V6OPS Working Group
Internet-Draft
Intended Status: Informational
Expires: November 18, 2013

C. Byrne
T-Mobile USA
D. Drown
A. Vizdal
Deutsche Telekom AG
May 17, 2013

Extending an IPv6 /64 Prefix from a 3GPP Mobile Interface to a LAN
draft-ietf-v6ops-64share-05

Abstract

This document describes three methods for extending an IPv6 /64 prefix from a User Equipment 3GPP radio interface to a LAN.

Status of this Memo

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1. Introduction

3GPP mobile cellular networks such as GSM, UMTS, and LTE have architectural support for IPv6 [RFC6459], but only 3GPP Release-10 and onwards of the 3GPP specification supports DHCPv6 Prefix Delegation [RFC3633] for delegating IPv6 prefixes to a LAN. To facilitate the use of IPv6 in a LAN prior to the deployment of DHCPv6 Prefix Delegation in 3GPP networks and in User Equipment (UE), this document describes how the 3GPP UE radio interface assigned global /64 prefix may be extended from the 3GPP radio interface to a LAN. This is achieved by receiving the Router Advertisement (RA) [RFC4861] announced globally unique /64 IPv6 prefix from the 3GPP radio interface and then advertising the same IPv6 prefix to the LAN with RA. As in this case, the UE may be any device that can be function as an IPv6 router.

This document describes three methods for achieving IPv6 prefix extension from a 3GPP radio interface to a LAN including:

1) The 3GPP UE does not have a global scope IPv6 address on any interface, only link-local IPv6 addresses are present on the UE
2) The 3GPP UE only has a global scope address on the LAN interface
3) The 3GPP UE maintains the same consistent 128 bit global scope IPv6 anycast address [RFC4291] on the 3GPP radio interface and the LAN interface. The LAN interface is configured as a /64 and the 3GPP radio interface is configured as a /128.

Section 3 describes the characteristics of each of the three approaches.

2. The Challenge of Providing IPv6 Addresses to a LAN via a 3GPP UE

As described in [RFC6459], 3GPP networks assign a /64 global scope prefix to each UE using RA. DHCPv6 Prefix Delegation is an optional part of 3GPP Release-10 and is not covered by any earlier releases. Neighbor Discovery Proxy (ND Proxy) [RFC4389] functionality has been suggested as an option for extending the assigned /64 from the 3GPP radio interface to the LAN, but ND Proxy is an experimental protocol and has some limitations with loop-avoidance.

DHCPv6 is the best way to delegate a prefix to a LAN. The methods described in this document should only be applied when deploying DHCPv6 Prefix Delegation is not achievable in the 3GPP network and the UE. The methods described in this document are at various stages of implementation and deployment planning. The goal of the document is create a common understanding of the available methods which may used prior to DHCPv6 deployment.

3. Methods for Extending the 3GPP Interface /64 IPv6 Prefix to a LAN

3.0 General Behavior for All Scenarios

As [RFC6459] describes, the 3GPP network assigned /64 is completely dedicated to the UE and the gateway does not consume any of the /64 addresses. The gateway routes the entire /64 to the UE and does not perform ND or Network Unreachability Detection (NUD) [RFC4861]. Communication between the UE and the gateway is only done using link-local addresses and the link is point-to-point. This allows for the UE to reliably manipulate the /64 from the 3GPP radio interface without negatively impacting the point-to-point 3GPP radio link interface. The LAN interface RA configuration must be tightly coupled with the 3GPP interface state. If the 3GPP interface goes down or changes the IPv6 prefix, that state should be reflected in the LAN IPv6 configuration. Just as in a standard IPv6 router, the packet TTL will be decremented when passing packets between interfaces across the UE. The RA function on the UE is exclusively run on the LAN interface.

3.1 Scenario 1: No Global Address on the UE

In this case, the UE receives the /64 from the 3GPP network via RA and simply configures Neighbor Discovery Protocol (NDP) [RFC4861] on the LAN interface to announce the /64 via RA. The UE forwards all traffic destine to the /64 out of the LAN interface. The UE shall not run Stateless Address Autoconfiguration [RFC4862] to assign a global address on the 3GPP radio interface while routing is enabled. The 3GPP UE does not assign itself any global IPv6 addresses. Lack of global scope connectivity will limit network services running on the UE (e.g. DNS caching that requires global connectivity) and prevent proper Path MTU Discovery [RFC1981] to occur on the UE. The LAN attached devices have complete access to the /64, but the 3GPP UE only has link-local addresses.

This method is appropriate for a use-case where the UE is only an IPv6 router that does not require any global connectivity.

Below is the general procedure for this scenario:

1. The user activates router functionality for a LAN on the UE.

2. The UE checks to make sure the 3GPP interface is active and has an IPv6 address. If the interface does not have an IPv6 address, an attempt will be made to acquire one, or else the procedure will terminate.

3. In this example, the UE finds the 3GPP interface has the IPv6 address 2001:db8:ac10:f002:1234:4567:0:9/64 assigned and active.

4. The UE copies the prefix 2001:db8:ac10:f002::/64 from the 3GPP interface to the LAN interface, removes the global IPv6 address configuration from the 3GPP radio interface, disables the IPv6 Stateless Address Autoconfiguration (SLAAC) [RFC4862] feature for global addresses on the 3GPP radio interface to avoid address autoconfiguration, and begins announcing the global prefix 2001:db8:ac10:f002::/64 via RA to the LAN. The 3GPP interface and LAN interface only maintain link-local addresses while the UE uses RA to announce the /64 to the LAN.

