

The background of the slide is a photograph of the Aurora Borealis (Northern Lights) over a snowy, mountainous landscape at night. The aurora displays vibrant green and purple hues against a dark, starry sky. The snow-covered ground is visible in the foreground, and the overall scene is serene and atmospheric.

Deploying an Intra and Inter-facility IP Media Production Network

Chin Koh – Nevion
Robert Welch - Arista

TV 2 Norway

- Largest Commercial Broadcaster in Norway
- News and sports operation (7 studios)
- Large MCR operation
- 9 linear channels
- 31 OTT event channels
- VOD and web services

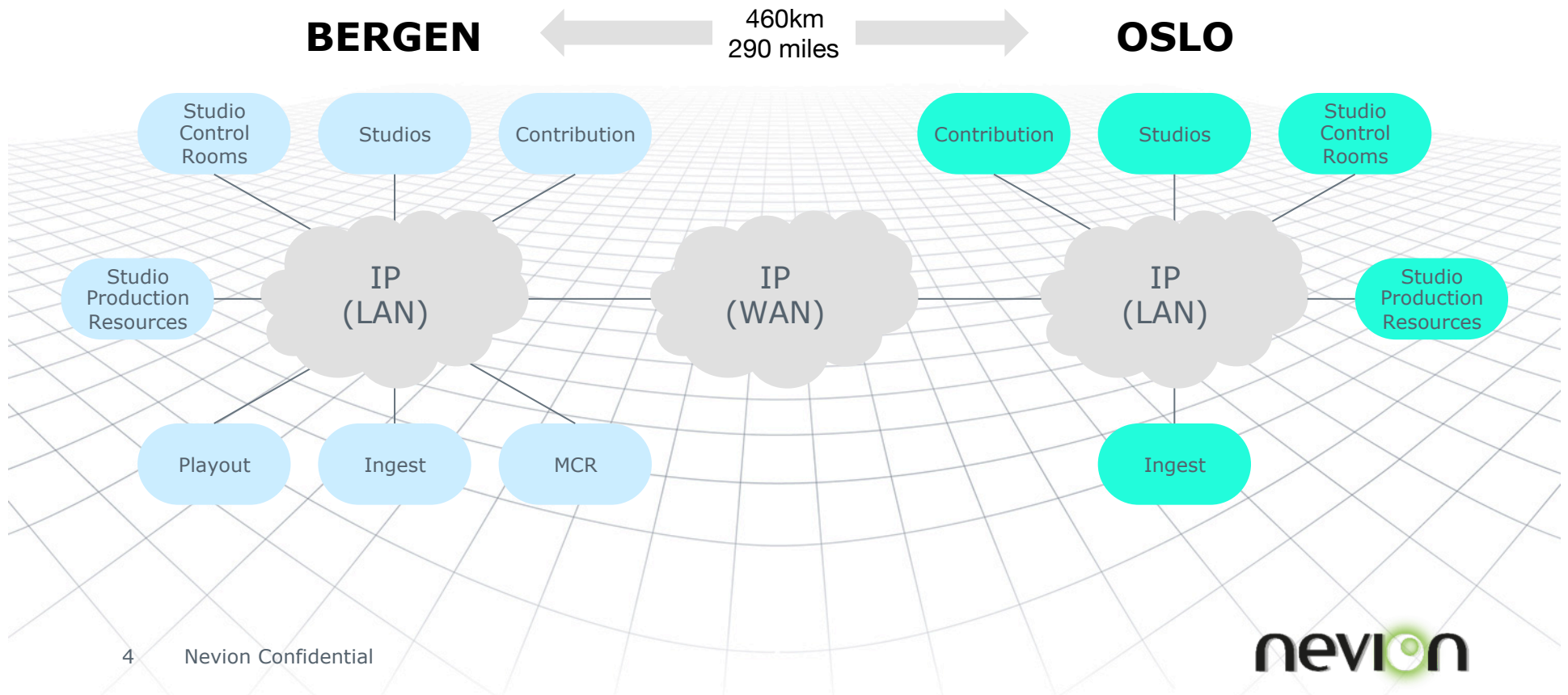


Objective: move to IP in facilities

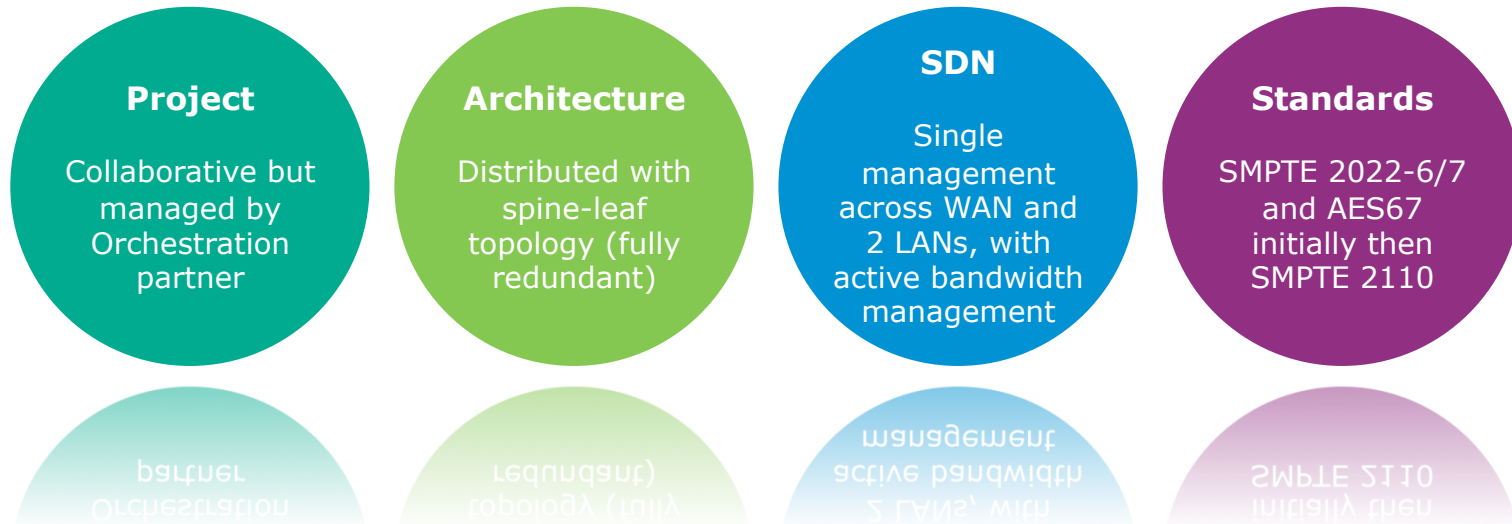


- Driven by:
 - **Facilities relocation** to Bergen (08/2017) and Oslo (12/2017)
- Wanted to:
 - **Reduce OPEX**
 - **Avoid SDI Infrastructure**
 - **Platform Flexibility** (reduce impact of distance)
 - **Share resources** (on demand access)

