

IPv6 Test Service

IPv6-Only Network
Functional Test Plan
Phase 1

Technical Document

Version 1.1_DRAFT



**University of New Hampshire
InterOperability Laboratory
IPv6 Test Service
<https://www.iol.unh.edu>**

**21 Madbury Road, Suite 100
Durham, NH 03824
Phone: +1-603-862-0090
Fax: +1-603-862-4181**

Table of Contents

Acknowledgements.....	3
References.....	4
Introduction.....	5
Test Organization.....	6
Common Topology.....	7
Test Specification Execution.....	7
Section 1: Lifecycle Functionality.....	9
IPv6-Only.1.1: Online Installation.....	10
IPv6-Only.1.2: Online Update.....	11
IPv6-Only.1.3: User Initiated Management/Monitoring Access.....	12
IPv6-Only.1.4: Device Initiated Management/Monitoring Functions.....	13
IPv6-Only.1.5: User Interface.....	14
Part A: IPv6 Address Display.....	14
Part B: IPv6 Address Input.....	15
IPv6-Only.1.6: Logging.....	16
Part A: Logs viewable locally by User/Administrator.....	16
Part B: IP Enabled Remote Logging.....	17
Modification Record.....	18

Acknowledgments

The University of New Hampshire would like to acknowledge the efforts of the following individuals in the development of this test suite:

Timothy Carlin
Marion Dillon
Michayla Newcombe
Kyle Ouellette
Ben Patton
Timothy Winters

University of New Hampshire
University of New Hampshire
University of New Hampshire
University of New Hampshire
University of New Hampshire
QA Café

DRAFT

References

The following documents are referenced in this text:

- [NIST IPv6 Profile] "NIST IPv6 Profile", NIST Special Publication (NIST SP) - 500-267Ar1, November 2020.
<https://doi.org/10.6028/NIST.SP.500-267Ar1>
- [USGv6-R1] "USGv6 Profile", NIST Special Publication (NIST SP) - 500-267Br1, November 2020.
<https://doi.org/10.6028/NIST.SP.500-267Br1>
- [RFC 5952] A Recommendation for IPv6 Address Text Representation. S. Kawamura, M. Kawashima. August 2010.

DRAFT

Introduction

The University of New Hampshire's InterOperability Laboratory (UNH-IOL) is an institution designed to improve the interoperability of standards-based products by providing an environment where a product can be tested against other implementations of a standard. This suite of tests validates that a product properly functions on an IPv6-only network.

Scope:

The following tests verify the general functionality of a product in an IPv6-only network.

The NIST IPv6 Profile (500-267Ar1) defines an **IPv6-Only** product as capable of operating "in environments with no IPv4 capabilities (e.g., either IPv4 is not implemented or is administratively disabled, or IPv4 is not provided on the network)." Some products do not allow IPv4 to be administratively disabled and may automatically provision IPv4 addresses for themselves; in such cases, those IPv4 addresses must not be routable outside of the product's immediate network.

The IPv6-Only capability applies to a product as a whole in its primary role. Additional Application level testing may be warranted for products that serve as a platform to run one or more additional applications or services.

This Test Specification exercises a product to ensure support for the following functions: Installation, Upgrade/Update, Configuration, Management, Instrumentation.

Phase 1:

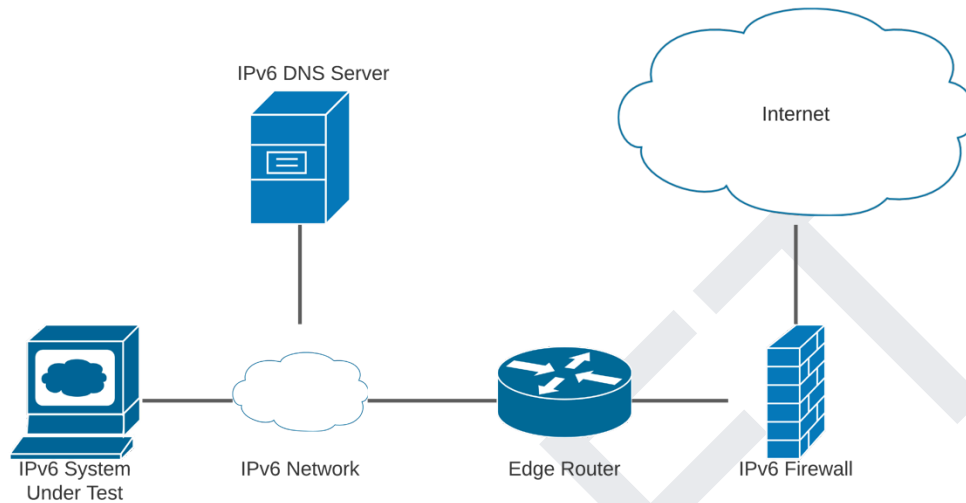
This test plan as written is intended to be an initial and minimum approach ("**Phase 1**") to testing and validating the IPv6-Only functionality. As IPv6 adoption and deployment grows, and IPv4 support dwindles, the importance of IPv6-Only functional parity will increase. As appropriate, more extensive and rigorous revisions of this testing in the form of additional Phases is expected.

