SMPTE 2110 Topologies & the Benefits of Network Orchestration

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IP SHOWCASE

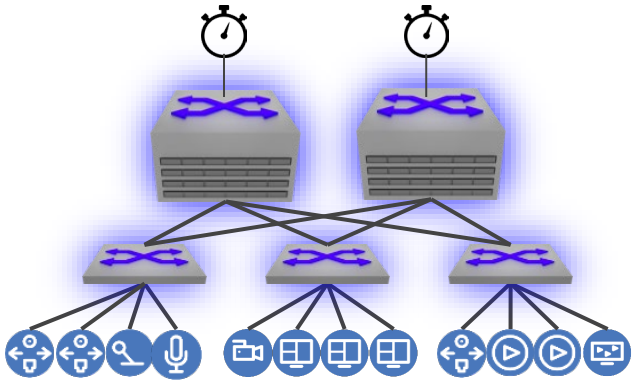
Audio Engineering Society · AIMS Alliance for IP Media Solutions · AMWA Networked Media. Working. · EBU · SMPTE · VSF Video Services Forum

Architectural Options – Things to Think About

- What Will Impact Your Topology?
  - Which switch platforms should we use?
  - How resilient will the network be?
  - What will the topology be? Monolithic or Spine -Leaf? Physical layout of facility
  - How much do you see this system growing?
  - If we will be using Layer 2 or Layer 3?
  - If the networks will be red/blue or purple?
  - If we use SSM? Or ASM? Or Static Multicast? Or ALL?
  - What about our oversubscription ratio?

Most Common SMPTE 2110 Topologies

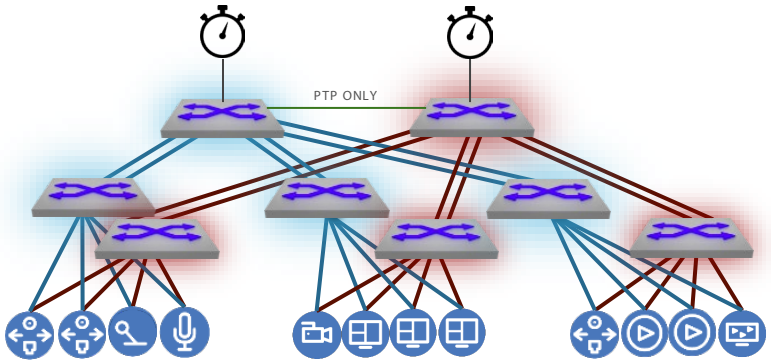
Shared Fabric
Spine and Leaf



Any Media Note TX to RX for full resiliency. Scaled bandwidth between Spines for failure domain redundancy.

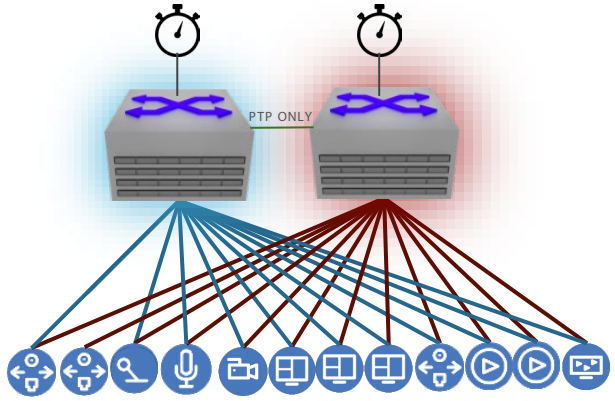
Red & Blue Networks "Air Gap Design"
SMPTE ST-2022-7

Spine / Leaf



Separate Red and Blue Spine / Leaf topology. Media Nodes w/ connection to both Red and Blue.

Spline- / Monolithic

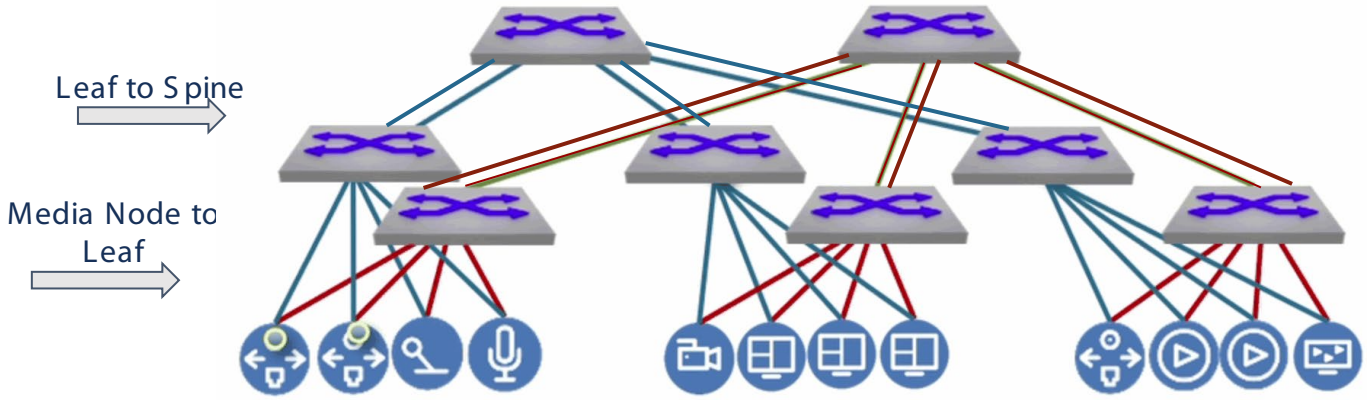


Separate Red and Blue monolithic switch topology. Media Nodes w/ connection to both Red and Blue.

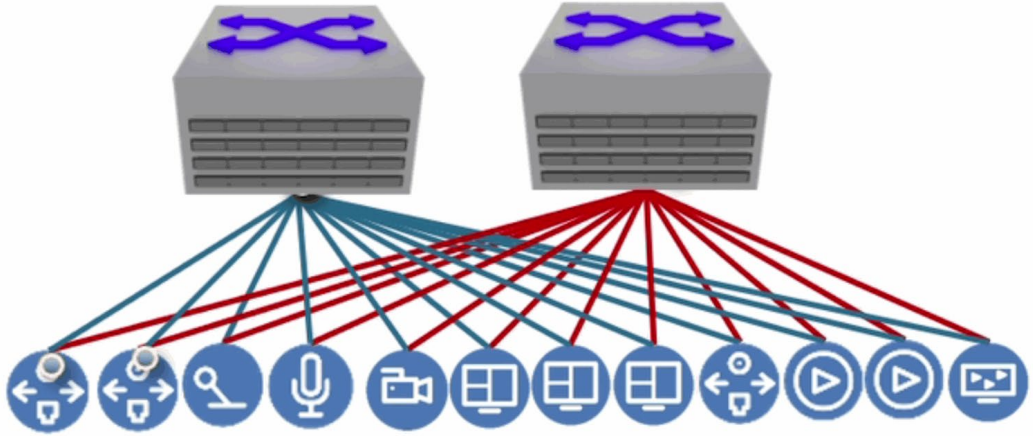
Bandwidth Through The Network

Considerations for Large Networks

- **Inter-Switch Bandwidth**
- Route between Spines and Leafs
- IGMP Snooping Querier and Querier IP Address on each Leaf
- Multiple Spine / Leaf Connections for Redundancy and Load Sharing
- Some typical endpoints are 100G native, capable of sending and receiving near 90Gbps
- Workflows call for dynamic switches of senders to receivers, with bandwidths constantly changing. Possibly hundreds of multicast routes changing in one button push

