Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of )
) MB Docket No. 03-185
Amendment of Parts 73 and 74 of the )
Commission’s Rules to Establish Rules for )
Digital Low Power Television and Television )
Translator Stations )

To: The Media Bureau

COMMENTS OF
NATIONAL PUBLIC RADIO, INC.

Jonathan D. Hart
Chief Legal Officer and General Counsel
Michael Riksen
Vice President, Policy and Representation
Joni Lupovitz
Senior Director, Public Policy
Gregory A. Lewis
Deputy General Counsel
1111 North Capitol Street, N.E.
Washington, DC 20002

January 22, 2020
Summary

Authorizing low power television (“LPTV”) Channel 6 stations to operate analog FM radio services after the final digital television (“DTV”) conversion deadline would be misguided. These so-called “Franken FM” or “LPTV6” stations exploit regulatory gaps to transmit a silent video signal for TV receivers and an unrelated audio service for reception by FM radios tuned to 87.7 – with each Franken FM occupying 30 times the spectrum a traditional FM station uses. With the upcoming mandatory DTV transition, the Commission should no longer allow this misuse of the public airwaves; it should refuse to authorize LPTV stations’ operation of analog radio service and complete the digital transition of the broadcast television service as Congress intended.

NPR and the public radio community have a significant interest in this matter. Franken FMs pose an ongoing threat of harmful interference to public radio stations operating in the immediately adjacent FM band reserved for noncommercial educational (“NCE”) broadcast stations. Moreover, the grossly inefficient use of spectrum adjacent to the NCE reserved FM band ultimate prevents public radio stations from expanding their signal coverage or otherwise offering a multiplicity of additional public service programming for the American public.

The Communications Act, Commission regulations, and fundamental federal communications and spectrum policy all dictate against continued operation of Franken FMs. Section I of NPR’s comments demonstrates that an LPTV6 station providing an analog audio service for reception by FM radios does not constitute an “ancillary and supplementary service” under the Communications Act. In addition, the Commission rule permitting television stations to operate independent visual and aural transmitters is not intended to permit an LPTV6 station to transmit a silent video service for DTV receivers and a separate analog FM radio service.
While Franken FM stations may claim their analog FM service benefits unserved or under-served audiences, these stations typically provide well-established FM radio formats like “country,” “contemporary,” “Spanish language,” “religious,” and “sports” to reach audiences well served by actual FM radio stations. Reallocating the Channel 6 spectrum in otherwise unserved Channel 6 markets for actual FM radio station use would be a far better approach. By doing so, the Commission could (1) authorize many more FM radio stations to serve the same programming needs using only 200 kHz of spectrum each, (2) advance the Commission’s longstanding interest in expanding the diversification of media ownership by creating many new broadcast ownership opportunities, and (3) address the continued overwhelming demand for FM radio station facilities.

Franken FM stations also present significant technical and interference issues for spectrum adjacent FM stations and LPTV6 stations alike as detailed in Section II of NPR’s comments and the accompanying Expert Engineering Statement. If the Commission finds its way past these fundamental legal, regulatory, policy, and technical constraints and allows continuation of LPTV6 analog FM radio service, it would have to develop additional rules to govern these Franken FM services to avoid interference to adjacent reserved band NCE FM stations and to assure reception of the LPTV’s primary video service by DTV receivers. Rather than creating such a new regulatory scheme, the Commission would better serve the public interest by reaffirming the DTV conversion deadline for all LPTV operations, without exception for analog Franken FM services.
## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary</td>
<td>i</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>I. As a Matter of Law, Regulation, and Longstanding Federal Spectrum and Communications Policy, the Commission Must Require LPTV Stations to Complete the Digital Television Transition without Exception for Analog FM Radio Services.</td>
<td>2</td>
</tr>
<tr>
<td>A. The Communications Act Does Not Permit LPTV6 Stations to Offer Analog FM Radio Service as an “Ancillary and Supplementary Service”</td>
<td>2</td>
</tr>
<tr>
<td>B. The Commission Rule Permitting Separate Operation of TV Aural and Visual Transmitters Does Not Permit LPTV6 Stations to Operate as FM Radio Stations.</td>
<td>4</td>
</tr>
<tr>
<td>C. Fundamental Principles of Spectrum Efficiency and Diversification of Ownership Also Dictate Against Authorizing Digital Television Stations to Operate as Analog FM Radio Stations.</td>
<td>7</td>
</tr>
<tr>
<td>II. LPTV6 Analog FM-Radio Type Services Raise Significant Technical and Interference Issues for LPTV6 and Adjacent NCE Reserved FM Stations.</td>
<td>13</td>
</tr>
<tr>
<td>A. LPTV6 Analog FM-Radio Type Services Are An Ongoing Threat of Harmful Interference to Adjacent NCE Reserved Band FM Stations.</td>
<td>14</td>
</tr>
<tr>
<td>B. The Commission’s Technical Rules are Inadequate to Assure the LPTV6’s Primary (Video) Service.</td>
<td>16</td>
</tr>
<tr>
<td>C. Other Rules Would be Required to Govern the Franken FM Service, Taking Account of Analogous FM Radio Station Rules and Appropriate Policy Limits Specific to the LPTV Service</td>
<td>17</td>
</tr>
<tr>
<td>Conclusion</td>
<td>19</td>
</tr>
</tbody>
</table>
In the Matter of  
Amendment of Parts 73 and 74 of the Commission’s Rules to Establish Rules for Digital Low Power Television and Television Translator Stations  
MB Docket No. 03-185

To: The Media Bureau

COMMENTS OF NATIONAL PUBLIC RADIO, INC.

Introduction

Pursuant to Section 1.415 of the Commission’s rules, 47 C.F.R. § 1.415, National Public Radio, Inc. (“NPR”) hereby submits its Comments in response to the Media Bureau’s Public Notice in the above-captioned proceeding.¹

NPR is a non-profit membership corporation that produces and distributes noncommercial educational (“NCE”) programming through more than 1,000 public radio stations nationwide. In addition to broadcasting award winning NPR programming, including All Things Considered® and Morning Edition®, NPR Member stations are themselves significant program producers and community institutions. Most of these public radio stations operate with channel frequencies in the NCE reserved portion of the FM band. NPR also operates the Public

Radio Satellite System ("PRSS"), provides a variety of digital services to its Members, and represents their collective interests in public policy matters.

