



Executive HDTV Report

The Economics of Professional HDTV Technology

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Broadcast 720p60 is rising . . . May 1080i60 (soon) rest in peace.

The handwriting has been on the wall for several years, but it took Mobile Television, the FCC “Spectrum Grab” and OTT TV to finally propel 720p60 to the forefront of TV consumer delivery and to deal a serious blow to the 1080 interlaced supporters.

► 1080i60 is not ATSC M/H friendly

One year ago, the headline for this NAB-2010 issue was “Why 720p60 may rise again”. I detailed the reasons why 720p60 ATSC OTA (Over-the-Air) would allow for several M/H channels while 1080i60 ATSC OTA would not. I briefly recap last years story.

The ATSC 8VSB modulation format can handle a total of 19.4 Mbps in the 6 MHz channel. In here lies the problem (or opportunity): MPEG-2 encoding technology is significantly more efficient in compressing progressive as compared with interlaced. For a given broadcast quality OTA HD signal, a MPEG-2 (ATSC) encoder requires about 16 Mbps minimum for 1080i while only about 12 Mbps for 720p. The TV station can potentially free up 4 Mbps of bandwidth for M/H and other services by converting from 1080i to 720p OTA.

↑ ATSC OTA PIPE 19.39 Mbps ↓	Mobile >6 Mbps	Mobile >2 Mbps ~16 Mbps
	~12 Mbps 720p Primary HD Channel	1080i Primary HD Channel

Look at the above diagram, which approximately represents what the major TV Networks believe to be the minimum primary HD OTA bitrate for a major market TV station, to deliver top network HD quality. The net payload for the ATSC 8-VSB is about 18 Mbps, perhaps a bit higher.

720p60 at 12 Mbps generally delivers live (fast) sports in better perceived OTA HD than using 1080i60 at 16 Mbps. Remember, ATSC uses old MPEG2 encoding, and not the twice as efficient H.264 MPEG4.

FCC’s “120 MHz DTV Spectrum Grab” may require ATSC OTA Channel Sharing

Also one year ago, the FCC released their National Broadband Plan (I call it National Wireless Broadband Plan) where they propose to grab 120 MHz of the TV broadcast UHF band from Ch.31 through Ch.51 (the 600 MHz band) and auction that spectrum off for wireless broadband use, requiring that 682 full power DTV stations must vacate the 600 MHz band. There is no DTV OTA channel availability in most of the larger DMAs, thus the FCC has suggestion a number of “solutions” including ATSC OTA channel sharing, meaning that two (2) current full power DTV stations each occupy half of one current 6 MHz ATSC OTA channel.

Take the Los Angeles DMA #2. Good (or bad) examples would be the two sets of duopolies of (1) KCBS-2 on Ch.43 and KCAL-9 on Ch.9, and (2) KTTV-11 on Ch.11 and KCOP-13 on Ch.13. The two CBS stations obviously transmit 1080i60 (the CBS HD standard) while KTTV/KCOP obviously transmit on 720p60 (the FOX standard).

In a FCC mandated OTA channel sharing arrangement, KCBS may need to be relocated to share Ch.9 with sister station KCAL, while KCOP may need to share Ch.11 with sister station KTTV. Presumably, all of the stations require to be OTA delivering HD quality, thus the sharing of available net ATSC 8-VSB payload (18+ Mbps) affords only 9 Mbps for each “station”.

720p60 at 9 Mbps is acceptable . . . for interlaced 1080 it is NOT

For the FOX (and ABC) stations, to reduce the realtime 720p60 ATSC MPEG2 encoding from 12 Mbps down to 9 Mbps is acceptable, although the HD quality will be somewhat reduced from prime network HD quality to local HD quality.

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However, no such luck for the CBS (and NBC and PBS) stations, as the 1080i60 at 9 Mbps is a 40% reduction in available traditional bitrate, seriously degrading the delivered OTA HD quality, particularly when broadcasting fast sports events like car racing, football and ice hockey.

How many DTV stations are OTA on 1080i60?

