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Extending an IPv6 /64 Prefix from a Third Generation Partnership Project (3GPP) Mobile Interface to a LAN Link

Abstract

This document describes requirements for extending an IPv6 /64 prefix from a User Equipment Third Generation Partnership Project (3GPP) radio interface to a LAN link and describes two implementation examples.

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1. Introduction

3GPP mobile cellular networks such as Global System for Mobile Communications (GSM), Universal Mobile Telecommunications System (UMTS), and Long Term Evolution (LTE) have architectural support for IPv6 [RFC6459], but only 3GPP Release-10 and onwards of the 3GPP specification [TS.23401] supports DHCPv6 Prefix Delegation [RFC3633] for delegating IPv6 prefixes to a single LAN link.

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 requirements and provides examples on how the 3GPP UE radio interface assigned global /64 prefix may be extended from the 3GPP radio interface to a LAN link.

There are two scenarios where this might be done. The first is where the 3GPP node sets up and manages its own LAN (e.g., an IEEE 802.11 Service Set Identifier (SSID)) and provides single-homed service to hosts that connect to this LAN. A second scenario is where the 3GPP node connects to an existing LAN and acts as a router in order to provide redundant or multi-homed IPv6 service.

This document is intended to address the first scenario; it is not applicable to the second scenario, because the operational complexities of the second scenario are not addressed.

This can be achieved by receiving the Router Advertisement (RA) [RFC4861] announced globally unique /64 IPv6 prefix from the 3GPP radio interface by the UE and then advertising the same IPv6 prefix to the LAN link with RA. For all of the cases in the scope of this document, the UE may be any device that functions as an IPv6 router between the 3GPP network and a LAN.

This document describes requirements for achieving an IPv6 prefix extension from a 3GPP radio interface to a LAN link including two practical implementation examples:

1) The 3GPP UE only has a global-scope address on the LAN link.

2) The 3GPP UE maintains the same consistent 128-bit global-scope IPv6 anycast address [RFC4291] on the 3GPP radio interface and the LAN link. The LAN link is configured as a /64 and the 3GPP radio interface is configured as a /128.

Section 4 describes the characteristics of each of the two example approaches.

1.2. Special Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

Note that this document is not a Standard, and conformance with it is not required in order to claim conformance with IETF Standards for IPv6.

This document uses the normative keywords only for precision.

2. The Challenge of Providing IPv6 Addresses to a LAN Link 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 link, 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 link. 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 this memo is to document the available methods that may be used prior to DHCPv6 deployment.

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

R-1: The 3GPP network provided /64 prefix MUST be made available on the LAN link.

LAN attached devices shall be able to use the 3GPP network assigned IPv6 prefix (e.g. using IPv6 Stateless Address Autoconfiguration - SLAAC [RFC4862]).

R-2: The UE MUST defend all of its IPv6 addresses on the LAN link.

In case a LAN attached node will, for example, autoconfigure the same global IPv6 address as used on the 3GPP interface, the UE must fail the Duplicate Address Detection (DAD) [RFC4862] process run by the LAN node.

R-3: The LAN link configuration MUST be tightly coupled with the 3GPP link state.

R-4: The UE MUST decrement the time to live (TTL) when passing packets between IPv6 links across the UE.

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

4.1. General Behavior for All Example 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 Neighbor 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 link RA configuration must be tightly coupled with the 3GPP link state. If the 3GPP link goes down or changes the IPv6 prefix, that state should be reflected in the LAN link IPv6 configuration. Just as in a standard IPv6 router, the packet TTL will be decremented when passing packets between IPv6 links across the UE. The UE is employing the weak host model [RFC1122]. The RA function on the UE is exclusively run on the LAN link.

The LAN-link-originated RA message carries a copy of the following 3GPP radio-link-received RA message option fields:

- o MTU (if not provided by the 3GPP network, the UE will provide its 3GPP link MTU size)

- o Prefix Information

4.2. Example Scenario 1: Global Address Only Assigned to LAN Link

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-interface-received RA /64 prefix information is used to configure the Neighbor Discovery Protocol (NDP) on the LAN. The UE assigns itself an IPv6 address on the LAN link from the 3GPP-interface-received RA. The LAN link uses RA to announce the prefix to the LAN. The UE LAN link interface defends its LAN IPv6 address with DAD. The UE shall not run SLAAC 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 link may result in long-lived data connections being terminated during the transition from a host-only mode to router-and-host mode. Connections that are likely to be affected are ones that have been specifically bound to the 3GPP radio interface. 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; otherwise, the procedure will terminate.

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

4. The UE moves the address 2001:db8:ac10:f002:1234:4567:0:9 as a /64 from the 3GPP interfaces to the LAN link 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 link interface, there is no chance of address conflict since the address is defended using DAD. The 3GPP radio interface only has a link-local address.

4.3. Example Scenario 2: A Single Global Address Assigned to a 3GPP Radio and LAN Link

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 link as a /128 and on the LAN link 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]. When Privacy Extensions are in use, all temporary addresses will be copied from the 3GPP radio interface to the LAN link. The preferred and valid lifetimes will be synchronized, such that the temporary anycast addresses on both interfaces expire simultaneously.

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 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; otherwise, the procedure will terminate.

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

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.

5. Security Considerations

Since the UE will be switched from an IPv6 host mode to an IPv6 router-and-host mode, basic IPv6 Customer Premises Equipment (CPE) security functions [RFC6092] SHOULD be applied.

Despite the use of temporary IPv6 addresses, the mobile-network-provided /64 prefix is common to all the LAN-attached devices potentially concerning privacy. An IPv6 prefix provided by a nomadic device (e.g., a smartphone) is not a long-lived one due to re-attaches caused by a device reload, traveling through loosely covered areas, etc. The network will provide a new IPv6 prefix after a successful re-attach.

3GPP-mobile-network-capable CPEs (e.g., a router) are likely to keep the mobile network data connection up for a longer time. Some mobile networks may be re-setting the mobile network connection regularly (e.g., every 24 hours), others may not. Privacy-concerned users shall take appropriate measures to not keep their IPv6 prefixes long lived.

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