DANTE CERTIFICATION
LEVEL 3

Introduction

Dante Certification Program

Certification ensures a consistent set of methods and knowledge in the industry.

Tells others you have the base knowledge and skills to implement Dante networks.

Use the Dante Certification logos to promote your skill on social media and other promotional materials.

Dante Certification Goals: Level 3

Understanding Large Scale & Converged Networks

- *How to Work with an IT Department*
- *Understand IT Best Practices and Why They Exist*
- *Perspective on Dante Domain Manager*

Network Concepts for Design, Ops & Troubleshooting

- *Packet Travel on a Network and Routing*
- *Building Robust Network Architecture*
- *Network Optimization Concepts*

Topics for Today

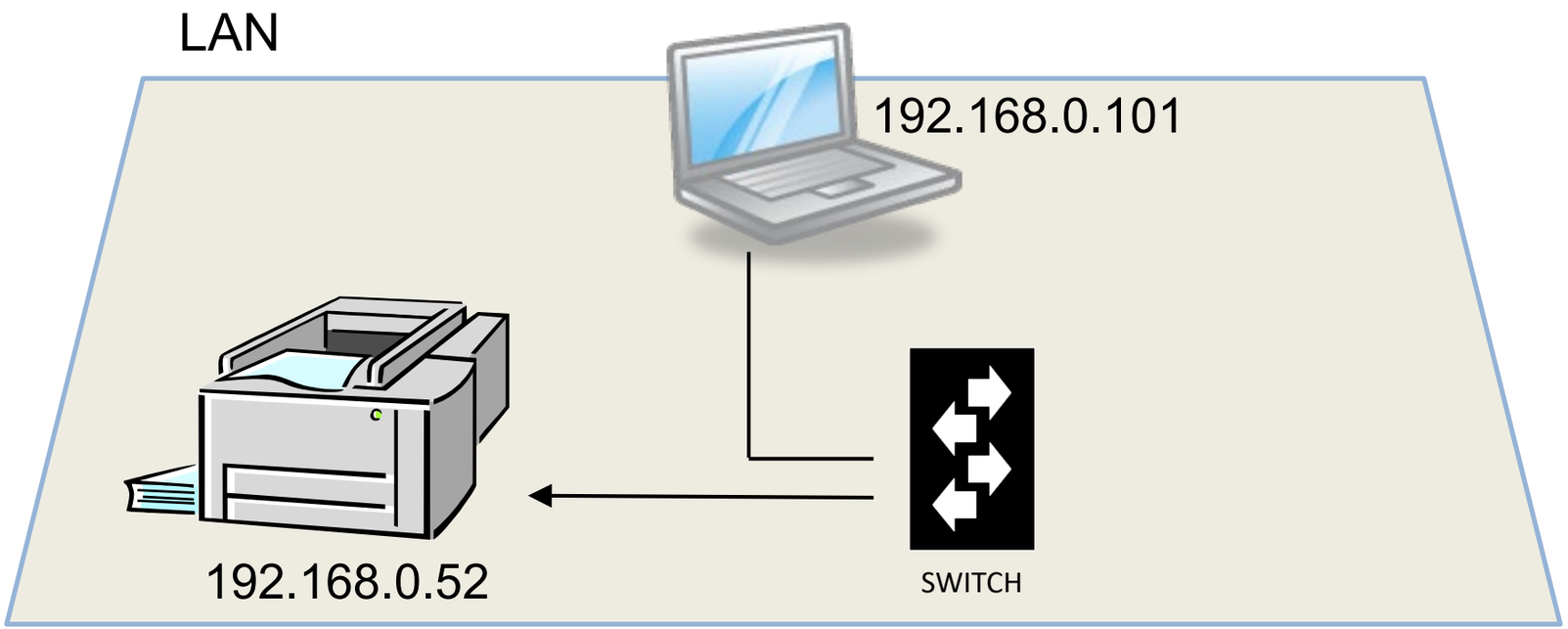
Topics for Today

ENHANCE	**Core IP Settings**	*IP Address, Subnet Mask, Gateway/Router, LAN Range*
	DNS	*Domain Name Service*
	DHCP/Link Local	*Automatic Address Settings*
	TCP/UDP	*Transmission Methods*
	Unicast, Multicast and Broadcast	*Distribution Methods*
	QoS	*Quality of Service – Traffic Prioritization*
	VLAN & Trunk Implications	*VLAN, Trunk, Tagged VLAN, STP, LAG*
NEW	**Network Ports**	*Managing Simultaneous Connections*
	PTP Clocking	*Precision Time Protocol (PTP)*
	ARP	*Switching by MAC vs IP*
	Layered Network Models	*OSI and TCP Conceptual Models*
	Segmenting Broadcast Domain	*Managing the “Noise” in a Network*
	Design & Troubleshooting	

Core IP Settings: *IP Address, Subnet Mask, Gateway*

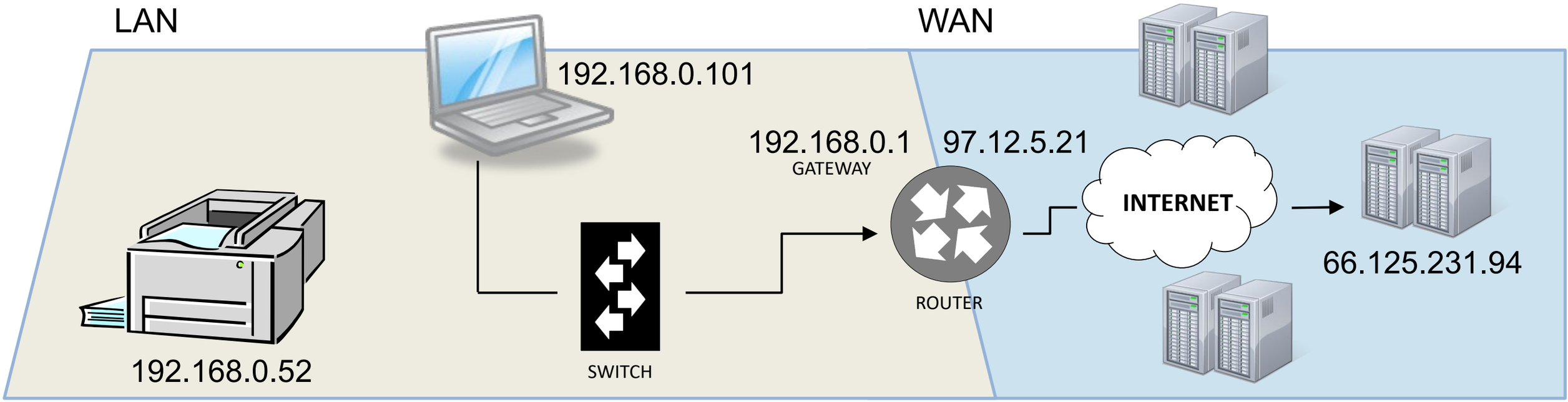
Core IP Settings: IP Address

- Devices on the Local Area Network (LAN) are contacted directly.



Core IP Settings: Gateway (Router)

- Devices on the Local Area Network (LAN) are contacted directly.
- Devices on the Wide Area Network (WAN) are reached through the router.



How does a device know to connect on the LAN or through the Gateway (to the WAN)?

IP Address & Subnet Mask

Core IP Settings: Subnet Mask & Gateway

If the Destination is on the LAN:

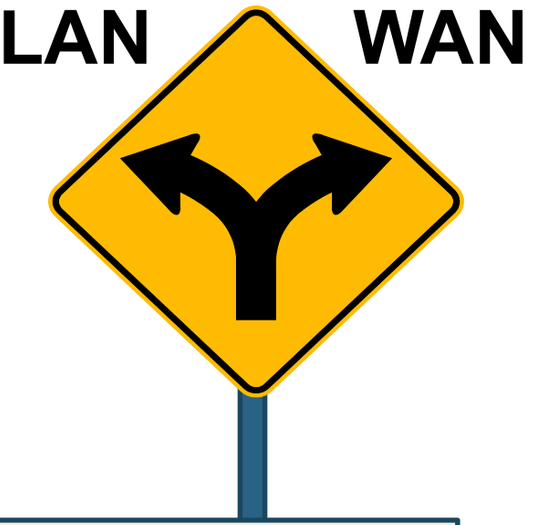
Access the devices directly on the local network switches.

The router is not involved in this connection.

Otherwise:

The destination IP address is passed to the Gateway (Router).

Similar to dialing “O” for the operator.



IP Address:	192.168. 10. 11
Subnet Mask:	255.255.255. 0
LAN Range:	192.168. 10. xxx

Quiz: Subnet Mask

IP Address: 192.168. 10. 11
Subnet Mask: 255.255.255. 0

LAN Range: 192.168. 10. xxx

Are these sought on the LAN or through the Gateway?

192.168.10.18 … LAN

18.231.109.77 … Gateway (WAN)

192.168.1.113 … Gateway (WAN)

Core IP Settings: Subnet Mask

IP Address:	192.168. 10. 11
Subnet Mask:	255.255.255. 0
LAN Range:	192.168. 10. xxx

IP Address:	10. 0. 1. 11
Subnet Mask:	255.255.255. 0
LAN Range:	10. 0. 1. xxx

Core IP Settings: Subnet Mask

IP Address: 10. 0. 1. 11
Subnet Mask: 255.255.255. 0

LAN Range: 10. 0. 1. xxx

IP Address: 10. 0. 1. 11
Subnet Mask: 255.255. 0. 0

LAN Range: 10. 0. xxx. xxx

Subnet Mask Values 0, 255

Residential:	255.255.255. 0
Dante Audio Default:	255.255. 0. 0

DSL Static IPs:	255.255.255.248
Corp Network:	255.255.252. 0

There are 10 types of people in the world:

Binary	Decimal
0	0
1	1
10	**2**
11	3

those who understand binary, and those who don’t.

Core IP Settings: 32-bit Addresses

We call this “dotted-quad notation”.

192	.	168	.	1	.	12
1100 0000	.	1010 1000	.	0000 0001	.	0000 1100

Dotted Quad Notation: 192.168.1.12

Value Range of Each Field: 0 – 255 (8 bits)

4 fields x 8 bits each: 32-bit address

Core IP Settings: 32-bit Addresses

IP Address and Subnet Mask are 32-bit numbers.
Subnet Mask defines significant binary digits.

192 1100 0000	168 1010 1000	1 0000 0001	12 0000 1100
255 1111 1111	255 1111 1111	255 1111 1111	0 0000 0000
192 1100 0000	168 1010 1000	1 0000 0001	x xxxx xxxx

Core IP Settings: Subnet Mask Length

This LAN range setting is commonly abbreviated:

192.168.1.12 /24

192 1100 0000	168 1010 1000	1 0000 0001	12 0000 1100
255 1111 1111	255 1111 1111	255 1111 1111	0 0000 0000
192 1100 0000	168 1010 1000	1 0000 0001	x xxxx xxxx

Core IP Settings: Subnet Mask Length

You can break the mask “mid-field”:

192.168.0.12 /22

192 1100 0000	168 1010 1000	1 0000 0001	12 0000 1100
255 1111 1111	255 1111 1111	252 1111 1100	0 0000 0000
192 1100 0000	168 1010 1000	0-3 0000 00xx	x xxxx xxxx

Core IP Settings: Subnet Mask Length

You can break the mask “mid-field”:

192.168.26.12 /22

192 1100 0000	168 1010 1000	26 0001 1010	12 0000 1100
255 1111 1111	255 1111 1111	252 1111 1100	0 0000 0000
192 1100 0000	168 1010 1000	24-27 0001 10xx	x xxxx xxxx

Core IP Settings: Subnet Mask Length

The Subnet Mask has a Length.

A String of Binary 1's, then Binary 0's.

192	.	168	.	26	.	12
1100 0000	.	1010 1000	.	0001 1010	.	0000 1100
255	.	255	.	255	.	0
1111 1111	.	1111 1111	.	1111 1111	.	0000 0000

Core IP Settings: Subnet Mask Length

The Subnet Mask has a Length.

A String of Binary 1's, then Binary 0's.

192	.	168	.	26	.	12
1100 0000	.	1010 1	.	1 1010	.	0000 1100
255	.		.	5	.	0
1111 1111	.	0000 0000	.	111 1111	.	0000 0000

Core IP Settings: Subnet Mask Length

The Subnet Mask has a Length.

A String of Binary 1's, then Binary 0's.

192	.	168	.	26	.	12
1100 0000	.	1010 1	.	1 1010	.	0000 1100
255	.	2	.		.	0
1111 1111	.	111 1111	.	000 1111	.	0000 0000

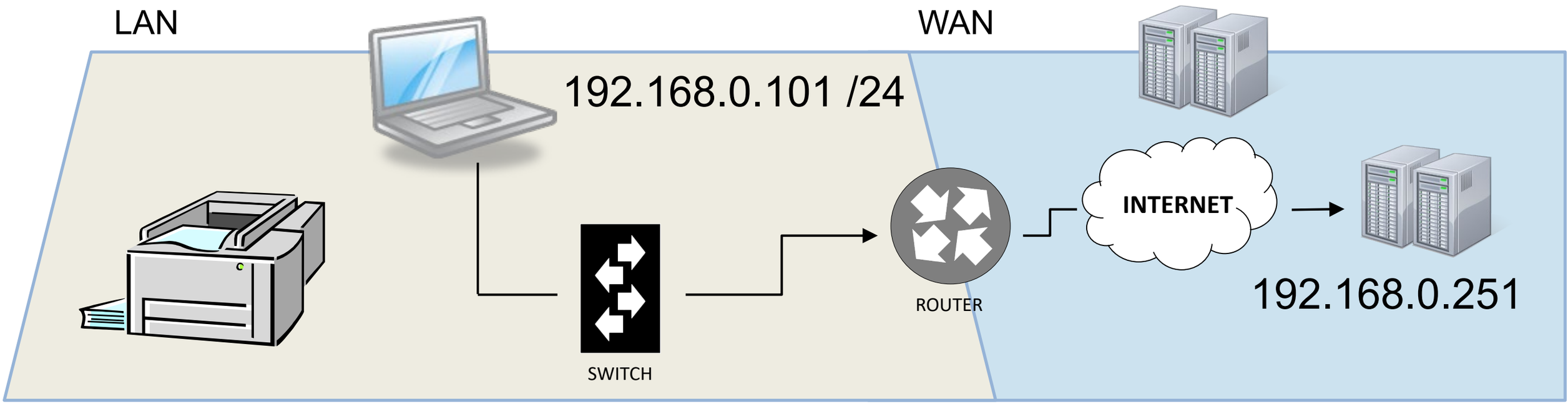
Core IP Settings: Subnet Mask Valid Values

Mask	Binary Value								Answers
255	1	1	1	1	1	1	1	1	1
254	1	1	1	1	1	1	1	0	2
252	1	1	1	1	1	1	0	0	4
248	1	1	1	1	1	0	0	0	8
240	1	1	1	1	0	0	0	0	16
224	1	1	1	0	0	0	0	0	32
192	1	1	0	0	0	0	0	0	64
128	1	0	0	0	0	0	0	0	128
0	0	0	0	0	0	0	0	0	256

Reserved LAN Ranges

Can the laptop connect to the server?

http://192.168.0.251/



Reserved LAN Ranges

These are reserved for your LAN use.

IP Address Range:	Common Uses
192.168.___.___	
10.___.___.___	
172.16-31.___.___	Dante Secondary (172.31.x.x)
169.254.___.___	Link Local, Dante Primary

Addresses to Avoid

Avoid these addresses – they often have meaning.

IP Address Range:	Common Uses
___.___.___. **0**	Network Identifier
___.___.___. **1**	Commonly Used For Router or Network Infrastructure
___.___.___**.254**	
___.___.___**.255**	Broadcast Address

Quiz: Valid IP Ranges

Are These Valid LAN Addresses?

192.168. 10. 0 … No: Avoid 0 or 255 in last field.

Quiz: Valid IP Ranges

Are These Valid LAN Addresses?

192.168. 10. 0 … No: Avoid 0 or 255 in last field.

10.255. 0. 15 … Yes.

Quiz: Valid IP Ranges

Are These Valid LAN Addresses?

192.	168.	10.	0	…	No: Avoid 0 or 255 in last field.
10.	255.	0.	15	…	Yes.
172.	26.	0.	1	…	Maybe: Could be Router.

Quiz: Valid IP Ranges

Are These Valid LAN Addresses?

192.	168.	10.	0	…	No: Avoid 0 or 255 in last field.
10.	255.	0.	15	…	Yes.
172.	26.	0.	1	…	Maybe: Could be Router.
192.	169.	150.	11	…	No: Not in a LAN range.

DNS (Domain Name Service)

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DNS: Multi Layer Look-Up

If everything is run by IP Addresses, how do I get to a web site?

https://www.audinate.com/certify/

Protocol | Server Domain Name or IP Address | Folder/Request

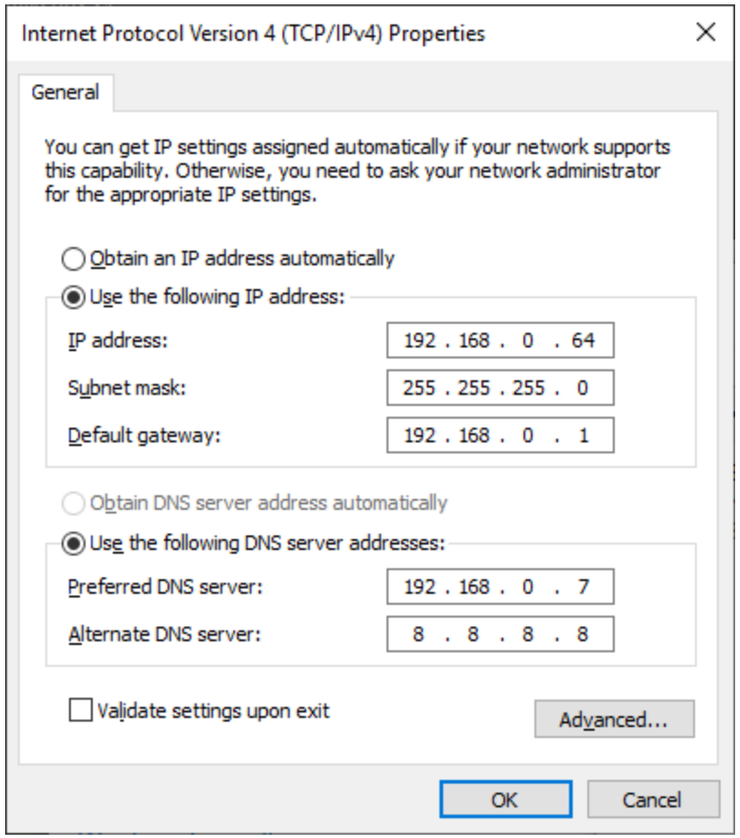
DNS: Multi Layer Look-Up

If everything is run by IP Addresses, how do I get to a web site?

https://www.audinate.com/certify/

https://45.33.44.50/certify/

DNS: Multi Layer Look-Up



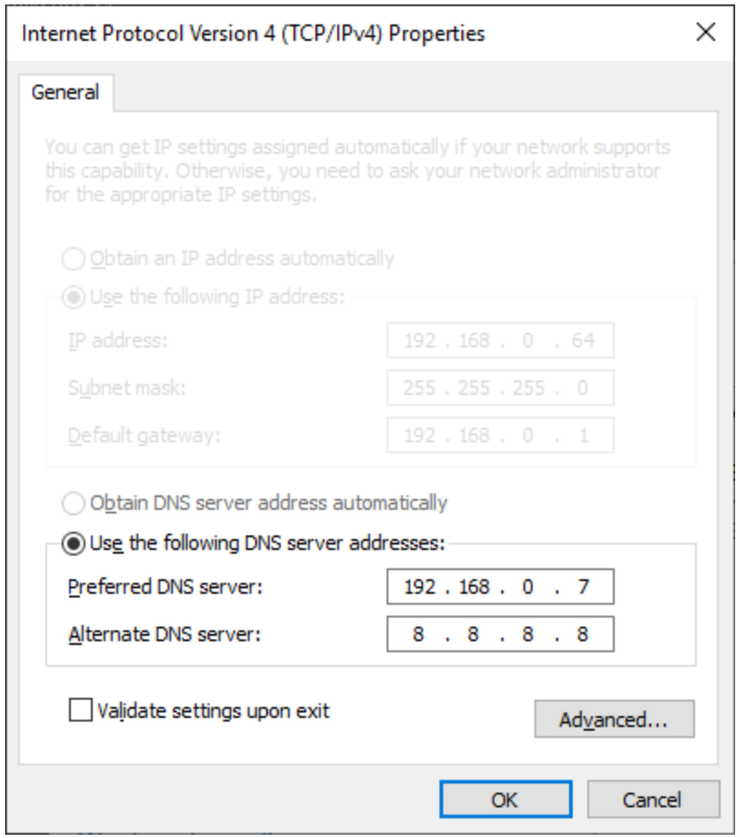
DNS (Domain Name Service)

Resolves names to IP Addresses

https://www.audinate.com/certify/

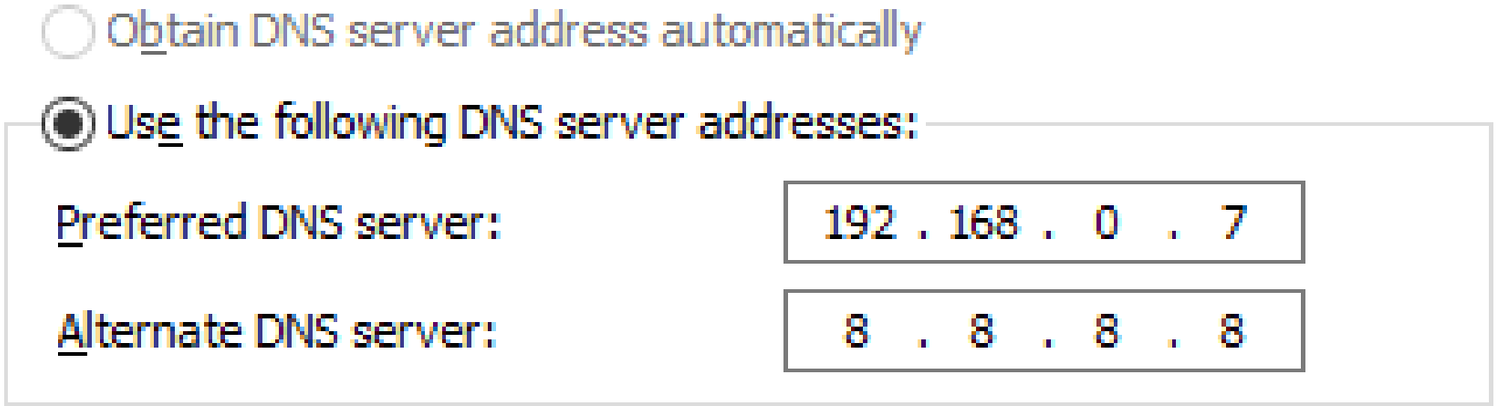
https://45.33.44.50/certify/

DNS: Multi Layer Look-Up

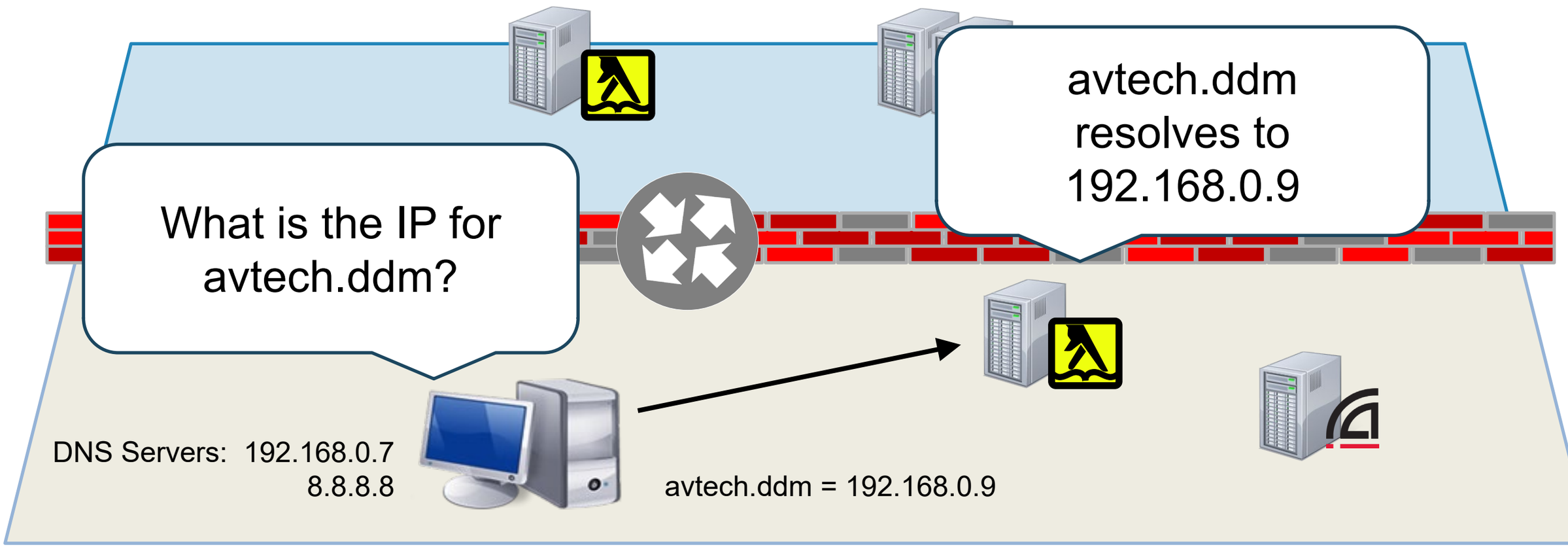


DNS (Domain Name Service)

Resolves names to IP Addresses



DNS: Multi Layer Look-Up



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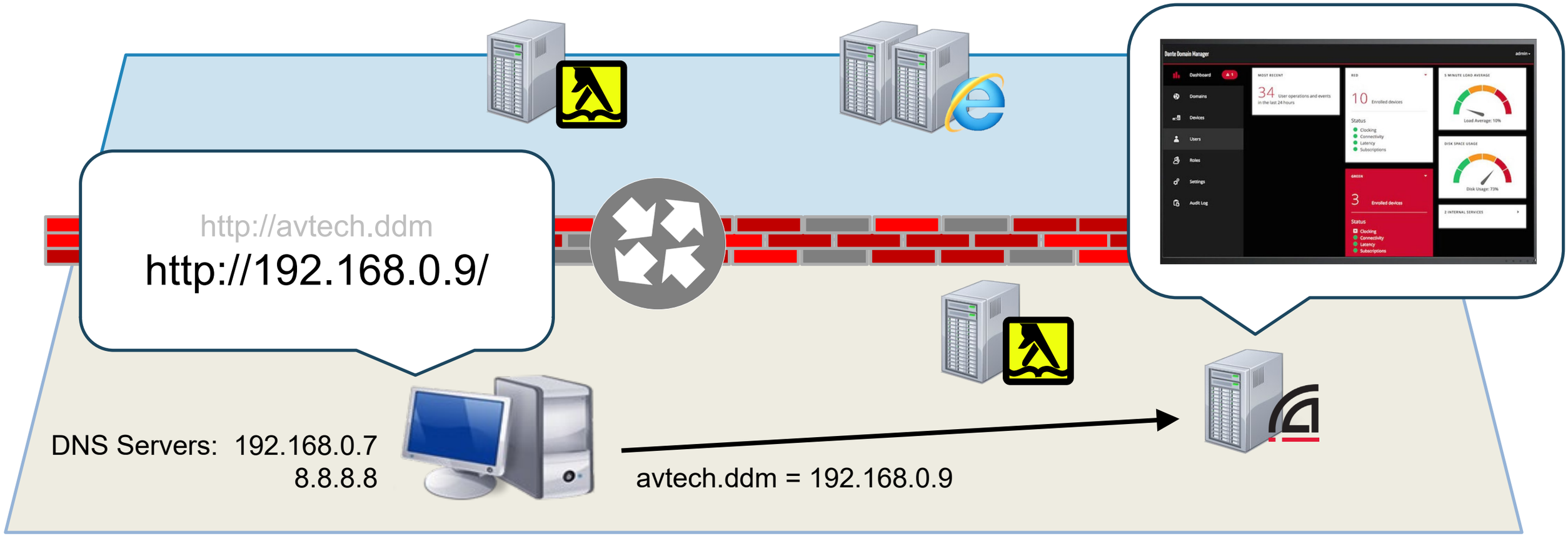

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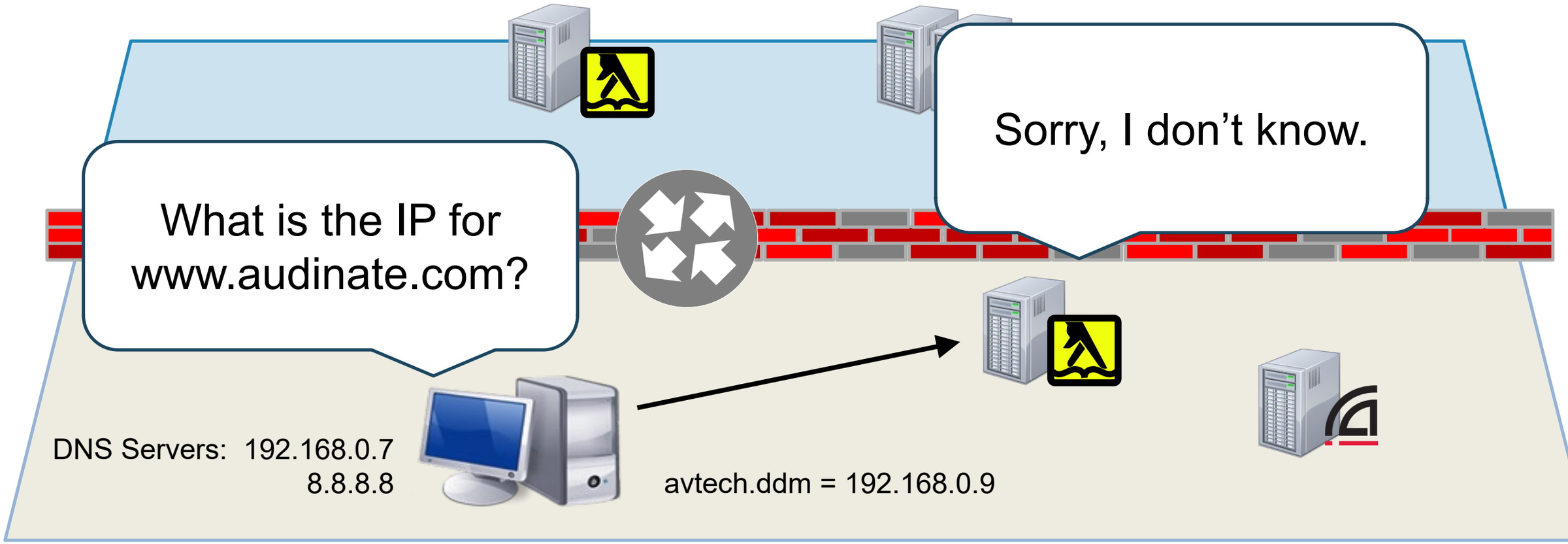

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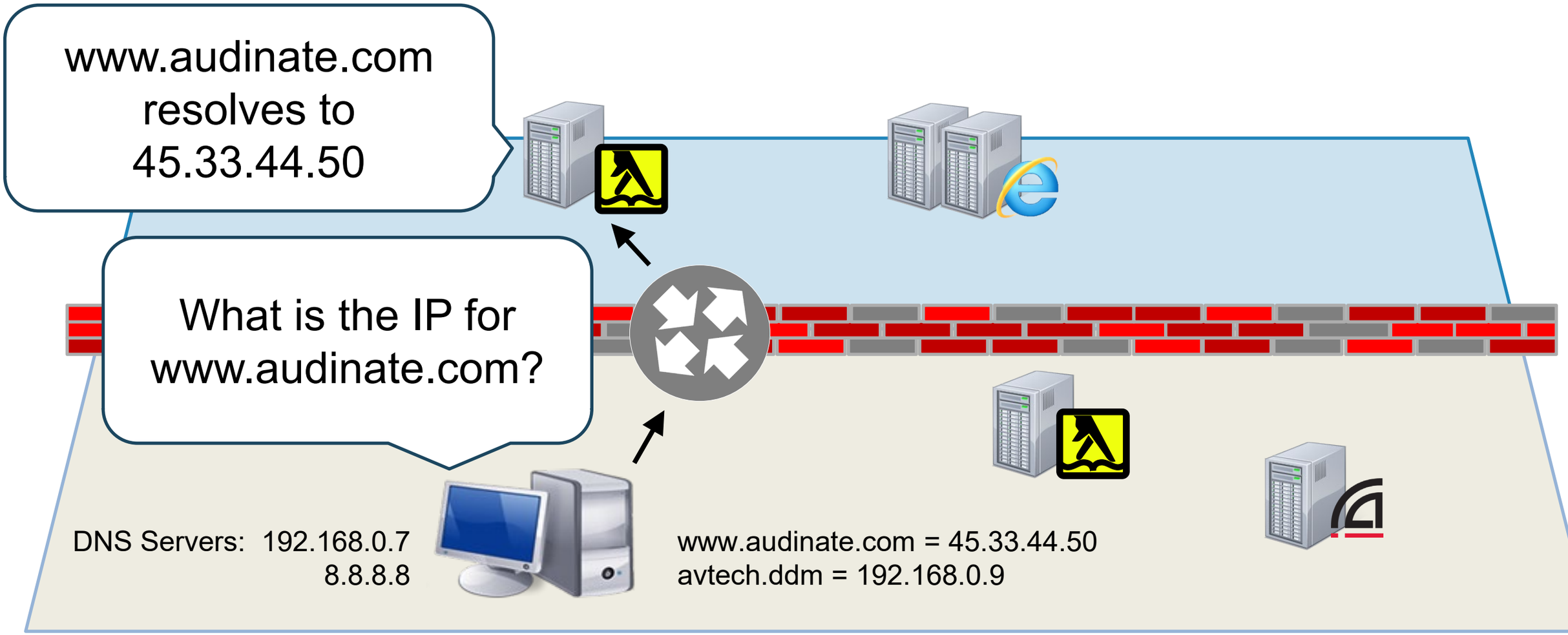
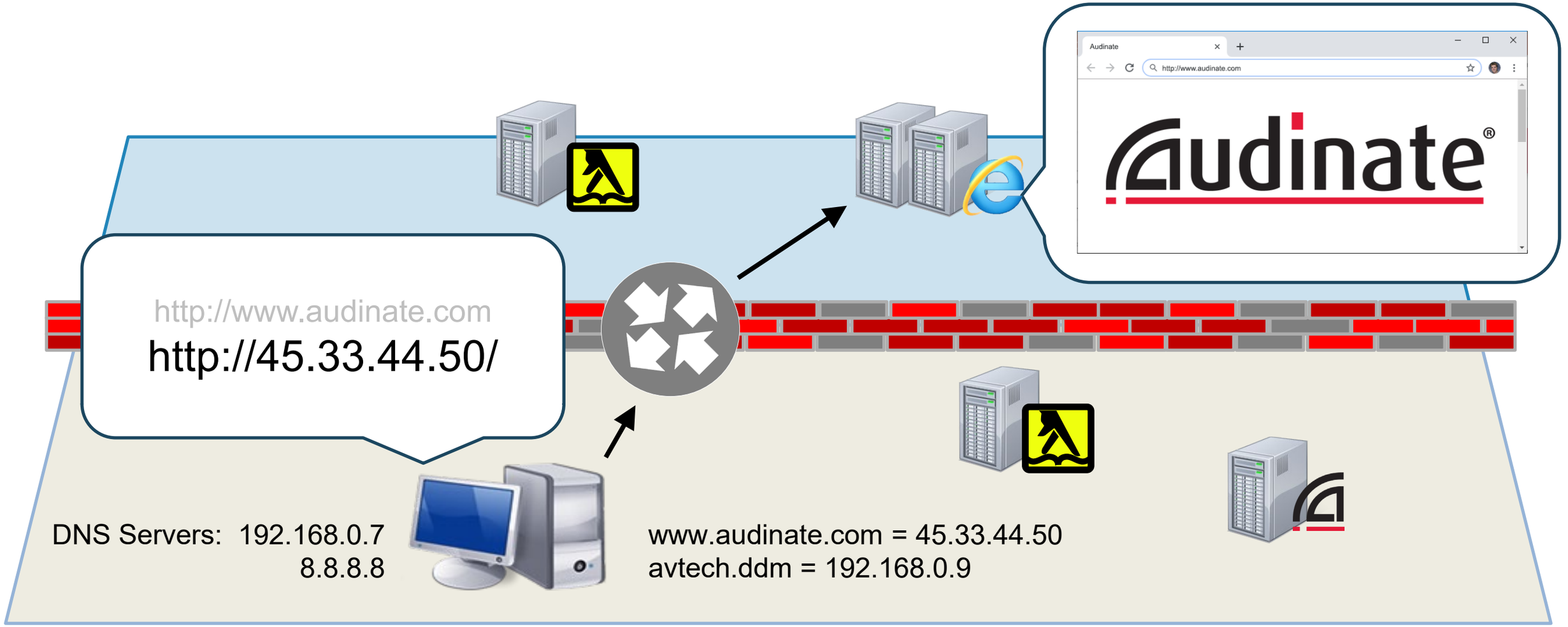


DNS: Multi Layer Look-Up



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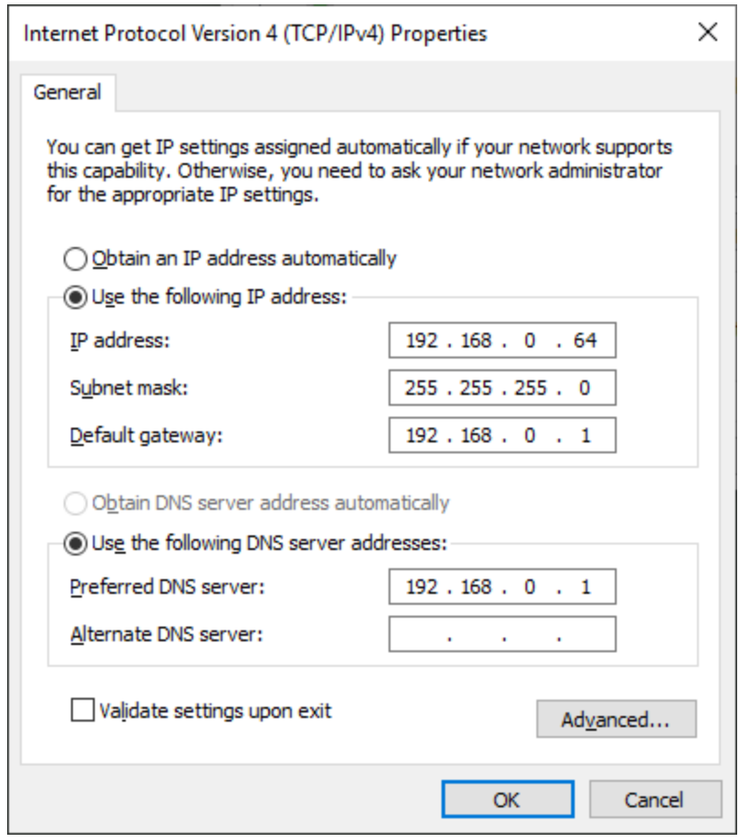
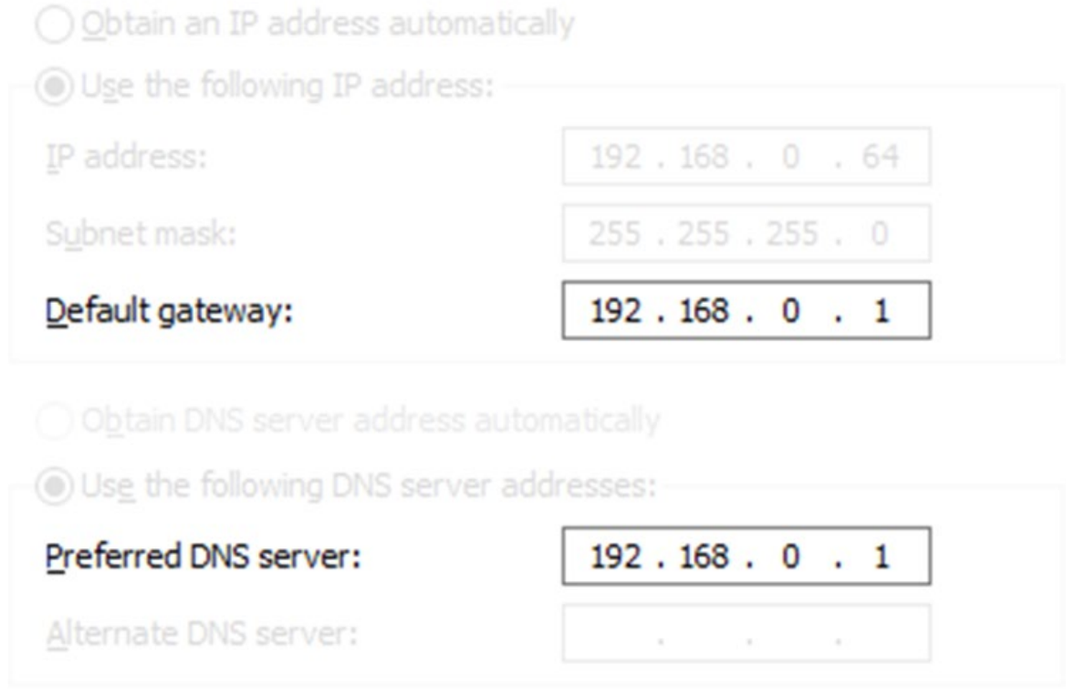
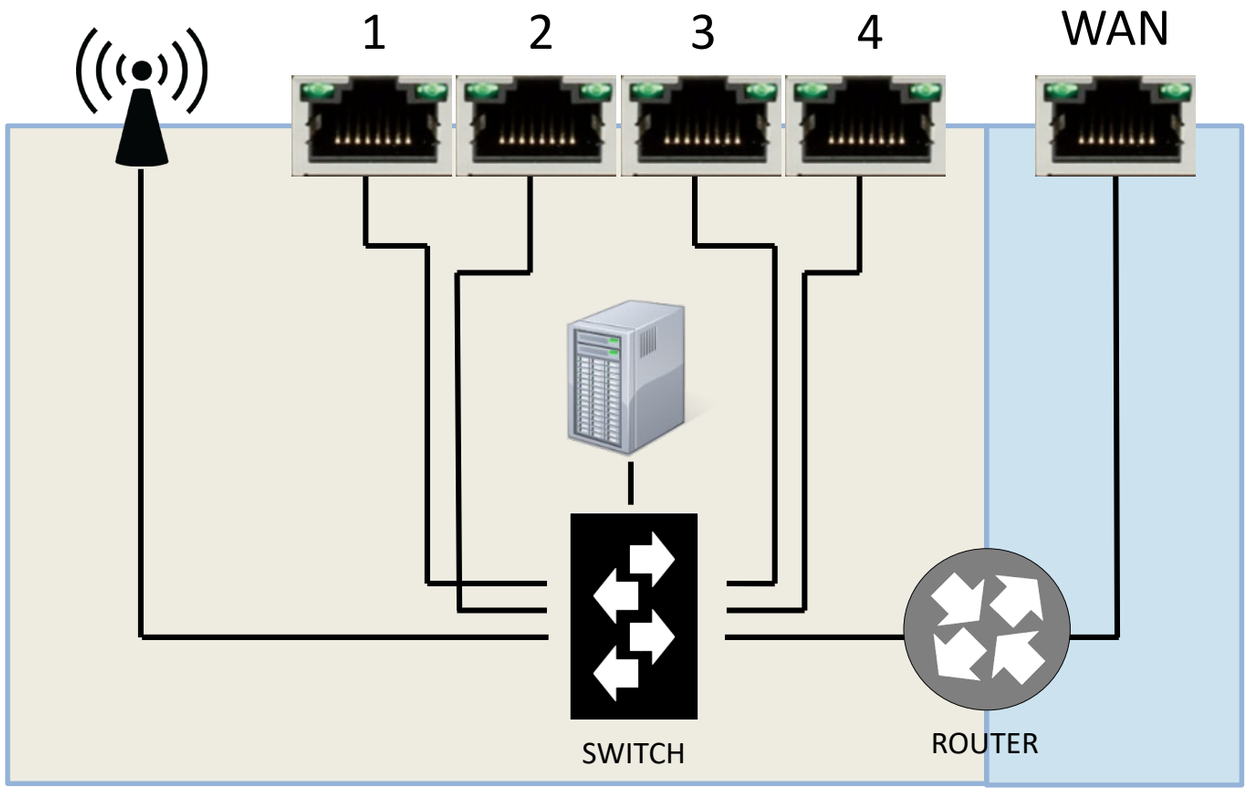


Gateway & DNS Server can be the same address?

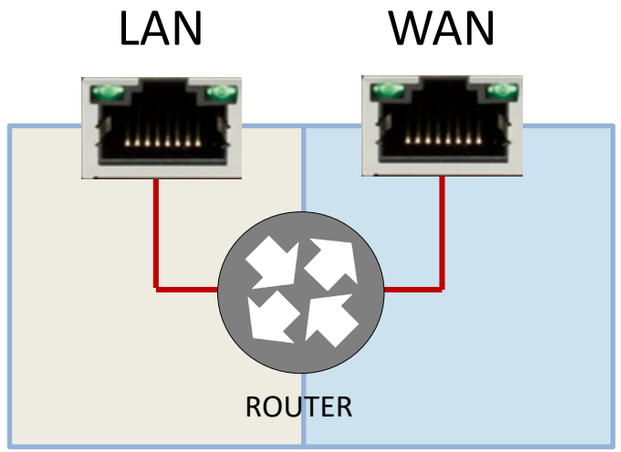


A “Wireless Router” Serves Many Functions

Typical Home Wireless Router:



Router:



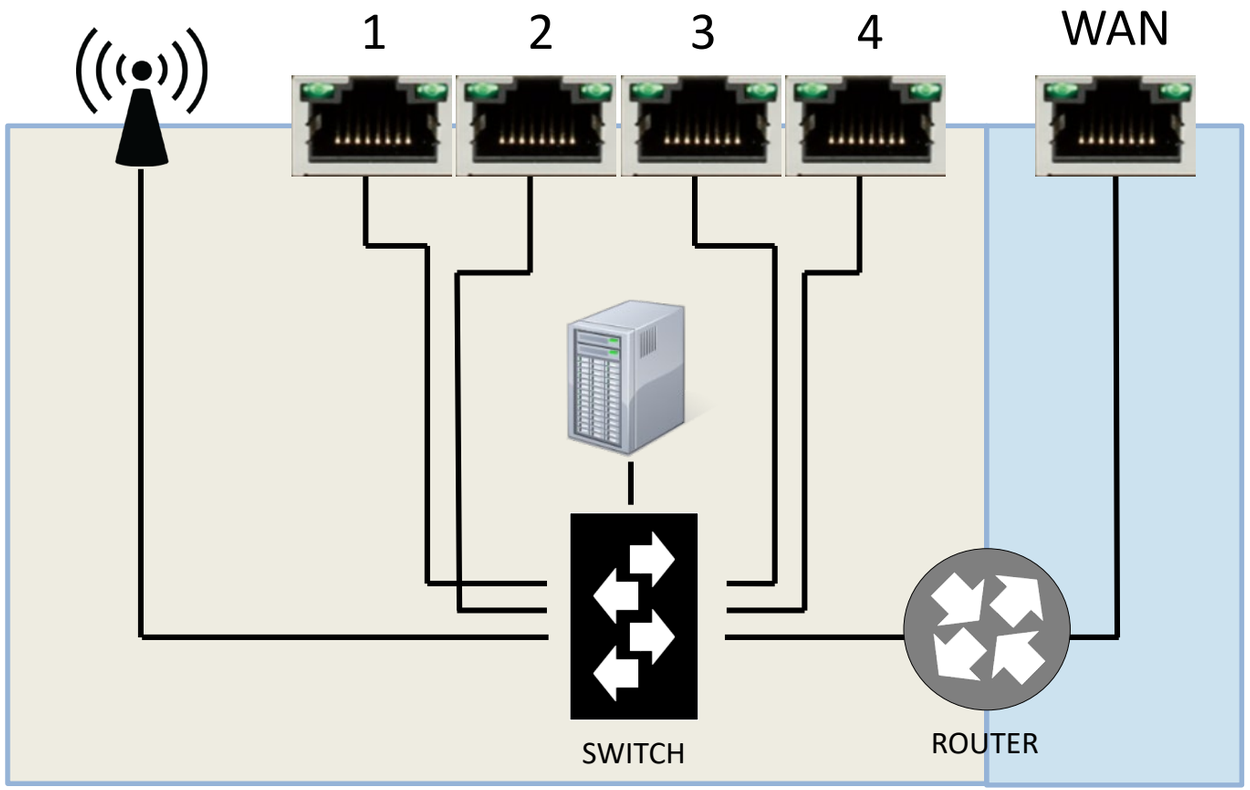
A “Wireless Router” Serves Many Functions

A mixer used to require racks of external gear…

+

DNS Caching

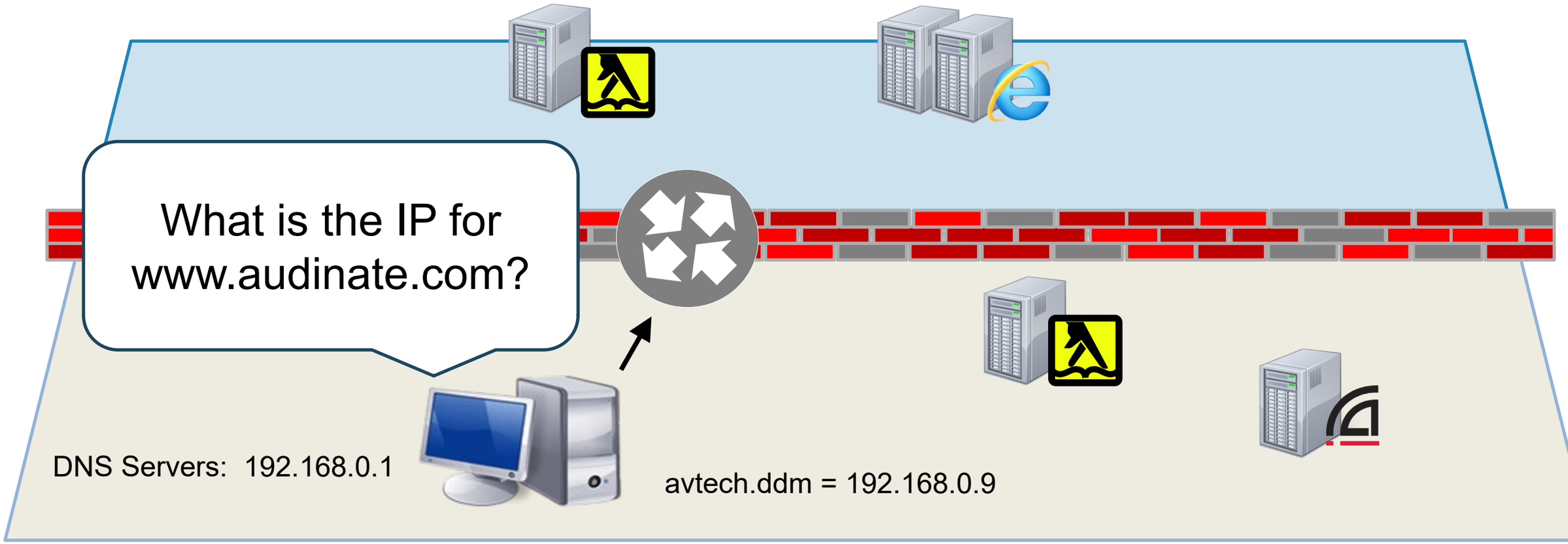
Typical Home Wireless Router:



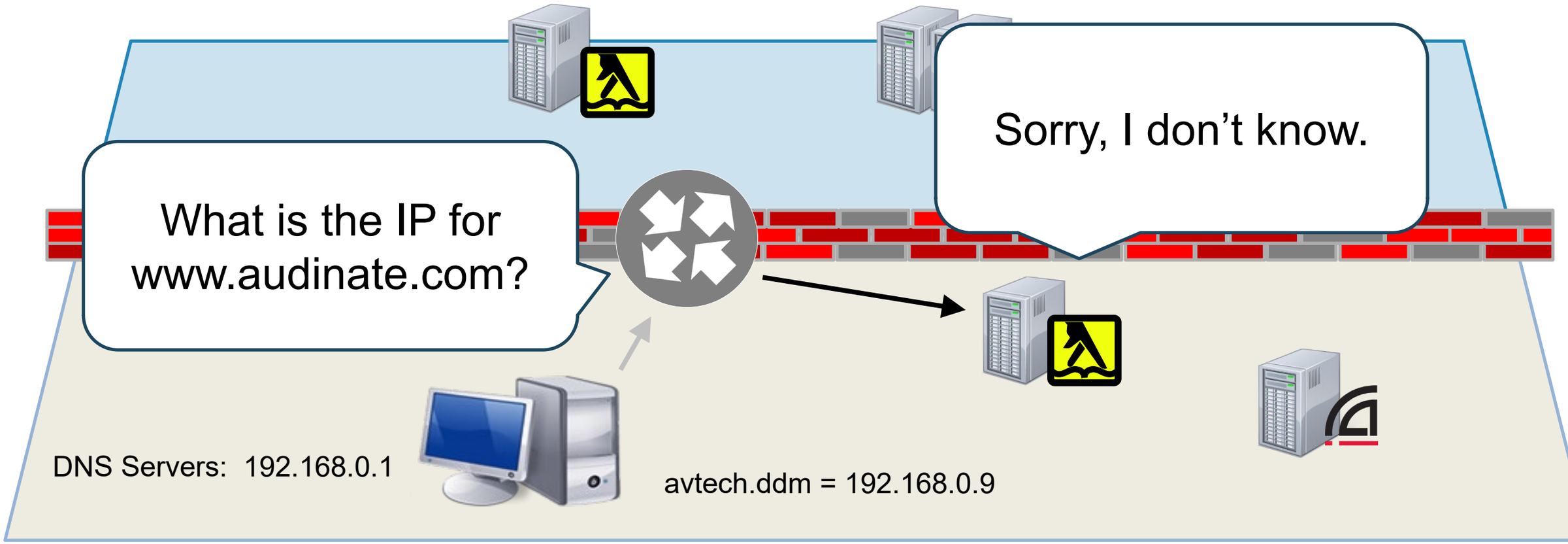
Also Includes:

- DHCP Server
- VPN (Remote Login)
- DNS Resolution & Caching

DNS Caching


What is the IP for www.audinate.com?
DNS Servers: 192.168.0.1
avtech.ddm = 192.168.0.9

DNS Caching


Sorry, I don’t know.
What is the IP for www.audinate.com?
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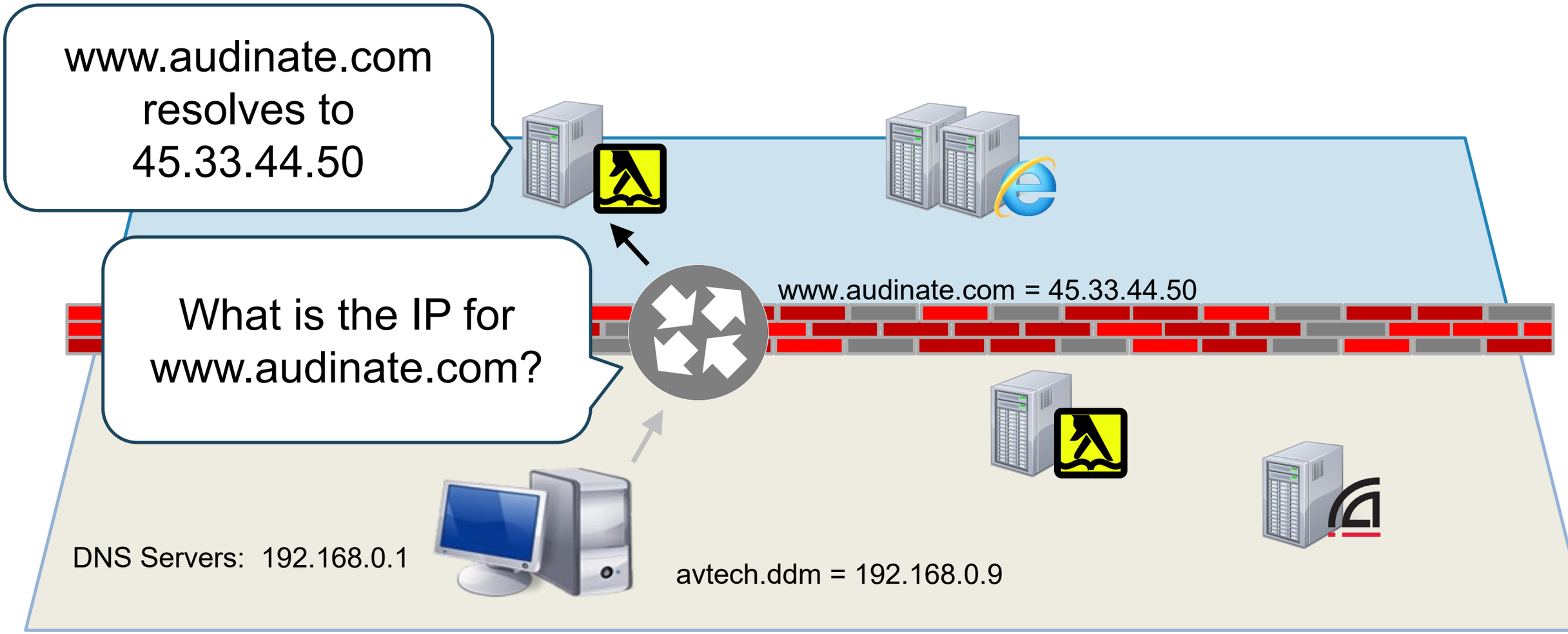
DNS Caching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What is the IP for www.audinate.com?
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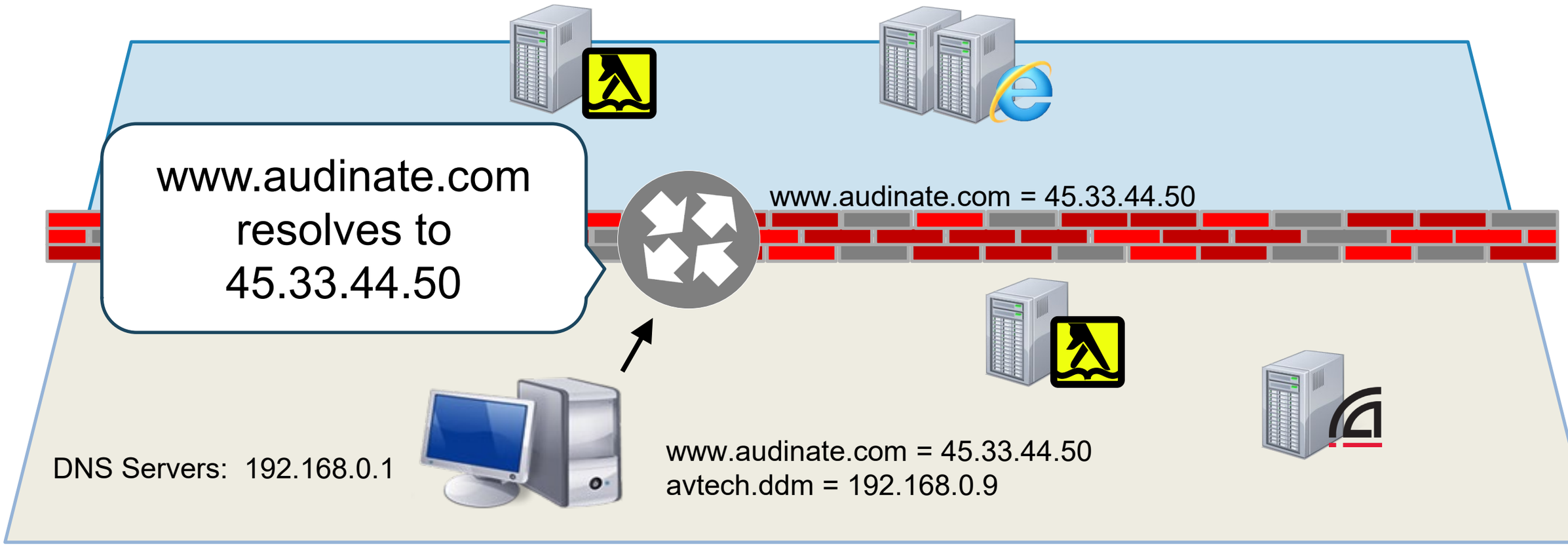
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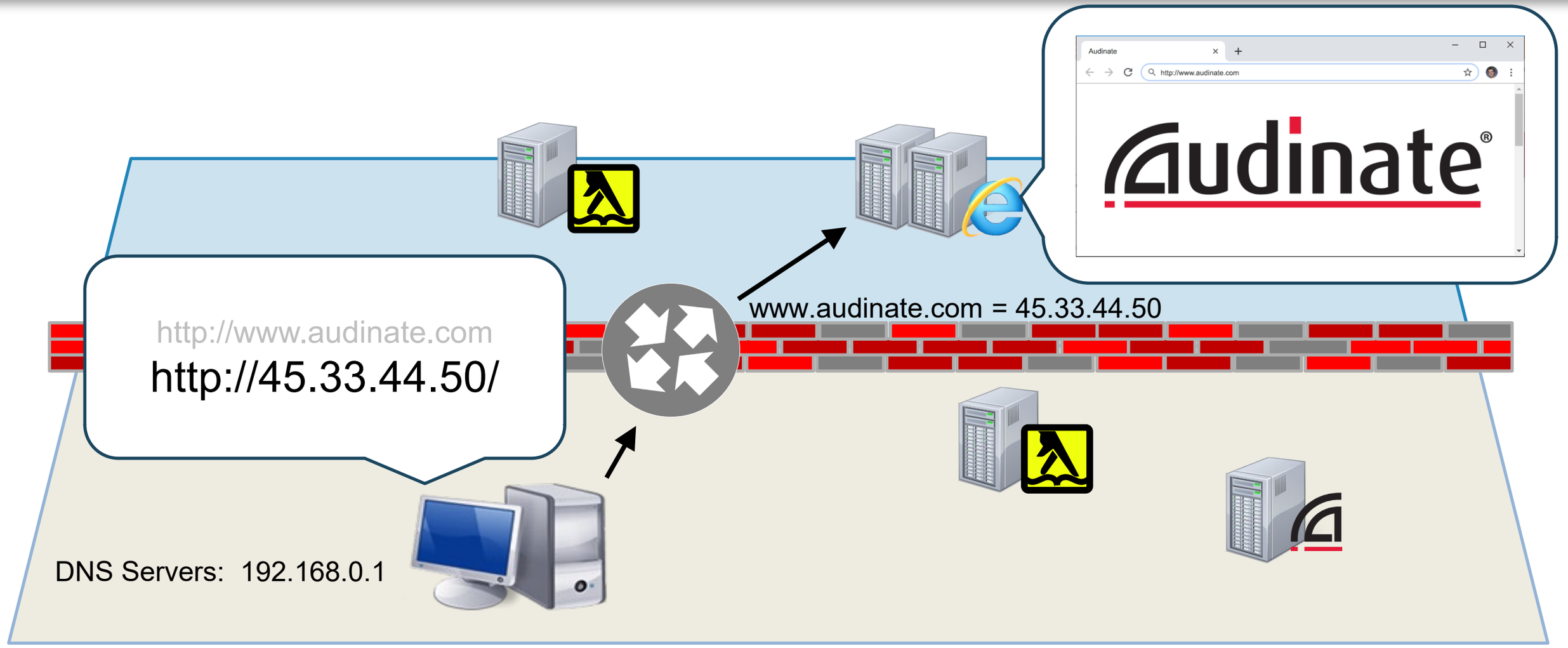
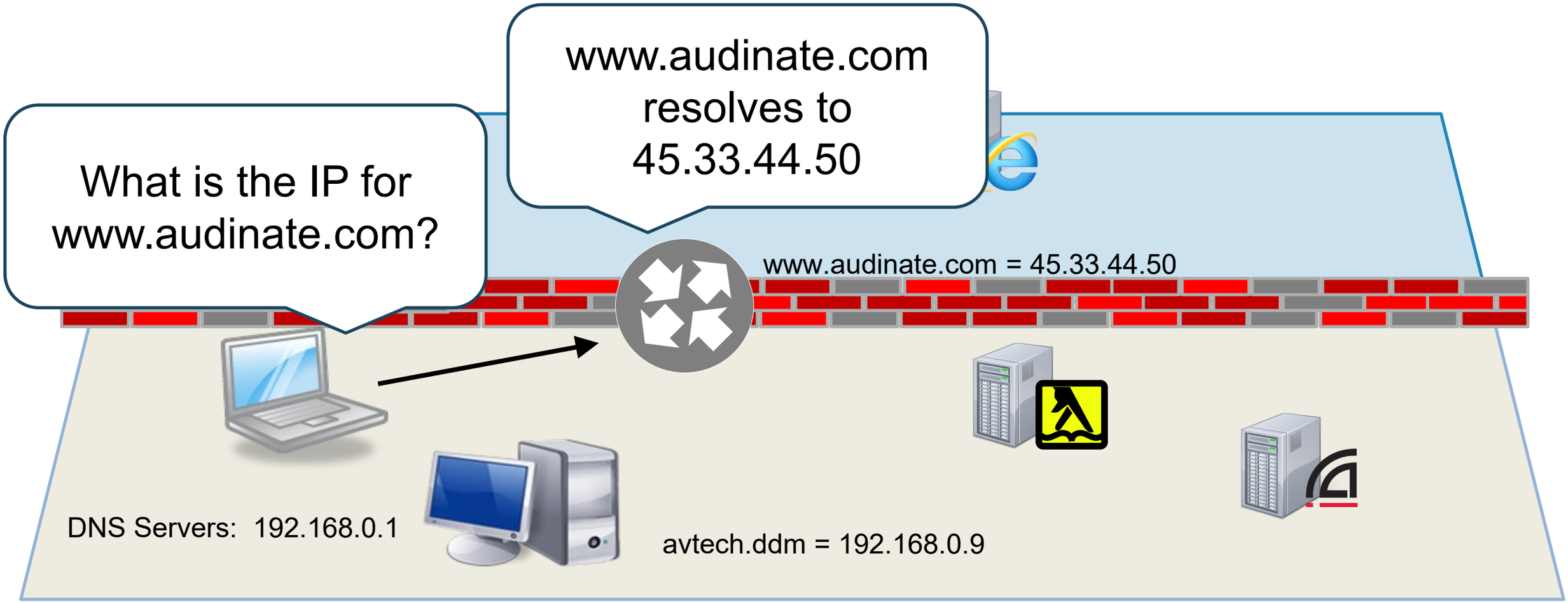

Audinate
http://www.audinate.com
Audinate®
http://www.audinate.com
http://45.33.44.50/
www.audinate.com = 45.33.44.50
DNS Servers: 192.168.0.1

DNS Caching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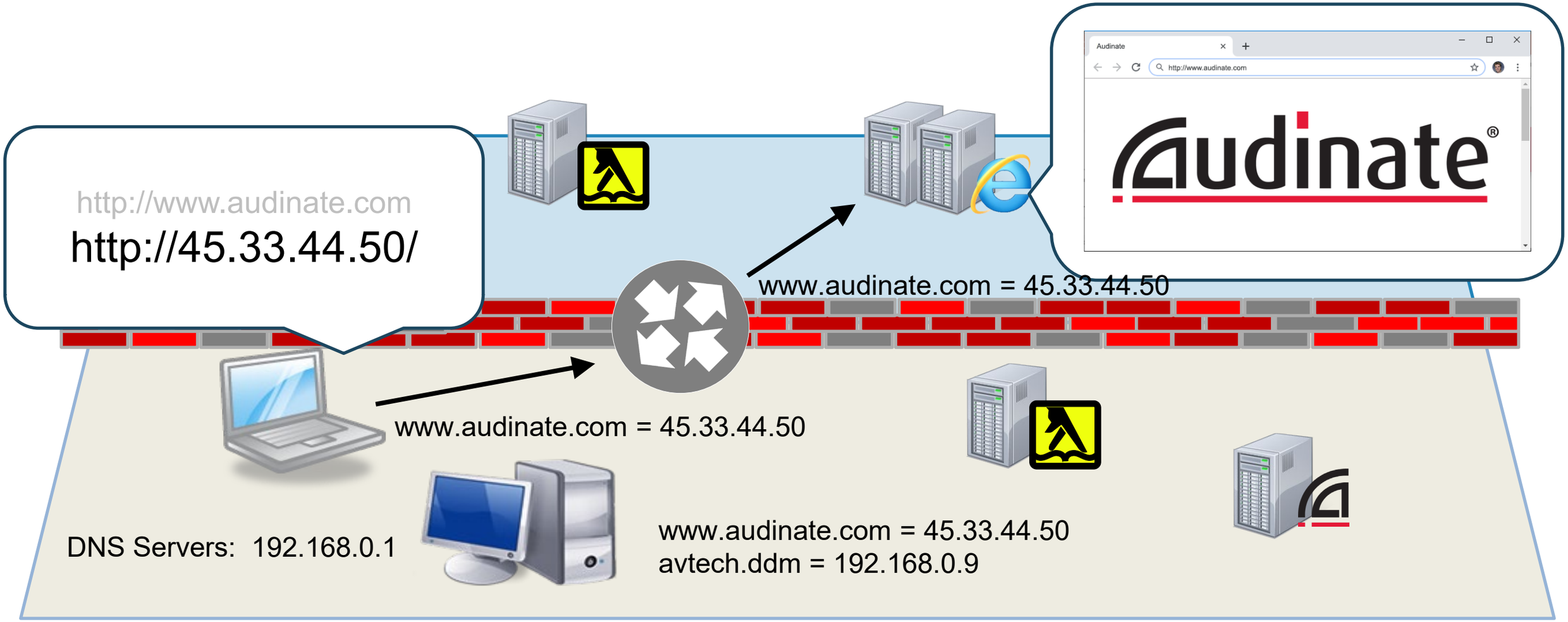
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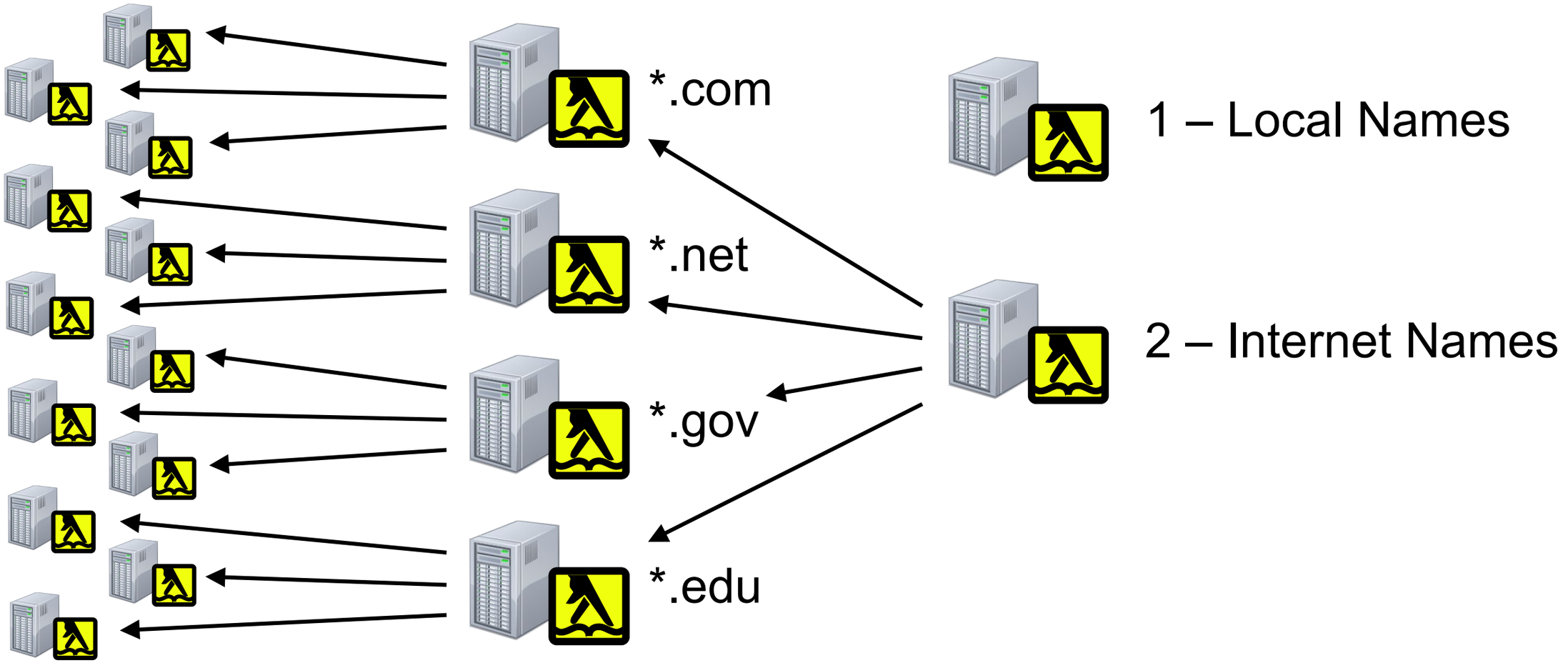
Audinate
http://www.audinate.com
Audinate

DNS Resolution – Network Is Very Large



DNS Summary

Domain Name Service

- DNS is like a phone book, resolving URLs (names) to IP Addresses
- There can be many DNS servers – your system defines them by priority
- The process returns first answer it sees – not a voting system.
- Localized devices cache the names of common sites for speed

DHCP and Link Local

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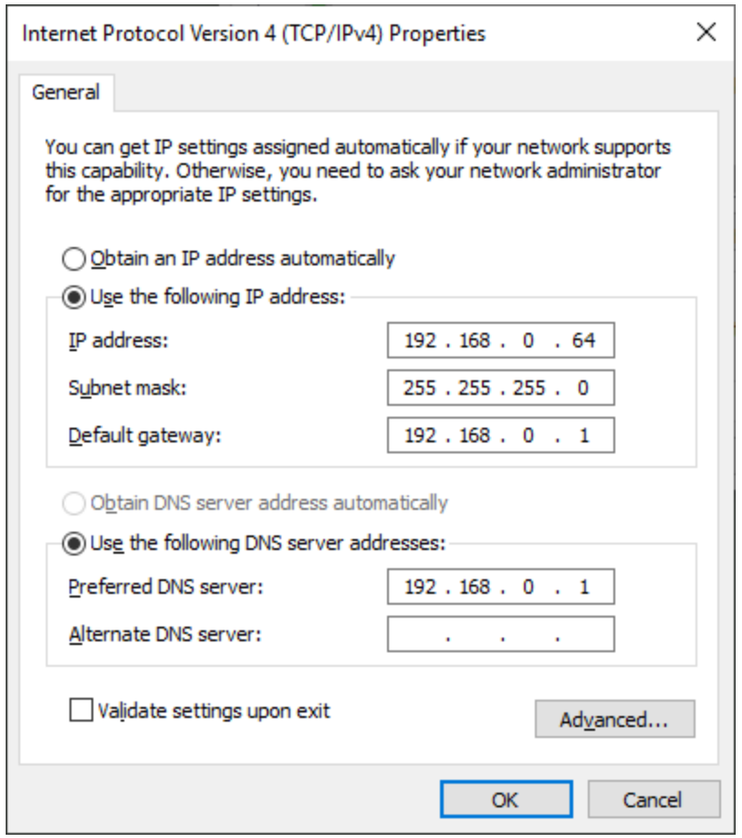
Automatic IP Addressing: DHCP

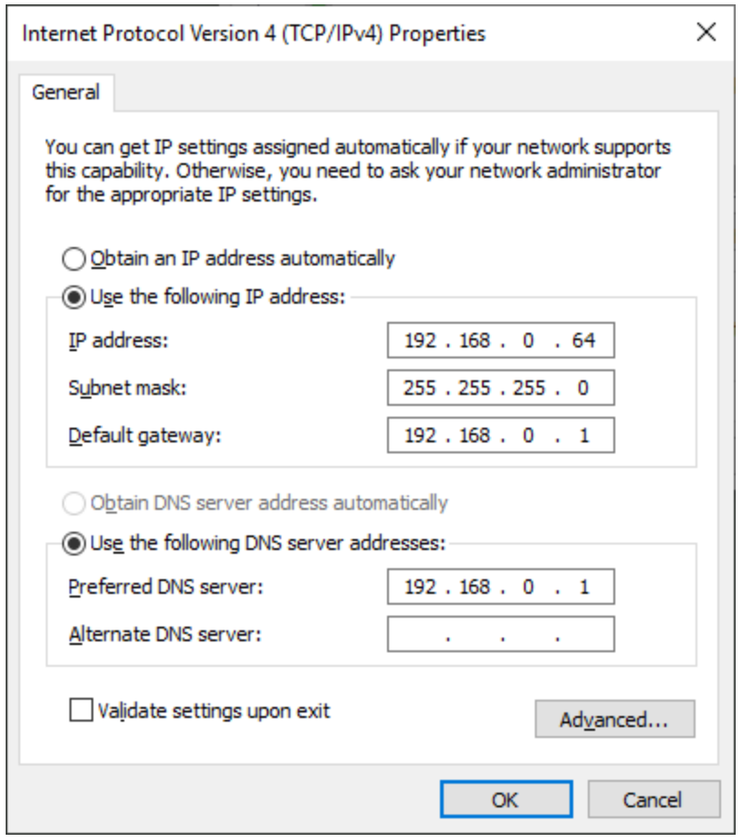


DHCP Automatically Assigns:

- IP Address — Different on each device
- Subnet Mask
- Gateway
- DNS

The same on all devices

Automatic IP Addressing: DHCP



DHCP Settings:

IP Range:

IP addresses to hand out:

192.168.0. 100 to
192.168.0. 254

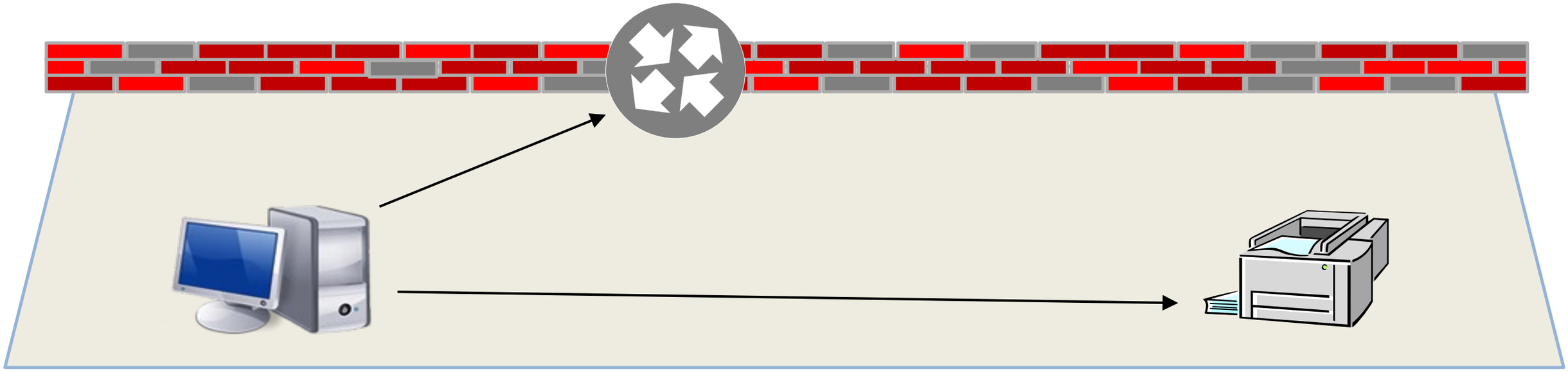
DHCP Lease Time:

Configuration “Time to Live”:

e.g. – 24 hours

Automatic IP Addressing: DHCP

IP	MAC	Expiration

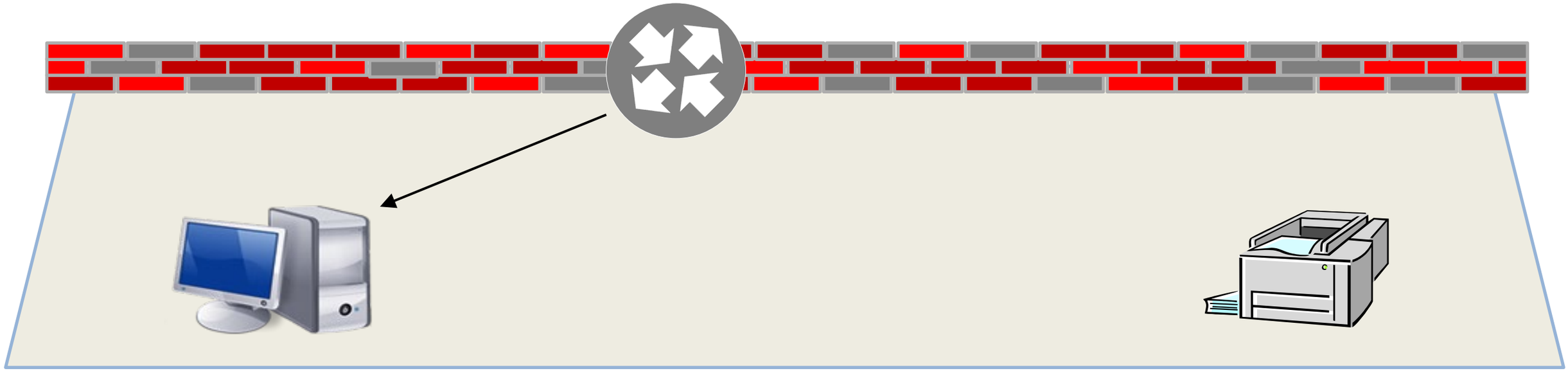


?

.51 - Static

Automatic IP Addressing: DHCP

IP	MAC	Expiration
.101	F7.51.32.CB.4F.21	2019-06-19 09:30

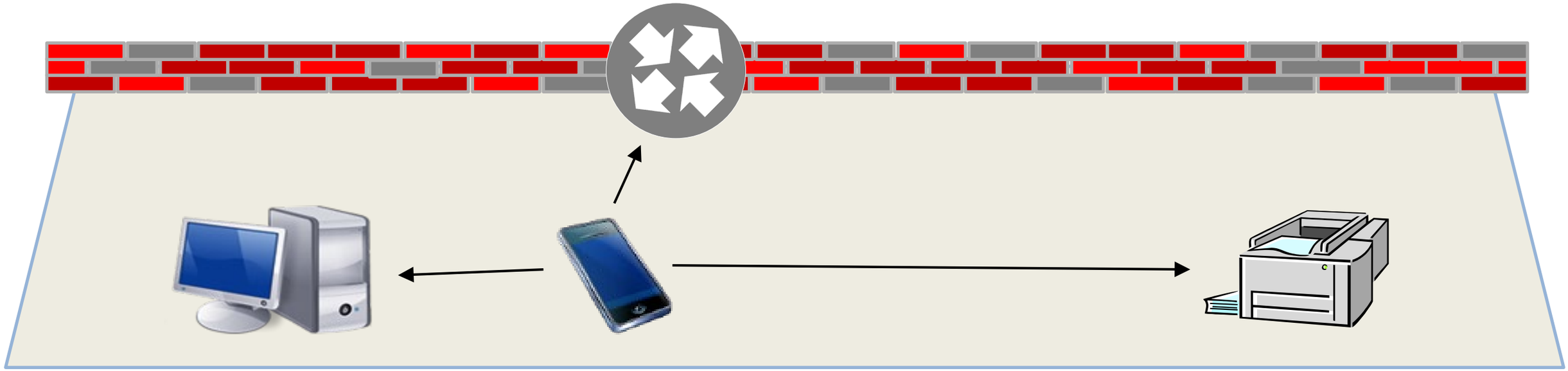


.101 – 9:30am

.51 - Static

Automatic IP Addressing: DHCP

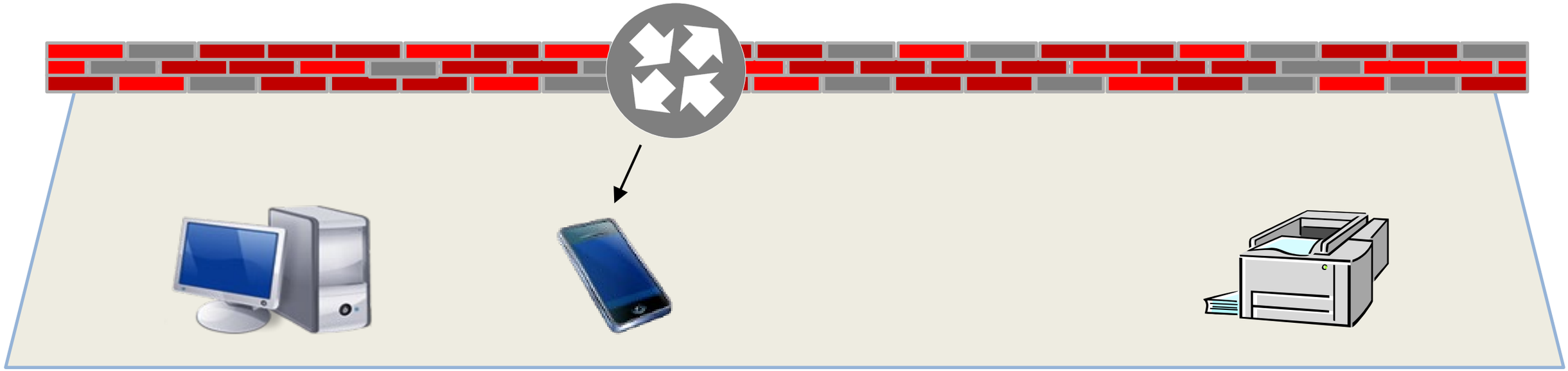
IP	MAC	Expiration
.101	F7.51.32.CB.4F.21	2019-06-19 09:30



.101 – 9:30am ? .51 - Static

Automatic IP Addressing: DHCP

IP	MAC	Expiration
.101	F7.51.32.CB.4F.21	2019-06-19 09:30
.102	44.DC.24.B4.11.96	2019-06-19 09:40



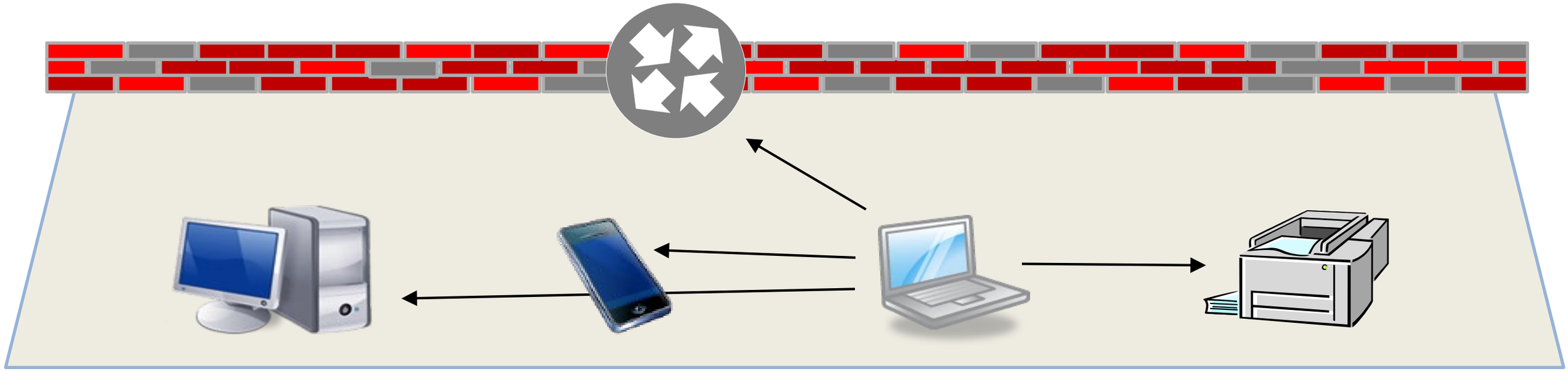
.101 – 9:30am

.102 – 9:40am

.51 - Static

Automatic IP Addressing: DHCP

IP	MAC	Expiration
.101	F7.51.32.CB.4F.21	2019-06-19 09:30
.102	44.DC.24.B4.11.96	2019-06-19 09:40



.101 – 9:30am .102 – 9:40am ? .51 - Static

Automatic IP Addressing: DHCP

IP	MAC	Expiration
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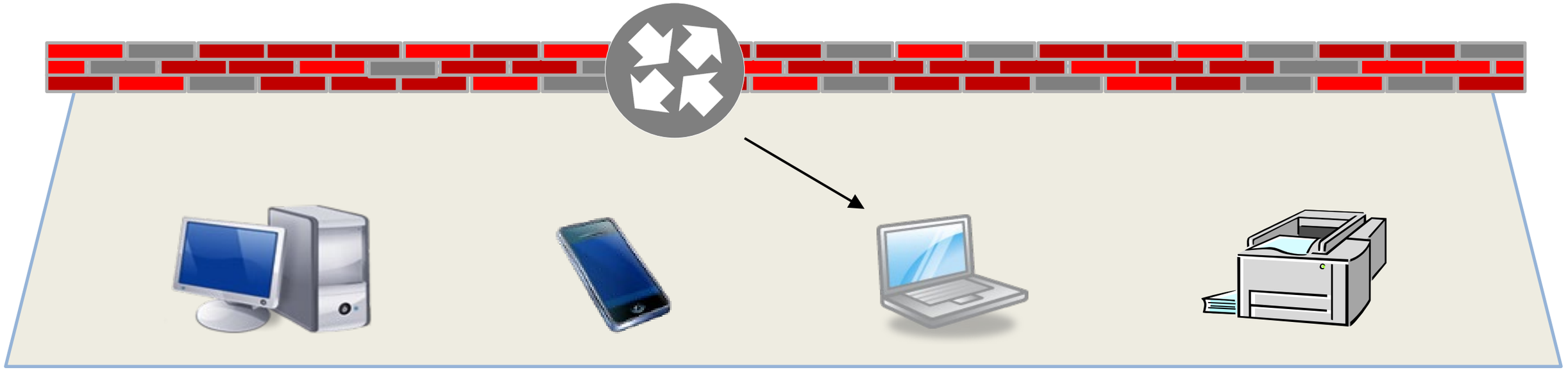
.102	44.DC.24.B4.11.96	2019-06-19 09:40
.103	B3.55.E1.7C.BA.D3	2019-06-19 09:45



.101 – 9:30am .102 – 9:40am .103 – 9:45am .51 - Static

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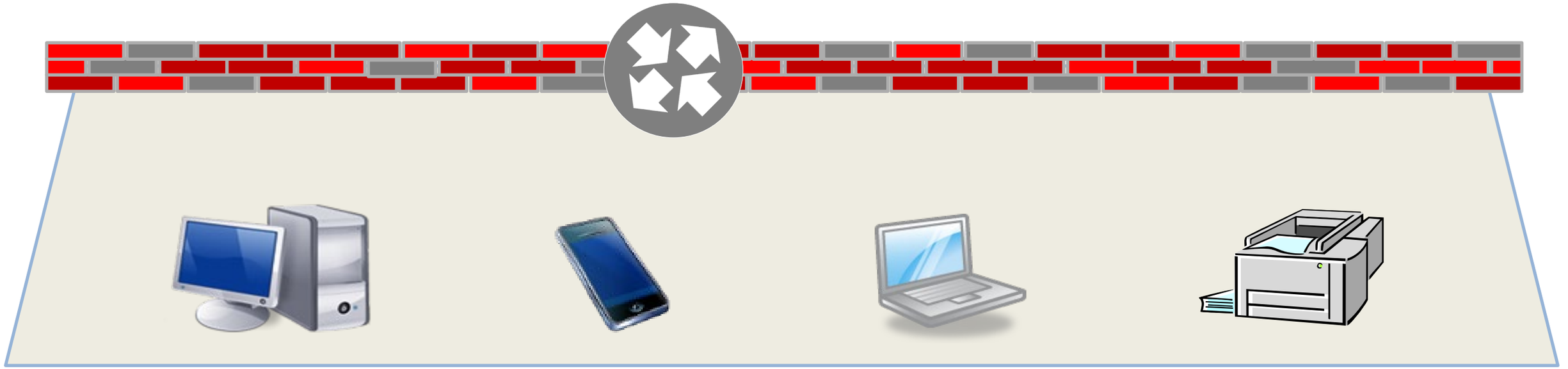

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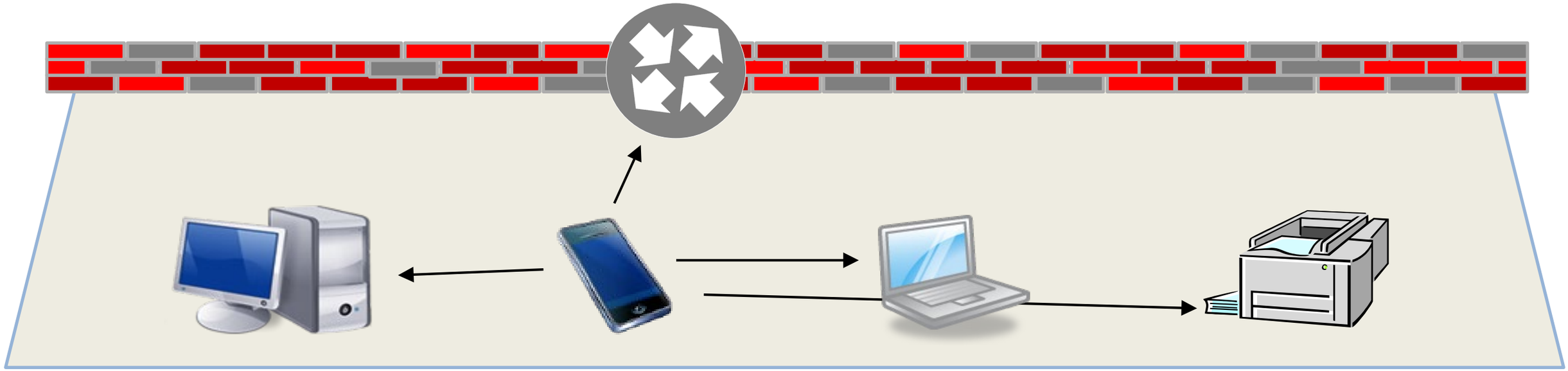
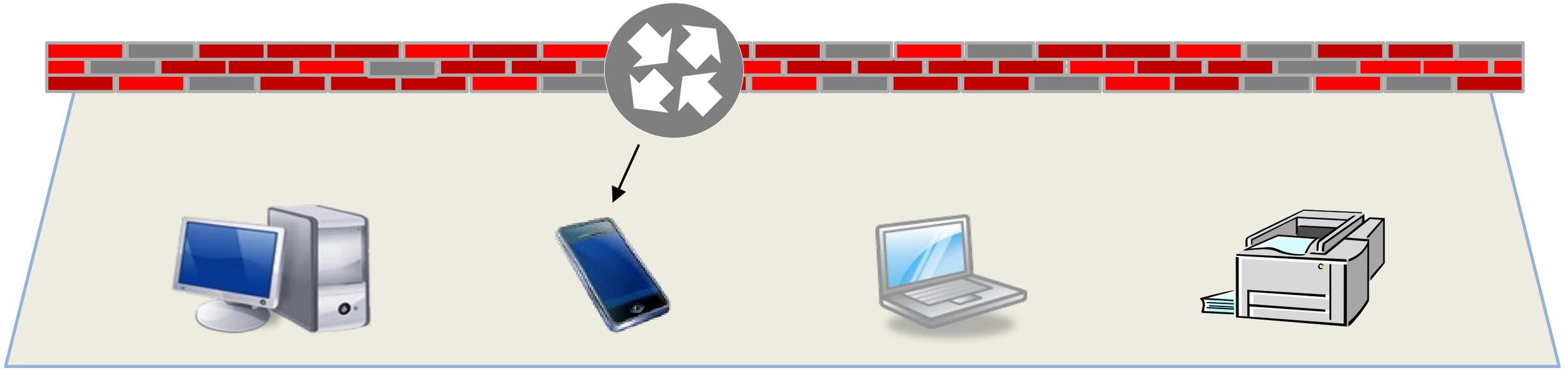


.101 – 9:30am ? .103 – 9:45am .51 - Static

Automatic IP Addressing: DHCP

IP	MAC	Expiration
.101	F7.51.32.CB.4F.21	2019-06-19 09:30
.102	44.DC.24.B4.11.96	2019-06-19 13:05
.103	B3.55.E1.7C.BA.D3	2019-06-19 09:45



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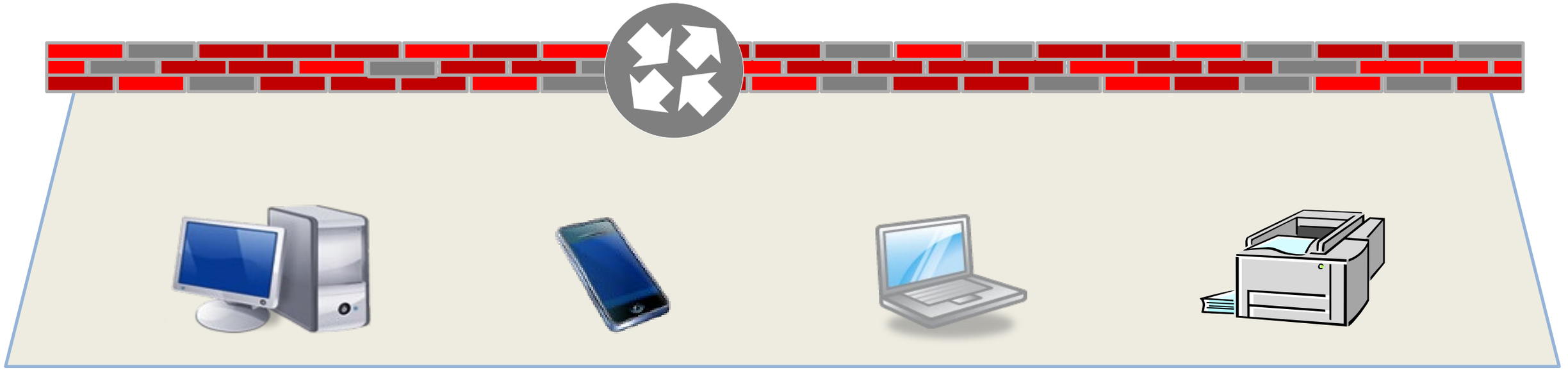

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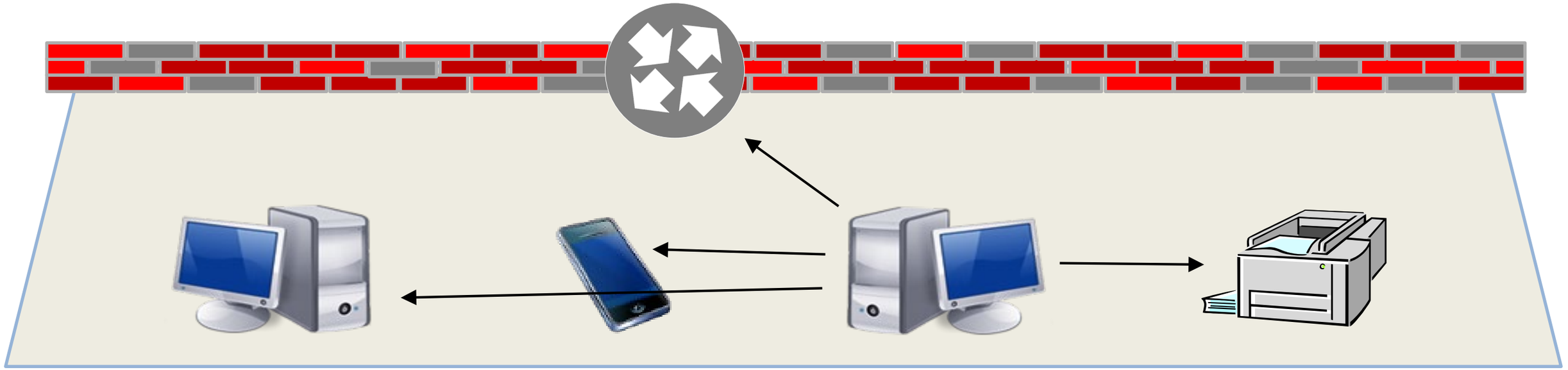

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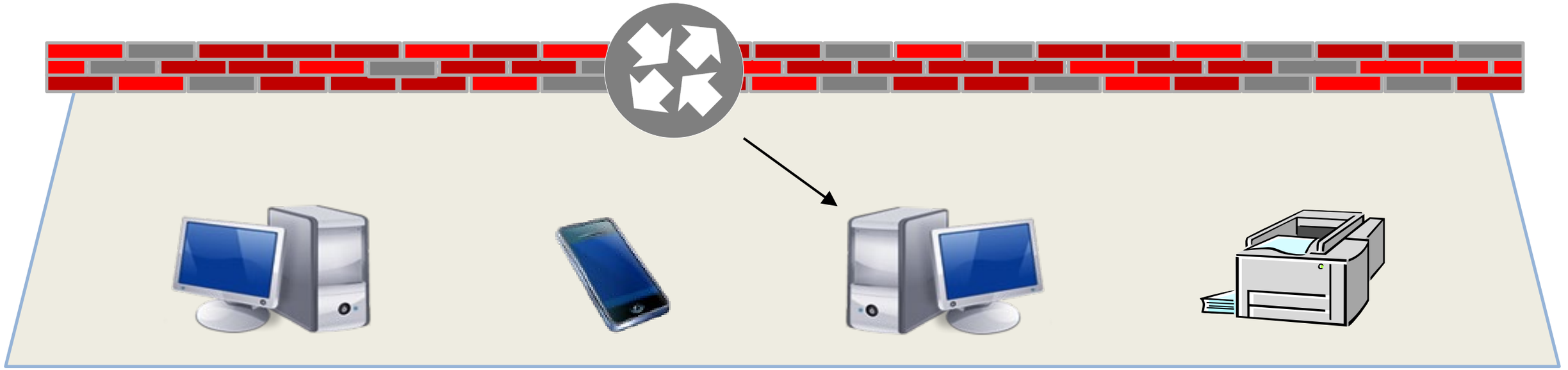
.104	A4.45.BC.D3.59.19	2019-06-19 15:10



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IP	MAC	Expiration
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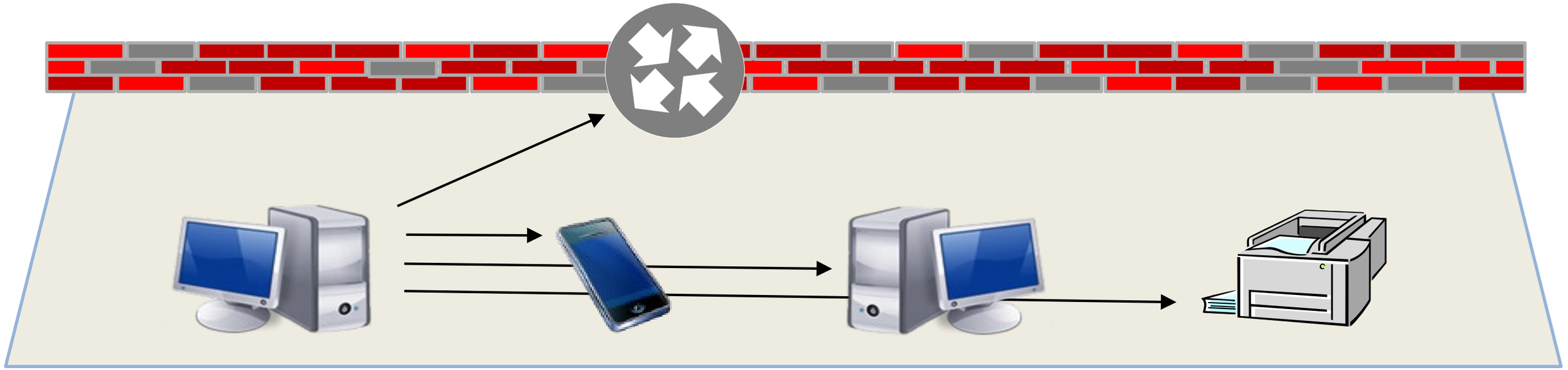

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Automatic IP Addressing: DHCP

IP	MAC	Expiration
.101	F7.51.32.CB.4F.21	2019-06-20 09:30
.102	44.DC.24.B4.11.96	2019-06-19 13:05
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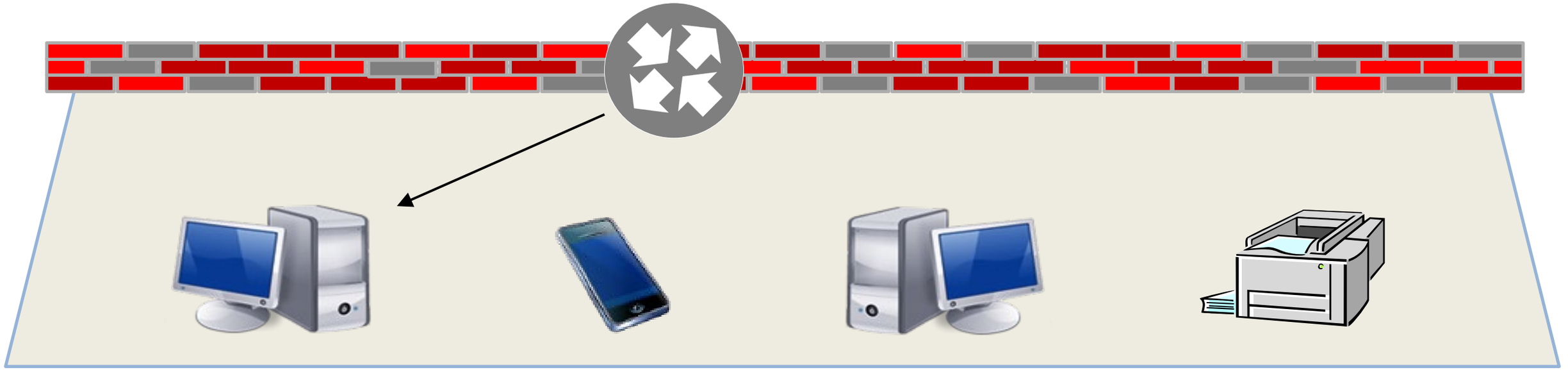

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.104	A4.45.BC.D3.59.19	2019-06-19 15:10

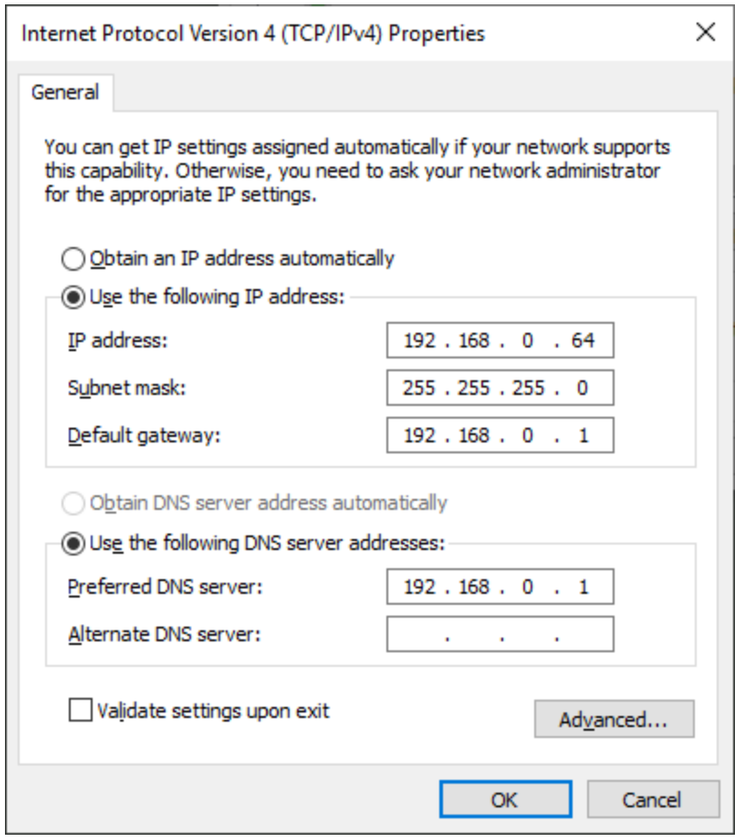
.101 – 9:30am .102 – 1:05pm .104 – 3:10pm .51 - Static

Automatic IP Addressing: DHCP

What if there is no DHCP Server?