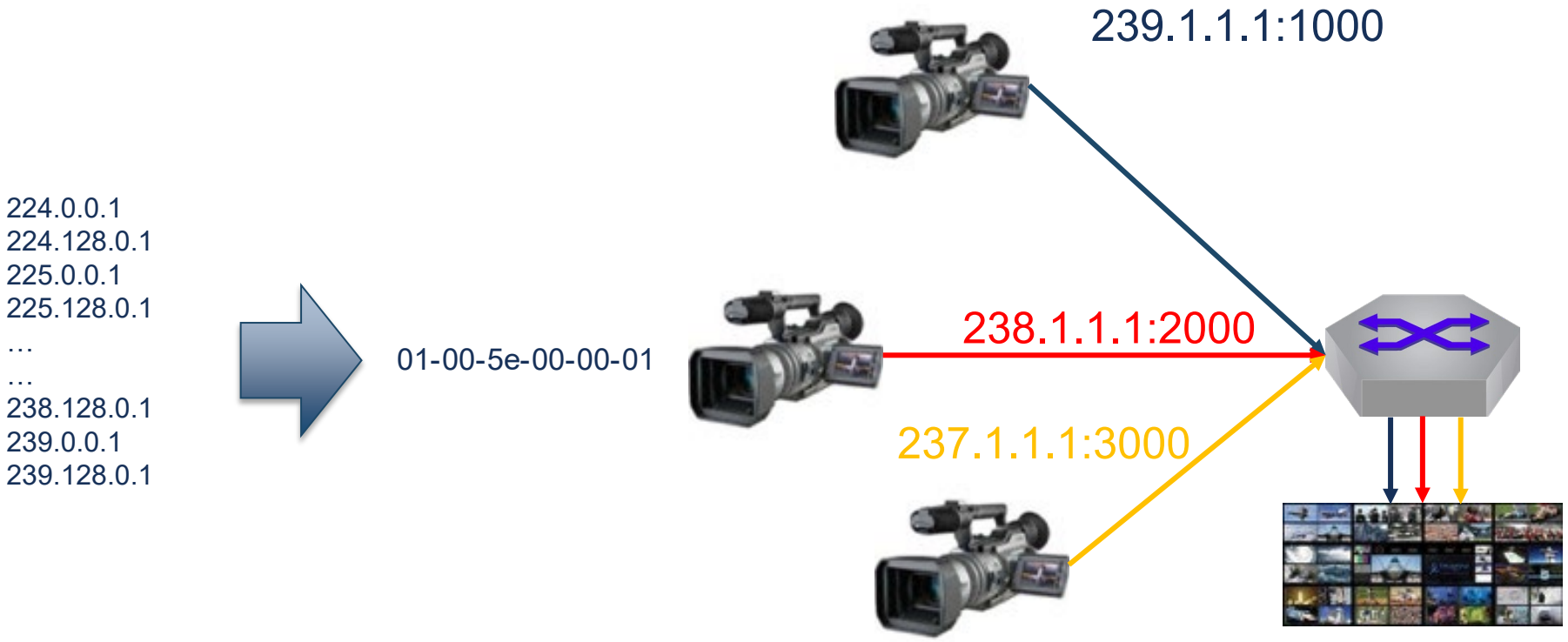


Format	Gen Pkt Mod	Per 10G	Per 40G	Per 100G
720p59.94	1.176 Gbps	7	30	80
1080i59.94	1.325 Gbps	6	26	65
1080p59.94	2.650 Gbps	3	13	35
2160p59.94	10.600 Gbps	~1	3	8
4320p59.94	42.397 Gbps			2



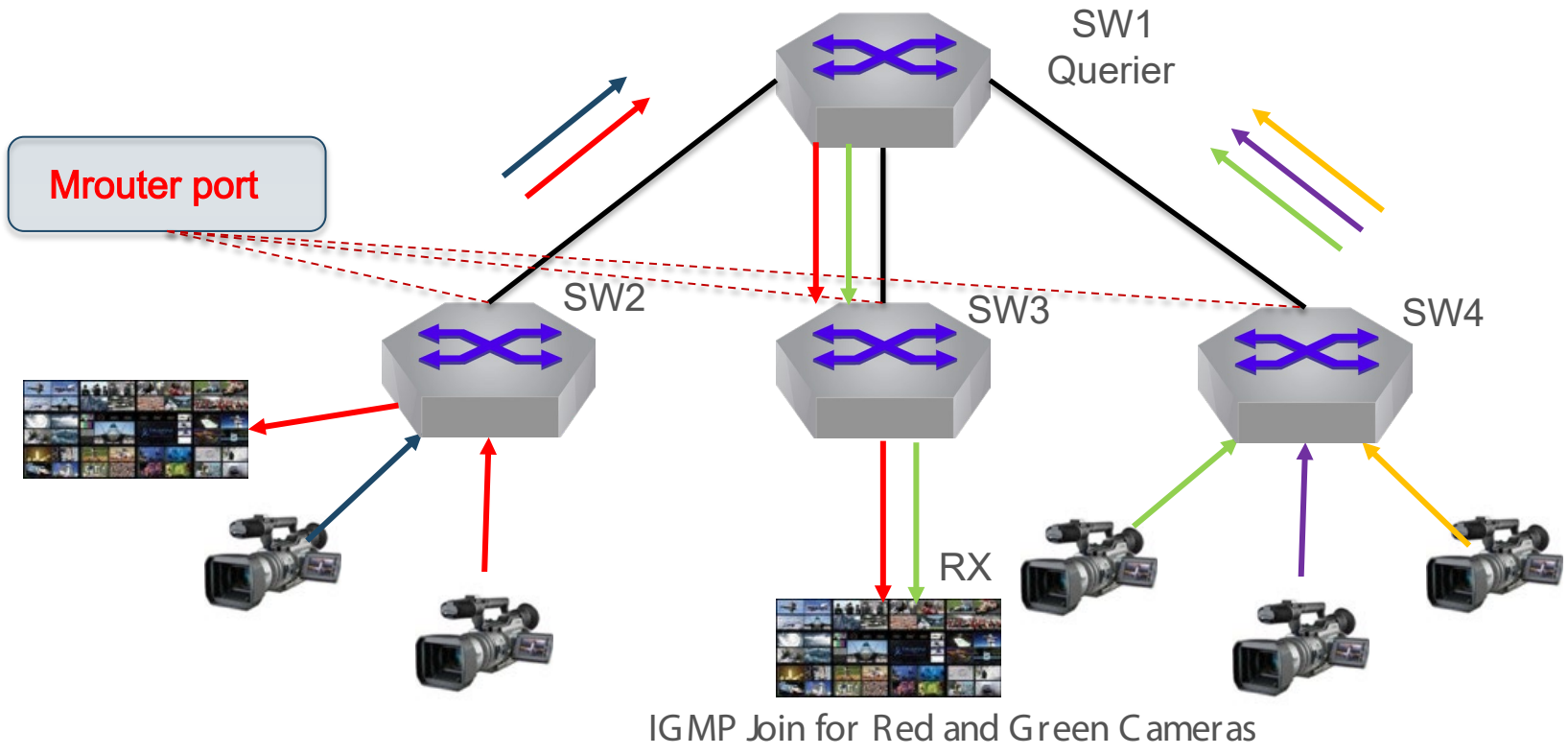
“Fun” With L2 Multicast

- L2 aliasing
- All multicast MACs start with 01-00-5e, while first 4 bits of multicast IPs are 1110
- 28 more bits per multicast address to be converted to the MAC, but only 23 bits are available for the conversion
- 5 most significant bits of multicast addresses are ignored, leading to 32 multicast addresses per MAC address!



