
Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of)
)
Establishment of an Interference Temperature) ET Docket No. 03-237
Metric to Quantify and Manage Interference)
and to Expand Available Unlicensed Operation)
in Certain Fixed, Mobile and Satellite Fre-)
quency Bands)

To: The Commission

REPLY COMMENTS

CINGULAR WIRELESS LLC

J. R. Carbonell
Carol L. Tacker
David G. Richards
5565 Glenridge Connector
Suite 1700
Atlanta, GA 30342

BELLSOUTH CORPORATION

James G. Harralson
Charles P. Featherstun
1155 Peachtree St., N.E.
Suite 1800
Atlanta, GA 30309
(404) 249-3855

May 5, 2004

TABLE OF CONTENTS

SUMMARY ii

I. THE COMMENTS REVEAL A COMPLETE LACK OF SUPPORT FOR THE COMMISSION’S INTERFERENCE TEMPERATURE SCHEME FOR UNLICENSED ACCESS TO LICENSED SPECTRUM..... 1

 A. Negative Impact on Quality, Coverage, and Capacity..... 3

 B. Lack of a “Margin” that Can Be Exploited by Unlicensed Users..... 7

 C. IXTemp Prevents Licensed Users from Innovating and Increasing Capacity through More Efficient Spectrum Use..... 8

 D. IXTemp Is Unproven and Untested 10

 E. Monitoring Proposals Entail Significant Costs..... 14

 F. Enforcement Issues and the Tragedy of the Commons 16

 G. Return to Command and Control..... 18

II. THE COMMENTS SUPPORT THE USE OF SEPARATELY ALLOCATED BANDS AND/OR VOLUNTARY LEASES FOR UNLICENSED USE..... 19

III. SHARED SPECTRUM’S PROPOSED “OPEN LOOP” SCHEME FOR UNLICENSED ACCESS BASED ON INTERFERENCE TEMPERATURE LACKS MERIT 20

CONCLUSION..... 22

SUMMARY

The Interference Temperature proposal is not workable; this proceeding should be terminated. None of the comments supported the Commission's proposal for giving unlicensed users access to licensed spectrum based on an interference temperature metric. Even unlicensed wireless vendors and users did not support the Commission's proposals. For example, the Wi-Fi Alliance found it impractical and suggested pursuing other avenues for unlicensed wireless relief.

A few commenters supported the theoretical concept of an interference temperature metric, but none of them supported the approaches set forth in the *NOI/NPRM*. One manufacturer of unlicensed devices, Proxim, could find no way for a sharing device to determine on its own whether it would cause interference to a licensed network. Agilent found that interference temperature-based sharing is not feasible in spectrum where terrestrial licensees use directional antennas. Another supporter of the general concept, Shared Spectrum, found the Commission's "closed loop" approach would not work in many cases. Shared Spectrum did advocate its own "open loop" approach, but this approach assumes that a licensed station will always transmit and receive on the same frequency with fixed power — conditions that are completely inapposite to CMRS, which is characterized by rapidly varying power levels and frequency assignments and by use of paired channels for FDD operation.

Commenters from every sector found that the effect of interference temperature underlays on coverage, capacity, and service quality would require substantial engineering of existing networks just to replicate current coverage, capacity, and quality levels, assuming the additional sites and funds were available. Commenters also showed that interference temperature devices in CMRS and safety-related bands would degrade the availability and reliability of public safety services.

Many commenters noted that, contrary to the Commission's belief, there is no "margin" between the noise floor and peak noise levels that can be exploited by unlicensed operators by use of an interference temperature metric. Networks such as CMRS and fixed wireless are designed to work down to the noise floor, and utilize the existing margin to ensure successful, reliable communications under varying conditions.

Commenters observed that the long-term consequence of giving unlicensed devices access to licensed spectrum would be to deter licensees from using spectrum-efficient technologies and innovative techniques as they have in the past and are continuing to do, punishing the use of efficient technology. In effect, implementation of interference temperature underlays would place a "technology freeze" on licensed networks.

Many commenters pointed out that there are unresolved fundamental issues regarding the interference temperature metric and called into question the assumptions on which the *NOI/NPRM* was based. Commenters also noted that the FCC had not yet compiled the noise floor and environmental data needed for meaningful discussion of the issue. Commenters also criticized the monitoring proposals discussed in the *NOI/NPRM* as unworkable, impracticable, and costly. Numerous commenters also noted that the interference temperature scheme would be impossible to enforce.

Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of)
)
Establishment of an Interference Temperature) ET Docket No. 03-237
Metric to Quantify and Manage Interference)
and to Expand Available Unlicensed Operation)
in Certain Fixed, Mobile and Satellite Fre-)
quency Bands)

To: The Commission

REPLY COMMENTS

Cingular Wireless LLC (“Cingular”) and BellSouth Corporation (“BellSouth”) hereby submit their reply comments in response to the Commission’s Interference Temperature *Notice of Inquiry and Notice of Proposed Rulemaking*.¹

I. THE COMMENTS REVEAL A COMPLETE LACK OF SUPPORT FOR THE COMMISSION’S INTERFERENCE TEMPERATURE SCHEME FOR UNLICENSED ACCESS TO LICENSED SPECTRUM

None of the comments filed in response to the *NOI/NPRM* supported the Commission’s proposal for giving unlicensed users access to licensed spectrum based on an interference temperature (“IXTemp”) metric. Even the Wi-Fi Alliance found that the proposal was “not broadly practical and applicable” and suggested pursuing other avenues.² In addition, the IEEE 802 found that “some spectrum segments, like mobile bands including public safety, deserve special protection from interference and should not be considered for unlicensed use on the basis of the

¹ *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 03-237, *Notice of Inquiry and Notice of Proposed Rulemaking*, 18 F.C.C.R. 25309 (2003) (*NOI/NPRM*), summarized, 69 Fed. Reg. 2863 (Jan. 21, 2004), correction, 69 Fed. Reg. 5945 (Feb. 9, 2004).

