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MIF API consideration
draft-ietf-mif-api-extension-05

Abstract

Hosts may connect to the internet using more than one network API at a time, or to a single network on which service is provided by more than one provider. Existing APIs are inadequate to allow applications to successfully use the network in this environment. This document presents a new abstract API that provides the minimal set of messages required to enable an application to communicate successfully in this environment.

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1. Introduction

Traditionally, applications that communicate on the network have done so over a single network link, which is provided by a single service provider. However, this operating environment is now the exception rather than the rule. Most devices now have multiple wireless interfaces that are, in practice, connected to networks operated by different providers. These networks may or may not have different reachability characteristics with respect to any given service an application may wish to connect to.

For example, consider a typical modern host with two wireless interfaces: a wireless interface connected to a broadband network, and another connected to some kind of cellular network. The same host may also have a wired interface which is sometimes connected to a third broadband link. It is also quite common for hosts to have

VPN links that are configured, for example, for access to corporate networks, or for access to network privacy services.

As a result, it is now quite typical that a program attempting to communicate in such an environment will be presented with conflicting configuration information from more than one provider. In addition, the cost of bandwidth on different links and the power required ny those links may require consideration.

The API specified in this document is intended to describe the minimal complete set of API calls required to implement higher level APIs that solve these problems. It is not expected that applications will be implemented to this API, although it should be possible to do so. Rather, we expect this API to be used as a basis for building higher-level APIs that provide domain-specific solutions to these problems. The reason for specifying a lower-level API is to enable any arbitrary domain- specific API to be implemented, since no single higher-level API is likely to satisfy the needs of every application.

The API specified here is an abstract API. This means that we specify the functionality that is required to implement the API, but we do not provide specific bindings for any programming language: these are left up to the implementation. The API is described in terms of messages sent and messages received, rather than in terms of procedure calls, because it is necessary to be able to interleave these messages; a procedure call API necessarily precludes interleaving.

This document is intended to be read and used as a checklist by operating system vendors who are interested in providing adequate functionality to applications that must run on hosts in environments like the ones described here. It should also be useful to purchasers of devices that must operate in such environments, so that they can tell if they are getting a device that can actually succeed in these environments.

2. Conventions used in this document

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].

3. MIF API Concept

The MIF API is intended to deal with situations where more than one interface may be active at a time. It must also deal with situations where a single interface is connected to a link that provides more

than one type of network service. The most common example of this that we expect is a dual-stack network configuration.

3.1. Provisioning Domains

Document [I-D.ietf-mif-mpvd-arch] defines Provisioning Domain (PvD) architecture and its associated mechanism, such as PvD identity/ naming concept, conveying mechanism etc. According to [I-D.ietf-mif-mpvd-arch], a provisioning domain is a consistent set of network configuration information. Classically, the entire set available on a single interface is provided by a single source, such as network administrator, and can therefore be treated as a single provisioning domain. In modern IPv6 networks, multihoming can result in more than one provisioning domain being present on a single link.

To properly handle these multiple-service interfaces, we specify the API not in terms of interfaces, but in terms of provisioning domains. From the perspective of the MIF API, a provisioning domain consists of a link, plus all the configuration information received on that link for that provisioning domain. So for an IPv4 provisioning domain, that would be whatever information is received from the DHCP server. For an IPv6 provisioning domain, the information received through router advertisements would be combined with the information recieved via DHCPv6.

3.2. MIF API Elements

There are a number of different, essentially independent, pieces of software that need to be connected together in order to fully support a successful MIF communication strategy. These elements are shown in figure 3.1.

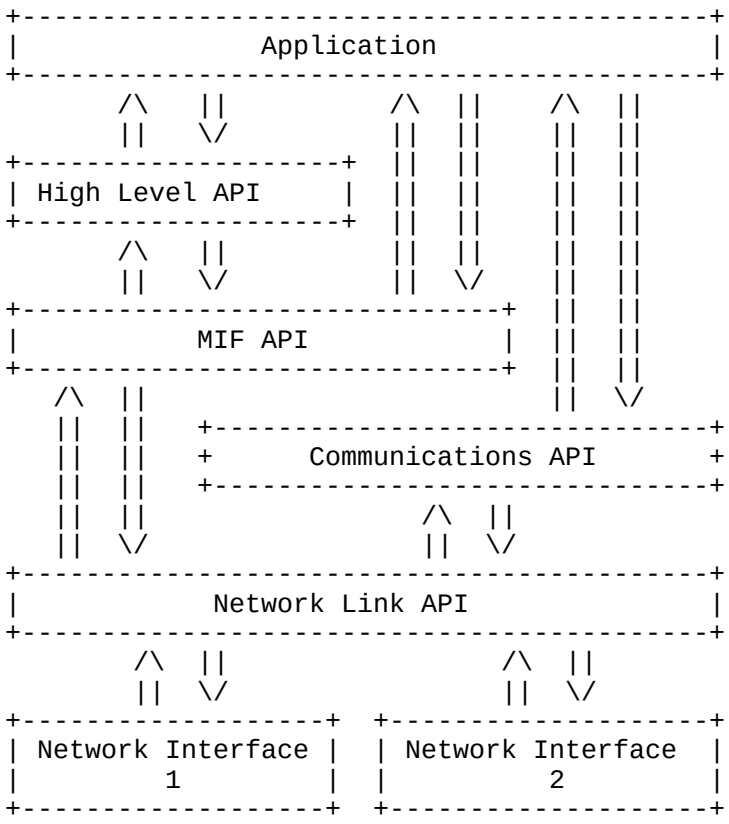


Figure 1: MIF API Elements

3.2.1. Application Element

This is an actual application. Applications fall into a variety of broad categories, including network servers, web browsers, peer-to-peer programs, and so on. Although we are focusing here on the mechanisms required to allow these applications to originate connections to remote nodes, it is worth noting that applications must also be able to receive connections from remote nodes.

3.2.2. High Level API

Applications are generally expected to originate connections using some general-purpose high-level API suited to their particular function. It is likely that different applications may use different high-level APIs to communicate, depending on their particular needs. We do not describe the functioning of such high-level APIs; however,

one such API under current consideration is the Happy Eyeballs for MIF [reference]. These APIs are expected to be able to be implemented using functionality like that described in the MIF API.

3.2.3. MIF API

This is the API being described in this document. Generally speaking, this API is used by higher-level APIs. However, it is permissible for applications to use the MIF API when it is deemed necessary. Currently, several modern web browsers take this approach to establishing network connections, rather than relying on vendor-provided connection mechanisms.

3.2.4. Communications API

Once an application has originated a connection with a remote node using either a high-level API or the MIF API, it must communicate. Similarly, when an application receives a connection from a remote node, it must communicate with that remote node. The communications API is used for this communication. Popular examples of such APIs include the POSIX socket API and a variety of other related APIs.

It is likely that in some instances, implementations of the MIF API will be done as extensions to the Communications API provided by a particular operating system; the functional separation we show here is intended to allow us to illustrate only those features required in a MIF environment, while relying on existing communications APIs to provide the rest.

3.2.5. Network Link API

This is the software that is responsible for actually managing whatever network links are present on a node, whether these are physical links or tunnels. What precisely this functional box contains may vary greatly from device to device. On a typical modern computer workstation, this functionality would almost certainly reside entirely in the system kernel; however, on an embedded device everything from the Application down to the Network Link API could easily be running together on the bare metal as a single program.

The Network Link API can completely concealed from the Application, so we don’t show a connection between them on the functional diagram, and indeed we do not talk about the functionality provided by this API. The reason for showing it on the functional diagram is simply to show that there likely is an API in common between MIF and the Communications API.

3.2.6. MIF API communication model

MIF API requests are made in the form of messages posted to the MIF API, and messages received from it. To accomplish this, several API calls are available. These calls mediate communication between the MIF API and the High Level API, or between the MIF API and the Application. In addition, the CHECK MESSAGE call allows the application to probe for or wait for messages from any of the APIs.

3.2.6.1. POST MESSAGE call

This call causes a message to be posted to the MIF API. The call posts the message, and then returns.

3.2.6.2. CHECK MESSAGE call

This call checks to see if there is a message waiting either from the High Level API, the MIF API, or the Communications API. Ideally it should be able to report the availability of any message or event that the application might anticipate receiving, so that the application can simply block waiting for such an event using this call. The application should be able to do a non-blocking probe, wait for some limited period of time, or wait indefinitely.

An example of a function of this type in existing practice is the POSIX poll() system call.

3.2.6.3. GET MESSAGE call

This call checks to see if there is a message waiting. If there is no message, it returns a status code indicating that there is no message waiting. If there is a message, it returns the message.

