Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
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	)	ET Docket No. 03-237

SPRINT CORPORATION COMMENTS

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Summary

Sprint makes the following points in its "Interference Temperature" ("ITemp") comments:

1. Mobile services licensees will not benefit from the ITemp concept. The ITemp sharing paradigm will not prevent a further erosion of licensed spectrum as the NOI claims because the unlicensed devices causing this erosion would not be subject to any ITemp rules. More fundamentally, the deliberate introduction of additional interference will necessarily harm mobile services licensees (and their millions of subscribers) by diminishing existing service reliability and coverage – and adversely impacting deployment of new services in mobile bands. Adoption of the ITemp paradigm would constitute a reallocation decision, because the FCC would be taking from licensees spectrum they currently use and giving that spectrum instead to unlicensed devices.

2. The ITemp concept is not spectrally efficient as applied to mobile services networks. A Telcordia analysis, which accompanies Sprint's comments, demonstrates that one of the core assumptions of the NOI – ITemp would improve overall spectrum efficiency – is not accurate as applied to mobile services networks. Instead, Telcordia determines that the loss of licensed capacity would exceed the limited capacity that unlicensed devices would gain.

3. There are major technical challenges in implementing the interference control mechanisms needed to make the ITemp concept workable in mobile services bands. Two of the three approaches discussed in the NOI – the "self" and "indirect" monitoring methods – are not workable at all as applied to mobile services bands. The third, "direct" approach is also not effective as applied to mobile services downlink (base-to-mobile) bands. The technical and engineering challenges associated with implementing ITemp in uplink (mobile-to-base) bands are so many and severe that the ITemp concept is not practically feasible.

4. Under long-standing FCC policy and precedent, it is the unlicensed industry that would have the obligation of funding all ITemp implementation/operational costs. ITemp devices would be far more costly and have less range than "ordinary" unlicensed devices designed for unlicensed bands. If given the choice between two products with similar functionality, consumers will purchase the less expensive product, especially if the cheaper product can operate at further distances than the more expensive product. Thus, it is not at all apparent that manufacturers would even build ITemp devices (even ignoring the implementation and spectral efficiency issues) given that "ordinary" (and less costly) unlicensed devices already have access to more than 500 MHz of spectrum.

5. The ITemp concept would retard introduction of more spectrally efficient technologies in licensed bands. The short history of the commercial mobile services industry has been one of continual and documented technological innovation (1G-to-2G-to-2.5/3G), with each technology using less power and using spectrum more efficiency. Further concrete technological developments (planned or in research) promise yet further increases in spectral efficiency. This continued innovation, which clearly promotes the public interest (as well as our nation's economy), will be impeded if the FCC adopts ITemp levels based on today's technology.

6. The NPRM's proposal for ITemp introduction in fixed point-to-point networks would cause harmful interference. Neither transmit power control ("TPC") nor dynamic frequency selection ("DFS") will facilitate band sharing between unlicensed devices and fixed point-to-point

one-way links in the 13 GHz band. Correctly implemented, TPC allows for only a very limited output power of the unlicensed device in the area surrounding the licensed microwave receiver and significantly limits the maximum range between the unlicensed transmitter and unlicensed receiver. The DFS threshold values proposed in the NPRM will result in inaccurate channel occupancy determinations in the area surrounding the licensed microwave receiver. While an "exclusion zone" is a theoretical alternative, practical problems render it unworkable.

7. The ITemp Concept Raises Serious Non-Technical Concerns. Implementation of the ITemp concept in mobile services bands would nullify technological advances and would undermine the FCC's market-oriented policies, as well as important public safety and Homeland Security objectives. Secondary market activities provide a better mechanism for making spectrum available for unlicensed use. It avoids the problems associated with the ITemp concept and allows licensees to manage interference in their spectrum. Implementation of ITemp would upset the investment expectations of licensees by preventing full realization of spectrally-efficient technologies, and would chill future investment in new technologies by introducing regulatory uncertainty into the technology development/deployment process. Finally, implementation of the ITemp concept would impinge upon licensees' legal rights.

In sum, if unlicensed devices need access to more spectrum, despite the FCC's recent allocation of an additional 255 MHz of spectrum, that need can be better addressed at far less cost by allocating additional spectrum for unlicensed use or by secondary market mechanisms. Licensed mobile services and subscribers would be harmed by introduction of ITemp sharing in mobile service bands.

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SPRINT COMMENTS

Sprint Corporation, on behalf of its wireless division ("Sprint"), submits these comments in response to the Notice of Inquiry and Notice of Proposed Rulemaking that seek information concerning a new "interference temperature" ("ITemp") model to "possibly create opportunities for new and additional use of radio communications," including unlicensed device access to licensed spectrum.[1] Sprint appends as Attachment A a technical analysis prepared by Telcordia Technologies, Inc. ("Telcordia") that extensively examines the ITemp paradigm as a means to facilitate unlicensed device access to licensed spectrum.[2]

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[1] *See 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,* ET Docket No. 02-237, *Notice of Inquiry and Notice of Proposed Rulemaking,* FCC 03-289, at ¶ 1 (Nov. 28, 2003), *summarized in* 68 Fed. Reg. 68831 (Jan. 21 2004)("*ITemp NOI/NPRM*").

[2] *See* Dr. Jay E. Padgett and Dr. Robert A. Ziegler, Telcordia Technologies, Inc., *Analysis of "Interference Temperature to Support Spectrum Sharing Between Licensed Services and Unlicensed Devices* (April 2003)("Telcordia Report"), appended as Attachment A. Dr. Jay Padgett and Dr. Robert Ziegler together have 40 years of research and development experience in the telecommunications and wireless industries. Their expertise covers a broad range of wireless topics including second- and third-generation wireless networks, ultra wideband ("UWB") radio, adaptive antenna array processing, and unlicensed technologies. During their careers they have both been involved in internal product development programs, as well as consulting for external Government and commercial customers. Biographies of Drs. Padgett and Ziegler are appended to the end of the Telcordia Report.

Sprint supports the unlicensed industry and the benefits it provides. Indeed, Sprint uses unlicensed devices throughout its business, and it offers "WiFi" access to both consumers and enterprise customers.[3] But as Sprint demonstrates below, utilization of the ITemp concept as a means to facilitate unlicensed device access to additional spectrum is not workable in frequency bands allocated for mobile services due to significant technical obstacles – not the least of which is the fact that unlicensed "ITemp devices" would be unable to ascertain the cumulative interference levels encountered by a licensed receiver they cannot see. Moreover, even if the substantial technical hurdles could be overcome, and even ignoring the significant policy, economic, market and legal consequences of the ITemp paradigm, the fact is that the ITemp concept – adding unlicensed uses in licensed bands – is *spectrally inefficient* when compared to the alternative of allocating separate bands for unlicensed devices.

Sprint has supported, and continues to support, the Spectrum Policy Task Force's recommendation to move more spectrum from the "command-and-control" model to either the licensed "exclusive use" or unlicensed "common" models. But combining the "exclusive use" and "commons" models into one "hybrid" model in current licensed bands raises a host of policy, economic, engineering and legal impediments that, as demonstrated below, benefit neither the licensed nor the unlicensed industries. The negative consequences of diminished service reliability and capacity that ITemp presents implicates commercial operations and public safety functions.

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[3] *See, e.g.*, www.sprintbiz.com/solutions mobile; www.sprint.com/pscbusiness/products_services/data/wifi. In this regard, Sprint supported the FCC's recent allocation of an additional 255 MHz of spectrum for unlicensed devices. *See, e.g.*, Sprint Comments, ET Docket No. 02-135, at 7-8 (Jan. 27, 2003).

Sprint and other firms have invested substantial resources to construct and upgrade wireless networks that maximize spectral efficiency and that provide reliable, innovative, high-quality services demanded by wireless consumers. Sprint's efforts in this regard cover Personal Communications Services ("PCS") spectrum as well as Multipoint Distribution Service ("MDS") and Instructional Television Fixed Service ("ITFS") spectrum. The Commission should reject the ITemp concept in mobile services bands, so licensees can be confident that their investments and efforts to date, and their additional capital investments in more spectrally efficient technologies will not be undermined.

I. THE NOI IS MISTAKEN IN SUGGESTING THAT MOBILE SERVICES LICENSEES WOULD BENEFIT BY THE ITEMP CONCEPT

The NOI states that licensees would benefit by the adoption of the ITemp paradigm because they supposedly would receive "greater certainty regarding the maximum permissible interference, and greater protections against harmful interference that could be present in frequency bands in which they operate."[4] Sprint must respectfully disagree, at least with regard to mobile services in the PCS bands and those expected to be implemented in the MDS/ITFS bands.[5] In point of fact, implementation of the ITemp concept will harm mobile services licensees and the 150-plus million subscribers who rely on their services.

[4] *ITemp NOI* at ¶ 1. *See also id.* at ¶¶ 7, 8, 9, 15 and 18.

[5] MDS licensees have been authorized to provide mobile services. *See MDS/ITFS Mobile Services Authorization Order*, 16 FCC Rcd 17222 (2001). While the deployment of mobile services in the MDS/ITFS band realistically cannot begin until the FCC completes a revision of the band rules, *see MDS/ITFS Rules Rewrite NPRM*, 18 FCC Rcd 6722 (2003), the MDS band is nevertheless appropriately classified as a mobile services band. Throughout these comments, Sprint includes the MDS bands within its discussion of mobile services.

The Commission has previously characterized RF interference as "spectrum pollution" and "electromagnetic smog,"[6] and its staff has defined ITemp as "a measure of the pollution of the electromagnetic spectrum by all devices operating in that band."[7] The theory of the ITemp concept is that if there is some pollution in a licensed band, it may be appropriate to add additional pollution in the band – at least up to the ITemp "cap" established for a given licensed band in a given geographic market.

Whatever the merits of the ITemp concept as an approach in providing additional spectrum access for unlicensed devices, one cannot credibly conclude that licensees would benefit by the deliberate introduction of additional RF pollution. After all, the solution to pollution is to reduce existing levels – and not to add deliberately yet more pollution. This is particularly the case for licensed systems utilizing the highly advanced, interference-limited Code-Division Multiple Access ("CDMA") technology. As documented below, the introduction of any new interference in CDMA bands necessarily reduces the system's coverage and/or capacity – and, thus, necessarily harms CDMA licensees and their customers.

The NOI's view of the ITemp concept – from which the Commission perceives potential benefit for licensees – is flawed in several important respects. Specifically, as demonstrated below:

- The ITemp concept, depicted in Figure 1 of the NOI, rests upon several assumptions that cannot be reconciled with available facts;

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[6] *See, e.g., Revision of Part 15,* 51 F.C.C.2d 459 ¶ 3 (1974); *Deregulation of Radio,* 84 F.C.C.2d 968, 1015 (1981).

[7] OSP Working Paper No. 39, *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues,* at 56 (May 2003).

- Whereas Figure 1 presents implementation of the ITemp paradigm as a straight-forward technical exercise, in reality, the concept as applied to mobile service bands is fraught with technical challenges that make the concept impossible and/or impractical to implement; and
- The ITemp concept ignores the fundamental fact that, with respect to advanced CDMA networks, all incremental increases in external interference result in a net degradation of service that is harmful both to CDMA network operators and the consumers who subscribe to their services.

In these comments, Sprint focuses on the CDMA air interface, the technology it utilizes in its mobile services network. CDMA, unlike other multiple-access technologies – *i.e.*, TDMA (including GSM) and FDMA – can operate below the noise floor. However, all three air interfaces are adversely affected by an increase in the noise floor, because such an increase necessarily results in a reduction in network capacity.[8]

A. THE ITEMP CONCEPT AS ILLUSTRATED IN FIGURE 1 OF THE NOI CONTAINS SEVERAL FUNDAMENTAL INCORRECT FACTUAL ASSUMPTIONS

Figure 1 in the NOI, which was reprinted from the November 2002 report of the Spectrum Policy Task Force ("SPTF"),[9] purports to show "how the interference temperature limit approach could be beneficial to licensees":[10]

[8] It also bears noting that third-generation ("3G") standards for GSM carriers specify a transition to CDMA technology – specifically, Wideband CDMA ("WCDMA"), also known as Universal Mobile Telecommunications System ("UMTS"). *See Eighth CMRS Annual Report*, 18 FCC Rcd 14783, at ¶ 36 (2003).

[9] *See* Spectrum Policy Task Force Report, ET Docket No. 02-135, at 29, Figure 3 (Nov. 2002)("SPTF Report").