² Comments of Wi-Fi Alliance at 2.

interference temperature concept.”³ Only four commenters expressed any support for the general concept of using IXTemp to facilitate unlicensed access to licensed spectrum, and even these commenters had serious issues with the Commission’s proposal.

Shared Spectrum found the Commission’s proposal largely unworkable and advocated a different way of using interference temperature; that comment will be addressed in Section III. Proxim, a manufacturer of unlicensed equipment, could find no way to make a highly simplified version of the Commission’s proposal work, saying that “the most straightforward method of using the Interference Temperature concept, in which devices make local measurements that determine the transmit/no-transmit decision, is fraught with difficulty.”⁴ Although it clearly wanted to support the use of IXTemp for unlicensed access, it concluded, “we have not been able to discover an efficient method for a sharing device to determine, based on measurements that it, itself, makes, whether or not it can transmit without causing harmful interference.”⁵ Proxim noted that using a distributed network of interference temperature monitors would entail “much more complex procedures to implement, involving central coordinators, location capability, and possibly grids of RF monitoring devices. . . . [A]ny such solution is certain to be very complicated.”⁶

Agilent, which cautiously supported exploring the use of IXTemp despite “hav[ing] raised questions about [its] technical merits,”⁷ indicated just how complicated it would be to implement a measurement grid scenario for IXTemp. For example, Agilent suggested that in terrestrial networks employing directional antennas, IXTemp would not be feasible:

³ Comments of IEEE 802 at 8.

⁴ Comments of Proxim Corporation at 10.

⁵ *Id.* at 2.

⁶ *Id.* at 11.

⁷ Comments of Agilent Technologies, Inc. at 2.

[I]nformation about [the antennas'] response behavior cannot be readily conveyed to the prospective secondary transmitters. For this reason, it is difficult to envision a system based on the interference temperature alone that would efficiently share spectrum with a secondary user while maintaining high reliability in the primary service. A system that provides for the dissemination of information about the geographic distribution of the various participants may well be adequate to serve the intended goals, but cost and complexity tradeoffs for such schemes will require a somewhat more protracted process than would be feasible within the time limits of the pending *NPRM*.⁸

For that reason, Agilent believed satellite spectrum to be better suited to an IXTemp regime than spectrum used for fixed terrestrial point-to-point service. Even for the satellite spectrum, however, Agilent envisioned IXTemp sharing having “a reasonable chance for success,”⁹ that was feasible only through use of an extraordinarily complex scheme, as discussed in Section I.G, below.

Other commenters were less charitable. Virtually all of the commenters strongly opposed the use of IXTemp citing technical infeasibility, adverse effects on licensed spectrum usage, and other issues, as discussed in the following sections.

A. Negative Impact on Quality, Coverage, and Capacity

Commenters from every sector found that unlicensed use of spectrum based on an IXTemp metric would have negative effects on licensees' service quality, coverage, and capacity. TIA noted that an interference temperature “cap” above the noise floor “necessarily subjects the

⁸ Comments of Agilent at 4-5. While Agilent found terrestrial licensed point-to-point systems with directional antennas unsuited to an IXTemp approach, Proxim found that omnidirectional point-to-multipoint systems also posed insuperable difficulties for an IXTemp implementation based on individual measurement, because no unlicensed unit would be able to make a determination that its transmissions will be below the permitted IXTemp at a licensed system's receivers. *See* Comments of Proxim at 2.

⁹ Comments of Agilent at 2.

licensed, victim wireless system to increased external interference.”¹⁰ CTIA observed that any increase in the noise floor due to IXTemp operations “would manifest itself to consumers through lower voice quality, slower data transmission with greater numbers of packet retransmissions, decreased coverage, and more dropped calls in cell-to-cell handoff.”¹¹

Commenters pointed out that coverage would be affected not only at the cell edge, but in other areas where coverage is impaired due to propagation conditions, such as in buildings, in elevators, and in underground garages.¹²

Commenters noted that the degradation would affect not only range (and thus coverage), but also capacity — especially in CMRS systems that have managed intrasystem interference so as to maximize capacity.¹³ Data capacity of 3G networks would also be adversely affected.¹⁴

¹⁰ Comments of Telecommunications and Internet Association (“CTIA”) at 4.

¹¹ Comments of CTIA at 6; *see also* Comments of Lucent Technologies Inc. at 2 (“The presence of additional sources of noise, such as that caused by out-of-band energy in adjacent spectrum, or by external inband sources such as unlicensed devices, necessarily and significantly degrades the signal to noise ratio and negatively impacts the call quality of the victim system, both in range (the coverage area of the cell that can be adequately served by a single base station) and in capacity (the number of simultaneous users or aggregate rate of data transmission that can be achieved in one cell.”)); Comments of Motorola, Inc. at 7 (stating that additional interference to systems providing data service would “significantly decrease a given system’s capacity and degrade the efficiency of the network by reducing throughput or the number of users that can be served, thereby limiting a licensee’s ability to provide its intended service.”); Comments of TIA at 4.

