



## 780 HANDHELD TEST INSTRUMENT CASE STUDY

### Diagnosing HDMI Interoperability Problem in University Auditorium

**Summary:** Quantum Data was asked to diagnose a persistent interoperability problem at a major University in the upper Midwest. The problem was occurring in an auditorium where University professors would often lecture to large groups. The venue was also used for showing films both for entertainment and education.

**Network:** The test set up is shown in figure 1 below. The HDMI AV network had two HDMI source devices in the equipment rack at the lectern. There was a BluRay DVD player and a PC. The BluRay is the source that exhibited the problem. This is important because HDCP content protection would not normally be used from the PC but it would be from the BluRay DVD player. The output from the BluRay was connected to an HDMI splitter and then to an HDMI Cat5 extender. The extender carried the signal from the lectern up to the equipment rack in the projector booth. The HDMI output from the HDMI Cat5 extender was connected an HDMI 2x4 switch and then to the DVI projector via an HDMI-to-DVI converter cable.

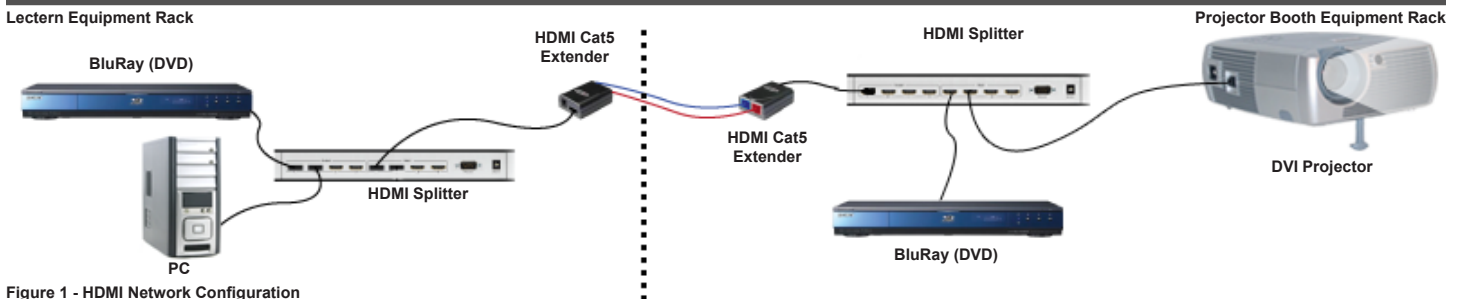


Figure 1 - HDMI Network Configuration

**Symptom:** The problem was that video failed to appear intermittently when the source was either of the BluRay DVD players (at the lectern or up on the booth). Often this problem exhibited itself when there was a port change on the HDMI switch up in the projector equipment booth. Usually the problem could be resolved by cycling the ports on the HDMI switch or by powering down the components and then repowering them from source to sink. But this was not an acceptable long term solution.

**Diagnostic Approach:** Typically the problem component can be identified by simplifying the network, in other words removing components and determining when the problem went away. But in this case because of the intermittent nature of the problem a different approach was used. In this case the Quantum Data 780 was used to substitute ("emulate") various HDMI source and sink components in the network and test HDMI video, HDCP and EDID.

**Diagnostic Procedure:** Quick confidence tests were performed with the 780 emulating a known-good HDMI sink starting initially from the projector and looking upstream toward the HDMI source for problems with the EDID and to check basic HDCP authentication. *Refer to Figure 2* The 780 can emulate any EDID and for these tests, a set of known-good EDIDs were used to test the sources' response. There were no EDID handling anomalies detected in this first series of tests. But there were some failures to detect incoming video on the upstream side of the HDMI 2x4 switch. These were most likely related to HDCP.

Following this initial set of tests, the 780 role was reversed and it was used to emulate a known-good source to test toward the downstream side of the network. *Refer to Figure 3* During these tests HDCP was enabled and disabled to determine quickly if the problem was related to HDCP or not. *These tests clearly indicated that the problem was related to HDCP.* At each point where the 780 was substituted for an HDMI device, a pattern was clear: when HDCP was enabled, there was no picture; when HDCP was disabled, there was a picture coming out of the projector.

During this second series of tests the error that occurred was "invalid BKSv; not 20 ones and 20 zeros". *Refer to Figure 3* The BKSv is a 40 bit public key whose value selects a specific set of private keys for HDCP authentication. Each KSV (the AKSV for the source and the BKSv for the sink) have to have 20 ones and 20 zeros. When the HDMI 2x4 switch in the projector booth was bypassed, the errors disappeared. Further troubleshooting verified that the HDMI 2x4 switch did in fact have an invalid BKSv. But the problem remained, why did it work sometimes and not others. The reason for this appears to be that the switch's BKSv had 22 ones, so it is possible that some source devices simply look for 20 ones and do not verify that there are only 20 ones.

