SDVoE™ Alliance
Software Defined Video Over Ethernet

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# Networking Crash Course for AV Systems Engineers

60 min
9 February 2018
1:30pm – 2:30pm CET
ISE 2018 Elicium Room D203

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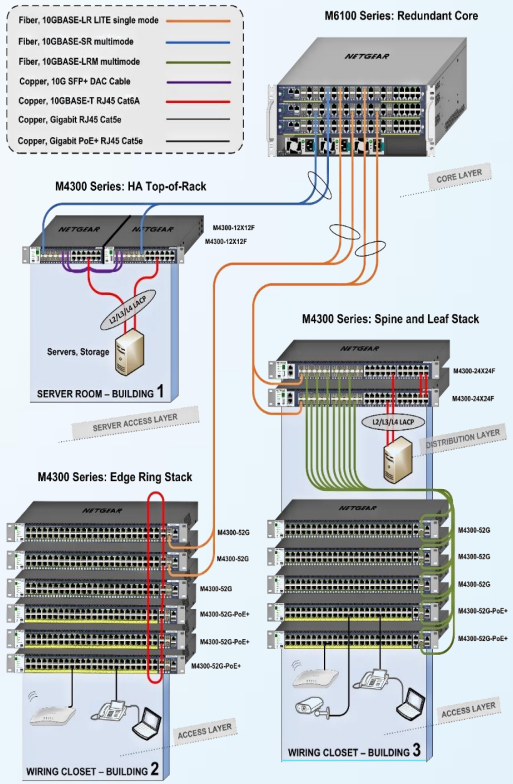
# Networking Crash Course for AV Systems Engineers

- Learn the basics of important networking topics for AV: Multicast, VLANs, routing vs switching
- Understand the different switch topologies and concepts: non-blocking, spine and leaf, link aggregation
- Apply calculations of video bandwidth to network design in order to ensure a flawlessly working AV over IP system

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ProSAFE

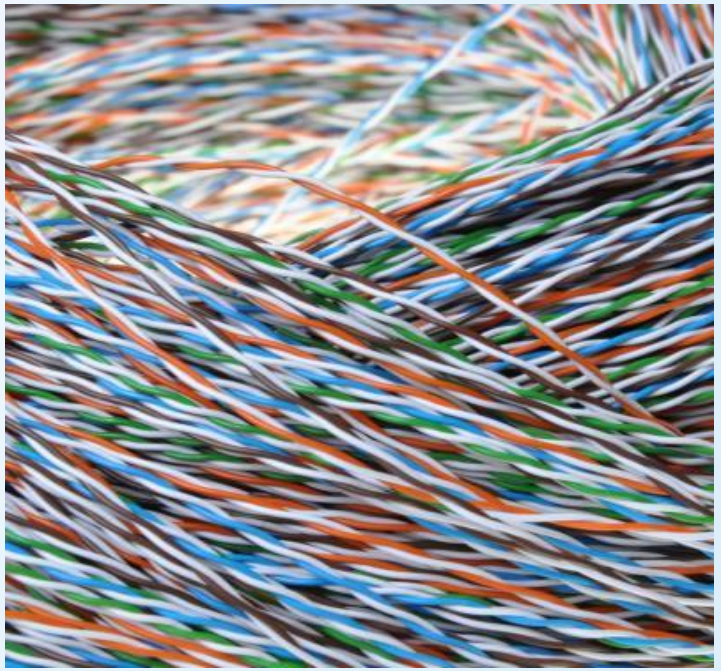
# Pro AV/IT convergence: progress report

+Control moved to Ethernet two decades ago

+Audio has moved to Ethernet (quickly!) in the last 5 years

+Video over Ethernet transition well underway

- No clear winner
- Most solutions require performance compromise



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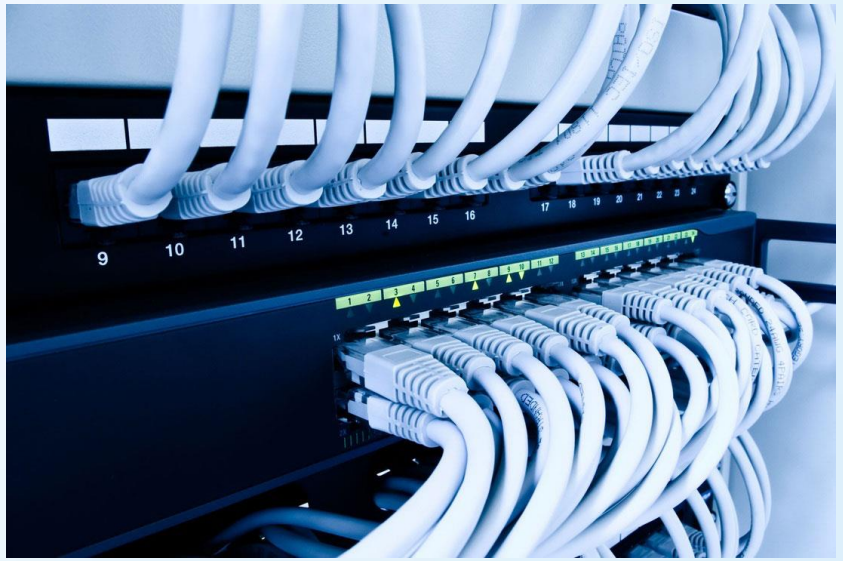
# Will convergence ever happen?

+We have been promised AV/IT convergence for years

+No one seems to know when



# What is the hold up for video?

+Bandwidth isn't the problem

+The problem is *shared* bandwidth

+There is not enough space on a 1 Gbps network for quality AV and IT users

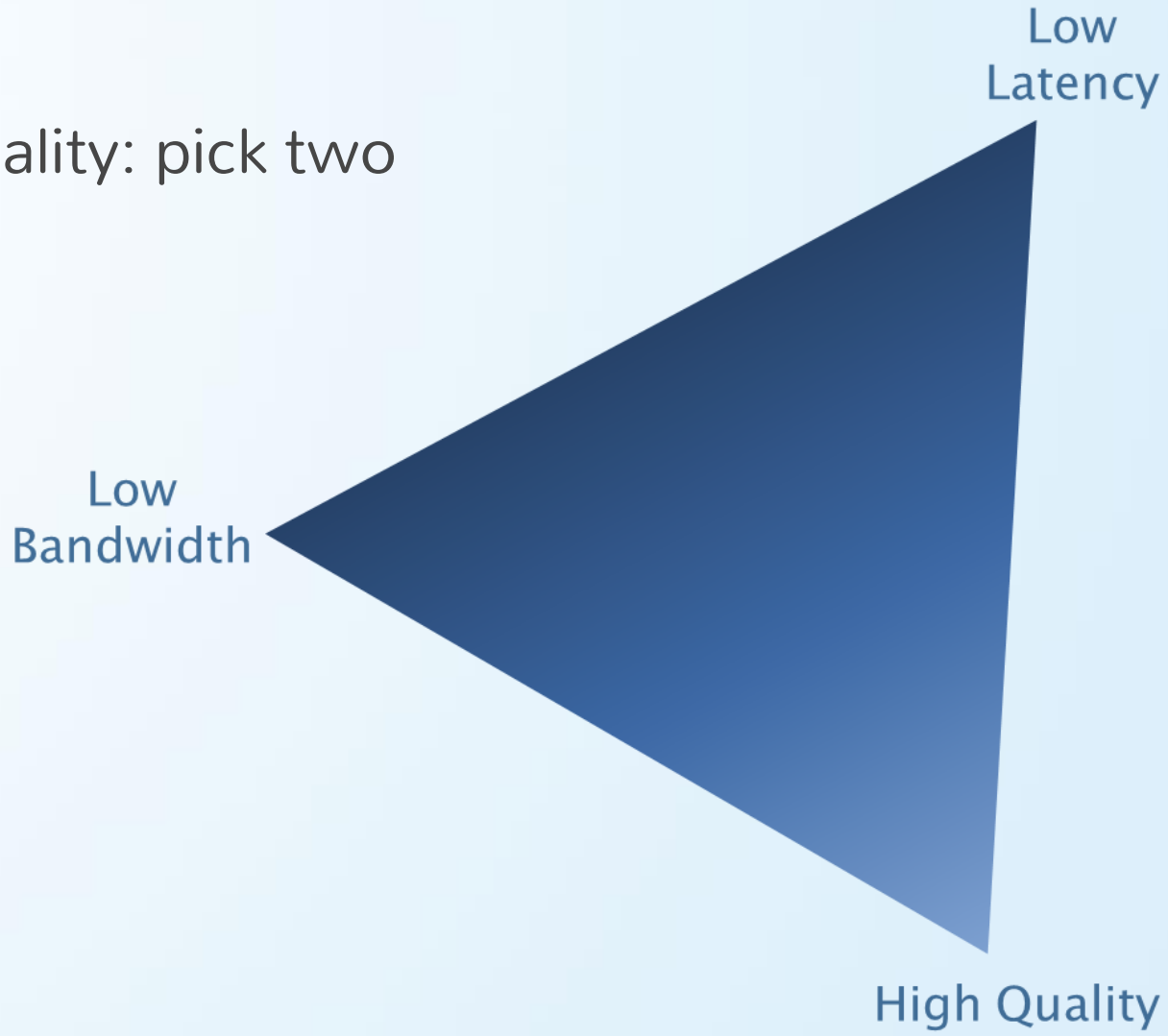
# High quality video requires many bits

| Image size | Frame rate | Bits per pixel | Chroma sampling | Bandwidth |
|---|---|---|---|---|
| 1280x720 | 60 fps | 8-bit | 4:4:4 | 1 Gbps |
| 1920x1080 | 60 fps | 8-bit | 4:2:0 | 1.5 Gbps |
| 1920x1080 | 60 fps | 8-bit | 4:2:2 | 2 Gbps |
| 1920x1080 | 60 fps | 8-bit | 4:4:4 | 3 Gbps |
| 3840x2160 | 30 fps | 8-bit | 4:4:4 | 6 Gbps |
| 3840x2160 | 60 fps | 8-bit | 4:2:0 | 6 Gbps |
| 3840x2160 | 60 fps | 10-bit | 4:2:0 | 7.5 Gbps |
| 3840x2160 | 60 fps | 8-bit | 4:4:4 | 12 Gbps |

# The codec triangle

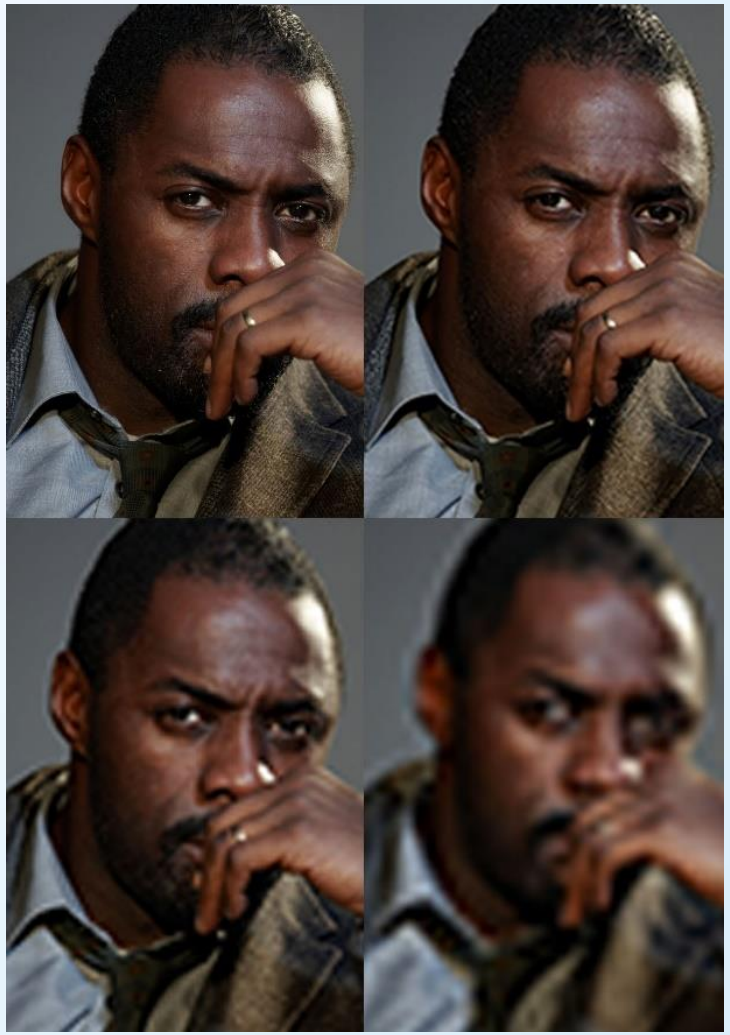
Low latency, low bandwidth, high quality: pick two

- Any technical/engineering decision like this is always about weighing pros and cons, benefits against drawbacks, and finding the right solution for your application



# The consequences of 1 Gbps

- 1 Gbps means high compression
- Pro AV demands high performance
  - Zero latency
  - Flawless image quality
- Anyone claiming 12-to-1 compression without latency can’t write it in spec sheets



# Software-defined Video over Ethernet

## The SDVoE Alliance Mission Statement

The SDVoE Alliance is a non-profit consortium of technology providers collaborating to standardize the adoption of Ethernet to transport AV signals, and to create a platform allowing software to define AV applications.

