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# LIVE-LIVE TECHNOLOGY INCREASES MULTICAST RESILIENCY

Juniper Networks addresses the need for dynamic, end-to-end multicast resiliency with a sophisticated solution that combines standards-based restoration and innovative fast failover detection.

White Paper

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# EXECUTIVE SUMMARY

Service providers and enterprises alike are seeing a steady rise in the volume of IP multicast traffic on their networks, driven by media-rich applications such as IPTV and video conferencing, as well as content distribution applications such as stock market feeds and software distribution. The dramatic increase in IPTV is impacting service providers, in particular.

Many multicast applications are sensitive to delay, jitter, loss, or a combination of the three, so end-to-end resiliency and rapid recovery from failure events is critical. Historically, IP multicast has lacked resiliency mechanisms. Consequently, in the event of any type of network failure, multicast applications can suffer poor service quality or fail outright. For service providers, content distributors, and even their users, these application impacts can mean lost revenue. This paper explains how the innovative "Live-Live" technology from Juniper Networks addresses the multicast resiliency challenge.

## Introduction

Video applications that utilize multicast distribution are sensitive to delay, jitter, and packet loss—which can result in dropped video frames. Consequently, they require special handling across the network to accommodate their quality-of-service requirements and to meet customer/user expectations and service-level agreements (SLAs). This huge increase in video traffic has brought sharp focus to multicasting's long recovery times in the event of network failures, which results in packet delay, packet loss, or both, and can disrupt an application or even cause outright failure.

Commonly used multicast resiliency mechanisms have many deficiencies. For instance, RSVP-Traffic Engineering (RSVP-TE)- based MPLS fast reroute (FRR) operates locally to redirect traffic around a failure and onto a preset backup path. While this mechanism provides rapid restoration to multicast traffic within an MPLS tunnel, it doesn't address failures at the ingress device/provider edge or close to the source. At the same time, network architects who want to set up redundant multicast paths must manually configure dual feeds, creating considerable management overhead and constraining traffic to static paths. Both approaches fall far short of an ideal solution.

Juniper Networks is addressing the need for dynamic, end-to-end multicast resiliency and restoration with a sophisticated ”Live-Live" solution that combines standards-based restoration mechanisms with an innovative fast failover detection mechanism. By sending two live multicast streams over divergent, redundant paths across the network and responding rapidly to a wide range of failure scenarios, Live-Live technology ensures end-to-end protection with sub-50 milliseconds (ms) restoration.

With Live-Live, service providers and enterprises are protected against failures anywhere in the multicast path. Whether a link fails, an encoder goes down, or an ingress PE node stops working, a Live-Live implementation ensures that multicast traffic is delivered within the bounds of SLAs and application sensitivities.

## Multicast Resiliency Challenges

Traditional IP multicast recovery methods are slow because they involve a multistep process that relies on the underlying unicast topology configuration. Before disrupted multicast traffic can flow down a new path, the unicast topology needs to converge on new routes that can reach the multicast source. Once that's done, multicast protocols use that information to send join requests hop by hop from receivers toward the sender. The network then builds the appropriate distribution tree(s) from receivers to the source and establishes state.

[1] footnote to come

This process can take several seconds, which is long enough to cause many applications to fail[2]. This dependence on the unicast topology prevents consistent <50 ms recovery times for end-to-end multicast traffic, which is key to avoiding service disruption.

Another challenge is the variety of multicast applications and the different multicast technologies used to support them. For example, some multicast traffic is global in nature and available to subscribers from multiple organizations that are geographically widespread. Service providers typically support these types of applications using native multicast technologies, including Protocol Independent Multicast (PIM) and MPLS-based RSVP-TE and multicast LDP (MLDP).

Other multicast applications involve participants from the same company—this traffic is typically carried over a VPN. Network architects often use BGP-based multicast VPN (MVPN) solutions for these applications.

The industry has invested considerable engineering expertise and manpower to develop resiliency and recovery mechanisms for the various approaches to IP multicasting. These solutions primarily address network link, node, and path failures—that is, they operate at the link layer, within a provider tunnel, or both (for example, RSVP-TE-based FRR). However, legacy multicast restoration technologies don't address failures close to the source or at the ingress provider edge. And provisioning dual multicast feeds by creating static paths from source to egress is inflexible and operationally expensive.

Today, more than ever, service providers and enterprises need multicast resiliency and recovery mechanisms that dynamically address network failures, no matter where they occur. Providers need path diversity on both primary and backup paths, support for PE redundancy, and the ability for the network to switch rapidly from one incoming stream to another in less than 50 ms in the event of a failure.

## The Live-Live Solution from Juniper

Providing a comprehensive solution for multicast restoration, Live-Live technologies address the full spectrum of network failure scenarios, including the challenges inherent in global and VPN multicast usage. Live-Live speeds restoration by implementing fast failover to backup multicast paths and PE devices, which allows multicast traffic to continue to flow without waiting for unicast convergence. Juniper is implementing Live-Live on Juniper Networks® MX Series Universal Routing Platforms, which are based on Juniper Networks Trio Chipset.