Test Organization

This document organizes tests by group based on related test methodology or goals. Each group begins with a brief set of comments pertaining to all tests within that group. This is followed by a series of description blocks; each block describes a single test. The format of the description block is as follows:

Test Label	<p>The Test Label is the first line of the test page. It will have the following form: IPv6-Only.A.B</p> <p>Where each component indicates the following: IPv6-Only – Test Suite Identifier A – Group Number B – Test Number</p> <p>Scripts implementing this test suite should follow this convention, and may also append a character in the set [a-z] indicating a particular test part.</p>
Purpose	<p>The Purpose is a short statement describing what the test attempts to achieve. It is usually phrased as a simple assertion of the feature or capability to be tested.</p>
Test Setup	<p>The Test Setup section describes the configuration of all devices prior to the start of the test. Different parts of the procedure may involve configuration steps that deviate from what is given in the test setup. If a value is not provided for a protocol parameter, then the protocol's default is used for that parameter.</p>
Procedure and Expected Behavior	<p>The Procedure and Expected Behavior table contains the step-by-step instructions for carrying out the test. These steps include such things as enabling interfaces, unplugging devices from the network, or sending packets from a test station. The test procedure also cues the tester to make observations of expected behavior, as needed, as not all steps require observation of results. If any behavior is expected for a procedure, it is to be observed prior to continuing to the next step. Failure to observe any behavior prior to continuing constitutes a failed test.</p> <p>Note, that while test numbers continue between test parts, each test part is to be executed independently (Following Common Test Setup and Cleanup as indicated), and are not cascaded from the previous part.</p>
Possible Problems	<p>The Possible Problems section contains a description of known issues with the test procedure, which may affect test results in certain situations.</p>

Common Topology



Test Specification Execution

When executing the test cases in this document, use the following steps:

- 1) The IPv6 Network **MUST NOT** be provisioned with any IPv4 services (e.g. DHCP).
- 2) IPv4 Capabilities **MUST NOT** be configured on any devices used for testing, and may be administratively disabled.
 - a. If IPv4 cannot be administratively disabled, then any automatically provisioned IPv4 addresses **MUST NOT** be routable outside the local network.
- 3) DNS Records used for testing have both IPv4 and IPv6 records.
- 4) The IPv6 DNS Server is configured either manually or automatically.

Section 1: Lifecycle Functionality

Overview

The product must support full product lifecycle functions (defined below) in an IPv6-only context. Note that often the product support functions below are often provided by additional applications or functions distinct from the main function of the product (e.g., installer applications, update applications, management applications for an OS). [Special Publication (NIST SP) - 500-267Ar1, Section 4.1.1]

DRAFT

IPv6-Only.1.1: Installation

Purpose: The product or service must be able to be instantiated and installed on nodes and in network environments that do not provide IPv4 services. Initial configuration of the product to a state where other remote services are operational, are part of the installation functions. [Special Publication (NIST SP) - 500-267Ar1, Section 4.1.1]

Applicable Product Types:

- Host, Router, NPP, Switch, Application

Prerequisites:

- None

Test Evidence Collected: Collect applicable evidence as described below.

- Description of process and any User Intervention needed for network
- Installation URL, Commands, etc.
- Description of the use, input, or display, of IPv6 addresses.
- Screenshots as needed

Procedure:

Step	Action	Expected Observation
1.	Initiate Installation.	Installation starts successfully.
2.	Monitor Installation progress.	Installation completes successfully and according to supplier description.
3.	Perform initial configuration of the system to a state where other remote services are operational.	Any use of the network must function without error and any input or display of IPv6 Addresses must follow RFC 5952.

Possible Problems:

- If the product comes pre-installed, comes as a complete software + hardware system, or can be completely installed via offline means, steps 1 and 2 may be omitted.

