Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Office of Engineering and Technology's	)	ET Docket No. 16-191
Technological Advisory Council Noise	)	
Floor Technical Inquiry	)	

COMMENTS OF AT&T

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TABLE OF CONTENTS

I. INTRODUCTION AND SUMMARY……. 1

II. DISCUSSION……. 2

A. The TAC Inquiry is Timely……..……..… 2

B. The Increase in the Noise Floor Interferes with Services……..... 4

1. Electric switching power supplies adversely affect multiple Services …….…… 4

2. Certain unintentional radiators interfere with Commission Licensees……..…… 5

C. Possible Actions to Reduce the Impact of Noise ..…… 7

1. Improved Commission rules, standards, device design and testing will reduce noise from incidental radiators…… 7

2. Clarification of Commission rules and improved standards would reduce noise from unintentional radiators …… 8

D. Performing the Noise Study and Beneficial Use of the Resulting Data …….…… **9**

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AT&T Services, Inc., on behalf of its affiliated companies, ("AT&T") files these comments in response to the Public Notice[1] released by the Federal Communications Commission (the "Commission") seeking information to assist with a noise floor technical inquiry to be performed by the Commission's Technological Advisory Council ("TAC").

I. INTRODUCTION AND SUMMARY

The last 20 years has brought an explosion in technological innovation that has led to the unprecedented availability of high-tech consumer products—computers of all shapes and sizes, electronic treadmills, global positioning system ("GPS"), smartphones, electric cars, light-emitting diodes ("LEDs"), Wi-Fi, and solar panels. The noise floor has increased correspondingly because the switching power supplies in all of these and other electrical devices can create noise. These noise sources are evident in wireless and wireline communications systems in both public and private spaces. Also, incidental radiators, such as FM station cabinets and data busses and interfaces in computing devices, continue to be troubling noise sources. Noise from each of these sources has the potential to substantially degrade licensed and unlicensed services, to the detriment of the service providers and their customers. Thus, AT&T supports the TAC noise study.

[1] Office of Engineering and Technology Announces Technological Advisory Council Noise Floor Technical Inquiry, *Public Notice*, ET Docket No. 16-191 (June 15, 2016) ("*Public Notice*").

Though some noise can be easily mitigated through "good engineering practices," a lack of clear design and testing standards for some devices and a lack of regulatory clarity impede the understanding of those "practices" and who needs to perform them. The result is often intransigence, delay, and inefficient processes to resolve a problem that could be easily and inexpensively resolved at the source during design. Industry efforts to develop better and more complete standards and Commission guidance would go a long way to resolving these issues. This TAC study would benefit the Commission in that endeavor and set the stage for a cleaner spectrum environment.

II. DISCUSSION

A. The TAC Inquiry is Timely.

In the June 2016 TAC meeting,[2] the Spectrum and Receiver Performance Working Group noted that the Broadband Spectrum Monitoring Studies by The Institute for Telecommunication Sciences ("ITS"), the research and engineering arm of the National Telecommunications & Information Administration ("NTIA"), concluded that no clear trends about the noise floor were evident, since most ITS reports focus on spectrum occupancy and not noise. As a result, the TAC initiated this technical inquiry to ask and determine answers to the broad questions: Is there a noise floor problem? Where do problems exist (spectrally, spatially, and temporally)? Is there quantitative evidence of harmful interference from noise? How should a noise study be performed?

The *Public Notice* succinctly explains the TAC's expectation: "[T]he noise floor in the radio spectrum is rising as the number of devices in use that emit radio energy grows."[3] That

[2] https://www.fcc.gov/general/technological-advisory-council.

[3] *Public Notice* at 1.

expectation is well placed. The use of consumer electronic devices has experienced unprecedented growth in the last 20 years. Manufacturers are in a heated battle of one upmanship, developing devices with all manner of capabilities, such as, but not limited to, GPS units, electronic treadmills, computing devices in various forms, alarm systems, smart TVs, car charging systems, and solar panels. This trend will likely continue with the evolution to the Internet of Things, which Intel estimates will result in up to 200 billion connected devices by 2020.[4] All of these devices require a power supply, which over the years has become a greater source of spectrum noise. At the same time, consumers, private businesses, and local governments are transitioning from incandescent bulbs to more efficient, yet harmonically rich, LEDs.