3.2.7. MIF Messages

MIF messages always go in one direction or the other: from the subscriber to the MIF API, or to the subscriber from the MIF API. We use the term "subscriber" here to mean either the Application or the High Level API, since either is permitted to communicate with the MIF API.

Messages described here are grouped according to function.

3.2.7.1. Announce Interfaces

This message is sent to the MIF API to ask it to send a message announcing the existence of any interface. When the MIF API receives this message from a subscriber, it iterates across the list of all

known interfaces; for each known interface, it sends an Interface Announcement message to the subscriber.

In addition, the MIF API sets a flag indicating that the subscriber is interested in learning about new interfaces. When the MIF API detects the presence of a new interface, it sends an Interface Announcement message for that interface to the subscriber. This would happen, for instance, when a new tunnel is configured, or when a USB device that is a network interface is discovered by the Network API.

Also, if a network interface goes away, either because the physical network device is disconnected, or because a tunnel is disabled, the MIF API will send a No Interface Announcement message to the subscriber.

3.2.7.2. Stop Announcing Interfaces

This message is sent to the MIF API when a subscriber is no longer interested in receiving announcements about new interfaces. Subsequently, the MIF API will no longer send Interface Announcement or No Interface Announcement messages to the subscriber.

3.2.7.3. Interface Announcement

This message announces the existence of an interface. The announcement includes an interface display name and interface identifier.

3.2.7.4. No Interface Announcement

This message announces that an interface that had been previously announced is no longer present. The announcement includes the interface identifier.

3.2.7.5. Announce Provisioning Domain

This message requests the MIF API to announce the availability of any provisioning domains configured on a particular interface. The interface identifier must be specified.

Upon receipt, the MIF API will iterate across the list of Provisioning Domains present for a particular interface, and will send a Provisioning Domain Announcement for each such Provisioning Domain.

In addition, the MIF API will set a flag indicating that the subscriber wishes to know about new provisioning domains as they

appear. Subsequently, when a new Provisioning Domain appears, the MIF API will send a Provisioning Domain Announcement message to the subscriber.

Finally, if a Provisioning Domain expires or is invalidated, the MIF API will send the subscriber a No Provisioning Domain Announcement message for that Provisioning Domain.

In the event that an interface on which provisioning domains has been announced goes away, a No Provisioning Domain Announcement message will be sent for each provisioning domain that had previously been announced on that interface before the No Interface Announcement message is sent.

Once a No Interface Announcement message has been sent, any subscriber that had subscribed to Provisioning Domain announcements for that interface will be automatically unsubscribed.

3.2.7.6. Stop Announcing Provisioning Domains

This message requests that the MIF API stop sending the subscriber Provisioning Domain Announcement and No Provisioning Domain Announcement messages. The subscriber must indicate the interface for which it no longer wishes to receive Provisioning Domain announcements.

3.2.7.7. Provisioning Domain Announcement

This message is sent by the MIF API to the subscriber to indicate that a new Provisioning Domain has successfully been configured on an interface. The announcement includes the interface identifier and the provisioning domain identifier.

3.2.7.8. No Provisioning Domain Announcement

This message is sent by the MIF API to the subscriber to indicate that an existing, previously announced provisioning domain has expired or otherwise become invalid, and can no longer be used.

3.2.7.9. Announce Configuration Element

This message is sent by the subscriber to request a specific configuration element from a specific provisioning domain. A provisioning domain identifier must be specified.

The MIF API will respond by iterating across the complete list of configuration elements for a provisioning domain, sending a

Configuration Element Announcement message to the subscriber for each one.

Additionally, if any Configuration Elements subsequently complete for a particular provisioning domain, the MIF API will send a Configuration Element Announcement message to the subscriber for each such element. If a Configuration Element becomes invalidated after it has been announced, the MIF API will send a No Configuration Element message.

If a provisioning domain expires or becomes invalid, the MIF API will iterate across the list of remaining configuration elements for that provisioning domain amd send a No Configuration Element Announcement message for each such configuration element.

3.2.7.10. Configuration Element Announcement

The Configuration Element Announcement message includes a Provisioning Domain ID and a Configuration Element Type, which can be one of the following: Config Element RA Config Element DHCPv6 Config Element DHCPv4 etc.

3.2.7.11. No Configuration Element Announcement

The No Configuration Element Announcement message indicates that a previously valid configuration element for a provisioning domain is no longer valid. The message includes a provisioning domain identifier and a configuration element type.

3.2.7.12. Stop Announce Configuration Element

The Stop Announce Configuration Element message requests that MIF API stop announce configuration element.

3.2.7.13. Announce Address

This message is sent by the subscriber to request announcements of valid IP addresses for a specific provisioning domain. A provisioning domain identifier must be specified.

The MIF API will respond by iterating across the complete list of configuration elements for a provisioning domain, sending a Address Announcement message to the subscriber.

Additionally, if any new Address is subsequently configured on a particular provisioning domain, the MIF API will send an Address Announcement message to the subscriber for each such element. If an

address becomes invalidated after it has been announced, the MIF API will send a No Address Announcement message.

If a provisioning domain expires or becomes invalid, the MIF API will iterate across the list of remaining configuration elements for that provisioning domain amd send a No Address Announcement message for each such address.

3.2.7.14. Address Announcement

The Address Announcement message includes single IPv4 or IPV6 address and a Provisioning Domain identifier, as well as the valid and preferred lifetimes for that IP address (IPv6 only).

3.2.7.15. Stop Announcing Address

The Stop Announcing Address message requests the MIF API to stop announcing address.

3.2.7.16. No Address Announcement

The No Address Announcement message indicates that a previously valid address for a provisioning domain is no longer valid. The message includes a provisioning domain identifier and an IPv4 or IPv6 address.

3.2.7.17. Get Configuration Data

The Get Configuration Data message is sent to the MIF API, and includes a Provisioning Domain ID, a Configuration Element Type, and a Configuration Information Identifier.

Configuration Information Identifiers: DNS Server List etc.

The MIF API searches the configuration database for the specific type of Configuration Element on the specified Provisioning Domain to see if there is any configuration data of the specified type. If so, the MIF API sends a Configuration Data message to the subscriber; otherwise it sends a No Configuration Data message to the subscriber.

3.2.7.18. Translate Name

The Translate Name message is sent to the MIF API. It includes a provisioning domain and a name, which is a UTF8 string naming a network node. The message also includes a Translation Identifier, which the subscriber must ensure is unique across all outstanding name service requests.

The MIF API begins a name resolution process. As results come in from the name resolution process, the MIF API sends Name Translation messages to the subscriber for each such result.

Name resolution can be handled by one or more translations systems such as local host table lookup, Domain Name System, NIS, LLMNR, and is implementation-dependent. **need to think about this

3.2.7.19. Stop Translating Name

This message is sent to the MIF API to indicate that the subscriber is no longer interested in additional results from a particular name translation process. The message includes the Translation Identifier.

3.2.7.20. Name Translation

The MIF API sends a Name Translation message to subscribers whenever results come in from a name translation process being performed on behalf of the subscriber. The Name Translation message includes the Translation ID generated by the subscriber, and an IP address returned by the translation process. If a single translation result contains more than one IP address, or IP addresses of different types, the MIF API sends a single Name Translation message for each such IP address.

3.2.7.21. Connect to PvD

The Connect to PvD message is used for the advanced application to select the PvD. Advanced application can use this message to select a specific PvD by providing the PvD identifier as parameter. This is the advanced case that discussed in section 6.3 of [I-D.ietf-mif-mpvd-arch].

3.2.7.22. Connect to Address

The Connect to Address message contains an IP address, a provisioning domain identifier, and a connection identifier which the subscriber must ensure is unique. The MIF API attempts to initiate a TCP connection to the specified IP address using one or more source addresses that are valid for the specified provisioning domain, according to the source address selection policy for that provisioning domain.

If the connection subsequently succeeds, the MIF API will send a Connected message to the subscriber. If it subsequently fails, the MIF API will send a Not Connected message to the subscriber.

3.2.7.23. Connect to Address From Address

The Connect to Address From Address message contains a source IP address, a destination IP address, a provisioning domain identifier, and a connection identifier which the subscriber must ensure is unique. The MIF API attempts to initiate a TCP connection to the specified IP address using the specified source address.

If the connection subsequently succeeds, the MIF API will send a Connected message to the subscriber. If it subsequently fails, the MIF API will send a Connection Failed message to the subscriber.

3.2.7.24. Connected

The Connected message contains the connection identifier that was provided in a previous Connect to Address or Connect to Address From Address message sent by the subscriber. It also contains an token, suitable for use with the connection API, for communicating with the end node to which the connection was established.

