Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	WT Docket No. 12-268

COMMENTS OF GE HEALTHCARE

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EXECUTIVE SUMMARY

As a market-leading provider of medical products and services, including wireless medical telemetry systems, designed to assist healthcare providers better diagnose, treat, and monitor patient medical conditions, GE Healthcare ("GEHC") urges the Commission to take prompt action in this proceeding to ensure that wireless medical telemetry operations can remain in Channel 37 with adequate protection from harmful interference. As the Commission knows, wireless telemetry technologies have played a transformative role in the healthcare industry by enhancing patient mobility and comfort, reducing medical complications caused by patient immobility, creating workflow efficiencies that improve the quality of medical services, and significantly decreasing healthcare costs. For this reason, the Commission established the wireless medical telemetry service ("WMTS") in 2000, noting the need "to protect the public safety by providing spectrum where medical telemetry equipment can operate without interference."[1] Designing the incentive auction in a manner that fails to protect and preserve WMTS devices on Channel 37 would not only jeopardize the operations and workflow of healthcare facilities across the country—risking the safety of millions of patients and delaying the development of new medical innovations—it would also undermine longstanding Commission precedent and policy, contrary to the public interest.

First, the Commission should not force the involuntary relocation of WMTS operations on Channel 37, as the cost of doing so would far exceed the $300 million designated for that purpose in the Spectrum Act. Even before considering the potential costs of moving the Radio Astronomy Service, and assuming the Commission could locate new frequencies, relocating WMTS

[1] Amendment of Parts 2 and 95 of the Commission's Rules to Create a Wireless Medical Telemetry Service, *Report and Order*, 15 FCC Rcd 11206, 11206 ¶ 11 (2000) (noting also that migrating wireless medical telemetry devices to the specific WMTS spectrum allocation would also allow the Commission to lift the freeze placed on the filing of applications for high power land mobile operations at 450-470 MHz).

operations from Channel 37 would impose substantial financial costs on healthcare facilities, patients, and device makers alike, including (i) equipment replacement costs; (ii) the transition and operational costs that manufacturers would incur to engineer, develop, manufacture, and market the new systems; (iii) system disposal, installation, testing, and training costs; (iv) increased operating and maintenance costs; (v) regulatory hurdles that manufacturers would face to bring new WMTS equipment to market (including the cost of obtaining regulatory approval); and (vi) transactional and third party expenses, such as consulting and legal fees. Moreover, relocating WMTS systems from Channel 37 would give rise to onerous intangible costs, such as disruption of hospital operations and patient safety, that are more difficult to quantify, but likely to be even more significant than the financial burdens of migrating WMTS operations to a new spectrum band. However, if the Commission does decide to relocate the WMTS from Channel 37, despite the severe costs of doing so, it should ensure that the relocation expenses are covered for all Channel 37 WMTS operations, regardless of whether or when they were registered in the ASHE database.

Second, in addition to retaining WMTS authority in Channel 37, the Commission should adopt more rigorous technical rules to protect incumbent WMTS operations from the changing operational landscape in the 600 MHz band. In suggesting that the proposed 600 MHz out-of-band ("OOBE") and fundamental emissions limits would provide as much or more protection to WMTS systems on Channel 37 than they currently receive from DTV operations, the Commission has erroneously assumed that (a) the emissions limits imposed upon DTV stations sufficiently protect Channel 37 services, and (b) the nature and scope of wireless communications in the 600 MHz band near Channel 37 will remain relatively unchanged after the incentive auction is complete. Both assumptions are flawed. In fact, the current DTV regulatory framework has forced hospitals and other WMTS users to take costly measures to protect their operations from

undesirable DTV broadcast signals. Likewise, because new mobile base stations and consumer devices will be far more ubiquitous and located closer to WMTS receivers than TV transmitters following the incentive auction, the actual, in-hospital field strength observed by WMTS systems will be materially higher than the field strength of DTV stations. As such, the Commission should adopt the following measures:

1. Require wireless carriers to coordinate and obtain the concurrence of registered WMTS users prior to the construction and operation of base stations within certain distances from registered WMTS systems;

2. Limit the maximum allowable 600 MHz base station field strength in Channels 36 and 38 to 20 mV/m/MHz, and the maximum allowable 600 MHz base station OOBE field strength in Channel 37 to 10 μV/m/100 kHz, as measured at the perimeter of a registered WMTS facility;

3. Require mobile devices transmitting in the 600 MHz band to comply with the emissions mask applicable to unlicensed devices operating between 602-620 MHz, codified at Section 15.709(c)(4) of the Commission's rules;

4. Adopt a band plan that will reduce the need to repack DTV stations into Channel 36 and/or 38, and which increases the likelihood that, instead, mobile base stations will be located on either side of Channel 37 (as the risk of base station interference would be the most manageable, assuming the adoption of the coordination requirements and absolute field strength limits proposed above).

Finally, the Commission should not allow unlicensed devices to transmit in Channel 37. The Commission's proposal to authorize such devices for operation in Channel 37 assumes the availability, and viability, of some adequate means to protect WMTS devices from unlicensed interference. However, a geolocation database would be unworkable. Likewise, spectrum sensing technologies do not yet offer a reliable solution for co-channel sharing. With potentially millions of portable, unlicensed devices in circulation, even a highly effective interference regime (*i.e.*, 99.99% effective) would incapacitate thousands of WMTS systems.

In view of the foregoing, the Commission should act promptly to resolve the issues in this proceeding that could affect WMTS operations, even if other auction-related questions remain unresolved or warrant further consideration by the Commission and/or industry stakeholders.

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Opportunities of Spectrum Through Incentive	)	
Auctions	)	

COMMENTS OF GE HEALTHCARE

I. INTRODUCTION

GE Healthcare ("GEHC") submits these comments in response to the Notice of Proposed Rulemaking ("NPRM") issued by the Federal Communications Commission ("FCC") in the above captioned proceeding.[2] GEHC, a unit of General Electric Company, provides a broad range of products and services that enable healthcare providers to better diagnose and treat diseases and medical conditions, including products and services that incorporate wireless technology. As a leading provider of systems that use spectrum allocated to the wireless medical telemetry service ("WMTS"),[3] GEHC has long supported innovation in the wireless sector.[4] Wireless medical telemetry equipment is routinely used in hospitals and other healthcare facilities to transmit patient data (such as electrocardiography ("ECG"), pulse, and oxygen saturation ("SpO_2") data) to a nearby receiver.[5] As the Commission knows, by empowering

[2] Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, *Notice of Proposed Rulemaking*, 27 FCC Rcd 12357 (2012) ("*NPRM*").

[3] GEHC was the first provider of WMTS systems to utilize advanced frequency hopping spread spectrum technology. For more information on GEHC's wireless telemetry products, see http://www3.gehealthcare.com/en/Products/Categories/Patient_Monitoring/Wireless_Networks.

[4] *See, e.g.*, Comments of GE Healthcare, Unlicensed Operation in the TV Broadcast Bands, ET Docket No. 04-186 (filed Jan. 31, 2007); Ex Parte Comments of GE Healthcare, Investigation of the Spectrum Requirements for Advanced Medical Technologies, ET Docket No. 06-135 (filed Dec. 27, 2007).

[5] *See* Technical Appendix at 1.

healthcare providers to remotely monitor their patients' physiological data, WMTS equipment has played a transformative role in the healthcare industry, "provid[ing] significant benefits to patients in terms of mobility and comfort" and emerging as a "significant tool in reducing healthcare costs."[6] Early mobility helps to avoid physiological effects of immobilization, such as deep vein thrombosis ("DVT"), pressure ulcers and other medical complications. Moreover, by reducing complications caused by patient immobility, wireless patient monitoring can materially reduce the duration of a patient's hospital stay, expediting his or her return home.[7]

In light of its extensive experience with the WMTS marketplace, GEHC submits these comments to provide the Commission with information regarding: (i) the high cost and adverse impact on patients and healthcare facilities of relocating WMTS operations from Channel 37; (ii) the adverse effect that the Commission's proposed emissions limits for the reallocated 600 MHz band would have on WMTS operations on Channel 37, if not relocated; and (iii) the degree of harmful interference that authorizing unlicensed operations in Channel 37 would cause to existing WMTS systems, to the detriment of healthcare facilities and patients alike.

As set forth more fully below, the Commission must take strong measures in this proceeding to ensure that WMTS operation can remain in Channel 37 with adequate protection from harmful interference. Relocating incumbent WMTS operations from Channel 37 would impose onerous costs, both tangible and intangible, that far exceed the $300 million Congress has allocated to relocate all Channel 37 licensees. Moreover, because 600 MHz handset and

[6] Amendment of Parts 2 and 95 of the Commission's Rules to Create a Wireless Medical Telemetry Service, *Order*, 16 FCC Rcd 4543, 4543 ¶ 2 (2001) ("*WMTS ASHE Order*"); *see also* Amendment of Parts 2 and 95 of the Commission's Rules to Create a Wireless Medical Telemetry Service, *Report and Order*, 15 FCC Rcd 11206, 11206 ¶ 1 (2000) ("*WMTS R&O*"); Amendment of the Commission's Rules to Provide Spectrum for the Operation of Medical Body Area Networks, *First Report and Order and Further Notice of Proposed Rulemaking*, 27 FCC Rcd 6422, 6427 ¶ 8 (2012); 47 C.F.R. § 95 subpart H.

[7] *See* Dale M. Needham, MD, PhD, *Mobilizing Patients in the Intensive Care Unit: Improving Neuromuscular Weakness and Physical Function*, 300 Journal of the American Medical Association 1685 (2008).

base station transmitters would be far more ubiquitous and closer in proximity to hospitals and other healthcare facilities than current transmitters in the band, the proposed OOBE and power limits for the 600 MHz band would be inadequate to protect WMTS operations in Channel 37 from harmful interference, creating an unreasonable risk to a safety-of-life technology. Finally, allowing unlicensed devices to operate in Channel 37 would be in direct conflict with Commission precedent, expose thousands of WMTS devices to harmful interference and create societal costs that greatly outweigh any benefit that expanding unlicensed operations might generate. Accordingly, the Commission should adopt clear rules in this proceeding to ensure that the broadcast incentive auction, and the wireless environment following the auction, will not adversely affect incumbent WMTS systems in Channel 37.

II. BACKGROUND

A. The History of WMTS and Its Primary Allocation on Channel 37

Understanding the regulatory history of WMTS is vital to appreciating the adverse impact that disrupting the existing Channel 37 framework would have on healthcare facilities and their patients. Before 2000, wireless medical telemetry devices operated on an unlicensed basis (on vacant VHF and UHF television channels) under Part 15 of the Commission's rules or on a licensed basis, secondary to private land mobile radio ("PLMR"), under Part 90 (in the 450-470 MHz band).[8] To ensure that wireless medical telemetry devices could continue operating free from harmful interference following the introduction of DTV service in the UHF/VHF bands and the rechannelization of the 450-470 MHz band in the PLMR refarming proceeding, the Commission established the WMTS in 2000, allocating 14 MHz of spectrum on a primary basis, including the frequencies in Channel 37 (608-614 MHz, co-primary with the radio astronomy

[8] *WMTS ASHE Order* ¶ 3.

service ("RAS")).[9] In doing so, the Commission explained that the WMTS allocation was necessary "to protect the public safety by providing spectrum where medical telemetry equipment can operate without interference."[10]

As the Commission noted in 2000, Channel 37—which constitutes the largest contiguous block of the WMTS allocation—is ideal for wireless medical telemetry systems because (i) it had previously been used for unlicensed medical telemetry under Part 15 of the FCC's rules; and (ii) no commenters opposed the Commission's proposal to allocate the channel for WMTS.[11] However, the Commission also recognized the constraints associated with using Channel 37, including the presence of radio astronomy quiet zones, potential interference from adjacent TV channels 36 and 38, high power radars, and grandfathered protected Federal sites.[12]

The Commission likewise acknowledged the substantial costs that WMTS users would incur in migrating to the new spectrum, and that mandating the "replacement of functional medical telemetry systems . . . would be an unnecessary financial burden on hospitals."[13] To avoid this cost and ensure that hospitals and healthcare providers could "operate their existing systems as long as possible," the Commission authorized the operation of Part 90 medical telemetry equipment for two years.[14]

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[9] *WMTS R&O* ¶ 11; 47 C.F.R. § 95.630 (authorizing WMTS transmitters to operate in the following frequency blocks: 608-614 MHz, 1395-1400 MHz; and 1427-1429.5 MHz). In 2001, the Commission designated the American Society for Health Care Engineering of the American Hospital Association ("ASHE") as the WMTS frequency coordinator. *WMTS ASHE Order* ¶ 1.

[10] *WMTS R&O* ¶ 11 (noting also that migrating wireless medical telemetry devices to the specific WMTS spectrum allocation would also allow the Commission to lift the freeze placed on the filing of applications for high power land mobile operations at 450-470 MHz).

[11] *Id.* ¶ 19.

[12] *Id.* ¶ 11.

