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Support for multiple provisioning domains in IPv6 Neighbor Discovery Protocol
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Abstract

The MIF working group is producing a solution to solve the issues that are associated with nodes that can be attached to multiple networks. One part of the solution requires associating configuration information with provisioning domains. This document details how configuration information provided through IPv6 Neighbor Discovery Protocol can be associated with provisioning domains.

Status of This Memo

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1. Introduction

The MIF working group is producing a solution to solve the issues that are associated with nodes that can be attached to multiple networks based on the Multiple Provisioning Domains (MPVD) architecture work [RFC7556]. One part of the solution requires associating configuration information with Provisioning Domains (PVD). This document describes an IPv6 Neighbor Discovery Protocol (NDP) [RFC4861] mechanism for explicitly indicating provisioning domain information along with any configuration which is associated with that provisioning domain. The proposed mechanism uses an NDP option that indicates the identity of the provisioning domain and encapsulates the options that contain the configuration information as well as any accompanying authentication/authorization information. The solution defined in this document aligns as much as possible with the existing IPv6 Neighbor Discovery security, namely with Secure Neighbor Discovery (SeND) [RFC3971].

2. Terminology

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 [RFC2119].

3. PVD Container option

The PVD container option (PVD_CO) is used to mark the start of the configuration options that belong to the explicitly identified provisioning domain. The PVD container option MUST encapsulate exactly one PVD identity option (PVD_ID, see Section 4). The PVD container option MAY occur multiple times in a Router Advertisement (RA) message. In this case each PVD container MUST belong to a different provisioning domain. The PVD container options MUST NOT be nested. The PVD Container option is defined only for the RA and Router Solicitation (RS) NDP messages, and intended to be only used with IPv6 RA messages. However, if a host wants to solicit information for a specific provisioning domain it can include the PVD identity option into an RS message and use the PVD container to sign the PVD identity option.

Since implementations are required to ignore any unrecognized options [RFC4861], the backward compatibility and the reuse of existing NDP options is implicitly enabled. Implementations that do not recognize the PVD container option will ignore it, and any PVD container option "encapsulated" NDP options without associating them into any provisioning domain (since the implementation has no notion of provisioning domains). For example, the PVD container could "encapsulate" a Prefix Information Option (PIO), which would mark that this certain advertised IPv6 prefix belongs and originates from a specific provisioning domain. However, if the implementation does not understand provisioning domains, then this specific PIO is also skipped and not configured to the interface.

The optional security for the PVD container is based on X.509 certificates [RFC6487] and reuses mechanisms already defined for SeND [RFC3971] [RFC6495]. However, the use of PVD containers does not assume or depend on SeND being deployed or even implemented. The PVD containers SHOULD be signed per PVD certificates, which provides both integrity protection and proves that the configuration information source is authorized for advertising the given information. See

[RFC6494] for discussion how to enable deployments where the certificates needed to sign PVD containers belong to different administrative domains i.e. to different provisioning domains.

