Troubleshooting HDMI® Systems:
Diagnostic Principles & Techniques

Neal Kendall
Quantum Data
nkendall@quantumdata.com

CUSTOM
ELECTRONIC
DESIGN &
INSTALLATION
ASSOCIATION

CEDIA Survey on HDMI

- Most installations involve some HDMI components – 66%.
- HDMI installations require a great deal more time – 57%.
- About half say callbacks are more likely when HDMI components are involved - 49%.
- Most installers have had to take steps to simplify an installation that involved HDMI components - 83%.
- Most installers have had to remove HDMI components to make them work - 82%.

"The vast majority of our service calls are HDMI or control related."

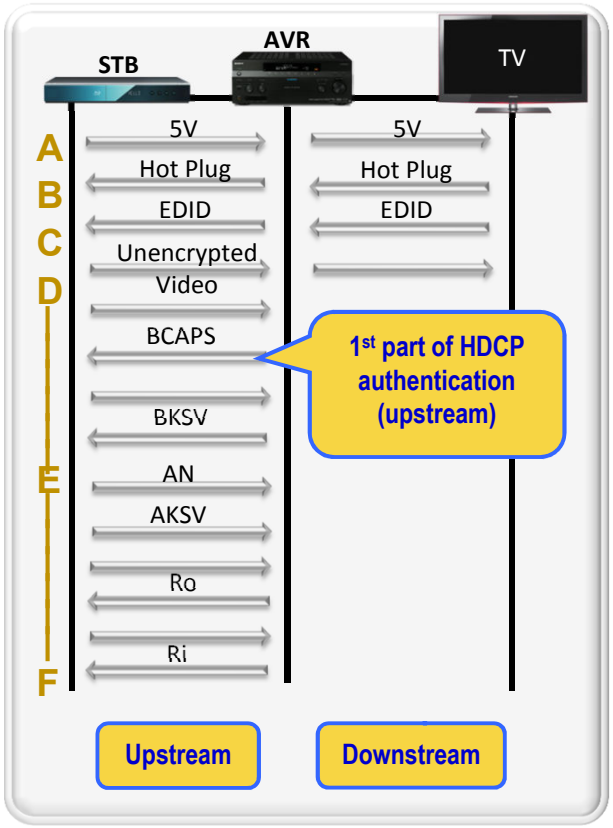
HDMI Connection Sequence

HDMI Connection Sequence
Troubleshooting Principles
Hot Plug Problems
EDID Problems
HDCP Problems
Physical Layer Problems
Audio Dropout

Connection Sequence – Root of many problems

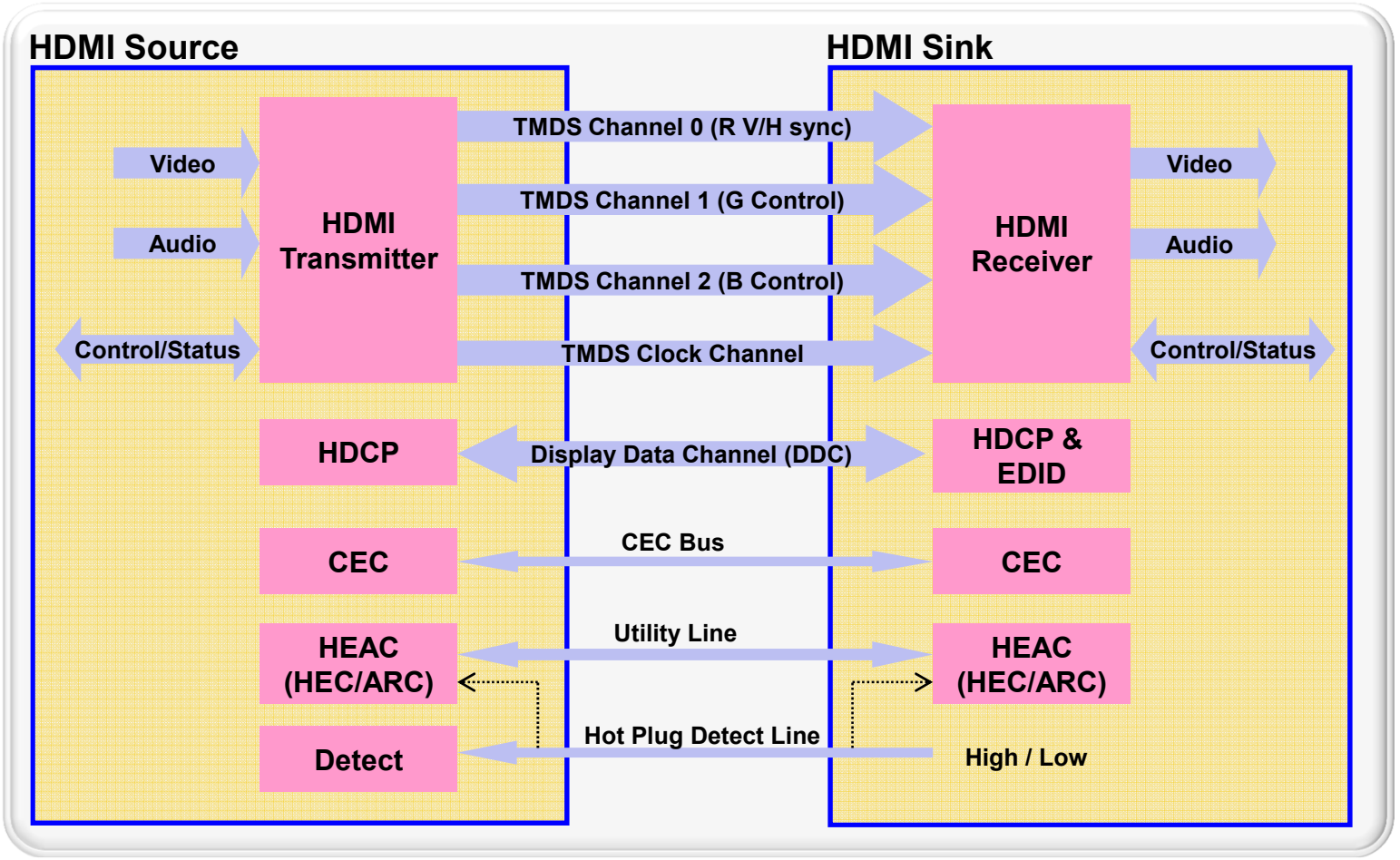
- The protocol sequence of events between a source and sink (handshaking) upon turn up or connection.
- Connection sequence involves the following functions:
  - Connection detection (Hot Plug).
  - Plug and Play (EDID).
  - Content Protection (HDCP).
- Types of problems or symptoms
  - No picture – typically hot plug related.
  - Improper or non-optimal video or audio – typically EDID related.
  - Flashing picture – typically HDCP.
- Resolution of connection sequence problems
  - Usually requires replacing a component or device; sometimes adding a device.

HDMI Connection Sequence



- **A** - HDMI source (e.g. DVD player) outputs +5V power toward HDMI sink (e.g. HDTV).
- **B** - Source waits for hot plug detect to be asserted (i.e. to go to its high voltage state).
- **C** - Source reads the sink's capabilities in the sink's EDID.
- **D** - Source chooses video and audio formats and outputs unencrypted video and audio content & metadata.
- **E** - Source performs HDCP authentication if content is flagged as content protected.
- **F** - Source monitors connection every 2-seconds with an HDCP heartbeat (Ri).
- Source re-authenticates if there is a mismatch in the heartbeat (Ri') value or if a hot plug event occurs.
- Sink uses metadata to get the picture and sound correct.

HDMI Anatomy (v1.4)



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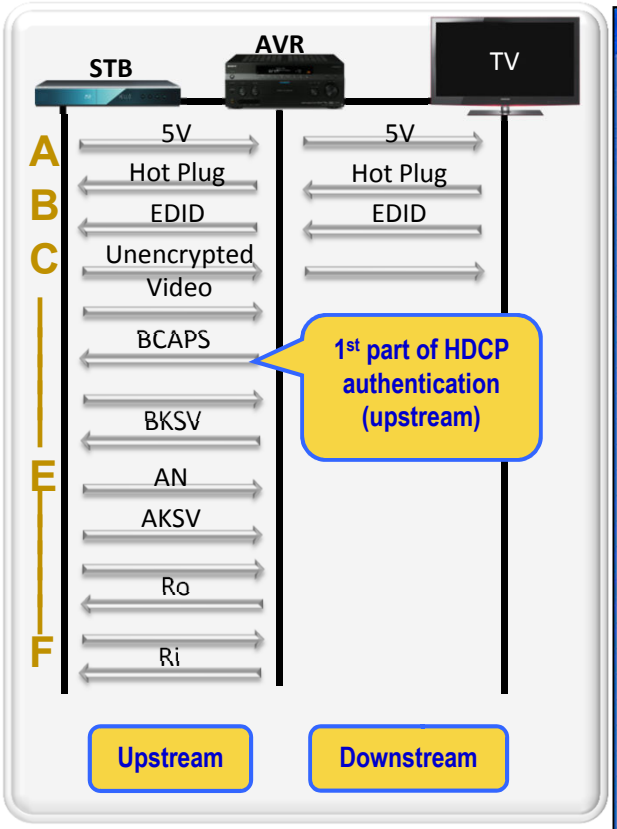
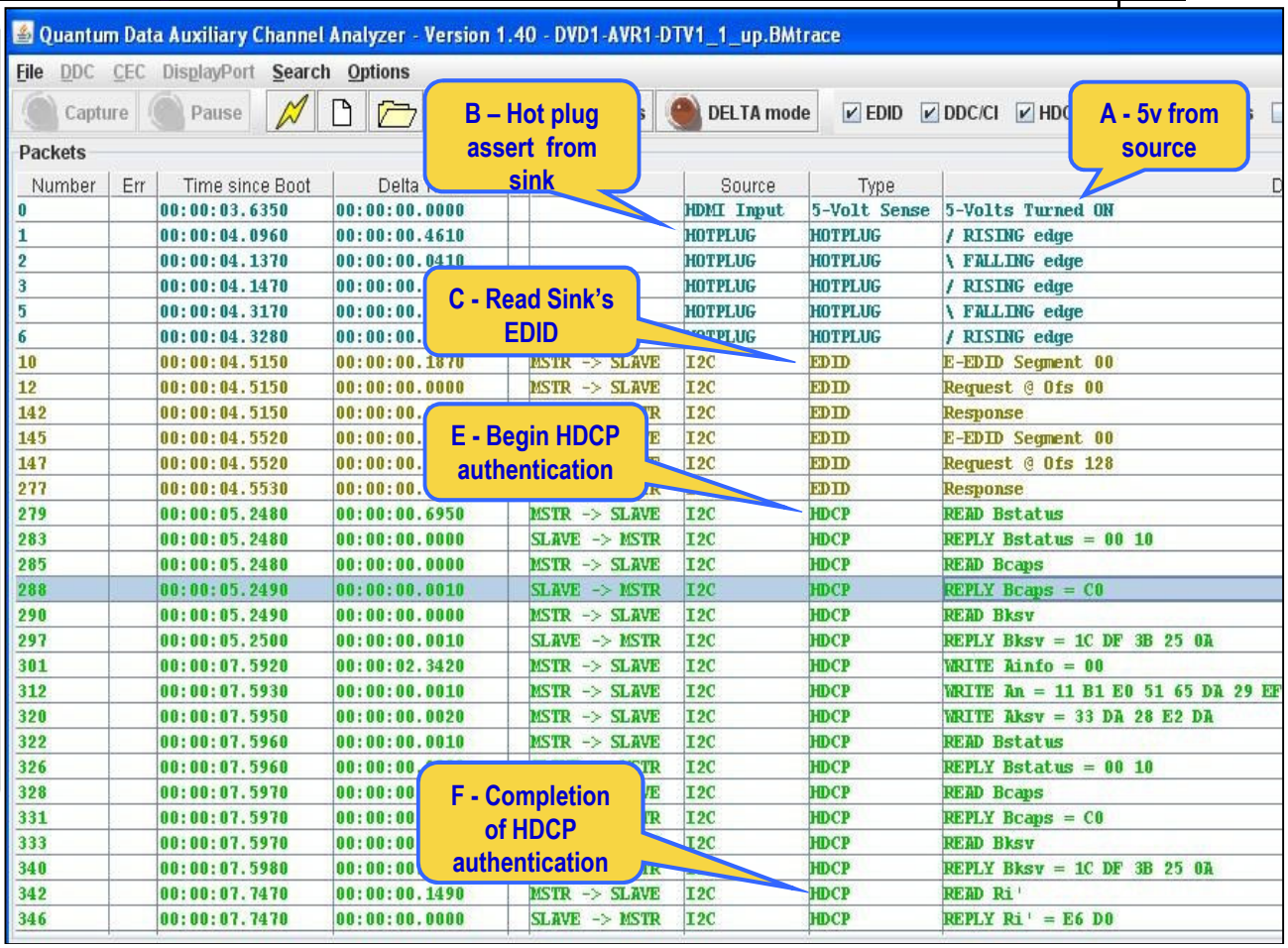
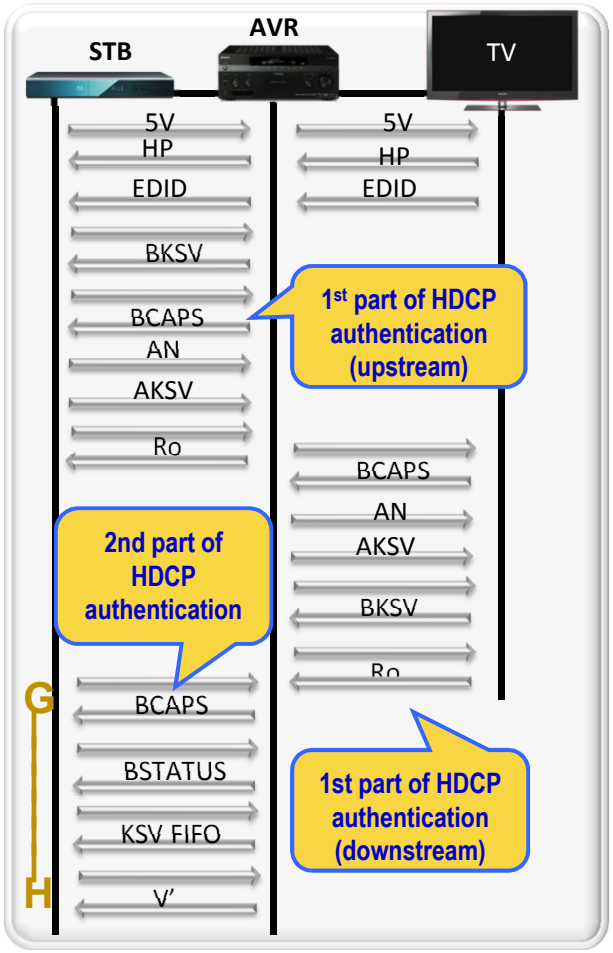




