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 REPLY COMMENTS

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Summary

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

1. There is broad consensus that the ITemp concept is not in the public interest. Virtually all commenters, representing the gamut of the telecommunications industry – including unlicensed device interests – conclude that the FCC should not pursue the ITemp concept.

2. The comments demonstrate that the ITemp concept is not technically feasible in mobile wireless service bands. Virtually every commenter addressing the technical challenges associated with the ITemp concept concludes that it is not technically feasible to implement the ITemp construct in mobile wireless service (and other) bands. The three commenters in favor of the ITemp concept do not provide empirical data or substantive technical analyses that address the numerous problems underlying the ITemp construct.

3. The ITemp concept would cause substantial harm to the 160 million consumers of mobile wireless services. The comments demonstrate that implementation of the ITemp concept in mobile wireless service bands would result in significant losses of network coverage and capacity. Local zoning processes and other technical constraints make it unrealistic to expect that wireless carriers would be able to add sites to fill in the new dead zones created by the ITemp construct. Implementation of the ITemp concept would result in wireless service consumers paying more for a degraded quality of mobile services, and would compromise introduction of new services in licensed bands.

4. The ITemp concept would undermine spectral efficiency in mobile wireless service bands. As the Telcordia analysis submitted by Sprint makes clear, even assuming *arguendo* that the numerous technical impediments to implementing the ITemp concept could be overcome, the ITemp concept would still result in a net reduction in data throughput and capacity in licensed mobile wireless bands. The public interest would not be served by implementation of a concept that actually decreases rather than increases spectrum efficiency.

5. It is unrealistic to expect that market demand would develop for ITemp devices. Commenters make clear that the technology required to make the ITemp concept functional does not exist and would be so costly to implement as to make it unreasonable to expect that any economically rational consumer would buy these devices.

6. The NPRM's proposal for introducing unlicensed device operation alongside fixed point-to-point networks is flawed and unworkable. The commenters make clear that 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. The TPC approach unrealistically assumes that unlicensed devices will be able to accurately measure the RF signal power of the fixed link transmitter, does not account for the aggregate interference effects of unlicensed devices, and incorrectly assumes that interference from the unlicensed device closest to the fixed link receiver will dominate when, in fact, interference aggregation effects could be significant. The DFS approach does not account for the limitations of the unlicensed device's ability to accurately detect and measure fixed link use of a given channel, and the potential for the unlicensed device to cause interference to the fixed link operations in situations where the unlicensed device detects RF signal power below the DFS threshold.

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SPRINT REPLY COMMENTS

Sprint Corporation hereby replies to the comments filed in response to the Notice of Inquiry and Notice of Proposed Rulemaking that seek information concerning a new "interference temperature" ("ITemp") model for permitting unlicensed devices to access licensed spectrum.[1]

I. THERE IS BROAD CONSENSUS THAT THE PUBLIC INTEREST WOULD BE DISSERVED BY ADOPTION OF THE ITEMP CONCEPT

The comments reveal broad consensus – among economists,[2] equipment manufacturers,[3] existing licensees in all bands,[4] experts in advanced radio technologies,[5] state public safety net-

[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, 18 FCC Rcd 25309 (2003) ("*ITemp NOI/NPRM*").

[2] *See, e.g.*, Comments of Thomas Hazlett and Matthew Spitzer; Report of Michael Katz (appended to CTIA's Comments).

[3] *See, e.g.*, Comments of Ericsson; Lucent; Luxon Wireless; Motorola; Nokia; PacifiCorp; Qualcomm; Telecommunications Industry Association ("TIA").

[4] *See, e.g.*, Comments of Association for Maximum Service Television/National Association of Broadcasters; AT&T Wireless; Cellular Telecommunications & Internet Association ("CTIA"); Central Station Alarm Association; Cingular/BellSouth; Delphi; DirecTV; Globalstar/ICO/Intelsat/Lockheed Martin/ Loral/New Skies/Northrop/Panamsat/SES Americom; Idaho Power; Inmarsat; National Academy of Sciences/National Research Council's Committee on Radio Frequencies; National Radio Astronomy Observatory; Nextel; Sirus; Sprint; Union Telephone; United Telecom Council ("UTC"); Verizon Wireless; Wireless Communications Association International ("WCA"); Xcel Energy.

[5] *See, e.g.*, Telcordia Report (appended to Sprint Comments); V-Comm Comments; Jackson Declaration (appended to Verizon Wireless Comments); Society of Broadcast Engineers Comments.

work operators,[6] and even unlicensed device interests[7] – that the Commission should not implement the ITemp concept. For example, one former FCC Chief Economist, Michael Katz, concludes, that it would "not be in the public interest to use the interference temperature metric to establish a government-mandated underlay rights in CMRS frequency bands at this time."[8] Similarly, another former FCC Chief Economist, Thomas Hazlett, concludes that adoption of the ITemp concept would "substantially reduce social welfare":

> The evidence in today's marketplace strongly suggests that applying the Interference Temperature proposal to the CMRS bands would destroy social value rather than create it.[9]

Indeed, even the purported beneficiaries of the ITemp concept, such as the members of the Wi-Fi Alliance, state that the concept would "not be broadly practical" and would have a "profound impact on equipment design and cost, leading to increased outlays by operators and individual users alike."[10] The Wi-Fi Alliance therefore recommends that the Commission instead focus its resources on "other techniques such [as] those identified in the Commission's Cognitive Radio Proceeding."[11] Another unlicensed group, IEEE 802, similarly takes the position that "mobile bands . . . should not be considered for unlicensed use on the basis of the interference temperature concept."[12]

Out of this groundswell of opposition, Sprint notes that the comments make clear that

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[6] *See* Comments of New York State Office for Technology.

[7] *See, e.g.*, Comments of Wi-Fi Alliance; the Fixed Wireless Communications Coalition (representing both licensed and unlicensed vendors/users).