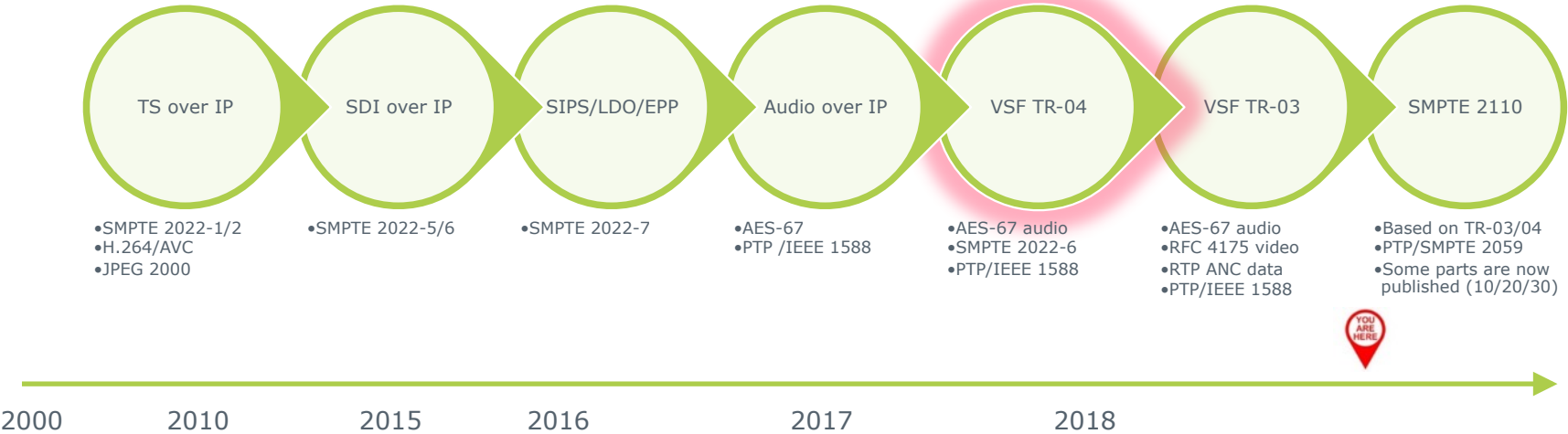
Basic target set-up



TV 2 choices



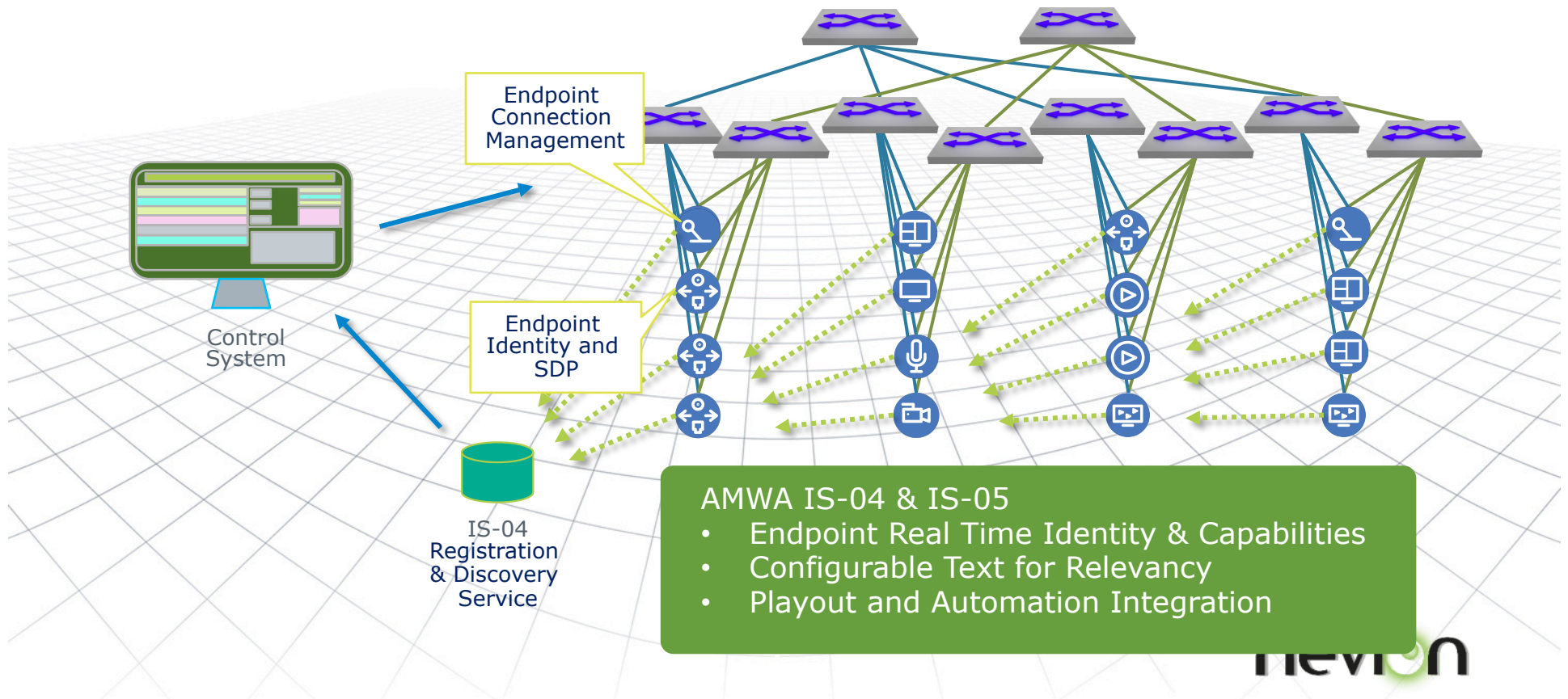
Standards evolution for IP production



Standards – Not ready in 2017

- ST 2110
 - 10: System Timing
 - 20: Uncompressed Video
 - 30: PCM Audio
 - 40: Ancillary Data
- NMOS
 - IS-04 Registration & Discovery
 - IS-05 Control
 - IS-06 Network API
 - IS-07 Event & Tally

AMWA IS-04 & IS-05 Connectivity Management



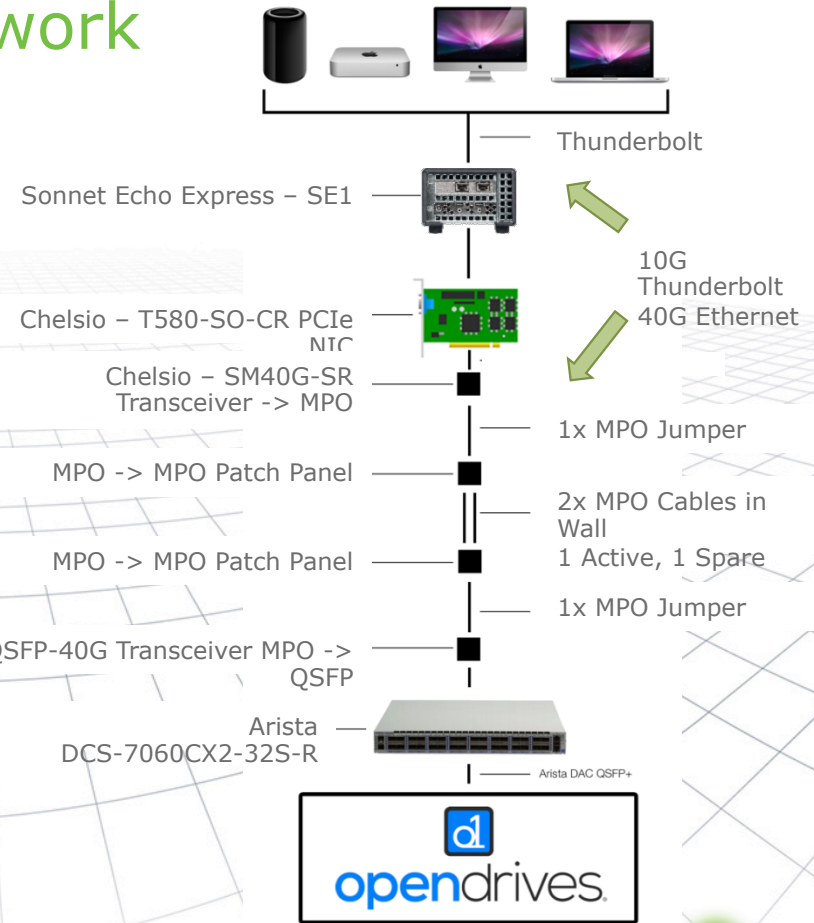
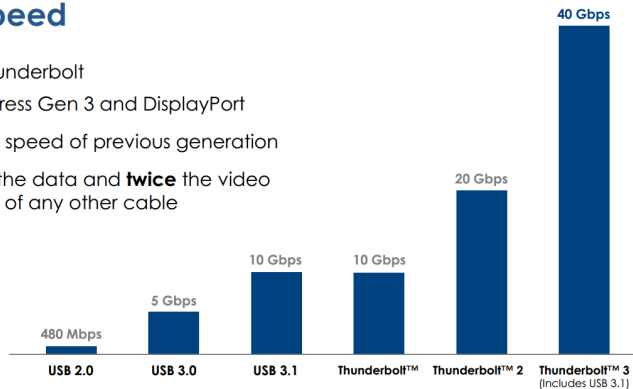
Thunderbolt 2 Edit Bay Network

Shared 40GbE Uplink Example

- USB 3.1 Exceeds the Speed of 10GbE
- Thunderbolt 1 Exceeds the Speed of 10GbE
- Throughput = Increased Productivity and Flexibility
- Adoption of 10G Edit Bays => 40G Edit Bays
- 10GbE Standard Interface Speed on New Systems
- **There is More Network Capacity at the Edge than in Your 10GbE Network.**

More Speed

- **40Gbps** Thunderbolt
 - PCI Express Gen 3 and DisplayPort
- **Double** the speed of previous generation
- **Four times** the data and **twice** the video bandwidth of any other cable



Thunderbolt 2 Edit Bay Network



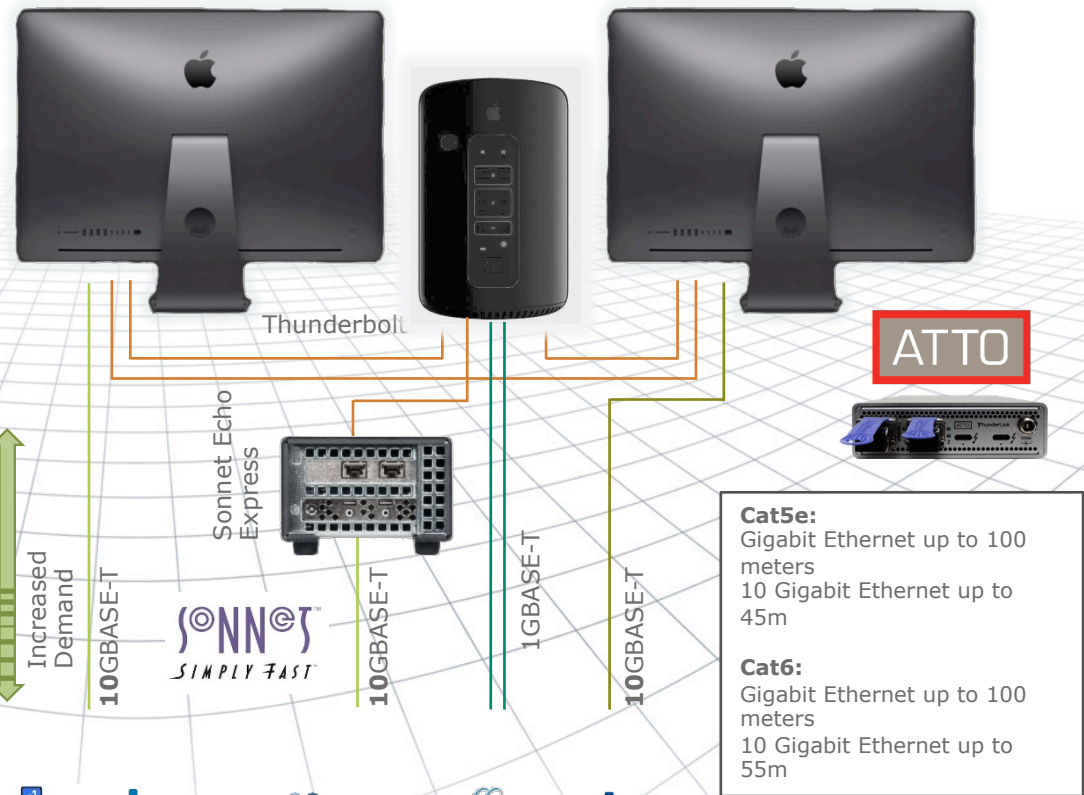
Per Device Uplink Example

iMAC Pro:

