Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, and	)	ET Docket No. 14-165
Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 600 MHz Duplex Gap	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268

COMMENTS OF ADAPTRUM, INC.

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ADAPTRUM

Adaptrum is a leading TV white space technology company. Being the first and only startup to provide a TV white space prototype to the FCC, and working together with leading tech companies like Microsoft and Google, Adaptrum played an important role in the US TV white space rulemaking leading to its successful conclusion in 2008. The US TV white space rulemaking was followed by similar rulemaking proceedings in the UK and Singapore, creating a global regulatory movement to open up the TV white space spectrum.

Adaptrum's first generation TV white space broadband system ACRS 1.0 was certified by FCC in 2012. As one of the first working TV white space broadband systems, ACRS 1.0 has been used in demonstrations and trials around the world. In Q1 2014, Adaptrum launched its second-generation volume-production TV white space product family ACRS 2.0. ACRS 2.0 radios have been deployed in 15 countries across 4

continents since introduction. Figure 1 shows an Adaptrum second generation TVWS product ACRS 2.0 in operation.

Figure 1: An Adaptrum ACRS 2.0 unit in operation

RURAL AREA ISSUES

As the *Notice* points out[2] the present TVBD rules do not differentiate between urbanized areas with a high density of TV broadcasters and rural areas. In a parallel proceeding,[3] Adaptrum has asked for a waiver of the present 30m height limit for an area in the furthest Northeast corner of the US near Machias ME. This area of rural Maine is notable for being a vast wasteland for both TV broadcasting and existing broadband networks. In particular, there are no US UHF TV broadcast stations anywhere near Machias and the only usable signals are VHF as shown in Figure 2 from the Commission's own website.[4]

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[2] *Notice of Inquiry* ("*Notice"*), Docket 14-165, September 30, 2014 at para. 44-53
[3] *Waiver request of Adaptrum, Inc.,* Docket 14-187, October 23, 2014
[4] http://transition.fcc.gov/mb/engineering/dtvmaps/

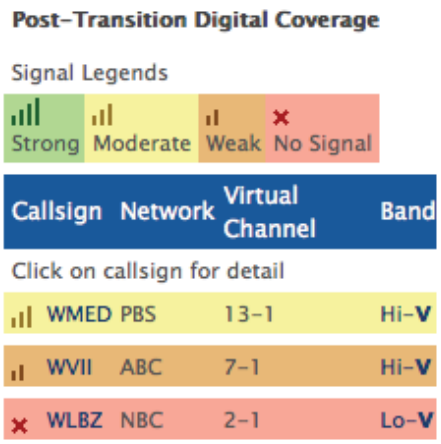

Figure 2: Present TV coverage in Machias ME

While the *Notice* talk about the benefits of changing the present rules to "increase coverage and provide improved service in rural areas"[5], the real issue is whether using the TVBD rules to provide broadband in such areas is economical or not. Such rural areas not only have little TV coverage and few, if any, broadband options, they also have a low population density. This low density means significantly fewer potential subscribers per TVBD base station than in urbanized areas. The present height and power limits severely constrain the number of potential customers that can be served by a base station making commercial operation of TVBD by WISPs to serve rural residents impractical. While the height and power limits were intended to protect the primary transmitters of TV broadcasters, it is not applicable in extreme rural areas such as Machias ME for the simple reason there are no UHF channels present and there may never be any because the same lower population density and rugged terrain makes UHF broadcasting unattractive financially.

[5] *Notice* at para. 44

We support the 250m height limit and 10W power limit proposed in cases where the proposed rural definition is met. We also support increasing the limit for personal/portable devices in rural areas although we recognize that RF safety limitations for unlicensed devices will limit the achievable power in many cases. We believe that a 250 mW EIRP limit for personal/portable devices instead of the current 100 mW EIRP limit[7] would be appropriate.

ANTENNA DIRECTIVITY

The *Notice* points out the present TVBD rules consider the directivity of TV receive antennas, but implicitly assumes that all fixed TVBD antennas are omnidirectional.[8] While this conservative assumption protects the TV service, it is overly conservative in limiting options for TVBD base stations, particularly in rural areas. In order to allow practical TVBD service in rural areas and to protect whatever TV signals may be present, the Commission should consider taking into account directivity for both TV receivers and TVBD fixed transmitters when computing channel availability.

