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P. Thubert, Ed.
cisco
IJ. Wijnands
Cisco Systems
October 18, 2013

Applying Available Routing Constructs to bicasting

[draft-thubert-rtgwg-arc-bicast-01](#)

Abstract

This draft introduces methods that leverage the concept of ARC to enable bicasting operations.

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 [RFC 2119](#) [RFC2119].

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Thubert & Wijnands

Expires April 19, 2014

[Page 1]

Internet-Draft

ARC bicasting

October 2013

Table of Contents

1.	Introduction	2
2.	Terminology	3
3.	Downward Bicasting Operation	4
4.	Upward Bicasting Operations	5
4.1.	Resolving crossing ARCs	5
4.2.	Single Point of Failure	6

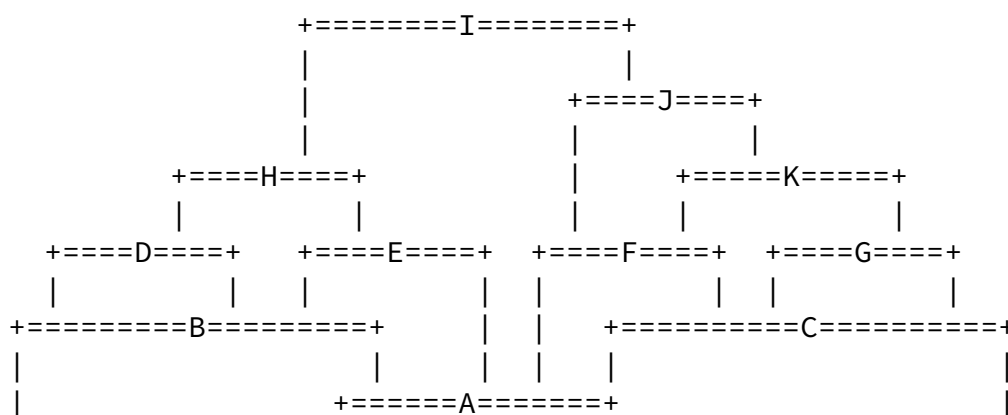
5.	Applicability	7
5.1.	In conjunction with Protocol Independent Multicast	7
6.	Manageability	7
7.	IANA Considerations	7
8.	Security Considerations	7
9.	Acknowledgements	7
10.	References	8
10.1.	Normative References	8
10.2.	Informative References	8
	Authors' Addresses	8

1. Introduction

Traditional routing and forwarding uses the concept of path as the basic routing paradigm to get a packet from a source to a destination by following an ordered sequence of arrows between intermediate nodes. In this serial design, a path is broken as soon as a single arrow is, and getting around a breakage can require path recomputation, network reconvergence, and incur delays to till service is restored.

Available Routing Constructs [I-D.thubert-rtgwg-arc] (ARC) introduces the concept of ARC as a routing construct made of a sequence of nodes and links with 2 outgoing edges, that is this resilient to one breakage so that an ARC topology is resilient to one breakage per ARC.

The routing graph to reach a certain destination is expressed as a cascade of ARCs, which terminates in an abstract destination Omega, each ARC providing its own independent domain of fault isolation and recovery:

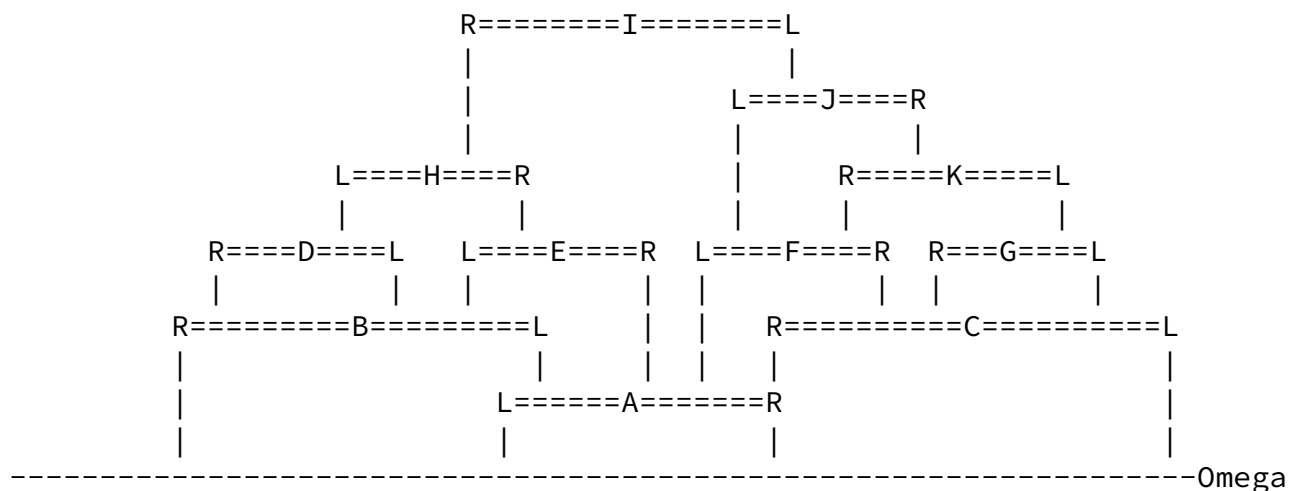


-----|-----|-----|-----|-----Omega

This cascade of ARCs appears ideally suited to the operation of bicasting (a.k.a. duocasting), which consists in sending two copies of a single packet, if possible over divergent - that is fully or partially non-congruent - paths, in order to augment the chances that at least one of the copies reaches the destination timely.

2. Terminology

The draft uses the terminology defined in [I-D.thubert-rtgwg-arc]. This specificatin also introduces Sided ARCs, that is ARCs with at least an Edge that is known as Left and an Edge that is known as Right. The sense of Left and Right adds up to the existing sense of height that is already defined in [I-D.thubert-rtgwg-arc].



One way of doing this is

- o The basic rule is that an ARC MUST have at least one Left and one Right Edge.

Thubert & Wijnands

Expires April 19, 2014

[Page 3]

Internet-Draft

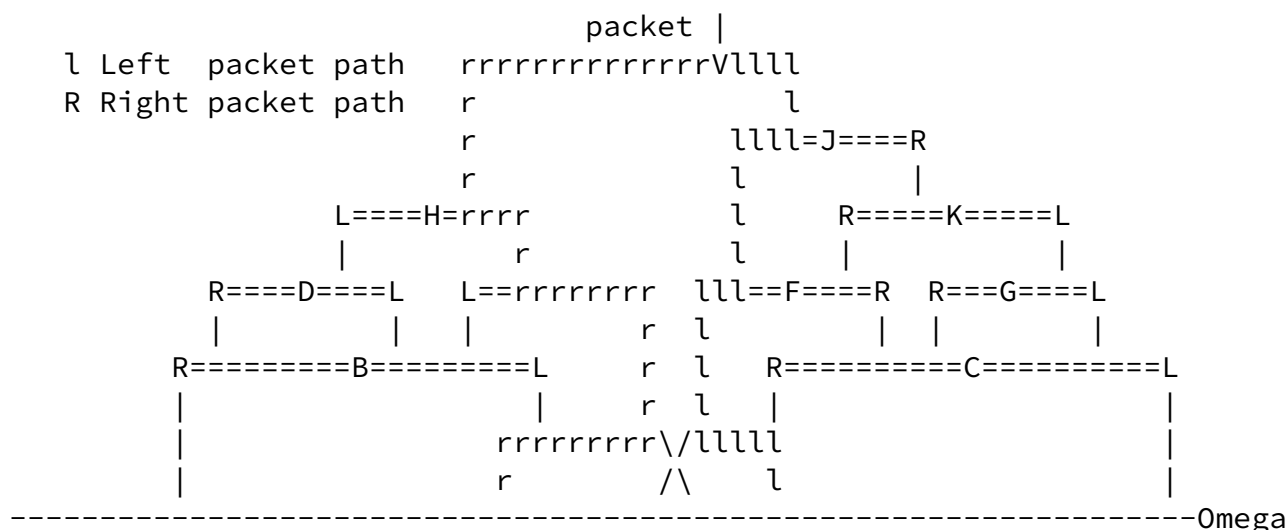
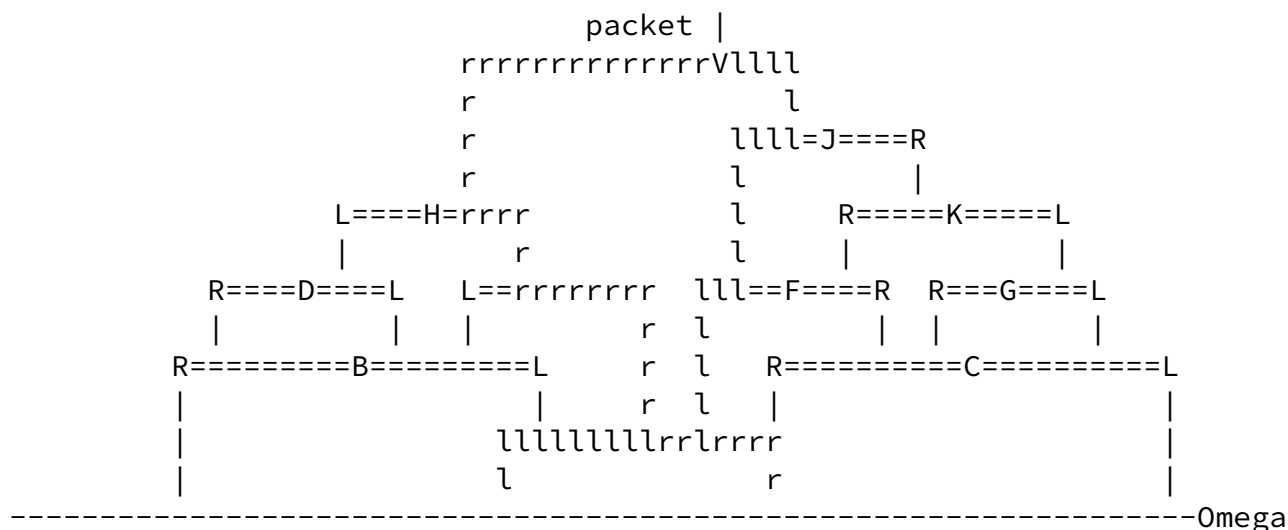
ARC bicasting

