# HDTV Deployment: A funny thing happened on the way to the decoder interface....

Robert M. Zitter
Senior Vice President, Technology Operations
**Home Box Office**
New York, NY
robert.zitter@hbo.com

Michael Adams
Senior Project Engineer, Advanced Engineering
Co-Chair, Digital Standards Working Group, JEC
**Time Warner Cable**
Denver, CO
michael.adams@twcable.com

*Abstract*

*The decoder interface has, for quite some time, been viewed as an important technology for cable -- first for consumer-friendly deployment; then by force of law; now a critical requirement for the deployment of High Definition Television (HDTV).*

*This paper describes how HDTV (and SDTV) digital transmission needs the decoder interface -- and what obstacles lie ahead. In the focus of cable technology over the years, the "last mile" has always been a critical hurdle to overcome. In the cable deployment of HDTV to digital TV's the critical technology hurdle has become the "last six-inches."*

*The specifics of digital interfaces such as 1394 "FireWire" are discussed as are business requirements such as digital copy protection.*

## THE BEGINNING

Program streams, in any form, start from an origination facility. The complexity of a contemporary digital origination facility is beyond the scope of this paper -- but it forms a critical foundation for the transition to a digital end-to-end delivery system for cable programming. Purely creative reasons have led to a fully-digital origination facility -- the complex graphics and promotional elements in most program networks could not be done without sophisticated digital environments.

Similarly, economics have drawn program networks toward a purely-digital origination model. State-of-the art, reliable, automated, and high-quality tape and server formats are all digital. In fact, improvements in picture quality (e.g. component digital) have also yielded benefits in the "Mb/s" -- consumed bandwidth for a given picture quality.

When HBO embarked on a transition to full end to end-digital

transmission in 1994, all of these benefits were capitalized on in a state-of-the-art digital facility completed in 1997. At that time HDTV was not part of the mid-term plan.

However, as plans were made for cable-industry digital infrastructure, it was evident that cable had the opportunity to leapfrog terrestrial broadcasters -- and attain parity with upstart DBS providers who had barely begun their business plans. Certainly, HDTV -- then a gleam on the horizon -- would fall into place behind a solid end-to-end digital infrastructure. Operators, such as Time Warner Cable were well into their upgrades to 750 MHz HFC – Time Warner Cable's upgrade is currently 50% complete.

## THE PLAN

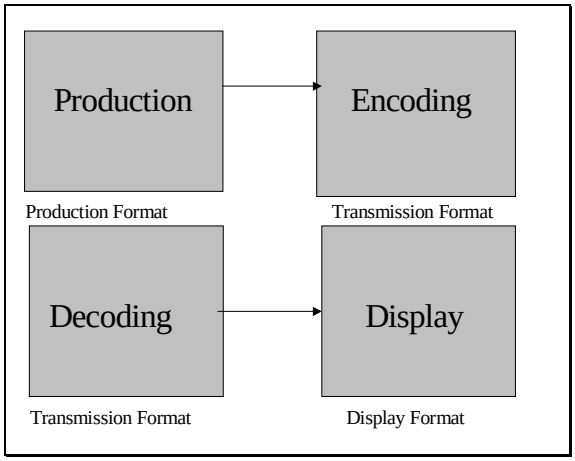
As cable and terrestrial HDTV plans became more of a business needing study and analysis, it was clear that the complex infrastructure for digital cable was falling nicely into place. The Time Warner Orlando Full Service Network had laid groundwork for service offerings and proved that computer-based cable equipment could leverage the ever-plummeting computer cost curves.

But the end-to-end infrastructure was originally viewed as a closed-system architecture. Then-deploying MPEG-2 equipment such as DVD was enjoying a ground swell of adoption -- and much of the cable infrastructure was not compatible. The major vendors and users deployed an MPEG-2 system layer -- which turned out to be a wise decision.

In short, an end-to-end infrastructure is now in place so that cable can leverage the already-deployed digital architecture to deploy HDTV in a timely manner.

## HARD-FOUGHT SUCCESSES

The design and deployment of digital infrastructure should not be hidden from view as is the foundation of a major skyscraper. The cable digital infrastructure deployed today took tens-of-millions of dollars and years of research and product development. But that hard work will make the deployment much easier than that of terrestrial broadcasters -- who have an intrinsically analog plant, a transmitter and tower on the "wrong frequency" and origination facilities based on analog designs of a scanning format that was not to be used in the future. Digital HD and SDTV will be deployed by cable using the groundwork already deployed.