[10] *See ITemp NOI* at ¶ 15.

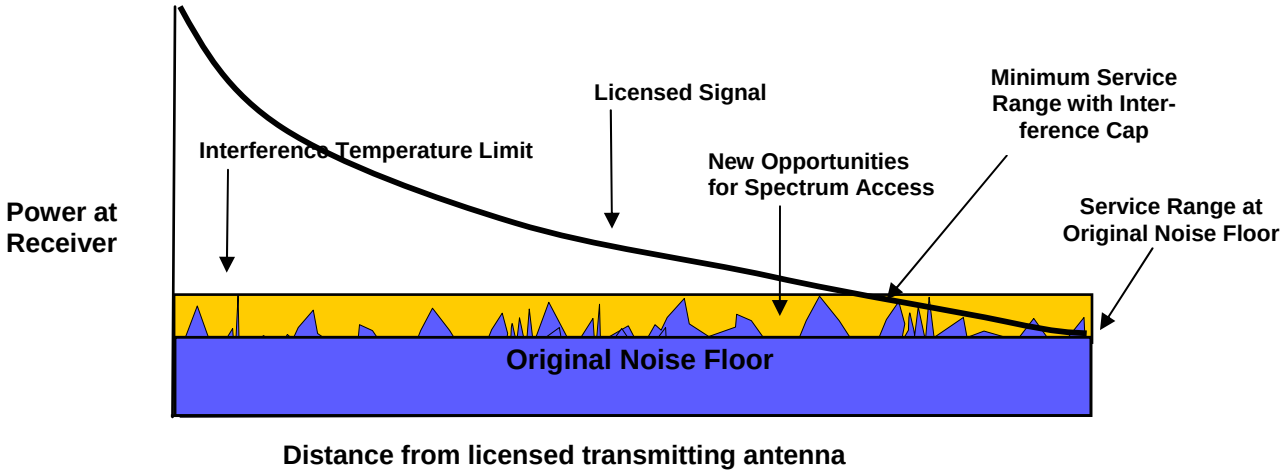

Figure 1: *ITemp concept illustration, reproduced from Figure 1 in the NOI*

Specifically, based on the assumption that licensees experience peaks of undesired RF emissions above the noise floor in their licensed spectrum, the NOI asserts that adoption of an ITemp "cap" would "assure" licensees that they will not experience "any further degradation or loss of service from new interference, and thereby provide incumbents greater certainty regarding the maximum permissible level of interfering RF energy in the bands in which they operate."[11] There are, however, several major flaws with the stated ITemp rationale, as Sprint explains below.

1. The NOI's Assumption That Sizable Peaks of Interference Exist Above the Noise Floor Is Not Documented and Is Inconsistent with Available Data

A fundamental assumption underlying the ITemp paradigm is that licensees encounter "additional interfering signals" after they design and construct their networks and that this new interference is indicated in Figure 1 "by the peaks above the original noise floor."[12] According to the ITemp rationale, capping these peaks of interference will prevent further erosion of licensed spectrum. The NOI, however, does not cite any empirical data to support the existence of

[11] *Id.*

[12] *Id.*

these purported peaks in the noise floor. Similarly, the SPTF Report, from which Figure 1 of the NOI was reprinted, did not purport to base the noise floor depiction in Figure 1 upon actual noise floor data, but rather concluded that concise noise floor data was required before any ITemp construct could be implemented.[13] Further, the findings of the Unlicensed Devices and Experimental Licenses Working Group, which informed the SPTF's Report, supported the conclusion that much more data is needed before the ITemp concept can be effectively evaluated:

> There appears to be no available data in the United States that show what the trends have been with regard to ambient noise or data that show how much of the noise present is due to unlicensed intentional emitters or any other specific types of source. There is no generally accepted methodology for measuring ambient noise levels and format for recording such information. . . . Moreover, such data are necessary for implementing Spectrum Policy Task Force recommendations, most specifically the interference temperature recommendation.[14]

In fact, recent studies suggest that the noise floor is not characterized by peaks of interference, but rather is relatively constant. For example, a study performed last year by the engineering firm, V-COMM, of the noise floor within the PCS band in Philadelphia and Allentown, Pennsylvania, demonstrated "low operating noise floor levels existing in the clean and occupied PCS spectrum bands":

> The median noise floor results for the clean spectrum measurements were consistently about –129 dBm. The RMS average noise floor results for the clean spec-

[13] *See, e.g.*, SPTF Report at 33 ("The Task Force recognizes that there are hurdles that must be overcome before the interference temperature metric could serve as a useful management tool. Foremost among these is the need to acquire data on the RF noise floor for different frequency bands and geographic regions."). The SPTF noted that the Technical Advisory Committee ("TAC") had observed that '"[u]ntil [noise floor] information is organized and analyzed, the FCC will not have a firm basis for deciding whether current noise standards are too tight, too loose, or maybe even just right.'" *Id.* at 13, n.20, *citing* Sixth TAC Meeting Report at 9.

[14] Spectrum Policy Task Force, Report of the Unlicensed Devices and Experimental Licenses Working Group, at 13 (Nov. 15, 2002). *See also id.* at 17 ("[T]he lack of reliable information on noise floor in typical radio user environments and trends in such noise floors has been a complicating issue in recent policy deliberations . . . .").

> trum measurements within a 1 MHz bandwidth are about –112 to –113, with an average of –112.4 dBm.[15]

Data from this study revealed that environmental noise in the PCS bands is "not appreciably increased above the thermal noise floor level."[16] The results of this PCS noise floor study are consistent with Sprint's real-world experience in operating a nationwide, state-of-the-art PCS network and fixed wireless networks in the MDS bands: there is no significant external interference in these bands today.

The Commission's own study of the RF environment in the global positioning system ("GPS") bands detected virtually no ambient interference outdoors, and attributed the limited ambient noise it detected in indoor environments to Part 15 incidental and unintentional radiators:

> The results of these tests show that the GPS frequency bands generally have very low levels of ambient radio noise in outdoor environments. In contrast, the GPS bands in indoor environments have levels of ambient radio noise . . . attribut[able] to radio frequency emissions from a variety of common electrical and electronic devices, such as personal computers, peripherals and electrical machinery.[17]

Importantly, however, the interference presented by these radiators – whether incidental, unintentional or intentional – would *not* be subject to, or otherwise controlled by, any ITemp rules being proposed. In other words, even if peaks of interference above the noise floor were caused by these devices, the ITemp concept could not, and would not, reduce such peaks or limit their growth in any way.

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[15] *See* V-COMM, L.L.C., *PCS Noise Floor Study*, at 2 (Sept. 16, 2003), submitted in WT Docket No. 02-86 on October 15, 2003, by AT&T Wireless Services, Inc., Cingular Wireless, and Verizon Wireless ("*V-COMM PCS Noise Floor Study*").

[16] *Id.* at 2.

[17] *See* Public Notice, *FCC Staff Releases Report*, ET Docket No. 98-153, DA 02-2786, at 2 (Oct. 22, 2002). *See also* FCC Project TRB 02-02 Report, *Measured Emissions Data for Use in Evaluating the Ultrawideband (UWB) Emissions Limits in the Frequency Bands Used by the Global Positioning System (GPS)*, ET Docket No. 98-153 (Oct. 22, 2002).

Sprint submits that, based on available data, Figure 2 below provides a more accurate depiction of existing noise levels in bands used by commercial mobile services providers than that provided in Figure 1 of the NOI:

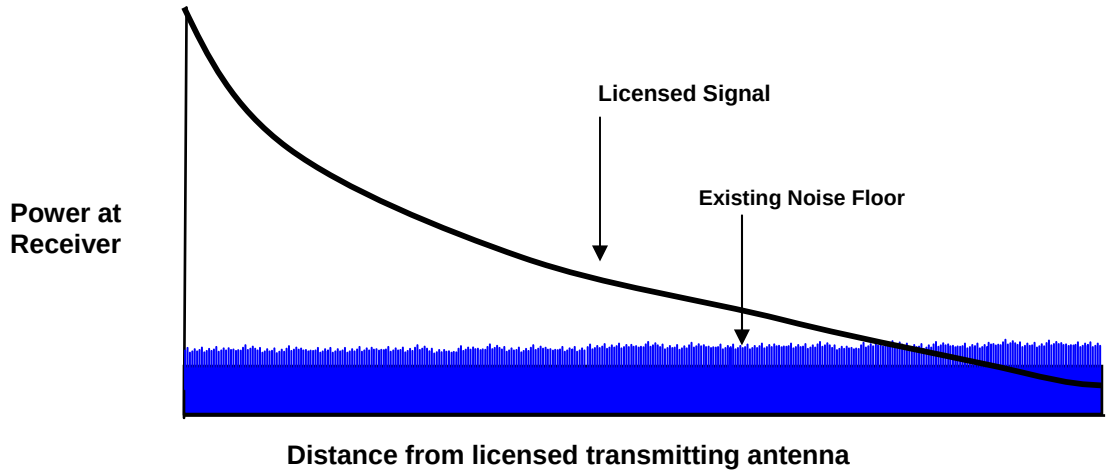

Figure 2: *Graphic depiction of ambient noise in today's mobile services bands.*

Accordingly, the NOI's assumption that there exist large pockets or peaks of interference above the thermal noise floor does not appear to be consistent with the facts, at least for the PCS and MDS/ITFS bands. At a minimum, as the NOI appears to anticipate and as the Spectrum Policy Task Force specifically recommended, the Commission must complete comprehensive studies of the noise floor on a band-by-band, area-by-area basis before it can seriously contemplate whether or not the ITemp concept is even valid.

2. Figure 1 in the NOI Inaccurately Portrays the Spectrum Used by CDMA Network Operators

The NOI appears to assume that licensed networks do not operate in between any peaks of interference above the noise floor that might exist in a given area (*i.e.*, the light gray area – or gold, if viewing in color – in the NOI's Figure 1, above the line labeled "original noise floor" and immediately below the line labeled, "interference temperature limit"). The NOI further im-

plies that licensed receivers can operate only above the noise floor, and not below the noise floor. The NOI thus gives the impression that unlicensed ITemp devices would merely be using only spectrum that licensees are not utilizing.

These assumptions are not accurate for licensees such as Sprint that utilize CDMA technology. In fact, as another experienced CDMA network operator has previously advised the Commission, "due to the inherent processing gain of the CDMA system, CDMA receivers have the ability to operate effectively below the noise floor. This is one of the basic principles of a spread spectrum system, and the manner in which a CDMA system provides increased capacity."[18]

In Sprint's CDMA (1xRTT) network, fast power control in the uplink (mobile-to-base station) is used to continuously adjust the base station power on the traffic channel to the handset, such that only sufficient power is provided after transmission loss to overcome the RF interference generated by undesired emitters plus noise ("I+N") present at the handset. Handsets in low interference/noise environments receive less power from the base station; conversely, handsets in higher interference/noise environments receive more power from the base station (assuming additional power is available). The point is that CDMA systems can operate in areas where there are spikes of interference – although the handset requires more power (to compensate for the interference spike), meaning that less power (and, thereby, less capacity) is available for other customers served by the base station.

Figure 3 below depicts the spectrum currently utilized by CDMA networks:

[18] Verizon Wireless Reply Comments, WT Docket No. 02-135, at 7 (Feb. 28, 2003). *See also* V-COMM PCS Noise Floor Study, WT Docket No. 02-86, at 35 (filed Oct. 15, 2003)(CDMA "is able to utilize signals below the thermal noise floor of its receivers.").

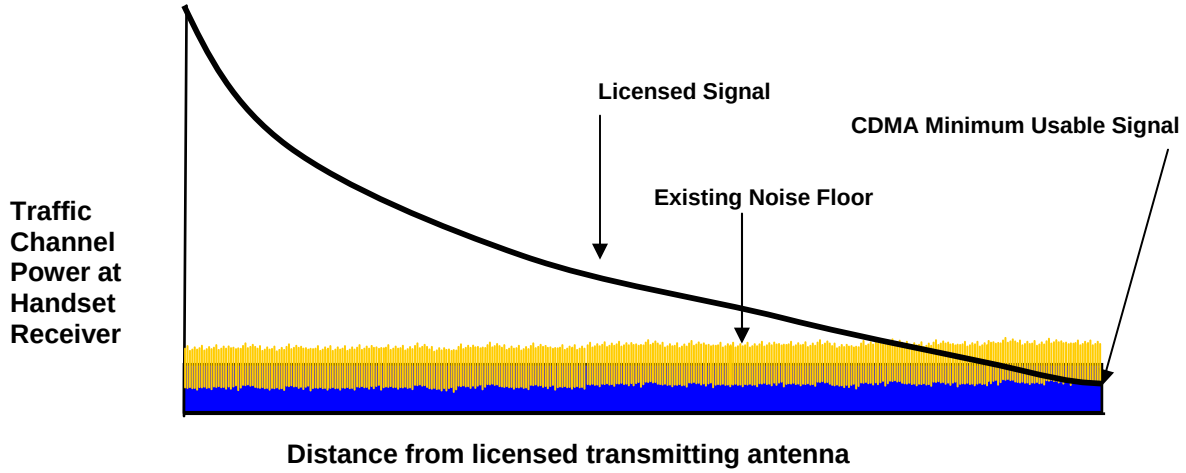

Figure 3: *Graphic depiction of spectrum utilized by CDMA operators*

The light gray (or gold, if viewing in color) area in Figure 3 (the area above the CDMA minimum usable signal line) is spectrum CDMA network operators currently utilize in the provision of their services.