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Software Defined Video Over Ethernet

# 28 members and accelerating growth




**Contributors**

**Adopters**

**Founding Members**

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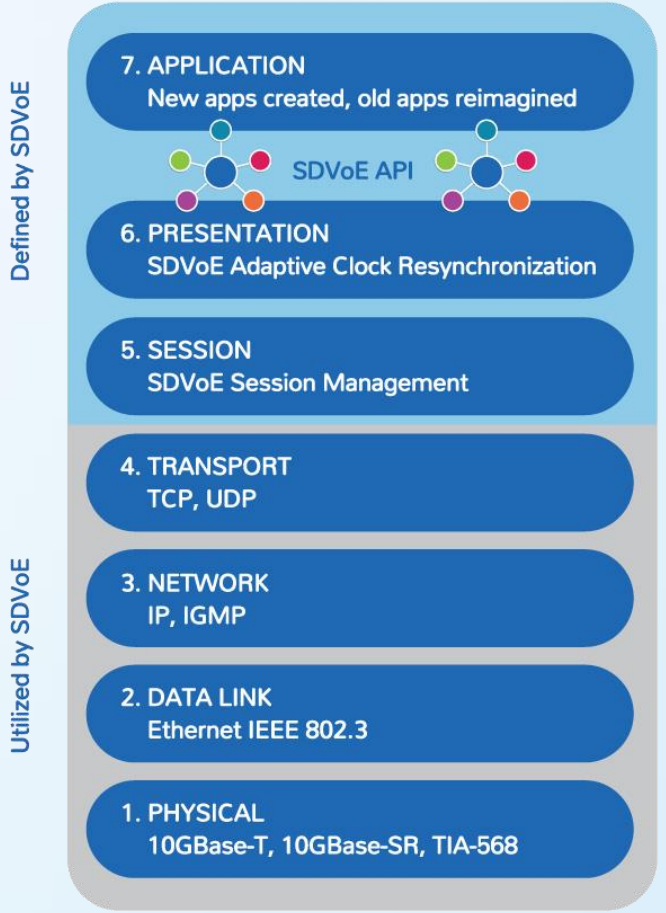
Software Defined Video Over Ethernet

# SDVoE technology

The only full-stack solution for AV over IP applications

- SDVoE addresses all layers of the network stack, from infrastructure to applications
- The most widely adopted networked AV standard, SDVoE delivers AV with zero-frame latency over Ethernet networks
- The SDVoE API is the interface to enable creative applications not yet conceived

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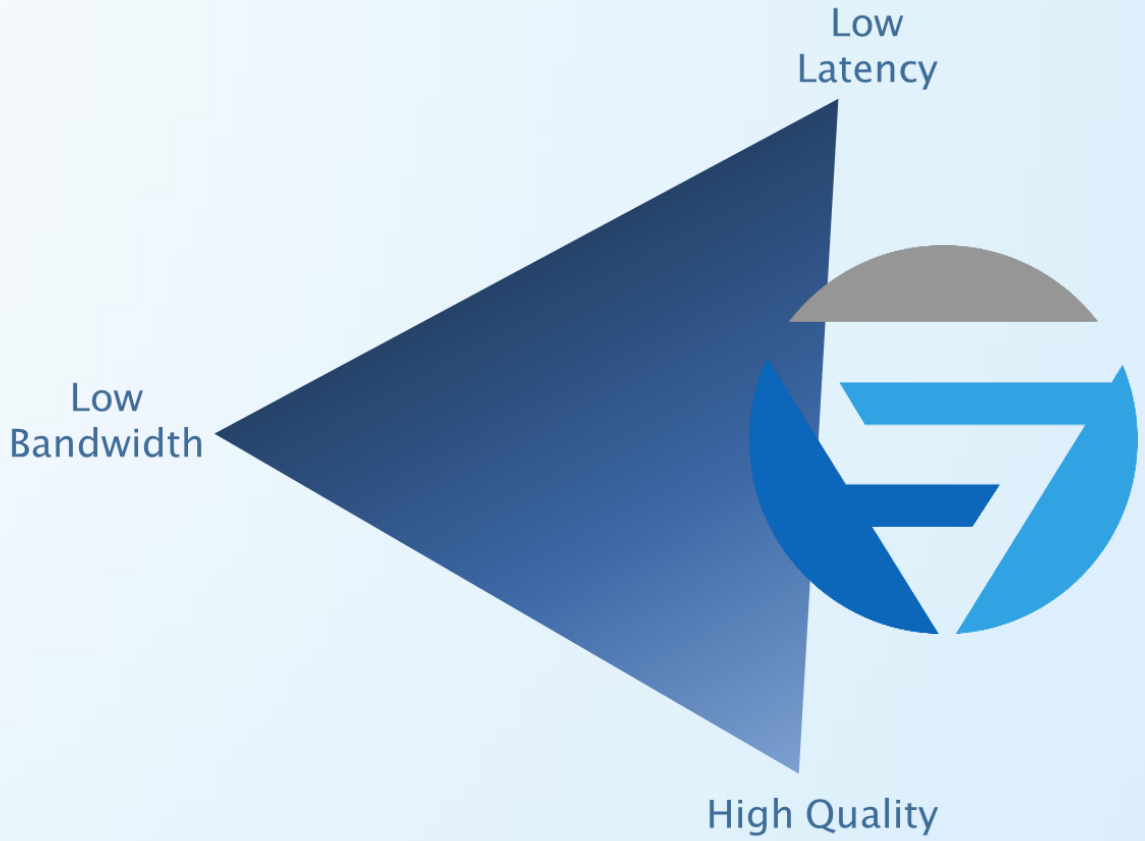
Software Defined Video Over Ethernet

# Compromise bandwidth, not experience!

SDVoE's pixel pipeline is the best choice for pro AV signal management

- Performance demands:
  - Zero latency
  - Flawless image quality
- Video quality demands are going up, not down
- Latency is literally your time
  - You are wasting your life waiting for that mouse pointer to move!
- Bandwidth is cheap *and getting cheaper!*

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Digital Signage

HDMI

USB 2.0

SDVoE Encoder

10G Ethernet (Copper)

4K Camera

HDMI

1G Ethernet

SDVoE Encoder

10G Ethernet (Copper)

4K Server

HDMI

Audio Embed

SDVoE Encoder

10G Ethernet (Copper)

Blu-ray Player

HDMI

IR

SDVoE Encoder

10G Ethernet (Copper)

Cable Satellite Box

HDMI

IR

SDVoE Encoder

10G Ethernet (Fiber)

Laptop

HDMI

1G Ethernet

Audio Embed

USB 2.0

SDVoE Encoder

10G Ethernet (Fiber)

SDVoE Controller

1G Ethernet

10G Ethernet (Copper)

SDVoE Decoder

HDMI

USB 2.0

HDTV Touchscreen

4K/60 4:4:4 with zero frame latency

10G Ethernet (Fiber)

SDVoE Decoder

HDMI

RS232

4K Display

Configurable Multi-Viewer

10G Ethernet (Fiber)

SDVoE Decoder

HDMI

RS232

Projector

EDID and HDCP 2.2 encryption support

10G Ethernet (Fiber)

SDVoE Decoders

HDMI

HDMI

HDMI

HDMI

Video Wall

Video Wall with bezel compensation

10G Ethernet (Fiber)

SDVoE Decoder

HDMI

1G Ethernet

Audio Embed

USB 2.0

IR

Smart TV

KVM access, real USB 2.0, infra-red control

Keyboard & Mouse

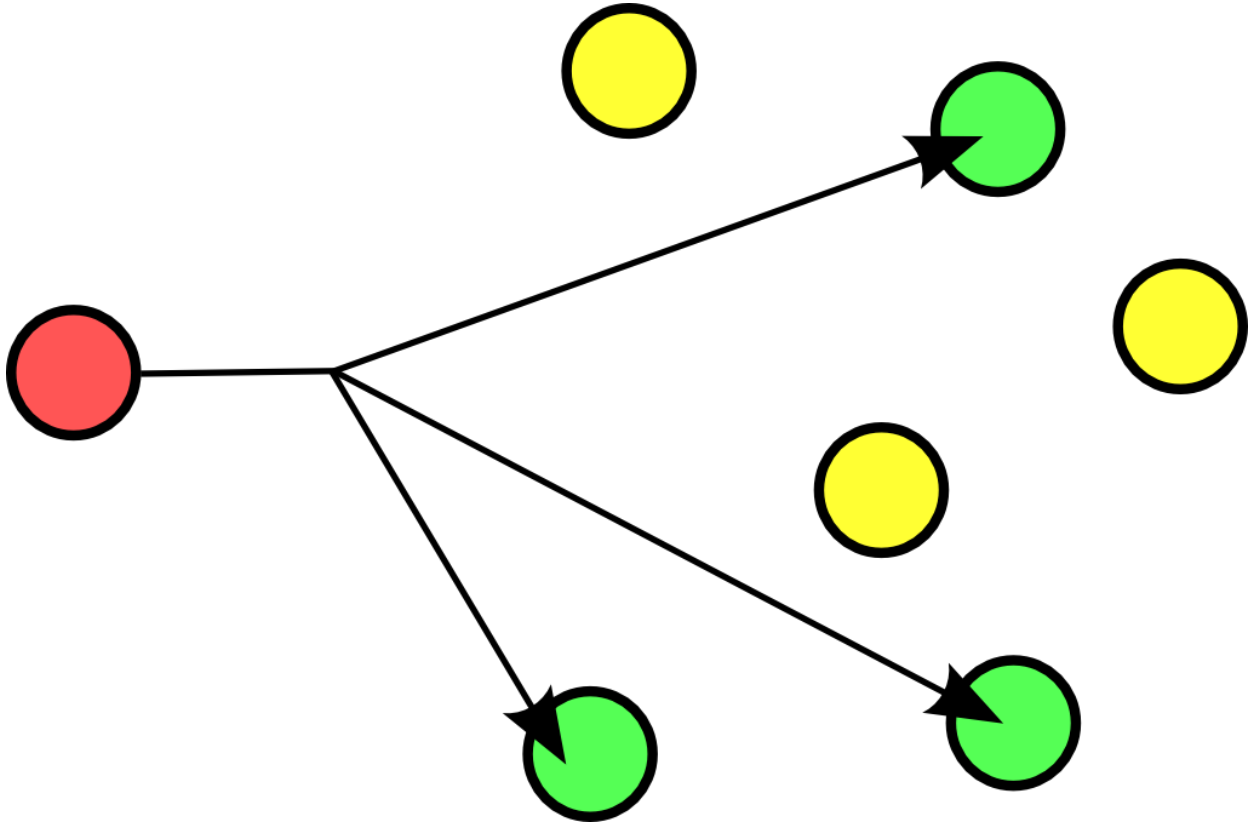
IR Receiver & Remote

Speakers

# AV-over-IP switching

+ Multicast communications, mostly

+ Can be 1G, or 10G



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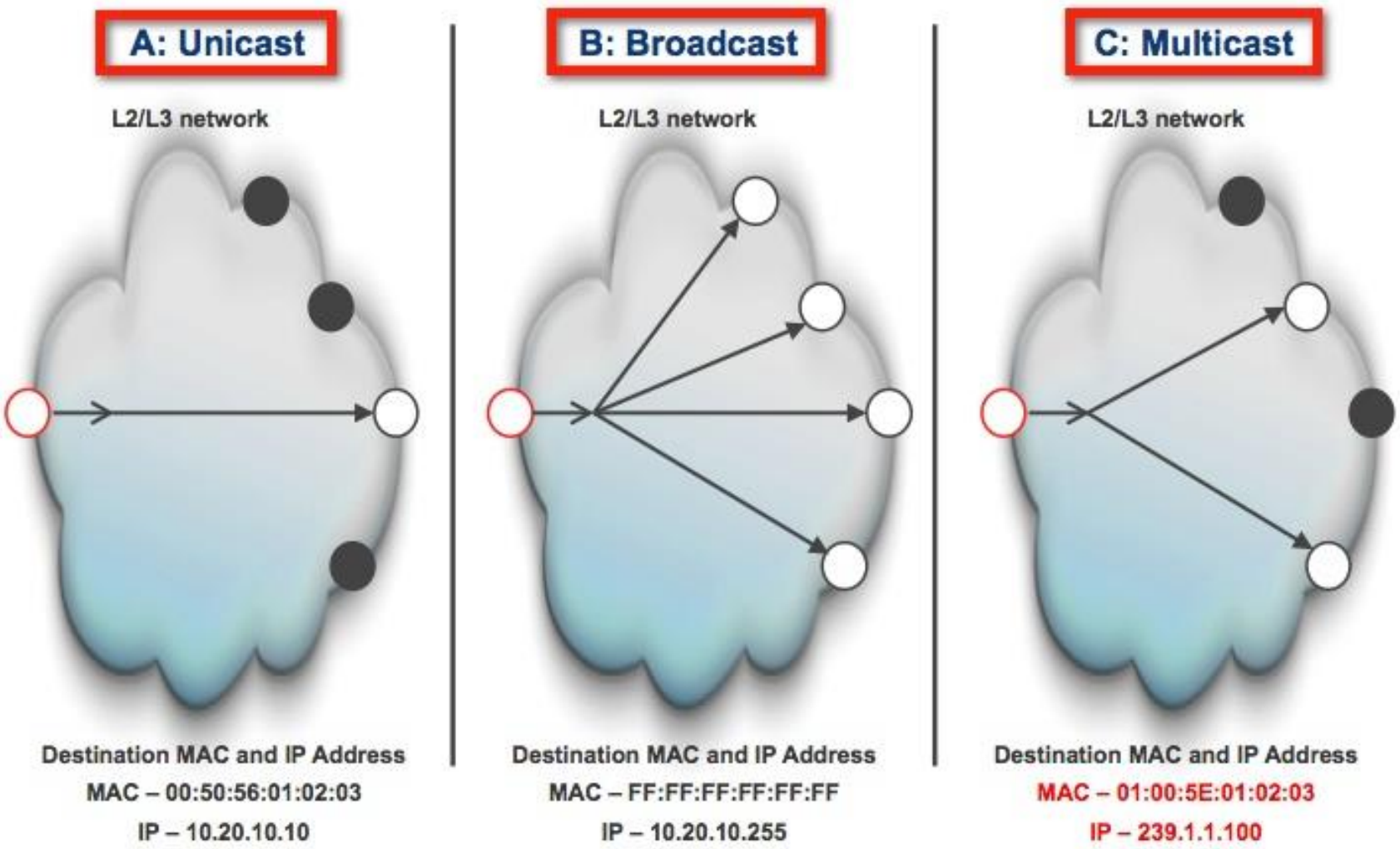
# IGMP (Internet Group Management Protocol)

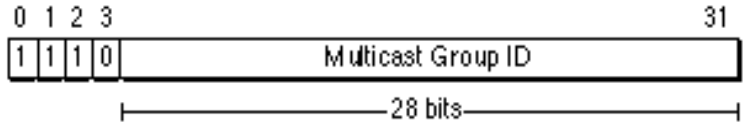



IP reserved class D addresses for multicast 224.0.0.0~239.255.255.255

Base address: 224.0.0.0 is reserved

224.0.0.1~224.0.0.255 are devoted to multicast routing and group maintenance protocols

| Class | From | To |
|---|---|---|
| D | 224.0.0.0 | 239.255.255.255 |

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# IGMP (Internet Group Management Protocol)


The Internet Group Management Protocol (IGMP) is an Internet protocol that provides a way for an Internet computer to report its multicast group membership to adjacent routers. Multicasting allows one computer on the Internet to send content to multiple other computers that have identified themselves as interested in receiving the originating computer's content.