- 1x 10GbE, 4x Thunderbolt 3, 4x USB 3

Mac Pro (Trash Can Mac):

- 2x 1GbE, 6x Thunderbolt 2, 4x USB3

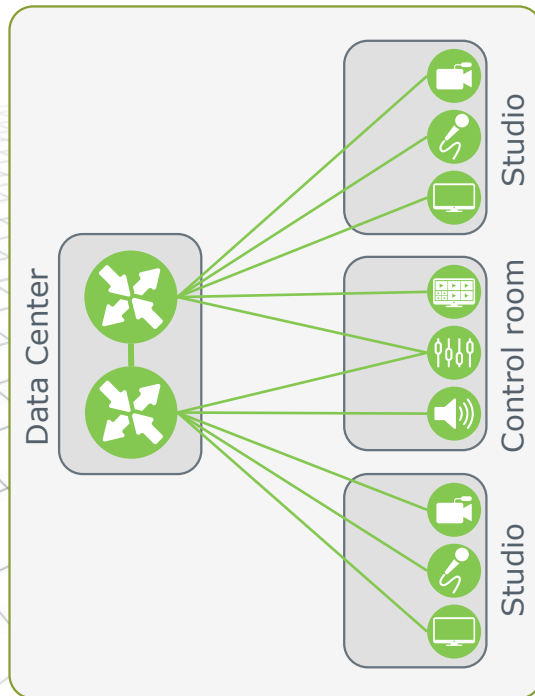


Cat6a:
Gigabit Ethernet up to 100 meters
10 Gigabit Ethernet up to 100 meters

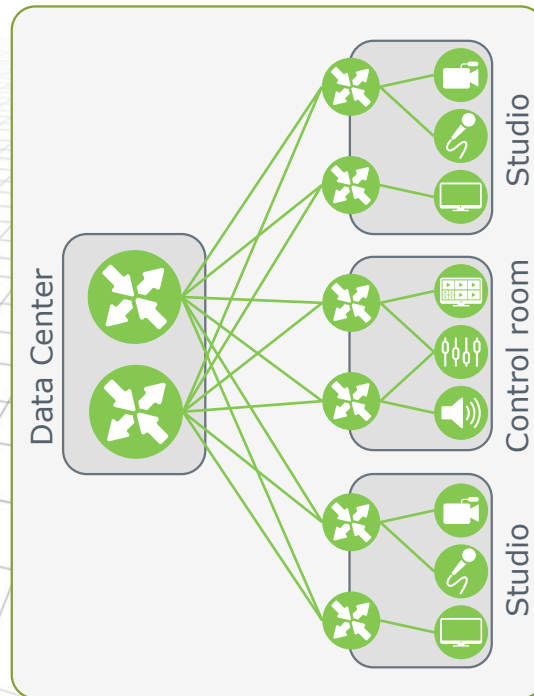


Typical architecture options

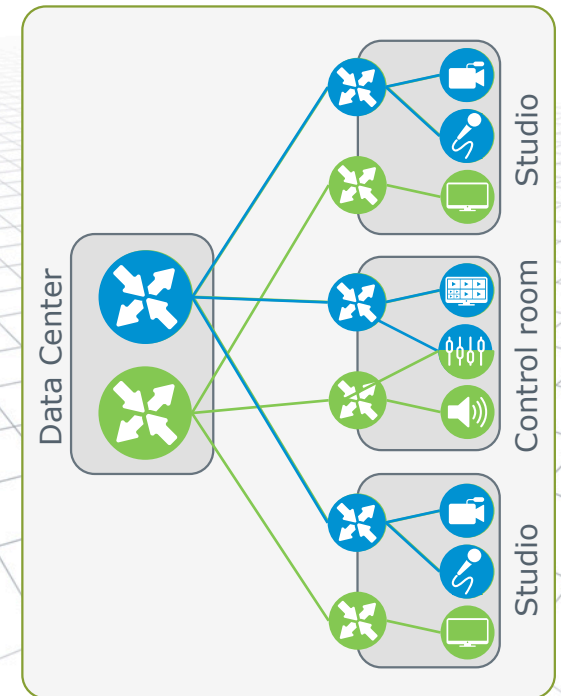
Centralized Star



True Leaf-Spine



Pseudo Leaf-Spine (Dual Star)



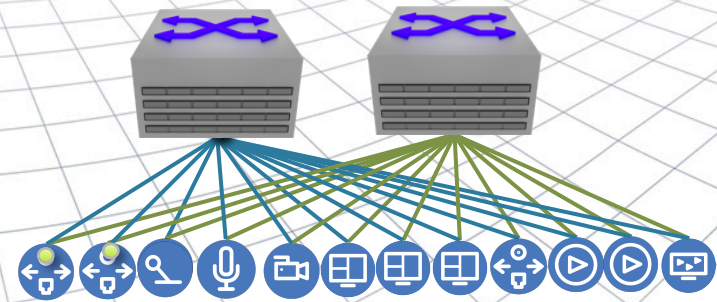
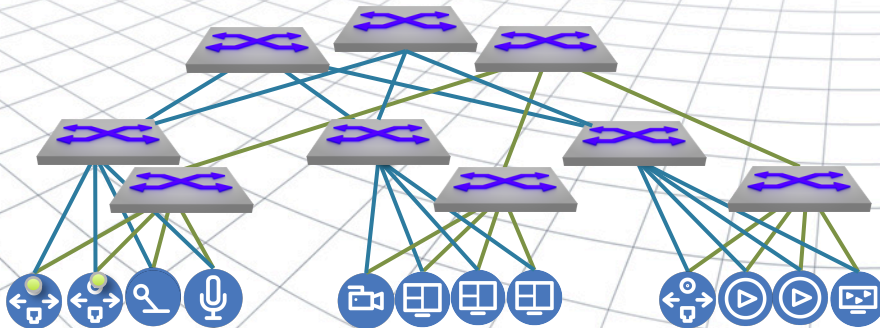
Network Topology Options

Spine / Leaf – Distributed

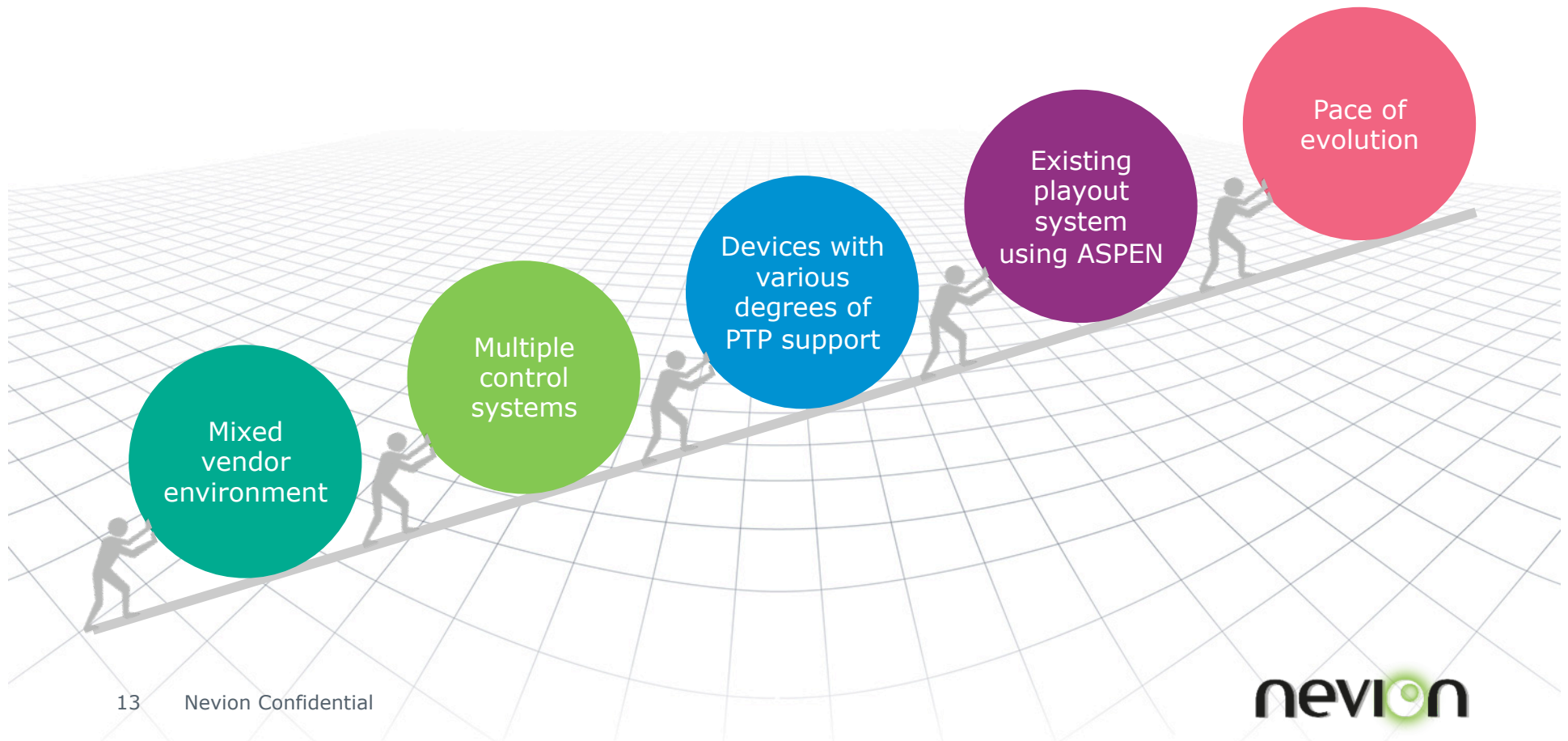
- Distributed Cabling
- Shared Uplink Bandwidth
- PTP Boundary Mode Considerations
- Mix and Match Spine and Leaf Options
- Inter-Switch Bandwidth Consideration
- Oversubscription Ratio

