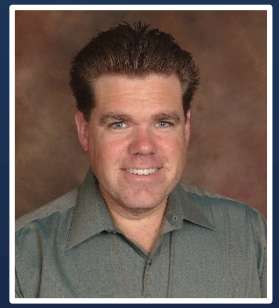


Patrick Killianey
Network Systems Applications Engineer
YAMAHA commercial audio

Terms & Tools to Know

- TCP vs UDP
- QoS (Quality of Service)
- Dante Flows
- Unicast, Broadcast & Multicast
- IGMP Snooping

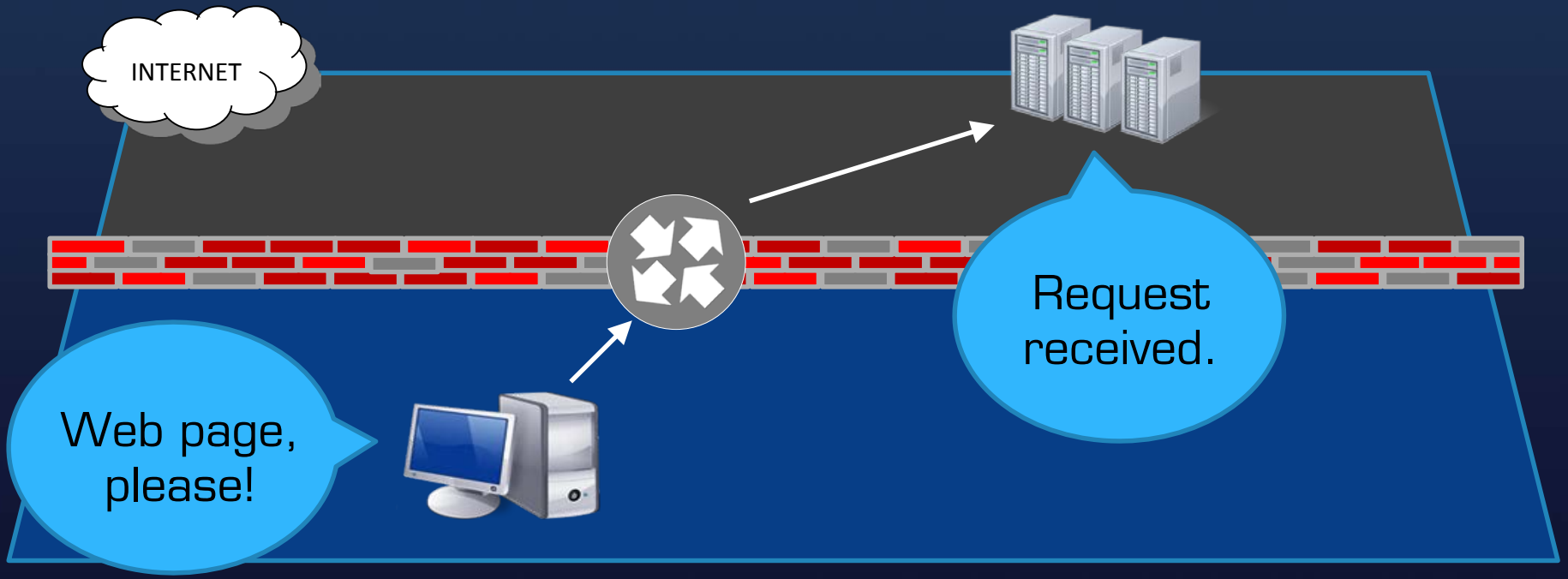
Dante's Word Clock

- Review: Digital Audio
- Review: Clocking Architecture
- Real Scope Views of Clocks
- Application: Why does it matter?

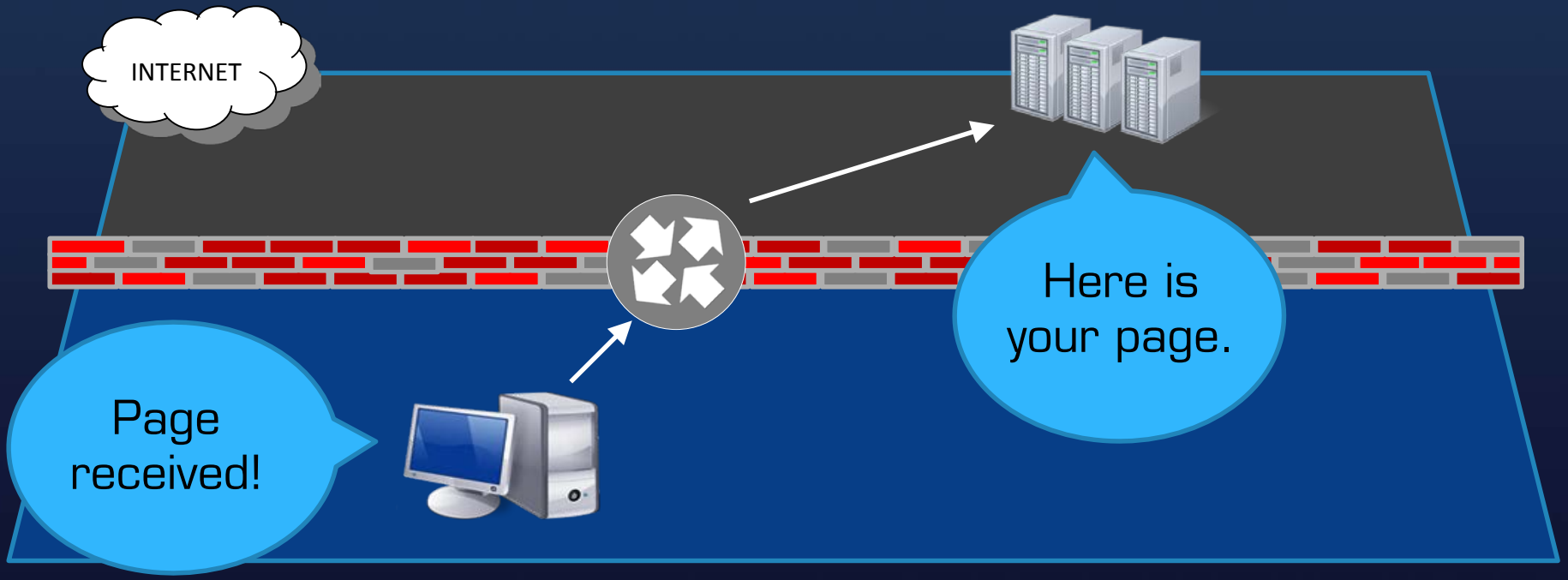
TCP vs. UDP

- TCP is akin to “Signature Required” delivery
  - System can slow down or retry a message
  - Configuration is received by sender
  - Typical for web browsing, email, “telnet” control
- UDP is more like “First Class Mail”
  - Sender trusts delivery occurs – no tracking/retries.
  - Streamlines delivery, reduces overhead.
  - Typical for time-sensitive content (streaming)

TCP Traffic



TCP Traffic



UDP Traffic

Traffic can occur both ways.
Data does not have to be verified.

Inputs

Mixes

QoS (Quality of Service)

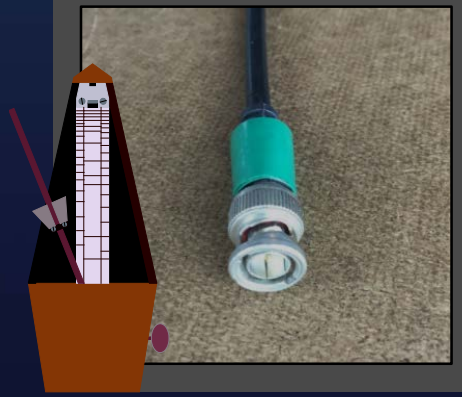
Prioritizing Time-Sensitive Traffic

- Large deliveries are broken in to pieces, shipped, reassembled.
- Packet types can be prioritized.

QoS (Quality of Service)

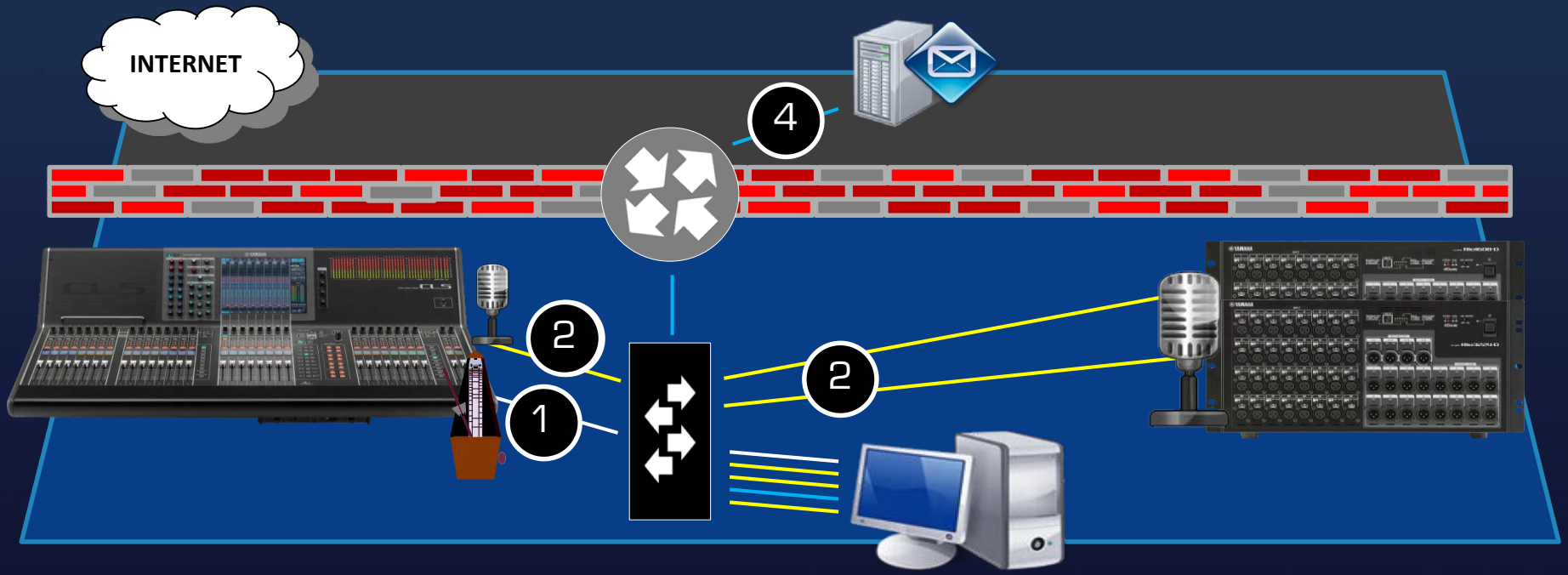
Prioritizing Time-Sensitive Traffic

1	2	3	4
Clock	Audio	Control	"Best Effort"
56 (CS7)	46 (EF)	8 (CS1)	



QoS (Quality of Service)