IPv6-Only.1.2: Update

Purpose: All forms of product update functions (e.g., software, BIOS updates), both automated and user initiated, must be fully functional in IPv6-only environments. [Special Publication (NIST SP) - 500-267Ar1, Section 4.1.1]

Applicable Product Types:

- Host, Router, NPP, Switch, Application

Prerequisites:

- Product supports an update function
 - If the product does not provide an update function, this test may be omitted.
- Product has available updates
 - If the product is already running its latest software version and has no available updates, this functionality may not be tested.

Test Evidence Collected: Collect applicable evidence as described below.

- Description of process and any User Intervention needed for network
- Update URL, Commands, etc.
- Description of the use, input, or display, of IPv6 addresses.
- Screenshots as needed

Procedure:

Step	Action	Expected Observation
1.	Copy/transfer update media (firmware image, installers, etc.) to the product.	Media copied successfully.
2.	Initiate Update.	Update starts successfully.
3.	Monitor Update progress.	Update completes successfully. Any use of the network must function without error and any input or display of IPv6 Addresses must follow RFC 5952.

Possible Problems:

- If the product does not require update media to be copied to the system before the update can be initiated, step 1 may be omitted.

IPv6-Only.1.3: User Initiated Management/Monitoring Access

Purpose: All forms of remote management and monitoring functions must be fully functional in IPv6-only environments. [Special Publication (NIST SP) - 500-267Ar1, Section 4.1.1]

Applicable Product Types:

- Host, Router, NPP, Switch, Application

Prerequisites:

- Product Supports Remote Management
 - If the product does not support remote management (i.e. can only be managed via direct access through console, or is unmanaged) this test may be omitted.
 - If supported, Select from at least one of the following functions for remote management and monitoring: **SSH, Telnet, HTTP/HTTPS**.
 - If available, both a command line interface (CLI) and graphical user interface (GUI) **MUST** be tested.

Test Evidence Collected: Collect applicable evidence as described below.

- Description of Tested Management Method(s)
- Management Method, Commands, etc.
- Description of the use, input, or display, of IPv6 addresses.
- Screenshots as needed

Procedure:

Step	Action	Expected Observation
1.	Connect to the DUT.	Connection is established.
2.	If applicable, perform login function.	Access to the management functions of the device is granted.
3.	Navigate the management interface to confirm functionality. (e.g. Confirm version, IPv6 Address(es), etc.)	The management interface is navigable and responsive.

Possible Problems:

- If the Product does not support any of the specified user-initiated remote management functions, another may be substituted.

IPv6-Only.1.4: Device Initiated Management/Monitoring Functions

Purpose: All forms of remote management and monitoring functions must be fully functional in IPv6-only environments. [Special Publication (NIST SP) - 500-267Ar1, Section 4.1.1]

Applicable Product Types:

- Host, Router, NPP, Switch, Application

Prerequisites:

- Product Supports Remote Management
 - If the product does not support remote management (i.e. can only be managed via direct access through console, or is unmanaged) this test may be omitted.
 - If supported, Select from at least one of the following functions for device-initiated remote management and monitoring: **SNMP, NETCONF, Email.**

Test Evidence Collected: Collect applicable evidence as described below.

- Description of Tested Management Method(s)
- Management Method, Commands, etc.
- Description of the use, input, or display, of IPv6 addresses.
- Screenshots as needed

Procedure:

Step	Action	Expected Observation
1.	Configure the DUT with a target for monitoring.	Configuration is accepted.
2.	Following procedures provided by the supplier, initiate action to cause the device to emit an alert.	Device successfully emits an alert and the alert is consumed by the target.

Possible Problems:

- If the Product does not support any of the specified device-initiated remote management functions, another may be substituted.

IPv6-Only.1.5: User Interface

Purpose: All forms of interactive access to the product (e.g., web-based interfaces or APIs) must fully support the use of IPv6 and IPv6 addresses of all forms. If the product displays IP addresses, then IPv6 addresses must be displayed according to [RFC5952]. [Special Publication (NIST SP) - 500-267Ar1, Section 4.1.1]

Applicable Product Types:

- Host, Router, NPP, Switch, Application

Prerequisites:

- Product Supports Interactive User Access
 - If the product does not support an interactive method for access, this test may be omitted.
 - If available, both a command line interface (CLI) and graphical user interface (GUI) MUST be tested.

Test Evidence Collected: Collect applicable evidence as described below.