CHANNEL 37 ACCESS

In the early days of TVBD deliberations, the focus of proposals was on a listen-before-talk (LBT) approach to cognitive radio such as that use for 5 GHz sharing of unlicensed systems with federal government radars. The Commission tested several prototype systems, including 2 from Adaptrum, and decided not to use that approach for

[7] *Notice* at para. 51
[8] *Notice* at para. 73

various reasons including complexity of reliably detecting Part 74 wireless microphone systems that did not have a standardized band plan or modulation in contrast to Part 73 DTV systems. Since the passive uses of Channel 37 could not be detected with LBT technology, this channel was ruled out as a possible channel for TVBD use.

However, the rules actually adopted uses a database-driven approach with geolocation, not LBT. With this type of system it is just as easy to identify locations far enough from passive systems that will not result in interference, as it is to identify locations far enough from TV stations to be interference free. Therefore the basic rational for excluding the use of channel 37 no longer exists. There are also Wireless Medical Telemetry Service (WMTS) users in channel 37, who can also be protected using the database approach.

Another issue is whether radio telescopes using channel 37 should be granted 24/7 protection by the TVBD database system regardless of how often they actually use the frequency for observations. We propose that permanent protection be given only to stations that make at least 40 hours of observations a week on channel 37 and that all other observatories must reserve time via database entries with the capability of reserving blocks of time up to 20% larger than expected observation time.

DUPLEXER GAP ACCESS

The Commission should establish one 6 MHz wide channel in the duplex gap and authorize TVBD operation on that channel at a power level of at least 40 mW. The record shows that the Commission's tentative conclusion that a 3 MHz frequency separation will

be sufficient to protect LTE downlink operations from harmful interference by unlicensed devices.[9]

ADJACENT CHANNEL USE & CHANNEL BONDING

We support the proposal to allow "fixed devices to operate adjacent to occupied TV channels (i.e., within their service contour), provided the operating power is reduced to 40 mW EIRP."[10] Real consumer grade TV sets do not have perfect filters in their front end that reject all energy from the adjacent channel and thus need some protection. But the 40 mW limit currently allowed for mobile devices is small enough that it will not cause interference.

We advocate allowing higher power on partial channels at least 3 MHz away from a channel in use in a given area. Thus, if one is within the service area of a channel 26, 542-548 MHz, one should be permitted to use a TVBD at a power greater than 40 mW on the upper half of channel 27, *e.g*. 551-554 MHz (provided channel 28 is not in use for TV broadcasting) or in the lower half of channel 25, e.g. 539-542 MHz (provide channel 24 is not in use for TV broadcasting). Interference-free operation can be achieved because the rejection of adjacent signals in all real receivers increases as the signal gets further from the desired tuned frequency.

The *Notice* also proposes use of "channel bonding".[11] It states,

> We note that the current out-of-band emission rules were written with the assumption that a white space device would transmit on a single six megahertz TV channel and meet the appropriate out-

[9] *See Notice* at para.83; Letter from Paul Margie, Wiltshire & Grannis LLP, to Marlene H. Dortch, Secretary, FCC, Docket No. 12-268, at Broadcom Attachment, Broadcom Corporation 600MHz WIFI-LTE Analysis at 8-9 (filed July 22, 2014).

[10] *Notice* at para. 35

[11] *ibid*. at para 56

> of-band emission limits at all frequencies outside of this single channel. However, a white space device could be designed to use two or more channels simultaneously to increase its transmission bandwidth and maximum data rate.

We fully agree. Even though in post-incentive auction spectrum there will be fewer opportunities for this type of bonding of adjacent channels, there is no interference related reason to continue the current limitation. In particular there will continue to be adjacent pairs of idle TV channels in rural areas and the ability to use those channel more effectively will benefit rural residents who lack both TV service and broadband alternatives.

PROPAGATION MODELS

The Commission traditionally uses different propagation models for TV signals in different contexts.[12] However, the laws of physics are the same regardless of whether we are considering TV coverage in order to allow rural residents to get network television via direct broadcast satellite systems or whether we want to see if a TV signal is present that might be interfered by a TVBD. The safety margins may be different in such cases, but the fundamental physics is the same.

The Commission should revisit this aspect of the rules now. When the FCC last considered this question, it defended its 1966 model by crediting an argument by the National Cable and Telecommunications Association that "terrain-based measures are not yet ready to be deemed reliable."[13] That is clearly no longer the case, as the FCC has

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[12] For example, the R-6602 is used for Part 73 coverage determinations and present TVBD rules, while a Longley-Rice model is used to determine if a home lacks TV network coverage over-the-air in order to be eligible for DBS networks coverage pursuant to the Satellite Home Viewer Improvement Act of 1999.

