TechTalk #74

Amateur Television (ATV)

- - The Digital Fork in the Road - -

By Ken W6HHC

By now, everyone has heard of commercial **Digital** Television. Old commercial analog TV transmitters will essentially go off the air in June of 2009 and are being replaced by digital TV transmitters.

For several years I have listened to some interesting ham conversations about "we hams should change analog ATV over to Digital-ATV (aka D-ATV or DATV) to keep up with technology".

This article is my attempt to get "my arms around digital ATV" and be able to explain it to other hams. I must admit that I am no expert in D-ATV, but I am very much interested in it.

Why Go Digital ATV?

The main benefits of digital ATV are:

1) The picture quality can be nearly perfect much of the time
2) Digital techniques allow error correction from noise, multi-path
3) Digital techniques allow advanced modulation (less bandwidth) and compression
4) Digital TV components will become more common on the marketplace.
5) Analog TV components will start to disappear from the marketplace.

Different Types of Digital Video Broadcasting Specs

To start with, there are three fundamental broadcasting environments for Digital Video broadcasting:

- Cable
- Satellite
- Terrestrial

Each of these three different environments requires a different specification as described below.

DVB-C (cable)

The DVB-C standard for cable broadcasting was established by the Digital Video Broadcasting organization (www.DVB.org). The environment of cable is very low noise and very low loss. So resistance-to-noise and lots of error-correction-technology is not needed for cable digital TV. The nice cable environment allows implementing higher order modulation schemes starting from QPSK up to 256QAM. Because of the guaranteed low signal path loss in cable, this does not represent a good choice of technology for hams to consider.

DVB-S (satellite)

The DVB-S standard for satellite broadcasting is designed to work in an environment that contains lots of signal path attenuation and line-of-sight communication. To compensate for the weak signals, the DVB-S standard uses different layers of Forward Error Correction (FEC) for a very robust protection against any kind of errors. One drawback for hams is that DVB-S was NOT designed to deal with multi-path environment situations. Typically, the DVB-S uses MPEG-2 for video data compression and QPSK for modulation that can be run in a 2 MHz bandwidth mode. This is the standard chosen by many European and United States D-ATV groups for digitizing ATV.

DVB-T (terrestrial)

The DVB-T standard for terrestrial broad-casting by the Digital Video Broadcasting organization is designed to work in the classic situation where a transmitter is broadcasting RF signals to home antennas coupled to a digital TV receiver.

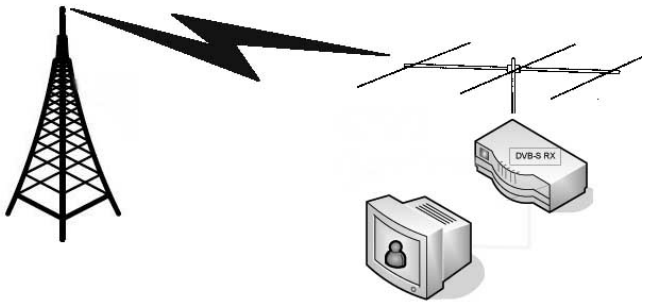

Fig 1 Terrestrial reception using commercial set-top box

Digital-ATV - - Cont'd from Pg 5

In over-the-air broadcasts, the technology needs to overcome the destructive effects of multipath reflections. Also, the terrestrial signal path attenuations can be frequency dependent and can result in a partly distorted received signal. The negative effects of multipath reflections can be reduced, by using 16QAM modulation for a low effective bitrate per carrier,. To reduce the effective bitrate per carrier, DVB-T spreads out the bitrate over a large amount of carriers. This spreading out will result in 1,705 closely spaced carriers (using COFDM...aka Coded Orthogonal Frequency Division Multiplexing) to create a 6 MHz bandwidth. Creating 1,705 different carrier frequencies with the conventional approach of VCO's and PLL chips is impossible. If we look at the possibilities for D-ATV then hams will come to the conclusion that DVB-T will be the ultimate approach if it comes to robustness. However the combination of, (1) the high signal to noise ratio which is needed for demodulation, (2) the big impact on hardware implementation and (3) the fact that commercial DVB-T set-top boxes are not widely available yet, let many hams come to the conclusion that the DVB-T approach is currently far away for amateur use.

What I have not mentioned, so far, is that the Digital Video Broadcasting organization standards are only used for commercial TV in Europe and Asia....NOT in the United States. In the United States (and Canada) the commercial TV industry uses standards from the Advanced Television Systems Committee (ATSC) a spin-off from the old NTSC TV standards organization. One exception in the US is that Dish Network uses DVB-S technology for its home satellite receivers.

ATSC 8-VSB (terrestrial)
8-VSB is the 8-level Vestigial Sideband Modulation method adopted for terrestrial broadcast of the ATSC digital television standard. Like DVB-S, it usually uses MPEG-2 for video compression and multiple layers of Forward Error Correction (FEC) for a very robust protection against any kind of errors. Interestingly, the 8-VSB modulation does not use phase-shift techniques, but uses 8 levels of amplitude for modulation and demodulation. This modulation approach produces a gross bit rate of 32 Mbit/s, and a net bit rate of 19.39 Mbit/s of usable data in a 6 MHz bandwidth. The net bit rate is lower due to the addition of forward error correction (FEC) codes. While, the set-top DTV boxes are very common, the current lack of low cost 8-VSB transmitting circuitry has prevented US hams from using this ATCS 8-VSB approach for ham radio D-ATV.