- Description of Tested Interface(s)
- Input/Display Location, Commands, etc.
- Description of the use, input, or display, of IPv6 addresses.
- Screenshots as needed

Procedure:

Part A: IPv6 Address Display

Step	Action	Expected Observation
1.	Navigate to a function for displaying the product's assigned IPv6 Addresses.	
2.	Observe existing link-local IPv6 address(es) on the product.	The observed address is displayed in a text format per RFC 5952, section 4.
3.	Observe existing global IPv6 address(es) on the product.	The observed address is displayed in a text format per RFC 5952, section 4.
4.	Manually configure an IPv6 address on the product that contains leading zeros in a 16-bit field: 2001:0db8::0001	

*University of New Hampshire
InterOperability Laboratory*

5.	Navigate to a function on the product for displaying the address configured in step 4.	The product displays the address configured in step 4 with leading zeros suppressed: 2001:db8::1
6.	Manually configure an IPv6 address on the product that contains consecutive groups of 16-bit zero fields: 2001:db8:0:0:0:0:2:1	
7.	Navigate to a function on the product for displaying the address configured in step 6.	The product displays the address configured in step 6 with multiple groups of leading zeros abbreviated to "::": 2001:db8::2:1
8.	Manually configure an IPv6 address on the product that contains a single 16-bit zero field: 2001:db8:0:1:1:1:1:1	
9.	Navigate to a function on the product for displaying the address configured in step 8.	The product does not display the address configured in step 8 with the single 16-bit zero field suppressed with "::": 2001:db8:0:1:1:1:1:1
10.	Manually configure an IPv6 address on the product that contains two sets of consecutive groups of 16-bit zero fields, one longer than the other: 2001:0:0:1:0:0:0:1	
11.	Navigate to a function on the product for displaying the address configured in step 10.	The product displays the address configured in step 10 with the longer group of consecutive zeros suppressed with "::": 2001:0:0:1::1
12.	Manually configure an IPv6 address on the product that contains two sets of consecutive groups of 16-bit zero fields, where both are equal length: 2001:db8:0:0:1:0:0:1	
13.	Navigate to a function on the product for displaying the address configured in step 12.	The product displays the address configured in step 12 with the first group of consecutive zeros suppressed with "::": 2001:db8::1:0:0:1

*University of New Hampshire
InterOperability Laboratory*

14.	Manually configure an IPv6 address on the product that contains characters A-F in uppercase: 2001:DB8:A:B:C:D:E:F	
15.	Navigate to a function on the product for displaying the address configured in step 14.	The product displays the address configured in step 14 with characters A-F in lowercase: 2001:db8:a:b:c:d:e:f

DRAFT

*University of New Hampshire
InterOperability Laboratory*

Part B: IPv6 Address Input

Step	Action	Expected Observation
16.	Navigate to a command line interface on the product containing a function that accepts IPv6 addresses as input (e.g. ping diagnostic utility).	
17.	Enter the invalid IPv6 link-local address that is too long: FE80:0:0:0::1:2:3:4:5:6	Observe that the address is not accepted.
18.	Enter the invalid IPv6 address that contains characters that are invalid: FE80::AB:CD:EF:GH	Observe that the address is not accepted.
19.	Enter the invalid IPv6 address with more "::" than are allowed in RFC 5952: FE80::1000::2000	Observe that the address is not accepted.
20.	Enter the invalid IPv6 global address that is too long: 2001:2:0:1:2:3:4:5:6	Observe that the address is not accepted.
21.	Enter the invalid IPv6 address that contains characters that are invalid: 2001:2:0:AB:CD:EF:G:H	Observe that the address is not accepted.
22.	Enter the invalid IPv6 address with more "::" than are allowed in RFC 5952: 2001:2::1000::1000	Observe that the address is not accepted.
23.	Enter a valid link-local IPv6 address assigned to a different device on the IPv6-Only network and perform the diagnostic.	Observe that the application displays the value entered and performs the diagnostic.
24.	Enter a valid global IPv6 address assigned to a different device and perform the diagnostic.	Observe that the application displays the value entered and performs the diagnostic.
25.	Enter a valid FQDN which has a AAAA (IPv6) record assigned to a different device and perform the diagnostic.	Observe that the application displays the value entered and performs the diagnostic.

*University of New Hampshire
InterOperability Laboratory*

26.	Navigate to a graphical user interface on the product.	
27.	Repeat steps 17-22 with the selected interface.	Observe that the function accepts valid addresses and does not accept invalid addresses as described in steps 17-22.
28.	Identify an appropriate API endpoint exposed by the product that accepts IPv6 addresses as input.	
29.	Repeat steps 17-22 with the selected API endpoint.	Observe that the function accepts valid addresses and does not accept invalid addresses as described in steps 17-22.

