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

In the Matter of	
Spectrum Policy Task Force Report	ET Docket No. 02-135

COMMENTS OF MOTOROLA, INC.

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SUMMARY

Motorola commends the Commission on taking the initiative to investigate possible ways to improve spectrum management in the United States. Motorola wholeheartedly agrees with the Task Force that the time is ripe for spectrum policy reform. The potential benefits from the adoption of a comprehensive long-range federal plan for spectrum management are enormous. They include identification of additional allocations of spectrum for commercial and public safety uses; the opportunity for significant reductions in the incidence of interference, improved global harmonization of spectrum allocations; and greater technical flexibility for spectrum licensees and users. Moreover, the Commission should develop a unified approach to spectrum policy with the National Telecommunications and Information Administration ("NTIA"). Motorola welcomes the recent efforts by both agencies to increase coordination on matters of spectrum policy.

Motorola supports many of the recommendations announced in the Task Force Report. We support allowing flexible spectrum use, but only within clearly defined technical parameters. Clear technical rules must be provided to limit co-channel and out-of-band interference to acceptable levels. For similar reasons, we also support the grouping of services with similar technical characteristics in adjacent bands. These limits on flexible use are essential to maximize the public benefit that can be attained from spectrum use.

We support the Task Force's recommendation to promote the efficient use of spectrum. Motorola stresses, however, efforts to impose or encourage efficiency must be taken in concert with users' operational requirements and the maturity of technology. It would be irresponsible to mandate that users deploy a certain level of efficiency before the technology required to do so

is adequately tested and proven in the applicable market. The ultimate objective must be economic efficiency, which requires consideration of operational efficiency considerations in addition to mere spectrum efficiency. Motorola supports the adoption of efficiency incentives across all spectrum bands and services, but these incentives must be tailored for each service to take account of operational requirements.

Motorola also supports the Task Force's recommendation for a periodic review of the Commission's rules on a predetermined schedule. In conjunction with this review process, the Commission should develop a long-range plan to guide the development and regulation of spectrum over a 7 to 10 year period. Projected spectrum requirements should be based upon anticipated technological advances as well as operational requirements.

Motorola urges the Commission to proceed carefully, however, with regard to the Task Force's suggestion to consider exploiting the time dimension of spectrum management. There are numerous technical obstacles that would need to be overcome before spectrum time-sharing can become a viable spectrum management tool. Motorola has addressed some of these technical difficulties in two White Papers that it has submitted in this proceeding. Considerable work remains to be done to fully understand how the time dimension can be exploited. In Motorola's view, while such arrangements may be helpful in some cases, they are not an adequate substitute for spectrum allocation and management.

Motorola supports the adoption of a more quantitative approach to interference management where feasible. The Task Force's "interference temperature" concept offers potential benefits in the long term. We stress, however, that it presents many difficult technical problems. The interference temperature theory envisions the dynamic ability of unlicensed transmitters to detect communications traffic within licensed spectrum bands. However, this

fundamental task of determining and controlling the influence of a transmitter's emissions upon a remotely located receiver is an enormously complex problem. In the attached Appendix, Motorola identifies some of the technical hurdles that must be overcome before the potential benefits of the interference temperature concept can be realized. While we support further analysis and study of this concept, Motorola notes that it is a long way from being ready for routine deployment in the real world as a reliable spectrum management tool.

Motorola believes that generic receiver standards would be inappropriate because receiver performance specifications are so system dependent. However, Motorola does believe that industry developed receiver specifications can be a useful tool in particular circumstances to resolve specific spectrum incompatibilities. The Commission must recognize, however, that imposing overly stringent receiver design specifications inflates the cost, and thus hinders public acceptance, of new equipment. Therefore, any Commission guidelines on receiver performance specifications should not dictate the design of specific receiver elements. Furthermore, Motorola believes that the appropriate use of spectral masking generally provides a more efficient solution to minimizing out-of-band interference. Whether addressing receiver or transmitter parameters, however, the Commission must consider users' operational requirements and must balance the relative costs of any guidelines with the benefits obtained in a real world setting.

