HDMI & HDCP

— the manufacturers' perspective

Note from the Editor: This article outlines the views of EICTA – the European CE equipment manufacturers association – on HD content protection using HDCP. The views of several European broadcasters are presented in a separate article published in this edition.

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HDTV signals offer great opportunities to broadcasters, but there is also the negative side – a high risk of piracy. In order to protect prime content against illegitimate use, content-protection mechanisms can be used.

For the digital HDMI interface between an HDTV set-top box and an "HD ready" display device, HDCP technology is chosen. This is a tool that can be used at the discretion of the broadcaster who can activate it by means of a switching signal. In the case of a piracy attack, the technology offers a revocation mechanism whereby a list of revoked devices is transmitted in a safe way to the receiver, where it is stored.

The availability of a content protection mechanism – being a mandatory requirement of the EICTA "HD ready" logo – does not mean that the display device always needs to be fed in a protected manner. Free-to-air signals that are transmitted in the clear are always displayed.
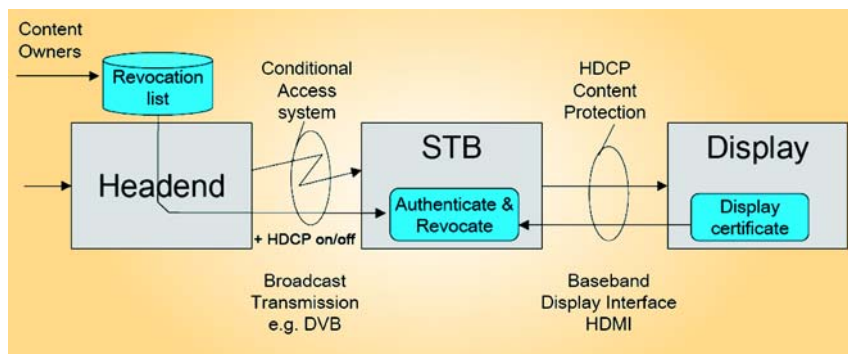
The high quality of digitally transmitted HDTV offers the broadcaster big opportunities – but also brings along some risks not to be neglected: pirates use the high-quality signals to illegally copy them and start their own business, thereby neglecting the copyright of the originator.

One of the links that are open to attacks is the digital baseband interface between a receiving set-top box (STB) and an HDTV display device. Here, either the *Digital Visual Interface* (DVI) [1] or the *High-Definition Multimedia Interface* (HDMI) [2] is in use. In order to protect high-quality digital signals on these interfaces, a technology called *High-bandwidth Digital Content Protection* (HDCP) [3] is used. The European CE industry association, EICTA [4], made HDCP part of their minimum requirements for an HD-capable display device that is labelled with the *HD ready* logo. This article explains the function of HDCP and the way it is implemented. It also highlights the different positions of European broadcasters concerning the control of the copy protection mechanism.

As of today, the application of any content-protection mechanism is mainly controlled by the content owner. The broadcaster or pay-TV operator is obliged by its licence contracts to ensure adequate content protection by switching on an appropriate mechanism, and the receiving/recording/displaying devices must have implemented it.

High-bandwidth Digital Content Protection (HDCP)

Fig. 1 sketches a digital transmission system for HDTV signals. The HDTV signal from the head-end is sent to a set-top box (STB). In many cases a Conditional Access (CA) system is used to enable the protection of the content as well as the subscription management. Once the STB has received and decoded the signal, it needs to be forwarded to a suitable display. In the case of HDTV signals, the digital connection between the
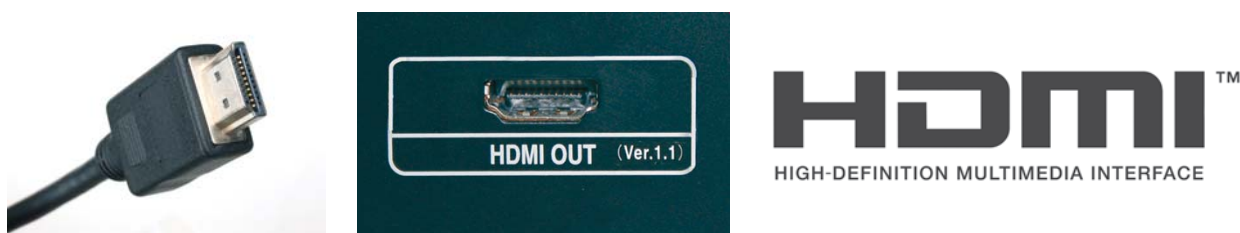

Figure 1
Concept diagram of a digital transmission system with Conditional Access and HDCP copy protection of the display interface

STB and the display will be either HDMI or DVI *(Figs 2 and 3)*, with the former being the most up to date.

