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P. Martinsen  
T. Reddy  
P. Patil  
Cisco  
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**ICE Multihomed and IPv4/IPv6 Dual Stack Fairness**  
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Abstract

This document provides guidelines on how to make Interactive Connectivity Establishment (ICE) conclude faster in multihomed and IPv4/IPv6 dual-stack scenarios where broken paths exist. The provided guidelines are backwards compatible with the original ICE specification.

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## [1.](#) Introduction

Applications should take special care to deprioritize network interfaces known to provide unreliable connectivity when operating in a multihomed environment. For example certain tunnel services might provide unreliable connectivity. The simple guidelines presented here describes how to deprioritize interfaces known by the application to provide unreliable connectivity. This application knowledge can be based on simple metrics like previous connection success/failure rates or a more static model based on interface types like wired, wireless, cellular, virtual, tunnelled and so on.

There is a also need to introduce more fairness in the handling of connectivity checks for different IP address families in dual-stack IPv4/IPv6 ICE scenarios. [Section 4.1.2.1](#) of ICE [[RFC5245](#)] points to [[RFC3484](#)] for prioritizing among the different IP families. [[RFC3484](#)] is obsoleted by [[RFC6724](#)] but following the recommendations from the updated RFC will lead to prioritization of IPv6 over IPv4 for the same candidate type. Due to this, connectivity checks for candidates of the same type (host, reflexive or relay) are sent such that an IP address family is completely depleted before checks from the other address family are started. This results in user noticeable setup delays if the path for the prioritized address family is broken.

To avoid such user noticeable delays when either IPv6 or IPv4 path is broken or excessive slow, this specification encourages intermingling the different address families when connectivity checks are performed. Introducing IP address family fairness into ICE connectivity checks will lead to more sustained dual-stack IPv4/IPv6



deployment as users will no longer have an incentive to disable IPv6. The cost is a small penalty to the address type that otherwise would have been prioritized.

The guidelines outlined in this specification are backward compatible with a standard ICE implementation. This specification only alters the values used to create the resulting checklists in such a way that the core mechanisms from ICE [[RFC5245](#)] are still in effect. The introduced fairness might be better, but not worse than what exists today.

## **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 document uses terminology defined in [[RFC5245](#)].

## **3. Improving ICE Multihomed Fairness**

A multihomed ICE agent can potentially send and receive connectivity checks on all available interfaces. To avoid unnecessary delay when performing connectivity checks it would be beneficial to prioritize interfaces known by the agent to provide connectivity.

Candidates from a interface known to the application to provide unreliable connectivity SHOULD get a low candidate priority. This ensures they appear near the end of the candidate list, and would be the last to be tested during the connectivity check phase. This allows candidate pairs more likely to succeed to be tested first.

If the application is unable to get any interface information regarding type or unable to store any relevant metrics, it SHOULD treat all interfaces as if they have reliable connectivity. This ensures all interfaces gets their fair chance to perform their connectivity checks.

## **4. Improving ICE Dual Stack Fairness**

Candidates SHOULD be prioritized such that a long sequence of candidates belonging to the same address family will be intermingled with candidates from an alternate IP family. For example, promoting IPv4 candidates in the presence of many IPv6 candidates such that an IPv4 address candidate is always present after a small sequence of IPv6 candidates, i.e., reordering candidates such that both IPv6 and IPv4 candidates get a fair chance during the connectivity check



phase. This makes ICE connectivity checks more responsive to broken path failures of an address family.

An ICE agent can choose an algorithm or a technique of its choice to ensure that the resulting check lists have a fair intermingled mix of IPv4 and IPv6 address families. However, modifying the check list directly can lead to uncoordinated local and remote check lists that result in ICE taking longer to complete or in the worst case scenario fail. The best approach is to modify the formula for calculating the candidate priority value described in ICE [\[RFC5245\] section 4.1.2.1](#).

Implementations SHOULD prioritize IPv6 candidates by putting some of them first in the the intermingled checklist. This increases the chance of a IPv6 connectivity checks to complete first and be ready for nomination or usage. This enables implementations to follow the intent of [\[RFC6555\]](#)Happy Eyeballs: Success with Dual-Stack Hosts.

## 5. Compatibility

ICE [\[RFC5245\] section 4.1.2](#) states that the formula in [section 4.1.2.1](#) SHOULD be used to calculate the candidate priority. The formula is as follows:

$$\begin{aligned} \text{priority} = & (2^{24}) * (\text{type preference}) + \\ & (2^8) * (\text{local preference}) + \\ & (2^0) * (256 - \text{component ID}) \end{aligned}$$

ICE [\[RFC5245\] section 4.1.2.2](#) has guidelines for how the type preference and local preference value should be chosen. Instead of having a static local preference value for IPv4 and IPv6 addresses, it is possible to choose this value dynamically in such a way that IPv4 and IPv6 address candidate priorities ends up intermingled within the same candidate type.