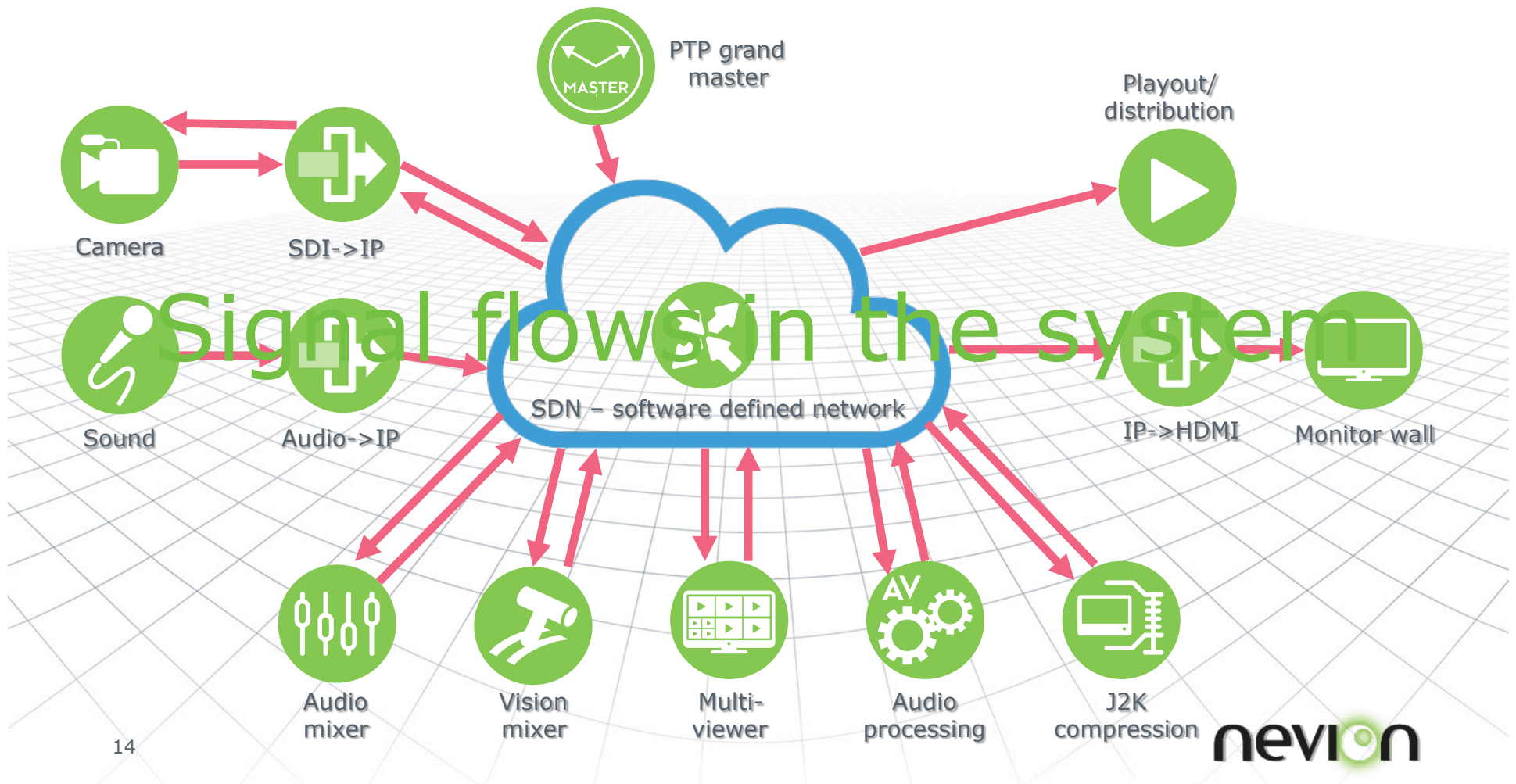
Monolithic Switch

- Non Blocking Architecture
- No SDN Requirement to Manage Inter-Switch Links
- PTP Boundary Mode Considerations
- Mix and Match Spine and Leaf Options
- Increase East / West Traffic Flow Bandwidth



Some challenges to overcome

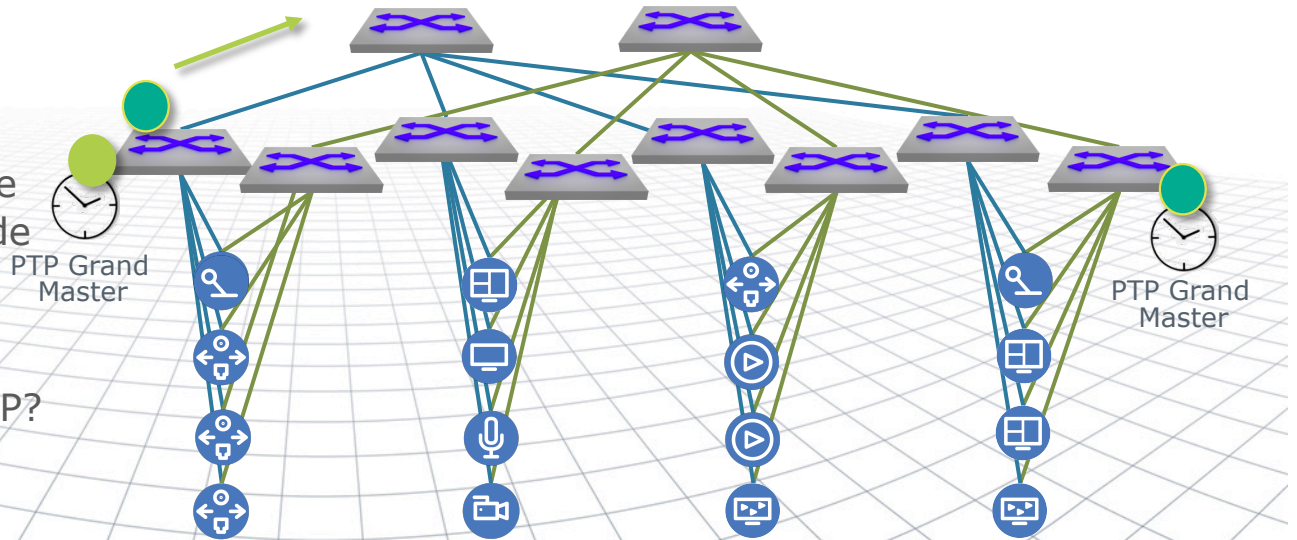




Grand Master Placement and Redundancy

- **Switch Considerations**

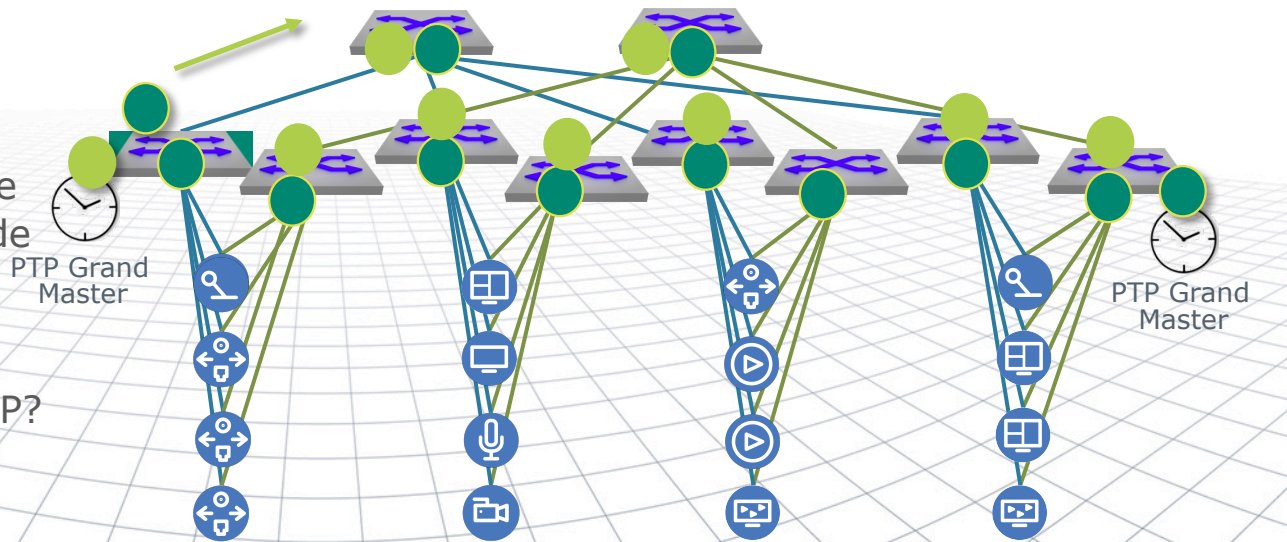
- Boundary Mode
- Boundary Mode Scale
- E2E Transparent Mode
- ST 2059-2 Support
- Routed Interface Requirement
- In or Out of Band PTP?
- 1 or 2 Step Support