3.2.7.25. Not Connected

The Not Connected message contains the connection identifier that was provided in a previous Connect to Address or Connect to Address From Address message sent by the subscriber. It also contains an indication as to what went wrong with the connection.

3.2.7.26. Application Connectivity Management

The following APIs are used for application connectivity management.

3.2.7.26.1. Application: Wants to connect

This message is sent by the application to the MIF API that indicates the application wants to connect to the network. The purpose of this call is to trigger the MIF API to engage in any work that is required to configure the network. If all interfaces are already operational, this message is a no-op. An application would typically send this message either because it has no provisioning domains on which it can attempt to connect, or because it has failed to connect on any existing provisioning domain.

3.2.7.26.2. Application: Connection is idle

This message is sent by the applicaiton to the MIF API to indicate that the application is not expecting to receive any data or send any data. This is a signal to the MIF API that, for example a radio that consumes a lot of power can be put into a temporary idle state, but

that the application expects to resume communication in the future using the existing connection.

3.2.7.26.3. Application: Connection can be broken

This message is sent by the application to the MIF API to indicate that the application can tolerate the connection being broken. This is a signal that the application could use the connection in the future if it were not broken, but can re-establish the connection if it is broken without any loss of functionality. A MIF API implementation on a power-conservative device might take this as a signal to shut down radios to conserve power.

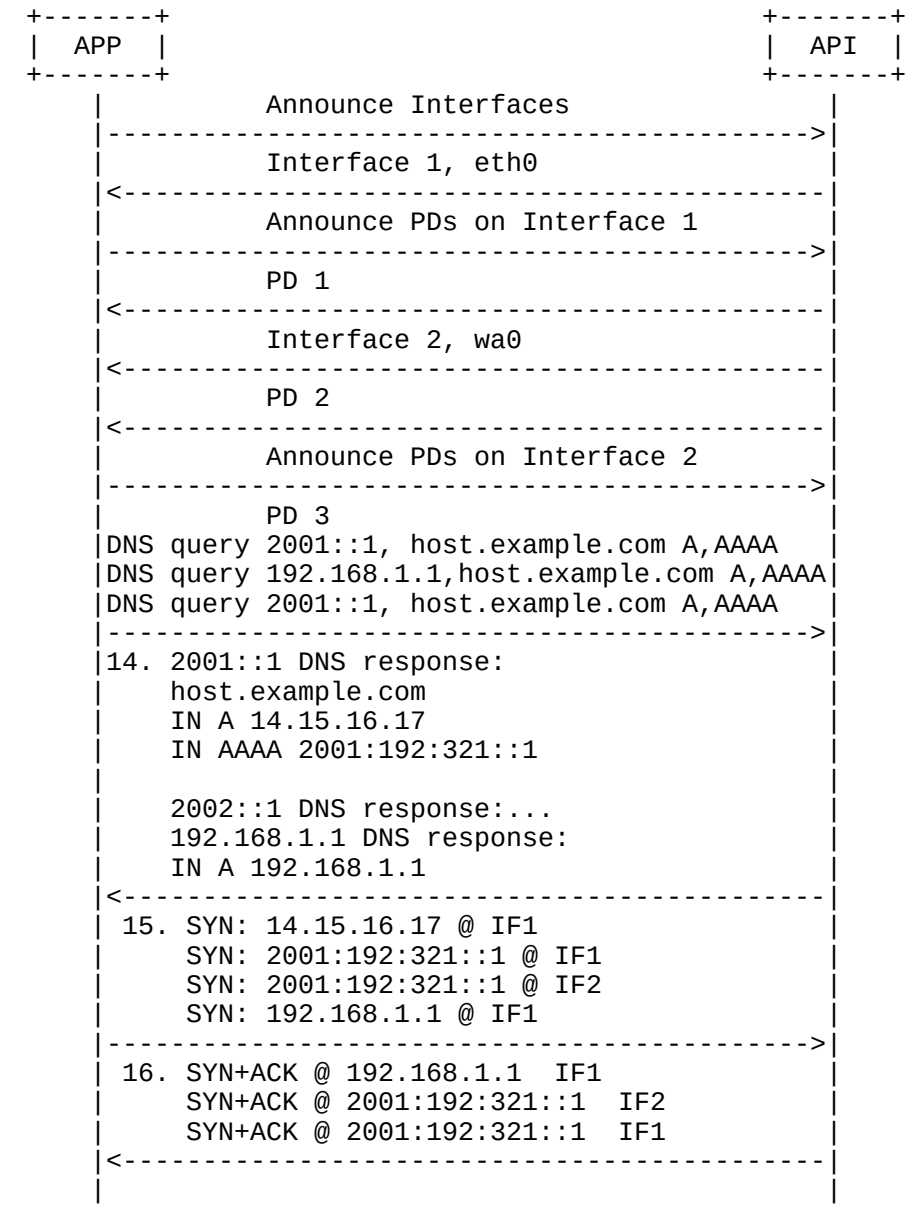
3.2.7.26.4. Interface is going away

This message is sent by the MIF API to the application to indicate that an interface is going away. This can happen when the interface is still up but the system intends to take it down.

3.2.7.26.5. Interface is going up

This message is sent by the MIF API to the application to indicate that an interface is going up. This can happen when the interface is still down but the system intends to take it up.

3.3. Example Usage



MIF API communication model

As shown in the preceding example, the application first invokes the MIF API to get a list of all the network interfaces in the host. As

soon as each interface has been identified, the application invokes the MIF API to get a list of provisioning domains that are attached to that interface.

The application then invokes the MIF API to look up a name in the context of each provisioning domain. The name lookup may return more than one IP address for each queried host name.

The The application then tries to connect to each such IP addresses by sending tcp SYN packet to each destination IP addresses through the provisioning domain on which it received that name. Some of the destination IP addresses may return an ACK packet; others may not.

The application then chooses a connection based on its preferred criteria. For example, the criteria may based on the quality of the link, who answered first, or whether, for example, a TLS authentication succeeds on that connection.

4. Security Considerations

This document specifies an abstract API and will not affect any existing protocols. It does not introduce any new security risk.

5. IANA Considerations

None

6. Acknowledgments

The authors want to thank Teemu Savolainen from Nokia, Dayi Zhao from Bitway, Dave Thaler from Microsoft and others for their useful suggestions and discussions. We would also like to acknowledge Yuri Ismailov’s work as the author of the initial version of this document, but was drawn away by other work and let us continue.

7. References

7.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

7.2. Informative References

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Multiple Provisioning Domain Architecture
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Abstract

This document is a product of the work of MIF architecture design team. It outlines a solution framework for some of the issues, experienced by nodes that can be attached to multiple networks. The framework defines the notion of a Provisioning Domain (PVD) - a consistent set of network configuration information, and PVD-aware nodes - nodes which learn PVDs from the attached network(s) and/or other sources and manage and use multiple PVDs for connectivity separately and consistently.

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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1. Introduction

Nodes attached to multiple networks may encounter problems due to conflict of the networks configuration and/or simultaneous use of the multiple available networks. While existing implementations apply various techniques ([RFC6419]) to tackle such problems, in many cases the issues may still appear. The MIF problem statement document [RFC6418] describes the general landscape as well as discusses many specific issues and scenarios details.

Problems, enumerated in [RFC6418], can be grouped into 3 categories:

1. Lack of consistent and distinctive management of configuration elements, associated with different networks.

2. Inappropriate mixed use of configuration elements, associated with different networks, in the course of a particular network activity / connection.

3. Use of a particular network, not consistent with the intent of the scenario / involved parties, leading to connectivity failure and / or other undesired consequences.

An example of (1) is a single node-scoped list of DNS server IP addresses, learned from different networks, leading to failures or delays in resolution of names from particular namespaces; an example of (2) is use of an attempt to resolve a name of a HTTP proxy server, learned from a network A, with a DNS server, learned from a network B, that is likely to fail; an example of (3) is use of an employer-sponsored VPN connection for peer-to-peer connectivity, unrelated to employment activities.

This architecture describes a solution to these categories of problems, respectively, by:

1. Introducing a formal notion of the PVD, including PVD identity, and ways for nodes to learn the intended associations among acquired network configuration information elements.

2. Introducing a reference model for a PVD-aware node, preventing inadvertent mixed use of the configuration information, which may belong to different PVDs.

3. Providing recommendations on PVD selection based on PVD identity and connectivity tests for common scenarios.

1.1. 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].

2. Definitions and types of PVDs

Provisioning Domain: a consistent set of network configuration information. Classically, the entire set available on a single interface is provided by a single source, such as network administrator, and can therefore be treated as a single provisioning domain. In modern IPv6 networks, multihoming can result in more than one provisioning domain being present on a single link. In some scenarios, it is also possible for elements of the same domain to be present on multiple links.