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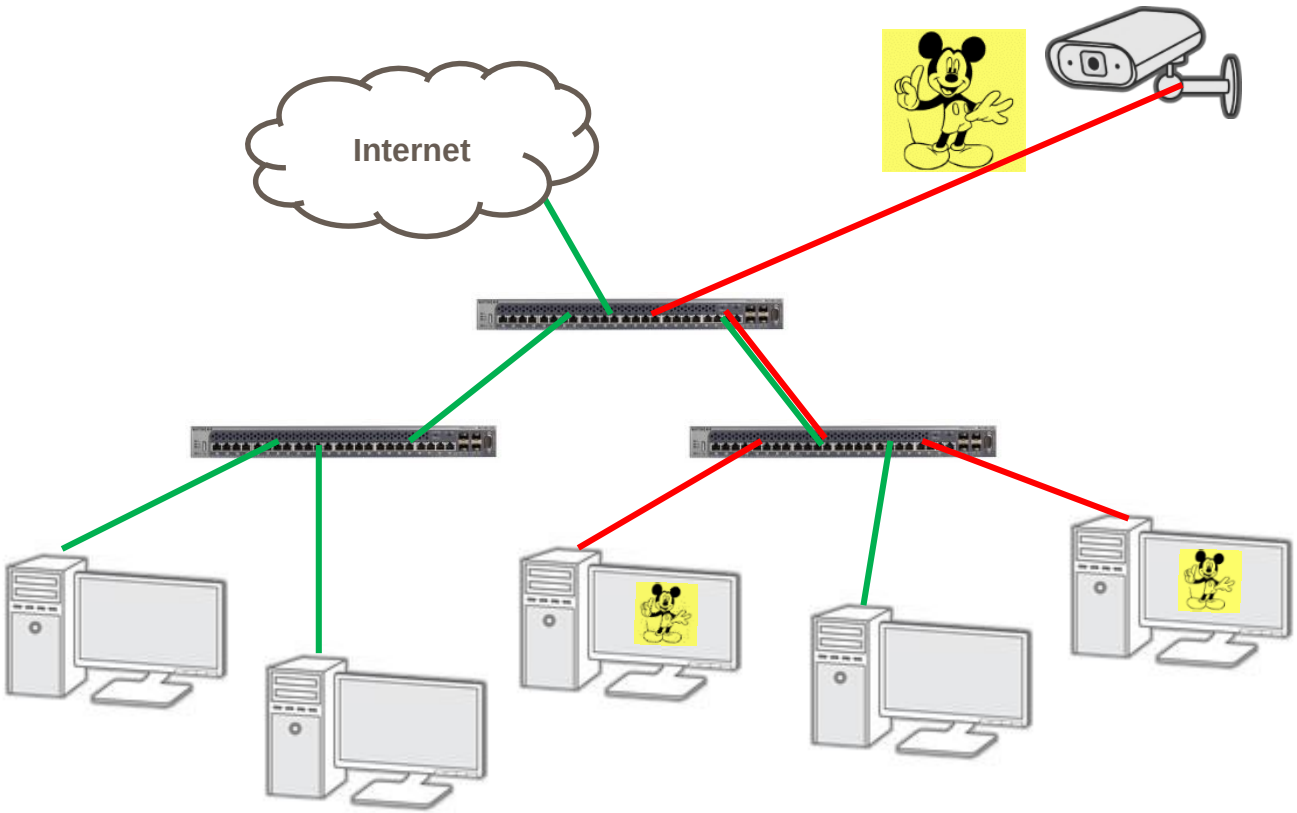
# IGMP Snooping

+ Reduces the Multicast traffic




A Layer 2 switch supporting IGMP Snooping can passively snoop on IGMP Query, Report, and Leave (IGMP version 2) packets transferred between IP Multicast routers/switches and IP Multicast hosts to determine the IP Multicast group membership. IGMP snooping checks IGMP packets passing through the network, picks out the group registration, and configures Multicasting accordingly.

Without IGMP Querying/Snooping, Multicast traffic is treated in the same manner as a Broadcast transmission, which forwards packets to all ports on the network. With IGMP Querying/Snooping, Multicast traffic is only forwarded to ports that are members of that Multicast group. IGMP Snooping generates no additional network traffic, which significantly reduces the Multicast traffic passing through your switches.

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# The need for IGMP Querier (router)

- **When the switch is used in network applications where video services such as IPTV, video streaming, and gaming are deployed, the video traffic is normally flooded to all connected ports because such traffic packets usually have multicast Ethernet addresses. IGMP snooping can be enabled to create a multicast group to direct that traffic only to those users that require it.**

- **However, the IGMP snooping operation usually requires an extra network device—usually a router—that can generate an IGMP membership query and solicit interested nodes to respond. With the built-in IGMP querier feature inside the switch, such an external device is no longer needed.**

- **Since the IGMP querier is designed to work with IGMP snooping, it is necessary to enable IGMP snooping when using it.**

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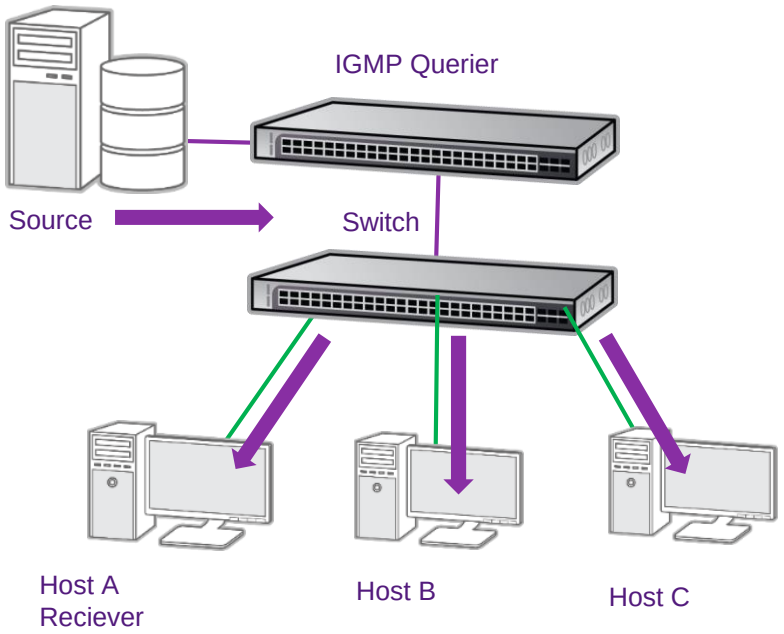
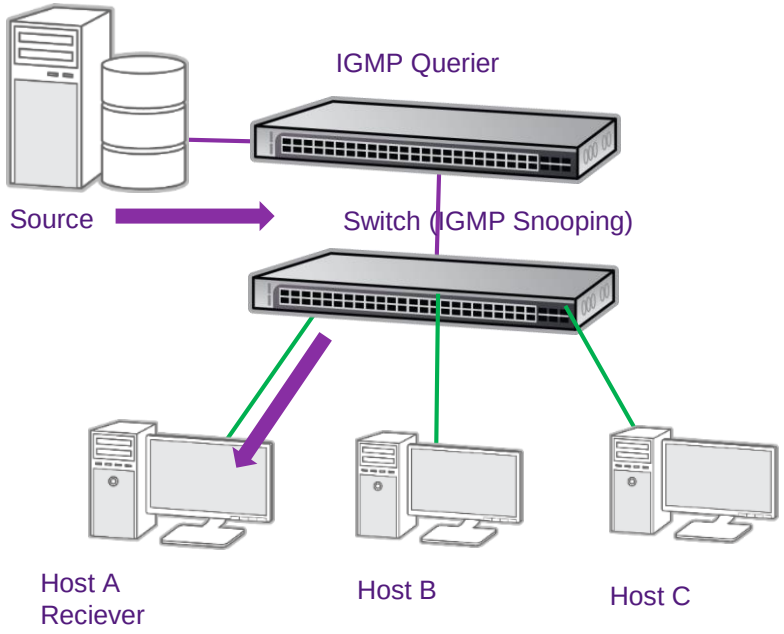
# Multicast Router / IGMP Snooping




**Network Without IGMP Snooping**




**Network With IGMP Snooping**

First lets look at IGMP Snooping and how it effects the flow of traffic. Without it multicast traffic in a network is essentially treated as a broadcast and forwarded to all ports, regardless of the whether the host on the port is a receiver for it or not. Once IGMP Snooping is configured then the traffic flow becomes much more efficient, with only receiver hosts needing the traffic.

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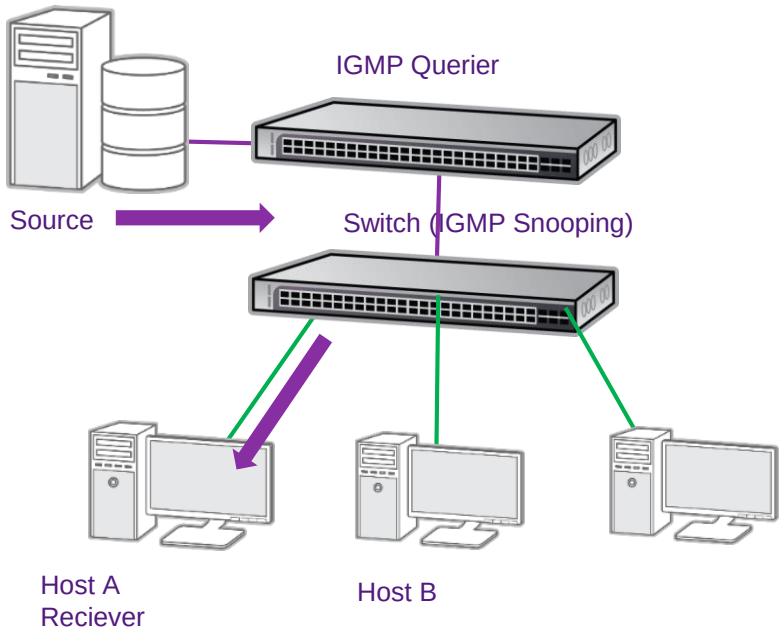
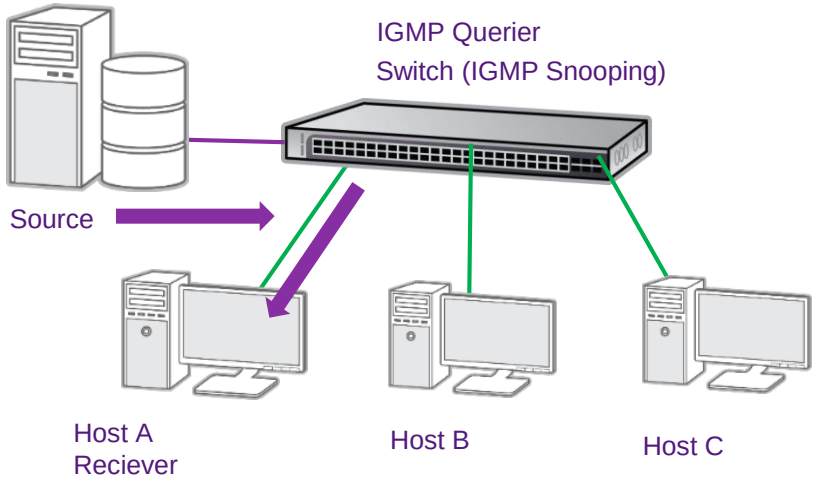
# Multicast Router / IGMP Snooping




IGMP Querier




IGMP Querier / IGMP Snooping

Let's now look at the network design when the Querier / Snooping resides in the same NETGEAR Managed Switch. Here we negate the need for an external device to act as the querier.

