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Internet Protocol Version 6 (IPv6) Requirements for Cellular Hosts
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Abstract

   This document lists a set of IPv6-related requirements to be
   supported by cellular hosts.

Requirements 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].

Status of this Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on May 19, 2013.

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1. Introduction

[RFC3316] lists a set of features to be supported by cellular hosts
to connect to 3GPP cellular networks. Since the publication of that
document, new functions have been specified within the 3GPP and the
IETF whilst others have been updated. Moreover, in the light of
recent IPv6 production deployments, additional features to facilitate
IPv6-only deployments while accessing IPv4-only service are to be
considered.

A detailed overview of IPv6 support in 3GPP architectures is provided
in [RFC6459].

This document makes use of the terms defined in [RFC6459].

PREFIX64 denotes an IPv6 prefix used to build IPv4-converted IPv6
addresses [RFC6052].

1.1. Scope

Various types of nodes can be connected to 3GPP networks requiring
specific functions. Indeed, a 3GPP network can be used to connect
user equipment such as a mobile telephone, a CPE or a machine-to-
machine (M2M) device. Because of this diversity of terminals, it is
necessary to define a set of IPv6 functionalities valid for any node
directly connecting to a 3GPP network. This document describes these
functionalities.

This document is structured to initially provide the generic IPv6
requirements which are valid for all nodes, whatever their function
or service (e.g., SIP [RFC3261]) capability. The document also
contains, dedicated sections covering specific functionalities the
specific device types must support (e.g., smartphones, devices
providing some LAN functions (mobile CPE or broadband dongles)).

M2M devices profile is not considered in the first version of this
document.

The requirements listed below are valid for both 3GPP GPRS and 3GPP
EPS access. For EPS, "PDN type" terminology is used instead of "PDP
context".

2. Connectivity Requirements

REQ#1: The cellular host MUST support the IPv6 addressing
        architecture described in ([RFC4291]). For address
        representation, [RFC5952] MUST be supported.

REQ#2: The cellular host MUST support both IPv6 and IPv4v6 PDP
        Contexts.

              This allows each operator to select their own strategy
              regarding IPv6 introduction. Both IPv6 and IPv4v6 PDP
              contexts MUST be supported in addition to the IPv4 PDP
              context. IPv4, IPv6 or IPv4v6 PDP-Context request
              acceptance depends on the mobile network configuration.

REQ#3: The cellular host MUST comply with the behavior defined in
        [TS.23060] [TS.23401] [TS.24008] for requesting a PDP context
        type. In particular, the cellular host MUST request an IPv6 PDP
        context if the cellular host is IPv6-only and requesting an
        IPv4v6 PDP context if the cellular host is dual stack or when
        the cellular host is not aware of connectivity types requested
        by devices connected to it (e.g., cellular host with LAN
        capabilities):

        *   If the requested IPv4v6 PDP context is not supported by the
              network, but IPv4 and IPv6 PDP types are allowed, then the
              cellular host will be configured with an IPv4 address
              and/or an IPv6 prefix by the network. It MAY initiate
              another PDP request in addition to the one already
              activated for a given APN.

        *   If the requested PDP type and subscription data allows only
              one IP address family (IPv4 or IPv6), the cellular host
              MUST NOT request a second PDP context to the same APN for
              the other IP address family.

        The text above focuses on the specification part which explains
        the behavior for requesting IPv6-related PDP context(s).
        Understanding this behavior is important to avoid having broken
        IPv6 implementations in cellular devices.

REQ#4: The cellular host MUST support the PCO (Protocol
        Configuration Options) [TS.24008] to retrieve the IPv6
        address(es) of the Recursive DNS server(s).

              In-band signaling is a convenient method to inform the
              cellular host about various services, including DNS server
              information. It does not require any specific protocol to
              be supported and it is already deployed in IPv4 cellular
              networks to convey such DNS information.