NPR and the public radio community have a significant interest in whether Channel 6 LPTV stations are permitted to continue broadcasting analog audio programming for reception by FM radio receivers after the 2021 deadline for LPTV stations to convert to digital operation. LPTV operators typically make little pretense of providing video programming for reception by television receivers, instead offering a silent video and separate unrelated audio programming that can be heard at 87.7 on a standard FM radio dial, with standard talk and music formats, just like an FM radio station. These so-called “Franken FMs” are not subject to technical requirements applicable to other television services and therefore threaten harmful interference to public radio stations operating on the adjacent NCE reserved portion of the FM band.

In addition, the Franken FM use of 6 megahertz ("MHz") of prime spectrum for analog FM radio service is patently inefficient. In simple terms, the 6 MHz of spectrum occupied by a single Franken FM could accommodate 600 AM or 30 FM radio channels. In today’s crowded radio marketplace, where there is an increasing and unmet demand for full power FM, low power FM, and FM translator station facilities, such grossly inefficient use of spectrum can no longer be justified.

I. As a Matter of Law, Regulation, and Longstanding Federal Spectrum and Communications Policy, the Commission Must Require LPTV Stations to Complete the Digital Television Transition without Exception for Analog FM Radio Services

A. The Communications Act Does Not Permit LPTV6 Stations to Offer Analog FM Radio Service as an “Ancillary and Supplementary Service”

As a threshold matter, the Communications Act and the Commission’s implementing rules were expressly intended to establish an advanced digital television service and make no provision for such DTV services to offer an analog audio service intended for reception by FM
radio receivers. Under the Communications Act, the Commission may only permit the offering of ancillary or supplementary services “if the use of a designated frequency for such services is consistent with the technology or method designated by the Commission for the provision of advanced television services.”

Section 73.682(d) of the Commission’s rules, in turn, provides that “digital broadcast television signals must comply with the standards for such transmissions set forth by the Advanced Television Systems Committee.” The relevant ATSC DTV standard does not address, let alone establish standards for, hybrid DTV/analog FM radio transmissions.

Moreover, the Franken FM proposal is at odds with the underlying rationale for allowing ancillary or supplementary services: to promote the efficient use of spectrum and to enhance the use of existing spectrum, consistent with the Commission’s basic statutory responsibility to manage the radio-frequency spectrum in the public interest. An LPTV operating as an analog FM radio station represents neither an enhanced nor an efficient use of spectrum. Analog FM

---

2 See 47 C.F.R. §§73.624, 74.790. See also In The Matter Of Advanced Television Systems And Their Impact Upon The Existing Television Broadcast Service, Fifth Report and Order, 12 FCC Rcd. 12809, at 12811 (1997) (“Digital technology holds great promise. It allows delivery of brilliant, high-definition, multiple digital-quality programs, and ancillary and supplementary services such as data transfer.”) [hereinafter “Fifth DTV Report and Order”].


4 47 C.F.R. § 73.682(d). See also id. § 74.795(a)-(b)(1) (requiring digital LPTV stations to operate with transmitters that, inter alia, “produce digital television signals that can be satisfactorily viewed on consumer receiving equipment based on the digital broadcast television transmission standard in § 73.682(d)”).


6 Fifth DTV Report and Order, 12 FCC Rcd. at 12823.

7 See 47 U.S.C. §§ 151, 303(g).

8 See also Section I.C, below.
radio services have been in existence for more than a century,\(^9\) and the LPTV6 stations currently offering such analog FM-like audio services, like television stations generally, each use a 6 MHz channel, while traditional FM radio stations use 200 kHz channels, or 1/30\(^{th}\) as much spectrum.\(^{10}\) Furthermore, the LPTV stations currently market their analog FM radio services as the primary service, not an ancillary or supplementary one.\(^{11}\) Therefore, the offering of an analog audio service for reception by FM receivers is separate and independent of, not “consistent with,” the DTV service technology, and is therefore not permitted under the Communications Act.\(^{12}\)

**B. The Commission Rule Permitting Separate Operation of TV Aural and Visual Transmitters Does Not Permit LPTV6 Stations to Operate as FM Radio Stations**

What purportedly enables these services is a Commission rule that permits a DTV station to operate separate aural and visual transmitters in providing a broadcast television service,\(^{13}\) but that rule was never intended to permit a DTV service for reception by DTV receivers and an independent analog audio service for reception by FM radio receivers. Indeed, the original rule

---


\(^{10}\) In the Matter of Operation of Visual and Aural Transmitters of TV Stations, Report and Order, 82 F.C.C.2d 193, at 196 n.9 (1980) (“The Commission’s allocation of 6 megahertz of spectrum space (approximately 52 mHz for visual and 2 mHz for aural) per TV channel far exceeds that for AM or FM. One TV channel is the equivalent of 600 AM or 30 FM radio channels.”) [hereinafter, “1980 Visual and Aural Transmitters Report and Order”].

\(^{11}\) See Attachment A (showing the Internet home pages of a number of these Franken FM services marketing the LPTV6 station as an FM radio service and excluding any mention of a video service).

\(^{12}\) See Public Notice ¶ 8.

\(^{13}\) 47 C.F.R. § 73.653.
was expressly intended to ensure the efficient use of the television broadcast spectrum, and the changes resulting in the current rule were intended simply to provide flexibility in the offering of services for reception by TV sets. Interpreting the current rule to authorize LPTV6 stations to offer analog FM radio services ignores the evolution of the rule, its intended purpose, and the gross inefficiency of using 6 MHz TV spectrum allotments for analog FM radio services.

Section 73.653 was originally adopted “to preclude such a large spectrum allocation required for TV to be used for aural programming,”14 and it remained virtually unchanged for the next 40 years, save for minor exceptions to address things like “emergency fills due to either aural or visual equipment failures.”15 The Commission proposed to modify the rule in response to requests for waivers from TV licensees seeking authority to broadcast informational programming on their visual transmitters, like chyrons. Thus, the Commission adopted the resulting rule change to allow “visual transmissions (the principal and dominant half of the TV visual/aural pair) to be complemented by aural transmissions of the licensee's choice during after-hours programming”16 for reception by television receivers.17 The intent was to complement or enhance the television service, not permit TV stations to operate as FM radio stations given the obvious spectrum inefficiency inherent in their doing so.

14 1980 Visual and Aural Transmitters Report and Order, 82 F.C.C.2d at 195-96. As the Commission further explained, a single 6 MHz television channel allotment “is the equivalent of 600 AM or 30 FM channels.” Id. at 196 n.9.


16 1980 Visual and Aural Transmitters Report and Order, 82 F.C.C.2d at 196 (emphasis added).