Most Devices Revert to “Link Local”

Automatic IP Addressing: Link Local



Link Local Automatically Assigns:

- IP Address
- Subnet Mask

} 169.254.0.0 /16

169.254.__.__
255.255. 0 . 0

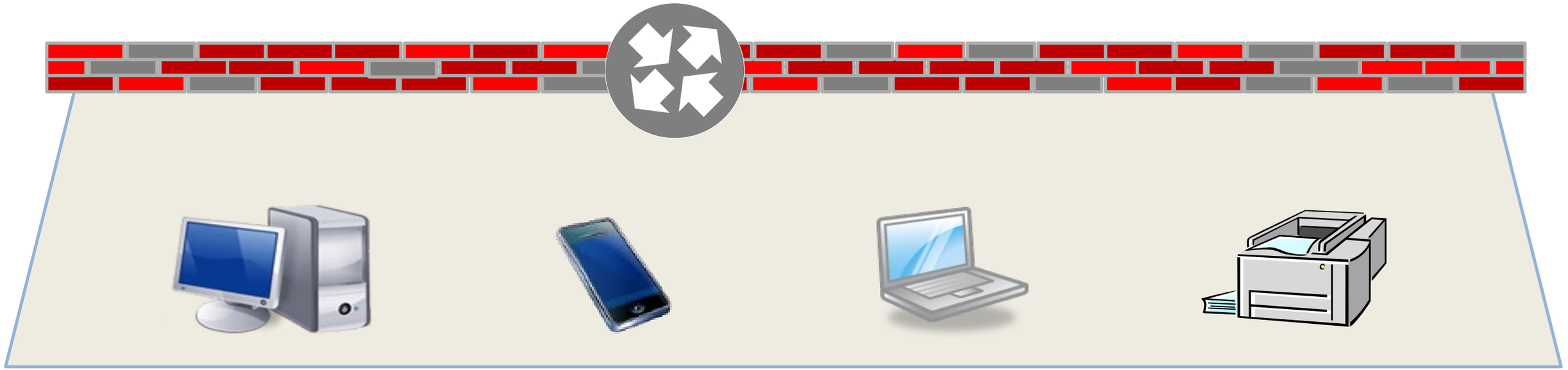
The goal is to allow devices to communicate on a LAN.

Link Local Does Not Deal With:

- Gateway
- DNS

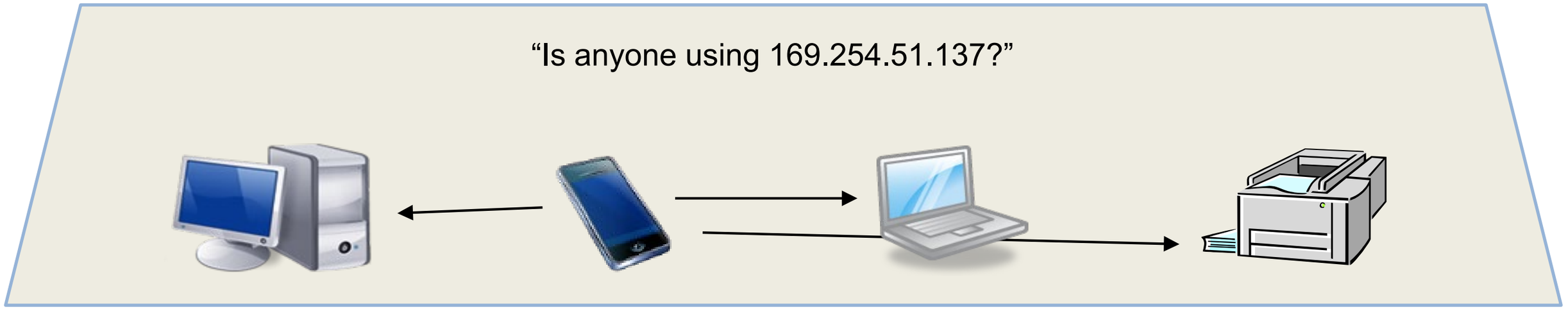
Automatic IP Addressing: DHCP

If DHCP Looks Like This…



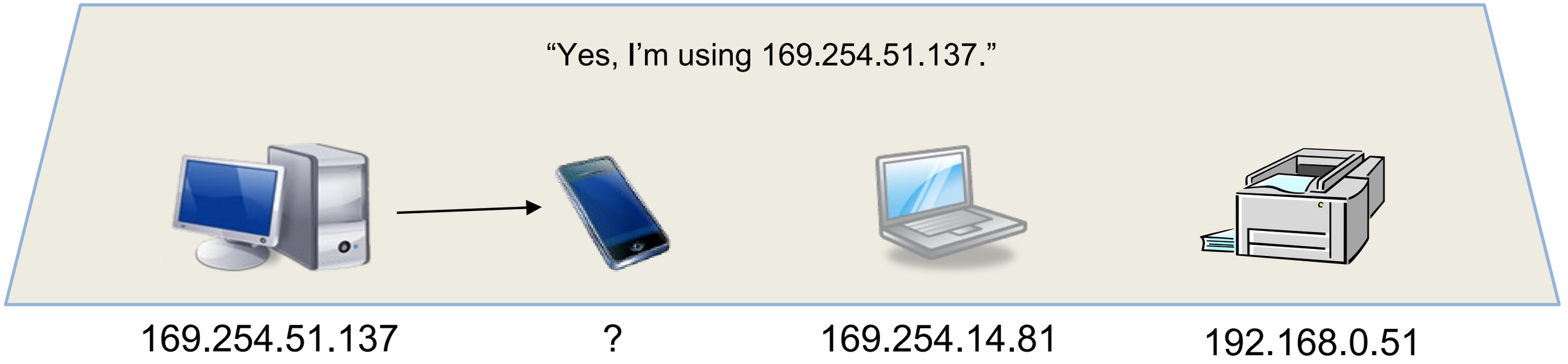
Link Local Looks Like This…

ARP Request: 169.254.51.137



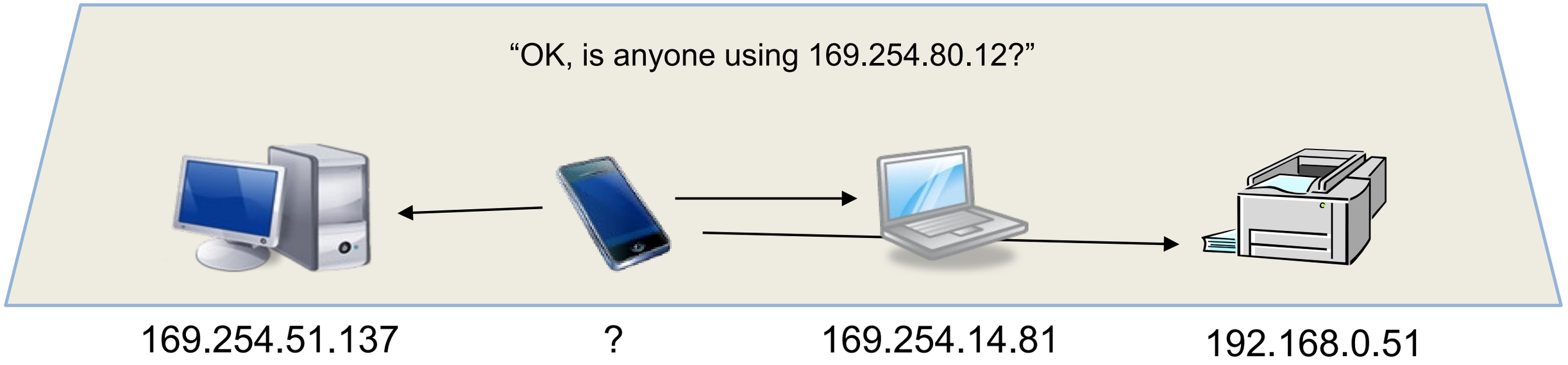
Link Local Looks Like This…

ARP Response



Link Local Looks Like This…

ARP Request: 169.254.80.12



Automatic IP Addressing: DHCP

Link Local Looks Like This…

169.254.51.137 ? 169.254.14.81 192.168.0.51

Automatic IP Addressing: DHCP

Link Local Looks Like This…

169.254.51.137 169.254.80.12 169.254.14.81 192.168.0.51

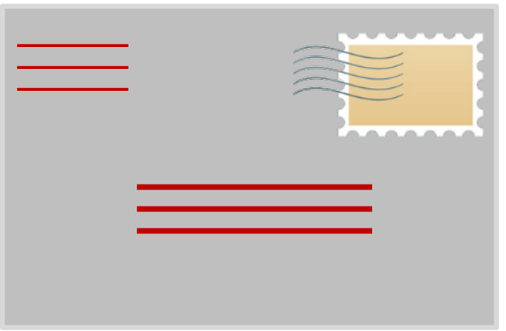
TCP vs UDP

Topics for Today

ENHANCE	**Core IP Settings**	*IP Address, Subnet Mask, Gateway/Router, LAN Range*
	DNS	*Domain Name Service*
	DHCP/Link Local	*Automatic Address Settings*
	TCP/UDP	*Transmission Methods*
	Unicast, Multicast and Broadcast	*Distribution Methods*
	QoS	*Quality of Service – Traffic Prioritization*
	VLAN & Trunk Implications	*VLAN, Trunk, Tagged VLAN, STP, LAG*
NEW	**Network Ports**	*Managing Simultaneous Connections*
	PTP Clocking	*Precision Time Protocol (PTP)*
	ARP	*Switching by MAC vs IP*
	Layered Network Models	*OSI and TCP Conceptual Models*
	Segmenting Broadcast Domain	*Managing the “Noise” in a Network*
	Design & Troubleshooting	

TCP vs UDP Traffic

- TCP traffic is like “Signature Required” mail
  The sender gets notification that the message was received.
- UDP traffic is like “First Class” mail
  Place envelope in mailbox and trust it gets delivered.



Does that mean UDP is less reliable?

No, it is a different tool for a different job.

TCP vs UDP Traffic

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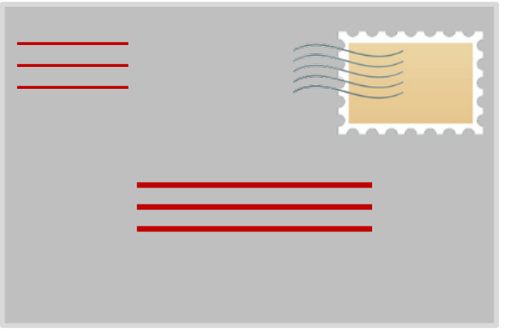


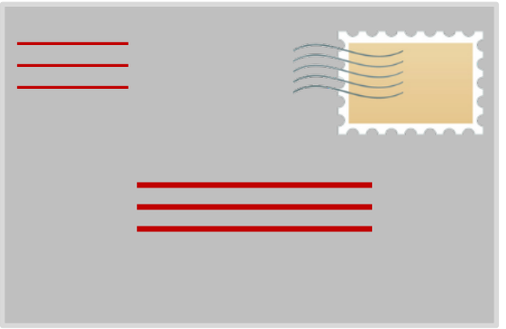
- TCP is appropriate for internet traffic where:
  - Communications are likely to be interrupted (internet),
  - Missing a packet invalidates data (ftp download) or
  - Timely delivery is a convenience, not a necessity.

- Problems with TCP for media:
  - If the packet was dropped, what is the time out on waiting for a confirmation?
  - Creates additional overhead, increasing likelihood of a problem.

TCP vs UDP Traffic

- UDP traffic is like “First Class” mail

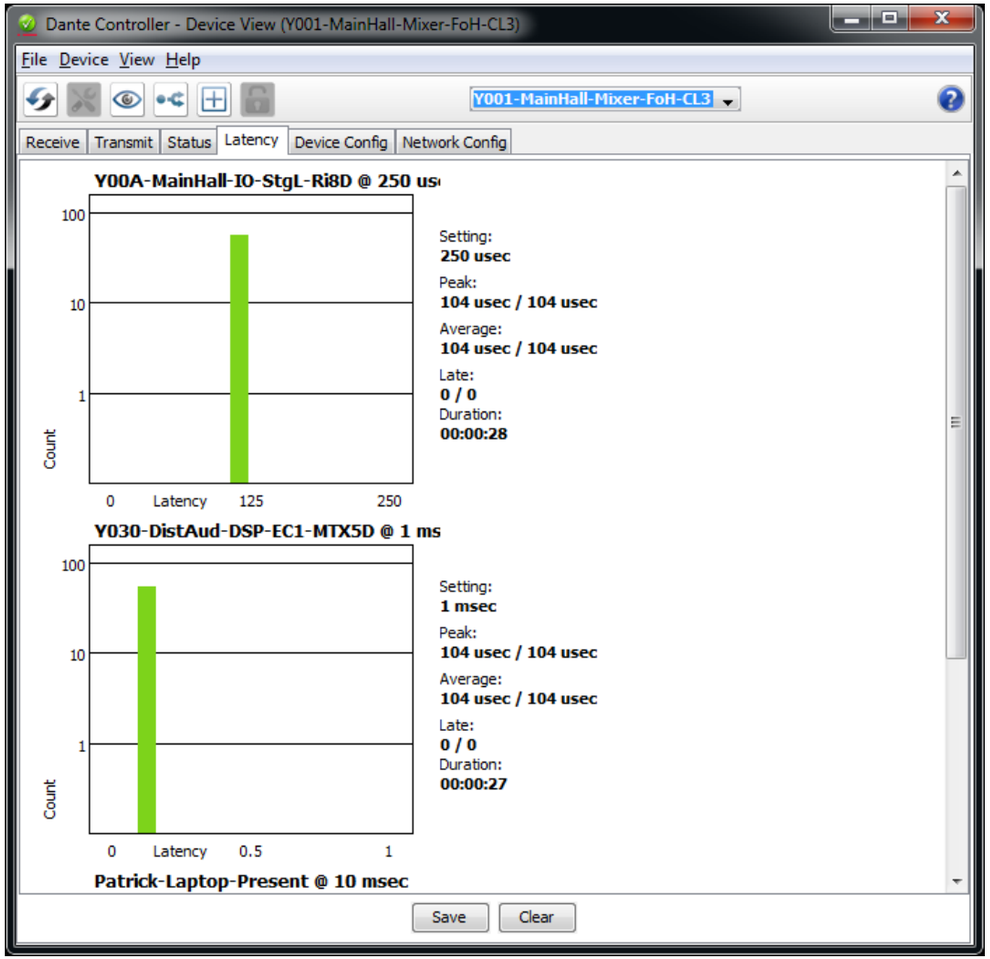
  Place envelope in mailbox and trust it gets delivered.



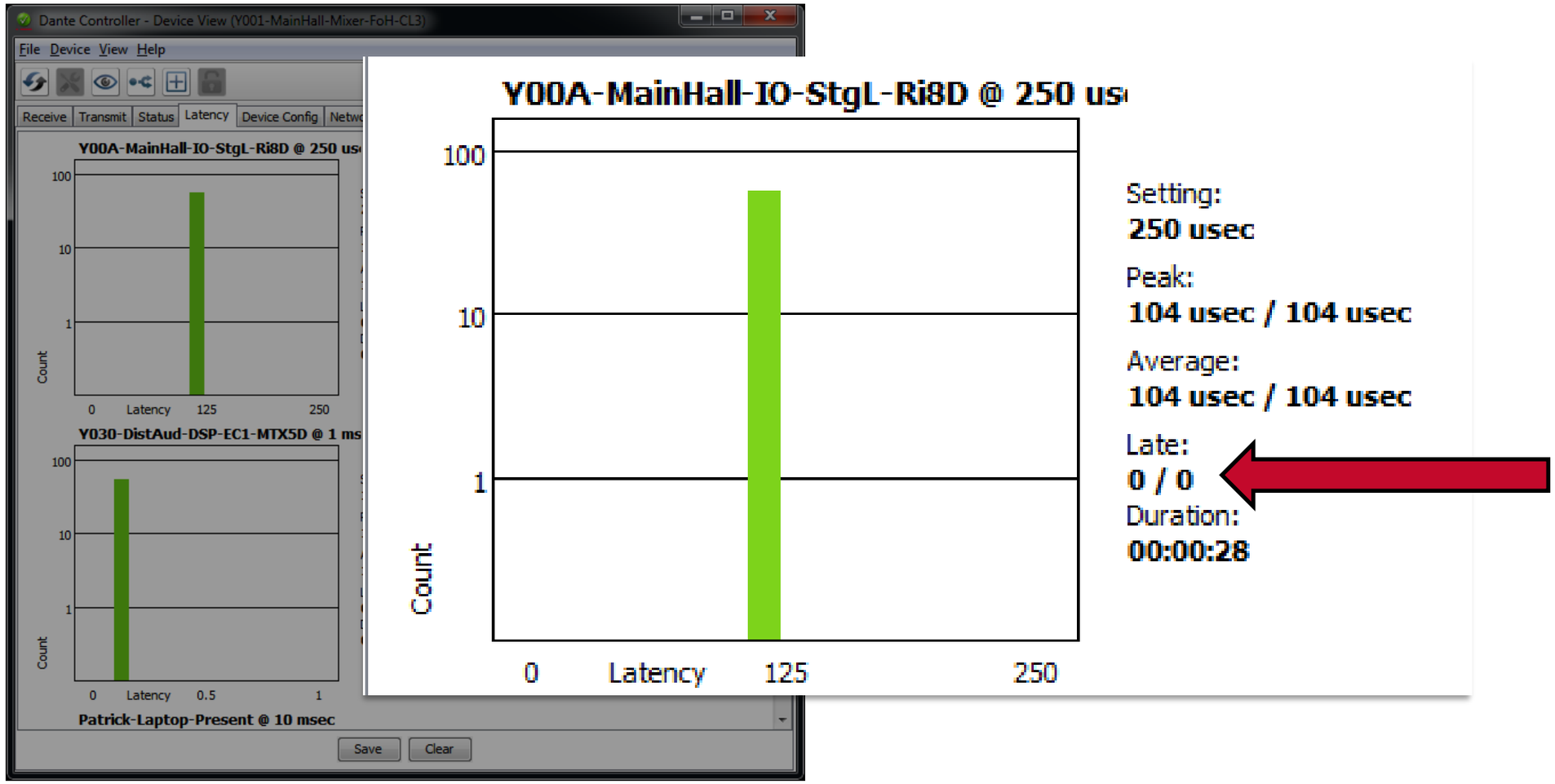
- UDP is appropriate for internet traffic where:
  - Communications are not likely to be interrupted (LAN),
  - Missing a packet in sequences can be overcome (error correction) or
  - Timely delivery or low overhead is key

- Devices can track network performance:
  - Managed switches and endpoints can log unhandled or missing packets

Verifying UDP Delivery



Verifying UDP Delivery



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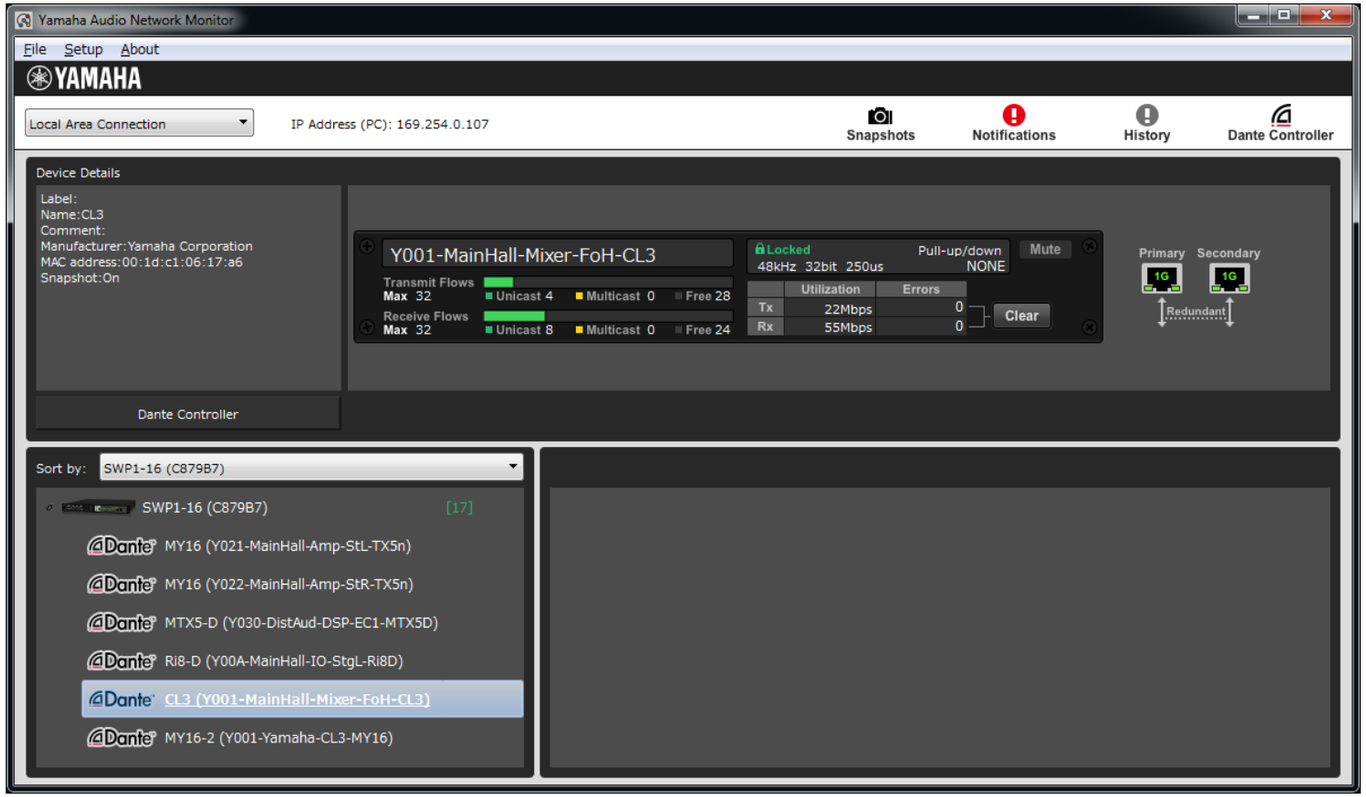

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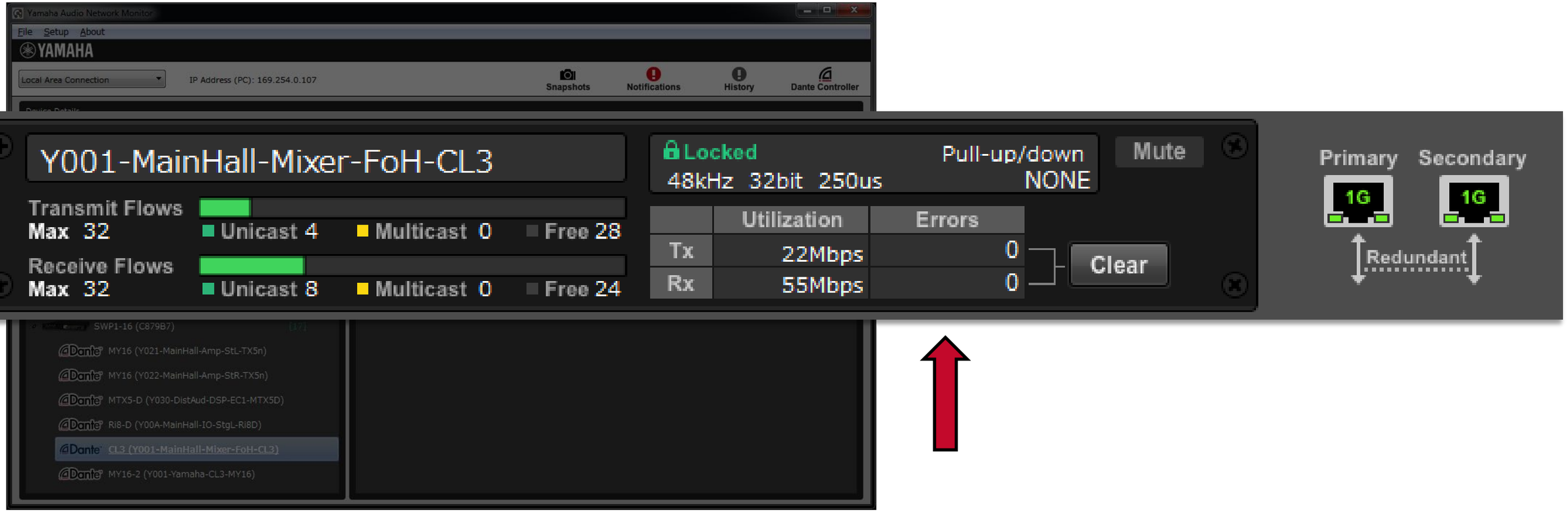

Festival System Profile

FoH Position
(2) Yamaha CL5 Mixing Consoles
Band A & Band B

Monitor Position
(2) Yamaha CL5 Mixing Consoles
Band A & Band B

Production Desk
Yamaha CL1 Mixing Consoles
MC Mic, BGM, Quick Routing

128 Stage Inputs
(4) RIO3224-D
Band A & Band B
Split Wireless Mic Systems

Main PA
Nexo STM Mains
Yamaha NXAMP Amps

Monitor PA
Nexo 45N12 Wedges
Nexo PS15/LS18 Side Fills
Yamaha NXAMP Amps

Unicast, Multicast and Broadcast

Topics for Today

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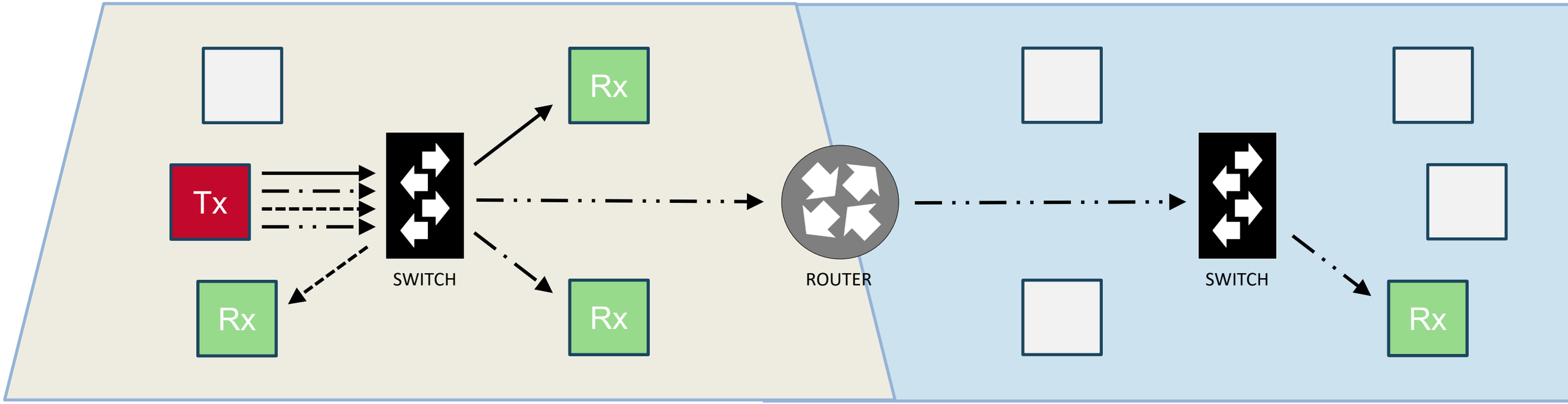
Unicast is like First Class Mail

One-to-One Transmission, Can Be Routed



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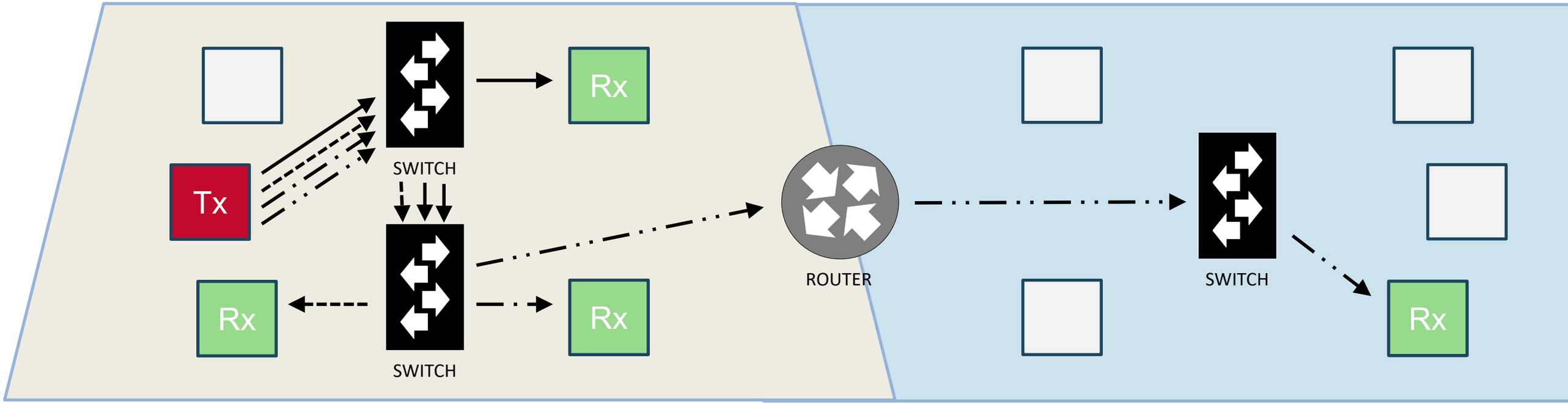
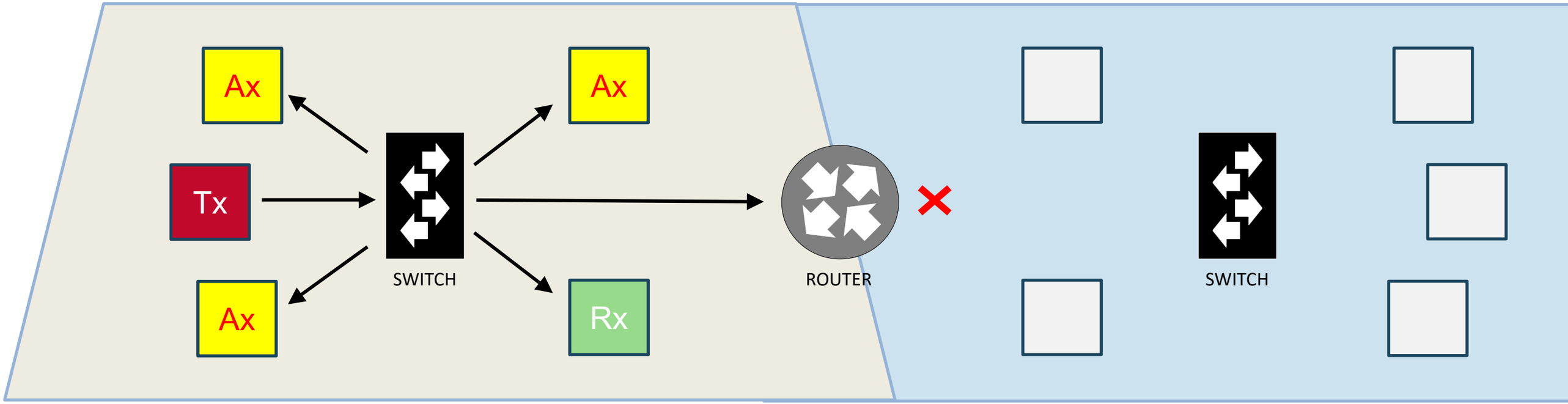


Broadcast is like Junk Mail by Zip Code

One-to-All Transmission, Does Not Cross a Router



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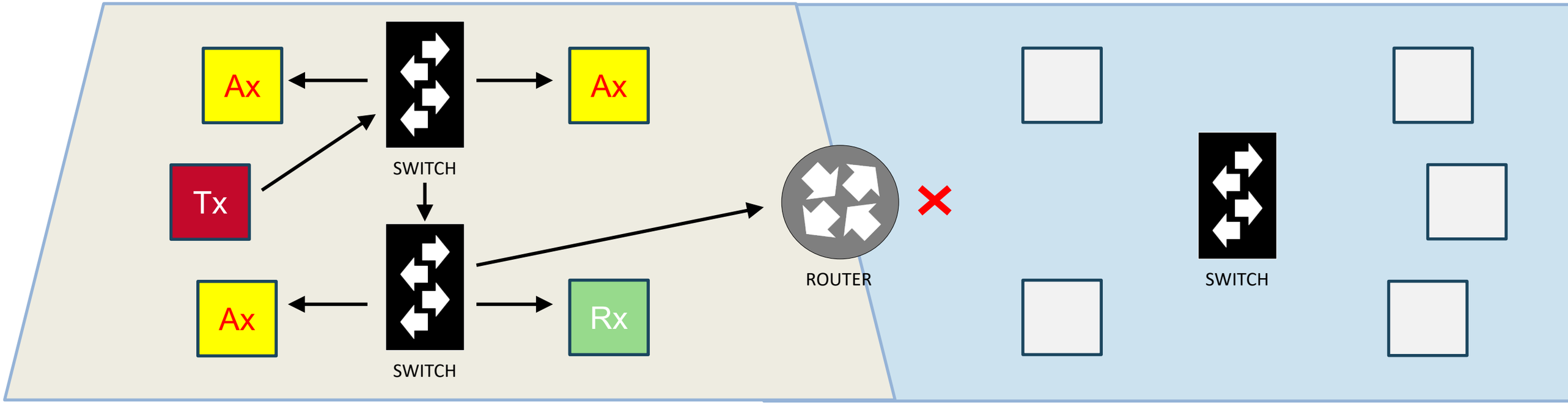
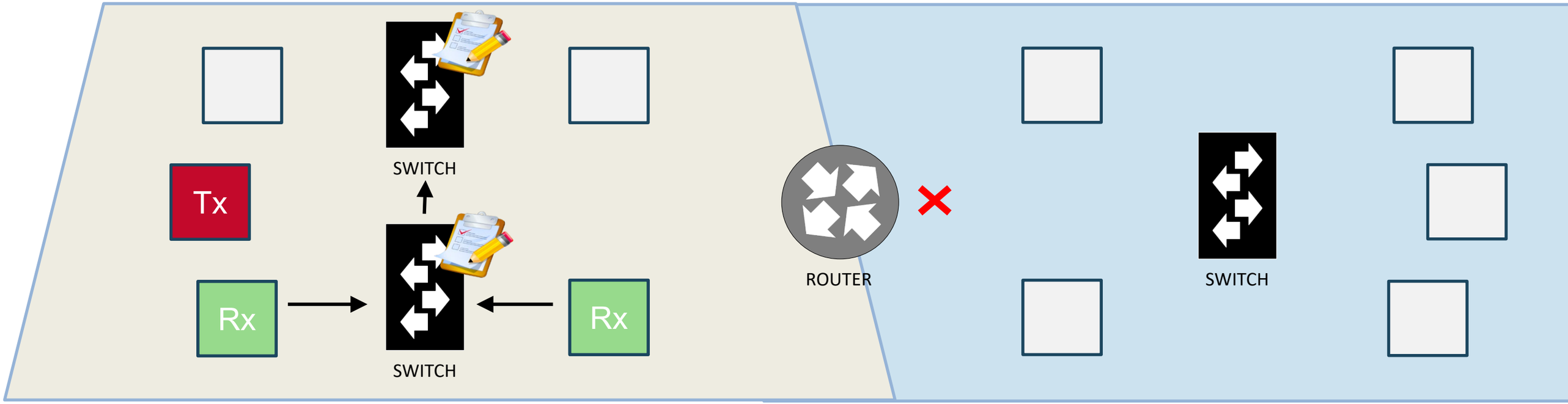


Multicast w/ IGMP is like a Magazine Subscription

One-to-Many Transmission, Does Not Cross Router (By Default)



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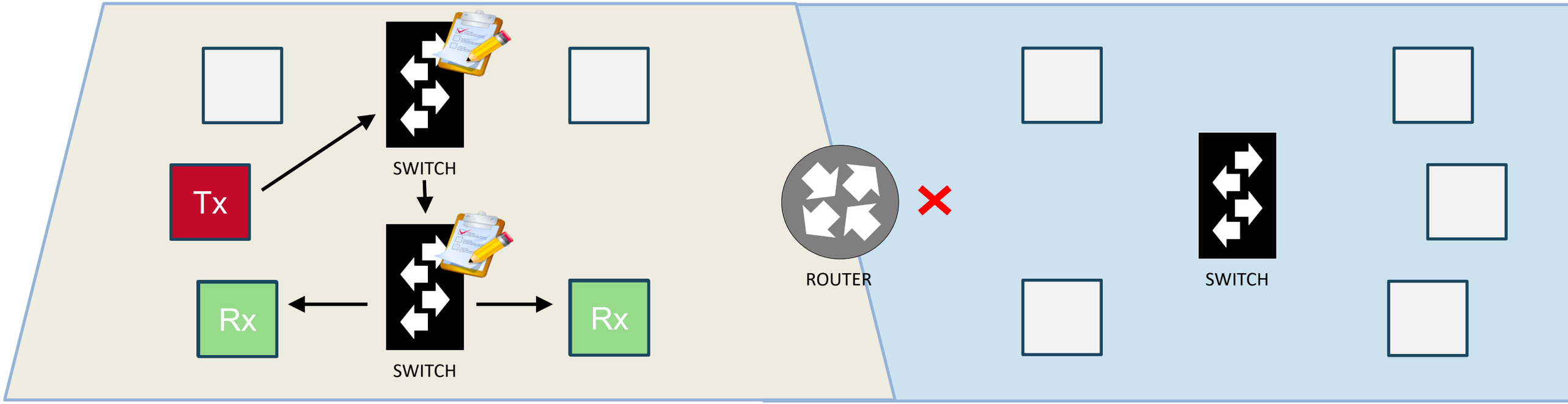


Distribution: Unicast, Multicast and Broadcast

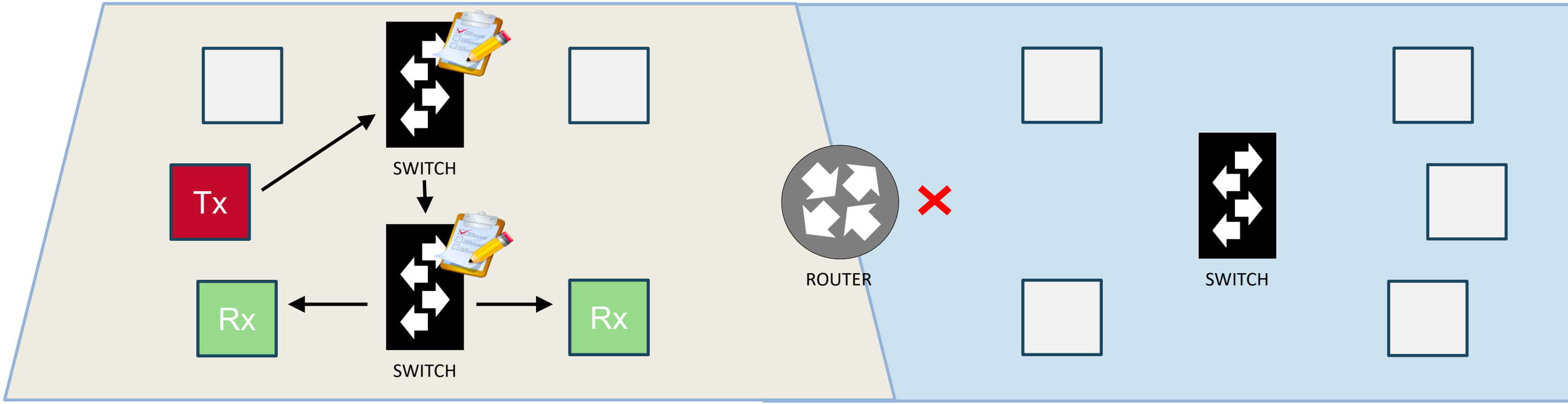
- Subscription is made to a Multicast IP Address
  224.0.0.0 /4, also known as 224.0.0.0 through 239.255.255.255

- IGMP Snooping is the bit that manages the subscriptions:
  - All switches would have IGMP Snooping Engaged
  - There should only be one IGMP Querier on the network

- IGMP Snooping v2 or v3:
  - Dante will work at v2 or v3.
  - Some other systems are still testing with v3 compatibility.

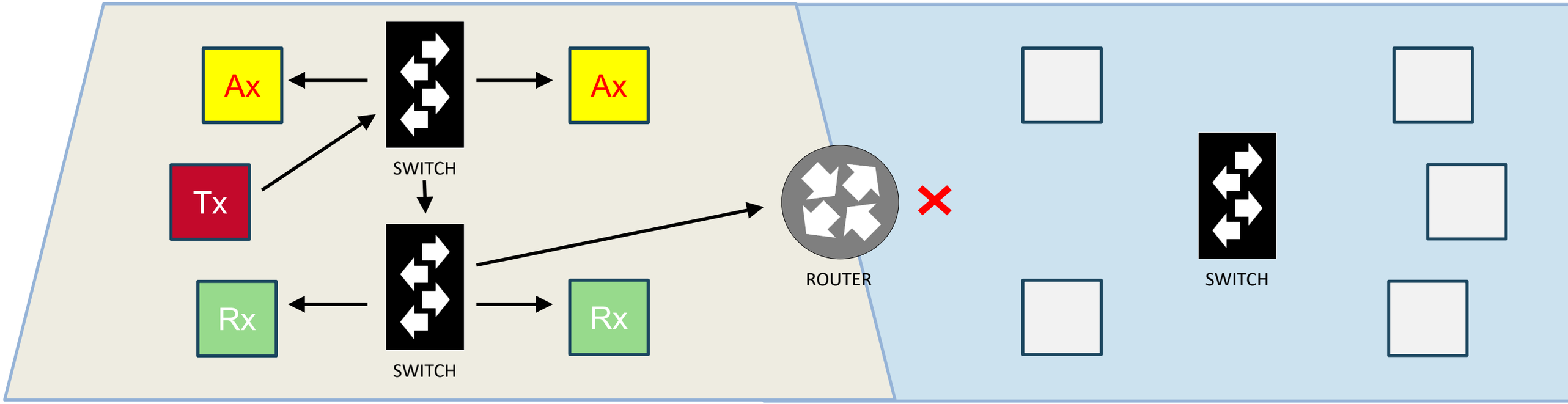
Multicast w/ IGMP is like a Magazine Subscription

One-to-Many Transmission, Does Not Cross Router (By Default)



Multicast w/o IGMP is like a Magazine Subscription

One-to-Many Transmission, Does Not Cross Router (By Default)



Distribution: Unicast, Multicast and Broadcast

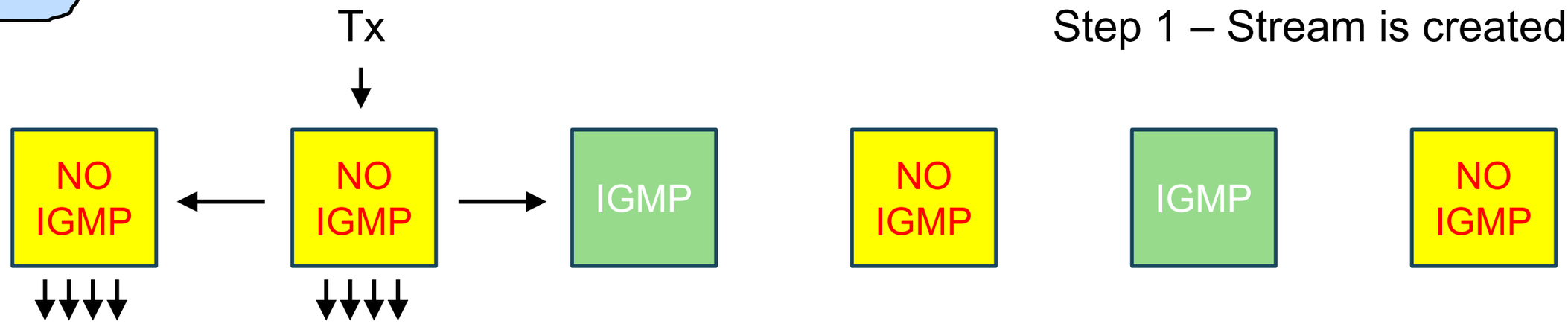
- What if multiple devices transmit to the same IP address?
  Devices subscribing to that stream will receive all contributions.

- Macintosh running DVS might have problems with IGMP.
  Luminex and Yamaha have a mode that overrides the "Time To Live".
  Others can solve this by manual registration or forward all multicast.

- Can we mix brands of switches with IGMP Snooping?
  Mostly, yes. But sticking with a brand will more likely auto-negotiate an IGMP Snooping querier and offer consistent management screens.

Distribution: Unicast, Multicast and Broadcast

- What if a network involves switches with and without IGMP?
  Switches with IGMP Snooping will control Multicast distribution.
  Switches without IGMP Snooping will flood Multicast that enters it.



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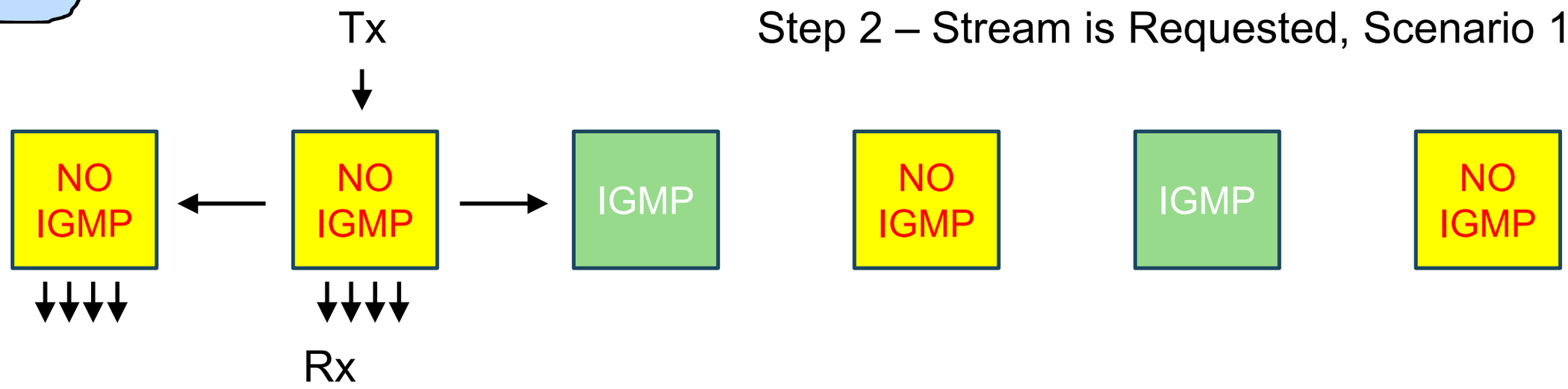

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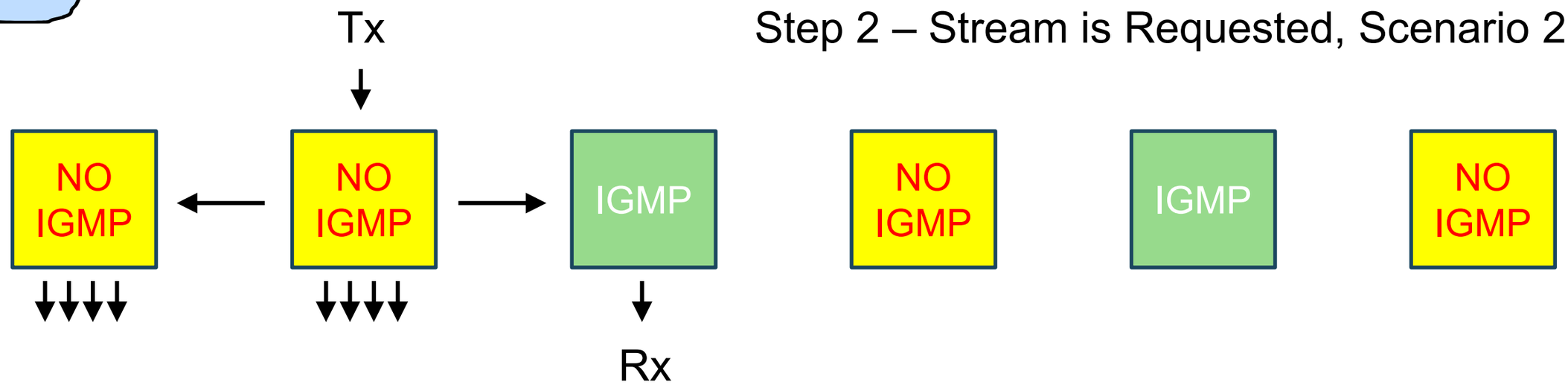

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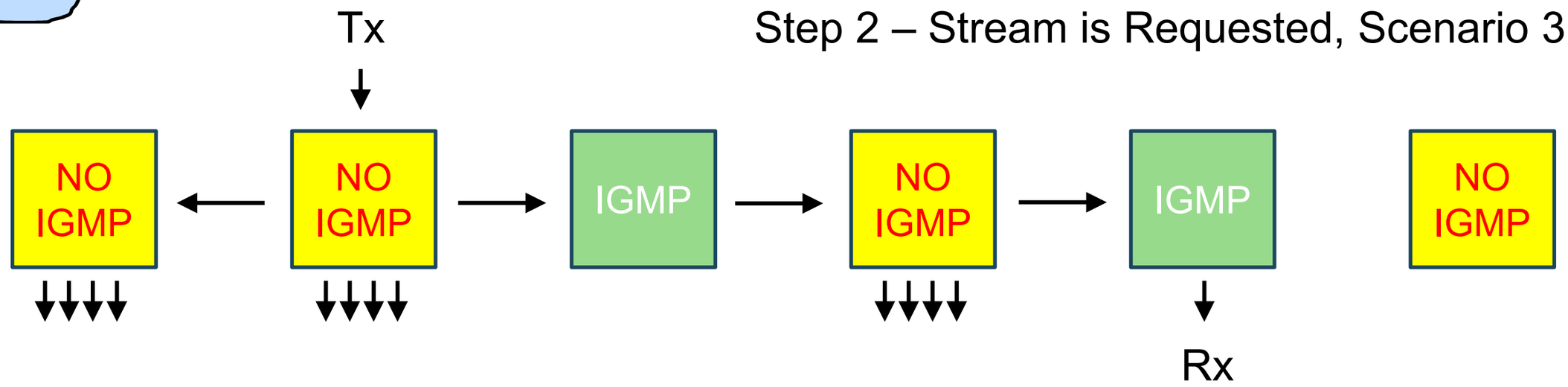

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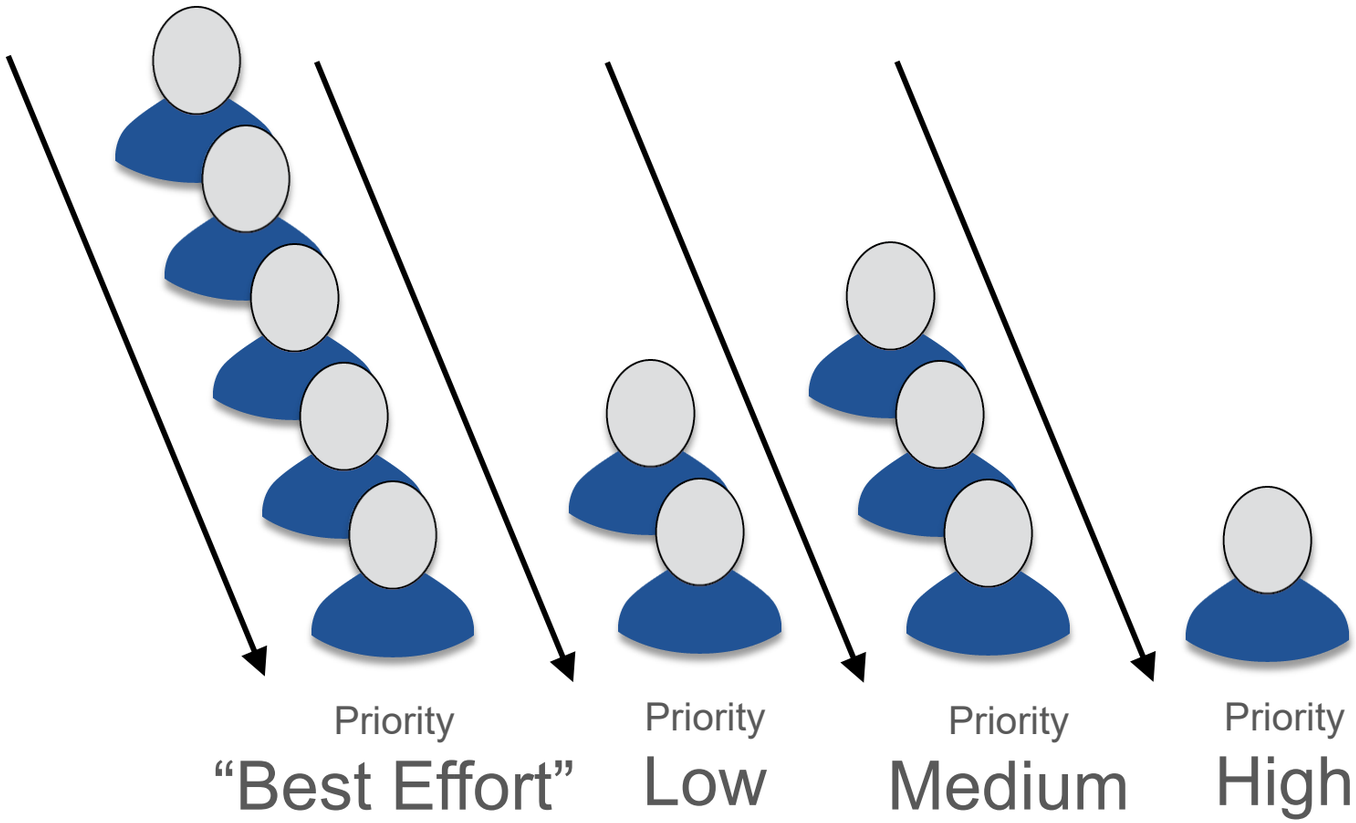
- Does multicast cross a router?
  By default, no. But where there is a will, there is a way.