5. Since the UE and gateway do not assign any of the addresses from the /64, there is no chance of an address conflict on the 3GPP radio interface. On the LAN interface, there is no chance of an address conflict since the hosts on the LAN will use Duplicate Address Detection (DAD) [RFC4862].

3.2 Scenario 2: Global Address Only Assigned to LAN

For this case, the UE receives the RA from the 3GPP network but does not use a global address on the 3GPP interface. The 3GPP RA /64 prefix information is used to configure NDP on the LAN and assigns itself an address on the LAN link. The LAN interface uses RA to announce the prefix to the LAN. The UE LAN interface defends its LAN IPv6 address with DAD. The UE shall not run Stateless Address Autoconfiguration [RFC4862] to assign a global address on the 3GPP radio interface while routing is enabled.

This method allows the UE to originate and terminate IPv6 communications as a host while acting as an IPv6 router. The movement of the IPv6 prefix from the 3GPP radio interface to the LAN interface may result in long-lived data connections being terminated during the transition from a host-only mode to router-and-host mode. This method is appropriate if the UE or software on the UE cannot support multiple interfaces with the same anycast IPv6 address and the UE requires global connectivity while acting as a router.

Below is the general procedure for this scenario:

1. The user activates router functionality for a LAN on the UE.

2. The UE checks to make sure the 3GPP interface is active and has an IPv6 address. If the interface does not have an IPv6 address, an attempt will be made to acquire one, or else the procedure will terminate.

3. In this example, the UE finds the 3GPP interface has the IPv6 address 2001:db8:ac10:f002:1234:4567:0:9 assigned and active.

4. The UE moves the address 2001:db8:ac10:f002:1234:4567:0:9 as a /64 from the 3GPP interfaces to the LAN interface, disables the IPv6 SLAAC feature on the 3GPP radio interface to avoid address autoconfiguration, and begins announcing the prefix 2001:db8:ac10:f002::/64 via RA to the LAN. For this example, the LAN has 2001:db8:ac10:f002:1234:4567:0:9/64 and the 3GPP radio only has a link-local address.

5. The UE directly processes all packets destined to itself at 2001:db8:ac10:f002:1234:4567:0:9.

6. The UE, acting as a router running NDP on the LAN, will route packets to and from the LAN. IPv6 packets passing between interfaces will have the TTL decremented.

7. On the LAN interface, there is no chance of address conflict since the address is defended using DAD. The 3GPP radio interface only has link-local addresses.

3.3 Scenario 3: A Single Global Address Assigned to 3GPP Radio and LAN Interface

In this method, the UE assigns itself one address from the 3GPP network RA announced /64. This one address is configured as anycast [RFC4291] on both the 3GPP radio interface as a /128 and on the LAN interface as a /64. This allows the UE to maintain long lived data connections since the 3GPP radio interface address does not change when the router function is activated. This method may cause complications for certain software that may not support multiple interfaces with the same anycast IPv6 address or are sensitive to prefix length changes. This method also creates complications for ensuring uniqueness for Privacy Extensions [RFC4941]. Privacy Extensions should be disabled on the 3GPP radio interface while this method is enabled.

There might also be more complex scenarios in which the prefix length is not changed and privacy extensions are supported by having the subnet span multiple interfaces, as ND Proxy does [RFC4389]. Further elaboration is out of scope of the present document.

Below is the general procedure for this scenario:

1. The user activates router functionality for a LAN on the UE.

2. The UE checks to make sure the 3GPP interfaces is active and has an IPv6 address. If the interface does not have an IPv6 address, an attempt will be made to acquire one, or else the procedure will terminate.

3. In this example, the UE finds the 3GPP interface has the IPv6 address 2001:db8:ac10:f002:1234:4567:0:9 assigned and active.

4. The UE moves the address 2001:db8:ac10:f002:1234:4567:0:9 as an anycast /64 from the 3GPP interface to the LAN interface and begins announcing the prefix 2001:db8:ac10:f002::/64 via RA to the LAN. The 3GPP interface maintains the same IPv6 anycast address with a /128. For this example, the LAN has 2001:db8:ac10:f002:1234:4567:0:9/64 and the 3GPP radio interface has 2001:db8:ac10:f002:1234:4567:0:9/128.

5. The UE directly processes all packets destined to itself at 2001:db8:ac10:f002:1234:4567:0:9.

6. On the LAN interface, there is no chance of address conflict since the address is defended using DAD. The 3GPP radio interface only has a /128 and no other systems on the 3GPP radio point-to-point link may use the global /64.

4. Security Considerations

Since Scenario 3.3 does not allow for Privacy Extension to run on the 3GPP interface, UEs that require this functionality must find an alternative method or only associate the IPv6 Privacy Extension procedure on the LAN.

5. IANA Considerations

This document does not require any action from IANA.

6. Acknowledgments

Many thanks for review and discussion from Dave Thaler, Sylvain Decremps, Mark Smith, Dmitry Anipko, Masanobu Kawashima, Teemu Savolainen, Mikael Abrahamsson, Eric Vyncke, Alexandru Petrescu, Jouni Korhonen, and Julien Laganier.

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Authors' Addresses

Cameron Byrne
T-Mobile USA
Bellevue, Washington, USA
EMail: Cameron.Byrne@T-Mobile.com

Dan Drown
Email: Dan@Drown.org

Ales Vizdal
Deutsche Telekom AG
Tomickova 2144/1
Prague, 149 00
Czech Republic
EMail: Ales.Vizdal@t-mobile.cz