[13] *Id.* ¶ 59.

[14] *Id.*

B. The Spectrum Act

The Spectrum Act provides the Commission with authority to relocate Channel 37 incumbent users in repurposing part of the UHF band for flexible wireless use, "provided that all such users can be relocated and that the total relocation costs of such users do not exceed $300,000,000."[15] Thus, if the Commission elects to clear Channel 37, it must (i) clear all incumbent users on Channel 37 (including WMTS and RAS users), (ii) relocate the incumbent users to other spectrum, (iii) ensure that the costs of relocating incumbent Channel 37 users are paid, and (iv) ensure that the relocation costs do not exceed $300 million. If any of those conditions are not met, the Commission would be acting inconsistent with its statutory authority under the Spectrum Act.

The Commission has tentatively concluded to allow existing WMTS operations to continue in Channel 37, and use that 6 MHz frequency block as a guard band between television operations and mobile broadband operations.[16] It has nevertheless sought comment on whether it should relocate WMTS users from Channel 37, and related issues,[17] despite noting estimates from ASHE that the cost of relocating existing WMTS users alone would be well in excess of $300 million.[18]

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[15] Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96 § 6403(b)(4)(A)(iii), 125 Stat. 156 (2012) ("*Spectrum Act*").

[16] *NPRM* ¶ 180.

[17] *Id.* ¶ 211. Specifically, the Commission has sought comment on (i) the number of WMTS systems deployed in the United States; (ii) the cost of relocating WMTS systems on Channel 37; (iii) whether the Commission should only consider relocating WMTS systems that were registered in ASHE's database by a date certain (such as the effective date of the NPRM); (iv) what alternative spectrum could support WMTS; (v) whether existing WMTS systems could be re-tuned to a new spectrum band, or whether full equipment replacement would be necessary; (vi) whether all WMTS operations could be accommodated in the WMTS bands at 1395-1400 MHz and 1427-1432 MHz; and (vii) the time frame and process for possible relocation of WMTS users on Channel 37 (including whether the Commission should extend the time frame for relocation or freeze the issuance of new WMTS registrations). *Id.* ¶¶ 211-213.

[18] *Id.* ¶ 210.

C. The Ubiquity and Success of WMTS Systems Deployed on Channel 37

Since 2000, the healthcare industry has invested billions of dollars developing and deploying WMTS systems on Channel 37, and thousands of systems are currently deployed throughout the country using those frequencies. Although the Commission has allocated three spectrum blocks for WMTS, most WMTS devices manufactured since 2000 have been designed for operations only on Channel 37 because it offers the widest range of frequencies (6 MHz) within which a system can locate a suitable frequency, and because the alternative frequencies above 1 GHz have historically posed greater technical challenges and required higher infrastructure and operating costs. As noted in the NPRM, ASHE estimates, based on registrations, that nearly 104,500 WMTS devices are deployed across 2,739 unique locations on Channel 37, and the number of registrations has continued to rise since ASHE provided the estimate.[19] However, the total number of actual WMTS devices operating on the channel is likely to be substantially higher because many WMTS systems are currently operating on Channel 37 but not registered with ASHE, and therefore lack the protection afforded by the Commission's WMTS rules.[20] ASHE has more recently informed GEHC that it currently estimates that approximately 200,000 WMTS devices are operating on Channel 37. GEHC's own records, which indicate that GEHC alone has sold over 100,000 devices, and more than 100 million square feet of WMTS antenna and access point-based wireless infrastructure, located across more than 1,300 hospitals, confirm this view.

Although, as noted above, the number of WMTS devices operating on Channel 37 today is likely much larger than the figure suggested by the number of official Channel 37

[19] *Id.*

[20] *See* ASHE Alert: *Update on Relocation of WMTS*, The American Society for Health Care Engineering, Nov. 5, 2012, http://www.ashe.org/resources/ashenews/2012/wmts_121106.html ("*ASHE Alert*").

registrations, that actual figure is certainly growing rapidly. Between 2005 and 2011, the U.S. telemetry market was projected to grown at an average annual rate of 11.5%[21]—a rate that is likely to escalate as hospitals and healthcare facilities experience higher patient acuities and an aging patient population with multiple medical problems.[22] In response to these trends, healthcare facilities have evolved from using telemetry monitoring mostly in step-down units to leveraging telemetry as a broader and more comprehensive "flexible bed" solution. When WMTS systems are employed in this manner, virtually any healthcare facility bed can become a monitored bed, with wireless medical telemetry solutions offering a lower cost and more mobile means of monitoring the patient's health. Moreover, as reimbursements for inpatient hospital services decline, healthcare providers are increasingly adding wireless medical telemetry monitoring systems to additional ambulatory areas, such as in cardiac rehabilitation and outpatient clinics.

The service life of WMTS systems has also increased within the last few years. Although the wireless infrastructure components are currently designed to operate for a period of 7-10 years, they can typically remain functional for a much longer period of time. Additionally, because WMTS infrastructure is costly, complex, and integrated into the physical building, which houses patients and supports patient care, it is more likely to be continually upgraded and updated, rather than replaced. Even after a hospital facility acquires new wireless medical telemetry equipment, its legacy equipment is usually "recycled" for use in other departments of the hospital. In GEHC's experience, WMTS devices can remain in service for up to twenty years.

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[21] *See U.S. Wireless Ambulatory Telemetry Monitoring Equipment Markets* 2-1, Frost & Sullivan (2005).

[22] Global Industry Analysts, Inc. predicts the market for electrocardiogram telemetry devices alone to reach $1.25 billion by 2015, as a result of the aging world population and increasing incidence of cardiovascular diseases. *See* Market Analysis: ECG Equipment | Medical Dealer, *at* http://medicaldealer.com/market-analysis-ecg-equipment.

III. THE COMMISSION SHOULD NOT RELOCATE CHANNEL 37 WMTS OPERATIONS.

A. The Cost of Relocating WMTS Operations in Channel 37 Would Far Exceed the $300 Million Designated for That Purpose in the Spectrum Act.

The Commission should adopt its tentative conclusion not to relocate WMTS systems in Channel 37 to another spectrum band, in light of the significant technical, financial, operational, and logistical costs involved. The burdens that generally attend the relocation of incumbent spectrum licensees to alternative frequencies are well known.[23] In this case, even without considering the potential costs of relocating the Radio Astronomy Service, relocating WMTS operations would result in enormous costs, both tangible and intangible, to healthcare facilities and patients alike; jeopardize the quality and consistency of healthcare across the United States; and undermine the public interest. These costs include tangible costs, such as (i) equipment replacement costs; (ii) the transition and operational costs that manufacturers would incur to engineer, develop, manufacture, and market the new systems; (iii) system disposal, installation, testing, and training costs; (iv) increased operating and maintenance costs; (v) regulatory hurdles that manufacturers would face to bring new WMTS equipment to market (including the need to obtain regulatory approval); and (vi) transactional and third party expenses (*e.g.*, consulting and legal fees). Likewise, involuntary relocation would impose sizeable intangible costs that are more difficult to quantify, but likely to be even more significant, such as disruption of hospital operations and patient safety following a mandated channel migration. Relocating WMTS operations would also undermine the notion of "protected spectrum," and create troubling Commission policy regarding a vital, life-saving wireless service. As these collective costs

[23] For evidence of these difficulties, the Commission need not look any further than the various attempts to relocate federal spectrum users to other frequency bands. *See, e.g.,* Andrew Berg, *FCC Issues NPRM for 3.5 GHz Band*, Wireless Week, Dec. 13, 2012, *available at* http://www.wirelessweek.com/news/2012/12/fcc-issues-nprm-35-ghz-band (quoting Robert Wheeler, Chief Information Officer of the United States Air Force, as stating that switching federal satellite operations in the AWS-1 band (1755-1780 MHz) would take approximately ten years).

would far exceed the $300 million allocated in the Spectrum Act, the Commission should not force the relocation of incumbent WMTS operations on Channel 37.[24]

1. Replacing the Existing WMTS Systems Would Result in Substantial Tangible and Financial Costs.

a. **Equipment Replacement Costs**

The cost of replacing the existing WMTS systems in operation—even before accounting for the other tangible and intangible costs that WMTS users on Channel 37 would incur following relocation—would dwarf the $300 million budget allocated for that purpose in the Spectrum Act. Due to technical design limitations and FCC rules, most existing WMTS systems are designed for narrowband operations on Channel 37 and cannot be re-tuned for used on alternative frequencies. The large separation between Channel 37 and L-band portions of the WMTS allocation make dual-band devices and infrastructure unfeasible or, at best, very costly. When the Commission established WMTS, it set a sunset date of two years for type certification of devices under Part 15, thereby prohibiting WMTS devices certified after that date from also supporting other UHF channels.[25] Consequently, the WMTS devices, access points, and active antennas typically contain integrated 608-614 MHz band pass filters, and cannot simply be relocated to a frequency range outside of Channel 37. Moreover, the coaxial cable, connectors and other non-narrowband components employed in the vast majority of infrastructure deployments have a useful upper range of only approximately 1 GHz. Accordingly, a change in the permitted WMTS frequency range would require existing wireless medical telemetry systems

[24] *Spectrum Act* § 6403(b)(4)(A)(iii) (providing the Commission discretion to relocate Channel 37 incumbent users to repurpose part of the UHF band for flexible use, "provided that all such users can be relocated and that the total relocation costs of such users do not exceed $300,000,000").

[25] *See* 47 C.F.R. § 15.37(b).

to be *fully replaced* by new systems (including devices, antennas, cabling, and access points) capable of operating on whatever new frequencies the Commission designated for WMTS use.

As noted above, over 100,000 WMTS devices are known to have been deployed on Channel 37 and registered with ASHE, across at least 2,739 unique locations, and many more are believed to exist on an unregistered basis.[26] At a retail price of approximately $6,000 to $10,000 per patient, the replacement cost that would be incurred by the device users (*i.e.*, hospitals and other healthcare facilities)—exclusive of any additional development, distribution, installation, and training costs—would dwarf $300 million.[27] After accounting for the installed WMTS systems currently operating on an unlicensed basis without the protection afforded by the Commission's WMTS rules,[28] GEHC's records indicate that the total replacement cost could rise to nearly $2 billion, almost seven times the amount allocated by Congress for this purpose.[29]

b. Transition Costs: System Engineering, Design, Manufacturing, Marketing, and Distribution

In addition to the direct replacement costs borne by healthcare facilities and patients described above, an involuntary migration of WMTS operations on Channel 37 would require equipment manufacturers to incur substantial costs to transition their operations and systems to another frequency range. WMTS systems are large and complex, typically configured to match the specific needs and constraints of each hospital or healthcare facility.[30] For example, the attributes of a WMTS system can vary by patient count, patient turnover, and the coverage needs of the specific healthcare facility. Similarly, WMTS systems vary based on the healthcare facility's surrounding DTV broadcaster environment and building construction characteristics.

[26] *NPRM* ¶ 210.
[27] *Id.*
[28] *See ASHE Alert*.
[29] ASHE has urged health care facilities to register their WMTS systems as soon as possible. *See id.*
[30] *See* Technical Appendix at 1.

Moreover, many wireless medical telemetry systems employ distributed antenna systems ("DAS"), which requires the use of hundreds of antennas located throughout the healthcare facility to provide seamless coverage areas that can cover hundreds of thousands of square feet.[31] In addition to the antennas, the DAS infrastructure requires the use of thousands of feet of coaxial cable and thousands of discrete modules (such as low noise amplifiers, attenuators, and filters) to combine signals received by the antennas and backhaul the composite signal to the WMTS system receiver.[32]

As a result, displacing incumbent Channel 37 users would not only force users to acquire new systems, it would require GEHC and other device makers to engage in the challenging, time consuming, and expensive process of engineering, designing, manufacturing, marketing, and distributing systems that are capable of both operating on the new band and meeting the unique needs of the WMTS customer base. Even the most aggressive development timeline would likely require 2-4 years before the newly engineered systems became available in the marketplace. Such a delay would thwart investment in new healthcare technologies and hospital workflow, to the detriment of hospitals and patients alike. Moreover, these costs would disproportionately affect some manufacturers that chose to invest more heavily in developing WMTS equipment for operation on Channel 37, as opposed to systems that operate in the 1.4 GHz band, on the assumption that the WMTS frequency allocations would be equally available in the future. The Commission should strive to avoid actions that would upset the competitive landscape in the WMTS industry and undermine investment decisions that were based on prior FCC guidance concerning the importance of protecting WMTS operations on Channel 37.

[31] *Id.*
[32] *Id.*

c. System Disposal, Installation, Testing, Training, and Registration Costs

Involuntary relocation of Channel 37 WMTS operations would also generate additional system disposal, installation, testing, training, and registration costs, which would be in addition to the direct replacement and transition costs described above. By prohibiting wireless medical telemetry systems from transmitting in Channel 37, the Commission would render thousands of systems (and their components) useless for deployment in other scenarios. Not only would that prejudice the thousands of hospitals and healthcare facilities that have reasonably expected to use their WMTS systems for their full product lives, it would create onerous obligations to properly dispose of the technologies and components that comprise the WMTS systems. Like other electronic and wireless devices, WMTS systems consist of hazardous materials, such as lead, mercury, hexavalent chromium, and cadmium, which must be disposed of properly without adversely affecting the environment.