Grand Master Placement and Redundancy

- **Switch Considerations**

- Boundary Mode
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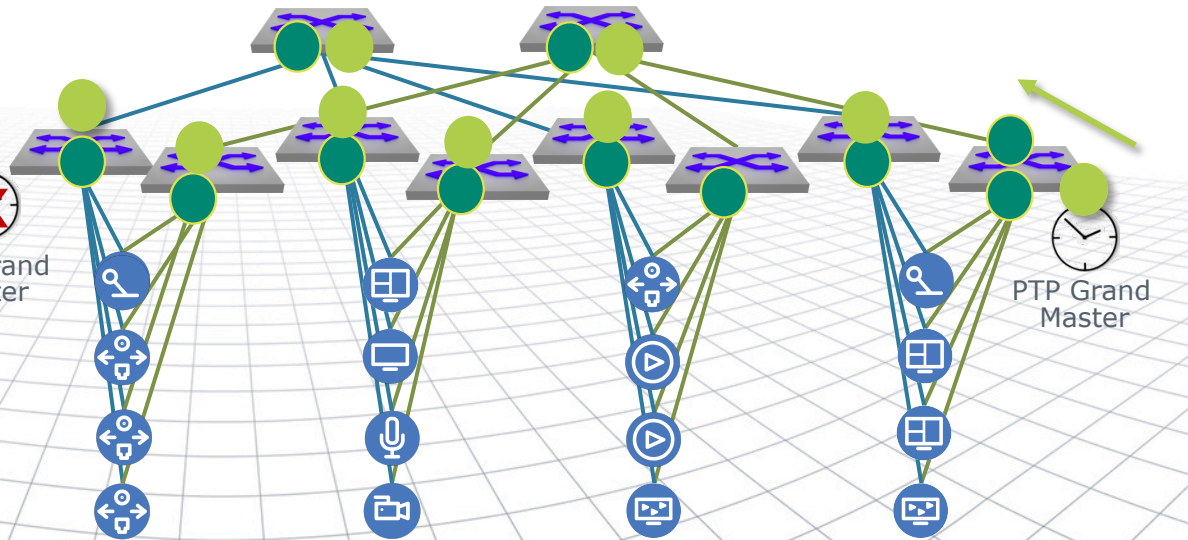
PTP Boundary Mode

- Increases PTP Grand Master Scale
- Is Master to Connected Nodes
- Improves System Wide Clock Synchronization

Grand Master Placement and Redundancy

- **Switch Considerations**

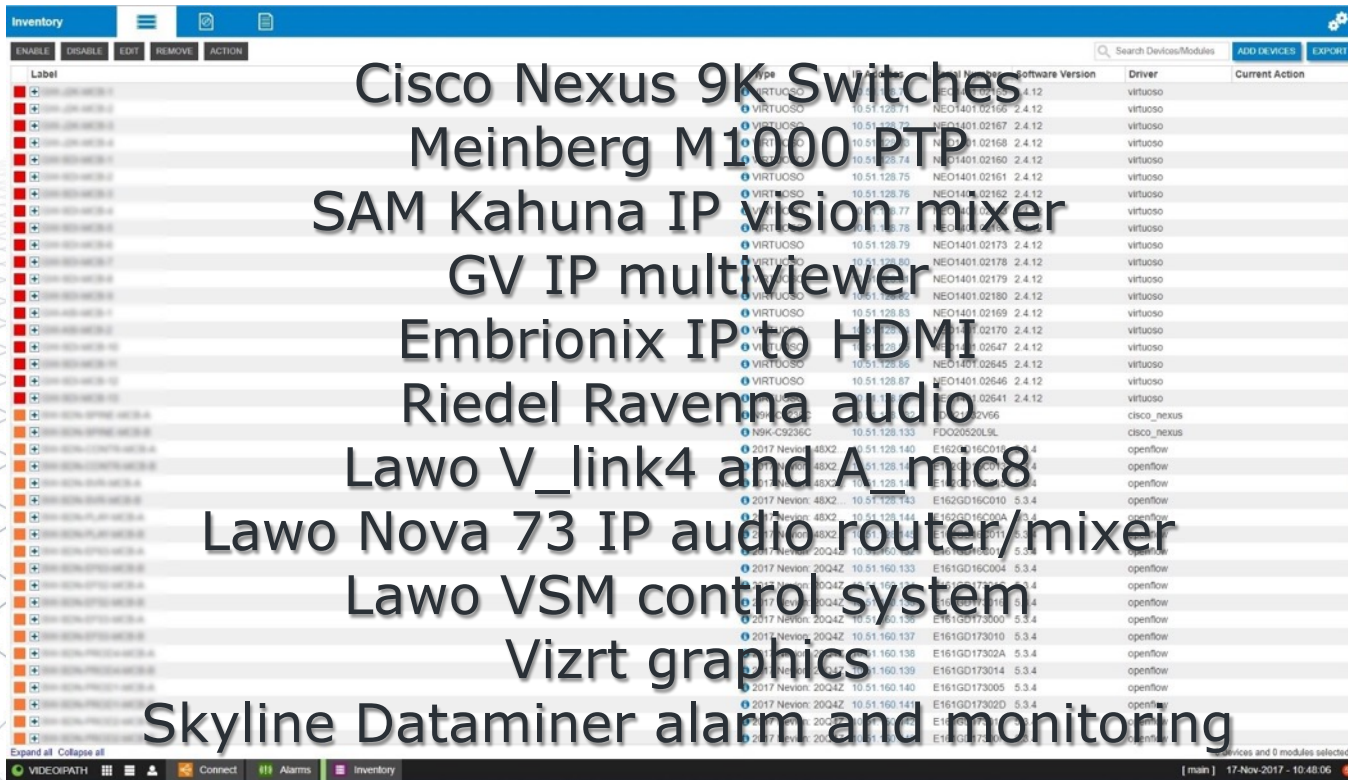
- Boundary Mode
- Boundary Mode Scale
- E2E Transparent Mode
- ST 2059-2 Support
- Routed Interface Requirement
- In or Out of Band PTP?
- 1 or 2 Step Support



PTP Boundary Mode – Grand Master Change

- Reduces Effect on Connected Nodes
- Enables Geographic Redundancy
- Improves System Wide Clock Synchronization

Technology Partners



Label	Type	IP Address	Serial Number	Software Version	Driver	Current Action
...	VIRTUOSO	10.51.128.71	NEO1401.02166	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.72	NEO1401.02167	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.73	NEO1401.02168	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.74	NEO1401.02169	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.75	NEO1401.02161	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.76	NEO1401.02162	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.77	NEO1401.02173	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.78	NEO1401.02179	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.79	NEO1401.02180	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.83	NEO1401.02169	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.84	NEO1401.02170	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.85	NEO1401.02647	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.86	NEO1401.02645	2.4.12	virtuoso	
...	VIRTUOSO	10.51.128.87	NEO1401.02646	2.4.12	virtuoso	
...	NSK-C8236C	10.51.128.133	FDO20520LSL		cisco_nexus	
...	2017 Nevon: 48X2	10.51.128.140	E162GD16C010	5.3.4	openflow	
...	2017 Nevon: 48X2	10.51.128.141	E162GD16C011	5.3.4	openflow	
...	2017 Nevon: 48X2	10.51.128.142	E162GD16C012	5.3.4	openflow	
...	2017 Nevon: 20Q4Z	10.51.160.133	E161GD16C004	5.3.4	openflow	
...	2017 Nevon: 20Q4Z	10.51.160.137	E161GD173010	5.3.4	openflow	
...	2017 Nevon: 20Q4Z	10.51.160.138	E161GD17302A	5.3.4	openflow	
...	2017 Nevon: 20Q4Z	10.51.160.139	E161GD173014	5.3.4	openflow	
...	2017 Nevon: 20Q4Z	10.51.160.140	E161GD173005	5.3.4	openflow	
...	2017 Nevon: 20Q4Z	10.51.160.141	E161GD17302D	5.3.4	openflow	