REQ#5:   The cellular host MUST support IPv6 aware Traffic Flow
         Templates (TFT) [TS.24008].

              Traffic Flow Templates are employing a Packet Filter to
              couple an IP traffic with a PDP-Context. Thus a dedicated
              PDP-Context and radio resources can be provided by the
              mobile network for certain IP traffic.

REQ#6:   The cellular host MUST support ICMPv6 ([RFC4443]).

              The base protocol MUST be fully implemented by every IPv6
              node as indicated in Section 2 of [RFC4443].

REQ#7:   The device MUST support the Neighbor Discovery Protocol
         ([RFC4861] and [RFC5942]).

              In particular, MTU communication via Router Advertisement
              SHOULD be supported since many 3GPP networks do not have a
              standard MTU setting due to inconsistencies in GTP
              [RFC3314] mobility tunnel infrastructure deployments.

REQ#8:   The cellular host MUST support IPv6 Stateless Address
         Autoconfiguration ([RFC4862]) apart from the exceptions noted in
         [TS.23060] (3G) and [TS.23401] (LTE):

              Stateless mode is the only way to configure a cellular
              host. The GGSN must allocate a prefix that is unique
              within its scope to each primary PDP context.

              The cellular host MUST use the interface identifier sent in
              PDP Context Accept message to configure its link local
              address. The cellular host may use a different Interface
              Identifiers to configure its global addresses.

REQ#9:   The cellular host SHOULD support Router Advertisement Options
         [RFC6106] for DNS configuration.

              The support of this function allows for a consistent method
              of informing cellular hosts about DNS recursive servers
              across various types of access networks. The cellular host
              SHOULD support RA-based DNS information discovery.

REQ#10: The cellular host SHOULD embed a DHCPv6 client [RFC3736].

              Stateless DHCPv6 is useful to retrieve other information
              than DNS.

If [RFC6106] is not supported, the cellular host SHOULD
retrieve DNS information using stateless DHCPv6 [RFC3736].

If the cellular host receives the DNS information in
several channels for the same interface, the following
preference order MUST be followed:
1.   PCO
2.   RA
3.   DHCPv6

REQ#11:   The cellular host SHOULD support a method to locally
construct IPv4-embedded IPv6 addresses [RFC6052]. A method to
learn PREFIX64 SHOULD be supported by the cellular host.

This solves the issue when applications use IPv4 referrals
on IPv6-only access networks.

The cellular host SHOULD implement the method specified in
[I-D.ietf-behave-nat64-discovery-heuristic] to retrieve the
PREFIX64.

REQ#12:   The cellular host SHOULD implement the Customer Side
Translator function (CLAT, [I-D.ietf-v6ops-464xlat]) function
which is compliant with [RFC6052][RFC6145][RFC6146].

CLAT function in the cellular host allows for IPv4-only
application and IPv4-referals to work on an IPv6-only PDP.
CLAT function requires a NAT64 capability [RFC6146] in the
core network.

REQ#13:   The cellular device SHOULD embed a DNS64 function [RFC6147].

Local DNS64 functionality allows for compatibility with
DNSSEC. Means to configure or discover a PREFIX64 is also
required on the cellular device.

REQ#14:   The cellular host SHOULD support PCP [I-D.ietf-pcp-base].

The support of PCP is seen as a driver to save battery
consumption exacerbated by keepalive messages. PCP also
gives the possibility of enabling incoming connections to
the user. Indeed, because several stateful devices may be
deployed in mobile networks (e.g., NAT and/or Firewalls),
PCP can be used by the cellular host to control network
based NAT and Firewall functions which will reduce per-
application signaling and save battery consumption.

REQ#15: When the cellular host is dual stack connected, it SHOULD
      support means to prefer native IPv6 connection over connection
      established through translation devices (e.g., NAT44 and NAT64).

            Cellular hosts SHOULD follow the procedure specified in
            [RFC6724] for source address selection.

