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White Paper

BUILDING HIGHLY RELIABLE MEDIA TRANSPORTS IN BROADCAST NETWORKS

Increase business agility and network scalability by orchestrating seamless protection of media streams

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Television programming simply can't go dark. People are passionate about their sci-fi shows, cartoons, and news channels. Sporting events draw huge audiences, and stunning clarity brings the game to life.

But the challenge of meeting viewers' and studios' expectations is growing. More ultra-high-definition video is being produced and distributed over broadcasters' network backbones. More stadium events are being produced remotely and broadcast in real time to viewers.

This white paper explores steps that broadcasters and network architects can take to build a highly resilient wide-area network and protect against unforeseen disruptions that could negatively impact the viewer or studio experience.

Introduction

Broadcasters' wide-area transport networks are under pressure as 4K and 8K video become mainstream and more live events are produced remotely. Broadcasters need an enterprise WAN that delivers scalable capacity and uncompromising reliability, ensuring that huge volumes of ultra-HD video can be transported and that unforeseen outages don't impact viewer or studio experiences.

Broadcasters and network architects can follow industry best practices to ensure guaranteed delivery of video, whether for creation or distribution. The Society of Motion Picture Television Engineers (SMPTE) created a set of standards to describe best practices for sending digital video over an IP network. The SMPTE ST 2022-7 standard describes the seamless protection of media streams over the IP network.

Utilizing an SDN controller, such as Juniper® Paragon Pathfinder (formerly NorthStar Controller), is critical to orchestrate the requirements of SMPTE ST 2022-7 and the transport network. An SDN controller automates the complex job of guaranteed video delivery, enabling greater scalability and efficiency.

Deliver Exceptional Viewer Experiences with Scalable Networks

Broadcasters' transport networks are designed to meet exacting requirements, but bandwidth demands are growing rapidly.

Production and media workflows are increasingly ultra-HD and uncompressed. A single stream of 4K ultra-HD video consumes 12 Gbps, which is 4X the bandwidth of an HD video. And as 8K content comes to fruition, a single stream will consume 48 Gbps of bandwidth.

Remote production of live events puts significant pressure on the WAN. Broadcasters are looking to remote production to reduce the cost of event production, increase agility, and speed consumption. But for remote production to deliver on its promise, the WAN must guarantee delivery of massive media volumes.

During an event, cameras are feeding a steady stream of raw video over the network to the remote production gallery, where it is edited and packaged for distribution to viewers in real time. An event with 12 ultra-HD cameras requires the network to flawlessly transport 144 Gbps of media. Looking ahead at 8K cameras, a live event will require 576 Gbps of uncompressed video to be sent from the venue to the studio in real time.

Ensure Guaranteed Delivery of Media Streams with Path Diversity

A cut fiber, equipment failure, or unplanned event cannot disrupt TV programming. The transport network must guarantee delivery of media, whether for contribution or distribution purposes.

SDN is the key to achieving guaranteed delivery of media with the agility and efficiency demanded by broadcasting today. The foundation is an MPLS network designed for scalable capacity, uncompromising reliability, and quality of service from end to end.

Figure 1 illustrates how one major European satellite television platform orchestrates seamless protection of its digital media channels over a redundant MPLS transport network. Each broadcast site is connected to the network through a pair of dual-homed provider edge (PE) routers, such as Juniper Networks® MX Series Universal Routing Platforms. The media streams are duplicated, with each Real-Time Transport Protocol (RTP) stream traveling over a different path to the customer sites. The two paths do not share the same fates. A fiber cut or router failure on one path will not affect delivery of the media.