Typical examples of information in a provisioning domain, learned from the network, are: source address prefixes that can be used by connections within the provisioning domain, IP address of DNS server, name of HTTP proxy server if available, DNS suffixes associated with the network etc.

PVD-aware node: a node that supports association of network configuration information into PVDs, and using these PVDs to serve requests for network connections in ways, consistent with recommendations of this architecture.

2.1. Explicit PVDs

A node may receive explicit information from the network and/or other sources, about presence of PVDs and association of particular network information with a particular PVD. PVDs, constructed based on such information, are referred to in this document as "explicit".

Protocol changes/extensions will likely be required to support the explicit PVDs by IETF-defined mechanisms. As an example, one could think of one or several DHCP options, carrying PVD identity and / or its elements. A different approach could be to introduce a DHCP option, which only carries identity of a PVD, while the association of network information elements with that identity, is implemented by the respective protocols - such as e.g., with a Router Discovery [RFC4861] option associating an address range with a PVD.

Specific, existing or new, features of networking protocols to enable delivery of PVD identity and association with various network information elements will be defined in companion design documents.

Link-specific and/or vendor-proprietary mechanisms for discovery of PVD information, different from the IETF-defined mechanisms, can be used by the nodes separately from or together with IETF-defined mechanisms, as long as they allow to discover necessary elements of the PVD(s). Another example of a delivery mechanism for PVDs are key exchange or tunneling protocols, such as IKEv2 [RFC5996] that allow transporting host configuration information. In all cases, by default nodes must ensure that the lifetime of all dynamically

discovered PVD configuration is appropriately limited by the relevant events - for example, if an interface media state change was indicated, the previously discovered information may no longer be valid and needs to be re-discovered or confirmed.

It shall be possible for sources of PVD information to communicate that some of their configuration elements could be used within a context of other networks/PVDs. PVD-aware nodes, based on such declaration and their policies, may choose to inject such elements into some or all other PVDs they connect to.

In some network topologies, the network infrastructure elements may need to advertise multiple PVDs. The details of how this is done generally will be defined in the individual companion design documents. However, where different design choices are possible, the choice that requires smaller number of packets shall be preferred for efficiency.

2.2. Implicit PVDs and incremental adoption of the explicit PVDs

It is likely that for a long time there may be networks which do not advertise explicit PVD information, since deployment of any new features in networking protocols is a relatively slow process.

When connected to networks, which don’t advertise explicit PVD information, PVD-aware node shall automatically create separate PVDs for configuration received on multiple interfaces. Such PVDs are referred to in this document as "implicit".

With implicit PVDs, PVD-aware nodes may still provide benefits to their users as compared to non-PVD aware nodes, by using network information from different interfaces separately and consistently to serve network connection requests, following best practices described in Section 5.

In the mixed mode, where e.g., multiple networks are available on the link the interface is attached to, and only some of the networks advertise PVD information, the PVD-aware node shall create explicit PVDs based on explicitly learned PVD information, and associate the rest of the configuration with an implicit PVD created for that interface.

2.3. Relationship between PVDs and interfaces

Implicit PVDs are limited to network configuration information received on a single interface. Explicit PVDs, in practice will often also be scoped to a configuration related to a particular interface, however per this architecture there is no such requirement or limitation and as defined in this architecture, explicit PVDs may include information related to more than one interfaces, if the node learns presence of the same PVD on those interfaces and the

authentication of the PVD ID meets the level required by the node policy.

It is an intent of this architecture to support such scenarios among others. Hence, it shall be noted that no hierarchical relationship exists between interfaces and PVDs: it is possible for multiple PVDs to be simultaneously accessible over one interface, as well as single PVD to be simultaneously accessible over multiple interfaces.

2.4. PVD identity/naming

For explicit PVDs, PVD ID (globally unique ID, that possibly is human-readable) is received as part of that information. For implicit PVDs, the node assigns a locally generated globally unique ID to each implicit PVD.

PVD-aware node may use these IDs to choose a PVD with matching ID for special-purpose connection requests, in accordance with node policy or choice by advanced applications, and/or to present human-readable representation of the IDs to the end-user for selection of Internet-connected PVDs.

A single network provider may operate multiple networks, including networks at different locations. In such cases, the provider may chose whether to advertise single or multiple PVD identities at all or some of those networks, as it suits their business needs. This architecture doesn’t impose specific requirements in this regard.

When multiple nodes are connected to the same link, where one or more explicit PVDs are available, this architecture assumes that the information about all available PVDs is advertized by the networks to all the connected nodes. At the same time, the connected nodes may have different heuristics, policies and/or other settings, including configured set of their trusted PVDs, which may lead to different PVDs actually being used by different nodes for their connections.

Possible extensions, where different sets of PVDs may be advertised by the networks to different connected nodes, are out of scope of this document.

2.5. Relationship to dual-stack networks

When applied to dual-stack networks, the PVD definition allows for multiple PVDs to be created, where each PVD contain information for only one address family, or for a single PVD that contains information about multiple address families. This architecture requires that accompanying design documents for the PVD-related protocol changes must support PVDs containing information from

multiple address families. PVD-aware nodes must be capable of dealing with both single-family and multi-family PVDs.

For explicit PVDs, the choice of either of the approaches is a policy decision of a network administrator and/or node user/administrator. Since some of the IP configuration information that can be learned from the network can be applicable to multiple address families (for instance DHCP address selection option [RFC7078]), it is likely that dual-stack networks will deploy single PVDs for both address families.

For implicit PVDs, by default PVD-aware nodes shall including multiple IP families into single implicit PVD created for an interface. At the time of writing of this document in dual-stack networks it appears to be a common practice for configuration of both address families to be provided by a single source.

A PVD-aware node that provides API to use / enumerate / inspect PVDs and/or their properties shall provide ability to filter PVDs and/or their properties by address family.

2.6. Elements of PVD

3. Conveying PVD information using DHCPv6 and Router Advertisements

DHCPv6 and Router Advertisements are the two most common methods of configuring hosts and they would need to be extended to convey explicit PVD information. There are several things that need to be considered before finalizing a mechanism to augment DHCPv6 and RAs with PvD information.

3.1. Separate messages or one message

When information from several PVDs is available at the same configuration source, there are two possibilities regarding how to send these out. One way is to send information from different provisioning domains in separate messages. The other is to combine information from several PVDs onto one message. The latter method has the advantage of being more efficient but could have issues due to authentication and authorization issues as well as potential issues with accommodating common information and information not tagged with any PVD information.

3.2. Securing the PVD information

DHCPv6 and RAs both provide some form of authentication that ensures the identity of the source as well as the integrity of the contents that have been secured. While this is useful, the authenticity of the information provides no information whether the configuration source is actually allowed to provide information from a given PVD. In order to do be able to do this, there must be a mechanism for the

owner of the PVD to attach some form of authorization token to the configuration information that is delivered.

3.3. Backward compatibility

The extensions to RAs and DHCPv6 should be defined in such a manner than unmodified hosts (i.e. hosts not aware of PvDs) will continue to function as well as they did before the PvD information got added. This could imply that some information may need to be duplicated in order to be conveyed to legacy hosts. Similarly PvD aware hosts need to be able to handle legacy configuration sources which do not provide PvD information. There are also several initiatives ongoing that are aimed at adding some form of additional information to prefixes [refs to draft-bhandari and draft-korhonen] and any new mechanism should try to consider co-existence with these existing mechanisms.

3.4. Selective propagation

When a configuration source has information regarding several PvDs it is not clear whether it should provide information about all of them to any host that requests info from it. While it may be reasonable in some cases, this might become an unreasonable burden once the number of PvDs starts increasing. One way to restrict the propagation of useless information is for the host to select the PvD information they desire in their request to the configuration source. One way this could be accomplished is by using an ORO with the PvDs that are of interest. The configuration source can then respond with only the requested information.

By default, a configuration source SHOULD provide information related to all provisioning domains without expecting the client to select the PvD(s) it requires. This is necessary to ensure that hosts that do not support requesting selective PvD information will continue to work. Also note that IPv6 neighbor discovery does not provide any functionality analogous to the DHCPv6 ORO.

In this case, when a host receives PvD information it does not require, the information can simply be discarded. Also, in constrained networks such as LLNs, the amount of configuration information needs to be restricted to ensure that the load on the hosts is bearable while keeping the information identical across all the hosts.

In case selective propogation is required, some form of PvD discovery mechanism needs to be specified so that hosts/applications can be pre-provisioned to request a specific PvD. Alternately, the set of

PvDs that the network can provide to the host can be propogated to the host using RAs or stateless DHCPv6. The discovery mechanism may potentially support the discovery of available PvDs on a per-host basis.