            Some potential issues are discussed in
            [I-D.ietf-mif-happy-eyeballs-extension] for MIFed devices.

REQ#16: The cellular host SHOULD support Happy Eyeballs procedure
      defined in [RFC6555].

REQ#17: The cellular host SHOULD NOT perform Duplicate Address
      Detection (DAD) for these Global IPv6 addresses (as the GGSN or
      PDN-GW must not configure any IPv6 addresses using the prefix
      allocated to the cellular host). Refer to Section 4 for DAD
      considerations on the LAN interface when the 3GPP connection is
      shared.

REQ#18: The cellular device MAY embed a BIH function [RFC6535]
      facilitating the communication between an IPv4 application and
      an IPv6 server.

2.1. WiFi Connectivity

It is increasingly common for cellular hosts have a Wi-Fi interface
in addition to their cellular interface. These hosts are likely to
be connected to private or public hotspots. Below are listed some
generic requirements:

REQ#19: IPv6 MUST be supported on the Wi-Fi interface. In
        particular, IPv6-only connectivity MUST be supported over the
        Wi-Fi interface.

                Recent tests revealed that IPv4 configuration is
                required to enable IPv6-only connectivity. Indeed,
                some cellular handsets can access a Wi-Fi IPv6-only
                network by configuring first a static IPv4 address.
                Once the device is connected to the network and the
                wlan0 interface got an IPv6 global address, the IPv4
                address can be deleted from the configuration. This
                avoids the device to ask automatically for a DHCPv4
                server, and allows to connect to IPv6-only networks.

                IPv6 Stateless Address Autoconfiguration ([RFC4862])
                MUST be supported.

REQ#20: DHCPv6 client SHOULD be supported on Wi-Fi interface
         ([RFC3736]).

REQ#21: Wi-Fi interface SHOULD support Router Advertisement Options
         for DNS configuration ([RFC6106]). If the device receives the
         DNS information in several channels for the same interface,
         the following preference order MUST be followed:
         1.   RA
         2.   DHCPv6

3. Advanced Requirements

REQ#22: The cellular host MUST support Path MTU discovery
         ([RFC1981]). If the MTU used by cellular hosts is larger than
         1280 bytes, they can rely on Path MTU discovery function to
         discover the real path MTU.

REQ#23: The cellular host SHOULD support the Privacy Extensions for
         Stateless Address Autoconfiguration in IPv6 ([RFC4941]).

             The activation of privacy extension makes it more
             difficult to track a host over time when compared to
             using a permanent interface identifier. [RFC4941] does
             not require any DAD mechanism to be activated as the
             GGSN (or PDN-GW) MUST NOT configure any global address
             based on the prefix allocated to the cellular host.

REQ#24: The cellular host SHOULD support ROHC for IPv6 ([RFC5795]).

             Bandwidth in mobile environments must be optimized as
             much as possible. ROHC provides a solution to reduce
             bandwidth consumption and to reduce the impact of
             having bigger packet headers in IPv6 compared to IPv4.

REQ#25: The cellular host SHOULD support IPv6 Router Advertisement
         Flags Options ([RFC5175]).

             Some flags are used by the GGSN (or PDN-GW) to inform
             cellular hosts about the autoconfiguration process.

REQ#26: The cellular host SHOULD support Router Advertisement
         extension for communicating default router preferences and
         more-specific routes as described in [RFC4191].

             This function can be used for instance for traffic
             offload.

4. **Cellular Devices with LAN Capabilities**

   This section focuses on cellular devices (e.g., CPE, smartphones or
   dongles with tethering features) which provide IP connectivity to
   other devices connected to them. In such case, all connected devices
   are sharing the same GPRS, UMTS or EPS connection. In addition to
   the generic requirements listed in Section 2, these cellular devices
   have to meet the requirements listed below.