- How much multicast can a network handle?
  Watch the CPU load on your switch. But generally, it can move a lot...

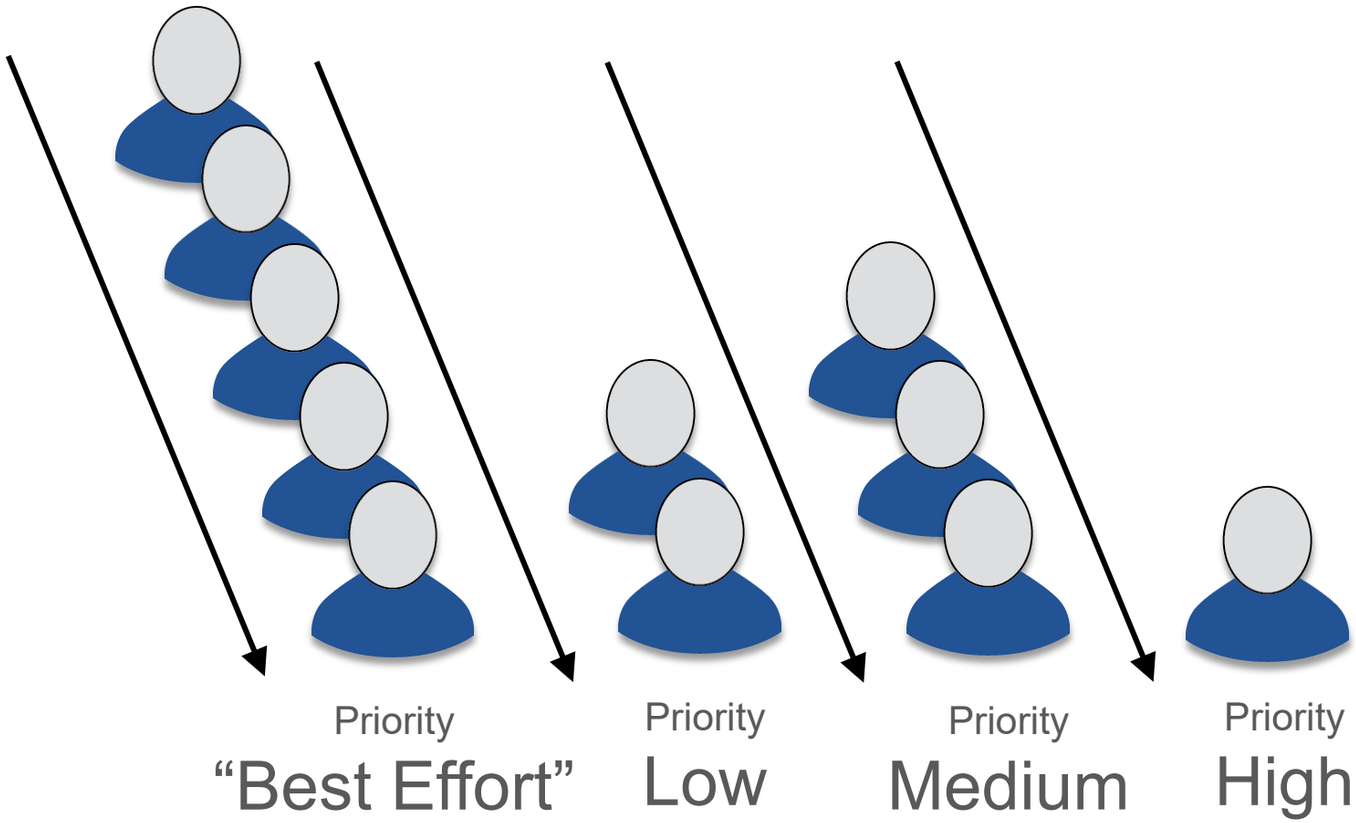
QoS (Quality of Service)

QoS: Quality of Service



- If many data packets need to go out a single port, they queue up.
- QoS allows us to prioritize some packets, similar to priority status on an airline.

QoS: Quality of Service



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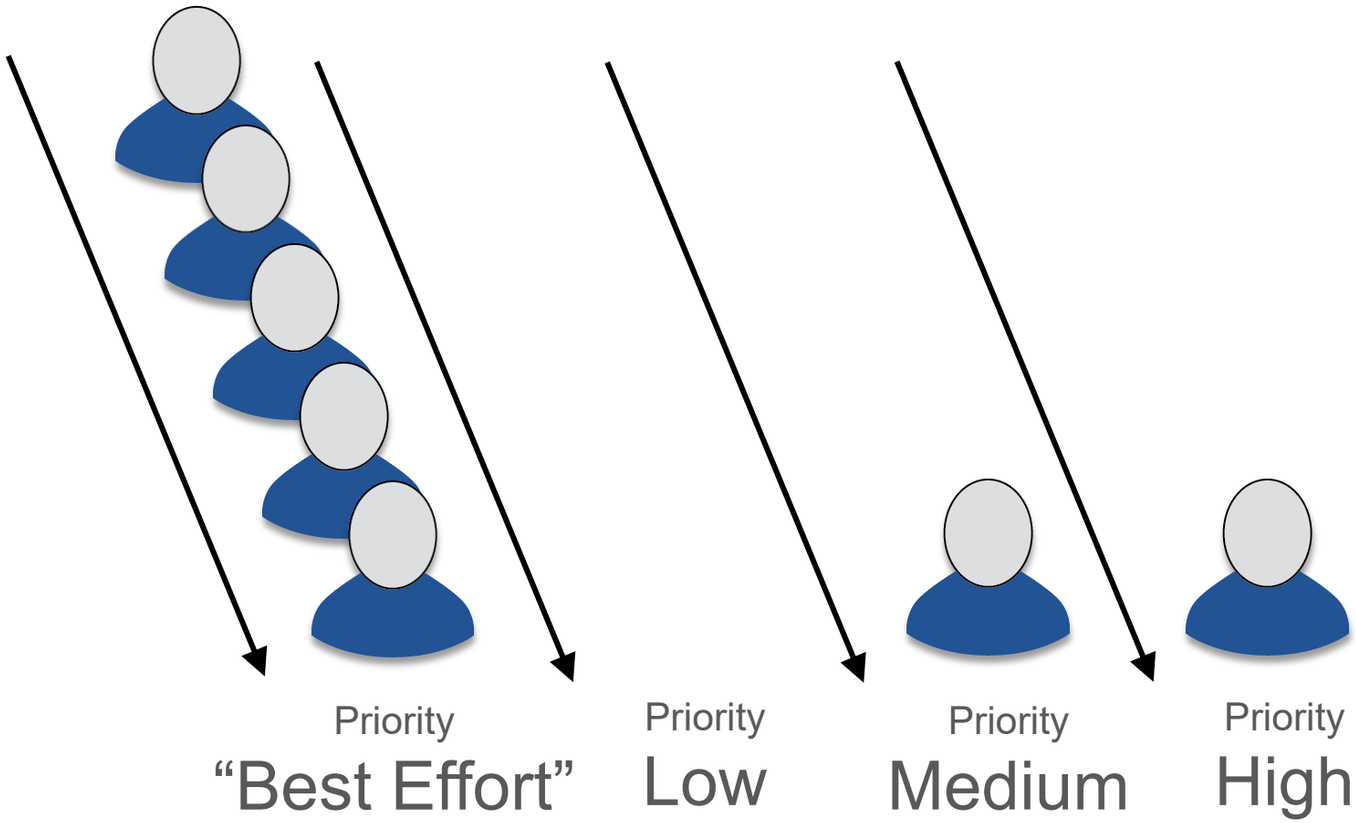

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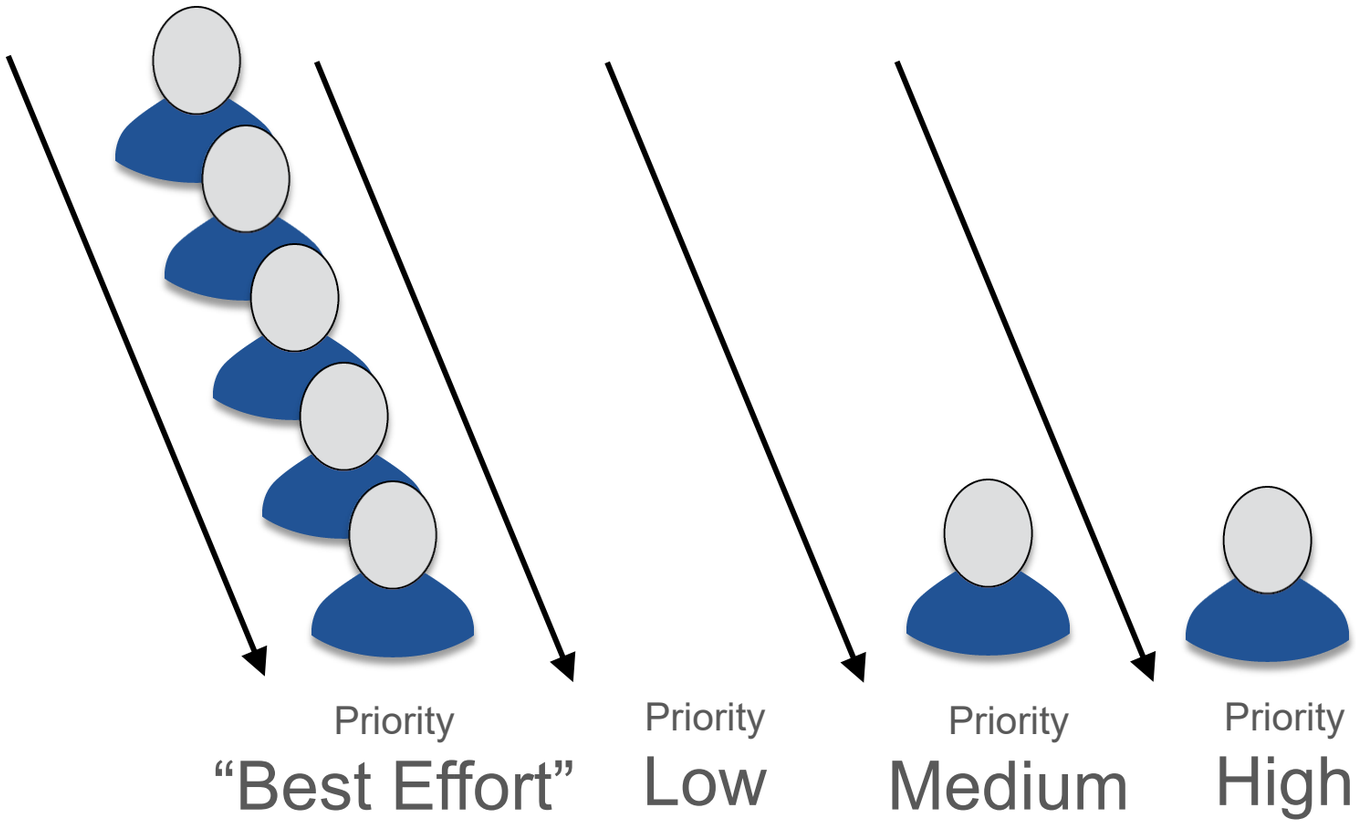


- If many data packets need to go out a single port, they queue up.
- QoS allows us to prioritize some packets, similar to priority status on an airline.
- Prioritizing some means de-prioritizing others.

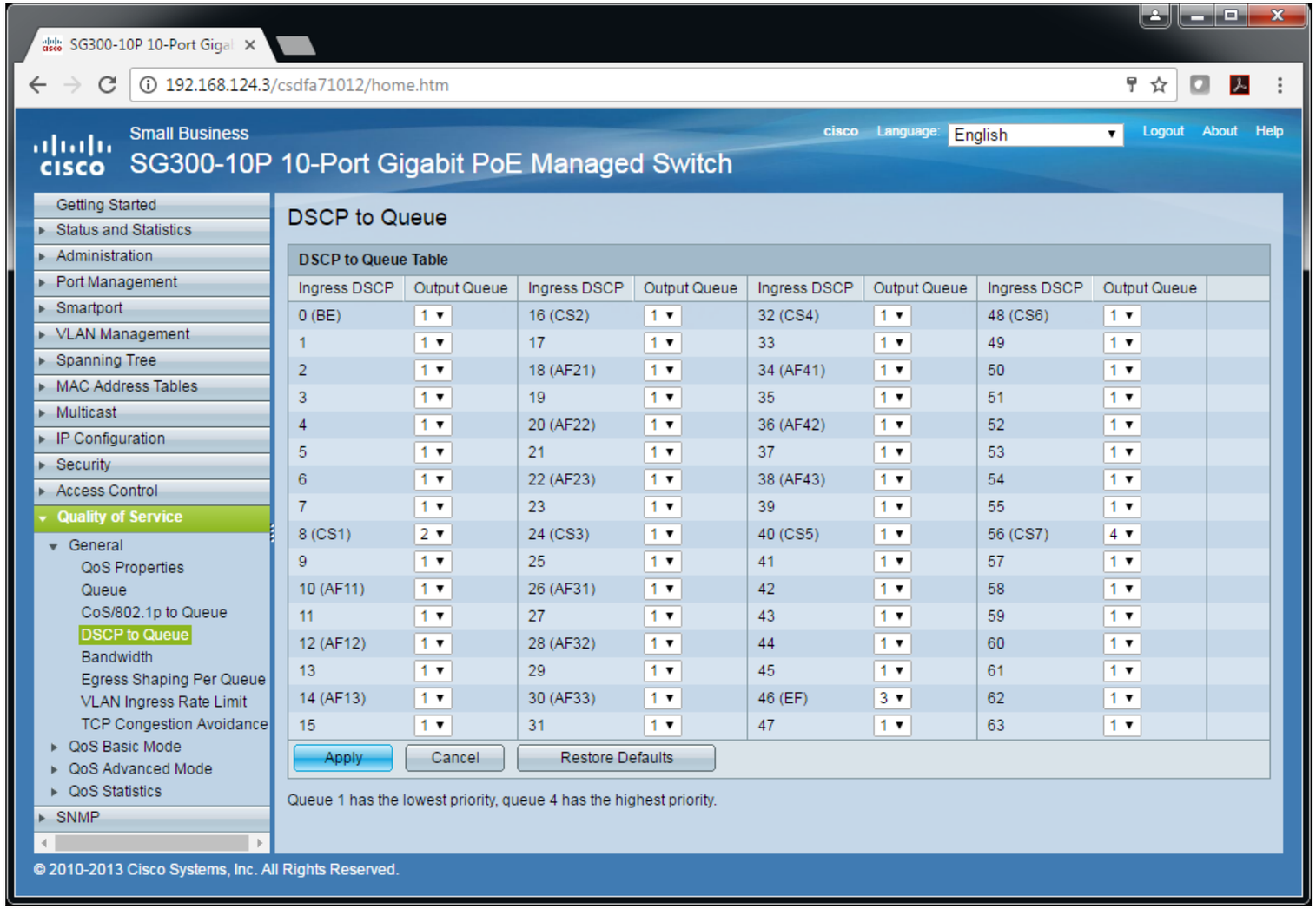
QoS: Quality of Service

Best Effort	Low	Medium	High
Other	Control 8 (CS1)	Audio 46 (EF)	Clock 56 (CS7)
			

QoS: DSCP Values

Priority	Usage	DSCP Label	Hex	Decimal	Binary
High	Time critical PTP events	CS7	0x38	56	111000
Medium	Audio, PTP	EF	0x2E	46	101110
Low	Control Data	CS1	0x08	8	001000

QoS: Quality of Service



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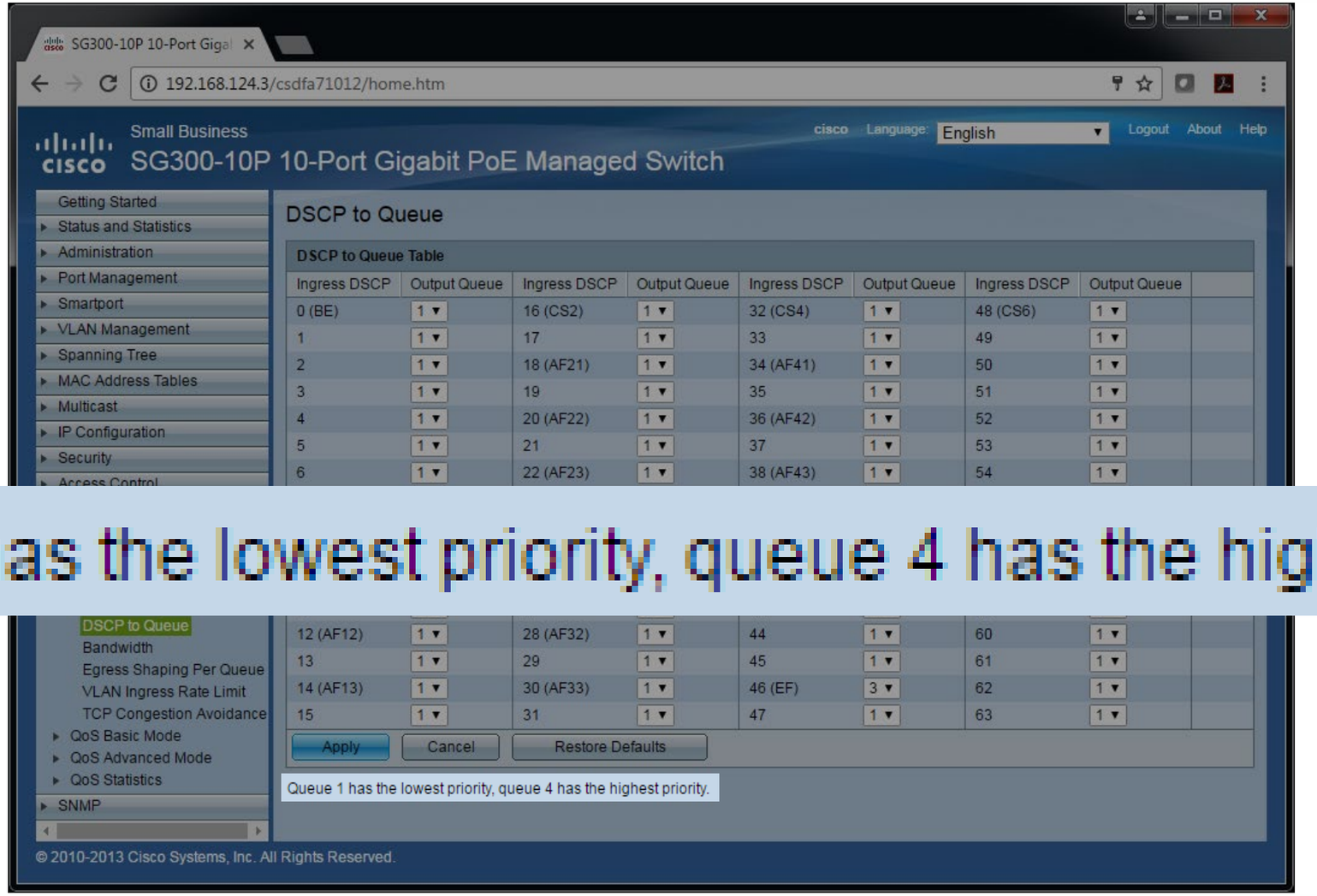


Queue 1 has the lowest priority, queue 4 has the highest priority.

QoS: Types of QoS

- QoS (e.g. Diffserv) is Class Based
  Specify what is important
  Timing is relative
  Easy to implement – you can mix switches with and without QoS

- Alternative is Reservation Based
  Specify how much, how often – then decide if it is possible
  Timing is absolute
  Complex to implement – reservations must be present the whole way or no link

QoS: Types of QoS

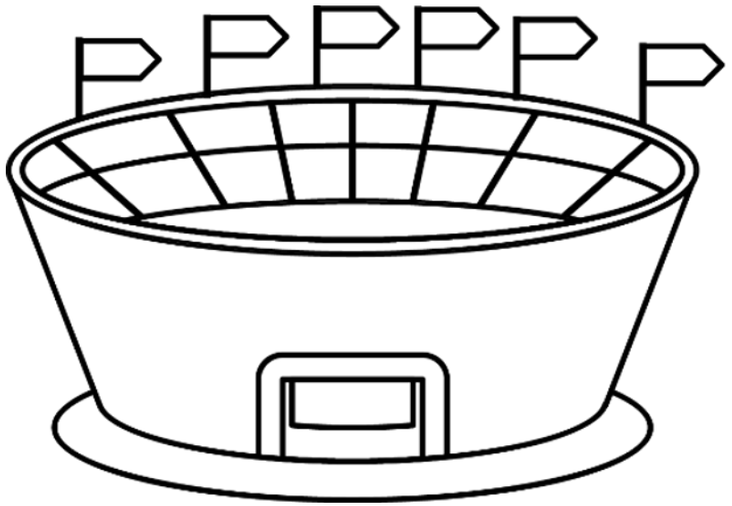
- Neither is magic – they do not generate additional bandwidth
  The best QoS is more bandwidth
  Prioritizing some traffic means de-prioritizing others
  “If everyone is important, then no one is.”

- QoS can help when…
  Running a converged network.
  Links are approaching 70% saturation or more.
  Using slower (100Mbit) links.

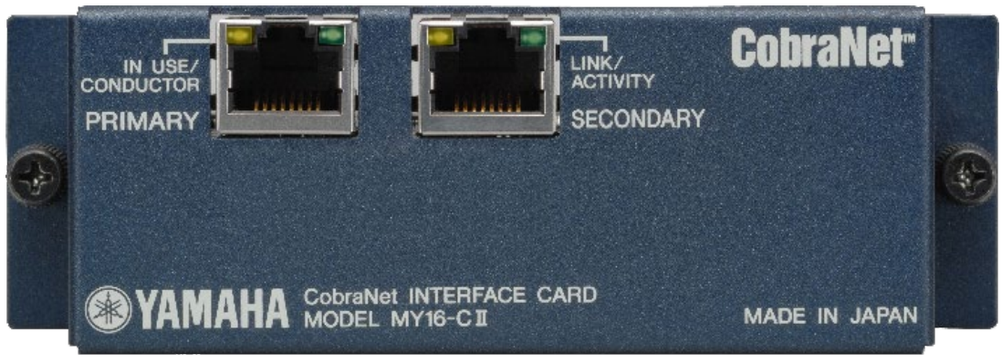
- When using QoS, use “Strict Priority”
  Strict Priority always serves the most important class
  Weighted Round Robin serves queues by weighted averages
  Shaped Round Robin serves by statistical analysis

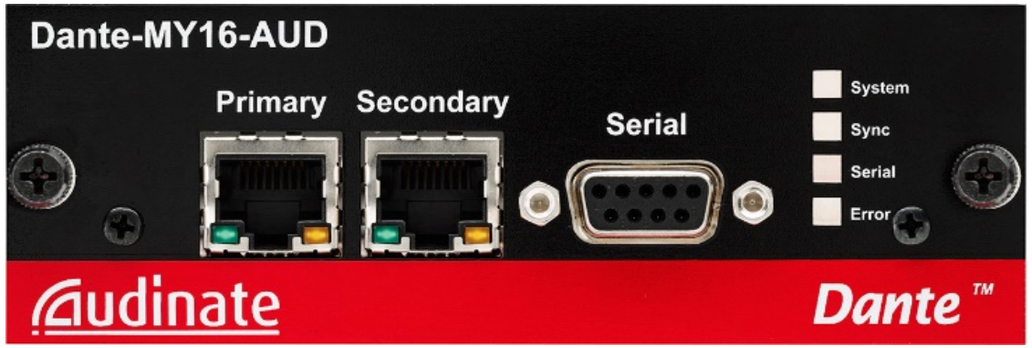
QoS: Quality of Service

2008 - CobraNet®



QoS: Quality of Service



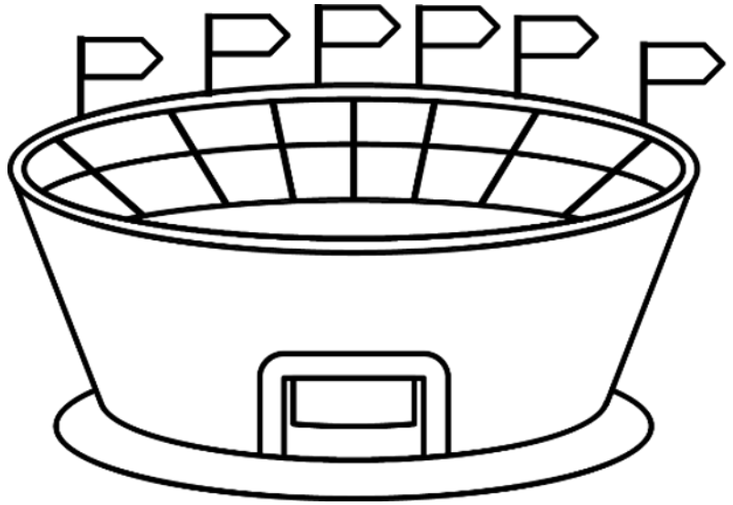


CobraNet®

Dante™

QoS: Quality of Service

2014 - Dante™



QoS: Quality of Service

VLANs and Trunk Implications

Topics for Today

ENHANCE

Core IP Settings	*IP Address, Subnet Mask, Gateway/Router, LAN Range*
DNS	*Domain Name Service*
DHCP/Link Local	*Automatic Address Settings*
TCP/UDP	*Transmission Methods*
Unicast, Multicast and Broadcast	*Distribution Methods*
QoS	*Quality of Service – Traffic Prioritization*
VLAN & Trunk Implications	*VLAN, Trunk, Tagged VLAN, STP, LAG*

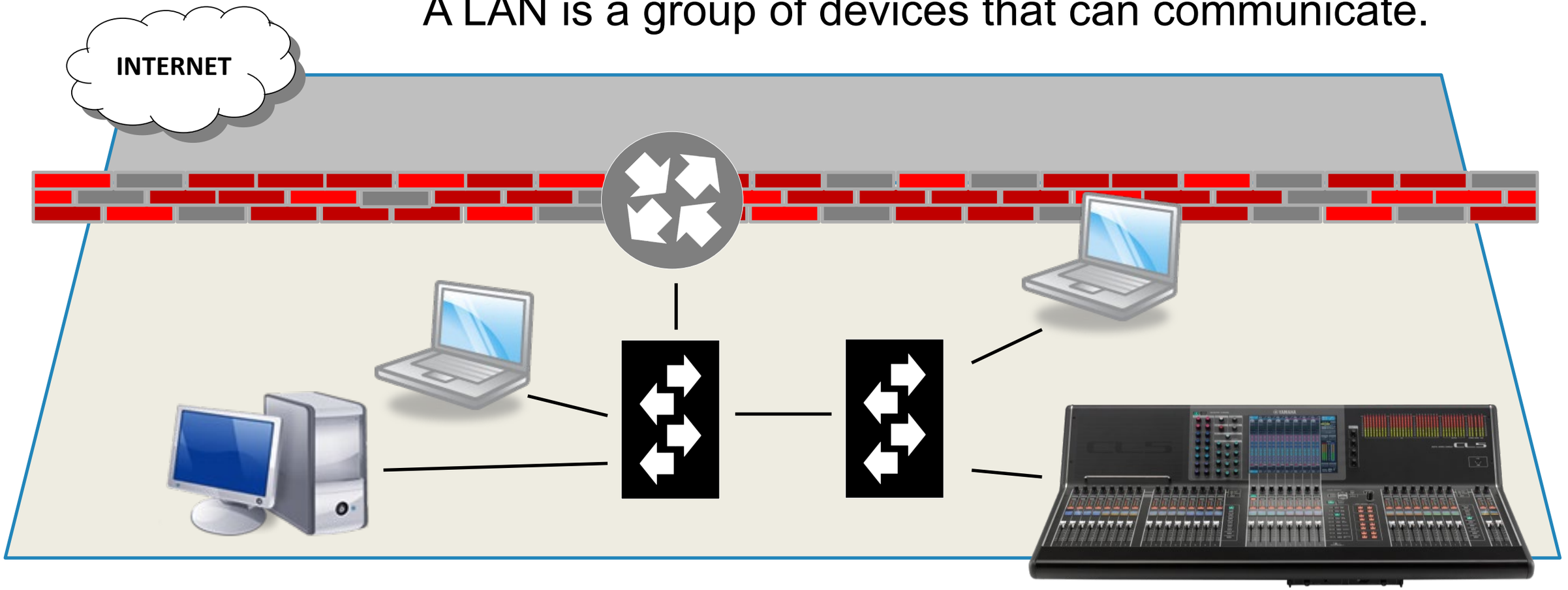
NEW

Network Ports	*Managing Simultaneous Connections*
PTP Clocking	*Precision Time Protocol (PTP)*
ARP	*Switching by MAC vs IP*
Layered Network Models	*OSI and TCP Conceptual Models*
Segmenting Broadcast Domain	*Managing the “Noise” in a Network*

Design & Troubleshooting

What is a LAN?

A LAN is a group of devices that can communicate.



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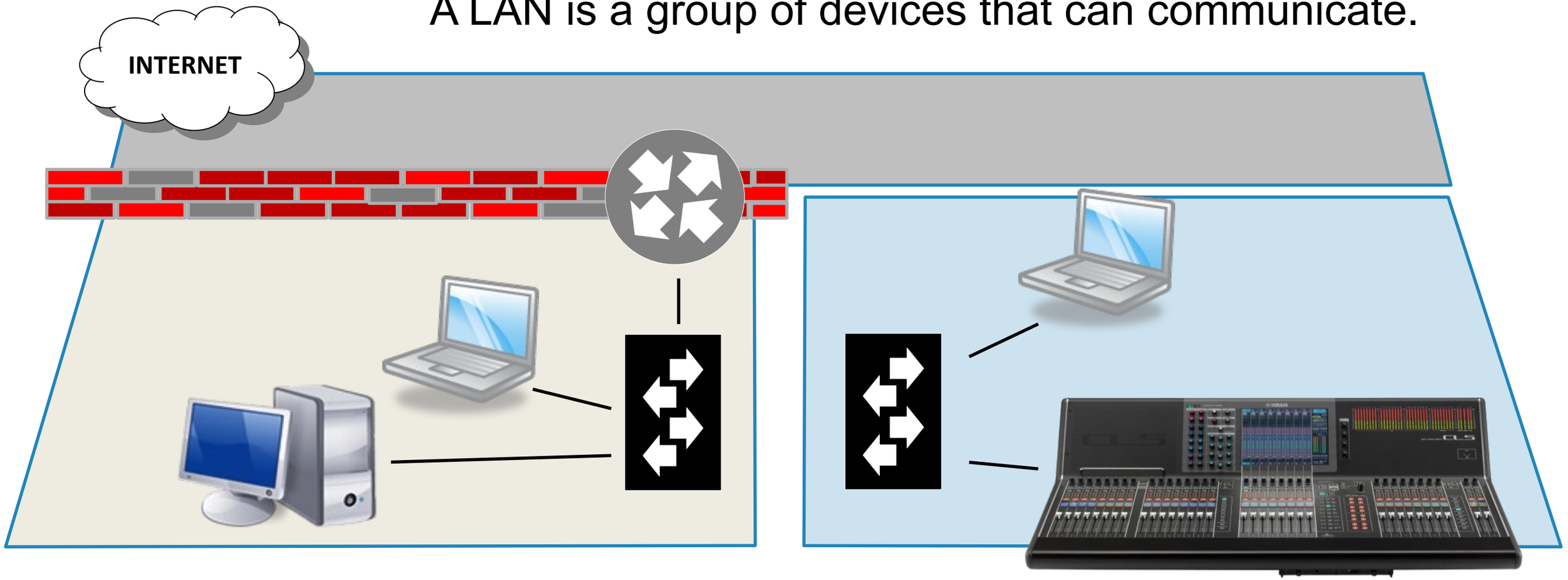
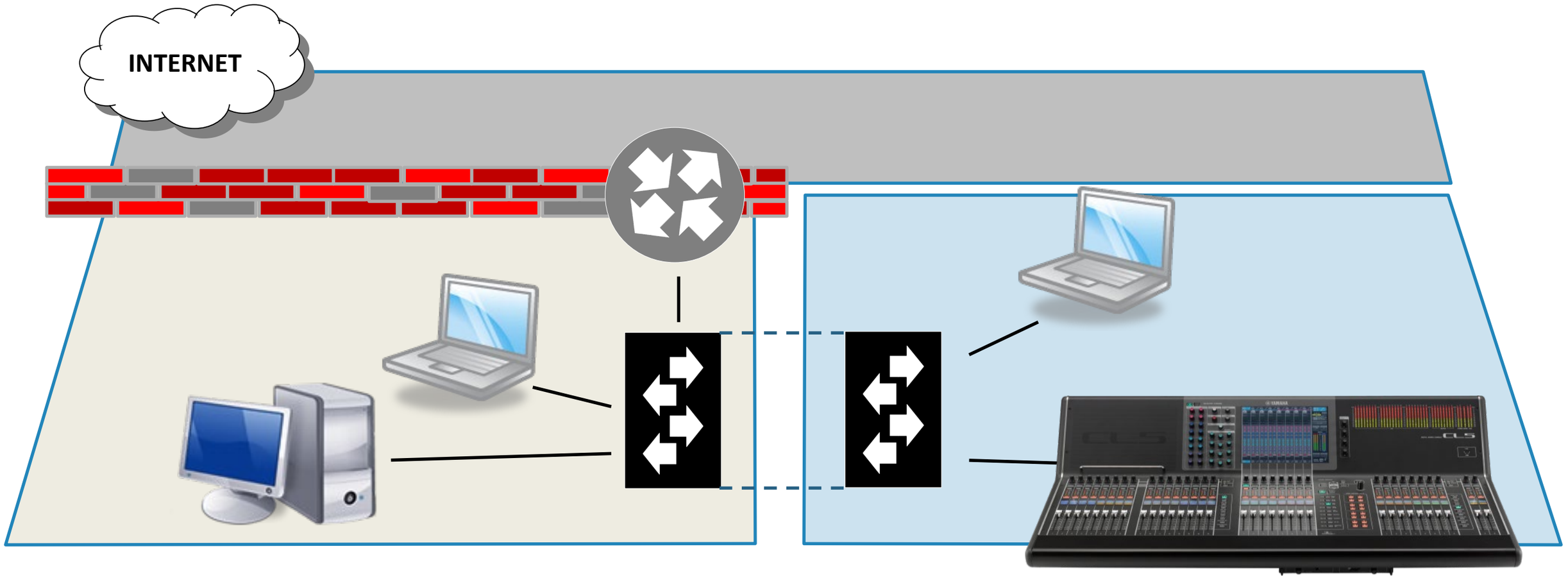


What is a VLAN?

A VLAN simulates isolated networks in one switch

You do not have to offer the same number of ports per VLAN – you can assign the quantity you need.

What is a LAN?



What is “Non-Blocking Architecture”?

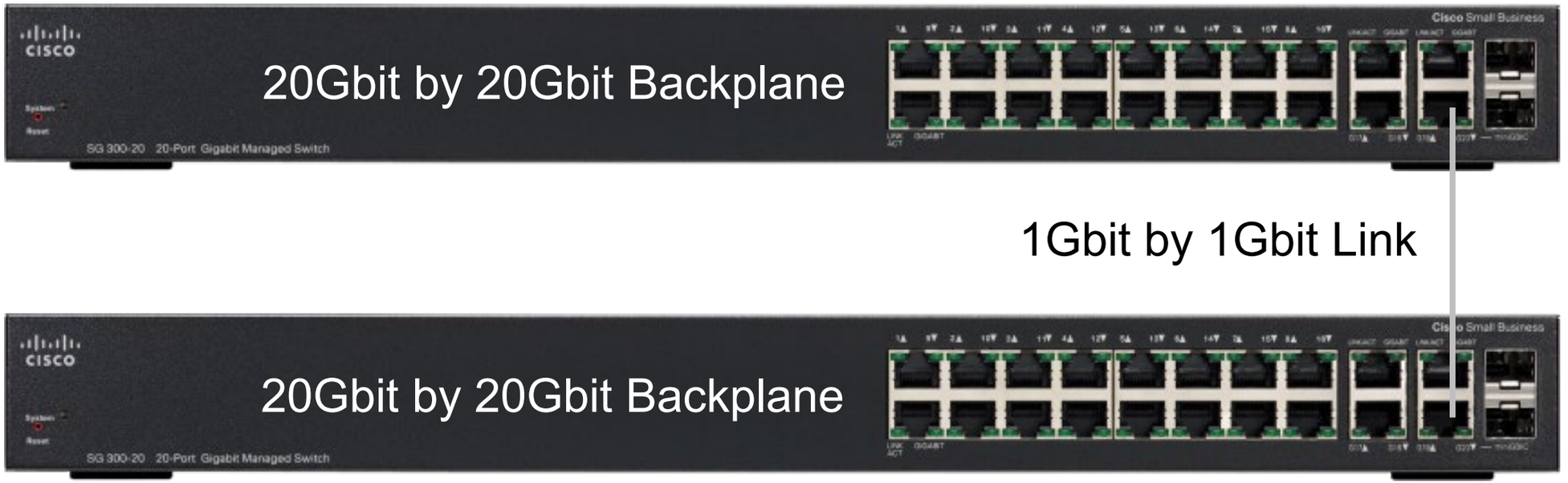
“Non-Blocking Architecture” means the *switch* is not the bandwidth bottleneck – the *port/cable* is.

---

20 ports x 1 Gbit x 2 Directions = 40 Gbit Backplane

What is a Trunk?

A Trunk Line is a link Between Switches



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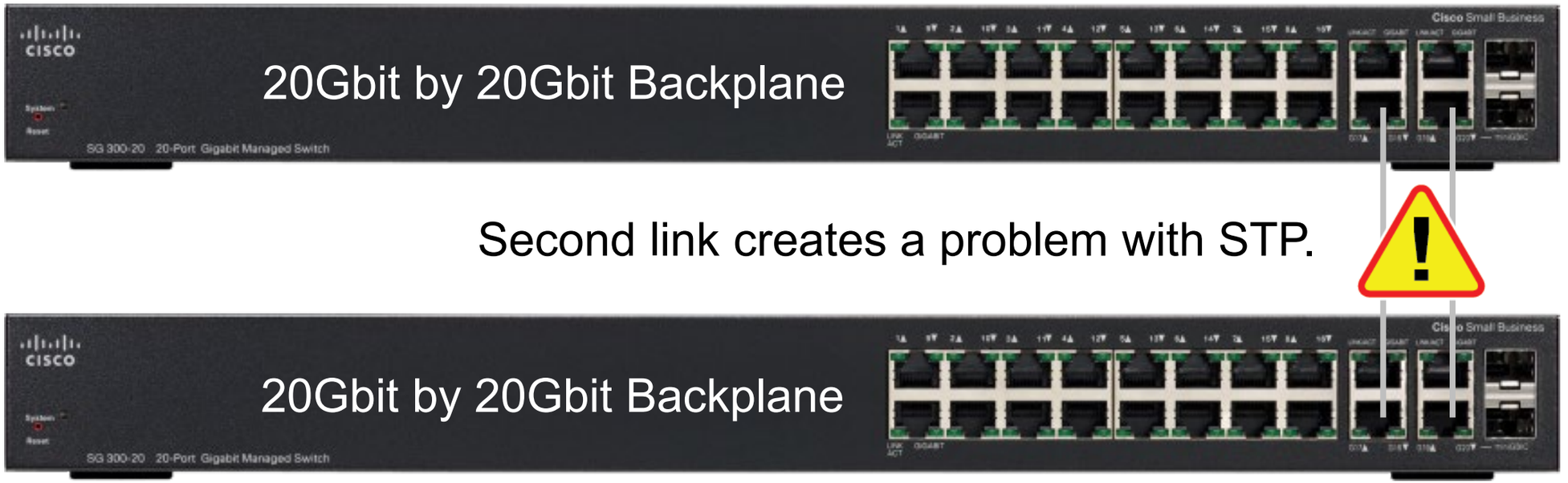
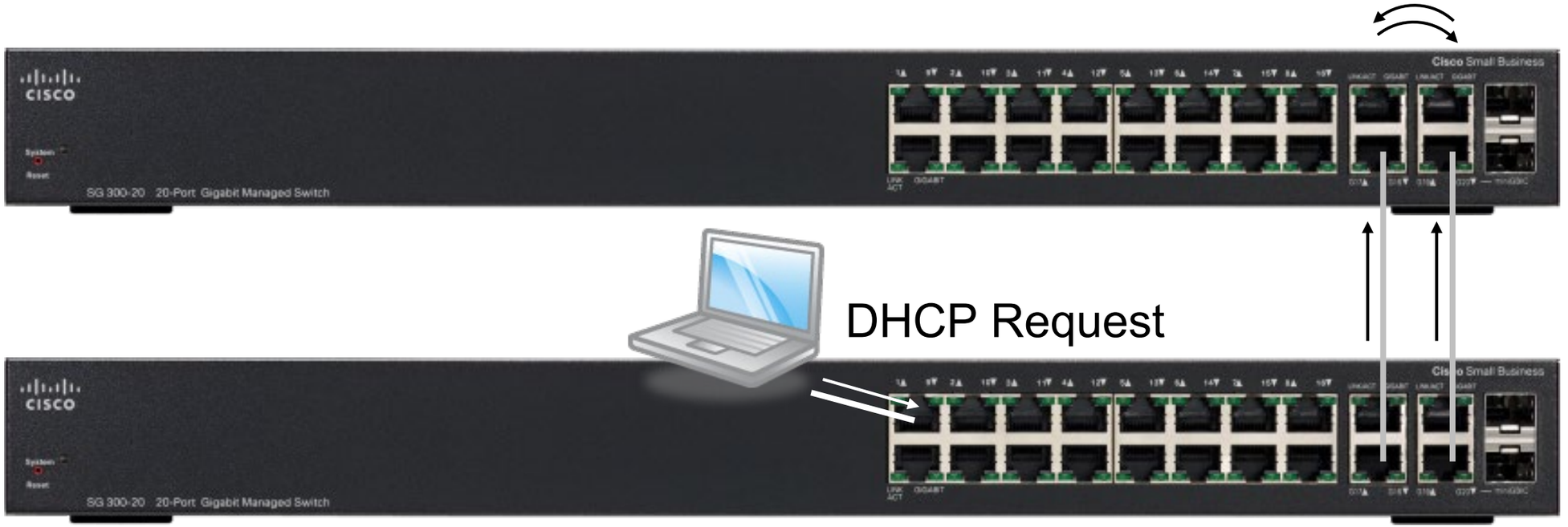


STP Prevents “Loops” in the Network



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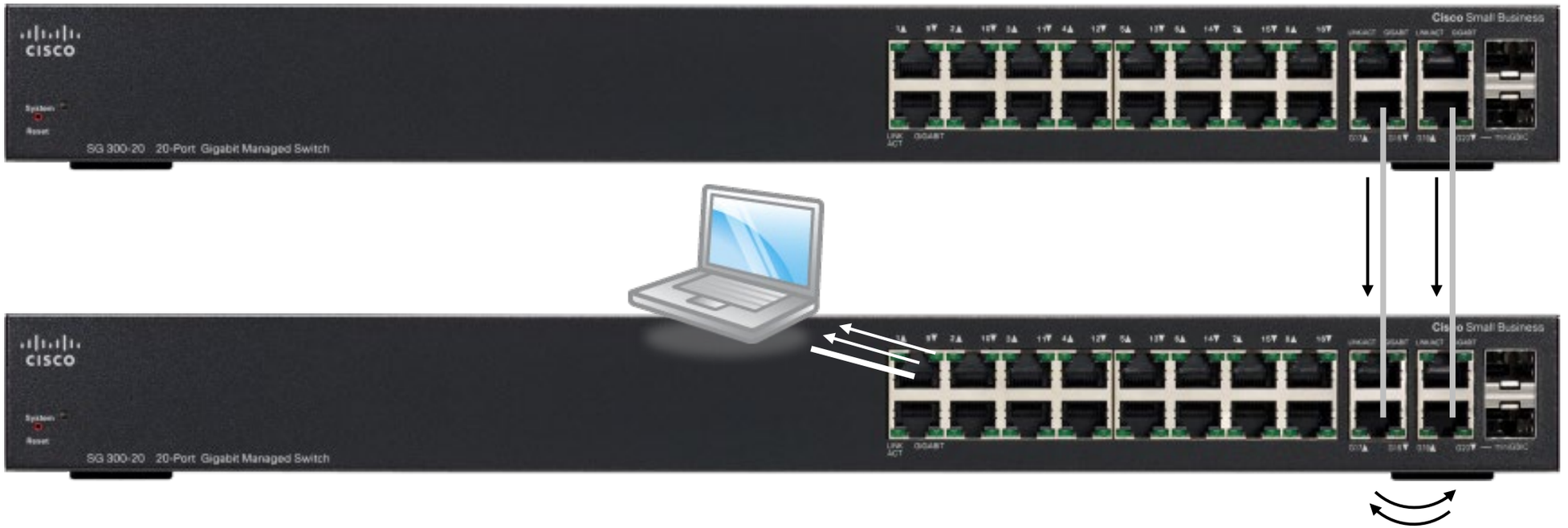

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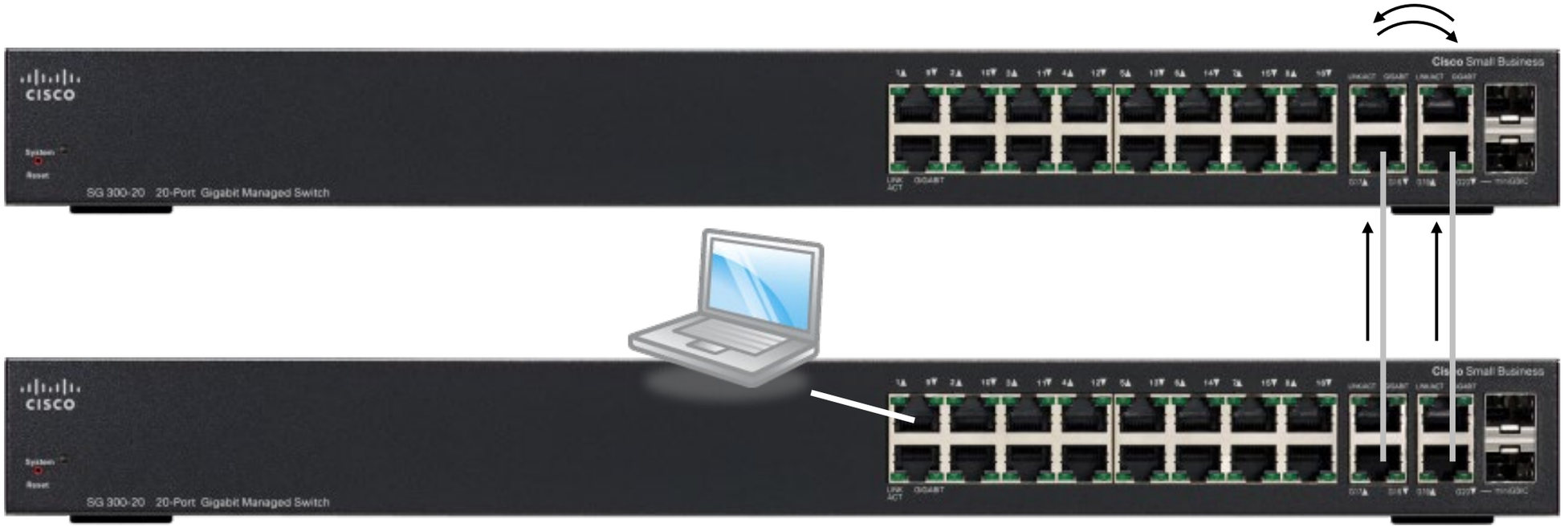

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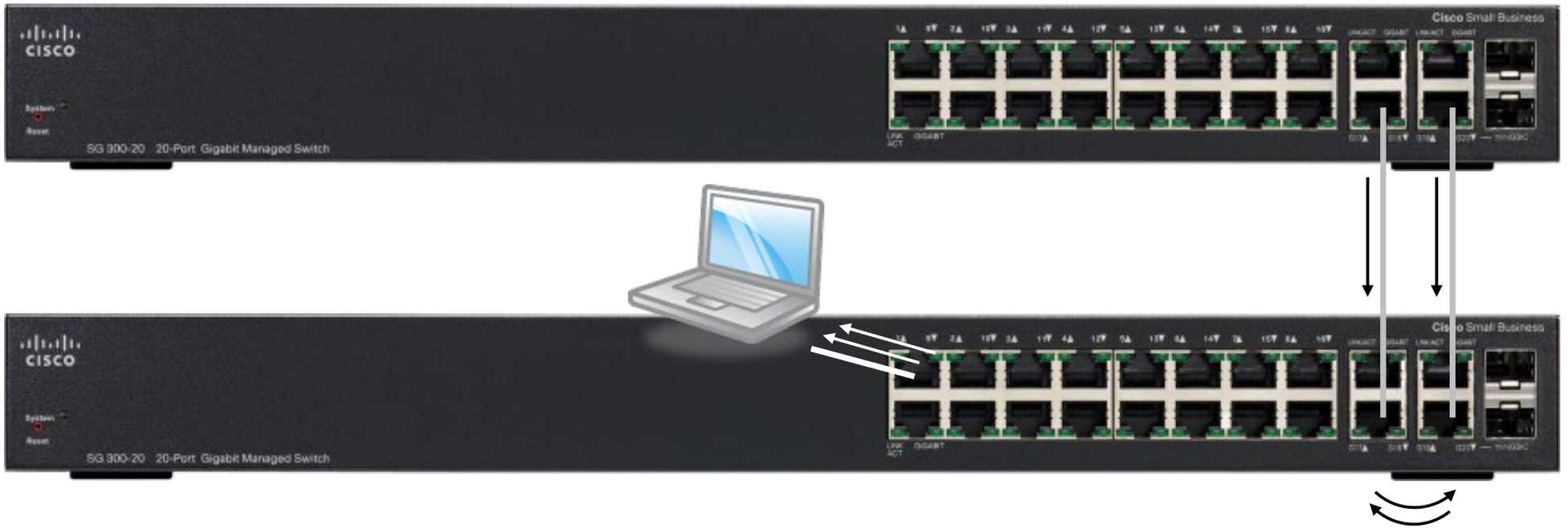
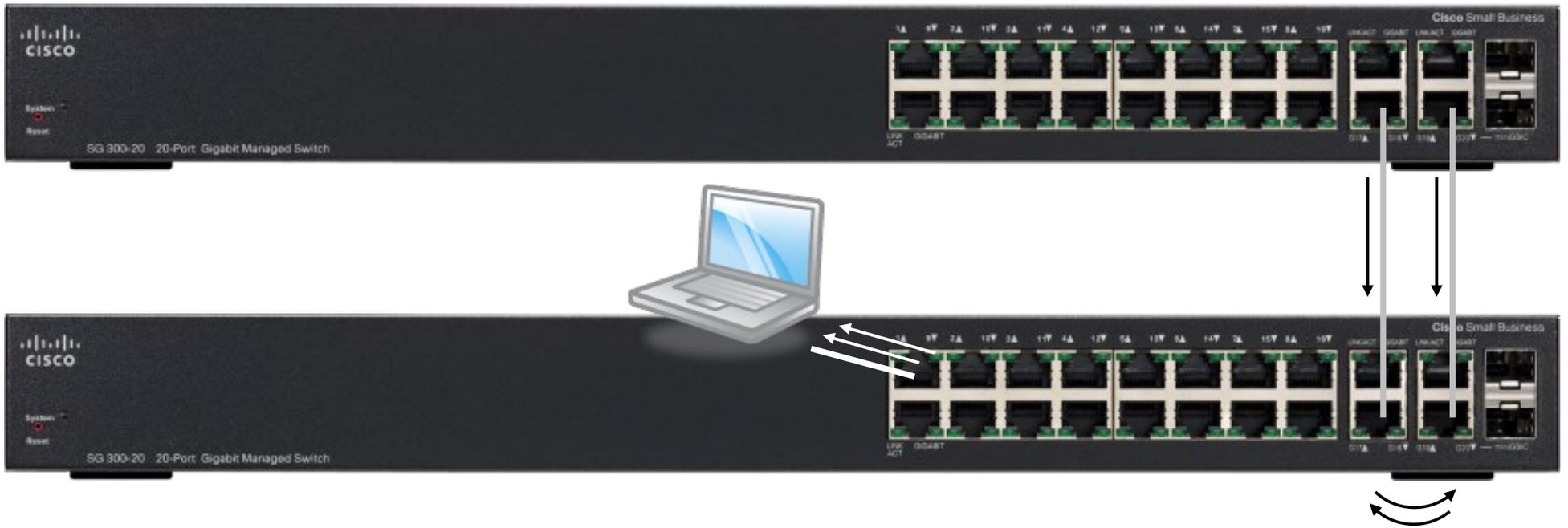
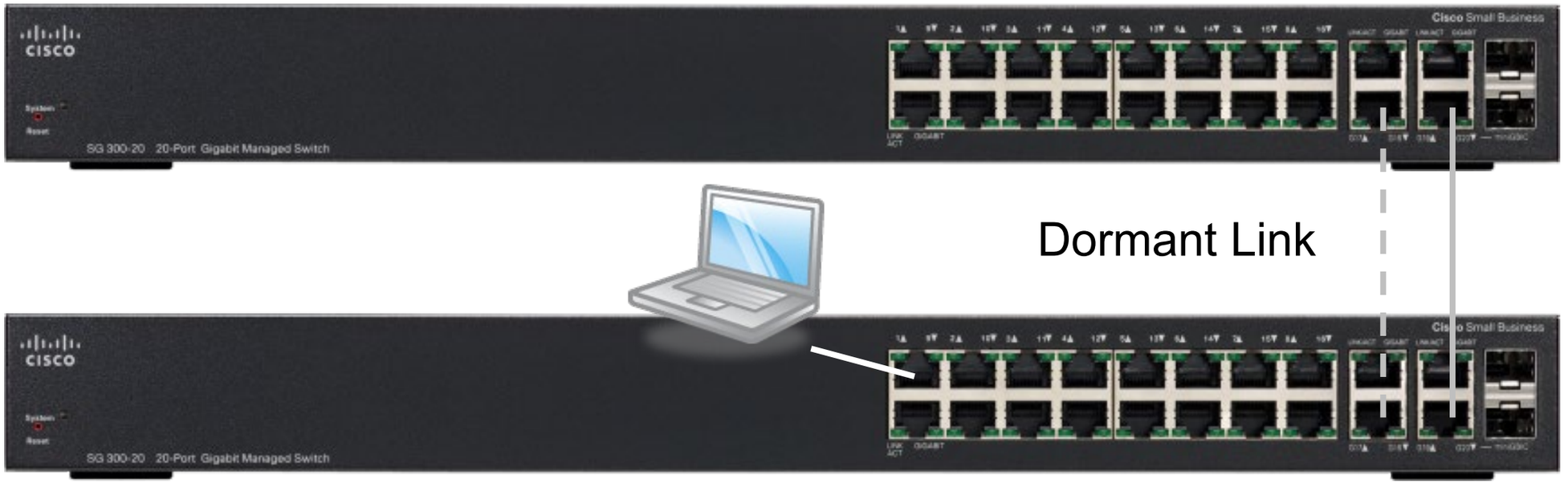