17 See id. at 193.
When the Commission revisited the rule in 1989, it did so specifically to eliminate the time of day restriction that had limited non-synchronized audio and visual transmissions to the “grave yard” hours between midnight and 6:00 a.m.\(^\text{18}\) The Commission adopted the change because it believed there were instances when the separate transmission of unrelated audio and visual programming material could serve particular needs.

For instance, there are some communities where certain news or special interest reports, e.g., farm crops index reports, may be of significant public benefit at certain times of the regular broadcast day. Rather than broadcasting such information with an on-air announcer, stations could elect to transmit these reports more cost effectively via a video text bulletin board-like service. In general, we believe that competitive pressures from competing stations and from viewers will create incentives for broadcasters to decide whether to transmit regular integrated sound and video signal programming or to transmit non-associated audio and video informational services, depending upon the interest and desires of their viewers.\(^\text{19}\)

Thus, while the rule change accorded television broadcasters greater flexibility over their broadcast service, the touchstone was and remains to serve their television viewers via television receivers in a spectrally efficient manner.

Those touchstones apply with equal force to the LPTV6 service.\(^\text{20}\) Accordingly, the Commission would have to wrench the text of Section 73.653 from its history and the underlying policy rationale to conclude, as the Franken FM proponents do, that the rule

---


\(^\text{20}\) See 47 C.F.R. § 74.701(f), (g) (defining authorized LPTV service in terms of television program signals).
authorizes television stations to operate as FM radio stations.\textsuperscript{21} To the extent there may be a need to clarify the rule, the Commission should do so, but it should not adopt an interpretation of the current rule that produces a result so completely at odds with basic legal and policy considerations.

C. Fundamental Principles of Spectrum Efficiency and Diversification of Ownership Also Dictate Against Authorizing Digital Television Stations to Operate as Analog FM Radio Stations

In addition to these statutory and regulatory obstacles to permanently authorizing Franken FM services, there are significant public policy issues at stake. In particular, authorizing television stations to operate as FM radio stations implicates fundamental Commission goals and responsibilities for managing the radio-frequency spectrum in the public interest at a time when there is an unmet demand for FM radio station facilities and lagging diversification of broadcast media ownership. The Commission must therefore address these critical considerations and relevant factors and data in resolving the ultimate issue.\textsuperscript{22}

Managing the radio-frequency spectrum has been a core Commission purpose since its establishment in 1934.\textsuperscript{23} Given a finite supply of spectrum amidst a seemingly insatiable demand, spectrum efficiency remains a primary consideration in managing the resource.\textsuperscript{24} In its

\textsuperscript{21} See Public Notice ¶ 4 & n.13.


\textsuperscript{23} 47 U.S.C. §§ 151, 301.

\textsuperscript{24} See, e.g., In the Matter of Petition for Reconsideration of Amendment of Parts 2 and 73 of the Commission's Rules Concerning Use of Subsidiary Communications Authorization, Memorandum Opinion and Order, 98 FCC.2d 792, 801-02 (1984) (“The mandate of Section 301 that we provide for the use of channels authorizes the Commission to allocate the Nation's scarce spectrum resources. In attempting to satisfy that mandate, the public's need for new or additional
most basic terms, “[s]pectrum efficiency occurs when the maximum amount of information is transmitted within the least amount of spectrum.”25 Spectrum efficiency also requires evaluating incumbent uses of spectrum to ensure the highest and best use of the spectrum.26

Of equally compelling significance, “[i]t has been a longstanding goal of the Commission to promote diverse ownership of broadcast stations, including ownership by women and minorities.”27 This goal reflects a statutory mandate under Sections 257 and 309(j) of the Communications Act to promote opportunities for small businesses and businesses owned by women and minorities in the broadcasting industry.28 The goal of increasing ownership among small businesses, women, and minorities remains substantially unrealized.29

services must be balanced against the limited spectrum currently available. In sum, we must strive for economy in the use of spectrum.”


Coupled with these statutory and Commission policy imperatives is an undeniable and relentless demand for FM radio station facilities. The Commission recently acknowledged that the AM and FM “radio broadcast spectrum is now fully utilized.” Yet, the demand for radio station facilities continues to grow. As the Chairman cogently noted:

[I]n the last generation, there have been massive changes in the radio marketplace. Over the past 27 years, the number of commercial AM, FM, and FM translator stations has nearly doubled, from 11,600 to 19,400. The number of non-commercial education stations has more than doubled, from 1,588 to 4,122. And the Commission has since established the low power FM service, which comprises over 2,000 hyper-local stations providing unique and hyper-local content.

Indeed, the Commission has conducted several proceedings just in the past year to accommodate the continued demand for AM and FM broadcast facilities.

---


31 Id. (appending Statement of Chairman Ajit Pai).

32 See In the Matter of Amendment of Part 74 of the Commission’s Rules Regarding FM Translator Interference, Report and Order, 34 FCC Rcd 3457, 3458 (2019) (clarifying and increasing the requirements for complaints of interference by FM translator stations to accommodate the substantial growth in the translator service, particularly as a result of the Commission’s authorizing such stations to retransmit AM station signals as part of the Commission’s AM Revitalization proceeding.) [hereinafter "2019 FM Translator Interference Report and Order"]; In the Matter of Reexamination of the Comparative Standards and Procedures for Licensing Noncommercial Educational Broadcast Stations and Low Power FM Stations, Report and Order, 2019 FCC LEXIS 3684 (2019) (adopting changes to improve and expedite the comparative process for choosing among competing broadcast station applicants based on the Commission’s expectations of continued high demand for new stations licenses and limited spectrum).
Surprisingly, the Public Notice largely ignores spectrum efficiency,\textsuperscript{33} even though using a 6 MHz television station allotment to transmit an FM radio-type service is far from “the most efficient use of spectrum.”\textsuperscript{34} As the Commission previously found:

The Commission’s allocation of 6 megahertz of spectrum space (approximately 52 mHz for visual and 2 mHz for aural) per TV channel far exceeds that for AM or FM. One TV channel is the equivalent of 600 AM or 30 FM radio channels.\textsuperscript{35}

As indicated in Attachment A, these Franken FM stations make no pretense of providing a television service; they present themselves to the public as FM broadcast stations.\textsuperscript{36} Indeed, the material submitted by the LPTV6 proponents and cited in the Public Notice makes no attempt to tout any of the video content these stations offer or document any appreciable audience data for television viewers who consume the video content.\textsuperscript{37} For the Franken FMs in question, the visual content, if

\textsuperscript{33} Indeed, the words “spectrum” and “efficiency” (or their variations) appear only once in proximity, and there for the odd proposition that spectrum efficiency is an “additional issue” recently raised by certain LPTV6 proponents. See Public Notice at ¶ 4 ("Several parties have also recently raised some additional issues on which we seek comment. For example, the Channel 6 Commenters maintains that LPTV licensees should be allowed to make “the most efficient use of spectrum” by providing analog FM radio-type service on an ancillary or supplementary basis."). In fact, the basic elements of these LPTV6 operations have been understood for quite some time. See In the Matter of Amendment of Parts 73 and 74 of the Commission’s Rules to Establish Rules for Digital Low Power Television, Television Translator, and Television Booster Stations, Third Notice of Proposed Rulemaking, 29 FCC Rcd. 12536 (2014).