Possible Problems:

- If the product does not have a function for displaying its assigned link-local addresses, then step 2 may be omitted.
- If the product does not have a function for displaying its assigned global addresses, then step 3 may be omitted.
- If the product does not support a method for manually configuring IPv6 addresses, then steps 4-15 may be omitted.
- If the product does not support a CLI-accessible user interface that accepts IPv6 addresses as input, steps 16-22 may be omitted.
- If the product does not support a GUI-accessible user interface that accepts IPv6 addresses as input, steps 26 and 27 may be omitted.
- If the product does not support an API endpoint that accepts IPv6 addresses as input, steps 28 and 29 may be omitted.

IPv6-Only.1.6: Logging

Purpose: All forms of interactive access to the product (e.g., web-based interfaces or APIs) must fully support the use of IPv6 and IPv6 addresses of all forms. If the product displays IP addresses, then IPv6 addresses must be displayed according to [RFC5952]. [Special Publication (NIST SP) - 500-267Ar1, Section 4.1.1]. Representation of IPv6 Literals in Logs according to [RFC5952] are of particular importance to enable searching and efficient user review.

Applicable Product Types:

- Host, Router, NPP, Switch, Application

Prerequisites:

- Product Supports Logging Functionality
 - If the product does not support logging, or logs are not accessible to the end-user/administrator, this test may be omitted.
- Product Supports Local Logging
 - If the product does not support a method for viewing local logs, then part A may be omitted.
- Product Supports IP Enabled Remote Logging
 - If the product does not support IP Enabled Remote Logging, Part B may be omitted.

Test Evidence Collected: Collect applicable evidence as described below.

- Description of Logging Function
- Logging Location, Commands, etc.
- Description of the use, input, or display, of IPv6 addresses.
- Screenshots as needed

Procedure:

Part A: Local Logging

Step	Action	Expected Observation
1.	Navigate to a mechanism for viewing logs locally on the product, or where IPv6 addresses are logged.	
2.	Observe link-local IPv6 addresses in log messages.	Observed addresses are displayed in a text format per RFC 5952, section 4.

*University of New Hampshire
InterOperability Laboratory*

3.	Observe global IPv6 addresses in log messages.	Observed addresses are displayed in a text format per RFC 5952, section 4.
----	--	--

Part B: IP Enabled Remote Logging

Step	Action	Expected Observation
4.	Configure the device for remote logging over IPv6.	
5.	Enter the valid IPv6 address (or a FQDN with a AAAA DNS record that resolves to a valid IPv6 address) of an IPv6 Destination Server capable of receiving the logs.	Observe that logs are correctly transmitted to the Remote Logging Server.
6.	Observe link-local IPv6 addresses in the collected logs on the Remote Logging Server.	Observed addresses are displayed in a text format per RFC 5952, section 4.
7.	Observe global IPv6 addresses in the collected logs on the Remote Logging Server.	Observed addresses are displayed in a text format per RFC 5952, section 4.

Possible Problems:

- If log messages displayed by the product do not contain link-local IPv6 addresses, then steps 2 and 5 may be omitted.
- If log messages displayed by the product do not contain global IPv6 addresses, then steps 3 and 6 may be omitted.

Modification Record

Version	Date	Editor	Modification
1.1	2024-07-31	Ben Patton	<ul style="list-style-type: none"> ● Revise possible problems and prerequisite text for Installation and Update tests. ● Add steps to 1.5a procedure for checking specific format requirements in RFC 5952. ● Add steps to 1.5b procedure for address input on different types of user interface (GUI, CLI, and API). ● Revise possible problems for Logging test cases. ● Add notes to scope in Introduction section and to Test execution section regarding automatically provisioned IPv4 addresses
1.0	2022-01-31	Timothy Carlin	<ul style="list-style-type: none"> ● Typos and bug fixes
0.4	2021-12-16	Timothy Carlin	<ul style="list-style-type: none"> ● 1.2 - Specify "offline" exception as with 1.1 ● 1.2 - Specify file upload as exception ● 1.5B - Add steps to test invalid IPv6 link-local addresses ● 1.5B - Clarify that Valid link-local and valid global addresses should be assigned to devices different from the DUT ● 1.5B - Add FQDN Diagnostic
0.3	2021-08-30	Timothy Carlin	<ul style="list-style-type: none"> ● Specify functions to be tested
0.2	2021-05-20	Timothy Carlin	<ul style="list-style-type: none"> ● Updates following internal review ● Added Logging Tests
0.1	2021-01-20	Timothy Carlin	<ul style="list-style-type: none"> ● Initial Version