For global applications based on native multicast protocols, Juniper offers Multicast Live-Live, which implements Multicast-only Fast Reroute (MoFRR) as defined by the IETF in RFC7431. For multicast VPNs, Juniper offers MVPN Live-Live, which combines technology defined by the IETF in RFC9026 with Juniper's unique approach to fast failover detection. The following sections discuss each approach in detail.

### Multicast Live-Live

Multicast Live-Live implements MoFRR, a fast reroute approach that leverages the two-plane topology that many service providers have adopted to eliminate single points of failure in their network core. MoFRR takes advantage of these fully disjointed planes to pre-build a secondary multicast tree.

Multicast Live-Live uses this dual-plane capability to send two multicast traffic streams to each egress router (PE router), which is able to switch quickly from one stream to the other in the event of a link or node failure on the primary path. Because failover paths are pre-built, MoFRR enables fast convergence, which limits traffic loss to levels acceptable for most applications.

Ideal for service providers and other organizations that need native multicast resiliency in the global context, Juniper's Multicast Live-Live supports two architectures:

- **IP-based network cores**: For organizations with network cores that run IP end to end, Multicast Live-Live enables receiver PE devices to send two native PIM joins to form the multicast tree.
- **MPLS in-band signaling**: For organizations that run MLDP in their core, Multicast Live-Live enables PE devices to use MLDP in-band signaling to convert PIM control messages into MLDP messages and send the equivalent of multicast joins over MLDP.

[2] Convergence times for Protocol Independent Multicast (PIM) are particularly long, often exceeding tens of seconds.

### How MoFRR Works

MoFRR doesn't require new protocols. Rather, it makes simple changes to the way routers use PIM and MLDP. When MoFRR is enabled on an egress router, that router sets up a multicast tree on both the primary path and the backup path to each multicast source. During normal operation, the egress PE device forwards traffic on the primary path and discards the traffic received on the backup path. If there's a link or node failure on the primary path, the backup path is automatically made the primary path and a new backup path is established using PIM for IP-based cores and MLDP for MPLS-based cores. (With MLDP MoFRR, MPLS streams are duplicated and sent along the primary and backup paths.

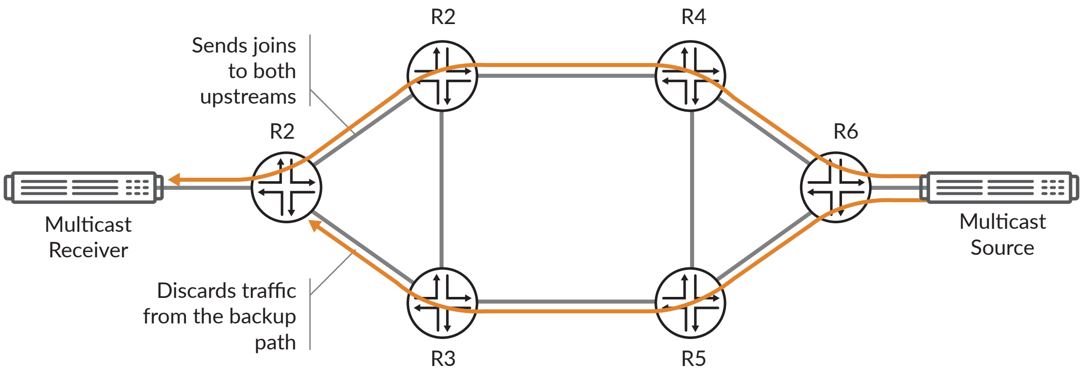
R2
R4
Sends joins to both upstreams
R2
R6
Multicast Receiver
Multicast Source
Discards traffic from the backup path
R3
R5

*Figure 1: Multicast-only Fast Reroute (MoFRR) implementation*

MoFRR achieves its fast rerouting by operating in a local context. That is, at each merge point, a router enabled with MoFRR determines a primary and a secondary upstream multicast hop (UMH) and joins the multicast tree via both UMHs simultaneously. The primary and secondary UMHs have local context, but no end-to-end context.

Again, under normal operation, the multicast stream that a UMH receives over the primary path is accepted and forwarded to the downstream receivers, while the copy of the stream received from the secondary UMH is discarded.

With Live-Live, when a router detects a local link failure on the path to the primary UMH, Live-Live technology automatically triggers a switchover to the secondary UMH. This local repair happens quickly, without a waiting period for unicast routing protocols to detect the failure. As a result, convergence occurs rapidly, in less than 50 ms. Leveraging MoFRR, Multicast Live-Live speeds restoration by pre-building backup multicast trees and rapidly switching traffic to the backup path in the event of a failure.