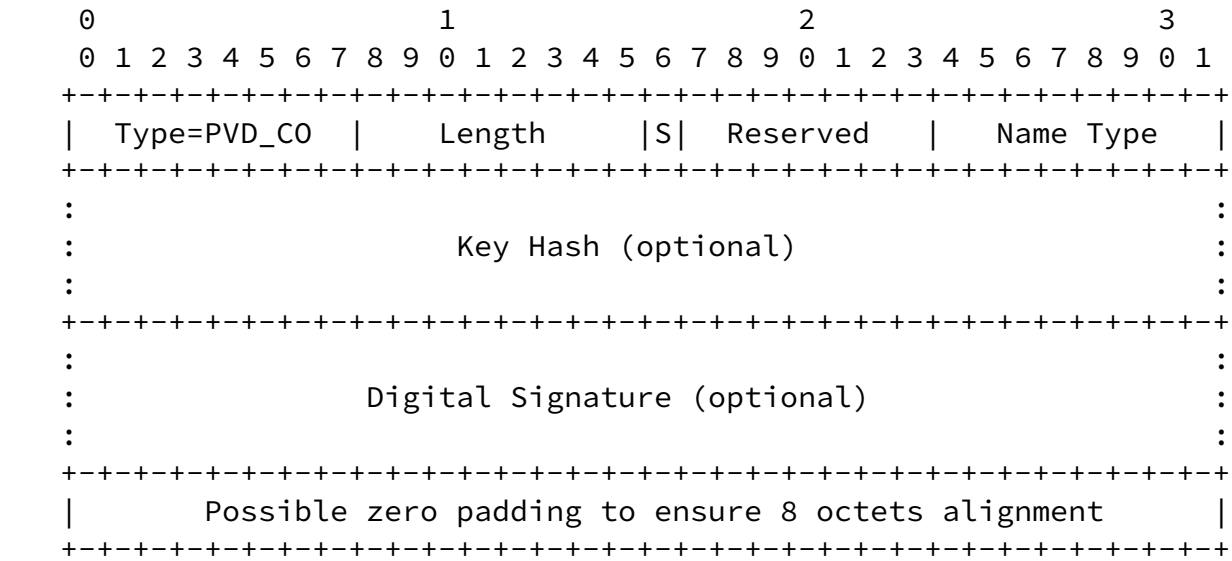

Figure 1: PVD Container Option

Type

PVD Container; Set to TBD1.

Length

Length of the PVD_CO. The actual length depends on the number of "encapsulated" NDP options, the length of the PVD identifier option, and the optional Key Hash/Digital Signature/Padding.

S

Security enabled/disabled flag. If S=0 then security (signing) of the PVD_CO is disabled. If S=1 then security (signing) is enabled.

Name Type

Names the algorithm used to identify a specific X.509 certificate using the method defined for the Subject Key Identifier (SKI) extension for the X.509 certificates. The usage and the Name Type registry aligns with the mechanism defined for SeND [RFC6495]. Name Type values starting from 3 are supported and an implementation MUST at least support SHA-1 (value 3). Note that if S=0 the Name field serves no use.

Key Hash

This field is only present when S=1. A hash of the public key using the algorithm identified by the Name Type. The procedure how the Key Hash is calculated is defined in [RFC3971] and [RFC6495].

Digital Signature

This field is only present when S=1. A signature calculated over the PVD_CO option including all option data from the beginning of the option until to the end of the container. The procedure of calculating the signature is identical to the one defined for SeND [RFC3971]. During the signature calculation the contents of the Digital Signature option MUST be treated as all zero.

Implementations MUST ensure that the PVD container option meets the 8 octets NDP option alignment requirement as described in [RFC4861].

If the PVD_CO does not contain a digital signature, then other means to secure the integrity of the NDP message SHOULD be provided, such

as utilizing SeND. However, the security provided by SeND is for the entire NDP message and does not allow verifying whether the sender of the NDP message is actually authorized for the information for the provisioning domain.

If the PVD_CO contains a signature and the verification fails, then the whole PVD_CO, PVD_ID and other NDP options MUST be silently ignored and the event SHOULD be logged.

4. PVD Identity option

The PVD identity option (PVD_ID) is used to explicitly identity a provisioning domain. In an RA message the PVD identity option MUST be and in an RS message the PVD identity option SHOULD be encapsulated into the associated PVD container option. However, in the RS message PVD identity options MAY be included without any PVD container options and in this case the PVD identity options serve only as a hint for a specific provisioning domains.

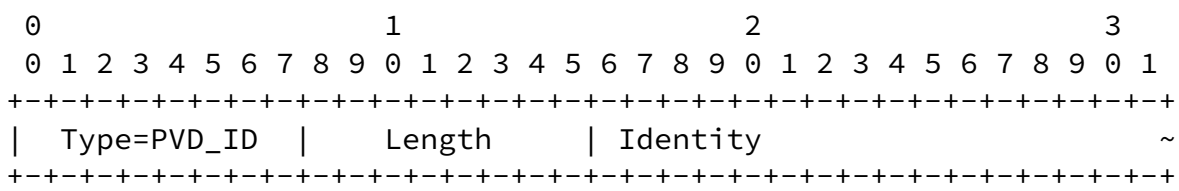

Figure 2: PVD_ID Option

Type

PVD identifier; Set to TBD2.

