosure 3 provides a list of more detailed requirements for a CER.
2. The UCR states the minimum interface requirement for a CER ASLAN and WAN interface is Ethernet 10Base-T or 100Base-T.
3. All interfaces were tested with the exception of 10Base-T and 100Base-T. Analysis determined 10Base-T and 100Base-T are low risk for certification based on the vendor's Letter of Compliance to comply with IEEE 802.3i, IEEE 802.3u, and testing data collected at all other rates.
4. The copper SFPs do not support auto-negotiation, a requirement in UCR, Change 3, Paragraph 5.3.1.3.1. DISA adjudicated this discrepancy as having a minor operational impact, provided that the following condition of fielding is met: The speed and duplex must be manually configured.

LEGEND:

802.3ab	1000BASE-T Gigabit/s Ethernet over Twisted Pair at 1 Gigabit/s	E1	European Carrier 1 (2.048 Mbps)
802.3ae	10-Gigabit Ethernet	E3	European Carrier 3 (34 Mbps)
802.3i	10 Megabits Per Second Base Band over Twisted Pair	FR	Functional Requirement
802.3u	Standard for carrier sense multiple access with collision detection at 100 Megabits per Second	GbE	Gigabit Ethernet
802.3Z	1000BASE-X Gigabit/S Ethernet over Fiber Optic at 1 Gigabit/s	ID	identification
ASLAN	Assured Services Local Area Network	IEEE	Institute of Electrical and Electronics Engineers
CER	Customer Edge Router	Kbps	Kilobits Per Second
CR	Capability Requirement	Mbps	Megabits Per Second
DISA	Defense Information Systems Agency	OC	Optical Carrier
DS1	Digital Signal Level 1 (1.544 Mbps)	POS	Packet over SONET
DS3	Digital Signal Level 3	SFP	Small Form-factor Pluggable
		SONET	Synchronous Optical Network
		SUT	System Under Test
		UCR	Unified Capabilities Requirements
		WAN	Wide Area Network

11.2 Capability Requirements and Functional Requirements. The SUT's CR and FR status is depicted in Table 2-6. Detailed CRs/FRs are provided in Enclosure 3, Table 3-1.

Table 2-6. SUT Capability Requirements and Functional Requirements Status

CR/FR ID	Capability/Function	Applicability (See note 1)	UCR Reference	Status	Remarks
Product Interface Requirements					
1	Internal Interface Requirements	Required	5.3.2.4.1	Met	The SUT met all critical CRs and FRs.
	External Physical Interfaces between Network Components	Required	5.3.2.4.2	Met	The SUT met all critical CRs and FRs.
	IP Queue Control Capabilities	Required	5.3.2.17.3.4.2. 12, Para. 1	Met	The SUT met all critical CRs and FRs.
	Differentiated Services Code Point	Required	5.3.3.3.2	Met	The SUT met all critical CRs and FRs.
	VVoIP Per-Hop Behavior Requirements	Required	5.3.3.3.3	Met	The SUT met all critical CRs and FRs.
	Traffic Conditioning Requirements	Required	5.3.3.3.4	Met	The SUT met all critical CRs and FRs.
Customer Edge Router Requirements					
2	Traffic Conditioning	Required	5.3.2.14.1	Met	The SUT met all critical CRs and FRs.
	Differentiated Services Support	Required	5.3.2.14.2	Met	The SUT met all critical CRs and FRs.
	Per-Hop Behavior Support	Required	5.3.2.14.3	Met	The SUT met all critical CRs and FRs.
	Interface to the LSC/MFSS for Traffic Conditioning	Conditional	5.3.2.14.4	Not Tested	The SUT does not support this feature and it is not required.
	Interface to the LSC/MFSS for Bandwidth Allocation	Conditional	5.3.2.14.5	Not Tested	The SUT does not support this feature and it is not required.
	Availability	Required	5.3.2.14.7	Met	The SUT met all critical CRs and FRs. The SUT met High Availability CER requirements.[2]
	Packet Transit Time	Required	5.3.2.14.8	Met	The SUT met all critical CRs and FRs.
	CER Interfaces and Throughput Support	Required	5.3.2.14.9	Met	The SUT met all critical CRs and FRs.
	Assured VVoIP Latency	Required	5.3.3.4	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Latency	Required	5.3.3.4.2	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Latency	Required	5.3.3.4.4	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Jitter	Required	5.3.3.5.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Jitter	Required	5.3.3.5.4	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Packet Loss	Required	5.3.3.6.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Packet Loss	Required	5.3.3.6.4	Met	The SUT met all critical CRs and FRs.[3]
	End-to-End Availability	Required	5.3.3.12.1	Met	The SUT met all critical CRs and FRs.[3]
	Availability Design Factors	Required	5.3.3.12.2	Met	The SUT met all critical CRs and FRs.[3]

Table 2-6. SUT Capability Requirements and Functional Requirements Status (continued)

Customer Edge Router Requirements (continued)					
2	Product Quality Factors	Required	5.3.3.12.3	Met	The SUT met all critical CRs and FRs.
	Layer 1 – Physical Layer	Required	5.3.3.12.4.1	Met	The SUT met all critical CRs and FRs.
	Layer 2 – Data Link Layer	Required	5.3.3.12.4.2	Met	The SUT met all critical CRs and FRs.
	Provisioning	Required	5.3.3.13	Met	The SUT met all critical CRs and FRs.[3]
	Interchangeability	Required	5.3.3.14	Met	The SUT met this requirement with Static Routing, BGP-4, IS-IS, OSPFv2, and OSPFv3.
	Voice Grade of Service	Required	5.3.3.15	Met	The SUT met all critical CRs and FRs.[3]
	Survivability	Required	5.3.3.16	Not Tested	This is an E2E engineering requirement and is not testable in a lab environment.[4]
Internet Protocol Version 6 Requirements					
3	IPv6	Required	5.3.3.10	Partially Met	The SUT met all critical CRs and FRs.[5]
	Product Requirements	Required	5.3.5.4	Met	The SUT met all critical CRs and FRs.
Network Management Requirements					
4	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	SUT met all critical CRs and FRs for the 802.3u (100Base-T) interface.
	NM Requirements for CERs	Required	5.3.2.18.1	Met	SUT met all critical CRs and FRs for the 802.3u (100Base-T) interface.
	Network Management	Required	5.3.2.14.6	Met	SUT met all critical CRs and FRs for the 802.3u (100Base-T) interface.