### MVPN Live-Live

MVPN Live-Live provides redundancy and resiliency for multicast in MPLS/BGP-based VPNs. Like Multicast Live-Live, MVPN Live-Live reduces the convergence time needed to recover from a failure. This is a local procedure on an egress PE device, so failover occurs rapidly, without the need for—or the time delay associated with—unicast route convergence.

Since VPNs are implemented using tunnels, MVPNs require slightly different resiliency and recovery mechanisms than native multicast traffic. For example, RFC9026 defines how downstream PE devices can select an upstream multicast hop based on the status of provider tunnels, and extends BGP MVPN routing so that a customer's multicast route can be advertised toward a backup upstream PE device. Juniper leverages these capabilities to enable hot leaf standby, which encompasses both establishing backup PE devices and a mechanism for rapid failover.

With MVPN Live-Live, egress PE devices can send multiple joins for the same traffic stream. Consequently, an egress or downstream PE device can receive redundant multicast streams from a source that is multihomed to two or more sender or upstream PE devices. Legacy MVPNs, however, were not designed to detect traffic arriving on two different tunnels. To prevent duplication of traffic, MVPN Live-Live ensures the downstream PE device uses sender- based reverse path forwarding (RPF) to forward only one copy to its receivers.

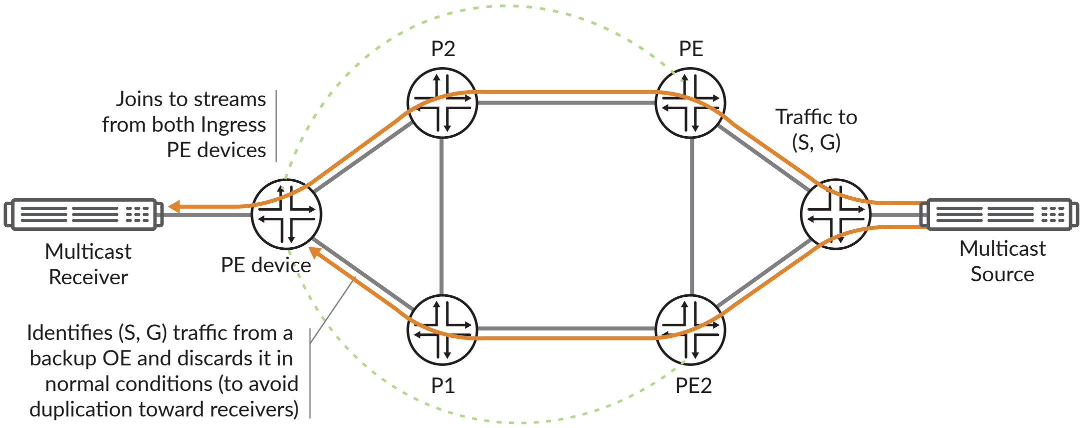
P2
PE
Joins to streams from both Ingress PE devices
Traffic to (S, G)
Multicast Receiver
PE device
Multicast Source
Identifies (S, G) traffic from a backup OE and discards it in normal conditions (to avoid duplication toward receivers)
P1
PE2

*Figure 2: Multicast VPN (MVPN) implementation*

Detecting a failure is key to providing fast failover. Since multicast streams with tight SLAs are often characterized by a continuous high packet rate, Juniper monitors multicast stream characteristics to detect any failures in the primary path.

Specifically, MVPN Live-Live technology monitors the data rate at the egress PE device. If the rate falls below a (user) specified threshold, MVPN Live-Live switches the multicast traffic to a backup PE device in a few tens of milliseconds. By using multicast traffic rate monitoring to implement fast failover for NG-MVPNs, Juniper is able to deliver <50 ms restoration times.

## Conclusion: Keep Traffic Flowing

With the volume of multicast traffic steadily increasing, service providers and enterprises need resiliency and recovery mechanisms that keep video and other sensitive traffic flowing in the event of a network failure. With Live-Live technology, Juniper provides a comprehensive solution for restoration that addresses all failure scenarios with sub-50 ms failover times, so that quality of experience is not impacted, and SLAs are upheld. Whether multicast traffic is global in nature or carried over a VPN, and whether a failure occurs in the core, on an encoder, or anywhere between the source and egress PE device, Juniper's solution provides rapid restoration.

With Live-Live, service providers and enterprises can meet user expectations and SLAs while cutting operational expenses. By automatically setting up redundant paths and PE devices and using a unique approach to fast failover detection, Live-Live eliminates the need for time-consuming manual configuration. In addition, Live- Live accommodates the dynamic nature of multicast traffic, so applications are never interrupted.

## About Juniper Networks

At Juniper Networks, we are dedicated to dramatically simplifying network operations and driving superior experiences for end users. Our solutions deliver industry-leading insight, automation, security and AI to drive real business results. We believe that powering connections will bring us closer together while empowering us all to solve the world's greatest challenges of well-being, sustainability and equality.

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