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IP Addressing Model in Ad Hoc Networks
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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.

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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 have as purpose 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 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 which 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.

Subnet prefix configuration on such interfaces must thus 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:

- 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]).

Configuring an IP address that is unique within the routing domain satisfies the less stringent uniqueness requirements of local uniqueness, while also enabling protocols which have the most stringent requirements of uniqueness within the routing domain. This suggests the following principle:

- 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

Section 4 and Section 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 Section 4 and Section 5 suggest the following rules:

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

- 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:

- There is no mechanism to ensure that IPv6 link-local addresses are unique across multiple links, hence they cannot be used to reliably identify routers (it is often desirable to identify a

router with an IP address).

- 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 Section 4 and Section 5 suggest rules similar to those mentioned for IPv6 in Section 6.1, that are:

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

- 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. IANA Considerations

This document has no actions for IANA.

8. Security Considerations

This document thus 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.

9. References

9.1. Normative References

[RFC1136] Hares, S. and D. Katz, "Administrative Domains and Routing Domains: A Model for Routing in the Internet", RFC 1136, December 1989.

[RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing Architecture", RFC 4291, 2006.

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[RFC4632] Fuller, V. and T. Li, "Classless Inter-domain Routing (CIDR): The Internet Address Assignment and Aggregation Plan", RFC 4632, 2006.

9.2. Informative References

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

Appendix A. Contributors

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