1) Origination. Digital infrastructure based on MPEG-2 is the core foundation for DTV. Program networks that are compressed for delivery to set tops can easily add HDTV-compatible compression cards to their existing encoding systems. Put simply, in an existing transport multiplex the compression system merely has a

channel with a greater hunger for bandwidth.

2) Format: The ATSC digital standard for terrestrial broadcasting has been adopted by the FCC and supports no fewer than 18 different image formats. While each of these formats have requirements for source material and different difficulties for processing in the display device -- they all are transported by the same digital highway. While there has been much public debate about the "best and only" digital image format for DTV, the end users are mostly indifferent to the actual format (since they are all supported in the ATSC chip set), the only substantive difference is a format's particular "hunger for bits" which varies by program content and picture quality objectives.

## Bandwidth

| Scanning Format | Frame Rate | Bandwidth (Estimated) |
|---|---|---|
| 1080I | 30 | 13+ Mb/s |
| 720P | 60 | 12 Mb/s |
| 480P | 60 | 6+ Mb/s |
| 480I | 30 | 3-4 Mb/s |

3) Transmission and Encryption: Broadcasters continue to ponder how conditional access can be added to their proposed digital transport systems -- and, must also deal with the political issues associated with their offerings of non-free services. The conditional access and digital transport systems currently being deployed by cable are compatible with DTV transmission to set tops. Although some modifications may be necessary to support the recently-adopted broadcast system information and navigation system, it is generally expected that the headend Integrated Receiver Transcoders (IRT's) of today will support satellite-delivered DTV transport without replacement. Additional headend equipment will be required to process the terrestrial VSB signal and convert it to QAM.

4) Plant: 64 QAM is being deployed today. Some systems have deployed 256 QAM and most HFC rebuilds can easily support this very-efficient modulation scheme. Cable's ability to support two terrestrial 8 VSB signals into one cable QAM-modulated 6 MHz channel is a significant benefit during the "transition years" from analog to digital end-users. While some operators may practically have to transport 8 VSB, the Program System Information Protocol (PSIP) used by broadcasters is very complex and may raise many transmission issues for cable operators who heterodyne VSB and / or convert to 64- or 256-QAM

## Modulation

| Modulation | Capacity |
|---|---|
| 8-VSB | 19.3 Mb/s |
| 64-QAM | 26.97 Mb/s |
| 256-QAM | 38.8 Mb/s |

5) Consumer Interface: In the analog world, the set top provided the "common denominator" of VHF-3 to the television set. All conditional access, navigation, user interface (e.g. character display or overlay) was provided upstream. As mainstream digital

MPEG-2 decoders dropped in price ("it's only silicon"), the affordable set top transitioned from advanced analog to sophisticated digital set top. However, this affordability does not scale to HDTV. Initial low-quantity chip sets are, to say the least, higher cost. HDTV processing -- RAM and resolution -- is many multiples of SDTV NTSC. It was economically impossible to layer HDTV processing on top of the costs of advanced digital interactive set tops. A more necessary (and desirable) approach was to separate the conditional access -- leaving it in the set top -- and passing a decrypted stream to the already-purchased DTV receiver for processing and display. Such is the way of NRSS and OpenCable.

Consumer Interface (Issues)

However, the rosy story of compatible, deployed infrastructure temporarily came to a screeching halt at this point. Unfortunately, several technical and political issues clouded the consumer interface.

First, the Consumer Electronics manufacturers -- sensing zeal on the part of broadcasters (real or not) designed the first-generation receivers without an interface to cable. VSB was left as the common denominator interface for digital cable -- and cable had clearly stated that QAM was the key enabling technology for the digital cable system of the future. No digital baseband interface was planned. Consumer Electronics manufacturers wish to build only to adopted standards. The ATSC was the organization of record for DTV – and they had adopted VSB as a transmission standard. Cable's selection of QAM was not viewed as mandatory by the CE industry. This is was a major "disconnect" by the CE industry.