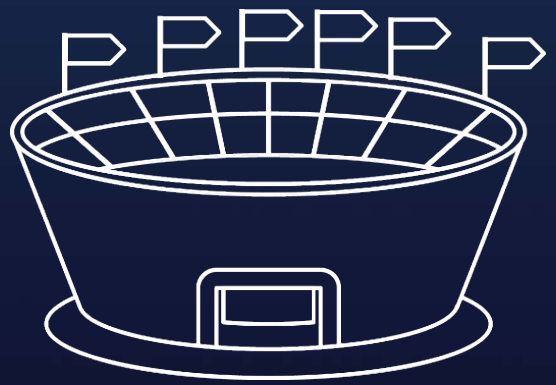
Prioritizing Time-Sensitive Traffic



QoS (Quality of Service)

Prioritizing Time-Sensitive Traffic

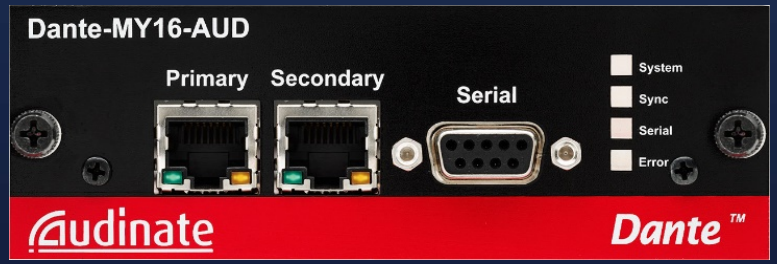
2008 - CobraNet®



QoS (Quality of Service)

Prioritizing Time-Sensitive Traffic

CobraNet®



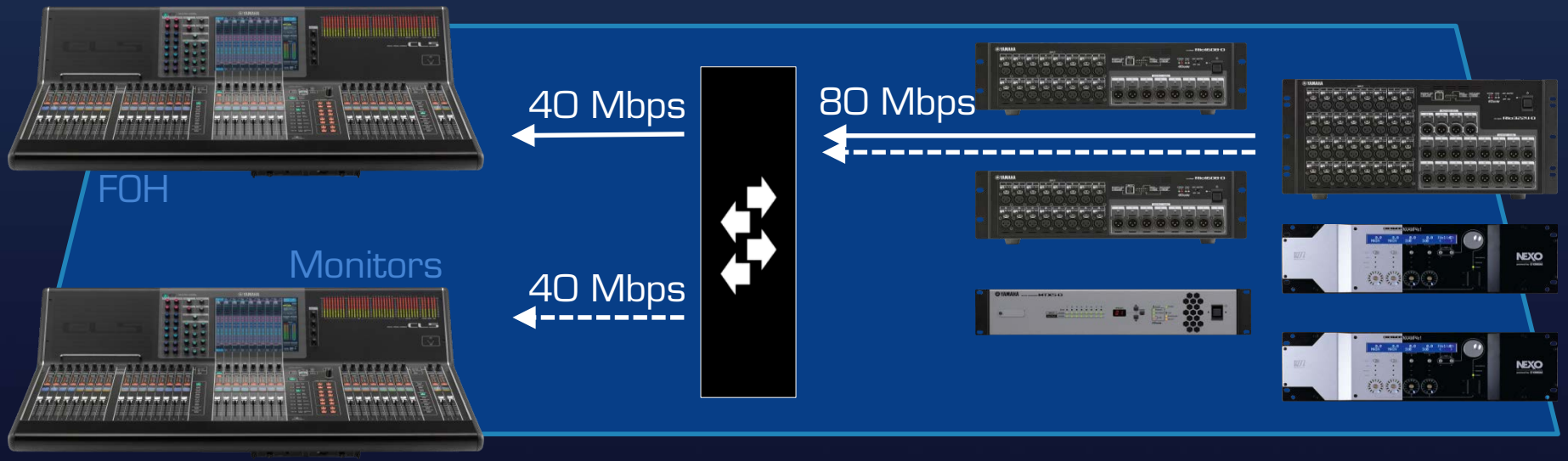
Dante™

QoS (Quality of Service)

Prioritizing Time-Sensitive Traffic

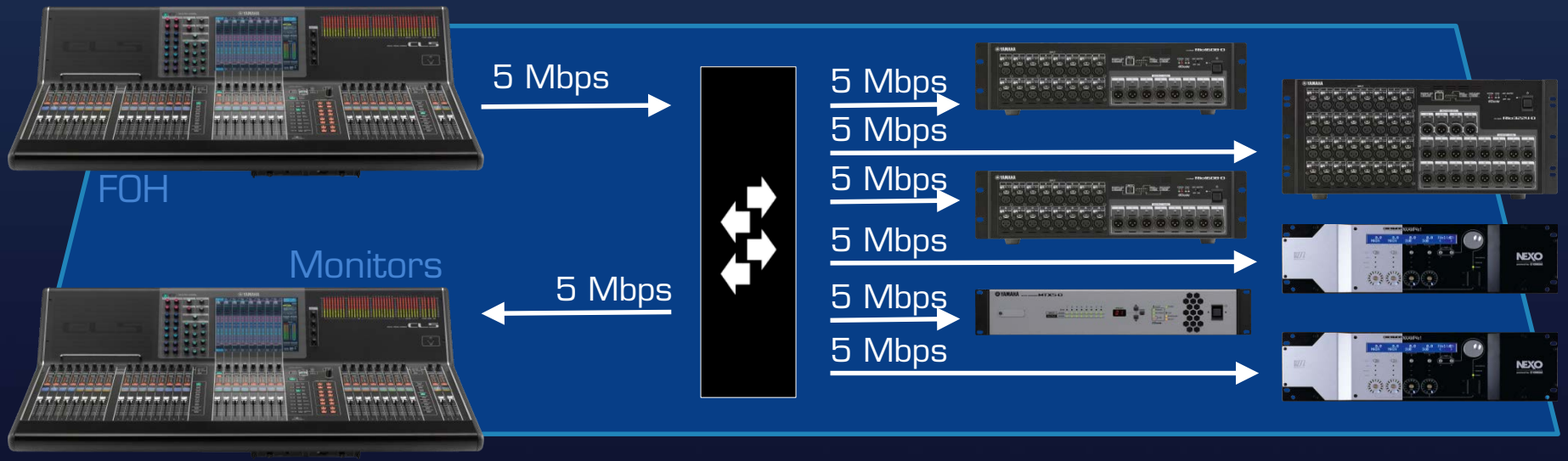
Unicast Distribution

1:1



Broadcast Distribution

1:All

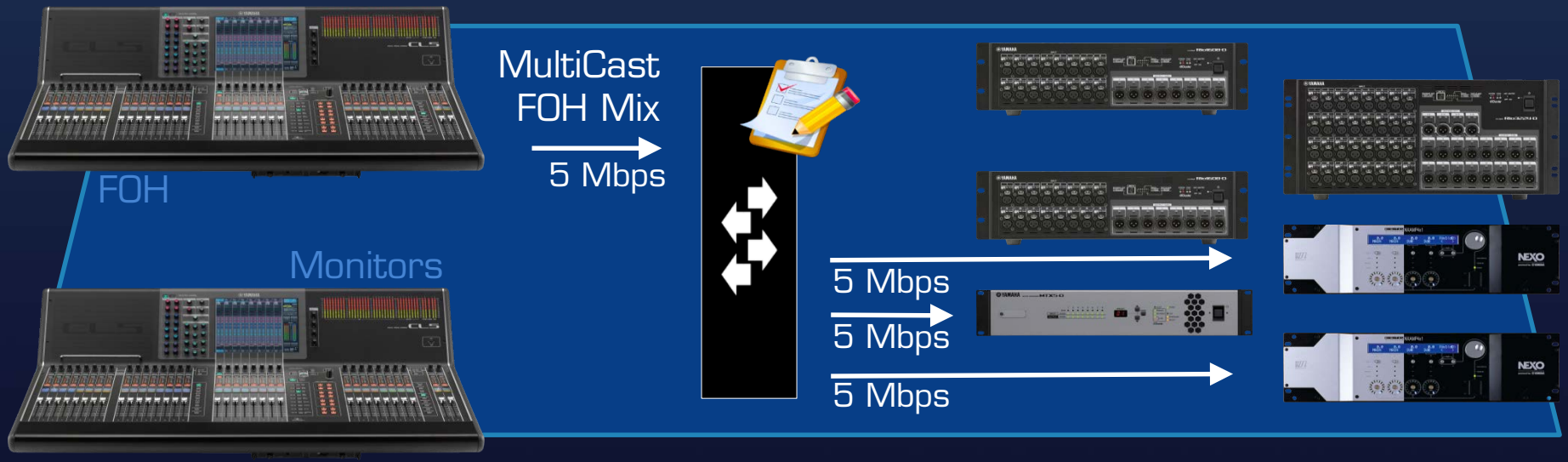


Multicast Distribution

1:Select List

Multicast Distribution

1:Select List



Multicast Distribution

1:Select List

- IGMP Snooping gives Multicast its advantage
- No IGMP Snooping Turns Multicast to Broadcast
- IGMP Snooping is more processor intensive in switch.

Guesstimating Network Bandwidth

Initial Assumptions:

1) Port speed ≥1Gbit
2) Switch backbone is 2x Port Speed

20 ports x 1Gbit x 2 = 40Gbit backbone

Guesstimating Network Bandwidth

- Raw capacity within a network switch is OK.
- Only examine uplinks between switches.
  ≤320 channels in each direction (per 1Gbit)
- Using Multicast? Watch CPU load in switch.