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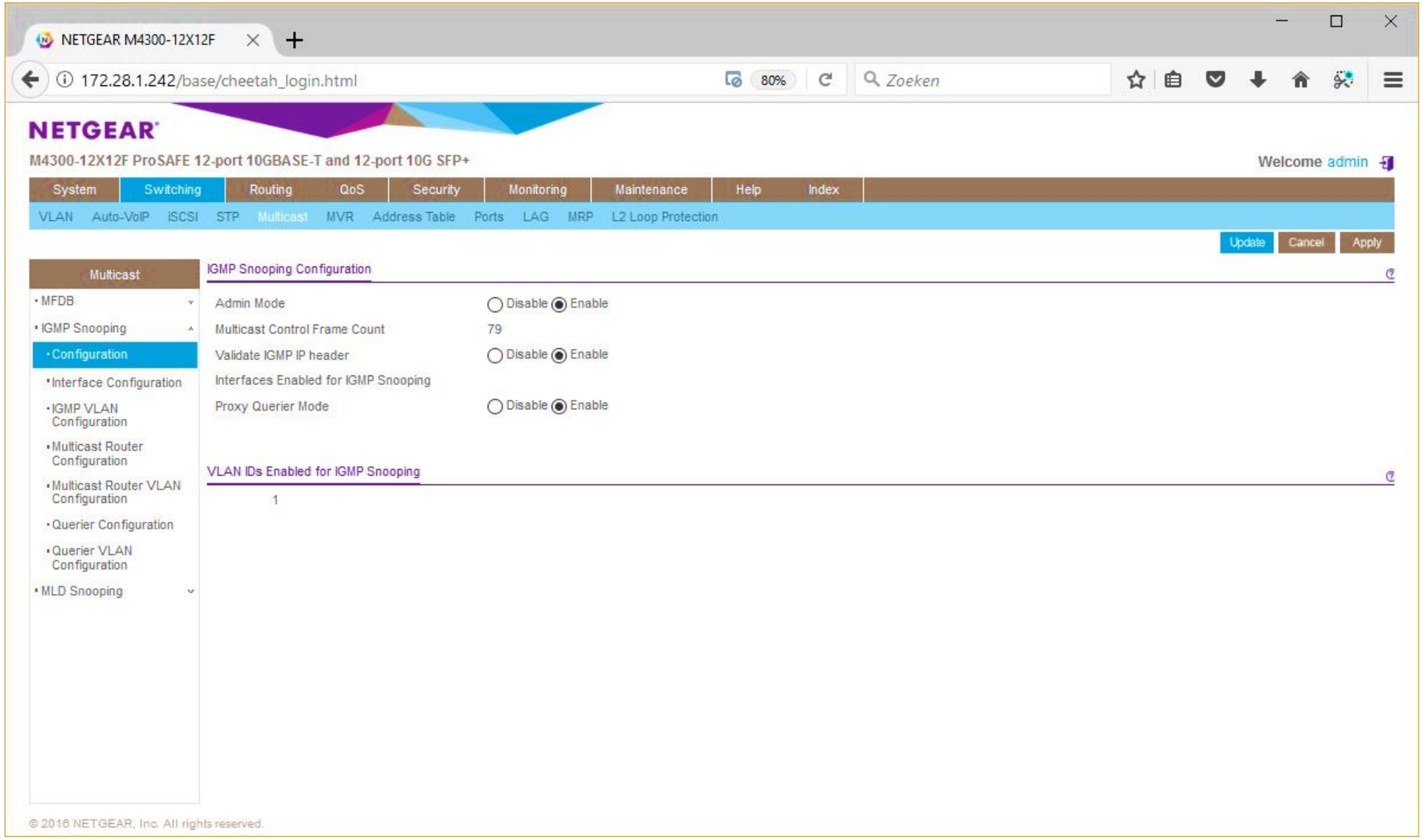
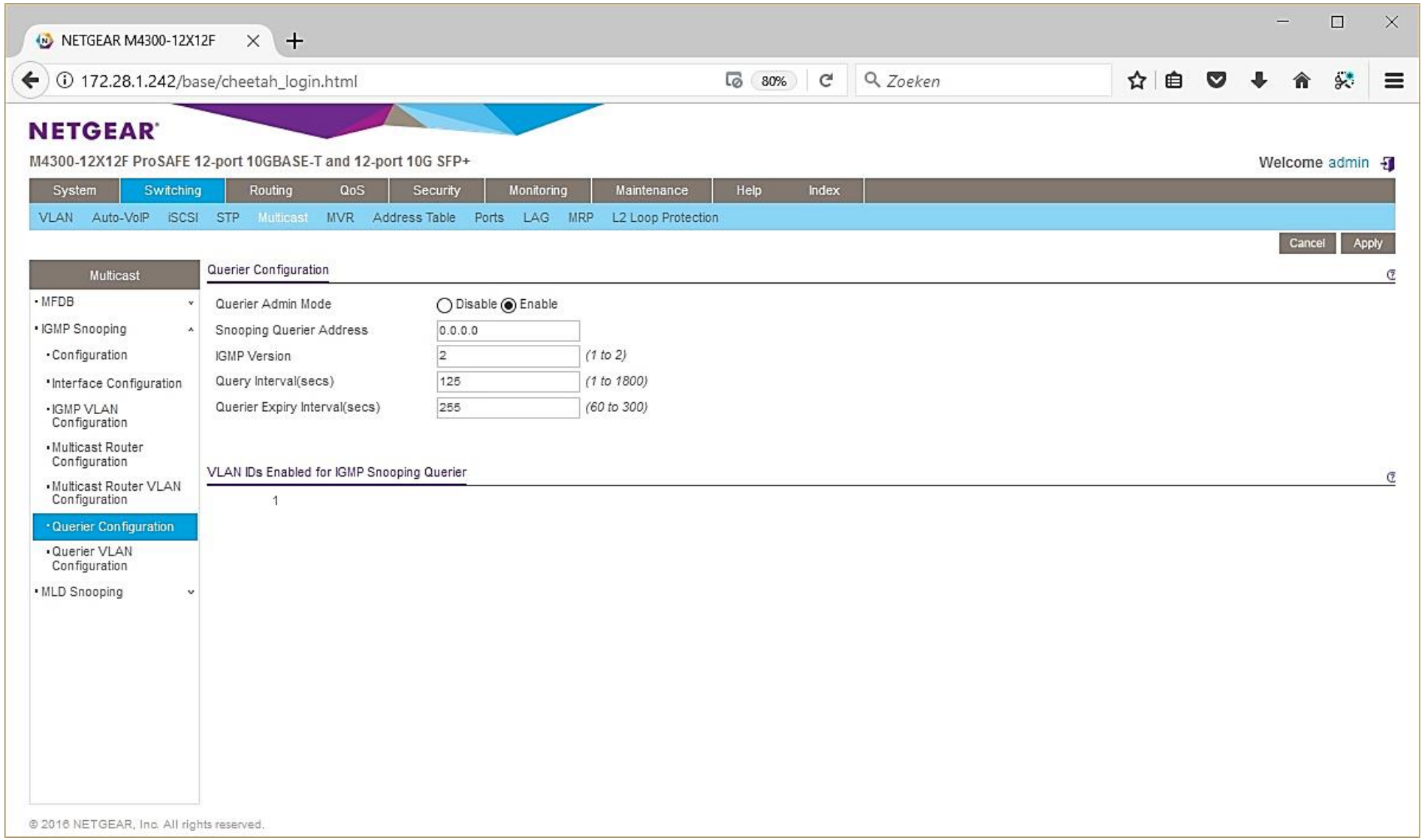
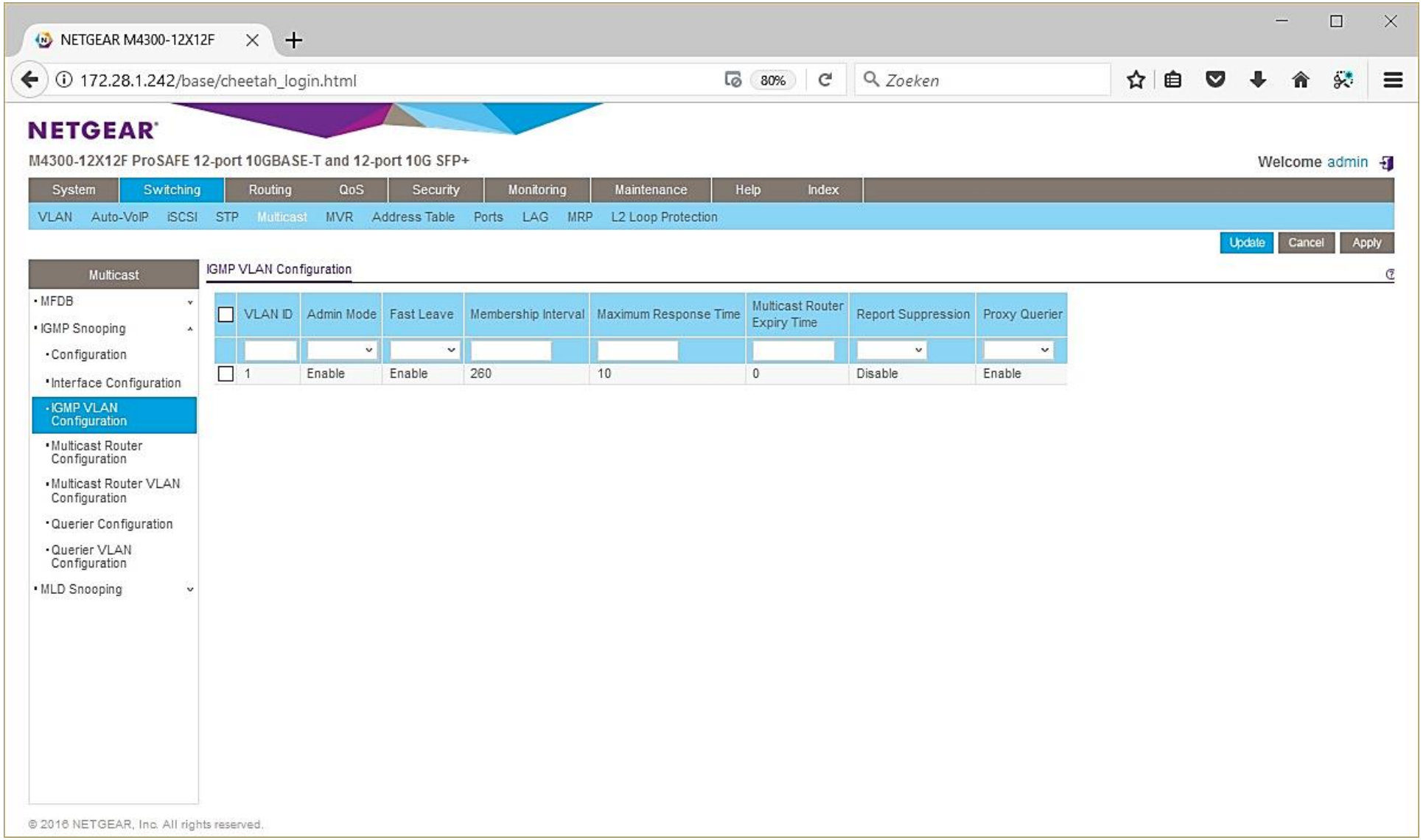
# IGMP Snooping



# IGMP Querier



# IGMP Fast Leave

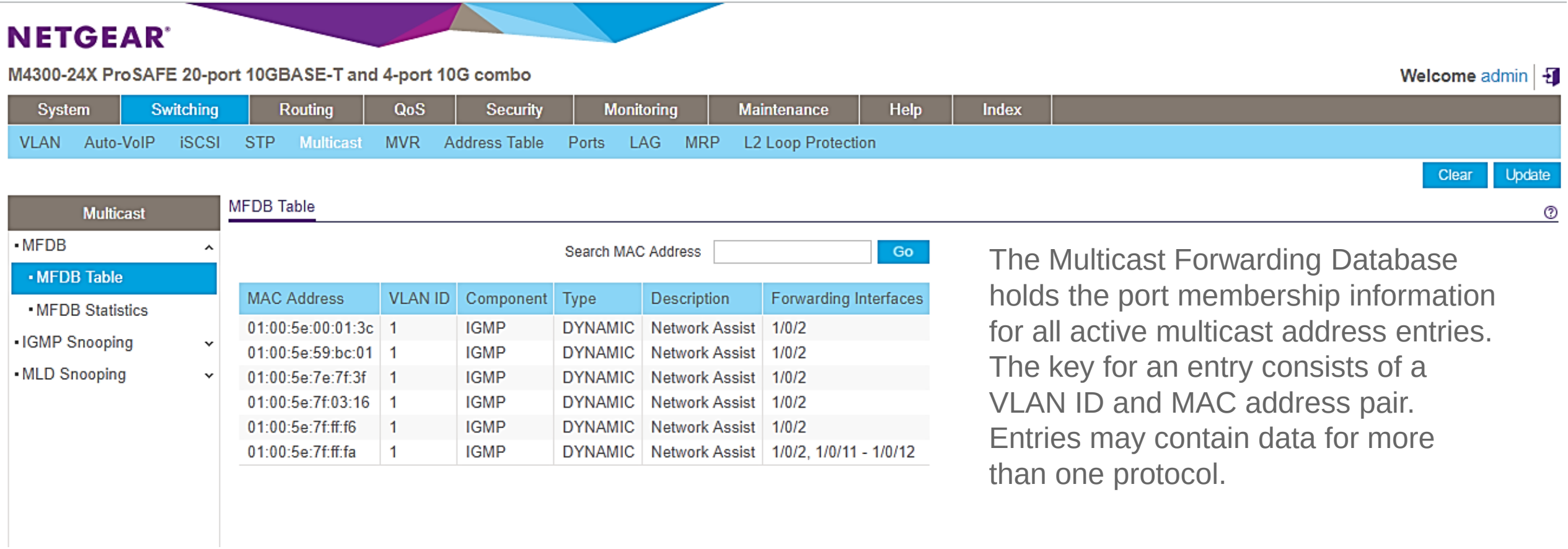


# Drop Unregistered Multicast Flooding

+ Default behavior of the NETGEAR M4300 series

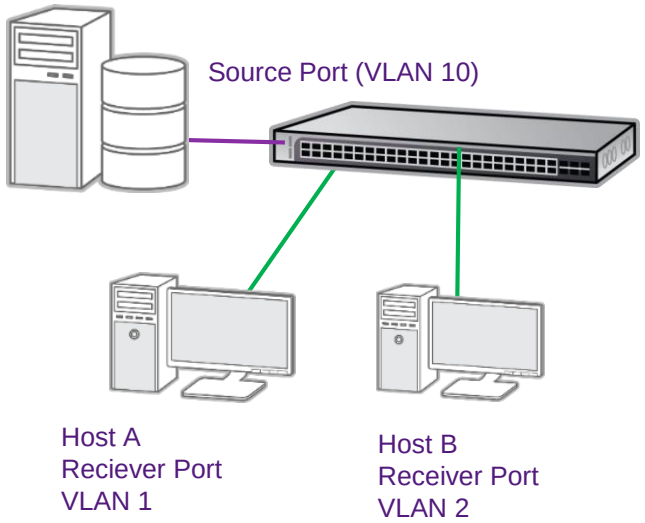
# Troubleshoot IGMP Multicast

## + Inspect the MC table (MFDB)




The Multicast Forwarding Database holds the port membership information for all active multicast address entries. The key for an entry consists of a VLAN ID and MAC address pair. Entries may contain data for more than one protocol.

# Multicast VLAN Registration (MVR)




As we know IGMP Snooping Protocol resolves the issue of multicast streams being received by unwanted ports. However the problem re-appears when we try to stream multicast traffic across different VLANs.

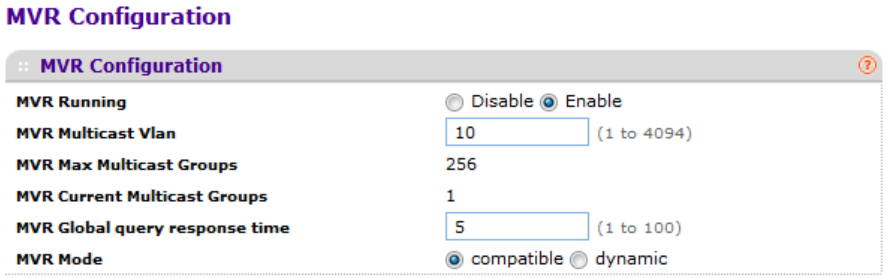
Multicast VLAN Registration (MVR) is intended to solve the problem of receivers in different VLANs. It uses a dedicated manually configured VLAN, called the multicast VLAN, to forward multicast traffic over Layer 2 network in conjunction with IGMP snooping.

There are two types of MVR ports: source and receiver.
The source port is the port to which the multicast traffic flows using the multicast VLAN.

The receiver port is the port where a listening host is connected to the switch. It can utilize any (or no) VLAN, except the multicast VLAN. This implies that the MVR switch performs VLAN tag substitution from the multicast VLAN source port to the VLAN tag used by the receiver port.