(Note: When we say 60, we mean 59.94)

Between CBS, NBC and PBS, counting O&Os and affiliates, about 800 TV stations are transmitting 1080i60 OTA. Adding in others, we're looking at about 1,000 DTV stations on 1080i60 in the U.S. Here's a great business opportunity for the TV broadcast equipment manufacturers, as I believe that most of these stations will no longer transmit 1080i60 as of 2015.

OTT—Over-The-Top Television: What's interlaced 1080?

OTT TV is Netflix, VUDU, HULU and many others delivering streaming TV programs and movies on demand bypassing cable TV and satellite over broadband internet connections, mostly wired so far but with a great potential for delivery over wireless. All of the OTT vendors use 720p as their primary high-level HD delivery format, encoded H.264 to reduce bitrate. The exception is VUDU which also offers a 1080p24, the progressive 24 frames per second format used by movies. No major HD streaming provider is using 1080i60. The 1080p24 is displayed using the 3:2 pull-down process which converts the 24p streaming to 60p display. The same system is used in Blu-ray Disc players.

1080p24 is wonderful for movies displayed on large HDTVs, it does not work for live TV because of the low frame rate, and particularly not for fast action sports.

Bottom line is that the OTT folks have never seriously considered interlaced 1080, as the world has been progressive for years.

It's interesting to note that the uncompressed bitrate for 1080p24 is about the same as for 720p60. 1080p24 has twice the spatial resolution of 720p60, while 720p60 has potentially more than twice the temporal resolution of 1080p24. However, 720p streaming by the OTT folks are generally at 24p or 30p to reduce the sustained bitrate requirement, as the program material is mostly movies and TV series rather than fast sports.

Bottom line: No real reason for 1080i60

What is the operational, technical or market advantage of 1080i60? **I cannot think of any.**

Will TV Broadcasters ever OTA progressive 1080p60?

A common justification for going 1080i60 (rather than 720p60) back in the late 1990s as stated by one of the largest TV networks was: "We're preparing for future 1080p60". I respectfully say "when donkeys fly". Will we see 1080p60 in our homes? Yes, but not delivered live OTA.

The logic says that 1080p60 is only needed in the home, never as a mobile live signal, thus all home delivery of 1080p60 should be by FTTH (fiber-to-the-home) to save precious wireless spectrum for mobile on-the-go applications and for "free OTA TV". 720p60 OTA is more than sufficient to provide exceptional HD presentations on the majority of HDTVs in the home, even up to 52-inch sets, particularly fast sports action, in addition to satisfying all mobile demands for live HD programs.

Thus, with the severe spectrum shortage envisioned in the future, free TV over-the-air will be limited to a resolution of 1280x720 at 60 Hz progressive frame rate, which may be compressed down to 5 Mbps broadcast quality HD in the future, and coupled with new improved OTA transmission/modulation scheme may fit into a 3 MHz channel, with mobile reception reliability through required FEC.

By 2020, free OTA TV will be 720p60 . . . Pay-for-TV over FTTH will be 1080p60

A 3 MHz TV channel with 2,000 HDTV OTA stations across America limited to the 500 MHz UHF band (470—608 MHz) after the TV broadcasters "horse-trade" with the FCC to surrender the VHF TV bands in exchange for FCC recapturing much less than the proposed 120 MHz from the UHF TV band. The TV broadcasters keep the UHF band from 470 up to Ch.37 (assigned to radio astronomy) or 608 MHz, yielding a total of 138 MHz or 46 TV channels of 3 MHz each. This likely cell-based system of transmitters, of relative high power and few cells in each DMA (downlink only system), whether SFN (Single Frequency Network) or not, will support free OTA TV to "stationary" homes and to moving vehicles at 720p60.

Long term planning this time: Another 8 years of ATSC . . . then AOTV

Advanced Over-the-air Television (AOTV) transition is no later than 2019, meaning that any recaptured UHF spectrum from the broadcasters is not available to the spectrum auction winners until 2019.

BUT . . . if your DTV station is 1080i60, you should start planning your move to 720p60 AND get going with MDTV to gain market share and oppose a take-over of local OTA TV by the wireless broadband providers.