NOTES:

1. Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.
2. To meet the High and Medium Availability requirements with SQF, the SUT must be deployed with dual Embedded Service Processors, dual Route Processors, and dual SPA Interface Processor cards.
3. This requirement was verified in an operational emulated environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.
4. This is an E2E engineering requirement, and due to variations in network architectures, it could not be accurately tested in a lab environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.
5. The SUT met all IPv6 requirements for a CER through testing and the vendor LoC with following exceptions: The SUT partially met RFC 1981, Path MTU Discovery for IPv6. The PMTUD is supported for TCP only, and does not comply with RFCs 2473 and 4301. On 10 January 2012, DISA adjudicated these deficiencies as minor and accepted the vendor POA&Ms for 31 December 2012.

Table 2-6. SUT Capability Requirements and Functional Requirements Status (continued)

LEGEND:			
BGP	Border Gateway Protocol	LSC	Local Session Controller
CE	Customer Edge	MFSS	Multifunction Softswitch
CER	Customer Edge Router	NM	Network Management
CR	Capability Requirement	NMS	Network Management System
DISA	Defense Information Systems Agency	MTU	Maximum Transmission Unit
E2E	End-to-End	PMTUD	Path MTU Discovery
EBC	Edge Boundary Controller	Para.	paragraph
FR	Functional Requirement	POA&M	Plan of Actions and Milestones
ID	identification	OSPF	Open Shortest Path First
IP	Internet Protocol	RFC	Request For Comment
IPv4	Internet Protocol version 4	SQF	System Quality Factors
IPv6	Internet Protocol version 6	SUT	System Under Test
IS-IS	Intermediate System-Intermediate System	UCR	Unified Capabilities Requirements
LoC	Letters of Compliance	VVoIP	Voice and Video over Internet Protocol

a. Product Interface Requirements

(1) Internal Interface Requirements. The UCR 2008, Change 3, Section 5.3.2.4.1, states that the CER shall support auto-negotiation even when the Institute of Electrical and Electronics Engineers (IEEE) 802.3 standard has it as optional. This applies to 10/100/1000-T Ethernet standards; i.e., IEEE, Ethernet Standard 802.3, 1993; IEEE, Fast Ethernet Standard 802.3u, 1995; or IEEE, Gigabit Ethernet Standard 802.3ab, 1999.

(2) External Physical Interfaces between Network Components. The UCR 2008, Change 3, Section 5.3.2.4.2, states the physical interface between a Local Session Controller (LSC) (and its appliances), the Edge Boundary Controller (EBC), the Assured Services Local Area Network (ASLAN) switches/routers, and the CER shall be a 10/100/1000Base-T Megabits per second (Mbps) Ethernet interface. Whenever the physical interfaces use 802.3 Ethernet standards, they shall support auto-negotiation, even when the IEEE 802.3 standard has it as optional. This applies to 10/100/1000Base-T Ethernet standards, i.e., IEEE, Ethernet Standard 802.3, 1993; IEEE, Fast Ethernet Standard 802.3u, 1995; or IEEE, Gigabit Ethernet Standard 802.3ab, 1999. Per the vendor's Letters of Compliance (LoC), the copper small form-factor pluggables (SFPs) do not support auto-negotiation. On 14 February 2012, Defense Information Systems Agency (DISA) adjudicated this discrepancy as minor, with the following condition of fielding: The speed and duplex must be manually configured.

(3) Voice and Video over Internet Protocol (VVoIP) Network Management System (NMS) Interface Requirements. The UCR 2008, Change 3, Section 5.3.2.4.4, states that the physical VVoIP NMS interface between the DISA VVoIP Enterprise Management System (EMS) and the network components (i.e., LSC, Multifunction Softswitch [MFSS], EBC, CER) is a 10/100-Mbps Ethernet interface. The interface will work in either of the two following modes using auto-negotiation: IEEE, Ethernet Standard 802.3, 1993; or IEEE, Fast Ethernet Standard 802.3u, 1995.

b. CER Requirements.

(1) Traffic Conditioning. The CER shall be capable of performing traffic conditioning (policing and shaping) on inbound and outbound traffic IAW Section 5.3.2.14.1 of UCR 2008, Change 3. This may involve the dropping of excess packets or the delaying of traffic to ensure conformance with Service Level Agreements (SLAs). The SUT met this requirement for both Internet Protocol version 4 (IPv4) and internet Protocol version 6 (IPv6) for four queues.

(2) Differentiated Services (DiffServ) Support. The CER shall be capable of supporting DiffServ IAW Request for Comments (RFCs) 2475 and 2474 IAW Section 5.3.2.14.2 of UCR 2008, Change 3. The SUT met this requirement for both IPv4 and IPv6, with both testing and vendor's LoC.

(3) Per-Hop Behavior (PHB) Support. The CER shall be capable of supporting the PHBs IAW Section 5.3.2.14.3 of UCR 2008, Change 3. The CER shall be capable of supporting Expedited Forwarding (EF) PHBs IAW RFC 3246 and Assured Forwarding (AF) PHB IAW RFC 2597. The SUT met this requirement with the vendor's LoC.

(4) Interface to the LSC/MFSS for Traffic Conditioning. The CER shall be capable of interfacing to the LSC or MFSS in real time to adjust traffic conditioning parameters based on the updated LSC/MFSS budgets IAW Section 5.3.2.14.4 of UCR 2008, Change 3. This is a conditional requirement and was not tested.

(5) Interface to the LSC/MFSS for Bandwidth Allocation. The CER shall be capable of interfacing to the LSC/MFSS in real time to adjust the PHB bandwidth allocations based on the updated LSC/MFSS budgets IAW Section 5.3.2.14.5 of UCR 2008, Change 3. This is a conditional requirement and was not tested.

(6) Network Management (NM). The CER shall support fault, configuration, accounting, performance and security (FCAPS) NM functions as defined in Section 5.3.2.17, Management of Network Appliances, and IAW Section 5.3.2.14.6 of UCR 2008, Change 3. The SUT met this requirement through the vendor's LoC.

(7) Availability. The UCR 2008, Change 3, Section 5.3.2.14.7, depicts the four types of CERs and their associated availability requirements. Locations serving FLASH OVERRIDE/FLASH (FO/F) users and IMMEDIATE/PRIORITY (I/P) users and ROUTINE users with PRIORITY and above precedence should install High Availability CERs. The Medium Availability and Low Availability CERS provide cost-effective solutions for locations that serve ROUTINE users. The SUT met the requirements for High Availability CER with the vendor's LoC. A system that meets High Availability requirements meets the lesser availability categories of CER. The SUT is certified with any equivalent Layer 3 ASLAN component listed on the UC APL.