# Multicast using IGMP and MVR

**1. To enable MVR, go to “Switching => MVR => Basic” and “Enable” MVR Running setting:**




**2. Go to “MVR => Advanced => MVR Interface Configuration” and select the “source” port as the VLC Server and VLAN1 ports as the “receiver” ports:**

MVR Interface Configuration

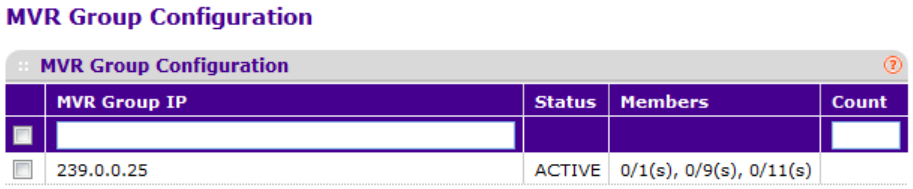
1 All  Go To Interface  GO

| Interface | Admin Mode | Type | Immediate Leave | Status |
|---|---|---|---|---|
| 0/1 | Enable | source | Disable | ACTIVE/InVLAN |
| 0/2 | Disable | none | Disable | ACTIVE/InVLAN |
| 0/3 | Disable | none | Disable | INACTIVE/InVLAN |
| 0/4 | Disable | none | Disable | INACTIVE/InVLAN |
| 0/5 | Disable | none | Disable | ACTIVE/InVLAN |
| 0/6 | Disable | none | Disable | INACTIVE/InVLAN |
| 0/7 | Disable | none | Disable | INACTIVE/InVLAN |
| 0/8 | Disable | none | Disable | INACTIVE/InVLAN |
| 0/9 | Enable | receiver | Disable | ACTIVE/InVLAN |
| 0/10 | Disable | none | Disable | INACTIVE/InVLAN |
| 0/11 | Enable | receiver | Disable | ACTIVE/InVLAN |
| 0/12 | Disable | none | Disable | ACTIVE/InVLAN |

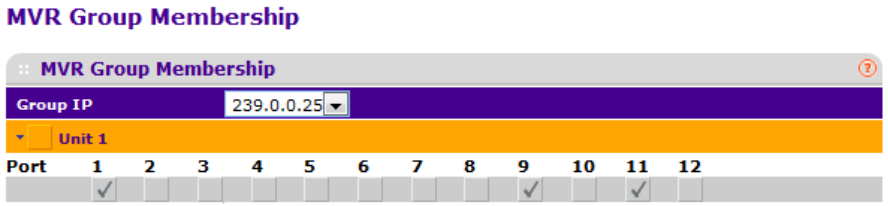
1 All  Go To Interface  GO

# Multicast using IGMP and MVR

**3. The “MVR Group Configuration” should now show as “Active”:**




**4. The “MVR Group Membership” should now reflect the source and receiver ports:**




**Now connect a PC to a designated receiver port in routed VLAN1 and try to run the stream.**

**That should work.**

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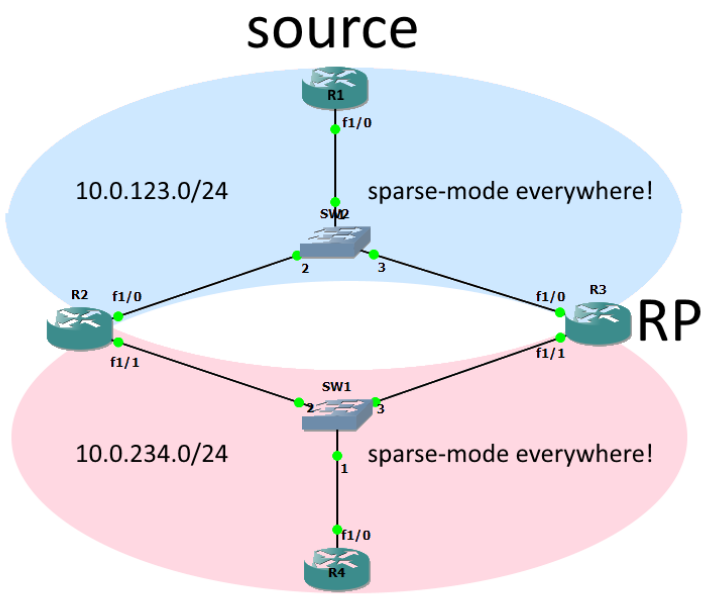
# Multicast Routing

**Distance Vector Multicast Routing Protocol (DVMRP) is a dense mode multicast protocol also called Broadcast and Prune Multicasting protocol**

+ DVMRP uses a distributed routing algorithm to build per-source-group multicast trees
+ DVMRP assumes that all hosts are part of a multicast group until it is informed of multicast group changes
+ It dynamically generates per-source-group multicast trees using Reverse Path Multicasting
+ Trees are calculated and updated dynamically to track membership of individual groups

**Multicast routing (PIM-SM and PIM-DM, both IPv4 and IPv6) ensure multicast streams can reach receivers in different L3 subnets**

+ Multicast static routes allowed in Reverse Path Forwarding (RPF) selection
+ Multicast dynamic routing (PIM associated with OSPF) including PIM multi-hop RP support for routing around damage advanced capabilities
+ Full support of PIM (S,G,Rpt) state machine events as described in RFC 4601
+ Improved Multicast PIM timer accuracy with hardware abstraction layer (HAPI) polling hit status for multicast entries in real time (without caching)



Lo1: ip igmp join-group 239.1.1.1

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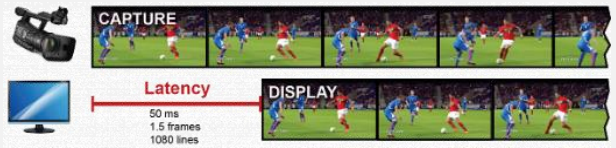
# Pro AV / IT Network

*What matters, from a **switching** standpoint*

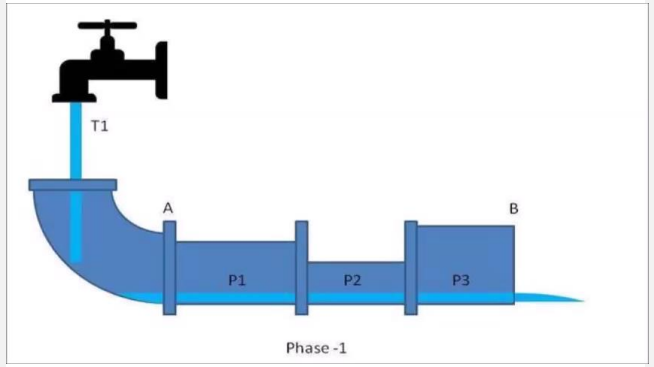

## Codec / Quality

- Doesn't matter



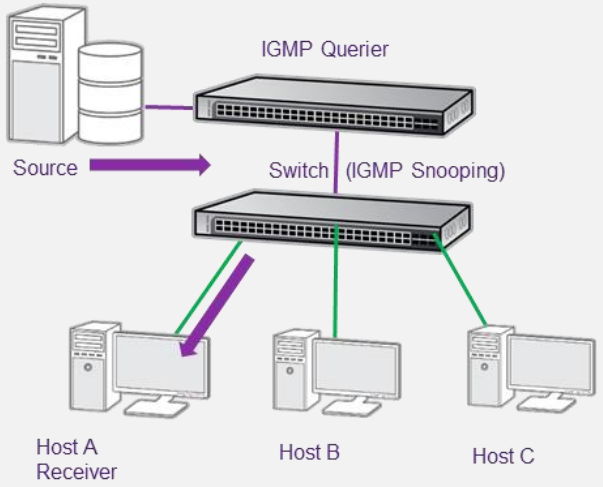

## Latency

- Doesn't matter




## Bandwidth

- #1 requirement for switches
- At the switch level (1G, 10G)
- In between switches (1G, 10G)
- Stacking / interconnect




## Multicast / IGMP

- #2 requirement for switches
- IGMP Snooping + Querier
- IGMP Fast Leave

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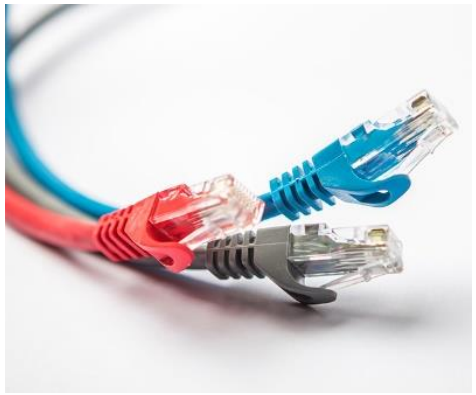
# Bandwidth – single switch installations

+ 1G, or 10G encoders and decoders
  - 1G encoders / decoders → 1G switch requirement
  - 10G encoders / decoders → 10G switch requirement
  - The switch total port count >= total number of (encoders + decoders)



**RJ-45**

CAT5e: Gigabit, 100m

CAT6: Gigabit, 100m
10 Gigabit, 35m to 55m

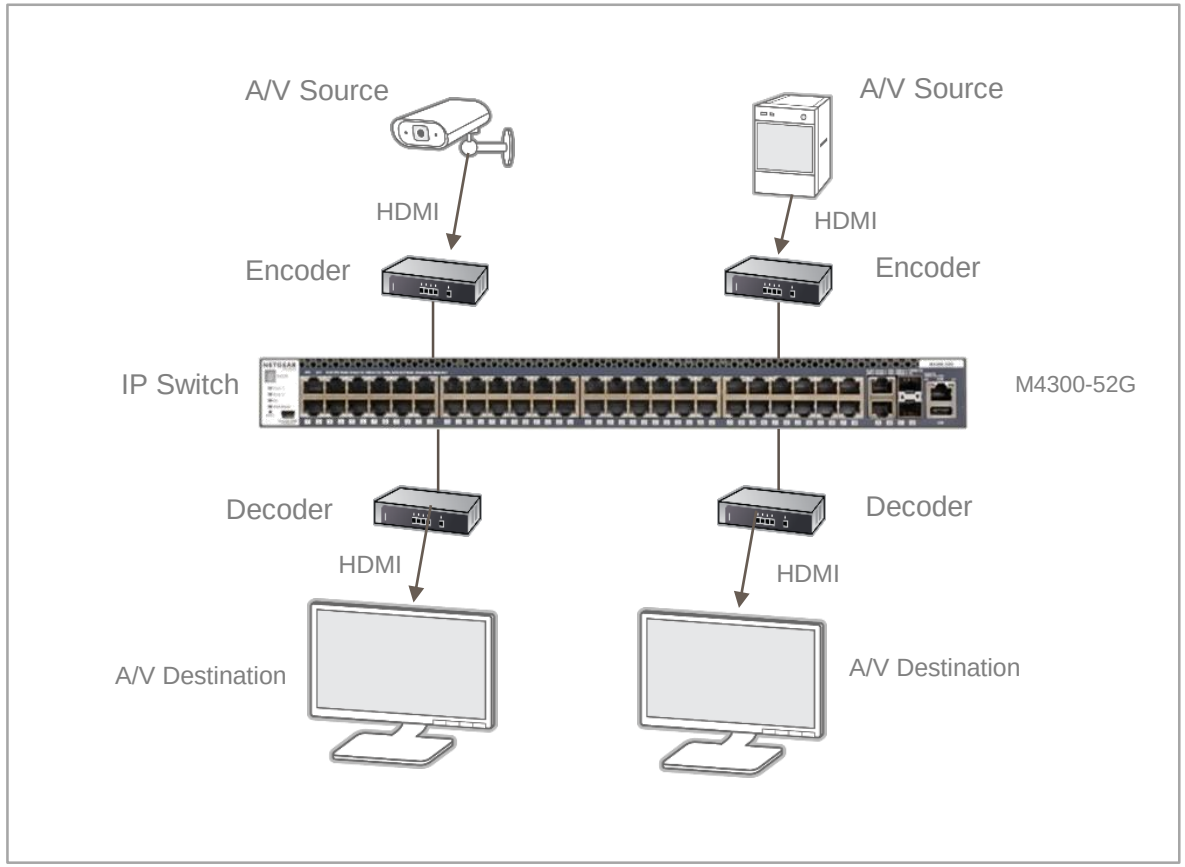
CAT6A: Gigabit, 100m
10 Gigabit, 100m

**Fiber**

Transceivers

DAC cables

**AV/IP Network**

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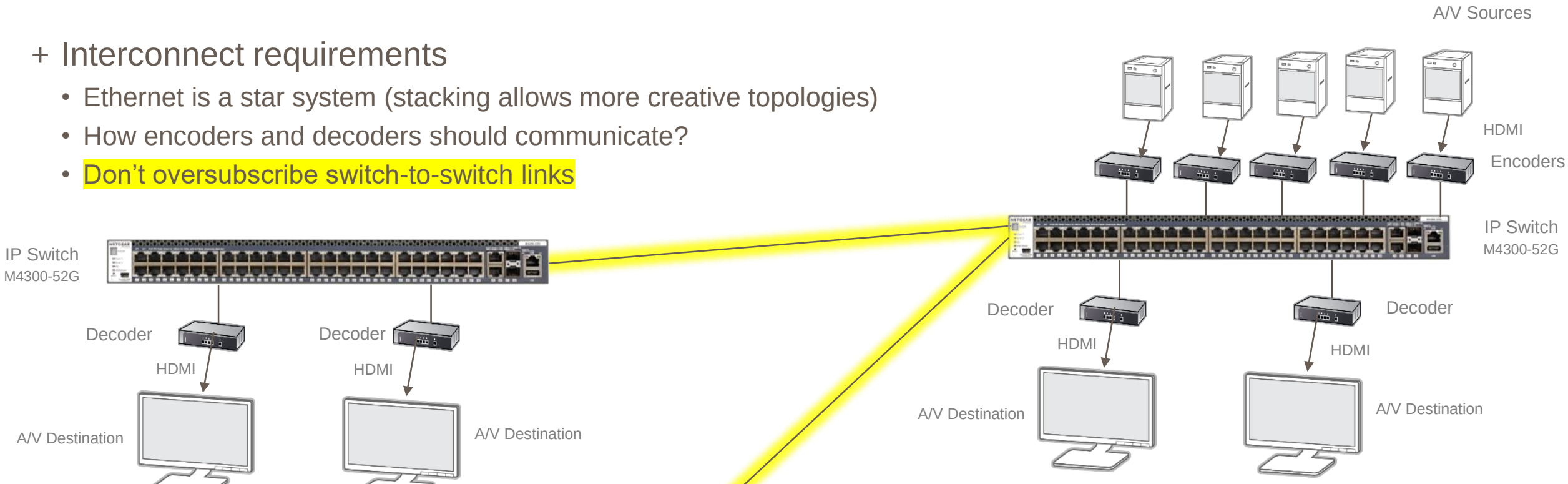
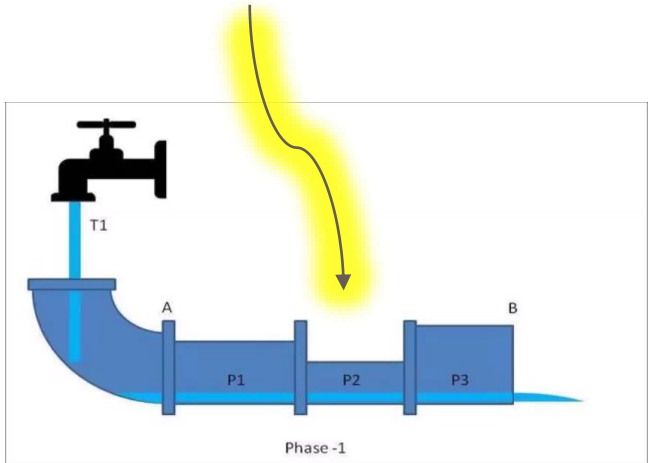
# Bandwidth – multi-switch installations

+ Interconnect requirements
  - Ethernet is a star system (stacking allows more creative topologies)
  - How encoders and decoders should communicate?
  - Don’t oversubscribe switch-to-switch links