Number	Err	Time since Boot	Delta		Source	Type	
0		00:00:03.6350	00:00:00.0000		HDMI Input	5-Volt Sense	5-Volts Turned ON
1		00:00:04.0960	00:00:00.4610		HOTPLUG	HOTPLUG	/ RISING edge
2		00:00:04.1370	00:00:00.0410		HOTPLUG	HOTPLUG	\ FALLING edge
3		00:00:04.1470	00:00:00.		HOTPLUG	HOTPLUG	/ RISING edge
5		00:00:04.3170	00:00:00.		HOTPLUG	HOTPLUG	\ FALLING edge
6		00:00:04.3280	00:00:00.		HOTPLUG	HOTPLUG	/ RISING edge
10		00:00:04.5150	00:00:00.1870	MSTR -> SLAVE	I2C	EDID	E-EDID Segment 00
12		00:00:04.5150	00:00:00.0000	MSTR -> SLAVE	I2C	EDID	Request @ Ofs 00
142		00:00:04.5150	00:00:00.	R	I2C	EDID	Response
145		00:00:04.5520	00:00:00.	E	I2C	EDID	E-EDID Segment 00
147		00:00:04.5520	00:00:00.		I2C	EDID	Request @ Ofs 128
277		00:00:04.5530	00:00:00.	R		EDID	Response
279		00:00:05.2480	00:00:00.6950	MSTR -> SLAVE	I2C	HDCP	READ Bstatus
283		00:00:05.2480	00:00:00.0000	SLAVE -> MSTR	I2C	HDCP	REPLY Bstatus = 00 10
285		00:00:05.2480	00:00:00.0000	MSTR -> SLAVE	I2C	HDCP	READ Bcaps
288		00:00:05.2490	00:00:00.0010	SLAVE -> MSTR	I2C	HDCP	REPLY Bcaps = C0
290		00:00:05.2490	00:00:00.0000	MSTR -> SLAVE	I2C	HDCP	READ Bksv
297		00:00:05.2500	00:00:00.0010	SLAVE -> MSTR	I2C	HDCP	REPLY Bksv = 1C DF 3B 25 0A
301		00:00:07.5920	00:00:02.3420	MSTR -> SLAVE	I2C	HDCP	WRITE Ainfo = 00
312		00:00:07.5930	00:00:00.0010	MSTR -> SLAVE	I2C	HDCP	WRITE An = 11 B1 E0 51 65 DA 29 EF
320		00:00:07.5950	00:00:00.0020	MSTR -> SLAVE	I2C	HDCP	WRITE Aksv = 33 DA 28 E2 DA
322		00:00:07.5960	00:00:00.0010	MSTR -> SLAVE	I2C	HDCP	READ Bstatus
326		00:00:07.5960	00:00:00.	STR	I2C	HDCP	REPLY Bstatus = 00 10
328		00:00:07.5970	00:00:00	E	I2C	HDCP	READ Bcaps
331		00:00:07.5970	00:00:00	R	I2C	HDCP	REPLY Bcaps = C0
333		00:00:07.5970	00:00:00		I2C	HDCP	READ Bksv
340		00:00:07.5980	00:00:00	R		HDCP	REPLY Bksv = 1C DF 3B 25 0A
342		00:00:07.7470	00:00:00.1490	MSTR -> SLAVE	I2C	HDCP	READ Ri'
346		00:00:07.7470	00:00:00.0000	SLAVE -> MSTR	I2C	HDCP	REPLY Ri' = E6 D0

HDMI Connection Sequence - Downstream



Quantum Data Auxiliary Channel Analyzer - Version 1.40 - DVD1-AVR1-DTV1_1_up.BMtrace

File DDC CEC DisplayPort Search Options

Capture Pause ALL Packets DELTA mode ☑ EDID ☑ DDC/CI ☑ HDCP ☑ CEC ☑ Events ☐ Others

Packets

Number	Err	Time since Boot	Delta Time	Speed (kHz)	Dir	Source	Type	Details
320		00:00:07.5950	00:00:00.0020		MSTR -> SLAVE	I2C	HDCP	WRITE Aksv = 33 DA 28 E2 DA
322		00:00:07.5960	00:00:00.0010		MSTR -> SLAVE	I2C	HDCP	READ Bstatus
326		00:00:07.5960	00:00:00.0000		SLAVE -> MSTR	I2C	HDCP	REPLY Bstatus = 00 10
328		00:00:07.5970	00:00:00.0010		MSTR -> SLAVE	I2C	HDCP	READ Bcaps
331		00:00:07.5970	00:00:00.0000		SLAVE -> MSTR	I2C	HDCP	REPLY Bcaps = C0
333		00:00:07.5970	00:00:00.0000		MSTR -> SLAVE	I2C	HDCP	READ Bksv
340		00:00:07.5980	00:00:00.0010		SLAVE -> MSTR	I2C	HDCP	REPLY Bksv = 1C DF 3B 25 0A
342		00:00:07.7470	00:00:00.1490		MSTR -> SLAVE	I2C	HDCP	READ Ri'
346		00:00:07.7470	00:00:00.0000		SLAVE -> MSTR	I2C	HDCP	REPLY Ri' = E6 D0
348		00:00:07.9330	00:00:00.1860		MSTR -> SLAVE	I2C	HDCP	READ Bcaps
351		00:00:07.9330	00:00:00.0000		SLAVE -> MSTR	I2C	HDCP	REPLY Bcaps = E0
353		00:00:07.9330	00:00:00.0000		MSTR -> SLAVE	I2C		READ Bstatus
357		00:00:07.9340	00:00:00.0010		SLAVE ->			REPLY Bstatus = 01 11
359		00:00:07.9340	00:00:00.0000		MSTR ->			READ KSV FIFO
366		00:00:07.9350	00:00:00.0010		SLAVE ->			REPLY KSV FIFO = 67 6C 75 4A 2A
368		00:00:07.9370	00:00:00.0020		MSTR ->			READ V'.H0
390		00:00:07.9370	00:00:00.0000		SLAVE ->			REPLY V'.H0 = F3 3E FC EC 85 8D

G - Begin 2nd part of HDCP authentication

H - Completion of 2nd part of HDCP authentication

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Troubleshooting Principles

- Avoid the need to troubleshoot – Prequalify equipment in the home and that you procure in your lab.
- Consider the Origin of the Problem – Determine if HDMI system has ever worked. If so what changed? Take careful notes.
- Make one Change at a time - Make only one change at a time to limit the variables to only one. Take careful notes.
- Simplification – Configure or “reduce” the HDMI system to the most simple configuration that still exhibits the symptom.
- Substitution – Substitute suspect devices or components with known-good devices (sources and sinks) or preferably with test equipment that can emulate sources and sinks with other convenient control functions.
- More…

Troubleshooting Principles

- Continued…
- Disable Protocols – Disable CEC and HDCP if possible. Disabling HDCP will immediately tell you if the problem is related to HDCP.
- Diagnostic Sequence – Use the diagnostic procedure which provides greatest insight and is easiest to conduct.

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Hot Plug (Connection Detection) – What is it?

- Hot plug is a signal to an HDMI source indicating that an HDMI sink is connected.
- HDMI source provides +5V to the sink which the sink sends back as the hot plug assertion voltage.
- A repeater passes a hot plug pulse (100ms) to an upstream HDMI source device.

Hot Plug – What Can Go Wrong?

- HDMI sink draws excessive current from source's +5V supply. Hot plug may not be asserted.
- Extender doesn't provide/pass hot plug.
- HDMI source +5V supply voltage is not at least 4.7 to 5.3V. Sink may not assert hot plug.
- HDMI source can't supply at least 55mA on +5V supply. Sink may not assert hot plug.
- HDMI sink does not reset its hot plug assert voltage when a user switches between ports on an HDTV.
- HDMI repeater doesn't forward hot plugs when there is a downstream connection event.
- Cable can be partially pulled out…+5V pin is set back from other leads in the HDMI cable.

AVS Forum Issues – Hot Plug Related Problem

Symptom: No picture following standby

"Having problem with media server and HDTV. Once the TV goes to standby, the media server and HDTV will not handshake properly and I get the infamous *green screen* instead of video. The only solution that works for me is literally unplugging the HDMI cable from the media server and re-inserting it. That is completely absurd and makes the box useless to me."

Probable cause: Media server not asserting hot plug.
Resolution: Replace media server or put "fix it" device between media server and HDTV.