Drawbacks for D-ATV
There are two main drawbacks to DATV for ham radio ATV enthusiasts:

1) Weak Signal Reception
Digital TV technology tends to have "ALL or NOTHING" video performance. The picture is GREAT thru noise and weakening signals....then POOF, it's gone. The transition phase between ALL or NOTHING tends to be very narrow. As Henry AA9XW explained in the Amateur Television of Central Ohio News (ATCO), "Yes digital [ATV] is "noise free" until you hit the blue wall. **There is 1 dB between perfect and nothing. So don't expect a lot of DX** since you can't find the signal in the noise without a spectrum analyzer and BPF [band pass filter]."

2) High Cost of Equipment
One advantage of analog ATV was the cost of equipment, especially transmitting equipment was relatively cheap. You could buy commercial analog CCTV equipment and easily modify it for ham radio ATV use. The receiving circuits can be obtained from old home satellite dishes (DVB-S) that are surplus on e-Bay & can be converted to D-ATV. But, obtaining

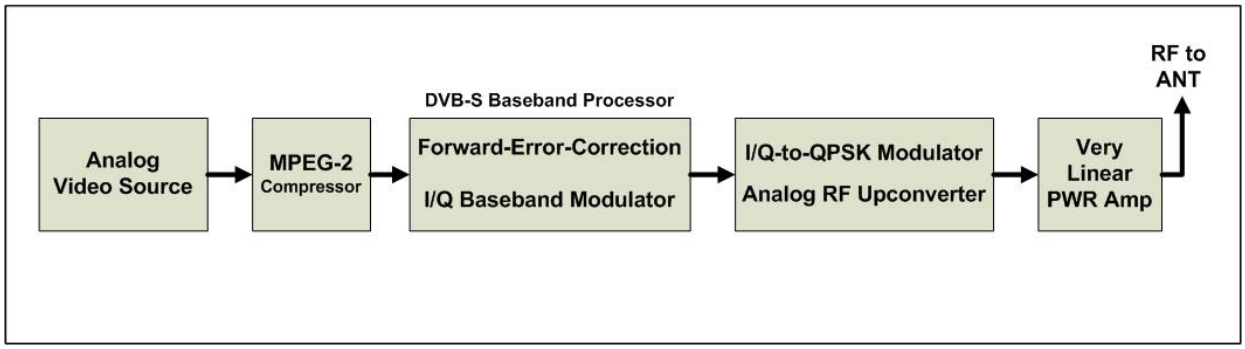

Figure 2 – Block Diagram of DVB-S Transmitter for Digital-ATV

Digital-ATV - - Cont'd from Pg 6

transmitters...with image processing and the modulators...is the main problem. There is no surplus satellite transmitting equipment around. So you either buy boards from European D-ATV companies or you buy the Integrated Circuits used by transmitters and build your own equipment. In my opinion, this last approach takes a lot of engineering/software technical skill that most hams do not possess and requires an investment of a lot of time. SR-Systems in Germany offers a wide selection of printed circuit boards for D-ATV. Robbie KB6CJZ of OCARC estimates it costs about $1,200 or more to buy a D-ATV transmitter exciter, digital band-pass filter, and very-linear power amp. A camera and a wide-bandwidth antenna would also be needed. D-ATV repeaters are more expensive.

Status of DATV Today.
Groups and clubs of D-ATV enthusiasts have shown that digital technology was possible for hams and works as expected.

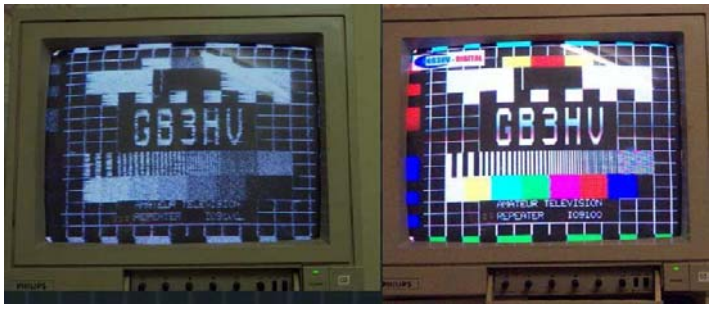

Fig 3 – Comparison of analog PIX and DATV PIX using the same antennas with weak sigs
(courtesy of G7LWT & GB3HV)

In next column, Fig 4 is a picture of an early European DVB-S prototype transmitter demonstrated at the 2001 Friedrichshafen Ham Fair in Germany by Howard HB9JNX/AE4WA, et al.