We applaud the Task Force's recognition that there is no "one size fits all" approach to spectrum management. The Commission must continue to use a combination of the command-and-control, exclusive use and commons models as appropriate. In particular, the Commission must continue to allocate spectrum for public safety uses using the command-and-control model, as the Task Force recommends. Such an approach is necessary to meet the unique mission

critical requirements of public safety entities as they work to protect the lives and property of the entire public. A similar approach is also warranted for private radio users that deploy communications systems for critical infrastructure and business safety applications that provide important public needs. Any secondary use of public safety spectrum must be controlled by public safety licensees through secondary market arrangements.

Motorola takes issue with the suggestion, implicit in the Task Force Report, that no further allocations of dedicated spectrum for public safety use are necessary. As demonstrated in the 1996 PSWAC Final Report, there is a great need for additional allocations of spectrum for public safety use. That assessment of the need for additional dedicated public safety spectrum remains valid today. None of the alternatives to dedicating spectrum for public safety use that the Task Force suggests — acquisition of public safety spectrum in public auctions, or access to commercial spectrum via easements or "priority access" mechanisms — are viable at the present time or at any time in the foreseeable future.

Moreover, the spectrum that the Commission has allocated for public safety use since 1996 is still largely inaccessible. The 700 MHz spectrum remains inaccessible for public safety users in half of the major metropolitan markets due to the lingering presence of television incumbents, and the Commission has not established any definitive date when this spectrum will be cleared. Furthermore, the Commission has yet to finalize service rules for the 4.9 GHz band. Motorola urges the Commission to move quickly to make these bands accessible for public safety use and to include further allocations for public safety spectrum in a long-range spectrum plan.

Motorola recommends that spectrum below 6 GHz should be assigned primarily using either the exclusive use or command-and-control models, as appropriate. As discussed in our

August 30, 2002 White Paper in this proceeding, the physical characteristics of the lower frequency bands, particularly spectrum below 3.7 GHz, are ideally suited for wide area systems. In contrast, unlicensed systems are well suited to high frequency bands above 10 GHz where there is reduced potential for interference and larger bandwidths are available for high-speed applications. Therefore, future allocations of unlicensed spectrum should generally be restricted to spectrum above 10 GHz.

Motorola believes that secondary market arrangements would provide the most appropriate means to provide secondary use of spectrum. Critically, the secondary market approach would enable incumbents to determine the conditions under which secondary use would occur, and thus to prevent harmful interference to incumbent operations. The alternative easement approach, in contrast, is dependent upon the ability of secondary users to detect and exploit "spectrum holes." For a variety of technical reasons discussed in the accompanying Appendix and Motorola's White Papers, we believe that such opportunistic or dynamic unlicensed use of licensed spectrum presents many technical problems that will be difficult to overcome.

Finally, Motorola reasserts its support for legislation that would authorize the use of auction proceeds to fund the relocation expenses of incumbents, including non-government incumbents. Such legislation would provide certainty to prospective licensees regarding the cost of spectrum, and certainty to incumbents that they will not be forced to bear the costs of relocating to alternative spectrum. In the longer term, the Commission should also explore alternatives to allocating spectrum by auctions, which drain resources from new licensees and increase the cost of deploying new services.

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COMMENTS OF MOTOROLA, INC.

Motorola, Inc. ("Motorola") hereby submits these comments on the November 2002 Report of the Spectrum Policy Task Force ("Task Force") providing recommendations to the Commission on spectrum management reform.[1]

I. INTRODUCTION

Motorola commends the Commission on taking the initiative to investigate possible ways to improve spectrum management in the United States. Motorola wholeheartedly agrees with the Task Force that the time is ripe for spectrum policy reform.[2] The potential benefits from the adoption of a comprehensive long-range federal plan for spectrum management are enormous. They include identification of additional allocations of spectrum for commercial and public safety uses; the opportunity for significant reductions in the incidence of interference, improved

[1] *See* Spectrum Policy Task Force Report, ET Docket No. 02-135 (filed Nov. 15, 2002) ("Task Force Report"); *see also* Public Notice, *Commission Seeks Public Comment on Spectrum Policy Task Force Report*, ET Docket No. 02-135, FCC 02-322 (rel. Nov. 25, 2002); Order, ET Docket No. 02-135, DA 02-3400 (rel. Dec. 11, 2002).

[2] *See* Task Force Report at 11.

global harmonization of spectrum allocations; and greater technical flexibility for spectrum licensees and users.