¹² *See, e.g.*, Comments of AT&T Wireless Services, Inc. at 16.

¹³ *See, e.g.*, Comments of AT&T Wireless at 8-10; Comments of Sprint Corporation at 15 (“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.”).

¹⁴ *See, e.g.*, Comments of AT&T Wireless at 10 (noting that the presence of external interference would affect advanced data systems negatively, causing systems such as EDGE to adjust their modulation and coding to adapt to the increased interference level, thereby reducing data throughput, with the result that “an operator is forced to accept either lower capacity or reduced data transmission rates, and users will experience either lower data rates or higher incidences of blocked sessions”); Comments of Motorola at 7 (“Motorola has assessed the potential impact to

(continued on next page)

The negative effect on service quality of giving unlicensed devices access to licensed spectrum based on IXTemp was cited by many commenters.¹⁵ CTIA said that IXTemp underlays “would reduce service quality for licensed wireless technologies that consumers now expect to be on a par with wireline connections.”¹⁶ Both analog and digital services will experience decreased quality.¹⁷ Adding cell sites to compensate for degraded quality is not a viable option.¹⁸

Moreover, the introduction of IXTemp underlays in CMRS bands would degrade the availability and reliability of “fundamental public safety services, such as E-911 call processing.”¹⁹ Qualcomm asserts that “[e]very one dB increase in the GPS enabled mobile terminal[’]s effective interference temperature translates to one dB decrease in sensitivity, and hence a reduction in both the location position yield and positioning accuracy in challenging RF environments.”²⁰ Even some unlicensed devices used for safety-related purposes would be adversely affected by the employment of an IXTemp metric; manufacturers and users of safety-related un-

(footnote continued)

WCDMA operations at 850 MHz and has concluded that a 1 dB increase in interference to the thermal noise [level] could decrease the uplink capacity by nearly 10 percent.”).

¹⁵ See, e.g., Comments of AT&T Wireless at 19-20 (noting that some customers who barely received service would receive none, and some customers who received good quality service would receive only acceptable or marginal service quality); Comments of Sprint at 17 (“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.”).

¹⁶ Comments of CTIA at 8.

¹⁷ Comments of CTIA at 9.

¹⁸ Comments of Sprint at 17 (“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.”).

¹⁹ Comments of CTIA at 9.

²⁰ Comments of Qualcomm at 12; see also Comments of Sprint at 17 (“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.”).

unlicensed devices said that this would decrease the reliability of those devices, endangering public safety.²¹

Many commenters observed that the effects of IXTemp-based underlays on coverage, capacity, and service quality would require substantial reengineering of existing licensed networks.²² Qualcomm states that “[c]arriers would need to add large numbers of base stations just to replicate their present coverage area, at a cost of billions of dollars. However, due to zoning issues, site availability, and a host of other practical issues, it is doubtful that the carriers, even if they had the funds, could actually deploy these new base stations. As a result, the American public would suffer a substantial diminution of wireless service.”²³ This would strike an economic blow to operators who are in the process of upgrading to 3G service by requiring substantial expenditures just to stay at current coverage, capacity, and quality levels.²⁴ Moreover, an-

²¹ See, e.g., Comments of Central Station Alarm Association at 4 (underlay devices in 300-500 MHz range would decrease the reliability of existing low-power unlicensed devices used to transmit burglar alarm data to central stations, and imposing IXTemp-based transmission blockages on unlicensed safety-related units would delay or impede transmission of safety-related communications); Comments of Delphi Corporation at 4-5 (opposing use of IXTemp in bands used for vehicular radar).

²² See, e.g., Comments of AT&T Wireless at 17-18 (estimating, *inter alia*, that a 1 dB degradation would reduce coverage of a hypothetical suburban/rural system by 271 km², requiring the addition of 17 sites, and would cause a loss of 1250 erlangs of capacity in a hypothetical urban system, requiring the addition of 33 sites); Comments of Motorola at 7 (stating that an increase in the noise floor by 1 dB could decrease WCDMA uplink capacity by 10 percent, affecting reliability and availability of service, negatively impacting data rates, or requiring licensee to spend millions of dollars to deploy additional infrastructure.”); Comments of Qualcomm Incorporated at 7 (stating that a 1 dB increase in noise temperature would cause 10-15% decrease in CDMA cell site coverage, most pronounced in urban areas, leading to a “dramatic and intolerable loss of coverage for . . . American wireless subscribers.”); *id.* at 8 (1 dB increase in noise temperature would require 12-17% more cell sites to maintain coverage); Comments of Verizon Wireless at 11-12.

²³ Comments of Qualcomm at 4.