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Extended Display Identification Data (EDID)

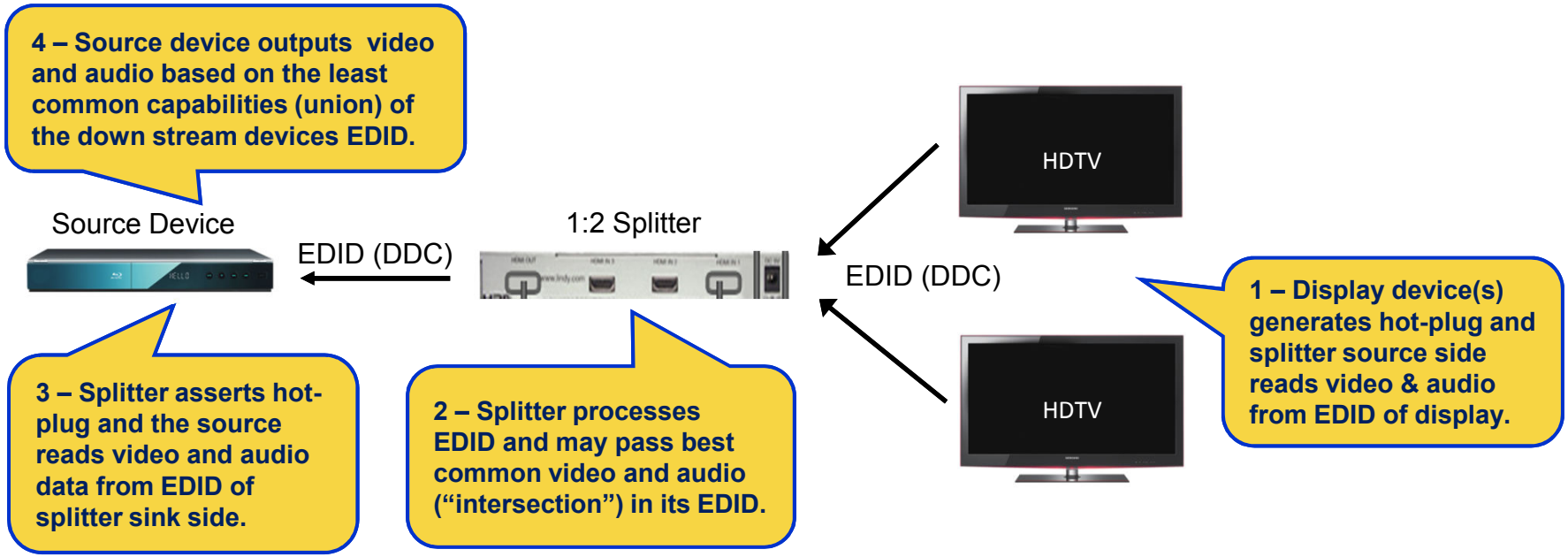
- What is an EDID?
  - EDID is a VESA creation to support Plug & Play.
  - EDID is a data structure residing in an HDMI sink.
  - HDMI EDIDs typically have two 128 byte blocks.
- What is the purpose of an EDID?
  - EDID is an HDMI sink's way of describing its capabilities to an HDMI source device.
  - The HDMI source selects its output in accordance with what HDMI sink device supports.

EDID – What Can Go Wrong?

- Physical Layer problem: DDC bit errors that cause corruption of the EDID (checksum error) due to excess “stray” capacitance.
- HDMI source cannot read EDID and doesn’t output minimal format (at-least 640x480).
- HDMI extender alters the downstream EDID and/or changes formats.
- HDMI repeater device or extender does not forward EDID of a downstream device.
- HDMI AV receiver forwards the downstream sink’s EDID capabilities unmodified to the source.
- Sink declares a color mode of YCbCr (“color difference”) in its EDID, but doesn’t support both types of sampling modes (4:4:4 & 4:2:2).
- Splitter device is hard coded with an EDID or simply takes the EDID of the first device connected.

EDID "Gotchas" – Splitters

- When splitter is used, the EDID can be one of the following:
  - EDID of the device connected initially.
  - A forced or "provisioned" EDID.
  - Mathematical intersection of the two devices.



AVS Forum Issues – EDID Related Problem

Symptom: No audio with projector

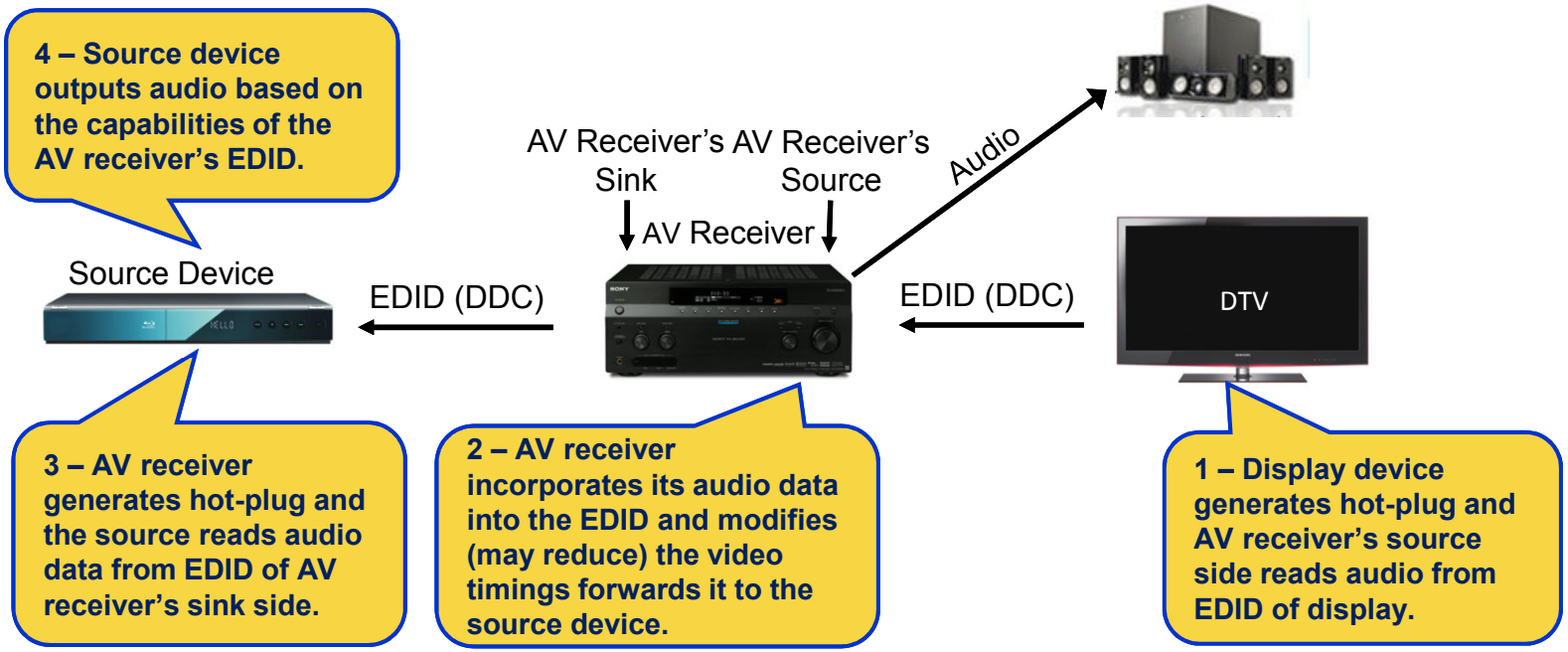
DVR –-HDMI→ AVR —HDMI→ Projector = No audio

“DVR connected to AVR to Projector, all HDMI connections. No audio with projector plugged into receiver.”

Probable cause: AVR not substituting its audio block into EDID.
Resolution: Short term: Bypass AVR; long term: replace AVR.

EDID "Gotchas" – AV Receiver

- When an AV Receiver is used, the EDID should show the audio from the AVR and the video should be the "intersection" of the video data of the AVR and the sink device.



AVS Forum Issues – EDID Related Problems

Symptom: Pink tint on TV

STB –-HDMI→ HDTV = Pink tint on TV

“HDMI communication problem. Sometimes the picture has a pink tint…

I can resolve this issue if I connect using component instead of HDMI. I can also resolve the issue if I connect to a different brand of television.

I have replaced HDMI cable, swapped television for same new one, and replaced DVR box for same new. Satellite provider has been out to see the issue and does not have a resolution. I have spoken with HDTV manufacturer and they want me to send pictures to them, which I will do.”

Possible Causes: Mismatch in color space. Source sending YCbCr to an HDTV in RGB mode. (1) EDID or (2) AVI Infoframe.

Resolution: Source STB not reading EDID properly or sending incorrect infoframe; consider replacing STB source.

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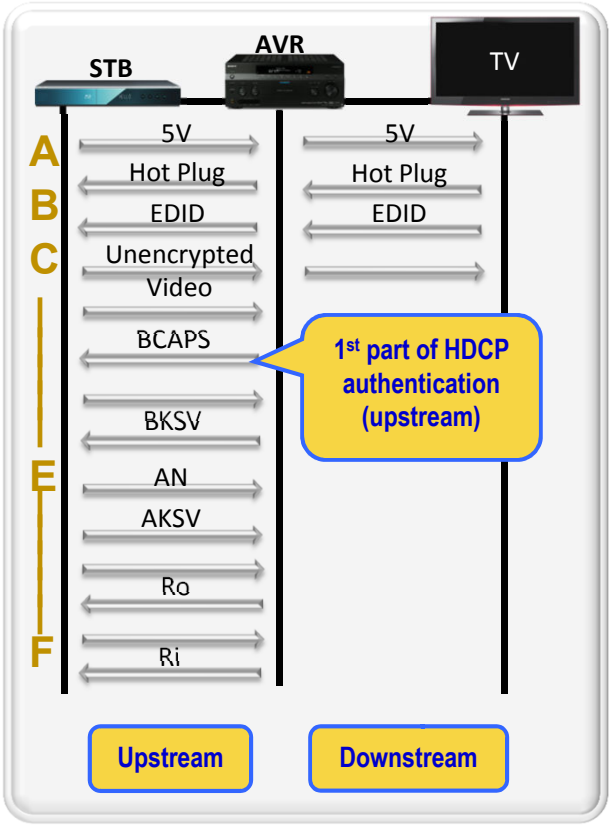
HDCP Interoperability

- High Definition Content Protection
- “HDCP is the hardest thing about HDMI (*or any digital interface*) interoperability”. Why?
  - The goals of HDMI compliance and HDCP compliance are different.
  - Many devices were shipped without any HDCP testing until 2006
  - Cable, Satellite, and IPTV service providers update the software in their set-top-boxes often without warning.

HDCP – What Can Go Wrong?

- The common symptom of an HDCP failure is repeated flashing video, no video or “snow”. The following is a list of some of the causes of HDCP authentication failure:
  - Physical Layer problem - DDC bit errors due to “stray” capacitance.
  - HDMI sink device doesn’t reset its HDMI port properly when a user switches between ports on an HDTV.
  - HDMI source and sink registers to not interact properly during HDCP authentication.
  - HDMI sink device doesn’t support HDCP properly or at all.
  - HDMI source doesn’t support repeaters in HDCP authentication.
  - HDMI network exceeds the HDCP maximum number of cascade devices or total devices.
  - HDMI source does not properly handle HDCP max devices / cascade information from sink BSTATUS register.
  - HDMI source doesn’t support “empty repeater” in HDCP authentication.

HDMI Connection Sequence



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File DDC CEC DisplayPort Search Options

Capture Pause DELTA mode EDID DDC/CI HDCI

Packets

Number	Err	Time since Boot	Delta Time		Source	Type	D
0		00:00:03.6350	00:00:00.0000		HDMI Input	5-Volt Sense	5-Volts Turned ON
1		00:00:04.0960	00:00:00.4610		HOTPLUG	HOTPLUG	/ RISING edge
2		00:00:04.1370	00:00:00.0410		HOTPLUG	HOTPLUG	\ FALLING edge
3		00:00:04.1470	00:00:00.		HOTPLUG	HOTPLUG	/ RISING edge
5		00:00:04.3170	00:00:00.		HOTPLUG	HOTPLUG	\ FALLING edge
6		00:00:04.3280	00:00:00.		HOTPLUG	HOTPLUG	/ RISING edge
10		00:00:04.5150	00:00:00.1870	MSTR -> SLAVE	I2C	EDID	E-EDID Segment 00
12		00:00:04.5150	00:00:00.0000	MSTR -> SLAVE	I2C	EDID	Request @ Ofs 00
142		00:00:04.5150	00:00:00.	R	I2C	EDID	Response
145		00:00:04.5520	00:00:00.	E	I2C	EDID	E-EDID Segment 00
147		00:00:04.5520	00:00:00.		I2C	EDID	Request @ Ofs 128
277		00:00:04.5530	00:00:00.	R		EDID	Response
279		00:00:05.2480	00:00:00.6950	MSTR -> SLAVE	I2C	HDCP	READ Bstatus
283		00:00:05.2480	00:00:00.0000	SLAVE -> MSTR	I2C	HDCP	REPLY Bstatus = 00 10
285		00:00:05.2480	00:00:00.0000	MSTR -> SLAVE	I2C	HDCP	READ Bcaps
288		00:00:05.2490	00:00:00.0010	SLAVE -> MSTR	I2C	HDCP	REPLY Bcaps = C0
290		00:00:05.2490	00:00:00.0000	MSTR -> SLAVE	I2C	HDCP	READ Bksv
297		00:00:05.2500	00:00:00.0010	SLAVE -> MSTR	I2C	HDCP	REPLY Bksv = 1C DF 3B 25 0A
301		00:00:07.5920	00:00:02.3420	MSTR -> SLAVE	I2C	HDCP	WRITE Ainfo = 00
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328		00:00:07.5970	00:00:00.	E	I2C	HDCP	READ Bcaps
331		00:00:07.5970	00:00:00.	R	I2C	HDCP	REPLY Bcaps = C0
333		00:00:07.5970	00:00:00.		I2C	HDCP	READ Bksv
340		00:00:07.5980	00:00:00.	R		HDCP	REPLY Bksv = 1C DF 3B 25 0A
342		00:00:07.7470	00:00:00.1490	MSTR -> SLAVE	I2C	HDCP	READ Ri'
346		00:00:07.7470	00:00:00.0000	SLAVE -> MSTR	I2C	HDCP	REPLY Ri' = E6 D0

B – Hot plug assert from sink

A - 5v from source

C - Read Sink's EDID

E - Begin HDCP authentication

F - Completion of HDCP authentication

AVS Forum Issues

Symptom: “Annoying HDMI blinking!”