Motorola commends the open process that has been utilized throughout this initiative, which has encouraged a healthy dialog between industry and the Task Force. Motorola has been an active participant since the beginning of this proceeding, participating in a number of public workshop discussion panels, filing Comments[3] in response to the Commission's June 6, 2002, Public Notice and submitting two White Papers on spectrum management issues that are central to this proceeding.[4] Motorola will continue to participate actively in this proceeding and to provide further input on these issues to assist the Commission in developing appropriate forward-looking spectrum policies.

Motorola supports many of the recommendations announced in the Task Force Report. We are particularly pleased that many of the Task Force's recommendations are consistent with comments filed by Motorola in this proceeding, including:

- There is no "one-size-fits-all" solution to managing spectrum; instead, the Commission should maintain a balance of different approaches;[5]
- Incumbent licensees require greater certainty regarding their interference protection rights;[6]

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3 Comments of Motorola, Inc., ET Docket No. 02-135, July 8, 2002 ("Motorola Comments").

4 The first White Paper addressed four principal topics: ad hoc wireless networks; spectrum management policy; future allocations of unlicensed spectrum; and experimental licensing and spectrum. *See A White Paper on Future Federal Communications Commission Spectrum Policy*, ET Docket No. 02-135, Aug. 30, 2002 ("*Motorola Spectrum Policy White Paper*"). The second focused on the problems surrounding exploitation of "spectrum holes." *See A White Paper on the Exploitation of "Spectrum Holes" to Enhance Spectrum Efficiency*, ET Docket No. 02-135, Oct. 28, 2002 ("*Motorola Spectrum Holes White Paper*").

5 *See* Motorola Comments at 8.

6 *See id*. at 3.

- There should be no wholesale conversion of all spectrum to a commons approach;[7]

- Because frequencies above 6 GHz are not suitable for wide area mobile services, the Commission should assign lower frequency spectrum, and particularly spectrum below 3.7 GHz, for these services using the exclusive use or command-and-control models, as appropriate;[8]

- Expanded use of the commons model should be focused on the higher frequency bands above 10 GHz because the physical characteristics of these bands are well suited for unlicensed applications;[9]

- Spectrum policy must accommodate the unique demands of critical services such as public safety, which require dedicated spectrum;[10]

- The processing time for experimental license applications involving the use of Government spectrum should be shortened, by allowing direct interface between applicants and the Government to develop mutually acceptable license conditions;[11]

- Spectrum should be set aside or pre-cleared for experimental use to facilitate the development and testing of new products;[12]

- Global and regional harmonization provides significant economic benefits and should be a factor in allocating spectrum.[13]

While the Task Force Report touches on a number of Government spectrum issues, in Motorola's view it does not sufficiently emphasize the importance of collaboration between the Commission and the National Telecommunications and Information Administration ("NTIA") to

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7 *See Motorola Spectrum Policy White Paper* at 23-24.

8 *See id.* at 15-17.

9 *See id.* at 17-18.

10 *See id.* at 23.

11 *See id.* at 25-26.

12 *See id.* at 25.

13 *See* Motorola Comments at 25-26; Comments of Motorola, Inc., ET Docket No. 00-258, Feb. 22, 2001, at 18; Comments of Motorola, Inc., ET Docket No. 00-258, Oct. 22, 2001, at 5-6.

develop a unified and comprehensive approach to spectrum management.[14] Motorola has consistently supported a unified approach to spectrum policy by the Commission and the NTIA,[15] and it reaffirms that support again in these Comments. Under the divided spectrum management structure currently in place, the success of any long-term spectrum policy for the United States depends on the close cooperation between these two agencies.[16]

II. COMMENTS ON KEY ELEMENTS OF THE PROPOSED NEW SPECTRUM POLICY

A. Service Flexibility Must Be Limited by Clearly Defined Technical Rules

Motorola supports the Task Force's recommendation that the Commission should provide licensees with flexibility "within technical parameters."[17] While greater flexibility in spectrum use is a laudable objective, the Commission must not allow users total flexibility to provide any service, under any technical parameters. Unlimited flexibility would allow extreme variations in technical parameters and could result in systems with radically different power and operating characteristics operating in the same or adjacent channels. Such a scenario would

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[14] The Task Force Report recommends that the Commission and the NTIA collaborate to make improvements in the area of experimental licensing. *See* Task Force Report at 61, 68 (Task Force Policy Recommendation 39). While Motorola strongly supports this recommendation, the Task Force did not make any recommendations regarding broader collaboration between the two agencies on other spectrum management or planning issues.