It is also possible to dynamically change the type preference in such a way that IPv4 and IPv6 address candidates end up intermingled regardless of candidate type. This is useful if there are a lot of IPv6 host candidates effectively blocking connectivity checks for IPv4 server reflexive candidates.

The list below shows a sorted local candidate list where the priority is calculated in such a way that the IPv4 and IPv6 candidates are intermingled. To allow for earlier connectivity checks for the IPv4 server reflexive candidates, some of the IPv6 host candidates are demoted. This is just an example of how a candidate priorities can be calculated to provide better fairness between IPv4 and IPv6 candidates without breaking any of the ICE connectivity checks.



	Candidate Type	Address Type	Component ID	Priority
-----				
(1)	HOST	IPv6	(1)	2129289471
(2)	HOST	IPv6	(2)	2129289470
(3)	HOST	IPv4	(1)	2129033471
(4)	HOST	IPv4	(2)	2129033470
(5)	HOST	IPv6	(1)	2128777471
(6)	HOST	IPv6	(2)	2128777470
(7)	HOST	IPv4	(1)	2128521471
(8)	HOST	IPv4	(2)	2128521470
(9)	HOST	IPv6	(1)	2127753471
(10)	HOST	IPv6	(2)	2127753470
(11)	SRFLX	IPv6	(1)	1693081855
(12)	SRFLX	IPv6	(2)	1693081854
(13)	SRFLX	IPv4	(1)	1692825855
(14)	SRFLX	IPv4	(2)	1692825854
(15)	HOST	IPv6	(1)	1692057855
(16)	HOST	IPv6	(2)	1692057854
(17)	RELAY	IPv6	(1)	15360255
(18)	RELAY	IPv6	(2)	15360254
(19)	RELAY	IPv4	(1)	15104255
(20)	RELAY	IPv4	(2)	15104254

SRFLX = server reflexive

Note that the list does not alter the component ID part of the formula. This keeps the different components (RTP and RTCP) close in the list. What matters is the ordering of the candidates with component ID 1. Once the checklist is formed for a media stream the candidate pair with component ID 1 will be tested first. If ICE connectivity check is successful then other candidate pairs with the same foundation will be unfrozen ([\[RFC5245\] section 5.7.4](#). Computing States).

The local and remote agent can have different algorithms for choosing the local preference and type preference values without impacting the synchronization between the local and remote check lists.

The check list is made up by candidate pairs. A candidate pair is two candidates paired up and given a candidate pair priority as described in [\[RFC5245\] section 5.7.2](#). Using the pair priority formula:

$$\text{pair priority} = 2^{32} * \text{MIN}(G, D) + 2 * \text{MAX}(G, D) + (G > D ? 1 : 0)$$



Where G is the candidate priority provided by the controlling agent and D the candidate priority provided by the controlled agent. This ensures that the local and remote check lists are coordinated.

Even if the two agents have different algorithms for choosing the candidate priority value to get an intermingled set of IPv4 and IPv6 candidates, the resulting checklist, that is a list sorted by the pair priority value, will be identical on the two agents.

The agent that has promoted IPv4 cautiously i.e. lower IPv4 candidate priority values compared to the other agent, will influence the check list the most due to  $(2^{32} * \min(G, D))$  in the formula.

These recommendations are backward compatible with a standard ICE implementation. The resulting local and remote checklist will still be synchronized. The introduced fairness might be better, but not worse than what exists today

A test implementation with an example algorithm is available [[ICE dualstack\\_imp](#)].

## 6. IANA Considerations

None.

## 7. 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.

## 8. Acknowledgements

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### Authors' Addresses

Paal-Erik Martinsen  
Cisco Systems, Inc.  
Philip Pedersens Vei 22  
Lysaker, Akershus 1325  
Norway

Email: [palmarti@cisco.com](mailto:palmarti@cisco.com)

Tirumaleswar Reddy  
Cisco Systems, Inc.  
Cessna Business Park, Varthur Hobli  
Sarjapur Marathalli Outer Ring Road  
Bangalore, Karnataka 560103  
India

Email: [tiredy@cisco.com](mailto:tiredy@cisco.com)

Prashanth Patil  
Cisco Systems, Inc.  
Bangalore  
India

Email: [praspati@cisco.com](mailto:praspati@cisco.com)