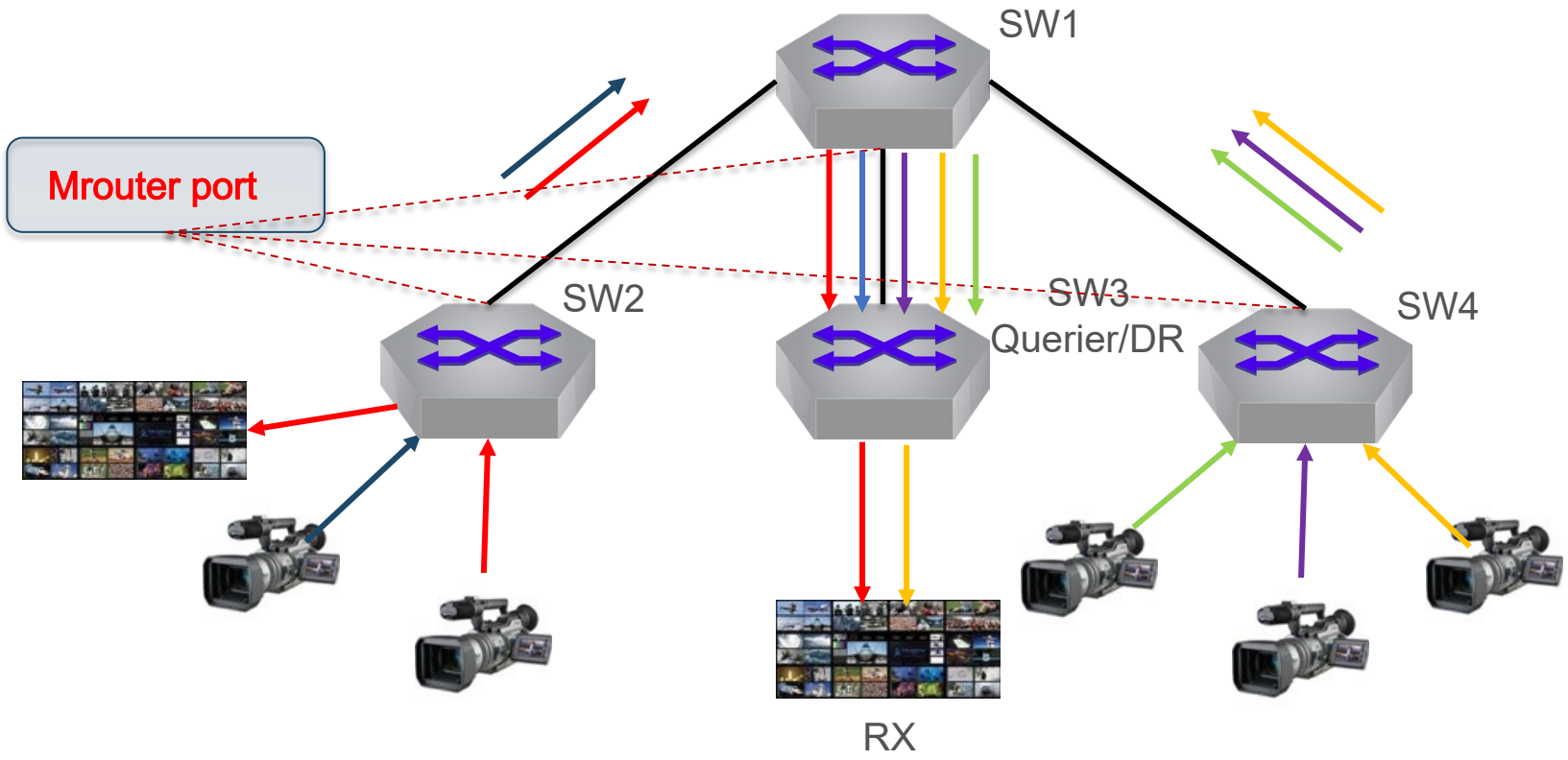
L2 Multicast – Impact of the Querier

- Layer 2 Multicast networks can be implemented for video applications
  - Multicast is forwarded to the IGMP Querier
  - Expansion can be tricky – because of the Querier – and the ensuing forwarding of multicast traffic



L2 Multicast – Impact of the Querier

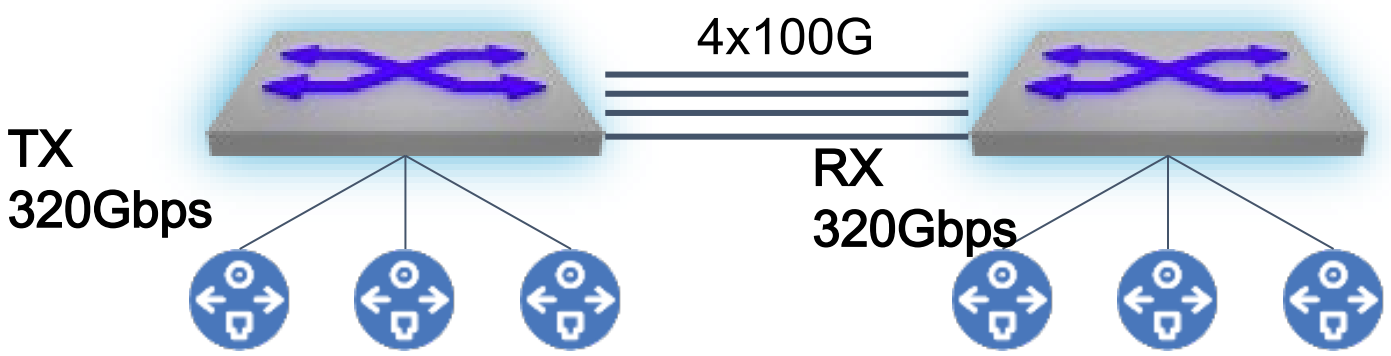
What happens when the Querier is not on the spine, but on a leaf?



IGMP Join for Red and Brown Cameras

Fix with PIM - Enter: Multicast Hashing

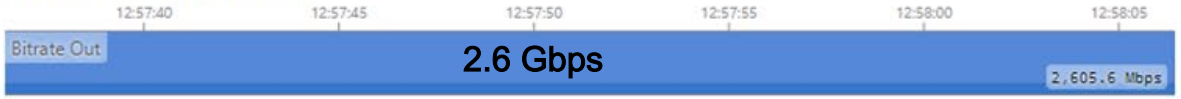
- **Existing limitations**
  - PIM/IGMP/LAG are not bandwidth aware
  - No standardized way to enforce stream state and bandwidth
  - Hashing algorithm is based on :
    - Multicast Group
    - Multicast Source Address
    - Next Hop Address



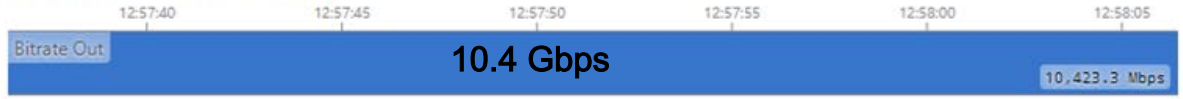
  - **Question:** Is this small network below a blocking or non-blocking topology?