[15] *See, e.g.*, Motorola Comments at 4-7.

[16] In this regard, Motorola welcomes the recent efforts by the Commission and the NTIA to "institutionalize and elevate the coordination between the two agencies beyond historical levels, given the importance of spectrum management to the country." *Chairman Powell and Assistant Secretary Victory Meet to Plan and Coordinate Spectrum Policy*, FCC News Release, Dec. 10, 2002. This announcement notes that the agencies have agreed to execute a new Memorandum of Understanding ("MOU") detailing the terms of their interaction in the near future. A new MOU would be a valuable starting point for a comprehensive government spectrum policy.

[17] Task Force Report at 64 (Task Force Policy Recommendation 1).

create the significant potential for harmful interference, uncertainty in the radio operating environment and

inefficient use of spectrum. Therefore, as the Task Force properly recognized, flexibility must be balanced with appropriate boundaries.[18] The Commission must provide clear technical rules in all spectrum bands to limit interference and enable users in common or adjacent bands to successfully co-exist.

Limitations on technical and regulatory flexibility are also essential to provide sufficient guidance for the development of new services and equipment. New services have struggled to develop where the Commission has granted too much flexibility. For example, the auction of spectrum in the 2.3 GHz band for the Wireless Communications Service ("WCS") in April 1997 has resulted in only modest use of the spectrum to date, largely due to the uncertain technical and regulatory environment.[19] Motorola predicted this unfortunate result based on the Commission's proposal to provide almost total flexibility in the band.[20] The experience with WCS emphasizes the importance of providing appropriate limits on flexible use.

Reasonable restrictions on flexible use are necessary and appropriate in certain circumstances. For example, Motorola supports the Task Force's recommendation that the Commission group services with similar technical characteristics in adjacent bands.[21] This spectrum management policy would reduce the potential for interference, provide for more

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18 *See id*. at 16.

19 *See* Motorola Comments at 9.

20 *See* Comments of Motorola, Inc., WT Docket No. 99-168, July 19, 1999, at 3-6.

21 *See* Task Force Report at 64 (Task Force Policy Recommendation 6); *id*. at 22 (discussing the "Good Neighbor" policy).

efficient use of the spectrum, and limit the need for guardbands. We note that there is widespread support for this approach.[22]

As discussed in further detail below, Motorola also supports the Task Force's recommendation that the Commission retain the use of command-and-control regulation for public safety spectrum.[23] Such an approach is necessary to meet the unique mission critical requirements of public safety entities as they work to protect the lives and property of the entire public. We also note that a number of private radio users also deploy communications systems for critical infrastructure and important business safety needs that are critical to the public. These users have requirements that deserve similar treatment.

B. The Commission Must Clearly Define Licensee's Spectrum Rights

Motorola agrees with the Task Force that the Commission must clearly define licensees' spectrum rights. The Task Force Report identifies four basic parameters that should be defined for all licensed and unlicensed spectrum where rights should be defined:

- Designated frequency range and bandwidth;
- Geographic scope of right to operate;
- Maximum RF output (in-band and out-of-band); and
- Interference protection, *i.e.*, the maximum level of noise/interference that the spectrum user must accept from other RF sources.[24]

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[22] As one example, most commenting parties support the segregation of "high-site" non-cellular systems and "low-site" cellular systems in the ongoing 800 MHz interference proceeding. *See, e.g.*, Reply Comments of Motorola, Inc., WT Docket No. 02-55, Aug. 7, 2002, at 9-10 ("Motorola 800 MHz Reply Comments").

[23] *See infra* § IV.B; Task Force Report at 43, 65 (Task Force Policy Recommendation 26).

[24] Task Force Report at 18.

Motorola agrees that these are the four key parameters. Historically, the Commission successfully has described the first three of these elements when it has established licensing rules for new radio services.[25] The Commission, however, has provided only a vague definition of the interference protection parameter to date. As the Task Force notes, existing rules provide insufficient guidance regarding objective measures of "harmful interference."[26] Accordingly, Motorola agrees that the Commission should define this parameter for each spectrum band and type of service so that users have greater certainty regarding the limits of acceptable interference. In this regard, the Commission should be mindful of its obligations to provide adequate interference protection to incumbent services and, also, to minimize the disruption to existing operations. In addition, it is important to recognize the need to take into account the operational requirements of a particular service in establishing interference parameter benchmarks. Finally, licensees should not be required to assume additional burdens to ensure that new spectrum users operate in conformance with FCC rules.