Accordingly, the NOI's assumption – "opportunities would exist for additional operation by 'underlay' transmitters"[19] – is *not accurate* as applied to licensed CDMA networks. If ITemp devices are permitted to use any part of the spectrum used by a CDMA system, the operational noise floor would be increased, and the CDMA minimum usable signal would, in turn, have to be increased (to achieve the signal-to-noise ratio that existed prior to the operational noise floor increase), resulting in reduced capacity and coverage. In other words, implementation of the ITemp sharing paradigm would effectively constitute a spectrum reallocation decision – because it would take spectrum CDMA licensees are currently using and give that spectrum to unlicensed use.[20]

[19] *See ITemp NOI* at ¶ 16.

[20] The ITemp paradigm could also preclude licensee deployment of innovative new technologies that are even more spectrally efficient, as Sprint discusses in Section V below.

3. The NOI's Assumption That an "ITemp Cap" Would Prevent Interference Above the Cap Is Unexplained and Fundamentally Wrong

According to the NOI, licensees would benefit by the ITemp concept because adoption of an ITemp "cap" would "fix the amount of new interference" that a licensee would encounter:

> This would assure that the licensed operation would not experience any further degradation or loss of service from new interference, and thereby provide incumbents greater certainty regarding the maximum permissible level of interfering RF energy in the bands in which they operate.[21]

These statements are not accurate.

Whatever spikes of interference that may exist in any given band today are caused by unintentional radiators (*e.g.*, personal computers); incidental radiators (*e.g.*, hair dryers, electric motors); and spurious (or out-of-band) emissions of licensed and unlicensed intentional radiators. These devices would not be subject to any ITemp rules adopted. As a result, the ITemp rules would not stem or otherwise control the aggregate interference effects of the continued proliferation of these non-ITemp devices. The introduction of ITemp-compliant devices also would have no effect on the operation of, or interference caused by, non-ITemp devices.

Accordingly, even if the ITemp construct could establish an interference cap specific to ITemp-compliant devices, the NOI's statement that the ITemp would "serve as an upper bound or 'cap' on the potential RF energy that could be introduced into [a licensed] band"[22] is erroneous, as is the NOI's assertion that ITemp would provide licensees with "greater certainty regarding the maximum permissible level of interfering RF energy in the bands in which they operate."[23]

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[21] *ITemp NOI* at ¶ 15.

[22] *Id.* at ¶ 1.

[23] *Id.* at ¶ 15.

B. FIGURE 1 IN THE NOI IS MISLEADING BECAUSE IT DOES NOT CONVEY THE TECHNICAL COMPLEXITIES OF IMPLEMENTING THE ITEMP CONCEPT IN MOBILE SERVICES BANDS

Figure 1 in the NOI gives the impression that the ITemp concept is relatively easy to implement, by suggesting that an unlicensed device need only measure the I+N level where it is being used and may operate so long as its contribution to the noise floor would not push the I+N level above the specified ITemp cap. Indeed, Figure 1 suggests that the task of meeting the ITemp level is akin to filling a bucket (the relevant frequency band) with water (RF power) until one reaches a given water line (the ITemp limit).

Figure 1 in the NOI is thus misleading in several material respects. First of all, as the Commission acknowledges, the relevant issue is the "cumulative effects of all undesired RF energy" that is present "at a [licensed] receiver at any instant in time" – *not* the RF energy present at the unlicensed device.[24] The attached Telcordia Report confirms that it does not matter what the I+N level is at the unlicensed device – the critical measure is rather the I+N level that is experienced by the licensed receiver.[25] Significantly, as discussed below, none of the NOI's three suggested approaches for implementing the ITemp concept is capable of providing the unlicensed device with the actual I+N level experienced by a licensed mobile services transceiver.

It is also important to emphasize that the ITemp concept is not a listen-before-talk construct, where the unlicensed device simply checks the total RF power level present in the band and transmits so long as the total RF power level it measures has not exceeded some given threshold (*i.e.,* fills "water" up to the specified "water" line). In point of fact, the bucket (the licensed band) is already full of "water" (comprised of noise and emissions from the licensed and

[24] *Id*. at ¶ 1.

[25] *See* Telcordia Report, Executive Summary at 1.

unlicensed devices). Thus, for the ITemp concept to work, the ITemp device must be capable of (i) separating the "water" contributions of the unlicensed device from the "water" contributions of noise and the licensed devices, *and* (ii) ensuring that its contributions do not cause the "water" to exceed the "water" line level. In other words, an ITemp device must discriminate among and between noise, licensed device RF signals and unlicensed device RF signals within the band. It is not clear how any ITemp device could distinguish among the aggregate RF signal power, the RF signal contributions received from unlicensed devices, licensed transmitters and background noise; nor is the enormous complexity of this task conveyed by the NOI's Figure 1. Again, Telcordia discusses this in the attached report.[26]

Moreover, computing interference is not simply a question of raw RF power generated by unlicensed transmitters present at the licensed receiver. As the Telcordia analysis points out, the waveform sensitivity of the licensed receiver must also be factored in, which requires evaluation of the "spectral, temporal, and statistical characteristics of the interference."[27] In other words, not all types of interference will affect the victim receiver in the same way as additional background noise, and there is no one-size-fits-all definition of I+N that will apply in all bands to all licensed network technologies. And in the end, Figure 1 in the NOI does not depict the fundamental technical challenges of implementing the ITemp concept.

[26] Telcordia notes that it might be possible to require unlicensed devices to transmit a pilot signal (at a constant, preset output power) on a separate frequency from the primary channel may provide a means to monitor aggregate signal strength of the unlicensed devices at the receiver separate from the signals of licensed transmitters. *See* Telcordia Report at § 2.6. However, this approach would require a separate allocation of unused spectrum for that purpose, thus defeating the very spectrum sharing that supposedly is the benefit of the ITemp concept.

[27] Telcordia Report at § 2.5.

C. ANY EXTERNAL INTERFERENCE IS HARMFUL TO MOBILE SERVICES LICENSEES AND THEIR SUBSCRIBERS

The Commission acknowledges that the introduction of new external interference in a frequency band harms existing licensees. Specifically, the NOI states that as "additional interfering signals appear, the noise floor has increased . . . " and "*[a]s a result*, the station's service reliability and signal coverage have been reduced."[28] In short, as manufacturers have previously advised the Commission in the Spectrum Policy Task Force docket, any increase in external interference (such as would be generated by ITemp devices) necessarily would cause diminished service reliability and diminished coverage.[29]

Unwanted interference translates directly into a loss in system capacity for CDMA networks, because the system is designed for a maximum level of noise plus self-interference. If the noise level is raised, the self-interference must be reduced – meaning that signal transmission from system users must be reduced. Section 4 of the Telcordia analysis explains and quantifies these impacts. Figure 4 below, reprinted from Figure 19 of the Telcordia Report, shows the impact of the ITemp construct upon reverse link (or "uplink") capacity:

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[28] *ITemp NOI* at ¶ 15 (emphasis added). As cited above, the purported benefit of the ITemp concept is to ensure that licensed operations would not experience "*any further degradation or loss of service* from new interference," notwithstanding the fact that the ITemp concept would itself introduce entirely new interference into licensed bands. *Id*. (emphasis added).

[29] *See, e.g.*, Motorola Comments, ET Docket No. 02-135, at 13 (Jan. 27, 2003)("[A]dding interference and raising the noise floor at minimum reduces coverage and in some cases totally disrupts communications."); Lucent Comments, ET Docket No. 02-135, at 2 (Jan. 27, 2003)("[A] noise cap or interference temperature above the noise floor necessarily subjects the licensed, victim wireless system to increased interference in the form of additional noise and can result in reduced signal to noise ratios, and, consequently, reduced call quality."); Nokia Comments, ET Docket No. 02-135, at 4 (Jan. 27, 2003) ("According to Shannon's law, the capacity of spectrum decreases as the noise floor rises. . . . Any increase in the noise floor will reduce the overall capacity of the spectrum."); Telecommunications Industry Association Comments, ET Docket No. 02-135, at 8 (Jan. 27, 2003)("[A] noise cap (interference temperature) above the noise floor necessarily subjects the licensed, victim wireless system to increased external interference. Also, actions necessary to mitigate the impacts of additional interference can require a reduction in victim system capacity and/or a reduction in cell size.").

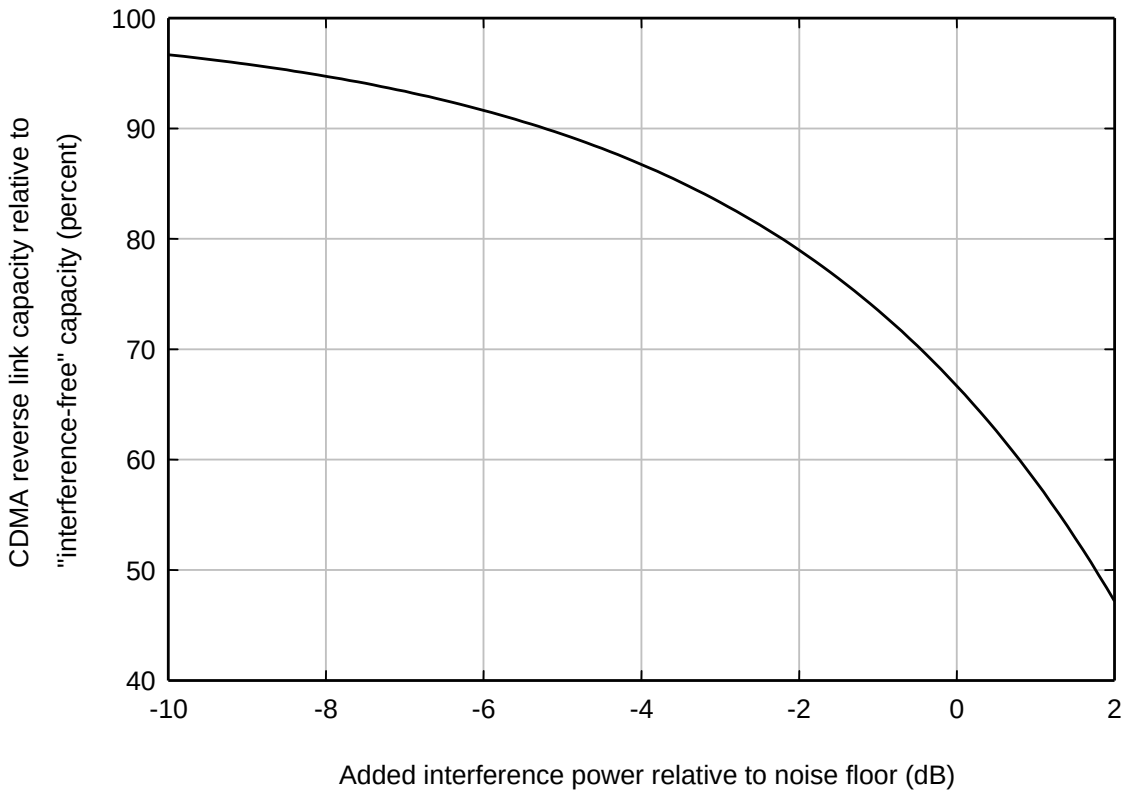

Figure 4: *CDMA reverse link capacity reduction due to external interference.*

As this Figure documents, if the ITemp cap is set at 4 dB below the noise floor (*i.e.*, -112 dB, assuming a noise floor of –108 dBm), a CDMA network would lose approximately 13 percent of its existing capacity. If the ITemp cap is instead set at the noise floor, a CDMA network would lose approximately 33 percent of its existing capacity. Moreover, as discussed in Section II below, the data throughput lost by the CDMA system always will be greater than that which is gained by the unlicensed device. *In other words, the lost capacity caused by implementation of the ITemp concept would constitute a net loss in spectrum efficiency – contrary to the Commission's core objective.*

The addition of new external interference (whether from ITemp or other devices) necessarily harms the consumers of mobile services. Service quality would deteriorate because mobile service subscribers will be unable to originate calls, or will encounter dropped calls, in areas and under circumstances where they previously did not experience these problems. In theory, carriers might attempt to mitigate this new interference by adding cell sites – but that is not a realistic or appropriate solution. Such an effort would require these consumers to pay more for their existing services even if engineering solutions could be identified and deployed in all affected cases. Further, it is wholly unrealistic to think, given the difficulties in the zoning and siting processes, that carriers will be able to obtain additional cell sites in all of the locations needed, especially since current networks are optimized to provide continuous coverage today. Even a 13 percent reduction in network capacity would have enormous negative consequences on mobile service subscribers, as the number of "dead zones" would mushroom impacting service reliability and coverage. Degradation of service reliability and coverage also would undermine Homeland Security goals for maximizing the reliability of the nation's communications infrastructure, and would adversely impact 911 call completion and Phase II location services.