Length

Length of the PVD_ID.

Identity

The provisioning domain identity. The contents of this field is defined in a separate document [I-D.ietf-mif-mpvd-id]. Note that the Identity field may need to be zero padded at the tail to

meets the natural NDP option's alignment.

If the receiver of a PVD identity option does not have one (or more) of the received ID-Type format's implemented, then all configuration and options which are associated with the unimplemented PVD(s) MUST be silently discarded.

5. Set of allowable options

The PVD container option MAY be used to encapsulate any allocated IPv6 NDP options, which may appear more than once in a NDP message. The PVD container option MUST NOT be used to encapsulate other PVD_CO option(s).

6. Security Considerations

An attacker may attempt to modify the information provided inside the PVD container option. These attacks can easily be prevented by using SeND [RFC3971] or per PVD container signature that would detect any form of tampering with the IPv6 NDP message contents.

A compromised router may advertise configuration information related to provisioning domains it is not authorized to advertise. e.g. A coffee shop router may provide configuration information purporting to be from an enterprise and may try to attract enterprise related traffic. The only real way to avoid this is that the provisioning domain container contains embedded authentication and authorization information from the owner of the provisioning domain. Then, this attack can be detected by the client by verifying the authentication and authorization information provided inside the PVD container option after verifying its trust towards the provisioning domain owner (e.g. a certificate with a well-known/common trust anchor).

A compromised configuration source or an on-link attacker may try to capture advertised configuration information and replay it on a different link or at a future point in time. This can be avoided by including some replay protection mechanism such as a timestamp or a nonce inside the PVD container to ensure freshness of the provided information. This specification does not define a replay protection solution. Rather it is assumed that if replay protection is required, the access network and hosts also deploy existing security

solutions such as SeND [RFC3971].

7. IANA Considerations

This document defines two new IPv6 NDP options into the "IPv6 Neighbor Discovery Option Formats" registry. Options TBD1 and TBD2 are described in Section 3 and Section 4 respectively.

8. Acknowledgements

The authors would like to thank the members of the MIF architecture design team for their comments that led to the creation of this draft.