Cisco Nexus 9K Switches

Meinberg M1000 PTP

SAM Kahuna IP vision mixer

GV IP multiviewer

Embrionix IP to HDMI

Riedel Ravenna audio

Lawo V_link4 and A_mic8

Lawo Nova 73 IP audio router/mixer

Lawo VSM control system

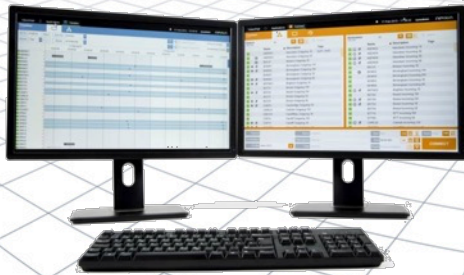
Vizrt graphics

Skyline Dataminer alarm and monitoring

Nevion's Contribution



Nevion VideoIPath
SDN control and
platform management



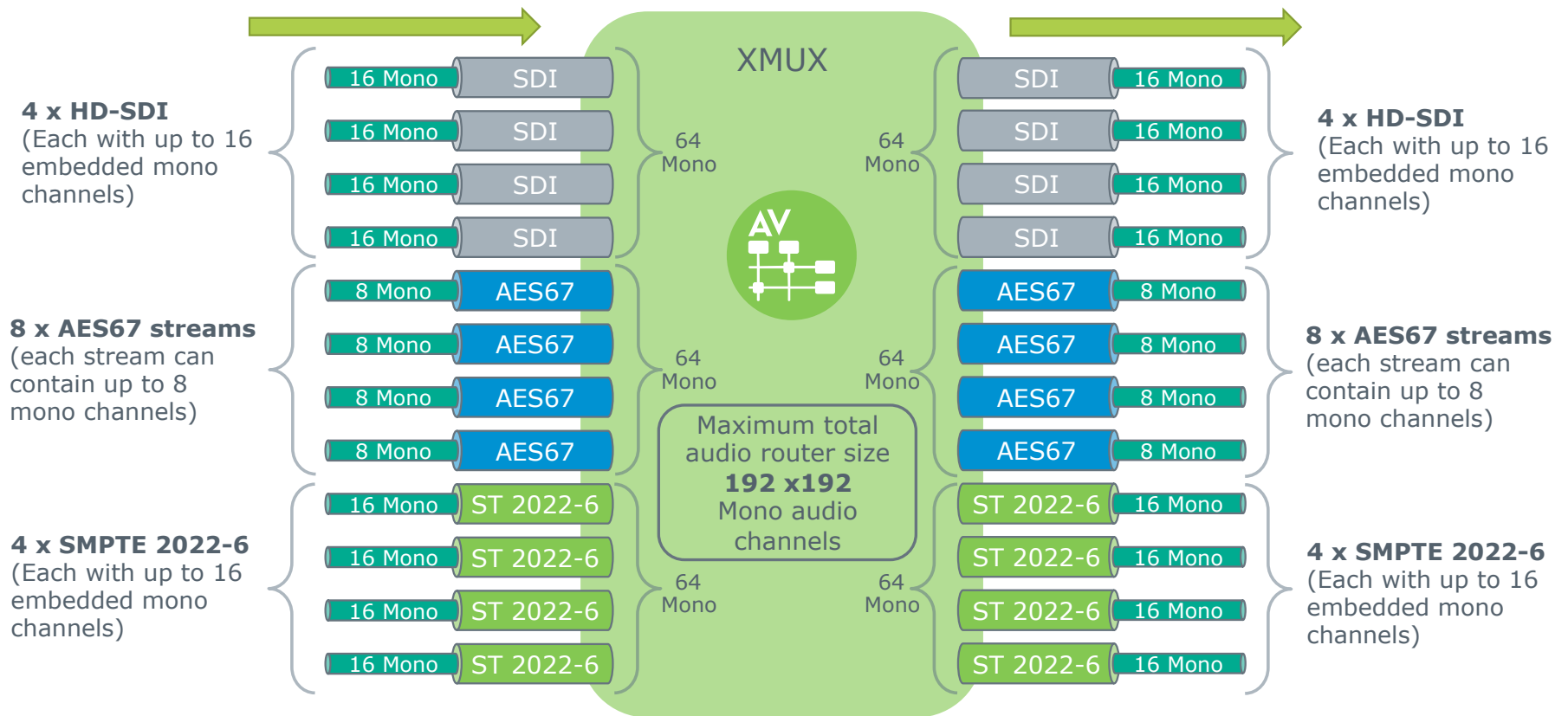
Nevion eMerge
10/40/100 Gb leaf switches
with Openflow



Nevion Virtuoso
Processing units

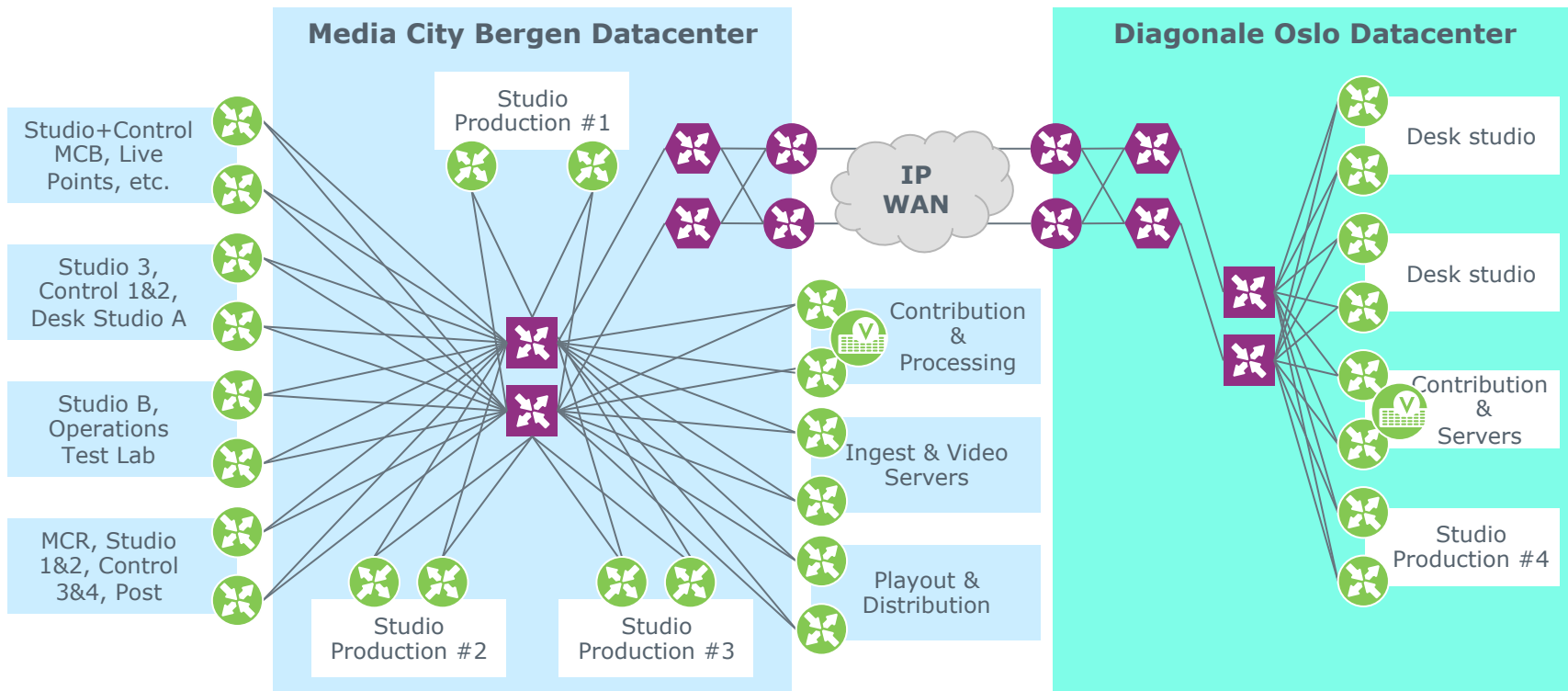


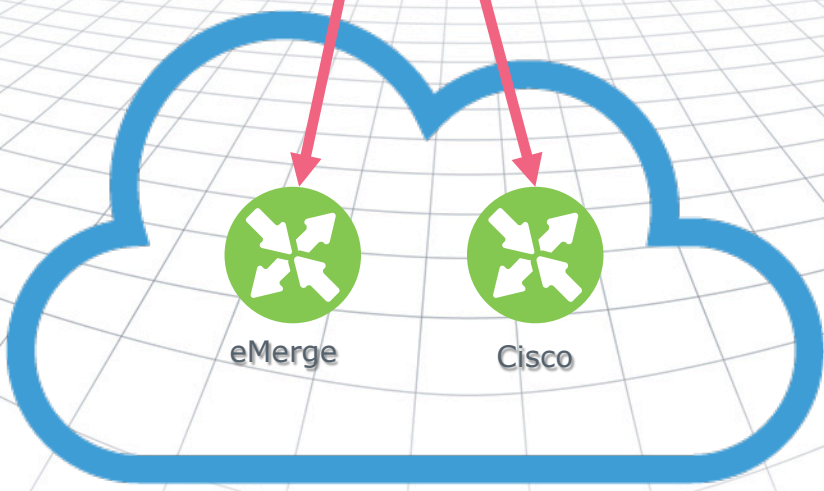
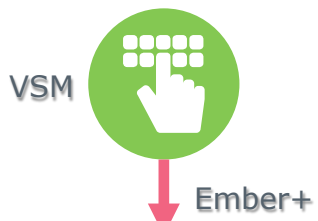
Gateway XMUX Video/Audio router





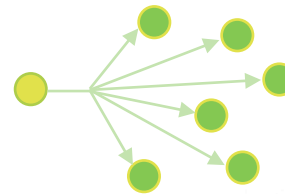
Orchestration and SDN Management



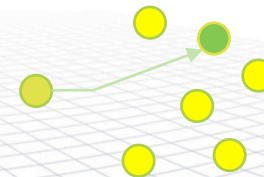


Multicast At A Glance

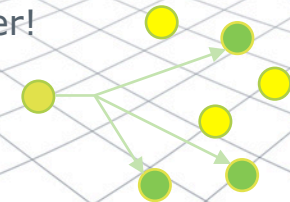
- Broadcast: One to all within the subnet



- Unicast: One to one, routable. Destination defined by sender.