[13] *Second Memorandum Opinion and Order*, Docket 02-380, at para 19.

determined to rely on the terrain-based Longley-Rice propagation model to ensure broadcasters do not interfere with each other after they are repacked following the incentive auction.[14]

The *Notice* states

> "(W)e do not believe the use of the Longley-Rice methodology would be appropriate for determining whether a white space device would cause interference to TV reception as it is computationally intensive and would significantly slow the determination of available TV channels by the white spaces databases."[15]

We respectfully disagree. As is well know, "computationally intensive" is a relative term and the rapid advances in integrated circuits and processors driven by the Moore's law makes computations that seemed burdensome a few years ago easily done in smartphones. Indeed, real time computation might be avoided by clever algorithms that precompute much of the data in order to decrease real time computation requirements There is no reason to prohibit the use of Longley-Rice by those data base providers who are willing to invest the resources to implement it. Those providers using the more complex algorithm will give their users better access to white space spectrum without risk of interference to primary licensees. This way the marketplace, rather than the Commission, will determine what model is computationally practical. We see no reason for not allowing optional use of the Longley-Rice model by the database providers. The Appendix has further discussions and examples relevant to this topic.

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[14] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112–96, 126 Stat. 156, § 6403(b)(2) (2012) (requiring use of FCC Office of Engineering and Technology Bulletin 69, which incorporates the Longley-Rice propagation model, to calculate post-auction coverage areas for repacked broadcasters).

[15] *Notice* at para. 71

CONCLUSIONS

Adaptrum wishes to thank the Commission for its many proposals for updating the TVBD rules in this *Notice*. Some of these proposals are necessary as a result of pending spectrum changes, while others are basically an updating of the rules based on experience to date with geolocation/database systems that were an abstract concept when these rules were last discussed in depth.

In particular, rural Americans with little TV service and few broadband options stand to benefit from many of the proposals discussed above. Unrealistic overprotection of unused TV spectrum serves no public benefit in such areas. As in the past, Adaptrum looks forward to working with the Commission's staff to resolve the technical details of these proposals.

/S/

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APPENDIX – PROPAGATION MODEL REVIEW

The R-6602 model that is the basis of the Grade B contour was published by the Commission in 1966, as the name implies.[16] It was a brilliant technical accomplishment of the Commission's staff in an era when the measurements the model was based on could only be made by hand with heavy analog instruments, transferred later to punched ("IBM") cards, and then tabulated. These limitations resulted in relatively few data point for the analysis compared to later models such as Longley-Rice. The terrain data used in calculations using this model was literally read off a contour map with a ruler and dividers. This is very different from the age we live in today!

We acknowledge that there are real benefits of "administrative certainty' of protecting broadcaster's service area from new Part 73 entrants. But denying TVBD use in some areas within Grade B contours where *there are actually no usually signals serves no public interest*. Consider the case of Monterey, CA.[17] Figure 3 shows data from the

[16] FCC Report R-6602, Development of VHF and UHF Propagation Curves for TV and FM Broadcasting, September 7, 1966 (http://transition.fcc.gov/oet/info/documents/reports/R-6602.pdf)
[17] In this example we use as the coordinates the address of City Hall: 580 Pacific Street

Google database on white space availability in Monterey:

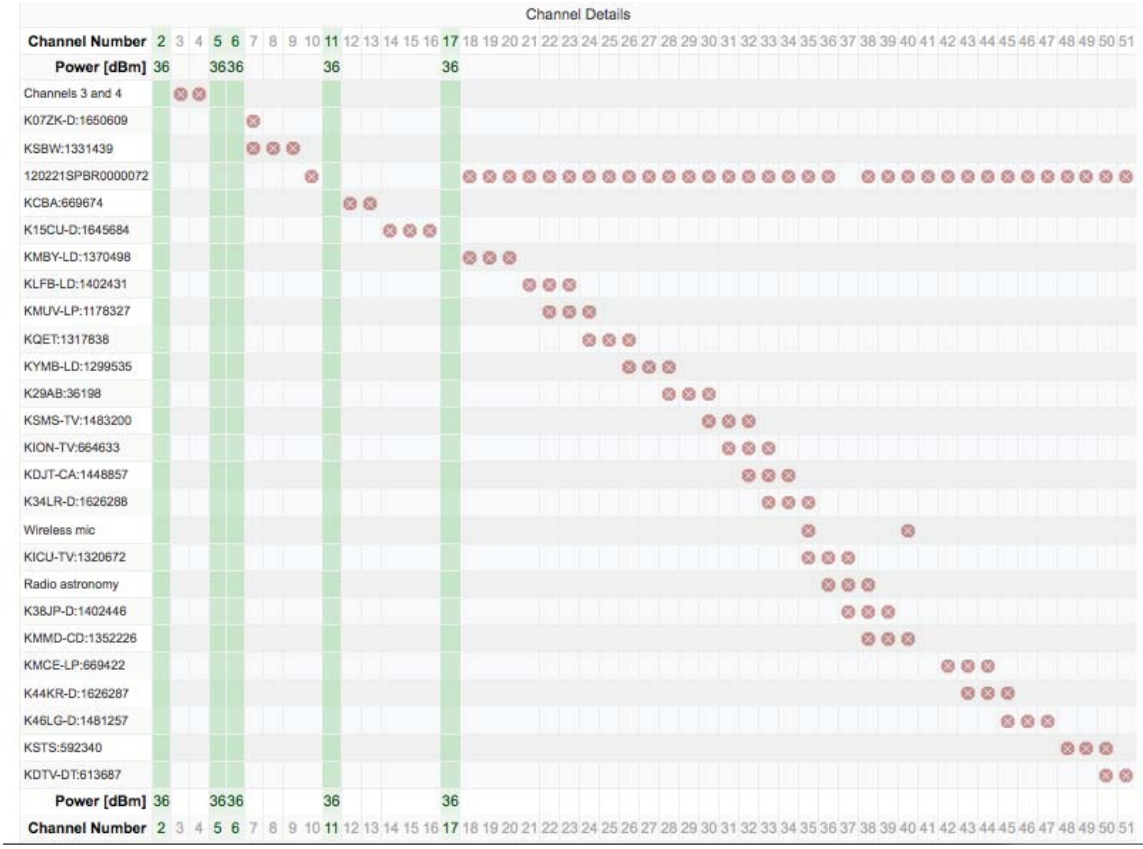

Figure 3: TV white space availability in Monterey CA per Google database

The only UHF channel available is Channel 17 under the present FCC Rules. Perhaps this is reasonable given the proximity to urbanized areas in San Francisco and Sacramento? Now let's look at the Commission's own predictions of TV service in Monterey:

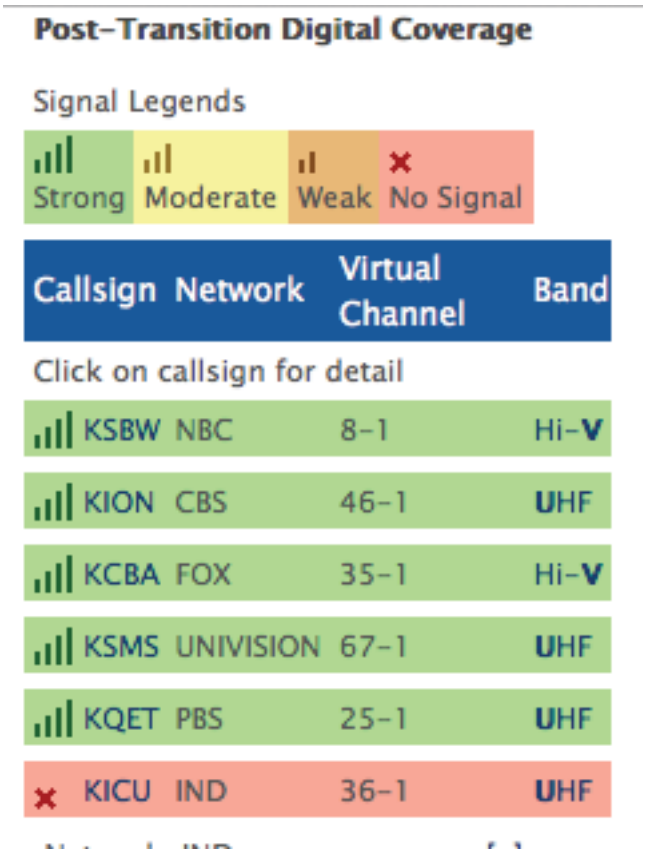

Figure 4: Prediction of TV coverage in Monterey CA from http://transition.fcc.gov/mb/engineering/dtvmaps/