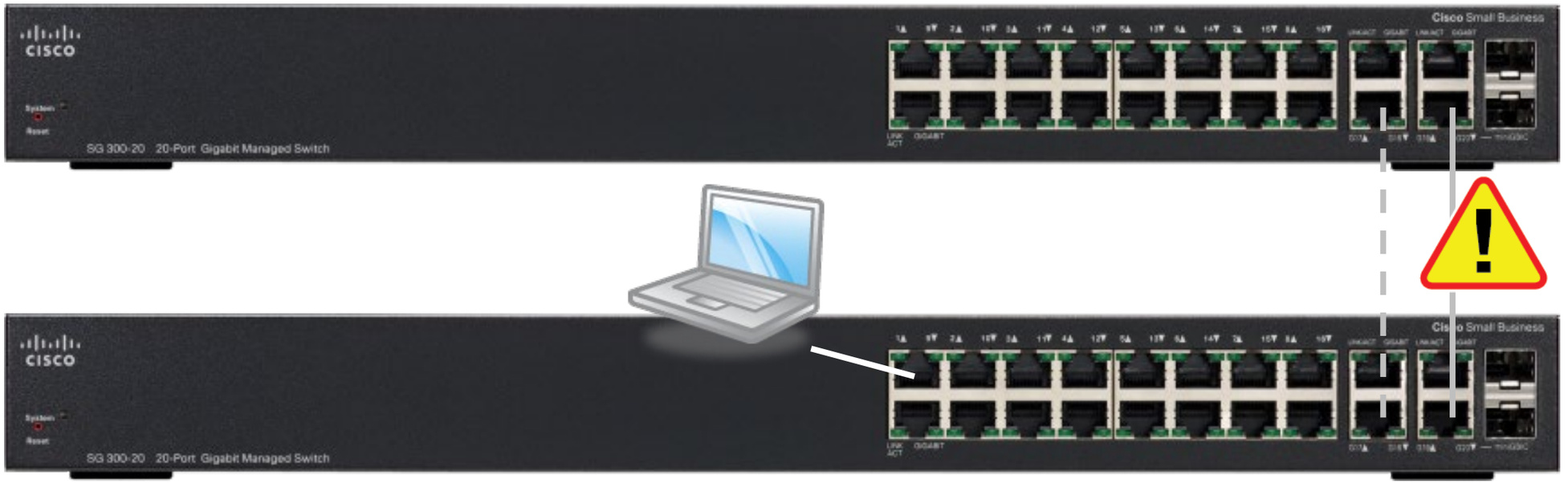
This Endless Loop is Called a “Broadcast Storm”



STP Creates a “Dormant Link”



STP Can Be a Form of Redundancy



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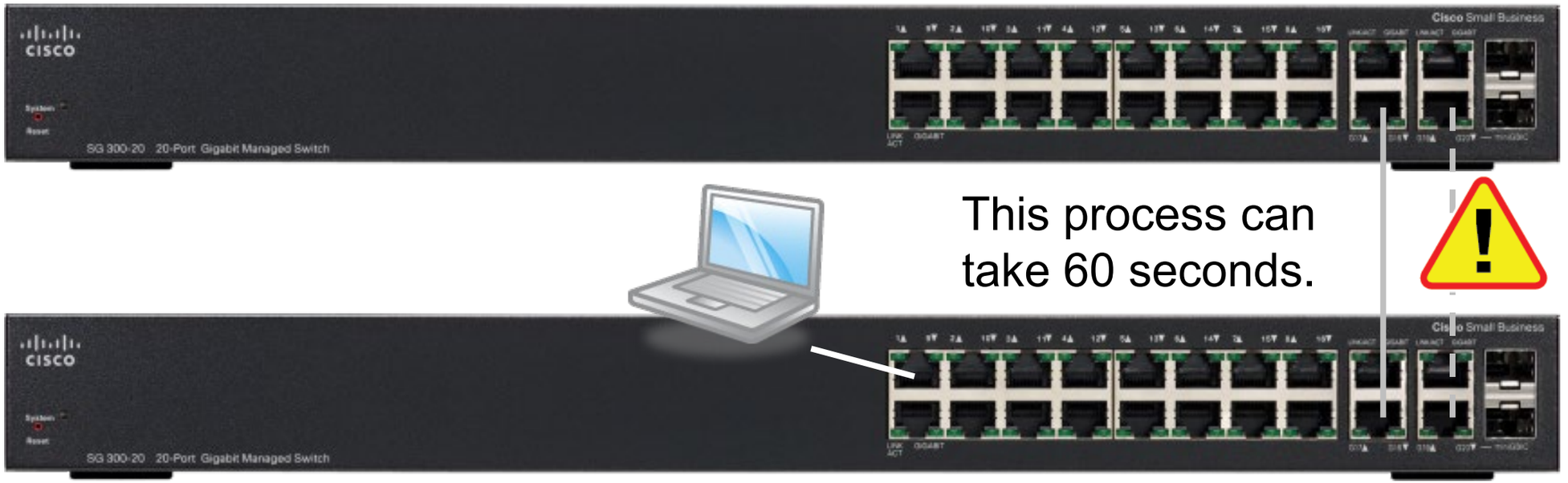
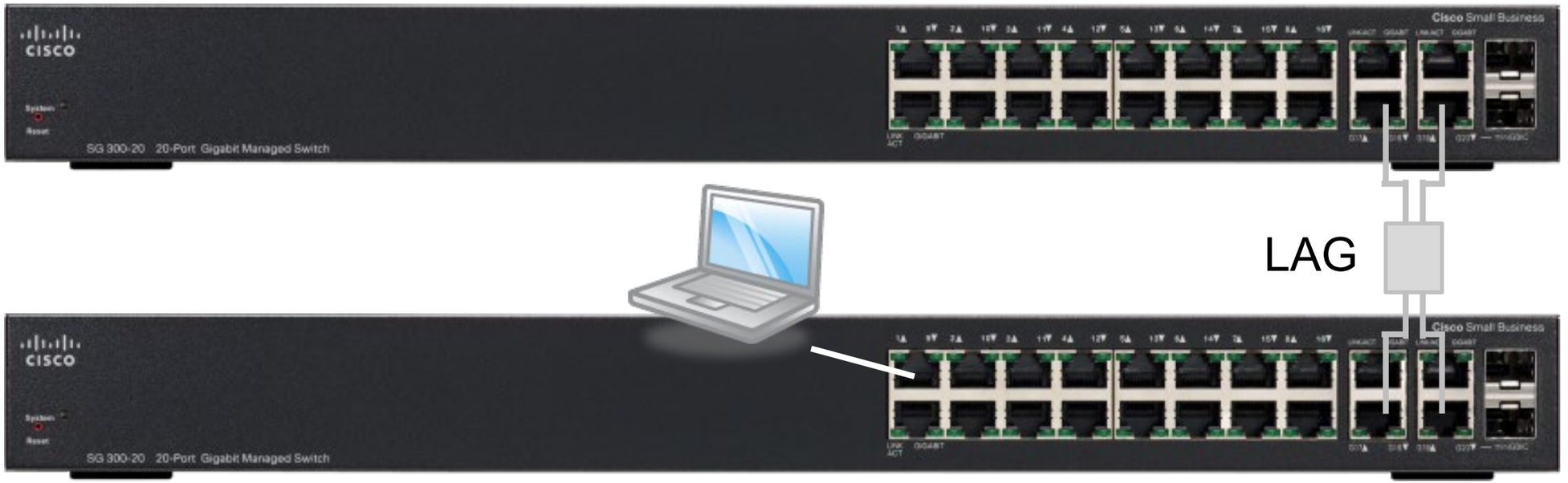


Link Aggregation Group Solves the Loop Problem



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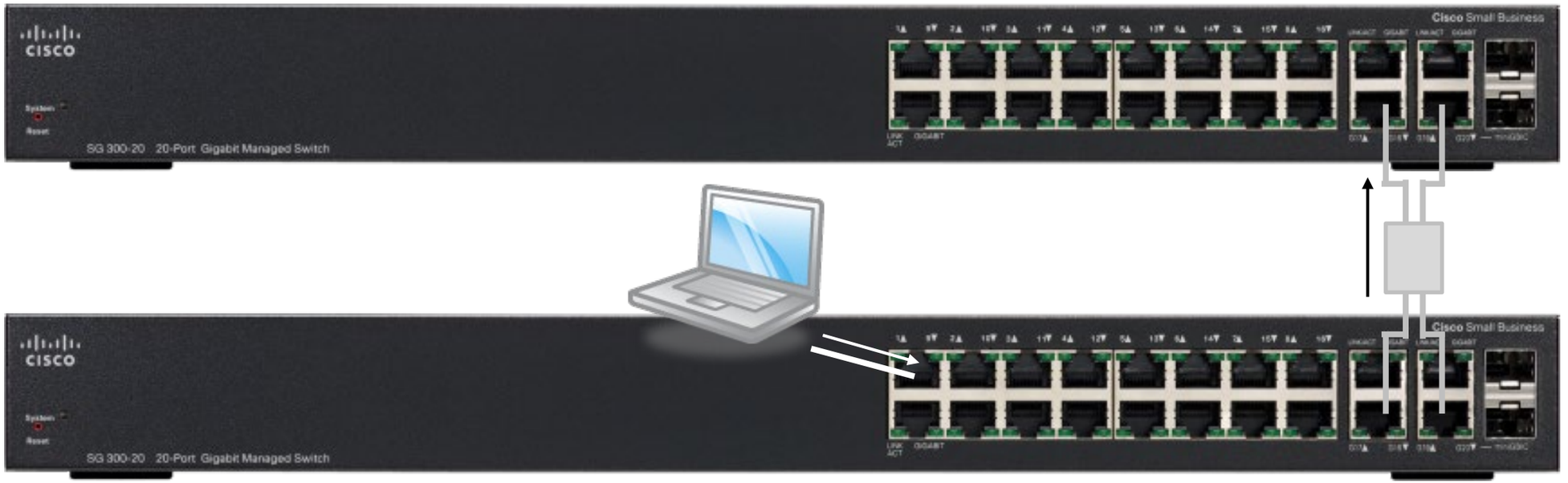

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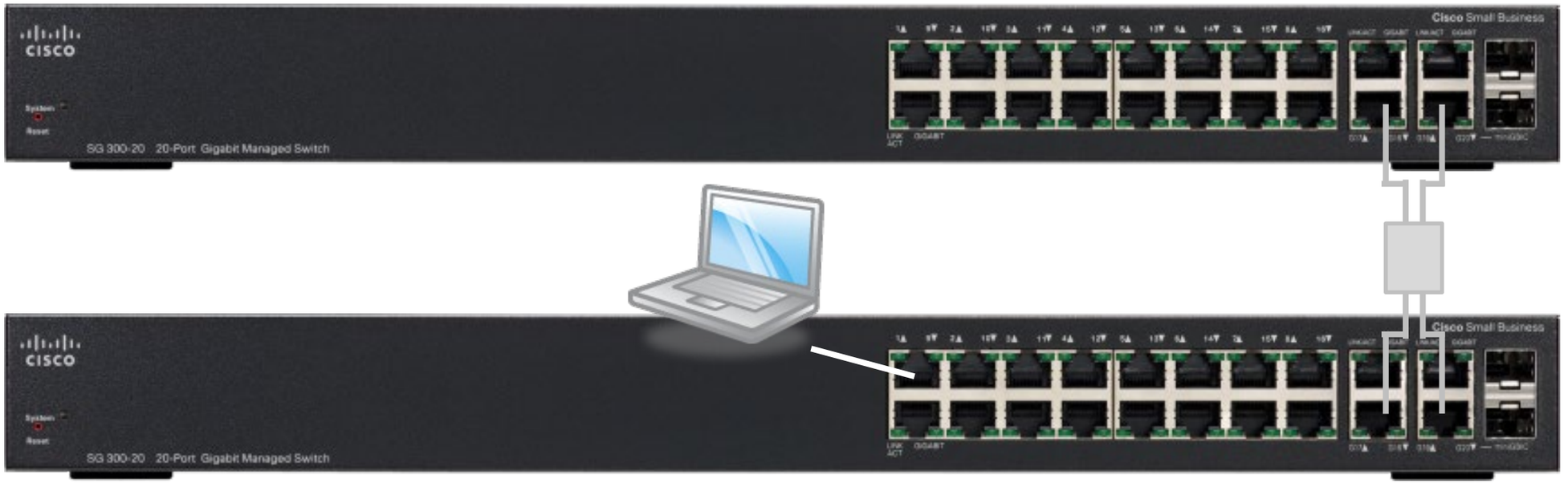
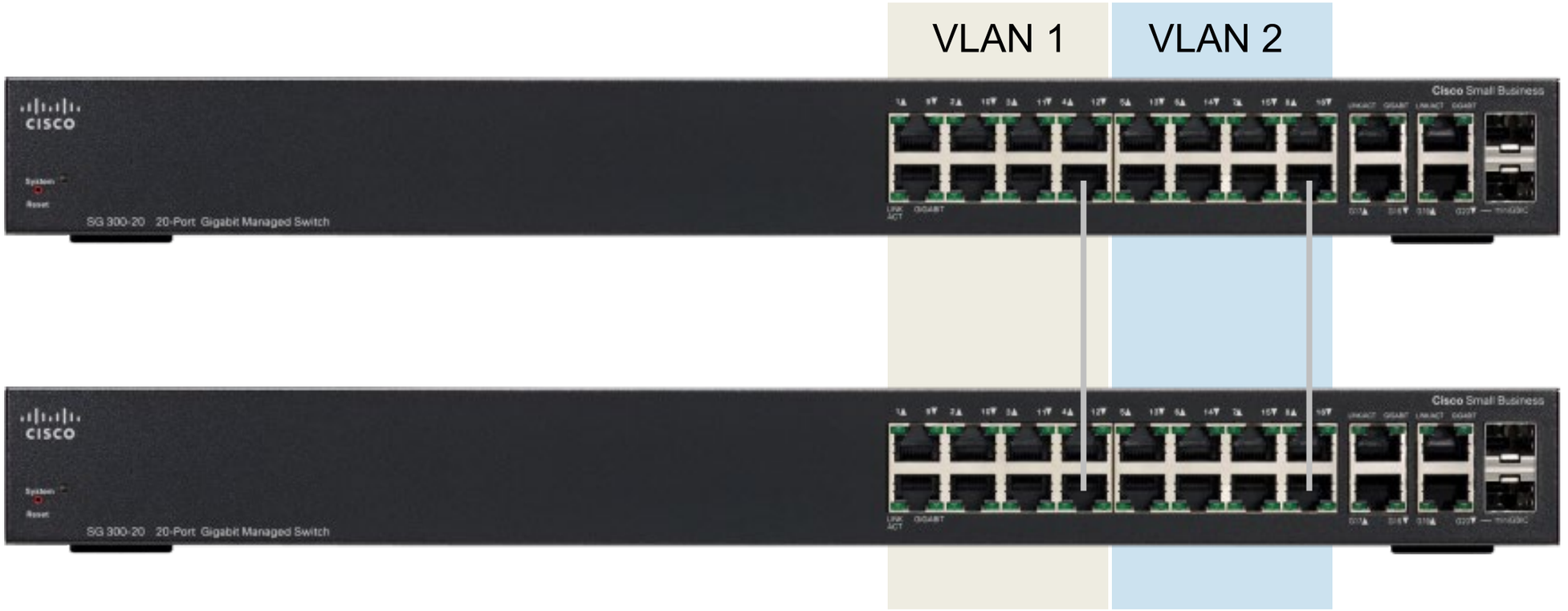


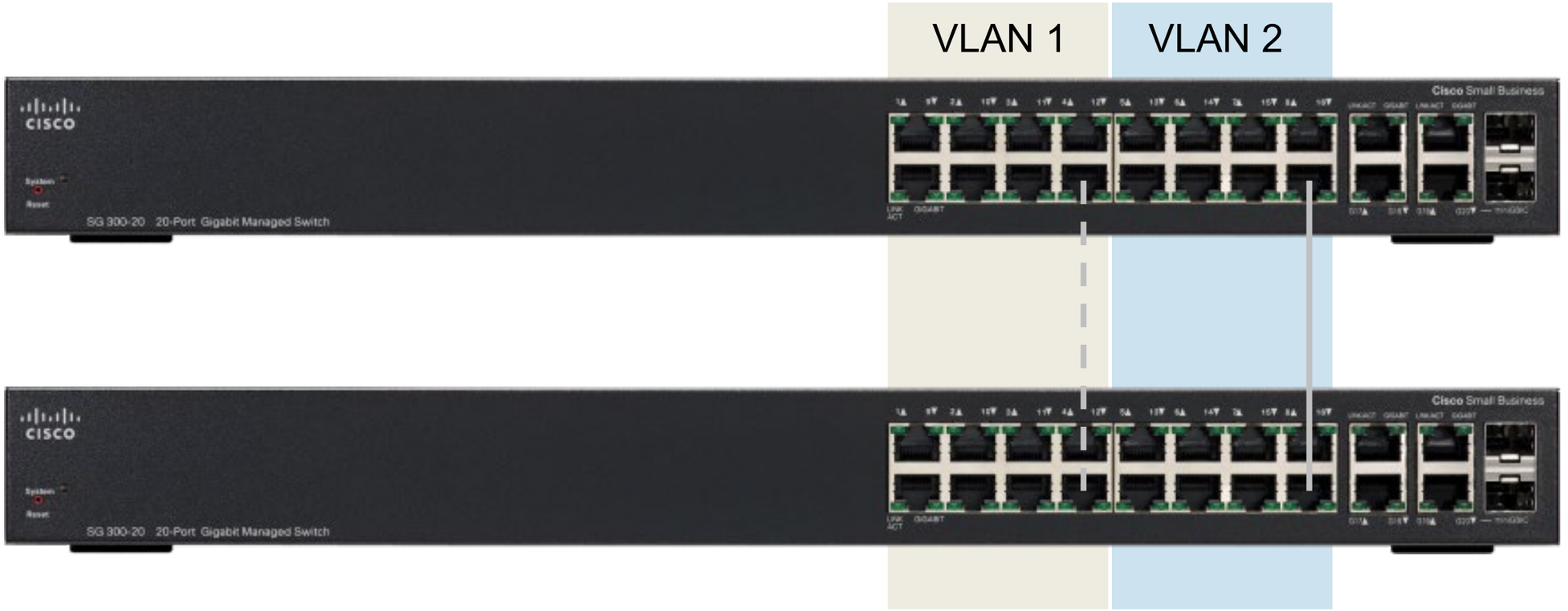
Multiple VLANs on a Trunk

Can we do this?

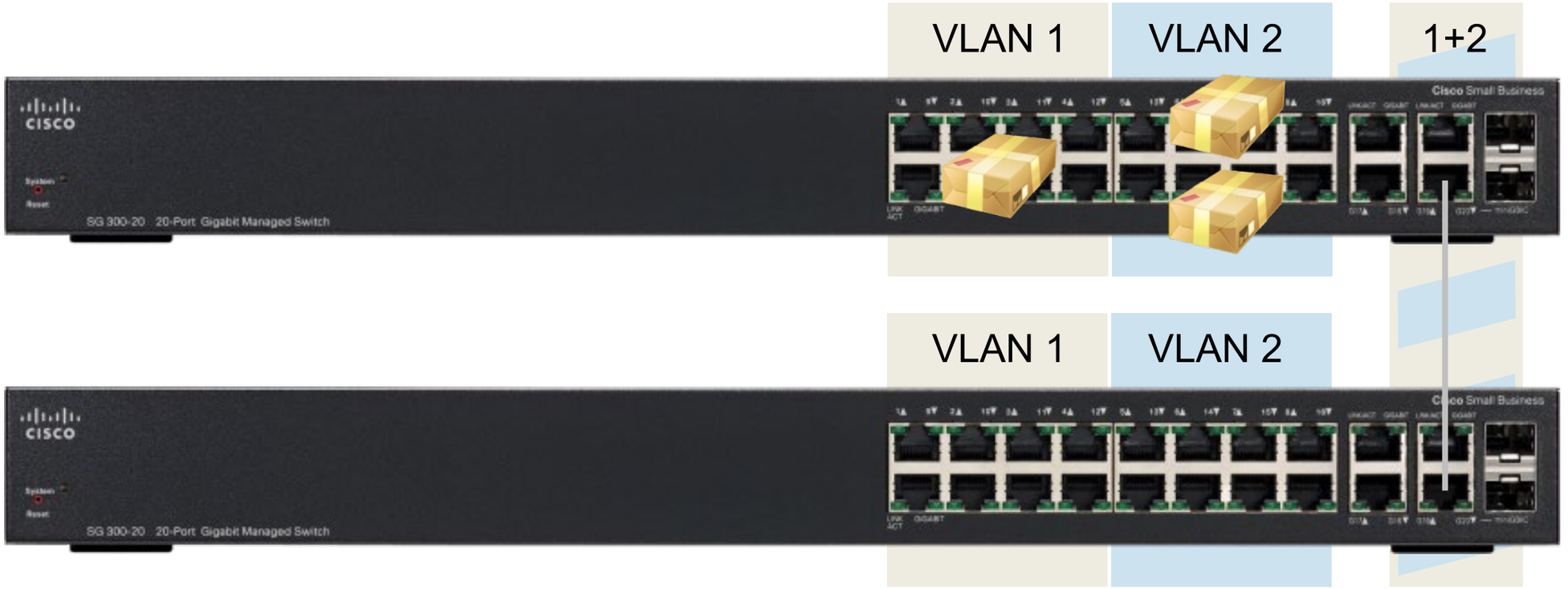


Multiple VLANs on a Trunk

No – STP is not “VLAN aware”.



Create a Trunk with Tagged VLANs



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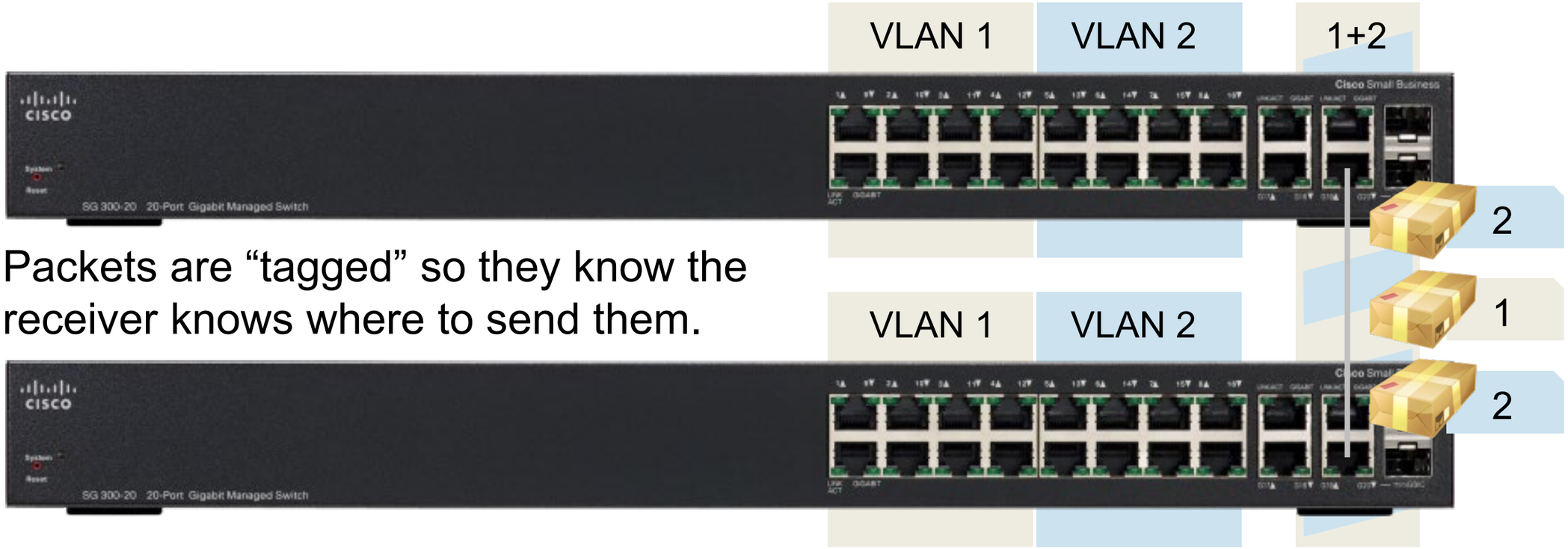
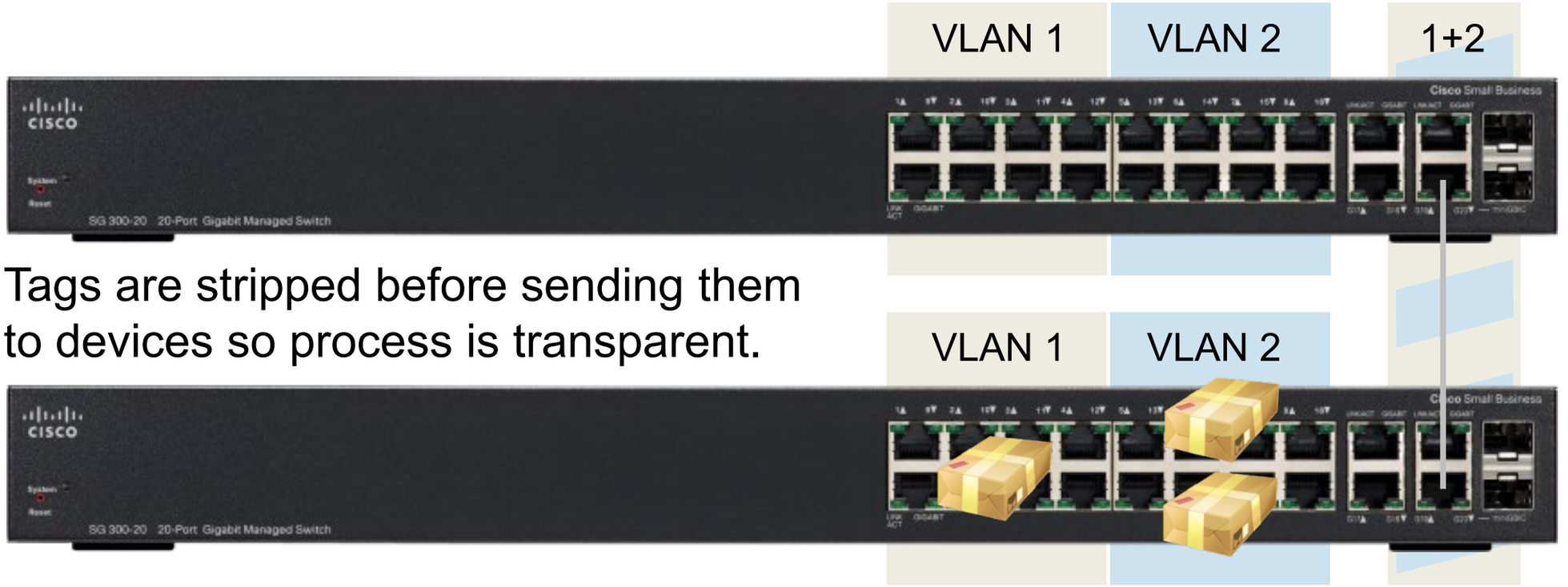


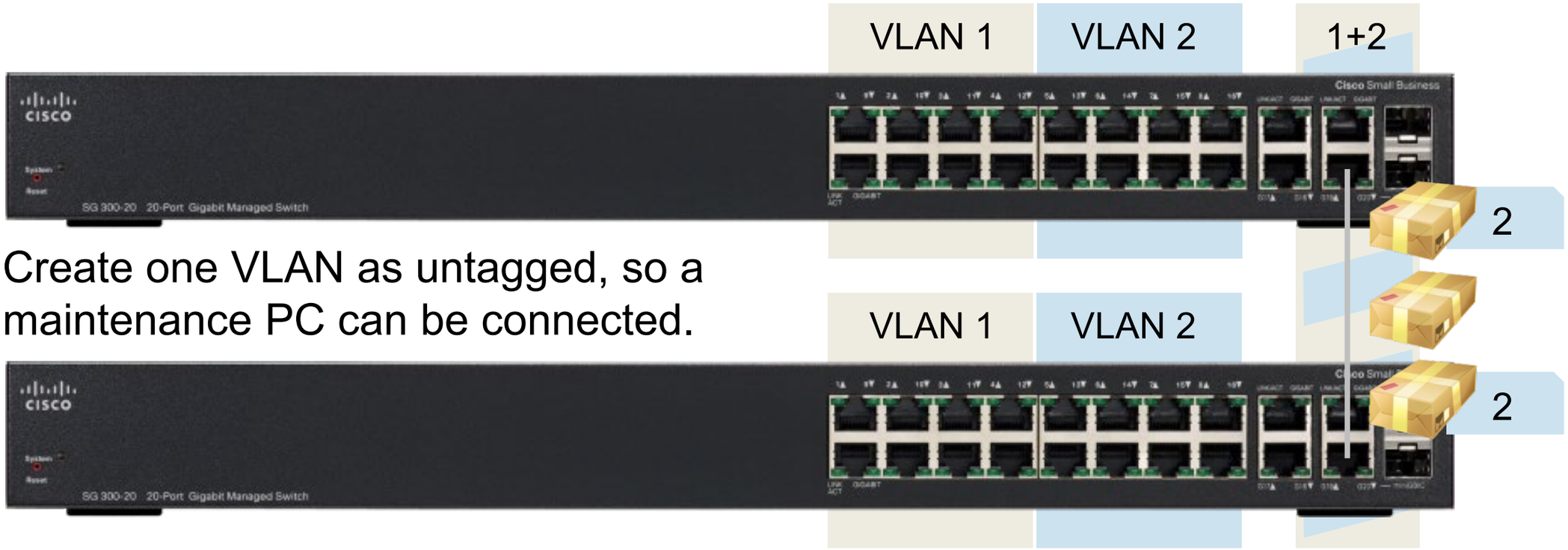
Packets are “tagged” so they know the receiver knows where to send them.

Create a Trunk with Tagged VLANs



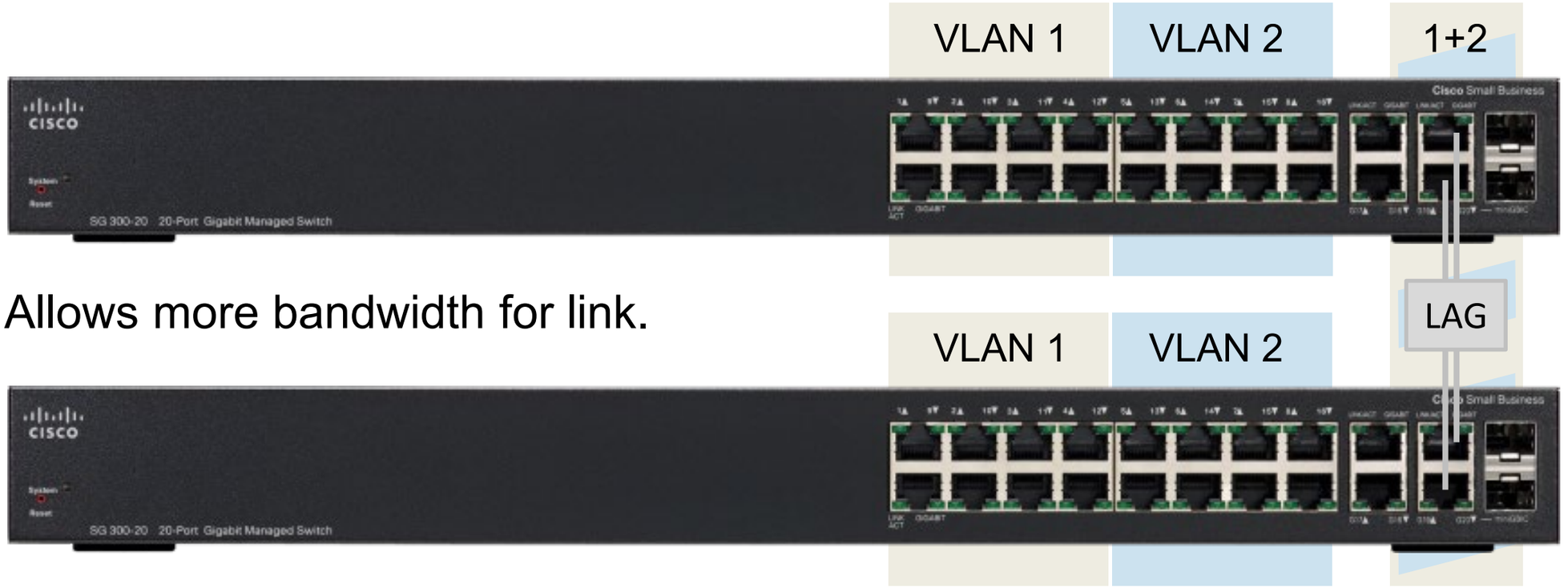
Tags are stripped before sending them to devices so process is transparent.

The “Untagged” VLAN on a Trunk



Create one VLAN as untagged, so a maintenance PC can be connected.

Combine Ideas – a LAG of Trunk Lines



Allows more bandwidth for link.

Network Ports: *https://www.audinate.com:443*

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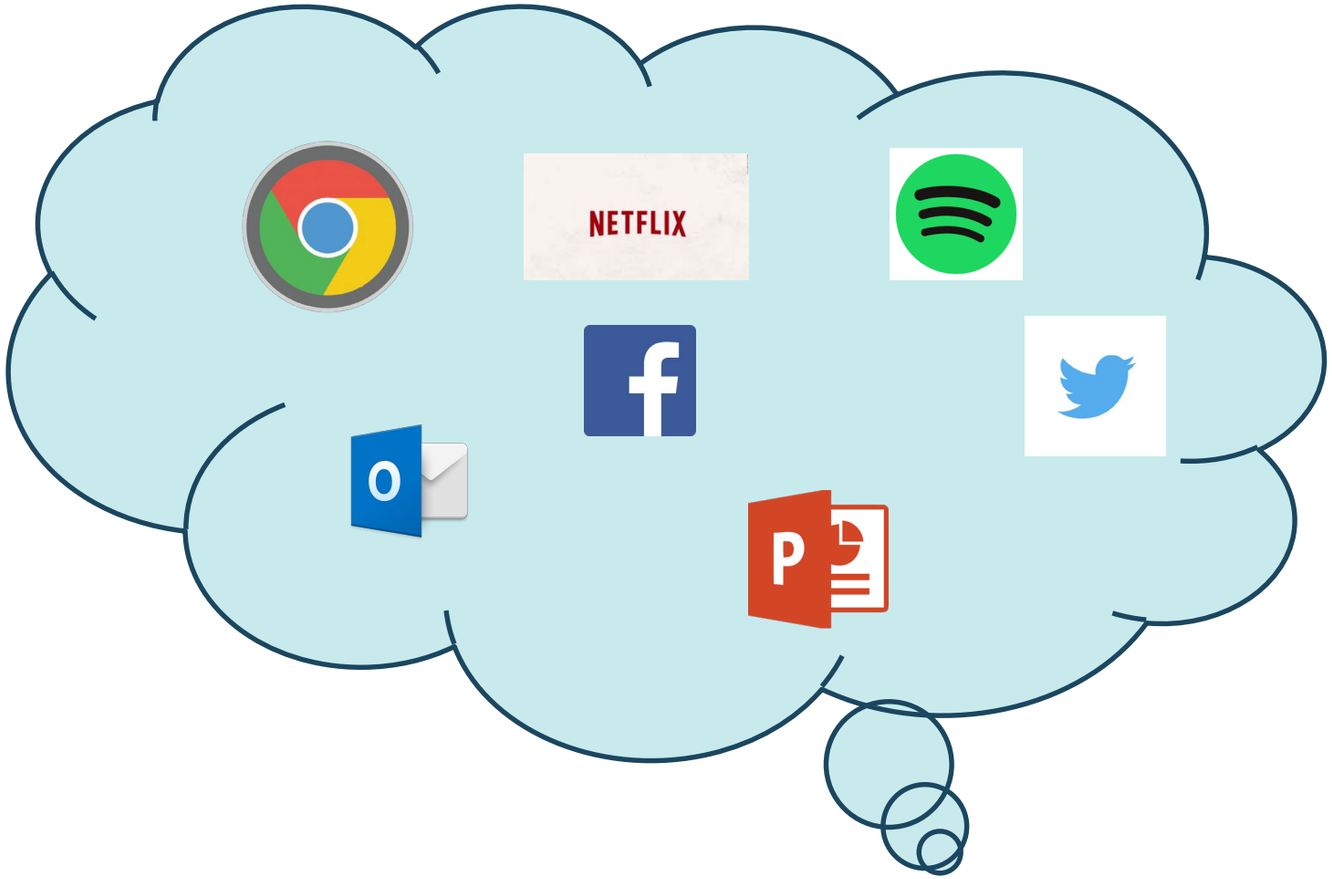
	Design & Troubleshooting	

HOW DO WE MANAGE SO MANY CONNECTIONS AT ONCE?



APPLICATION ADDRESSES

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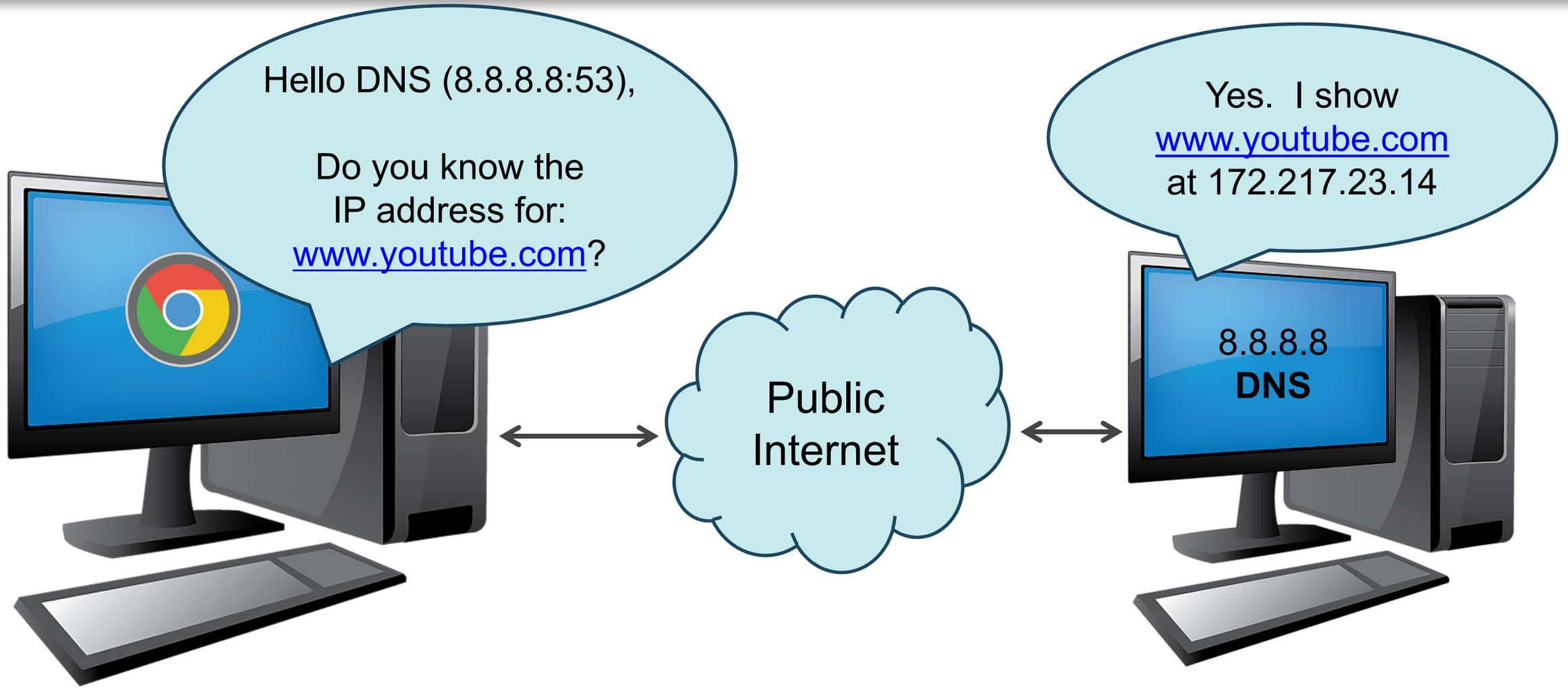

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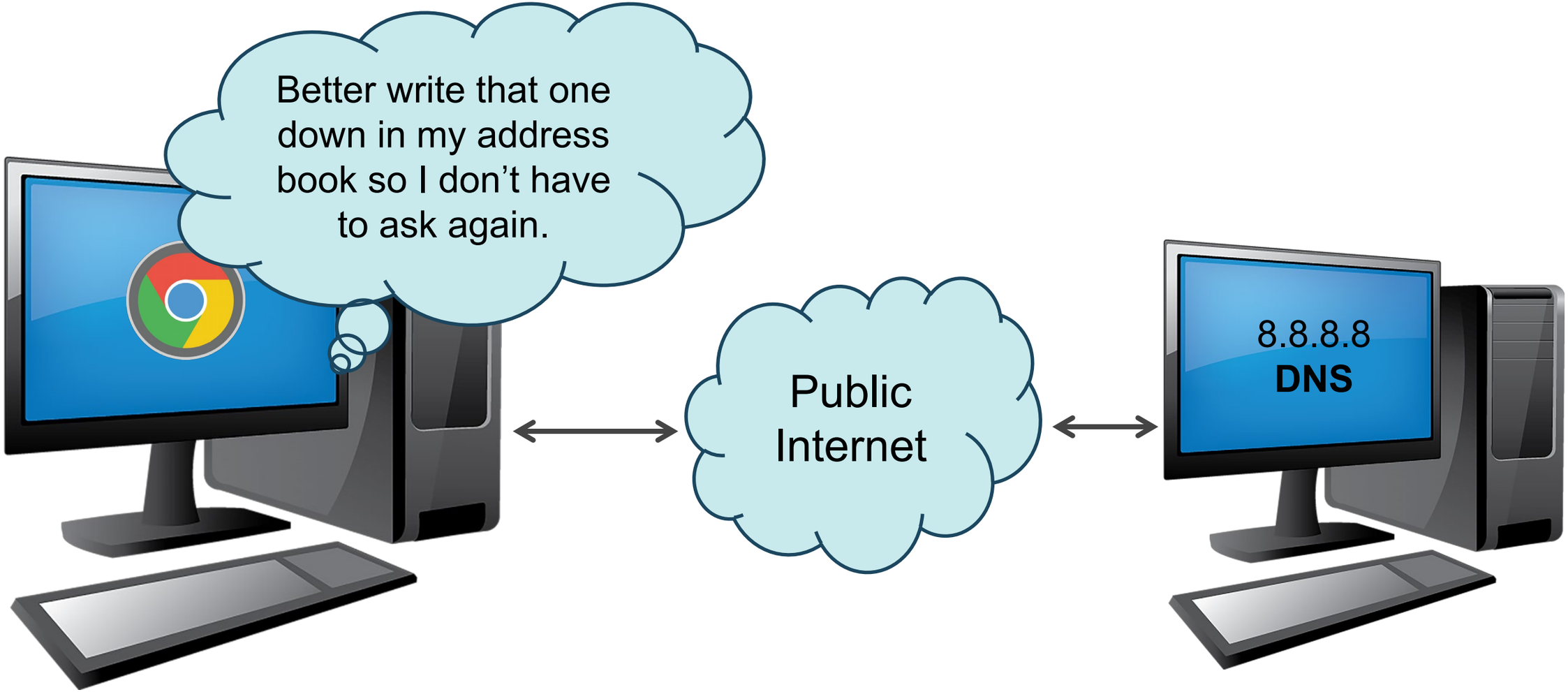

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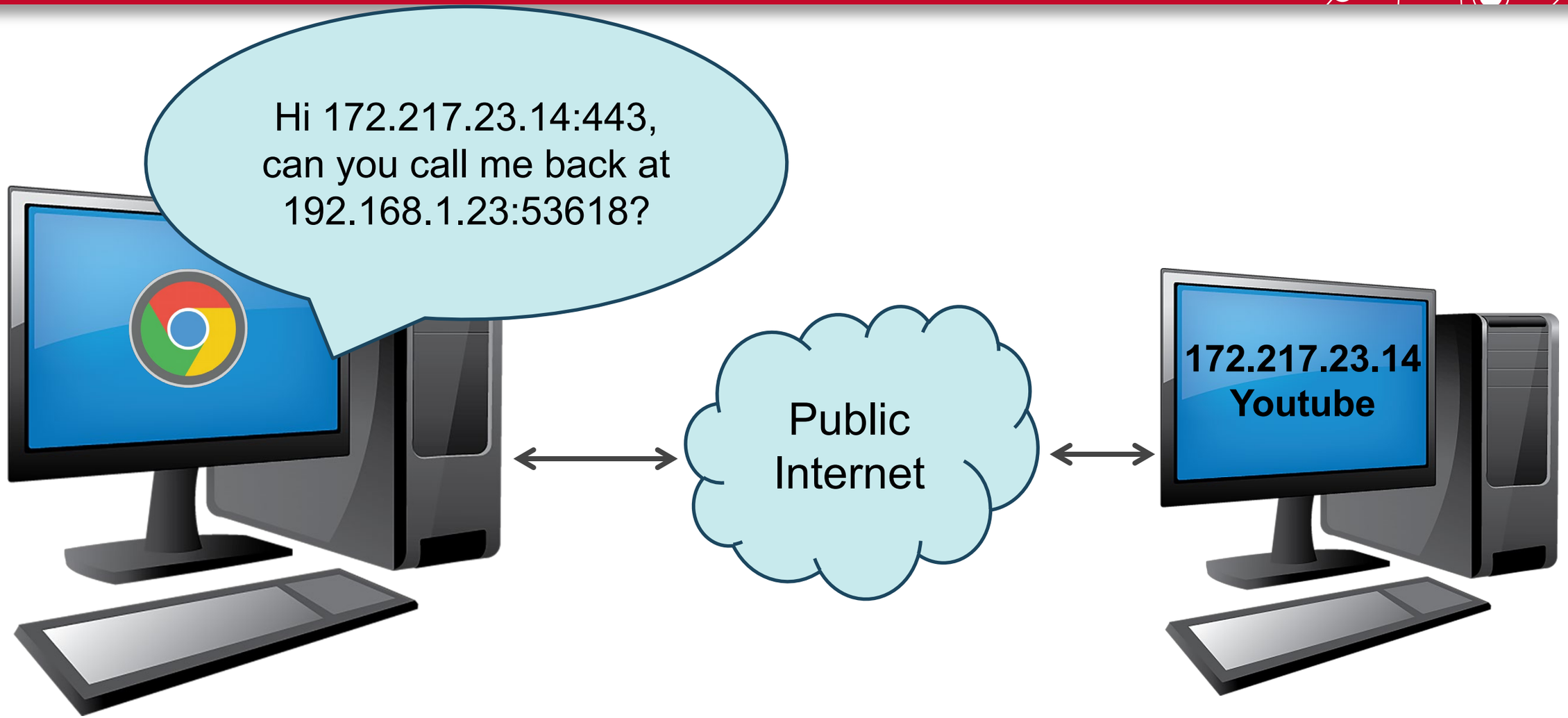

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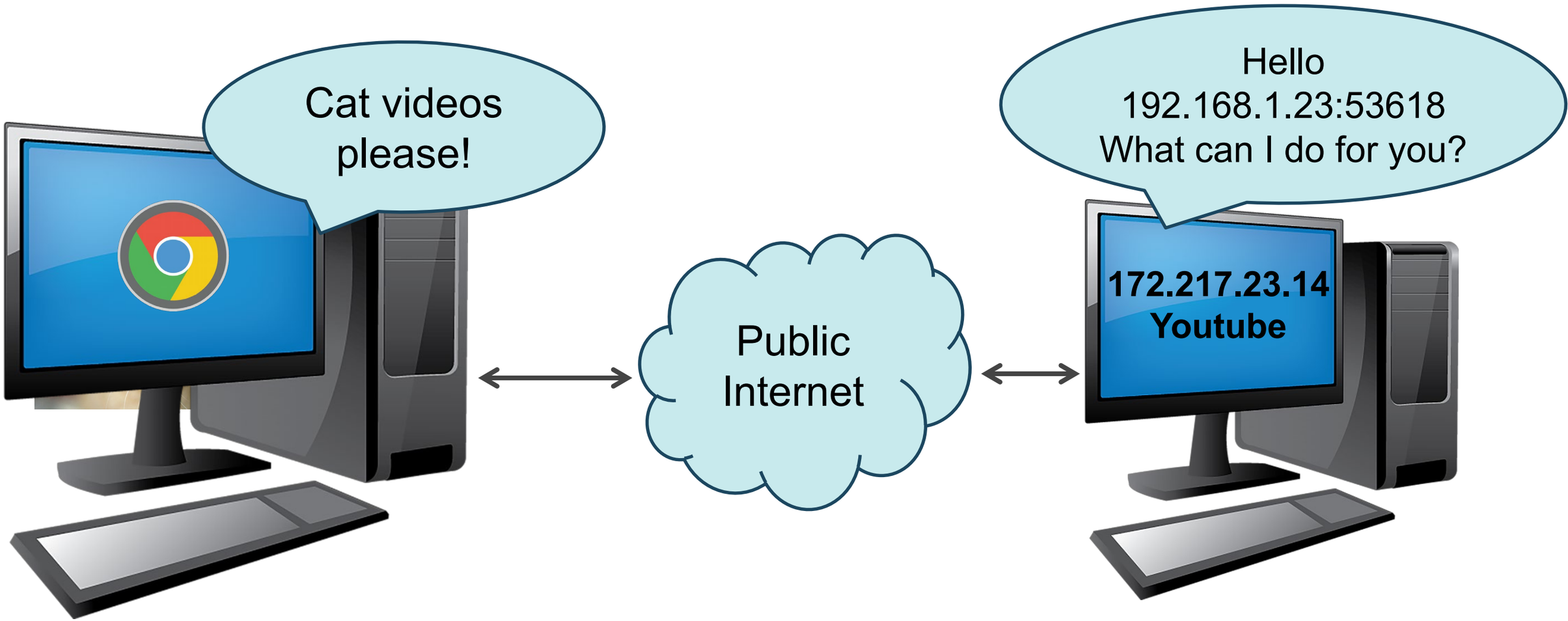

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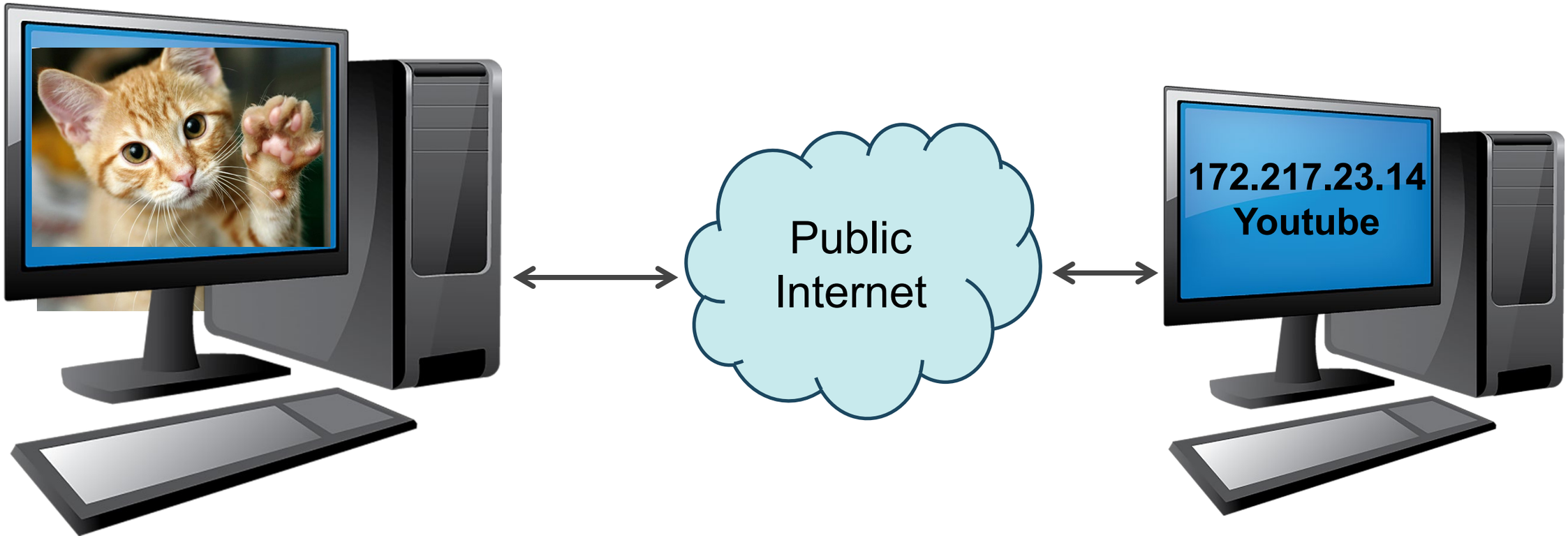

APPLICATION ADDRESSES

- The same process repeats for every application
- Each application has its own unique Internal (port) address

Application	Local Port	Remote IP	Remote Port
Youtube	TCP 53618	172.217.23.14	TCP 443
Facebook	TCP 53653	31.13.92.36	TCP 443
Outlook	TCP 67123	105.40.225.204	TCP 389
Spotify	TCP 57453	194.132.198.198	TCP 443

APPLICATION ADDRESSES

- The same process repeats for every application
- Each application has its own unique Internal (port) address
- Dante networks do this as well.