In summary, unlicensed device manufacturers and their customers may benefit by the ITemp paradigm, insofar as the concept may provide access to spectrum that was not previously available. *But see* Section IV *infra.* However, in no circumstance can it credibly be stated that licensees and their subscribers (including "first responders") would benefit by the deliberate introduction of new spectrum pollution that negatively impacts wireless service reliability and coverage.

II. THE ITEMP CONCEPT IS NOT SPECTRALLY EFFICIENT AS APPLIED TO CDMA MOBILE SERVICES NETWORKS

The ITemp sharing concept is facially appealing because proponents suggest that it would improve overall spectrum efficiency and thereby promote the public interest. Indeed, the Spectrum Policy Task Force specifically developed the paradigm as a means to "increase the public benefits derived from the use of the spectrum resource."[30] As the Task Force stated:

> The overarching goal of effective spectrum policy is to maximize the potential public benefits to be derived through spectrum-based services and devices.[31]

The rationale underlying the ITemp concept is to improve spectrum efficiency, defined as maximizing the amount of information that can be transmitted within the least amount of spectrum.[32] The ITemp theory is that spectrum efficiency would be enhanced because licensed bands would be opened to both licensed and unlicensed users (supposedly without harming licensed users), as opposed to limiting licensed bands to licensed users. In other words, the ITemp paradigm as presented in the NOI assumes that spectrum efficiency would necessarily increase by implementation of the ITemp concept. In fact, as demonstrated by the Telcordia analysis, ITemp sharing is not spectrally efficient as applied to CDMA networks.

Telcordia examined this spectral efficiency assumption by calculating the total spectrum efficiency (licensed plus unlicensed capacity) versus the allowable ITemp interference level. The analysis defines a spectrum efficiency measure as bps/Hz per cell area multiplied by the fraction of the nominal cell area that is covered. The fractional coverage is included in the spectrum efficiency definition because there is an inherent throughput-vs.-coverage tradeoff with fre-

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[30] *ITemp NOI* at ¶ 2, *citing* SPTF Report at 1.

[31] SPTF Report at 11-12.

[32] *See id.* at 21 ("Spectrum efficiency occurs when the maximum amount of information is transmitted within the least amount of spectrum.").

quency reuse systems.[33] For example, given a wireless network infrastructure operating over a given amount of spectrum, the throughput per cell can be increased by reducing coverage (*e.g.*, not serving handsets on the outer portion of each cell).

Telcordia's analysis demonstrates that, from the perspective of the overall efficiency of spectrum utilization, ITemp sharing is a losing proposition when the concept is implemented in CDMA networks.[34] Figure 5 below is derived from Telcordia's Figure 26:

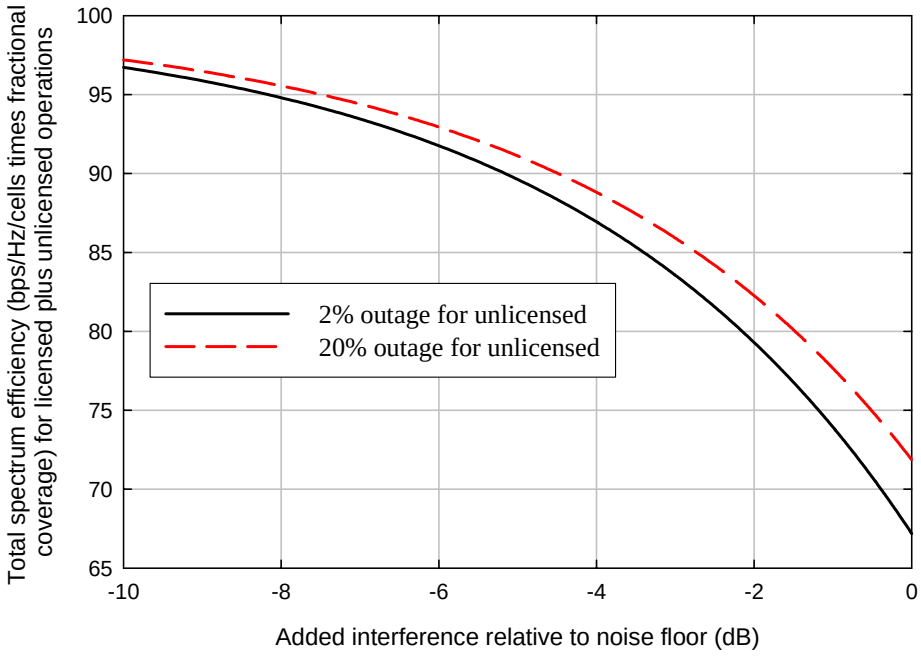

Figure 5: *Effect of ITemp sharing on total spectrum efficiency, including the added unlicensed capacity, for a CDMA uplink.*

[33] *See* Telcordia Report at § 6. Coverage is an important factor in the value proposition because "the more complete the coverage, the greater the value to the subscriber. Clearly, a wireless channel that is available over a complete metropolitan area is more valuable than one limited to a home or an office building, or selected 'hotspots.'" *Id.* at § 5.5.1. The throughput-vs.-coverage tradeoff shows up clearly in the analysis of the unlicensed link performance.

[34] *See* Telcordia Report at § 5.

Figure 5 shows, for example, that if the ITemp level were set at 4 dB below the noise floor, the combined available throughput capacity of both licensed and unlicensed use of the band would approximate 89 percent of total potential capacity – as opposed to 100 percent throughput capacity that is fully utilized by the licensee before introduction of the ITemp concept. In short, in this example, there would be a net reduction of total spectral efficiency of 11 percent.

Fundamentally, this loss in efficiency is due to the mixing of unlike systems. The performance of ITemp devices is limited by the fact that they would sustain interference from licensed handsets. If a transmitting mobile handset comes near enough to an unlicensed receiver, the handset will disrupt the unlicensed link and cause an outage to the unlicensed transmission. The analysis demonstrates that ITemp is spectrally inefficient when applied to CDMA networks. Telcordia concludes:

> [I]t is clear that the loss in value to the licensed service is greater than [the] added value associated with the unlicensed devices.[35]

There are also three important caveats to the Telcordia analysis, which suggest that the actual inefficiency of ITemp would be even greater for CDMA networks. Telcordia assumed that: (a) the ITemp concept is implemented perfectly; that is, the aggregate interference from the unlicensed devices as seen at the CDMA base station is somehow perfectly regulated by an ITemp monitoring and feedback mechanism; (b) there are no monetary or additional spectrum costs in implementing or operating in an ITemp environment; and (c) the interference to an unlicensed receiver was due solely to the nearest CDMA handset (interference aggregation from CDMA handsets was ignored). In other words, the Telcordia analysis assumes the "best case" in terms of spectral efficiency. As costs of ITemp implementation and operation are added to the

[35] *Id*. at § 5.6.

equation and as imperfections in implementation (as invariably will occur), such as measurement inaccuracy and latency, are taken into account, the spectral inefficiencies of the ITemp paradigm become even greater.

In summary, contrary to belief of some, *the ITemp concept would decrease rather than improve spectral efficiency when introduced in mobile services bands.* And the analysis summarized above underscores the need to conduct a case-by-case assessment of the balance between the degradation of a licensed service and the benefits of additional unlicensed capacity. This is particularly important given that once the unlicensed devices are marketed, the FCC has no real or practical ability to prevent or enforce its rules against interference caused by these devices.

III. THERE ARE MAJOR TECHNICAL CHALLENGES IN IMPLEMENTING THE INTERFERENCE CONTROL MECHANISMS WHICH MAKE THE ITEMP CONCEPT UNWORKABLE IN MOBILE SERVICES BANDS

For the ITemp paradigm to work, an unlicensed device must know "the cumulative effects of all undesired RF energy" that "is present at a [licensed] receiver at any instant of time," so the unlicensed device can determine whether it can transmit and, if so, at what power levels:

> For an interference temperature limit to function effectively on an adaptive or real-time basis, a system would be needed to measure the interference temperature in the band and communicate that information to devices subject to the limit, and a response process would also be needed to restrict the operation of devices so as to maintain the interference temperature at or below the level of the limit.[36]

The NOI seeks comment on three different ITemp interference control/feedback mechanisms – self monitoring, indirect monitoring, and direct monitoring – as a means to implement the ITemp concept.[37] The Telcordia Report demonstrates that all three of these ITemp measuring approaches are ineffective, technically unfeasible or impractical in mobile service bands.

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[36] *See ITemp NOI* at ¶¶ 1 and 11.

[37] *See id.* at ¶¶ 11-12.

A point of clarification is needed at the outset. For the ITemp concept to work, an unlicensed device needs two pieces of information about the licensed receiver: (1) the interference levels encountered by the licensed receiver at a given point in time, so that the interference margin relative to the designated ITemp level can be computed; and (2) the path loss between the unlicensed transmitter and the licensed receiver. As Telcordia observes, without this information, an unlicensed device would not be able to calculate the amount of power it can transmit in order to stay within that margin of interference::

> [This] requires that each ITemp device be able to measure the electromagnetic path loss between itself and the victim receiver, which in turn requires that there be a signal transmitted from the victim receiver site that can be received by the ITemp device and used to compute the path loss (by comparing the signal transmit power, which must be known, to the received signal power).[38]

The NOI does not appear to mention this critical function (identification of the location of the licensed receiver) that must be incorporated in any ITemp implementation scheme.

A. THE "SELF" AND "INDIRECT" MONITORING INTERFERENCE CONTROL MECHANISMS ARE INEFFECTIVE METHODS TO IMPLEMENT THE ITEMP CONCEPT IN MOBILE SERVICES BANDS

Two of the three ITemp interference control methods mentioned in the NOI are the "self monitoring" and "indirect monitoring" techniques:

- Self Monitoring. Under this approach, an unlicensed ITemp device would "measure the interference temperature at its location and make a transmit/not transmit decision based on this measurement plus the device's own contribution of RF energy."[39]

[38] Telcordia Report at § 2.3.

[39] *ITemp NOI* at ¶ 11.

- Indirect Monitoring. This approach involves "a grid of monitoring stations that would continuously examine the RF energy levels in specified bands, process that data to derive interference temperatures, and then broadcast that data to subject [unlicensed] transmitters on a dedicated frequency."[40]

These two proposed ITemp measuring methods are ineffective implementation techniques when applied to mobile services bands because, as demonstrated below, neither can satisfy the requirements of: (1) accurately measuring aggregate interference as seen by the licensed receiver; and (2) determining the path loss between the unlicensed transmitter and the licensed receiver.

As the Commission has acknowledged, for the ITemp concept to work, an unlicensed device must know "the cumulative effects of all undesired RF energy" present "*at a [licensed] receiver at any instant of time*."[41] The task of any ITemp monitoring and control mechanism is to ensure that the RF signal power contribution of the unlicensed device does not cause the total contribution of the RF signal strength attributable to all unlicensed devices at the victim receiver to exceed the ITemp level. However, neither the "self" nor "indirect" monitoring approach measures the total interference (the overall RF signal strength attributable to all unlicensed devices) encountered by the victim licensed receiver. Rather, with the "self" monitoring approach, the unlicensed device measures the RF signal power it sees rather than the RF signal power seen by the licensed receiver. Similarly, with the "indirect" approach, a monitoring station would measure RF signal power at its location rather than the RF signal power seen by licensed receivers in the area. Without knowing the RF signal power levels at nearby licensed receivers, it is

[40] *Id.* at ¶ 12.