STB → HDMI ==========> HDTV = OK
STB → HDMI AVR → HDMI → HDTV = Video/Audio blinking
DVD → HDMI ==========> HDTV = OK

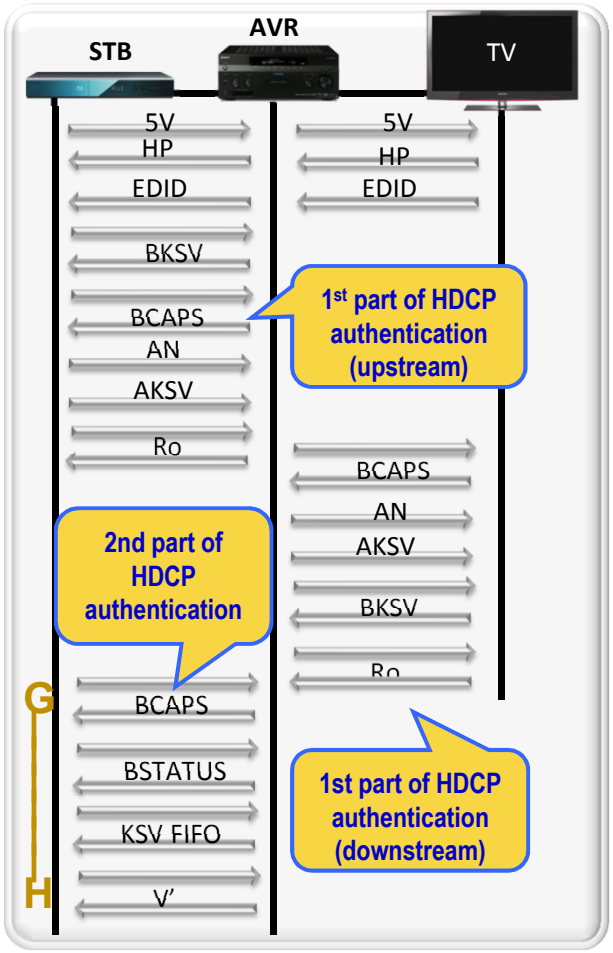
“I get blinking/dropout of audio/video. Tried updating the TV's firmware. When I watch from a DVD recorder (HDMI) going thru the same receiver, I don’t see the blinking occur.

Now trying to bypass the AV receiver for cable viewing, but obviously this isn't what I want to do forever. I've tried messing with the various HDMI and audio options on the receiver, to no avail. It could be the ports for the SAT STB on the AVR.

All this leads me to believe that the problem is with the STB or the cable service. And possibly something with the AVR in the middle. But since it can serve up content from my HDMI DVD player fine, I doubt the receiver is completely to blame.”

Probable cause: HDCP Authentication failure. STB does not support repeaters or does not parse HDCP repeater bit.
Resolution: Swap out STB.

HDMI Connection Sequence - Downstream



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333		00:00:07.5970	00:00:00.0000		MSTR -> SLAVE	I2C	HDCP	READ Bksv
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342		00:00:07.7470	00:00:00.1490		MSTR -> SLAVE	I2C	HDCP	READ Ri'
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357		00:00:07.9340	00:00:00.0010		SLAVE ->			REPLY Bstatus = 01 11
359		00:00:07.9340	00:00:00.0000		MSTR ->			READ KSV FIFO
366		00:00:07.9350	00:00:00.0010		SLAVE ->			REPLY KSV FIFO = 67 6C 75 4A 2A
368		00:00:07.9370	00:00:00.0020		MSTR ->			READ V'.H0
390		00:00:07.9370	00:00:00.0000		SLAVE ->			REPLY V'.H0 = F3 3E FC EC 85 8D

G - Begin 2nd part of HDCP authentication

H - Completion of 2nd part of HDCP authentication

AVS Forum Issues

Symptom: Flashing intermittently.

STB-DVR –-HDMI→ AVR —HDMI→ HDTV = Flash intermittently

DVD BluRay –-HDMI→ AVR –-HDMI→ HDTV = OK

“Everything works EXCEPT the DVR HDMI video will not work (it will flash intermittently) when passed thru the AVRs HDMI ports. The BluRay DVD works perfectly.”

Probable cause: HDCP authentication failure – STB not processing AV receiver’s HDCP repeater bit.
Resolution: Swap out STB-DVR.

AVS Forum Issues

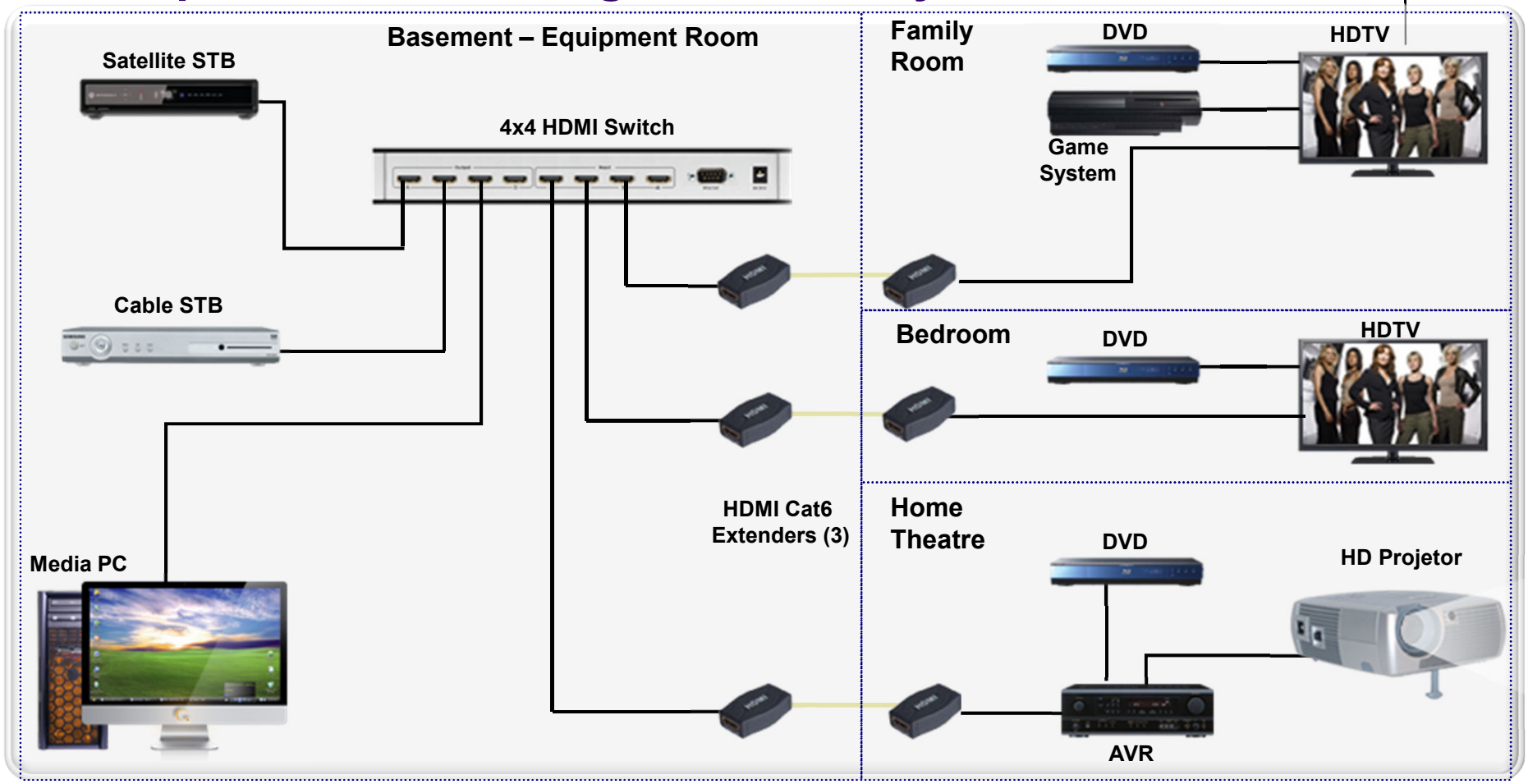
Symptom: Flashing video for 2 seconds.

DVR –-HDMI → AVR —HDMI→ HDTV = Picture drops for 2 seconds

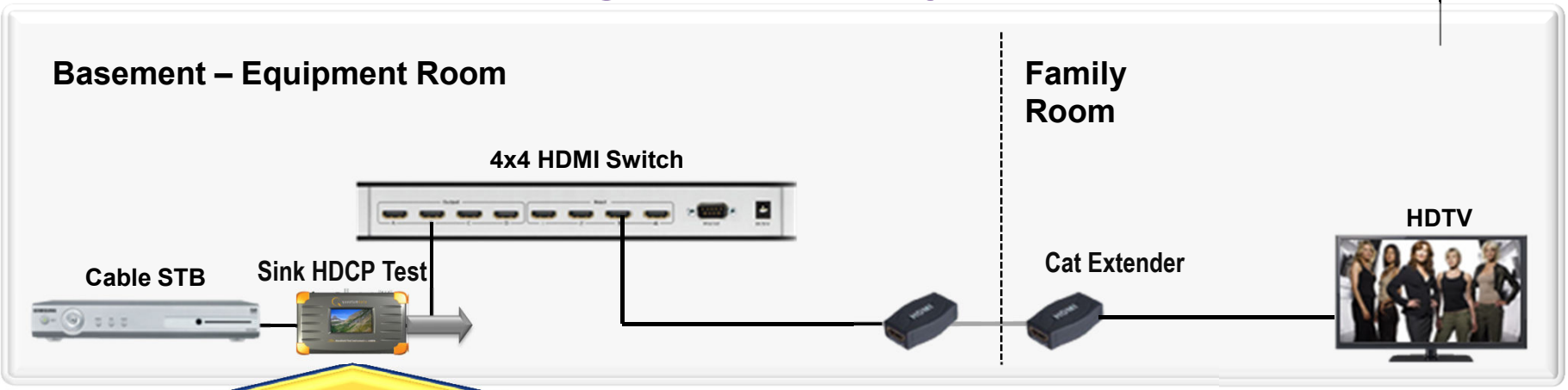
“Connect DVR to AVR to HDTV with HDMI. Signal (picture and sound) periodically drop for a second or 2. AV receiver manufacturer claims it is DVR box. Cable provider doesn't agree or disagree, but tells me I have to use component video connections from DVR to AVR. Nobody will take ownership of the problem and either find me a solution or tell me that they are aware of it and are working on it.”

Probable cause: HDCP authentication failure – STB not processing AV receiver’s HDCP repeater bit.
Resolution: Swap out STB.