Moreover, installing and testing new WMTS systems—particularly tens of thousands at a time—would prove a daunting and expensive task. A typical medical telemetry system project involves five phases that can take up to a year to complete: consultation and planning, site survey and design, site preparation, installation, and commissioning and go-live. This complicated, phased approach is necessary to ensure that contractors are able to adequately prepare the site, pull infrastructure cable, install new equipment, and perform commissioning tests prior to the system's operation on a care unit-by-care unit basis.

GEHC estimates that these costs could add another 20 percent to the equipment replacement costs described above, yielding an additional expense of up to $400 million.

d. Additional Operational and Maintenance Costs

In addition to imposing the foregoing equipment replacement, transition, and installation costs, displacing Channel 37 WMTS operations could impose substantially higher operational and maintenance costs on hospitals and healthcare facilities forced to use and maintain systems at a new frequency (assuming the Commission could even identify suitable alternative spectrum). As noted above, most WMTS systems have been designed to operate only on Channel 37 because that channel offers the widest spectrum range in which a system can identify a suitable frequency, and because the Channel 37 operating environment poses fewer technical challenges and lower infrastructure and operating costs than the other two WMTS frequency bands above 1 GHz. Despite the initial limitations that attended Channel 37 when it was first allocated for WMTS operations, it now offers hospitals and healthcare facilities a substantial degree of operational security and certainty. The spectral landscape regarding Channel 37 is relatively well known, as are the mechanics for ensuring continued operation without experiencing harmful interference. By compelling hospitals and healthcare facilities to involuntarily migrate to a new frequency band at this point, the Commission would not only undermine years of development work and erase hundreds of millions of investment dollars, but would also potentially impose prohibitive operational and maintenance costs on WMTS users.

The Commission has historically considered such increased operational and maintenance expenses eligible for reimbursement in connection with a mandatory spectrum relocation. For example, in 1996, when the Commission cleared spectrum for PCS operations, incumbent microwave licensees were entitled to compensation for any operational cost increases that resulted from their frequency relocation, as well as "any increased recurring costs associated

with replacement facilities."[33] Similarly, in 1992, the Commission required emerging technology service providers that displaced incumbent licensees to pay the costs incurred by incumbents "as a result of operation in a different fixed microwave band or migration to other media."[34]

e. **Regulatory Costs**

An involuntary relocation of Channel 37 WMTS operations would also expose wireless medical telemetry equipment manufacturers to onerous regulatory burdens associated with bringing new WMTS systems to market. Such costs would not only encompass the regulatory and administrative fees imposed by the FCC, but also those imposed by the Food and Drug Administration ("FDA"). Because WMTS systems constitute medical devices, manufacturers of these systems (including GEHC) are subject to a rigorous FDA product review regime that can include establishment registration,[35] medical device listing,[36] premarket notification,[37] premarket approval,[38] quality system regulation,[39] labeling,[40] and medical device reporting.[41] Accordingly, adopting rules that require the re-design and manufacture of WMTS systems to accommodate another frequency band would give rise to considerable regulatory costs industry-wide.

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[33] Amendment to the Commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation, *First Report and Order and Further Notice of Proposed Rule Making*, 11 FCC Rcd 8825, 8842-43 ¶¶ 31-32 (1996) ("*Microwave Relocation Order*").

[34] Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, *First Report and Order and Third Notice of Proposed Rule Making*, 7 FCC Rcd 6886, 6890 ¶ 24 (1992) ("*Encouraging Innovation Order*").

[35] *See* 21 C.F.R. Part 807.

[36] *Id.*

[37] *Id.* Part 807, Subpart E

[38] *Id.* Part 814.

[39] *Id.* Part 820.

[40] *Id.* Part 801.

[41] *Id.* Part 803.

f. Transactional and Third Party Fees to Facilitate the Migration

Finally, a forced relocation of WMTS operations on Channel 37 would give rise to substantial transactional and third party costs to facilitate a seamless frequency migration, so as to minimize the disruption to patients, healthcare operations, and equipment manufacturers. For example, GEHC anticipates that it would need to engage a variety of technical and legal consultants to assist in any involuntary spectrum migration. Such costs would arise industry-wide.

The Commission has previously deemed transactional and third party fees to be within the scope of costs to which relocated licensees are entitled. In 1996, the Commission directed that displaced microwave licensees be reimbursed for outside assistance, such as fees for attorneys and consultants, because not all incumbents have the necessary internal expertise to effect an involuntary migration.[42] Likewise, relocated microwave operators have been entitled to "transaction expenses that [were] directly attributable to any involuntary relocation, subject to a cap of two percent" of the direct, tangible costs involved with the migration.[43] If the Commission chooses to apply a similar two percent cap in this case, the amount of transaction fees could still rise to approximately $40 million, more than thirteen percent of the entire amount allocated for Channel 37 relocation in the Spectrum Act.

2. Replacing the Existing WMTS Systems Would Result in Substantial Intangible Costs That Are Contrary to the Public Interest.

Even if the tangible and financial costs described above could be reimbursed through auction proceeds, an involuntary WMTS relocation would be highly disruptive to hospital operations and jeopardize the safety of patients across the country. Although such costs may be

[42] *Id.* ¶ 42.
[43] *Id.*

more difficult to quantify than the direct costs described above, they are likely to be far more significant, in both the short- and long-term. In light of the complexities involved with distributing, installing, testing, and operating new WMTS systems, replacing the thousands of existing units cannot be done without creating a significant risk of disruption to hospital operations. The logistical complexities and challenges that generally arise when hospitals upgrade their facilities are sufficiently onerous; a shift in the regulatory landscape that requires an industry-wide WMTS overhaul, at the same time, could prove insurmountable and frustrate the ability of healthcare facilities to adequately monitor hundreds of thousands of patients.

Large, capital equipment infrastructure projects require on-site project managers and cross-functional team coordination prior to and during the system's installation and commissioning. Hospital IT, Biomedical Engineers, Nurse Managers, Facilities Managers and Nurse Trainers typically rely on a Project Manager to plan and coordinate the installation with the equipment manufacturer and other contractors involved to minimize disruption and preserve hospital workflow. A carefully planned WMTS system replacement would require a clinical plan to either move patients out of the affected areas during construction, or the installation and use of dust containment systems to minimize additional health risks to patients. During the actual transition, healthcare facilities may need to use additional caregivers to ensure continuity of patient monitoring during equipment decommissioning and commissioning. In parallel to these installation activities, each hospital will need to engage in a review of whether and how the new WMTS equipment affects its clinical workflow and treatment protocols, as well as train its nursing staff on the new medical telemetry equipment and procedures.

Minimizing customer disruption is a key consideration in this proceeding.[44] Likewise, one of the core principles of the Commission's *Emerging Technologies* relocation policies—through which the Commission requires new entrants to fully compensate incumbents upon a service displacement—is to "minimize disruption to incumbent operations used to provide service to customers during the transition."[45] In light of the critical nature that WMTS systems play in patient monitoring and public safety, that principle should assume an even greater role in this proceeding.

B. If the Commission Does Relocate WMTS Systems in Channel 37, It Should Reimburse All Registered WMTS Systems as of the Relocation Date, Regardless of When the System Was Registered.

If the Commission nevertheless chooses to relocate WMTS systems operating on Channel 37, despite the substantial costs and public interest harms that would result, it should ensure that the migration costs are covered for all WMTS devices, regardless of whether or when they were registered in the ASHE database. The Commission has sought comment on whether "it should only consider relocating WMTS systems that were contained in the ASHE database by a date certain (*e.g.*, the effective date of [the] NPRM)" in order to "avoid unlimited increases in possible relocation costs."[46] But any artificial or arbitrary registration deadline by which WMTS users could qualify for relocation payments would be contrary to the public interest, for a number of reasons. First, a rule that precludes some WMTS operators from receiving funds to cover

[44] *See NPRM* ¶¶ 307, 321 (noting the need to carry out the incentive auction in a manner that minimizes disruption to broadcast stations and their viewers); *id.* ¶ 330 (noting that "some consumer education may be appropriate to ensure an orderly transition and minimize disruptions in service"). As Commissioner Rosenworcel noted, "[f]airness demands that [the Commission] consider how to accomplish repacking by minimizing unnecessary disruption." *Id.* (Statement of Commissioner Jessica Rosenworcel).

[45] Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems, *Ninth Report and Order and Order*, 21 FCC Rcd 4473, 4479-80 ¶ 11 (2006) (describing the Commission's *Emerging Technologies* policies) ("*3G Wireless Systems Order*").

[46] *NPRM* ¶ 211.

their involuntary migration costs would run counter to the legislative mandate that the Commission provide relocation costs to "all" Channel 37 incumbent users, without qualification, and without regard to whether the Channel 37 system is registered or not. Notably, the Spectrum Act did not restrict the $300 million designation to compensating only *registered* operations on Channel 37.[47] Second, placing an artificial limit on the type of WMTS users entitled to relocation expenses would be inconsistent with longstanding Commission precedent and policies, such as the *Emerging Technologies Doctrine*, designed to ensure that all licensees required to move to alternative spectrum are compensated for their involuntary relocation expenses.[48] Third, arbitrarily excluding some WMTS users from receiving relocation expenses would ignore the reality that thousands of WMTS systems are currently deployed and operational at healthcare facilities across the country. Although ASHE has encouraged all WMTS users to register their systems as soon as possible, there is no compelling or reasonable basis for the Commission to knowingly withhold relocation funds from those who have not registered by a specific date, particularly in light of the legitimate, critical health-related function that wireless medical telemetry systems play. Finally, such a rule would materially disrupt and stifle the marketplace for WMTS equipment by punishing those healthcare facilities (and their patients) that are currently in the process of installing, or are planning to install, a WMTS system capable of operating in Channel 37. The Commission should avoid such inequity.

[47] *See Spectrum Act* § 6403(b)(4)(A)(iii).

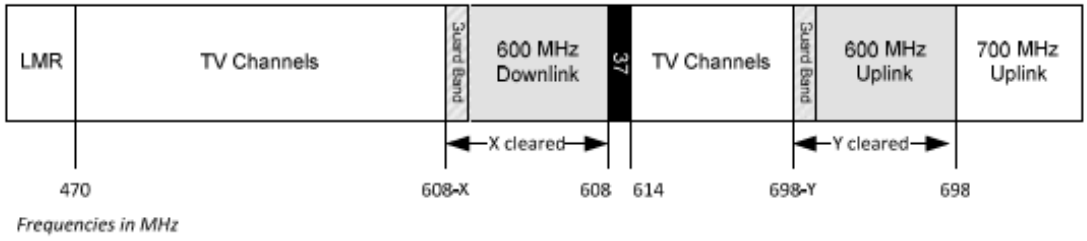
[48] *See Microwave Relocation Order*; *Encouraging Innovation Order*; *3G Wireless Systems Order*; Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use, *Third Order on Reconsideration*, 19 FCC Rcd 10777, 10787 ¶ 22 (2004).

IV. TO FULLY PROTECT EXISTING WMTS OPERATIONS, THE COMMISSION SHOULD ADOPT COORDINATON REQUIREMENTS, ABSOLUTE FIELD STRENGTH LIMITS, AND EMMISION LIMITS FOR THE 600 MHZ BAND MORE STRINGENT THAN THOSE PROPOSED IN THE NPRM.

A. The Proposed Band Plan and Emissions/Power Limits for the Reallocated 600 MHz Band Will Not Adequately Protect Incumbent WMTS Operations on Channel 37.

Under the FCC's proposed band plan, Channel 37 would serve as a guard band between 600 MHz downlink transmissions and repacked DTV operations on Channel 38, as set forth in the diagram below.[49]

Proposed 600 MHz Band Plan



Although the Commission has acknowledged that channels used for DTV transmission cannot be located directly next to 600 MHz spectrum allocated for mobile devices (used for uplink transmissions) due to the potential for interference through both spurious OOBE and overload desensitization mechanisms,[50] it has inexplicably failed to recognize, by proposing to provide no guard band between new mobile broadband operations and WMTS operations on Channel 37, the material risk of interference that wireless base stations and mobile devices would pose for the more sensitive WMTS devices operating in Channel 37.[51] Rather, the Commission has suggested that, because DTV broadcast stations currently operate next to Channel 37 without any guard band, and "because the proposed in-band and out-of-band emissions of the 600 MHz

[49] *NPRM* ¶¶ 126, 153, 155.
[50] *Id.* ¶ 156.
[51] *Id.* ¶ 155.

downlink band are significantly lower than those of the television stations," the proposed 600 MHz OOBE and fundamental emissions limits "should provide as much or more protection to Channel 37 than they currently receive from DTV operations."[52] This rationale is fundamentally flawed because it rests on two incorrect assumptions: that (i) "the OOBE and power limitations required of DTV stations are sufficient to protect Channel 37 services,"[53] and (ii) the nature and scope of wireless communications in the 600 MHz band around Channel 37 will remain relatively unchanged after the incentive auction is complete.