Dante Word Clock

But first, a *quick* introduction to
Digital Audio & Word Clock

Perspective from Knott's Berry Farm

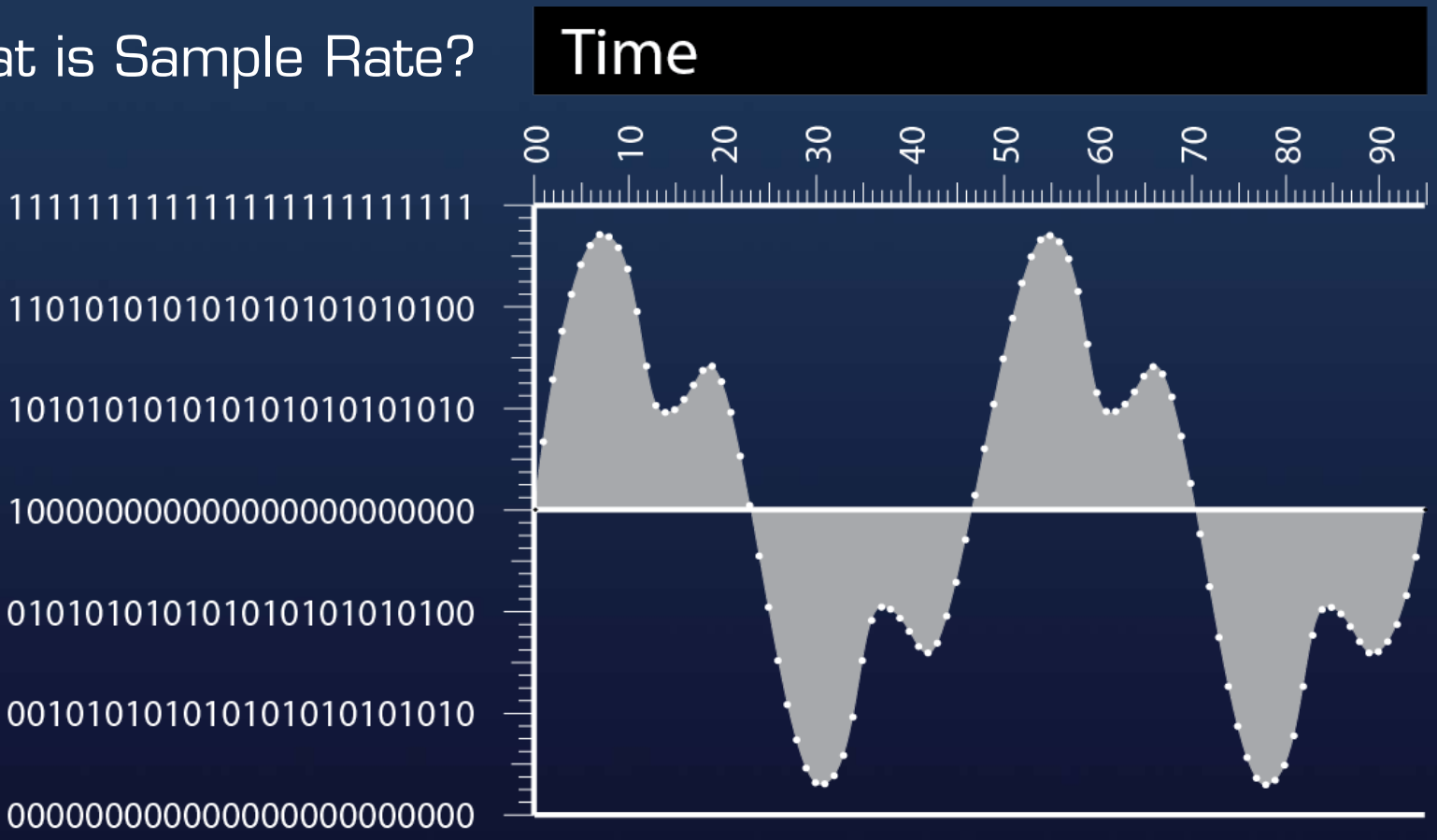
Why Do We Cover Digital Audio Basics?

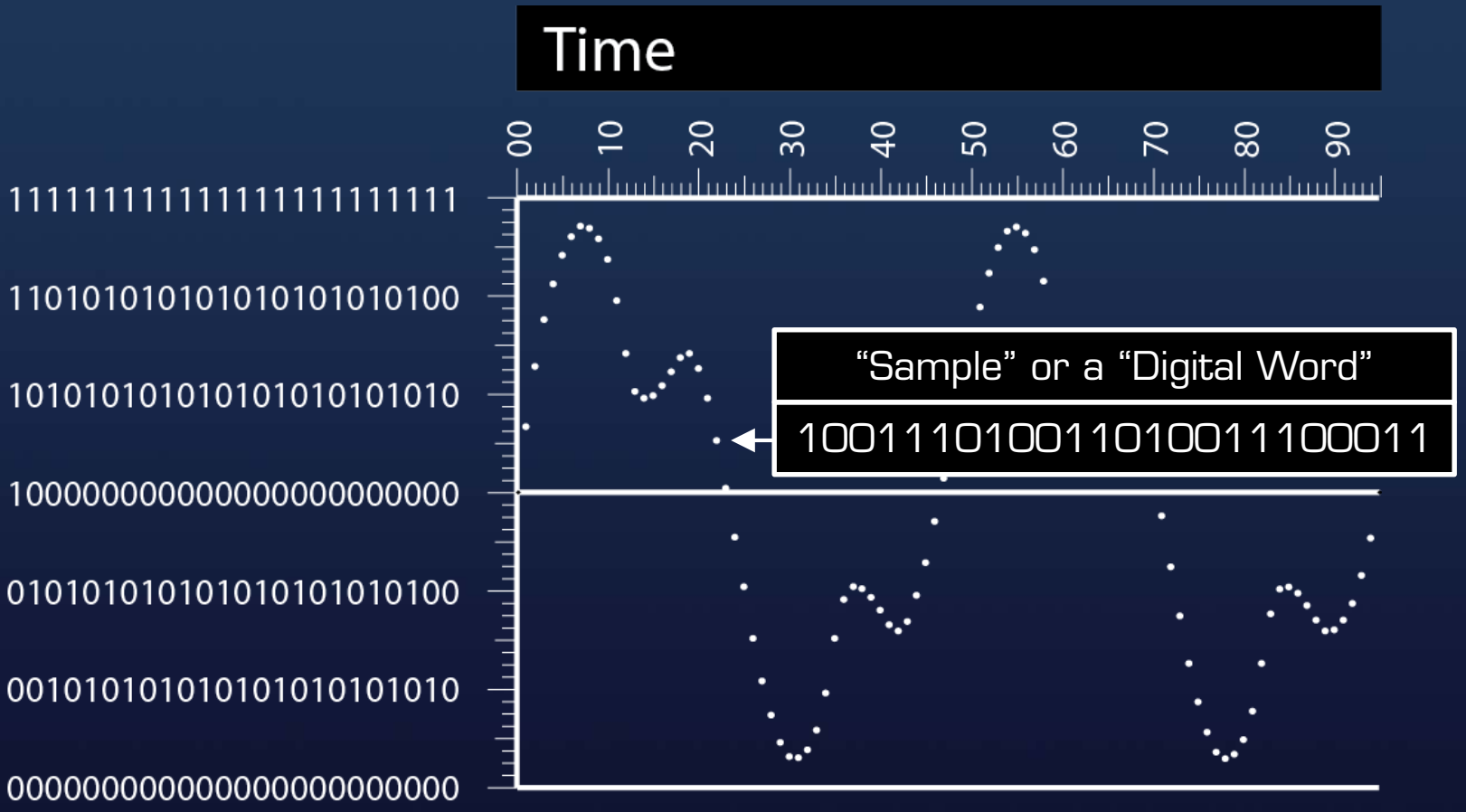
While getting trained
for a new show…

Why Do We Cover Digital Audio Basics?

What is a sample rate?

What is Sample Rate?




Time
00
10
20
30
40
50
60
70
80
90
11111111111111111111111
11010101010101010101010100
10101010101010101010101010
10000000000000000000000000
01010101010101010101010100
00101010101010101010101010
00000000000000000000000000
“Sample” or a “Digital Word”
10011101001101001110001 1

Sample Rate

X-Axis Resolution

Num of Samples/Sec?

44.1kHz (44,100/sec)
48kHz (48,000/sec)
88.2kHz (88,200/sec)
96kHz (96,000/sec)

Sample Rate	Bit Depth / Word Length
X-Axis Resolution	*Y-Axis Resolution*
Num of Samples/Sec?	*Accuracy of Each Sample?*
44.1kHz (44,100/sec)	16-bit
48kHz (48,000/sec)	20-bit
88.2kHz (88,200/sec)	24-bit
96kHz (96,000/sec)	32-bit

Why Do We Cover Digital Audio Basics?

Talking to an engineer
fresh off a tour …

Why Do We Cover Digital Audio Basics?

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

Why Do We Cover Digital Audio Basics?

Dante™ means your whole system is connected digitally.

Dante™ represents the first time many will connect digitally.