[41] *Id.* at ¶ 1 (emphasis added).

impossible for an unlicensed device to determine whether there exists a margin of interference that can be applied to a victim receiver before the ITemp level is exceeded.

The "self" and "indirect" measuring techniques might be workable in theory if one could assume that I+N is uniform throughout an area – that is, the ITemp the unlicensed device (or monitoring station) sees is the same ITemp that the licensed receiver sees, even though they are at different locations. But as Telcordia explains, this assumption is not reasonable because I+N "depends heavily on the location of the receiver":

> This means that [an unlicensed device or monitoring station] "monitoring" a channel at one location generally cannot draw an accurate conclusion about the interference at another location.[42]

As Telcordia further explains, "the monitored levels must be highly correlated with the interference into the licensed receivers that are being protected."[43]

Telcordia quantifies the conditions necessary to meet this requirement through use of an "exclusion zone" model.[44] Specifically, if there is an "exclusion zone" surrounding the victim receiver (an area within which there can be no interfering transmitters), then it is only necessary that the monitoring receiver be near the victim receiver, relative to the size of the exclusion zone.[45] Figure 6 below, reprinted from Telcordia Figure 16, shows the correlation between the measured interference and the monitored interference versus the distance between the victim and monitoring receivers (with the victim receiver assumed to be surrounded by a circular exclusion zone). The curve was determined by simulation, and it was assumed that the unlicensed trans-

[42] Telcordia Report at § 2.4.

[43] *Id.* at § 3.1.

[44] *Id*. at § 3.

[45] This is necessary so that the interference measured by the monitoring receiver is highly correlated with the interference that is experienced by the victim receiver.

mitters were randomly located outside the exclusion zone.[46] Note that if the monitoring receiver is moved to the edge of the exclusion zone, the monitored interference is uncorrelated with the interference experienced by the victim receiver.

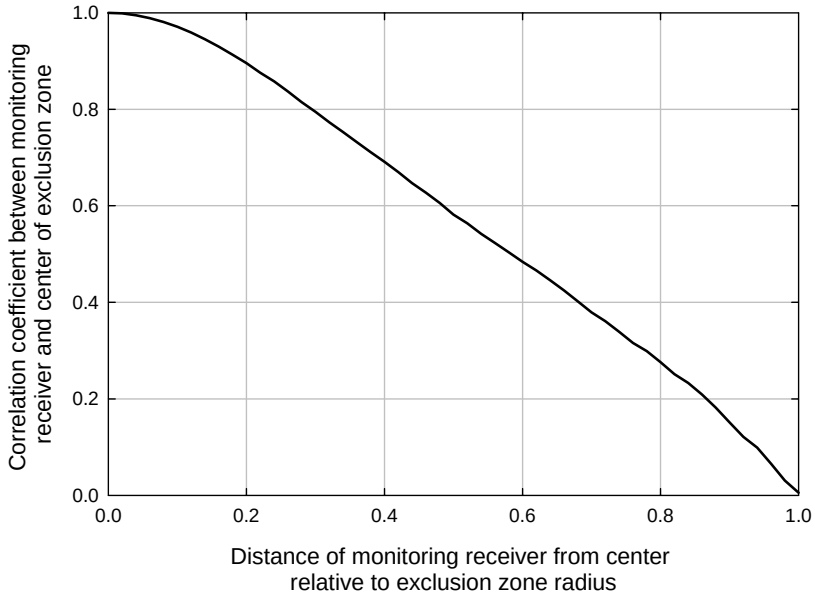

Figure 6: *Correlation between interference power levels at victim and monitoring receivers vs. distance between them.*

Three observations logically follow from Figure 6. First, if there is no exclusion zone, then monitoring the interference at a location other than that of the victim receiver is not useful, because the monitored level is not correlated with the level seen by the victim receiver. Second, for monitoring to be effective in any case, the locations of the victim receivers must be known (and generally stationary as well); otherwise, the monitors cannot be located sufficiently close to the victim receivers to be reliable. Third, the self-monitoring approach (whereby the unlicensed device measures the I+N level relative to it) does not work because to make an accurate meas-

[46] The assumptions and theoretical development of this exclusion zone concept are explained in Section 3 of the Telcordia Report.

urement, the unlicensed device would need to be well within the exclusion zone, where, by definition, it would not be allowed to transmit.

From these observations, it also follows, in turn, that there are some types of licensed receivers for which ITemp monitoring-and-feedback cannot be implemented. Prominent among these are most types of mobile transceivers (or handsets) as well as broadcast receivers, for which there will typically be little or no exclusion zone. The locations of such receivers are typically unknown, and generally cannot be inferred by measuring signals emanating from receiver locations. Broadcast receivers have no associated transmission capability, and mobile handsets often are idle, which means the proximity of a licensed mobile device cannot reliably be estimated by measuring its transmitted signal.

An unlicensed device (or monitoring station) obviously cannot measure the ITemp of a licensed receiver at an unknown location, whether because the licensed receiver is blocked from view of the unlicensed device (or monitoring station) or because the licensed receiver is inactive (or idle) at a moment in time. This problem is exemplified by the downlink (base-to-mobile) mobile service band, because there may be dozens (or hundreds) of licensed handsets in range of an unlicensed device, the locations of which are entirely unknown to the unlicensed device, and may be near or far, blocked or in line-of-sight.[47] Telcordia concludes:

> Therefore, short of integrating the ITemp monitoring-and-feedback capability within the affected licensed devices themselves (which is often not practical), the "closed-loop" [monitoring and feedback] form of ITemp is limited to licensed receivers for which the monitoring receiver can be either co-located, or located well within the boundary of any exclusion zone that might exist. This means that a

[47] As Telcordia explains, this "hidden station" problem might be addressed through use of a "request-to-send, clear-to-send (RTS/CTS) exchange." *Id.* at § 2.4. But this RTS/CTS exchange approach is not workable in practice as unlicensed devices would be required to use the same air interface as the licensed services because the unlicensed devices "must be able to decode the RTS/CTS (not simply sense energy) and must comply with the transmit-inhibition rules." *Id.*

> network of arbitrarily-placed monitoring receivers will generally not be an effective way to implement closed-loop ITemp.[48]

Of course, if the monitoring and feedback capability is included within the victim receiver, then the measuring method is "direct" (discussed below). It is therefore clear that for mobile services, "self" and "indirect" measuring methods are not viable due to the lack of an exclusion zone, and in the case of the downlink, lack of knowledge about the location of the licensed receiver.

In addition to the drawbacks with respect to accurate monitoring of the interference as seen by the victim receiver, there remains the problem that the "self" and "indirect" methods would not inform the unlicensed transmitter of the path loss between itself and the licensed receiver. As noted above, for the ITemp paradigm to work, the unlicensed device must know this path loss so that it can accurately calculate the amount of power it can transit in order to avoid violating the receiver's ITemp level threshold.

Telcordia concludes that the "self" monitoring method is "not an effective means of controlling interference into the victim receiver":

> Such monitoring cannot be reliably used by the unlicensed device to determine whether or not it is within the usable service area of the victim receiver. It also cannot be used to determine the state of the victim receiver relative to the interference threshold, or the effect that a transmission would have on the victim receiver, because if the victim receiver is passive (not transmitting) there is no way for the unlicensed device to know the path loss between itself and the victim receiver.[49]

B. THE "DIRECT" MONITORING INTERFERENCE CONTROL METHOD IS PRACTICALLY AND TECHNICALLY INFEASIBLE IN MOBILE SERVICES DOWNLINK BANDS

The third measuring technique mentioned in the NOI is the "direct" monitoring approach, whereby "the receive sites of a licensed service" would "measure the temperature and communi-

[48] Telcordia Report, Executive Summary at 2.

[49] *Id*. at § 2.4.

cate those measurements to a central site," and "then be broadcast" to unlicensed devices in the area.[50] In a mobile services downlink band (*i.e.*, base station-to-mobile transmissions), this approach would require that the ITemp measurement be made by the victim receiver (the mobile handset). The "direct" monitoring approach thus overcomes some of the major problems with the "self" and "indirect" monitoring approaches discussed above. Nevertheless, the "direct" monitoring approach would be practically and technically infeasible in a mobile services downlink, as the NOI appears to acknowledge.[51]

First of all, every mobile handset currently in use would have to be fundamentally redesigned to incorporate ITemp capabilities. Among other things, the handset would have to be capable of isolating and identifying the RF signal power contribution of unlicensed devices from the aggregate RF signal strength received by the handset from noise and the licensed devices that are detected by the handset, so that the ITemp level can be measured at any given moment in time. The handset also would have to be capable of transmitting an ITemp beacon signal, which would: (1) identify the I+N level measured by the handset; and (2) allow an unlicensed device to compute the path loss between it and the handset so as to determine how much power it can transmit without violating the handset's ITemp limit. This added complexity would necessarily increase the cost of handsets, and given that over 150 million handsets are in use today, it would take years before the ITemp concept could be implemented.

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[50] *See ITemp NOI* at ¶ 11. Sprint does not understand the reference in this paragraph to an ITemp "profile for the region." *See id.* As discussed above, for the ITemp concept to work, an unlicensed device must know the ITemp for each licensed receiver that potentially may be affected by the unlicensed device's transmissions, and there is no basis for the FCC to assume that the ITemp of one licensed receiver is the same ITemp encountered by another licensed receiver. In short, there is no one "profile for a region."

[51] *See id*. (The direct monitoring approach "may be appropriate in services such as those involving fixed point-to-point operations where there are relatively few receive sites in a given area.").

Second, even if mobile handsets could be redesigned to perform these functions, requiring handsets to regularly transmit the "ITemp information" signal would reduce their battery power to a fraction of what it is today and consume more spectrum. Such a requirement would be particularly devastating for CDMA networks, as the added in-cell interference due to the ITemp signal transmissions will reduce capacity. Moreover, handset power in a CDMA system is governed by the base station, and inextricably tied into the overall operation of the cell to maximize efficiency, which means that the ITemp monitoring process would have to be incorporated into the power and coverage budgets for the entire system. Entire CDMA networks likely would have to be redesigned to account for this new use of power and corresponding loss of capacity. This is not a realistic or workable approach – and certainly would not further the public interest.

Alternatively, the Commission presumably could allocate additional spectrum for the necessary "ITemp feedback communications."[52] It is not apparent where the Commission would find additional spectrum for ITemp communications. Allocating additional spectrum for ITemp implementation also would undermine the very concept of ITemp spectrum sharing. And, if the Commission is able to locate additional spectrum for this purpose, it would be more efficient (both spectrally and economically) to allocate that spectrum for unlicensed use and abandon the ITemp paradigm altogether, as Section II above demonstrates.

Finally, even if dedicated spectrum for "ITemp feedback" communications could be allocated and even if unlicensed devices could utilize the handsets' ITemp level "feedback" transmission as a frame of reference to determine the path loss of its signal without suffering from

[52] Without the allocation of additional spectrum, the capacity of licensed systems would necessarily decrease further which, in turn, would require efforts to further redesign existing licensed systems (*e.g.*, adding base stations, moving the location of existing base stations).

hidden station and other obstacles, each unlicensed device also would have to possess the capability of adjusting continuously its RF power in real-time in response to (i) the dozens (if not hundreds) of handsets, near and far, moving at various speeds and (ii) the untold numbers of other unlicensed devices, which also may be in motion at various speeds. In short, the inherent complexity of getting ITemp devices to work properly would add considerable cost to each unlicensed device, as well as to each licensed device.

In summary, implementation of the ITemp paradigm in the mobile services downlink bands would involve significant, daunting technical and engineering challenges and would add substantial costs to both licensed handsets and unlicensed devices. As Telcordia explains, it does "not appear practical, even in concept, to apply ITemp to the forward link or downlink of mobile services."[53] Further, as discussed more fully in Section IV below, the Commission has long applied "cost causer" principles in determining who should pay for new functionality, having already determined that, consistent with this principle, unlicensed devices should pay the costs incurred in making additional spectrum available to them. Sprint therefore looks forward to having ITemp advocates explain how they would pay for the costs that would be incurred in efforts to make licensed handsets and networks ITemp capable, as well as address the loss of capacity that would result.

