HDTV, SDTV, NTSC, MPEG, DVB–ASI

Are *you* as confused as *I am*?

By Michael J. Martin

As we begin 2000, all of us in the television broadcasting world are facing many new changes and challenges: technical, operational, business, competitive and organizational to name a few. Winston Churchill once said, "There is nothing wrong with change, if it is in the right direction." Well, when the topic is the Canadian television industry, change is everywhere - whether or not it is in the right direction has yet to be determined, especially when we discuss what is happening in the area of "over the air" HDTV broadcasting.

Television in Canada is converting from analog to digital, shifting from NTSC to HDTV, adding high quality, five speaker surround sound, increasing the aspect ratio to wide screen and including new, complex, digital compression techniques. The result is that every chief engineer and operations manager in this country must immediately become very knowledgeable of the many new and different technical standards for over the air transmission of HDTV television. In Canada, we are lucky, because we can benefit from watching and learning from the HDTV advances being made by the U.S. broadcasting community, which is ahead of us due to their government's directives.

Having just finished participating in a significant project to collect five HDTV signals from ABC, CBS, NBC, FOX and PBS for the purpose of digital redistribution for a Canadian BDU, we have learned first hand of the tremendous confusion that exists concerning standards. Confusion about standards is found throughout the entire industry with broadcasters, system integrators, cablecasters, DTH providers, manufacturers and even the folks who set these standards. This article will identify some of the standards that you will need to know about in order to be successful in your future technical changes as your station advances towards HDTV.

SMPTE 259M-1997

Many of you should already be well aware of this important serial digital interface technical specification. It has been in use for many years and was seen as long ago as 1993. It is relevant to both composite and component digital NTSC. Several of the newer broadcast facilities built in Canada during the past decade have been planned with this specification in mind. It is considered to be a cornerstone specification to aid in the transition to HDTV. The composite format is configured as 4fsc, whereas the component format is configured as 4:2:2. The standard offers four unique levels shown in Table 1 (see page 12). The more important of these levels is Level C. It offers a 4 x 3 aspect ratio, component digital, 4:2:2, 10-bit serial digital interface. Many VTRs used today make use of the ITU-R BT.601.5 studio encoding parameters, which when coupled with SMPTE 259M, permit great exploitation of this VTR format throughout a station. Several respected manufacturers are

developing devices to upconvert this digital NTSC Level C format to one, or more of the new ATSC compliant HDTV formats. This is a vital first step to successfully manage the high cost of the migration to the advanced television formats.

The SMPTE 259M standard encompasses four different levels (see Table 1).

Table 1: SMPTE 259M Levels

Level	*Data Rate*	*NTSC / PAL*	*Aspect Ratio*	*Format*
Level A	143 Mbps	NTSC	4 x 3	4fsc
Level B	177 Mbps	PAL	4 x 3	4fsc
Level C	270 Mbps	NTSC & PAL	4 x 3	4:2:2
Level D	360 Mbps	NTSC & PAL	16 x 9	4:2:2

SMPTE 292M-1998

If the above mentioned SMPTE 259M is the serial digital interface accepted by the Canadian broadcasting industry for digital NTSC, then SMPTE 292M should become the standard as the serial digital interface for High-Definition Television Systems.

This standard is expected to continue to evolve as new source formats develop and become documented. Currently, it is able to manage HDTV formatted signals with data rates up to an astounding 1.485 Gbps. This includes the HDTV formats perceived to be leading the race in the U.S. to become the de facto standards: 1080I and 720P. As well, it is documented for other format standards based upon 1035 lines, 1080 progressive and numerous frame rates from 60, 30, 25 to 24.

SMPTE 292M is specified as either a coaxial cable or an optical fibre connection. Since moving data at 1.5 Gbps is challenging, 1310 nm single mode fibre will likely be used for any longer cable runs up to 2 km. Great care will be required when making cables and mating connectors. Typical 75 ohm BNC type connectors will likely not be acceptable. The specification requires expensive precision connectors and terminations be utilized which are able to manage frequencies up to 2.4 GHz. This may result is your technical staff having to learn all over again how to apply connectors and what to look for when things fail to work as expected. Optical fibre running just inside the boundaries of a station is expected to be commonplace, so training to apply SC/PC simplex and duplex connectors, fusion splice fibre and properly configure optical splice trays and patch panels will be required technician skills needed in the future too.

SMPTE 274M-1998

This standard defines multiple system formats that are all fully compliant to the specification and are known as the 1920 x 1080 format. It covers both the 2:1 interlace and the progressive scanning formats of this standard. Frame rates very from 60, 50, 30, 25 to 24 frames per second. The image aspect ratio is 16 x 9. Besides the scanning format, this standard details the system colourimetry, raster structure, digital representation, timing, ancillary data, 10-bit interface (compatible to SMPTE 292M), electrical characteristics, clock and much more.

SMPTE 296M-1997

This standard defines two system formats that are all fully compliant to the specification and are known as the 1280 x 720 format. This standard is often referred to as simply 720P. It covers only the progressive scanning format. Frame rates are either 60 or 59.94 frames per second. The image aspect ratio is 16 x 9. This standard is well detailed concerning all characteristics of the scanning format like its sister format, SMPTE 274M mentioned above.