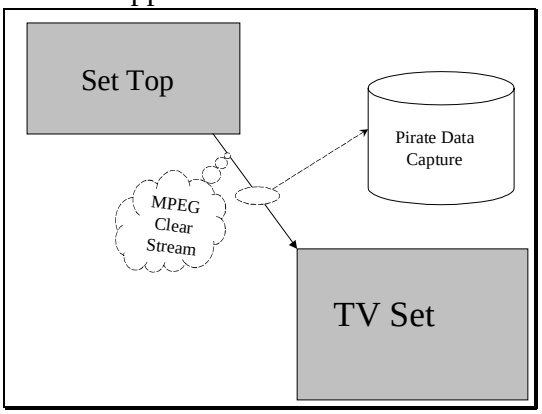
Second, the cable industry did not send a clear message that a baseband interface would be acceptable. Previous decoder interfaces and even NRSS have not been deployed on a widespread basis. Practical cable business issues such as user interface (ranging from I/R pass-thru to NRSS-B extensions) have not been understood by the CE industry. Cable use of a baseband interface would likely represent a "short-term" solution with the implementation of NRSS representing "mid-term" and the "Open Cable" initiative representing the "long-term" solution. The cable industry was focusing on configurations to be implemented several years after the HDTV introduction.

Lastly, copyright owners (e.g. movie studios) have seen improvements in digital consumer technology such as powerful computers, digital recording, video compression and Internet bandwidth. Such advances are enabling technologies for very high quality copyright piracy -- if not on the wholesale scale of Chinese disc factories certainly one clip at a time. Copyright owners, computer system developers and DVD manufacturers worked out a series of copy protection guidelines for DVD equipment -- and a cable baseband digital interface was fertile ground for PPV and other premium television content to be potentially captured and distributed. "Bypass" distribution of pirated content is not healthy for the content providers and certainly not for cable.

Copy protection proposed includes control over the ability to not

record based on the following business practices:

- PPV = No Copy Permitted
- Premium (Pay) = One Copy (Time Shift)
- Ad Supported = Unrestricted




Consumer Interface (Solutions Underway)

Each of the issues raised has a solution in process. As of this writing, the solutions are close enough at hand to enable (with some assurance) that cable can deliver DTV on a competitive par with terrestrial broadcasters -- and, we hope, with recently-announced satellite broadcasts of HDTV.

First, the CE industry took a look at the demographics of American television purchasers -- and the early adopters who would likely purchase DTV receivers were already cable subscribers. With virtually no installed base of unproven "digital rabbit-ear antennas" it is highly improbable that a "non-cable-compatible" DTV set would enjoy much retail activity.

Second, the cable industry looked at the economics and politics of OpenCable -- and now, more than ever before, it does appear that both retail-sale of "set top devices" could practically occur and it also appears that NRSS-B could provide the necessary user interface (UI) functionality for a consumer to continue their transactional business relationship with their cable provider whilst fully-utilizing their high-priced, high-powered DTV receiver.

Lastly, the synergy of these solutions has led to some rapid decisions for the form and function of the interface itself and the copy protection implementation that is a practical requirement for a contemporary digital consumer product:

a) The 1394 "FireWire" architecture will be used for consumer / cable interconnection. Extensions to 1394 for high-speed operation as well as interfaces to other CE devices are underway;

b) A copy protection system will be provided for the CE and cable "nodes" in the home electronics infrastructure. In the copy protection system, the "source" of video streams in the home (e.g. DVD, set top, etc.) serves as the host for a LAN-based encryption and authentication system. The system proposed is that proposed jointly by “5-companies”—Hitachi, Intel, Matsushita, Sony and Toshiba -- which provides for a public- and private-key authentication and encryption system.

c) Additional aspects of the interface such as the control protocol and extensions to support cable's necessary transactional user interface are under discussion. While also on the critical path, the implementation of a) and b) had system design impacts much more critical than user interface adaptation. As a result some first-generation HD receivers will be incompatible with cable

at introduction, others will only be so in a subsequent release. This was done at the last minute of interface design of some manufacturers receivers some designs had already been frozen.

## CONCLUSION

In conclusion, the foundation laid by the deployment of digital infrastructure by cable has resulted in cable's ability to assume a leadership role in the deployment of valuable high-profile digital programming to consumers. HBO and our cable affiliates look forward to providing "cable's best" programming in the best -- and highest quality HDTV format.