C. THE "DIRECT" MONITORING INTERFERENCE CONTROL METHOD IS PRACTICALLY AND TECHNICALLY INFEASIBLE IN MOBILE SERVICES UPLINK BANDS

Similar technical and cost challenges exist with implementation of the "direct" measuring approach in mobile services uplink bands (*i.e.*, mobile-to-base station transmissions). The scope of the challenge is smaller than the downlink band, given there are "only" 150,000 or so com-

[53] Telcordia Report at § 4.1.

mercial mobile radio services ("CMRS") base stations (compared to over 150 million CMRS handsets) and given that base stations, unlike handsets, have a fixed location – but daunting challenges remain in attempting to implement the ITemp concept in mobile services uplink bands.

First, as discussed above, the Telcordia analysis makes clear that raising the noise floor by adding interference to a CDMA base station results in a reduction in licensed spectrum capacity, which, in turn, represents a net loss in spectral efficiency (with respect to the data throughput capacity gained by unlicensed devices in the band). Sprint again looks forward to proposals from ITemp proponents addressing how they would propose to compensate mobile services licensees for the loss of this capacity.

In addition, as with any ITemp interference control approach, the monitoring base station receiver would have to be capable of isolating and identifying the RF signal power contribution of the unlicensed devices from the aggregate RF signal power contributions of noise, other-cell reverse link interference, and the licensed handsets that are detected by the base station receiver. However, as Telcordia indicates, "[g]iven that the aggregate power from the unlicensed devices would be on the order of 18 dB below the power received on the CDMA uplink, this represents a fairly challenging signal processing problem."[54] Although, as Telcordia further notes, a separate receiver having an antenna pattern matching the base station receiver could be used to monitor a pilot tone transmitted by the unlicensed devices outside the uplink as a frame of reference, such approach would be impractical, as it would require the allocation of dedicated spectrum for this purpose and the acquisition of additional tower space for the monitoring antenna and the associated equipment.[55] Further, to relay the base station's ITemp level to the unlicensed devices, and

[54] *Id*. at § 4.2.6.

[55] *See id.*

provide them with a means to compute their path loss to the base station, there would need to be a separate ITemp beacon transmitted from the base station, which would require additional spectrum, outside of the band used by the mobile radio service.

In summary, the "self" and "indirect" methods are completely ineffective interference control mechanisms with regard to mobile services networks. The "direct" interference control mechanism might be workable in theory, but would involve so many technical, engineering and cost challenges that the approach is not feasible as a practical matter.

IV. UNDER LONG–STANDING COMMISSION POLICY AND PRECEDENT, THE UNLICENSED INDUSTRY WOULD HAVE THE OBLIGATION OF FUNDING ALL ITEMP IMPLEMENTATION COSTS

The Commission asks "[h]ow would monitoring systems be funded and who would be responsible for their establishment, operation, and maintenance"?[56] It is clear from long-standing Commission policy and precedent that it would be the unlicensed industry that would have the obligation of funding any monitoring systems and other ITemp-related implementation and operational costs.

The Commission has a "well established policy that costs should be recovered from cost-causers."[57]

> [T]he public interest is best served, and a competitive marketplace is best encouraged, by policies that promote the recovery of costs from the cost-causer.[58]

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[56] *ITemp NOI* at ¶ 22.

[57] *Special Access Tariffs,* CC Docket No. 85-166, FCC 96-52, n.97 (Jan. 21, 1986). *See also Toll Free Access Codes,* 15 FCC Rcd 11939, 11953 ¶ 37 (2000)(FCC invokes "long-standing principle that costs should be borne by the cost-causer."); *Number Portability,* 11 FCC Rcd 8352, 8419 ¶ 131 (1996)(FCC refers to "the general principle, long recognized by the Commission, that the cost-causer should pay for the costs that he or she incurs.); *Expanded Interconnection,* 9 FCC Rcd 2718, 2728 ¶ 46 (1994)("This is consistent with the Commission's long-held view that costs should be paid by the cost causer."); *LEC Validation,* 8 FCC Rcd 4478. 4482 ¶ 22 (1993)(FCC's "policy is that the costs of providing a service should be borne by the cost causers.").

[58] *Access Tariff Non-Recurring Charges,* 2 FCC Rcd 3498. 3502 ¶ 34 (1987).

The Commission has recognized that recovering costs directly from cost-causers "promotes efficiency and equity" and permits "society to best utilize its resources."[59]

The Commission has, moreover, applied this cost-causer principle to the unlicensed industry. Ten years ago, the Commission initially allocated 20 MHz of spectrum (1910-30 MHz) for unlicensed PCS systems and devices. This spectrum had to be cleared of existing microwave systems before unlicensed PCS devices could use this band. Requiring microwave licensees to fund their own relocation costs would have been incompatible with cost-causer principles, so the unlicensed industry formed UTAM (Unlicensed PCS Ad Hoc Committee for 2 GHz Microwave Transition and Management) to develop a plan to fund these relocation costs. The Commission later approved UTAM's proposal to assess a $20 clearing fee surcharge for every unlicensed PCS device to generate the revenues needed to fund the microwave relocation costs.[60]

The establishment and operation of ITemp monitoring stations and other ITemp functions would be incurred for one reason: to enable unlicensed devices to access and use licensed spectrum. Under the Commission's long-standing policy, these costs would be borne by the cost-causer – namely, the unlicensed industry. Requiring licensees to fund a portion of the ITemp implementation and operational expenses could not be justified in law, policy or equity – for it would result in subscribers of licensed services subsidizing the cost of unlicensed device usage.

The subject of cost recovery raises the practical problem that even if technical means could be found to implement the ITemp paradigm, it is highly unlikely that market forces would support the substantial costs of overcoming these technical and practical challenges. As noted, UTAM imposed a $20 surcharge on every unlicensed PCS device to fund microwave relocation

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[59] *MTS/WATS Market Structure,* 93 F.C.C.2d 241, 399 (1982); *MTS Rates and Rate Structure Plans,* CC Docket No. 84-1235, FCC 84-564, at ¶ 25 (Nov. 21, 1984).

[60] *See Fourth PCS Order,* 10 FCC Rcd 7955 (1995).

costs. But the microwave clearing costs were relatively modest – approximately $67 million nationwide, covering relocation of fewer than 400 microwave links.[61] The cost to install, operate, upgrade and maintain effective ITemp monitoring systems will certainly be far more costly, given the immense complexity of such systems and sheer volume of such systems that would be required for nationwide ITemp device use.

Moreover, aside from any surcharge to recover monitoring and other ITemp-related costs, it also would be more costly to build ITemp devices because they, too, must contain sophisticated ITemp functionality. As Commission staff has noted, unlicensed devices "derive much of their benefit from being inexpensive [and] small," and including "smart technology will add significant cost, thereby reducing the attractiveness to consumers."[62] Also, the Telcordia analysis suggests that ITemp-compliant devices would have only a small fraction of the range compared to "ordinary" unlicensed devices designed for unlicensed bands.[63] And these challenges still do not address the interference and spectral inefficiency of the ITemp construct.

Two points bear emphasis. First, even if the Commission was to adopt the ITemp paradigm, manufacturers would always retain the choice to continue to build "ordinary" non-ITemp devices for use in unlicensed spectrum bands. In this regard, the Commission has allocated over 520 MHz of prime spectrum for unlicensed devices,[64] and has initiated other proceedings to

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[61] *Id*. at 7957 ¶ 8.

[62] OPP White Paper No. 39, *Unlicensed and Unshackled: a Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues,* at 47 (May 2003).

[63] *See* Telcordia Report at § 5.3.

[64] The FCC has allocated the following bands for higher-powered unlicensed devices likely similar in functionality to the type of unlicensed devices envisioned for the ITemp concept: 902-928 MHz; 1920-1930 MHz; 2400-2483.5 MHz; 5150-5350 MHz; 5470-5825 MHz; and 24.0-24.25 GHz.

make spectrum available for unlicensed use in other bands.[65] Second, because "ordinary" unlicensed devices are not as technically complex as ITemp devices would be and because "ordinary" unlicensed devices would have no "ITemp surcharge," ordinary unlicensed devices would be far cheaper to produce, and could be sold at a much lower price, relative to an ITemp device providing the same functionality.

Second, if given the choice between two products with similar functionality, most consumers will purchase the less expensive product – especially if the cheaper product has a much longer range than the more expensive product. This suggests that even if the Commission were to adopt the ITemp concept, it is unlikely that economically rational manufacturers would build ITemp devices, given the alternative of building far more inexpensive products using unlicensed bands. As one large consumer products retailer has previously advised the Commission, "[w]hile such [ITemp] technology *might* be cost effective in more expensive devices, it could also preclude the manufacture of very inexpensive low-power devices."[66]

The Commission should ask the unlicensed industry how it would propose to pay for ITemp implementation and operational costs and to assess whether there will, in fact, be a market demand for ITemp devices, given that the same functionality can be provided by simpler and less expensive non-ITemp devices.[67]

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[65] *See, e.g., Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Notice of Inquiry, 17 FCC Rcd 25632 (2002).

[66] RadioShack Comments, ET Docket No. 02-135, at 6 (Jan. 27, 2003)(emphasis added). *See also* Proxim Comments, ET Docket No. 02-135, at 2 (Jan. 27, 2003)(FCC should "recognize that there is likely to be a significant cost/benefit tradeoff to the use of advanced technologies like SDR. . . . [T]hey will also add significant cost to products in the foreseeable future."); Consumer Electronics Association Comments, ET Docket No. 02-135, at 6 (Jan. 27, 2003)("[A]chieving success with these technologies and building them into affordable consumer electronics products is years down the road.").

[67] Indeed, the sole justification the FCC proffers for pursuing the ITemp concept is that "there are no unoccupied frequency bands within the range of frequencies where *low-cost consumer applications* can be easily manufactured." *ITemp NOI* at ¶ 19 (emphasis added). This rationale is unconvincing, however,

V. ONE MAJOR POLICY ISSUE THE NOI DOES NOT EVEN MENTION: THE DELETERIOUS IMPACT OF THE ITEMP PARADIGM ON FURTHER TECHNOLOGICAL INNOVATION

Notably absent in the NOI is any discussion of how the ITemp paradigm would impact further technological innovation. Congress has directed the Commission to adopt policies that promote both "the development and rapid deployment of new technologies" and the "efficient and intensive use of the electromagnetic spectrum."[68] The Spectrum Policy Task Force has recommended that the Commission expand use of the "commons" and "exclusive use" models precisely because both models "provide incentives for users to migrate to more technologically innovate and economically efficient uses of spectrum" and because "[a]dvances in technology create the potential for systems to use spectrum more intensively."[69] Sprint submits that these policies would be undermined by implementation of the ITemp concept in mobile services bands – even assuming that all of the challenges (*e.g.*, technical, market, spectral efficiency, etc.) associated with ITemp could be overcome.

Presumably, the Commission would establish an ITemp level for a given band based upon the state of the technology currently used by the existing licensees.[70] Once this level is established, unlicensed devices could freely operate under the ITemp cap without concern that their use will be preempted by the licensee, thereby effectively precluding the licensee from ever us-

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given the substantial up-front and ongoing costs of installing, operating, upgrading and maintaining an effective ITemp monitoring system that will somehow have to be borne by the manufacturers and users of these same "low-cost consumer applications" – particularly in light of the substantial spectrum below 6 GHz that already has been allocated for unlicensed use that would not impose these added costs on unlicensed device manufacturers and users.

[68] 47 U.S.C. § 309(j)(3). *See also* 47 U.S.C. § 157; Section 706 of the Telecommunications Act of 1996.

[69] SPTF Report at 3 and 15.

[70] While the FCC could attempt to adopt some margin to account for future innovations, any margin it might pick necessarily would be arbitrary – and dangerous – because the FCC cannot predict the nature and extent of future advances in technology.

ing this portion of the spectrum. But in setting an ITemp level for a given band, the Commission would necessarily freeze technology development that would use more of the spectrum (including that portion below the designated ITemp level) as a means to use the licensed spectrum more efficiently.

The short 20-year history of the CMRS industry has been one of continued technological innovation with dramatic improvements in spectral efficiency over time. The analog air interface has largely been replaced with second-generation digital technology, which improved call capacity and supported the provision of entirely new capabilities (*e.g.*, caller ID, short message service, etc.). Licensees like Sprint have replaced their initial digital technology (IS-95) with a more robust technology (IxRTT) that has provided sizable improvements in capacity and other benefits (*e.g.*, much faster data rates, longer battery lives, etc.). In each instance, newer technology has utilized less power and used spectrum more efficiently, amplifying the loss in spectrum efficiency that would be caused by subjecting mobile licensed services to interference from unlicensed devices via ITemp sharing.