Capture
#4

Transmit
#3

Process
#2

Transmit
#1

48kHz

Problem: Digital Connection, No Sync

48,000.3 Hz

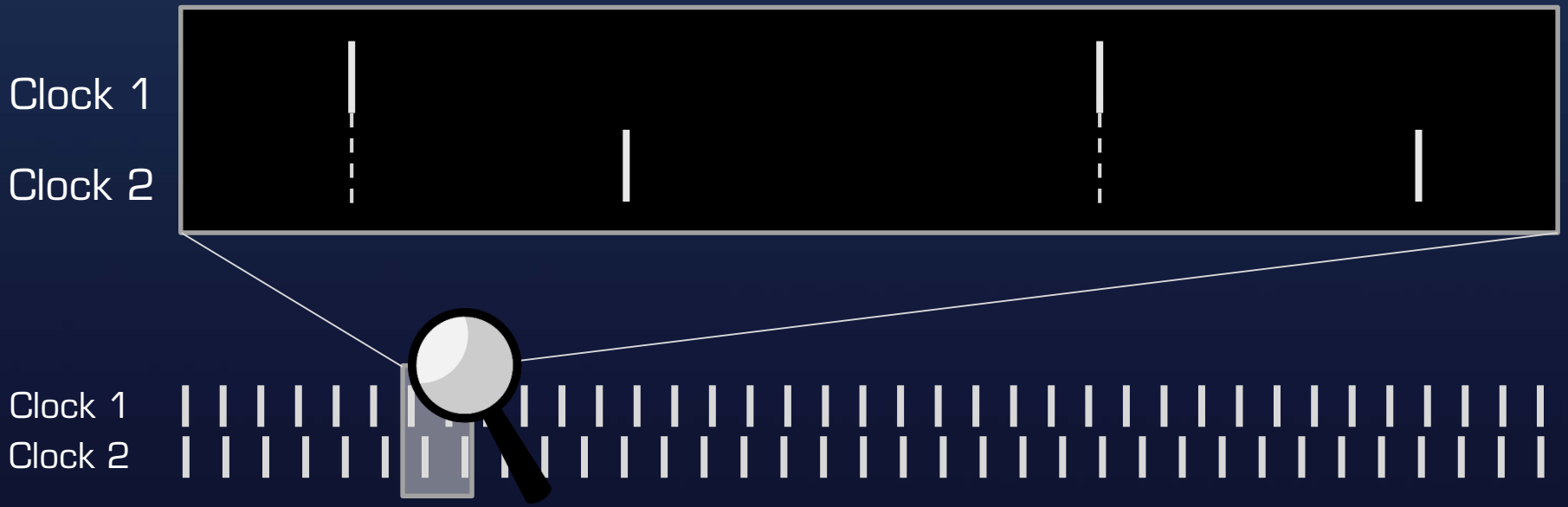
48,000.1 Hz

Clock 1

Clock 2

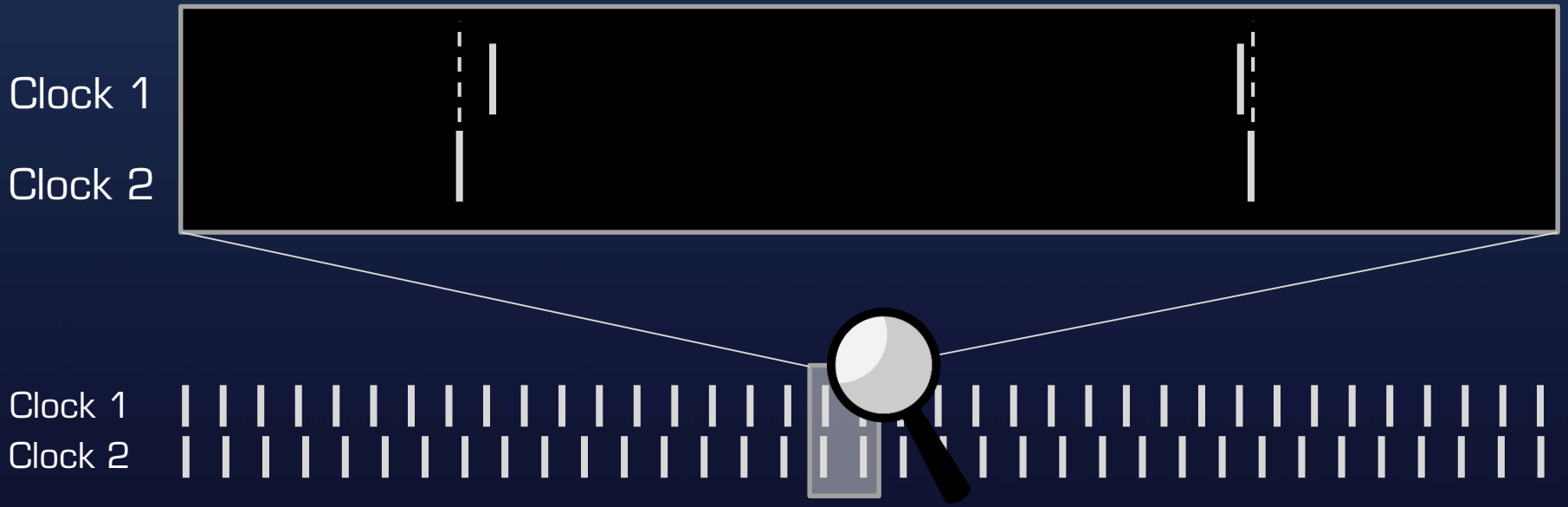
Problem: Digital Connection, No Sync

OK: Signal “out of phase”, but one sample appears per period.



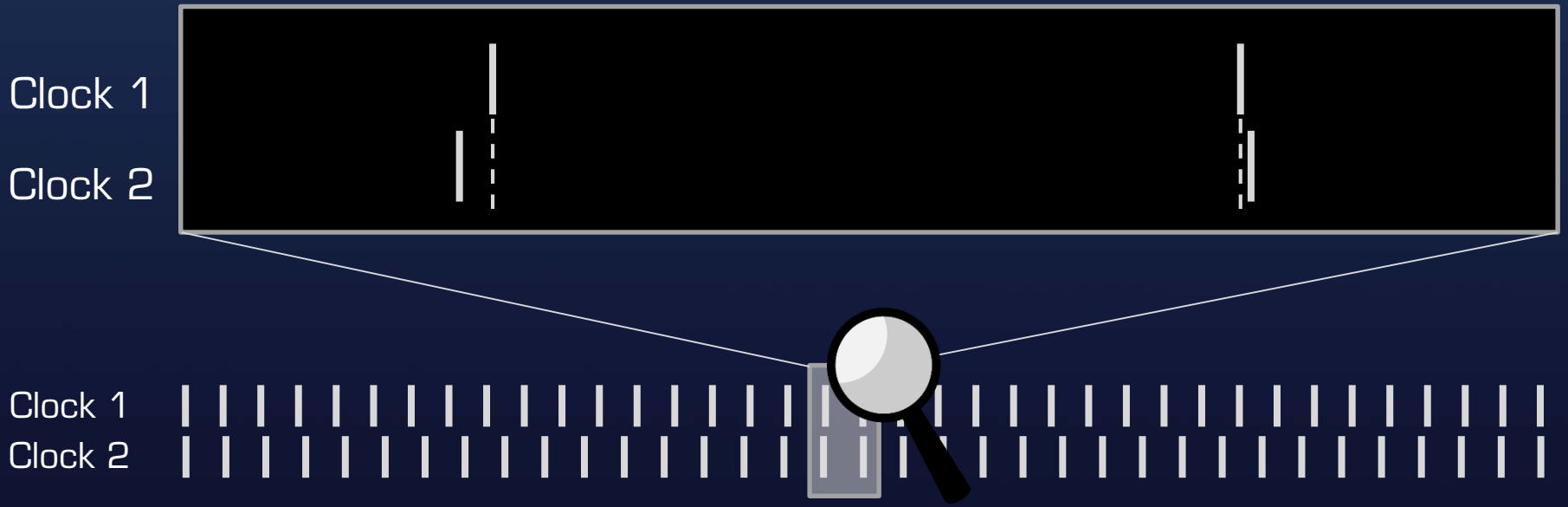
Problem: Digital Connection, No Sync

2 Samples Received in 1 Sample Period!
(Buffer Overrun)



Problem: Digital Connection, No Sync

0 Samples Received in 1 Sample Period!
(Buffer Underrun)

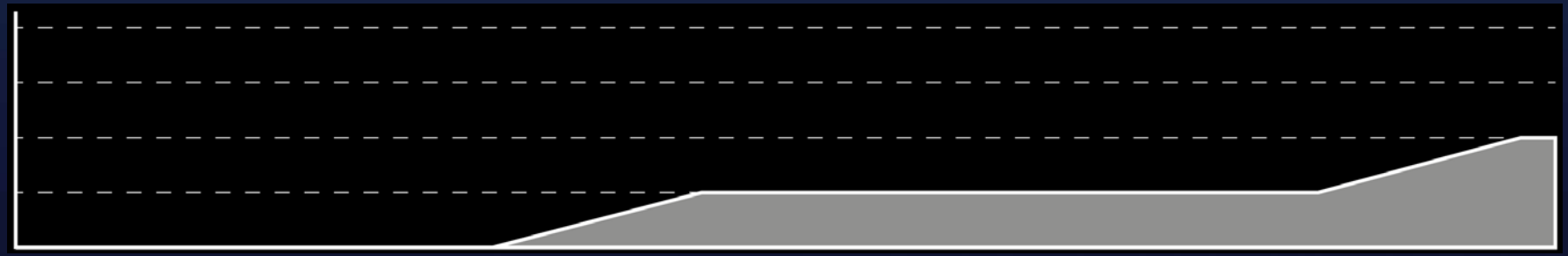


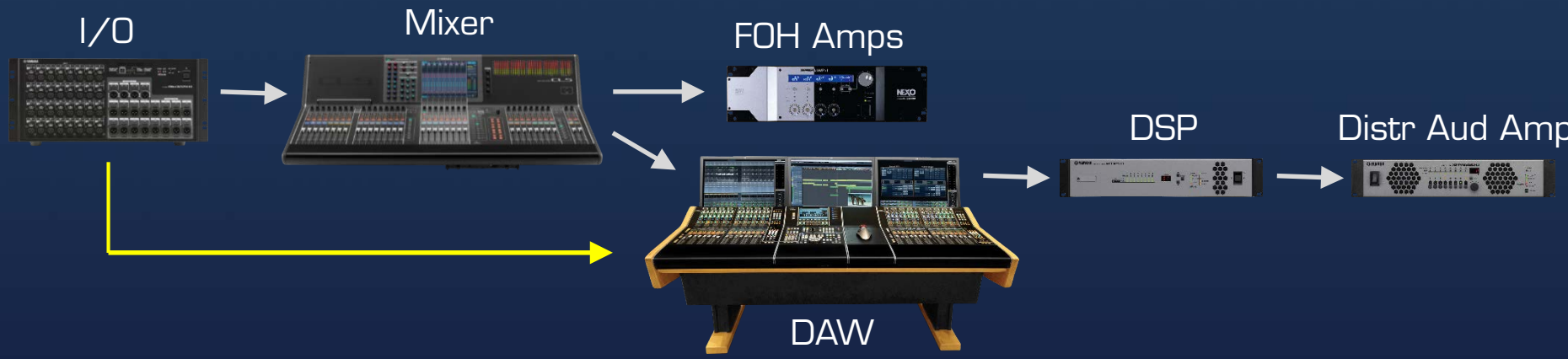
I/O

Mixer

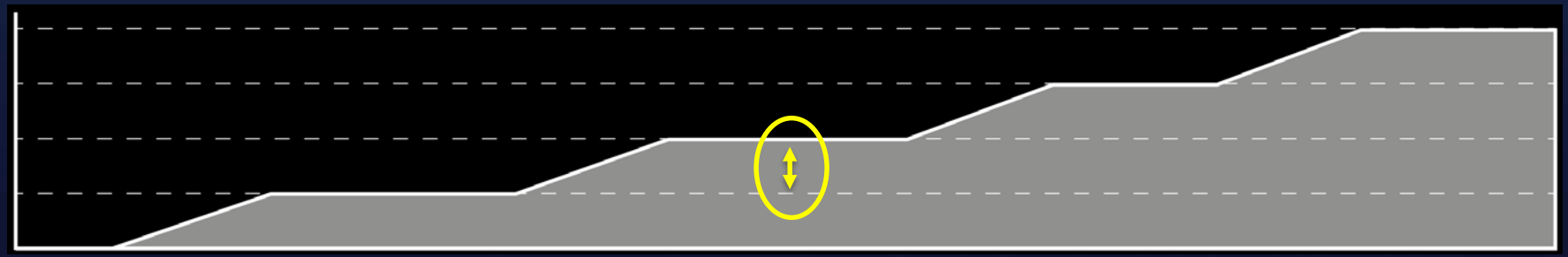
Chase clock at digital input.