[8] Katz Report at 2-3 ¶ 6.

[9] Hazlett/Spitzer Comments at 4 and 30.

[10] Wi-Fi Alliance Comments at 2 and 4.

[11] *Id.* at 2.

[12] IEEE 802 Comments at 7 ¶ 28.

implementation of the ITemp concept in mobile wireless service bands: (a) is not technically feasible; (b) would cause substantial harm to incumbent licensees and the consumers of their services; (c) would undermine spectral efficiency; and (d) likely would require unlicensed devices of such expense as to be economically irrational. It is inconceivable that the public interest would be served by such results.

A. THE COMMENTS MAKE CLEAR THAT THE ITEMP CONCEPT IS NOT TECHNICALLY FEASIBLE IN MOBILE WIRELESS SERVICE BANDS

Virtually every commenter addressing the technical challenges associated with the ITemp construct concludes that it is not technically feasible to implement the ITemp construct in mobile wireless service (and other) bands. Specifically, as the comments demonstrate, the various monitoring approaches described in the NOI as ITemp implementation methodologies do not work, because they would:

- fail to measure the actual RF signal power experienced by the victim licensed receiver;
- fail to account for path loss between the unlicensed transmitter and the victim licensed receiver;
- fail to account for hidden node problems and other instances in which RF signal power contributions to the interference experienced by the victim licensed receiver cannot be accurately measured due to blockages;
- fail to explain how any device monitoring the aggregate interference levels to determine available signal power below the ITemp level would be able to identify and separate out the RF signal power contributions received from unlicensed devices, licensed transmitters and background noise; and
- fail to explain how the technical complexities involved in the ITemp theory, even if these could be overcome with respect to a single unlicensed device/licensed receiver model, could practically be implemented in real time on a real-world scale involving tens if not hundreds of unlicensed devices and licensed receivers, all moving simultaneously in varying regions having varying interference characteristics.[13]

[13] *See, e.g.*, Motorola Comments at 11-15; V-Comm Comments. at 30-32, 47-51; IEEE 802 Comments at ¶ 19; Ericsson Comments at 14-19; the WCA Comments at 18-22.

The three lone commenters in favor of the ITemp concept – Agilent Technologies ("Agilent"), Hypres and Shared Spectrum Company ("Shared Spectrum") – provide neither empirical data nor substantive technical analyses that address the litany of problems underlying the ITemp construct. Agilent suggests that some kind of Internet-based system of "frequency servers" could be deployed to regulate when unlicensed ITemp devices can transmit and could set the operative power levels.[14] But absent in Agilent's proposal is any analysis of such non-trivial matters as: how interference should be defined; how any defined ITemp level would be measured; how aggregate interference from ITemp device transmissions would (or could) be separated from other sources of interference; how any ITemp measurements would be relayed to the "frequency servers"; and who will operate and pay for this Internet-based system.

Agilent contends that a "[p]roperly designed, [] permanent grid of monitoring stations" could measure interference levels,[15] yet as Telcordia and other commenters make clear, monitoring grids are inaccurate mechanisms for measuring the actual RF signal power experienced by mobile receivers and are impractical to implement.[16] Moreover, how these grids would or even could "observe, locate, and document infractions," as asserted by Agilent, is unexplained.[17] It also is difficult to fathom how an Internet-based system that essentially issues temporary "licenses" can be held out as offering real-time control over inherently unlicensed ITemp device operation.

Hypres's suggestion of using existing licensed wireless networks as a grid to monitor ITemp levels in tandem with some undefined Internet-based system to manage real-time use of

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[14] *See* Agilent Comments at 6.

[15] *Id.* at 8-9.

[16] *See* Telcordia Report at 19-38.

[17] Agilent Comments at 8-9.

the spectrum by unlicensed ITemp devices is similarly bereft of any engineering or empirical substance, and is unworkable. As outlined in the Telcordia Report, interference events that will affect a licensed service tend to be highly localized in time and space and cannot be effectively managed by a distributed wide-area system that tracks long-term trends.[18]

Shared Spectrum provides a rudimentary analysis of ITemp issues characterized by conjecture and unsubstantiated assumptions. It proposes to set an ITemp threshold at initially 3 dB below the victim (licensed) receiver's noise figure, which corresponds to a $\Delta T/T$ figure of 50 percent.[19] Shared Spectrum does not provide any quantitative, qualitative or evaluative justification or empirical data to support this proposed level. Instead, it simply asserts, without support, that the 3 dB value provides a "balance" between the impact upon the victim licensed receiver and the unlicensed device's ability to transmit at "reasonable" levels.[20]

Shared Spectrum further suggests that the ITemp level should be set "high enough to enable the maximum number of Tranceivers to use the spectrum as long as it does not cause more than minimal impact to the existing spectrum users," yet does not define what "minimal impact" means.[21] As Sprint and other carriers have made clear with respect to CDMA and other wideband networks, there is a direct correlative relationship between interference, on the one hand, and capacity and coverage, on the other, such that even small increases in interference cause

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[18] *See* Telcordia Report at 19-38.

[19] Shared Spectrum Comments at 1.

[20] *Id.* at 13. Shared Spectrum also asserts, however, that the ITemp limit should be "approximately 3 dB below the typical effective input power caused by the affected receiver's preamplifier in a band" (*see id.*), which, aside from lacking any engineering justification, is inconsistent with its suggestion to set the interference temperature should be 3 dB below the receiver noise, since that noise includes the preamplifier noise plus other factors. *See id.* at 11 (wherein Shard Spectrum likens RF front-end noise to "preamplifier noise, cable, filter, and RF switch losses.").

[21] Shared Spectrum Comments at 14.

immediate and significant degradations in coverage and capacity. Further, existing and developing technologies are being deployed to allow CDMA base stations to operate well below the existing noise floor. In short, there is no such thing as "minimal impact" in the context of ITemp implementation in CDMA bands.