3.5. Retracting/updating PvD information

After the PvD information is provided to the host it may be outdated or updated with newer information before the hosts would normally request updates. Thos would require the mchanism to be able to update and/or withdraw all (or some subset) of information related to a given PvD. For efficiency reasons, there should be a way to specify that all the information from the PvD needs to be reconfigured instead of individually updating each item associated with the PvD.

3.6. Conveying configuration information using IKEv2

Internet Key Exchange protocol version 2 (IKEv2) [RFC5996] [RFC5739] is another widely used and a popular method of configuring IP information in a host. In the case of IKEv2 the provisioning domain could actually be implicitly learnt from the Identification - Responder (IDr) payloads the IKEv2 initiator and the responder inject during the IKEv2 exchange. The IP configuration may depend on the named IDr. Another possibility could be adding specific provisioning domain identifying payload extensions to IKEv2. All of the considerations listed above for DHCPv6 and RAs potentialy apply to IKEv2 as well.

4. Example network configurations and number of PVDs

5. Reference model of PVD-aware node

5.1. Constructions and maintenance of separate PVDs

It is assumed that normally, configuration information contained in a single PVD, shall be sufficient for a node to fulfill a network connection request by an application, and hence there should be no need to attempt to merge information across different PVDs.

Nevertheless, even when a PVD lack some parts of the configuration, merging of information from different PVD(s) shall not be done automatically, since typically it would lead to issues described in [RFC6418].

A node may use other sources, such as e.g., node local policy, user input or other mechanisms, not defined by IETF, to either construct a PVD entirely (analogously to static IP configuration of an interface), or supplement with particular elements all or some PVDs learned from the network, or potentially merge information from different PVDs, if such merge is known to the node to be safe, based on explicit policies.

As an example, node administrator could inject a not ISP-specific DNS server into PVDs for any of the networks the node could become attached to. Such creation / augmentation of PVD(s) could be static or dynamic. The particular implementation mechanisms are outside of the scope of this document.

5.2. Consistent use of PVDs for network connections

PVDs enable PVD-aware nodes to use consistently a correct set of configuration elements to serve the specific network requests from beginning to end. This section describes specific examples of such consistent use.

5.2.1. Name resolution

When PVD-aware node needs to resolve a name of the destination used by a connection request, the node could decide to use one, or multiple PVDs for a given name lookup.

The node shall chose one PVD, if e.g., the node policy required to use a particular PVD for a particular purpose (e.g. to download an MMS using a specific APN over a cellular connection). To make the choice, the node could use a match of the PVD DNS suffix or other form of PVD ID, as determined by the node policy.

The node may pick multiple PVDs, if e.g., they are general purpose PVDs providing connectivity to the Internet, and the node desires to maximize chances for connectivity in Happy Eyeballs style. In this case, the node could do the lookups in parallel, or in sequence. Alternatively, the node may use for the lookup only one PVD, based on the PVD connectivity properties, user choice of the preferred Internet PVD, etc.

In either case, by default the node uses information obtained in a name service lookup to establish connections only within the same PVD from which the lookup results were obtained.

For simplicity, when we say that name service lookup results were obtained from a PVD, what we mean is that the name service query was issued against a name service the configuration of which is present in a particular PVD. In that sense, the results are "from" that particular PVD.

Some nodes may support transports and/or APIs, which provide an abstraction of a single connection, aggregating multiple underlying connections. MPTCP [RFC6182] is an example of such transport protocol. For the connections provided by such transports/APIs, a PVD-aware node may use different PVDs for servicing of that logical connection, provided that all operations on the underlying

connections are done consistently within their corresponding PVD(s).

5.2.2. Next-hop and source address selection

For the purpose of this discussion, let’s assume the preceding name lookup succeeded in a particular PVD. For each obtained destination address, the node shall perform a next-hop lookup among routers, associated with that PVD. As an example, such association could be determined by the node via matching the source address prefixes/ specific routes advertized by the router against known PVDs, or receiving explicit PVD affiliation advertized through a new Router Discovery [RFC4861] option.

For each destination, once the best next-hop is found, the node selects best source address according to the [RFC6724] rules, but with a constraint that the source address must belong to a range associated with the used PVD. If needed, the node would use the prefix policy from the same PVD for the best source address selection among multiple candidates.

When destination/source pairs are identified, then they are sorted using the [RFC6724] destination sorting rules and the prefix policy table from the used PVD.

5.3. Connectivity tests

Although some PVDs may appear as valid candidates for PVD selection (e.g. good link quality, consistent connection parameters, etc.), they may provide limited or no connectivity to the desired network or the Internet. For example, some PVDs provide limited IP connectivity (e.g., scoped to the link or to the access network), but require the node to authenticate through a web portal to get full access to the Internet. This may be more likely to happen for PVDs, which are not trusted by the given PVD-aware node.

An attempt to use such PVD may lead to limited network connectivity or connection failures for applications. To prevent the latter, a PVD-aware node may perform connectivity test for the PVD, before using it to serve network connection requests of the applications. In current implementations, some nodes do that, for instance, by trying to reach a dedicated web server (e.g., see [RFC6419]).

Per Section 5.2, a PVD-aware node shall maintain and use multiple PVDs separately. The PVD-aware node shall perform connectivity test and, only after validation of the PVD, consider using it to serve application connections requests. Ongoing connectivity tests are also required, since during the IP session, the end-to-end connectivity could be disrupted for various reasons (e.g. poor L2,

IP QoS issues); hence a connectivity monitoring function is needed to check the connectivity status and remove the PVD from the set of usable PVDs if necessary.

There may be cases where a connectivity test for PVD selection may be not appropriate and should be complemented, or replaced, by PVD selection based on other factors. This could be realized e.g., by leveraging some 3GPP and IEEE mechanisms, which would allow to expose some PVD characteristics to the node (e.g. 3GPP Access Network Discovery and Selection Function (ANDSF) [TS23.402], IEEE 802.11u [IEEE802.11u]/ANQP).

5.4. Relationship to interface management and connection managers

Current devices such as mobile handsets make use of proprietary mechanisms and custom applications to manage connectivity in environments with multiple interfaces and multiple sets of network configurations. These mechanisms or applications are commonly known as connection managers [RFC6419].

Connection managers sometimes rely on policy servers to allow the node, connected to multiple networks, perform the network selection. They can also make use of routing guidance from the network (e.g. 3GPP ANDSF [TS23.402]). Although connection managers solve some connectivity problems, they rarely address the network selection problems in a comprehensive manner. With proprietary solutions, it is challenging to present a coherent behaviour to the end user of the device, as different platforms present different behaviours even when connected to the same network, with the same type of interface, and for the same purpose.

6. PVD support in APIs

In all cases changes in available PVDs must be somehow exposed, appropriately for each of the approaches.

6.1. Basic

Applications are not PVD-aware in any manner, and only submit connection requests. The node performs PVD selection implicitly, without any otherwise applications participation, and based purely on node-specific administrative policies and/or choices made by the user in a user interface provided by the operating environment, not by the application.

As an example, such PVD selection can be done at the name service lookup step, by using the relevant configuration elements, such as e.g., those described in [RFC6731]. As another example, the PVD selection could be done based on application identity or type (i.e., a node could always use a particular PVD for a VOIP application).

6.2. Intermediate

Applications indirectly participate in selection of PVD by specifying hard requirements and soft preferences. The node performs PVD selection, based on applications inputs and policies and/or user preferences. Some / all properties of the resultant PVD may be exposed to applications.

6.3. Advanced

PVDs are directly exposed to applications, for enumeration and selection. Node polices and/or user choices, may still override the application preferences and limit which PVD(s) can be enumerated and/or used by the application, irrespectively of any preferences which application may have specified. Depending on the implementation, such restrictions, imposed per node policy and/or user choice, may or may not be visible to the application.

7. PVD-aware nodes trust to PVDs

7.1. Untrusted PVDs

Implicit and explicit PVDs for which no trust relationship exists are considered untrusted. Only PVDs, which meet the requirements in Section 7.2, are trusted; any other PVD is untrusted.

In order to avoid various forms of misinformation that can be asserted when PVDs are untrusted, nodes that implement PVD separation cannot assume that two explicit PVDs with the same identifier are actually the same PVD. A node that did make this assumption would be vulnerable to attacks where for example an open Wifi hotspot might assert that it was part of another PVD, and thereby might draw traffic intended for that PVD onto its own network.

Since implicit PVD identifiers are synthesized by the node, this issue cannot arise with implicit PVDs.

