Why I Selected DVB-T for Amateur Digital TV
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I have received numerous inquiries from other radio amateurs inquiring "Why did you chose DVB-T instead of DVB-S or 8-VSB ?" I am writing this application note to answer this fundamental question.

My major DTV objectives in Amateur TV (ATV) were:

1. Broadcast quality, high-definition, 1080 line video and CD quality audio
2. Perfect pictures, no snow nor "ghosting"
3. Be useful for Public Safety, ARES operations
4. Work well in difficult terrain and RF propagation conditions
5. Work well with low power (< 10 watts), portable transmitters and simple antennas
6. Off the shelf equipment, especially the modulators and receivers.
7. Low cost for both transmitters and receivers
8. Use conventional consumer grade, camcorders, DVD players as program sources.
9. Open source technology -- no sole supplier
10. KISS - i.e. Keep It Simple Stupid!

I first became active in amateur Digital Television (DTV) in 2011 when I discovered the relatively low cost ($1,200) Drake model DSE-24, CATV-DTV modulator. It used the North American cable TV (CATV) system with Quadrature Amplitude Modulation (QAM) of either 64QAM or 256QAM, as specified by the standard ITU-T/J.83B, Annex B. Early experiments showed that ultra-linear rf power amplifiers were required, so I proceeded to design a line of such amplifiers. Thus my earliest work was focused on digital CATV, but being radiated over the air.

DVB-S & CATV-64QAM: In the fall of 2011, I and several other Boulder, Colorado, TV amateurs performed an exhaustive set of field trials to compare the relative merits of analog TV and digital TV. We compared VUSB-TV, FM-TV, DVB-S and CATV-64QAM. The results were documented in AN-2a and AN-3a [1, 2]. The basic conclusions were that both DTV methods of DVB-S and also CATV-64QAM failed criteria 4, i.e. "Work well in difficult terrain and RF propagation conditions". Neither was found to work well under multi-path conditions. Thus as a result, they were not acceptable for criteria 3, "ARES - Public Safety applications". This was considered a fundamental "show stopper" defect as we are always faced with multi-path issues with terrestrial, horizontally over the earth's surface rf propagation. DVB-S was designed for
vertical propagation from outer space to the earth and thus relatively free from multi-path. CATV-64QAM (DVB-C in the rest of the world) was designed strictly for a perfect transmission medium of coaxial cable with absolutely no multi-path (i.e low VSWR). By design, neither system was ever intended for use in multi-path situations.

8-VSB (ATSC): So, why not use the USA broadcast standard for DTV of 8-VSB? Wasn't it designed for terrestrial broadcast? I eliminated 8-VSB on the basis of cost. Numerous searches on the internet for 8-VSB modulators always ended up with units costing many thousands of dollars. Earlier searches in the 2005-2010 time frame only found modulators costing $50K or more! Of lesser importance was the fact that all of the modulators found were AC powered and for mounting in 19" racks. Thus, they were not suitable for back pack, portable, ARES operations. Another discouraging issue was numerous reports in the literature talking about technical deficiencies of 8-VSB vs. the European standard of DVB-T. The most damming was a statement from an FCC 1999 report comparing 8-VSB and DVB-T “...the COFDM (DVB-T) system has better performance in dynamic and high level static multi-path situations, and offers advantages in mobile reception.” [3]

I need to admit that the high cost issue is now finally disappearing. From recent Google searches, I have finally discovered (Nov 2015) at least one manufacturer that is offering a hi-def, HDMI input, ATSC modulator for under $1,000 [4]. I am sure more will follow. Plus the PVI modulator satisfies my other requirements of small size, working from 12Vdc, and accepting consumer type video (i.e. composite & HDMI) inputs.

DVB-T: I expended no more serious efforts on DTV from 2011 until 2014 when the spring issue of ATV Quarterly arrived in the mailbox.[5]. It carried glowing reports of recent DVB-T experiments by WB8ELK, W4HTB & W8ZCF. They were using low-cost, DVB-T modulators and receivers from Hi-Des in Taiwan [6]. I immediately purchased a modulator (HV-100EH) and receiver (HV-110) from Hi-Des for evaluation. I again ran an exhaustive set of rf propagation tests comparing DVB-T to VUSB-TV. The results were truly amazing showing the superiority of digital DVB-T over the old analog, VUSB-TV system. I documented the results in AN-17 [7].

All of my above ten criteria were met using the Hi-Des modulator plus a 3 watt linear amplifier of my own design (model 70-7B). The Hi-Des HV-100EH cost a low $570, was small enough for a back pack, operated on 12Vdc battery with minimal current drain, accepted consumer type video inputs of hi-def HDMI or std. def. composite, and was extremely simple to operate. The only control was an Up/Down channel selector. A true KISS solution!