C. Significant Technical Problems Limit the Feasibility of Time-Sharing Spectrum At Present

The Task Force Report theorizes that new technologies permit the Commission to consider exploiting the time dimension of spectrum management in the future. While it may be appropriate for the Commission to seek to maximize the use of the spectrum by evaluating spectrum time-sharing, Motorola urges the Commission to proceed carefully so as not to

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[25] In some instances, however, the Commission has adopted maximum RF output rules that are too lenient and fail to consider adequately the potential interference impact on other users, including adjacent channel licensees. For example, the recently adopted service rules for the 698-746 MHz band allow transmitter powers that create the potential for significant interference by allowing 50 kilowatt transmitters to occupy spectrum immediately adjacent to the 746-806 MHz band, where licenses are limited to a maximum base transmitter ERP of up to 1 kilowatt.

[26] *See* Task Force Report at 18.

jeopardize existing services. Motorola's two White Papers in this proceeding have highlighted some of the principal technical difficulties involved with exploiting the time dimension. For example, the White Papers note that determining whether a frequency channel is unused is far more complex than simply measuring activity on that channel at any one location.[27] Considerable work remains to be done to fully understand how best to take advantage of this dimension.

The numerous technical obstacles that exist in this area illustrate a broader point: the Commission should not seek to rely solely on technological solutions in lieu of active spectrum management based on market and operational needs. Because of the significant potential for interference, Motorola recommends that the Commission require direct involvement of incumbent licensees before time-sharing of spectrum is allowed. In most instances, this could be achieved by authorizing incumbents to enter into secondary market agreements, or by requiring consultation with incumbents, particularly where incentives exist for efficient spectrum use. We emphasize, however, that while such arrangements may be helpful in some cases, they are not an adequate substitute for spectrum allocation and management. The Commission has allowed spectrum disaggregation and partitioning in the 1850-1990 MHz Personal Communications Service ("PCS") band since the mid 1990s. It is clear that such flexibility has not solved the country's spectrum requirements.

[27] *Motorola Spectrum Policy White Paper* at 23-24; *Motorola Spectrum Holes White Paper* at 2-5.

D. Promoting Efficient Spectrum Use

While Motorola agrees that promotion of efficient use of spectrum is a laudatory goal, efforts to impose or encourage efficiency must be taken in concert with users' operational requirements and the maturity of technology. It would be irresponsible to mandate that users deploy a certain level of efficiency before the technology required to do so is adequately tested and proven in the applicable market. Also, we reiterate our prior comments that efficient spectrum use is a much broader and more complex issue than merely the amount of information that is transmitted over a finite amount of spectrum.[28] Instead, efficiency should be measured by how well spectrum use meets the requirements of spectrum users, *i.e.*, economic efficiency, which is dependent upon operational efficiency as well as spectrum efficiency.[29] Information must be distributed reliably throughout the area where it is needed without undue degradation. If not, communications must be repeated, leading to inefficient and possibly even unsafe situations. Achieving the highest spectrum efficiency does not necessarily result in the highest operational efficiency.

Motorola recommends that the Commission adopt incentives for efficient spectrum use, rather than mandate specific spectrum efficiency standards. While the specific incentives would need to vary by service to take account of operational requirements, geographic area, etc., the Commission should be consistent in applying efficiency incentives across all spectrum bands. For example, it would be unfair to apply incentives only to public safety and private radio bands but not to broadcast use.

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[28] *See* Motorola Comments at 3.

[29] *See id.*; *see also* Task Force Report at 21 (defining "economic efficiency" in similar terms, and distinguishing this concept from "spectrum efficiency" and "technical efficiency").