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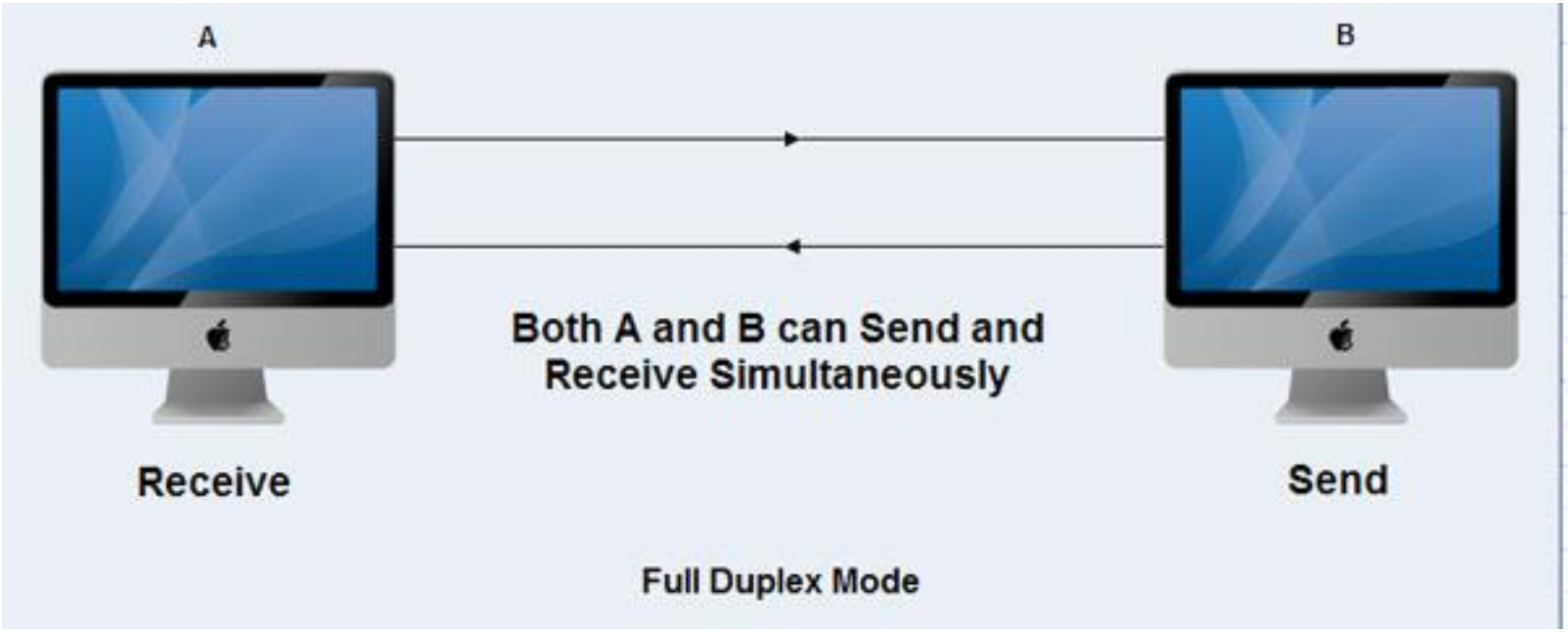
# Full Duplex mode

+ Switch-to-switch links
  - Full duplex operation allows encoders and decoders on both sides, “sharing” the interconnect bandwidth in both directions

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# Full Duplex mode

+ Switch-to-switch links
  - For instance, with one encoder (1G) and one decoder (1G) on each side
  - 1G interconnect is sufficient, because of full duplex


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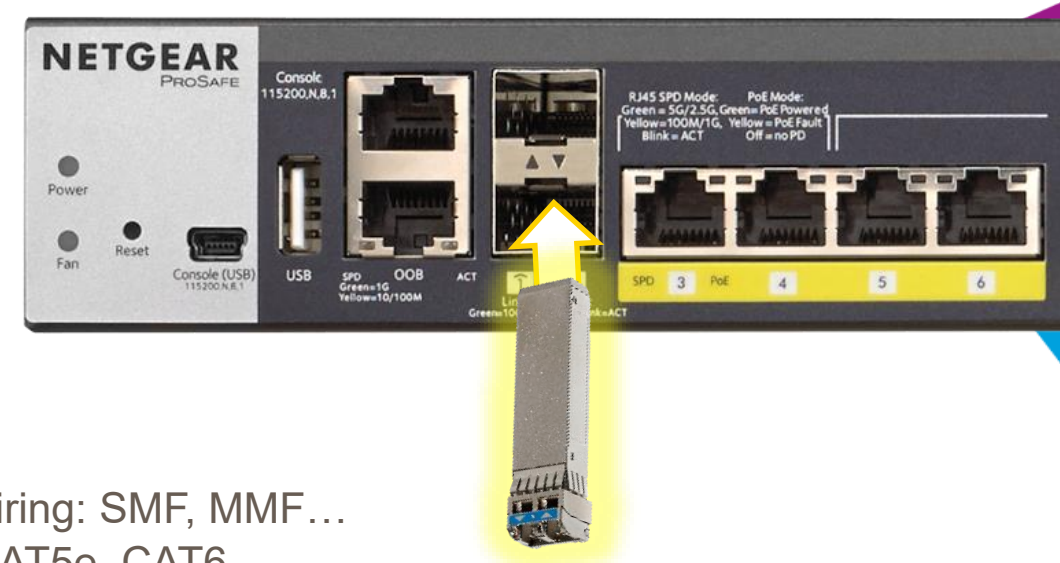
# Transceivers




## + Why Transceivers for Switches?

- For equipping their SFP or SFP+ fiber ports (cages)
  - Fiber ports are “modular” since there are many different types of fiber wiring: SMF, MMF…
  - Copper ports are “built-in”, because same RJ45 port applies to CAT5, CAT5e, CAT6, CAT6A…

## + Why Fiber in Ethernet Networks?

- RJ45 Copper connections are 100 meter (328 feet) long max
  - Too short a run for switch interconnect in buildings
- Fiber can reach up to 10 km (6.2 miles)
  - Fiber is mainly used between switches

SMF or MMF LC Duplex Connector

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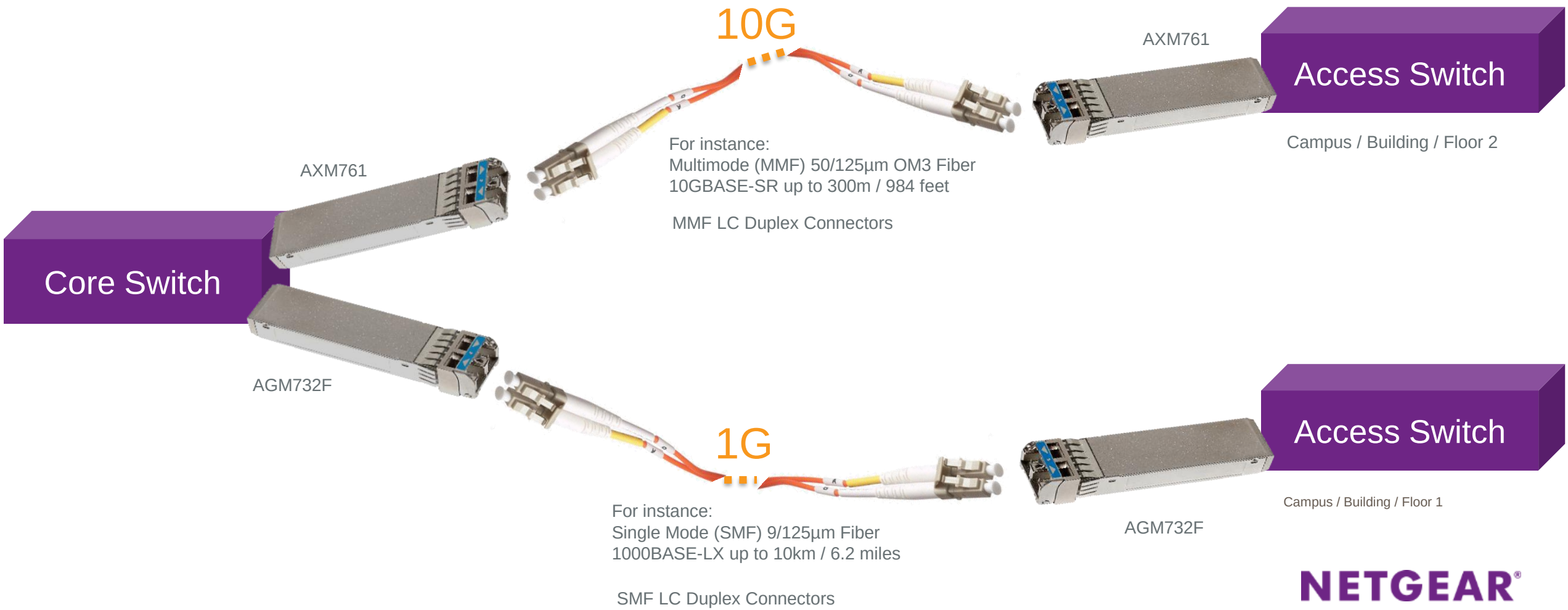
# Why transceivers:

## Because we don’t know which Fiber runs in between switches

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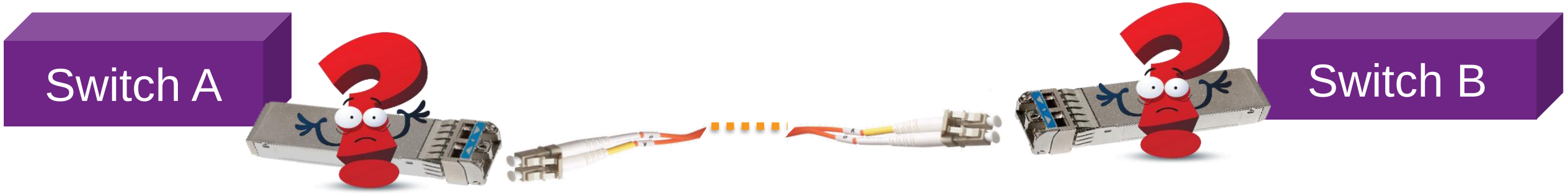
# Same Standard is Needed on Both Ends




| STANDARD | SPEED | MAX | FIBER | DIAMETER | GRADE |
|---|---|---|---|---|---|
| 10GBASE-SR | 10G | 330/550m | Multimode MMF | 50/125µm | OM3 / OM4 |
| 10GBASE-LRM | 10G | 220m | Multimode MMF | 62.5/125µm | OM1 / OM2 |
| 10GBASE-LR | 10G | 10km | Single Mode SMF | 9/125µm | Any |
| 10GBASE-LR LITE | 10G | 2km | Single Mode SMF | 9/125µm | Any |
| 1000BASE-SX | 1G | 275/550m | Multimode MMF | 50 or 62.5/125µm | OM1 / OM2 / OM3 / OM4 |
| 1000BASE-LX | 1G | 10km | Single Mode SMF | 9/125µm | Any |
| 100BASE-FX | 100M | 2km | Multimode MMF | 50 or 62.5/125µm | OM1 / OM2 / OM3 / OM4 |

**Applicable standards are dictated by fiber type, diameter, grade and length**

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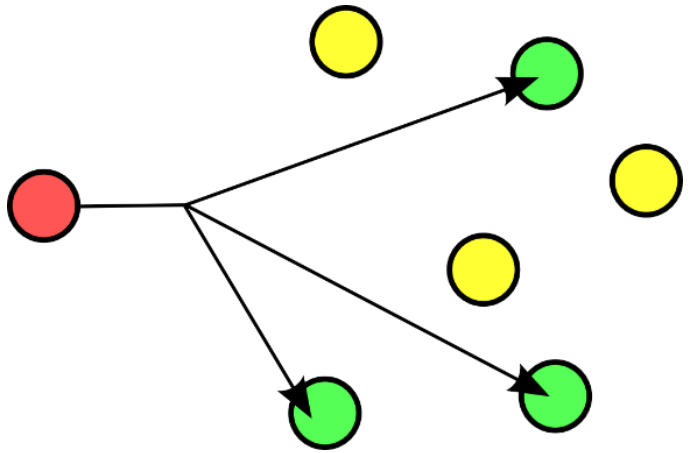
# Multicast – single switch installations

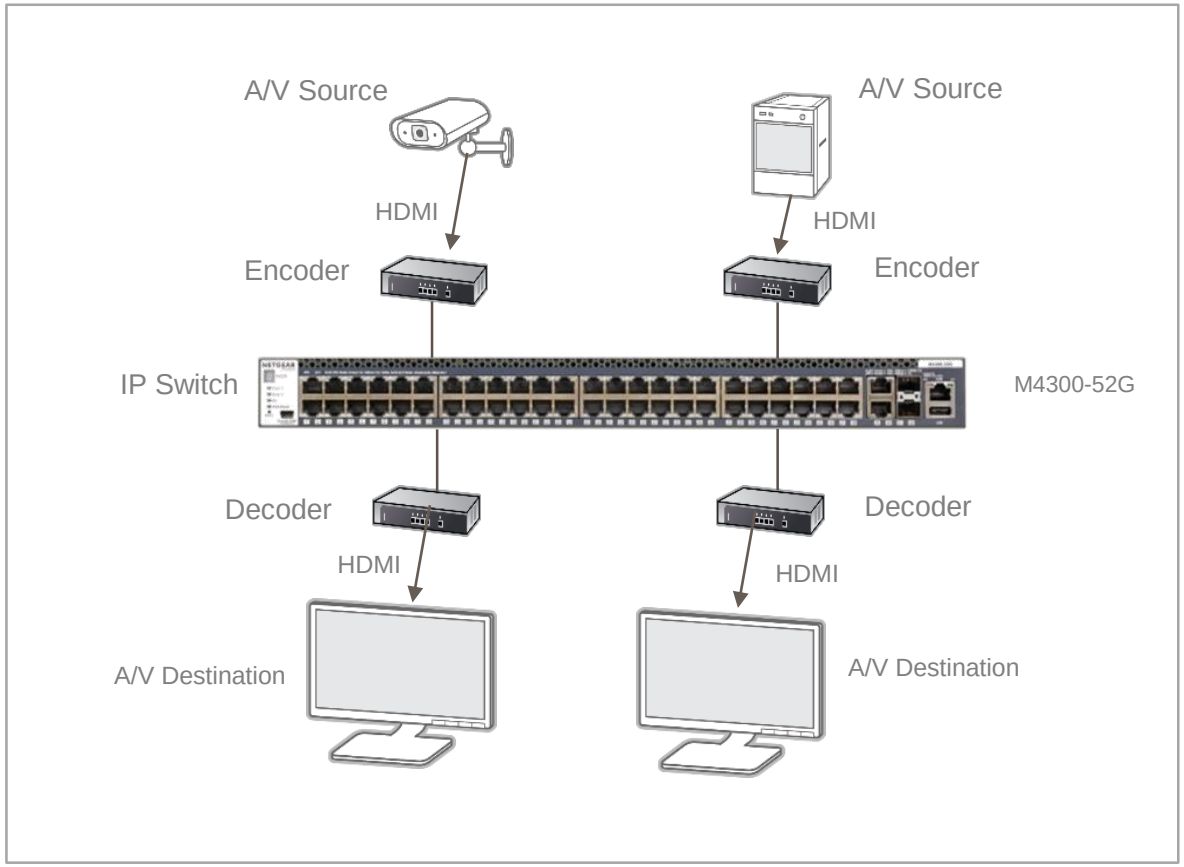
+ 1G, or 10G encoders and decoders

- The switch must be capable of IGMP Snooping (v2)
- The switch must be capable of IGMP Querier (v2)
- The switch must be capable of IGMP Fast Leave
- The switch should drop unknown Multicast packets