Mechanisms exist (for example, [RFC6731]) whereby a PVD can provide configuration information that asserts special knowledge about the reachability of resources through that PVD. Such assertions cannot be validated unless the node has a trust relationship with the PVD; assertions of this type therefore must be ignored by nodes that receive them from untrusted PVDs. Failure to ignore such assertions could result in traffic being diverted from legitimate destinations to spoofed destinations.

7.2. Trusted PVDs

Trusted PVDs are PVDs for which two conditions apply. First, a trust relationship must exist between the node that is using the PVD configuration and the source that provided that configuration; this is the authorization portion of the trust relationship. Second, there must be some way to validate the trust relationship. This is the authentication portion of the trust relationship. Two mechanisms for validating the trust relationship are defined.

It shall be possible to validate the trust relationship for all advertised elements of a trusted PVD, irrespectively of whether the PVD elements are communicated as a whole, e.g. in a single DHCP option, or separately, e.g. in supplementary RA options. Whether or not this is feasible to provide mechanisms to implement trust relationship for all PVD elements, will be determined in the respective companion design documents.

7.2.1. Authenticated PVDs

One way to validate the trust relationship between a node and the source of a PVD is through the combination of cryptographic authentication and an identifier configured on the node. In some cases, the two could be the same; for example, if authentication is done with a shared secret, the secret would have to be associated with the PVD identifier. Without a (PVD Identifier, shared key) tuple, authentication would be impossible, and hence authentication and authorization are combined.

However, if authentication is done using some public key mechanism such as a TLS cert or DANE, authentication by itself isn’t enough, since theoretically any PVD could be authenticated in this way. In addition to authentication, the node would need to be configured to trust the identifier being authenticated. Validating the authenticated PVD name against a list of PVD names configured as trusted on the node would constitute the authorization step in this case.

7.2.2. PVDs trusted by attachment

In some cases a trust relationship may be validated by some means other than described in Section 7.2.1, simply by virtue of the connection through which the PVD was obtained. For instance, a handset connected to a mobile network may know through the mobile network infrastructure that it is connected to a trusted PVD, and whatever mechanism was used to validate that connection constitutes the authentication portion of the PVD trust relationship. Presumably such a handset would be configured from the factory, or else through mobile operator or user preference settings, to trust the PVD, and this would constitute the authorization portion of this type of trust relationship.

8. Acknowledgements

This document was created as a product of a MIF architecture design team.

9. IANA Considerations

This memo includes no request to IANA.

10. Security Considerations

There are at least three different form of attacks that can be performed using configuration sources that use multiple provisioning domains.

Tampering with configuration information provided An attacker may attempt to modify the information provided inside the PVD container option. These attacks can easily be prevented by using the message integrity features provided by the underlying protocol used to carry the configuration information. e.g. SEND [RFC3971] would detect any form of tampering with the RA contents and the DHCPv6 [RFC3315] AUTH option that would detect any form of tampering with the DHCPv6 message contents. This attack can also be performed by a compromised configuration source by modifying information inside a specific , in which case the mitigations proposed in the next subsection may be helpful.

Rogue configuration source A compromised configuration source such as a router or a DHCPv6 server may advertise information about PvDs that it is not authorized to advertise. e.g. A coffee shop may advertise 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 PvD related configuration container contains embedded authentication and authorization information from the owner of the PvD. 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 PvD owner (e.g. a certificate with a well-known/common trust anchor).

Replay attacks 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.

11. References

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Support for multiple provisioning domains in IPv6 Neighbor Discovery Protocol
draft-kk-mpvd-ndp-support-01

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

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

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at http://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any 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 August 18, 2014.

Table of Contents

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 [I-D.ietf-mif-mpvd-arch]. 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 that will be provided. 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 identifier option (PVD_ID, see Section 4), which also marks the end of configuration options belonging to the specific provisioning domain. The PVD container option MAY occur multiple times in the same NDP message but each of these PVD container options MUST have a different PVD identity specified under its PVD identity option. The PVD container options MUST NOT be nested. A PVD container is intended to be used in IPv6 Router Advertisement (RA) NDP messages. However, including a PVD container or identity options inside a Router Solicitation (RS) NDP messages is also possible (actually, in this way a host can solicit for information from a specific provisioning domain). The PVD container option MUST NOT be included in a NDP message without accompanying PVD identity option (see Section 4). If, for some reason, the NDP message does not include the accompanying PVD identity option, then the implementation MUST ignore the PVD container option and SHOULD log the event.

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 plain ignore it and continue processing PVD container option "encapsulated" NDP options normally 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 the PIO is processed as any PIO.

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.

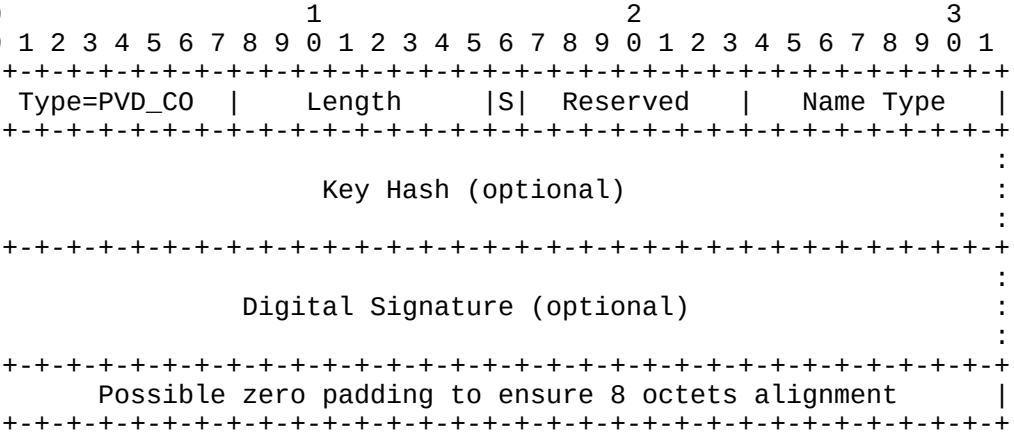

Figure 1: PVD Container Option

Type

PVD Container; Set to TBD1.

Length

Length of the PVD_CO. The actual length depends on the number of suboptions and the optional Key Hash/Digital Signature/Padding. The minimum length is 1 when no Key Hash or Digital Signature field are present in the option.

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 ending PVD_ID option (see Section 4). 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. This MAY imply adding padding zero octets to the tail of the PVD container option until the alignment requirement has been met. The padding is independent of the 'S' flag setting.

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 between the PVD_CO and the PVD_ID MUST be silently ignored and the event SHOULD be logged.

4. PVD Identity option

The PVD identity option (PVD_ID) is used to explicitly indicate the identity of the provisioning domain that is associated with the configuration information encapsulated by the PVD container option. The PVD identity option also marks the end of provisioning domain "encapsulated" NDP options. A PVD container option MUST have exactly one PVD identity option. However, the PVD identity option MAY also be included in a NDP message without the PVD container option. In this case it merely serves as a hint of provisioning domain and could, for example, be used in an RS message to solicit information from specific provisioning domains.

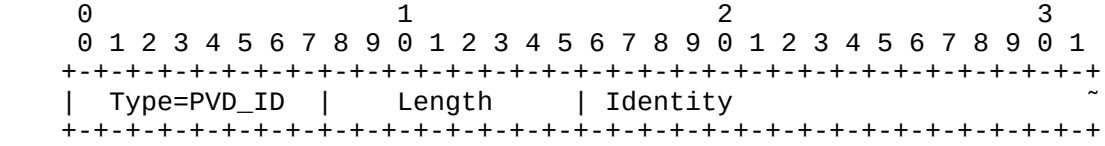

Figure 2: PVD_ID Option

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.kkb-mpvd-id]. Note that the Identity field may need to be zero padded at the tail to meets the natural NDP options' alignment.

If the receiver of the PVD identity option does not understand any of the ID-Types, then anything belonging to this provisioning domain

MUST be silently discarded. This would mean the PVD identity option, the PVD container option and all other options in between the former two.

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. The options TBD1 and TBD2 are described in Section 3 and Section 4.

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. 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 disable, 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 can be associate to the provisioning domain found in the PVD_ID option.

   The rest of the options are parsed and configured into the implicit domain since there is no encapsulating provisioning domain. The interface is configured with prefix 2001:db8:cafe:babe::/64 and MTU of 1500 octets. The implicit provisioning domain also assumes a link MTU of 1500 octets, since there is no provisioning domain specific MTU configuration, only the configuration from the implicit provisioning domain.

2. The host ignores both PVD_CO and PVD_ID options and ends up configuring two prefixes on its interface (2001:db8:abad:cafe::/64 and 2001:db8:cafe:babe::/64) with a link MTU of 1500 octets.