²⁴ See, e.g., Comments of AT&T Wireless at 19.

other negative effect of IXTemp underlays was pointed out by Qualcomm: a reduction in end-users' talk-time due to the toll taken by higher power on battery life.²⁵

Even IXTemp supporter Agilent conceded that use of IXTemp for unlicensed access to licensed bands might have an adverse effect on the licensees' ability to make the most efficient use of their spectrum:

[W]hile it may be possible to establish an interference temperature threshold, this presumes that current license holders will never desire to improve system throughput. Unless the interference temperature threshold can be adjusted, a successful implementation of [the] interference temperature concept could preclude the primary user from increasing system capacity.²⁶

B. Lack of a “Margin” that Can Be Exploited by Unlicensed Users

The invalidity of the Commission's belief that there is a “margin” between the noise floor and the peak noise level that can be exploited by unlicensed operators was decisively demonstrated by numerous commenters. Verizon Wireless correctly stated that this view “is completely divorced from engineering reality.”²⁷ CTIA pointed out that “[t]o take advantage of licensed spectrum, CMRS systems are now designed to operate down to the noise floor. As a consequence, any unwanted signals, such as those from unlicensed devices in the bands, will cause degradation of the service to consumers.”²⁸ In a similar vein, AT&T Wireless observed:

This “unused” space in reality is the operators' opportunity to utilize the spectrum most efficiently, to ensure that calls will be successful in worst case RF conditions, and to maximize system capacity for voice and data when the RF conditions are more favorable.

²⁵ See Comments of Qualcomm at 10-11 (showing that a 1 dB increase in noise temperature will result in “a 20% decrease in battery life”).

²⁶ Comments of Agilent at 3.

²⁷ Comments of Verizon Wireless at 6.

²⁸ Comments of CTIA at 6.

The . . . margin that is incorporated in the system design . . . [is] provided by operators to account for system interference and to provide coverage to the user at the cell edge.²⁹

The same is true in the fixed services, according to comments filed by the Fixed Wireless Communications Coalition:

[A]lthough FS links operate much of the time with high levels of signal margin, users need that margin to maintain reliability under fading conditions — and they pay for it in equipment costs. The fade margin is not a public resource the Commission can allocate out for use by others.³⁰

C. IXTemp Prevents Licensed Users from Innovating and Increasing Capacity through More Efficient Spectrum Use

Many commenters, echoing the Cingular and BellSouth comments, pointed out that the long-term consequence of giving unlicensed devices access to the CMRS bands would be to deter licensees from using spectrum-efficient technologies and innovative techniques as they have in the past and are continuing to do.³¹ CMRS licensees have taken advantage of the flexibility

²⁹ Comments of AT&T Wireless at 11. AT&T Wireless notes that systems such as EDGE and HSDPA use adaptive techniques to “make the most of the available S/I at any given point,” *id.*, and provides a chart similar to Figure 1 in the *NOI/NPRM* demonstrating that there is no unused margin as a result, *see id.* at 12 (Figure 1). *See also* Comments of Lucent at 4 (“However, this very ‘headroom’ is built into the link budget of CMRS spread spectrum systems and is inherently used to effectively provide the required capacity to meet subscriber demand. Accordingly, the ‘headroom’ would rarely, if ever, be available to the underlay devices.”); Comments of Nextel at 7; Comments of Qualcomm at 14; Comments of Sprint at 10-11; Comments of Verizon Wireless at 6-8.

³⁰ Comments of Fixed Wireless Communications Coalition at 3; *see also* Comments of Idaho Power at 2.

³¹ *See, e.g.*, Comments of AT&T Wireless at 20-24 (citing adaptive modulation rate coding (“AMR”) and single-antenna interference cancellation (“SAIC”)); Comments of CTIA at 5 (citing digitalization of air interfaces, advances in compression, deployment of smart antennas, cell splitting, and more frequency reuse); Comments of Thomas Hazlett and Dean Spitzer (“Hazlett and Spitzer”) at 34-36 (citing analog-to-digital transition, move from TDMA to GSM, transition to 3G); Comments of Lucent at 2 (IXTemp will hinder the introduction of 3G services that are “susceptible to degradation caused by noise from external sources.”); Comments of Nextel Communications, Inc. at 4-5; Comments of Lucent at 4; comments of Qualcomm at 12-14; Comments of Sprint at 36-38; Comments of Verizon Wireless at 12-18.

granted by the Commission to employ an ever-widening array of efficiency-increasing technological innovations, from the initial introduction of digital technologies to the 3G technologies now being introduced.³² The exclusively-licensed, flexible-use licensee such as a CMRS operator, according to economists Thomas Hazlett and Dean Spitzer, “tends to discover and deploy efficient wireless solutions, as it internalizes both the expense and the gains from creating valuable services. This makes the licensee a zealous protector of radio space, an aggressive investor in infrastructure, and a risk-taking entrepreneur in search of new ‘killer apps.’”³³ They note that “[m]arket forces *compel* wireless carriers to efficiently utilize bandwidth so that additional users, and revenues can be accommodated. . . . [O]perators strategically monitor market developments and network performance to locate additional profit opportunities.”³⁴ To the extent there is currently unused capacity within licensed spectrum, the licensees have the incentive to develop that capacity in an economically productive manner, but granting others access to that potential capacity will diminish the ability and incentive of licensees to improve their efficiency.³⁵

Indeed, it will punish the use of efficient technology: Hazlett and Spitzer observed that under an IXTemp regime, “[t]he most serious losses will be inflicted on licensees that have deployed the most advanced techniques for utilizing the low power frequency space . . . now reassigned for other uses.”³⁶ Nextel correctly notes that “[u]nderlays would impair the ability of CMRS licensees to make their future spectrum operations more spectrally efficient; it could deprive them of the ability to exploit the ‘margins’ of whatever spectrum efficiency innovations

³² See Comments of CTIA at 4; Comments of Verizon Wireless at 8-9.