Either on VLAN 1 (default VLAN for all ports) – BEST

Or on every port (physical interfaces) – More fastidious



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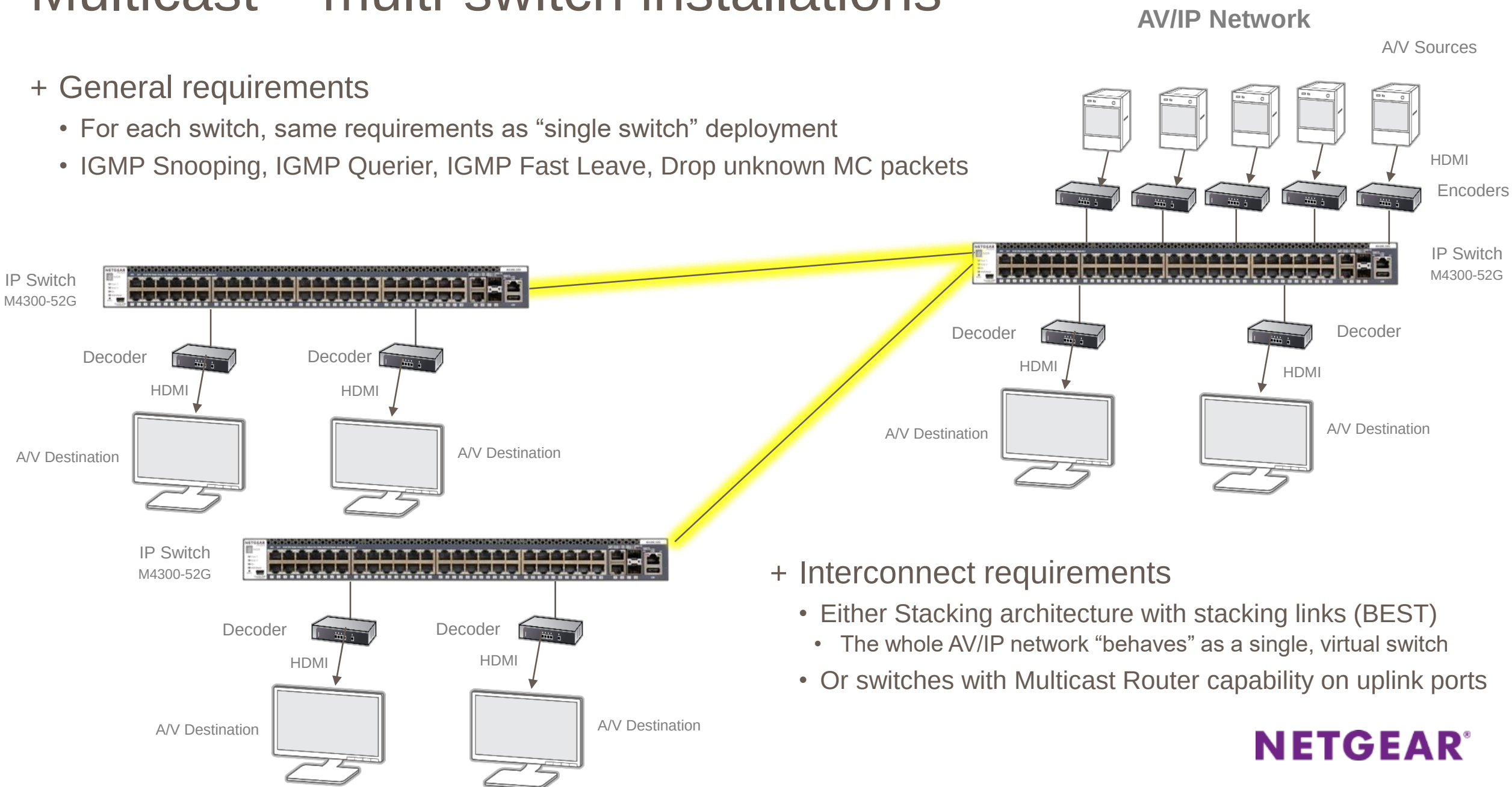
# Multicast – multi-switch installations

+ General requirements
  - For each switch, same requirements as “single switch” deployment
  - IGMP Snooping, IGMP Querier, IGMP Fast Leave, Drop unknown MC packets




+ Interconnect requirements
  - Either Stacking architecture with stacking links (BEST)
    - The whole AV/IP network “behaves” as a single, virtual switch
  - Or switches with Multicast Router capability on uplink ports

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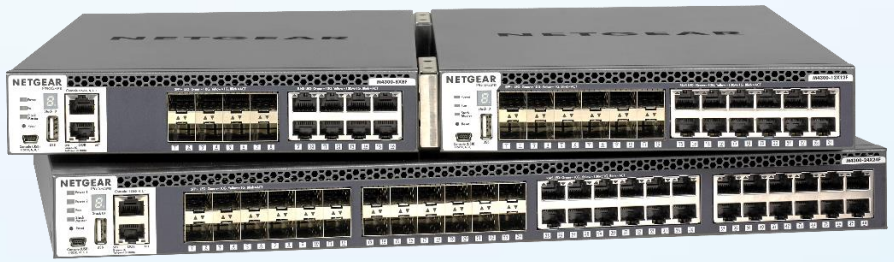
# The M4300 makes AV over IP solutions simple

- NETGEAR commits to the SDVoE standard with products that are easy to setup and use
- M4300 series is configured for Pro AV and Multicast right out of the box
- Its zero-touch configuration eliminates the need for switch programming, making SDVoE installations plug and play



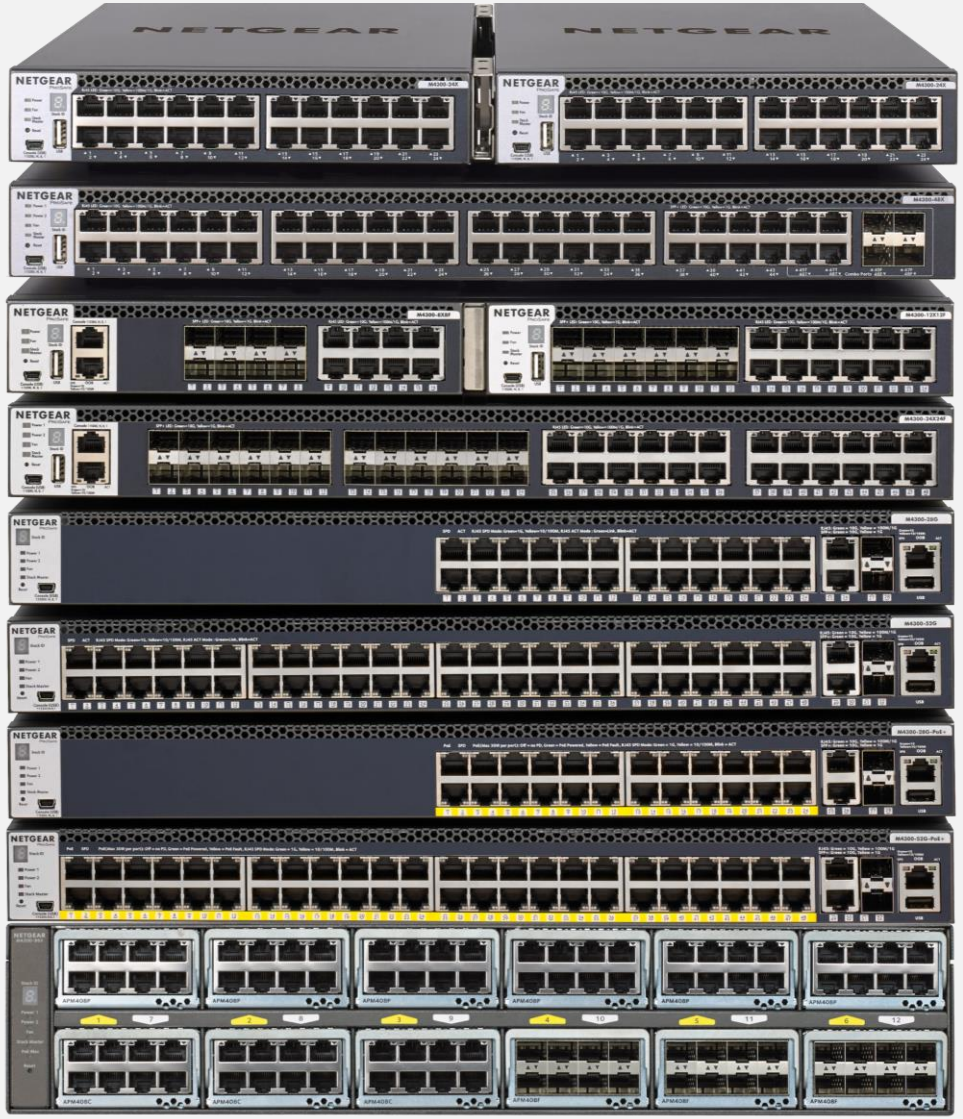
IGMP Snooping Enabled VLAN 1

IGMP Querier Enabled VLAN 1

IGMP Fast Leave Enabled VLAN 1

Drop Unregistered Multicast Flooding

SDVoE™ Alliance
Software Defined Video over Ethernet



# NETGEAR M4300 SERIES

*L3 Fully Managed Switches*

40G, 10G and 1G stackable platform with Non-Stop Forwarding (NSF)

From 24x1G to 96x10G, and up to 8 switches per stack including Spine and Leaf

Scalable for small installations, with half-width 10G models for 1U active-active setups

Scalable for larger installations, with cost-effective card frame design and 8-port modules

SDN ready

LIFETIME Hardware Warranty

LIFETIME Next Business Day

LIFETIME Tech Support

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| Model Name | M4300-8X8F | M4300-12X12F | M4300-24X | M4300-24X24F | M4300-48X | M4300-96X NEW! |
|---|---|---|---|---|---|---|
| Model Number | XSM4316S | XSM4324S | XSM4324CS | XSM4348S | XSM4348CS | XSM4396K0…..(empty switch)<br>XSM4396K1…….(starter kit) |
| 10GBASE-T RJ45 | 8 ports | 12 ports | 24 ports | 24 ports | 48 ports | Up to 96 ports…(up to 48xPoE+) |
| 1G/10G SFP+ | 8 ports | 12 ports | 4 shared ports | 24 ports | 4 shared ports | Up to 96 ports |
| 40G QSFP+ | - | | | | | Up to 24 ports |
| Form Factor | Half-width | | | Full width | | Modular |
| Rack Mount | 1-unit in 1U or 2-unit in 1U | | | 1-unit in 1U | | 1-unit in 2U |
| Power Supply | Modular 1 bay | | | Modular 2 bays | | |
| Included PSU | (1) APS250W | | | | | XSM4396K0…….no PSU<br>XSM4396K1…… (1) APS600W |
| Fans | Front-to-back | | | | | |
| Max Noise @25°C | 36.9dB | 36.9dB | 37dB | 35.8dB | 40.3dB | Without PoE…….. 35.8dB<br>Max PoE load…….66.8dB |
| Max Power Consumption | 49 Watts | 97 Watts | 125 Watts | 161 Watts | 237 Watts | Without PoE……566 Watts<br>With 1,440W PoE…2,006 Watts |
| PoE Budget | - | | | | | 1xAPS600W……..0W<br>2xAPS600W shared……..634W<br>1xAPS1200W……..720W<br>2xAPS1200W redundant……720W<br>APS600W+APS1200W shared…1,084W<br>2xAPS1200W shared……..1,440W |
| Management | Ethernet: Out-of-band 1G port Console: RJ45 RS232 and Mini-USB Storage: USB | | | | | |

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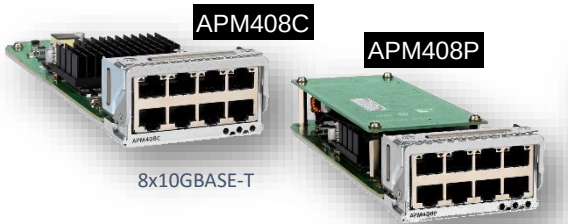
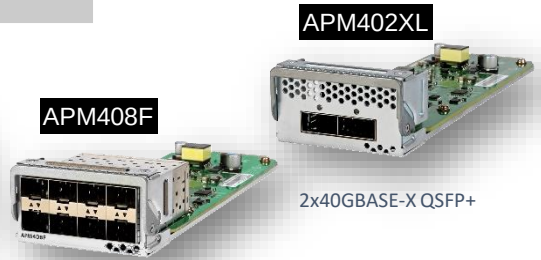
# M4300 10G Models







| Model Name | M4300-28G | M4300-52G | M4300-28G-PoE+ | | M4300-52G-PoE+ | |
|---|---|---|---|---|---|---|
| Model Number | GSM4328S | GSM4352S | GSM4328PA | GSM4328PB | GSM4352PA | GSM4352PB |
| 10/100/1000 RJ45 | 24 ports | 48 ports | 24 ports PoE+ | | 48 ports PoE+ | |
| 10GBASE-T RJ45 | 2 ports | 2 ports | 2 ports | | 2 ports | |
| 1G/10G SFP+ | 2 ports | 2 ports | 2 ports | | 2 ports | |
| Form Factor | Full width | | | | | |
| Rack Mount | 1-unit in 1U | | | | | |
| Power Supply | Modular 2 bays | | | | | |
| Included PSU | (1) APS150W | | (1) APS550W | (1) APS1000W | (1) APS550W | (1) APS1000W |
| Fans | Front-to-back | | | | | |
| Max Noise @25°C | 30.3dB | 31.5dB | 39.8 dB | | 39.8dB | |
| Max Power Consumption | 34.5 Watts | 47.4 Watts | 797 Watts | 833.2 Watts | 865 Watts | 1,628 Watts |
| PoE Budget @110V AC | With 1 PSU, or 2 PSUs in Redundant Mode: | | 480 Watts | 630 Watts | 480 Watts | 591 Watts |
| | With 2 PSUs in Shared Mode: | | 720 Watts | 720 Watts | 720 Watts | 1,010 Watts |
| PoE Budget @220V AC | With 1 PSU, or 2 PSUs in Redundant Mode: | | 480 Watts | 720 Watts | 480 Watts | 860 Watts |
| | With 2 PSUs in Shared Mode: | | 720 Watts | 720 Watts | 720 Watts | 1,440 Watts |
| Management | Ethernet: Out-of-band 1G port Console: RJ45 RS232 and Mini-USB Storage: USB | | | | | |

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# M4300 1G Models

# Up to 96-port 10G, or 24-port 40G

Modular. Granular. Unique.

