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Default Locator-pair selection algorithm for the SHIM6 protocol
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Abstract

In this note, we present a locator-pair selection mechanism for the shim6 protocol. The presented mechanism provides an ordered list of available locator-pairs that can be used for outgoing traffic.

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1. Introduction

Once that a shim6 context is established between two peers, they are free to select the best locator pair to continue the communication. In particular, when an outage is detected, they will need to select a new locator pair to rehome the communication. Besides, policy or other considerations may lead to change the locator pair used in the communication even if no outage has occurred.

In this note, we present a locator-pair selection mechanism for the shim6 protocol. The presented mechanism provides an ordered list of available locator-pairs that can be used for outgoing traffic (note that since unidirectional locator pairs are supported by the shim6 protocol, the locator pair used in the outgoing direction may not affect the locator pair used by the peer to send incoming traffic).

The motivation for having a locator selection mechanism different than RFC 3484 [3] is that RFC 3484 was designed to select addresses that were both identifiers and locators, so, in some cases the selection criteria differs from the one used when selecting addresses that will used only as locators. In particular, when addresses are to be used as identifiers and as locators, stable addresses such as Home Addresses are preferred over more temporary addresses as Care-Off Addresses. If an address is to be used only as a locator, probably the stability property is not as important as achieving a more direct path, making a Care-off Address more attractive than a Home Address. Similar considerations can be made with respect to private and public addresses. In addition, the locator pair selection mechanism described in this document incorporates into the selection mechanism shim-specific information, such as available reachability information and local and remote locator preferences obtained through the shim6 protocol. Finally, the mechanism presented in this note is a locator pair selection mechanism as opposed to separate source address and destination address selection mechanisms as described in RFC 3484. We think that such approach is more appropriate for the shim6 protocol, since reachability seems to be a property of an address pair rather than a property of a single address.

The presented mechanism takes into account general properties of the available addresses, in particular the address family (v4 or v6), address scope [3], mobility consideration (Home-Addresses and Care-off Addresses) [4], status of the addresses (Preferred and Deprecated addresses) [5], privacy considerations (Public and Temporary addresses) [6]. In addition it also takes into account shim6 specific information such as whether the addresses are known to be locally operational (as defined in [2]), if locator pairs are know to be unidirectionally operational [2], the local and remote preferences

for the different locators available in the shim6 context.

Multicast addresses are out of the scope of the document.

2. Preliminary considerations

2.1. Candidate Locator-pair set

We define the local set of locally-operational locators (LOLs(local)) as the local locators that are included in the local locator set (Ls(local) as defined in [1]) and that are locally operational as defined in [2]. Locally operational addresses are discovered through local means that are outside of the scope of this document.

We define the set of the locally-operational locators of the peer (LOLs(peer)) as the remote locators that are included in the peer locator set (Ls(peer) as defined in [1]) and that are locally operational in the peer as defined in [2]. The peers' locally operational locators are discovered through the Locator List Option and the Locator Preferences Option (in particular the BROKEN flag) defined in the shim protocol [1].

The candidate locator-pair set is the set of locator pairs that can be used to send packets in a shim context.

The candidate locator-pair set contains in all the possible locator pairs formed with the first of them belonging to the local set of locally-operational locators (LOLs(local)) and the second locator belonging to the locally-operational locators of the peer (LOLs(peer)).

This can be expressed as:

Cand_Loc_Pair_Set ={(x,y)/[x in LOLs(local) and y in LOLs(peer)}

Current shim6 protocol specification only supports IPv6 addresses as locators. In case the shim6 protocol specification is updated and IPv4 addresses are accepted as locators, the creation of the Candidate Locator Pair Set must only accept locator pairs where both source and destiantion address are of the same family. The result would be the following formula:.

Cand_Loc_Pair_Set ={(x,y)/[family(x) = family(y)] AND [x in LOLs(local) and y in LOLs(peer)]}

Question: should we allow locator pairs with all types of scope combinations or should we restrict the type of scope combinations for

the inclusion in the cadidate set? If we don't allow all the combinations, we can remove rule 1 aboput scopes

2.2. Locator-pair States

Locator pairs can be in the following state:

- o Unidirectionally Operational state: As defined in [2], is when packets send with the first locator as the source address and the second locator as a destination address are known to reach the destination. In the shim6 case, a locator pair is know to be unidirectionally operational when there is fresh information about packets reaching the peer, using the mechanisms defined in [2] or thanks to recent ULP feedback. When the information about reachability expires, the locator pair moves to Unknown state.
- o Non-Operational state: The locator pair is known to be non-operational i.e. that packets containing the first locator as source address and the second locator as destination address do not reach the destination. In the shim6 case this can be known because recent attempts to exchange packets have failed. When the information about unreachability expires, the locator pair moves to Unknown state.
- o Unknown state: No recent reachability information is available for this locator-pair.

2.3. Locator preferences

2.3.1. Remote locator preferences

Remote locator preferences can be obtained through the shim6 protocol using the Locator Preference option. The preferences consist in a Flag octet, a Priority octet and an optional Weight octet.

The weight field express the relative weight for locators with the same priority, and as defined in [7] larger weights should be given a proportionally higher probability of being selected. In order to include this probability information in the locator-pair selection algorithm, a new weight* information is generated from the weight values as following:

We order each set of destination addresses with the same priority and defined weight values using the following algorithm defined in [7]:

Arrange all addresses (that have not been ordered yet) in any order, except that all those with weight 0 are placed at the beginning of the list.