9. References

9.1. Normative References

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9.2. Informative References

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Appendix A. Examples

A.1. One implicit PVD and one explicit PVD

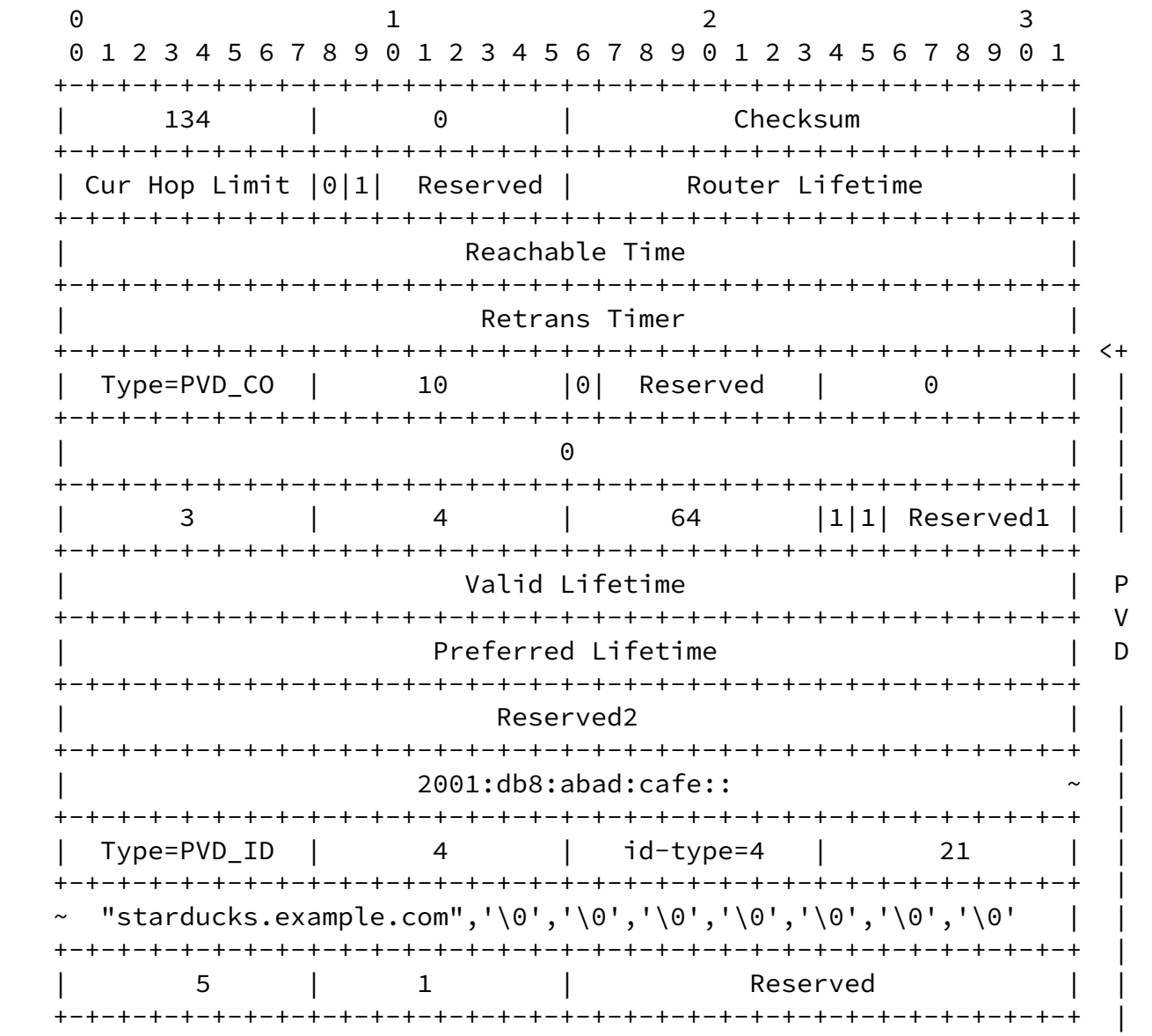
Figure 3 shows how the NDP options are laid out in an RA for one implicit provisioning domain and one explicit provisioning domain. The example does not include security (and signing of the PVD container). The assumption is the PVD identity consumes 14 octets.

The explicit provisioning domain ("starducks.example.com" in a NAI Realm format) contains a specific PIO for 2001:db8:abad:cafe::/64 and the MTU of 1337 octets. The implicit provisioning domain configures a prefix 2001:db8:cafe:babe::/64 and the link MTU of 1500 octets. There are two cases: 1) the host receiving the RA implements provisioning domains and 2) the host does not understand provisioning domains.

1. The host recognizes the PVD_CO and "starts" a provisioning domain specific configuration. Security is disabled, thus there are no Key Hash or Digital Signature fields to process. The prefix 2001:db8:abad:cafe::/64 is found and configured on the interface. Once the PVD_ID option is located the interface prefix configuration for 2001:db8:abad:cafe::/64 and the MTU of 1337 octets can be associated to the provisioning domain found in the PVD_ID option.

The rest of the options are parsed and configured into the implicit provisioning domain since there is no encapsulating provisioning domain. The interface is configured with prefix 2001:db8:cafe:babe::/64. The implicit provisioning domain uses the link MTU of 1500 octets, whereas the "starducks.example.com" provisioning domain uses the MTU of 1337 octets (this means when packets are sourced using 2001:db8:abad:cafe::/64 prefix the link MTU is different than when sourcing packets using 2001:db8:cafe:babe::/64 prefix).

2. The host ignores the PVD_CO (including the PVD_ID and other options) and ends up configuring one prefix on its interface (2001:db8:cafe:babe::/64) with a link MTU of 1500 octets.