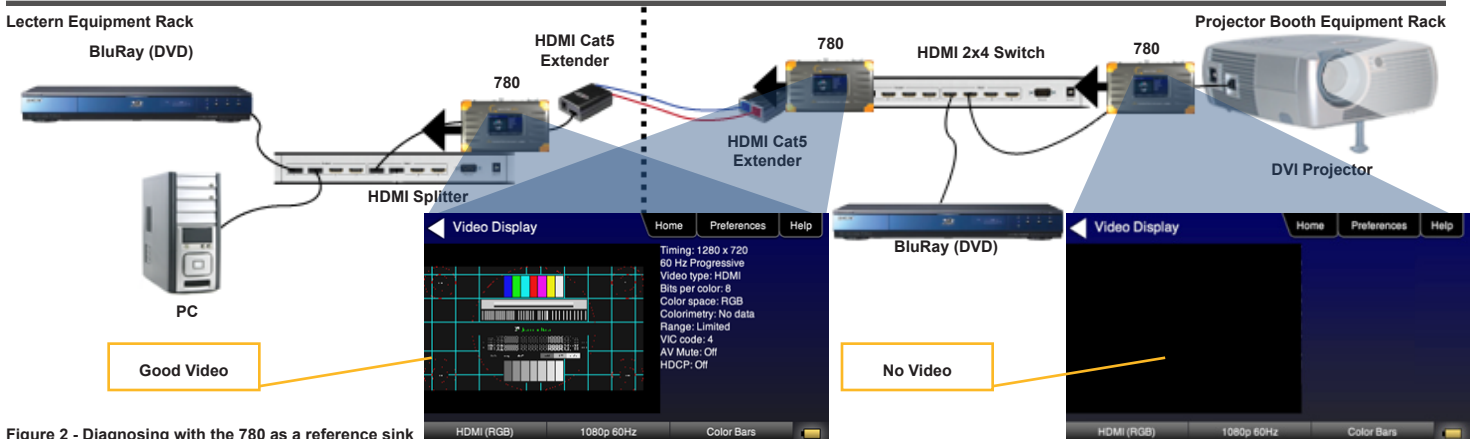


Figure 2 - Diagnosing with the 780 as a reference sink

**Diagnostic Procedure (Continued):** During the diagnostics it was also discovered that the HDMI 2x4 switch ports would lock up when the operator cycled through them. In this case the switch did not respond to any HDCP read from the 780 acting as a known-good HDMI-HDCP source. *Refer to Figure 4* Furthermore, the 780 also showed that the HDMI switch did not set the repeater bit indicating that it was an HDCP repeater. This can cause HDCP authentication failures because this repeater bit value (which is in the "BCAPS" register) is used in the calculation to validate the HDCP authentication.

**Resolution:** The resolution was to replace the HDMI 2x4 switch in the projector equipment booth. The root cause of the problem was diagnosed in about 30 minutes using the Quantum Data 780.