\textsuperscript{34} Public Notice at ¶ 4.

\textsuperscript{35} 1980 Visual and Aural Transmitters Report and Order, 82 F.C.C.2d at 196 n.9.

\textsuperscript{36} See Attachment A, attached hereto, showing how many of these LPTV6 stations characterize and promote themselves.

\textsuperscript{37} See, e.g., Venture Technologies Group, Inc., et al., “Notice of Communications,” MB Docket No. 03-185, filed June 10, 2019; Preserve Community Programming Coalition, “Informal Comments,” MB Docket No. 03-185, filed July 3, 2019. Indeed, comments recently submitted by one of these Franken FM stations demonstrates this point, making no mention of the video service the station provides or any audience for such service. MeTV FM Comments, MB Docket No. 03-185 (submitted Jan. 17, 2020).
any,\textsuperscript{38} may be nothing more than a still image, and the aural content conforms to program formats commonly found among FM radio stations using a 200 kHz spectrum allotment. As reflected in Attachment A, these stations offer standard FM radio formats, like Country (KNIK-LP, Anchorage, AK), Contemporary (WRME-LP, Chicago, IL, WMTO-LP, Norfolk, VA), Sports (WPGF, Memphis, TN), and Religious (WVOA-LP, Syracuse, NY).\textsuperscript{39} Using 6 MHz allotments of spectrum in this way occupies spectrum that could be used by many more FM radio stations, particularly if low power FM stations are included, and eliminates as many opportunities to diversify broadcast station ownership.

As the attached Expert Engineering Statement makes clear, moreover, even assuming an LPTV6 station offers a meaningful video service, offering independent digital video and analog FM services necessitates a trade-off between the two, and the result is anything but spectrally efficient.\textsuperscript{40} LPTV6 stations may have a financial incentive to sacrifice the digital video service in favor of the analog FM service by allocating transmitter power to the latter at the expense of the former,\textsuperscript{41} but the LPTV station’s economic benefit comes at the expense of the service it is

\textsuperscript{38} E.g., \textit{In the Matter of DFW Broadcasting, Inc.}, Notice of Violation, File No. EB-FIELDSCR-13-00006934 (2013) (“At the time of inspection, Station KZFW-LP was not transmitting a visual carrier. The low power television station was only transmitting audio.”)

\textsuperscript{39} See Attachment A; https://www.nielsen.com/us/en/insights/article/2019/tops-of-2019-radio/ (identifying the top radio formats for 2019). See also www.chicagotribune.com/business/ct-post-game-format-1207-biz-20141205-story.html ("WGWG-LP is a low-power television station whose Channel 6 frequency delivers audio at the bottom of the FM band. It has been everything from Spanish to country to smooth jazz to alternative rock to sports in the six years since it fired up its signal in Chicago, with varying degrees of ratings success.").

\textsuperscript{40} See John Kean, Cavell, Mertz & Associates, Inc., Engineering Statement at 5 (January 22, 2020) (attached hereto as Attachment B) [hereinafter “Expert Engineering Statement”].

\textsuperscript{41} See \textit{In the Matter of Syncom Media Group, Inc. Licensee of Station WMTO-LP Facility ID: 127802}, Notice of Violation, File No. EB-FIELDNER-18-00027853 (2018) (“The agent observed the station was operating a Nautel FM Transmitter (Model NS2.5) to generate the station’s aural carrier. The agent used the observed transmitter output (TPO) along with the values noted in the station’s license to calculate the effective radiated power (ERP) of 12.4 kW for the aural carrier, which exceeded the authorized ERP of 660 Watts.”); \textit{In the Matter of}
actually licensed to offer. An LPTV station occupying 6 MHz of spectrum should be offering a
digital television service first and foremost and, if it does, it would only be able to offer a
severely compromised analog FM radio service that provides minimal additional benefit to the public.42

The Public Notice’s inquiry about limiting the further proliferation of these operations43 or
terminating a given LPTV station’s authorization upon license assignment or licensee transfer of
control44 underscores how contrary these operations are to basic federal communications law and
policy objectives. To the extent the Commission feels some obligation to “grandfather” existing
LPTV operations, the concern is entirely misplaced.

The Commission has made abundantly clear for a number of years that licensees of LPTV
stations would no longer be able to offer analog services following the DTV transition deadline:

We conclude that the new digital transition date must be a hard deadline. That is,
all LPTV and TV translator stations must terminate all analog operations
(including any analog companion channels) by 11:59 p.m. local time on the new
transition date regardless of whether their digital facilities are operational. Those
without operational digital facilities will be required to remain silent while they
complete construction. As we did in 2011 when we adopted the first hard
transition date, we once again conclude that stations will have a stronger incentive
to complete construction of their digital facilities by the new transition date if they

Venture Technologies Group, LLC, Licensee of Class A Television Station KSFV-LP, Facility
(“At the time of inspection, the agent observed that the effective radiated power of the aural
transmitter of KSFV-LP was 171% of the station's visual transmitter power.”).

42 See Expert Engineering Statement at 5 (with transmitter power properly allocated
between the LPTV station’s digital video and analog FM services, quality stereo service appears
unattainable and monophonic operation is only marginal).

43 See Public Notice at ¶ 5 (“Further, we seek comment on whether, and how, we could
legally limit the number of stations eligible to offer such a service.”).

44 See id. at ¶ 8 (“Should channel 6 digital LPTV stations authorized to provide analog FM
radio-type operations be prohibited from transferring such authorization and should the right to
continue the analog operation terminate with an assignment or transfer?”).
are required to cease analog operations after that date. Thus, we find this requirement is necessary in order to ensure that analog LPTV and TV translator stations take all steps necessary to complete their digital construction in a timely manner.\textsuperscript{45}

The date of the deadline may have changed but the bottom line has not: go digital. Nothing more is warranted as a matter of law, policy, or fairness, or of the Commission, with respect to these LPTV6 operations.