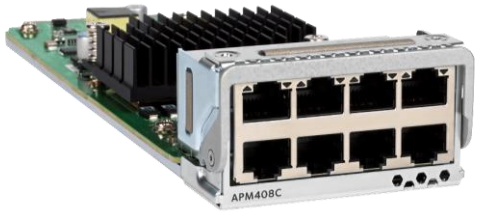
Starter Kit – 48xSFP+ & 600W PSU
(XSM4396K1)

Empty Version – No PSU
(XSM4396K0)

- 1.92Tbps non-blocking fabric for 96x10G or 24x40G or a combination
- 12 slots in 2RU for 8x10G or 2x40G port expansion cards
- Innovative "Spine and Leaf" 1G, 10G and 40G mixed stacking with NSF
- Zero Touch AV-over-IP with pre-configured L2 Multicast (SDVoE-ready)
- ProSAFE LIFETIME Limited Warranty, NBD Replacement, Online support

# M4300-96X

8x10GBASE-T Port Card - 100M/1G/2.5G/5G/10G
(APM408C)




8xSFP+ Port Card - 1G/10G
(APM408F)


8x10GBASE-T PoE+ Port Card - 100M/1G/2.5G/5G/10G
(APM408P)


2xQSFP+ Port Card - 40G
(APM402XL)

Modular PSU 600W / 1200W
(APS600W) (APS1200W)



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# CONFIGURE YOUR MODULAR SWITCH

You may begin a new M4300-96X configuration below. Click or unclick ports and features you need. Alternatively, click the "+" sign on the Front View to add port cards. Finally, download your bill of materials as a PDF or XLS file, or send it by email.

www.netgear.com/96x-config

**HOW MANY 10G COPPER (10GBASE-T) PORTS?**

8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96

**HOW MANY 10G COPPER WITH POE+ (10GBASE-T POE+) PORTS?**

8 | **16** | 24 | 32 | 40 | 48

**HOW MANY 10G FIBER (SFP+) PORTS?**

8 | **16** | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96

**HOW MANY 40G FIBER (QSFP+) PORTS?**

2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24

**POWER SUPPLY**

NO | 600W | **1200W**

**POWER SUPPLY REDUNDANCY?**

**NO** | YES

**INSTALLATION SERVICE CONTRACT?**

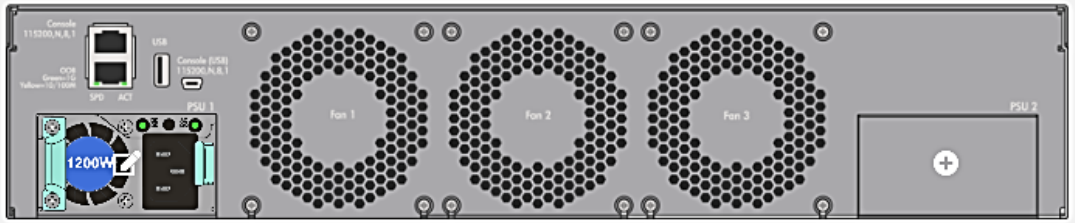
**NO** | REMOTE | ONSITE

## SWITCH FRONT VIEW

Add new port cards or modify existing port cards here.

## SWITCH BACK VIEW

See which PSU(s) you have selected.




## KEY METRICS

10G Copper ports: 0 | 10G Copper PoE+ ports: 16 | 10G Fiber ports: 16 | 40G Fiber ports: 0 | Total number of 10G ports: 32 | Available PoE budget : 720 Watts

# IT Applications

## Building 1: HA Top-of-Rack

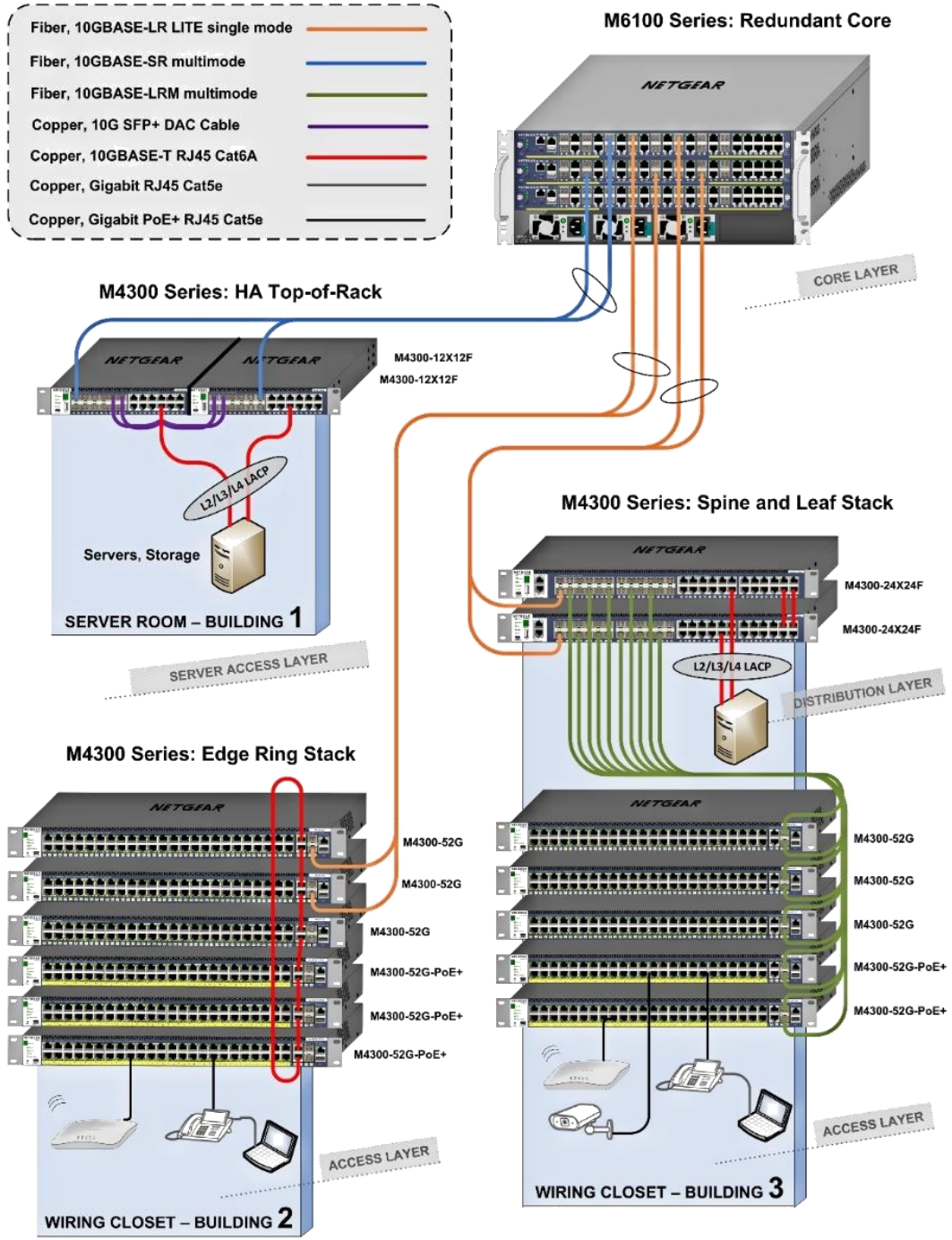
- **Server installations**
- *Management unit hitless failover and nonstop forwarding (NSF) ensure no single point of failure*

## Building 2: Edge Ring Stack

- **Stacking simplify deployments**
- *Management unit hitless failover and nonstop forwarding (NSF) ensures continuous uptime for clients*

## Building 3: Spine and Leaf Stack

- **Collapsed core installations**,
- *With management unit hitless failover and nonstop forwarding (NSF), leaf switches keep forwarding L2 and L3 traffic in and out, while backup spine unit guarantees connectivity to the core*

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# Pro-AV Application

NETGEAR BUSINESS

SDVoE ALLIANCE

Digital Signage
HDMI
USB 2.0
SDVoE Encoder
10G Ethernet (Copper)

4K Camera
HDMI
1G Ethernet
SDVoE Encoder
10G Ethernet (Copper)

4K Server
HDMI
Audio Embed
SDVoE Encoder
10G Ethernet (Copper)

Blu-ray Player
HDMI
IR
SDVoE Encoder
10G Ethernet (Copper)

Cable Satellite Box
HDMI
IR
SDVoE Encoder
10G Ethernet (Fiber)

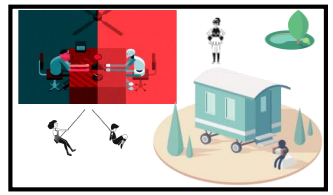
Laptop
HDMI
1G Ethernet
Audio Embed
USB 2.0
SDVoE Encoder
10G Ethernet (Fiber)

SDVoE Controller
1G Ethernet

10G Ethernet (Copper)
SDVoE Decoder
HDMI
USB 2.0
HDTV Touchscreen

4K/60 4:4:4 with zero frame latency

10G Ethernet (Fiber)
SDVoE Decoder
HDMI
RS232
4K Display



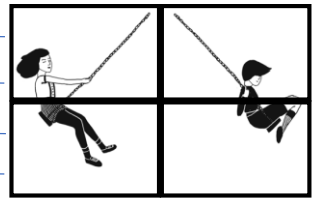
Configurable Multi-Viewer

SDVoE Decoder
HDMI
RS232
Projector

EDID and HDCP 2.2 encryption support

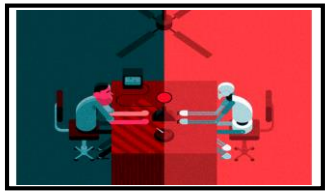
10G Ethernet (Fiber)

SDVoE Decoders
HDMI
HDMI
HDMI
HDMI
Video Wall



Video Wall with bezel compensation

10G Ethernet (Fiber)
SDVoE Decoder
HDMI
1G Ethernet
Audio Embed
USB 2.0
IR
Smart TV

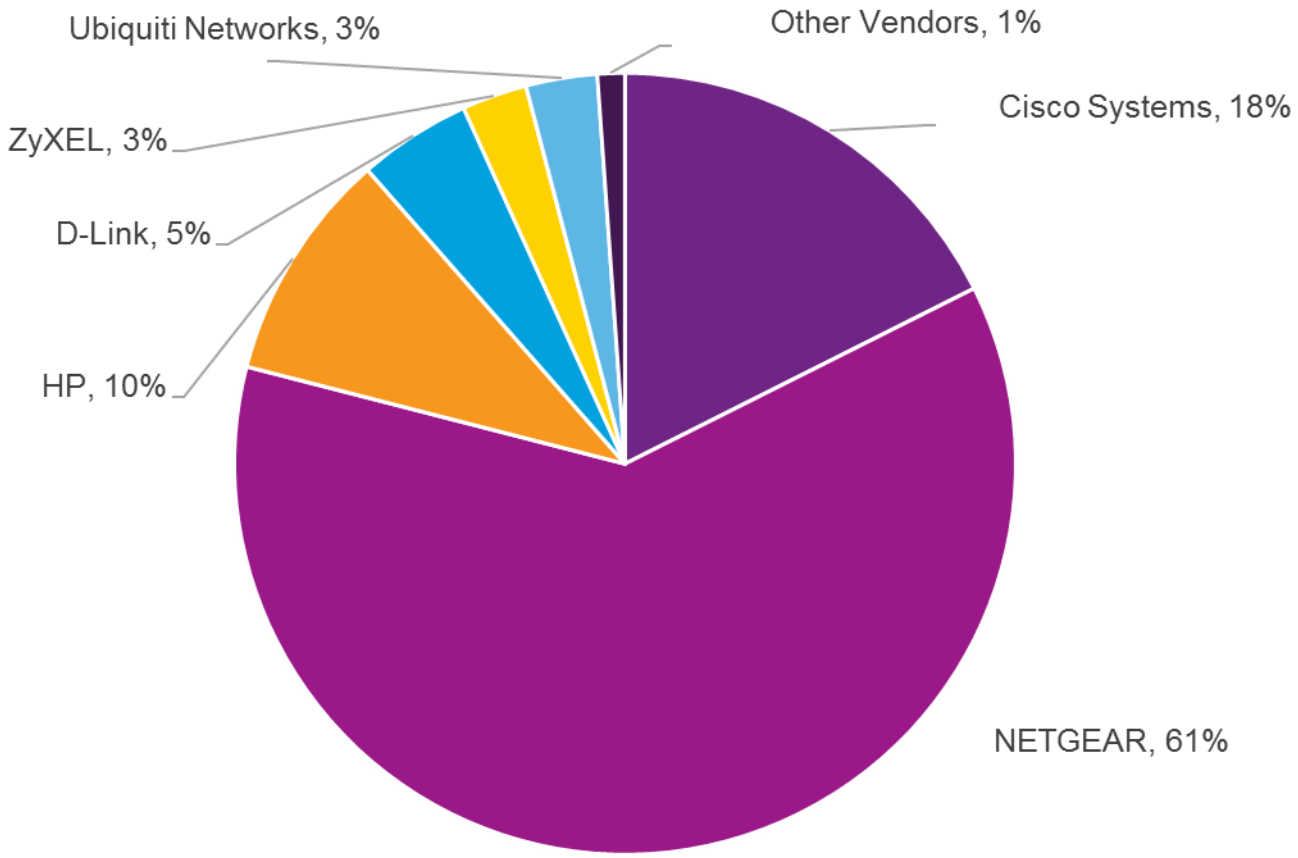


KVM access, real USB 2.0, infra-red control

Keyboard & Mouse
IR Receiver & Remote
Speakers

# NETGEAR #1 in 10-Gigabit Switching

## From Unmanaged to Fully Managed Solutions under $10K




NETGEAR®

*(based on Context EMEA and NPD North America combined unit market share*
*In Jan-Nov 2017 for competitive 10Gbps switches shipped less than $10K ASP)*

# The NETGEAR Difference, for SMB and Pro-AV

## Reliable

LIFETIME Limited* Warranty

Next Business Day Replacement

Providing Network Solutions for businesses since 1996

## Affordable

A fraction of the cost of traditional Big IT Vendors

Scales as your business grows

Reduce operating expenses

## Easy To Use

Easy installation

No extra training or additional IT staff required

Easy Network Management


* At NETGEAR, Limited means LIFETIME!

NETGEAR®

# Questions

NETGEAR®

Laurent Masia
Sr. PLM Smart & Managed Switches

SDVoE™ Alliance
Software Defined Video Over Ethernet