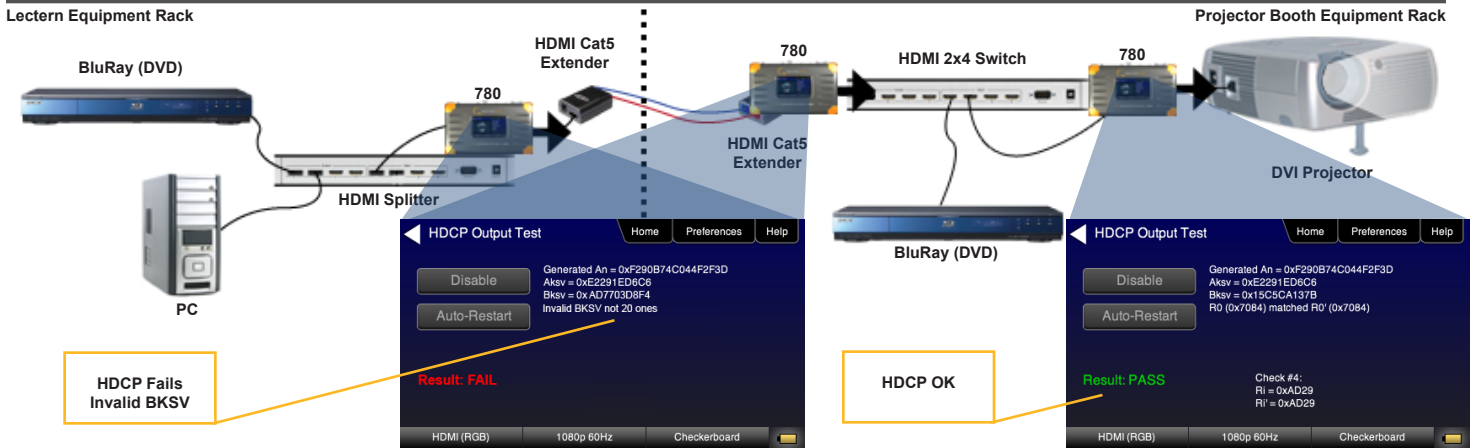


Figure 3 - Diagnosing with the 780 as a reference source

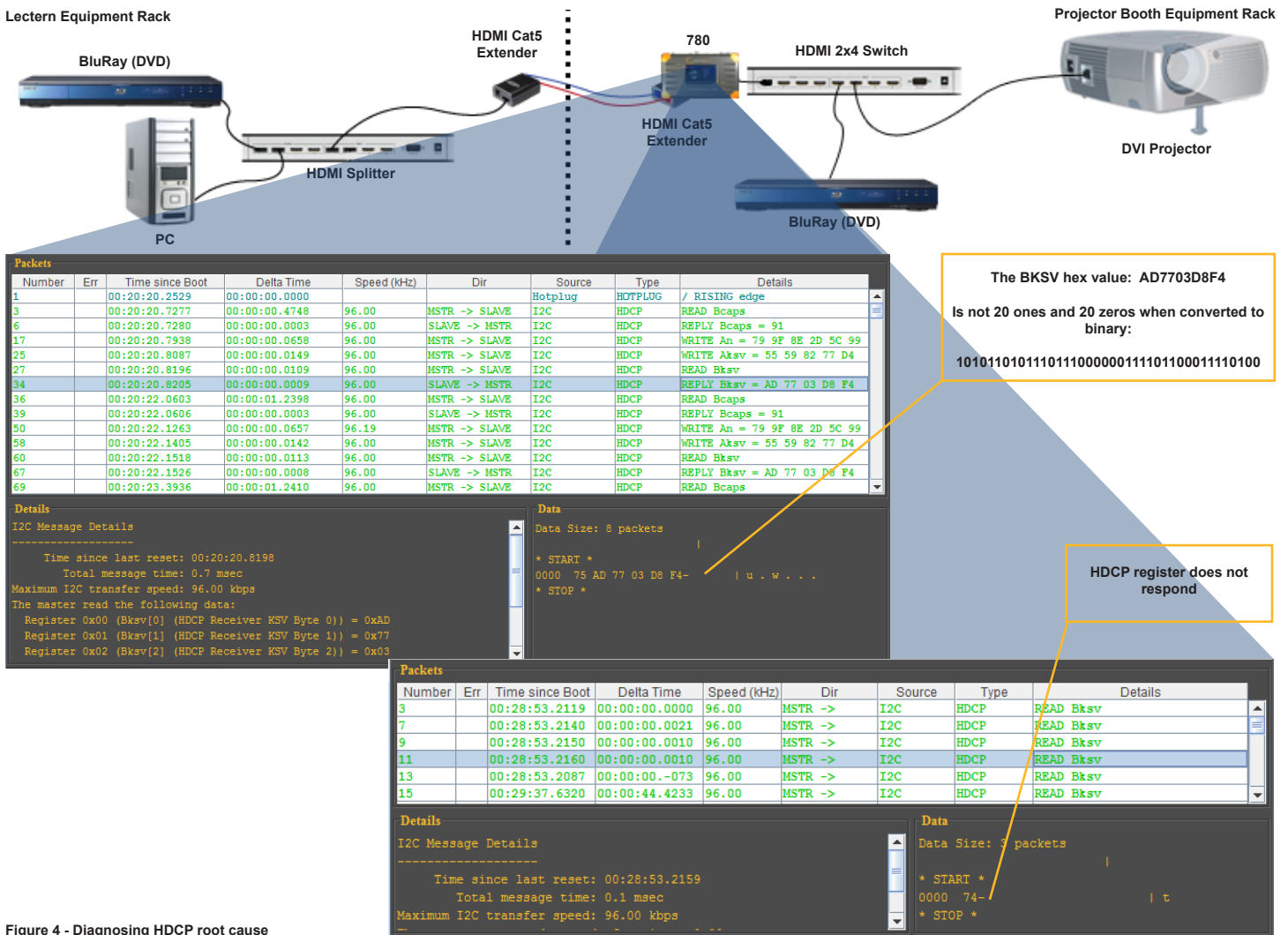


Figure 4 - Diagnosing HDCP root cause