Application	Local Port	Remote IP	Remote Port
PTP	UDP 53618	224.0.1.129	UDP 319
Audio Flow	UDP 14340	192.168.1.56	UDP 14390
Audio Flow	UDP 14350	192.168.1.60	UDP 14367
Gain control	UDP 50135	192.168.1.56	UDP 50231

Advanced Clocking

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Perspective from Knott's Berry Farm

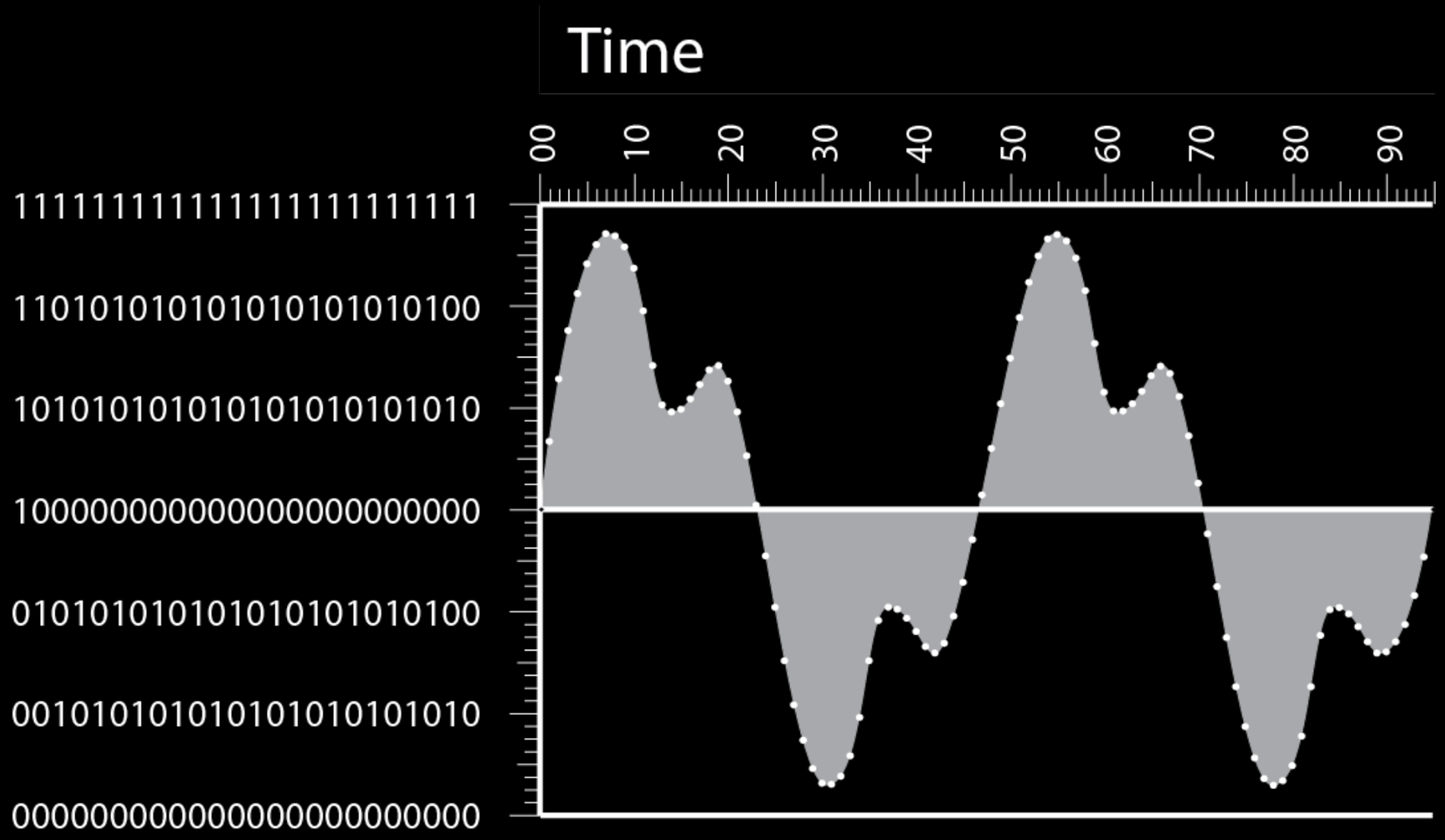
Perspective from Knott's Berry Farm

While getting trained for a new show…

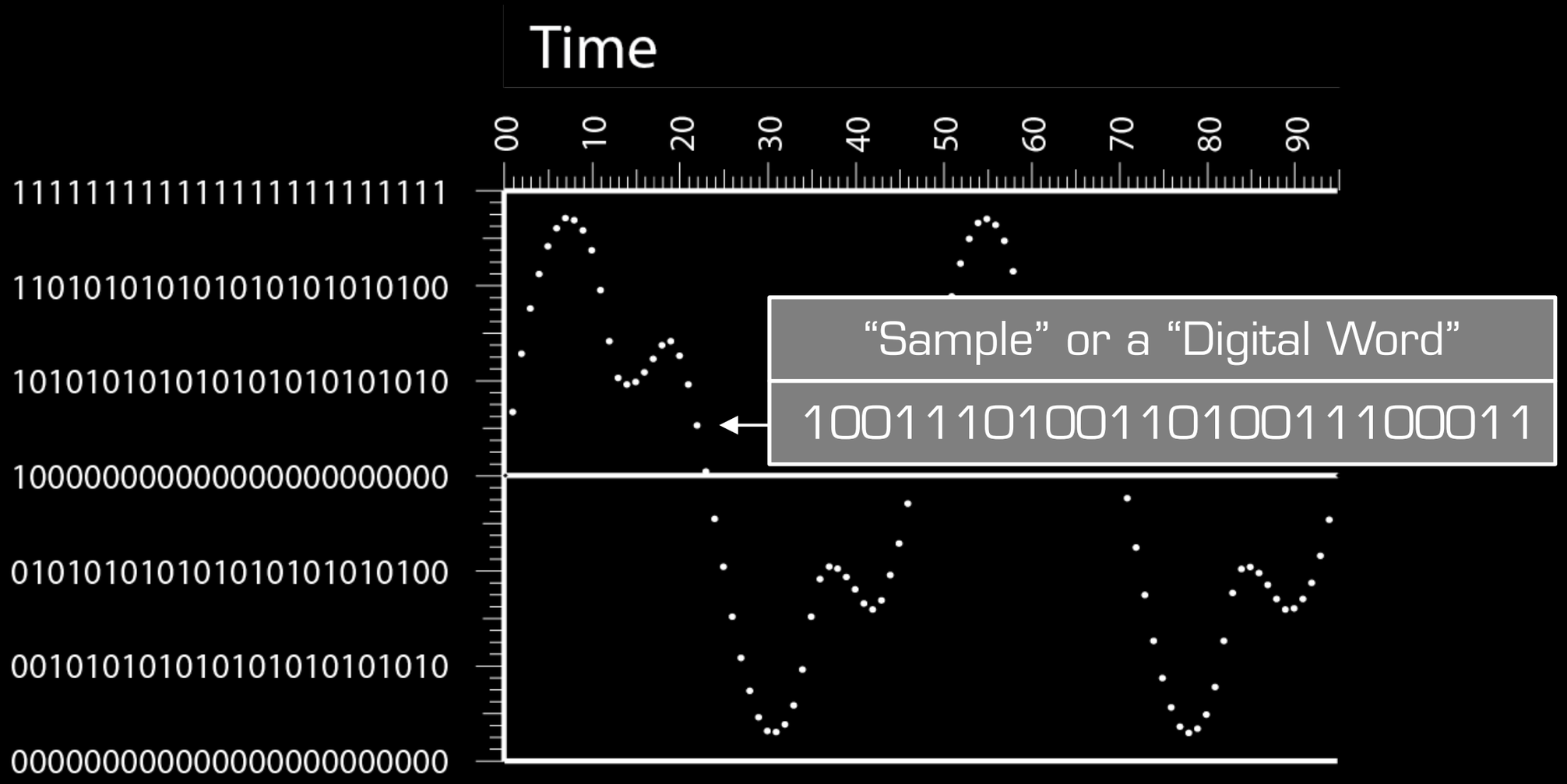
Perspective from Knott's Berry Farm

What is a sample rate?

Basics of Sample Rate & Clock



Basics of Sample Rate & Clock



Perspective from Knott's Berry Farm

Talking to an engineer fresh off touring with Glen Campbell…

Perspective from Knott's Berry Farm

I enjoy working with the M7CL and PM5D. They are great analog consoles.

Why Do We Cover Clocking?

Dante means your whole system is connected digitally.

This is often the first time people work with a digitally-connected system.

Troubleshooting: Fear and lack of knowledge cause people to blame clock quickly.

Digital Audio Chain

Capture

#1

Digital Audio Chain

Capture

#2

Transmit

#1

Digital Audio Chain

Capture

#3

Transmit

#2

Process

#1

Digital Audio Chain

Capture

#4

Transmit

#3

Process

#2

Transmit

#1

48KHz Internal

Digital Audio Chain

Capture

#4

48,000.1 Hz

Transmit

#3

Process

#2

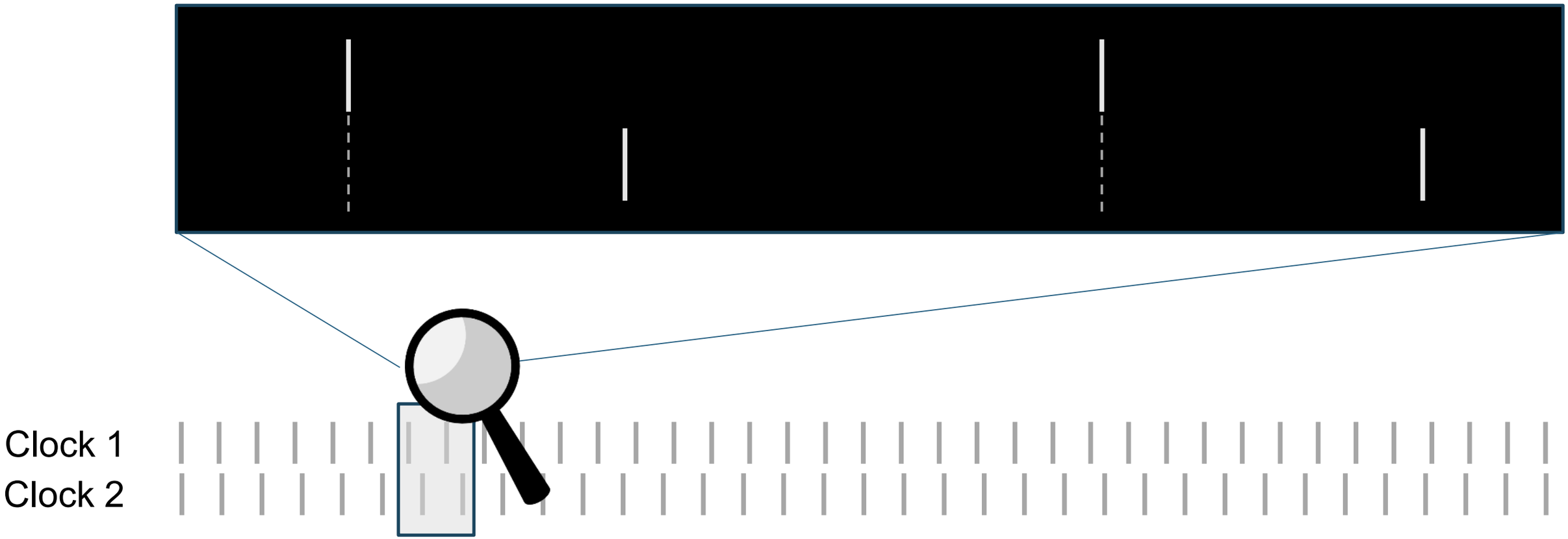
48,000.3 Hz

Transmit

#1

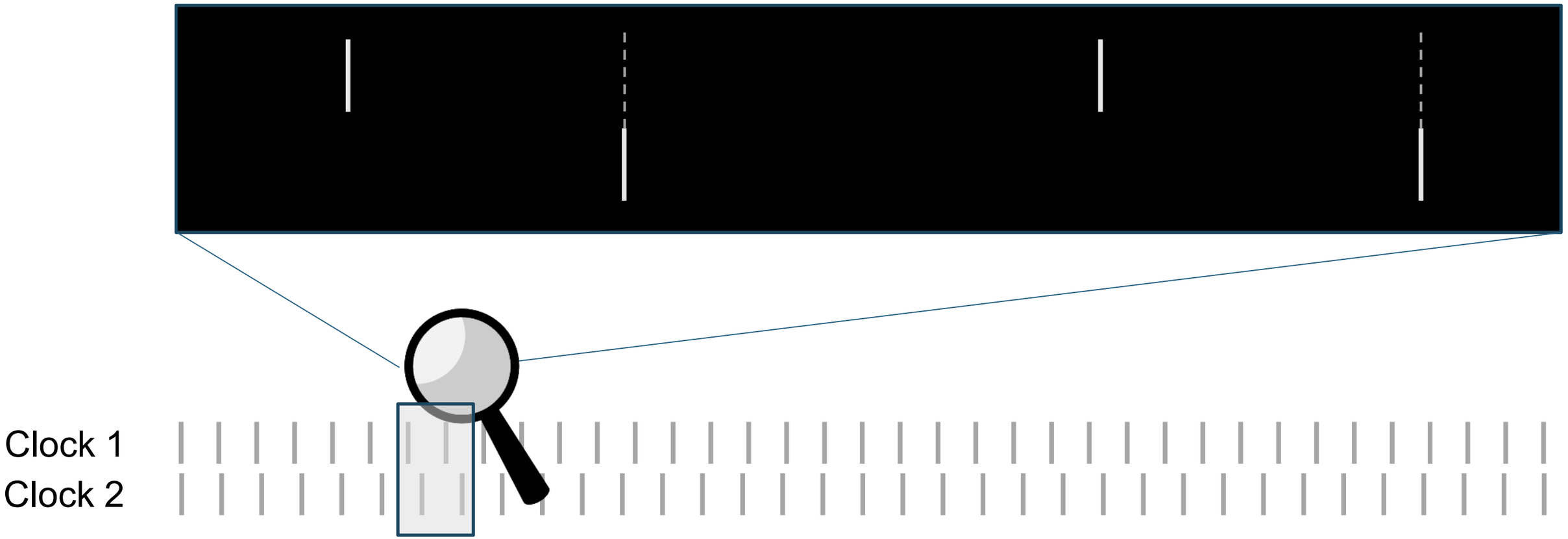
Clock: In Sync vs In Phase

OK: Digital Connection, No Sync



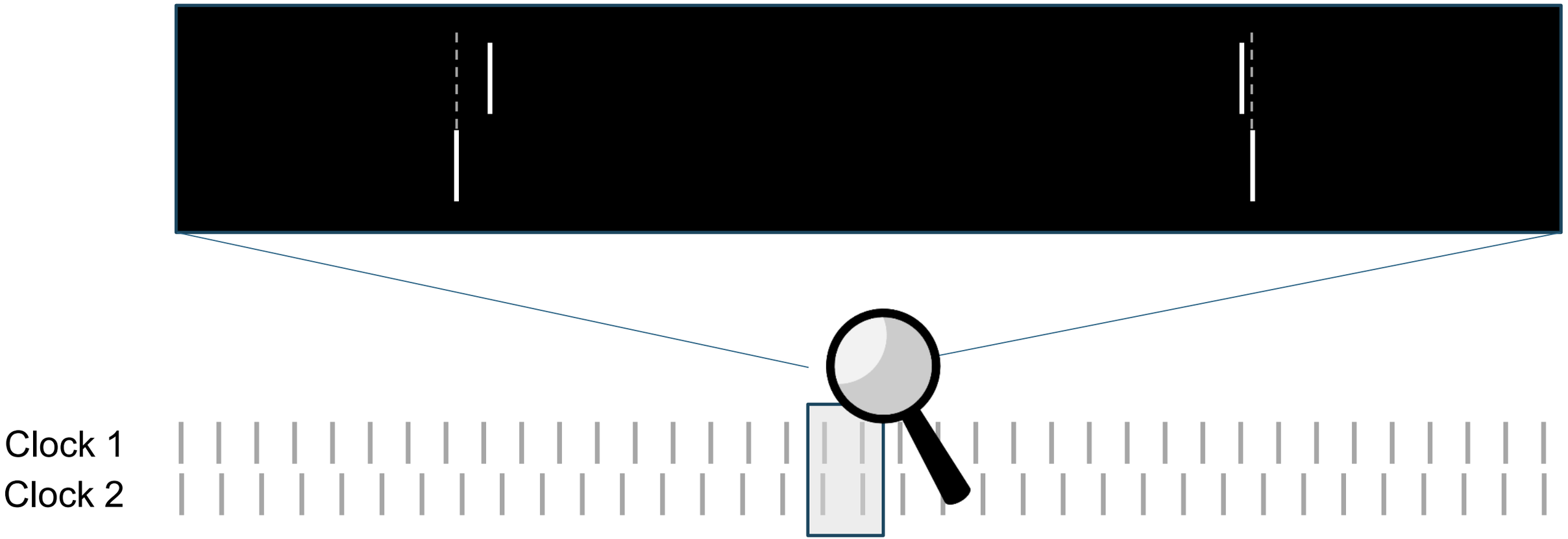
Clock: In Sync vs In Phase

OK: Digital Connection, No Sync



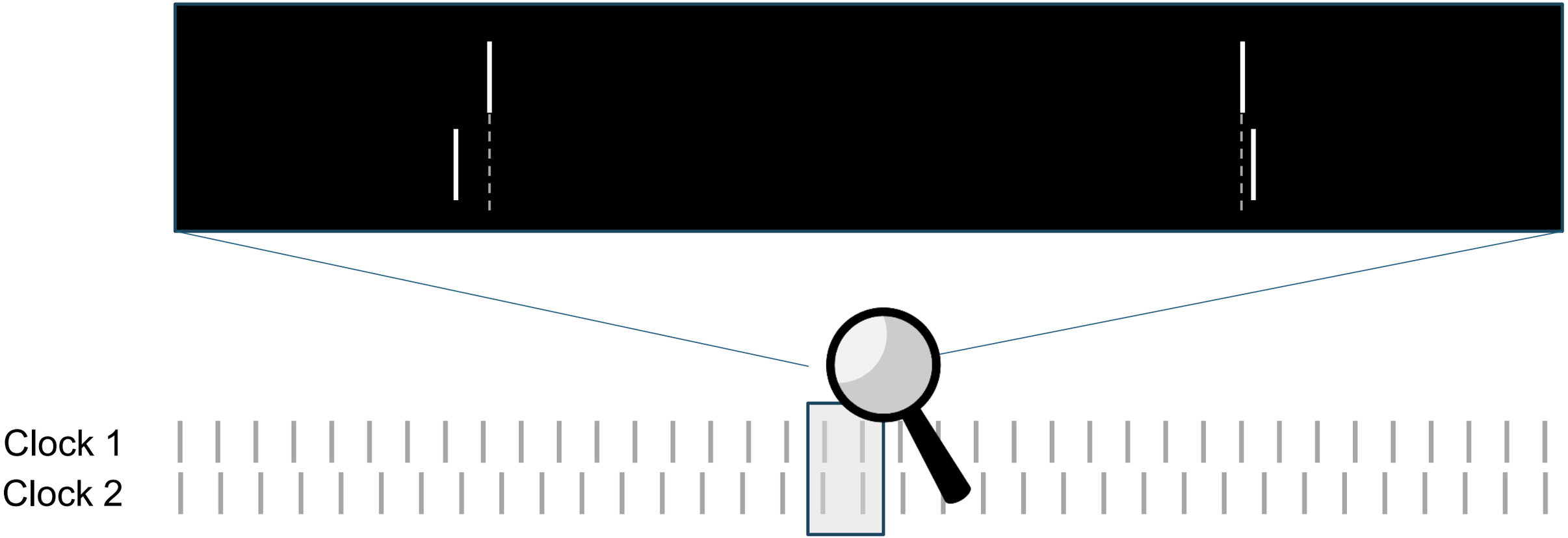
Clock: In Sync vs In Phase

Problem: No Sync – Buffer Overrun/Underrun



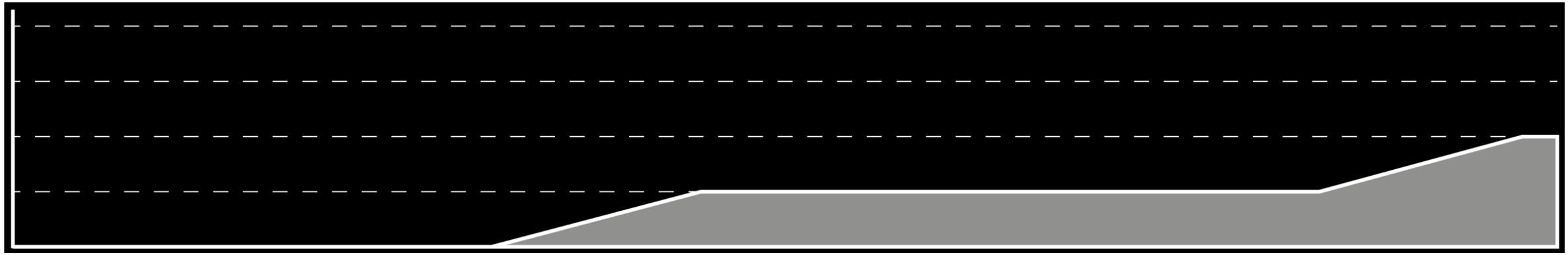
Clock: In Sync vs In Phase

Problem: No Sync – Buffer Overrun/Underrun



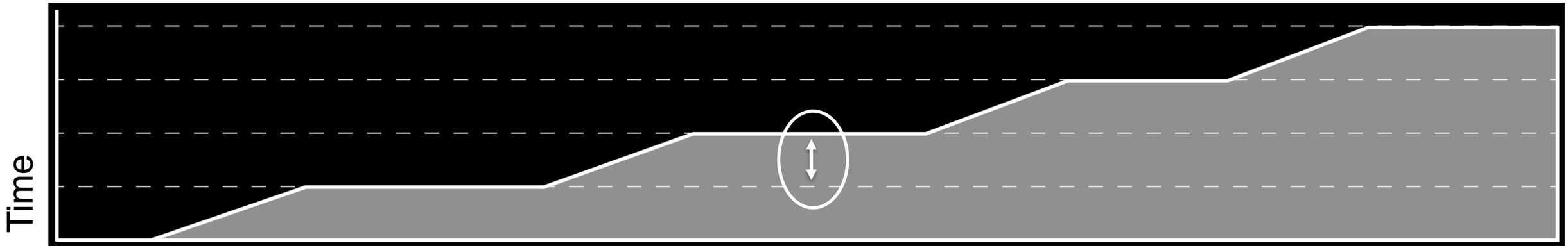
Clock: Propagation Delay

Word Clock Variance (Propagation Delay)



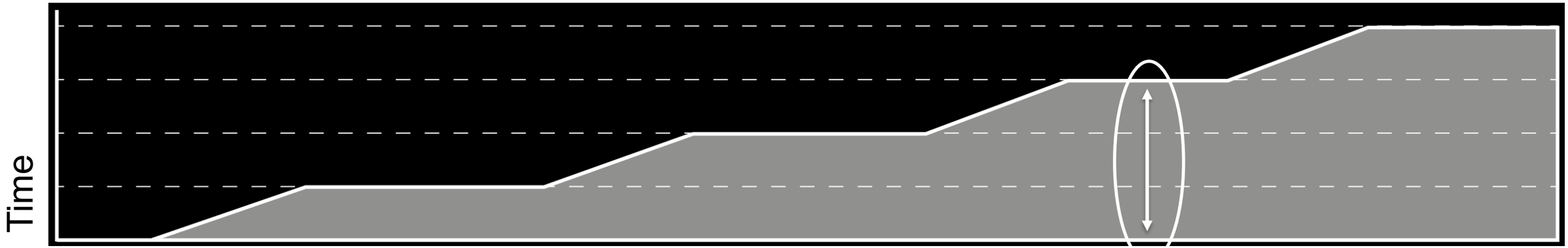
Clock: Propagation Delay

Word Clock Variance (Propagation Delay)

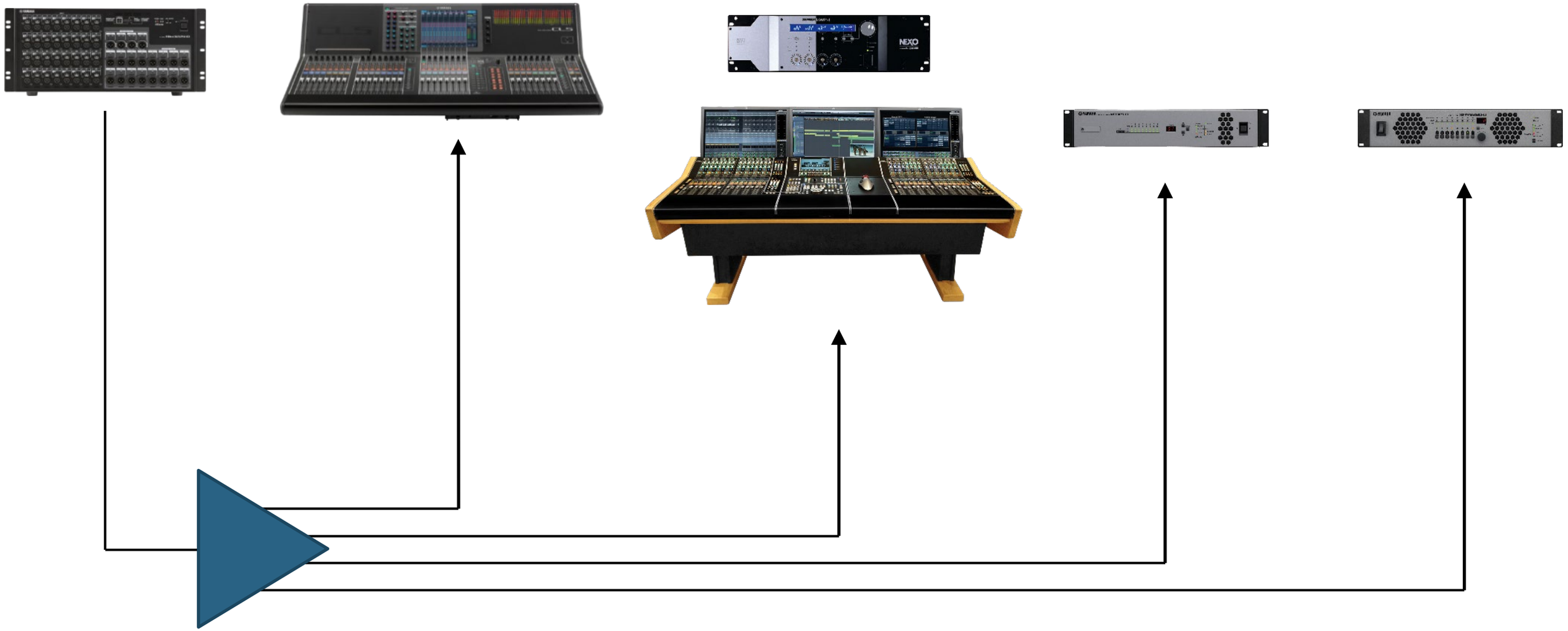


Clock: Propagation Delay

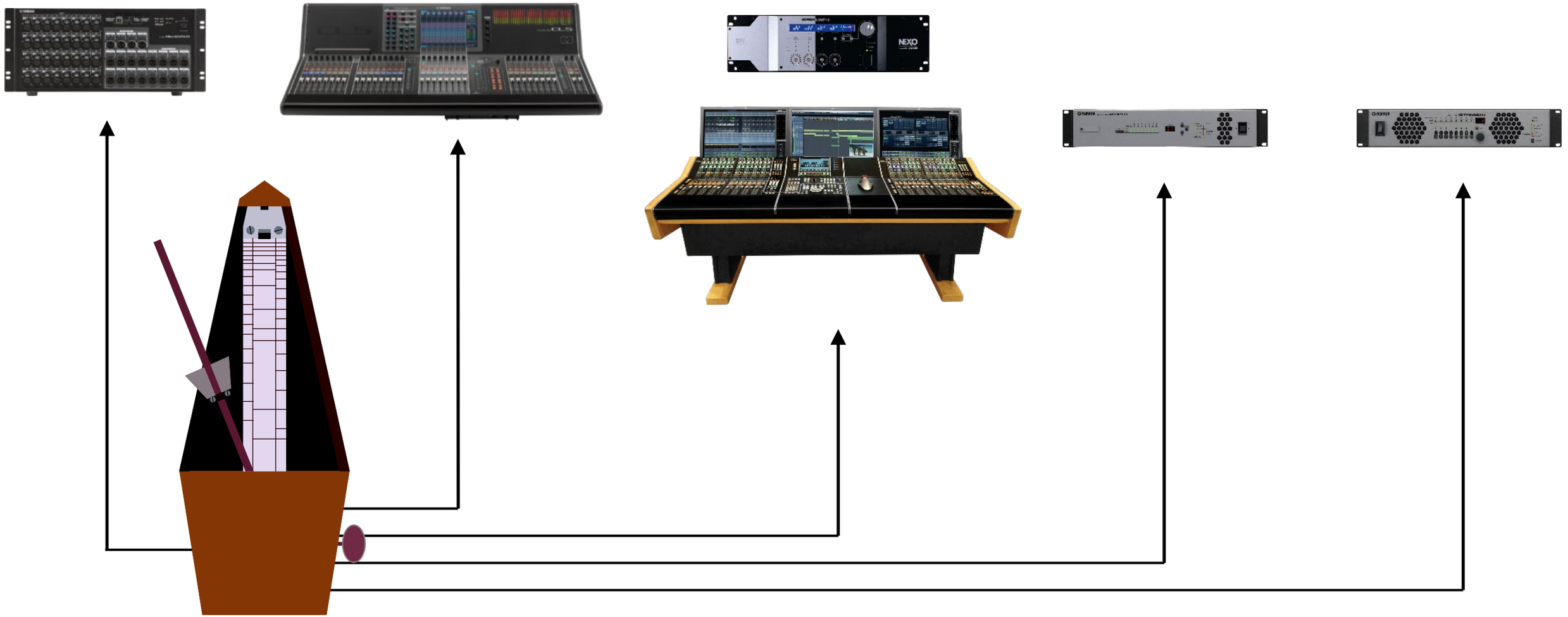
Word Clock Variance (Propagation Delay)



Clock: Buffered Distribution



Clock: Central Clock

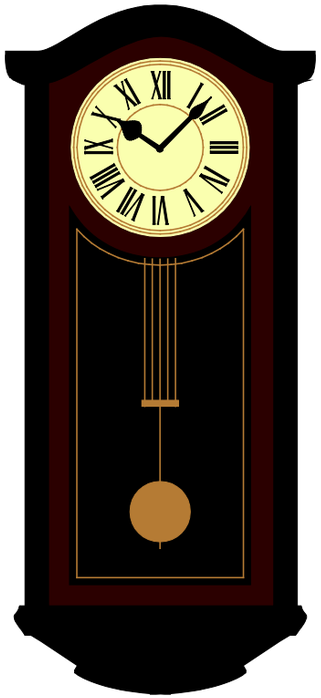


Clock: Cyclical Reference vs Positional Pointer

Is word clock like SMPTE time code?

SMPTE time code → *(face of the clock)*

Word Clock → *(pendulum)*



Word Clock and SMPTE Time Code must be "resolved", meaning they are related and align, but they are not describing the same thing.

Dante Word Clock

Dante Simplifies Configuration.

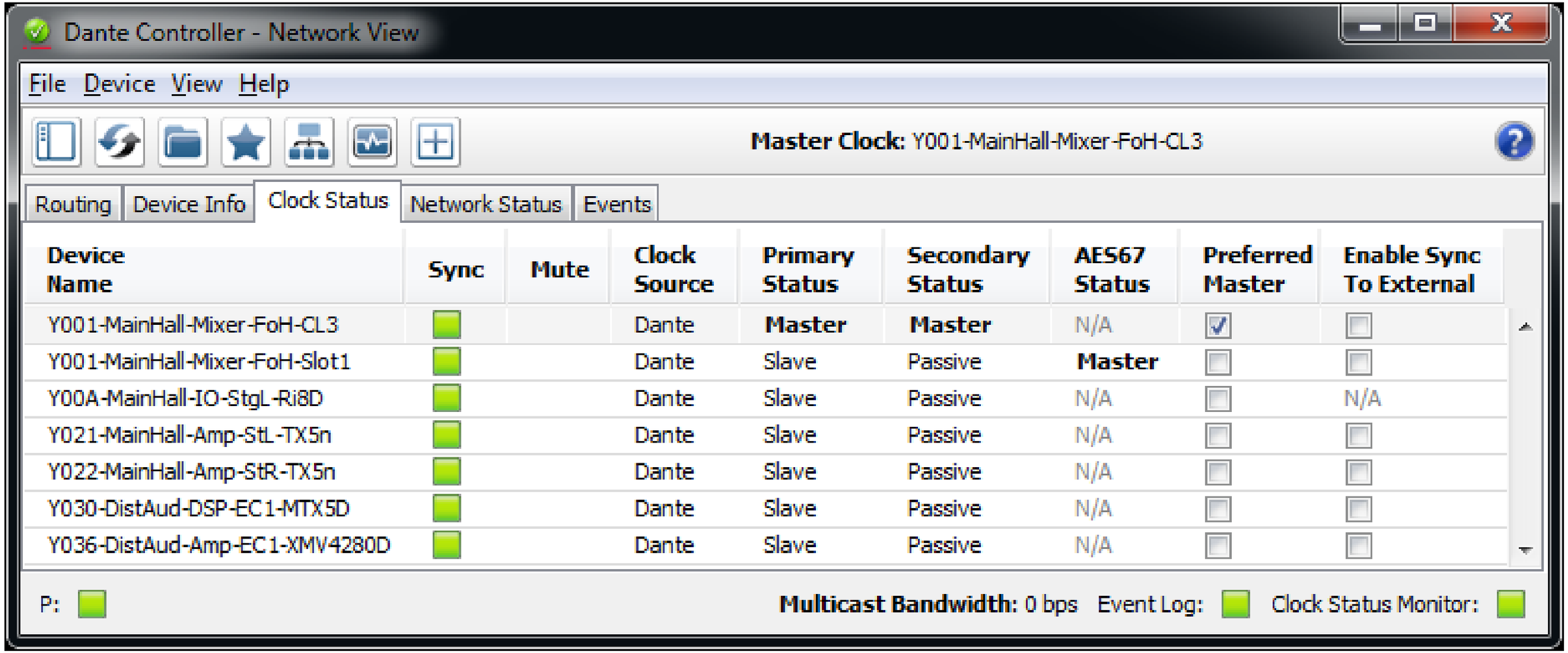
Not Just In Sync, but In Phase.

Dante Word Clock Master Election

- Automated Election Criteria:

Preferred Master	User Intervention
Chasing External Clock	Automatic Process
“Best Clock” (chipset)	
Lowest MAC Address	

Dante Word Clock Master Election



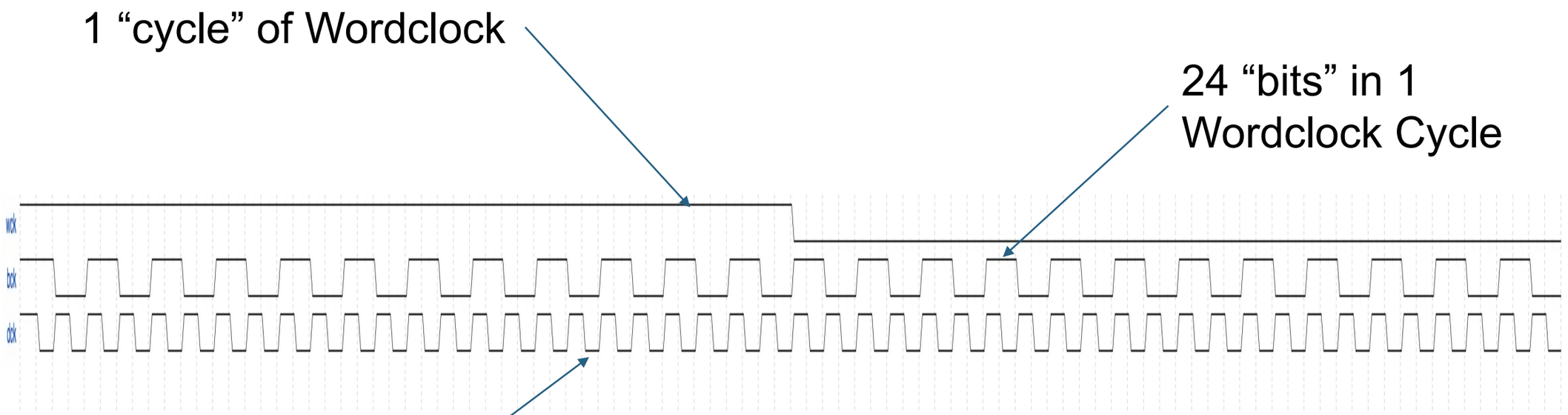
Dante Word Clock Master Election

- Automated Election Criteria:

Preferred Master	User Intervention
Chasing External Clock	Automatic Process
“Best Clock” (chipset)	
Lowest MAC Address	

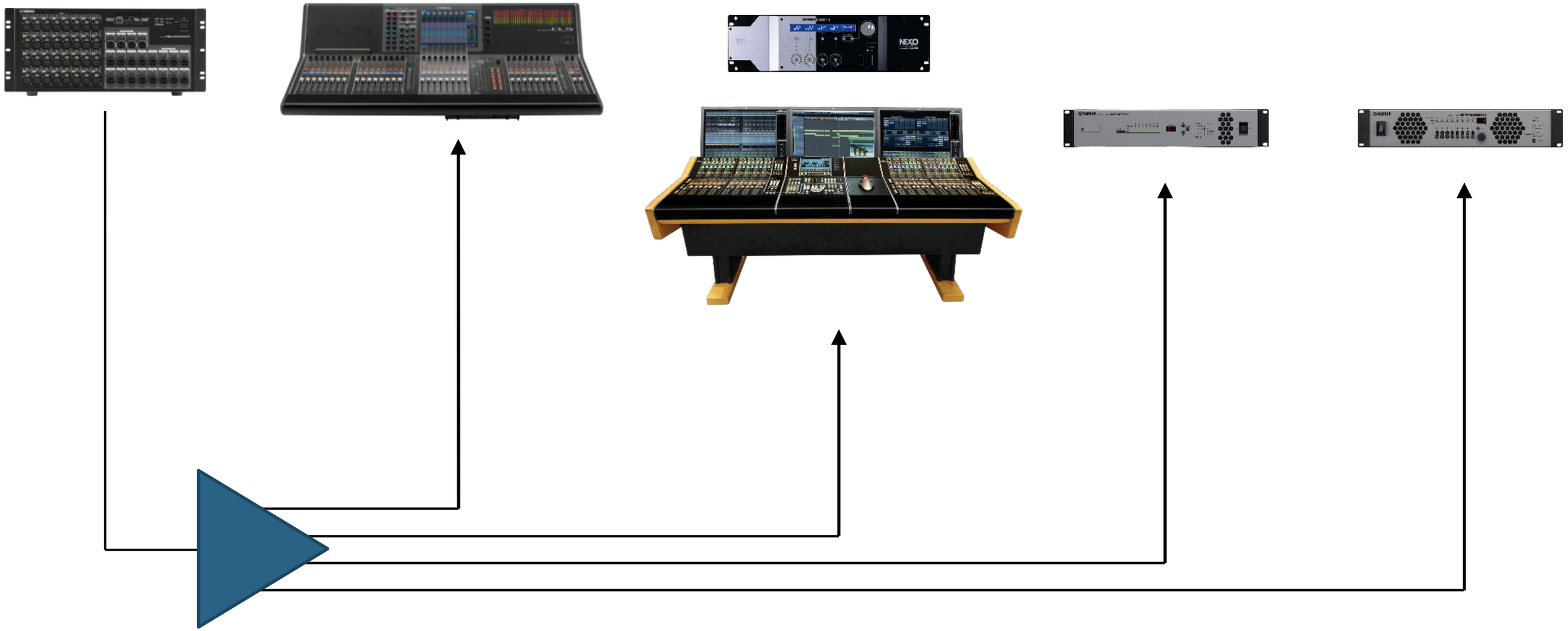
- Synchronize “Time of Day” to sub-microsecond accuracy.
- Derive the desired audio sample rate or video frame rate.

How Does a Network Synchronize Word Clocks?

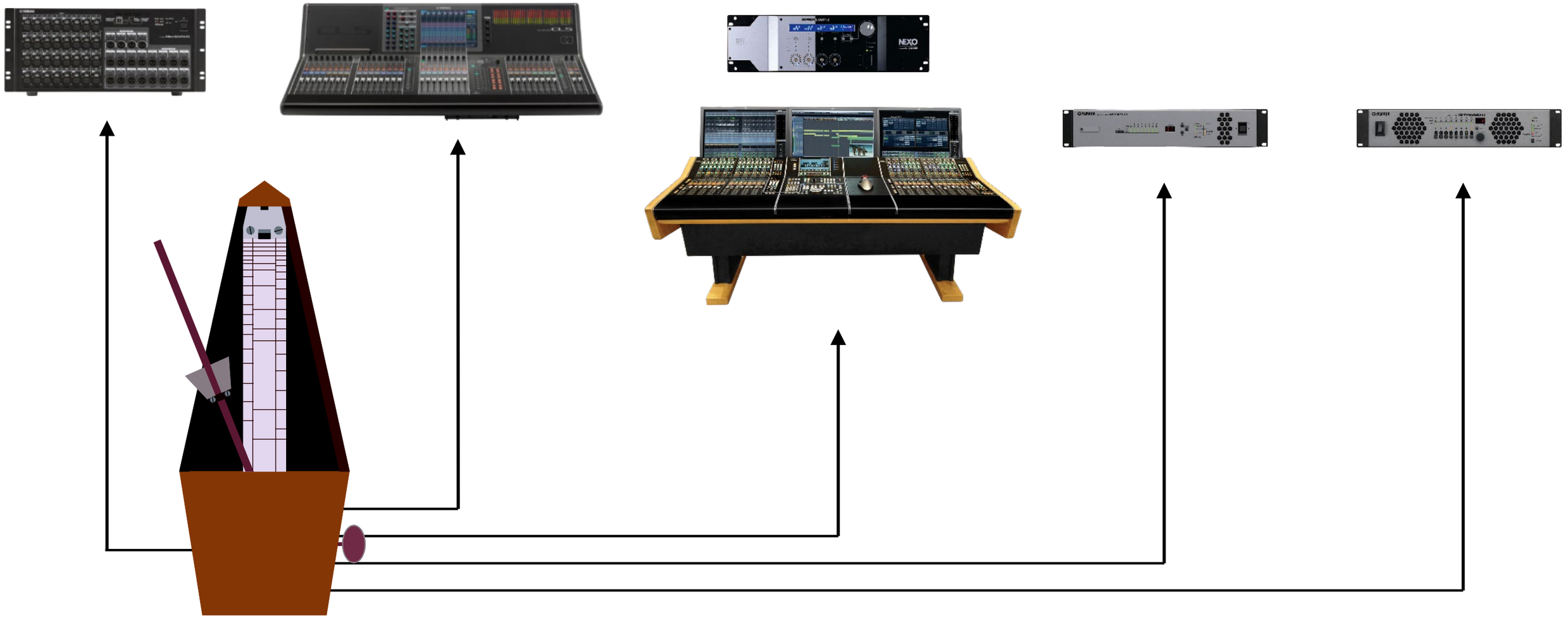


- Simplified example
- “Real” AES3 contains other data frames too
- This is more like a format called LJ I2S

