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IGP Unreachable Prefix Announcement  
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## Abstract

In the presence of summarization, there is a need to signal loss of reachability to an individual prefix covered by the summary in order to enable fast convergence away from paths to the node which owns the prefix which is no longer reachable. This document describes how to use existing protocol mechanisms in IS-IS and OSPF to advertise such prefix reachability loss.

## Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [BCP 14](#) [[RFC2119](#)][RFC8174] when, and only when, they appear in all capitals, as shown here.

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## [1.](#) Introduction

Link-state IGP protocols like IS-IS and OSPF are primarily used to distribute routing information between routers belonging to a single Autonomous System (AS) and to calculate the reachability for IPv4 or IPv6 prefixes advertised by the individual nodes inside the AS. Each node advertises the state of its local adjacencies, connected prefixes, capabilities, etc. The collection of these states from all the routers inside the area form a link-state database (LSDB) that describes the topology of the area and holds additional state information about the prefixes, router capabilities, etc.

The growth of networks running a link-state routing protocol results in the addition of more state which leads to scalability and convergence challenges. The organization of networks into levels/ areas and IGP domains helps limit the scope of link-state information within certain boundaries. However, the state related to prefix

reachability often requires propagation across a multi-area/ level and/or multi-domain IGP network. Techniques such as summarization have been used traditionally to address the scale challenges associated with advertising prefix state outside of the local area/ domain. However, this results in suppression of the individual prefix state that is useful for triggering fast-convergence mechanisms outside of the IGPs - e.g., BGP PIC Edge [I-D.ietf-rtgwg-bgp-pic].

This document describes how the use of existing protocol mechanisms can support the necessary functionality without the need for any protocol extensions. The functionality being described is called Unreachable Prefix Announcement (UPA).

## [2.](#) Supporting UPA in IS-IS

[RFC5305] defines the encoding for advertising IPv4 prefixes using 4 octets of metric information. [Section 4](#) specifies:

"If a prefix is advertised with a metric larger than MAX\_PATH\_METRIC (0xFE000000, see paragraph 3.0), this prefix MUST NOT be considered during the normal SPF computation. This allows advertisement of a prefix for purposes other than building the normal IP routing table."  
"

Similarly, [\[RFC5308\]](#) defines the encoding for advertising IPv6 prefixes using 4 octets of metric information. [Section 2](#) states:

"...if a prefix is advertised with a metric larger than MAX\_V6\_PATH\_METRIC (0xFE000000), this prefix MUST NOT be considered during the normal Shortest Path First (SPF) computation. This will allow advertisement of a prefix for purposes other than building the normal IPv6 routing table."

This functionality can be used to advertise a prefix (IPv4 or IPv6) in a manner which indicates that reachability has been lost - and to

do so without requiring all nodes in the network to be upgraded to support the functionality.

### [2.1.](#) Advertisement of UPA in IS-IS

Existing nodes in a network which receive UPA advertisements will ignore them. This allows flooding of such advertisements to occur without the need to upgrade all nodes in a network.

Recognition of the advertisement as UPA is only required on routers which have a use case for this information. Area Border Routers

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(ABRs), which would be responsible for propagating UPA advertisements into other areas would need to recognize such advertisements.

As per the definitions referenced in the preceding section, any prefix advertisement with a metric value greater than 0xFE000000 can be used for purposes other than normal routing calculations. Such an advertisement can be interpreted by the receiver as a UPA.

Optionally, an implementation may use local configuration to limit the set of metric values which will be interpreted as UPA. The only restriction is that such values MUST be greater than 0xFE000000.

### [2.2.](#) Propagation of UPA in IS-IS

ISIS L1/L2 routers may wish to advertise received UPAs into other areas (upwards and/or downwards). When propagating UPAs the original metric value MUST be preserved. The cost to reach the originator of the received UPA MUST NOT be considered when readvertising the UPA.

## [3.](#) Supporting UPA in OSPF

[RFC2328] [Appendix B](#) defines the following architectural constant for OSPF:

"LSInfinity The metric value indicating that the destination described by an LSA is unreachable. Used in summary-LSAs and AS-external-LSAs as an alternative to premature aging (see [Section 14.1](#)). It is defined to be the 24-bit binary value of all ones: 0xffffffff."

[RFC5340] [Appendix B](#) states:

"Architectural constants for the OSPF protocol are defined in [Appendix B](#) of OSPFv2."

indicating that these same constants are applicable to OSPFv3.

[RFC2328] [section 14.1](#). also describes the usage of LSInfinity as a way to indicate loss of prefix reachability:

"Premature aging can also be used when, for example, one of the router's previously advertised external routes is no longer reachable. In this circumstance, the router can flush its AS-external-LSA from the routing domain via premature aging. This procedure is preferable to the alternative, which is to originate a new LSA for the destination specifying a metric of LSInfinity."

### [3.1.](#) Advertisement of UPA in OSPF

Using the existing mechanism already defined in the standards, as described in previous section, an advertisement of the inter-area or external prefix inside OSPF or OSPFv3 LSA that has the age set to value lower than MaxAge and metric set to LSInfinity can be interpreted by the receiver as a UPA.

Existing nodes in a network which receive UPA advertisements will propagate it following existing standard procedures defined by OSPF.

OSPF Area Border Routers (ABRs), which would be responsible for propagating UPA advertisements into other areas would need to recognize such advertisements.

### [3.2.](#) Propagation of UPA in OSPF

OSPF ABRs may wish to advertise received UPAs into other connected areas. When doing so, the original LSInfinity metric value in UPA MUST be preserved. The cost to reach the originator of the received UPA MUST NOT be considered when readvertising the UPA to connected areas.

#### [4.](#) Deployment Considerations for UPA

The intent of UPA is to provide an event driven signal of the transition of a destination from reachable to unreachable. It is not intended to advertise a persistent state. UPA advertisements should therefore be withdrawn after a modest amount of time, that would provides sufficient time for UPA to be flooded network-wide and acted upon by receiving nodes, but limits the presence of UPA in the network to a short time period. The time the UPA is kept in the network SHOULD also reflect the intended use-case for which the UPA was advertised.

As UPA advertisements in ISIS are advertised in existing Link State PDUs (LSPs) and the unit of flooding in IS-IS is an LSP, it is recommended that, when possible, UPAs are advertised in LSPs dedicated to this type of advertisement. This will minimize the number of LSPs which need to be updated when UPAs are advertised and withdrawn.

In OSPF and OSPFv3, each inter-area and external prefix is advertised in it's own LSA, so the above optimisation does not apply to OSPF.

It is also recommended that implementations limit the number of UPA advertisements which can be originated at a given time.

#### [5.](#) IANA Considerations

This document makes no requests to IANA.

#### [6.](#) Security Considerations

The use of UPAs introduces the possibility that an attacker could inject a false, but apparently valid, UPA. However, the risk of this occurring is no greater than the risk today of an attacker injecting any other type of false advertisement .

The risks can be reduced by the use of existing security extensions as described in [[RFC5304](#)] and [[RFC5310](#)] for IS-IS, in [[RFC2328](#)][ and [[RFC7474](#)] for OSPFv2, and in [[RFC5340](#)] and [[RFC4552](#)] for OSPFv3.

## 7. Acknowledgements

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