Uneven Multicast Distribution…

Ethernet49/1 on media-leaf-1

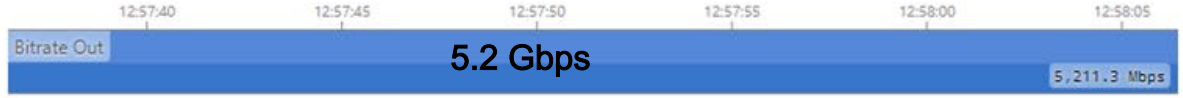


Ethernet50/1 on media-leaf-1

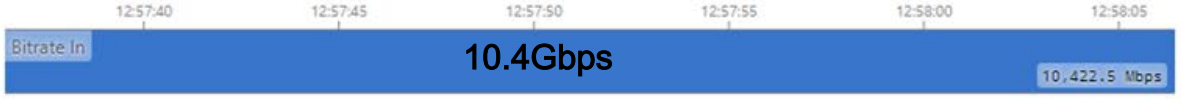


Ethernet51/1 on media-leaf-1

Ethernet52/1 on media-leaf-1



Ethernet49/1 on media-leaf-2



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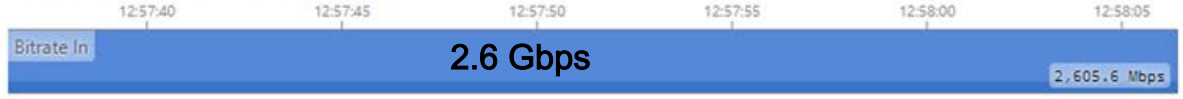

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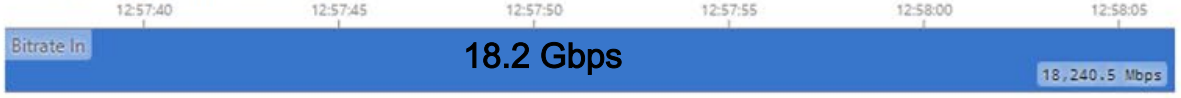
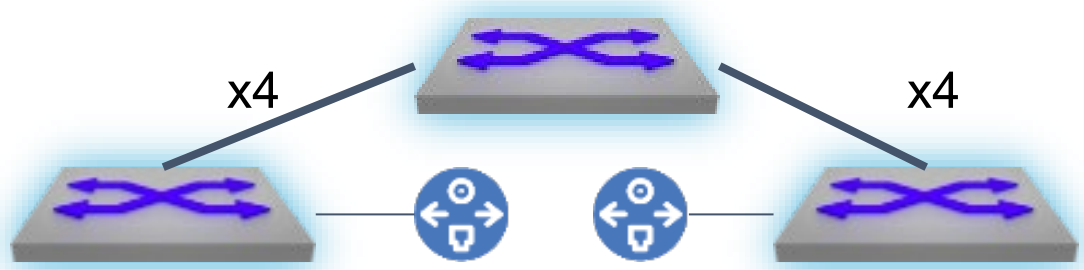
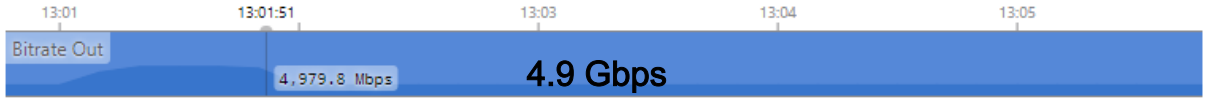


Ethernet52/1 on media-leaf-2



… Now With a Link Failure

Ethernet49/1 on media-leaf-1



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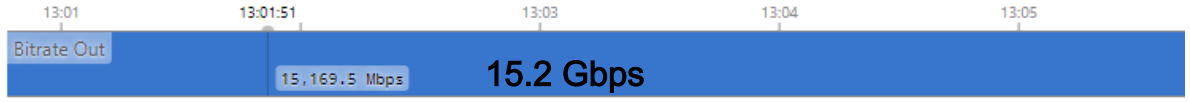

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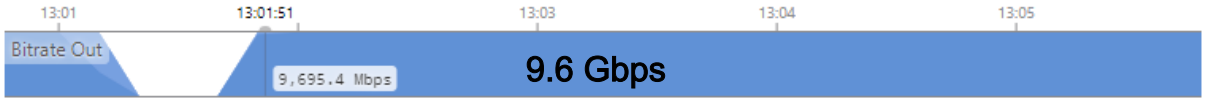

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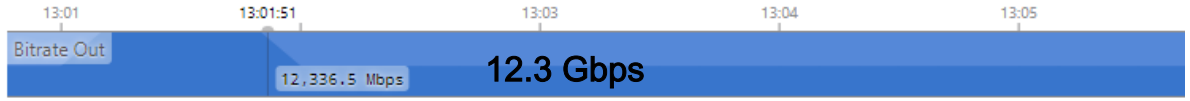

Ethernet49/1 on media-leaf-2

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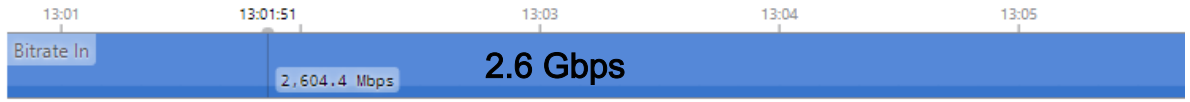

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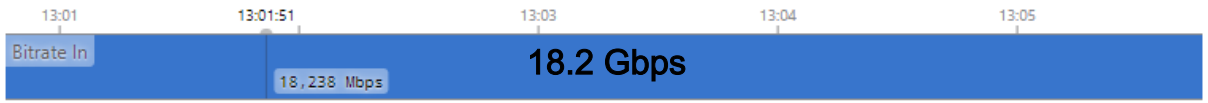