³³ Comments of Thomas Hazlett and Dean Spitzer (“Hazlett and Spitzer”) at 18.

³⁴ *Id.* at 33; Comments of Verizon Wireless at 16-17.

³⁵ See Comments of AT&T Wireless at 22-24; Comments of CTIA at 10; Comments of Verizon Wireless at 8-9, 12-18.

³⁶ Comments of Hazlett and Spitzer at 14.

they create. The Commission’s decision to place its faith in the market is the better policy approach for commercial services.”³⁷

CTIA pointed out that “the migration path for wireless systems relies on wideband spread spectrum modulation techniques, a technology that is dependent upon maintaining an adequate signal-to-interference ratio.”³⁸ It warned that underlay operations would interfere with the advanced techniques used to achieve 3G performance and efficiency and will thus “impact both the types and quality of service CMRS customers will receive.”³⁹

This is not true only with respect to CMRS. Fixed broadband wireless operators commented that “introduction of forced underlays through application of the interference temperature metric presents a clear and present danger to future improvements in spectral efficiency.”⁴⁰ Likewise, satellite operators pointed to past efficiency-enhancing innovations and warned that an IXTemp-based underlay would place a “technology freeze” on their futures. This would, they say, “unavoidably constrain the future growth and development of existing users, likely condemning them to eventual obsolescence.”⁴¹

D. IXTemp Is Unproven and Untested

TIA observed that “the concept [of IXTemp] . . . is unproven” and that decisions based on such concepts “should await the demonstrable existence of such technology at reasonable

³⁷ Comments of Nextel at 5.

³⁸ Comments of CTIA at 7.

³⁹ Comments of CTIA at 7.

⁴⁰ Comments of Wireless Communications Association International, Inc. at 5.

⁴¹ Comments of Globalstar, L.P., ICO Global Communications, Inmarsat Ventures Ltd., Intelsat Global Services Corp., Lockheed Martin Corp., Loral Space & Communications Ltd., New Skies Satellites, Northrop Grumman Space Technology, PanAmSat Corporation, and SES Americom, Inc., at 8-9.

costs for widespread deployment and market acceptance.”⁴² Moreover, many commenters pointed out that there are substantial fundamental questions that remain unanswered about IX-Temp. CTIA noted that these include:

(i) how to determine whether systems with widely varying “protection” needs are compatible; (ii) who “should be parties to the process of setting” applicable [IXTemp] metrics; and (iii) how to “gauge the success” of the introduction of the [IXTemp] metric.⁴³

Sprint goes even further, stating that the IXTemp “concept as applied to mobile service bands is fraught with technical challenges that make the concept impossible and/or impractical to implement” and “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.”⁴⁴

A variety of commenters noted, in accordance with the initial comments of Cingular and BellSouth, that the use of IXTemp for unlicensed access to licensed spectrum rested on faulty premises. Sprint observed that the assumption that licensees experience peaks above the original noise floor level for which systems were designed is both unsupported and incorrect.⁴⁵

AT&T Wireless pointed out that the “threshold assumption” of this scheme was that unlicensed units would be able to determine, based on analysis of the RF environment, “when they could operate and at what power levels,” but that there is no way for unlicensed devices to determine either “the RF environment ‘around’ the licensed receiver [or] the interference the re-

⁴² Comments of Telecommunications Industry Association at 3-4.

⁴³ Comments of CTIA at 15.

⁴⁴ Comments of Sprint Corporation at 5.

⁴⁵ *Id.* at 6-87, citing V-Comm PCS Noise Floor Study, originally submitted in WT Docket 02-86 by AT&T Wireless, Cingular, and Verizon Wireless on October 15, 2003 (subsequently submitted in the instant docket on April 5, 2004 as an attachment to V-Comm’s comments).

ceiver is actually experiencing at any point in space or time.”⁴⁶ Unlicensed device manufacturer Proxim came to the same conclusion.⁴⁷ Likewise, Motorola observed that it would be exceedingly difficult to measure the interference temperature in a CMRS environment, regardless of where it is measured, because interference temperature excludes licensed transmissions, which would be nearly impossible for any monitoring system to cancel out.⁴⁸

Many commenters pointed out that the constantly varying power levels, dynamically changing frequencies, and mobility of handsets in CMRS networks pose insuperable difficulties for the establishment of IXTemp underlays.⁴⁹ CTIA notes, for example, that “[a] particular signal from a non-primary user that may be allowable one millisecond may cause interference once it begins transmitting during the next millisecond.”⁵⁰ Moreover, the waveform characteristics of many CMRS signals are difficult to distinguish from noise, making it “virtually impossible to discriminate between primary users’ signals and actual interference temperature.”⁵¹ As a result, Motorola notes, “it is impossible to predict whether dynamic interference temperature measurements precisely model the nearby radio environment.”⁵²

Consistent with the Cingular and BellSouth comments, AT&T Wireless notes that grids of interference temperature sensors “around” licensed receive sites would not be sufficient — the RF environment would have to be “analyzed *within* [the licensed] receiver,” taking into account an “internal description of its interference environment.”⁵³ The company also observes that even

⁴⁶ Comments of AT&T Wireless at 5; *accord* Comments of Verizon Wireless at 9-10.