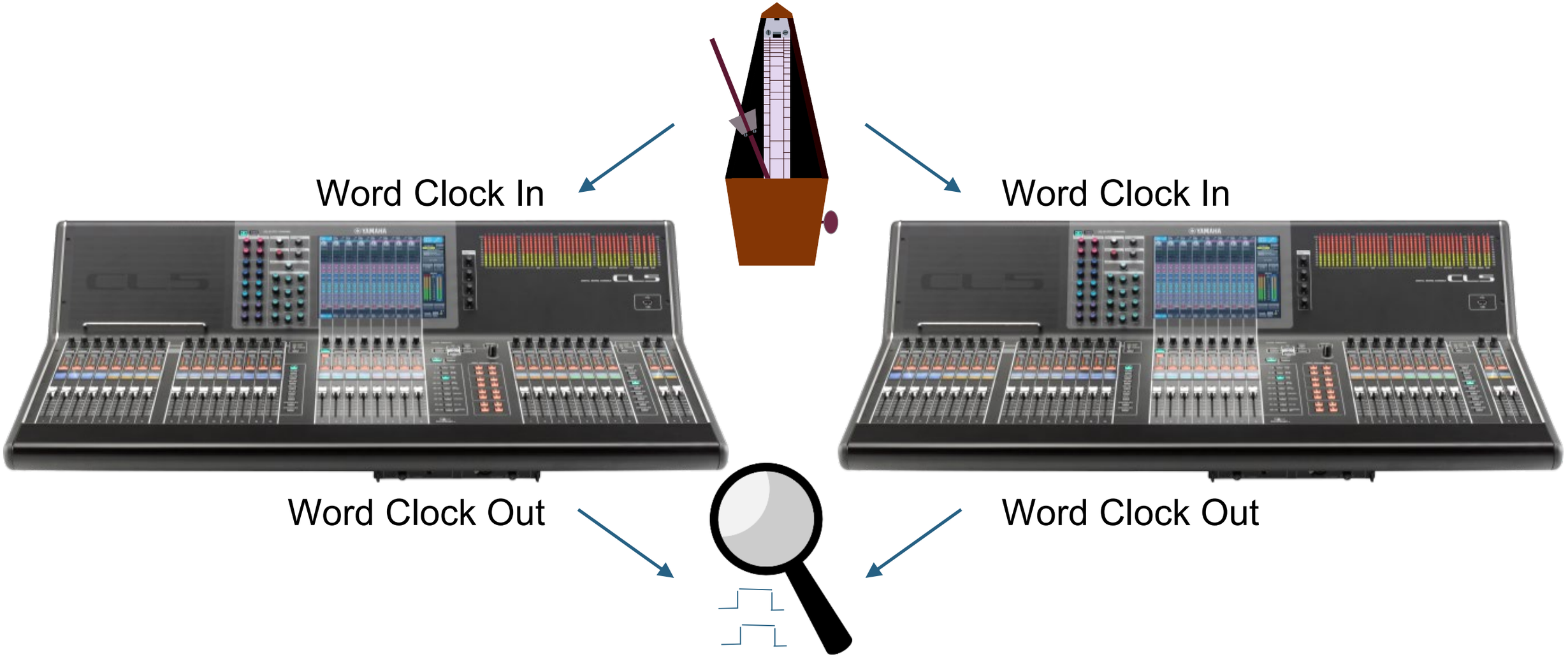
Clock: Buffered Distribution



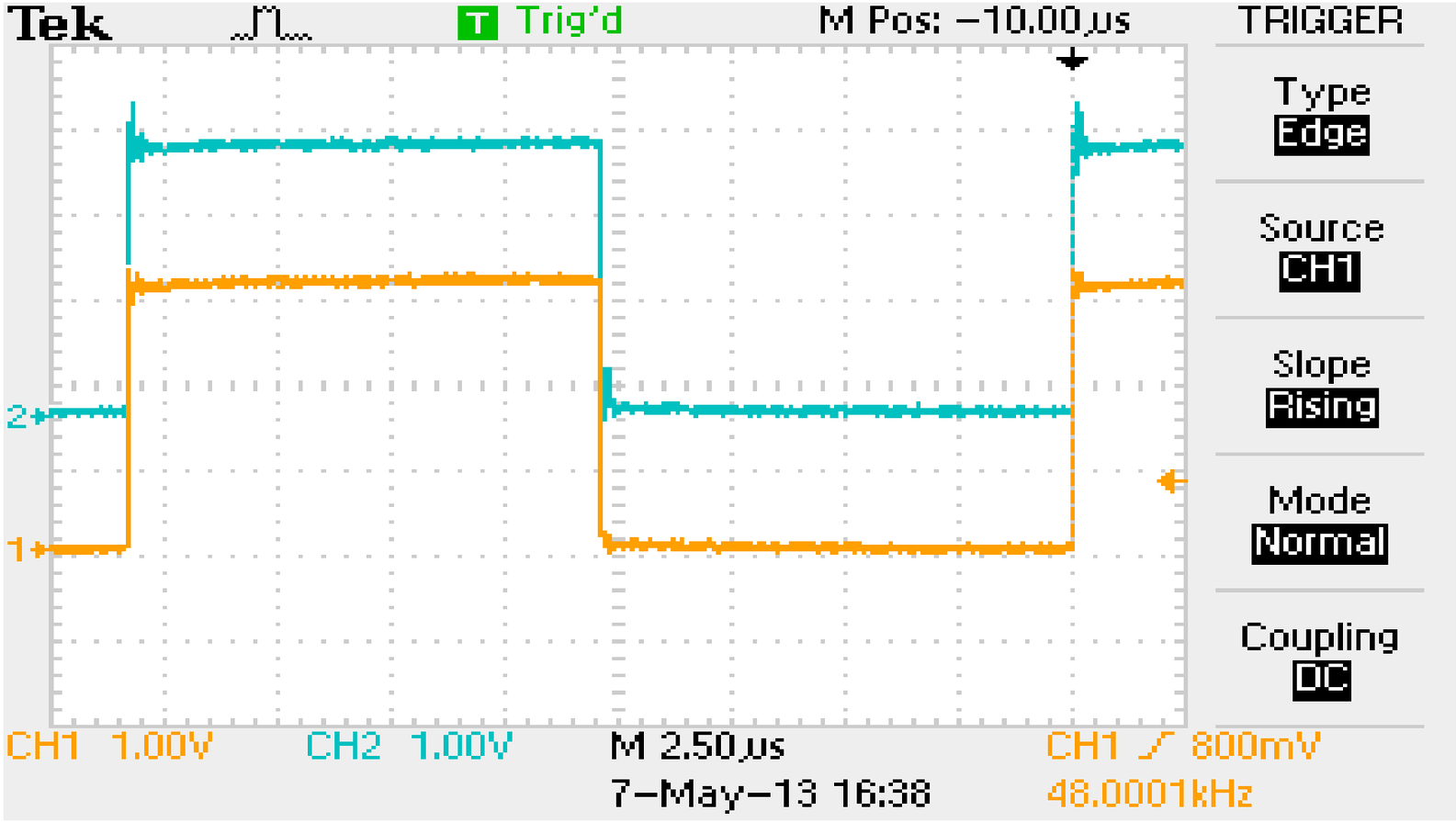
Clock: Central Clock



Clock: Testing Accuracy – Central Clock

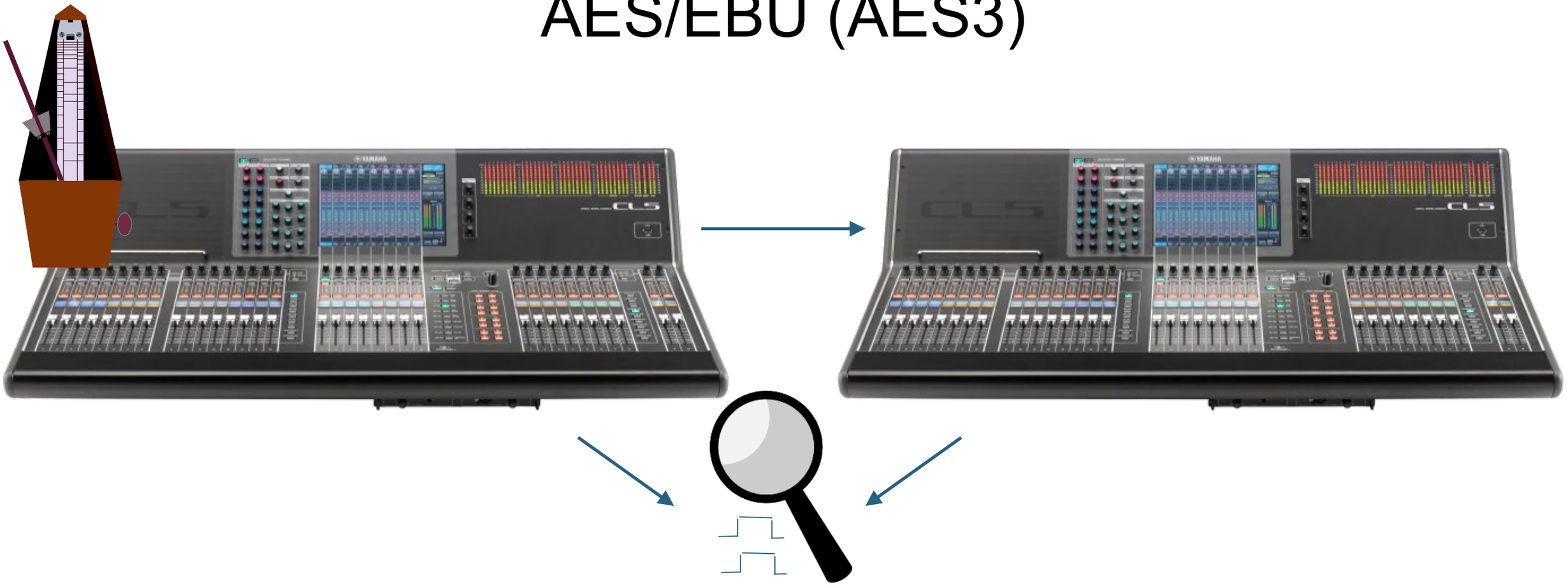


Clock: Testing Accuracy – Central Clock

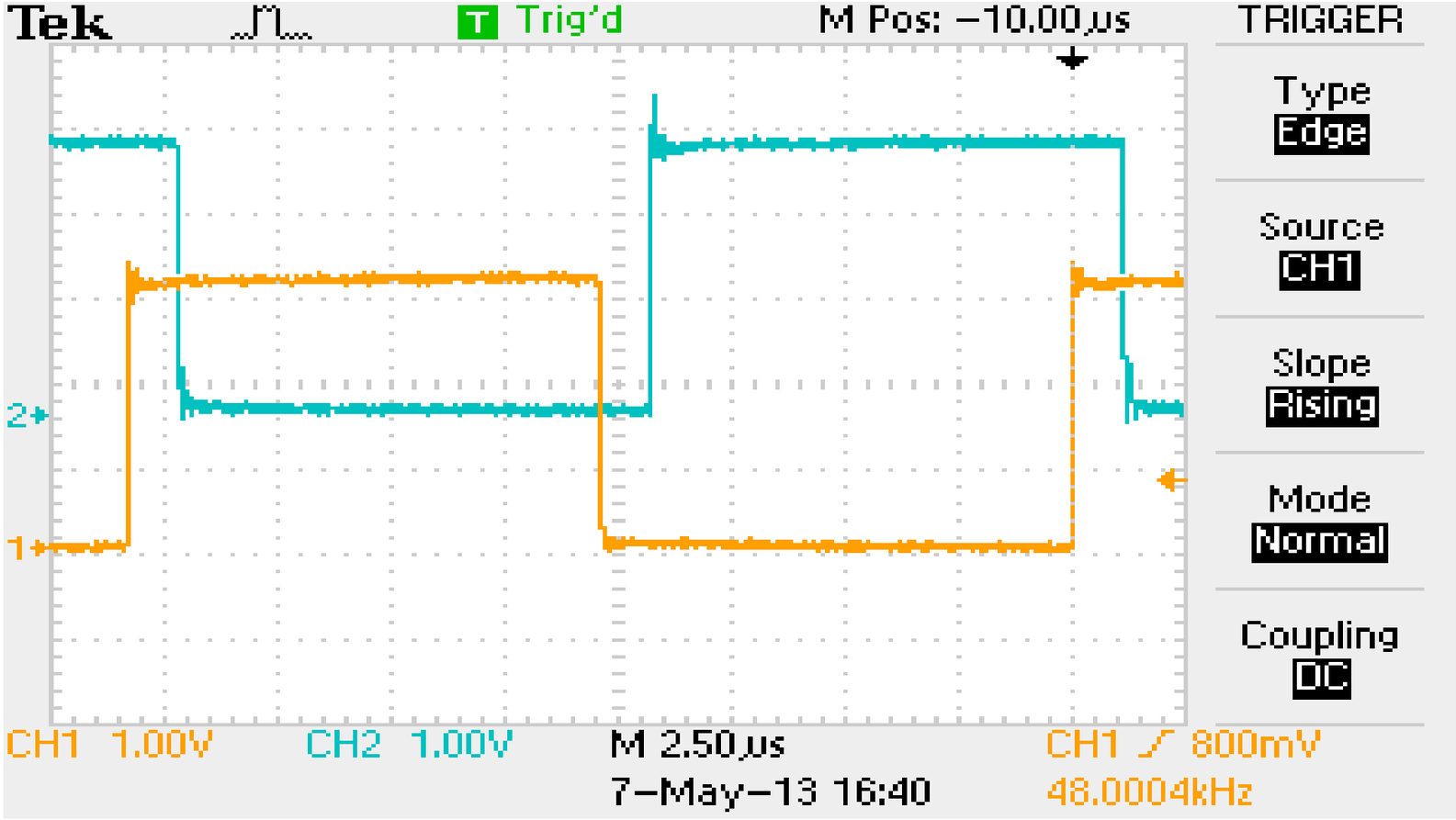


Clock: Testing Accuracy – AES3

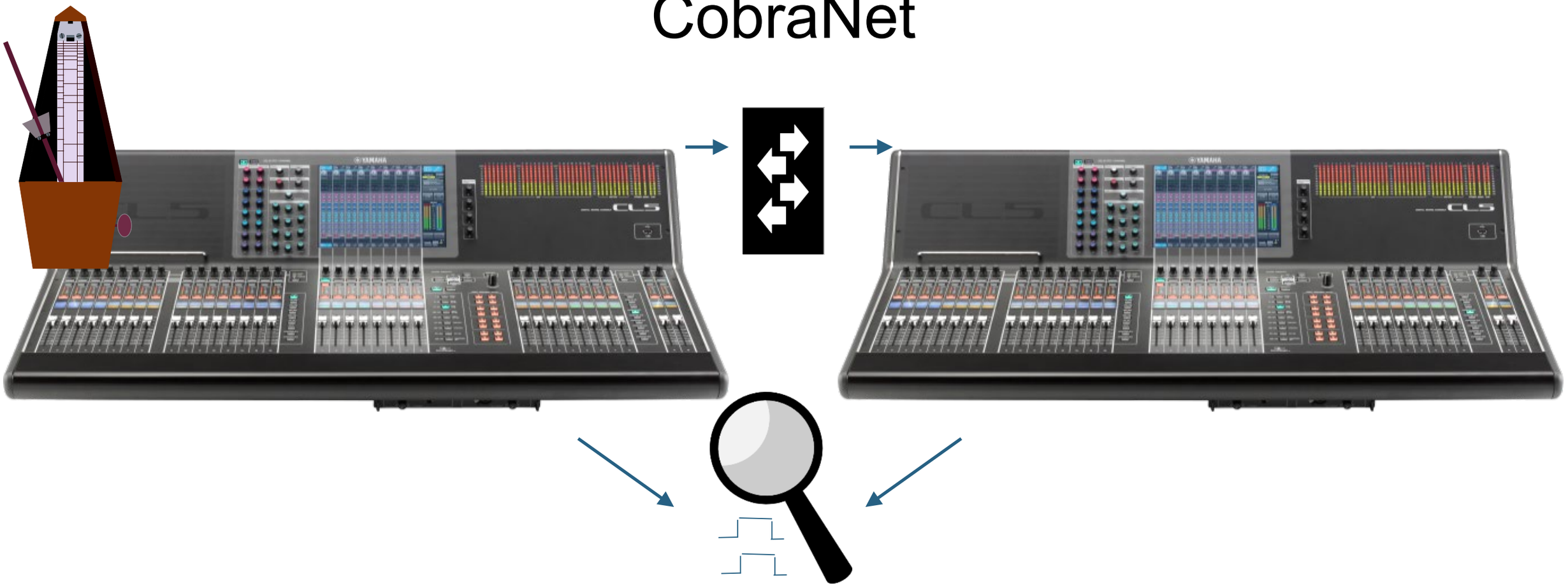
AES/EBU (AES3)



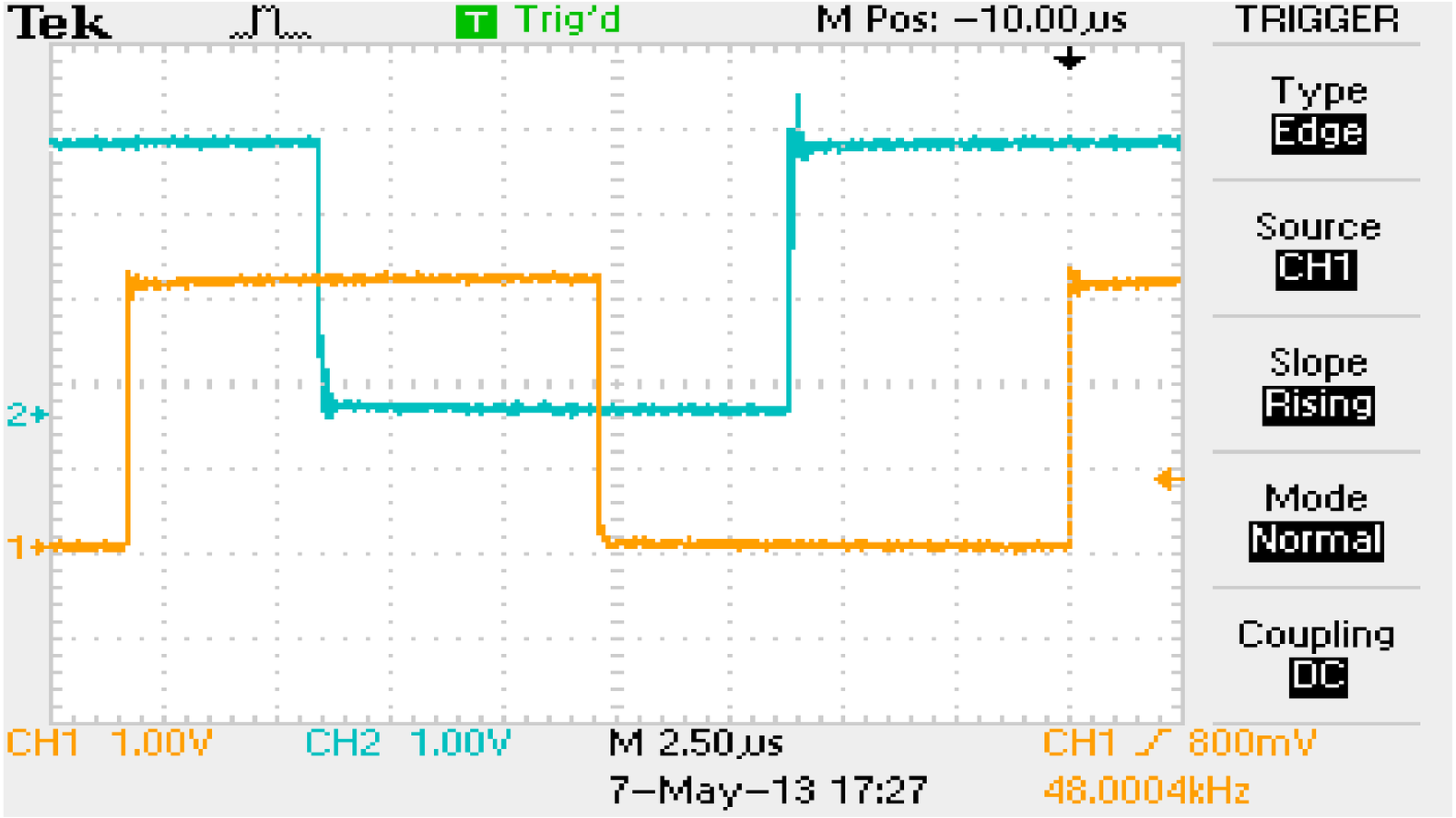
Clock: Testing Accuracy – AES3



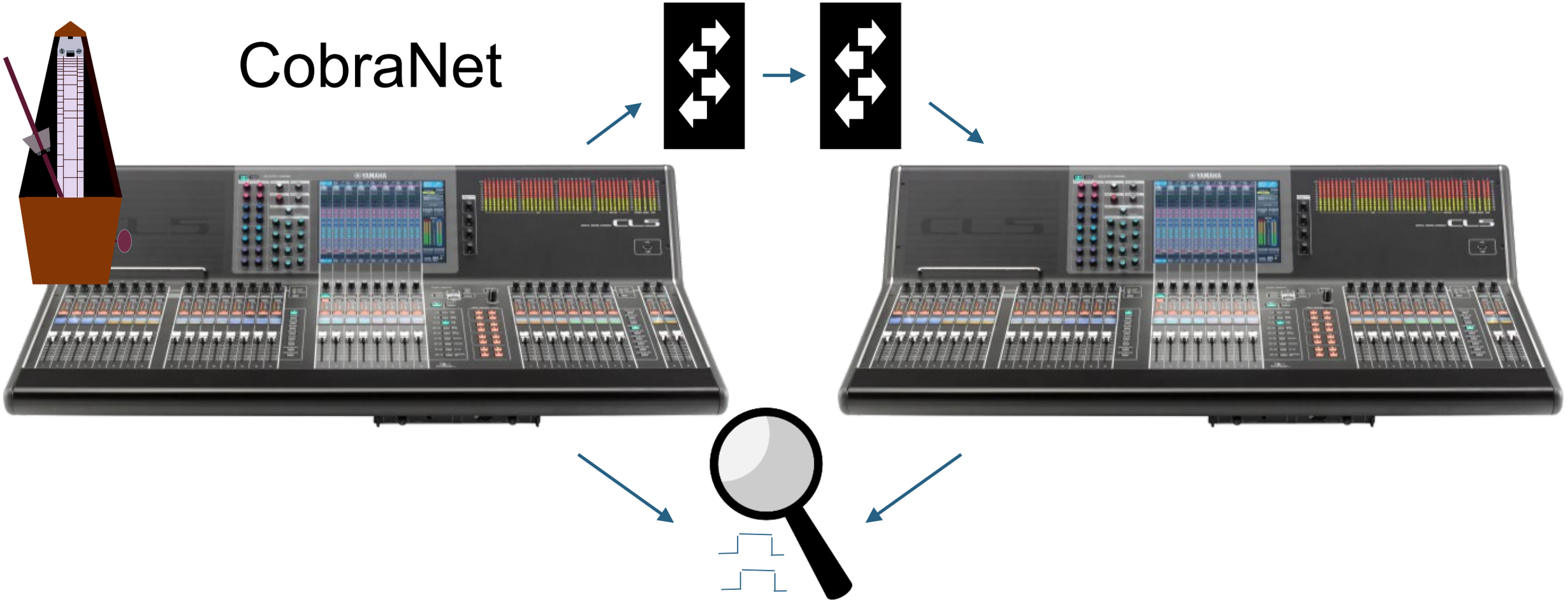
Clock: Testing Accuracy – CobraNet



Clock: Testing Accuracy – CobraNet

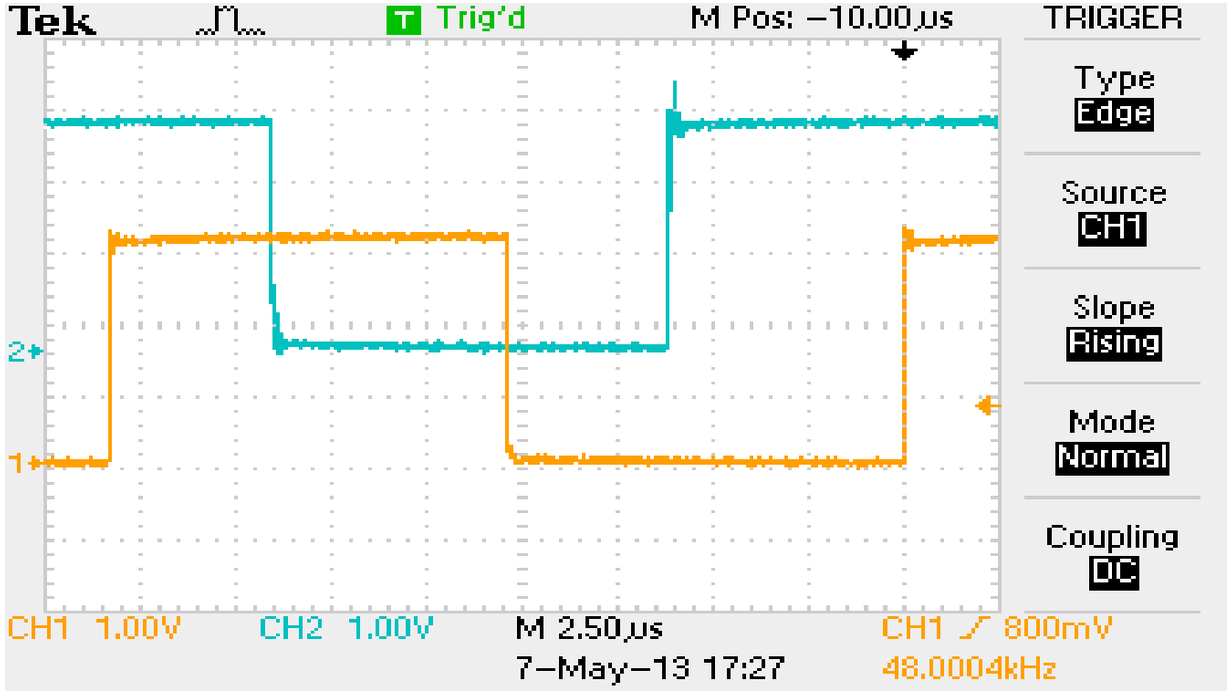


Clock: Testing Accuracy – CobraNet

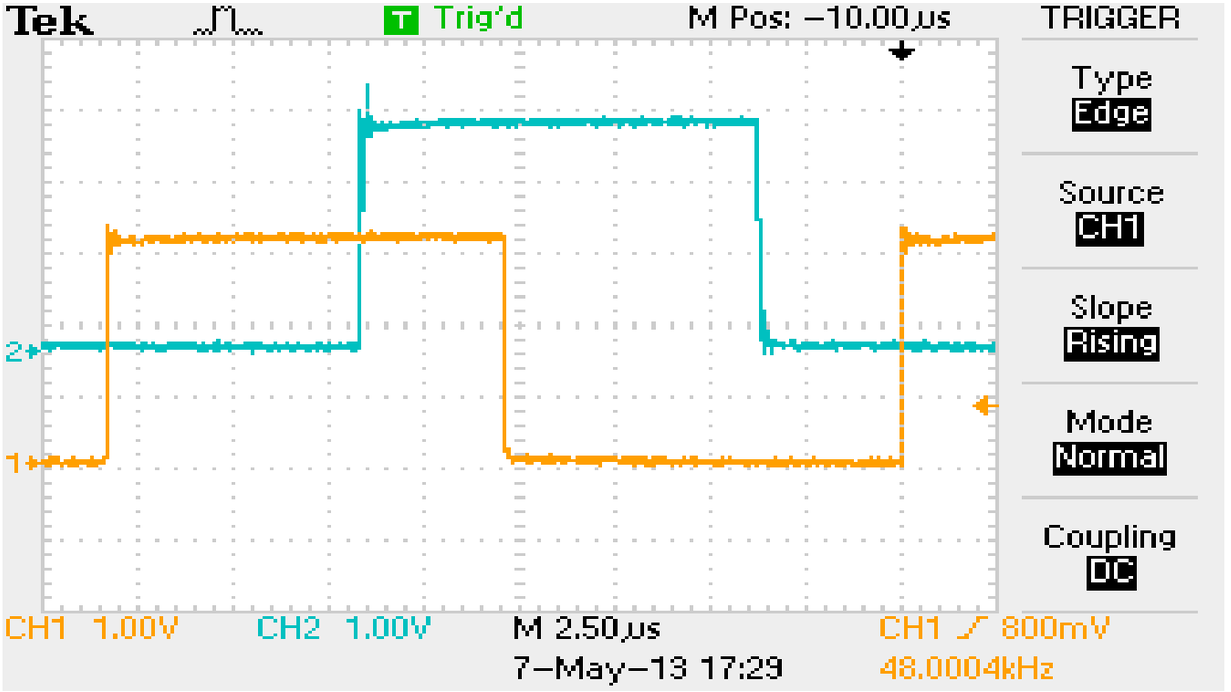


Clock: Testing Accuracy – CobraNet

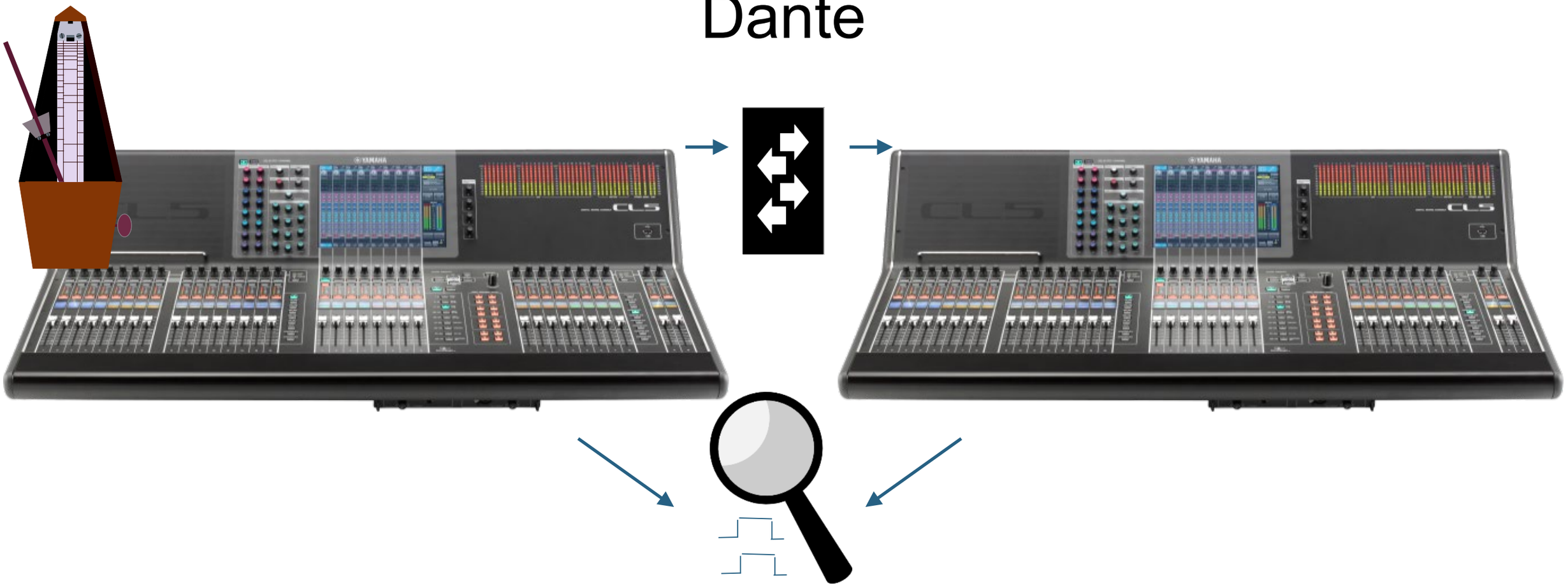
One Switch



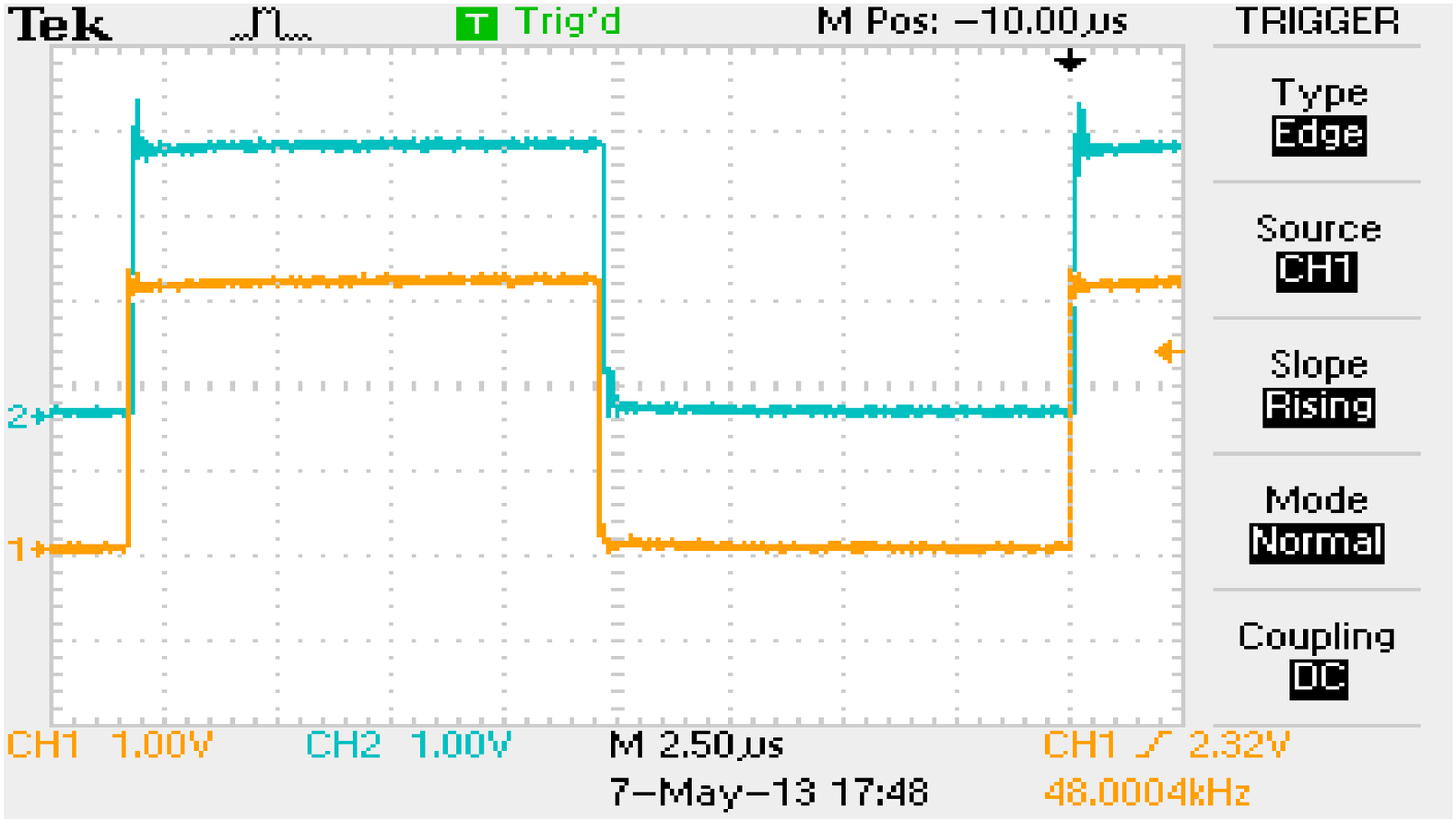
Two Switches



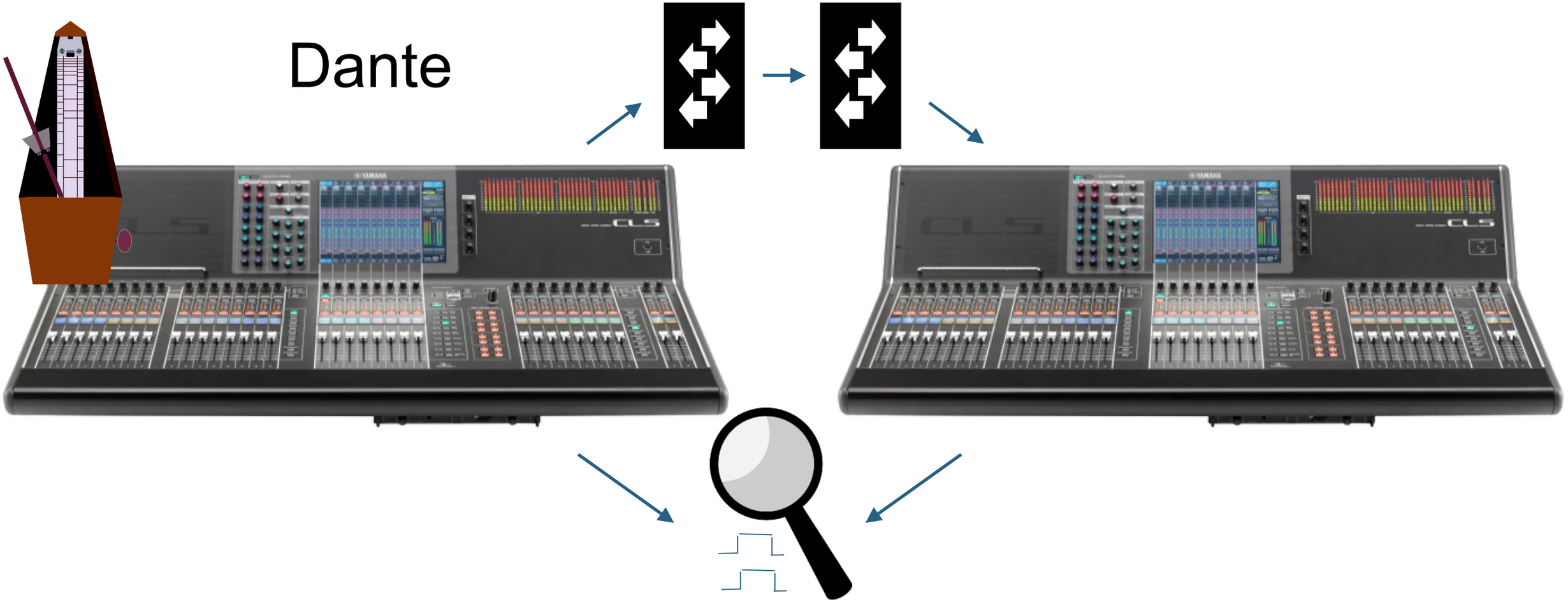
Clock: Testing Accuracy – Dante



Clock: Testing Accuracy – Dante

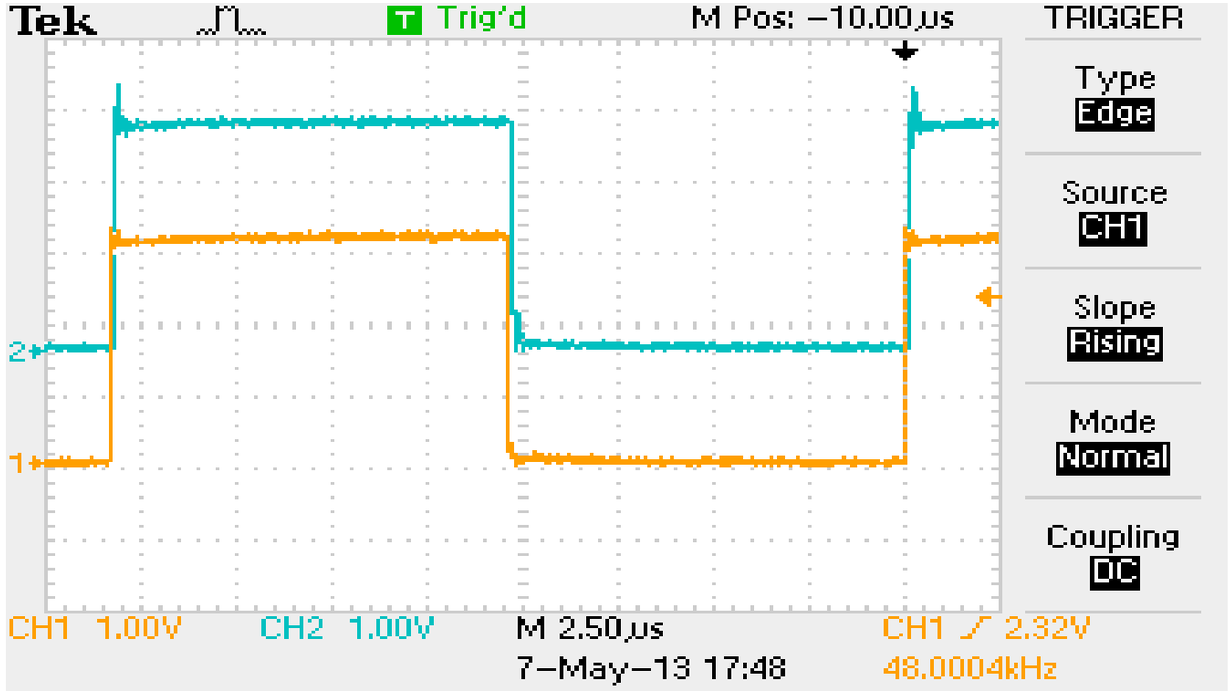


Clock: Testing Accuracy – Dante

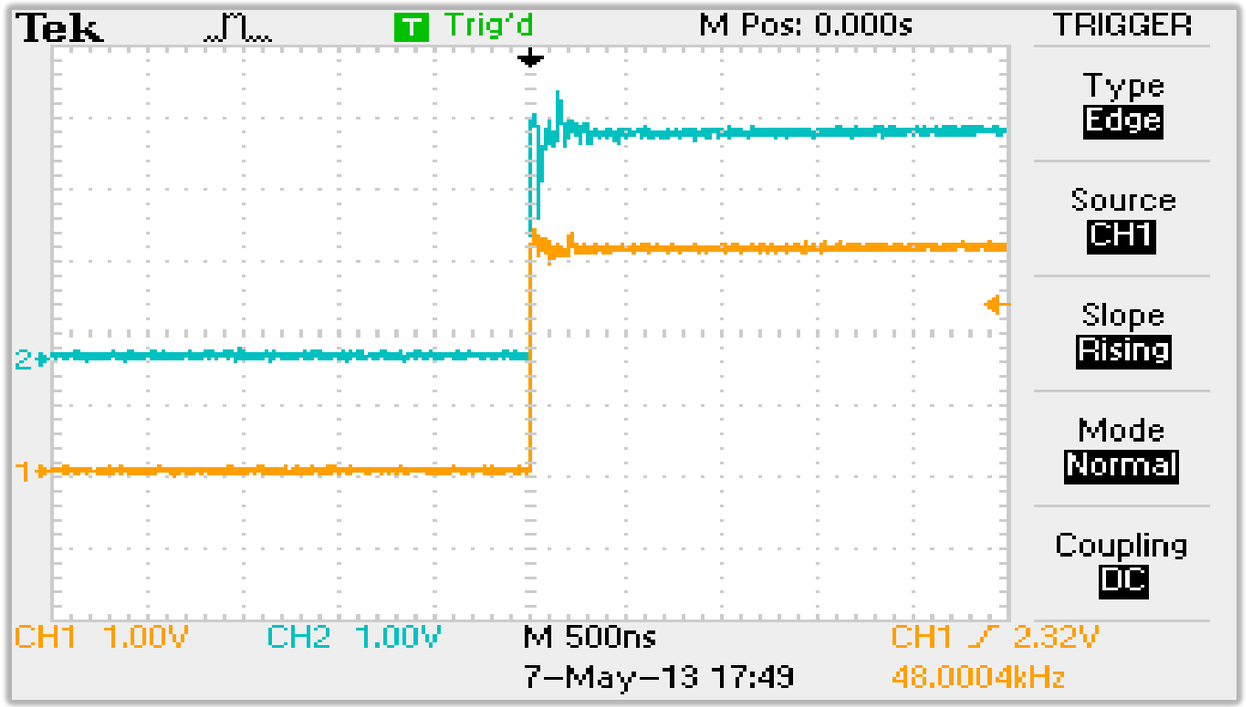


Clock: Testing Accuracy – Dante

One Switch



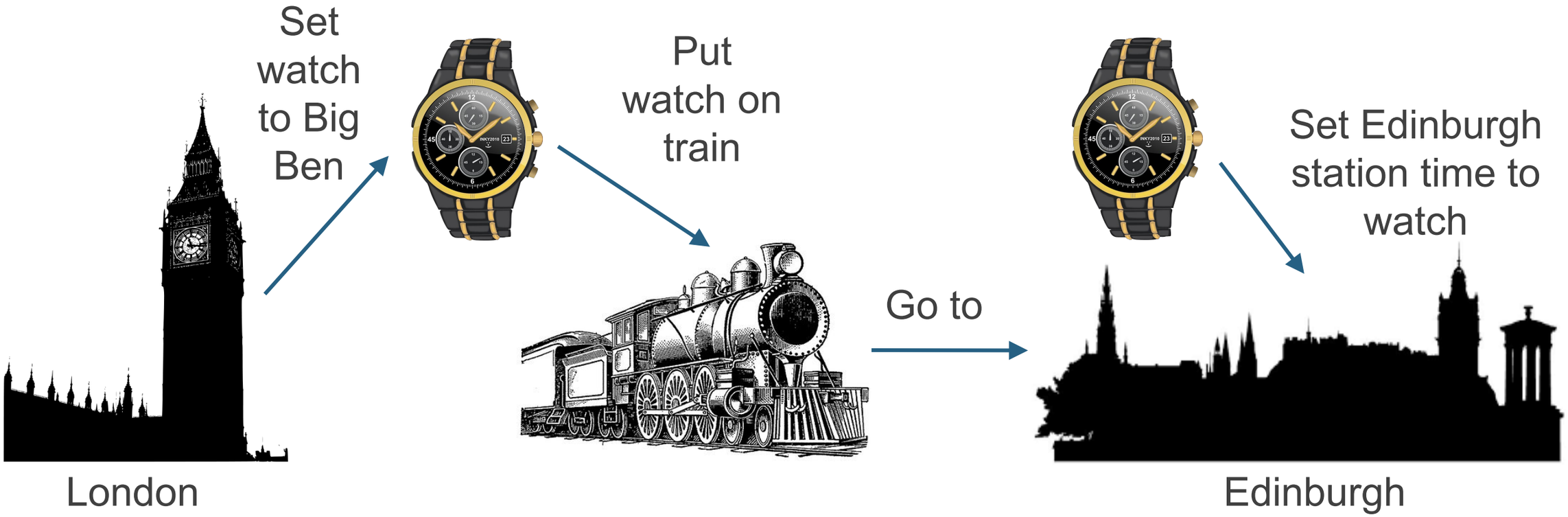
Two Switches



PTP: Synchronizing Time

- The idea of distributing time over a network started with British Railways
- Trains had a schedule – arrive/departure times.
- Stations on the route needed to agree on what time it was, so trains would be “on time”.

PTP: Synchronizing Time



PTP: Sync (Time) and Follow-ups (Speed)

Sync (Set Time) - Multicast
Ref 1435: 2019 June 12 09:00:01.000325364

→ Follower Sets Clock

Follow-Up (Set Speed) - Multicast
“Ref 1435: 2019 June 12 09:00:01.000326789”

→ Follower Adjusts Speed:

Compare elapsed time from master and local clock, then slow or speed up to match.

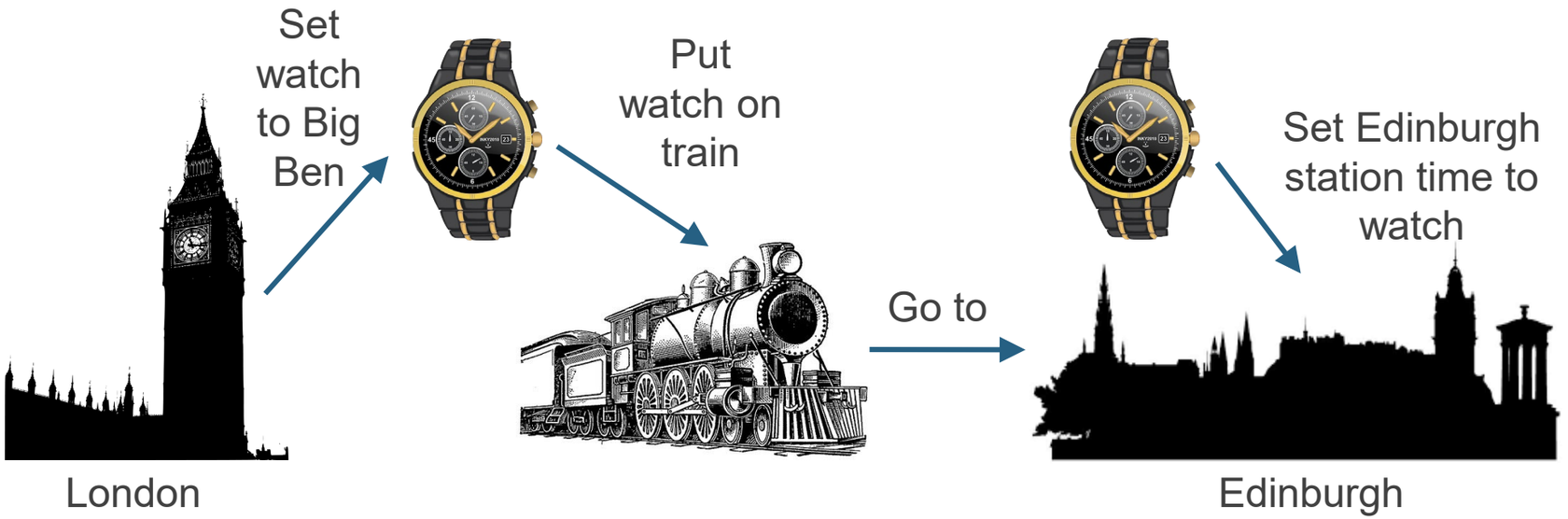
PTP: Sync (Time) and Follow-ups (Speed)

PTP: Sync (Time) and Follow-ups (Speed)

Clock: Testing Accuracy – Dante

Wait, what about propagation delay?

PTP: Synchronizing Time



The watch on the train continued keeping time. Network packets don't.

PTP: Sync and Follow-ups are Multicast

Clock followers send delay requests to the clock master, to which the clock master responds.

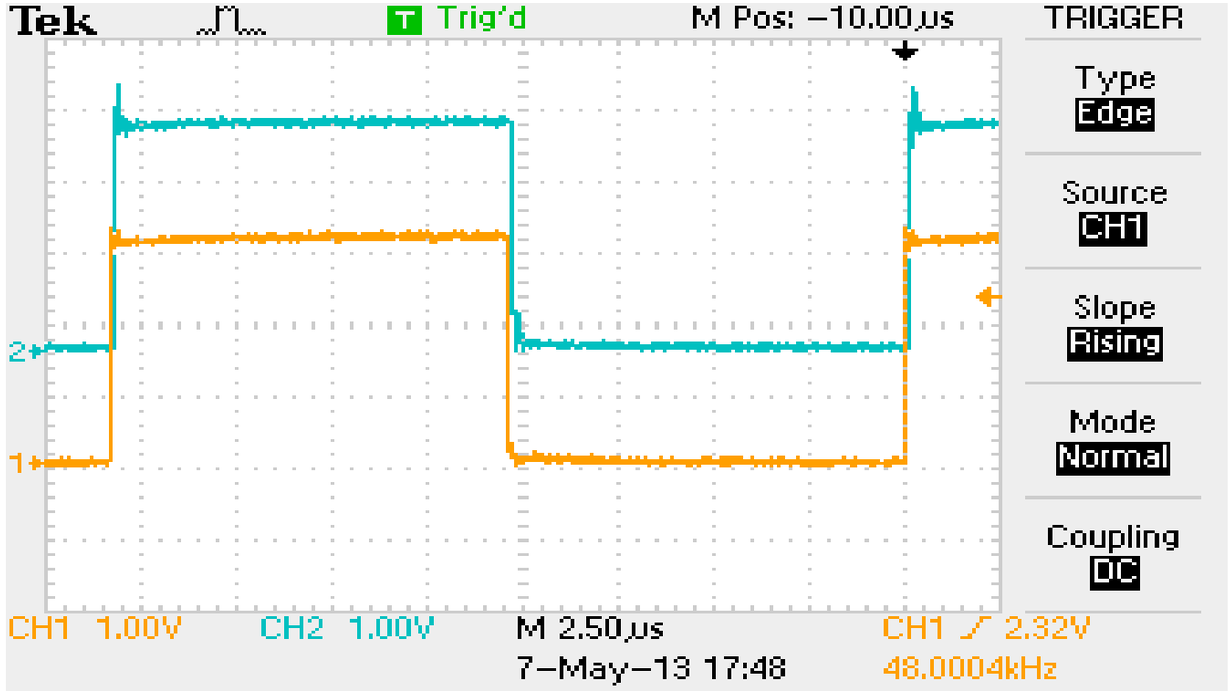
Delay Request – Unicast
Delay Req 1066: 09:00:02.00567283

Delay Response - Unicast
Delay Response 1066: Received: 09:00:02.001325745 Responded: 09:00:02.008564367

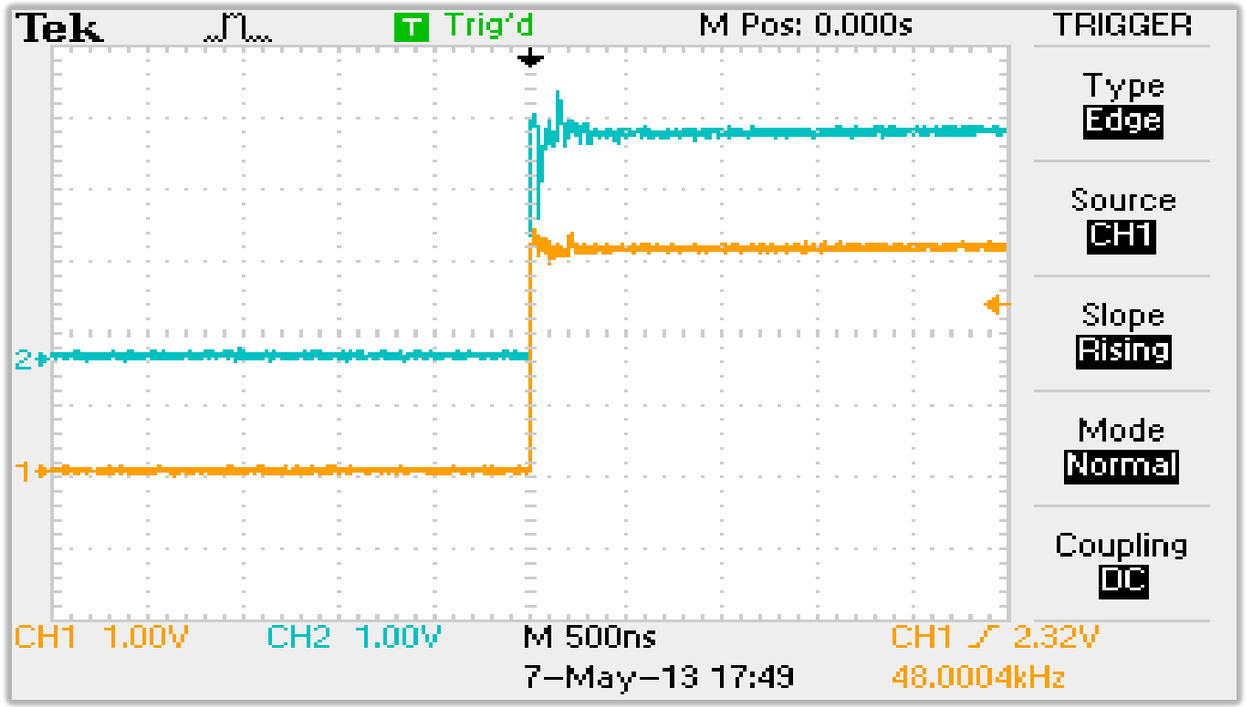
Clock follower knows Tx & Rx timestamps of request & response, mathematically averages to pinpoint network traversal times.