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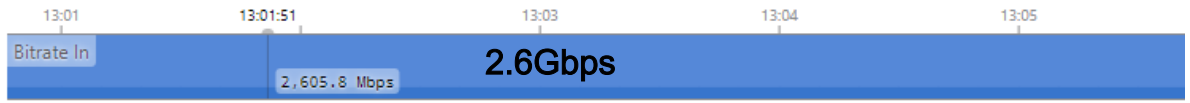
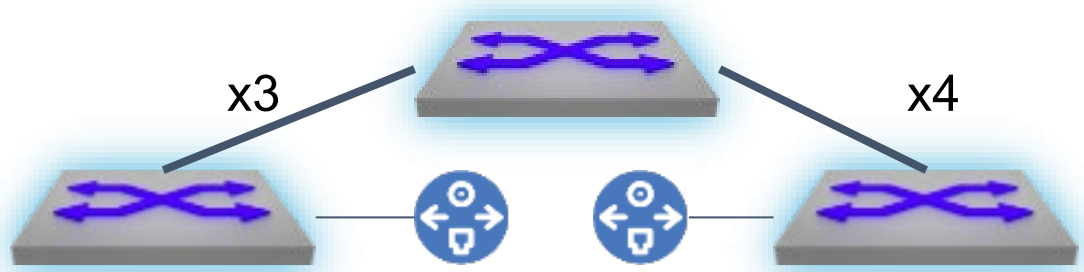
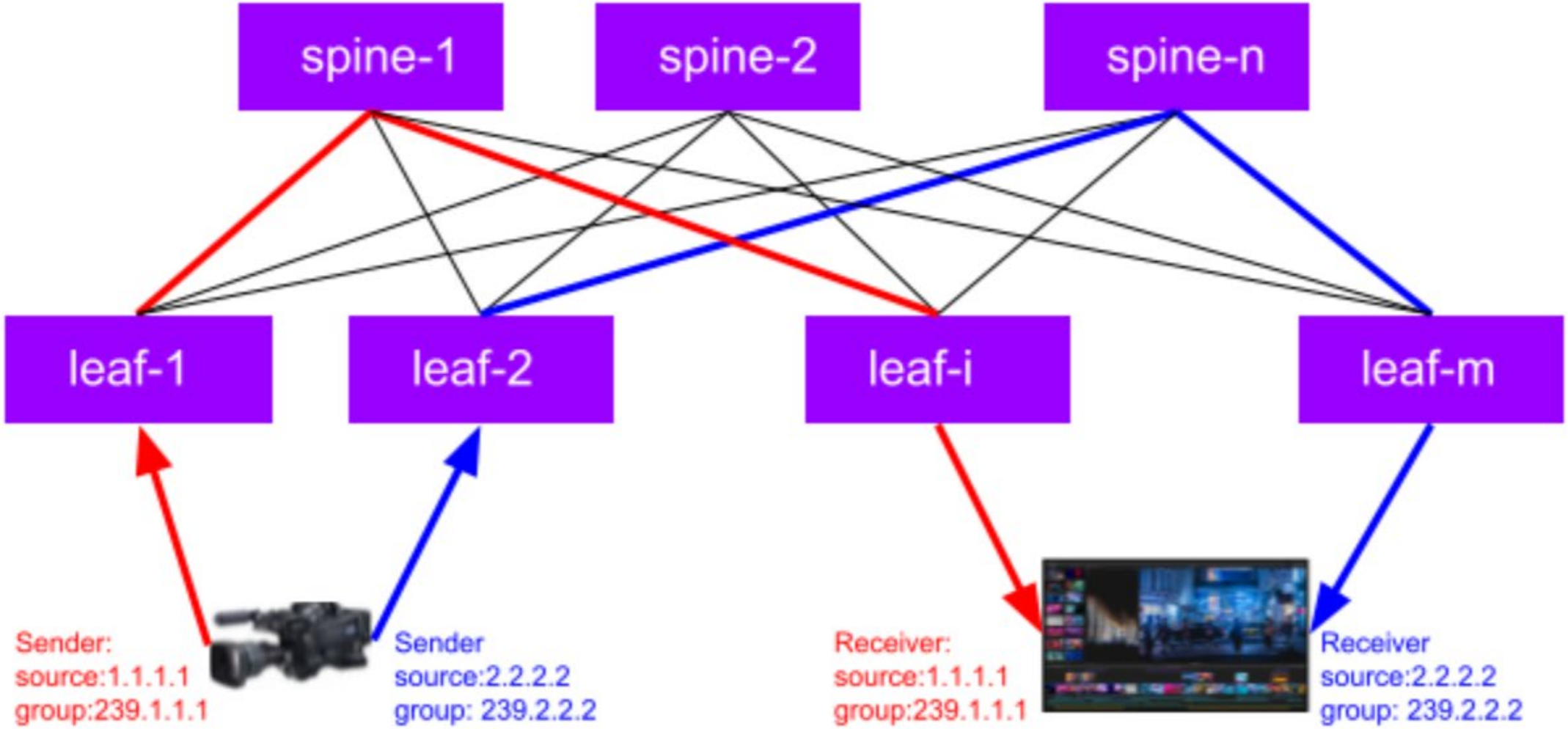




Purple / Meshed Network



Ideas Learned / Questions to Ask

- Design a clean and scalable network
  - Might be monolithic in some cases
  - Usually will be some sort of Spine/Leaf
  - Take advantage of 400G and soon 800G - systems don’t shrink - only grow!
- Do not cascade switches - see above point
- Don’t create a large blast radius - Layer 3 really helps!
- Understand your redundancy model
  - SMPTE 2022-7
  - Multi-spine Red/Blue Networks
  - Fully purple
- Will you need Orchestration? Strong possibility answer is ‘Yes’

What Is Orchestration?

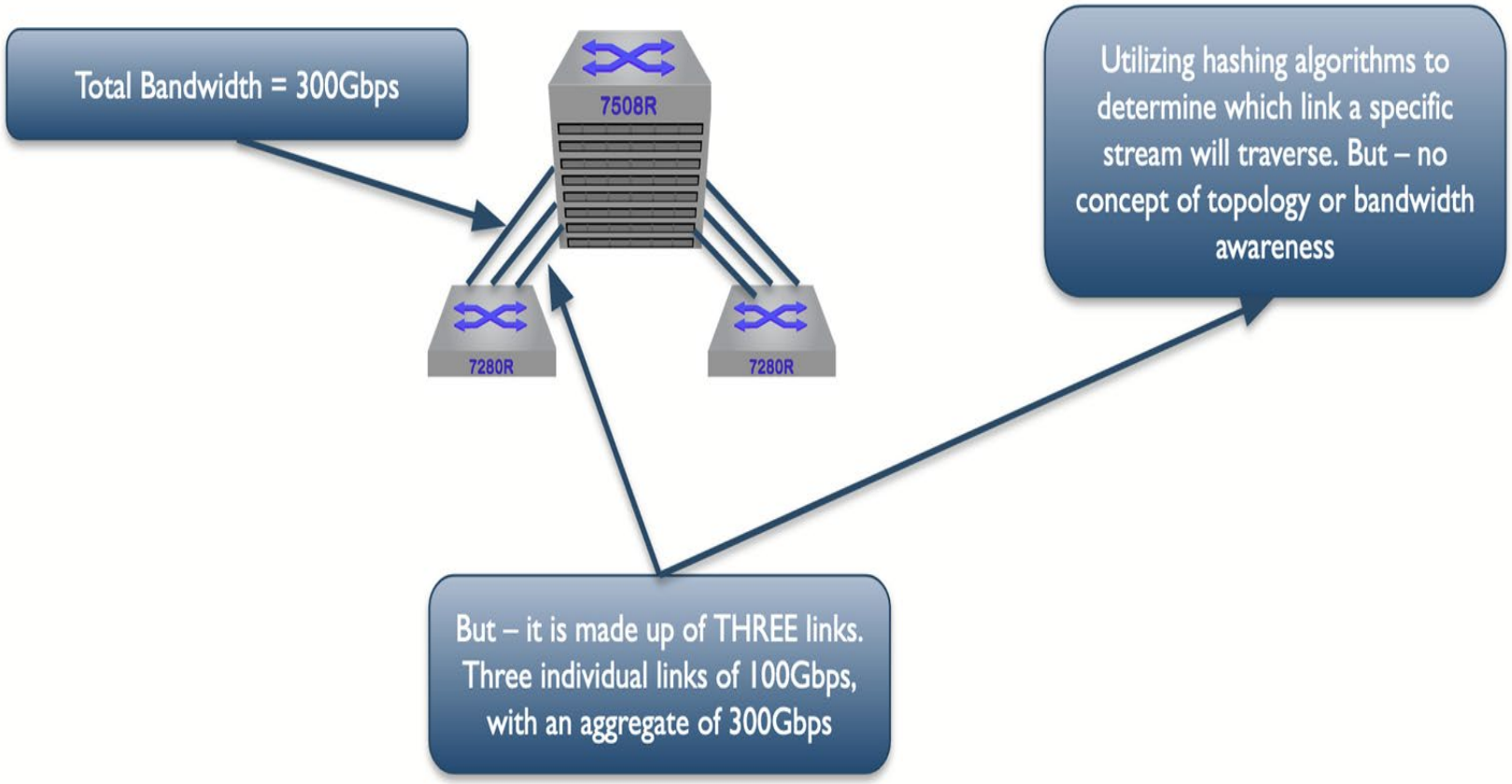
- **Systematic provisioning** of multicast routes using a centralized controller in IP network to provide
- Few of the drivers,
  - Bandwidth protection
    - Predictability and Determinism
  - Scalability and Performance
  - Resilience and Security
  - Flexibility
  - Monitoring and Visibility

