



Unlicensed Operation in the TV Bands

ET Docket No. 04-186

May 14, 2008

The Motorola TVWS test device primarily relies on geo-location database techniques to protect incumbents

Geo-location is the preferred operating mode in the field (and the mode that the experimental test unit was designed for, several months ago...)

Motorola device provides a special 'test mode' to separately assess DTV sensor performance (designed for FCC lab-based testing/evaluation)

- Unit was not intended to operate *solely* based on sensing, however, we understand the FCC's desire to test as many units in sensing-only mode as possible
- Geo-location database alleviates need to rely on spectral sensing for successful incumbent detection
- Geo-location database alleviates adjacent channel sensing issues with strong signals (it does not degrade based on receiver performance levels)

Only sensing-only WSD operating modes have been tested by FCC so far...

- *The Motorola device has not yet been tested in its preferred mode of operation*

Motorola strongly supports a multi-tiered incumbent protection scheme

Primary reliance on geo-location database for incumbent protection

- Easily adapts to *new services* or *daily/hourly changes in services* in the TV bands
 - Can contain not only Broadcasters, but other services, including 470-512 LMR, wireless microphone deployments in limited area deployments (e.g., sports stadiums, concerts, etc.), or other uses the FCC determines appropriate
- Readily addresses interference issues in the field once units are deployed
 - Through normal dynamic database (e.g., interference protection requirements) updates to fielded units

Reliance on IEEE 802.22.1 Beacon signal for nomadic wireless mic protection

- Applies to roving, un-planned news-gathering operations (not in database)
- Beacon signal is much easier to detect (by about 15-20dB) than other types of incumbent signals (e.g., DTV, wireless mics)
- Supports priority for licensed and authorized unlicensed services
- Supported by multiple industry groups

Sensing for verification that channel is viable

- Enhances compatibility among TVWS devices

Motorola submits minor modification to existing TVWS test device to further allow the FCC to gather sensing-only WSD test results

Modification is intended only to improve sensing-mode performance of device - it does not affect the preferred geo-location database mode of operation

- Designed to improve adjacent channel sensing performance and receiver overload performance
 - Demonstrates that a simple, low-cost technology can be utilized to improve sensing-only WSD performance
 - Same techniques commonly utilized in cellular phones & two-way radios
 - Geo-location ('normal mode') operation of device is completely unaffected

Motorola is continuously working on WSD radios to ensure reliable protection per FCC requirements.

- *The technology should by no means be considered static (or at/near its limits)*
- *The algorithms should by no means be considered final*

Motorola makes specific recommendations for sensing-only WSD performance in the presence of adjacent channels

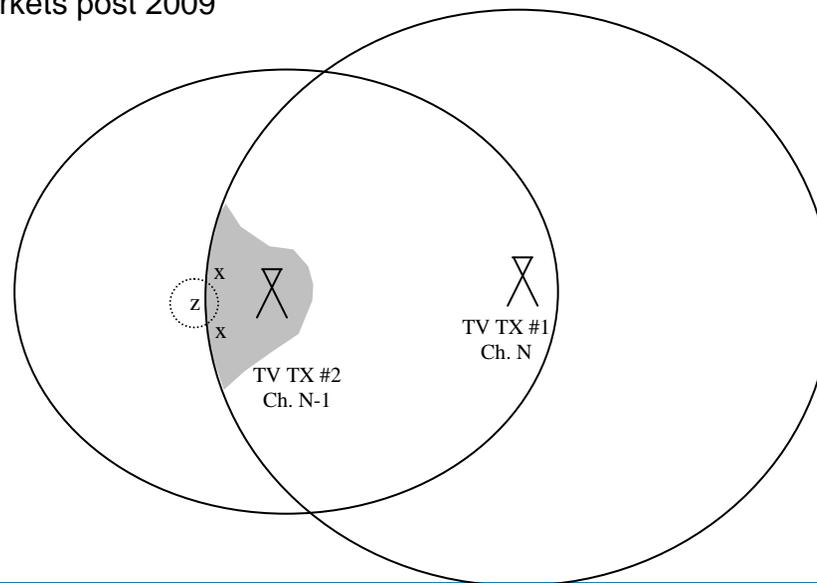
Recommendation is based on the premise of *protecting all viewable TV signals* in the field