In my probing the internet and through having local conversations, I found that there was a very large burst of D-ATV efforts by hams (mainly in Europe) that lasted from about 2000 to about 2004. Many (if not most) of these ham radio sites on D-ATV seemed to eventually go dormant:

- www.D-ATV.com in Holland went dormant in 2005
- pagesperso-orange.fr/jf.fourcadier/television/exciter/exciter_e.htm Jean-François F4DAY went inactive in 2004/2005
- www.G7LWT.com in UK appears to be now dormant on D-ATV
- www.BATC.org.uk British Amateur TV Club is very active with ATV, but very small amount of D-ATV activity.
- www.GB3BH.com South West Herts UHF Group in UK is active with D-ATV
- www.ATCO.TV Amateur Television of Central Ohio published its last ATV newsletter in 2007, although the WEB site appears alive and a D-ATV repeater is up.

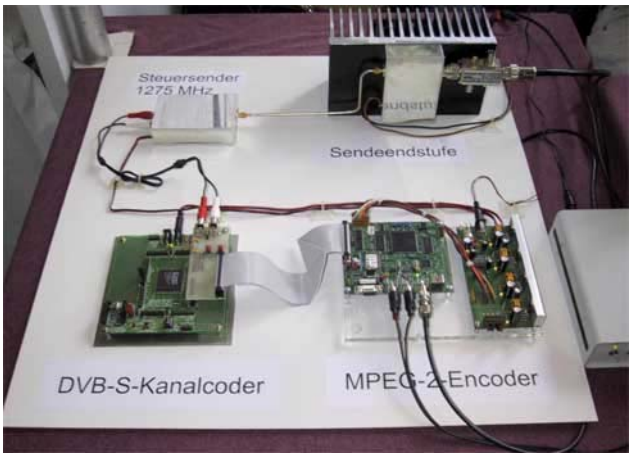

Fig 4 – Prototype DVB-S D-ATV transmitter like Fig 2
(courtesy of Thomas Sailer HB9JNX/AE4WA, et al.)

From what I have learned, there are only three or four areas in the US that have D-ATV repeaters or are even testing D-ATV.

- ATCO has the WR8ATV/R digital DVB-S repeater output on 1260 MHz
- Nick Sayer, N6QQQ from Santa Clara is designing/building/testing an 8-VSB D-ATV transmitter on 900 MHz
- There is a ham from OC who moved to Idaho who has been actively designing and building and using D-ATV for several years.
- Rumors of a group in either Oregon or Washington who are active in D-ATV (but I can not find them via the internet).

What is the Future for D-ATV??
Based on what I have learned while preparing this article on D-ATV, I am surprised by the small amount of current D-ATV activities in the United States. I expected a lot more activity. There is a great picture-quality-performance attraction for Digital TV. But, it seems to me that the weak signal picture loss associated with D-ATV may be taking some of the adventure of DX out of the equation.

Digital-ATV cont'd - - see Pg 10

Digital-ATV - - Cont'd from Pg 7

If I examine the needs of emergency communications groups (like RACES and ARES) to provide ATV pictures back to an EOC....currently it is difficult to get a little analog ATV (point-to-point) through the hills of Orange County...I can imagine that DATV may have more path loss difficulties and may deliver NO picture at all. Some DATV testing in Orange County needs to be done.

Finally, I personally find DATV technology quite complex. Since transmitters for D-ATV are expensive or you can design your own...I find the complexity of designing my own D-ATV much much more complex than designing my own SSB transmitter or FM transmitter. In addition, commercial standards continue to evolve. For example: The DVB-S spec is being replaced by the newer DVB-S2 standard. While DVB-S2 is faster and better (and even more complex - using new FEC scheme like Bose-Chaudhuri-Hocquengham), it threatens to obsolete D-ATV equipment built with DVB-S designs.

In conclusion, it appears that the mainline ATV-ers in US are currently passing up the "the Digital Fork in the Road" for D-ATV and continuing to use analog ATV. I will be surprised to see a big increase in D-ATV usage over the next five years. Only the cheap availability of US DTV antenna set-top boxes and more inexpensive D-ATV transmitters/components are probably able to change my outlook.

As I said in the beginning, I am not a D-ATV expert, just very much interested in D-ATV technology. If readers have other knowledge of DATV information and activities, and other insights on the viability of DATV...I would be delighted to hear from you.

D-ATV References and Links:

- Digital Video Broadcasting organization (DVB) – see www.DVB.org
- Advanced Television Systems Committee (ATSC) – see www.ATSC.org
- The Ultimate Resource for Digital Amateur Television – see www.D-ATV.com
- WHAT EXACTLY IS 8-VSB ANYWAY? – see http://www.broadcast.net/~sbe1/8vsb/8vsb.htm
- Digital Amateur TeleVision (D-ATV), by HB9JNX/AE4WA, et al – see www.baycom.org/~tom/ham/dcc2001/datv.pdf
- DATV / Digital Amateur Television Primer – G7LWT – see www.G7LWT.com/datv.html
- CQ-TV magazine from BATC (mostly analog) – see www.BATC.org.uk/cq-tv/
- SR-Systems D-ATV components (Boards) – see www.SR-systems.de