The acid test for ARES was next addressed. The Boulder County ARES group has been providing TV coverage of the University of Colorado football games for the university police dept. since 1995 using 70cm, 1 watt, VUSB-TV transmitters. I took the complete DVB-T transmitter and receiver to the first football game in the fall of 2014 for a demonstration. It far outperformed the older analog TV equipment. High definition pictures, with no ghosts, nor snow and it was able to provide pictures from parts of the
stadium where we had never before been able to get TV signals out of. The CU Police chief was impressed enough that he authorized a grant of $10K to fund a complete replacement of the BCARES video equipment to use DVB-T. BCARES now operates four (4), 70cm, DVB-T transmitters simultaneously on channels 57, 58, 59 & 60 providing video for public safety at CU football games, major 10K foot race with 50,000 runners, and other large events, such as the recent GOP presidential debate held on the campus. I wrote up a short article about DVB-T and its application to ARES which was published in the June, 2015 issue of the ARRL's national magazine, QST [7]. The bottom line is I am convinced the best solution for my ARES group and my own personal objectives is to use DVB-T. For additional, detailed technical reading on the various DTV methods, I recommend W. Fisher's book [8].

OPEN SOURCE: Another issue that has concerned some amateurs relative to DTV is that of relying upon a sole source supplier. This has seriously held back the adoption by the amateur radio community of digital voice radios, in particular the D-STAR system. Many amateurs have refused to buy D-STAR radios because they contain proprietary technology only offered by ICOM. They also fear having a sole source supplier go out of business. I have heard these "fears" expressed by several amateurs, including the QST editor, about using Hi-Des equipment. This is ungrounded. First the DVB-T technology is widely available because it was intended for broadcast and has been adopted by many countries worldwide. There are a very large number of suppliers for both DVB-T modulators and also receivers. Hi-Des has been accepted in the amateur DTV community because they offer attractive, functional equipment at reasonable prices with excellent customer support. The only unique feature of Hi-Des equipment at present is the fact that they have addressed requests from amateurs to have lower modulator bandwidths below the standard 6, 7 or 8 MHz which are used in broadcast DTV. Hi-Des offers bandwidths down to 2 MHz. A quick Google search on the internet for DVB-T modulators will provide a large number of "hits" on products similar to those from Hi-Des with a growing number with price tags under $1,000.

For DVB-T receivers, there are also a lot of other low cost solutions besides those offered by Hi-Des. The Hi-Des model HV-110 receiver costs $170. It's key advantage is the ability to receive low bandwidth (down to 2MHz) DVB-T transmissions. For as little as $10, one can have a DVB-T receiver. Very low cost, USB-Dongle TV tuners are offered from many sources on the internet. These are dongles using the RTL2832 software defined radio IC. Using the free shareware software, VLC, they become a DVB-T tuner. There are also a lot of low cost ($30 to $100) DVB-T, FTA (Free-to-Air), set-top box receivers available from many suppliers on the internet. The cost of these are similar to the FTA, satellite set-top box receivers used by DVB-S amateurs.
A KISS complete DVB-T Transmitter, 3 Watts, 70cm
Canon camcorder with HDMI output, Hi-Des HV-100EH Modulator & KH6HTV Video 70-7B RF Linear Power Amplifier

KISS: My final requirement was to keep it simple. A lot of other amateurs working on DTV have focused their efforts on doing a lot of the video and rf processing on their PC or Linux computers. They have been using plug-in cards for their PCs and/or custom, home designed, circuit cards. They have been digitizing and massaging video data streams with a lot of complex software. Much of their video is not "live" but from processed files. All of the work has already been done by the IC and modulator manufacturer's engineers to design all the necessary hardware and internal firmware, etc. Why try to reinvent the wheel? I myself am not a computer guru and get lost right away in massive computer projects. Thus I far prefer the "plug-n-play" approach. Take a low cost consumer video source, such as a hi-definition camcorder with an HDMI output, plug it into a commercial modulator and let the modulator spit out a suitable RF signal. Then I apply my RF knowledge to amplify it up to the Watt level for radiation as an amateur DTV signal. For amateurs that don't want to home-brew their own rf linear amplifiers, there are several suppliers of such amplifiers. As seen in the above figure, the only controls for this DVB-T Transmitter are Up/Down channel selector on the modulator and RF power level adjustment on the RF linear amplifier. The most complex controls are those on the camcorder. This is far easier to operate than my hand-held 2m/70cm transceiver! I do agree that a little bit of computer knowledge is required to initially setup the modulator parameters with a PC over the USB.

Hope I have convinced you to at least give DVB-T some consideration when getting started in amateur DTV.
REFERENCES:

6. Hi-Des Technologies, Taiwan, supplier of DVB-T modulators and receivers to the amateur DTV market www.hides.com.tw

note: all KH6HTV Video Application Notes are available from the web site: www.kh6htv.com