Bandwidth Protection and Determinism

Remember:

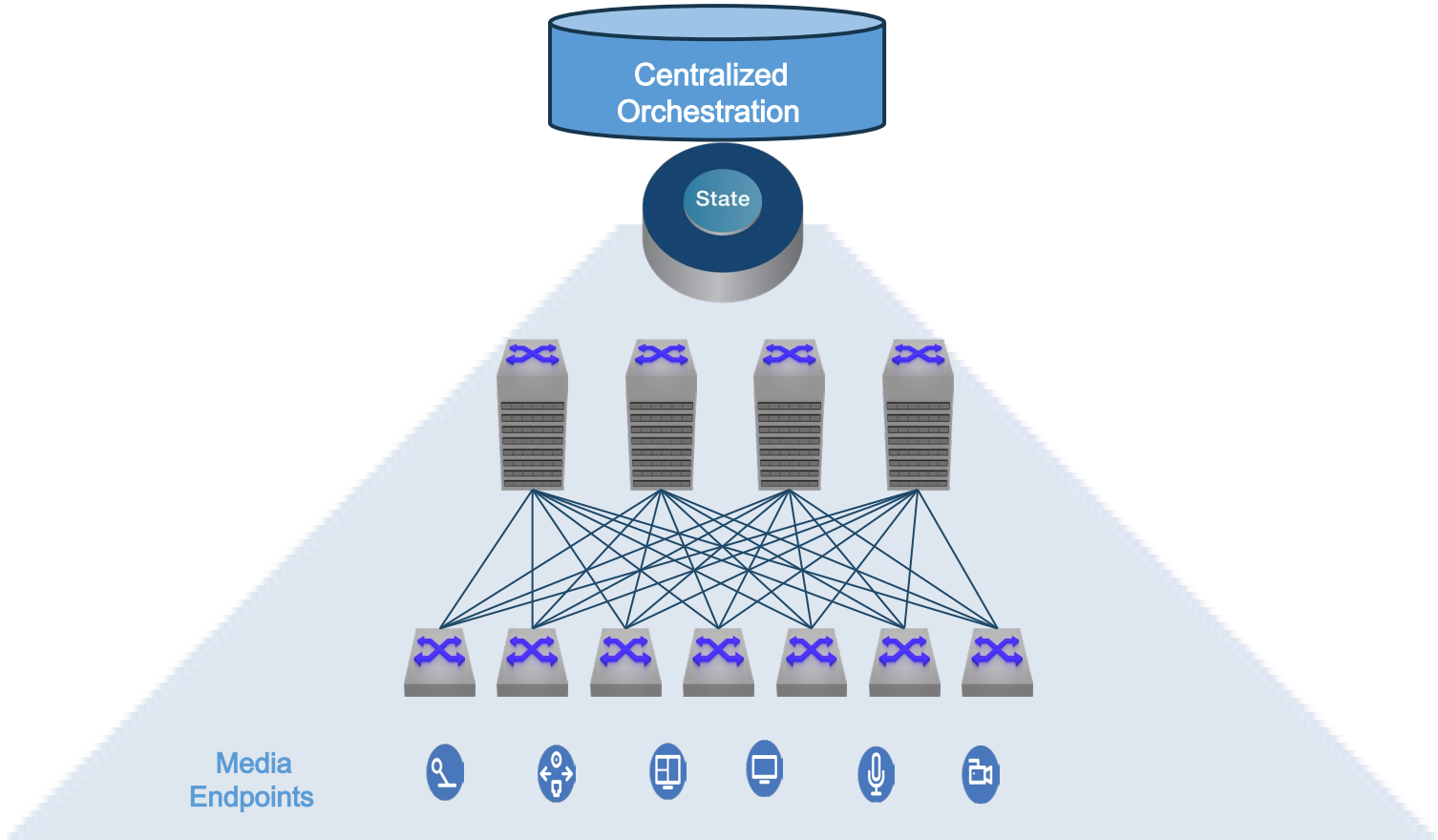
Lack of bandwidth awareness with PIM leads to,

- Unpredictable route choices
- Lack of deterministic route programming
- Possibility of concentrated failure domains