With respect to this first assumption, as described further below, in markets where DTV stations transmit on an adjacent channel, healthcare facilities have not been fully protected by the FCC's rules, and have been forced to take costly measures to protect their WMTS operations from undesirable broadcast signals.[54] As for the second assumption, because new mobile base stations and consumer devices will be far more ubiquitous and located closer to WMTS receivers than TV transmitters, the actual, in-hospital field strength observed by WMTS systems will be substantially higher than the field strength typically observed from DTV stations. The few locations at which a DTV broadcast facility is located in close proximity to a WMTS system are generally discrete and known, as are the precautions that healthcare facilities may take to secure

[52] *Id.* ¶¶ 155, 191. Also, as explained in the Technical Appendix, in some cases the limit for radiated DTV OOBE is actually more stringent than the proposed OOBE limit for 600 MHz Part 27 devices, due to the fact that the required DTV OOBE attenuation increases as a function of frequency offset and the required OOBE attenuation is fixed regardless of DTV fundamental ERP. Technical Appendix at 5.

[53] *NPRM* ¶ 191.

[54] Technical Appendix at 1 (indicating that the SAW filters typically used in WMTS systems have relatively limited rejection of transmissions from Channels 36 and 38, but that WMTS systems may be further "hardened" to employ alternative filtering in the DAS design, together with the use of passive antennas and discrete low noise amplifiers, but at a significantly higher cost and consumption of bandwidth in Channel 37). Moreover, although the proposed minimum OOBE attenuation for Part 27 wireless broadband devices of -43 + 10*log10(P) is lower than the existing DTV limit, in many cases, the limit for radiated DTV OOBE is actually more stringent because the required DTV OOBE attenuation increases as a function of frequency offset (to as much as -110 dBc for $\Delta f \geq 6$ MHz). Additionally, because the required DTV OOBE attenuation is fixed—regardless of DTV fundamental ERP—the radiated OOBE limit for lower-powered DTV transmitters is proportionately lower than for full powered DTV. *See* Technical Appendix at 5.

additional protection from broadcast emissions. However, the abundance and complexity of interference issues affecting WMTS equipment would multiply many times over in an environment of widespread mobile broadband operations, in which an untold number of closely located base stations and portable consumer devices could overwhelm healthcare facilities with interfering wireless signals. This risk of interference would be further magnified if substantially more DTV stations were repacked into Channel 38.

The Commission can and should avoid these interference threats by (i) adopting appropriate coordination requirements for base stations used for mobile broadband operations and (ii) an emissions mask for mobile devices that provides at least the same degree of protection that WMTS systems are afforded under the emissions mask applicable to unlicensed devices in Channels 36-38, reflected in Section 15.709(c)(4) of the Commission's rules,[55] which was promulgated after an analysis of the potential for interference from TV White Space devices only a few years ago. In the absence of such coordination requirements and more stringent OOBE and power limits than those proposed in the NPRM, Channel 37 WMTS receivers will face debilitating interference, in contravention of the public interest and the Commission's longstanding policy of promoting and protecting safety-enhancing wireless technologies.

B. The Commission Should Require Coordination and Absolute Field Strength Limits for Base Stations Authorized to Transmit in the Reallocated 600 MHz Band.

1. Base Station Operations

Today, only seventy-four full-power DTV stations transmit on channels adjacent to Channel 37 (*i.e.*, on Channel 36 or 38).[56] While this number may appear to be manageable, these

[55] 47 C.F.R. § 15.709(c)(4).

[56] Federal Communications Commission, *List of All Full-Power Stations (Nationwide)*, http://www.dtv.gov/stationlist.htm (last visited Jan. 4, 2013 4:45 P.M.).

stations have created substantial interference problems for nearby WMTS devices. Because "DTV stations operate adjacent to Channel 37 without any guard bands,"[57] and because WMTS systems use highly sensitive narrowband receivers with very low-power transmitters (*i.e.*, less than 0 dBm EIRP, which permits continual transmission for several days powered by two AA batteries), some healthcare facilities have been forced to incorporate aggressive filtering mechanisms and/or implement a de facto guard band within Channel 37 to protect WMTS operations from adjacent channel broadcast signals.[58] Such measures are not only expensive, they increase system complexity and reduce network capacity. Fortunately, because DTV signals are not overwhelmingly prevalent on Channels 36 or 38, and commencing new DTV broadcasting operations is a lengthy, difficult, and relatively infrequent process, these protective measures have not yet imposed insurmountable barriers to WMTS use of Channel 37.

However, the proliferation of wireless base stations in the 600 MHz band—including those that would be used to provide a mobile broadband service—will present an even greater threat to WMTS operations in Channel 37. A commercially viable mobile network typically requires the construction of multiple base stations in a given market to provide adequate signal coverage. Consequently, the reallocation of 600 MHz spectrum will spawn far more base stations and antenna structures than the number of DTV broadcast transmitters currently in operation. This in turn will lead to more base stations in closer proximity to WMTS systems on Channel 37, and create actual in-hospital field strength of fundamental and spurious emissions materially higher in many locations than the unwanted emissions received today from DTV

[57] *NPRM* ¶ 191 (*citing* 47 C.F.R. § 27.53(i)).
[58] *See* Technical Appendix at 1.

stations.[59] The number of base stations, and the attendant risk of interference to WMTS users, will likely escalate in time, as wireless carriers strive to improve their network coverage through the deployment of additional base stations. As set forth in the Technical Appendix, rural base stations located closer than approximately 1.4 kilometers from a WMTS system, and non-rural base stations located closer than approximately 1 kilometer from a WMTS system, could cause significant blocking interference to non-hardened WMTS systems.[60] Likewise, a Part 27 base station located closer than 0.55 km to a WMTS facility could cause significant desensitization caused by OOBE co-channel interference.

The elevated risk of interference will reduce actual WMTS capacity in virtually every area in which mobile base stations are deployed in Channel 36. Under the best of circumstances, healthcare facilities will have to incur the substantial expense of procuring additional systems to function within the same hospital campus to maintain the same capacity, or forego the expense and reduce their reliance on wireless medical telemetry systems, halting any WMTS expansion plans they may have. At worst, interference received by a single WMTS antenna could cripple an entire WMTS system. As noted above, many wireless medical telemetry systems employ a DAS infrastructure that consists of hundreds of antennas placed throughout a facility to aggregate received signals across the entire coverage area, typically covering hundreds of thousands of square feet. In these systems, a single source of interference could result in the loss of monitoring to all patients, regardless of their location within the coverage area. These effects would clearly undermine the public interest, particularly at a time when hospitals and other medical care providers are facing unprecedented capital budgetary constraints.

[59] Even if the Commission restricted WCS operations to a similarly sparse level as current DTV operations in channels 36 and 38, the Commission would have to do so according to the same contours on which DTV stations currently broadcast. If those contours change, the FCC could not rely on WMTS systems' built-in protections.
[60] *See* Technical Appendix at 4.

2. Adoption of a Coordination Requirement and Absolute Field Strength

The Commission can reduce the risk of base station interference to WMTS operations on Channel 37 by requiring wireless carriers to coordinate the construction and operation of base stations within certain distances from registered WMTS systems, and obtain the written concurrence of the affected healthcare facility. Additionally, to reduce the potential for blocking interference from base stations near Channel 37, the Commission should limit the maximum allowable field strength of Part 27 base station fundamental emissions in Channels 36 and 38 to 20 mV/m/MHz (i.e., 86 dBμV/m/MHz), as measured at the perimeter of a registered WMTS facility.[61] Likewise, to mitigate the risk of co-channel interference caused by Part 27 base station OOBE, the Commission should require a limit of 10μV/m/100kHz (i.e., 20 dBμV/m/100 kHz) for Part 27 OOBE within Channel 37.[62] Such a coordination regime with applicable maximum field strengths is certainly feasible, would affect few base station deployments, and the Commission has already adopted such provisions with regard to Channel 37 and Part 27 operations.[63] Moreover, because medical telemetry systems are "used to protect safety of life," the Commission has required DTV stations to notify nearby healthcare facilities prior to making any DTV license modification.[64] Absent the creation of guard bands on either side of Channel 37 and more stringent absolute transmitted OOBE limits for base stations similar to those described below for mobiles, these proposed measures will be critical to preserving the viability

[61] *See id.* at 5.

[62] *Id.*

[63] *See* 47 C.F.R. §§ 95.1119, 27.55(a), 27.60, 27.73.

[64] *WMTS R&O* ¶ 57; *see also* Joint Statement of the Federal Communications Commission and the Food and Drug Administration Regarding Avoidance of Interference Between Digital Television and Medical Telemetry Devices (March 25, 1998), *available at* http://transition.fcc.gov/Bureaus/Engineering_Technology/News_Releases/1998/nret8003.html ("[T]he FCC will ensure that TV broadcasters communicate with area hospital and other health care facilities to avoid interference to medical telemetry devices"). The requirement to notify nearby hospitals is often contained as a condition on the DTV licensee's authorization.

of WMTS systems transmitting on Channel 37 throughout the country, and mitigating the potential interference caused by base stations operating in adjacent channels.

C. The Commission Should Adopt Stringent Emissions Limits for Mobile Devices Authorized to Operate in the Reallocated 600 MHz Band.

1. Mobile Device Operations

While the risk of interference from base stations is substantial, the potential for mobile uplink transmissions near Channel 37 to disrupt WMTS operations is even greater. Under the Commission's lead 600 MHz band plan proposal, channels for the uplink band would be allocated downward starting at Channel 51, but could occur as low in frequency as Channel 38.[65] Thus, if enough spectrum is cleared in the reverse auction (or if the Commission adopts another band plan that would place mobile uplink transmissions near the upper edge of Channel 37), millions of handheld devices could begin transmitting in spectrum near or adjacent to Channel 37.

Although mobile devices would operate at a lower power than base stations, their nature and scope make them a heightened concern for the WMTS community. Portable devices, when carried into hospitals by patients, visitors, and staff, would send and receive signals within only a few feet of WMTS receive antennas, which are typically mounted on ceilings and have not been hardened to withstand such transmissions. Consequently, the actual in-hospital field strength observed by WMTS receivers would, in many cases, be substantially higher than the field strength observed in the current DTV broadcast environment. Engineering analysis indicates that the received fundamental emission from a Part 27 portable device transmitting at only 1 meter separation (*e.g.*, directly under a ceiling-mounted WMTS system antenna) would exceed

[65] *NPRM* ¶¶ 126, 191. Although the Commission recognizes that it "is unlikely" for the uplink band to be located directly adjacent to channel 37 "because it would not provide the necessary bandwidth for the duplex gap," its lead band plan proposal nevertheless raises the possibility that mobile devices would be operating near Channel 37 after the 600 MHz band reallocation. *Id.* ¶ 191 n.275.

the estimated adjacent channel blocking threshold for WMTS systems by over 44 dB.[66] Furthermore, because this 44 dB of inadequate isolation exceeds the ultimate rejection of the bandpass filters typically employed in WMTS systems, it is possible that signals of this level could cause blocking, even from several channels above or below Channel 37.[67] Consequently, even at a lower power level than base stations, portable handsets operating near Channel 37 would cause significant WMTS receiver desensitization.

In addition, the Commission's proposal to allow devices located inside a healthcare facility to radiate OOBE levels of -13 dBm/100 kHz into Channel 37 would cripple WMTS operations in those frequencies.[68] Specifically, GEHC's technical analysis demonstrates that the received OOBE from a Part 27 portable device transmitting at only 1 meter separation would exceed the WMTS noise floor by over 58 dB—a level that would undoubtedly result in severe interference to WMTS operations.[69] Due to size and cost constraints, mobile devices would likely incorporate the least sophisticated—and least effective—emissions filtering capabilities. Consequently, in the absence of a more stringent emissions mask, the probability is high that these devices would frequently emit strong spurious components into Channel 37 even when the fundamental frequency of their transmissions is several channels away.

2. Application of the Emissions Mask in Section 15.709(c)(4)

To stem this risk of interference to Channel 37 WMTS systems caused by portable devices transmitting near Channel 37, the Commission should adopt technical rules that are at least as stringent as the emissions mask applicable to unlicensed devices operating between 602-

[66] *See* Technical Appendix at 4-5.
[67] *Id.*
[68] *NPRM* ¶ 188.
[69] Technical Appendix at 5-6.