Shared Spectrum's claims and proposals are speculative and riddled with inconsistencies. It claims, for example, to have taken noise level measurements, but does not produce the results. Instead, it presents "hypothetical results" and "estimates," apparently based upon its unreported measurements below 500 MHz from "over the last several years."[22] Sprint submits that "hypothetical" ambient noise probability calculations and "estimates" based upon undisclosed, undefined and untested data are not sufficient bases to form policies that affect licensees and their subscribers. Indeed, the apparent basis of Shared Spectrum's open loop ITemp construct – *i.e.*, in areas of high environmental noise, adding signal power that is 3 dB below the "typical" effective input power of the victim licensed receiver will have negligible effects – is wholly inconsistent with its observation that "it is well known that a significant number of Affected Receivers enjoy low levels of ambient noise."[23]

Moreover, Shared Spectrum's contention that open loop architecture represents "a practical approach that is widely applicable" is fundamentally wrong.[24] As Sprint and others ex-

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[22] *Id*. at 11.

[23] *Id*. at 17.

[24] *Id*. at 6. Shared Spectrum is also wrong about the instances in which it contends that closed loop architectures can work. *Id*. Specifically, placing monitoring sites at elevated locations relative to the affected receiver will not facilitate accurate measurements of interference plus noise at the victim receiver. Such monitoring sites may generally have a minimum separation distance from the interfering transmitters, but may also have better line-of-sight propagation paths to the interfering transmitters. Overall, these monitoring sites are likely to see interference that is completely different than that seen by the victim receiver and thus will not be effective in regulating interference.

Surrounding the affected receiver with multiple monitoring sites is equally ineffective. If the monitoring receivers are far away from the victim receiver (relative to the radius of the exclusion zone, if any), the

plained in their comments, open loop systems do not measure the interference experienced by the victim licensed receiver and, thus, are ineffective.[25] The Shared Spectrum proposal suffers from this same fundamental deficiency. It assumes that affected licensed receivers will have a transmitter associated with them whose signals could be measured by the unlicensed device "to estimate the path loss" to the affected licensed receiver, and that the path losses to other unlicensed ITemp devices could similarly be measured.[26] Such "estimation," however, would require affected licensed receivers to be constantly active and for their transmit power to remain constant, neither of which is realistic.

Further, knowing the path loss between the other unlicensed ITemp devices and the unlicensed ITemp device making these "estimates" says nothing about the spatial relationship – and thus the path loss – between such other unlicensed ITemp devices and the victim licensed receiver. Finally, there is no explanation of how the unlicensed ITemp device making these measurements/estimates would (or could) isolate the RF signal power contributions of unlicensed devices from the aggregate noise and RF signal power contributions of licensed devices that are detected by the victim licensed receiver, which would be necessary to calculate the additional interference power allowed under the ITemp threshold.[27]

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interference received by each monitor is uncorrelated with that seen by the victim licensed receiver. Averaging the readings of several such monitors does not alleviate this problem, because the average interference near the exclusion zone edge (or beyond the edge) is higher than that seen at the center of the exclusion zone by the victim receiver. *See, e.g.*, Telcordia Report, Figures 9-11. Closed loop monitoring where the victim licensed receiver and the monitoring site are close together relative to the distance to the interfering transmitter – *i.e.*, where the monitor is near the victim relative to the exclusion zone radius – may be accurate, but requires an exclusion zone and is only effective in those instances in which the mobile receiver is reliably near the monitor. These conditions generally do not apply to situations in which both the unlicensed device and licensed receivers are mobile.

[25] *See* Sprint Comments at 22-27. *See also* Telcordia Report at 11-19.

[26] Shared Spectrum Comments at 6-7.

[27] Shared Spectrum's proposal would require that the unlicensed ITemp device estimate the number of co-channel users to gauge the cumulative effect of their transmissions, but does not explain how such an

Neither Agilent, Hypres nor Shared Spectrum have begun to explain, much less document, how their limited ITemp proposals are workable and would prevent harmful interference, loss of capacity and diminished service quality and options for licensed service deployment.

B. THE ITEMP CONCEPT WOULD SIGNIFICANTLY HARM THE 160 MILLION CONSUMERS OF MOBILE WIRELESS SERVICES

Equipment manufacturers and network operators have documented that implementation of the ITemp concept in mobile wireless service bands would directly result in a significant loss of network coverage and/or capacity:[28]

- A CDMA network operator would lose 10 to 15 percent of its existing network coverage by a 1 dB increase in the noise floor caused by ITemp devices. Alternatively, the network operator would have to attempt to increase its number of cell sites by 12 to 17 percent simply to maintain its existing coverage.[29]
- If the ITemp level was set around the current receiver noise floor (–109 dBm), a CDMA network operator would lose either 30 percent of its existing coverage or about 80 percent of its network capacity.[30]
- An EDGE network operator would lose approximately 15 percent of its coverage area by a 1 dB degradation of the noise floor – or it would be required to attempt to add 17 percent more cell sites in order to maintain existing coverage.[31]

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estimate could be accurately made. *Id*. at 8-9. In any event, knowing the number of transmitters is irrelevant to knowing the RF signal power contribution of each transmitter at the input to the victim licensed receiver.

[28] As detailed in the attached Telcordia analysis, the comments that included technical assessments of the relationship between CDMA uplink capacity and the external interference level used different assumptions for the load factor and the receiver noise figure, which explains the differences in numerical results. Lucent, for example, assumed a load factor of 55 percent. V-Comm assumed a system composed of 50 percent IS-95 technology with a load factor of 55 percent and 50 percent 3G technology with a load factor of 72 percent, and Telcordia assumed a load factor of 75 percent. Motorola also assumed a 75 percent load factor and used simulation to derive the capacity reduction, obtaining the same results given by Telcordia's closed-form expression. Under all assumptions, the ultimate results were the same – even marginal increases in the noise floor directly result in significant losses in system capacity and/or coverage. *See* Dr. Jay E. Padgett, Telcordia Technologies, Inc., *Comparison of CDMA Uplink Capacity Impact Results* (May 5 2004), appended as Attachment A.