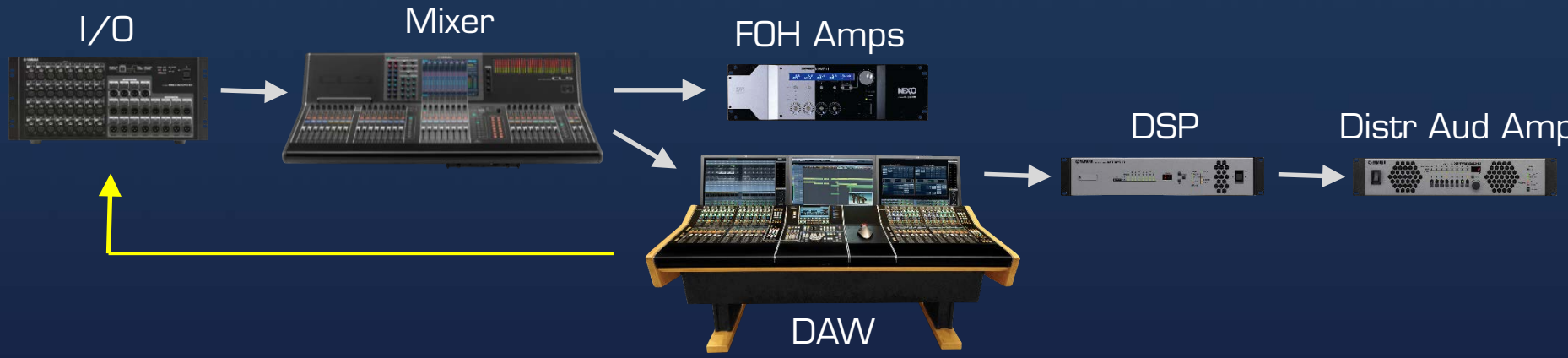
Word Clock Variance (Propagation Delay)





Word Clock Variance (Propagation Delay)





Word Clock Variance (Propagation Delay)

I/O

Mixer

FOH Amps

DAW

DSP

Distr Aud Amp

Distribution Amp

I/O

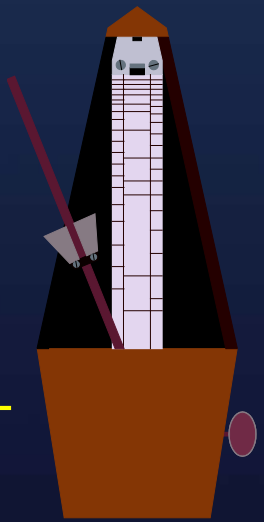
Mixer

FOH Amps

DAW

DSP

Distr Aud Amp

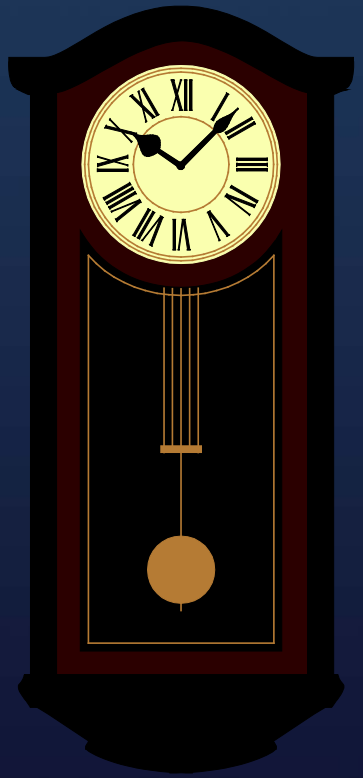


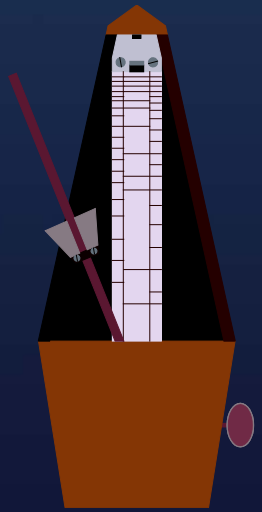
Word Clock Master

Why Do We Cover Digital Audio Basics?

"Is Word Clock like SMPTE?"

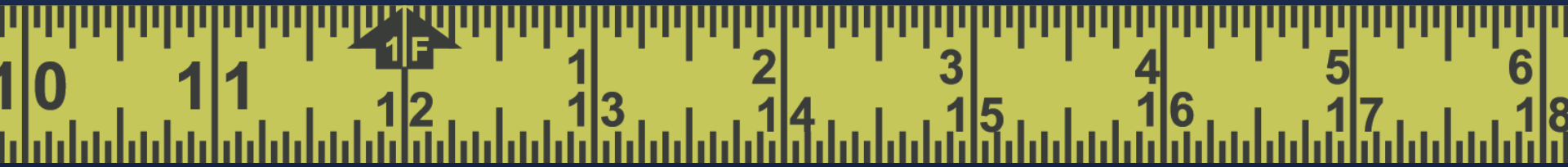
SMPTE is a positional (timeline) reference.

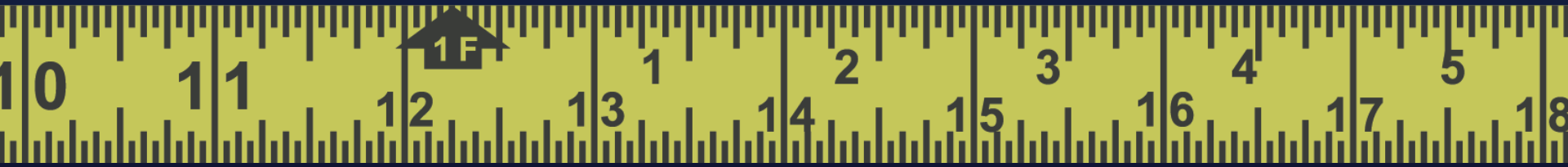




Word Clock is a cyclical reference.

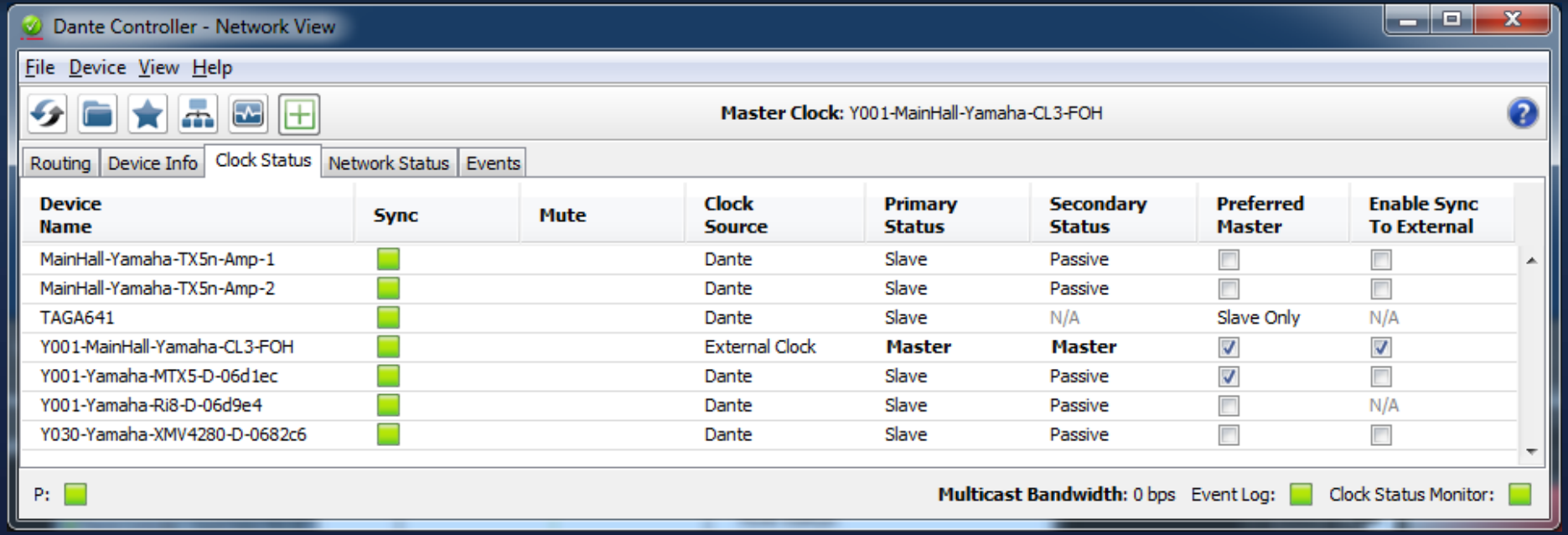
Time Code and Word Clock Need to be “Resolved”





Dante Word Clock

Simplifying Configuration
Not Just In Sync, but In Phase



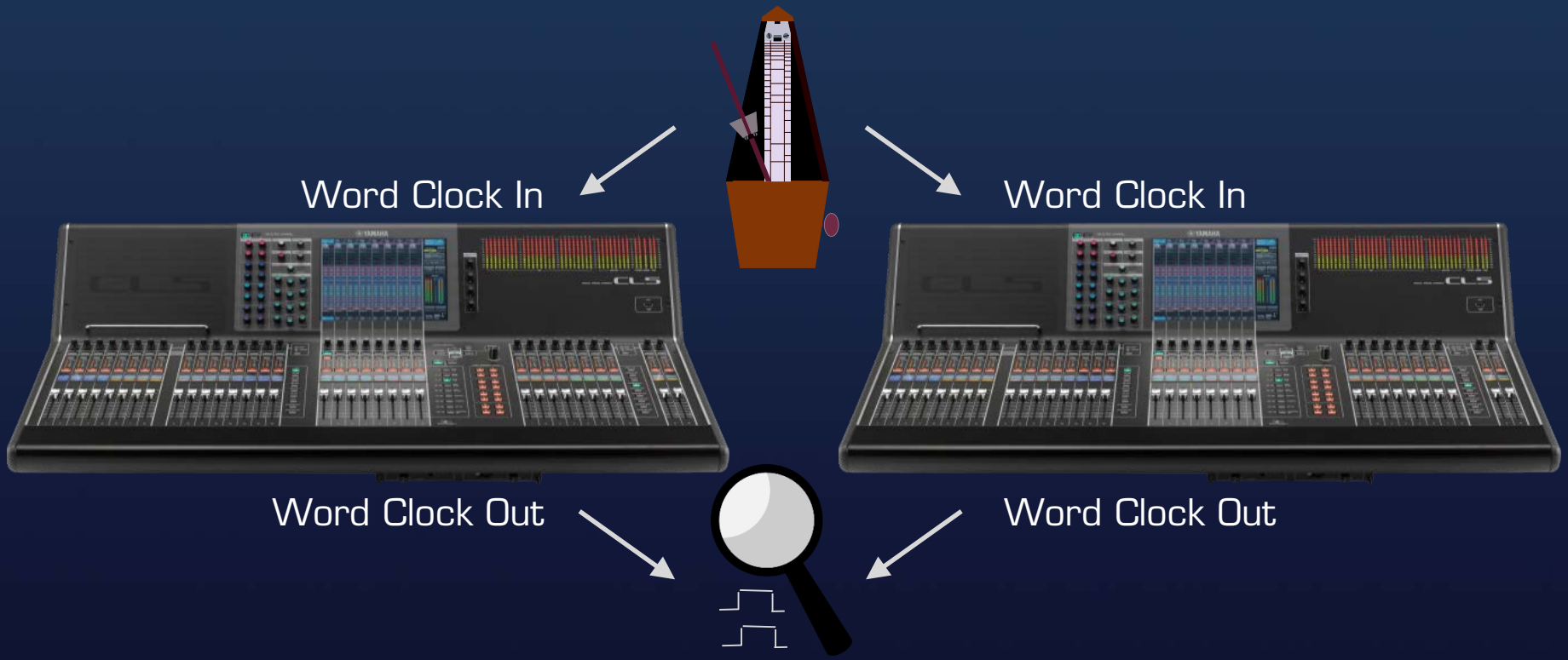
Clock Master Election:

(1)	Preferred Master	Your Choice
(2)	Chasing External Clock	Automatic
(3)	Best Clock	
(4)	Lowest MAC Address	