(a) The High Availability CER shall have an availability of 99.999 percent, including scheduled hardware and software maintenance (non-availability of no more than five minutes per year). The High Availability CER shall meet the requirements specified in UCR 2008, Change 3, Section 5.3.2.5.2, Product Quality Factors.

(b) The Medium Availability CER without SQF shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). The SUT met this requirement through the vendor's LoC.

(c) The Medium Availability CER with SQF shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). The Medium Availability CER with SQF shall meet the requirements specified in UCR 2008, Change 3, Section 5.3.2.5.2, Product Quality Factors. The SUT met this requirement through the vendor's LoC.

(d) The Low Availability CER shall have an availability of 99.9 percent, including scheduled hardware and software maintenance (non-availability of no more than 8.76 hours per year).

(8) Packet Transit Time. The CER shall be capable of receiving, processing, and transmitting a voice packet within 2 milliseconds or less in addition to the serialization delay for voice packets, as measured from the input interface to output interface under congested conditions, (as described in UCR 2008, Change 3, Section 5.3.1.4.1.1, ASLAN Voice Services Latency) to include all internal functions. The SUT met this requirement through testing.

(9) The CER Interfaces and Throughput Support. In accordance with Section 5.3.2.14.9 of UCR 2008, Change 3, the CER supports an ASLAN-side connection to the EBC and a wide area network (WAN)-side connection to the DISN WAN. The ASLAN-side interface shall be an Ethernet interface (10/100/1000/10000Base-T), full duplex, and at least one of the WAN-side interfaces shall be an Ethernet interface (10/100/1000/10000Base-T), full duplex. Per DISA, a threshold of +/- 10 percent of maximum line rate is acceptable, with the intent to clarify this in the next revision of the UCR. The IEEE 802.3z (1000Base-X) interface met this requirement with 0 percent loss.

(a) The CER may conditionally support a WAN-side access connection interface, which can also be time division multiplexing (TDM)-based, i.e., Digital Signal Level (DS)1, DS3, European Carrier (E)1. These are all full-duplex interfaces and support two-way, simultaneous information exchange at the "line rate" for the interface (i.e., 1.5 Mbps for DS1, 45 Mbps for DS3, 2.0 Mbps for E1, and 34 Mbps for E3). The SUT is certified for the following WAN interfaces: Ethernet 100Base-T, 1000Base-T/X, 10000Base-X, DS1, DS3, E3, Packet over Synchronous Optical Network (SONET) (POS) Optical Carrier (OC)-3, POS OC-12, POS OC-48, and POS OC-192.

(b) The CER shall support the maximum possible throughput on the WAN-side interface for a full traffic load of all traffic types sent in the ASLAN-to-WAN direction. The SUT met this requirement for all interfaces within +/- 10 percent maximum possible throughput of each WAN interface.

(c) The CER shall support the maximum possible throughput on the WAN-side interface in a full-duplex mode for a full traffic load of unified communications packets sent simultaneously in both the ASLAN-to-WAN and WAN-to-ASLAN directions. The SUT met this requirement for all interfaces within +/- 10 percent maximum possible throughput of each WAN interface.

(d) The maximum possible throughput on the WAN-side interface shall be the maximum line rate the WAN-side interface is provisioned for on the CER. Per DISA, a threshold of +/- 10 percent of maximum line rate is acceptable. All WAN-side interfaces met this requirement.

c. Remote Network Management Command Requirements. The UCR 2008, Change 3, Section 5.3.2.17.3.4.2.12, Paragraph 1, states that setting the queue bandwidth allocations on the CER and its connected port on the Aggregation Router (AR) involves setting the amount (or percentage) of bandwidth allocated to each of the (currently) four queues on the CER and connected Provider Edge router. Two bandwidth allocation actions/functions can be performed as follows: Set the bandwidth allocations by router queue, and set the drop probabilities with each queue if the router supports this functionality. The SUT met these requirements through testing and the vendor's LoC.

d. NM Requirements for CERs. The UCR 2008, Change 3, Section 5.3.2.18.1, states that the CER shall support the NM requirements for CERs specified below:

(1) The CER shall report faults IAW RFCs 1215 and 3418. This requirement was met by the vendor's LoC.

(2) The CER shall present configuration management (CM) IAW RFCs 1215 and 3418. This requirement was met by the vendor's LoC.

(3) The CER shall present performance management (PM) IAW RFCs 1215 and 3418. This requirement was met by the vendor's LoC.

(4) Conditionally, nonstandard (vendor-specific) CM and PM information shall be presented as private, vendor Management Information Bases (MIBs), as defined by the applicable RFCs. This conditional requirement was met by the vendor's LoC.

(5) The CER QoS queues must be readable and settable by the VVoIP EMS. This requirement was met by the vendor's LoC.

e. General Network Requirements.

(1) General Network Requirements. The CER shall support the network requirements IAW the UCR 2008, Change 3, Section 5.3.3.3, specified below:

(a) DiffServ Code Point (DSCP). The CER shall support the plain text DSCP plan, as shown in the UCR 2008, Change 3, Table 5.3.3-1, and the DSCP assignment shall be software configurable for the full range (0-63) to support deployments that may not use the DSCP plan. This requirement was met by the SUT through testing and the vendor's LoC..

(b) VVoIP PHB Requirements. The CER shall support the four-queue PHBs, as defined in UCR 2008, Change 3, Table 5.3.3-2. This requirement was met by the SUT with testing and the vendor's LoC. The CER may conditionally support the six-queue PHBs as defined in the UCR 2008, Change 3, Table 5.3.3-3. The four-queue requirement was met by the SUT through testing.

(c) Traffic Conditioning Requirements. The UCR 2008, Change 3, Section 5.3.3.3.4, states that all CER interfaces toward the CER shall support traffic conditioning on an aggregate granular service class basis on the input interface. The SUT met this requirement through testing.

i. The CER shall be able to traffic condition using IP addresses, virtual local area network tags, protocol port numbers, and DSCPs as discriminators, at a minimum. This requirement was met through testing. The SUT met granular service class basis for 100Base-T, 1000Base-T/X, 10000Base-X, DS1, DS3, E3, POS OC-3, POS OC-12, POS OC-48, and POS OC-192 WAN interfaces within +/- 10 percent of the shaped queue.

ii. All CER interfaces toward the CER shall support traffic conditioning on a granular service class basis on the output interface. This requirement was met through testing. The SUT did meet granular service class basis within +/- 10 percent of the shaped queue for 10/100Base-T and 1000/10gBase-X interfaces when the priority voice queue was oversaturated.