⁴⁷ Comments of Proxim at 2.

⁴⁸ *See* Comments of Motorola at 9-10.

⁴⁹ *See, e.g.*, Comments of CTIA at 12-13.

⁵⁰ Comments of CTIA at 12.

⁵¹ Comments of Motorola at 12.

⁵² Comments of Motorola at 13.

⁵³ Comments of AT&T Wireless at 6 (emphasis added); *see* Comments of Sprint at 23-27.

if external measurements were sufficient, the IXTemp metric “would still be unworkable in the CMRS bands,” because of variations in the actual noise floor in these bands, “which make the development of an accurate picture of the RF environment almost meaningless.”⁵⁴ None of the various scenarios for measuring IXTemp will “measure it *at the mobile victim receiver*, and so cannot assess the RF environment in which the mobile receiver is actually operating. Without such knowledge, *an unlicensed device cannot make a valid decision on whether to transmit and at what power.*”⁵⁵ This is particularly true in the case of services using directional antennas, which can make use of received signals too weak to be detected by an IXTemp measurement device; thus, an IXTemp-based device directly in the directional antenna’s “boresight” might decide to transmit and, as a result, override a weak signal being received.⁵⁶

Numerous commenters pointed out that the Commission is proceeding without sufficient information about actual noise levels,⁵⁷ which the Spectrum Policy Task Force had said needed detailed study, band-by-band, as a prerequisite to IXTemp implementation.⁵⁸ For example, ARRL states:

The management tools necessary as components of an interference temperature metric include . . . a firm baseline understanding of the ambient noise levels in a wide variety of environments in a wide variety of frequency bands. These include rural, exurban, suburban, urban, and metropolitan land use environments . . . it would also include data, to be developed over substantial periods of time,

⁵⁴ Comments of AT&T Wireless at 6.

⁵⁵ Comments of AT&T Wireless at 8 (emphasis added, footnote omitted); *accord* Comments of Sprint at 13.

⁵⁶ Comments of Fixed Wireless Communications Council at 3; *see also* Comments of Motorola at 11-12.

⁵⁷ *See* Comments of ARRL, the National Association of Amateur Radio, at 7; Comments of CTIA at 15; Comments of Nextel at 6; Comments of Sprint at 9.

⁵⁸ *See Spectrum Policy Task Force Report* at 28 (SPTF Nov. 7, 2002) (*SPTF Report*), available at <http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf>.

of trends in ambient noise in those same environments in those same frequency bands.⁵⁹

The need for baseline data was echoed by Agilent, one of the few supporters of IXTemp, which cautioned that “before the interference temperature concept is expanded beyond the experimentation stage, . . . a comprehensive and ongoing survey of the spectrum is warranted. The initial survey would establish a baseline against which future spectral measurements can be compared. Without a baseline to compare against, the success or failure of new spectrum management techniques will be difficult to quantify.”⁶⁰

E. Monitoring Proposals Entail Significant Costs

Nokia commented that any IXTemp implementation “should be simultaneously effective, simple, and inexpensive for both unlicensed and licensed systems to implement.”⁶¹ None of the alternatives proposed by the Commission for monitoring IXTemp meet these criteria. The first method, monitoring by the unlicensed devices, received no support; even an unlicensed vendor could find no way to make it work.⁶²

The second method, which would make the licensee responsible for the monitoring, would unacceptably shift the burden and cost of facilitating unlicensed use to licensed operators. This would, as Sprint observes, require every cellular and PCS base station *and handset* to continually isolate and report RF power received from unlicensed devices as part of the aggregate RF received signal, interference, and noise level, a virtually impossible task, and one which would take untold capital expenses and years to accomplish, if it could be accomplished at all.⁶³

⁵⁹ Comments of ARRL at 7.

⁶⁰ Comments of Agilent at 9; *see also* Comments of Shared Spectrum Company at 17-18.

⁶¹ Comments of Nokia Inc. at 2-3.

⁶² *See* Comments of Proxim at 2; *see also* Comments of Sprint at 22-27.

⁶³ Sprint Comments at 28.

Cingular and BellSouth concur with Nextel's comment that the suggestion in the *NOI* that licensees support the establishment of "a grid of monitoring stations to continuously examine RF energy levels, derive interference temperatures[,] and then broadcast that information to subject transmitters" is a "daunting undertaking whose costs can only be guessed."⁶⁴

The third method, involving a grid of monitoring stations around the licensed receivers, is unreasonably expensive (in addition to being unworkable, as discussed in Section I.D). Nokia said this approach "would be so costly as to be impractical."⁶⁵ Moreover, the ARRL pointed out that for the establishment of any network of measurement stations to monitor interference temperature in real time and somehow relay that information to unlicensed units, "the cost of the system is going to be high," and noted that it was "difficult to rationalize" such a costly scheme with the Commission's objective of making available "frequencies where low-cost consumer applications can be easily manufactured."⁶⁶ Motorola's comments furthered this point, stating:

The industry only now is starting to develop the types of sensory and control technologies that could even begin to govern the action of emitters in response to real-time interference temperature data. Technologies that will effectively protect licensees are, therefore, either beyond the current state-of-the-art or so prohibitively expensive that the Commission cannot reasonably expect consumers to buy equipment that utilizes these technologies. As such, it is impractical to begin implementation of an interference temperature metric when the technologies that will adequately protect incumbent licensees do not exist⁶⁷

Moreover, any system relying on a monitoring network external to the unlicensed devices will require a means to communicate with unlicensed devices. This will either require dedicated

⁶⁴ Comments of Nextel at 4.