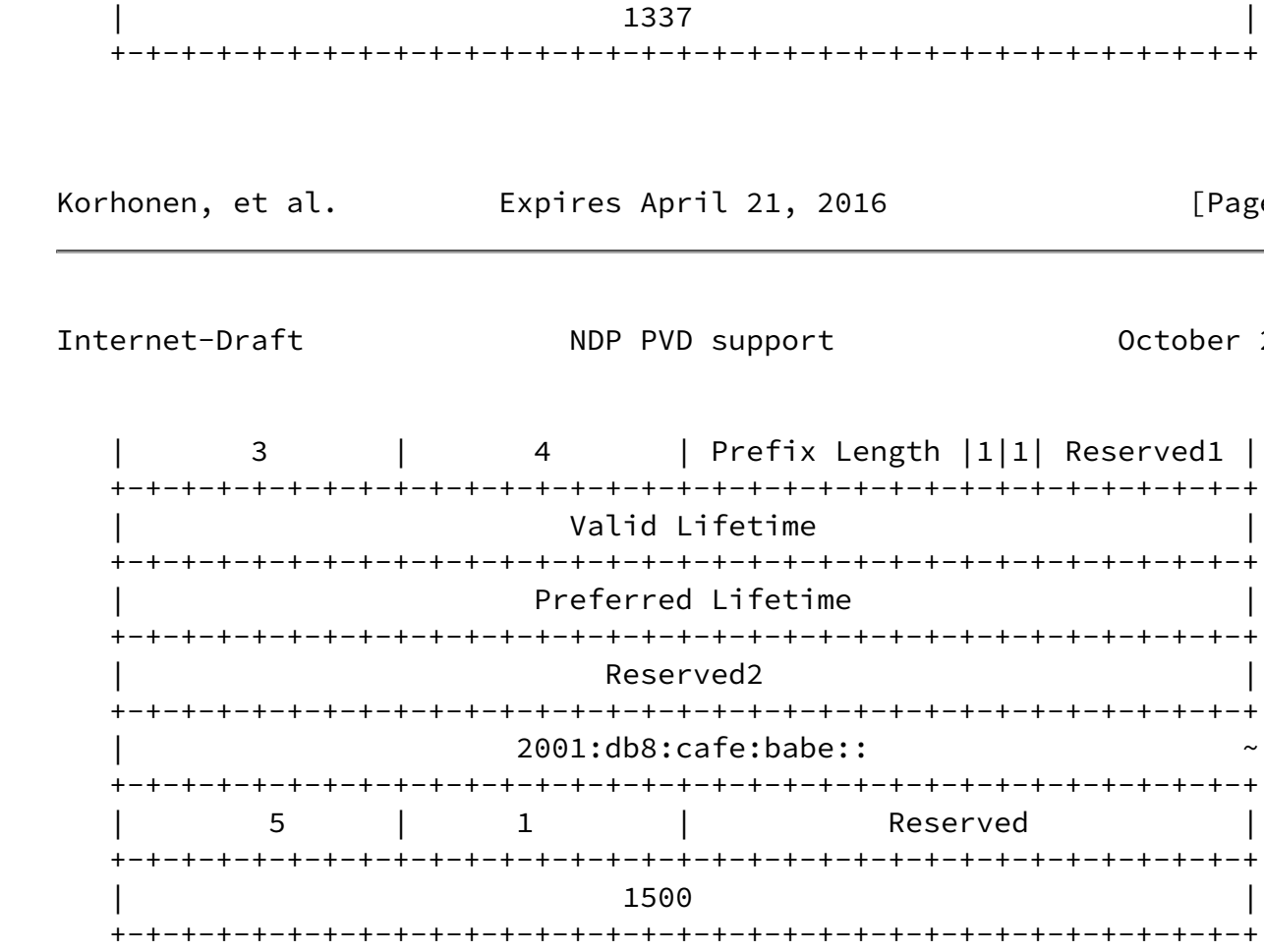


Figure 3: An RA with one implicit PVD and one explicit PVD

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