(2) Assured VVoIP Latency. The UCR 2008, Change 3, Section 5.3.3.4, states that all CERs shall be capable of receiving, processing, and transmitting a voice packet within 6 milliseconds (ms) or less, in addition to the serialization delay for voice packets as measured from the input interface to output interface under congested conditions. The requirements in the subparagraphs below depict E2E engineering requirements. The SUT met the requirement through lab testing, however the variations in network architectures could not be accurately replicated in a lab environment.

(a) Assured VVoIP Customer Edge (CE) Latency. The CE Segment supporting VVoIP shall ensure that the one-way latency from the IP handset to the CER

within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute period.

(b) The CE Segment supporting VVoIP shall ensure the one-way latency from the CER to the IP handset within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute period.

(c) Assured VVoIP CER-to-CER Latency. The DISN infrastructure supporting VVoIP shall ensure that the one-way latency from the CER to the CER across the DISN infrastructure for fixed-to-fixed (F-F) nodes does not exceed 150 ms (or 132 ms if the CER is collocated with an AR) for VVoIP during any 5-minute period.

(3) Assured VVoIP CER-to-CER Jitter. The UCR 2008, Change 3, Section 5.3.3.5, states that the DISN infrastructure products supporting VVoIP shall meet the jitter requirements in the subparagraphs below. The requirements in the subparagraphs below depict E2E engineering requirements. The SUT met the requirement through lab testing, however the variations in network architectures could not be accurately replicated in a lab environment.

(a) Assured VVoIP CER-to-CER Jitter. The CE Segment supporting VVoIP shall ensure that the one-way jitter from the CER to the CER across the DISN infrastructure for F-F does not exceed 14 ms (or 10 ms if the CER is collocated with the AR) for VVoIP sessions during any 5-minute period.

(b) Assured VVoIP CE Jitter. The CE Segment supporting VVoIP shall ensure that the one-way jitter between the handset and CER within the Edge Segment does not exceed 3 ms (or 5 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute period.

(4) Assured VVoIP Packet Loss. The UCR 2008, Change 3, Section 5.3.3.6, states that the DISN infrastructure products supporting VVoIP shall meet the packet loss requirements in the subparagraphs below. The requirements in the subparagraphs below depict E2E engineering requirements. The SUT met the requirement through lab testing, however the variations in network architectures could not be accurately replicated in a lab environment.

(a) The DISN infrastructure supporting VVoIP shall ensure that the one-way packet loss from the CER across the DISN infrastructure for F-F nodes does not exceed 0.8 percent (or 0.3 percent if the CERs are collocated with the ARs) for VVoIP sessions during 5-minute period.

(b) The CE Segment supporting VVoIP shall ensure that the one-way packet loss between the handset and CER does not exceed 0.05 percent for VVoIP sessions during any 5-minute period.

(5) System-Level Quality Factors. The UCR 2008, Change 3, Section 5.3.3.12.1, states that all CERs shall meet the SQFs E2E availability in the subparagraphs below. The requirements in the subparagraphs below depict E2E engineering requirements. The SUT met the requirement through lab testing, however the variations in network architectures could not be accurately replicated in a lab environment.

(a) The availability for the network infrastructure within the F-F from CER-to-CER shall be 99.96 percent or greater, to include scheduled maintenance.

(b) The availability to include scheduled maintenance for the network infrastructure within a CE Segment, which includes ASLAN and EBC, shall be 99.998 percent or greater for FO/F users, 99.996 percent or greater for I/P users, and 99.8 percent or greater for other users.

(6) Availability Design Factors. The UCR 2008, Change 3, Section 5.3.3.12.2, states that the CER, as part of E2E network infrastructure, shall meet the following Availability Design Factors:

(a) The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall have no single point of failure, to include power sources and NM. The SUT met this requirement through testing.

(b) In the event of an E2E network infrastructure component failure in a network supporting VVoIP users with precedence above ROUTINE, all sessions that are active shall not be disrupted (i.e., loss of existing connection requiring redialing), and a path through the network shall be restored within 5 seconds. The SUT met this requirement through testing and the vendor's LoC. Table 2-7 shows failover times per interface for each failover event.

Table 2-7. SUT Failover Times per Failover Event

Interface	OSPF	BGP	Processor	Power
DS1 (T1)	NA	3619.61 ms	NT	NT
DS3 (T3)	NA	330.72 ms	NT	NT
E1	NA	2333.66 ms	NT	NT
E3	NA	785.63 ms	0.39 ms	0.00 ms
100Mb	NT	NT	NT	NT
1Gb (40GE-E)	1083.74 ms	286.8 ms	NT	NT
1Gb (2T20GE-E)	1518.48 ms	320.79 ms	NT	NT
10Gb (8T/4-E)	55.24 ms	281.39 ms	NT	NT

Table 2-7. SUT Failover Times per Failover Event (continued)

Interface	OSPF	BGP	Processor	Power
10Gb (16T/8-B)	84.5 ms	281.35 ms	NT	NT
10Gb (2T20GE-E)	NA	280.39 ms	NT	NT
10Gb (8T-E)	NA	282.63 ms	NT	NT
POS OC-3	NA	276.47 ms	NT	NT
POS OC-12	NA	299.3 ms	NT	NT
POS OC-48	NA	381.29 ms	NT	NT
POS OC-192	NA	285.68 ms	NT	NT

Notes:
1. 100Mb interface results were accepted as part of the 1Gb (40GE-E).
2. Not all interfaces are intended to be implemented on the LAN side.
3. Processor and power failover testing were conducted with the WAN E3 interface only.

Legend:

DS1	Digital Signal Level 1	ms	millisecond
DS3	Digital Signal Level 3	NA	not applicable
E1	European Carrier 1 (2.048 Mbps)	NT	not tested
E3	European Carrier 3 (34 Mbps)	OC	Optical Carrier
Gb	Gigabit	POS	Packet over SONET
LAN	local area network	SONET	Synchronous Optical Network
Mb	Megabit	WAN	wide area network

(c) No segment of the E2E network infrastructure shall use split cost metric routing for VVoIP traffic. The SUT met this requirement through testing and through the vendor's LoC.