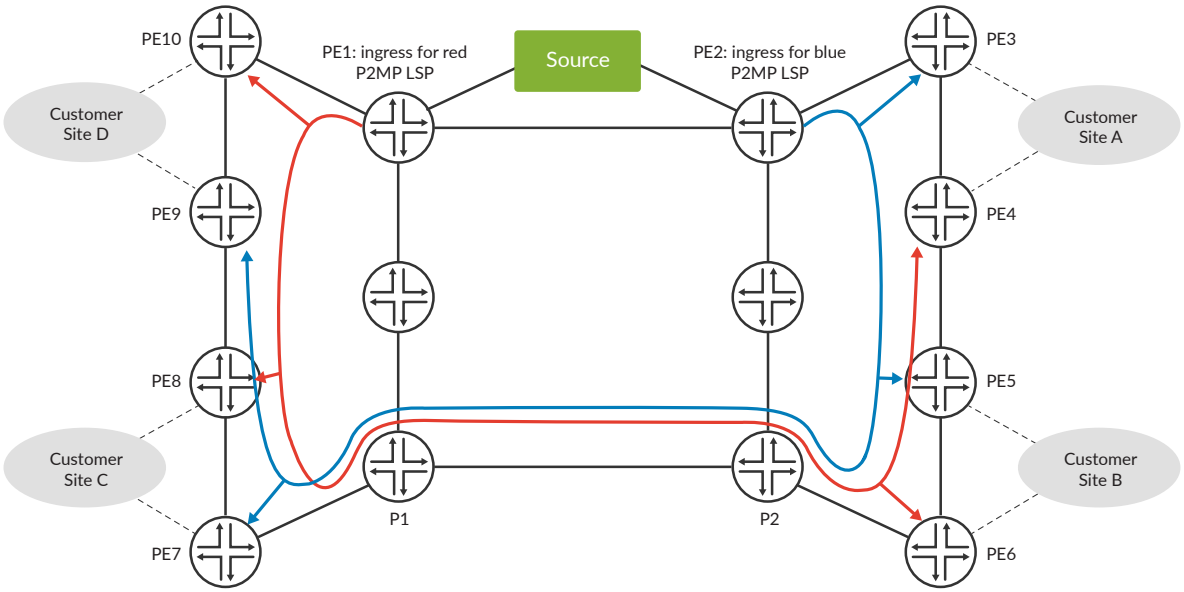

Figure 1: To ensure guaranteed delivery of media through path diversity, each customer site is dual-homed to a pair of PE routers. One router is served by the red P2MP LSP, and the other router is served by the blue P2MP LSP.

Because the RTP streams are sent through completely different paths, the packets generally are not received at the same time. If packets from one path are lost, the data can be constructed from the second stream. It's called "seamless" because switching between streams is instantaneous and doesn't impact the content and user experience.

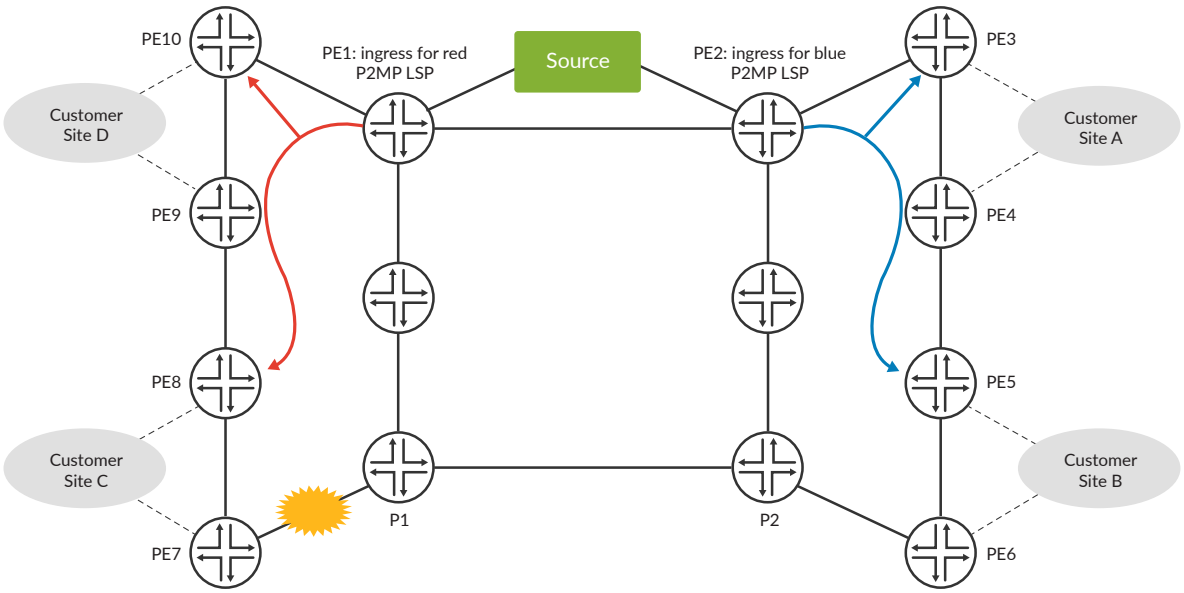

Figure 2: With path diversity and seamless protection, if any node or link breaks, each site will be served by at least one point-to-multipoint label-switched path (LSP), so there is no service interruption and media is delivered flawlessly.