Clock: Testing Accuracy – Dante

One Switch



Two Switches



PTP Clocking at the Late Late Show (CBS)

Studio

House Band

FOH

Monitors

Guest Band

Sound FX

160 Mic Ins (Studio)
64 Mic/Line Ins (Remote)
32 Guest Band “Tracks”
64 Monitor Mixes (32 stereo)
32 Stems
16 Communication Lines

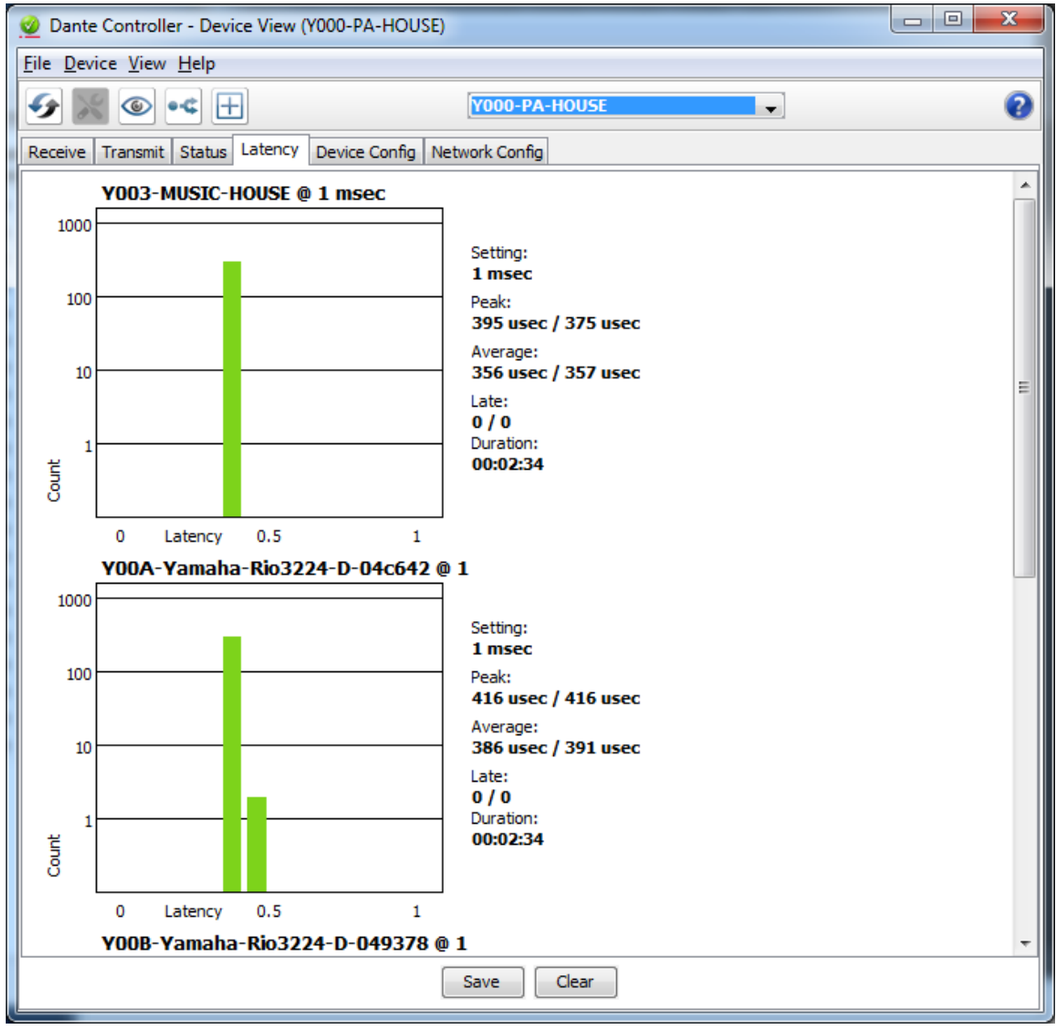
256 Multicast Streams
112 Unicast Streams

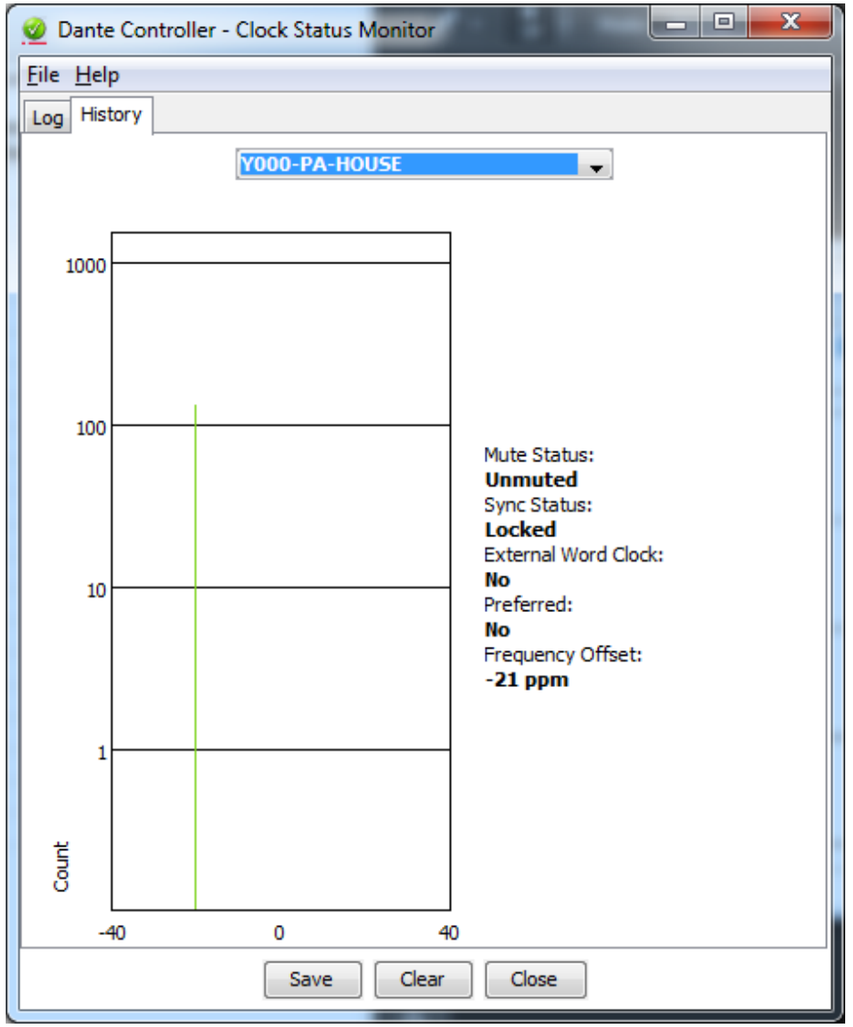
500-1000 Patches

Remote Feed

FOH

Monitors


Dante Controller - Device View (Y000-PA-HOUSE)
File Device View Help
Y000-PA-HOUSE
Receive Transmit Status Latency Device Config Network Config
Y003-MUSIC-HOUSE @ 1 msec
1000
100
10
1
Count
0 Latency 0.5 1
Setting:
1 msec
Peak:
395 usec / 375 usec
Average:
356 usec / 357 usec
Late:
0 / 0
Duration:
00:02:34
Y00A-Yamaha-Rio3224-D-04c642 @ 1
1000
100
10
1
Count
0 Latency 0.5 1
Setting:
1 msec
Peak:
416 usec / 416 usec
Average:
386 usec / 391 usec
Late:
0 / 0
Duration:
00:02:34
Y00B-Yamaha-Rio3224-D-049378 @ 1
Save
Clear


Dante Controller - Clock Status Monitor
File Help
Log History
Y000-PA-HOUSE
1000
100
10
1
Count
-40 0 40
Mute Status:
Unmuted
Sync Status:
Locked
External Word Clock:
No
Preferred:
No
Frequency Offset:
-21 ppm
Save
Clear
Close

ARP – Address Resolution Protocol

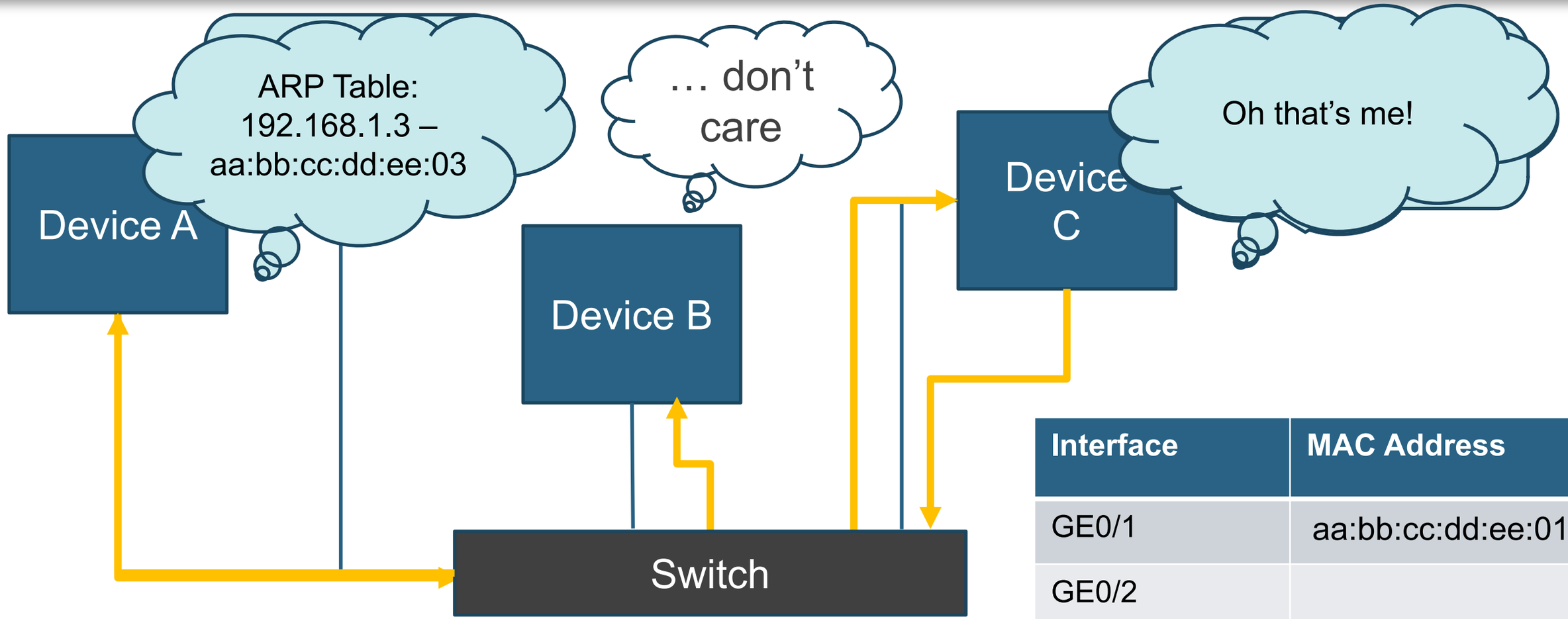
Topics for Today

ENHANCE	**Core IP Settings**	*IP Address, Subnet Mask, Gateway/Router, LAN Range*
	DNS	*Domain Name Service*
	DHCP/Link Local	*Automatic Address Settings*
	TCP/UDP	*Transmission Methods*
	Unicast, Multicast and Broadcast	*Distribution Methods*
	QoS	*Quality of Service – Traffic Prioritization*
	VLAN & Trunk Implications	*VLAN, Trunk, Tagged VLAN, STP, LAG*
NEW	**Network Ports**	*Managing Simultaneous Connections*
	PTP Clocking	*Precision Time Protocol (PTP)*
	ARP	*Switching by MAC vs IP*
	Layered Network Models	*OSI and TCP Conceptual Models*
	Segmenting Broadcast Domain	*Managing the “Noise” in a Network*
	Design & Troubleshooting	

ARP – ADDRESS RESOLUTION PROTOCOL

- Devices use ARP to match MAC to IP Address (in their broadcast domain)
- If a device doesn't know the MAC address of the target IP address:
  - It issues an ARP "whohas" message is issued as a broadcast
  - The device with that IP replies in unicast
  - The sender will remember that correlation – as will switches.
- So, an ARP message "glues" Layer 2 and 3 together.

SENDING AND RECEIVING UNICAST



Interface	MAC Address
GE0/1	aa:bb:cc:dd:ee:01
GE0/2	
GE0/3	aa:bb:cc:dxd:ee:03

Layered Network Models & Encapsulation

Topics for Today

ENHANCE	**Core IP Settings**	*IP Address, Subnet Mask, Gateway/Router, LAN Range*
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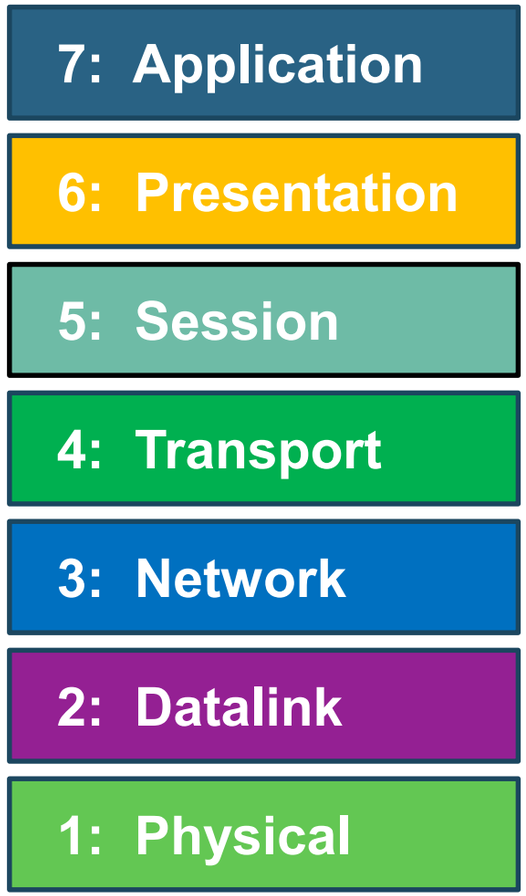
	Layered Network Models	*OSI and TCP Conceptual Models*
	Segmenting Broadcast Domain	*Managing the “Noise” in a Network*
	Design & Troubleshooting	

LAYERED MODELS

OSI Model



Layered Models are:

- Conceptual, not concrete
  Concepts tend to last longer than concrete models.
  Hardware independent, doesn't always reflect real life.
- Helpful in designing or troubleshooting
  An unplugged cable is a "Layer 1" problem.
  I'm looking for a "Layer 3" network switch.
- Not required skill to set up a simple Dante network
  But it is on the Dante Level 3 Certification test.

LAYERED MODELS

OSI Model

- 7: Application
- 6: Presentation
- 5: Session
- 4: Transport
- 3: Network
- 2: Datalink
- 1: Physical

I write a letter…
(data)

That is put in an envelope…
(datagram)

With to/from addresses…
(both in MAC and IP Address)

That goes to the postal service
(CAT6 or fiber cable)

LAYERED MODELS

OSI Model

- 7: Application
- 6: Presentation
- 5: Session
- 4: Transport
- 3: Network
- 2: Datalink
- 1: Physical

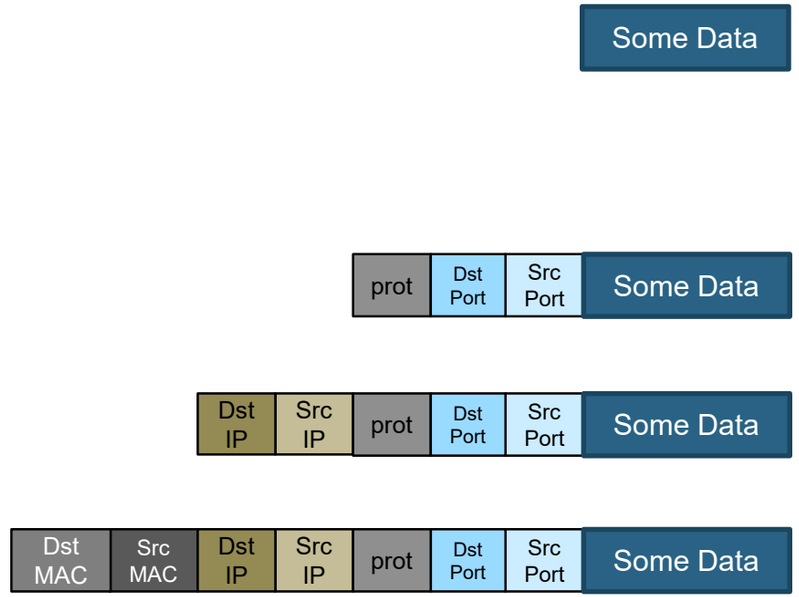
Data for the network

gets put in a datagram…

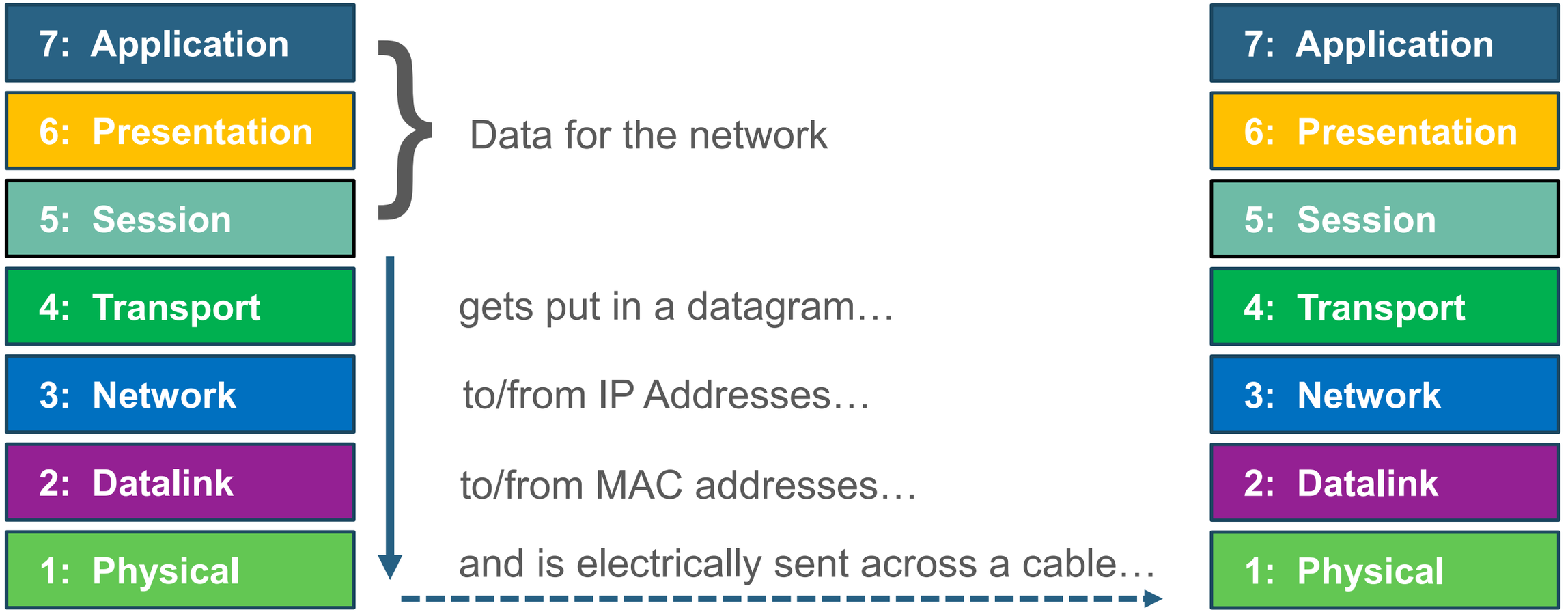
to/from IP Addresses…

to/from MAC addresses…

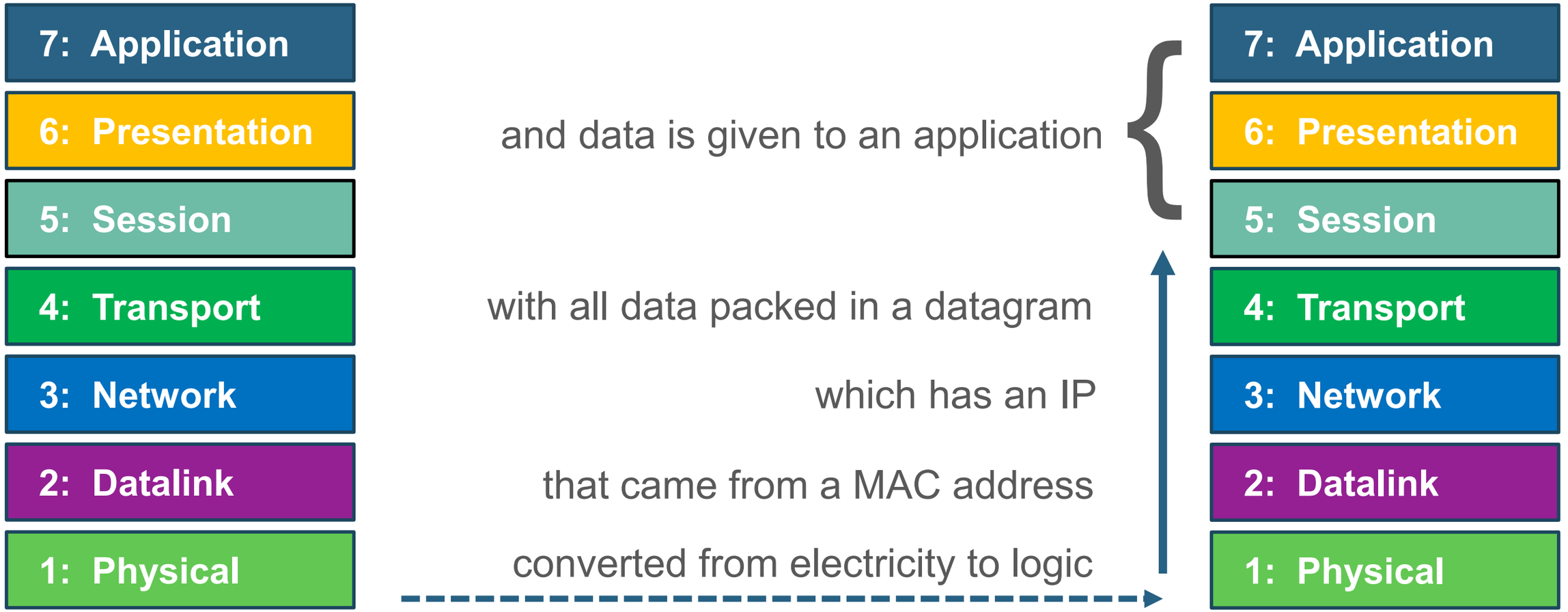
Encapsulation



OSI Model

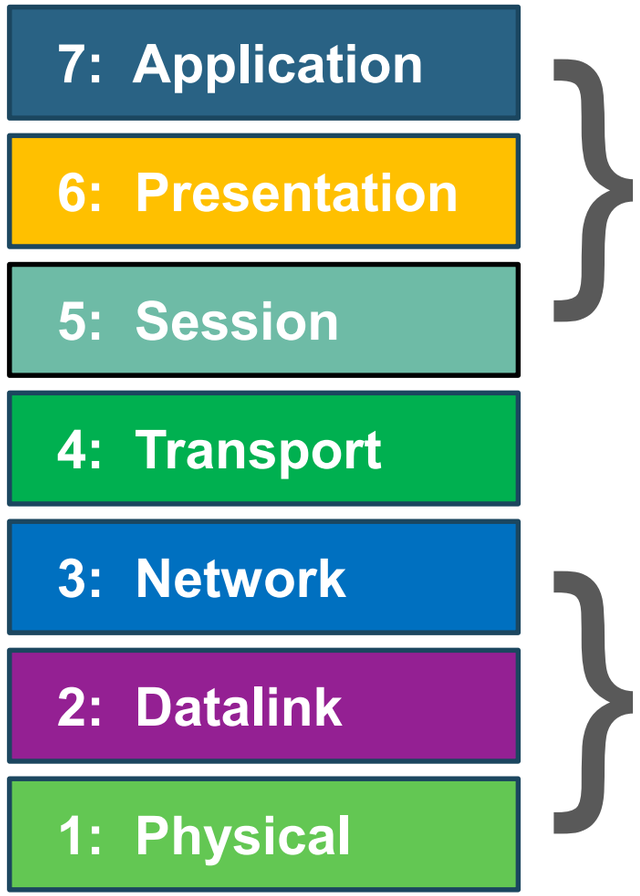

7: Application
6: Presentation
5: Session
4: Transport
3: Network
2: Datalink
1: Physical
Data for the network
gets put in a datagram…
to/from IP Addresses…
to/from MAC addresses…
and is electrically sent across a cable…
7: Application
6: Presentation
5: Session
4: Transport
3: Network
2: Datalink
1: Physical

OSI Model


7: Application
6: Presentation
5: Session
4: Transport
3: Network
2: Datalink
1: Physical
and data is given to an application
with all data packed in a datagram
which has an IP
that came from a MAC address
converted from electricity to logic
7: Application
6: Presentation
5: Session
4: Transport
3: Network
2: Datalink
1: Physical

LAYERED MODELS

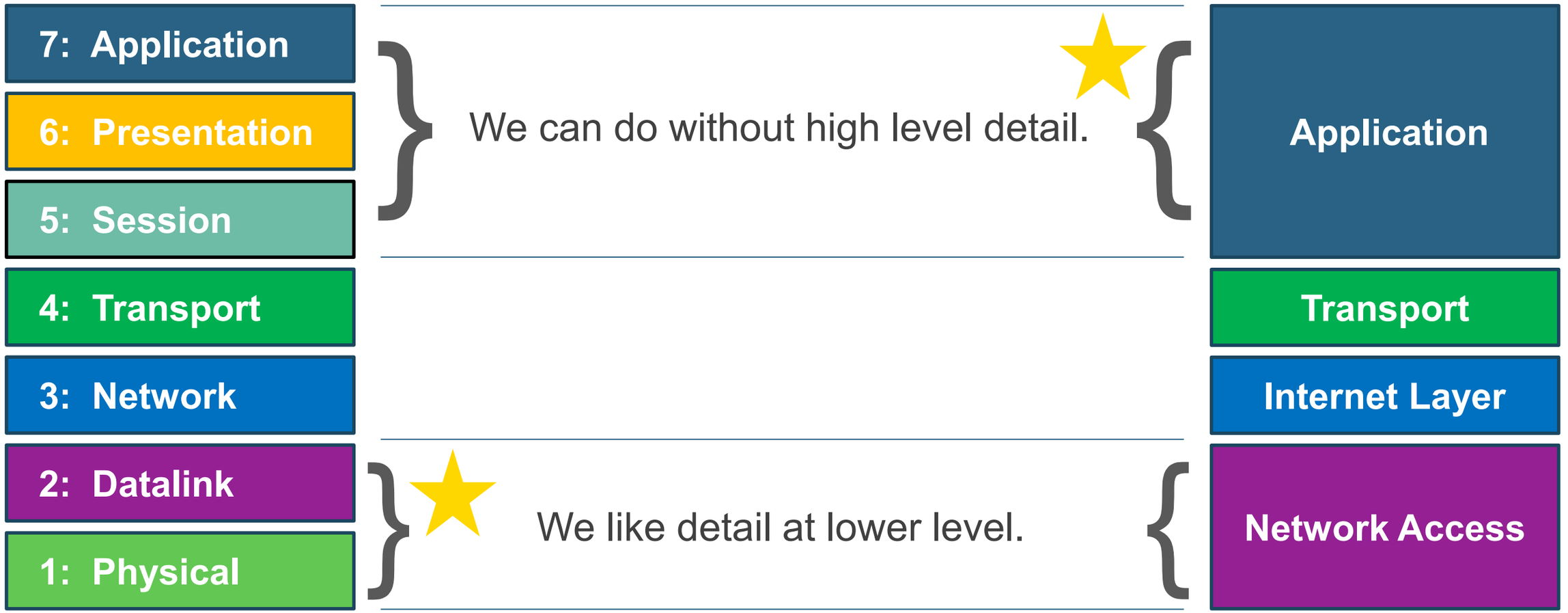
OSI Model



If you are a designing a computer application, you probably care about the higher levels of the model.

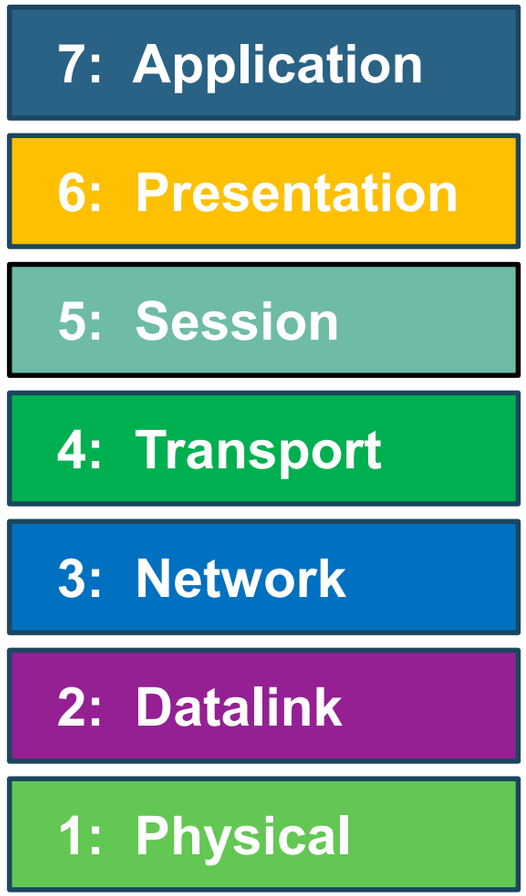
If you are a network engineer, you probably care more about the lower levels of the model.

LAYERED MODELS



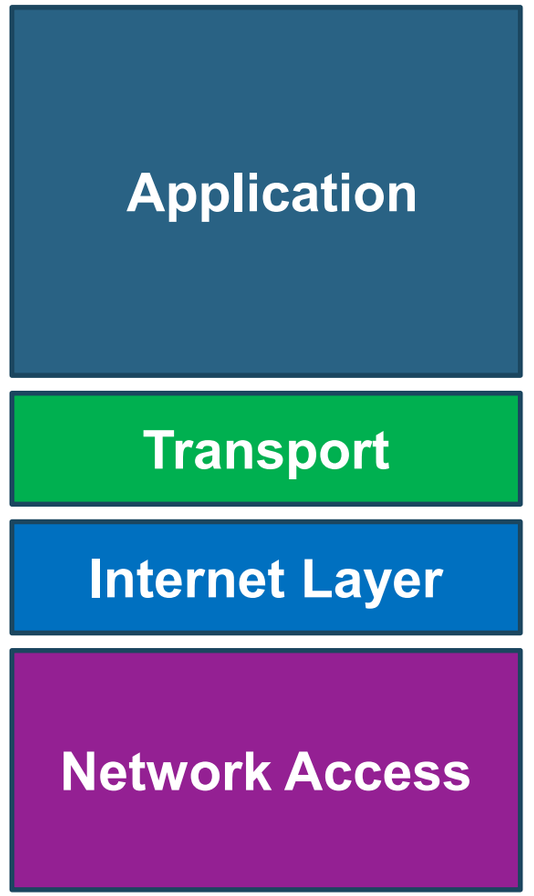
LAYERED MODELS

OSI Model

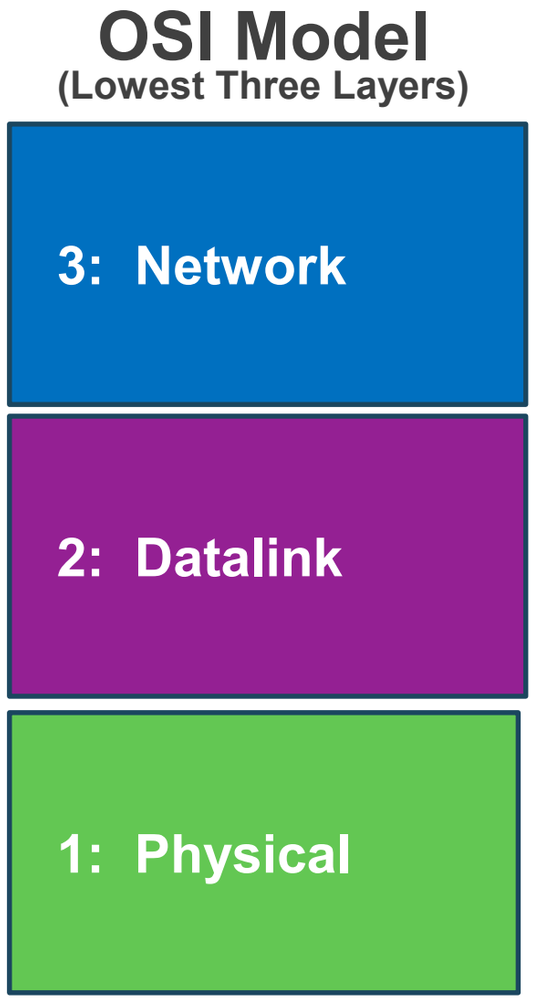


Neither model is perfect. But if we focus on the bottom three layers of the OSI model, we'll get what we need.

TCP/IP Model

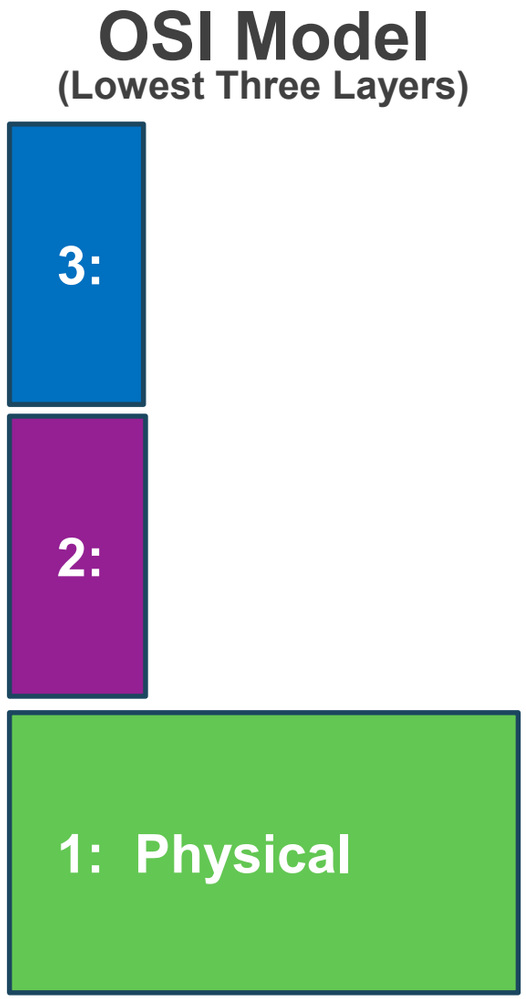


LAYERED MODELS



Layer 1 refers to the cable and the electrical signal on it.

- Is it plugged in?
- Is the cable broken, problem with impedance, etc?
- Is there electro-magnetic interference on copper?
- Is there light or dirty ends on the fiber optic cable?



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- Is the cable broken, problem with impedance, etc?
- Is there electro-magnetic interference on copper?
- Is there light or dirty ends on the fiber optic cable?

LAYERED MODELS

OSI Model
(Lowest Three Layers)

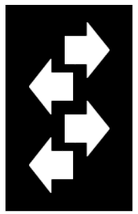
3: Network

2: Datalink

1:

ROUTER

Managed by IP Address



SWITCH

Managed by MAC Address

Segmenting the Broadcast Domain

LAYERED MODELS

OSI Model
(Lowest Three Layers)

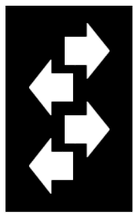
3: Network

2: Datalink

ROUTER

Layer 3 = Router
Passing data from one LAN to another

Unicast only
No Multicast passes (there are workarounds)
No Broadcast passes



SWITCH

Layer 2 = Switch
Passing data within a LAN

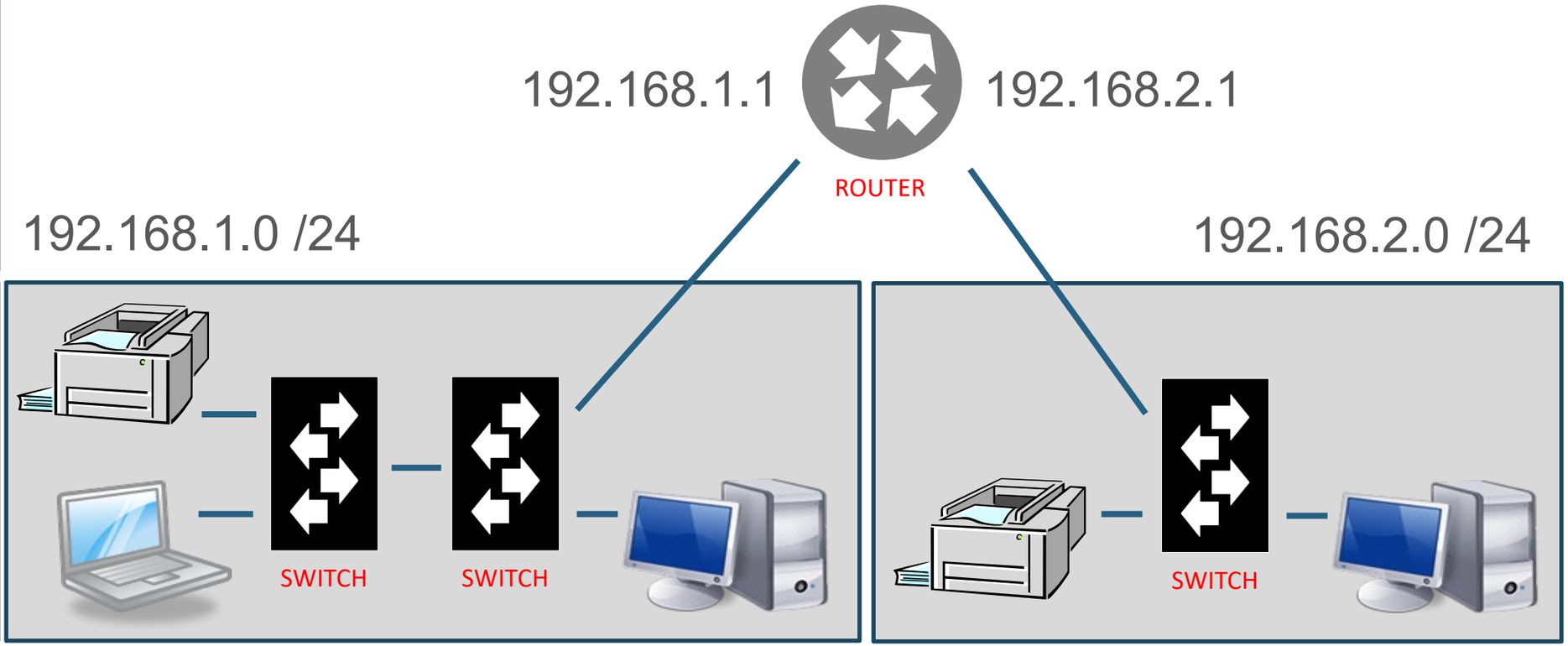
Unicast, Multicast, Broadcast allowed

OSI Model
(Lowest Three Layers)

3: Network

2: Datalink

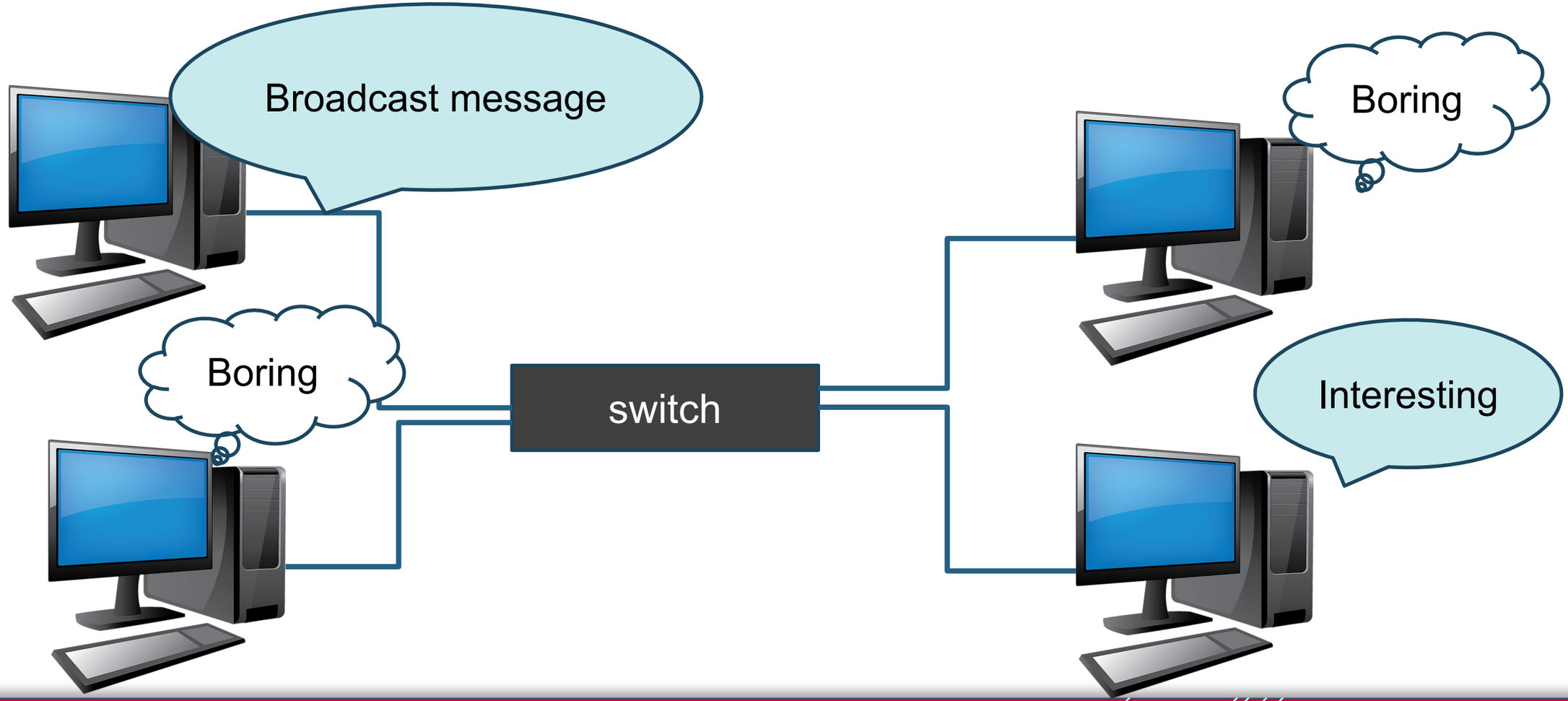
On any VLAN, there should only be one LAN Range.
LAN Ranges should only appear in one VLANs.



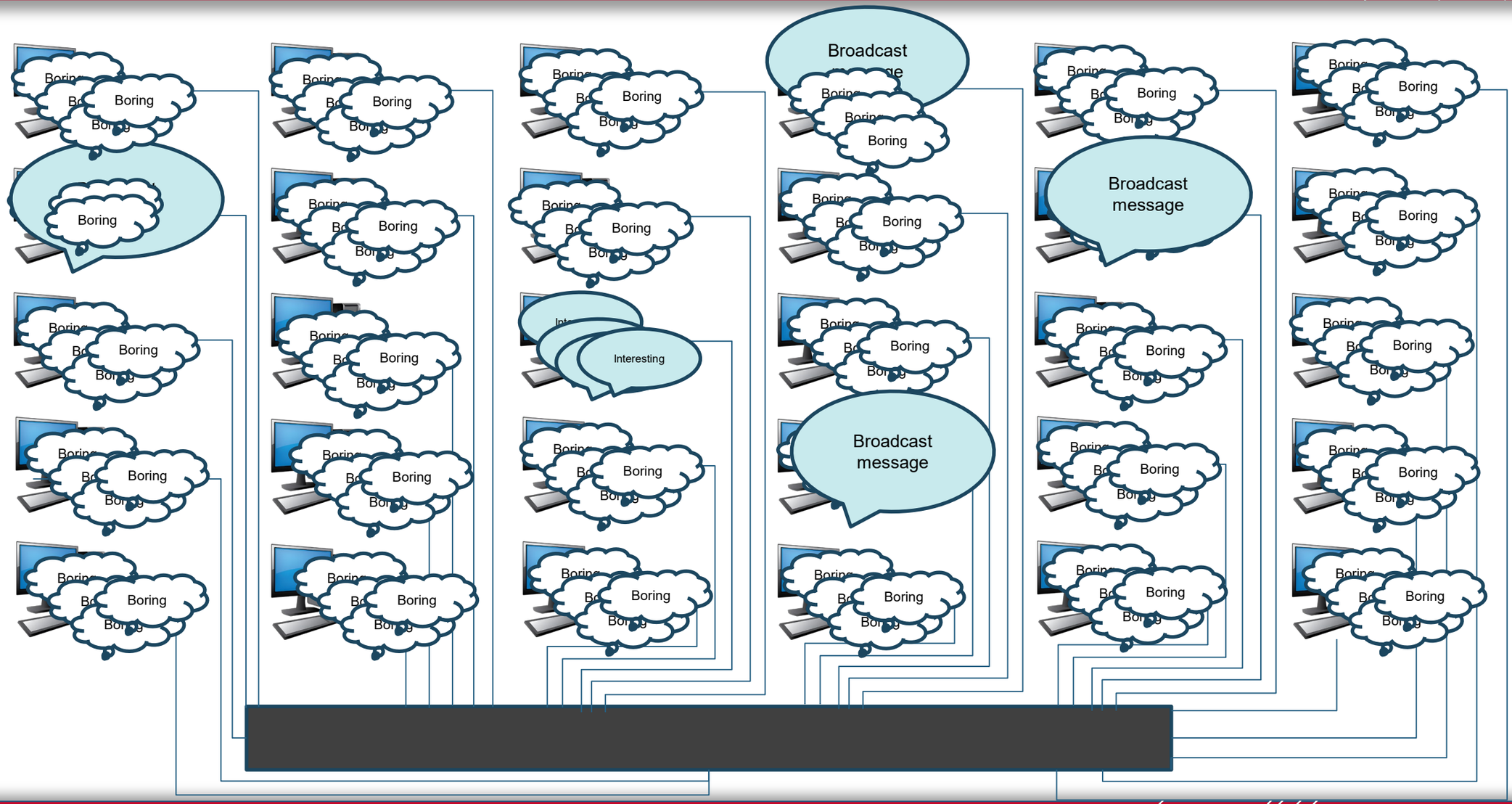
A Meeting Space w/ Airwalls is analogous to VLANs in a Network…

BROADCAST TRANSMISSION

Broadcast Messages are one to all Messages

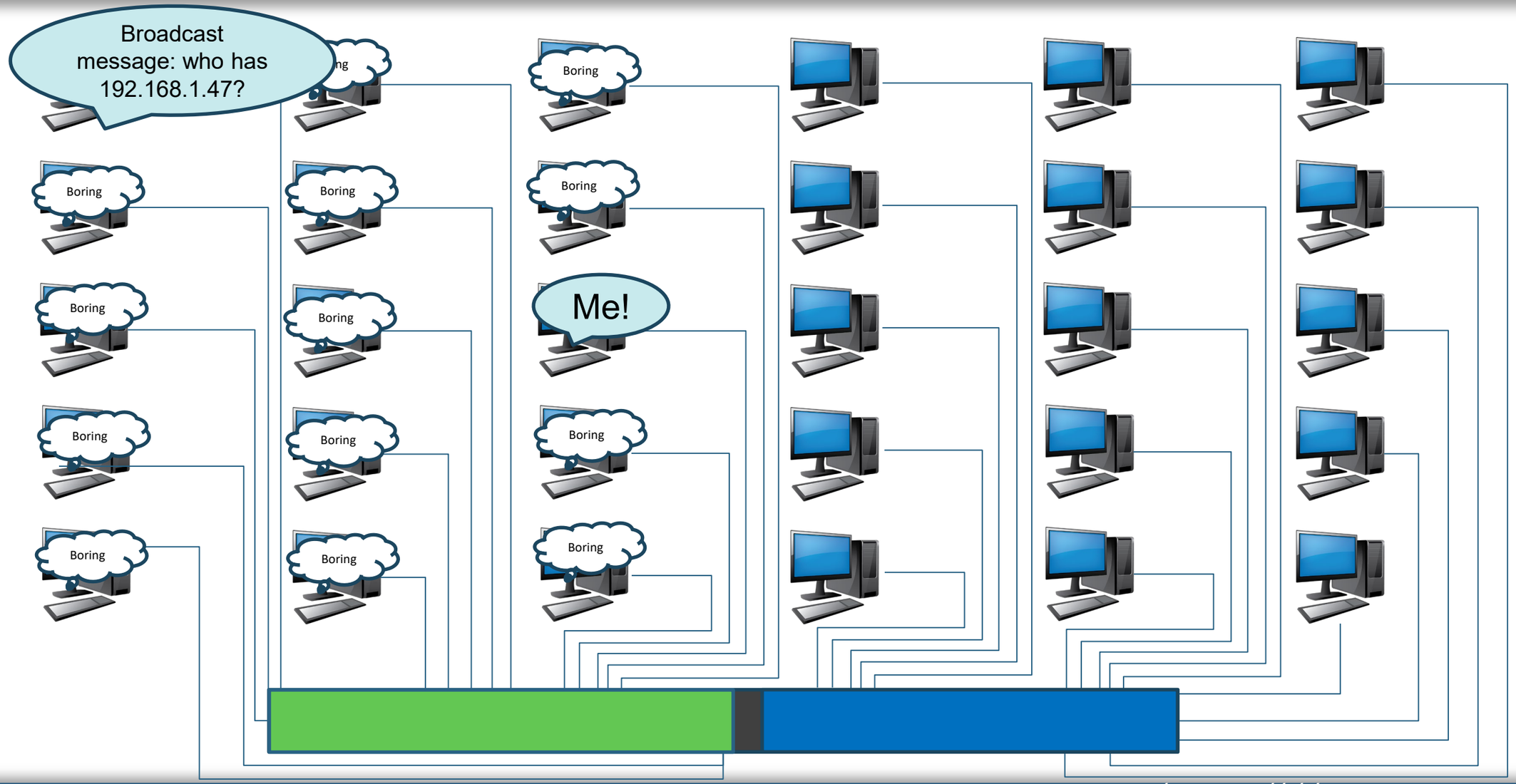


BROADCAST TRAFFIC

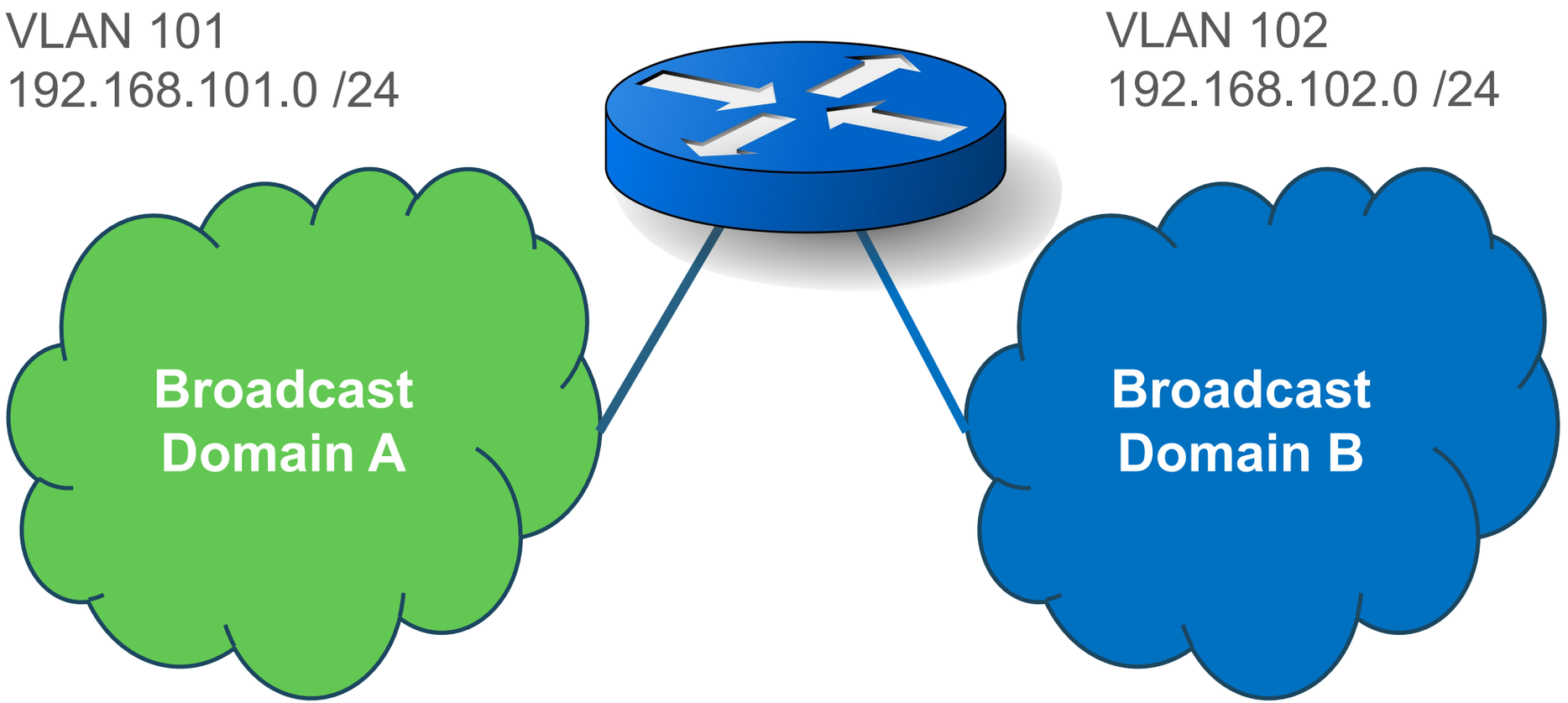


Surely there is a better way to deal with this?

SEGMENTING BROADCAST DOMAINS – GOOD PRACTICE



SEGMENTING BROADCAST DOMAINS – BUT STAYING CONNECTED

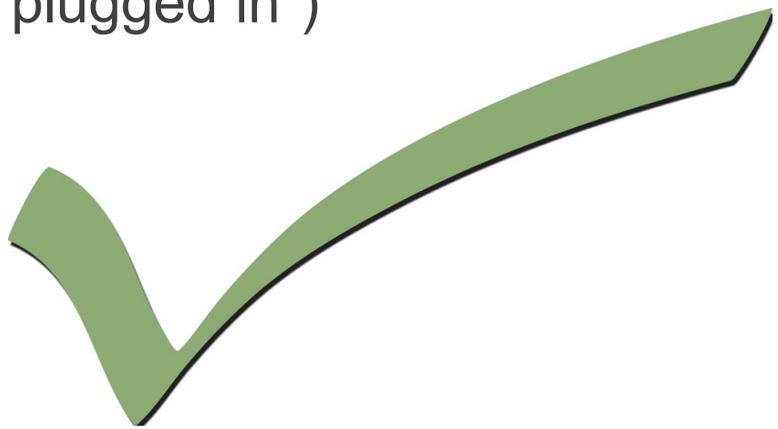


Design & Troubleshooting

DEFINING RESOURCE REQUIREMENTS

- Any project in anything requires this phase of planning

- Required resources for a Dante network:
  - ✓ Enough Transmit flows to serve all receivers
  - ✓ Enough Receive flows available on devices connecting to transmitters
  - ✓ Enough Bandwidth to carry flows
  - ✓ Unblocked logical connections (“wire” is not cut, and is “plugged in”)



TROUBLESHOOTING - DANTE “PORT” ADDRESSES

- Traffic used by Dante is as follows:

mDNS	224.0.0.251:5353
Control and Monitoring	224.0.0.230 – 232:8700-8708
PTP	224.0.1.129 – 132:319-320
Multicast Audio	239.255.0.0/16:4321
Unicast Audio	RX Unicast IP:14336 – 14600
AES67 Multicast Audio	239.XX.0.0/16:5004

  - All Dante traffic is UDP/IP
  - This means that if any traffic to/from these ports and IP addresses is blocked, then the ”wire” carrying that particular service can be considered “cut!”

NETWORK PORTS – 2 WAYS TO CUT THE WIRE

- The Network Switch Fabric can have ACLs applied (Access Control Lists)
  - ACLs are very powerful tools for filtering traffic in the network
  - Many advanced IT Networks will be applying ACLs
  - Normally IT departments will not wish to reveal or discuss these (potential security concern)

- It is reasonable to expect that the required service be provisioned with the required resources – at a Port level this is defined in previous slides

COMMON SYMPTOMS AND CAUSES

Device doesn’t show up in Dante Controller

- Is it connected/on?
- Is it placed in the same VLAN?
- Is multicast (mDNS) blocked?

COMMON SYMPTOMS AND CAUSES

Clock is giving lock/unlock messages

- Possible blocked multicast.
- Check the clock histogram in Dante controller to confirm drift.
- *Dante clocks can run for a surprising amount of time before falling out of sync badly enough to affect audio… hours*
- Unicast Delay Requests can be a quick tool to test if this is the case

COMMON SYMPTOMS AND CAUSES

Device Name shows in Dante Controller - no + visible to expand channels & status view missing Data

- Is the device in same subnet?
- Check Firewall settings on your computer's Operating System

COMMON SYMPTOMS AND CAUSES

Multiple Clocks Masters

- If only on primary only, devices “cannot hear” multicast sync messages from other devices – assume they are master. Look for blocked multicast.
- If primary is fine but secondary shows multiple masters, may simply be a broken trunk line.

TALKING TO AN IT DEPARTMENT

- Networking is about making a lot of parts of an unique “jigsaw” work together
- This course explains the requirements and performance of the “Dante piece” of the jigsaw
- Remember – an IT department have to make many pieces fit together – remain patient, it can and will be made to fit together nicely.

Next Steps

TAKE THE LEVEL 3 TEST

http://www.audinate.com/certify

- Create an Audinate account if you don’t have one
- Login to your account
- Take Level 3 test
- Certificate is automatically generated

Thank You