\textbf{II. LPTV6 Analog FM-Radio Type Services Raise Significant Technical and Interference Issues for LPTV6 and Adjacent NCE Reserved FM Stations}

In addition to the legal, regulatory, and policy issues discussed above, Franken FM stations present significant technical and interference issues that caution against permitting their continued operation. The attached Expert Engineering Statement describes the ongoing threat of harmful interference that Franken FMs create for spectrum adjacent NCE FM broadcast stations.\textsuperscript{46} Because Franken FMs have no antenna height limit, they can pose significant interference issues for nearby FM stations. In addition, the hybrid nature of the digital video/analog audio service creates interference risks both for the Franken FM’s FM carrier and the LPTV6 digital video “host.” Indeed, operating the hybrid LPTV6 stations to provide an adequate digital \textit{television} service, as they must to constitute a DTV station, has real consequences for the quality of the LPTV6 FM service. The Commission cannot ignore these technical and interference obstacles.


\textsuperscript{46} See Expert Engineering Statement at 2-3.
If the Commission nevertheless decides to authorize LPTV6 stations to operate analog FM radio services after the final DTV transition date, the Commission must adopt appropriate technical rules to govern the service. The LPTV service itself may have been established as an experiment in substituting market forces for direct or indirect regulation of programming, \(^{47}\) but it remains a broadcast service subject to the laws of physics. As discussed in greater detail in the attached Expert Engineering Statement, \(^{48}\) additional technical rules would be needed to avoid interference to adjacent NCE FM stations, protect the LPTV’s DTV video service, and set appropriate power limits on any LPTV-offered analog FM radio-type services. Essentially, the Commission would need to (1) ensure the protection of adjacent NCE FM stations and (2) the adequacy of the LPTV6 station's video service.

A. LPTV6 Analog FM-Radio Type Services Are An Ongoing Threat of Harmful Interference to Adjacent NCE Reserved Band FM Stations

LPTV6 analog FM radio services, like FM radio stations generally, cause interference to adjacent NCE FM stations whenever the LPTV6 signal is strong enough relative to the adjacent NCE FM station signal. \(^{49}\) A number of factors determine the risk and severity of interference, including proximity of the undesired (LPTV6) frequency to the desired (NCE FM) frequency and the relative strength of the signals. The strength of a given signal is further determined by the power and height of the transmitter.


\(^{48}\) See Expert Engineering Statement at 3.

\(^{49}\) Id. at 2.
LPTV6 stations pose an ongoing threat of interference because there are no technical rules governing the coexistence of LPTV6 and adjacent NCE FM stations. It is well established that LPTV6 stations are secondary services and, as such, must accept interference from and not cause any harmful interference to adjacent NCE FM stations.\(^50\) Beyond that, however, there is no system for allocating LPTV6 stations in relation to spectrum adjacent NCE FM stations comparable to either the distance separation table used to allocate commercial FM stations or the contour overlap approach used to site reserved band NCE FM stations.\(^51\) Furthermore, there are no rules governing the process for remediating LPTV6 interference to adjacent NCE FM stations. The matter is particularly problematic because the technical rules governing the LPTV service completely ignore the height of the LPTV6 transmitter.\(^52\) That is a critical gap in the Commission’s rules since the interference potential of any broadcast transmitter depends on its power and height.

\(^50\) See An Inquiry Into the Future Role of Low Power Television Broadcasting and Television Translators in the National Telecommunications System, Final Rule, 47 Fed. Reg. 21468, at ¶ 29 (1982) (“We do caution, however, that low power use of certain channels (principally 4, 5, 6, 7, 13, 14 through 21 and 69) may be subject to interference from authorized land mobile, point-to-point or FM stations; the rules we are adopting are not designed to protect low power stations from this. Prudence would suggest choosing a different channel where possible, but we shall not adopt a rule requiring this.”) [hereinafter “LPTV Service Final Rule”]; In the Matter of Amendment of Parts 73 and 74 of the Commission’s Rules to Establish Rules for Digital Low Power Television, Television Translator, and Television Booster Stations, Second Memorandum Opinion and Order, 28 FCC Rcd 14412, at 14419-20 (2013) (“We confirm that, as Hammett & Edison and NPR observe, our current rules do not distinguish between primary NCE FM stations on different adjacent channels in terms of the protection that secondary low power television stations must provide to NCE FM stations.”).

\(^51\) See C.F.R. §§ 73.207, 73.509.

\(^52\) See Expert Engineering Statement at 3.
To the extent interference to NCE FM stations occurs even with additional technical rules, the Commission would also have to adopt strict requirements for the LPTV station licensee to resolve any interference immediately and at its sole expense. Simply put, there should be zero tolerance for interference caused by a secondary service of a secondary LPTV6 station to the primary service of a primary NCE FM station.53

B. The Commission’s Technical Rules are Inadequate to Assure the LPTV6’s Primary (Video) Service

In addition to protecting reserved band NCE FM stations from interference, the Commission must ensure that the LPTV6 video service is capable of reception by DTV receivers. Otherwise, an LPTV DTV video service not being received by most, if not all, DTV receivers is effectively not providing a DTV service and should not be licensed as a DTV station.54 As explained in the accompanying Expert Engineering Statement, prior testing introduced into the record of this proceeding establishes that in balancing the allocation of power between the LPTV visual transmitter and the LPTV aural transmitter, substantially all of the LPTV station’s authorized transmitter power must be allocated to the visual transmitter to assure an LPTV digital video service receivable by substantially all DTV receivers.55 The need for

53 It would be insufficiently protective of the primary FM radio service to apply the recently revised requirements for establishing interference caused by FM translator stations to interference caused by LPTV6 stations’ Franken FM services. See 2019 FM Translator Interference Report and Order.

54 See 47 C.F.R. § 74.795(a)-(b)(1) (requiring digital LPTV stations to operate with transmitters that, inter alia, “produce digital television signals that can be satisfactorily viewed on consumer receiving equipment based on the digital broadcast television transmission standard in § 73.682(d)”).

55 See Expert Engineering Statement at 5 (“Based on a combined power for the DTV and FM emissions not exceeding 3 kW, and the 13 dB (1/20th) D/U power level necessary to protect the DTV service as described above, the FM power allowance is 136 Watts (2857 W for DTV and 143 W for FM = 3000 W.”).
such technical requirements is underscored by the propensity of LPTV6 stations to substantially increase the power of the station’s aural transmitter at the expense of the station’s visual transmitter.\textsuperscript{56} While the LPTV6 station licensee may not care whether anyone actually views the station’s video programming, the Commission has no choice but to protect and promote the public interest in digital television service.