[29] *See* Qualcomm Comments at 7-8.

[30] *See* Lucent Comments at 3.

[31] *See* AT&T Wireless Comments at 17-18.

- A GSM network operator serving an urban area would lose approximately 25 percent of its capacity from a 1 dB increase in the noise floor – or it would be required to attempt to add 33 percent more cell sites in order to maintain existing capacity levels.[32]
- A W-CDMA network operator would lose 10 percent of its capacity by a 1 dB increase in the noise floor.[33]
- Subscribers owning CDMA handsets would encounter a decrease in their handset battery lives of 20 percent or more.[34]

AT&T Wireless' Figure 3 graphically displays the new dead zones that subscribers would experience by implementation of the ITemp concept.[35] As this Figure demonstrates, subscribers would encounter dozens of new dead zones in a single metropolitan area.

Implementation of the ITemp concept would result in wireless service consumers paying more for lowered quality of mobile services than they receive today, and would adversely affect service quality and options in the future. Network operators likely would be compelled to attempt to add cell sites and purchase additional equipment in an effort to offset the effects of new interference from ITemp devices. Given the nature of the local zoning process and other technical constraints, however, it is unrealistic to expect that wireless carriers would be able to add sites to fill in all of the new dead zones created – or even many of them.[36] Subscribers would thus encounter new dead zones in areas where they are today accustomed to receiving service. Moreover, the very notion establishing a specific ITemp interference level necessarily forecloses future technological innovation in equipment designed to more fully and efficiently utilize licensed spectrum by operating further *below* the existing noise levels. The ITemp concept thus

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[32] *See id.* at 18-19.

[33] *See* Motorola Comments, Appendix A at A02.

[34] *See* Qualcomm Comments at 10-11.

[35] *See* AT&T Wireless Comments at 16, Figure 3.

[36] *See, e.g.,* Sprint Comments at 17; Qualcomm Comments at 4.

adversely affects both current operations and the ability of licensees to develop and deploy innovative service options in the future.

It is important for the Commission to understand that, in the final analysis, any specific ITemp level that it might set would simply determine the level and scope of diminished service reliability and costs imposed upon wireless consumers; this is not a case where a "low" ITemp level will avoid harmful interference.[37] As Verizon Wireless states:

> Hazlett and Spitzer calculate that to overcome a minimal .33 dB increase in noise would require $2.2 billion in additional capital expenditure of a hypothetical CDMA carrier.[38]

Sprint submits that the public interest would not be served by forcing mobile service licensees or the 160 million consumers of their services to endure diminished services or pay higher prices for reduced services – "at a cost of billions of dollars" according to one vendor[39] – to subsidize the costs of spectrum entry by unlicensed devices.[40]

C. For Mobile Wireless Service Bands, the ITemp Concept Would Undermine, Rather than Promote, Spectrum Efficiency

As indicated above, virtually all commenters agree that the enormous technical challenges associated with implementing the ITemp concept are currently insurmountable.[41] For

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[37] *See, e.g.,* Qualcomm Comments at 5 ("Any increase in the thermal noise floor *N* reduces the received signal-to-noise ratio, and consequently reduces the E_b/N_o by the same amount, leading to decreased service area."); Ericsson Comments at 13 ("[T]he greater the interference experienced by a single or multiple mobile terminals, the fewer the mobiles that can be served by the base station. For this reason, an interference increase at any terminal will decrease the capacity of the base station."); Lucent Comments at 2; CTIA Comments at 8 ("[A]ny increase in noise will reduce the coverage available to the public.").

[38] Verizon Wireless Comments at 15-16.

[39] *See, e.g.,* Qualcomm Comments at 4 ("Carriers would need to add large numbers of base stations just to replicate their present coverage area, at a cost of billions of dollars.").

[40] CTIA estimates that there were 158.7 mobile services customers at the end of 2003. *See* CTIA Semi-Annual Wireless Industry Survey (2004).

[41] *See, e.g.,* AT&T Wireless Comments at 13 ("From a practical standpoint, the interference temperature concept requires technology that does not exist."); Ericsson Comments at 2 (ITemp concept "is not technically feasible at this time") and at 19 ("Ericsson believes that a great deal more research will be neces-

purposes of its filing, Sprint nevertheless asked Telcordia to assume all of these engineering challenges could be overcome as a way to further analyze and test the central hypothesis of the ITemp concept – that spectrum efficiency would be improved. Telcordia's analysis demonstrates that, from the perspective of the overall efficiency of spectrum utilization, ITemp sharing remains a losing proposition when the concept is implemented in CDMA networks.[42] Figure 1 below is adapted from Telcordia's Figure 26:

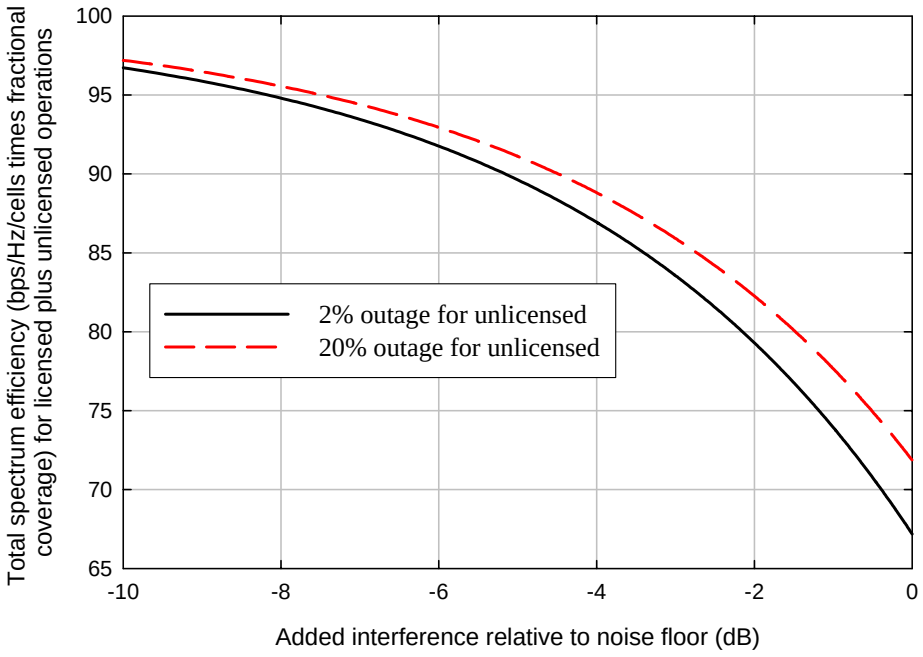

Figure 1: *Effect of ITemp sharing on total spectrum efficiency, including the added unlicensed capacity, for a CDMA uplink.*

Telcordia concludes that it is "clear that the loss in value to the licensed service is greater than [the] added value associated with the unlicensed devices."[43]

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sary to determine whether many of the concepts introduced are even possible."); Motorola Comments at 2 ("[T]he technology necessary for widespread implementation is beyond the current state of the art") and at 5 (ITemp "technologies that will adequately protect incumbent licensees do not exist."); Qualcomm Comments at 15 (ITemp paradigm "is not a viable solution.").

[42] *See* Telcordia Report at § 5.

[43] *Id*. at § 5.6.

Sprint submits that this analysis alone dictates that the Commission declare unequivocally that the ITemp concept should *not* be implemented in bands utilized for mobile wireless services. The ITemp concept cannot possibly promote the public interest if its implementation would decrease spectrum efficiency.

Exacerbating the spectral inefficiency of the ITemp concept is the fact that unlicensed devices already have access to over 700 MHz of spectrum[44] – and it has not been established that unlicensed users need access to yet more spectrum. Indeed, the Commission reallocated unlicensed PCS spectrum at 1910-1920 MHz precisely because, nine years after its allocation, it remains unused.[45] Further, the spectral inefficiencies of the ITemp concept translate into economic inefficiencies. The Spectrum Policy Task Force has estimated that sales of all unlicensed consumer devices approximate $2 billion annually,[46] whereas, last year (in 2003), mobile services licensees using half as much spectrum contributed $88 billion to our nation's economy.[47] Neither the spectral nor economic inefficiencies associated with the ITemp concept can be justified, particularly in light of the fact that the Commission has not explored the less intrusive alternative of providing spectrum access *via* its new Secondary Markets/leasing rules[48] – an approach two former FCC Chief Economists suggest would be superior to a government reallocation.[49]

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[44] *See, e.g.,* SPTF Report at 54; Cingular/BellSouth Comments at 8.

[45] *See Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems*, 18 FCC Rcd 2223 at ¶ 46 (2003).

[46] *See* SPTF Report at 54.

[47] *See* CTIA Semi-Annual Wireless Industry Survey (2004).

[48] *See Secondary Markets Order,* 18 FCC Rcd 20604 (2003).

[49] *See* Hazlett/Sptizer Comments at 19-20; Katz Report at 5-11. *See also* CTIA Comments at 11-12.

D. IT IS UNLIKELY THERE WOULD BE A MARKET DEMAND FOR ITEMP DEVICES

All commenters addressing the issue agree that ITemp devices would require extraordinarily complex technology even if all engineering challenges could be overcome. Indeed, as Verizon Wireless notes, an ITemp device designed to operate in CDMA bands would be required to perform "the same reception function as 40 licensed CDMA devices."[50] In addition, record evidence demonstrates that ITemp devices would have significantly less range than "ordinary" unlicensed devices.[51]

Nokia observes that even if it were feasible to design ITemp devices, such devices would be considerably more expensive and would have less functionality than "ordinary" unlicensed devices designed to utilize unlicensed spectrum:

> Given that many of these unlicensed devices are designed as relatively low-cost, mass-market communications devices, adding expensive radio components to the overall design may have the unintended effect of discouraging the wide deployment of unlicensed devices.[52]

There is also agreement that even if ITemp measuring/monitoring networks were technically feasible,[53] such networks would be prohibitively expensive to install and operate.[54] As one unlicensed group states:

> We believe that the cost of creating, not to mention maintaining, a ubiquitous network of monitoring stations would completely overwhelm any short term or long term benefit in new economic activity.[55]

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[50] Verizon Wireless Comments at 10.

[51] *See, e.g.,* Ericsson Comments at 16-17.

[52] Nokia Comments at 2-4. *See also* Wi-Fi Alliance Comments at 4 (ITemp would have "profound impact on equipment design and cost, leasing to increased outlays by operators and individual users alike.").

[53] *But see* IEEE 802 Comments at 5 ¶ 19 ("It is not clear to use how such a system would be effective.").

[54] *See, e.g.,* Ericsson Comments at 17.

[55] IEEE 802 Comments at 5 ¶ 20.

Sprint discussed in its comments that no economically rational consumer would purchase an ITemp device when it is more expensive and has less range compared to an "ordinary" unlicensed device.[56] Motorola, a manufacturer of both licensed and unlicensed devices, indicates that ITemp devices would be "so prohibitively expensive that the Commission cannot reasonably expect consumers to buy equipment that utilizes these technologies."[57] There is no basis for the Commission to assume that any manufacturer would build and sell ITemp devices, even assuming all the "significant design challenges" could be overcome.[58]

In sum, the Commission should, consistent with the recommendations of the unlicensed industry, declare unequivocally that "mobile bands . . . deserve special protection from interference and should not be considered for unlicensed use on the basis of the interference temperature concept."[59]

II. RESPONSE TO THE NPRM: TRANSMIT POWER CONTROL AND DYNAMIC FREQUENCY SELECTION ARE TECHNICALLY INFEASIBLE METHODS FOR IMPLEMENTING UNLICENSED OPERATIONS ALONGSIDE FIXED POINT-TO-POINT RADIO NETWORKS

There is not a single commenter who favors the NPRM proposal to implement transmit power control ("TPC")- and/or dynamic frequency selection ("DFS")-based unlicensed operations alongside fixed point-to-point terrestrial services operating in the 13 GHz band (12.75-13.25 GHz, excluding 13.15-13.2125 GHz). To the contrary, *every commenter addressing this issue is staunchly opposed to the TPC and DFS proposals for reasons similar to those set forth in Sprint's comments*.[60]

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[56] *See* Sprint Comments at 32-35.