If there's an outage between P Router #1 and PE Router #7 (as shown in Figure 2), the entire stream is taken from the other path. If any node or link breaks entirely, each site will still be served by at least one point-to-multipoint (P2MP) connection. Either way, the media stream is actively protected against failure and there is no interruption to the viewer or producer experience.

To achieve SMPTE ST 2022-7 seamless protection, the MPLS network uses pairs of path-diverse traffic-engineered LSPs (TE-LSPs) to carry the duplicate streams. RSVP-Traffic Engineering (RSVP-TE) P2MP LSPs are the technology of choice to deliver multicast content. A P2MP LSP has a single source and multiple destination addresses. By taking advantage of the MPLS packet replication capability, P2MP LSPs avoid unnecessary packet replication at the ingress router, as packet replication only takes place when the packets are forwarded to multiple destinations requiring different network paths.

Broadcasters can also leverage BGP/MPLS IP VPNs for multicast traffic, which enables multitenancy and isolation between different customers or business units that share the same physical infrastructure. Thus, each customer or business unit has its own dedicated P2MP LSPs with guaranteed bandwidth and service levels so that its media is not impacted by other customers' traffic or business requirements.

Automate Guaranteed Delivery with Paragon Pathfinder

Assuring seamless protection of media with manual processes is simply not practical. Few network teams would choose to calculate diverse routes for each video feed and make router configuration changes at the command line. It's an onerous, error-prone process that should be automated.

Using an SDN controller can streamline the work of guaranteed delivery using SMPTE ST 2022-7 by automating and orchestrating seamless protection.

Juniper Paragon Pathfinder is a cloud-native controller that simplifies traffic engineering and efficiently orchestrates guaranteed media delivery in a multivendor network. With Paragon Pathfinder, broadcasters can meet their viewer and studio expectations through automated network planning, provisioning, and monitoring. Broadcast network operators can be assured of the necessary predictability, resiliency, and service-level guarantees. Automating path computation and P2MP LSP creation with Paragon Pathfinder delivers massive time savings and protects against manual errors that could otherwise impact service quality.

Figure 3 shows Paragon Pathfinder being used to orchestrate guaranteed delivery of media for remote production of a sports event. The source cameras are feeding raw video over the wide-area network to the studio.

The broadcast orchestration and control system communicate directly with Paragon Pathfinder through a Representational State Transfer (REST) API, requesting the setup of the media flow. Paragon Pathfinder performs the detailed calculations required to enable diverse paths from end to end and then creates the P2MP LSPs in real time. Path computation takes into account the bandwidth requirements of the media stream, and only uses links that can support that capacity.