\textbf{C. Other Rules Would be Required to Govern the Franken FM Service, Taking Account of Analogous FM Radio Station Rules and Appropriate Policy Limits Specific to the LPTV Service}

In addition to appropriate technical rules, the Commission would have to establish or clarify the applicability of other rules if it authorizes LPTV6 stations to operate FM radio services past the July 13, 2021 DTV transition deadline. Under current Commission rules, a DTV licensee offering ancillary services that are analogous to other services subject to regulation by the Commission must comply with the regulations governing such analogous services.\textsuperscript{57}

Therefore, every rule governing the over-the-air FM radio broadcast service should apply to an

\textsuperscript{56} See supra note 39.

\textsuperscript{57} 47 C.F.R. § 73.624(c). The Commission has previously permitted ancillary or supplementary services but only subject to compliance with the same rules that apply to the analogous service. See, e.g., In The Matter Of Digital Audio Broadcasting Systems And Their Impact On The Terrestrial Radio Broadcast Service Second Report And Order; First Order On Reconsideration And Second Further Notice Of Proposed Rulemaking, 22 FCC Rcd. 10344, at 10359 (2007) (“Because these agreements are essentially leasing arrangements, they achieve benefits similar to those achieved through leasing arrangements. The Commission has for many years permitted brokering of FM subcarriers and excess digital television bandwidth.”); In The Matter Of Advanced Television Systems And Their Impact Upon The Existing Television Broadcast Service, Memorandum Opinion and Order on Reconsideration of the Fifth Report and Order, 13 FCC Rcd. 6860, at 6870 (1998) (“The Fifth Report and Order addressed the issue of parity in the treatment of various service providers. We stated that, consistent with Section 336(b)(3), all non-broadcast services provided by digital licensees will be regulated in a manner consistent with analogous services provided by other persons or entities.”).
LPTV station offering an analog FM audio service for reception by FM radio receivers absent a compelling reason to conclude otherwise.  From a regulatory and policy perspective, there would be no justification for regulating comparable services differently. From the public's perspective, it should not matter whether a particular broadcast source they listen to on their FM radio is an FM radio station or an LPTV station masquerading as one.

Finally, certain rules would have to be established to prevent the LPTV service from becoming completely divorced from its intended purpose. For instance, the Commission should not allow TV translators to offer analog FM radio services either by retransmitting another LPTV station or by transmitting an actual FM radio station. As addressed in Section I.C, above, the spectrum inefficiency of such use of a 6 MHz television station allotment is clear and inappropriate. Moreover, such use of TV translators by LPTV stations would be completely at odds with a service established to serve “relatively small coverage areas” with a high degree of licensee responsiveness to the needs of the service area involved.  

---

58 Such rules would include emergency alerting, public file obligations, and the statutory and Commission content commands and restrictions applicable to the FM radio service.

Conclusion

For the foregoing reasons, NPR urges the Bureau and the Commission to confirm the applicability of the July 13, 2021 DTV transition deadline to the LPTV service without exception.

Respectfully submitted,

NATIONAL PUBLIC RADIO, INC.

Gregory A. Lewis /s/

Jonathan D. Hart  
Chief Legal Officer and General Counsel  
Michael Riksen  
Vice President, Policy and Representation  
Joni Lupovitz  
Senior Director, Public Policy  
Gregory A. Lewis  
Deputy General Counsel  
1111 North Capitol Street, N.E.  
Washington, DC 20002

January 22, 2020
Attachment A

Comments of National Public Radio, Inc.

In MB Docket 03-185

January 22, 2020
NEED TO KNOW: All The Details Of Tim McGraw’s Here On Earth 2020 Tour

This is going to be big. Huge, in fact. Not...

Ashley McBryde Digs Into The Saga Of “Martha Divine”

Ashley McBryde releases "Martha Divine," the second video in a...
La Invasora 87.7 FM
La Mejor Opción de Radio en Español en Denver y Alrededores
Anúnciese en La Invasora
Advertise On La Invasora
KBKF-LP

San Jose

KBKF-LP
87.7 FM
San Jose, CA
Location: 37.11, -121.84
WVOA 87.7 FM

WVOA is on 87.7 FM

Central New York's Inspirational Voice
La Raza Las Vegas 87.7FM

“LA CHIQUI BABY”
LUNES A VIERNES
10:00 AM A 12:00 PM

Escúchanos en vivo
CTG - The Variety Station
96.5 for MD & DE
101.5 for VA
WOWZ-LP
The Chicken Sandwich Is Back At Popeye's

More LOCAL jobs

DOWNLOAD OUR FREE MOBILE APP

LISTEN
KFLZ-LP
This Engineering Statement is prepared for National Public Radio ("NPR") regarding the FCC’s Public Notice seeking to update the record in MB Docket No. 03-185 on the operation of analog FM radio as ancillary or supplementary services of LPTV stations ("Notice").¹ This narrative provides technical background for NPR’s Comments.

My qualifications as a telecommunications consulting engineer are a matter of record with the FCC. I have supported a variety of broadcast and telecommunications client activities, applying 40 years of experience in television and radio technology, as summarized on my attached resume. My professional work has included radiofrequency engineering related to the interference susceptibility of digital television. As indicated in my resume, this includes investigation and development of signal propagation and coverage models for digital television and FM radio. Related work also includes laboratory studies of consumer digital television ("DTV") receiver interference susceptibility, field studies of RF signal propagation and development of technical policy for FM and DTV services.

Certain LPTV Channel 6 ("LPTV6") stations operate audio services intended for receivers designed and used for standard FM service, in addition to a video service capable of reception by DTV receivers. As the FM component of this hybrid service is effectively another FM radio station that is adjacent to stations in the NCE-FM broadcast band, the threat of interference to broadcast FM service is no different than that of conventional FM-to-FM interference. In addition, the hybrid nature of the LPTV6 FM-radio type service raises risks of interference by its FM carrier to the LPTV6 digital video "host" and vice versa. The following sections address these compatibility concerns in response to the Commission’s Notice.

Interference to Adjacent NCE-FM Stations

Potential interference to a desired FM signal may occur whenever the undesired signal is strong enough and affects receiver compatibility, technical quality, and spectrum compatibility. All FM receivers, whether analog or digital, have a susceptibility to undesired signals that are adjacent in frequency to the desired signal. The potential for interference is increased as the frequency of the undesired signal moves closer to the frequency of the desired signal. Interference increases as the strength of the undesired signal rises, relative to the strength of the desired signal. These are core principles of FM service protection that the Commission put in place for FM radio broadcasting.