Other important standards which you should be aware of include the following:

SMPTE 170M-1999

This is the basic NTSC composite (4fsc), analog video signal standard for studio applications. It is the foundation that we all know, and from which, many of the future standards are evolving. It is vital to know this standard in order to appreciate the other new specifications. SMPTE 170M is the 525 line, 59.94 fields, 2:1 interlace with an 4:3 aspect ratio that anchors our industry. It serves us all every day.

Recently updated from the previous SMPTE 170M-1994, it is worth your time to revisit this specification. Amazingly, it still includes some compatibility with the earliest specifications going back to years like 1941 and 1953! Of course, everyone should be an expert on this standard, but we are continually surprised to meet people who do not hold as tight a grasp as is needed on this vital document. It is good reading and will refresh many of you about where we came from before digital burst on the scene.

SMPTE 293M-1996

SMPTE 293M defines a standard for a 16 x 9 wide screen version of a 720 x 483 progressive scan signal at 59.94 Hz. This format has a similar sample and line rate to the traditional analog SMPTE 170M NTSC signal, but is offering a progressively scanned image in a wide screen format. There may be a greater role for this format in the future as a lower definition cousin to the 1080I, 1080P and 720P specifications. The progressive scan aspect may lend itself to computer related applications.

What makes this standard of particular interest is its companion standard SMPTE 294M-1997. SMPTE 294M is a serial interface specification. It offers a unique dual-link interface for 4:2:2P where the active data is transparently divided, line sequentially, into two data streams, operating in compliance to SMPTE 259M. A single-link interface for 4:2:0P at 360 Mbps is also defined. This relationship to SMPTE 259M may have some interesting implications for the future since many facilities already own SMPTE 259M equipment, such as routing switchers.

SMPTE 310M-1998

This is a very important standard that everyone needs to learn about before you begin broadcasting HDTV, regardless of which HDTV format that your station decides upon.

SMPTE 310M is the standard that defines a point to point serial interface for MPEG-2 transport streams with data rates up to 40 Mbps. It will likely be used for linking the output of an ATSC compliant, over the air, modulator to the input of a HDTV transmitter. Regardless of the baseband HDTV format, it must be MPEG compressed and readied for over the air transmission. Currently, this means that it will comply with the ATSC A/53 and ATSC A/64 standards. It will occupy a 6 MHz channel spacing just like an analog NTSC channel does today. Using the 8VSB modulation defined by the ATSC, a maximum data throughput of 19,392,658.46 bits per second (19.39 Mbps) will be possible. So, whatever HDTV format you finally decide is best for your station, it will ultimately need to be compressed down to fit within this maximum 19.39 Mbps data rate.

Likewise, any over the air demodulators used, like the recently announced Videotek DDM-500 used in our project, will likely make use of SMPTE 310M as an output standard. Demodulators will commonly be used to feed TV transmitters and translators. As well, they will be used for decoding signals back to baseband HDTV. And finally, we expect to see them used for new applications like transmodulation. Transmodulation permits signals to be re-modulated to other common consumer technology modulation schemes like:

— QPSK used by the two Canadian DBS companies,
— 256 QAM expected for use by the CATV service providers,

— 64 QAM used by the Wireless Cable service providers,
— VDSL being tested by some of the telcos.

Note: Currently, there is a controversial disagreement occurring in the United States concerning the best modulation scheme for over the air HDTV transmission. The FCC supports the standardized 8VSB modulation technique. Whereas, a group of broadcasters, lead by the Sinclair Broadcast Group of TV stations, wants COFDM, as used in Europe. Both parties make good arguments. But, for now, 8VSB is what we are planning for, since it adheres to the Canadian government's acceptance of the ATSC specifications. Stay tuned for more debates, excitement and perhaps, even legal actions, concerning this hotly contested dispute.

DVB-ASI

Be careful of DVB-ASI. It is part of the well known set of DVB standards used primarily in the fifteen member countries of Western Europe, as well as Australia and New Zealand. DVB stands for Digital Video Broadcasting and is part of the European Broadcast Union. There are many specifications for numerous signal formats published by the DVB for Cable (DVB-C), Satellite (DVB-S), Terrestrial (DVB-T) and the Internet (DVB-Data). DVB competes with the North American standards based upon the ATSC. Canada is conforming to the ATSC standards.

Table 2: HDTV Relevant Web Sites

Web Sites of Interest for HDTV	*URL Address*
SMPTE	www.smpte.org
ATSC	www.atsc.org
DVB	www.dvb.org
ETSI	www.etsi.org
FCC - DTV Information	http://www.fcc.gov/mmb/prd/dtv/
NAB	www.nab.org
CAB	www.cab-acr.ca
Industry Canada	http://info.ic.gc.ca/

However, you will find many areas of technology where a DVB specification is used, even here in Canada. Satellite uplink / downlink equipment and MPEG encoding / decoding equipment commonly make use the DVB-ASI standard. The "ASI" part of DVB-ASI means Asynchronous Serial Interface. It is a good specification for connecting two pieces of equipment together. It competes with SMPTE 310M in many ways. However, it does offer much higher data rates commonly found in the MPEG encoding products, so it is well suited for this kind of application. Unfortunately, it does add yet another flavour to the mix of standards to maintain the current state of confusion.

In summary, it looks like we all need to head back to the drawing board to learn more about these future HDTV technologies. Having just completed a project, Comlink Systems understands that HDTV is coming sooner, rather than later. To support this point, during the first week of January 2000, the National Association of Broadcasters reported that 109 HDTV stations are now on the air as of December 31, 1999.

See Table 2, above, for a few relevant Internet sites to help you begin your learning process. B

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