620 MHz.[70] That mask—first proposed by GEHC on May 6, 2008,[71] endorsed by a number of companies advocating the use of unlicensed devices (including Dell, Inc., Google, Inc., Hewlett-Packard Co., Microsoft Corp., Palm, Inc., Philips Electronics North America Corp., and TDK Corp.) in the television bands,[72] and now codified in Section 15.709(c)(4) of the Commission's rules[73]—was critical to ensuring that fundamental and spurious emissions from unlicensed devices in Channels 36 and 38 do not cause harmful interference to sensitive medical telemetry receivers operating in Channel 37. The Commission has already concluded that those limits are necessary to protect WMTS operations from harmful adjacent-channel interference generated by unlicensed devices.[74] As such, the Commission should use the existing 15.709(c)(4) mask as the baseline for determining what OOBE and power limits should apply to Channels 36-38 in the reallocated 600 MHz band following the incentive auctions.[75]

Whatever approach the Commission adopts to curtail the risk of harmful interference to wireless medical telemetry systems on Channel 37, it should avoid measures that saddle healthcare providers with the burden of resolving the additional interference issues that arise following reallocation of the 600 MHz band. It is not practically or economically feasible to require WMTS customers to retrofit the filtering capabilities of their Channel 37 wireless telemetry systems to protect against mobile downlink and uplink transmissions in Channels 36

[70] 47 C.F.R. § 15.709(c)(4).

[71] *See* Ex Parte Letter from Neal Seidl, Wireless System Architect, Monitoring Solutions, GE Healthcare, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket Nos. 04-186, 02-380 (May 6, 2008).

[72] *See* Ex Parte Letter from R. Paul Margie, Harris, Wiltshire & Grannis LLP, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 04-186 (May 8, 2008); *See* Letter from R. Paul Margie, Harris, Wiltshire & Grannis LLP, to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 04-186 (May 7, 2008).

[73] 47 C.F.R. § 15.709(c)(4).

[74] *See* Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, *Second Report and Order and Memorandum Opinion and Order*, 23 FCC Rcd 16807, 16889 ¶ 236 (rel. Nov. 14, 2008) ("*Second White Spaces Order*").

[75] As noted below, GEHC also urges the Commission to adopt the spectrum mask as applicable to any uplink fundamental emissions from handheld devices that may occur on Channel 38.

and 38. Even if modifying WMTS systems to filter these signals was possible, doing so would require the outlay of considerable time and money, risk serious disruption to WMTS operations, and in many cases materially reduce WMTS system capacity. In short, the Commission's adoption of its proposed emissions limits in and around Channel 37 would be tantamount to a forced relocation of WMTS operations out of Channel 37, and give rise to the same industry-wide costs described above.[76]

D. The Commission Should Not Repack DTV Channels into Channels 36 or 38.

The Commission should also refrain from repacking additional DTV stations into Channel 38 or 36 or significantly changing the existing DTV contours because doing so would likely result in additional interference to WMTS operations. As noted above, due to the lack of a guard band around Channel 37 and the sensitive narrowband receivers of wireless medical telemetry equipment, DTV stations have created interference challenges for a number of nearby WMTS facilities.[77] To mitigate this interference, healthcare facilities have been forced to incorporate stronger filtering mechanisms and/or implement a de facto guard band within Channel 37, thereby reducing the bandwidth available for WMTS operations. While the cost of taking these measures has been significant, it has not been insurmountable because the DTV presence in Channels 36 and 38 is relatively discrete and manageable, and because commencing a new digital broadcasting operation is a relatively rare event.

However, if the number of DTV stations adjacent to Channel 37 increases, or if the broadcast contours of those DTV stations are altered to accommodate mobile operations in the 600 MHz band, healthcare facilities will lose even more bandwidth and be forced to spend tens

[76] *See supra* Section III.A.

[77] *See* Technical Appendix at 34 & Tables 1-2.

of millions of dollars to attenuate the unwanted broadcast signals. Accordingly, even if incumbent DTV broadcasters do not relinquish enough spectrum to accommodate mobile uplink transmissions immediately above Channel 37 in a particular market, the Commission's lead band plan could nevertheless create an intolerable DTV broadcast environment that would significantly reduce WMTS system capacity and impose onerous costs on healthcare providers.

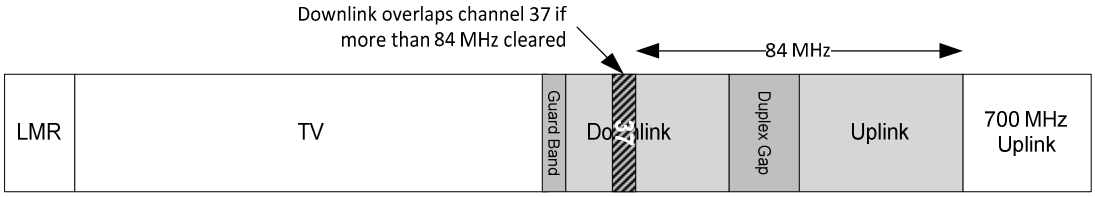
The Commission can avoid this scenario by preserving an adequate number of channels in which to relocate DTV stations remaining after the incentive auction, such that Channels 36 or 38 are not essential to carry out the Commission's repacking plan. As described further below, the Commission can adopt a variety of alternative band plans to achieve this result. In particular, a plan that would place base stations on either side of Channel 37, which could result if the Commission adopts the "Down from Channel 51" plan and clears more than 84 MHz of spectrum, would be most effective in protecting WMTS operations from an elevated risk of interference created by a denser DTV broadcaster environment in Channels 36 and/or 38.

E. The Commission Can Avoid Additional Interference to WMTS Operation in Channel 37 by Adopting an Alternative Band Plan.

To avoid creating an intolerable risk of harmful interference to WMTS operations in Channel 37, the Commission should adopt an alternative band plan that increases the likelihood that base stations will be located on either side of Channel 37, and maintain the existing DTV contours. Because the risk of interference from base stations would be more manageable for WMTS users than the risk of interference from both portable devices authorized in the 600 MHz band and additional DTV channels repacked into Channels 36 and 38 (assuming the Commission adopts adequate coordination requirements for permitted base stations, as proposed above), such a plan would be preferable in the eyes of the WMTS community, and would best serve the public interest.

The Commission has already proposed one such alternate band plan: "Down from Channel 51."[78] Under that plan, the Commission would clear DTV broadcast channels at Channel 51 and expand downward, as reflected in the figure below.[79] The cleared spectrum would be organized into an uplink band (adjacent to the 700 MHz uplink band) and expand downward to include a duplex gap, a downlink band, and a guard band to protect remaining DTV operations that remain next to the downlink band. This plan would be most desirable in markets where more than 84 MHz of spectrum is cleared, as reflected in the figure below, because it would place downlink operations on either side of Channel 37.

Alternate Band Plan: "Down From Channel 51" (> 84 MHz Cleared)



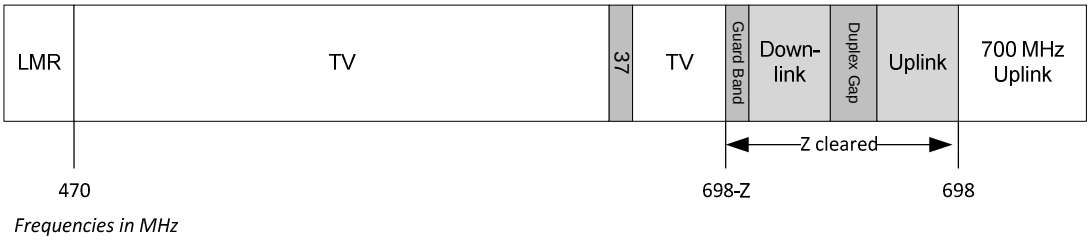
Although this scenario would still necessitate coordination to protect incumbent WMTS operations in Channel 37 from nearby base stations (which would transmit in both Channels 36 and 38), it would at least reduce the greater (and more untenable) risk of millions of mobile handsets transmitting near Channel 37 interfering with WMTS receivers installed throughout hospitals and other healthcare facilities, as well as the risk of more DTV stations being repacked in Channels 36 and/or 38.

But even if less than 84 MHz (the amount of television bandwidth currently above Channel 37) is cleared, this plan would still mitigate the potential interference concerns that

[78] *See NPRM* ¶¶ 178, 181.
[79] *Id.* ¶ 178.

would arise from base station and device operations surrounding Channel 37.[80]

Alternate Band Plan: "Down From Channel 51" (< 84 MHz Cleared)



V. THE COMMISSION SHOULD NOT ALLOW UNLICENSED OPERATIONS ON CHANNEL 37.

Just over six years ago, in late 2006, the Commission adopted rules to prohibit unlicensed devices from operating in Channel 37 to "prevent interference to radio astronomy operations and the WMTS."[81] Shortly thereafter, to further protect WMTS devices in Channel 37, the Commission imposed the emissions mask for unlicensed devices operating in Channels 36-38 described above.[82] Despite these safeguards, the general consensus that unlicensed devices should not be permitted in Channel 37 because that channel is "not . . . used for TV band services and will therefore have different interference considerations,"[83] and the well-founded decision to protect WMTS operations on Channel 37 to allow the operation of "life-critical medical telemetry equipment . . . on an interference-protected basis," the Commission now hypothesizes that "there may be an opportunity for unlicensed devices to operate in channel 37," regardless of whether the WMTS and RAS users in those frequencies are relocated to alternative spectrum.[84]

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[80] Note that this solution would not wholly avoid the risk of interference to WMTS systems because, as noted above, portable mobile devices would still have the potential for creating interference from several channels away.

[81] *See* Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, *First Report and Order and Further Notice of Proposed Rule Making*, 21 FCC Rcd 12266, 12267 ¶ 2 (2006) ("*First White Spaces Order*"); 47 C.F.R. § 15.707(a) (permitting TV band devices to operate on Channels 21-36 and 38-51).

[82] *See Second White Spaces Order* ¶ 236.

[83] *First White Spaces Order* ¶ 20 (citing comments from the Telecommunications Industry Association, National Academy of Sciences, and National Radio Astronomy Observatory).

[84] *NPRM* ¶ 237.

Unraveling the Commission's current regulatory framework to permit unlicensed devices in Channel 37 would have a disastrous effect on WMTS operations. As reflected in the attached Technical Appendix, an unlicensed device transmitting at the fixed/access TV band device ("TVBD") EIRP limit[85] of 18.6 dBm/100 kHz would cause significant desensitization to WMTS facilities located with 21 kilometers, while an unlicensed device transmitting at the personal/portable TVBD EIRP limit[86] of 2.6 dBm/100 kHz would cause significant desensitization to WMTS facilities within 3.3 kilometers.[87] The aggregation of multiple sources of unlicensed devices would further magnify the interference risk.[88] Accordingly, large exclusion distances would be necessary to prevent the fundamental emissions of unlicensed devices in Channel 37 from causing harmful interference to WMTS operations. GEHC therefore urges the Commission to abandon its proposal to make Channel 37 available for unlicensed use.

The Commission's current proposal rests on the unsupported notion that WMTS equipment may be supported "by establishing appropriate protection areas in the white space database."[89] However, employing a geolocation database or sensing technology will be infeasible to protect WMTS devices from co-channel interference caused by unlicensed operations. As a threshold matter, a geolocation-based strategy would require that all WMTS and unlicensed device locations be known, registered, and/or capable of being identified. While accounting for the large and static DTV broadcast contours is relatively straightforward, tracking the large number of WMTS systems operating on Channel 37 across the country will prove more

[85] *See* 47 C.F.R. § 15.709(a)(5)(i).
[86] *Id.* § 15.709(a)(5)(ii).
[87] *See* Technical Appendix at 6.
[88] *Id.*
[89] *NPRM* ¶ 237.

daunting. The number of WMTS locations will number in the many thousands, and regularly change.

Adopting a solution that heavily relies upon an accurate and complete registration database would also impose heavy burdens on hospitals, healthcare facilities, and other medical providers, imposing the very administrative costs that the Commission successfully avoided by creating a spectral mask to protect Channel 37 operations from unlicensed devices (and choosing not to adopt a protection regime based on geolocation or spectrum sensing). Moreover, the penalty for failing to register the WMTS system would have the draconian effect of creating potential interference with life-critical services—an inappropriate penalty that would threaten patient safety throughout the country and be anathema to the public interest.

Likewise, spectrum sensing technologies do not offer a viable or safe solution for co-channel sharing on Channel 37. Unlicensed devices, transmitting at power levels significantly greater than the relatively low-power levels of WMTS devices, would be capable of interfering with WMTS operations from a much greater distance than the unlicensed devices could detect through current spectrum sensing technologies. When the Commission established the emission limits in and around Channel 37 in 2006, it concluded that sensing technology was not sufficient to protect incumbent operations from unlicensed devices,[90] recognizing that portable devices (such as potential unlicensed devices) pose significant challenges to sensing signals because of the practical limitations on antenna size and positioning.[91] It further found that sensing technology was not effective enough to protect wireless microphones, which are

[90] *See Second White Spaces Order* ¶ 71 (finding that spectrum sensing is not sufficient to "to enable unlicensed devices to reliably determine the TV channels that are available for use at a location").