For the non-commercial portion of the FM band, from 88.1 to 91.9 MHz, these core principles are established in Section 73.509 of the rules, which prescribes minimum desired-to-undesired signal ratios between stations that must be maintained between FM stations. The signal ratios are determined as a function of the frequency difference, power and height above average terrain (HAAT) of the stations involved. Allocation of commercial FM radio stations reflects the same considerations in the form of distance separations.

The Commission’s FM interference principles have recognized, almost since the beginning of FM broadcast service nearly 80 years ago, that interference protection must be considered between stations separated within 600 kHz (three 200 kHz FM channels) of a protected station. This ensures that interference to reception is minimal for most receivers and under most receiving conditions. This criterion has been applied countless times and has upheld the integrity and quality of FM radio service in the U.S.

The Commission Notice seeks comment on “LPTV audio operations on 87.7 MHz,” which is, according to standard 200 kHz FM channelization, two channels below the first NCE-FM channel, on 88.1 MHz, or “second adjacent channel.” The 87.7 MHz operation is three channels below, or “third adjacent channel” to 88.3 MHz. Clearly the frequency adjacencies of audio service on

2 Ibid, paragraph 7.
87.7 MHz are part of the interference protection standards of Section 73.509 of the Commission rules and should be considered in authorizing LPTV6 FM-radio services.

The Commission’s rules authorize LPTV stations under Subpart G of Part 74 as a secondary service, which specifies only a maximum visual power. Protection to all full-service TV stations, as well as other low power TV, TV translator and TV booster stations is necessary at the expense of the LPTV. While no one may have envisioned the LPTV operation of a supplementary FM radio service with power and modulation levels similar to FM broadcast stations when service was established, an LPTV station’s obligation to accept interference from and not cause interference to FM radio stations is understood.

As a result of limited technical specificity in the LPTV rules, FM-radio type services began on some LPTV6 stations with modulation levels and a stereophonic transmission mode not authorized under Part 73 rules for full-service stations. As a secondary service, the LPTV rules did not consider the HAAT of the LPTV6 antenna, which, when combined with a lack of definition for the allowable power of the FM-radio emission, raises serious risks of uncontrolled interference to FM broadcast stations. If the Commission decides to authorize DTV LPTV stations to provide analog audio services for reception by FM radio receivers, the Commission should properly specify rules to avoid adjacent NCE-FM station interference.

Assuring Adequate Protection to Host Digital LPTV Service

Low-Power Television service is the LPTV licensees’ primary responsibility to the public. Each licensee on channel 6 must ensure that any artificial addition of an FM-radio emission does not degrade the technical quality of their host DTV transmission. Tests filed with this proceeding in 2014 measured the desired signal amplitude ratio (D/U, where “D” is the digital LPTV signal and “U” is the FM-radio type signal) of 18 DTV receivers with the FM signals on 87.7 MHz. The study found

---

3 47 CFR 74.703(b).
5 Comments of Linley Gumm and Charles Rhodes to Section E, “Operation of Analog Radio Services by Digital LPTV Stations as Ancillary or Supplementary Services,” MB Docket No. 03-185, GN Docket No. 12-268 and ET Docket No.
that a D/U ratio of no less than -13 dB was required for acquisition of the digital TV signal for four of eighteen television receivers tested, which represents 22 percent of the test population of DTV receivers. The remainder of the receivers allowed a higher D/U ratio, but 22 percent of potential of DTV receivers failing to operate at or below -13 dB is substantial, and serves as appropriate criteria for the allowable FM transmission power.6

A similar study was performed in 2015 on behalf of a Low Power Television Station licensee in New York City operating a hybrid aural FM service on channel 6.7 This study was made only on 87.76 MHz and at a DTV carrier amplitude of -68 dBm, using 27 television receivers. Comparison of their results to the Gumm and Rhodes test data on the same frequency and signal amplitude shows agreement within 1 dB, as indicated by Figure 5 in the Bogner filing. This reinforces the findings of Gumm and Rhodes at 87.70 MHz.

LPTV6 FM-radio services began under the provisions of analog television, which employed separate carriers for the visual and aural transmissions. In the case of channel 6, the visual carrier was 83.25 MHz and the aural carrier was 4.5 MHz higher, at 87.75 MHz.8 The study by Bogner tested only 87.76 MHz, which affords an increase in the D/U ratio for digital acquisition. However, digitally-tuned FM receivers still receive on 87.70 MHz, which, due to the channel’s adjacency to the host DTV emissions, will suffer a poorer carrier-to-noise level than if the receiver could be correctly tuned to 87.76 MHz. Any potential increase in FM carrier power on 87.76 MHz, relative to 87.70 MHz may be offset by increased noise and distortion in the FM receivers. The Commission should not institute by rule a non-standard FM operating frequency that impairs reception.

14-175, November 12, 2014. Their study tested FM frequencies at 87.70 MHz, 87.76 MHz (established as the aural FM carrier frequency for channel 6 analog television in the U.S.) and 87.90 MHz. Measurements were performed at a DTV carrier amplitude of -68 dBm, which is equivalent to signal reception at the 43 dBµ protected contour.

6 “Signal acquisition” determined in the Gumm and Rhodes test is merely the threshold D/U at which each receiver began to receive the DTV signal as the hybrid in-channel FM signal was reduced. This point does not consider the effects of time variability in both signals (related to the “90” in the FCC’s F(50,90) propagation curves) which justifies an additional margin be added to the D/U ratio.

7 Joint Comments of Island Broadcasting LLC, licensee of WNYZ-LP and Richard D. Bogner, consultant, November 12, 2014.

8 To minimize co-channel interference, in some cases the carrier frequencies of one channel 6 station were offset by 10 kHz, such as 83.36 MHZ and 87.76 MHz for the visual and aural carriers. As the offset frequency mode appears to be used more frequently in this proceeding, it is used in this statement. However the technical difference is minimal.
Engineering Statement  
(Page 5 of 8)

Once digital television service is in effect for all LPTV stations, operation on 87.76 MHz should be discontinued, as this frequency differs from the channelization for FM broadcast in North America. In addition, 87.76 MHz is 60 kHz off of the frequency tuning steps of virtually all digitally-tuned FM receivers. This tuning error increases audio distortion and noise to reception, as all FM radios tune in 0.2 MHz increments, such as 88.1 MHz, 88.3 MHz, etc.

LPTV stations operating channel 6 are authorized up to 3 kilowatts effective radiated power, with no restriction on height, per Section 74.735 of the rules. Based on a combined power for the DTV and FM emissions not exceeding 3 kW, and the 13 dB (1/20th) D/U power level necessary to protect the DTV service as described above, the FM power allowance is 136 Watts (2857 W for DTV and 143 W for FM = 3000 W).