Technological developments planned and in research promise yet further dramatic increases in spectral efficiency. For example, vendors have recently developed new cryo-cooled superconducting products that improve capacity and service quality by lowering the noise floor and, consequently, reducing the required power level of a received signal (which is set at a specific margin below the I+N level). These and other new technologies (*e.g.*, more powerful error-correcting codes, multi-user detection, and smart antenna techniques) provide further optimization by reducing or mitigating the effects of self-interference present in CDMA network equipment and handsets. However, the spectral efficiencies achieved by CDMA networks utilizing these advanced technologies will be held hostage to a greater degree than ever by the interfer-

ence that is external to the system – interference that licensees cannot practically remove.[71] Adoption of the ITemp paradigm could preclude researchers from pursuing these and other promising spectrally efficient advances. Sprint submits that Commission actions that effectively discourage scientists from investigating new opportunities to improve spectral efficiency and provide innovative services clearly would undermine the public interest.

The Commission has recognized that its "focus should be toward decreasing power levels whenever possible":

> Such efforts would enable us to better manage, and make more efficient use of the spectrum.[72]

Implementation of the ITemp concept could destroy both the incentive and the ability of licensees to install lower-powered, more efficient technologies.

VI. THE NPRM ISSUE: TRANSMIT POWER CONTROL AND DYNAMIC FREQUENCY SELECTION ARE PRACTICALLY AND TECHNICALLY INFEASIBLE METHODS FOR IMPLEMENTING THE ITEMP CONCEPT IN FIXED POINT-TO-POINT RADIO NETWORKS

The NPRM proposes to apply the ITemp paradigm alongside both fixed satellite service ("FSS") uplink operations in the 6 GHz band (6525-6700 MHz), and fixed point-to-point terrestrial services operating in the 13 GHz band (12.75-13.25 GHz, excluding 13.15-13.2125 GHz).[73] Sprint below focuses on the proposal as it applies to the fixed point-to-point terrestrial services in

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[71] The FCC has recognized that licensees have no effective means to control many unlicensed devices causing harmful interference because of the difficulty of identifying devices that are mobile and interfere intermittently and because these interfering devices are not under the control of the licensee. *See Review of Part 15 Order*, 17 FCC Rcd 14063, 14067 ¶ 11 (2002). Further, the FCC cannot realistically remedy the capacity/service degradation impacts that ITemp would cause in licensed mobile services bands.

[72] *Advanced Wireless Service Rules Order,* WT Docket No. 02-353, FCC 03-251, at ¶ 100 (Nov. 25, 2003). *See also OTARD Reconsideration Order,* WT Docket No. 99-217, FCC 04-41, at ¶ 16 (March 24, 2004)("We do not believe that our rules should serve to disadvantage more efficient technologies.").

[73] *See ITemp NPRM* at ¶¶ 29-50.

the 13 GHz band, because Sprint uses some of this spectrum in the provision of services to educational institutions.

In stark contrast to the NOI and the SPTF's ITemp concept, the NPRM's approach to unlicensed operations in the fixed link bands discounts completely the actual interference at the input to the licensed receiver. Specifically, the NPRM proposes to employ transmit power control ("TPC") and dynamic frequency selection ("DFS") approaches to facilitate band sharing between unlicensed devices and fixed point-to-point simplex and full duplex links (*e.g.*, CARS). Under the proposed TPC approach, the unlicensed device would first monitor the spectrum to measure the level of RF signal power of the fixed link transmitter received at the unlicensed device (as opposed to the interference measured at the input to the licensed receiver), and employ TPC to adjust its transmit power to equal the received power, plus an offset to account for path loss and certain other factors.[74] Under the DFS approach, the unlicensed device would monitor the spectrum to measure the RF emission levels at the unlicensed transmitter, and would operate when such measured level is below a predetermined threshold,[75] or employ DFS to jump to another frequency if that level has been exceeded.

As a starting point, the NPRM's assertions that error correction factors and other link budget allowances render fixed link systems "highly robust" and able to operate in the presence of undesired signals "considerably higher than the level of the desired signal" are overly optimistic. Fixed link budgets are conservatively developed to provide a high degree of availability given the interference events predicted for the area and service. Introducing a new source of

[74] *Id*. at ¶¶ 43.

[75] The NPRM proposes to set this threshold at -64 dBm for unlicensed devices operating at output levels equal to or exceeding 23 dBm, and at -62 dBm for unlicensed devices operating at output levels below 23 dBm. *See ITemp NPRM* at ¶ 44.

background interference necessarily throws these predictive settings off, amplifying the effects of those events that were anticipated and accounted for in the link budget margins. As Telcordia observes, on the one hand, "[g]iven conservative engineering margins and high link availability requirements, a FS point-to-point link will almost always be able to tolerate interference from underlaid unlicensed devices, so it might appear that sharing can be easily and profitably accommodated." But, and this is critically important, "if a higher-than-anticipated level of background interference is always present, then a less severe degree of impairment (e.g., a smaller degree of amplitude dispersion across the channel bandwidth, or a smaller amount of rain attenuation of signal power) from the key physical phenomena around which the link was engineered will be required to induce outage":

> The probability of occurrence of this less severe degree of impairment will always be greater than a more severe degree, so the effect of an unanticipated increase in background interference is an increase in the outage time, or equivalently a decrease in service availability, for the affected link. If the supported service cannot tolerate this decrease in availability, then engineering mitigations such as diversity, antenna improvements, or increased transmit power – all of which imply significant cost to the link operator – must be employed.[76]

Any unanticipated increase in the background noise experienced by fixed links, thus, will make these links more susceptible to outages caused by rain or other periodic interfering events. Further, as explained below, the TPC and DFS approaches are not feasible methods for facilitating band sharing between unlicensed devices and fixed point-to-point simplex and full duplex links.

A. THE TPC APPROACH IS NOT A FEASIBLE METHOD FOR FACILITATING NON-INTERFERING OPERATION BETWEEN UNLICENSED DEVICES AND FIXED SIMPLEX AND DUPLEX LINKS

Section 7 of the Telcordia Report demonstrates that the TPC approach suggested in the NPRM is sound in principle for a *single* unlicensed transmitter, but is unworkable in the context

[76] Telcordia Report at 79 (emphasis in original).

of multiple unlicensed devices.[77] In particular, there are two important issues not addressed by the NPRM: (1) how to manage aggregate interference; and (2) the performance of the unlicensed devices themselves, which are subject to interference from the licensed transmissions.

To start, the NPRM assumes that "the unwanted emissions received by the FS receiver will be dominated by the emissions from the closest device," thus allowing the Commission to dismiss the effects of aggregate interference and simplify its theoretical justification to a single interfering unlicensed device whose worse-case path loss is constant at 100 meters.[78] Sprint disagrees with this assumption, because under the TPC construct, unlicensed devices further away from the licensed receiver will actually operate at *higher* power levels than the unlicensed device that is closest to the licensed receiver (because under TPC, the unlicensed devices base their output power upon the power received from the licensed transmitter, which will be closer to those unlicensed devices that are further away from the unlicensed receiver). Accordingly, unlicensed devices between the licensed transmitter and receiver sites, and near the path centerline, will make nearly equal contributions to the total unlicensed interference.[79] Moreover, for a fixed link, the path loss from a point on the ground to the receiver (including antenna discrimination) is not highly distance-sensitive (except for locations within several kilometers of the receive site, where the antenna pattern roll-off greatly increases the net loss). As a result, unlicensed devices distributed along the fixed length path and near the centerline will make *nearly equal* contributions to the aggregate interference received. This is exemplified in Figure 7 below:

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[77] The offset between measured and transmitted power for the unlicensed device must be determined for the worst case positioning of the unlicensed device (from an interference perspective), which is typically halfway between the transmit and receive sites, on the path centerline.

[78] *ITemp NPRM* at ¶ 41.

[79] Unlicensed devices very near to the licensed transmit or receive sites will contribute relatively less due to the pattern discrimination of the licensed antennas.

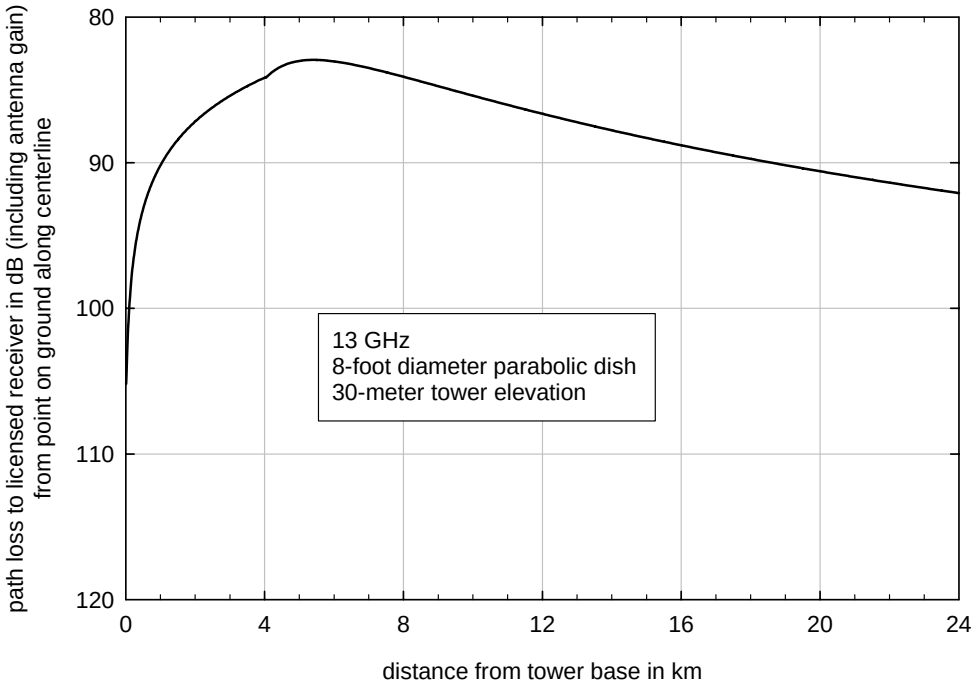

Figure 7: *Path loss to fixed link receiver from ground-level points along center-line vs. distance to receive tower base.*

To illustrate the aggregate interference effect, suppose that each ITemp device radiates one watt. At four kilometers ("km"), the path loss is about 83 dB, so the received power at the licensed fixed link receiver would be -53 dBm. Now suppose that there are another two ITemp devices operating at eight km and another two at 12 km. The path loss at eight km is about the same as at four km, and the path loss at 12 km is about 87 dB, thus the other four devices contribute another -48.5 dBm, *which is more than the single nearest device*. With TPC, the aggregation effect would be even more pronounced, because the farther-away devices would transmit more power (equal transmit power was assumed here). Accordingly, there is no justification for the assumption that unwanted emissions received by the fixed link receiver will be dominated by the emissions from the closest device, and there seems to be no practical way to manage aggre-

gate interference within the bounds of the proposed TPC construct, which includes no feedback from the licensed system.[80]

Feedback-based ITemp approaches are problematic in point-to-point architectures because co-locating a separate monitoring system antenna with same characteristics as the victim receiver's antenna is impractical. Further, sharing of the victim receiver's antenna between the fixed link and a monitoring system is complicated because, as Telcordia notes, "all components of the link, including splitters, circulators and cabling, factor into link budgets; a 'passive tap' for the monitoring system introduces further loss that must be compensated elsewhere in the link design."[81] Even if a dedicated monitoring receiver could be installed to measure the unlicensed interference at the receive site, it would need to do so in the presence of the signal received from the licensed transmitter, which would likely be some 30 to 50 dB above the unlicensed interference that the monitor is attempting to measure. As noted above in the context of mobile radio systems, this is not likely to be practical.

Finally, even if the TPC approach is implemented, the operating range of the unlicensed devices will be abysmally low due to interference from the licensed transmitter. As a simple example, consider the 24-km fixed link path operating near 13 GHz discussed in Section 7 of the Telcordia analysis. If sufficient margin is to be allowed in the interference budget for 100 simultaneous unlicensed transmitters, the operating range of each unlicensed device will be on the order of one to four meters, depending on how conservatively the TPC offset level is set.

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[80] In principle, the number of unlicensed devices within the radio horizon of a given fixed link receiver could be limited to some maximum number, and the unlicensed TPC offset reduced to keep the total maximum interference constant. This approach, however, would require some means to enforce the limit on the number of devices per fixed link receiver, and no such means is apparent.