[91] *Id.* ¶ 74 ("[P]ersonal/portable devices have antennas that are less efficient for sensing and may be in a less advantageous position for sensing incumbent signals (*e.g.*, a short, non-directional antenna located in an interior room rather than a high gain antenna on a 10 meter mast), increasing the difficulty of reliably detecting incumbent transmissions.").

many times less sensitive than WMTS devices, from interference.[92] If the Commission has been unwilling to adopt cognitive sensing technology to protect wireless microphones, it should not even consider using that technology to protect WMTS devices that are critical to patient welfare.

The ubiquity of unlicensed devices would also render any geolocation and spectrum sensing approach inadequate to protect WMTS operations. With potentially millions of portable, unlicensed devices in circulation, even a very effective interference scheme using a geolocation or spectrum sensing framework—even one that was 99.99% effective—could still result in thousands of interference cases. As noted above, because many WMTS systems rely upon DAS technology, interference at a single WMTS antenna can disable an entire WMTS network. Furthermore, when such interference inevitably does occur, identifying the responsible unlicensed mobile user and redressing the interference may be extremely difficult, if not impossible.[93]

The shortcomings of a geolocation and spectrum sharing regime under these circumstances cannot be overlooked or understated, as the consequences of failing to fully protect life-critical WMTS devices from unwanted interference extend far beyond the mere loss of communications signals. Unlike television, for example, WMTS is a safety-of-life service that plays a fundamental and increasingly prominent role in the welfare of medical patients. The Commission has long recognized that it must "take steps to protect medical telemetry from interference because it is used to protect safety of life."[94] As noted above, WMTS systems are used on a daily basis to monitor patients in real time, tracking physiological parameters such as electrocardiogram, oxygen saturation, blood pressure, and respiration in order to detect

[92] *Id.* ¶ 198.

[93] *Id.* ¶ 116 (explaining that "because the locations where non-fixed devices are used change," identification of both the unused frequency "and the devices themselves, if they cause interference," is "substantially more difficult").

[94] *WMTS R&O* ¶ 57.

life-threatening events (*e.g.*, cardiac arrhythmias, apneas, etc.). A regulatory framework that fails to minimize the risk of interference to these system by permitting unlicensed device operation on Channel 37 would not only contradict Commission precedent and extinguish the carefully crafted spectrum mask that has already been adopted and agreed to among industry participants, it would degrade the quality of healthcare services and undermine the very reason why the Commission adopted WMTS as a protected service on Channel 37 in the first place—to allow "life-critical medical telemetry equipment to operate on an interference-protected basis."[95]

VI. THE COMMISSION SHOULD ACT PROMPTLY TO RESOLVE THE ISSUES IN THIS PROCEEDING THAT AFFECT CHANNEL 37 OPERATIONS.

This proceeding—characterized by the prospect of relocating WMTS operations from Channel 37, permitting unlicensed devices to operate on Channel 37, and imposing inadequate emissions limits to protect incumbent WMTS operations on Channel 37—has already had an adverse impact on the healthcare industry, device manufacturers, and patient welfare. Since the NPRM was released, confusion and uncertainty regarding the fate of WMTS systems has stifled investment in the wireless telemetry equipment. Although ASHE has met with some medical device makers, hospital users, and other WMTS stakeholders (and has encouraged all WMTS users to register their systems with ASHE), no party can reasonably predict the outcome of this proceeding, the revised 600 MHz band plan, or the fate of WMTS operations on Channel 37. With such looming uncertainty, WMTS equipment manufacturers (including GEHC) have scaled back their investment in new WMTS technologies, and healthcare facilities have been less willing to upgrade, expand, or acquire new WMTS systems. Such delayed investment undermines the public interest by stalling the development and expanded use of vital

[95] Amendment of Parts 2 and 95 of the Commission's Rules to Create a Wireless Medical Telemetry Service, *Report and Order*, 15 FCC Rcd 11206, ¶ 1 (2000).

technologies that promote patient mobility, facilitate recovery, and aid in the detection of adverse medical events.

Accordingly, the Commission should act quickly to favorably resolve the issues in this proceeding that may affect WMTS operations, and should do so even if other auction-related questions remain unresolved or warrant additional consideration by the Commission and/or industry stakeholders. In light of the critical, safety-of-life function that WMTS systems play, the Commission should prioritize the Channel 37-related issues, clarify that it will not relocate WMTS operations from Channel 37, reaffirm its existing prohibition against unlicensed devices operating co-channel with WMTS systems in Channel 37, and strengthen the emissions limits and coordination requirements to protect WMTS operations on Channel 37 by adopting the Section 15.709(c)(4) interference mask already adopted to protect WMTS systems from unlicensed devices. Doing so would restore the marketplace certainty that is necessary to spur investment and innovation in WMTS technologies, and mitigate the public interest harms that the Commission's Channel 37-related proposals have already caused. Moreover, there is no compelling reason to delay such action. The treatment of Channel 37 is a threshold question that the Commission must resolve before devising the reallocated 600 MHz band plan, and has little bearing on the mechanics of the reverse and forward auctions. Resolving the Channel 37 concerns as soon as possible would actually speed resolution of this proceeding, and provide other auction participants with additional certainty, which would in turn enable them to better develop their auction strategies, plan their network deployments, and secure necessary financing.

VII. CONCLUSION

This proceeding offers the Commission an opportunity to effect significant changes to the broadcast and wireless communications landscape. However, such changes should not come at the expense of the continued availability and viability of WMTS operations on Channel 37. The

Commission has long recognized the value of wireless medical telemetry technologies and the benefit they provide to healthcare facilities and patients throughout the country. Accordingly, the Commission should take prompt action to clarify that it will not require incumbent Channel 37 licensees to involuntarily relocate to another spectrum band. The cost of such relocation would far exceed the $300 million allocated for that purpose authorized by Congress in the Spectrum Act. Even if auction proceeds could sufficiently cover the applicable financial costs of relocation, forcing WMTS systems to alter their frequencies would be highly disruptive to hospital operations and jeopardize patient safety throughout the country.

While preserving the Channel 37 operating environment is essential to protect WMTS users, it is not alone sufficient. The Commission must also adopt rules that ensure WMTS systems will not be incapacitated by adjacent channel transmissions. By ignoring the material risk of interference that base stations, portable devices, and repacked DTV stations could cause to Channel 37 licensees, the Commission could upend the WMTS and stifle the development of additional medical telemetry equipment, yielding a regulatory framework tantamount to a *de facto* relocation.

Accordingly, the Commission should (i) require wireless carriers to coordinate their 600 MHz base stations within certain distances from registered WMTS systems and limit the maximum allowable base station field strength in Channels 36 and 38 to 20 mV/m/MHz, and the maximum allowable 600 MHz base station OOBE field strength in Channel 37 to 10 μV/m/100 kHz, as measured at the perimeter of a registered WMTS facility; (ii) require mobile devices transmitting in the 600 MHz band to comply with the emissions mask applicable to unlicensed devices operating between 602-620 MHz; (iii) adopt a band plan that minimizes the number of

DTV stations repacked into Channel 38 or 36; and (iv) prohibit unlicensed devices from operating on Channel 37.

GEHC looks forward to its continued participation in this proceeding, as well as the opportunity to assist the Commission in devising a 600 MHz band plan that can accommodate the safety-of-life capabilities made possible by WMTS.

Respectfully submitted,

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Technical Appendix

Telemetry System Description

Wireless Medical Telemetry Service ("WMTS") systems are used to continuously monitor multiple patients' physiological parameters while allowing them to move freely within a healthcare facility. The systems include both small patient-worn devices and an extensive fixed infrastructure.

Figure 1 depicts the most common 600 MHz WMTS system architecture. The telemetry system comprises patient-worn transmitters ("TX"), a distributed antenna system ("DAS") infrastructure, receivers ("RX"), an IT network, and central monitoring stations where real-time patient data (e.g., electrocardiogram waveforms) may be viewed and where alarms (e.g., detected cardiac arrhythmia) are annunciated.

Transmitters are frequency-division multiplexed with typical occupied bandwidth of 10 kHz. In order to permit several days of continuous data transmission using a small inexpensive battery (e.g., two AA alkaline cells), the transmitters employ relatively low transmit power (e.g., less than 0 dBm).

The DAS infrastructure for each WMTS installation is custom-configured based on each hospital's specific needs, building architecture and RF environment. It may typically include hundreds of receive antennas distributed throughout the healthcare facility in order to provide a seamless telemetry coverage area that spans several hundred thousand square feet. In addition to the antennas, the DAS infrastructure includes tens of thousands of feet of coaxial cable and thousands of discrete modules, including low noise amplifiers ("LNAs"), attenuators and filters used to combine signals received by the antennas and backhaul the composite signal to the receivers. For efficiency and to minimize the antenna density (and corresponding DAS cost and complexity) as much as possible notwithstanding the transmitters' low radiated power, the receive antennas are typically active devices incorporating integrated LNAs.

In order to protect the LNAs from overload by strong nearby broadcast television signals, the active antenna modules also contain integrated bandpass filtering to reject signals outside of channel 37. Figure 2 shows the frequency response characteristic of a surface acoustic wave ("SAW") filter that is typically employed. As can be seen, the SAW filter exhibits a flat response across 608-614 MHz in order to allow use of the entire channel 37 and exhibits reasonably high attenuation (ultimate rejection of approximately 40 dBc) of channels 35 and below and 39 and above, but relatively limited rejection of adjacent channels 36 and 38, where the filter's transition bands are located. This performance proves adequate for the large majority of WMTS installations where no excessively strong channel 36 or 38 broadcast television signals are present. In environments where SAW filter performance is not sufficient, WMTS systems may be "hardened" by employing alternate filtering (e.g., high-Q cavity filters) in the DAS design, along with passive antennas and discrete LNAs. However, because these alternate filters are substantially larger and more costly, and are designed with transition bands located *inside* of channel 37 (effectively sacrificing some WMTS bandwidth and system capacity), and because the broadcast television environment at a given WMTS location is highly static, such hardening is the

exception, rather than the rule, and only done for facilities – or even subsets of facilities (e.g., only for antennas located on the side of a hospital that faces a television transmitter) – that truly require them.

Telemetry System Interference Susceptibility

There are two primary mechanisms of interest by which harmful interference to channel 37 WMTS operations could occur: 1) co-channel interference from signals falling into channel 37 impacting the WMTS signal-to-interference-plus-noise ("SINR"); and 2) overload desensitization ("blocking") from strong out-of-band signals. Each of these mechanisms is discussed in detail below.

Regardless of the mechanism at issue, two important properties of the DAS are critical to note:

1. Pervasive signals, such as interference received from a distant transmitter, can experience significant aggregation gain when received at near uniform levels on multiple antennas, whereas the desired short range telemetry signals typically are received by only a single antenna and thus do not benefit from a similar effect.

2. Interference received above a tolerable level on even a single DAS antenna in the facility can negatively impact reception of telemetry signals across the entire facility.

Co-channel Interference Mechanism

In order to reliably demodulate the telemetry signals, WMTS receivers require a minimum of approximately 10 dB SINR. Because channel 37 is currently a restricted band under section 15.205 of the Commission's rules and is allocated only to the radio astronomy service and low-power WMTS operations, it is very "quiet," typically exhibiting no measurable ambient in-band interference. As such, the WMTS noise floor at the receiver is dominated by the DAS's intrinsic thermal noise. A typical value for this noise floor, referred to the receive antenna output, is -110 dBm / 10 kHz, enabling signals as low as -100 dBm at the antenna output to be received reliably. However, if any extrinsic co-channel interference is introduced it will add to the existing noise floor to reduce SINR – and thus desensitize the WMTS system, impacting its ability to operate reliably – as follows:

$$\Delta SINR = \frac{1}{1 + I/N}$$

where ΔSINR is the SINR reduction factor (i.e., desensitization) and I/N is the interference-to-noise ratio. Accordingly, for example, to limit WMTS desensitization to 1 dB, I/N must be less than about -6 dB.

Interference Due to Blocking by Strong Out-of-Band Signals

Blocking is a well-known phenomenon that occurs when a strong off-channel signal forces amplifiers or other active components in the receive chain into compression, generating intermodulation products that rise above the in-channel noise floor, reducing SINR and desensitizing the receiver. Precise characterization of WMTS system blocking susceptibility depends on the specific frequency and spectral

properties of the offending off-channel signal. In practice, to date, the only significant threat of blocking for WMTS telemetry systems has been from strong broadcast TV signals, primarily on channels 36 and 38, where the default SAW filters offer only modest protection.

DTV Blocking Interference Analysis

Non-hardened WMTS systems typically begin to experience significant desensitization in the presence of DTV signals of -30 dBm or stronger referred to the receive antenna output.

The fundamental emission limit for UHF broadcast digital television ("DTV"), depending on broadcast antenna height-above-average-terrain ("HAAT"), is between 316 and 1000 kW.[96] Based on these limits, it is straightforward to show that received signal levels from nearby channel 36 or 38 DTV transmitters can, under some likely scenarios, significantly exceed the blocking threshold of the default (SAW-filter-only) WMTS system configuration, requiring further hardening to ensure reliable WMTS operation.