This confluence of factors and existing noise from unintentional radiators, like FM station cabinets and computing device busses and interfaces, has increased the noise floor. Service providers continue the struggle to pinpoint and mitigate noise. As a result, noise creates interference into public and private networks, reducing the reliability, coverage, and quality of service. In these comments, AT&T provides illustrative examples of the most prominent and measureable noise impacts on its networks.[5] We are hopeful that the TAC noise study can begin the process of assisting providers like AT&T minimize those service impacts. For these reasons, this TAC inquiry is timely and can set the stage for a less noisy spectrum environment going forward.

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[4] A Guide to the Internet of Things, How Billions of Online Objects are Making the Web Stronger, available at *http://www.intel.com/content/dam/www/public/us/en/images/iot/guide-to-iot-infographic.png* (last visited Aug. 7, 2016).

[5] AT&T's examples not exhaustive and do not include noise sources that are intermittent or that cannot be consistently measured.

B. The Increase in the Noise Floor Interferes with Services.

1. Electric switching power supplies adversely affect multiple services.

AT&T's U-verse offerings are often impacted by incidental radiators, such as electric motors, light dimmers, switching power supplies, utility transformers, and power lines, devices which are not designed to generate or emit RF energy but do so as a result of their operation. Switching power supplies of all types, such as those used by DC adapters, AC inverters, treadmills, compact fluorescent light ("CFL") ballasts, LEDs, solar panel inverters, and electric car chargers, are particularly insidious because they are ubiquitous in residential environments close to U-verse service end points and because a single poorly designed switching power supply can be a component of many different types of devices.

Noise created by these devices can radiate in the environment where generated and be conducted through electrical systems in home and businesses and through the power grid, disrupting signals in the home or business and even throughout a neighborhood. Electric lines function as an antenna and the absence of adequate filters within the power grid facilitate the conduction of the noise to various points. This noise affects U-verse set-top boxes, residential gateways, coax and other cables, and other auxiliary devices operating between 40 kHz and 38 MHz and could affect other home networks operating in this and higher frequency ranges.[6]

Noise from power supplies also impact AT&T's Mobility services. In particular, lighting systems, including CFL ballasts and LEDs, such as those used in sports scoreboards, billboards, and other large scale video displays, can wreak havoc with uplink signals to nearby cell sites operating in the Lower 700 MHz and 850 MHz Cellular services and will likely impact soon-to-be-

[6] Within the customer premise, the reliability of AT&T products and services requires effective wired and wireless network connectivity provided using HPNA, MoCA, Ethernet, Wi-Fi, POTS, and other technologies.

auctioned 600 MHz spectrum. AT&T has had marginal success working with larger manufacturers of industrial lighting to redesign power supply modules to better filter noise, thus decreasing the potential for interference to wireless networks. But some manufacturers of devices using LEDs and ballasts are less motivated to reduce noise because of the added cost. Instead, they take shortcuts in design and construction to keep prices low, which in turn makes those devices less expensive and unfortunately more attractive to the average consumer. These factors, combined with government encouragement to transition to LEDs, lead to an increased propagation of lighting systems with a high potential to significantly increase the noise environment.

Moreover, motivated by greater efficiency, lower power consumption, and lower toxins (e.g., mercury), Federal, State, and local governments are deploying LEDs to replace incandescent bulbs in public buildings and spaces. For example, LEDs deployed in traffic lighting systems and street lighting can create narrowband spikes at intersections and along roadways. LEDs deployed in this manner can reduce the reliability, coverage, and data rates of wireless services, especially along the cell site edges of coverage. AT&T is particularly concerned about the potential impact of this noise on small cells sharing a support structure with LEDs.

Predictably, AT&T's U-verse and Mobility networks experience interference from incidental radiators more frequently in urban areas, with its greater number of noise sources. AT&T can and does experience interference from incidental radiators in rural areas, though those occurrences are less frequent. The distance at which noise from incidental radiators creates interference depends on the device, the strength of the noise, and the number of noise sources. For example, a single faulty power supply conducting noise through power lines can compromise U-verse service out to half a mile whereas a single power supply noise source could affect subscribers and cell sites within about a 2000 foot radius.