   REQ#27: The cellular device MUST support Prefix Delegation
            capabilities [RFC3633] and MUST support Prefix Exclude Option
            for DHCPv6-based Prefix Delegation as defined in [RFC6603].
            Particularly, it MUST behave as a Requesting Router.

                    Cellular networks are more and more perceived as an
                    alternative to fixed networks for home IP-based
                    services delivery; especially with the advent of
                    smartphones and 3GPP data dongles. There is a need for
                    an efficient mechanism to assign shorter prefix than
                    /64 to cellular hosts so that each LAN segment can get
                    its own /64 prefix and multilink subnet issues to be
                    avoided.

                    In case a prefix is delegated to a cellular host using
                    DHCPv6, the cellular device will be configured with two
                    prefixes:

                            (1) one for 3GPP link allocated using SLAAC
                            mechanism and

                            (2) another one delegated for LANs acquired
                            during Prefix Delegation operation.

                    Note that the 3GPP network architecture requires both
                    the WAN and the Delegated Prefix to be aggregatable, so
                    the subscriber can be identified using a single prefix.

                    Without the Prefix Exclude Option, the delegating
                    router (GGSN/PDN-GW) will have to ensure [RFC3633]
                    compliancy (e.g., halving the Delegated prefix and
                    assigning the WAN prefix out of the 1st half and the
                    prefix to be delegated to the terminal from the 2nd
                    half).

REQ#28: The cellular device MUST be compliant with the CPE
         requirements specified in [RFC6204].

REQ#29: Prefix delegation which allows to allocate a shorter prefix
         to a cellular host is only available since 3GPP Release 10.
         For deployments requiring to share the same /64 prefix, the
         cellular device SHOULD support [I-D.ietf-v6ops-64share] to
         enable sharing a /64 prefix between the 3GPP interface towards
         the GGSN (WAN interface) and the LAN interfaces.

REQ#30: The cellular device SHOULD support the Customer Side
         Translator (CLAT) [I-D.ietf-v6ops-464xlat].

                 Various IP devices are likely to be connected to
                 cellular device, acting as a CPE. Some of these
                 devices can be dual-stack, others are IPv6-only or
                 IPv4-only. IPv6-only connectivity for cellular device
                 does not allow IPv4-only sessions to be established for
                 hosts connected on the LAN segment of cellular devices.

                 In order to allow IPv4 sessions establishment initiated
                 from devices located on LAN segment side and target
                 IPv4 nodes, a solution consists in integrating the CLAT
                 function in the cellular device. As elaborated in
                 Section 2, the CLAT function allows also IPv4
                 applications to continue running over an IPv6-only
                 host.

REQ#31: If a RA MTU is advertised from the 3GPP network, the
         cellular device SHOULD relay that upstream MTU information to
         the downstream attached LAN devices in RA.

                 Since 3GPP networks extensively use IP-in-IP/UDP GTP
                 tunnels, the effective MTU is frequently effectively
                 reduced to 1440 bytes. While a host may generate
                 packets with an MTU of 1500 bytes, this results in
                 undesirable fragmentation of the GTP IP/UDP packets.

                 Receiving and relaying RA MTU values facilitates a more
                 harmonious functioning of the mobile core network where
                 end nodes transmit packets that do not exceed the MTU
                 size of the mobile network's GTP tunnels.

5. APIs & Applications

REQ#32: Name resolution libraries MUST support both IPv4 and IPv6.

          In particular, the cellular host MUST support
          [RFC3596].

REQ#33: Applications MUST be independent of the underlying IP
      address family.

          This means applications must be IP version agnostic.

REQ#34: Applications using URIs MUST follow [RFC3986]. For example,
      SIP applications MUST follow the correction defined in
      [RFC5954].

6. Security Considerations

The security considerations identified in [RFC3316] are to be taken
into account.

REQ#35: If the cellular device provides LAN features, it SHOULD be
      compliant with the security requirements specified in
      [RFC6092].

7. IANA Considerations

This document does not require any action from IANA.

8. Acknowledgements

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