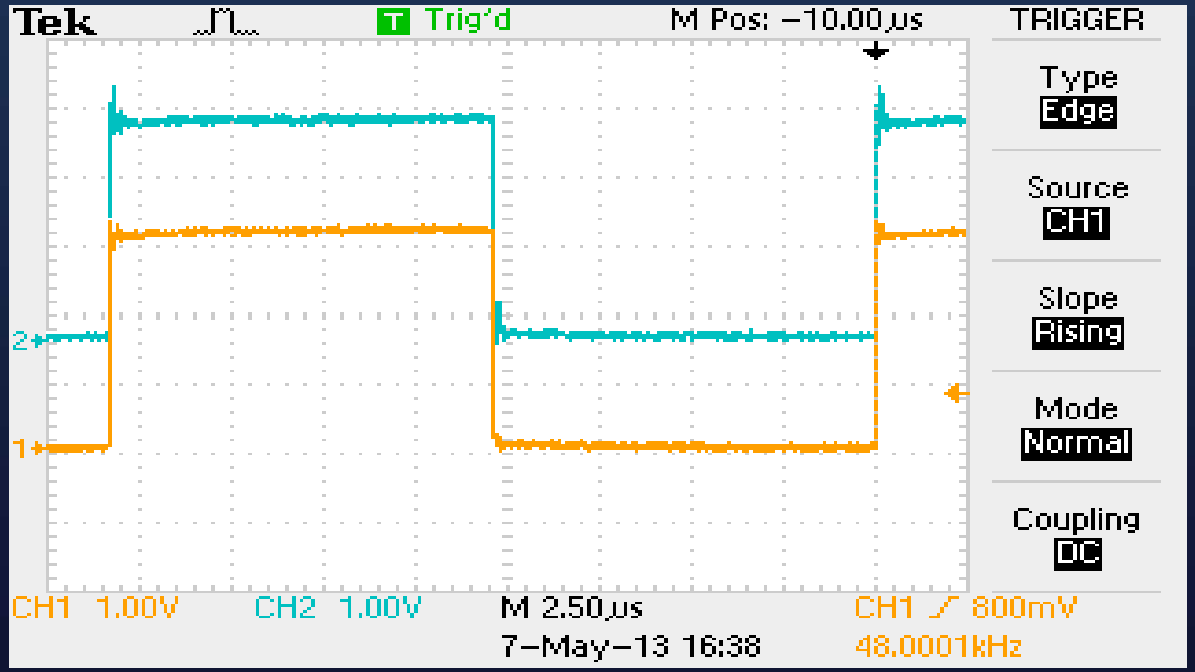
Word Clock Precision

- Digital Audio often uses Time Division Multiplexing (TDM)
  - TDM is typical for AES/EBU, MADI, CobraNet, EtherSound, etc.
  - Audio is sent in time, clock is derived from timing.
  - Each link down the chain is slightly later than its predecessor.
- Dante uses Precision Time Protocol (PTP)
  - IEEE1588, sub microsecond accuracy.
  - Sync packets are separate from audio packets.
  - Devices calculate delay in network transmission.
  - In Sync & In Phase

The “Control” Test



The “Control” Test



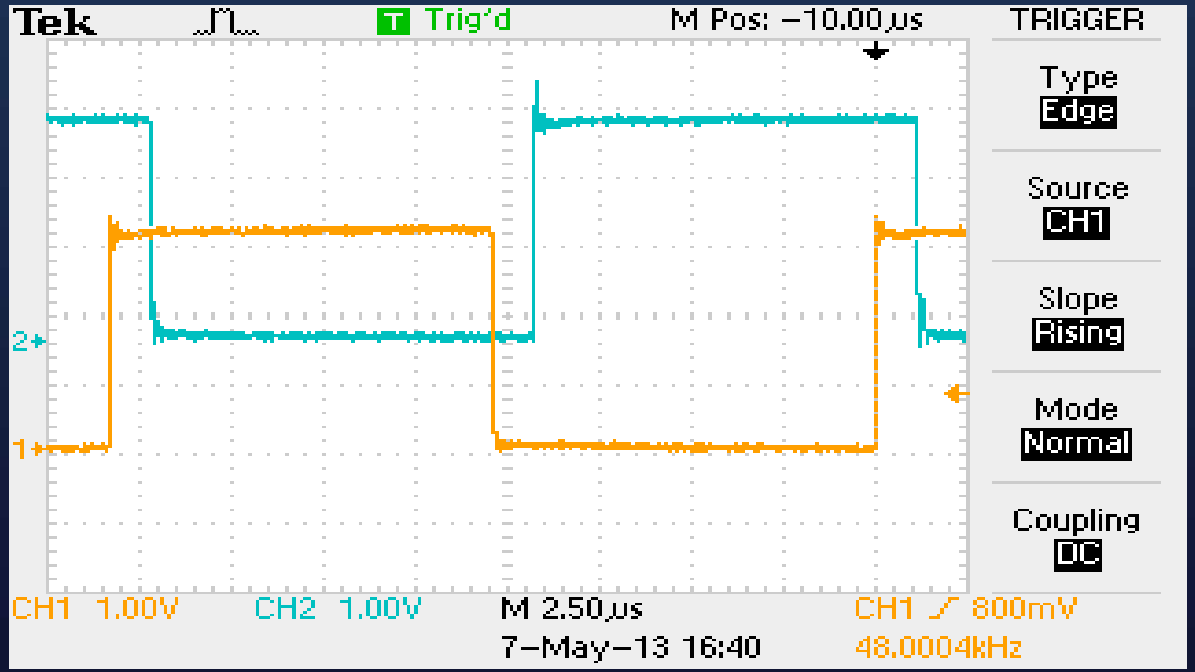
AES/EBU Test

AES/EBU

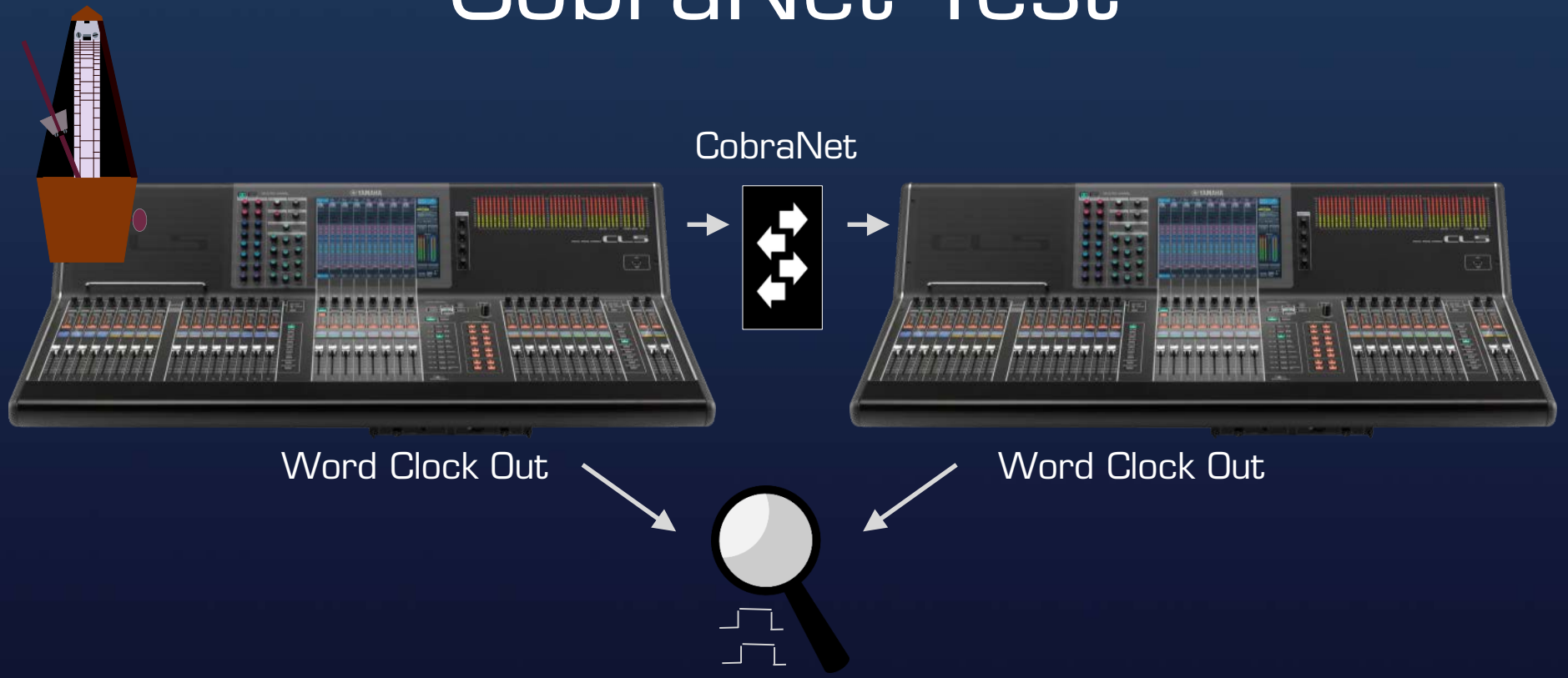
Word Clock Out

Word Clock Out

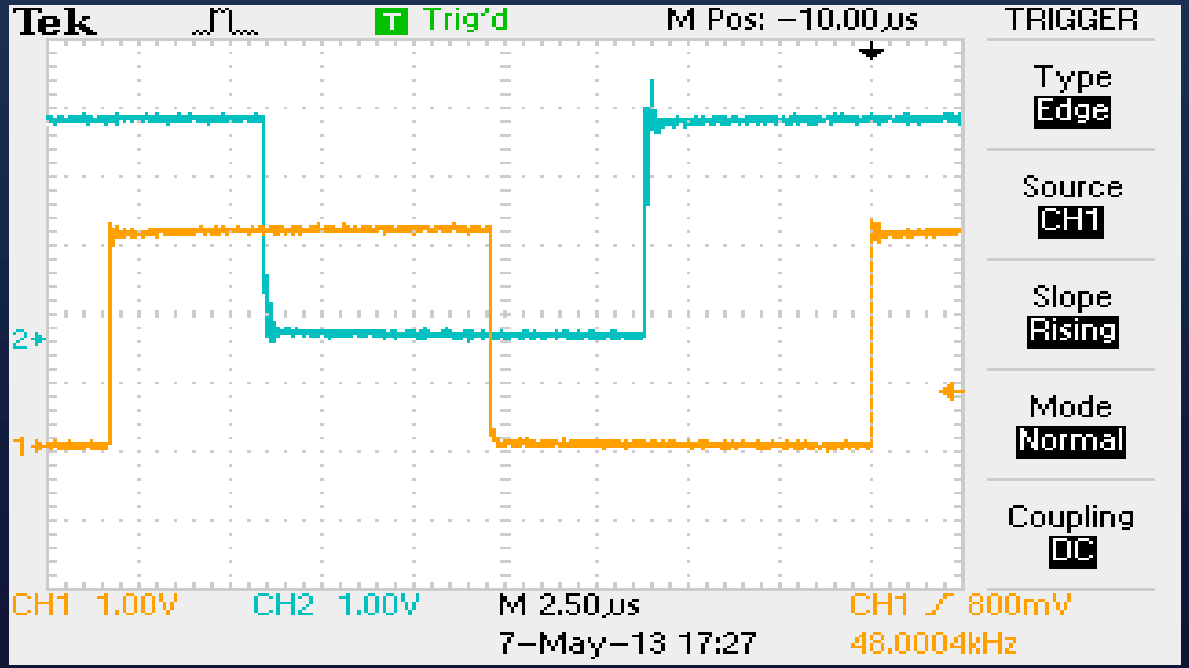
AES/EBU Test


Tek
Trig'd
M Pos: −10.00µs
TRIGGER
Type
Edge
Source
CH1
Slope
Rising
Mode
Normal
Coupling
DC
CH1 1.00V
CH2 1.00V
M 2.50µs
7−May−13 16:40
CH1 800mV
48.0004kHz