- Multicast: One to none, one or many, routable. Destination defined by receiver!



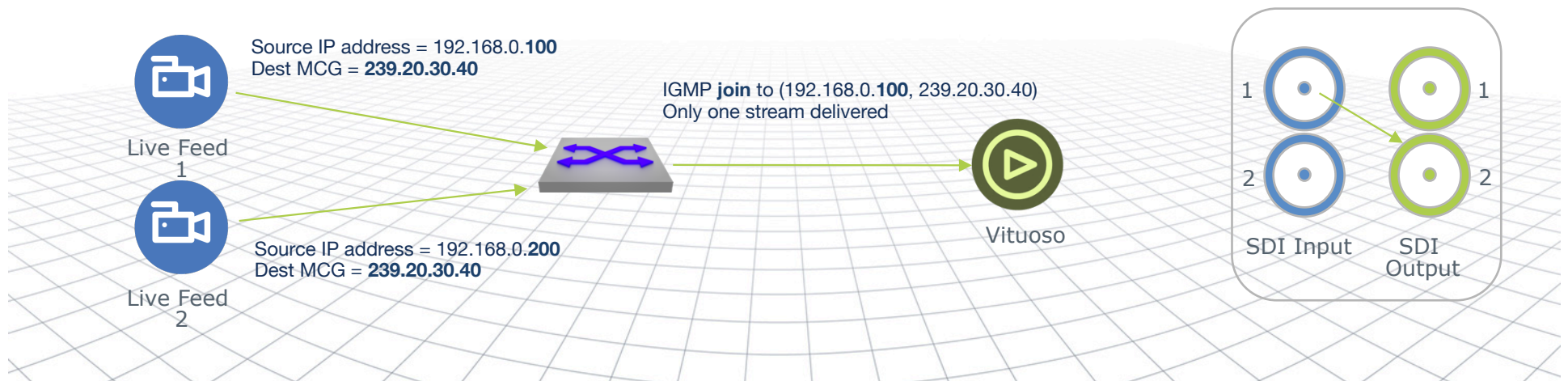
- Multicast is a good fit for live uncompressed media

- Typically there is a one to many fan out
- The senders do not know who needs to consume their output
- More efficient for sending endpoints, and network infrastructure - no traffic redundancy
- Receiver redundancy is easy to achieve



Multicast At A Glance

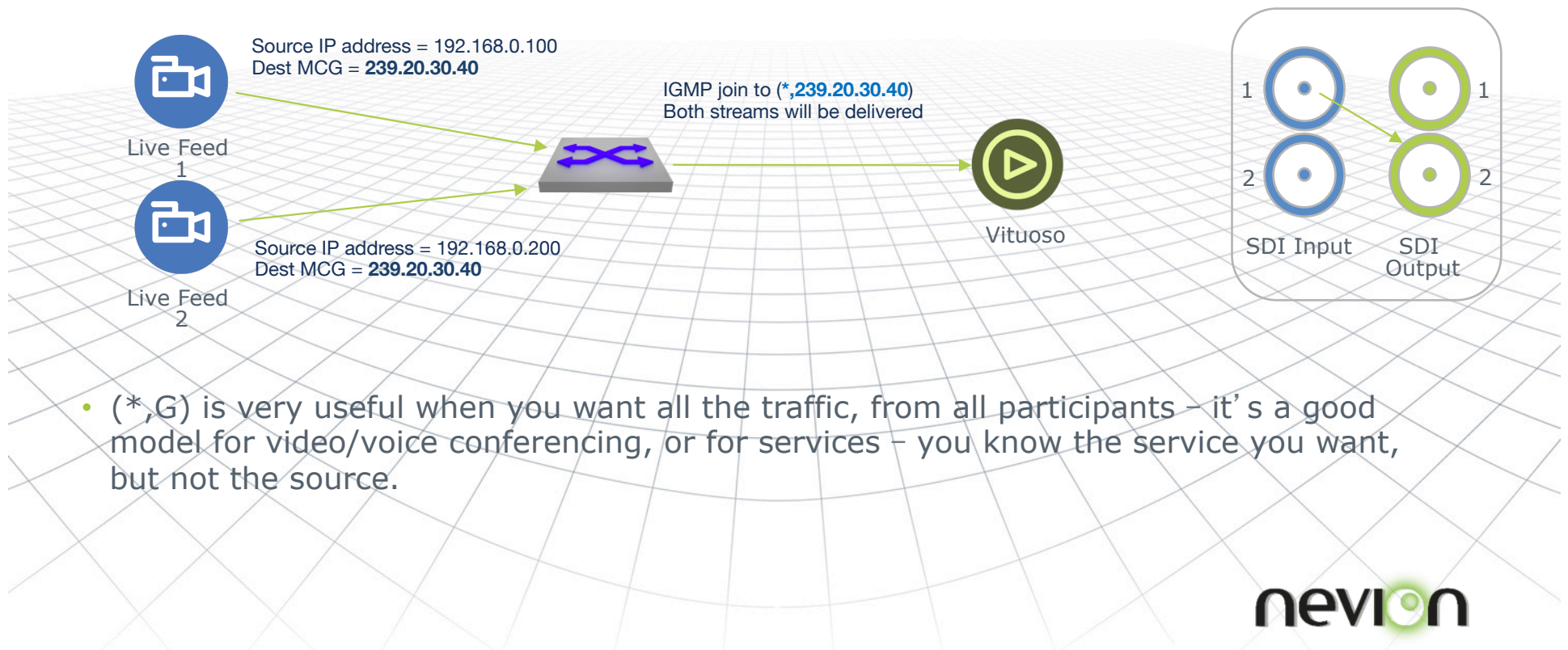
- (S,G), **Source Specific Multicast**. The *subscriber* asks for traffic that was sent to a multicast group address (G), **from a specific source (S)**.



- An IGMPv3 infrastructure is required to support (S,G) requests. (*,G) requests are supported in all IGMP versions
- 2022-7 and destination based switching enabled by multicast. (Make before break)
- 2022-6 is a single essence stream. 2110-x defines individual essence streams for video (-20), audio (-30) and ancillary data (-40)

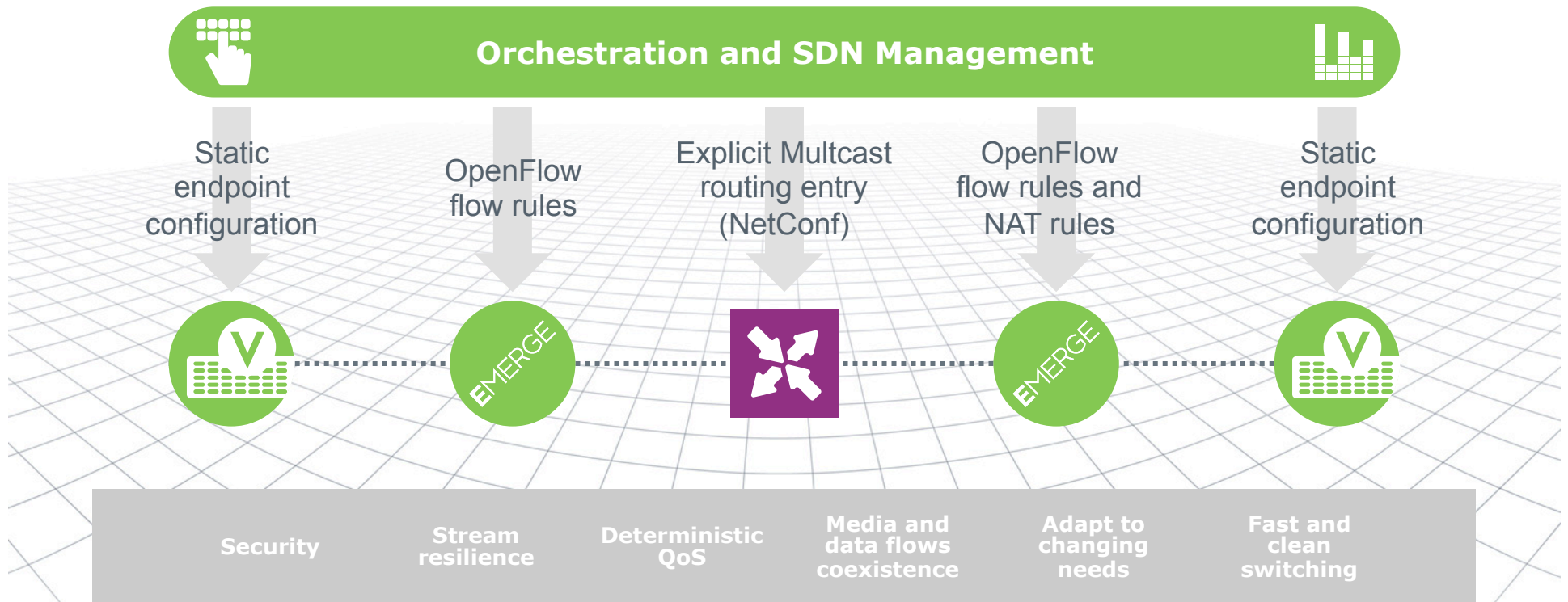
Multicast At A Glance

- (*,G), Any Source Multicast. The subscriber asks for ALL (*) traffic that was sent to the multicast group address requested (G).