Interference by the LPTV6 DTV "Host" to LPTV6 FM-Radio Service

Operation on 87.7 MHz is subject to noise from the host DTV emission. The Gumm and Rhodes report calculates that for FM signal power at a D/U ratio of -12.5 dB the noise in the upper skirt of the DTV signal produces an FM Receiver carrier-to-noise ratio of 4.8 dB (in a standard FM receiver bandwidth of 200 kHz). Using a recognized FM Improvement calculation, they estimate the monophonic audio signal-to-noise ratio is 32 dB. Studies by the author9 and ITU Recommendations10 indicate that this is not an acceptable audio quality for the majority of listeners.

Stereophonic FM transmission further lowers the audio signal-to-noise ratio of FM reception by 23 dB relative to monophonic reception. Given the already low values for monophonic reception, quality stereo service appears is unattainable for a hybrid FM service on a host digital LPTV operation, and monophonic operation is only marginal.

---

9 “Consumer Ratings of Impaired Audio at Various Signal-to-Noise Ratios”, E. Sheffield, PhD, Towson University, J. Kean and D. Schwab, NPR Labs, Natl. Assn. of Broadcasters Engineering Conf. Proceedings, April 2008. This study measured listener scores of audio noise impairment with a variety of speech and music samples. For music, 59% of listeners rated an audio SNR of 30 dB as “slightly annoying,” “annoying” or “extremely annoying”.

Pursuant to the Commission’s request to update the record for analog radio services by digital LPTV stations, this statement provided a brief summary of the technical matters involving a LPTV6 FM-radio type service, compatibility with the host DTV service, and the potential impact on full-service FM radio in the non-commercial FM band. The Commission is urged to fully consider the technical issues of this service before the provision of an analog FM radio-type service in association with digital low power television.

John C. Kean, Senior Engineer
Cavell Mertz & Associates Inc.

January 22, 2020
Resume

John Kean’s qualifications as a telecommunications consulting engineer are a matter of record with the FCC. He has supported a variety of broadcast and telecommunications client activities, applying 40 years of experience in television and radio technology.

Mr. Kean is a member of the consulting engineering firm of Cavell Mertz & Associates Inc. as a Senior Engineer. His special projects have included analysis of broadcast signal reradiation effects from large wind turbines, development of a mobile system for AM groundwave measurement and design of RF signal instrumentation for an unmanned aerial vehicle. As discussed below, he has experience in FCC regulations and procedures and has prepared numerous filings for broadcast, satellite and microwave facilities.

Before joining Cavell Mertz, Mr. Kean was Senior Technologist for National Public Radio, from 2004 until 2015, where he developed projects, procedures and standards and supervised all technical projects of NPR Labs, the only not-for-profit broadcast engineering laboratory in the U.S. Mr. Kean also was a Senior Engineer at NPR from 1980 to 1986, where he supported new broadcast technology and pioneered expansion of FM transmission services.

At NPR Labs, he completed a thorough study of the compatibility of AM Modulation-Dependent Carrier Level with HD Radio®, for the National Radio Systems Committee. Also for the NRSC, he conducted a study of the performance of Single-Sideband FM Stereo and it compatibility with present-day FM receivers. He developed and supervised a major study for the Consumer Electronics Association into loudness range preferences of listeners. Through published articles and training, he introduced ITU loudness measurements to the public radio industry, which is now adopted by all NPR departments and is used to normalize all network audio content.

For the U.S. Dept. of Commerce/NTIA Public Telecommunications Facilities Program, he developed and supervised the production of detailed terrain-sensitive coverage maps and population demographic studies of more than 850 FM stations, all 750 public television stations, and their associated translators. Other studies include a measurement of interference susceptibility of consumer DTV receivers with NCE-FM signals and, for Sirius-XM Radio, a study of protection ratios with over-the-air signals from potential high-power FM modulators.

In 2008, he directed an 18-month project for the CPB on the coverage capabilities of HD Radio®, the U.S. digital audio broadcast system. Comprehensive software on the ESRI ArcMap GIS platform produced nearly four-thousand detailed signal-interference maps of U.S. public radio stations. From this research he developed a technical algorithm for determining the signal coverage capability of In-Band On-Channel (“HD Radio”) broadcasting for which he was issued a U.S. patent (#8,374,556 B2). This model was extensively field-verified for accuracy.
Other Employment

Director of Wireless Architecture, XO Communications, 3/2000 to 1/2004
Key responsibility for fixed wireless technology at one of the largest spectrum holders in the U.S. (101 LMDS licenses totaling 1.5 billion MHz-Pops). Provided wireless network design oversight and integration into metro optical-fiber networks. Provided regulatory representation on FCC technical rules and rulemaking proceedings. Performed business case analysis and model development for fixed wireless networks, to determine product sets, price points, and return on investment (including development of fixed wireless for cellular backhaul applications).

Consulting engineering in the fields of analog and digital TV and radio facilities, FCC regulations, microwave and satellite systems, and mobile cellular networks. Some telecommunications projects:

- RFP development with Israel’s Ministry of Communications for the first private cellular telephone license; provided follow-on bidder evaluations and selection.
- Supervised engineering design teams in Seattle, Houston and other cities for major PCS clients using advanced RF mapping and GIS tools;
- Led cellular phone systems design in Egypt, Ghana-W. Africa using GIS tools and data developed in-house.
- Consultant to the South African Telecommunications Regulatory Authority to allocate of spectrum for a nationwide mobile cellular network, which required extensive GIS mapping and demographic analysis of South Africa.
- Research and development of mobile RF field measurement systems for real-world PCS and cellular propagation studies using custom mapping engines.
- Technology selection and business case study of LMDS service for Orange LP, Israel.
- Lead engineer on a feasibility study for the first VHF marine radiotelephone system in the Sultanate of Oman.

Professional Activities and Honors

- Recipient of the 2016 NAB Engineering Achievement Award for Radio
- As a member of the Institute of Electrical and Electronics Engineers (IEEE), Past President of the IEEE Broadcast Symposium.
- Past president of the Audio Engineering Society (Washington DC Section)
- Chairman of the National Radio Systems Committee AM Study Task Group and Document Management Working Group.
- Principal researcher for the NRSC DRB subcommittee on studies of digital audio broadcasting performance and compatibility.
- Contributing author to the National Associations of Broadcasters’ NAB Engineering Handbook, Editions 7, 8, 9 and 11.
- Presenter of numerous papers in the field of radio systems engineering to the National Association of Broadcasters’ Engineering Conference, the International Engineering Consortium, the Wireless Communications Association, and Public Radio Conferences.