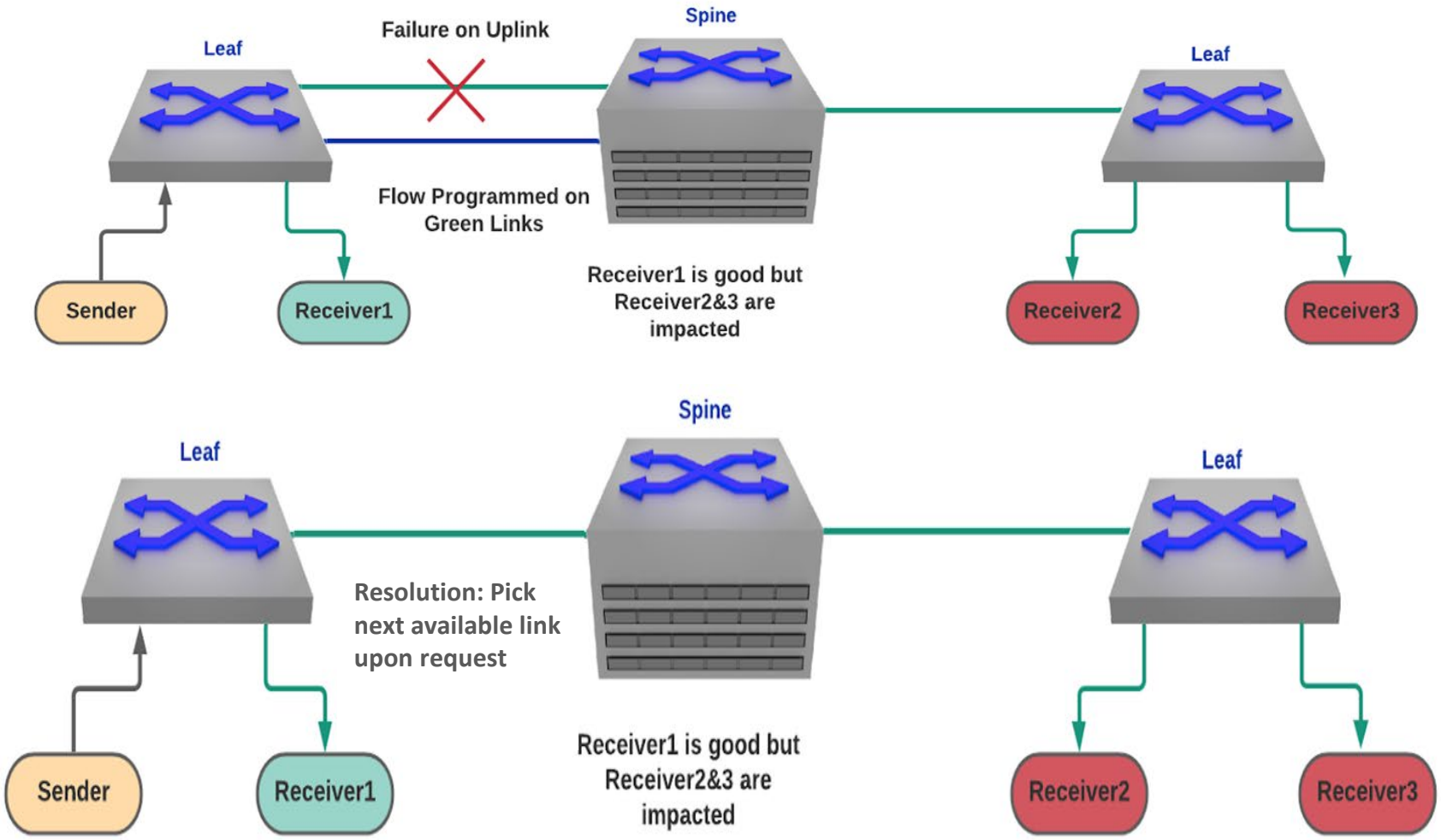
Bandwidth Protection and Determinism

- **Central state** to store and analyze bandwidth utilization
- **Dynamic decision** to route or not based on bandwidth utilization and availability



Resilience and Security

- Ability to detect network failures and associated impacted receivers
- Should not automatically reprovision flows but provide protected recovery
- Provide operator with a choice to recover multicast flows based on workflow priorities



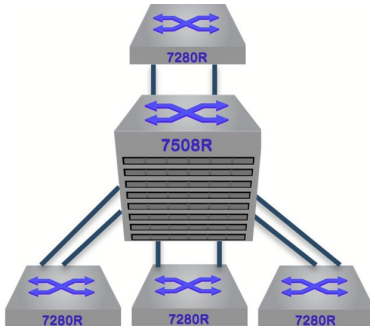
Resilience and Security

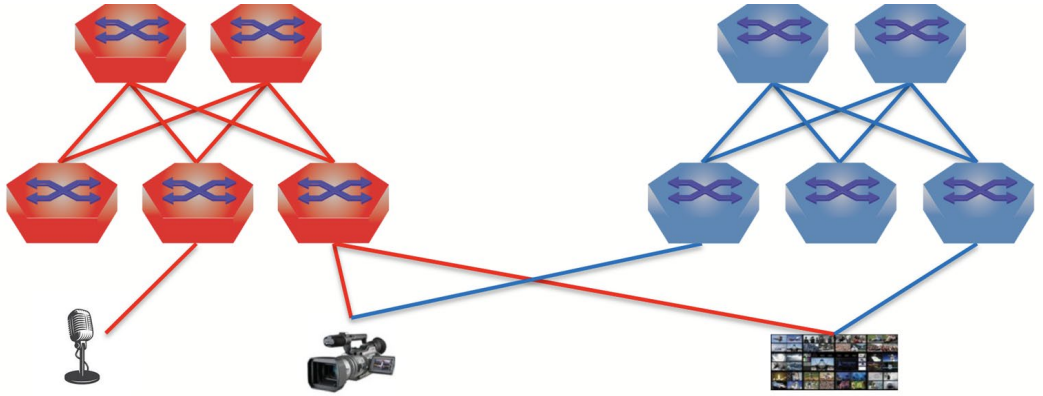
- **QoS protection to smooth out the traffic**
  - Protection from bursty multicast senders
- Highly available and data redundant orchestration
- Protection against user misconfigurations
- Eliminate Failure Domains

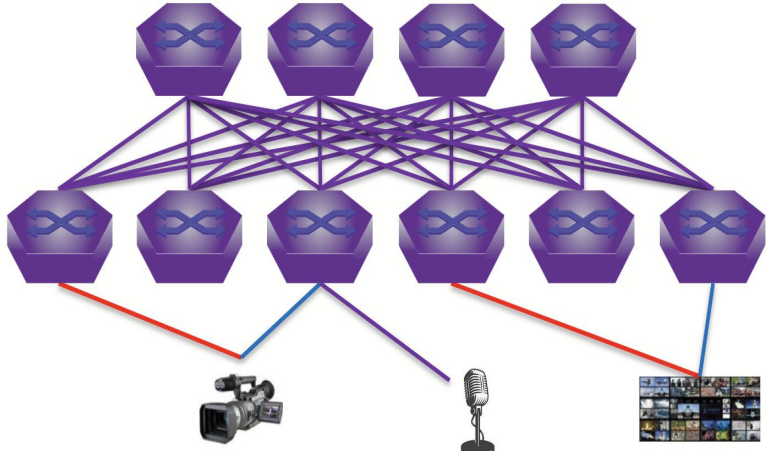
Flexibility

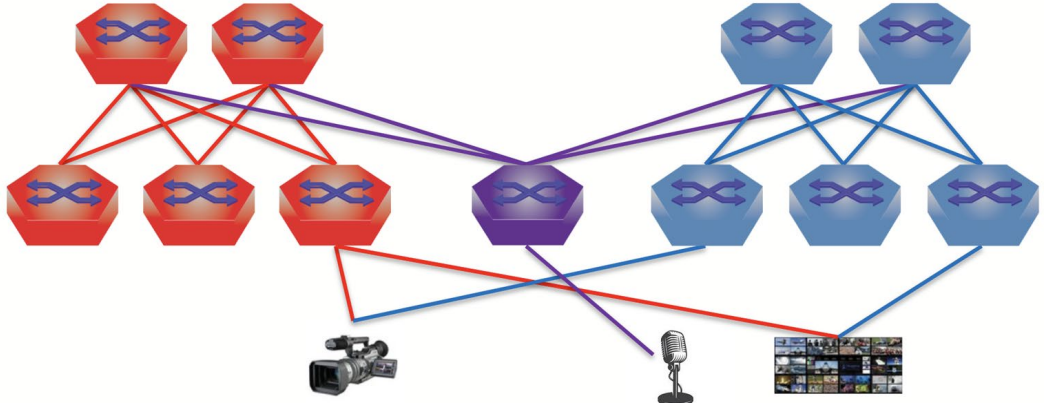
Seamlessly adapt across deployments as topology choices and workflow needs increase

