Lessons Learned From...

Interference to Wireless Medical Telemetry Service Systems

Rick Hampton

On February 27, 1998, Dallas TV station WFAA became the first station in the U.S. to test its new digital television (DTV) transmitter. WFAA was assigned a vacant TV channel, or so most thought. Both Baylor University Medical Center and Methodist Dallas Medical Center were using the channel for their cardiac telemetry systems. The resulting interference to both hospitals' telemetry systems not only became a national news story, but the impetus for creating the Wireless Medical Telemetry Service (WMTS).

Since the final rule establishing the WMTS in 2000, the general understanding has been that medical telemetry systems are "protected" from interference as long as they are registered according to the Federal Communications Commission (FCC) rules. In fact, there are several loopholes in the regulations that still allow interference from TV stations and other non-medical devices.

Episodes similar to WFAA continue to occur; three are described in this article. The hospitals involved have requested anonymity to avoid the press surrounding that incident. Following these descriptions are suggestions to prevent further occurrences.

Incident #1

In mid-2002, a Kansas hospital purchased a 608 to 614 MHz UHF WMTS band telemetry system. At the time of the initial site survey, only the presence of a nearby National Television System Committee (NTSC) analog TV38 transmitter was noted. The system was installed in September 2002 with a broadband antenna system and 54 channels of telemetry assigned to the lower portion of the WMTS band (from 608.2025 to 610.7250 MHz). Approximately one year after installation, the hospital began experiencing intermittent, severe dropout on all channels.

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During a resurveying in February 2004, the manufacturer found interference from the TV38 transmitter, now operating with increased power and a newly installed DTV36 transmitter. The manufacturer implemented corrective action in March 2004 by installing additional filtering and changing the operating frequencies of all transmitters to the middle 1/3 of the WMTS band. As a result of the additional radio frequency (RF) filtering, the useful portion of the WMTS band has been reduced to 610 to 612 MHz, limiting future expansion.

Incident #2

In 2003, a New Jersey hospital upgraded its existing Part 15 telemetry system to the UHF WMTS band. A total of 96 telemetry channels were installed, with 48 channels in the telemetry department and 48 channels in other hospital areas. The initial site survey did not indicate nearby TV stations on channels 36 or 38.

In November 2003, the hospital began experiencing excessive dropout on multiple channels. Investigation by the manufacturer showed high background noise and interference across the entire WMTS band as well as new DTV stations on channels 36 and 38. In January 2004, the manufacturer of the antenna subcomponents performed an onsite inspection, determining the amplifiers and antennas had too much gain to reject the energy from the two DTV transmitters. The manufacturer began replacing the amps and antennas with lower gain versions.

Unfortunately, changing the amps and antennas caused the problem to worsen with the telemetry department now experiencing serious problems. Most telemetry channels were not functioning properly. The manufacturer determined the bandwidth of the new amplifiers and antennas were too broad and even less able to reject energy from the nearby DTV stations. Two more weeks passed before the entire antenna system could be completely redesigned and installed to preclude overload from the nearby DTV transmitters. In the meantime,

low patient census allowed the hospital to use wired monitors and the remaining unaffected telemetry channels to continue operation for the duration of mitigation activities. This system was finally made fully functional across the entire 608 to 614 MHz band.

Incident #3

In September 2004, an Ohio hospital suddenly began suffering interference to its WMTS system on nearly one third of the 300+ channels. Although the system had been operating properly with nearby DTV stations on channels 36 and 38, the interference began when the DTV36 station increased transmitter output power from 200 kW to 1 MW.

Although hospital staff members were able to find enough wired monitors for all the affected patients, a short-term resolution presented itself when the DTV amplifier suffered a catastrophic failure later in the day, taking the station off the air. After discussing the situation with the station engineer, the clinical engineering (CE) manager was able to convince the station engineer to bring the system back online at only 200 kW until the hospital could remediate their telemetry system.

