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Entering IPv6 Zone Identifiers in User Interfaces

Abstract

This document describes how the zone identifier of an IPv6 scoped address, defined in the IPv6 Scoped Address Architecture specification (RFC 4007), should be entered into a user interface. This document obsoletes RFC 6874 and updates RFCs 4007, 7622, and 8089.

Status of This Memo

This is an Internet Standards Track document.

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1. Introduction

A number of software tools require or permit the user to enter an IPv6 address via a user interface (UI). The standard literal text format for an IPv6 address is defined by [RFC4291] and [RFC5952]. The IPv6 Scoped Address Architecture specification [RFC4007] extends the text representation of limited-scope IPv6 addresses, in particular link-local unicast addresses and multicast addresses with less than global scope, such that a zone identifier may be concatenated to an address. Note that [RFC5952] does not mention this extension.

Zone identifiers are especially useful in contexts in which literal addresses are typically used, for example, during fault diagnosis or device configuration (where a device may be physical or virtual) when it may be essential to specify which interface is used for sending to a link-local address. It should be noted that zone identifiers have purely local meaning within the node in which they are defined, usually being the same as IPv6 interface names. They are completely meaningless for any other node. At the time of writing, they are meaningful only when attached to link-local unicast and scoped multicast addresses, but it is possible that other uses might be defined in the future.

Examples of a link-local unicast address qualified by a zone identifier are "fe80::1234%eth0" on a Linux host or "fe80::4321%7" on a Microsoft Windows host.

Such addresses are directly supported by socket API calls including "getaddrinfo()" [RFC3493].

Devices whose network stack does not support the model of a human-readable zone identifier described in [RFC4007] are out of scope for this document.

2. Use Cases

Some examples of use cases for entering an address that includes a zone identifier into a UI are as follows:

1. A software tool may be used for simple debugging actions involving link-local addresses on a host with more than one active link interface. For example, the functioning of an interface and the existence of a device may be checked via "ping fe80::1234%eth0". If this succeeds, the user learns that the other device is reachable via the interface named "eth0".
2. A software tool must sometimes be used to configure or reconfigure a device that only has a link-local address, again in a host with more than one active link interface. For example, a typical home router may be configured via a well-known private address [RFC1918] such as "192.168.178.1" but not via "fe80::1%eth0", if the tool in use does not support the input of zone identifiers. More generally, link-local addresses need to be entered in network management UIs for use in formats such as YANG [RFC6991].
3. Using a monitoring tool such as a network sniffer, the user may need to specify a given link-local address on a given interface whose traffic is of interest. (For example, at the time of writing, Wireshark supports capture from multiple interfaces but does not appear to support the zone identifier in a display filter.)
4. The Microsoft Web Services for Devices (WSD) virtual printer port mechanism can present the user with an IPv6 link-local address

such as "fe80::823b:f9ff:fe7b:d9dc%10" in which the zone identifier is present but is not recognized by appropriate software.

5. The National Marine Electronics Association (NMEA) has defined the "OneNet Marine IPv6 Ethernet Networking Standard" [ONE-NET], which uses IPv6 link-local addresses exclusively. Proposed improvements to the standard include a web page for device configuration using link-local addresses.

Such requirements have already spawned hacks to work around current limitations (e.g., the hack described in [LL-HACK], which is no longer maintained and has been archived).

For all such use cases, it is highly desirable that a complete IPv6 link-local address can be cut and pasted from one UI (such as the output from a system command) to another. Since such addresses may include quite long hexadecimal strings, for example, "fe80::8d0f:7f26:f5c8:780b%enx525400d5e0fb", any solution except cut-and-paste is highly error prone.

3. Relationship to Other Documents

The use cases listed above apply to relatively simple actions on end systems. The zone identifiers that can be used are limited by the host operating system, since [RFC4007] only specifies that they are text strings, without specifying a maximum length or syntax. As [RFC4007] explains, each zone identifier corresponds to a numerical zone index that qualifies a link-local address.

It should be noted that whereas some operating systems and network APIs support a default zone identifier as recommended by [RFC4007], others, including Linux, do not, and for them a solution is particularly important, since a link-local address without a zone index cannot be used in the Linux socket API.