Path Diversity is **Critical**









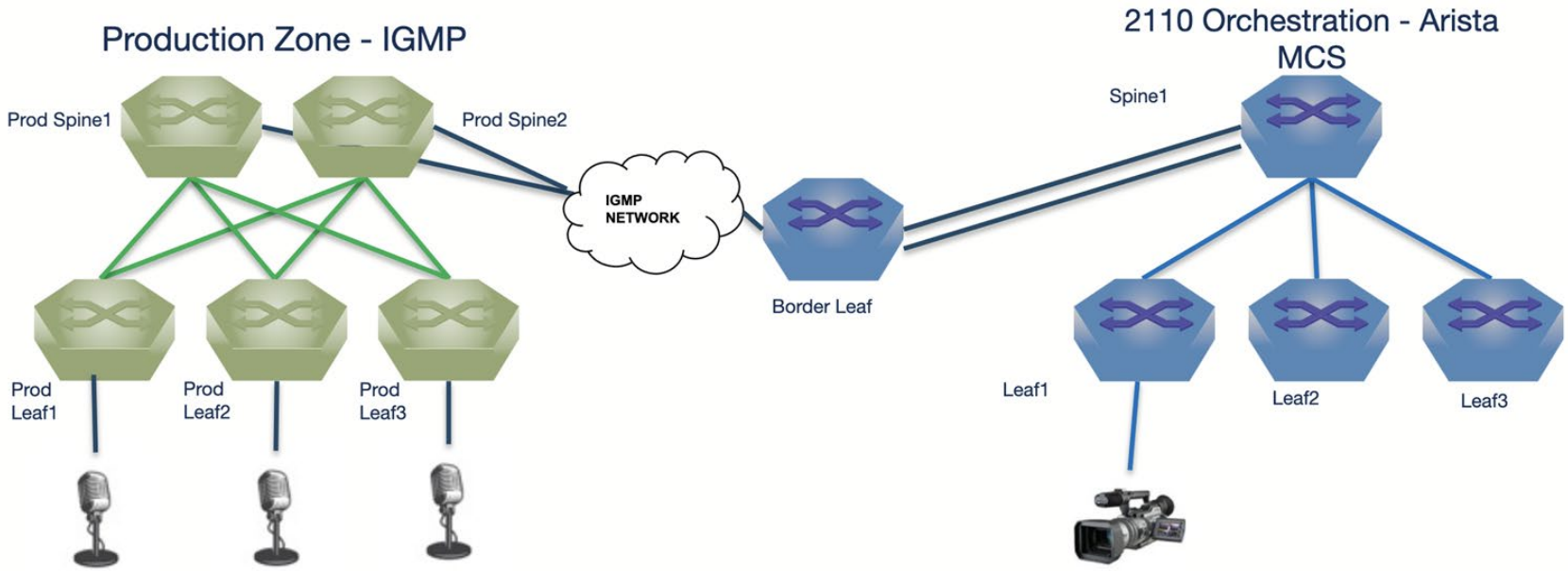
Flexibility

Seamlessly adapt across deployments as topology choices and workflow needs increase

Path Diversity is **Critical**

Co-Exist with IGMP workflows

Support for Hybrid and multi-site Deployment Zones



Scale and Performance

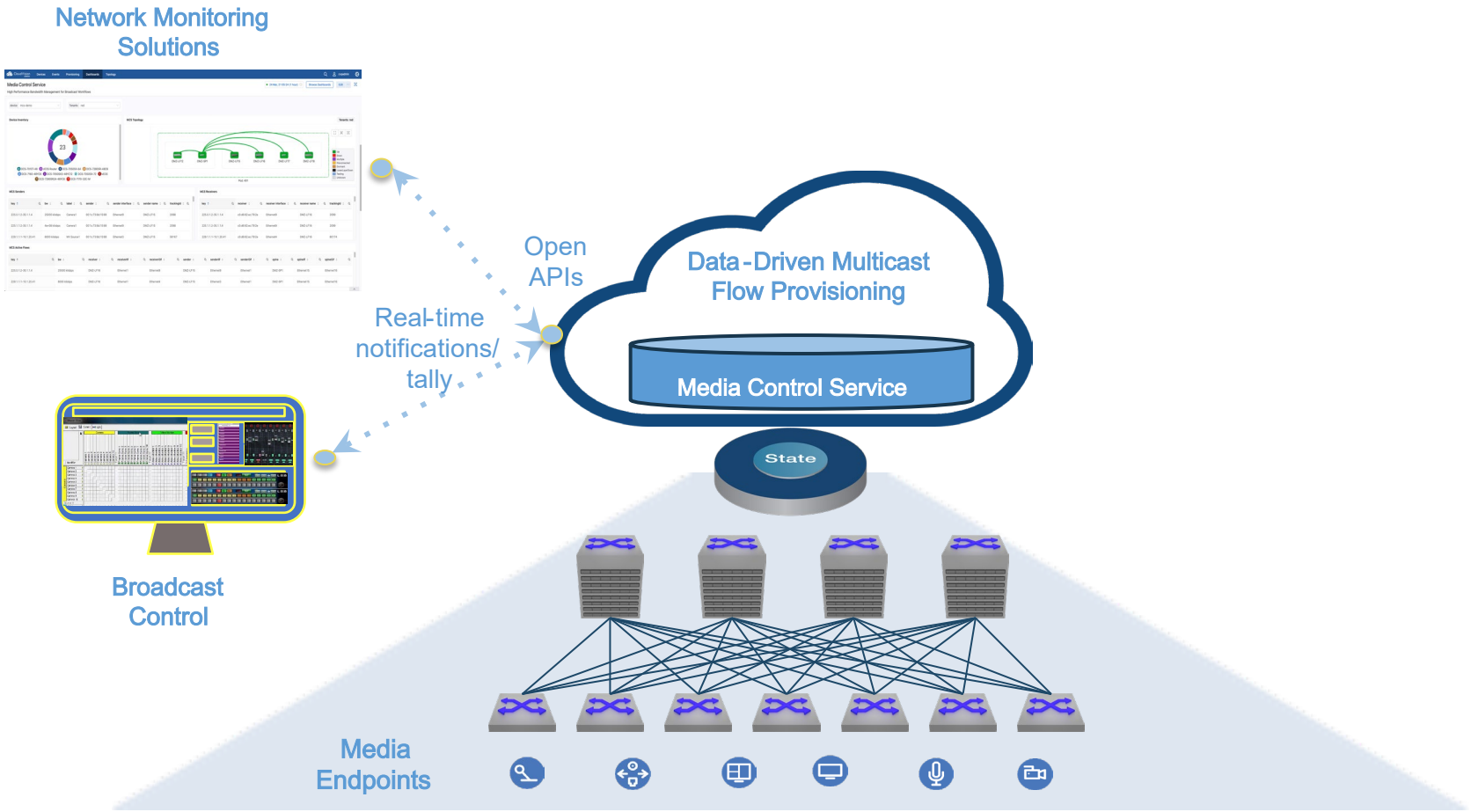
- Ability to Scale with increase in multicast workflows
- Provide consistent and predictable performance as scale increases
- Programming single multicast flow to large salvos efficiently
- Orchestration solution architected right will be able to deliver consistent performance at any scale!

Monitoring and Visibility

Orchestration should provide,

- Single point of integration for monitoring and visibility
- Tally notification for broadcast operator assurance with operator takes

Orchestration can enable monitoring solutions with relatable workflow troubleshooting (Identifying multicast streams by mnemonics example: Camera1)



Summary of Orchestration

- Demand more from Orchestration solutions,
  - Take high performance multicast configuration for bandwidth protection to next level
  - Orchestration should be more than fast typing of configuration
  - Should be architected within the operating model of IP infrastructure
  - Enable Broadcast operators with relatable experience and provide an ability to seamless scale workflows and workloads

Thank You ….. Or ….. Any Questions?

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