[57] Motorola Comments at 4-5.

[58] *See* Nokia Comments at 4.

[59] IEEE 802 Comments at 7 ¶ 28.

[60] *See* Sprint Comments at 38-46.

With respect to the TPC approach, the comments confirm that the NPRM is flawed because, among other things, it does not account for the interference effects of aggregate unlicensed devices.[61] The NPRM's assumption that the unwanted emissions received by the fixed link receiver "will be dominated by the emissions from the closest [unlicensed] device"[62] is exactly the *opposite* result that can be expected from the TPC construct. As Sprint and Comsearch point out, "devices that are farther away but in the main beam of the FS receive antenna may dominate unwanted emissions received by the FS receiver."[63] Further, as Sprint explained in its comments, the fact that the farthest devices actually operate at a higher power level than the nearest devices only aggravates the aggregate interference effects of unlicensed devices distributed along the fixed length path and near the centerline of the link.[64] The comments further indicate that an unlicensed device measuring RF signal power will not be able to discriminate among the RF signal power contributions of the licensed fixed link transmitter, on the one hand, and other unlicensed devices, on the other.[65] In fact, as Cingular observes, the unlicensed device might receive RF signal power emissions from other unlicensed devices, leading it to "calculate an even higher allowable transmit power and begin transmitting."[66] In addition, the TPC approach would allow for only extremely limited effective ranges of the unlicensed devices themselves.[67]

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[61] *See*, *e.g.*, Cingular Comments at 53; Society of Broadcast Engineers ("SBE") Comments at 4.

[62] *ITemp NPRM* at ¶ 41.

[63] Comsearch Comments at 12.

[64] *See* Sprint Comments at 41-42.

[65] *See*, *e.g.*, Comsearch Comments at 11.

[66] Cingular Comments at 53.

[67] *See* Sprint comments at 43; Telcordia Report at 86-94.

With respect to the DFS approach, the comments confirm that the NPRM proposal is flawed because it discounts both the limitations of the unlicensed device's ability to accurately detect and measure fixed link use of a given channel, and the potential for the unlicensed device to cause interference to the fixed link even in situations where the unlicensed device detects RF signal power below the DFS threshold. As Comsearch points out, "FS transmitters use only moderate EIRP levels and directional antennas that greatly suppress the radiated EIRP in all but the direction of the main beam. This makes the signal very difficult or impossible for an unlicensed device to detect."[68] As noted by the Fixed Wireless Communications Coalition ("FWCC"), "The signal power received by the unlicensed device will always be about 40 dB lower than that at the FS receiver, because of the difference in their antenna gains. When the FS receiver is subject to multipath fading, the incoming FS signal at the unlicensed device is likely to fall below the thermal noise floor of the unlicensed receiver."[69] This comports with Telcordia's finding that in 90 percent of random locations surrounding the fixed link receiver, the unlicensed device will measure approximately -106 dBm (which is around the thermal noise floor at a 6 MHz bandwidth).[70]

The NPRM's assumption that unlicensed devices will not be within 100 meters of the fixed link receiver such that their interference potential will be minimized is equally unfounded. In any event, as Comsearch points out, even if true in practice, "there could be a lot more of them in view of the antenna."[71] The aggregate effects of interference from multiple unlicensed de-

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[68] Comsearch Comments at 11. *See also* case studies of interference presented at 13-17.

[69] FWCC Comments at 19.

[70] Telcordia Report at 96.

[71] FWCC Comments at 16. *See also* Comsearch Comments at 11 ("[A]t much greater distances than the 100 meter distance the Commission was considering, it is very possible that an unlicensed transmitter could be in the main beam of the FS receive antenna.").

vices only worsens the degradation caused to the fixed link operations.[72] Although, as Telcordia points out, an exclusion zone theoretically could ensure a minimum separation distance between unlicensed devices and the fixed link receiver, it would be impractical to implement such a construct for a number of reasons and would relegate unlicensed devices to the very areas in which uncongested spectrum already exists for unlicensed use.[73]

Finally, as noted by Sprint and most other commenters addressing the NPRM, fixed link budgets are engineered to provide sufficient fade margins to prevent outages in the face of the predicted occurrence of natural interference events, such as rain. Overlaying interference onto these deployed systems would throw these predictive calculations off, reducing the level of interference required to trigger an outage.[74] Accordingly, as a fundamental matter, Sprint agrees with the observation of Cingular (and others) that the Commission is "attempting to move forward with new rules even though it acknowledges that more analysis and research are needed," and it is clear from the comments that much analytical work must be completed before any meaningful construct for allowing spectrum access by unlicensed devices in the 13 GHz band (or any other band, for that matter) can be established.[75]

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[72] *See*, *e.g.*, Telcordia Report at 94-97; FWCC Comments at 17-18.

[73] *See* Telcordia Report at 98-106; Sprint Comments at 45-46.

[74] *See*, *e.g.*, Sprint Comments at 39-40; FWCC Comments at 12-13.

[75] Cingular Comments at 44. *See also* Motorola Comments at 15.

