IP Addressing Model in Ad Hoc Networks

Abstract

   This document describes a model for configuring IP addresses and
   subnet prefixes on the interfaces of routers which connect to links
   with undetermined connectivity properties.

Status of This Memo

   This document is not an Internet Standards Track specification; it is
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1. Introduction

   The appropriate configuration of IP addresses and subnet masks for
   router network interfaces is generally a prerequisite to the correct
   functioning of routing protocols. Consideration of various items,
   including underlying link capabilities and connectivity, geographical
   topology, available address blocks, assumed traffic patterns etc.,
   are used when determining the appropriate network topology and the
   associated IP interface configuration.

   When the capabilities and connectivity of the links that connect
   routers are well-known and stable, logical network topology design
   and corresponding IP interface configuration are straightforward.
   Absent any assumption about link-level connectivity, however, there
   is no canonical method for determining a given IP interface
   configuration.

   Link-level connectivity is generally qualified as undetermined when
   it is unplanned and/or time-varying in character. Ad hoc networks
   are typical examples of networks with undetermined link-level
   connectivity. Routing protocols for ad hoc networks are purposely
   designed to detect and maintain paths across the network, even when
   faced with links with undetermined connectivity, assuming that
   routers' interfaces are configured with IP addresses. This document
   thus proposes a model for configuration of IP addresses and subnet
   prefixes on router interfaces to links with undetermined connectivity
   properties, to allow routing protocols and data packet forwarding to
   function.

   Note that routers may ultimately need additional IP prefixes for the
   diverse applications that could run directly on the routers
   themselves, or for assignment to attached hosts or networks. For

IPv6, these addresses may be global [RFC3587], Unique-Local [RFC4193]
or Link-Local [RFC4291]. For IPv4, the addresses may be global
(i.e., public) or private [RFC1918]. In general, global scope is
desired over local scope, though it is understood that this may not
always be achievable via automatic configuration mechanisms. In this
document however, automatic configuration of the prefixes used for
general applications is considered as a problem that is separable
from that of automatic configuration of addresses and prefixes
necessary for routing protocols to function. This document thus
focuses on the latter: the type of IP address and subnet mask
configuration necessary for routing protocols and data packet
forwarding to function.

2. Terminology

   This document uses the vocabulary and the concepts defined in
   [RFC1918] and [RFC4632] for IPv4, as well as [RFC4291] for IPv6.

3. Applicability Statement

   This model gives guidance about the configuration of IP addresses and
   the IP subnet prefixes on a router's IP interfaces, which connect to
   links with undetermined connectivity properties.

   When more specific assumptions can be made regarding the connectivity
   between interfaces or the (persistent) reachability of some
   addresses, these should be considered when configuring subnet
   prefixes.

4. IP Subnet Prefix Configuration

   If the link to which an interface connects enables no assumptions of
   connectivity to other interfaces, the only addresses that can be
   assumed "on link", are the address(es) of that interface itself.
   Note that while link-local addresses are assumed to be "on link", the
   utility of link-local addresses is limited as described in Section 6.

   Thus, subnet prefix configuration on such interfaces must not make
   any promises in terms of direct (one hop) IP connectivity to IP
   addresses other than that of the interface itself. This suggests the
   following principle:

   o   no on-link subnet prefix should be configured on such an
       interface.

   Note that if layer 2 communication is enabled between a pair of
   interfaces, IP packet exchange is also enabled, even if IP subnet
   configuration is absent or different on each of these interfaces.

Also note that if, on the contrary, assumptions can be made regarding
the connectivity between interfaces, or regarding the persistent
reachability of some addresses, these should be considered when
configuring IP subnet prefixes, and the corresponding interface(s)
may in such case be configured with an on-link subnet prefix.

5. IP Address Configuration

Routing protocols running on a router may exhibit different
requirements for uniqueness of interface addresses; some have no such
requirements, others have requirements ranging from local uniqueness
only, to uniqueness within, at least, the routing domain (as defined
in [RFC1136]).

Routing protocols that do not require unique IP addresses within the
routing domain utilize a separate unique identifier within the
routing protocol itself; such identifiers could be based on factory
assignment or configuration.

Nevertheless, configuring an IP address that is unique within the
routing domain satisfies the less stringent uniqueness requirements,
while also enabling protocols that have the most stringent
requirements of uniqueness within the routing domain. As a result,
the following principle allows for IP autoconfiguration to apply to
the widest array of routing protocols:

o   an IP address assigned to an interface that connects to a link
    with undetermined connectivity properties should be unique, at
    least within the routing domain.

6. Addressing Model

Sections 4 and 5 describe principles for IP address and subnet prefix
configuration on an interface of a router, when that interface
connects to a link with undetermined connectivity properties. The
following describes guidelines that follow from these principles,
respectively for IPv6 and IPv4.

Note that the guidelines provided in this document slightly differ
for IPv6 and IPv4, as IPv6 offers possibilities that IPv4 does not
(i.e., the possibility to simply not configure any on-link subnet
prefix on an IPv6 interface), which provide a "cleaner" model.

6.1. IPv6 Model

For IPv6, the principles described in Sections 4 and 5 suggest the
following rules:

o An IP address configured on this interface should be unique, at
   least within the routing domain, and

o No on-link subnet prefix is configured on this interface.

Note that while an IPv6 link-local address is assigned to each
interface as per [RFC4291], in general link-local addresses are of
limited utility on links with undetermined connectivity, as
connectivity to neighbors may be constantly changing. The known
limitations are:

o In general, there is no mechanism to ensure that IPv6 link-local
   addresses are unique across multiple links, though link-local
   addresses using an IID that are of the modified EUI-64 form should
   be globally unique.

o Routers cannot forward any packets with link-local source or
   destination addresses to other links (as per [RFC4291]), while
   most of the time, routers need to be able to forward packets to/
   from different links.

Therefore, autoconfiguration solutions should be encouraged to
primarily focus on configuring IP addresses that are not IPv6 link-
local.

6.2. IPv4 Model

For IPv4, the principles described in Sections 4 and 5 suggest rules
similar to those mentioned for IPv6 in Section 6.1, that are:

o An IP address configured on this interface should be unique, at
   least within the routing domain, and

o Any subnet prefix configured on this interface should be 32 bits
   long.

Note that the use of IPv4 link-local addresses [RFC3927] in this
context should be discouraged for most applications, as the
limitations outlined in Section 6.1 for IPv6 link-local addresses
also concern IPv4 link-local addresses. These limitations are
further exacerbated by the smaller pool of IPv4 link-local addresses
to choose from and thus increased reliance on Duplicate Address
Detection (DAD).

7. Security Considerations

This document focuses on the IP address and subnet mask configuration
necessary for routing protocols and data packet forwarding to
function. [RFC4593] describes generic threats to routing protocols,
whose applicability is not altered by the presence of interfaces with
undetermined connectivity properties. As such, the addressing model
described in this document does not introduce new security threats.

However, the possible lack of pre-established infrastructure or
authority, as enabled by the use of interfaces with undetermined
connectivity properties, may render some of the attacks described in
[RFC4593] easier to undertake. In particular, detection of
malevolent misconfiguration may be more difficult to detect and to
locate.

8. References

8.1. Normative References

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8.2. Informative References

   [RFC4593] Barbir, A., Murphy, S., and Y. Yang, "Generic Threats to
              Routing Protocols", RFC 4593, October 2006.

Appendix A. Contributors

   This document reflects discussions and contributions from several
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