If the content owner requests the broadcaster to protect the content against piracy, there must be a mechanism in place that prevents someone from tapping the interface between the STB and the display and making an illegal copy.

For this purpose, the HDCP scheme has been developed. Using this mechanism, the content on the interface between the STB and the display device is scrambled in order to make it useless for pirates.

Once a display device is hooked up to a source device (here, the STB), an initial authentication/ negotiation procedure between the source and the display is started. In the course of this authentication procedure, keys are exchanged and validated, and the scrambling mechanism is activated.

Authentication is also needed in order to have the possibility of taking action in case any of the devices involved have been compromised in a way that could be used for piracy. In those cases, the content owners can signal via so-called *revocation lists* that the compromised devices are black-

Figure 2
High-Definition Multimedia Interface (HDMI): plug, socket and logo *(courtesy of HDMI.org)*

Figure 3
Digital Visual Interface (DVI): plug, socket and logo *(courtesy of DDWG.org)*

listed and shall no longer be permitted to transport signals using the HDCP scrambling mechanism. By this method, content owners can render such devices useless and hence "plug the piracy holes".

The responsibility for putting together these revocation lists is with the content owners. The broadcasters as well as the equipment manufacturers are obliged to transmit the lists and react accordingly, based on the licence contracts they have signed for using HDCP. In order to protect these lists from being tampered with on their way to the receiver, they are transmitted with a digital signature.

HDCP switchable, programme-by-programme

Content protection on the display interface may not be needed for all the programmes broadcast by a particular TV channel; there may even be TV channels that do not request any content protection. In those cases, the HDCP mechanism can be switched off and the content can be transmitted in the clear as a high-bitrate baseband video and audio signal.

At present, such a switching mechanism is realised within the different CA systems. In the same channel that transmits the programme in protected form, the information is transmitted to the STB whether any copy protection is needed on the display interface (DVI/HDMI).

There are currently various implementations in use that differ in their ways of controlling the HDCP on/off switch. It goes without saying that control over this switch is sensitive and will not be made available to all potential users of the STB … including a potential pirate!

The way it is used is defined by the operator who specified the set-top box. In fact, the implementation in most cases is part of the Conditional Access system implementation. Based on conditions set by the content owners, copy-control mechanisms are even wider than the simple on/off switching of HDCP on the digital interface. Almost all set-top boxes have analogue as well as digital outputs, including one or more SCART plugs for hooking up standard-definition devices.

In the case where HDCP on the digital interface is enabled (for protecting a high-quality HDTV signal), the analogue interfaces may behave in several different ways:

❍ They could be copy-protected by an analogue system but, at present, such systems only exist for standard definition;

❍ The HD component interface could be switched off, with only the SD interface (SCART) delivering a copy-protected SDTV signal;

❍ All analogue interfaces could deliver a signal but only in standard definition – sometimes this can even be recordable;

❍ All analogue interfaces could be switched off.

It is very important to note that the behaviour of the analogue interfaces is defined by the body that specifies the set-top box and has nothing to do with the HDCP mechanism described above. HDCP does not deal with any analogue signals.

Free-to-air content and copy protection

Almost all HDTV set-top boxes on the European market are put there by pay-TV operators. At the end of 2006, there were approximately 500'000 STBs in consumer households. This number is quickly heading towards one million boxes, as further HDTV services get launched in various European countries. An intense debate has occurred around the way these boxes should handle free-to-air content.

All DVB set-top boxes defined for pay-TV are also capable of receiving free-to-air content. In the case of HDTV, the decoded signal is fed to the display device preferably by the HDMI interface in order to best preserve the high quality of the pictures. But the free-to-air broadcasters currently

Abbreviations			
A/D	Analogue-to-Digital	**EICTA**	European Information, Communications and Consumer Electronics Technology Industry Association
CA	Conditional Access		
CE	Consumer Electronics		
D/A	Digital-to-Analogue	**HDCP**	High-bandwidth Digital Content Protection
DVB	Digital Video Broadcasting http://www.dvb.org/	**HDMI**	High-Definition Multimedia Interface
		SDTV	Standard-Definition Television
DVI	Digital Visual Interface	**STB**	Set-Top Box

have no influence to control the way HDCP is used (or not) on that interface. These rights are defined by the party that specified the set-top box — the pay-TV operator. That being said, there is also no obligation on free-to-air broadcasters to deal with the transmission of revocation lists.