Sample Case – Flashing on TV Family Room from STB



Sample Case – Flashing on TV Family Room from STB



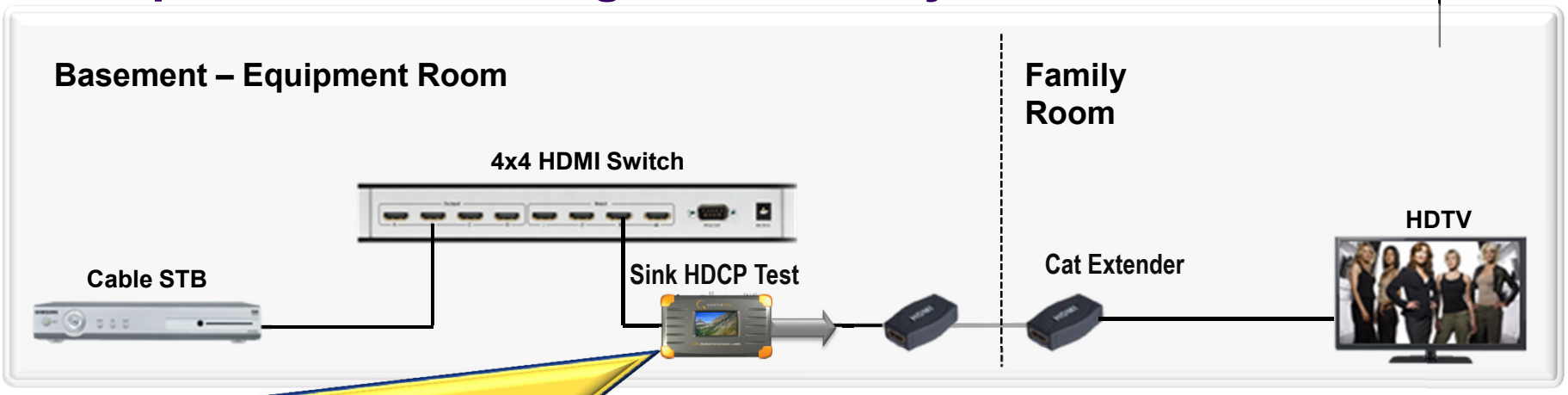
Test: HDCP Sink Test

Objective: Determine if you can authenticate HDCP from a known-good source through the HDMI network. First enable HDCP then disable HDCP.

Fail: If you get video with HDCP disabled but still see flashing when HDCP is enabled, this means that the problem is HDCP related but the STB is not the likely suspect device. Continue testing downstream (next slide).

Pass: If you do get video in either case (HDCP enabled or disabled), then the most likely cause is the STBs HDCP authentication protocol. Confirm by running source test with test equipment on suspect STB. Resolution is to swap the STB.

Sample Case – Flashing on TV Family Room from STB



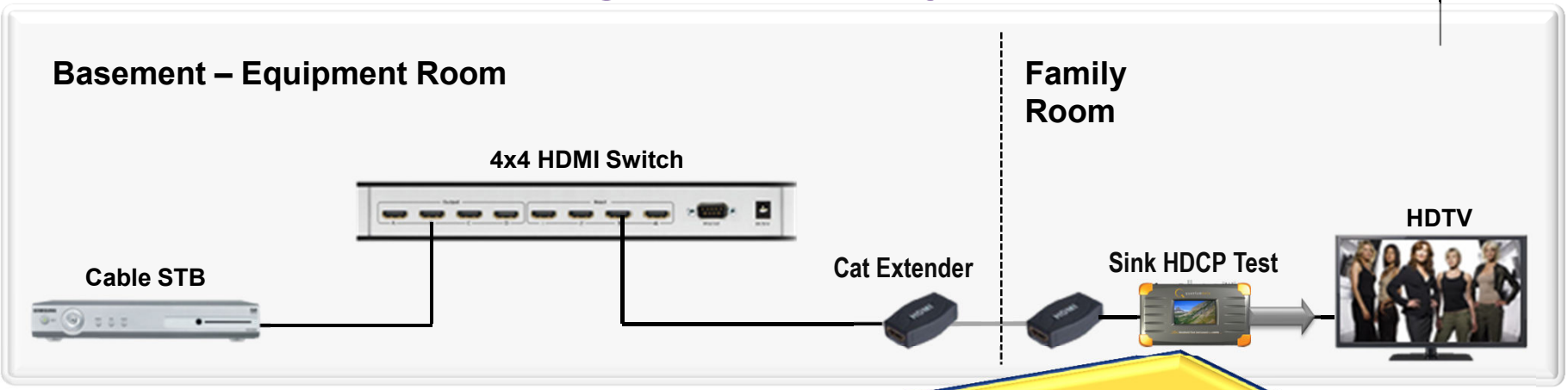
Test: HDCP Sink Test

Objective: Determine if you can authenticate HDCP from a known-good source through the HDMI network. First enable HDCP then disable HDCP.

Fail: If you get video with HDCP disabled but still see flashing when HDCP is enabled, this means that the problem is HDCP related but the HDMI switch is not the likely suspect device. Continue testing downstream (next slide).

Pass: If you do get video in either case (HDCP enabled or disabled), then the most likely cause is that the STB is incapable of HDCP authentication through the HDMI switch. Confirm by running source test with test equipment on suspect HDMI switch. Resolution is to swap the HDMI switch.

Sample Case – Flashing on TV Family Room from STB



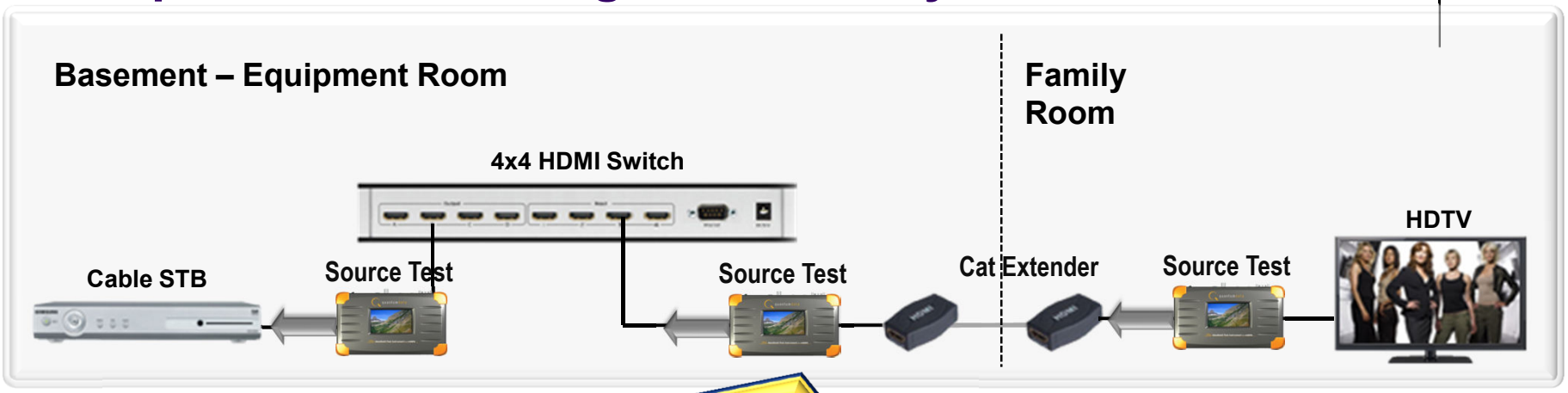
Test: HDCP Sink Test

Objective: Determine if you can authenticate HDCP from a known-good source through the HDMI network. First enable HDCP then disable HDCP.

Fail: If you get video with HDCP disabled but still see flashing when HDCP is enabled, this means that the problem is HDCP related but the extender is not the likely suspect device. The root cause may be a physical layer problem on the DDC; corrupt bits. Resolution is to replace it.

Pass: If you do get video in either case (HDCP enabled or disabled), then the most likely cause is that the STB is incapable of HDCP authentication through the HDMI switch and extender. Confirm by running source test with test equipment on suspect HDMI switch. Resolution is to swap the extender.

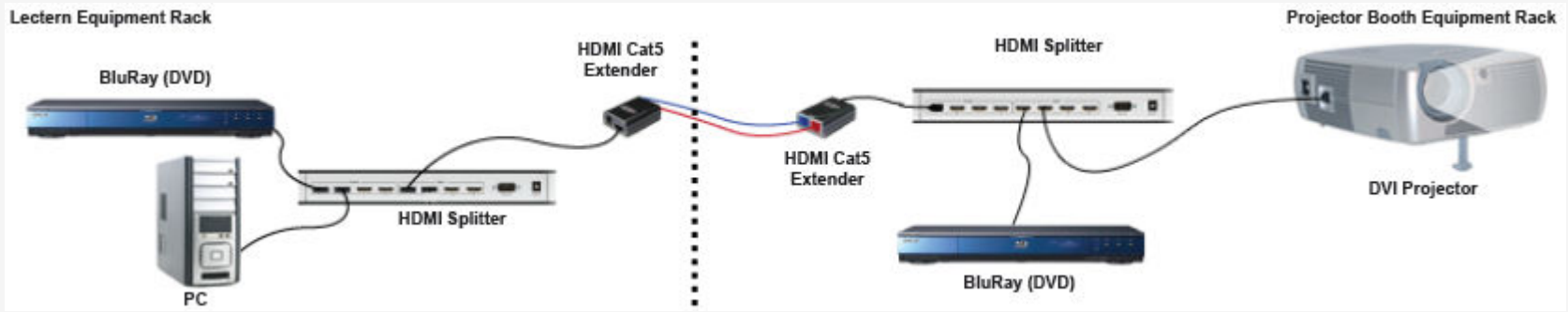
Sample Case – Flashing on TV Family Room from STB



Test: Source Test to confirm

Objective: Verify that the HDCP problem occurs with a known-good sink device.

Case History: No Video in University Auditorium



Case History: No Video in University Auditorium

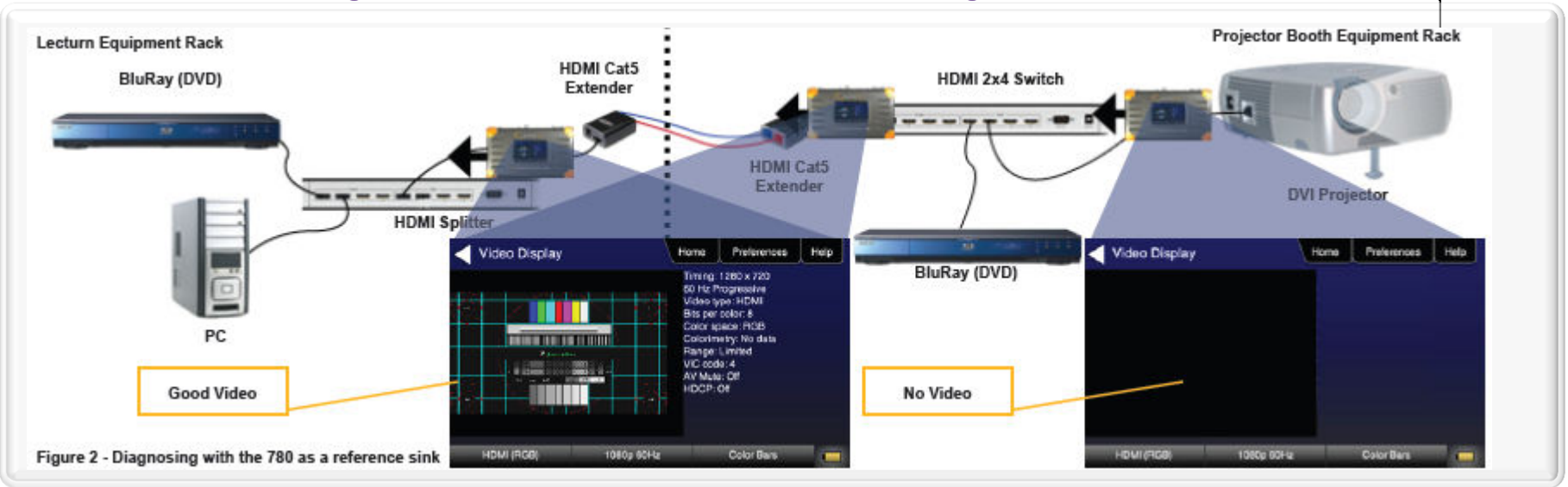
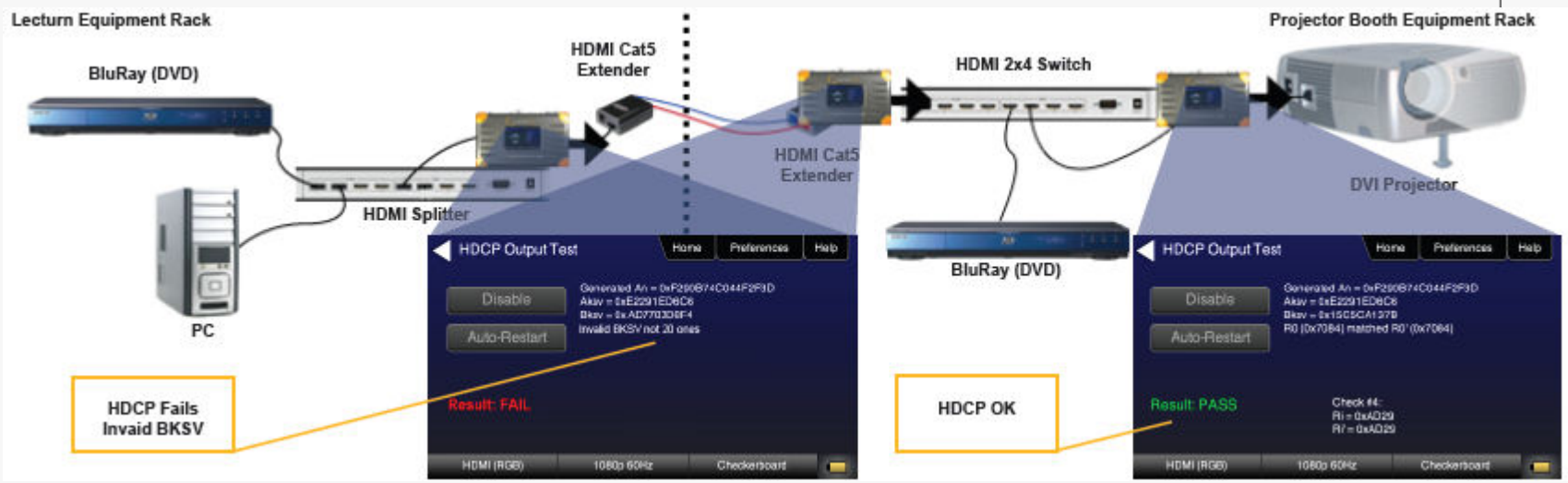


Figure 2 - Diagnosing with the 780 as a reference sink

Test: Source Test (emulate a known-good HDMI sink) from upstream to downstream

Objective: Determine where in the network the problem occurs.