2. Certain unintentional radiators interfere with Commission licensees.

Harmonics from unintentional radiators at FM stations, such as from radio cabinets, are the greatest noise source impacting AT&T Mobility services. FM station generated noise can interfere with the uplink signal for Mobility services operating from 700 MHz to 2300 MHz within about 2000 feet of the station, but most significantly impacts uplink signals in the 700 MHz and 850 MHz services and will equally impact 600 MHz frequencies once brought to market. This noise is typically caused by a lack of good engineering practices, poorly designed cabinets, and intermodulation.

FM station noise is not an intermittent problem. For years, AT&T has struggled to identify and mitigate noise from FM stations, often encouraging broadcasters to implement good engineering practices, such as ensuring that cabinets have a properly bonded ground, quality and properly torqued connectors, and proper cabinet shielding. AT&T has worked about 60 of these incidences in 2015-2016 alone, of which over 30 remain unresolved. Some FM stations are cooperative, while others force AT&T to choose between an uncertain and at times lengthy formal resolution process at the Commission, incorporate expensive filtering solutions into its network, or accept a certain level of noise. FM station transmitters with lack of adequate low band pass filtering also create noise problems for mobility service.

Computing devices contain data busses and interfaces that also can be a noise source. The busses and interfaces link the processor and other ancillary devices, such as the video display, transmitting data at speeds in the 3-4 GHz range, which leads to harmonics and noise products. These create noise for many industries and groups, including broadcasters, mobile service providers, public safety licensees, and other land mobile operators. Users of these services have a legitimate expectation that those services will operate as intended, but are often unable to do so due

to the elevated noise floor. The distance at which interference occurs depends on the level of noise in a particular situation and how the noise is radiated. Noise from unintentional radiators can radiate over a wide swath of spectrum, from the AM broadcast band up through 5 GHz Wi-Fi band. This noise source has impacted inside wire, very-high-bit-rate digital subscriber line services (VDSL), U-verse set-top boxes, and wireless services in the 700-850 MHz range.

C. Possible Actions to Reduce the Impact of Noise.

1. Improved Commission rules, standards, device design and testing will reduce noise from incidental radiators.

The Commission observes that noise from incidental radiators is not highly regulated and is expected to be minimized with "good engineering practices." AT&T agrees. For example, consumer device manufacturers could place filters on electric treadmills and power companies could place filters on transformers to reduce conducted noise from consumer devices. Yet, the absence of clear standards and regulatory guidance for manufacturers leads to different interpretations in what constitutes "good engineering practices" and who is responsible for implementing such practices. Device manufacturers, when they can be tracked down, can place millions of devices in the stream of commerce before their device is identified as a noise source. Those devices will remain in use for years.

Noise from incidental radiators could be mitigated through updated industry standards, better testing protocols for device manufacturers, and clarity in Commission regulations for spurious emissions. Updated standards would lead to improved designs and testing and facilitate a common playing field for all, reducing uncertainties and setting expectations prior to design. Better and more reliable design and construction would in turn minimize some noise, such as using oscillators that do not fall within mobile carriers' receive bands and tighten the emissions through shielding and overall better design. Improved testing at a wider frequency range, up to 6 GHz,

would identify the potential for interference to commercial mobile and public safety licensees, avoiding the inefficient and piecemeal approach of identifying and mitigating noise after it occurs. Current Commission rules require testing only to about 30 MHz, far below, and without considering harmonic impacts to, the spectrum used by those licensees.

2. Clarification of Commission rules and improved standards would reduce noise from unintentional radiators.

Similar issues impede the resolution of noise impacts from unintentional radiators in FM station facilities. FM broadcasters generally take the view that they have no obligation to reduce noise impacts to AT&T's mobility network as long as they comply with the Commission Part 73 technical rules. This forces AT&T to resolve noise issues in the slowest, most expensive, and most inefficient manner possible—case by case. Many interference complaints are identified only after a customer complaint, which is a piecemeal approach to resolving noise concerns. If the FM station is uncooperative, AT&T may have to deploy a filter on the impacted cell site at a cost of approximately $60,000 per affected frequency band. These sites then require continued management and experience trade-offs in spectral efficiency, reduced cell site coverage area, and network performance.

In contrast, FM broadcasters can mitigate harm from cabinet harmonics through the aforementioned "good engineering practices," which typically means merely ensuring that cabinets have properly bonded grounds, quality and properly torqued connectors, and proper cabinet shielding. Similarly, noise from FM station antennas with inadequate low band pass filters, which could potentially impact multiple cell sites, can be mitigated with a relatively inexpensive quality filter. The Commission can create the incentives for FM broadcasters to take these initiatives and for more consistent cooperation between FM broadcasters and mobile service providers by clarifying that existing rules require FM broadcasters to mitigate noise into cell sites from their

unintentional radiators and antennas with inadequate low band pass filters.

