### Inter-Area P2MP Segmented LSPs

draft-raggarwa-seamless-mcast-03.txt

R. Aggarwal (Juniper), Y. Rekhter (Juniper), T. Morin (France Telecom) I. Grosclaude (France Telecom), N. Leymann (Deutsche Telekom AG), S. Saad (AT&T)

## Inter-area P2MP Segmented LSPs for Multicast Goals (1)

Allow using different P2MP label distribution protocols within different IGP areas (e.g., area 0 uses RSVP-TE, while all other areas use mLDP)

Scope of P2MP LDP, P2MP RSVP-TE or ingress replication is limited to a given area

Follow the same principles as those of inter-area LSPs for unicast

 Segments of the inter-area P2MP LSPs are "stitched" at ABRs using BGP as the "stitching" protocol

Scale MPLS multicast infrastructure to potentially tens of thousands of PEs, by using hierarchy

- P-routers inside each area do not maintain state for inter-area P2MP segmented LSPs
- P-routers inside each area maintain state only for intra-area P2MP LSPs

## Inter-area P2MP Segmented LSPs for Multicast Goals (2)

BGP as the common inter-area and inter-AS label distribution protocol

In addition Inter-area P2MP segmented LSPs improve the efficiency of P2MP hierarchy

Inter-area P2MP segmented LSPs improve the bandwidth efficiency of ingress replication, when the P-tunnel data plane in each area is based on ingress replication

Applies to a multi-service infrastructure

- BGP MVPN
- VPLS
- Content multicast
- Internet multicast

#### Inter-area P2MP Segmented LSPs – data plane

An "Inter-area P2MP LSP" may comprise segments that use P2MP LSPs signaled using P2MP RSVP-TE or P2MP LDP

An "Inter-area P2MP LSP" may comprise segments that use only Ingress Replication

- A segment does not have to use P2MP label distribution protocols
- We will call this "Segmented Ingress Replication"

#### **Segmentation boundaries**

Q: How to decide on where to segment a given P2MP LSP?

A: Establish segmentation boundary, and segment a given P2MP LSP at the segmentation boundary

Q: What are the useful segmentation boundaries ?

A: Autonomous Systems (ASes), IGP areas

When P2MP LSP segmentation is performed at Autonomous System boundary, the current MVPN and Multicast VPLS specifications already specify procedures needed to create P2MP LSP Hierarchy (see draft-ietf-I3vpn-2547bis-mcast-bgp, draft-ietf-I2vpn-vpls-mcast)

Following slides provide an overview of the extension of these procedures when P2MP LSP segmentation is done at IGP areas Draft-raggarwa-mpls-seamless-mpls-multicast

#### Terminology

Ingress area: IGP area that contains the root PE of a P2MP LSP

A given P2MP LSP has exactly one ingress area

*Egress area*: IGP area that contains one or more leaf PEs of a P2MP LSP

- A given P2MP LSP may have one or more egress areas
  - As leaf PEs of a given P2MP LSP may reside in more than one area

*Ingress area segment*: for a given P2MP LSP it is its segment that is fully contained within the ingress area of that LSP

- Ingress PE as the root, with one or more ABRs in the ingress area as the leaves of that segment
- A given P2MP LSP has exactly one ingress area segment

*Egress area segment*: for a given P2MP LSP, it is its segment that is fully contained within an egress area of that LSP

- ABR in the egress area as the root, with one or more leaf PEs in the egress area as the leaf nodes
- A given P2MP LSP may have one or more egress area segments

**Backbone area segment:** for a given P2MP LSP, it is its segment that is fully contained within the Backbone area

- One of the ABRs in the ingress area as the root, with one or more ABRs in the egress area(s) as the leaf nodes
- A given P2MP LSP may have one or more backbone area segments

Aggregate P2MP LSP: an intra-area P2MP LSP that carries one or more segments



#### Inter-area P2MP Segmented LSPs Functionality

Discovery of the FEC of the Inter-area P2MP Segmented LSP

- Done by the application that utilizes Inter-area P2MP Segmented LSPs
- E.g., MVPN I/S-PMSI A-D route NLRI when the service is MVPN
- Auto-discovery of the leaves of an intra-area segment by the root of the segment done using BGP
  - E.g., Auto-discovery of all egress PEs in the egress area segment, by the egress ABR
  - If Ingress Replication is used then leaves also advertise the downstream assigned MPLS label that they bind to an intra-area segment

Binding of an intra-area P2MP LSP to an intra-area segment by the root and discovery by the leaves of this binding – done using BGP