Case History: No Video in University Auditorium



Test: HDCP Sink Test (emulate a known-good HDMI source) from upstream to downstream

Objective: Determine if the problem is HDCP related and determine where the problem occurs.

Case History: No Video in University Auditorium

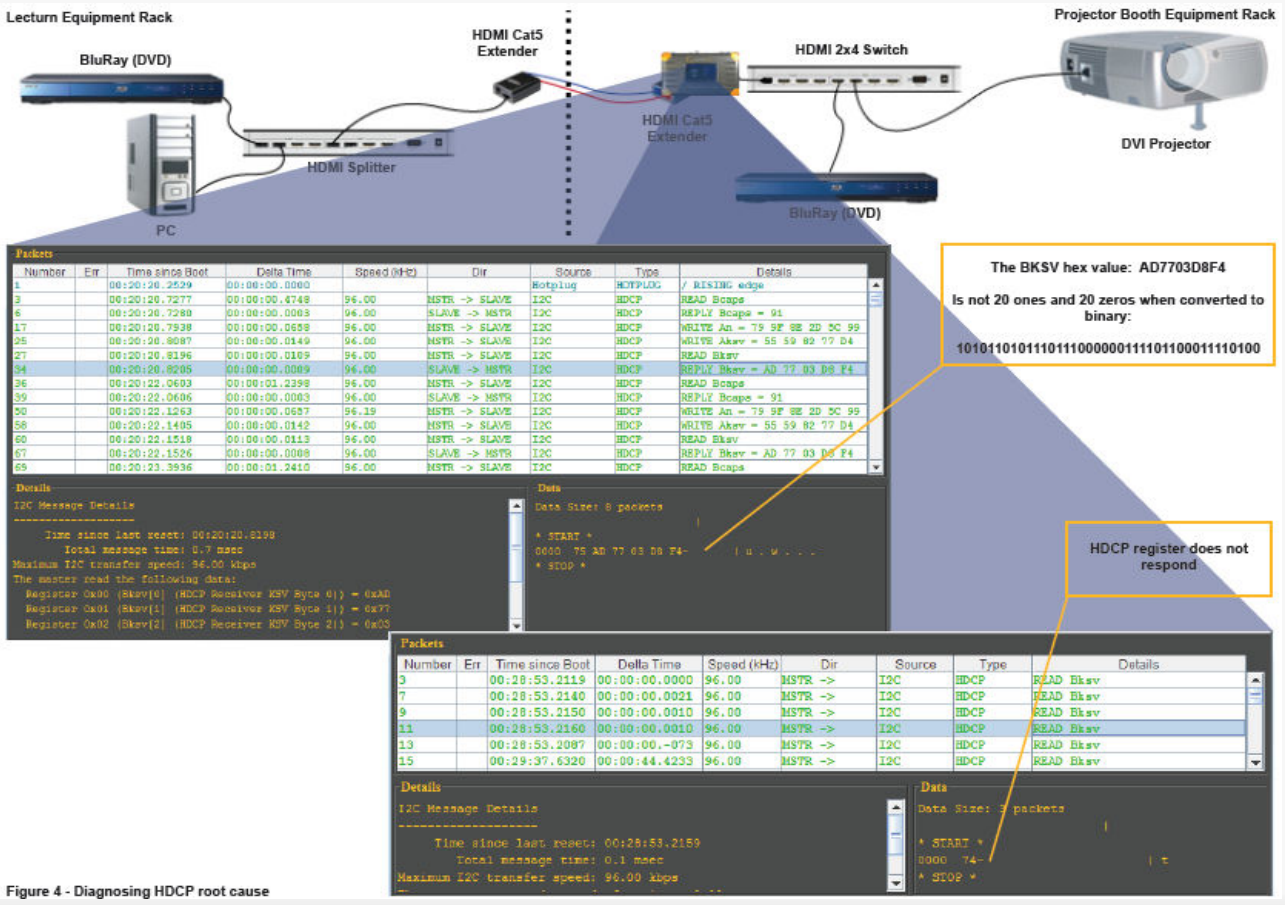


Figure 4 - Diagnosing HDCP root cause

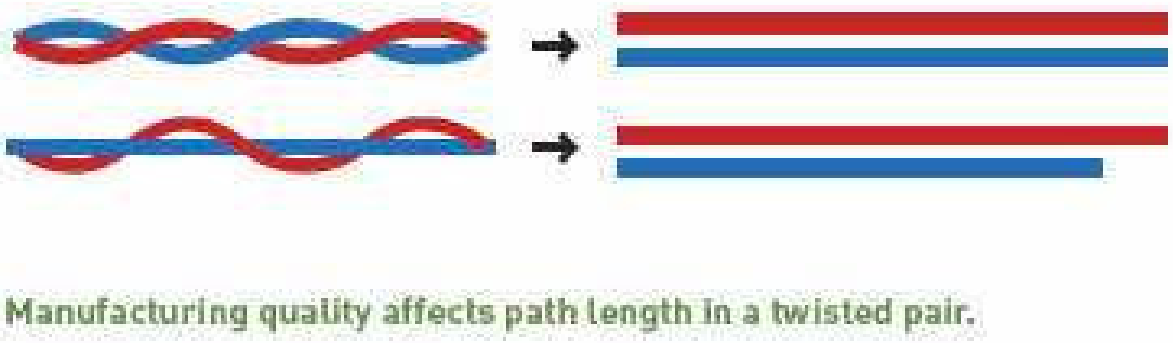
HDMI Connection Sequence

HDMI Connection Sequence
Troubleshooting Principles
Hot Plug Problems
EDID Problems
HDCP Problems
Physical Layer Problems
Audio Dropout

Pixel Errors (“Sparkles”)

- What causes pixel errors (“sparkles”)?
  - Intra-pair skew – The loss within one of the TMDS pairs. Typically results for differential lengths of the twisted pair.
  - Dielectric loss – Distortion or “smear” of the signal due to attenuation of high frequencies.
- Diagnosing physical layer problems requires very expensive equipment.
- Therefore diagnostics of physical layer problems is by inference and general symptom, i.e. pixel errors (“sparkles”) or intermittent snow.
- Symptom of some physical layer problems can be similar to HDCP protocol layer problems.

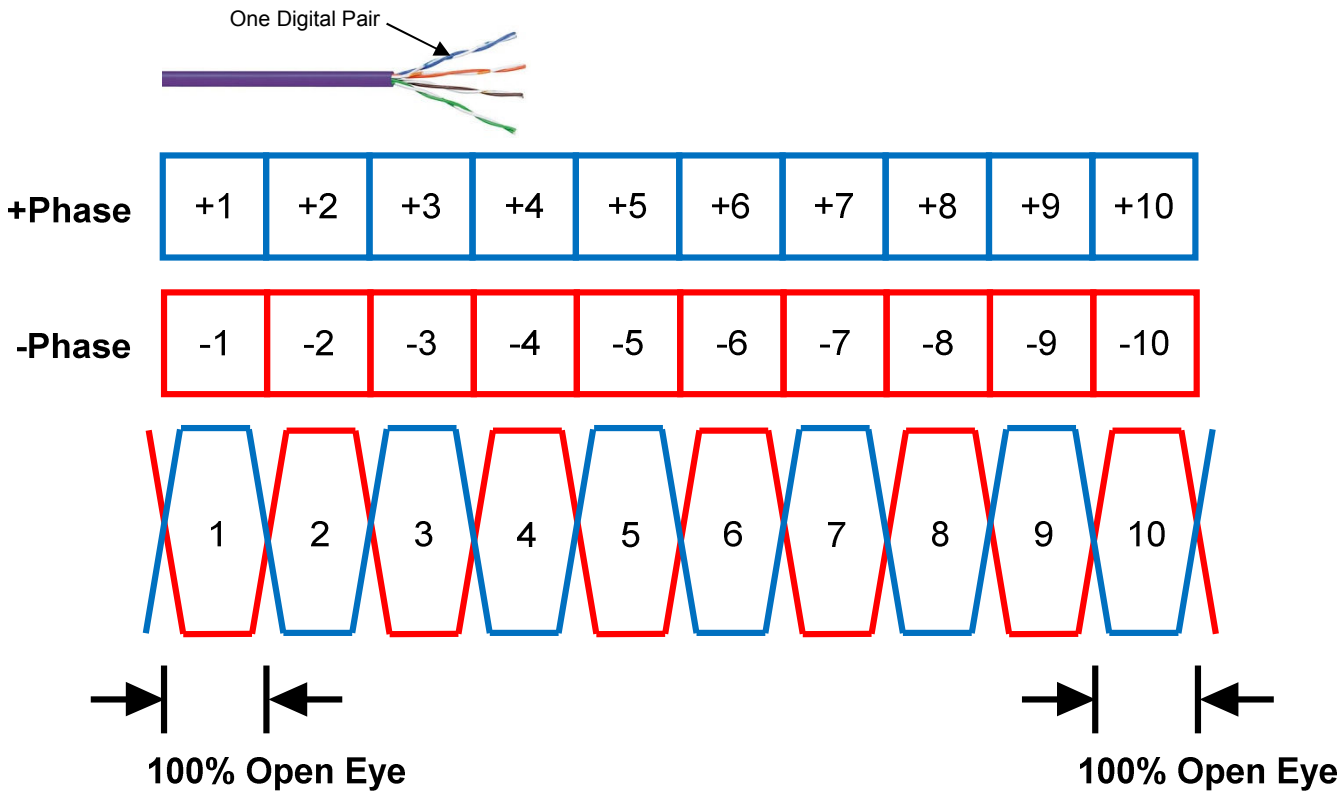
Inter-Pair Skew Cause of Velocity/Length Error



Manufacturing quality affects path length in a twisted pair.