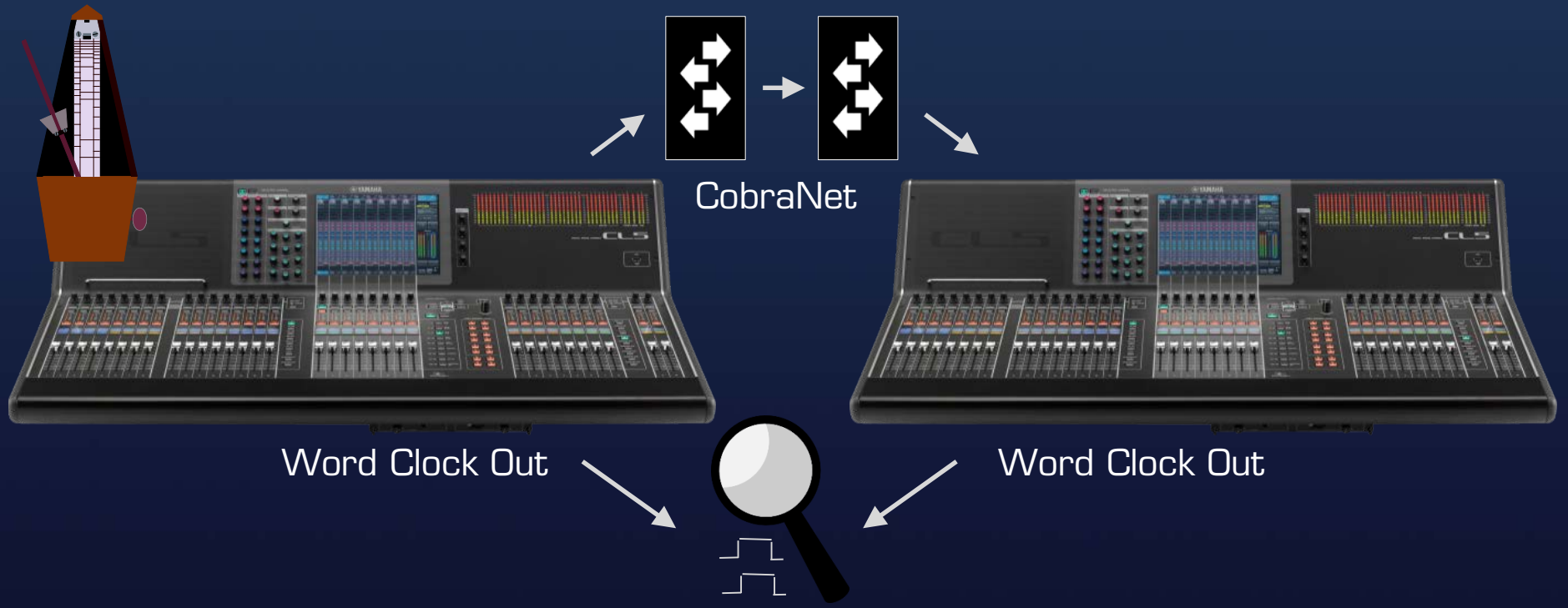
CobraNet Test



CobraNet Test

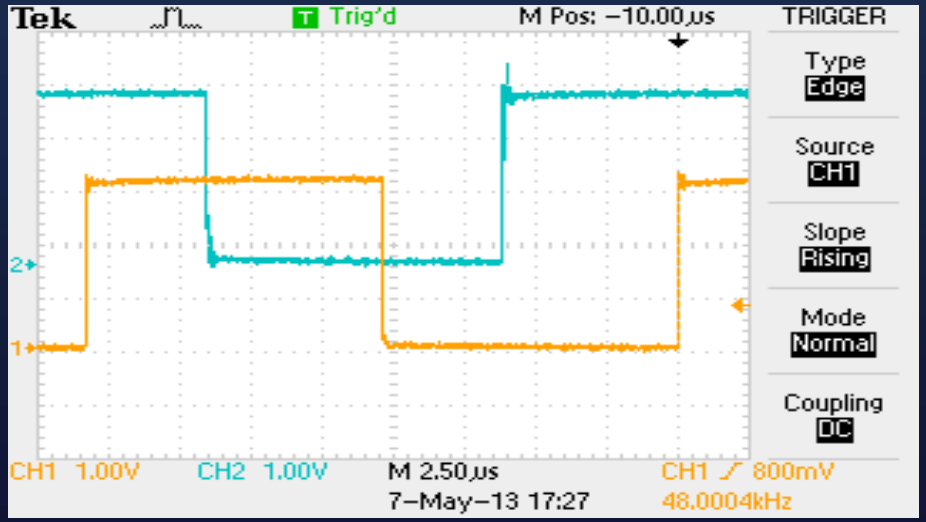


CobraNet Test

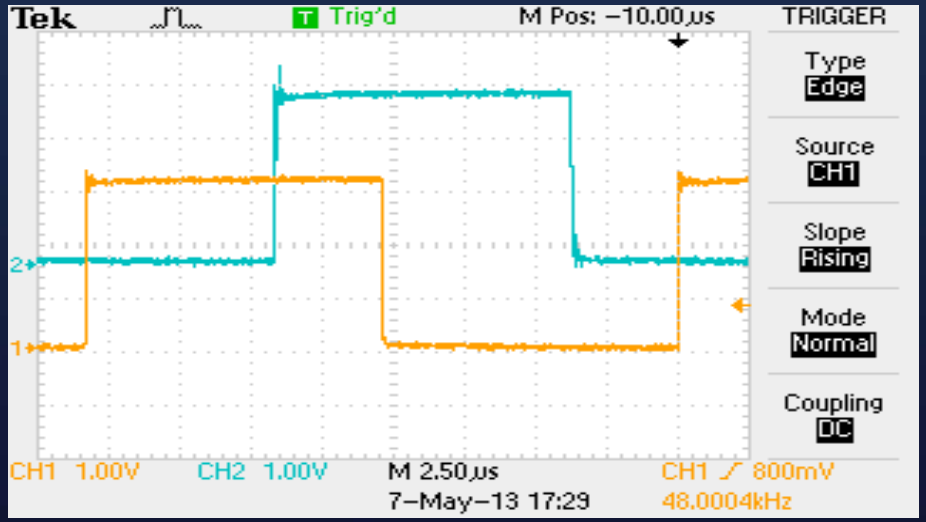


CobraNet Test

One Network Switch

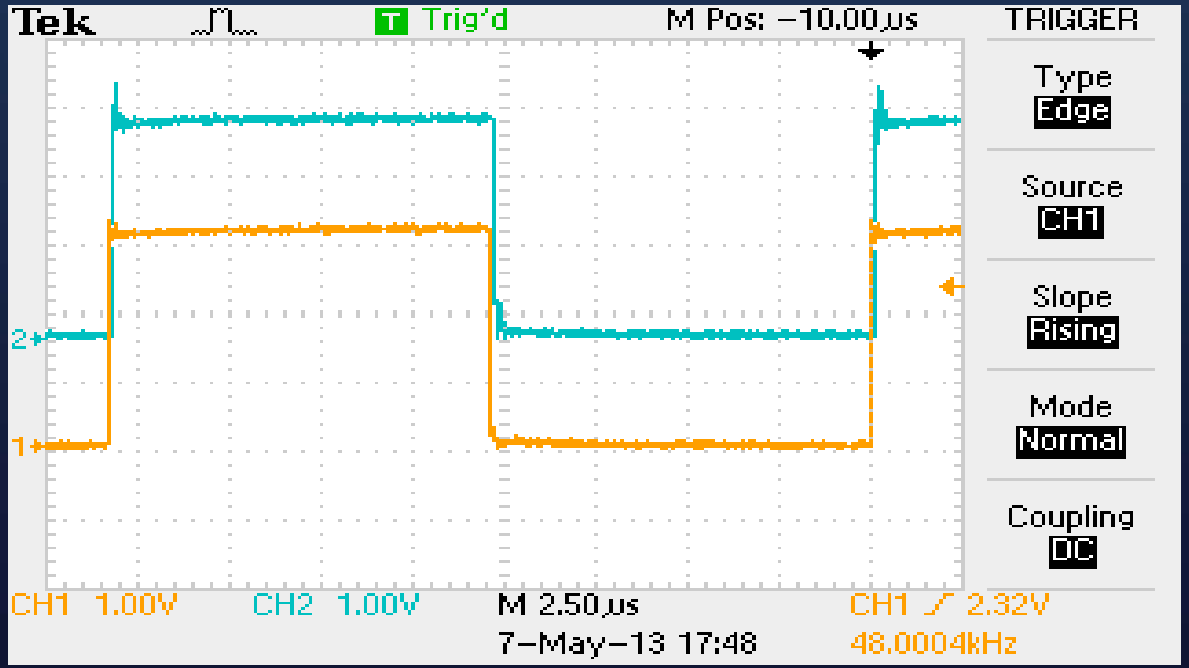


Two Network Switches

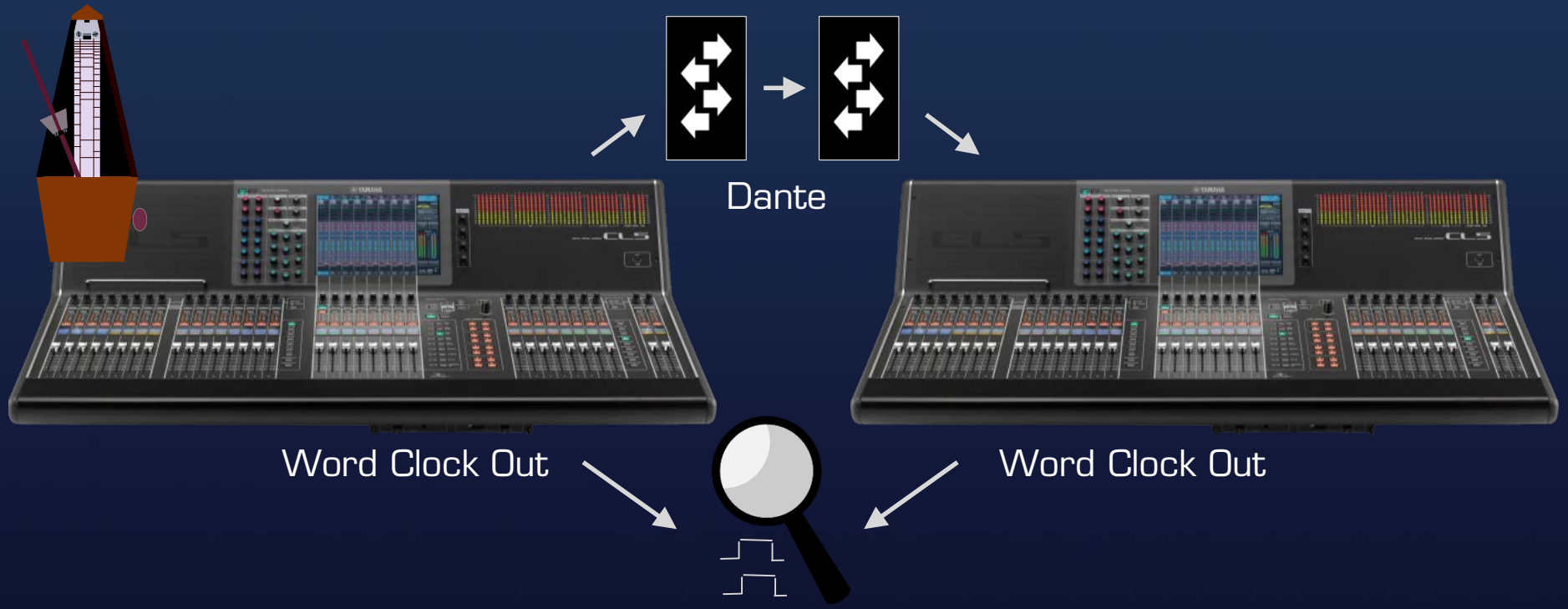


Dante Test

Dante Test

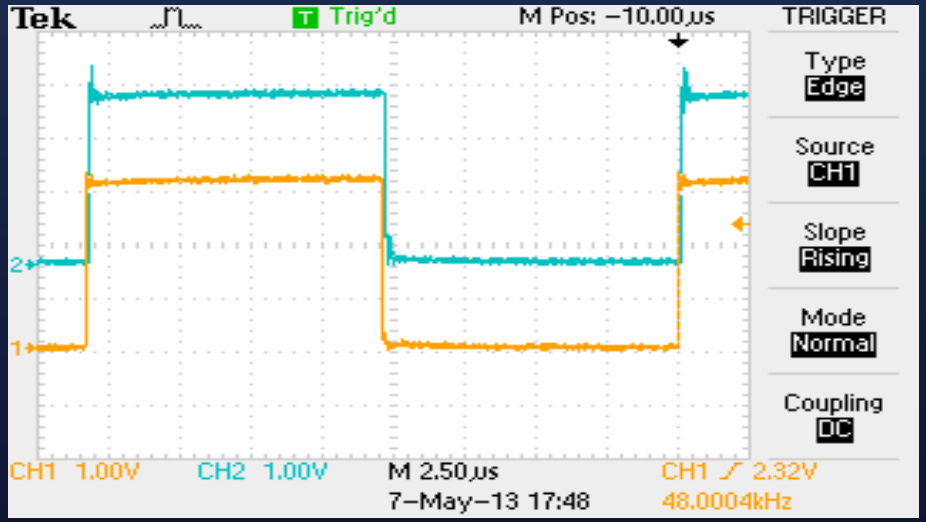

Tek
Trig'd
M Pos: -10.00µs
TRIGGER
Type
Edge
Source
CH1
Slope
Rising
Mode
Normal
Coupling
DC
CH1 1.00V
CH2 1.00V
M 2.50µs
7-May-13 17:48