While the TVBD device rules assume coverage from UHF TV transmitters on the following channels: 13,15,19, 22,23,25, 27,29, 31,32,33,34, 36,38,39,43,46, and 49 in the case of Monterey, the Commission's own predictions show that only channels 25 (RF 25) ,35 (RF 13) and 46 (RF 32) are viewable. Why? A satellite view of the area in Figure 5 shows mountains that block TV signals from Sacramento and San Francisco. While the algorithm in the R-6602 model considers "a terrain roughness factor"[18], it does so only in an approximate way consistent with data available in 1966. Today's Longley-Rice Model uses much more terrain data and hence makes more accurate predictions.

[18] 47 C.F.R. 73.699 Figures 10d and 10e

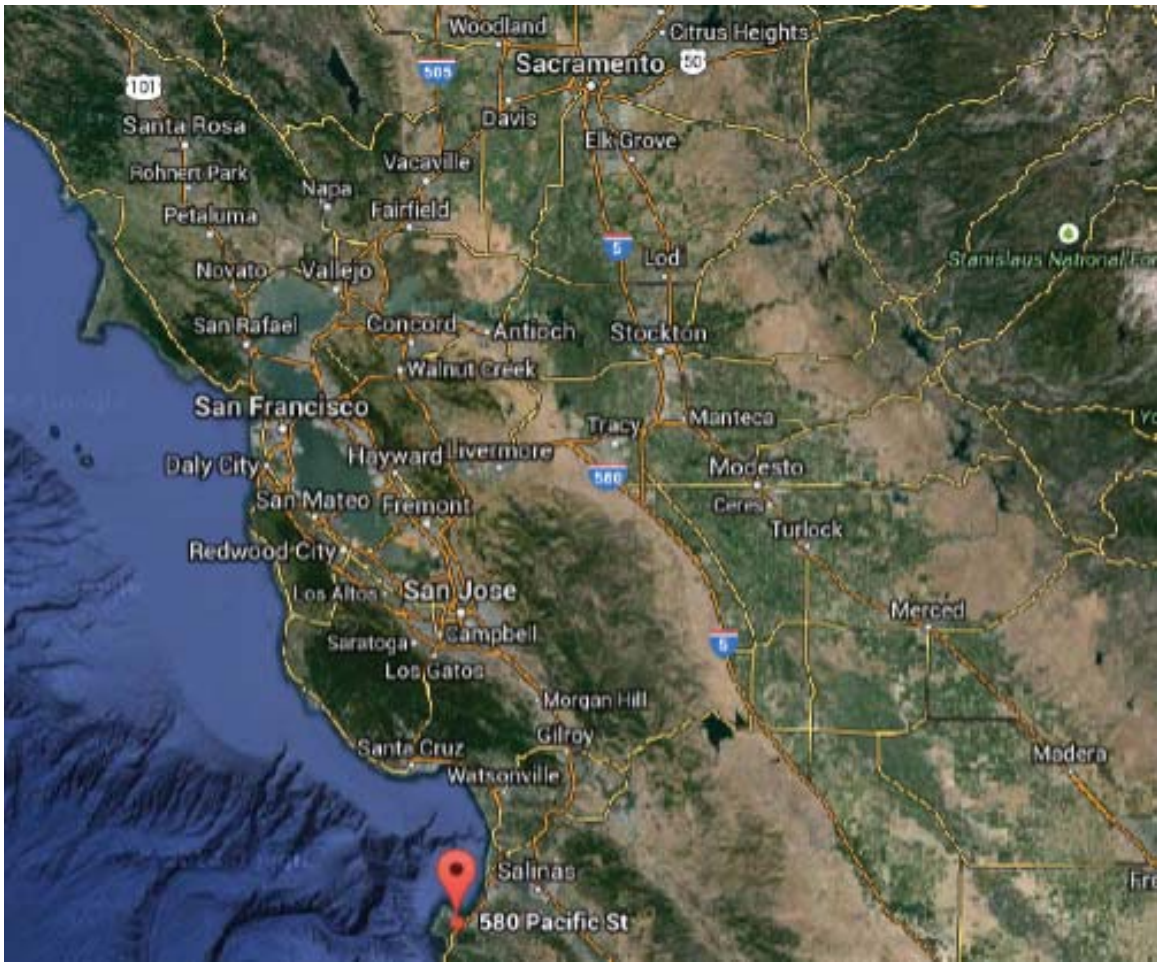

Figure 5: Location of Monterey and other nearby TV markets

Another example of the limits of the R-6602 model is shown in Figure 6 from the Commission's own calculations:

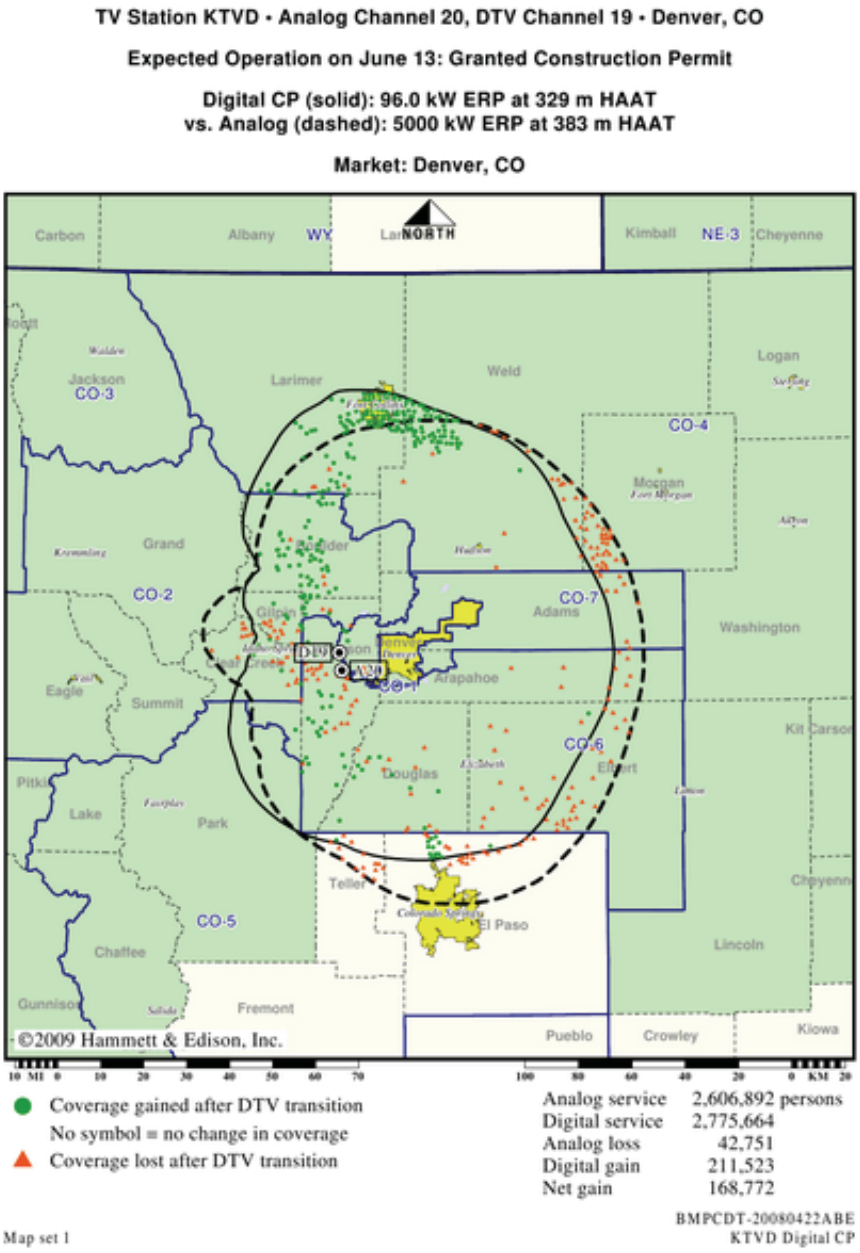

Figure 6: FCC calculation of coverage of KTVD-DTV Denver CO (http://transition.fcc.gov/mb/engineering/maps/images/callsigns/KTVD.gif)

Note the orange triangle symbol identified as “Coverage lost after DTV transition”. The solid black line is the Grade B contour of KTVD’s DTV signal. Note that west of Denver there are many orange triangles within the contour indicating no coverage in the post-DTV era for this station with those spots that are within the contour calculated using the R-6602 model. This does not include other areas within the contour that never had coverage in the analog era. But in rough terrain TV broadcasters often never had perfect coverage within their service contours and protecting their signals from TVBD devices in areas with no actual coverage serves no public purpose.