(d) All network infrastructure products supporting VVoIP users with precedence above ROUTINE shall have eight hours of backup power. Backup power is provided by the B/P/C/S where the SUT is deployed. The SUT has redundant power supplies to prevent single point of failure and works with backup power. However, backup power is not part of the SUT. This requirement is not a SUT requirement.

(7) Product Quality Factors. The UCR 2008, Change 3, Section 5.3.3.12.3, states that the CER, as part of E2E network infrastructure, shall meet the Product Quality Factors in the subparagraphs below.

(a) The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall support a protocol that allows for dynamic rerouting of IP packets to eliminate any single points of failure. The SUT met this requirement with dynamic routing protocols supported including Open Shortest path First (OSPF), Open Shortest path First version 3 (OSPFv3), Intermediate System-to-Intermediate System (IS-IS), and Border Gateway Protocol (BGP) dynamic routing protocols.

(b) All network infrastructure products supporting VVoIP users with precedence above ROUTINE, used to meet the reliability requirements, shall be capable of handling the entire session processing load in the event that its counterpart

product fails. The SUT met this requirement with redundant routing engines and switch fabrics.

(c) All network infrastructure products supporting VVoIP that implement Multiprotocol Label Switching (MPLS) shall have a Fast Re-Route (FRR) capability that restores paths around a local failure (i.e., a failure involving a single router or circuit) within 50 ms. The MPLS protocol was not tested and is not required by the SUT and therefore is not certified for joint use.

(d) Network infrastructure routers shall only enact switchovers based on a reduction in access network throughput or bandwidth with NM troubleshooting procedures, because the routers cannot determine where or what in the access IP connection is the cause of the reduction. This requirement was met through testing.

(e) The network infrastructure routers shall provide an availability of 99.999 percent, to include scheduled maintenance, for users with precedence above ROUTINE. The availability requirement of 99.999 for High Availability was met with the vendor's LoC.

(f) The CER shall switch to the alternate or backup access connection using an automatic process and shall not require operator actions if the CER has at least two separate access connections (i.e., dual homed) and detects an access connection failure. The SUT met this requirement through testing.

(8) Materials. The CER shall meet design and construction materials requirements of Section 5.3.3.12.4 of UCR 2008, Change 3:

(a) The UCR 2008, Change 3, Section 5.3.3.12.4.1, states that all F-F network, infrastructure network connections supporting VVoIP shall have a bandwidth of DS1 (1.544 Mbps) or greater. The SUT certified interfaces met this requirement through testing.

(b) The E2E network infrastructure (excluding session originators) supporting VVoIP sessions shall use the media default Maximum Transmission Unit (MTU). The media default MTU for Ethernet is 1500 bytes. The SUT met this requirement through testing.

(c) The E2E network infrastructure supporting VVoIP sessions shall permit packet fragmentation. The SUT met this requirement through the vendor's LoC.

(d) All E2E network, infrastructure network connections consisting of Ethernet connections that support VVoIP shall be switched full-duplex connections.

(e) All E2E network, infrastructure product, Ethernet interfaces shall support auto-negotiation as described in the IEEE 802.3 series of standards. The SUT met this requirement through the vendor's LoC.

(f) All E2E network, system network links consisting of Ethernet connections that support VVoIP shall not exceed IEEE recommended distances for Ethernet cabling as shown in the UCR 2008, Change 3, Table 5.3.3-5. The links connected to the SUT were within the recommended distances during testing and met the requirement.

(9) Provisioning. The UCR 2008, Change 3, Section 5.3.3.13, states that the CER shall support the provisioning requirements in the subparagraphs below. The requirements in the subparagraphs below depict E2E engineering requirements. Due to variations in network architectures, these requirements could not be accurately tested in a lab environment.

(a) The E2E network Infrastructure supporting VVoIP shall assume the use of International Telecommunication Union – Telecommunication Standardization Sector (ITU-T) G.711 (20 ms) for calculating bandwidth budgets within the fixed network, even if compressed codecs are used.

(b) The E2E network infrastructure design shall provide, at a minimum, a 25 percent increase in network capacity (i.e., throughput and number of sessions) above the current employed network capacity at all tandem switches, Multifunction Switches (MFSs), MFSSs, and critical, dual-homed, End Office (EO) switches and LSCs.

(10) IP Routing Protocols. The UCR 2008, Change 3, Section 5.3.3.14, states that the CER shall support the following IP routing protocol requirements in the subparagraphs below. All Edge System routers supporting VVoIP shall support, at a minimum, the following protocols and methods:

(a) Static Routing. Static routing is a manual method for determining the path that traffic should take on egress from a router. The SUT met this requirement through testing and the vendor's LoC.

(b) BGP-4 Protocol. The BGP-4 is a protocol for exchanging routing information between gateway hosts (each with its own router) in a network of autonomous systems and is described in RFCs 4271 and 1772. The SUT met this requirement through testing and vendor's LoC.

(c) IS-IS Protocol. The IS-IS is an OSI protocol by which intermediate systems exchange routing information. This protocol is not intended to be used as the protocol to interface to the ARs. It is a second method for interfacing between the Provider router and the AR, and it typically is associated with dual-homed Edge Segments. The SUT met the IS-IS requirement through the vendor's LoC.

(d) OSPF Protocol. The OSPF is an interior gateway protocol used to route IP packets within a routing domain. The OSPF version 2 (OSPFv2) for IPv4 is

described in RFC 2328. Updates to OSPF for IPv6 are described in RFC 5340. The SUT met OSPFv2 and OSPFv3 requirements through testing and the vendor LoC.

(11) Voice Grade of Service (GOS). The UCR 2008, Change 3, Section 5.3.3.15, states that the CER, as part of E2E network infrastructure, shall meet the product interchangeability requirements in the subparagraphs below. The requirements in the subparagraphs below depict E2E engineering requirements. Due to variations in network architectures, these requirements could not be accurately tested in a lab environment.

(a) The E2E network infrastructure shall provide a GOS of P.00 (i.e., zero sessions out of 100 will be "blocked" during the "busy hour") for FO/F VVoIP sessions. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in UCR Section 5.3.3.

(b) The E2E network infrastructure shall provide, at a minimum, a GOS of P.02 (i.e., two sessions out of 100 will be blocked during the busy hour) and P.01, respectively, during a 100 percent increase above normal precedence usage for PRIORITY and IMMEDIATE VVoIP sessions. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.