[81] *See* Telcordia Report at 97.

In summary, it is clear that the TPC approach proposed in the NPRM for sharing of the fixed point-to-point simplex and full duplex link bands with unlicensed devices is neither feasible, nor attractive from the perspective of unlicensed performance.

B. THE DFS APPROACH IS NOT A FEASIBLE METHOD FOR FACILITATING NON-INTERFERING OPERATION BETWEEN UNLICENSED DEVICES AND FIXED SIMPLEX AND DUPLEX LINKS

The Telcordia Report demonstrates that the DFS approach is equally problematic. In particular, the DFS threshold values in the vicinity of -65 dBm, as proposed in the NPRM, are "too high to infer that a given frequency channel is not in use by a neighboring fixed point-to-point microwave link."[82] The Telcordia Report further shows that "it is not possible to assume that unlicensed device locations at which power is measured below such a DFS threshold cannot cause significant interference to the paired [fixed link] receiver."[83] More specifically, using a random location analysis, the Telcordia paper shows that at 90 percent of the area surrounding the licensed microwave receiver, the unlicensed device will measure power levels less than -106 dBm, suggesting that it is safe to transmit when in fact significant interference to the fixed link receiver may result.

Notwithstanding the problems associated with implementing the TPC and DFS as methods to increase spectrum access by unlicensed devices, the Telcordia analysis examines the separate possibility of using exclusion zones coupled with GPS technology to ensure a minimum separation distance between unlicensed transmitters and fixed link microwave receivers. Although this method could theoretically minimize interference by restricting unlicensed device

[82] *See id*. at 96.

[83] *Id*.

operation to areas far away from fixed microwave links, the practical limitations of such an approach render it unworkable as a solution.

First, for the exclusion zone method to work, the unlicensed device would need to have access in real time to a database of all point-to-point facilities within its radio horizon and "understand" its own geographical coordinates and elevation, in order to determine the required "exclusion zone" and thereby avoid the power aggregation problems raised in the Telcordia Report. And even if a method could be developed to update the unlicensed device's memory on a real-time basis to account for the fixed links that are constantly being installed across the nation, it is not clear how the FCC could ensure that the unlicensed device is actually updated on such a real-time basis (which likely would be required on a daily basis).

Further, to avoid the possibility that high concentrations of unlicensed devices immediately beyond the exclusion zone could cause interference to exceed the threshold of the licensed receiver, the exclusion zone radius should be the radio horizon, taking into account the elevations of both the unlicensed device and the fixed link receive antenna.[84] The result would be a device that could not operate in locations where point-to-point facilities are within the unlicensed device's radio horizon, which likely would eliminate most if not all urban and densely populated areas. In short, the exclusion zone construct would necessarily relegate unlicensed operations to unpopulated areas where there is no need for an ITemp concept, because these areas already have uncongested spectrum for unlicensed devices to operate.

[84] An exclusion zone that is within the radio horizon necessarily relies on a device density estimate to set the allowable radiated power levels. If the actual device density becomes larger than the estimate, then the interference threshold will be exceeded.

In addition, the unlicensed device must not be permitted to transmit unless three-dimensional GPS lock is achieved,[85] which means that the device would not be able to operate indoors or in urban "canyons." Careful consideration must also be given to the security aspect of such an unlicensed device, so as to avoid the possibility of utilization of unauthorized external antennas and "spoofing" or defeating the logic of the unlicensed device to allow operation within the "exclusion zone." Incorporating the exclusion zone components – GPS, look-up table memory, etc. – and security components would almost certainly result in a considerable increase in the cost of the unlicensed device.

Ultimately, the exclusion zone method does not appear to be a practical solution to increasing access for unlicensed devices because, aside from the substantial increased costs of the unlicensed device itself, the areas in which it would facilitate spectrum access are areas in which uncongested spectrum already exists for unlicensed use.

VII. THE ITEMP CONCEPT RAISES SERIOUS NON-TECHNICAL CONCERNS

Although these comments focus primarily on the technical impediments to implementing the ITemp paradigm, the ITemp construct implicates serious concerns that are non-technical in nature. Specifically, implementation of the ITemp concept in mobile service bands would: (i) undermine the Commission's market-oriented policies; (ii) upset investment expectations and chill future investment in new technologies; and (iii) impinge upon licensees' legal rights. Sprint briefly addresses these issues below.

[85] Three-dimension lock (*i.e.*, including elevation) is necessary, because radio horizon depends on the elevations of both ends of a link.

A. IMPLEMENTATION OF THE ITEMP CONCEPT IN MOBILE SERVICES BANDS WOULD UNDERMINE THE COMMISSION'S MARKET-ORIENTED SPECTRUM MANAGEMENT POLICIES

The ITemp construct would undermine the Commission's market-oriented, "exclusive use" and "flexible use" policies. In establishing PCS, for example, the Commission made clear from the start that it is "essential that our decisions on PCS spectrum and regulatory structure furnish PCS providers the ability to reach and serve existing and new markets in an economic and responsive manner."[86] Accordingly, the Commission pursued a technology-neutral spectrum management approach that sought to maximize the "flexibility of PCS licensees to select standards and technologies best suited to their needs."[87] Licensees such as Sprint responded spending billions of dollars to deploy spectrally efficient network technologies, such as CDMA, and innovative broadband services sought by consumers, such as email, web browsing, text messaging and media streaming services. In short, the policy of leaving PCS licensees to develop their spectrum has been a huge success.

Shoehorning the ITemp concept into the PCS and other mobile services bands would jeopardize the important technological advances and market successes achieved by CMRS licensees. As explained above, implementation of the ITemp concept in mobile services bands will necessarily reduce existing network capacity and coverage, thus degrading the services that the market demands. As a result, substantial costs and effort would be incurred to mitigate the consequences of the new interference, not to mention the substantial costs of the ITemp network elements. Further, the degradation in service quality and coverage also adversely impacts the

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[86] *New Personal Communications Services,* 7 FCC Rcd 5676, 5679 ¶ 6 (1992).

[87] *Second PCS Reconsideration Order,* 9 FCC Rcd 4957, 5022 ¶ 165 (1994).

FCC's public safety and Homeland Security policies embodied in E911 and other emergency situations.

Given the serious technical obstacles concerning ITemp's feasibility and the enormous costs that undoubtedly would apply in attempting to implement the concept, providing access to licensed spectrum by unlicensed third parties through secondary market mechanisms represents a far superior option.[88] More specifically, to the extent licensed spectrum sharing is technically feasibility, utilization of secondary market mechanisms represents the only viable method for developing and implementing such access, because it would allow licensees to manage interference in their spectrum and work with unlicensed device proponents to develop interoperability solutions. Indeed, the Spectrum Policy Task Force recommended "looking primarily at the use of secondary markets"[89] as a model to enhance spectrum access by secondary users because "[t]he secondary markets model takes advantage of the flexibility and adaptability of the market to solve access problems."[90]

B. IMPLEMENTATION OF THE ITEMP CONCEPT IN MOBILE SERVICES BANDS WOULD UNDERMINE AND DETER INVESTMENT IN TECHNOLOGY

Shoehorning ITemp into bands wherein the licensees have deployed service in accordance with "exclusive use" or "flexible use" expectations also would have long-term adverse implications for innovation. Mobile services licensees have spent and continue to spend billions for equipment development, spectrum, relocation and network construction, based upon the spec-

[88] *See* Comments of Sprint Corporation filed in WT Docket 03-66 (filed on Sept. 8, 2003) at 7-15; Comments of Sprint Corporation filed in ET Docket 02-135 (filed on July 8, 2002) at 17-21; Reply comments of Sprint Corporation filed in ET Docket 02-135 (filed on July 23, 2002) at 4-9; Comments of Sprint Corporation filed in ET Docket 02-135 (filed on Jan. 27, 2003) at 13-16; Reply comments of Sprint Corporation filed in ET Docket 02-380 (filed on May 22, 2003) at 1-2.

[89] SPTF Report at 56; *see also* 58.

[90] *Id*. at 57.

trum management policies that protect their spectrum from interference. Capital markets require regulatory certainty to hedge against risk – particularly in competitive sectors such as the telecommunications industry. The Commission recognized this dynamic explicitly, for example, in developing service- and technology-neutral policies for PCS that would provide a "stable environment that is conducive to investment" in order to "foster the rapid development of PCS."[91] Indeed, the Spectrum Policy Task Force cautioned in its report that the Commission must be sensitive to "the potential impact of [] opportunistic devices on the expectations, business plans, and investment made by licensed spectrum users."[92]

Changing the terms of licensees' spectrum usage in a manner that adversely affects implemented business plans and constructed networks would chill future investment in technologies, as investors would lack certainty as to whether the benefits and innovations developed and predicted under existing rules will be eradicated by new rules. Moreover, the deleterious impact on investor confidence would not be limited to investment in technologies, but would lower valuations in future auctions because bidders would no longer have confidence that spectrum rights obtained will not be later changed materially by the government.

C. IMPLEMENTATION OF THE ITEMP CONCEPT IN MOBILE SERVICES BANDS WOULD IMPINGE UPON LICENSEES' LEGAL RIGHTS

The harmful effects of introducing interference into mobile services bands also would impinge upon licensees' legal rights. Courts have made clear that licensees have investment expectations in the spectrum they have developed and, in many instances, paid for at auction.[93] As

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[91] *Second PCS Order*, 8 FCC Rcd 7700, 7753 ¶ 131 (1993).

[92] SPTF Report at 58.

[93] *See, e.g., Yankee Network v. FCC*, 107 F.2d 212, 217 (D.C. Cir. 1939); *In Re Atlantic Business and Community Development Corp*., 994 F.2d 1069, 1074 (3rd Cir. 1983); *L.B.Wilson v. FCC*, 170 F.2d 793, 798 (D.C. Cir. 1948); *Orange Park Florida v. FCC*, 811 F. 2d 664, 674 n.19 (D.C. Cir. 1987); *Reuters Ltd. V. FCC*, 781 F. 2d 946, 950 n.5 (D.C. Cir. 1986).

the Commission has indicated, licensees "must have certain rights and responsibilities that define and ensure their economic interests," including "the right to be protected from interference to the extent provided in the Commission's rules."[94] Any ITemp construct that forces the customers of licensed service providers to accept additional outages to their services by an unlicensed device, or which requires modifications to the licensee's networks in an effort to accommodate ITemp devices, not only unlawfully interferes with the licensee's legitimate investment expectations, but is contrary to the rights and purposes associated with a primary service allocation.

As Sprint has previously explained, the Commission and the courts have recognized that a license auction establishes a contract between the federal government and the licensee, under which both parties owe duties to each other.[95] Auction winners pay considerable sums for licenses based upon the FCC rules and orders in existence prior to the auction. The key attractiveness of licenses governed by technology-neutral, "flexible use" policies, as described above for PCS, is the promise that licensees will be free to develop and deploy networks in accordance with market demand. Licensees, in reliance upon these flexible use policies, acquired licenses at auction and developed and deployed networks specifically designed and calibrated to fully utilize their licensed spectrum. Introducing Commission-sanctioned interference into the mobile services bands could "so substantially impair[] the value of the contract" with the government that recovery of damages based on the remaining contractual rights to performance is warranted.[96] At the very least, forcing licensees to absorb costs or monetary losses directly attributable to a

[94] *Spectrum Policy Statement*, 15 FCC Rcd 24178, 24186 (2000).

[95] *See* Reply Comments of Sprint Corporation filed in WT Docket Nos. 02-381, 01-14 and 03-202 (filed on Jan. 26, 2004) at 17-21.

[96] Restatement (Second) of Contracts § 243; *see Mobil Oil*, 530 U.S. at 608.

decision to sanction interference in mobile services bands could constitute a "regulatory taking."[97]

VIII. CONCLUSION

For the reasons discussed herein and in the attached Telcordia Report, the Commission should reject the concept of ITemp spectrum sharing in mobile services bands and in bands allocated for fixed point-to-point simplex and full duplex links.

Respectfully submitted,

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[97] One of the factors of particular significance in determining whether a particular government act constitutes a regulatory taking is "[t]he economic impact of the regulation on the claimant and, particularly, the extent to which the regulation has interfered with distinct investment-backed expectations." *Penn Central Transportation v. New York City*, 438 U.S. 104, 124 (1978). Clearly, having encouraged licensees to invest in, develop and deploy spectrally efficient technologies, any FCC-sanctioned interference that would diminish the effectiveness and value of these technologies also would interfere with the licensees' investment-backed expectations.

Attachment A