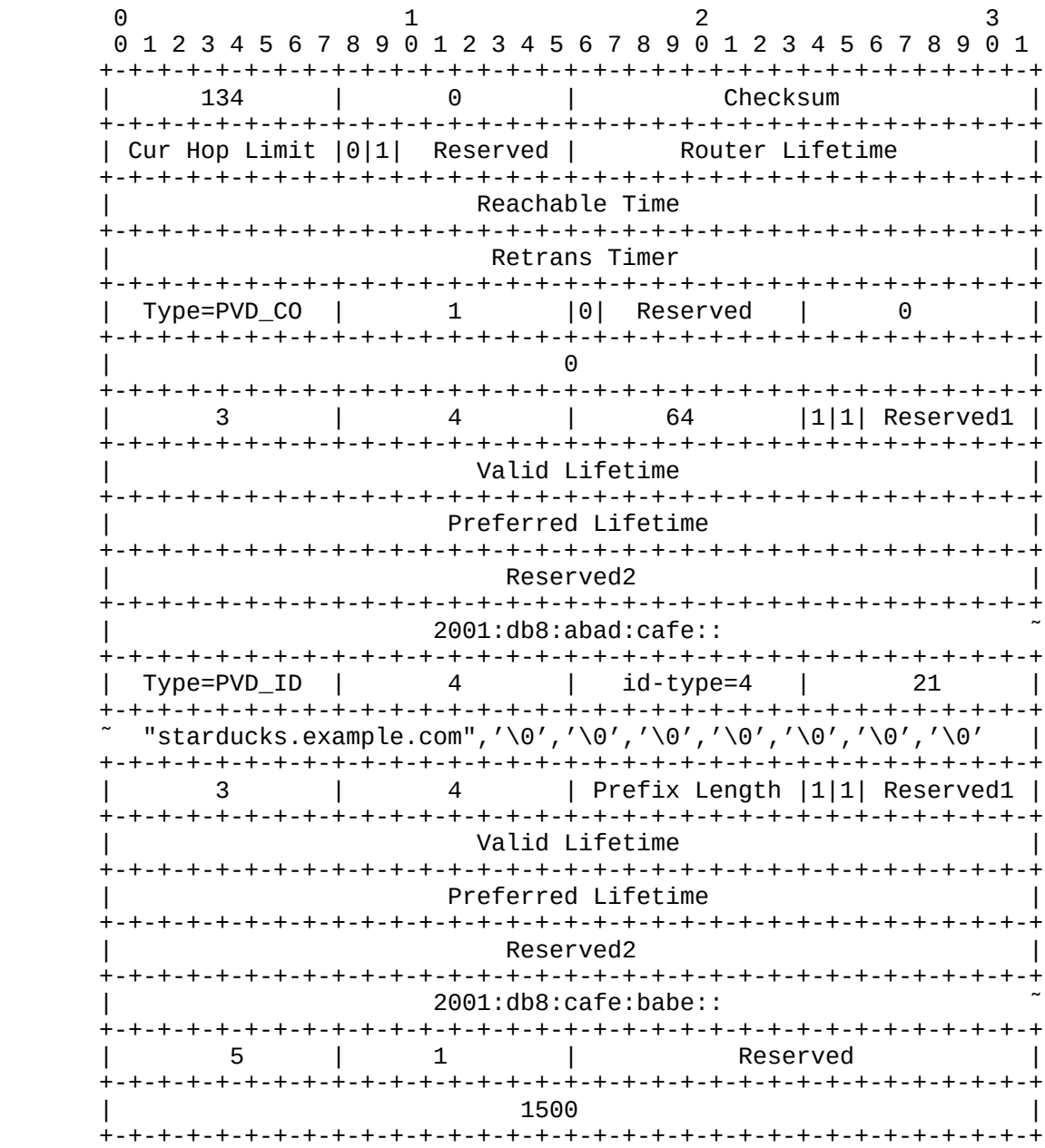

Figure 3: An RA with one implicit PVD and one explicit PVD

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Support for multiple provisioning domains in DHCPv6
draft-kkb-mpvd-dhcp-support-01

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 DHCPv6 can be associated with provisioning domains.

Table of Contents

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 [I-D.anipko-mif-mpvd-arch]. One part of the solution requires associating configuration information with provisioning domains. This document describes a DHCPv6 mechanism for explicitly indicating provisioning domain information along with any configuration that will be provided. The proposed mechanism uses a DHCPv6 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.

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 is used to encapsulate and group together all the configuration options that belong to the explicitly identified provisioning domain. The PVD container option MUST encapsulate exactly one OPTION_PVD_ID. The PVD container option MAY occur multiple times in the same message, but each of these PVD container options MUST have a different PVD identity specified under its PVD identity option. The PVD container option SHOULD contain exactly one OPTION_PVD_AUTH.

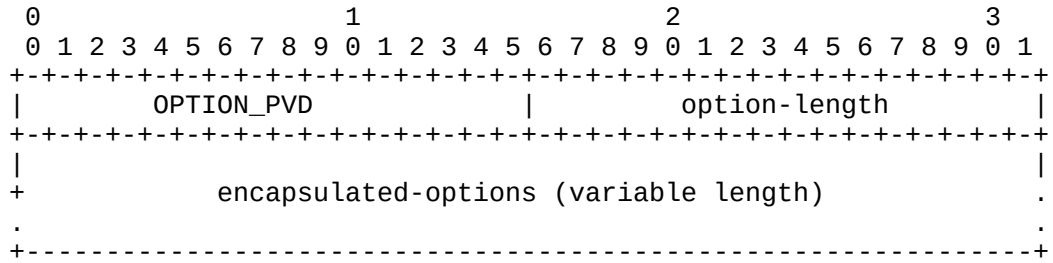

Figure 1: PVD Container Option

- option-code: OPTION_PVD (TBA1)
- option-length: Length of encapsulated options
- encapsulated-options: options associated with this provisioning domain.

4. PVD Identity option

The PVD identity option is used to explicitly indicate the identity of the provisioning domain that is associated with the configuration information encapsulated by the PVD container option.

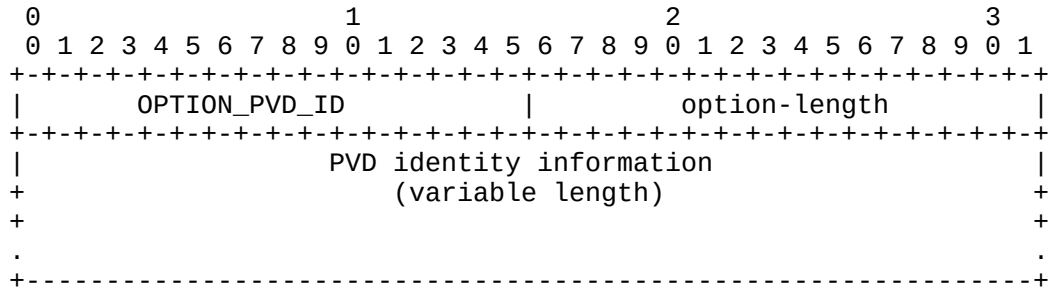

Figure 2: PVD ID Option

- option-code: OPTION_PVD_ID (TBA2)
- option-length: Length of PVD identity information
- PVD identity information: The provisioning domain identity. The contents of this field is defined in a separate document [PVDIDS].

5. PVD Authentication and Authorization option

The PVD authentication and authorization option contains information that could be used by the DHCPv6 client to verify whether the configuration information provided was not tampered with by the DHCPv6 server as well as establishing that the DHCPv6 server was authorized to advertise the information on behalf of the PVD per OPTION_PVD basis. The contents of the authentication/authorization information is provided by the owner of the provisioning domain and is completely opaque to the DHCPv6 server that passes along the information unmodified. Every OPTION_PVD option SHOULD contain at

most one OPTION_PVD_AUTH option. The OPTION_PVD_AUTH option MUST be the last option inside the OPTION_PVD option.