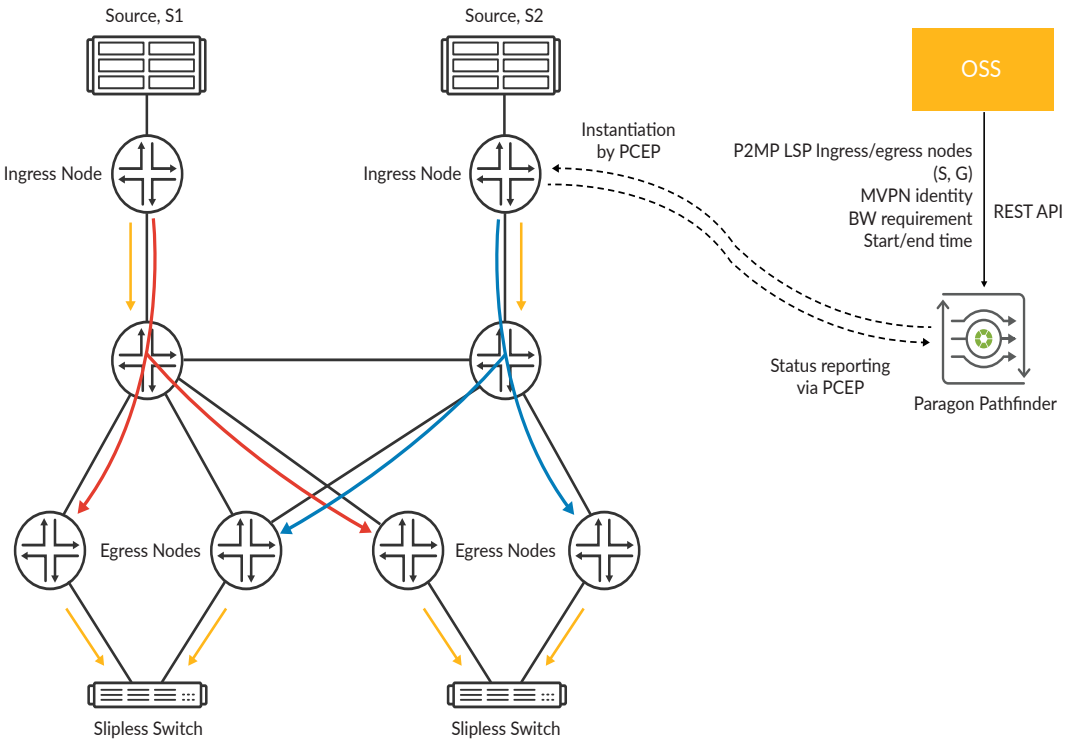

Figure 3: Media flow instantiation via Paragon Pathfinder

Behind the scenes, Paragon Pathfinder leverages the IETF Path Computation Element Communications Protocol (PCEP) to request the ingress router to set up the path that the controller has already computed. PCEP is an industry standard protocol that carries the flow mapping information, such as the route distinguisher of the multicast VPN and the multicast source and destination addresses. Paragon Pathfinder then instantiates the P2MP LSPs and binds them to the multicast VPNs.

If it is not possible to create two mutually exclusive paths for a media stream, Paragon Pathfinder computes the paths with the maximum diversity to mitigate the risk of disruption. If business requirements dictate, the request can be deliberately denied, allowing network team to step in, investigate, and make a business decision.

Using Paragon Pathfinder to calculate the diverse paths and orchestrate the instantiation of the P2MP LSPs delivers significant agility and time savings.

Paragon Pathfinder also provides an advantage over using broadcast orchestration and control systems that leverage Network Configuration Protocol (NETCONF) to create the P2MP LSPs. PCEP provides a standards-based approach, in order to enable interoperability between different vendors. Paragon Pathfinder operates directly at the network layer, enabling it to calculate and instantiate diverse paths immediately, mitigating the risk of dead air.

Paragon Pathfinder can be instrumental in planning for events or business growth as well. For example, network teams can use Paragon Pathfinder to ensure that the network has sufficient capacity to support a stadium event. Diverse path computation and bandwidth requirements for cameras, broadcast trucks, or remote studios can be taken into account prior to the event.

