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Happy Eyeballs Extension for ICE
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Abstract

This document specifies requirements for algorithms that make ICE connectivity checks more responsive by reducing delays in dual-stack host ICE connectivity checks when there is a path failure for the address family preferred by the application or by the operating system. As IPv6 is usually preferred, the procedures in this document helps avoid user-noticeable delays when the IPv6 path is broken or excessively slow.

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1. Introduction

In situations where there are many IPv6 addresses, ICE [RFC5245] will prefer IPv6 candidates [RFC6724] and will attempt connectivity checks on all the IPv6 candidates before trying an IPv4 candidate. If the IPv6 path is broken, this fallback to IPv4 can consume a lot of time, harming user satisfaction of dual-stack devices.

This document describes an algorithm that makes ICE connectivity checks more responsive to failures of an address family by reordering the candidates such that IPv6 and IPv4 candidates get a fair chance during connectivity checks. This document specifies requirements for any such algorithm, with the goals that the ICE agent need not be inordinately harmed with a simple reordering of the candidates.

2. Notational Conventions

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].

This note uses terminology defined in [RFC5245].

3. Candidates Priority

A prioritization formula is used by ICE [RFC5245] so that most preferred address pairs are tested first, and if a sufficiently good pair is discovered, the tests can be stopped. With IPv6, addresses obtained from local network interfaces, called host candidates, are recommended as high-priority ones to be tested first since if they work, they provide usually the best path between the two hosts. The ICE specification recommends to use the rules defined in [RFC6724] as part of the prioritization formula for IPv6 host candidates and [I-D.keranen-mmusic-ice-address-selection] updates the ICE rules on how IPv6 host candidates are selected.

For dual-stack hosts the preference for IPv6 host candidates is higher than IPv4 host candidates based on precedence value of IP addresses described in [RFC6724]. IPv6 server reflexive candidates have higher precedence than IPv4 server reflexive candidate since NPTv6 is stateless and transport-agnostic.

```
(highest)  IPv6 Host Candidate
           IPv4 Host Candidate
           IPv6 Server Reflexive Candidate
           IPv4 Server Reflexive Candidate
           IPv6 Relayed Transport Candidate
(lowest)   IPv4 Relayed Transport Candidate
```

Figure 1: Candidate Preferences in decreasing order

By using the technique described in Section 4, if there are both IPv6 and IPv4 addresses candidates gathered, and the first 'N' candidates are of the same IP address family, then the highest-priority candidate of the other address family is promoted to position N in the check list thus making ICE connectivity checks more responsive to failures of an address family.

Note: The algorithm works even if the administrator changes the policy table to prefer IPv4 addresses over IPv6 addresses as defined in [RFC6724].

4. Algorithm overview

The Happy Eyeballs Extension for ICE algorithm proposes the following steps after candidates are prioritized using the formula in section 4.1.2.1 of [RFC5245]:

a. If the first 'N' candidates are of the same IP address family, then the highest-priority candidate of the other address family is promoted to position 'N+1' in the list.

b. Step a is repeated for subsequent candidates in the list until all candidates of the preferred address family are exhausted.

The result of these steps is that after every consecutive 'N' candidates of the preferred family, a candidate of the other family is inserted.

The following figure illustrates the result of the algorithm on candidates:

```
Before Happy Eyeballs Extension for ICE algorithm :
----------------------------------------------------
 (highest)  IPv6 Host Candidate-1
            IPv6 Host Candidate-2
            IPv6 Host Candidate-3
            IPv6 Host Candidate-4
            IPv6 Host Candidate-5
            IPv6 Host Candidate-6
            IPv6 Host Candidate-7
            IPv4 Host Candidate
            IPv6 Server Reflexive Candidate
            IPv4 Server Reflexive Candidate
            IPv6 Relayed Transport Candidate
 (lowest)   IPv4 Relayed Transport Candidate


After Happy Eyeballs Extension for ICE algorithm :
--------------------------------------------------
 (highest)  IPv6 Host Candidate-1
            IPv6 Host Candidate-2
            IPv6 Host Candidate-3
            IPv4 Host Candidate                 ---> Promoted candidate
            IPv6 Host Candidate-4
            IPv6 Host Candidate-5
            IPv6 Host Candidate-6
            IPv4 Server Reflexive Candidate    ---> Promoted candidate
            IPv6 Host Candidate-7
            IPv6 Server Reflexive Candidate
            IPv6 Relayed Transport Candidate
 (lowest)   IPv4 Relayed Transport Candidate
```

4.1. Processing the Results

If ICE connectivity checks using IPv4 candidate is successful then ICE Agent performs as usual "Discovering Peer Reflexive Candidates" (Section 7.1.3.2.1 of [RFC5245]), "Constructing a Valid Pair" (Section 7.1.3.2.2 of [RFC5245]), "Updating Pair States" (Section 7.1.3.2.3 of [RFC5245]), "Updating the Nominated Flag" (Section 7.1.3.2.4 of [RFC5245]).

If ICE connectivity checks using an IPv4 candidate is successful for each component of the media stream and connectivity checks using IPv6 candidates is not yet successful, the ICE endpoint will declare victory, conclude ICE for the media stream and start sending media using IPv4. However, it is also possible that ICE endpoint continues to perform ICE connectivity checks with IPv6 candidate pairs and if checks using higher-priority IPv6 candidate pair is successful then media stream can be moved to the IPv6 candidate pair. Continuing to perform connectivity checks can be useful for subsequent connections, to optimize which connectivity checks are tried first. Such optimization is out of scope of this document.

The following diagram shows the behaviour during the connectivity check when Alice calls Bob and Agent Alice is the controlling agent and uses the aggressive nomination algorithm. "USE-CAND" implies the presence of the USE-CANDIDATE attribute.

```
    Alice                                                         Bob
     |                                                             |
     |                                                             |
     |  Bind Req USE-CAND                     Bind Req             |
     |  using IPv6                            using IPv6           |
     |------------------>X                X<-----------------------|
     |  Bind Req USE-CAND                     Bind Req             |
     |  using IPv6 after Ta                   using IPv6           |
     |------------------>X                X<-----------------------|
     |                                                             |
   [after connectivity checks for 2 IPv6 addresses, try IPv4]      |
     |                                                             |
     |  Bind Req USE-CAND                                          |
     |  using IPv4                                                 |
     |------------------------------------------------------------>|
     |                                        Bind Resp            |
     |                                        using IPv4           |
     |<----------------------------------------------------------- |
     |          RTP                                                |
     |============================================================>|
     |                                       Bind Req              |
     |                                       using IPv4            |
     |<------------------------------------------------------------|
     |  Bind Response                                              |
     |  using IPv4                                                 |
     |------------------------------------------------------------>|
     |          RTP                                                |
     |<===========================================================>|
```

Figure 2: Happy Eyeballs Extension for ICE

5. IANA Considerations

None.

6. Security Considerations

STUN connectivity check using MAC computed during key exchanged in the signaling channel provides message integrity and data origin authentication as described in section 2.5 of [RFC5245] apply to this use.

7. Acknowledgements

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8. References

8.1. Normative References

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8.2. Informative References

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