October 2013

- o The leg of an ARC between the cursor and the Edge inherits the side of the Edge. In a Comb, the whole buttressing ARC inherits the side of the Edge.
- o An Edge ending in Omega can arbitrarily become Left or Right as long as the basic rule is satisfied.
- o An Edge that does not end in Omega inherits the side of an ARC it terminates into, again as long as the basic rule is satisfied.
- o A collision occurs if all the Edges end up on the same side. The shortest path is used to resolve the collision and restore the basic rule: the Edge closer to Omega and all buttressing ARCs on the same side of the cursor keep the side, and the other Edges are toggled. In case of equal cost, an other tie breaker must be used.

- o For instance, this situation occurs in the representation above for ARC F, which has both ends ending in a Right side of ARCs, and since the Edge closer to Omega is the one that ends in ARC C, that Edge becomes Right and the other becomes Left.

Two copies of a same packet from a given node are forwarded downwards along opposite side of the cascading ARCs, each packet bearing an indication (such as a tag or a label) of its intended side, Left or Right.

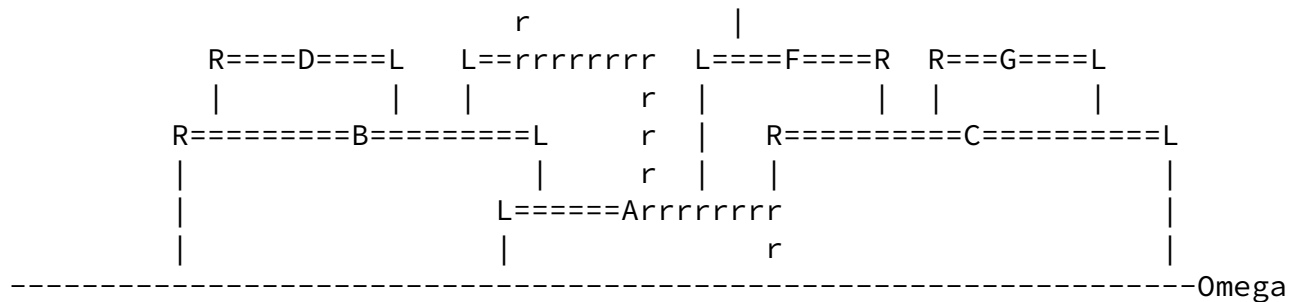


4. Upward Bicasting Operations

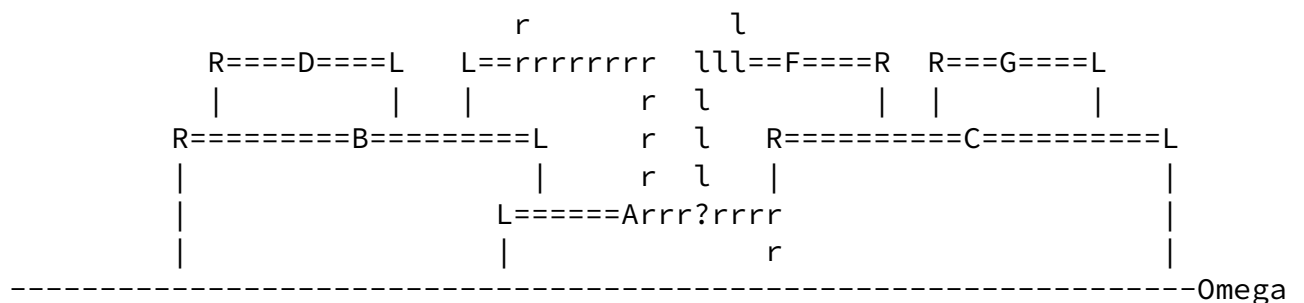
It is also possible with a downward bicasting to place states in the intermediate routers in order to provision an upward bicast path from Omega to a source D. In that case, if the graph is biconnected, it is possible to resolve the pathological cases so as to ensure a real separation of the left and Right paths.