As with incidental radiators, better and updated standards for designing, constructing, and testing would minimize noise from data busses and interfaces in computing devices. Specifically, the TAC should investigate the potential for higher frequency compliance standards to substantially reduce noise for those components because of the harmonically rich potential of busses and interfaces.

These actions to facilitate mitigation of noise from unintentional radiators would benefit all users of impacted spectrum, not just AT&T and other mobile service providers. Noise tends to affect multiple users across fairly wide swaths of spectrum. AT&T has the equipment, knowledge, and other resources to track down and identify noise problem, but not all spectrum users have those resources. While those users may not understand what noise sources are impacting their services, it should be acknowledged that they exist and that they can likewise benefit from this TAC study.

D. Performing the Noise Study and Beneficial Use of the Resulting Data.

The noise floor can vary greatly by location, time of day, and frequency. Thus, it is not possible to collect data for the study that accurately measures the noise floor at all times and locations and within all spectrum bands. Nevertheless, the TAC study can generate data on the major sources of noise affecting different services, which data could be used to assist licensed and unlicensed service providers' efforts to mitigate that noise, and reduce, if not eliminate, network interference. To maximize the accuracy of information generated, the noise floor study should collect data pertaining to noise at variable times of day and night. In AT&T's opinion, the noise study should collect data through an immersive, long-term study in environments where noise occurs, that is in neighborhoods with switching power supplies where electric car charging stations, solar panels inverters, and treadmills would be used; along public roads, intersections, and public

spaces where power lines and traffic lighting systems, large screen video displays with LEDS would be deployed; in industrial centers where CFL ballasts, LEDs, motors, and digital controllers would be encountered; and near FM stations.

The noise study should be based on a Fast Fourier Transform ("FFT") peak quadrature ("I-Q") receiver applied to both conducted and radiated RF energy. A FFT I-Q receiver should be accurate to +/− 2 dB and capable of measuring better than one quarter of the operating bandwidth of the channel in question. Measurements should be taken for peak signals, not quasi-peak, out to at least 1.3 GHz to capture the vast majority of impacts from an increase in the noise floor.[7] Quasi-peak (or other average) reading measurements made for Part 18 conducted emissions testing using the ANSI/IEEE C.63.4 standards would not capture the short burst noise signals that are either fundamental to the modulation scheme that is in use, a by-product of a switching device, or a harmonic or intermodulation product of one or many signals in the system or environment.

The TAC could also substantially advance the study by setting up an open platform process to collect data from third parties. Licensees and other third parties may have performed testing or conducted studies on noise impacts to their services and how to mitigate that noise. Licensees willing to submit such information for consideration by the TAC should be allowed to do so. In that vein, the TAC must consider only viable data to ensure data integrity and reliability. For example, measurements from uncalibrated or minimally calibrated devices would aid in the process

[7] The following sources also contain helpful information on noise measurements that could help the TAC in its noise study and the Commission in developing solutions to increased noise: Erik van Maanen, *Practical Radio Noise Measurements*, 18th Int'l Wroclaw Symposium and Exhibition on Electromagnetic Compatibility (2006), available at https://www.agentschaptelecom.nl/sites/default/files/practical-radio-noise-measurements_0.pdf, and Int'l Telecommunications Union Recommendation ITU-R P.372-12 (2005), available at https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.372-12-201507-I!!PDF-E.pdf.

without undermining the integrity of the data provided that it is used solely for directional only and only if the tools used to capture the data are accurate to +/− 2 dB.

Results of the TAC study should be used to help device manufacturers design and test for unwanted noise and help providers and users of licensed and unlicensed services more efficiently discern and mitigate noise when it does occur. It should not be used as justification for new spectrum sharing schemes.[8] AT&T has outlined above some of the more frequent sources of noise affecting it various networks. Those examples are illustrative only and do not include countless other interference incidents from other sources. Spectrum sharing within historically exclusive licenses would only increase those interference incidents, with the stamp of Commission acceptance.

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[8] See, e.g., Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands, *Notice of Inquiry and Notice of Proposed Rulemaking*, ET Docket No. 03-237, 18 FCC Rcd 25309 (2003).