(c) The E2E network infrastructure supporting VVoIP shall provide a peacetime, theater GOS of P.07 (i.e., seven voice sessions out of 100 will be blocked during the busy hour) or better and an inter-theater GOS of P.09 or better, as measured during normal business hours of the theaters for ROUTINE precedence voice and video (VVoIP only) sessions traversing the network from an EO or LSC End Instrument (EI) and/or Assured Services – Session Initiation Protocol (AS-SIP) EI. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in the UCR, Section 5.3.3.

(12) VVoIP Network Infrastructure Survivability. The UCR 2008, Change 3, Section 5.3.3.16, states that no more than 15 percent of the B/P/C/Ss shall be affected by an outage in the network. This requirement is a core network requirement, which cannot be measured in a lab environment.

(13) IPv6 Requirements. The UCR 2008, Change 3, Section 5.3.3.10, states that the network infrastructure products supporting VVoIP shall accept, route, and process IPv6 protocol traffic while providing parity to IPv4. The IPv6 requirements are in the UCR 2008, Change 3, Section 5.3.5. The UCR 2008, Change 3, Section 5.3.5.4, Paragraph 1.4 states that the products which provide a function in IPv4 will have to provide the same function in a seamless manner in IPv6 or provide for a suitable substitute using IPv6 technologies if such technologies are available. The CER met the IPv6 requirements with testing and the vendor's LoC with the following exceptions: The SUT partially met RFC 1981, Path MTU Discovery (PMTUD) for IPv6. The PMTUD is supported for Transmission Control Protocol (TCP) only and does not comply with

RFCs 2473 and 4301. These discrepancies were adjudicated by DISA on 10 January 2012 as having a minor operational impact.

11.3 Information Assurance. The IA report is published in a separate report, Reference (e).

11.4 Other. None.

12. TEST AND ANALYSIS REPORT. No detailed test report was developed IAW the Program Manager's request. The JITC distributes interoperability information via the JITC Electronic Report Distribution (ERD) system, which uses Unclassified-but-Sensitive Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System 2-7 Tracking Program (STP). The STP is accessible by .mil/gov users on the NIPRNet at https://stp.fhu.disa.mil. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool (JIT at http://jit.fhu.disa.mil (NIPRNet). Information related to Defense Switched Network testing is on the Telecom Switched Services Interoperability (TSSI) website at http://jitc.fhu.disa.mil/tssi.

SYSTEM FUNCTIONAL AND CAPABILITY REQUIREMENTS

The CERs have required and conditional features and capabilities that are established by the UCR, Section 5.3.2.14. The SUT need not provide conditional requirements. If conditional requirements are provided, they must function according to the specified requirements. The detailed FRs and CRs for CERs are listed in Table 3-1.

Table 3-1. Customer Edge Router Capability/Functional Requirements

ID	Requirement	UCR Reference	Required (R) Conditions (C)
1	Internal Interfaces are functions that operate internally to a SUT or UC-approved product. When the physical interfaces use IEEE 802.3 Ethernet standards, they shall support auto-negotiation, even when the IEEE 802.3 standard states it is optional. This applies to 10/100/1000Base-T Ethernet standards; i.e., IEEE Ethernet Standard 802.3, 1993; IEEE Fast Ethernet Standard 802.3u, 1995; and IEEE Gigabit Ethernet Standard 802.3ab, 1999.	5.3.2.4.1	R
2	External physical interfaces between components are functions that cross the demarcation point between SUT and other external network components. The physical interface between an LSC (and its appliances), EBC, ASLAN switches/routers, and the CER shall be a 10/100/1000Base-T Mbps Ethernet interface. When the physical interfaces use IEEE 802.3 Ethernet standards, they shall support auto-negotiation even when the IEEE 802.3 standard states it is optional. This applies to 10/100/1000Base-T Ethernet standards; i.e., IEEE Ethernet Standard 802.3, 1993; IEEE Fast Ethernet Standard 802.3u, 1995; and IEEE Gigabit Ethernet Standard 802.3ab, 1999.	5.3.2.4.2	R
3	The physical VVoIP NMS interface between the DISA VVoIP EMS and the network components (i.e., LSC, MFSS, EBC, CER) is a 10/100-Mbps Ethernet interface. The interface will work, in either of the two following modes, using auto-negotiation: IEEE Ethernet Standard 802.3, 1993 or IEEE Fast Ethernet Standard 802.3u, 1995.	5.3.2.4.4	R
4	The product shall be capable of performing traffic conditioning (policing and shaping) on inbound and outbound traffic.	5.3.2.14.1	R
5	The product shall be capable of traffic conditioning the bandwidth associated with a service class.	5.3.2.14.1	R
6	The product shall be capable of supporting DiffServ IAW RFCs 2475 and 2474.	5.3.2.14.2	R
7	The product shall be capable of supporting the PHBs, as specified in UCR 2008, Change 3, Section 5.3.3.	5.3.2.14.3	R
8	The product shall be capable of supporting EF PHBs IAW RFC 3246.	5.3.2.14.3	R
9	The product shall be capable of supporting the AF PHB IAW RFC 2597.	5.3.2.14.3	R
10	The CER shall be capable of interfacing to the LSC/MFSS in real time to adjust traffic conditioning parameters based on the updated LSC/MFSS budgets.	5.3.2.14.4	C
11	The product shall be capable of interfacing to the LSC/MFSS in real time to adjust the PHB bandwidth allocations based on the updated LSC/MFSS budgets.	5.3.2.14.5	C
12	The product shall support FCAPS Network Management functions as defined in the UCR 2008, Change 3, Section 5.3.2.17.	5.3.2.14.6	R

Table 3-1. Customer Edge Router Capability/Functional Requirements (continued)