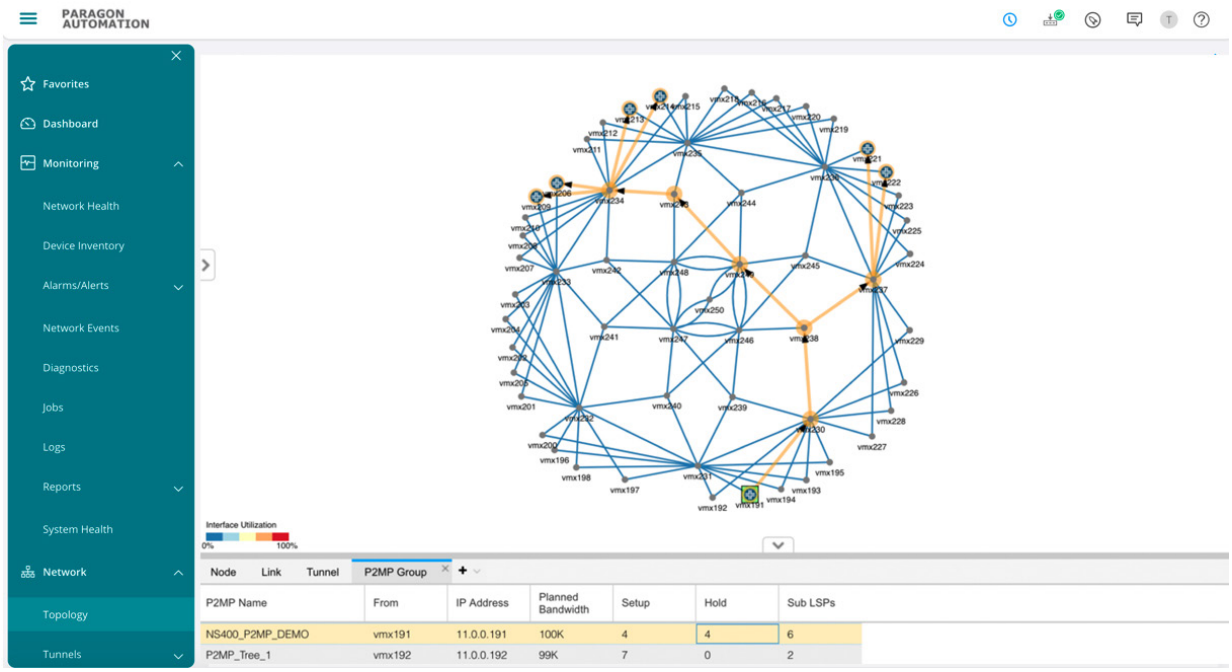

Figure 4: Paragon Pathfinder shows the visualization of one media stream from the ingress router (the green box at the bottom) to the egress router at the top.

Paragon Pathfinder provides real-time visibility of the network topology and monitors the status of the live P2MP LSPs and associated traffic statistics (see Figure 4). This gives the network operations team ongoing visibility into the network health.

Paragon Pathfinder can be used for failure simulation as a function of time against the bookings calendar, ensuring that all of the bookings, current and future, will be properly served over the MPLS network even in the event of the failure of some network elements. Such simulations can also be used to prepare the business for growth.

Conclusion—Efficiently Scale to Meet Evolving Business Requirements

As your business meets the challenges of rising viewer expectations, 8K media, and a growing demand for live sports events, you can take steps to ensure the flawless delivery of video streams from end to end with an agile network that simplifies the challenge of ensuring path diversity for duplicate media streams. Paragon Pathfinder eliminates the manual work of identifying and creating diverse paths, giving broadcasters the control, scalability, and efficiency they need to produce and deliver engaging programming to viewers.

Glossary

BGP/MPLS IP VPNs are a mechanism by which providers can use their IP backbones to provide Layer 3 VPN services to their customers.

Multiprotocol Label Switching (MPLS) is a method for engineering traffic paths by assigning short labels to network packets that describe how to forward them through the network.

NorthStar Controller has been renamed Paragon Pathfinder.

Paragon Pathfinder is Juniper's cloud-native SDN controller that simplifies traffic engineering and efficiently orchestrates guaranteed media delivery. Broadcasters and network architects can use Paragon Pathfinder to automate network planning, provisioning, and monitoring. Paragon Pathfinder was formerly known as NorthStar Controller.

Path Computation Element (PCE) is a component, application, or network node that can compute a network path or route based on a network graph and apply computational constraints.

Path Computation Element Protocol (PCEP) is described in RFC 5440 and enables communications between a client application requesting a path computation and the path computation element.

Point-to-Multipoint Label Switched Path (P2MP) is an LSP with a single source and multiple destinations. By taking advantage of the MPLS packet replication capability, point-to-multipoint LSPs avoid unnecessary packet replication at the ingress router. Packet replication takes place only when packets are forwarded to two or more destinations requiring different network paths.

Real-time Transport Protocol (RTP) is used for delivering audio and video over IP networks.

SDN controller is software that performs the functions of network orchestration, management, analytics, and automation in a software-defined (SDN) network.

Seamless protection switching enables the guaranteed delivery of video. The raw video feed is duplicated, and the duplicate streams take unique paths across the wide-area network. Switching from one path to another occurs without impact on the content of the stream.

SMPTE 2022 is a standard from the Society of Motion Picture and Television Engineers (SMPTE) that describes how to send digital video over an IP network.

SMPTE is Society of Motion Picture and Television Engineers

SMPTE ST 2022-7 is a standard that defines the requirements for multiple redundant streams of RTP packets to allow for the creation of a single reconstructed output stream through seamless protection switching at the RTP datagram level. describes the seamless protection switching of IP data grams.

Software-defined networking (SDN) is an approach to network virtualization that seeks to optimize network resources and quickly adapt networks to changing business needs, applications and traffic.

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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