In fact, the existing boxes in Germany, the UK and France handle the HDCP switching differently: some boxes leave HDCP on at all times whereas others switch HDCP on only for specific programmes such as first-run movies. In both cases, the free-to-air signals will be displayed on the connected HD-ready device and the viewer would not even know whether copy protection is active or not.

Obviously there is one exception ... once the display device has been misused for piracy activities and is consequently put on the revocation list, it will not receive any further images when HDCP is switched on.

HD ready and HD TV logos and copy protection

When HD-capable display devices became available on the market place, discussions started on which features needed to be implemented in order to have a future-proof device. One of the questions that needed to be answered was the necessity of implementing copy protection.

Figure 4
EICTA logos:
(left) **"HD ready"** for display devices and
(right) **"HD TV"** for receiving devices

The European CE, IT and communications industry association, EICTA, defined the "HD ready" and "HD TV" logos *(Fig. 4)*. While HD ready defines the minimum requirements for display devices, the HD TV logo does the same for HDTV receiving equipment. Details can be found on the EICTA website [4].

The HD ready minimum requirements include analogue as well as digital interfaces. The latter – which could be DVI or HDMI - necessarily needs to have HDCP implemented. This was made mandatory in order to ensure that the consumer will always see an HDTV picture, even if the broadcaster or content provider decides to use copy protection on the output of the receiving device.

After a lengthy debate, EICTA decided not to make HDCP mandatory for all receiving equipment. This pays tribute to the fact that, in future, there might be free-to-air receivers without any CA system that simply do not offer the technical means needed for HDCP implementation (i.e. a secure transmission channel for switching information and revocation lists).

When the first HD ready devices came on the market, there was a campaign in the technical press that the HD ready logo would simply be an industry action to have copy protection made mandatory in all cases. This definitely is not the case, because all interfaces always accept signals that are offered without copy protection. However, the logo assures the consumer that he will always see a picture … unless his display device has been misused for piracy action and has been revoked.

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Over the past 20 years, Mr Westerkamp has been involved in many projects to improve TV systems, ranging from HD-MAC and PALplus via DVC (the standard for digital camcorders) to MPEG and DVB. In the DVB Consortium, he has served for several years as an industry member of the Steering Board. Within EICTA, he chairs the HDTV issue group that developed the HD ready and HD TV product logos.

Handling of revocation lists

In the current implementations, the revocation list is stored in the STB. The receiving device gets the information via the broadcast channel as defined by the licensing authority, DCP LLC. Whenever a new version of the revocation list is issued, the information stored in the receivers will be updated.

Conclusions

The HDMI interface is the best choice for delivering HDTV content from a receiving device to a modern display device. It maintains the quality of the image at the highest possible level, by avoiding unnecessary cascaded A/D and D/A conversions. The high quality of the signal on the interface makes it a target for signal pirates to make illegal copies. HDCP is the means to prevent this.

EICTA has made HDCP part of the minimum requirements for HD ready display devices in order to assure the consumer that he will always get a high-quality HDTV picture on his display. It needs to be underlined here that the HDMI interface of the display also accepts non-copy-protected signals. Once the connected set-top box uses HDCP all the time, free-to-air content will also always be displayed, even if it is transmitted via the copy-protected link because the pay-TV operator who sponsored the set-top box has decided so.

There is an ongoing debate at the level of European standardization on whether there is a possibility of defining a secure switching mechanism that would allow every broadcaster to decide whether or not to activate HDCP. Looking at the current HD TV set-top boxes in the market place, it can be seen clearly that they all implement HDCP and are using different concepts on how to control the use of HDCP. Independent of that, all of these boxes can handle free-to-air signals and deliver them to the connected display. In all cases the consumer can enjoy the HDTV pictures … unless he has misused his display device for piracy actions and the device has been put on the revocation list. In that case, the screen will remain dark.

References

[1]   DVI   DDWG, "DVI Visual Interface", rev. 1.0, April 2, 1999 as further qualified in EIA/CEA-861 rev. B, "A DTV Profile for Uncompressed High Speed Digital Interfaces" May 2002
http://www.ddwg.org

[2]   HDMI   HDMI Licensing, LLC, "High-Definition Multimedia Interface", rev. 1.3, November 10, 2006
http://www.hdmi.org

[3]   HDCP   Intel, "High-Bandwidth Digital Content Protection System", rev. 1.2, June 13, 2006
http://www.digital-cp.com

[4]   EICTA   http://www.eicta.org