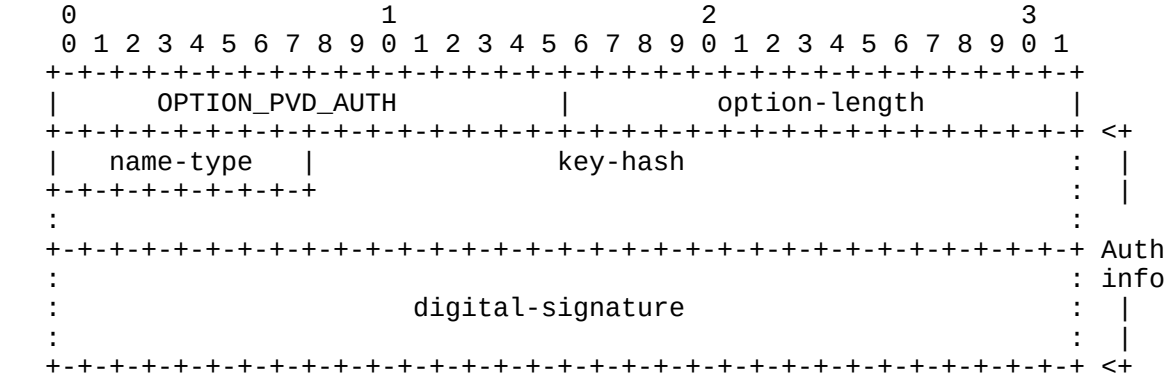

Figure 3: PVD Auth Option

- option-code: OPTION_PVD_AUTH (TBA3)
- option-length: Length of the Auth info
- 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 [RFC6494][RFC6495]. Name Type values starting from 3 are supported and an implementation MUST at least support SHA-1 (value 3).
- key-hash: 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: A signature calculated over the encapsulating OPTION_PVD including all option data from the beginning of the option while setting the digital-signature field to zero. The procedure of calculating the signature is identical to the one defined for SeND [RFC3971].

  [TODO: There may be some alignment considerations here for some implementations as DHCPv6 options are not aligned.]

6. Set of allowable options

The PVD container option MAY be used to encapsulate any allocated DHCPv6 options but MUST NOT be used to encapsulate another OPTION_PVD option. [TODO: Should we add any other exclusions?]

7. Behaviour of DHCPv6 entities

This section describes role of DHCPv6 entities involved in requesting and receiving DHCPv6 configuration or prefix and address allocation.

7.1. Client and Requesting Router Behavior

DHCPv6 client or requesting router can request for configuration from provisioning domain in the following ways:

- In the SOLICIT message it MAY include OPTION_PVD_ID requesting configuration for the specific PVD ID indicated in the OPTION_PVD_ID option. It can include multiple OPTION_PVD_ID options to indicate its preference for more than one provisioning domain. The PVD ID it requests is learnt via configuration or any other out of band mechanism not defined in this document.
- In the SOLICIT message include an OPTION_ORO option with the OPTION_PVD option code to request configuration from all the PVDs that the DHCPv6 server can provide.

The client or requesting router parses OPTION_PVD options in the response message. The Client or Requesting router MUST then include all or subset of the received OPTION_PVD options in the REQUEST message so that it will be responsible for the configuration information selected.

If DHCPv6 client or requesting router receives OPTION_PVD options but does not support PVD, it SHOULD ignore the received option(s).

7.2. Server and Delegating Router Behavior

If the Server or Delegating router supports PVD and it is configured to provide configuration data in one or more provisioning domains, it selects configuration for the PVD based allocation in the following way:

- If OPTION_PVD option code within OPTION_ORO is not present in the request, it MUST NOT include provisioning domain based configuration. It MAY select configuration and prefix allocation from a default PVD defined.

- o If OPTION_PVD_ID is included, it selects information to be offered from that specific PVD if available.
- o If OPTION_PVD option code within OPTION_ORO is included, then based on its configuration and policy it MAY offer configuration from the available PVD(s).

When PVD information and configuration are selected for address and prefix allocation the server or delegating router responds with an ADVERTISE message after populating OPTION_PVD.

If OPTION_PVD is not included, then the server or delegating router MAY allocate the prefix and provide configuration as specified in [RFC3315] and[RFC3633] and MUST NOT include OPTION_PVD option in the response.

If OPTION_ORO option includes the OPTION_PVD option code but the server or delegating router does not support PVD, then it SHOULD ignore the OPTION_PVD and OPTION_PVD_ID options received.

If both client/requesting router and server/delegating router support PVD but cannot offer configuration with PVD for any other reason, it MUST respond to client/requesting router with appropriate status code as specified in [RFC3315] and [RFC3633].

8. Security Considerations

An attacker may attempt to modify the information provided inside the PVD container option. These attacks can easily be prevented by using the DHCPv6 AUTH option [RFC3315] that would detect any form of tampering with the DHCPv6 message contents.

A compromised DHCPv6 server or relay agent may insert configuration information related to PvDs it is not authorized to advertise. e.g. A coffee shop DHCPv6 server 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 PvD container contains embedded authentication and authorization information from the owner of the PvD. 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 PvD 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.

9. IANA Considerations

This document defines three new DHCPv6 options to be allocated out of the registry at http://www.iana.org/assignments/dhcpv6-parameters/

OPTION_PVD (TBA1)
OPTION_PVD_ID (TBA2)
OPTION_PVD_AUTH (TBA3)

10. 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.

11. Normative References

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[RFC4282] Aboba, B., Beadles, M., Arkko, J., and P. Eronen, "The Network Access Identifier", RFC 4282, December 2005.

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[RFC6495] Gagliano, R., Krishnan, S., and A. Kukec, "Subject Key Identifier (SKI) SEcure Neighbor Discovery (SEND) Name Type Fields", RFC 6495, February 2012.

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Identification of provisioning domains
draft-kkbg-mpvd-id-00

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. This document describes several methods of generating identification information for provisioning them and a format for carrying such identification in configuration protocols.

Status of this Memo

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

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at http://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any 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 August 18, 2014.

Table of Contents

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 [I-D.ietf-mif-mpvd-arch]. This document describes a format for carrying identification information along with a few alternatives for reasonable sources for PVD identification. Since the PVD IDs are expected to be unique, the identification sources provide some level of uniqueness using either a hierarchical structure (e.g. FQDNs and OIDs) or some form of randomness (e.g. UUID and ULAs). Any source that does not provide either guaranteed or probabilistic uniqueness is probably not a good candidate for identifying provisioning domains.

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. Provisioning domain identity format

The identity of the PVD is independent of the configuration protocol used to communicate it and is formatted as follows.

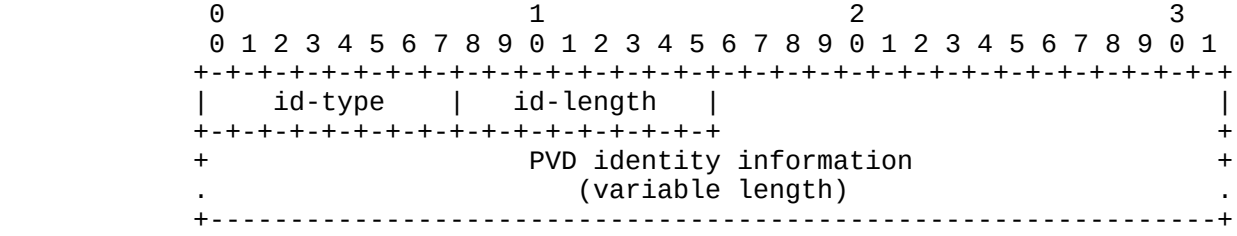

Figure 1: PVD ID Option

- id-type: Describes the type of identification information. This document defines six types of PVD identity information
  0x01: UUID [RFC4122]
  0x02: UTF-8 string
  0x03: OID [OID]
  0x04: NAI Realm [RFC4282]
  0x05: FQDN
  0x06: ULA Prefix [RFC4193]
  Further types can be added by IANA action.

- id-length: Length of the PVD identification in octets not including the id-type and id-length fields.

- PVD identity information: The PVD identification that is based on the id-type.

4. Security Considerations

An attacker may attempt to modify the PVD identity provided in a configuration protocol. These attacks can be prevented by using the configuration protocol mechanisms such as SEND [RFC3971] and DHCPv6 AUTH option [RFC3315] that detect any form of tampering with the configuration.

A compromised configuration source, on the other hand, cannot easily be detected by a configuration client. The only real way to avoid this is that the PvD identification is directly associable to some form of authentication and authorization information from the owner of the PvD (e.g. an FQDN can be associated with a DANE cert). 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 PvD owner (e.g. a certificate with a well-known/common trust anchor that).

5. IANA Considerations

This document creates a new registry for PVD id types. The initial values are listed below

0x01: UUID [RFC4122]
0x02: UTF-8 string
0x03: OID [OID]
0x04: NAI Realm [RFC4282]
0x05: FQDN
0x06: ULA Prefix [RFC4193]

6. Acknowledgements

The authors would like to thank the members of the MIF architecture design team, Ted Lemon, Brian Carpenter, Bernie Volz and Alper Yegin for their contributions to this draft.

7. Normative References

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[OID] IANA, "PRIVATE ENTERPRISE NUMBERS", SMI Network Management Private Enterprise Codes, http://www.iana.org/assignments/enterprise-numbers/enterprise-numbers.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

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