Applicable only when intra-area P2MP LSPs are used

Signaling Intra-area LSPs

- P2P, MP2P or P2MP
- Not done by BGP

# P2MP LSP Hierarchy with Segmentation example: Egress Area (1)



#### P2MP LSP Hierarchy with Segmentation example: **EgMest\_&Pebl**(2) archy with Segmentation example:



#### P2MP LSP Hierarchy with Segmentation example: Ingress and Backbone Areas (1)



LSP4 aggregates ingress area segments of LSP1 and LSP2 • LSP4 is an aggregate LSP

Aggregation is controlled by the ingress PE (PE1)

LSP5 aggregates backbone area segments of LSP1 and LSP2 • LSP5 is an aggregate LSP

Aggregation is controlled by the ABR in the ingress area (ABR1)

P1 and P2 maintain state only for LSP4 (but not for LSP1 and LSP2)

only for LSP5 (but not for LSP1, and LSP2)

#### P2MP LSP Hierarchy with Segmentation example: Ingress and Backbone Areas (2)



To perform aggregation of the backbone area segments of LSP1 and LSP2:

ABR1 needs to know that ABR3 and ABR5 are the leaf nodes of these segments

ABR3 and ABR5 need to know the identity of LSP5, and the (upstream) labels that ABR1 assigns to these segments

To perform aggregation of the ingress area segments of LSP1 and LSP2:

PE1 needs to know that ABR1 is the leaf node of these segments

ABR1 needs to know the identity of LSP4, and the (upstream) labels that PE1 assigns to these segments

## P2MP LSP Hierarchy with Segmentation: putting things together

Root PE aggregates ingress area segments of the P2MP LSPs rooted at that PE

 With other ABRs in the ingress area as the leaf nodes of the (intraarea) aggregate P2MP LSP

ABR in the ingress area aggregates backbone area segments rooted at that ABR

 With ABRs in the egress area(s) as the leaf nodes of the (intraarea) aggregate P2MP LSP

ABR in the egress area aggregates egress area segments rooted at that ABR

 With egress PEs as the leaf nodes of the (intra-area) aggregate P2MP LSP

#### **Backbone Area with Ingress Replication**



ABR1 carries packets for backbone area segments of LSP1 and LSP2 using P2P or MP2P intra-area LSPs to ABR3 and ABR5

ABR1 needs to know that ABR3 and ABR5 are the leaf nodes of backbone area segments of LSP1 and LSP2 • ABR1 also needs to know the

downstream assigned labels that ABR3 and ABR5 assigned to these segments

ABRs perform only label switching

P3 and P4 maintain no additional state above and beyond what is (already) needed by unicast.



#### Placement of Ingress PEs and Egress PEs

Ingress PEs and egress PEs may be placed in the backbone area

Ingress PEs may be placed in the egress area or egress PEs may be placed in the ingress area

ABRs may act as ingress PEs and egress PEs to carry IP multicast over MPLS in the backbone area

 For example when the service is Internet Multicast and ingress and egress areas use PIM for carrying multicast

For example if the service is Multicast VPN and the P-tunnel technology in the ingress and egress areas uses PIM based IP/ GRE P-tunnels

 On the ABRs PIM signaling for such P-Tunnels is handled as per the ingress/egress PE Internet Multicast procedures in the draft.

#### Inter-area P2MP Segmented LSPs: Summary (1)

Inter-area P2MP LSPs are segmented at the IGP area boundaries

Inter-area Segmented P2MP LSPs can be used to realize Segmented Ingress Replication which significantly improves the efficiency of Ingress Replication

Compared to "Non-segmented" Ingress Replication

WHERE BERNER B

**Ingress Replication** 

Within each IGP area segments of inter-area P2MP LSPs are carried over intra-area aggregate P2MP LSPs or intra-area P2P or MP2P LSPs

Scope of the label distribution protocols for setting up intra-area

non-segmented P2MP LSPs

Autonomous system boundaries provide one possible segmentation boundary

IGP areas provide another possible segmentation boundaries P2MP LSPs that span multiple autonomous systems could be segmented both at the autonomous system boundaries, and at the IGP **accordented arcels** at the autonomous system boundaries, and at the IGP area boundaries

#### Inter-area P2MP Segmented LSPs: Summary (3)

Inter-area P2MP Segmented LSPs facilitates hiding dynamic multicast Inter-area P2MP Segmented LSPs facilitates hiding dynamic multicast P2MPibliofalton and Segmented LSPs facilitates hiding dynamic multicast on extending some of the recently developed architectural concepts P2MP Hierarchy with Segmentation outlined in this presentation relies on extending some of the recently developed architectural concepts