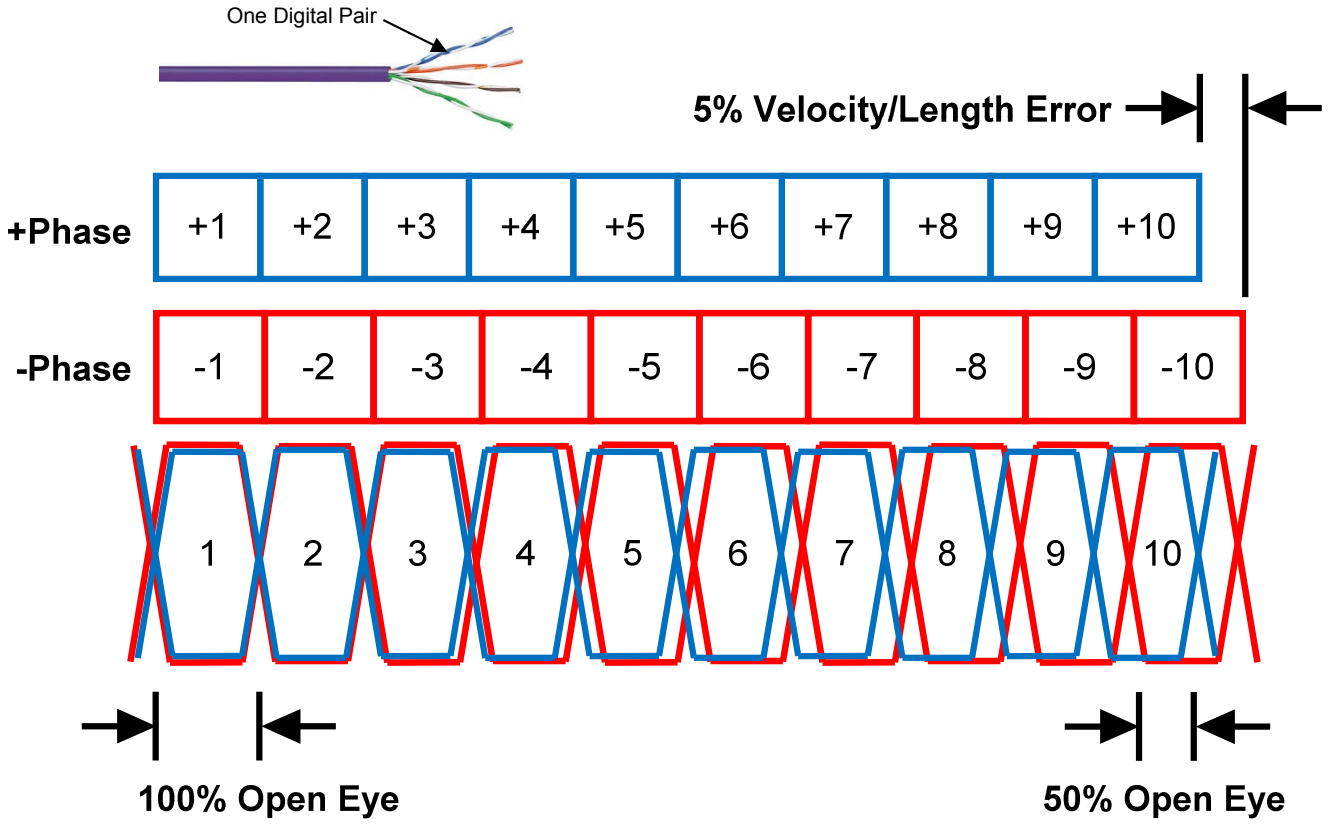
Intra-pair skew caused by asymmetric twists, which in this case makes the red wire longer

Intra-Pair Skew – Perfect Cable



In a perfect world, cabling wouldn't affect the eye…

Intra-Pair Skew – Real Cable



… but we live in the real world where wires aren't perfect

To keep the eye open, limit wire cable length to ≈10 standing bits

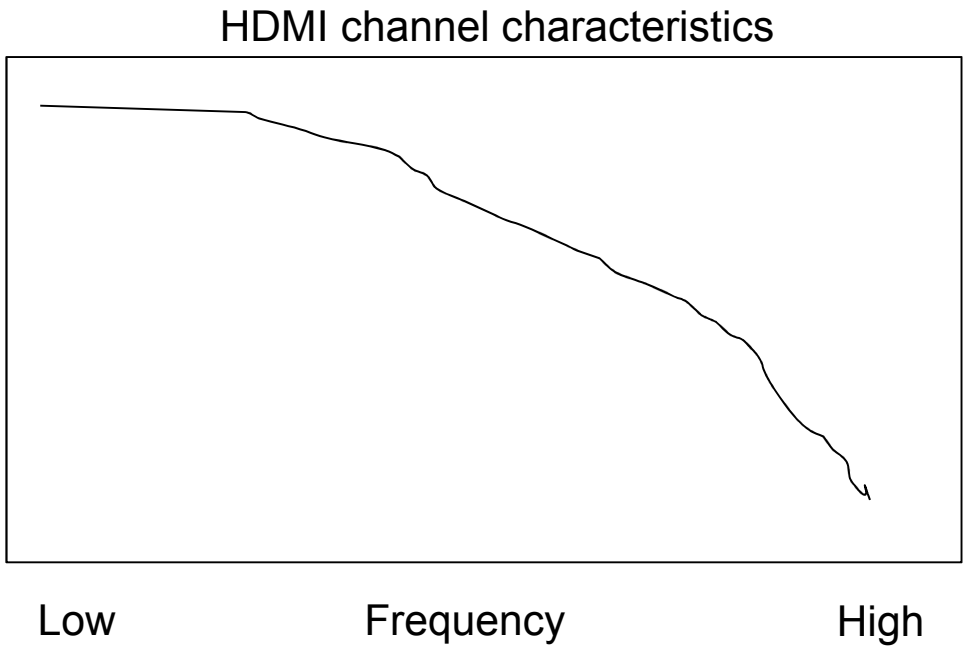
Note: active wires exist that can correct skew (e.g. Redmere)

Pixel Errors ("Sparkles") – Dielectric Loss

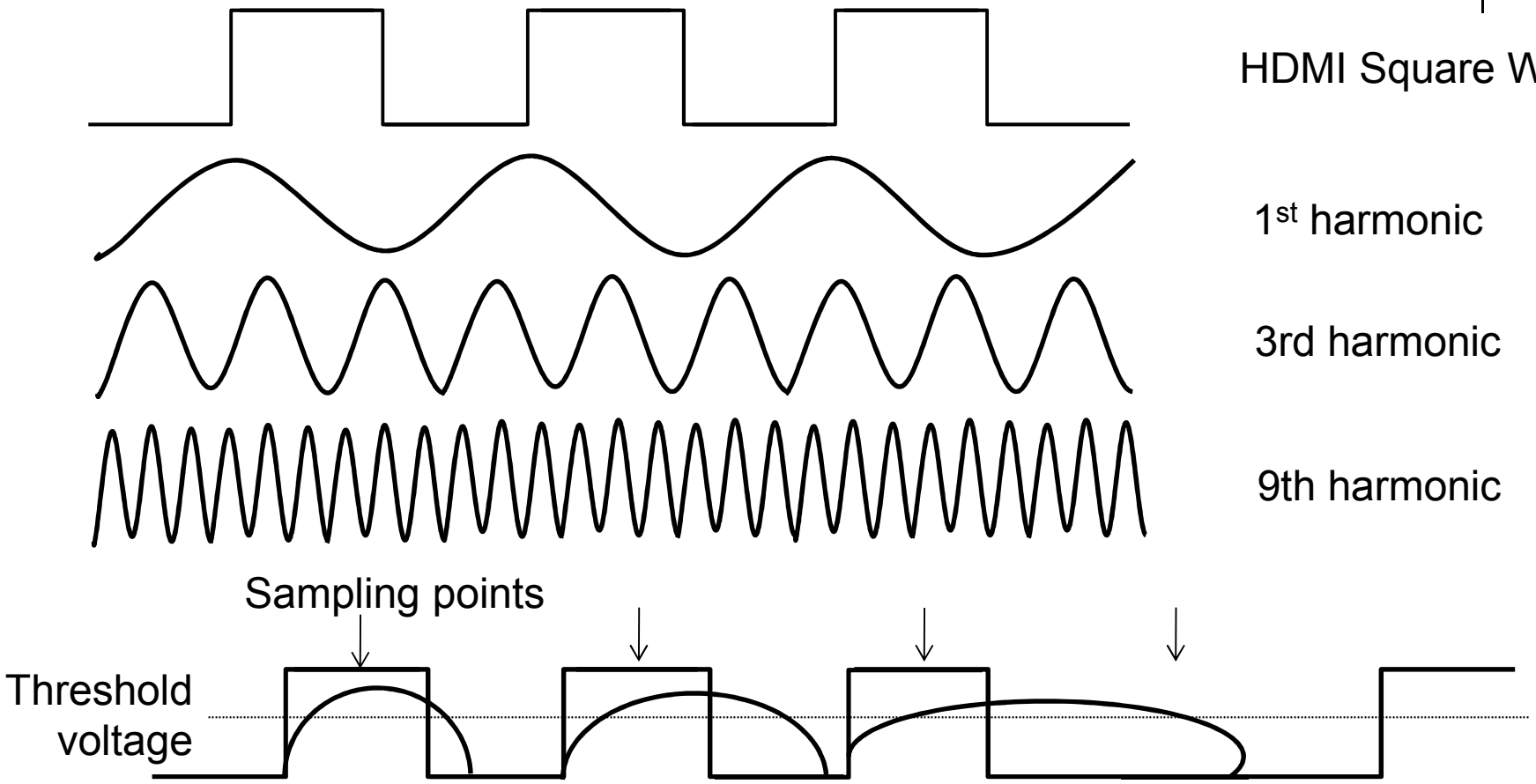
- Why does signal loss increase and signal-to-noise decrease at high frequencies?
- Signals are attenuated at high frequencies when passed over long distance transmission. *A cable is like a low pass filter.*
  - Digital signals are square waves which are comprised of multiple sine waves (the odd harmonics). Sine waves are a single frequency.
  - In order to properly reconstruct a square wave from a series of sine waves you need to maintain as many of the higher odd harmonics as possible.
  - Higher harmonics are attenuated by the HDMI cable "channel."

HDMI Cable – A Low Pass Filter

- Cables pass low frequency components of a signal.
- Attenuate high frequency components of a signal.

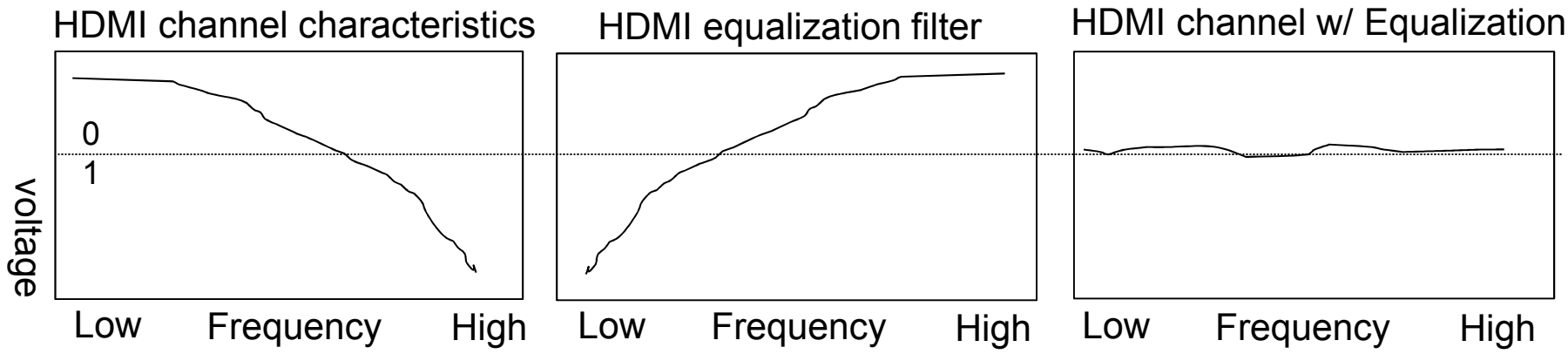


Digital Signal Transmission



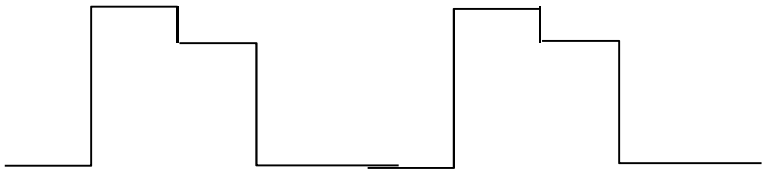
HDMI Equalization & Pre-emphasis

- HDMI uses Equalization and Pre-Emphasis to correct for signal distortion on long signal transmissions.
- What is Equalization?
  - The process of adjusting the strength of certain frequencies (typically high frequencies in HDMI) within a received signal.