Compute the sum of the weights of those addresses, and with each

address associate the running sum in the selected order. Then choose a uniform (pseudo)random number between 0 and the sum computed (inclusive), and select the address whose running sum value is the first in the selected order which is greater than or equal to the (pseudo)random number selected. This address is the next one to be included in the ordered list. Remove this address from the set of the unordered addresses and apply the described algorithm to the unordered address set to select the next target address. Continue the ordering process until there are no unordered addresses.

The weight* (W*1, W*2,...,W*N) values for each of the addresses is their final position in the resulting ordered list.

The procedure is repeated for each one of the sets containing destination addresses with equal priority.

The Weight information is not used in the locator-pair selection mechanism, but the Weight* information is.

2.3.2. Source locator preferences

With respect to the local locator preferences, this document assumes that the host will have a mechanism to express Priority and Weight information for local locators similar to the one defined in [7].

The same procedure is used to assign Weight* values to the source locators that have the same priority value.

Note that destination and source addresses are never included in the same set, even if they have the same priority value.

The Weight information is not used in the locator-pair s election mechanism, but the Weight* information is.

2.4. Locator-pair selection table

We define the Locator-pair selection table to express preferences about which source address prefix to use when communicating with a given destination address prefix. The table contains entries having a source prefix and a destination prefix each. Given a locator pair, it is then possible to find a match when both the source prefix is contained in the source address and the destination prefix is contained in the destination address.

3. Default Locator-Pair Selection Algorithm

The goal of the defualt locator-pair selection algorithm is to

produce an ordered list of locator pairs to be tried for rehoming an ongoing communication. The ordered list can be produced with any sorting algorithm. The set of rules described next are the comparison criteria to be used in the locator-pair sorting algorithm. This rules act must be processed in order and if a given rule selects a locator pair over the other one, then the following rules don't need to be processed and the selected locator pair is prefered.

We are comparing two locator pairs (src1,dst1) and (src2,dst2). Note that in some cases the source or the destination addresses of the two pairs may be equal.

Rule 1: Prefer appropriate scope: If scope(src1) >= scope(dst1) and scope(src2) < scope(dst2), then prefer (src1,dst1).

Rule 2: Avoid Non-Operational pairs: If (src1,dst1) is in Non-Operational state and (src2,dst2) is in Unidirectionally Operational or in Unknown state, then prefer (src2,dst2).

Rule 3: Prefer Unidirectionally Operational state: If (src1,dst1) is in Unknown state and (src2,dst2) is in Unidirectionally Operational, then prefer (src2,dst2).

Rule 4: Prefer fresher reachability information: If (src1,dst1) and (src2,dst2) are both in Unidirectionally Operational state, then prefer the one with smallest age information i.e. the one for which newer reachability information is available.

Rule 5: Prefer ULID-Pair: If (src1,dst1) is the ULID-pair of the context, the prefer (src1,dst1)

Rule 6: Prefer matching scope: If scope(src1) = scope(dst1) and scope(src2) < scope(dst2), then prefer (src1,dst1)

Rule 7: Prefer Locator-pair table match: If (dst1,src1) has a match in the Locator-pair selection table and (src2,dst2) does not have a match in the locator-pair selection table, then prefer (dst1,src1).

Rule 8: Prefer Preferred addresses: If src1 address is a Preferred address in the RFC2462 sense and src2 is a deprecated address in the RFC2462 sense, then prefer (src1,dst1)

Rule 9: Prefer Local Priority: If src1 of (src1,dst1) has a lowest Priority than src2 of (src2,dst2) then prefer (src1,dst1)

Rule 10: Prefer Local Weight*: If src1 of (src1,dst1) has a lowest Weight* than src2 of (src2,dst2) then prefer (src1,dst1)

Rule 11: Prefer Local Care-off Addresses: If src1 is a Care-off address [4] and src2 is a Home Address, the prefer (src1,dst1). This only applies to Mobile IP [4].

Rule 12: Prefer Remote Priority: If dst1 of (src1,dst1) has a lowest Priority than dst2 of (src2,dst2) then prefer (src1,dst1)

Rule 13: Prefer Remote Weight*: If dst1 of (src1,dst1) has a lowest Weight* than dst2 of (src2,dst2) then prefer (src1,dst1)

Rule 14: Prefer Remote Care-off Addresses: If dst1 is a Care-off address (Temporary flag set in the Locator preferences options defined in [1]) and dst2 is not a Care-off address, the prefer (src1,dst1). This only applies to Mobile IP [4].

Other rules that may be worth taking into account are:

- Prefer native transport
- Prefer smaller scope
- Prefer most dissimilar locator pair to the currently used
- Prefer locator pair contained in incoming packet
- Longest prefix match
- Should we eliminate the site and link local addresses from the accpetable locator set?

4. Security considerations

Note that according to the shim6 protocol specification, locators are included in the Ls(peer) only after HBA/CGA verification has been successful. This eliminates the possibility of using locators that do not belong to the peer. Besides, it should be noted that before using a given locator pair to actually send data packets, a reachability test is performed in order to prevent flooding attacks.

4.1. Privacy considerations

Including or not RFC3041 [6] addresses in the Locator set available for a shim6 context may have privacy implications. This is so because of two reaosns: First, the inclusion of RFC 3041 addresses in the locator set discloses the RFC3041 addresses of the host to the peer. Second, the locator sets of both peers are exchanged in clear text during the shim6 context establishment and/or in the subsequent UPDATE messages. This means that an attacker located along the path that can observe such packets can discover that all the addresses

included in the locator set belong to the same host, beating the purpose of RFC3041 private addresses. So, when forming the locator set of a shim6 context the host must take into account these privacy considerations in order to decide whether to include RFC3041 addresses in the locator set of a shim6 context.

5. Acknowledgements

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