III. CONCLUSION

For the foregoing reasons and those contained in its comments, Sprint respectfully requests that the Commission: (1) not pursue any form of interference temperature concept in spectrum allocated for mobile wireless services, as contemplated in the Notice of Inquiry; and (2) not authorize unlicensed operations alongside fixed point-to-point terrestrial services operating in the 12.75-13.25 GHz band, as contemplated in the Notice of Proposed Rulemaking.

Respectfully submitted,

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Attachment A

Attachment

Comparison of CDMA Uplink Capacity Impact Results

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May 5, 2004

Introduction

The purpose of this Attachment is to compare the relationships provided by commenting parties in ET Docket 03-237 showing the capacity reduction of a CDMA uplink caused by external interference. Telcordia and Lucent used closed form expressions, which are shown below to be equivalent. Motorola used a simulation as described in Appendix A of its Comments. V-Comm used the Lucent expressions but assumed a 50/50 mix of IS-95 and 3G technologies with two different load factors.

Analysis

Equation (60) of the Telcordia paper gives the fractional capacity reduction for a CDMA uplink as

$$\frac{\Delta\Lambda}{\Lambda_0} = \frac{I_{ext}/N}{\Phi - 1} \tag{1}$$

where I_{ext} is the external interference at the base station receiver, N is the base station receiver noise, and Φ is the maximum "noise rise" $\left(I_{TOT}/N\right)_{\max}$. Lucent used the "load factor" ρ which is related to Φ by

$$\Phi = \frac{1}{1-\rho} \qquad \rho < 1 \tag{2}$$

Equation (3) in Lucent's Comments is:

$$R_{cap} = 1 - \frac{N_{w/ext}}{N_{w/o\,ext}} = \left(\frac{I_{ext} + FN_0W}{FN_0W} - 1\right)\left(\frac{1}{\rho} - 1\right) \tag{3}$$

where F is the noise figure of the receiver, N_0 is the thermal noise power spectral density, and W is the bandwidth. Thus, FN_0W is the same as N in the Telcordia expression. I_{ext} has the same meaning in both the Telcordia and Lucent expressions, and Lucent's R_{cap} is the same as Telcordia's $\Delta\Lambda/\Lambda$. Thus, (3) is equivalent to:

$$\frac{\Delta\Lambda}{\Lambda_0} = \frac{I_{ext}}{N}\left(\frac{1}{\rho} - 1\right) \tag{4}$$

and since from (2), $\frac{1}{\rho} - 1 = \frac{1}{\Phi - 1}$, (4) is the same as (1) and the Telcordia and Lucent equations are in fact equivalent.

Note that this relative capacity reduction as expressed by (3) and (4) does not depend on whether the affected system uses IS-95 or 3G technology, except to the extent that the technology determines the baseline load parameter ρ.

Results Comparison

It is useful to compare capacity reduction results for different assumptions about loading and the receiver noise *N*. Figure 1 compares the Telcordia and Lucent results:

- 75% load ($\rho = 0.75$) and a 5 dB base station receiver noise figure ($N = -108$ dBm), which corresponds to the case shown in Figure 21 of the Telcordia paper.
- 55% load and a 4 dB noise figure, which is the case shown in Lucent's Comments, Figure 2.

To remove the effect of the noise figure assumption, Figure 2 shows the capacity reduction for the same values of load, but as a function of the total noise increase at the base station; i.e., $10\log(1 + I_{ext}/N)$. Also shown are four points from V-Comm's Comments for the mixed IS-95 and 3G system (which lie near the 62% load line as shown), and two points given for a GSM system by AT&T Wireless in its Comments. Figure 3 shows a similar curve from the Motorola Comments, which was derived by simulation as described in Motorola's Annex A for a 6 dB noise rise (75% baseline load) and agrees with the "75%" curve in Figure 2.