HDMI Equalization & Pre-emphasis

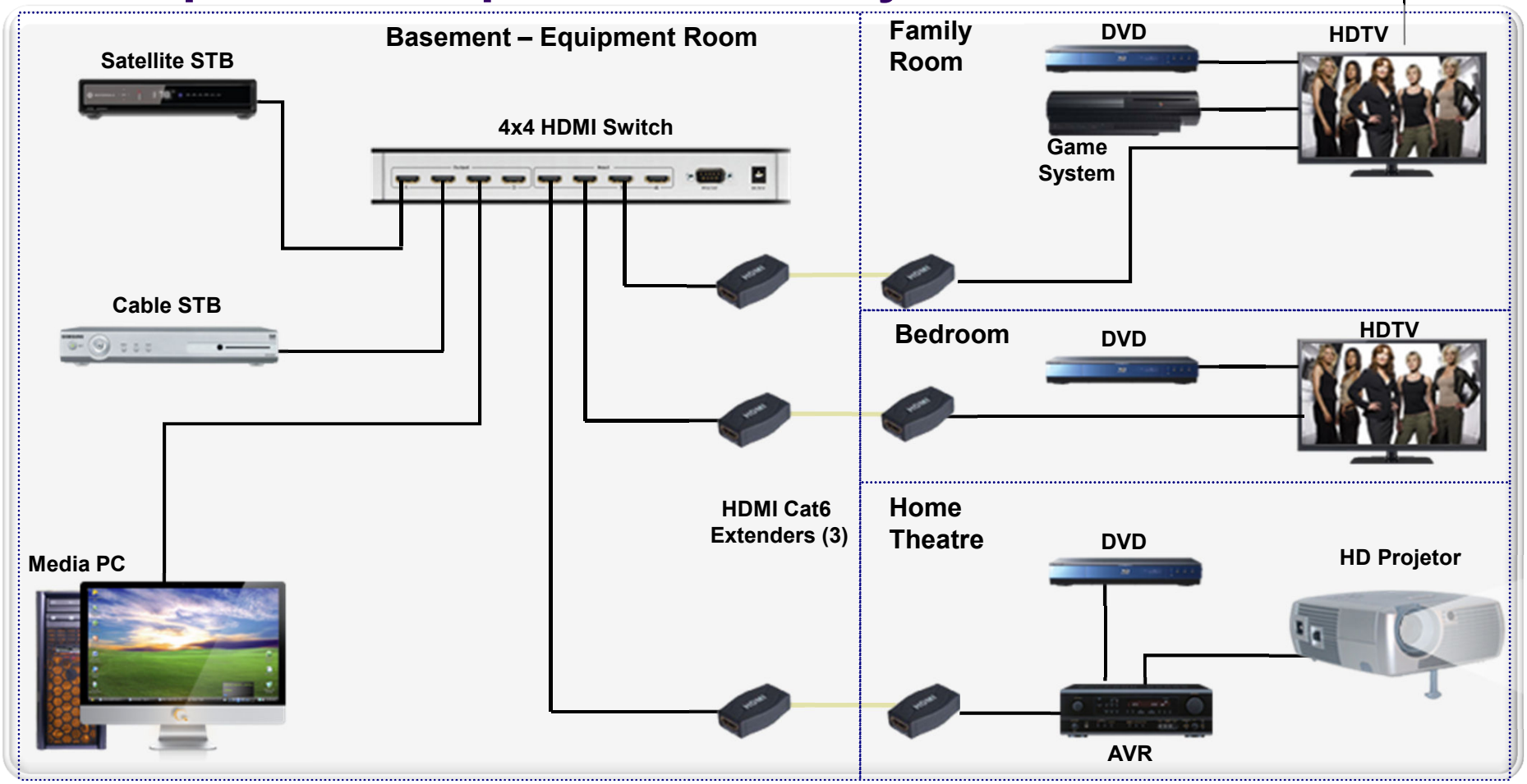
- Equalization increases the signal strength of the high frequencies over long distances but also increases the noise.
- The signal-to-noise level is not improved.
- What is Pre-emphasis?
  - HDMI 1.2 prohibited pre-emphasis because of restrictions on overshoot. HDMI 1.3 removed these restrictions.
  - The process designed to increase the magnitude of some higher frequencies with respect to the magnitude of lower frequencies in order to improve the overall signal-to-noise ratio.
  - Pre-emphasis increases the amplitude for a specific amount of time.



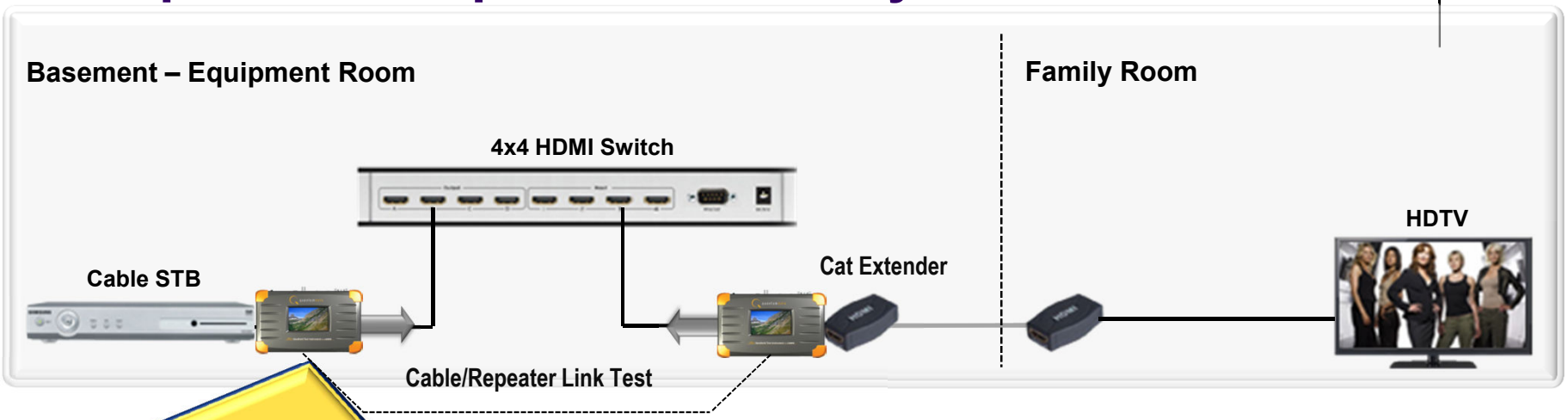
Sample Case - Sparkles in Family Room from STBs

- Symptom: Sparkles in Family Room from STB.
- Possible causes (partial list).
  - Excessive dielectric loss through HDMI cable or HDMI extender or repeater device.
  - Excessive skew on the TMDS pairs.
  - Poor quality HDTV (poor equalization).
  - Pre 1.3 HDMI source without pre-emphasis.

Sample Case - Sparkles in Family Room from STBs



Sample Case - Sparkles in Family Room from STBs



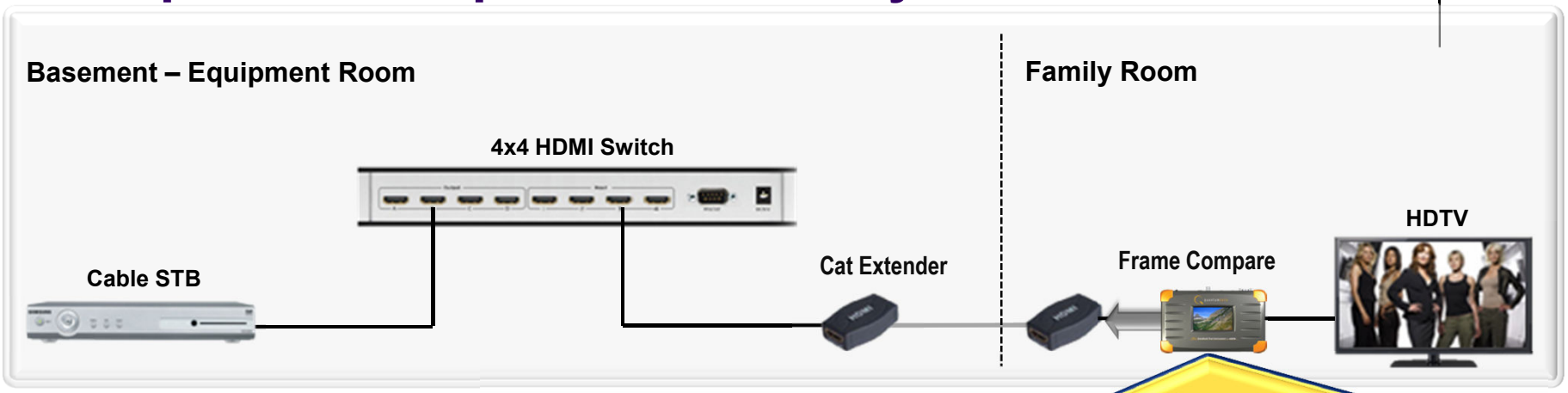
Test: Cable/Repeater Test

Objective: Determine if the HDMI cables to and from the matrix switch and the switch itself are passing good video.

Pass: If this test passes then the most likely cause is the Extender. Run a test on the Cat extender. (Next slide.)

Fail: If this test fails then you should perform individual cable tests on each cable. If one fails, replace it. If they do not fail, replace the matrix switch.

Sample Case - Sparkles in Family Room from STBs



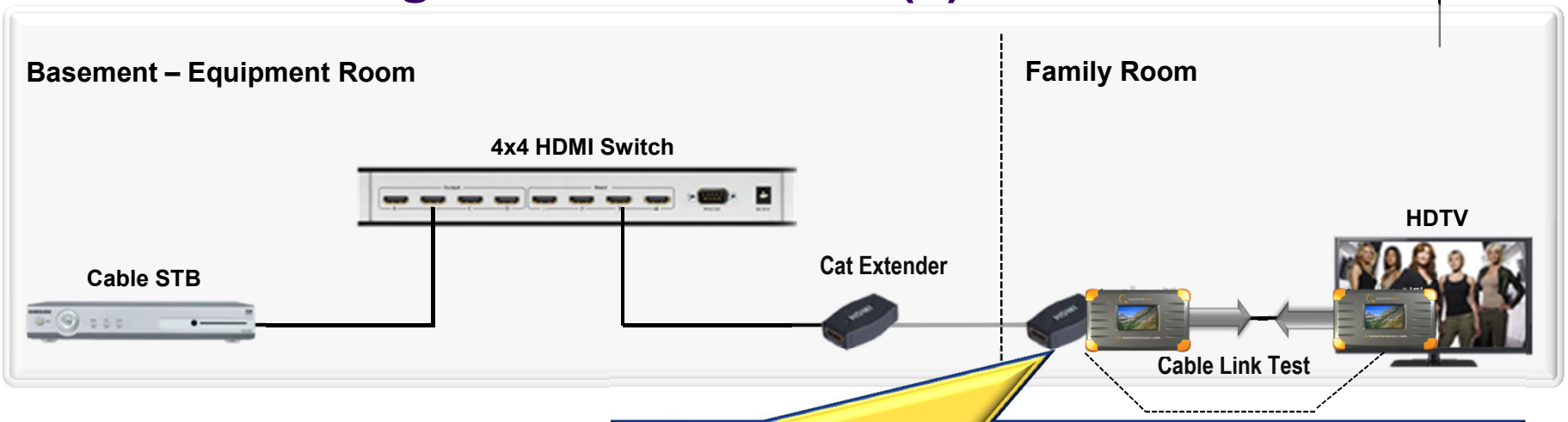
Test: Cable/Repeater Test or Frame Test

Objective: Determine if the HDMI cables to and from the matrix switch, the switch itself and the extender are passing good video. If you cannot run the cable/repeater test, then run the frame compare test.

Pass: If this test passes run a cable test on the HDMI cable to the HDTV. (Next slide.)

Fail: If this test fails then the most likely cause is the Extender or the Cat cable. Try running a new Cat 5 cable temporarily and repeat this test.

Case #3 – Diagnostic Procedure (c)



Test: Cable/Repeater Test

Objective: Determine if the HDMI cables to and from the matrix switch and the switch itself are passing good video.

Pass: If this test passes then the most likely cause is that the extender is exhibiting intermittent errors. Replace/swap the extender.

Fail: If this test fails then you should replace the cable.

AVS Forum Issues

Symptom: Audio Dropout

STB –-HDMI--> AVR —HDMI→ HDTV = Audio drops out

STB –-HDMI--> HDTV

STB –-optical--> AVR

“Watching the ballgame last night and suddenly no sound. I noticed only analog picking up on AV receiver, no matter what mode I had it on. I have changed the HDMI cable and still only analog shows up. Does this sound like the AV receiver is the problem? I have had the HDMI hooked up for over a year now. Does anyone have any ideas?”

Possible causes:
(1) Audio buffer being overrun by audio sample packets.
(2) Audio infoframes missing.
Resolution: Swap out STB.