The model in [RFC4007] assumes that the human-readable zone identifier is mapped by the operating system into a numeric interface index. Typically, this mapping is performed by the socket API, e.g., by "getaddrinfo()". The mapping between the human-readable zone identifier string and the numeric value is a host-specific function that varies between operating systems. The present document is concerned only with the human-readable string that is typically displayed in an operating system's user interface. However, in most operating systems, it is possible to use the underlying interface number, represented as a decimal integer, as an equivalent to the human-readable string. This is recommended by Section 11.2 of [RFC4007], but it is not required. This possibility does not affect the UI requirement given in this document.

As IPv6 deployment becomes more widespread, the lack of a solution for handling complete link-local addresses in all tools is becoming an acute problem for increasing numbers of operational and support personnel. It will become critical as IPv6-only or IPv6-mostly networks [RFC8925] [IPv6-MOSTLY], with nodes lacking native IPv4 support, appear. For example, the NMEA use case mentioned above is an immediate requirement. This is the principal reason for documenting this requirement now.

This document completely obsoletes [RFC6874], which implementors of web browsers have determined is impracticable to support [LINK-LOCAL-URI], and replaces it with a generic UI requirement. Note that obsoleting [RFC6874] reverts the change that it made to the URI syntax defined by [RFC3986], so [RFC3986] is no longer updated by [RFC6874]. As far as is known, this change will have no significant impact on non-browser deployments of URIs.

This document also updates [RFC7622] and [RFC8089] by deleting their references to [RFC6874].

It also updates [RFC4007] by adding a new requirement that user interfaces support the zone identifier as described in Section 5.

4. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

5. Specification

A user interface (UI) that allows or requires the user to enter an IPv6 address other than a global unicast address MUST provide a means for entering a link-local address or a scoped multicast address and selecting a zone identifier as specified by [RFC4007] (typically, an interface identifier as defined by the operating system).

In this case, the UI SHOULD support the complete format specified by [RFC4007] (e.g., "fe80::1%eth0").

If this is impossible for practical reasons, the UI MAY support an alternative delimiter in place of "%". The hyphen ("-") is suggested (e.g., "fe80::1-eth0").

If this too is impossible for practical reasons, the UI MAY provide two separate input fields (e.g., "fe80::1" in one box and "eth0" in another), selection from a list of active zone identifiers, or a separate command-line parameter for the zone identifier.

The program providing the UI will then store the address and the zone identifier, converting the latter to an interface index (typically via the socket API). A faulty zone identifier will be detected when attempting to convert it, and this should be reported to the user as an error. The resulting interface index will be used for any subsequent socket calls using the link-local address.

Note that an address string such as "fe80::1%eth0" cannot be converted to binary by the POSIX socket API function "inet_pton()" [POSIX]. It must be converted either by using "getaddrinfo()" or by splitting it into two strings and using "inet_pton()" and "if_nametoindex()" successively, in order to obtain the required interface index value.

In this model, the zone identifier is considered independently of the IPv6 address itself. However, this does not in itself resolve the difficulties in considering the zone identifier as part of the HTTP origin model [RFC6454]. Therefore, this approach does not resolve the issue of how browsers should support link-local addresses, which is discussed further in [LINK-LOCAL-URI]. Because of this, the recommendations and normative statements in this document do not apply to URIs fetched by web browsers.

6. Security Considerations

As explained in [RFC4007], zone identifiers are of local significance only and must not be sent on the wire. In particular, see the final security consideration of [RFC4007], which indicates that software should not trust packets that contain textual non-global addresses as data. Therefore, software that obtains a zone identifier through a UI should not transmit it further.

There is no formal limit on the length of the zone identifier string in [RFC4007]. A UI implementation should apply an appropriate length limit when inputting a zone identifier, in order to minimize the risk of a buffer overrun. Typically, this limit would be the same as the host operating system's limit on interface names.

[RFC4007] does not specify or restrict the character set allowed in a zone identifier. Therefore, each implementation processing zone identifiers needs to make checks appropriate for the environment it is used in. For example, a UI implementation should not allow ASCII NUL characters in a zone identifier string as this could cause inconsistencies in subsequent string processing.

7. IANA Considerations

This document has no IANA actions.

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