13	The product shall have an availability of 99.999 percent, including scheduled hardware and software maintenance (non-availability of no more than 5 minutes per year). The product shall meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a high availability CER.	5.3.2.14.7	R
14	**The product shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). The product does not need to meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a medium availability CER without SQF.**	5.3.2.14.7	R
15	The product shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). The product shall meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a medium availability CER with SQF.	5.3.2.14.7	C
16	The product shall have an availability of 99.9 percent, including scheduled hardware and software maintenance (non-availability of no more than 8.76 hours per year). The product does not need to meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a low availability CER.	5.3.2.14.7	C
17	The CER shall be capable of receiving, processing, and transmitting a voice packet within 6 ms or less, in addition to the serialization delay for voice packets, as measured from the input interface to output interface under congested conditions.	5.3.2.14.8	R
18	The ASLAN-side interface shall be an Ethernet interface (10Base-T or 100Base-T) full duplex. At least one of the WAN-side interfaces shall be an Ethernet interface (10Base-T or 100Base-T) full duplex.	5.3.2.14.9	R
19	The WAN-side access connection interface can also be TDM-based (i.e., DS1, DS3, or E1). These are all full-duplex interfaces and support two-way simultaneous information exchange at the “line rate” for the interface (i.e., 1.5 Mbps for DS1, 45 Mbps for DS3, 2.0 Mbps for E1).	5.3.2.14.9	C
20	The CER shall support the maximum possible throughput on the WAN-side interface for a full traffic load of all traffic types sent in the ASLAN-to-WAN direction.	5.3.2.14.9	R
21	The CER shall support the maximum possible throughput on the WAN-side interface for a full traffic load of all traffic types sent in the WAN-to-ASLAN direction.	5.3.2.14.9	R
22	The CER shall support the maximum possible throughput on the WAN-side interface in a full-duplex mode for a full traffic load of UC packets sent simultaneously in both the ASLAN-to-WAN and WAN-to-ASLAN directions.	5.3.2.14.9	R
23	The maximum possible throughput on the WAN-side interface shall be the maximum line rate that the WAN-side interface is provisioned for on the CER.	5.3.2.14.9	R
24	Setting the queue bandwidth allocations on the CER and its connected port on the AR involves setting the amount (or percentage) of bandwidth allocated to each of the (currently) four queues on the CER and connected PE Router. Two bandwidth allocation actions/functions can be performed as follows: Setting the bandwidth allocations by router queue and setting the drop probabilities with each queue if the router supports this functionality.	5.3.2.17.3.4.2. 12, Para. 1	R
25	Faults will be reported IAW RFCs 1215 and 3418.	5.3.2.18.1	R
26	Standard CM information shall be presented IAW RFCs 1213 and 3418.	5.3.2.18.1	R
27	Standard PM information shall be presented IAW RFCs 1213 and 3418.	5.3.2.18.1	R
28	Nonstandard (vendor-specific) CM and PM information shall be presented as private vendor MIBs, as defined by the applicable RFCs.	5.3.2.18.1	C
29	The CER QoS queues must be readable and settable by the VVoIP EMS.	5.3.2.18.1	R
30	The product shall support the plain text DSCP plan, as shown in UCR 2008, Change 3, Table 5.3.3-1, and the DSCP assignment shall be software configurable for the full range (0-63) to support deployable deployments that may not use the following DSCP plan.	5.3.3.3.2	R

Table 3-1. Customer Edge Router Capability/Functional Requirements (continued)

31	The system routers supporting VVoIP shall support the four-queue PHBs as defined in the UCR 2008, Change 3, Table 5.3.3-2.	5.3.3.3.3, Para. 1	R
32	The system routers supporting VVoIP shall support the six-queue PHBs as defined in the UCR 2008, Change 3, Table 5.3.3-3.	5.3.3.3.3, Para. 2	C
33	All CER and/or AR interfaces toward the CER shall support traffic conditioning on an aggregate granular service class basis on the input interface.	5.3.3.3.4, Para. 1	R
34	The system routers shall, at a minimum, be able to traffic condition using IP addresses, VLAN tags, protocol port numbers, and DSCPs as discriminators.	5.3.3.3.4, Para. 2	R
35	All CERs and/or AR interfaces toward the CER shall support traffic conditioning on a granular service class basis on the output interface.	5.3.3.3.4, Para. 3	R
36	All routers shall be capable of receiving, processing, and transmitting a voice packet within 6 ms or less, in addition to the serialization delay for voice packets, as measured from the input interface to output interface under congested conditions as described in the UCR 2008, Change 3, Section 5.3.1.4.1.1, to include all internal functions.	5.3.3.4	R
The requirements below depict E2E engineering requirements. Due to variations in network architectures, these requirements cannot be accurately tested in a lab environment.			
37	The CE Segment supporting VVoIP shall ensure that the one-way latency from the IP handset to the CER within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute period.	5.3.3.4.2, Para. 1	R
38	The CE Segment supporting VVoIP shall ensure that the one-way latency from the CER to the IP handset within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute or period.	5.3.3.4.2, Para. 2	R
39	The DISN infrastructure supporting VVoIP shall ensure that the one-way latency from the CER to the CER across the DISN infrastructure for F-F nodes does not exceed 150 ms (or 132 ms if the CER is collocated with an AR) for VVoIP during any 5-minute period.	5.3.3.4.4	R
40	The DISN infrastructure supporting VVoIP shall ensure that the one-way jitter from the CER to the CER across the DISN Infrastructure for F-F nodes does not exceed 14 (or 10 ms if the CER is collocated with the AR) for VVoIP sessions during any 5-minute period.	5.3.3.5.3	R
41	The CE Segment supporting VVoIP shall ensure that the one-way jitter between the handset and CER within the Edge Segment does not exceed 3 ms (or 5 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute period.	5.3.3.5.4	R
42	The DISN infrastructure supporting VVoIP shall ensure that the one-way packet loss from the CER to the CER across the DISN infrastructure for F-F nodes does not exceed 0.8 percent (or 0.3 percent if the CERs are collocated with the ARs) for VVoIP sessions during any 5-minute period.	5.3.3.6.3	R
43	The CE Segment supporting VVoIP shall ensure that the one-way packet loss between the handset and CER does not exceed 0.05 percent for VVoIP sessions during any 5-minute period.	5.3.3.6.4	R
44	The network infrastructure products supporting VVoIP shall accept, route, and process IPv6 protocol traffic, while providing parity to IPv4.	5.3.3.10	R
45	The availability for the network infrastructure within the F-F from CER to CER shall be 99.96 percent or greater, to include scheduled maintenance.	5.3.3.12.1, Para. 3	R
46	The availability to include scheduled maintenance for the network infrastructure within a Customer Edge Segment, which includes ASLAN and EBC shall be 99.998 percent or greater for FO/F users, 99.996 percent or greater for I/P users, and 99.8 percent or greater for other users.	5.3.3.12.1, Para. 4	R
47	The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall have no single point of failure, to include power sources and NM.	5.3.3.12.2, Para. 1	R
48	In the event of an E2E network infrastructure component failure in a network supporting VVoIP users with precedence above ROUTINE, all sessions that are active shall not be disrupted (i.e., loss of existing connection requiring redialing) and a path through the network shall be restored within 5 seconds.	5.3.3.12.2, Para. 3	R
49	No segment of the E2E network infrastructure shall use split cost metric routing for VVoIP traffic.	5.3.3.12.2, Para. 5	R