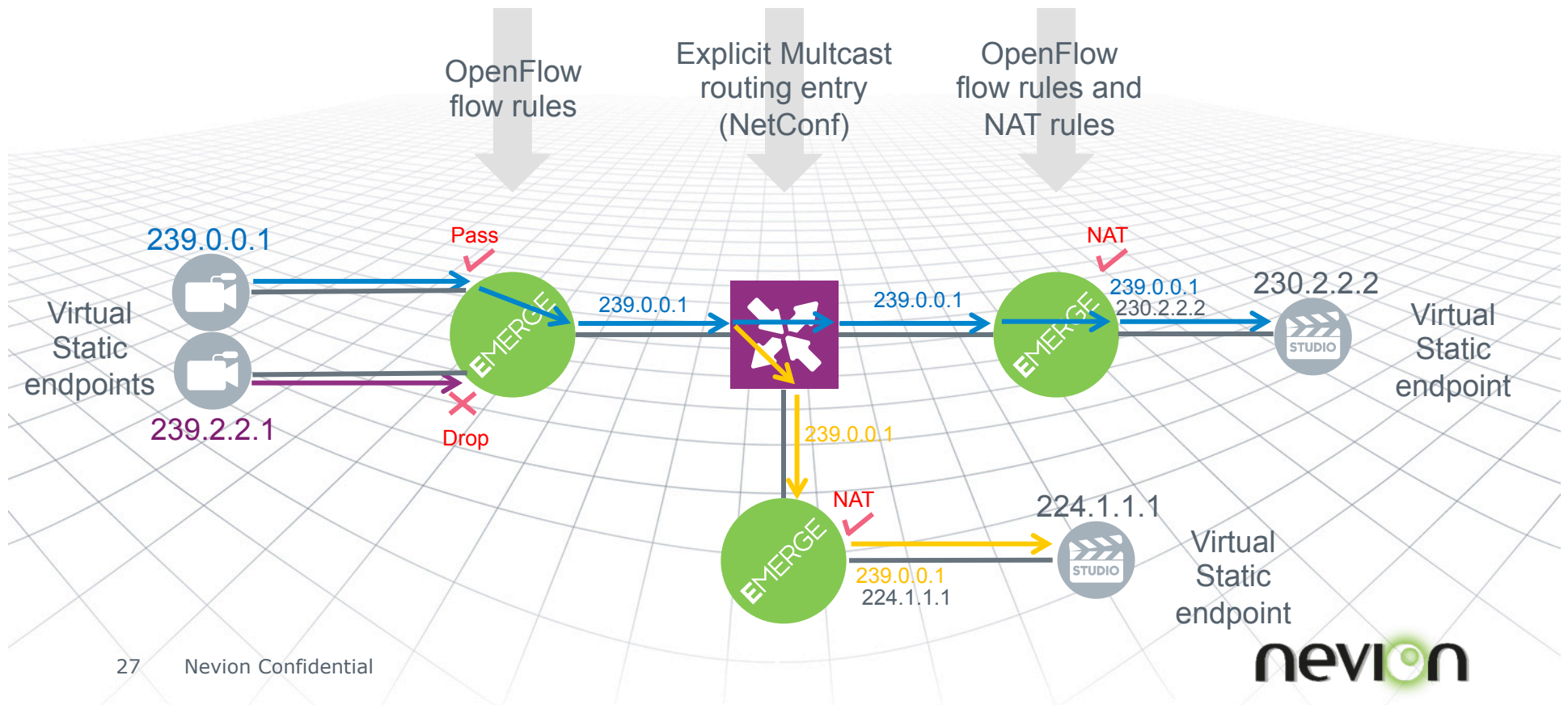


- (*,G) is very useful when you want all the traffic, from all participants – it's a good model for video/voice conferencing, or for services – you know the service you want, but not the source.

Hybrid SDN network control



NAT – Driver-less deployment





Source 921 (1638) All Search...

	Name	Description	Tags
☑	000-204-44738-1; 000-4; 003-0F-1	Studio 44738-1	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-4; 003-0F-2	Studio 44738-2	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-4; 003-0F-3	Studio 44738-3	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-4; 003-0F-4	Studio 44738-4	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 003-0F-1	Studio 44738-5	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 003-0F-2	Studio 44738-6	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 003-0F-3	Studio 44738-7	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 003-0F-4	Studio 44738-8	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 003-0F-1	Studio 44738-9	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 003-0F-2	Studio 44738-10	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 003-0F-3	Studio 44738-11	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 003-0F-4	Studio 44738-12	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 003-0F-1	Studio 44738-13	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 003-0F-2	Studio 44738-14	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 003-0F-3	Studio 44738-15	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 003-0F-4	Studio 44738-16	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-1; 003-0F-1	Videoconference	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-1; 003-0F-2	Videoconference	LINEAR-07-2000-7_106

3050 sources

Destination 1121 (2178) All Search...

	Name	Description	Tags
☑	000-204-44738-1; 000-4; 0F-003-1	44738- Studio 1	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-4; 0F-003-2	44738- Studio 2	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-4; 0F-003-3	44738- Studio 3	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-4; 0F-003-4	204-Rgn-4	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 0F-003-1	44738- Studio 4	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 0F-003-2	44738- Studio 5	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 0F-003-3	44738- Studio 6	LINEAR-07-2000-7_106
☑	000-204-44738-2; 000-4; 0F-003-4	204-Rgn-5	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 0F-003-1	204-Rgn-6	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 0F-003-2	204-Rgn-7	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 0F-003-3	204-Rgn-8	LINEAR-07-2000-7_106
☑	000-204-44738-3; 000-4; 0F-003-4	204-Rgn-9	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 0F-003-1	204-Rgn-10	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 0F-003-2	204-Rgn-11	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 0F-003-3	204-Rgn-12	LINEAR-07-2000-7_106
☑	000-204-44738-4; 000-4; 0F-003-4	204-Rgn-13	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-1; 0F-003-1	Videoconference	LINEAR-07-2000-7_106
☑	000-204-44738-1; 000-1; 0F-003-2	Videoconference	LINEAR-07-2000-7_106

3455 destinations

Source: Name (required): Start:

Destination: Description (optional): End:

Profile: Tags (optional): Route:

Fun Facts – Uncompressed 2110-20 Video Essence

Format	Sampling	Depth	Gen Pkt Mod	Per 10G	Per 40G	Per 100G
720p59.94	YCbCr-4:2:2	10	1,176 Mbps	7	30	80
1080i59.94	YCbCr-4:2:2	10	1,325 Mbps	6	26	65
1080p59.94	YCbCr-4:2:2	10	2,650 Mbps	3	13	35
2160p59.94	YCbCr-4:2:2	10	10,600 Mbps	~1	3	8
4320p59.94	YCbCr-4:2:2	10	42,397 Mbps			2



32x 100G Switch = 2,560 x 2560 SD
 Note: Ethernet is Bi-Directional

neviON

Why Merchant Network Silicon is Winning

Merchant Silicon Firsts

- 2008: First ultra-low latency 24-port 10G single chip
- 2010: First Large Buffer 10G Chip with VOQ Fabric
- 2011: First 64-port 10G single chip switch
- 2012: First 32-port 40G single chip
- 2013: First Large Buffer 40G Chip with VOQ Fabric
- 2015: First 32-port 100G single chip
- 2016: First Router 100G Chip with VOQ Fabric
- 2017: First 64-port 100G single chip
- 2018: First 32-port 400G single chip (forecast)

Bandwidth Improvement



Merchant Silicon: Faster Time-to-Market, Better Execution and Faster Innovation

nevi^on

Live on-air August 12, 2017

0 - 3

CHELSEA vs BURNLEY



What's next for TV2?

- ✓ Migration to **SMPTE 2110**
 - ✓ **Timing** already based on **2110-10** (2059-1/2)
 - ✓ **Audio** already based on **2110-30** (AES67)
 - ✓ **Video** using 2022-6, move to **2110-20**
 - ✓ **Metadata** using 2022-6, move to **2110-40**
- ✓ Adopt **NMOS** architecture
- ✓ Dynamic essence flows (**SDP**)
- ✓ **Orchestration** of workflows

A photograph of the Aurora Borealis (Northern Lights) over a snowy, dark landscape. The aurora displays vibrant green and purple hues against a starry night sky. The foreground shows a dark, snow-covered ground.

THANK YOU!

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