- Recommendation based on the same interference protection requirements that the FCC utilizes in its TV band planning / channel allocation process (e.g., see OET-69)
 - *Time-tested, field-proven methods that have been successfully utilized for decades*
 - *No reason why the same protection ratios should not apply*
- TV service reception limits due to typical TV receiver and transmitter limitations need to be fully considered
 - *Once a certain D/U ratio is exceeded at TV receiver, the TV signal becomes unviewable*
 - *Harmful interference can not occur to otherwise (previously) un-receivable TV signals*
 - *Similar in concept to outside-of-contour WSD operation*
 - *Where WSD generated interference causes no further harm to incumbent signal due to limitations from pre-existing noise & interference levels*
- WSD device operation should not impact or harm previously viewable signals

Adjacent channel interference case study (1)

Situations exist (especially in currently crowded TV bands) where undesired adjacent channel interference from licensed incumbent prevents successful reception of desired weaker incumbent signal

- Example taken from online FCC CDBS:
- WMPT-DT42 operates adjacent to WPXW-DT43 in Washington, DC area
 - Standard protected service contours overlap (each service area contains other adjacent channel transmitter)
 - Generally prevents reception in certain areas around strong adjacent channel station (D/U ratios well in excess of 35dB can be observed) – operation of WSD (on Ch. N) at 'z' causes no further harm to weaker TV signal
 - TV receiver antenna discrimination can not always be counted on for licensed TV signal ACI benefit (e.g., in areas marked 'x')
 - This particular situation is remedied in 2009 when WPXW-DT43 moves to channel 34, but other situations may exist in other markets post 2009



Specifically, Motorola recommends that sensing-only WSDs be required to detect incumbents down to levels related to adjacent (and alternate) channel incumbent signal strength

Reflects the reality that incumbent receivers *must also successfully deal with adjacent & alternate channel interference from licensed incumbents* (i.e., other TV transmitters)

- For example, TV receivers are known to tolerate only a certain level of adjacent channel interference:
 - FCC utilizes -26dB D/U for tolerable adjacent channel interference (DTV->DTV, upper adjacent channel) in TV band planning process (*includes the harmful effects from licensed full-power DTV transmitter splatter*)
 - Forms a starting point for analysis in the presence of adjacent channel interferers
 - Can be improved upon in some cases due to TV receiver antenna pattern discrimination (per OET-69)
 - Apply additional margin based on potential interference range of WSD (which is in turn based on maximum WSD transmit power level – 10mW assumed for Motorola analysis)
 - Ensures that required D/U ratios are met at edge of WSD interference radius (@ *conservative* 18dBu co-chan. WSD E-field)
 - TV receiver antenna discrimination (as well as many other effects) can also greatly reduce WSD interference radius
 - Apply additional margin based on other (differential) channel sensing effects (e.g., shadowing, etc.)
 - Fully discussed in attachment... amounts to 14dB of total margin
- Final incumbent detection requirement linked to required adjacent channel D/U ratios for successful reception of TV signals
 - *For DTV signals on upper adjacent channels ($P_{max\ adj}$ is maximum power in adjacent channel):*
 - *Required DTV incumbent detection level = $\max [-116\text{ dBm}, (P_{max\ adj} - 40)\text{ dBm}]$*

Recommended sensing methods should also be applied for alternate channel incumbents

Again, based on incumbent receiver and transmitter specifications

- Just as DTV receivers have adjacent channel interference requirements, they also have alternate channel ($N\pm 2$) interference protection requirements (e.g., ATSC A/74: -44dB vs. -33dB D/U)
 - As with WSD power level setting algorithms, *typical* receiver and transmitter performance levels should be taken into account
- Similar analysis applied to protect viewable signals from alternate channel interference
 - Utilizes typical recommended 11dB improvement in required alt. ch. D/U over adj. ch. D/U (44dB – 33dB)
 - Applies similar sensing margins to provide additional protection
- Final incumbent detection requirement also linked to required alternate channel D/U ratios required for *successful reception* of TV signals
 - *For DTV signals on alternate channels ($P_{max\ alt}$ is maximum power in alternate channel):*
 - *Required DTV incumbent detection level = max [-116 dBm, ($P_{max\ alt} - 51$) dBm]*
- When combined, the recommended DTV incumbent detection sensing thresholds are:
 - *Required DTV detection level = max [-116, ($P_{max\ adj} - 40$), ($P_{max\ alt} - 51$)] dBm.*