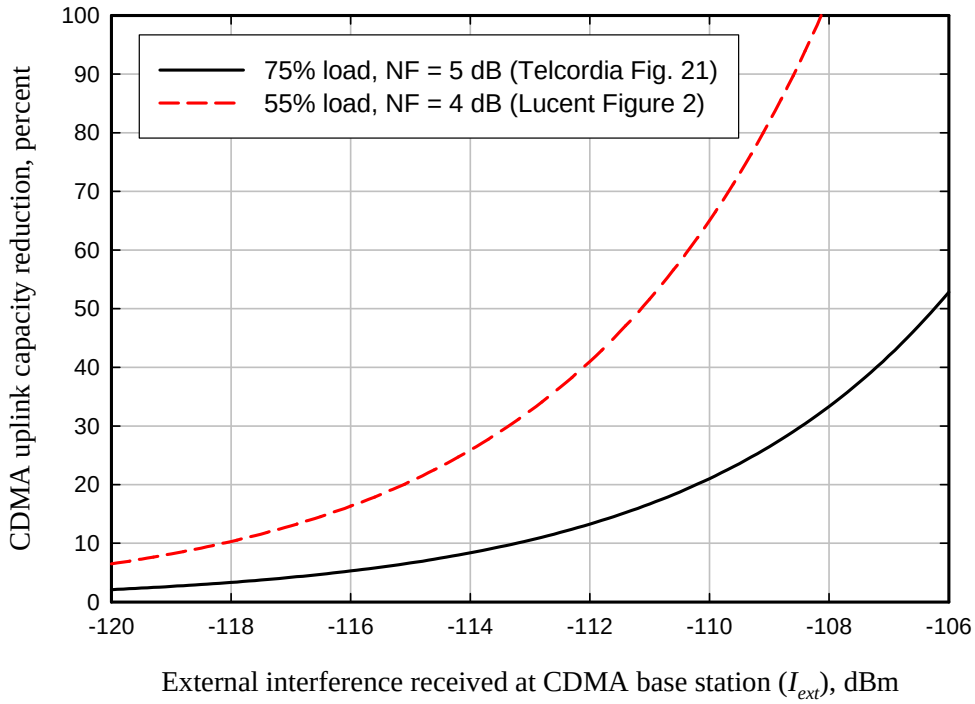

Figure 1

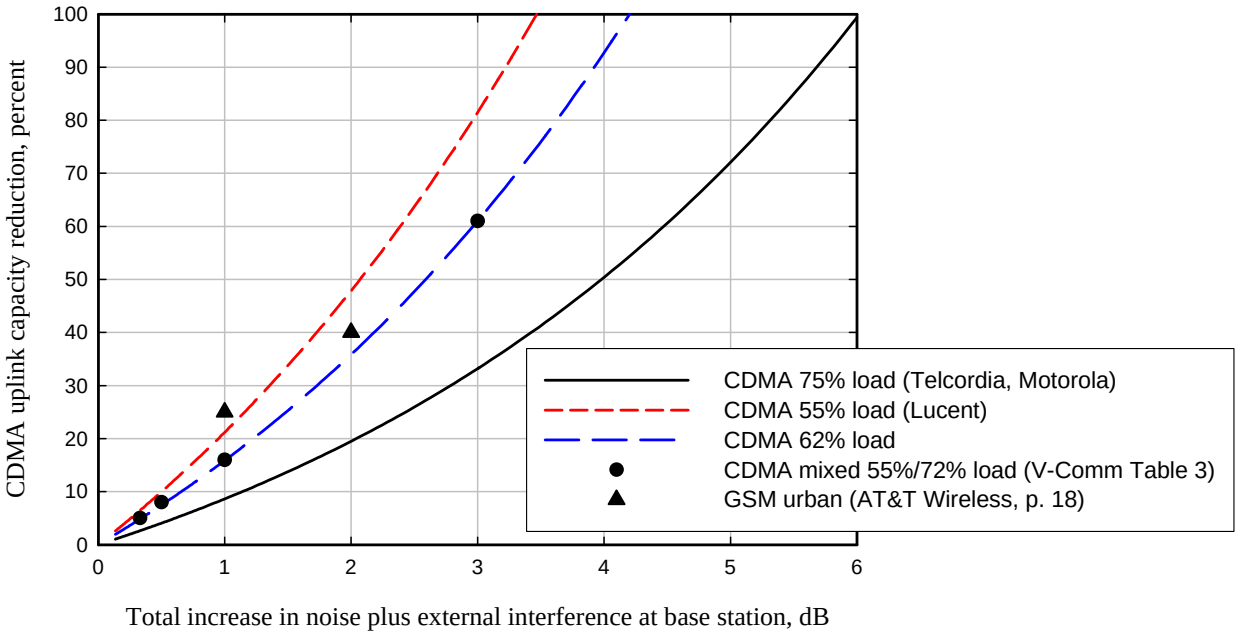

Figure 2

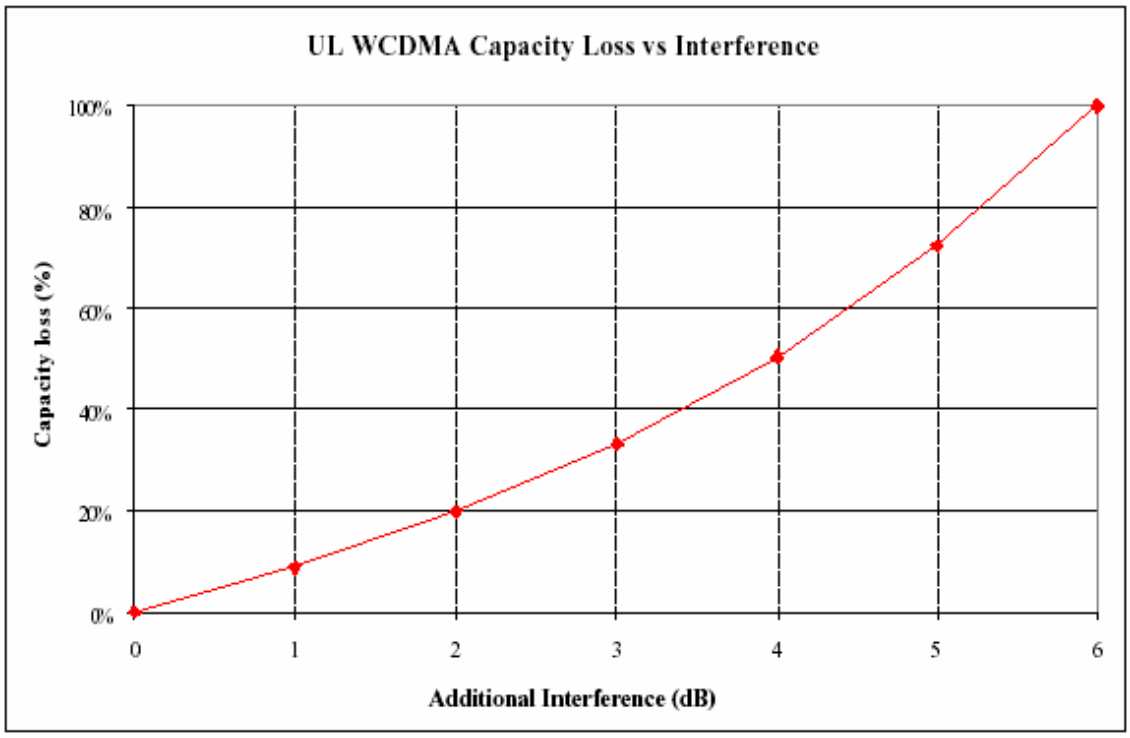

Figure 3: WCDMA Uplink capacity loss from Motorola Comments, Figure 1, page A-2.

Conclusion

It appears that all comments that addressed CDMA uplink capacity impacts gave consistent results, and the differences are due to variations in the assumed values of (1) the baseline load factor; and (2) the base station receiver noise figure. Significantly, Telcordia, Lucent, and Motorola independently developed identical relationships among the added interference, baseline load, receiver noise, and uplink capacity reduction.