This analysis, which is summarized in Table 1, assumes free space line-of-sight propagation between the DTV transmitter and the WMTS facility, 20 dB of nominal additional attenuation due to the WMTS facility's exterior structure and interference aggregation from ten dominant WMTS receive antennas (e.g., those located on the side of the facility facing the DTV transmitter). Under these assumptions, hardening is required for WMTS installations within 12.3 km of full power DTV transmitters.

Of course, real-world scenarios may vary significantly, but the analysis shown represents a reasonable worst-case. For example, the DTV transmit power may often be less than the maximum values used in this analysis. Also, many hospitals located close to a DTV transmitter may actually be located in a relative null below the main lobe of the DTV transmit antenna's vertical pattern.

DTV OOBE Co-channel Interference Analysis

Because channel 37 has heretofore been a restricted band, currently the only significant co-channel interference sources are spurious out-of-band emissions ("OOBE"), primarily from adjacent channel DTV.

The limits[97] for OOBE at frequency offset Δf from the DTV channel edge are as follows:

- For Δf ≤ 500 kHz, OOBE power spectral density must not exceed -47 dBc / 500 kHz (i.e. -64 dBc / 10 kHz – the bandwidth of interest for WMTS co-channel interference analysis), where dBc indicates the power relative to the average total power of the DTV fundamental signal.
- For 500 kHz ≤ Δf ≤6 MHz, OOBE power spectral density must not exceed -11.5Δf -41.4 dBc / 500 kHz (i.e. -11.5Δf -58.4dBc / 10 kHz)
- For Δf ≥ 6 MHz OOBE power spectral density must not exceed -110 dBc / 500 kHz (i.e. -127 dBc / 10 kHz).

[96] *See* 47 CFR 73.622(f)(8)
[97] *See* 47 CFR 73.622(h)

Based on these limits, a worst-case analysis (see Table 2) suggests that OOBEs from DTV transmissions in channel 36 or 38 can approach or exceed the typical -110 dBm / 10 kHz WMTS noise floor over approximately two-thirds of the WMTS band. In practice, however, adjacent channel DTV spurious emission levels actually measured at WMTS installations have been significantly lower than this worst-case analysis suggests, typically impacting at most only 1 or 2 MHz of the WMTS band. Several factors may explain this. As discussed above, the DTV transmit power may often be less than the 1000 kW limit and/or hospitals located in close proximity to a DTV transmitter may be located in a relative null below the main lobe of the DTV antenna's vertical pattern. In addition, the DTV OOBEs at the transmitter may actually be suppressed significantly further than required by FCC rules.[98]

Part 27 Wireless Broadband Blocking Analysis

While the detailed nature of potential Part 27 wireless broadband signals and their precise effect on WMTS systems are not known at this time, the DTV blocking threshold normalized to an assumed 1 MHz occupied bandwidth for Part 27 uplinks and downlinks is likely to be a reasonable and informative surrogate for consideration. As discussed above non-hardened WMTS systems typically begin to experience significant desensitization in the presence of DTV signals of -30 dBm (which equates to -37.8 dBm / MHz) or stronger referred to the antenna output.

The proposed fundamental emission limits for Part 27 wireless broadband devices are as follows:

- 2000 W / MHz ERP for base stations located in rural areas[99]
- 1000 W / MHz ERP for base stations located in non-rural areas[100]
- 3 W ERP for portable devices[101]

Table 3 summarizes a blocking analysis performed for these proposed Part 27 device fundamental emissions. The analysis for base station downlink signals uses identical assumptions as the DTV blocking analysis described above – i.e., free space line-of-sight propagation plus 20 dB of additional loss due to WMTS facility structure and interference aggregation from ten dominant WMTS receive antennas. Under these assumptions, rural base stations located closer than approximately 1.4 km and non-rural base stations located closer than approximately 1 km could cause significant blocking for non-hardened WMTS systems. This could be effectively addressed through coordination to an absolute field strength or power flux density limit for Part 27 downlink fundamental within channels 36 and 38 at WMTS facilities. A limit of 20 mV/m/MHz (i.e., 86 dBμV/m/MHz) would likely be sufficient while still impacting very few base station deployments (e.g., requiring modification of base station power, antenna pattern, or frequency, or provision of additional filtering to the affected WMTS facility).

[98] Prior measurements by GEHC of actual DTV OOBEs have shown suppression from 16 to over 30 dB better than the 47 CFR 73.622(h) requirement.
[99] NPRM ¶193
[100] Id.
[101] NPRM ¶194

By contrast to the base station analysis, the analysis for portable device uplink signals considers the expected common scenario of these devices being used *inside* of hospitals in very close proximity to WMTS receive antennas, with the only attenuation being through free space propagation loss. In particular, analysis for the case of a Part 27 portable device transmitting at only 1 meter separation (e.g., directly under a ceiling-mounted antenna) shows that the received fundamental emission would exceed the adjacent channel DTV blocking threshold by over 44 dB. Furthermore, since this 44 dB of inadequate isolation exceeds the ultimate rejection of the typical SAW filter (see Figure 1), it is possible that signals of this level could cause blocking, even from several channels above or below channel 37. In order to more precisely access the extent of this effect, testing with the actual wireless broadband signals is likely to be necessary.

Indeed, this situation was previously recognized and addressed by imposing a special 602-620 MHz emission mask for unlicensed TV band devices ("TVBDs") under Section 15.709(c)(4) of the Commission's rules. In that case, a spectral mask covering only channels 36 through 38 was deemed to be sufficient because the fundamental emission limit for portable TVBDs is only 100 mW, versus the 3 watt limit currently proposed for portable part 27 devices.

Part 27 Wireless Broadband OOBE Co-channel Interference Analysis

The proposed minimum OOBE attenuation for Part 27 wireless broadband devices is -43 + 10*log10(P), where P is the transmit power in watts, with compliance being verified using 100 kHz measurement bandwidth.[102] This is effectively a single absolute OOBE power spectral density limit of -13 dBm / 100 kHz for all transmitters (including base stations and portable devices) – *regardless of actual ERP or frequency offset*. Assuming the OOBE has uniform power spectral density within the 100 kHz measurement bandwidth, this limit equates to a -23 dBm in the 10 kHz bandwidth of interest for WMTS co-channel interference analysis.

It is important to note that, although the NPRM states categorically that this is a lower level than the existing DTV OOBE limit, in some cases the limit for radiated DTV OOBE is actually more stringent. This is because the required DTV OOBE attenuation increases as a function of frequency offset (to as much as -110 dBc / 500 kHz for $\Delta f \geq 6$ MHz) and also since the required OOBE *attenuation* is fixed regardless of DTV fundamental ERP. Accordingly, for example, the maximum allowable OOBE for a 100 kW DTV transmitter at $\Delta f \geq 3.9$ MHz is actually less than the limit for Part 27 base stations and portables.

Table 4 summarizes a co-channel interference analysis performed for base stations and portable devices using the proposed Part 27 device OOBE limit. This analysis uses the same coupling and aggregation assumptions as the blocking analysis described above. Under these assumptions, the analysis shows that a Part 27 base station located closer than 0.55 km to a WMTS facility could cause significant desensitization. As in the case of blocking interference from base stations, this could be effectively addressed through coordination to an absolute field strength or power flux density for Part 27 OOBE

[102] NPRM ¶¶ 187-188

within channel 37 at WMTS facilities. A limit of 10μV/m/100kHz (i.e., 20 dBμV/m/100 kHz) would likely be sufficient while still impacting (e.g., requiring use of additional OOBE filtering) very few base stations.

The analysis for Part 27 portable devices shows that, under the currently proposed OOBE limit, they pose a very serious threat of WMTS interference. In particular, analysis for the case of a Part 27 portable device transmitting at only 1 meter separation (e.g., directly under a ceiling-mounted antenna) shows that the received OOBE would exceed the WMTS noise floor by over 58 dB – a level that would undoubtedly result in devastating interference. Again, this situation was recognized and addressed for Part 15 TVBDs by imposing a field strength limit of 30 dBμV/m/120kHz at 1m for OOBEs emitted into channel 37. Imposing this same OOBE limit on Part 27 portable devices would likely mitigate the co-channel interference concern. This is illustrated as scenario #4 in Table 4.

Unlicensed TVBD Co-channel Interference Analysis

The NPRM proposes allowing unlicensed devices to share channel 37, but does not propose specific emission limits or other operating parameters. The co-channel interference analysis summarized in Table 5 considered the existing Part 15 TV-band device fundamental emission limits, as well as a substantially lower hypothetical limit.

Assuming free-space propagation plus 20 dB hospital structure loss and aggregation by ten WMTS antennas, the analysis shows that a single device transmitting at the fixed TVBD EIRP limit[103] of 18.6 dBm / 100 kHz (i.e. 8.6 dBm / 10 kHz) would cause significant desensitization to WMTS facilities within 21 km and a single device transmitting at the portable TVBD EIRP limit[104] of 2.6 dBm / 100 kHz (i.e. -7.4 dBm / 10 kHz) would cause significant desensitization to WMTS facilities within 3.3 km.

Due to the ubiquity and uncoordinated nature of unlicensed devices, it is also important to consider the effect of aggregation from multiple simultaneous transmissions. The analysis shows that when aggregation of interference from ten sources is considered, the exclusion radii for portable and fixed TVBD EIRP limits are 10.4 km and 2.25 km respectively, when optimistically assuming greater than free space propagation loss (path loss coefficient of n=2.4).

Finally, even when the substantially lower hypothetical limit of 10 mW / 100 kHz is considered, the required protection distance for a single device having free space propagation to the WMTS facility is 1 km.

Conclusion

This analysis demonstrates that the current DTV emission limits are not sufficient to adequately protect WMTS operations in channel 37 from mobile and unlicensed operations. To the contrary, under such conditions, WMTS installations would have to be deliberately modified – including hardening and/or

[103] *See* 47 CFR § 15.709(a)(5)(i).
[104] *See id.*§ 15.709(a)(5)(ii).

sacrificing part of channel 37 as a de-facto guard band – to work around channel 36 and 38 DTV emissions on an exception basis.

It is further shown that, as currently proposed, Part 27 wireless broadband operations can be expected to interfere with WMTS operations through both blocking and co-channel interference mechanisms, and that portable devices, which will frequently be used inside of WMTS facilities, pose a particularly serious threat.

Finally, it is shown that very large exclusion distances would be required in order to prevent proposed channel 37 unlicensed devices' fundamental emissions from causing harmful interference to WMTS operations.