4.1. Resolving crossing ARCs

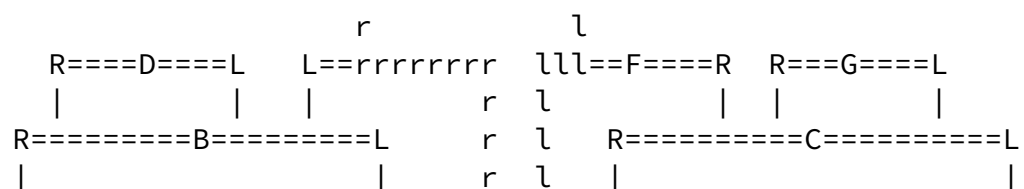
The first pathological case occurs when both Left and Right packet cross over the same ARC, as illustrated below. Say that the Right reservation comes first and sets up the right path:



Then comes the left reservation which collisions:



The segment between the two incoming point of the common ARC is common to both path and expose the bicasted traffic. The resolution is to leave the second packet through but prune the unwanted states along the collision segment of the ARC afterwards.



```

      |                               llllllllll==rrrrrr                               |
      |                               l                               r                               |
-----Omega

```

States along the ARC between the two incoming points are cleaned, up and the paths that were generated by the Left and Right packets are now crossed. This results in two non-congruent upward paths.

4.2. Single Point of Failure

The second pathological case occurs when both Left and Right packet reach a same ARC at the same node, which is this a Single Point Of Failure (SPoF) for both paths.

```

      r                               |
      R===D===L   L==rrrrrrrrr   L===F===R   R===G===L
      |           |           r   |           |           |
R=====B=====L   r /   R=====C=====L
      |           |           r/   |           |           |
      |           L=====A==rrrrrrr           |           |
      |           |           r           |           |
-----Omega

```

The resolution is to reject the second packet and send it back along the incoming ARC to exit on the other side. The rejected packet cleans up the states that it has created on its way back and then creates states on the other side of the ARC.

```

      r                               l
      R===D===L   L==rrrrrrrrr   llllllllll   R===G===L
      |           |           r   lll           l   |           |
R=====B=====L   r ll   R=====llllllllllllllllllll
      |           |           rll   |           |           l
      |           L=====Arrrrrrrr           |           l
      |           |           r           |           l
-----Omega

```

At this point the downward packet will exit the incoming ARC in the wrong side for its own indication.

```

      r                               l
      R===D===L   L==rrrrrrrrr   L=lllllllll   R===G===L
      |           |           r   |           l   |           |
R=====B=====L   r   |   R=====llllllllllllllllllll
      |           |           r   |           |           l
      |           L=====Arrrrrrrr           |           l
      |           |           r           |           l
-----Omega

```

This is in fact what happens also in the case of a monoconnected zone, or if a breakage cause the downward packet to bounce.

5. Applicability

5.1. In conjunction with Protocol Independent Multicast

Upwards bicasting can be used for Protocol Independent Multicast PIM [[RFC4601](#)] and Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths mLDP [[RFC6388](#)]. A bicasted downwards Join message would establish two non congruent return paths, each path joining the receiver and Omega that is the set of existing receivers.

6. Manageability

This specification describes a generic model. Protocols and management will come later

7. IANA Considerations

This specification does not require IANA action.

8. Security Considerations

This specification is not found to introduce new security threat.

9. Acknowledgements

Thubert & Wijnands

Expires April 19, 2014

[Page 7]

Internet-Draft

ARC bicasting

October 2013

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10. References

10.1. Normative References

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

10.2. Informative References

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[[RFC4601](#)] Fenner, B., Handley, M., Holbrook, H. and I. Kouvelas, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", [RFC 4601](#), August 2006.

[[RFC6388](#)] Wijnands, IJ., Minei, I., Kompella, K. and B. Thomas, "Label Distribution Protocol Extensions for Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths", [RFC 6388](#), November 2011.

Authors' Addresses

Pascal Thubert, editor
Cisco Systems, Inc
Village d'Entreprises Green Side
400, Avenue de Roumanille
Batiment T3
Biot - Sophia Antipolis, 06410
FRANCE

Phone: +33 497 23 26 34
Email: pthubert@cisco.com
IJsbrand Wijnands
Cisco Systems
De kleetlaan 6a
Diegem, 1831
Belgium

Email: ice@cisco.com

Thubert & Wijnands

Expires April 19, 2014

[Page 8]