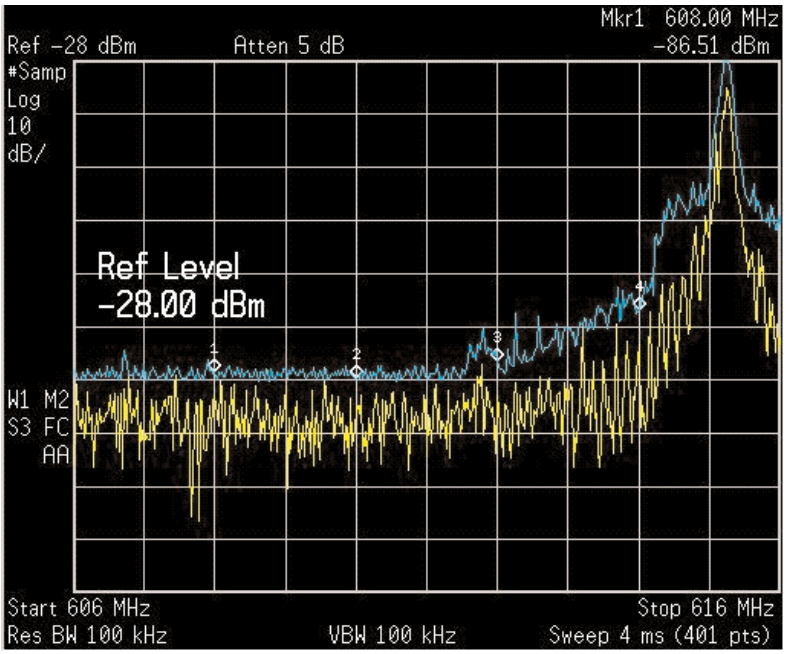

Figure 1. *This over-the-air spectrogram shows signals from the Boston TV38 station (the peak on the right) extending down into the UHF WMTS band. The signals between diamond-shaped markers 3 and 4 (612 and 614 MHz, respectively) are from the TV station and are legal even though they prevent use of this segment of the WMTS band. The bottom trace is real-time and the top trace is max hold.*

It took the manufacturer about a month to determine the problem and redesign the antenna system so it could reject the energy from the DTV36 transmitter. Subsequent to the redesign, the system has been able to operate correctly, even after the DTV36 transmitter was returned to the higher, licensed power.

Factors Leading to the Interference Events

In all instances, the TV station chief engineers were contacted and described as cordial, but only in the last instance was the chief engineer helpful. (The CE manager had opened a dialog with him before the interference occurred.) When contacted, the FCC redirected the hospitals to the American Society of Healthcare Engineering (ASHE), the official WMTS coordinator. In turn, ASHE advised the hospitals to continue working with the manufacturers to mitigate the problems.

It is important to note that the WMTS rules contain no recourse for institutions suffering interference from nearby, adjacent channel TV stations, even if, in some cases, TV signals fall inside the UHF WMTS band (see Figure 1). The rules state that it is up to the facility and telemetry manufacturer to solve the problem through additional filtering or moving to a different band.

Two major factors leading to the events cited are inadequate antenna design and a misunderstanding of the WMTS regulations. In all three cases, the WMTS installations utilized a highly amplified, broadband antenna system with filtering inadequate to attenuate the radio energy from the adjacent channel TV stations. This antenna design is a legacy from Part 15 days when telemetry allocations allowed operation on unused TV channels from 174 MHz to 668 MHz.

Of the events described, one hospital used a legacy antenna system installed before WMTS was created, while the others had new WMTS antennas installed with the old design. The lesson here is that new UHF WMTS systems should be designed with better filtering. Simply retuning the transmitters and receivers from the Part 15 allocations to the UHF WMTS band may

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Worth Noting

Hospitals utilizing UHF WMTS telemetry systems should take the following steps:

1) The FCC is constantly processing requests for new or different DTV channel allocations. There are currently 29 DTV36/38 stations on the air with allocations for another 55, a number sure to grow. You should perform a monthly search for new allocations in your area with the "TVQ TV Database Query" at www.fcc.gov/mb/video/tvq.html. Alternatively, you can check the updated list of DTV stations at www.fcc.gov/oet/dtv/ start/dtv2-69.txt. (Note: Pay close attention to the preparation date of any prepared lists you reference. Many links on the FDA and FCC websites are out of date and lead back to the original allocation list dated 1998.)
2) Contact your WMTS telemetry system manufacturer to ascertain the type of antenna system and receivers in your system. Request the manufacturer provide you with a detailed list of upgrades, along with their costs, needed to prevent your system from suffering from "adjacent channel interference" from TV36 and TV38 signals, if possible.
3) Should you find a new TV36 or TV38 station near activation in your vicinity, contact the TV station and respectfully request they delay beginning broadcasts until you can complete remediation of your system, if needed. You should copy your correspondence to ASHE, FDA, and FCC.
4) If remediation of a UHF WMTS system is not possible or desired, consider the deployment of an "L-band" (1395-1400 MHz or 1427-1432 MHz) WMTS system, or a Part 15 standards-based telemetry system in the ISM bands.

not provide adequate protection from digital TV interference with the legacy antenna system.

The second contributing factor was inadequate understanding of the WMTS rules by the hospital CEs and telemetry manufacturers. While one CE stated he did not receive the required notification letters from the TV stations announcing the pending activation of the TV transmitters, all said they did not realize remedial action might be necessary to prevent interference to WMTS systems. There is a common misunderstanding of what it means for the WMTS to be "protected" by the FCC. Many people believe 1) all WMTS systems are designed to prevent interference, 2) interference to WMTS, of ANY kind, will not be tolerated by the FCC, and 3) the FCC will take action against any interloper. It is obvious from examining the rules and these cases, none of these beliefs are correct.

Many have argued for years the potential interference issues from non-medical devices to Part 15 telemetry in the ISM bands. Few realize the same holds true for UHF and L-band WMTS systems. Additionally, several hospitals have learned proprietary WMTS systems from competing manufacturers may also interfere with each other. Consequently, experience shows that telemetry systems can operate in any portion of the spectrum, but only if good pre-installation planning is performed with the manufacturer and post-installation vigilance is maintained. ■