Table 3-1. Customer Edge Router Capability/Functional Requirements (continued)

50	All network infrastructure products supporting VVoIP users with precedence above ROUTINE shall have 8 hours of backup power.	5.3.3.12.2, Para. 6	R
51	The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall support a protocol that allows for dynamic rerouting of IP packets to eliminate any single points of failure.	5.3.3.12.3, Para. 1	R
52	All network infrastructure products supporting VVoIP users with precedence above ROUTINE, used to meet the reliability requirements, shall be capable of handling the entire session processing load in the event that its counterpart product fails.	5.3.3.12.3, Para. 2	R
53	All network infrastructure products supporting VVoIP that implement MPLS shall have a FRR capability that restores paths around a local failure (i.e., a failure involving a single router or circuit) within 50 ms.	5.3.3.12.3, Para. 3	R
54	Network infrastructure routers shall only enact switchovers based on a reduction in access network throughput or bandwidth with NM troubleshooting procedures, because the routers cannot determine where or what in the access IP connection is the cause of the reduction.	5.3.3.12.3, Para. 4	R
55	The network infrastructure routers shall provide an availability of 99.999 percent, to include scheduled maintenance, for users with precedence above ROUTINE.	5.3.3.12.3, Para. 5	C
56	The CER shall switch to the alternate or backup access connection using an automatic process and shall not require operator actions. If the CER has at least two separate access connections (i.e., dual homed) and detects an access connection failure.	5.3.3.12.3, Para. 7	C
57	All F-F network, infrastructure network connections supporting VVoIP shall have a bandwidth of DS1 (1.544 Mbps) or greater.	5.3.3.12.4.1	R
58	The E2E network infrastructure (excluding session originators) supporting VVoIP sessions shall use the media default MTU. The media default MTU for Ethernet is 1500 bytes.	5.3.3.12.4.2, Para. 1	R
59	The E2E network infrastructure supporting VVoIP sessions shall permit packet fragmentation.	5.3.3.12.4.2, Para. 2	R
60	All E2E network, infrastructure network connections consisting of Ethernet connections that support VVoIP shall be switched full-duplex connections.	5.3.3.12.4.2, Para. 5	R
61	All E2E network, infrastructure product, Ethernet interfaces shall support auto-negotiation, as described in the IEEE 802.3 series of standards.	5.3.3.12.4.2, Para. 6	R
62	All E2E network, system network links consisting of Ethernet connections that support VVoIP shall not exceed IEEE recommended distances for Ethernet cabling, as shown in the UCR 2008, Change 3, Table 5.3.3-5.	5.3.3.12.4.2, Para. 6	R
63	The E2E network Infrastructure supporting VVoIP shall assume the use of ITU-T G.711 (20 ms) for calculating bandwidth budgets within the fixed network, even if compressed codecs are used.	5.3.3.13, Para. 1	R
64	The E2E network infrastructure design shall provide, at a minimum, a 25 percent increase in network capacity (i.e., throughput and number of sessions) above the current employed network capacity at all tandem switches, MFSs, MFSSs, and critical dual-homed EO switches and LSCs.	5.3.3.13, Para. 4	R
65	All Edge System routers supporting VVoIP shall support, as a minimum, the following routing protocols and methods: Static Routing, BGP-4, and IS-IS or OSPF.	5.3.3.14, Para. 1	R
66	The E2E network infrastructure shall provide a GOS of P.00 (i.e., zero sessions out of 100 will be “blocked” during the “busy hour”) for FLASH and FLASH OVERRIDE voice and video (VVoIP only) sessions.	5.3.3.15	R
67	The E2E network infrastructure shall, at a minimum, provide a GOS of P.02 (i.e., two sessions out of 100 will be blocked during the busy hour) and P.01, respectively, during a 100 percent increase above normal precedence usage for PRIORITY and IMMEDIATE voice and video (VVoIP only) sessions.	5.3.3.15	R
68	The E2E network infrastructure supporting VVoIP shall provide a peacetime theater GOS of P.07 (i.e., seven voice sessions out of 100 will be blocked during the busy hour) or better, and an inter-theater GOS of P.09 or better, as measured during normal business hours of the theaters for ROUTINE precedence voice and video (VVoIP only) sessions traversing the network from an EO or LSC EI and/or GEI.	5.3.3.15	R
69	No more than 15 percent of the B/P/C/Ss shall be affected by an outage in the network.	5.3.3.16	R

Table 3-1. Customer Edge Router Capability/Functional Requirements (continued)

LEGEND:

AF	Assured Forwarding
AR	Aggregation Router
ASLAN	Assured Services Local Area Network
BGP	Border Gateway Protocol
B/P/C/S	base/post/camp/station
C	conditional
CER	Customer Edge Router
CM	Configuration Management
DiffServ	Differentiated Services
DISA	Defense Information Systems Agency
DISN	Defense Information System Network
DS1	Digital Signal Level 1 (1.544 Mbps) (2.048 Mbps European)
DS3	Digital Signal Level 3
DSCP	Differentiated Services Code Point
E1	European Carrier (2.048 Mbps)
E2E	End-to-End
EBC	Edge Boundary Controller
EF	Expedited Forwarding
EI	End Instrument
EO	End Office
F-F	Fixed-to-Fixed
FCAPS	fault, configuration, accounting, performance, and security
FO-F	FLASH OVERRIDE/FLASH
FRR	Fast Re-Route
GEI	Generic End Instrument
GOS	Grade of Service
I/P	IMMEDIATE/PRIORITY
IAW	in accordance with
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IS-IS	Intermediate System-Intermediate System
ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
LSC	Local Session Controller
Mbps	Megabits per second
MFS	Multifunction Switch
MFSS	Multifunction Softswitch
MIB	Management Information Base
MPLS	Multiprotocol Label Switching
ms	millisecond
MTU	Maximum Transmission Unit
NM	Network Management
NMS	Network Management System
OSPF	Open Shortest Path First
Para.	paragraph
PE	Provider Edge
PHB	Per-Hop Behavior
PM	Performance Management
QoS	Quality of Service
R	required
RFCs	Request for Comments
SQF	System Quality Factors
SUT	System Under Test
T1	Digital Transmission Link Level 1 (1.544 Mbps)
TDM	Time Division Multiplexing
UC	Unified Capabilities
VLAN	virtual local area network
VVoIP	Voice and Video over Internet Protocol
WAN	wide area network