Figure 1: Telemetry System Diagram

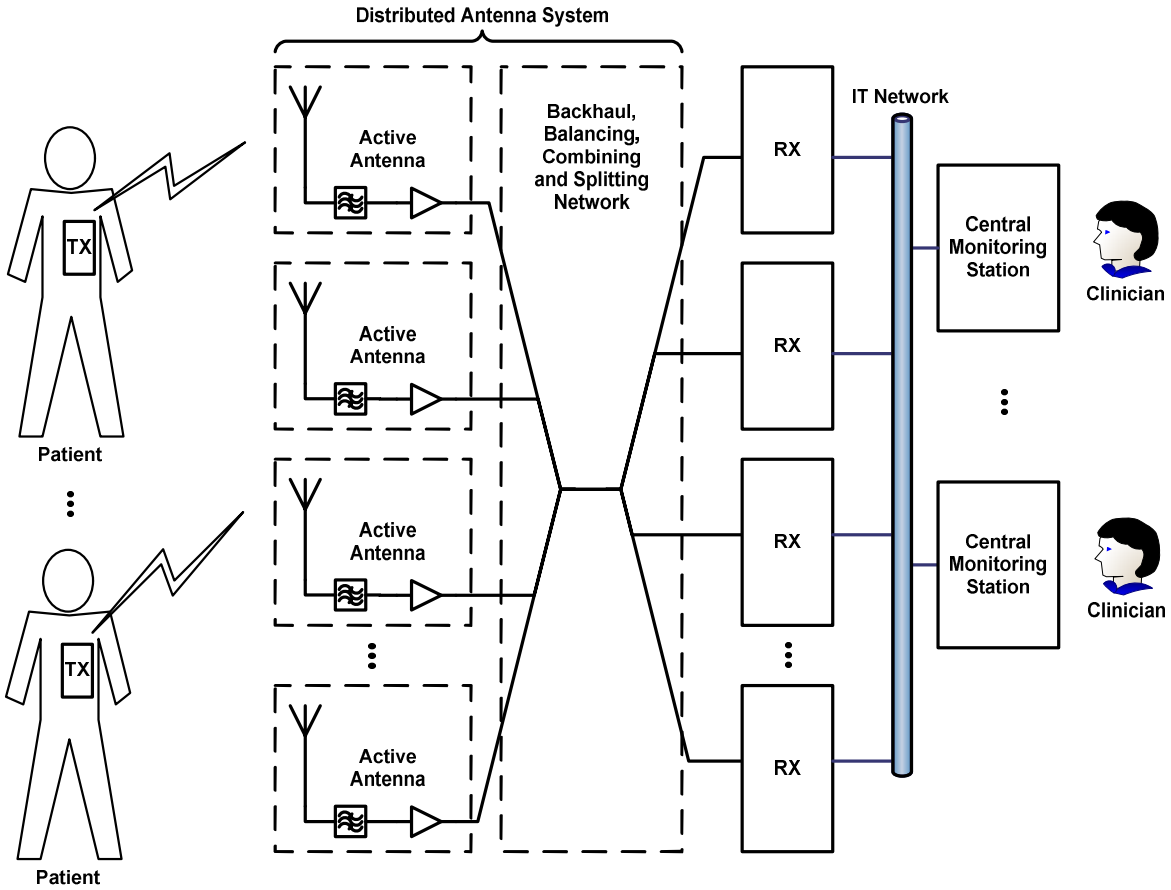
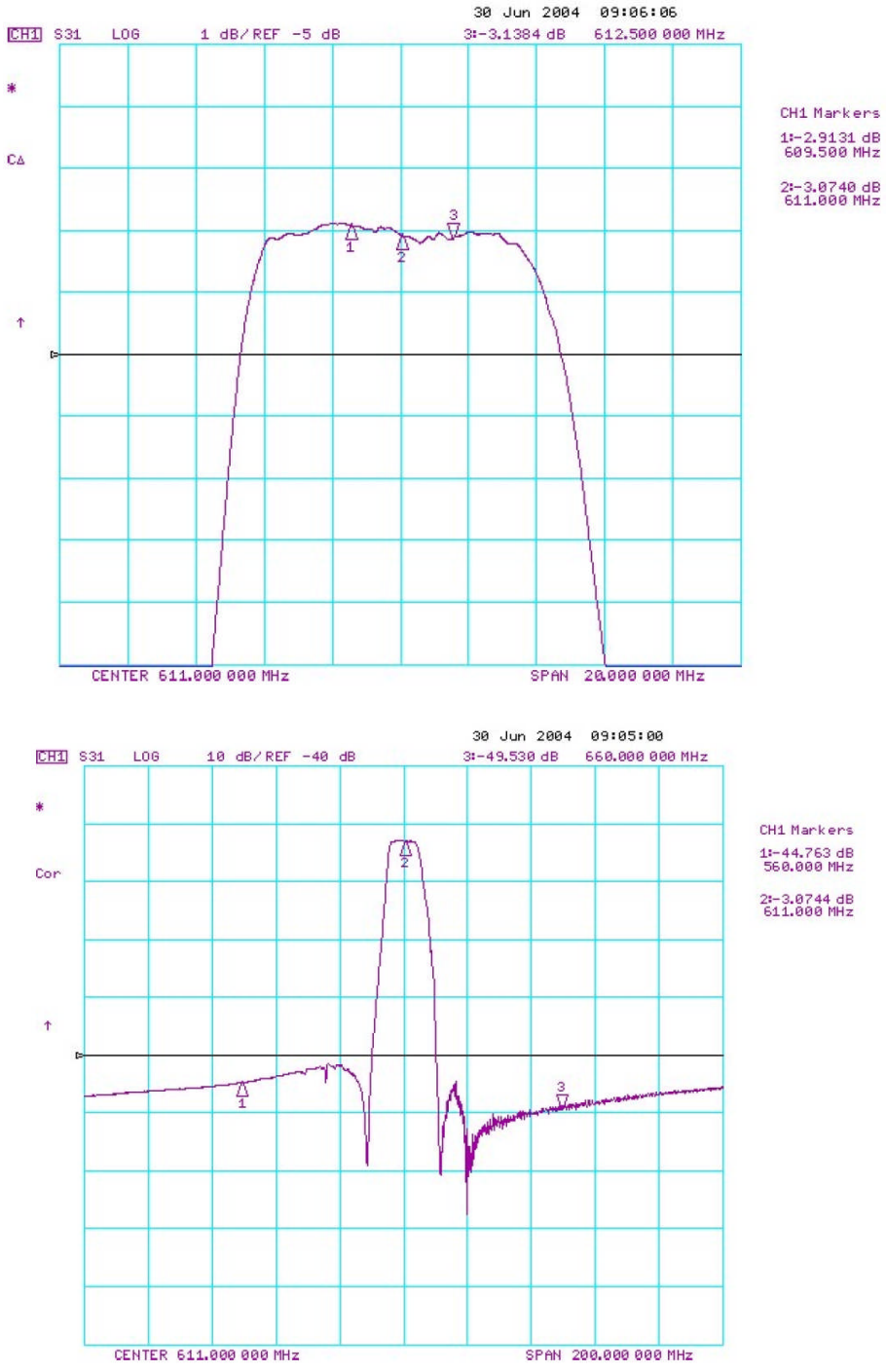


Figure 2: Typical Channel 37 SAW Bandpass Filter Characteristics[105]



[105] TAI-SAW Technology Co., Ltd. Approval Sheet for Product Specification, http://www.taisaw.com/upload/product/TA0326A_Rev%204.0_.pdf (last visited Jan. 25, 2013).

Table 1: DTV Blocking Analysis

Description	1000 kW Ch 38 DTV		316 kW Ch 38 DTV	
Scenario #	**1**	**2**	**3**	**4**
Emission Frequency (MHz)	614	614	614	614
Single transmitter EIRP (dBm / 6 MHz)	90.0	90.0	85.0	85.0
Transmitter to WMTS distance (meters)	**1000**	**12300**	**1000**	**6900**
Path loss coefficient, n	2.0	2.0	2.0	2.0
Path loss (dB)	88.2	110.0	88.2	105.0
Excess loss (building attenuation, etc)	20	20	20	20
Total coupling loss (dB)	108.2	130.0	108.2	125.0
Received interference per exposed WMTS antenna, per transmitter (dBm / 6 MHz)	-18.2	-40.0	-23.2	-40.0
Number of dominant transmitters	1	1	1	1
Number of exposed WMTS antennas per dominant transmitter	10	10	10	10
Overall aggregation factor	10	10	10	10
Overall aggregation factor (dB)	10.0	10.0	10.0	10.0
Aggregate received interference power (dBm / 6MHz)	-8.2	-30.0	-13.2	-30.0
Non-hardened WMTS blocking threshold (dBm / 6 MHz)	-30.0	-30.0	-30.0	-30.0

Table 2: DTV OOBE Co-channel Interference Analysis

Description	1000 kW Ch 38 DTV OOBE						316 kW Ch 38 DTV OOBE					
Scenario #	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Emission Frequency (MHz)	613.5	613	612	611	610	609	613.5	613	612	611	610	609
Single transmitter EIRP (dBm / 10 kHz)	26.0	20.1	8.6	-2.9	-14.4	-25.9	21.0	15.1	3.6	-7.9	-19.4	-30.9
Transmitter to WMTS distance (meters)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Path loss coefficient, n	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Path loss (dB)	88.2	88.2	88.2	88.2	88.1	88.1	88.2	88.2	88.2	88.2	88.1	88.1
Excess loss (building attenuation, etc)	20	20	20	20	20	20	20	20	20	20	20	20
Total coupling loss (dB)	108.2	108.2	108.2	108.2	108.1	108.1	108.2	108.2	108.2	108.2	108.1	108.1
Received interference per exposed WMTS antenna, per transmitter (dBm / 10 kHz)	-82.2	-88.1	-99.6	-111.1	-122.5	-134.0	-87.2	-93.1	-104.6	-116.1	-127.5	-139.0
Number of dominant transmitters	1	1	1	1	1	1	1	1	1	1	1	1
Number of exposed WMTS antennas per dominant transmitter	10	10	10	10	10	10	10	10	10	10	10	10
Overall aggregation factor	10	10	10	10	10	10	10	10	10	10	10	10
Overall aggregation factor (dB)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Aggregate received interference power (dBm / 10 kHz)	-72.2	-78.1	-89.6	-101.1	-112.5	-124.0	-77.2	-83.1	-94.6	-106.1	-117.5	-129.0
WMTS system noise floor (dBm / 10 kHz)	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0
I/N RATIO (dB)	37.8	31.9	20.4	8.9	-2.5	-14.0	32.8	26.9	15.4	3.9	-7.5	-19.0
WMTS Desensitization (dB)	**37.8**	**31.9**	**20.5**	**9.5**	1.9	0.2	**32.8**	**26.9**	**15.6**	**5.4**	0.7	0.1

Table 3: Part 27 Wireless Broadband Blocking Analysis

Description	1 kW / MHz BS ch36 @ 0.5 km	2 kW/ MHz Rural BS ch36 @ 1km	3 W Portable ch38 @ 1m	3 W Portable ch38 @ 10m
Scenario #	**1**	**2**	**3**	**4**
Emission Frequency (MHz)	608	608	614	614
Single transmitter EIRP (dBm / MHz)	60.0	63.0	34.8	34.8
Transmitter to WMTS distance (meters)	**1000**	**1400**	**1**	**10**
Path loss coefficient, n	2.0	2.0	2.0	2.0
Path loss (dB)	88.1	91.0	28.2	48.2
Excess loss (building attenuation, etc)	20	20	0	0
Total coupling loss (dB)	108.1	111.0	28.2	48.2
Received interference per exposed WMTS antenna, per transmitter (dBm / 6 MHz)	-48.1	-48.0	6.6	-13.4
Number of dominant transmitters	1	1	1	1
Number of exposed WMTS antennas per dominant transmitter	10	10	1	2
Overall aggregation factor	10	10	1	2
Overall aggregation factor (dB)	10.0	10.0	0.0	3.0
Aggregate received interference power (dBm / MHz)	**-38.1**	**-38.0**	**6.6**	**-10.4**
Assumed non-hardened WMTS blocking threshold based on DTV approximation (dBm / MHz)	-37.8	-37.8	-37.8	-37.8

Table 4: Part 27 Wireless Broadband OOBE Co-channel Interference Analysis

Description	Base Station OOBE @ 0.55 km	Portable OOBE @ 1m	Portable OOBE @ 10m	Portable OOBE w/ 15.709(c)(4) mask @ 1m
Scenario #	**1**	**2**	**3**	**4**
Emission Frequency (MHz)	611	611	611	611
Single transmitter EIRP (dBm / 10 kHz)	-23.0	-23.0	-23.0	-85.8
Transmitter to WMTS distance (meters)	550	1	10	1
Path loss coefficient, n	2.0	2.0	2.0	2.0
Path loss (dB)	83.0	28.2	48.2	28.2
Excess loss (building attenuation, etc)	20	0	0	0
Total coupling loss (dB)	103.0	28.2	48.2	28.2
Received interference per exposed WMTS antenna, per transmitter (dBm / 10 kHz)	-126.0	-51.2	-71.2	-114.0
Number of dominant transmitters	1	1	1	1
Number of exposed WMTS antennas per dominant transmitter	10	1	2	1
Overall aggregation factor	10	1	2	1
Overall aggregation factor (dB)	10.0	0.0	3.0	0.0
Aggregate received interference power (dBm / 10 kHz)	-116.0	-51.2	-68.2	-114.0
WMTS system noise floor (dBm / 10 kHz)	-110.0	-110.0	-110.0	-110.0
I/N RATIO (dB)	-6.0	58.8	41.8	-4.0
WMTS Desensitization (dB)	1.0	58.8	41.8	1.5

Table 5: Unlicensed TVBD Co-channel Interference Analysis

Description	Fixed / Access TVBD Max EIRP		Portable TVBD Max EIRP		10 mW / 100kHz EIRP	
Scenario #	**1**	**2**	**3**	**4**	**5**	**6**
Emission Frequency (MHz)	611	611	611	611	611	611
Single transmitter EIRP (dBm / 10 kHz)	8.6	8.6	-7.4	-7.4	-17.8	-17.8
Transmitter to WMTS distance (meters)	**21000**	**10400**	**3310**	**2250**	**1010**	**830**
Path loss coefficient, n	**2.0**	**2.4**	**2.0**	**2.4**	**2.0**	**2.4**
Path loss (dB)	114.6	124.6	98.6	108.6	88.2	98.2
Excess loss (building attenuation, etc)	20	20	20	20	20	20
Total coupling loss (dB)	134.6	144.6	118.6	128.6	108.2	118.2
Received interference per exposed WMTS antenna, per transmitter (dBm / 10 kHz)	-126.0	-136.0	-126.0	-136.0	-126.0	-136.0
Number of dominant transmitters	**1**	**10**	**1**	**10**	**1**	**10**
Number of exposed WMTS antennas per dominant transmitter	10	10	10	10	10	10
Overall aggregation factor	10	100	10	100	10	100
Overall aggregation factor (dB)	10.0	20.0	10.0	20.0	10.0	20.0
Aggregate received interference power (dBm / 10 kHz)	-116.0	-116.0	-116.0	-116.0	-116.0	-116.0
WMTS system noise floor (dBm / 10 kHz)	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0
I/N RATIO (dB)	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0
WMTS Desensitization (dB)	1.0	1.0	1.0	1.0	1.0	1.0