⁶⁵ Comments of Nokia at 3; *see also* Comments of Qualcomm at 15-16 ("proposed interference temperature methods invoke a number of complicated, expensive, and vulnerable methods to be developed, deployed, and managed.").

⁶⁶ Comments of ARRL at 10, *quoting NPRM* at ¶ 19.

⁶⁷ Comments of Motorola at 4-5.

spectrum, which, as Nokia points out, “is likely to lower the overall efficiency of the system and add to the cost of devices”⁶⁸ (and would require additional dedicated spectrum, which is unlikely given the premises of this proceeding⁶⁹), or require that the unlicensed devices be associated with access points connected to the Internet through a fixed line that can access the monitoring data, as suggested by Agilent.⁷⁰ In addition, if handsets are required to monitor spectrum usage and report continually, these transmissions would take a huge toll on their battery life, as Sprint indicates.⁷¹

Sprint also correctly points out that existing Commission precedent would require that the total cost of facilitating additional operations on already-licensed spectrum fall on the new entrants.⁷² It is difficult to see how this would be accomplished. Sprint notes that “it is highly unlikely that market forces would support the substantial costs” involved.⁷³

F. Enforcement Issues and the Tragedy of the Commons

Many commenters observed that the IXTemp scheme would be essentially unenforceable.⁷⁴ Sources of unlicensed interference will be movable and ubiquitous, and thus difficult or impossible to identify and track down.⁷⁵ Users of licensed networks will not be able to discern whether interference comes from unlicensed devices — perhaps even in their own homes or offices — and will hold their licensed service provider responsible.⁷⁶ When interference is caused,

⁶⁸ Comments of Nokia at 3-4.

⁶⁹ Comments of Sprint at 29; Comments of Wireless Communications Association International, Inc. (“WCA”) at 16.

⁷⁰ Comments of Agilent at 6.

⁷¹ Comments of Sprint at 29.

⁷² Comments of Sprint at 32-35.

⁷³ Comments of Sprint at 33.

⁷⁴ *See, e.g.*, Comments of CTIA at 13-14.

⁷⁵ *See* Comments of AT&T Wireless at 25.

⁷⁶ *See* Comments of CTIA at 14.

the licensee is unlikely to be able to identify its source so as to seek enforcement action, and thus reports of harmful interference are unlikely to be generated.⁷⁷ Moreover, the *NOI* provides no assurance that licensees or the Commission would be able to identify and promptly shut down renegade unlicensed devices that do not abide by the IXTemp protocols adopted.⁷⁸ Cingular and BellSouth concur with CTIA's recommendation that the Commission not authorize IXTemp underlays "unless it has a credible and effective means of locating, modifying and shutting down harmfully interfering devices."⁷⁹ This is unlikely to occur, however, because once unlicensed units are introduced, there will be little or no possibility of turning back the clock; if unacceptable interference results, there is no real remedy once innumerable devices are already in the hands of consumers.⁸⁰

Moreover, even minimal interference resulting from unlicensed operation in licensed bands is likely to result in power increases by licensed operators. AT&T Wireless noted that in the event external unlicensed interference became comparable to intrasystem interference, "there would be no benefit to reducing the power levels used (in contrast, there would likely be more incentive to increase power to compensate for underlay interference)."⁸¹ The unlicensed devices would all tend to increase power to keep pace, until they run into the interference temperature limit. In other words, making a commons of the licensed spectrum would inevitably lead to a "tragedy of the commons," where effective unlicensed use would be very limited due to interference from both other unlicensed devices and licensed operators, but licensed operators' capacity, quality, and coverage would also be significantly diminished by the unlicensed users. As Hazlett

⁷⁷ See Comments of CTIA at 14.

⁷⁸ See Comments of WCA at 21.

⁷⁹ Comments of CTIA at 14.

⁸⁰ See Comments of AT&T Wireless at 24-25; Comments of CTIA at 13-14.

⁸¹ Comments of AT&T Wireless at 10.

and Spitzer put it, “[e]xtending the use of unlicensed for services where congestion is problematic offers to expand the problem of inefficient spectrum use.”⁸² As a result, “applying the Interference Temperature proposal to the CMRS bands would destroy social value rather than create it.”⁸³

G. Return to Command and Control

The fact that adoption of an IXTemp regime would return market-based services to command-and-control regulation could not be more clearly stated than by Agilent’s complex scheme for IXTemp-based access to fixed satellite service spectrum. This would be limited to “mobile-clients with fixed-access-points connected to the Internet,” in order to facilitate “access to a frequency server on the Internet,”⁸⁴ and would require accounting for spectrum usage in order to provide compensation to primary users for secondary usage, either through tax credits or direct compensation by secondary users.⁸⁵ The primary licensee, the fixed satellite operator, would have to participate directly in the sharing scheme by having the satellite “periodically report . . . the observed interference temperature” to the frequency server, which would then adjust the number of permitted secondary-use authorizations available, the power level per unlicensed user, or the duty cycle of the unlicensed transmitters, as needed.⁸⁶ Clearly, implementing a scheme such as this through generally applicable regulations would be command-and-control regulation taken to its farthest reach.

