Abstract

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

This document updates RFC3316.

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].

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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.

This document updates [ RFC3316 ] with additional new functionalities which cellular hosts need to support.

While [ RFC3316 ] considered only GPRS and UMTS networks; this document also considers EPS (Evolved Packet System).

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.

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].

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-referrals 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: The cellular host SHOULD support means to prefer native IPv6 connection over NAT64 devices or NAT44 when the cellular host gets dual stack connectivity.

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 the 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).

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.

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]).

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.

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 has to support a mechanism to enable sharing a /64 prefix between the 3GPP interface towards the GGSN (WAN interface) and the LAN interfaces.
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: 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#30: 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#31: Name resolution libraries MUST support both IPv4 and IPv6.

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

REQ#32: Applications MUST be independent of the underlying IP
address family.

This means applications must be IP version agnostic.

REQ#33: 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#34: 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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