CH1 2.32V
48.0004kHz

Dante Test

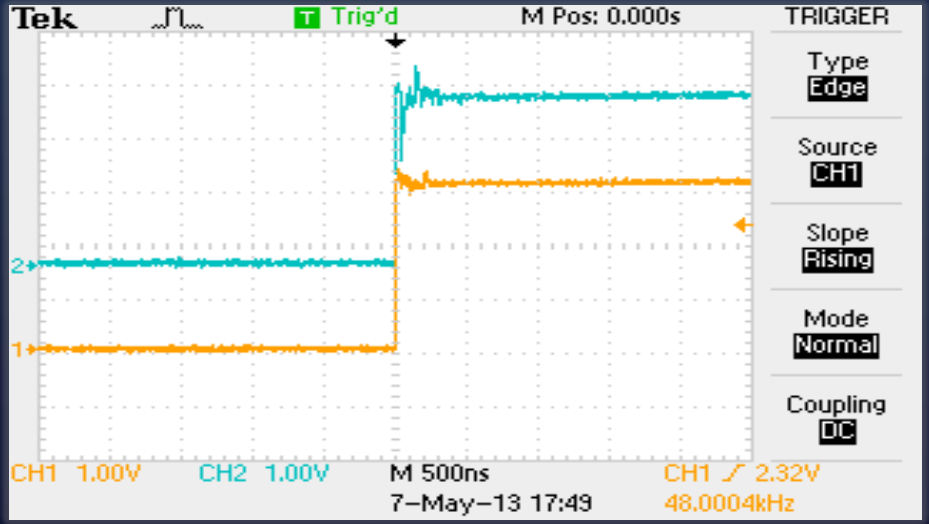


Dante Test

One Network Switch



Two Network Switches



Studio

Remote Feed

House Band

Recording

Nuendo

Guest Band

Sound FX

FOH

FOH

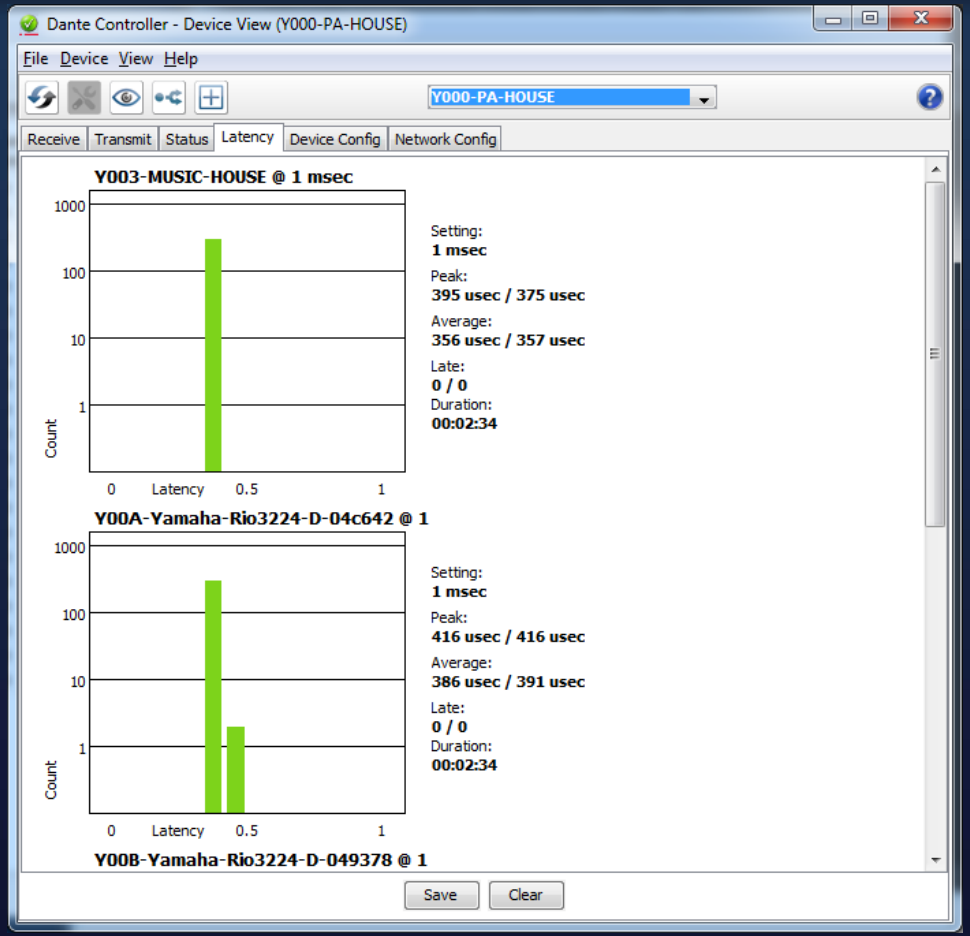
Monitors

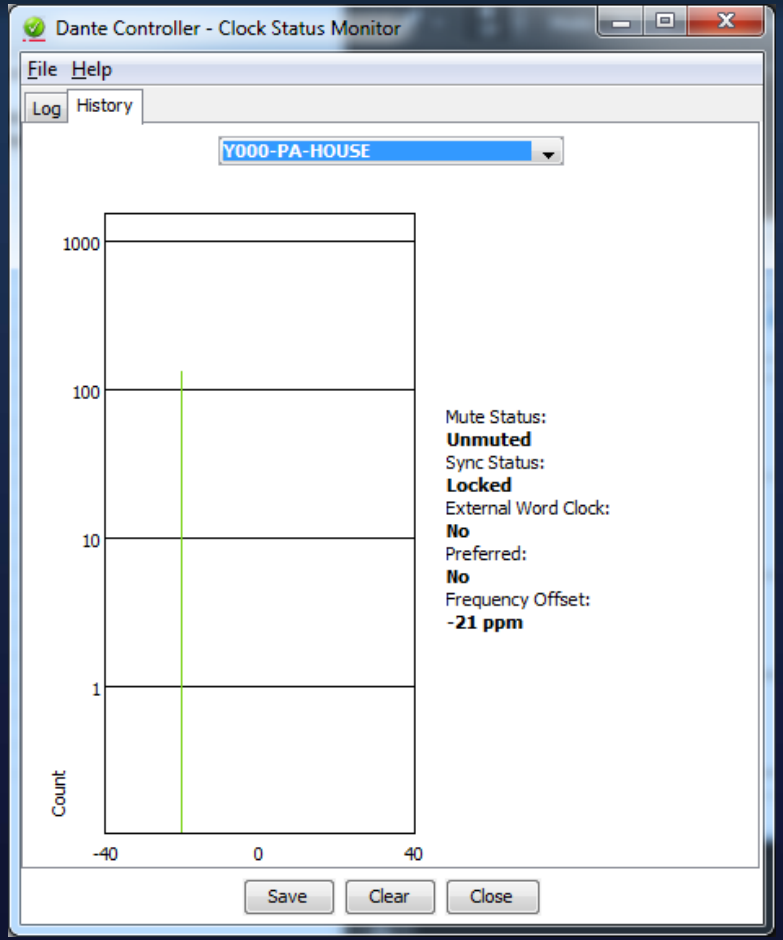
Monitors

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


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

Thank You!

Patrick Killianey
Network Systems Applications Engineer

YAMAHA commercial audio