⁸² Comments of Hazlett and Spitzer at 25.

⁸³ *Id.* at 30.

⁸⁴ Comments of Agilent at 6.

⁸⁵ *Id.* at 7.

⁸⁶ *Id.*

II. THE COMMENTS SUPPORT THE USE OF SEPARATELY ALLOCATED BANDS AND/OR VOLUNTARY LEASES FOR UNLICENSED USE

Some commenters supported allocations for unlicensed wireless service that are separate from those used for licensed service, avoiding the IXTemp scheme.⁸⁷ Cingular and BellSouth support this approach. Moreover, some of the approaches suggested for IXTemp implementations are more suited to negotiated secondary-market leases than broadly applicable regulations. For example, some variation on Agilent’s scheme (discussed in the preceding section) might potentially be workable as a negotiated secondary-market arrangement, subject to the licensee’s continuing consent, while it is wholly unsuited for imposition on an industry by regulation. Such arrangements could be worked out between affected parties based on the technical and economic features of the scheme, instead of the politics of forcing an industry to accommodate an attractive sounding “new technology” without a technological and economic basis for doing so.⁸⁸

Cingular and BellSouth note, in this connection, that the FCC appears to appreciate the problems of unlicensed devices operating in the same spectrum as licensed devices. In its *3650 MHz Band NPRM*, the Commission acknowledged that “even a moderate presence of potentially ubiquitous terrestrial services under a *licensed* allocation could hamper or preclude the operation of *unlicensed* devices in large geographic areas — including, especially, rural America where the need is greatest.”⁸⁹

⁸⁷ See, e.g., Comments of AT&T Wireless at 3, Comments of Wi-Fi Alliance at 3-4.

⁸⁸ See also Comments of Siddhartha Raja at 9, 12-14.

⁸⁹ Unlicensed Operation in the Band 3650-3700 MHz, ET Docket 04-151, *Notice of Proposed Rulemaking*, FCC 04-100 at ¶ 21 (April 23, 2004).

III. SHARED SPECTRUM'S PROPOSED "OPEN LOOP" SCHEME FOR UNLICENSED ACCESS BASED ON INTERFERENCE TEMPERATURE LACKS MERIT

Shared Spectrum's comments demonstrate that the Commission's IXTemp scheme cannot work in the CMRS band. The company asserts that the "closed loop" approach taken in the *NOI/NPRM*, whereby devices would use data from monitoring sites to make the determination whether or not to transmit, will not function properly in many cases because of substantial propagation loss between the licensed receive site and the unlicensed device.⁹⁰ Shared Spectrum also asserts, correctly, that bands used for IXTemp underlays should have low spectrum occupancy.⁹¹

Its alternative "open loop" proposal, however, does not provide a useful basis for sharing the CMRS spectrum. This scheme is premised on measurement of the transmissions from the licensed receive site over some period of time and comparison against the presumed transmit power of the licensed site to estimate propagation loss.⁹² Obviously, this only works if the transmit power is fixed and known. When the transmit power is variable over a wide range and cannot be known by the unlicensed device, there is no way for the device to use the received strength to estimate propagation loss. Moreover, the Shared Spectrum "open loop" proposal is also explicitly premised on the use of time division duplex ("TDD"), in that the signal transmitted at the licensed site must be on the same frequency as the signals received at that site. This is not the case with respect to CMRS, FS or FSS operations where frequency division duplex ("FDD") technology is used. In FDD systems, different frequencies are used for up- and down-

⁹⁰ Comments of Shared Spectrum Company at 5. The company claims that this "closed loop" approach can be made to work under very limited conditions not applicable to CMRS bands. *Id.* at 6.

⁹¹ *Id.* at 19.

⁹² *Id.* at 7-8.

downlinks. As a result, even if the transmit power of a licensed site were known precisely, and the propagation loss could be calculated from its received signal strength at the unlicensed device, transmissions on that same frequency would be subject to reception at *other* licensed sites in a FDD environment. The device would not hear those victim transceivers' signals on its desired frequency, however, because of their use of a different transmit frequency. Accordingly, Shared Spectrum's approach is not a useful way to implement an IXTemp scheme in CMRS spectrum.⁹³

⁹³ There are other serious technical issues with Shared Spectrum's analysis (*e.g.*, its assumption that interference from the unlicensed device would be allowable at the licensed receiver at levels up to 30 dB above the noise floor, *id.* at 8, and its contradictory but equally incorrect assumption that the interference temperature level should be 3 dB below the receiver noise floor, *id.* at 13). Given the inapplicability of its analysis to CMRS, it is unnecessary to address these flaws.

CONCLUSION

For the reasons set forth, Cingular and BellSouth submit that the Commission must terminate its rulemaking without action. The total lack of support for the IXTemp concept warrants it.

Respectfully submitted,

CINGULAR WIRELESS LLC

By: /s/ David G. Richards /ms
J. R. Carbonell
Carol L. Tacker
David G. Richards
5565 Glenridge Connector
Suite 1700
Atlanta, GA 30342
(404) 236-5543

Its Attorneys

BELLSOUTH CORPORATION

By: /s/ Charles P. Featherstun /ms
James G. Harralson
Charles P. Featherstun
1155 Peachtree St., N.E.
Suite 1800
Atlanta, GA 30309
(404) 249-3855

Its Attorneys

May 5, 2004