E. Motorola Supports the Adoption of a "Good Neighbor" Allocation Policy to Minimize the Potential for Interference Between Incompatible Systems

The Task Force recommends the adoption of a "good neighbor" spectrum allocation policy that would group future spectrum allocations based on similar technical characteristics.[30] As we noted earlier in these Comments,[31] Motorola strongly supports this recommendation because it would significantly reduce the potential for interference between incompatible systems.[32] This "good neighbor" policy is widely supported and is consistent with Motorola's Comments in this proceeding[33] and the *Best Practices Guide* developed by the Telecommunications Industry Association ("TIA").[34]

F. A Periodic Review of Rules Is Appropriate and Consistent with the Adoption of a Long-Range Spectrum Plan

Motorola supports the Task Force's recommendation that the Commission should review its rules on a predetermined schedule and make appropriate adjustments to reflect technological advances.[35] Periodic review would provide a valuable mechanism for ensuring that the rules governing wireless services remain current with technology and operational needs, and would complement the existing biennial review process. This review should be conducted in conjunction with the NTIA to develop a national review of both government and non-

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30 *See* Task Force Report at 22, 64 (Task Force Policy Recommendation 6).

31 *See supra* § II.A.

32 *See* Motorola Comments at 10.

33 *See id.*

34 *Avoiding Interference Between Public Safety Wireless Communications Systems and Commercial Wireless Communications Systems at 800 MHz – A Best Practices Guide* (Dec. 2000), *at* http://www.apcointl.org/frequency/downloads/BPG.pdf.

35 *See* Task Force Report at 22, 64 (Task Force Policy Recommendation 8).

government spectrum. The Task Force's recommendation of a 5 to 10 year review period[36] is consistent with Motorola's proposals that the Commission plan spectrum allocations 7 to 10 years in the future[37] and adopt a long-range spectrum plan.[38] The Commission should commence the development of a long-range plan to accommodate changing user and service requirements. Projected spectrum requirements should consider not only technological advances, but users' operational requirements as well. For example, the public safety community based its projection of spectrum requirements on both of these factors.[39] Studies for third generation ("3G") spectrum requirements also considered such factors. The Commission can then utilize the 5-10 year review process as a means to periodically adjust and refocus its long-range plan. The adoption of a long-range plan would also further the Commission's leadership position with regard to spectrum management policy.

G. Motorola Supports the Use of Effective Enforcement to Deter Harmful Interference

Motorola supports the Task Force's conclusion that the Commission must devote sufficient resources to monitoring spectrum use and enforcing spectrum management rules.[40] Motorola also endorses the recommendation that the Commission should examine the monitoring facilities and needs at its field offices and provide the additional funding and

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36 *See id*. at 64 (Task Force Policy Recommendation 8a).

37 *See Motorola Spectrum Policy White Paper* at 18.

38 *See id*. at 3, 25; Motorola Comments at 4, 9, 10-11.

39 *See* Public Safety Wireless Advisory Committee, Final Report (Sept. 1996) ("*PSWAC Final Report*"). The Commission and the NTIA established the PSWAC in 1995 to identify the spectrum needs of public safety agencies through the year 2010 and to formulate recommendations for meeting those needs. The *PSWAC Final Report* sets forth the PSWAC's detailed findings and key recommendations.

40 *See* Task Force Report at 23.

resources necessary to implement the proposals in the Task Force Report.[41] Motorola and the industry overall have routinely supported fair enforcement and increased FCC field resources to investigate and help solve interference cases. If the Commission intends to provide increased flexibility to licensees and if it also allows greater unlicensed use in additional spectrum bands, it will be increasingly important for the Commission to maintain a well-equipped and technically-competent enforcement staff that is able to quickly respond to and address interference issues.

III. INTERFERENCE AVOIDANCE

A. The Concept of Interference Temperature Presents a Host of Complex Technical Problems That Must Be Solved Before It Can Be Implemented

Motorola agrees with the Task Force that the Commission should adopt a more quantitative approach to interference management where feasible.[42] In real world deployments, some level of interference will always be present, regardless of good faith efforts to prevent it. Systems are typically designed to provide a certain level of reliability within a given expected environment. Adding interference and raising the noise floor at minimum reduces coverage and in some cases totally disrupts communications. Overcoming interference, even when technically possible, can significantly increase a users' cost. The critical objective must be to protect incumbents with primary rights from experiencing harmful interference. Properly developed quantitative interference standards, where possible, would assist the Commission in assessing the degree of harm from actual interference. It would also assist the Commission in assessing whether proposed secondary uses would create harmful interference if deployed.

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41 *See id.*

Motorola stresses, however, that the concept of interference temperature proposed in the Task Force Report is fraught with difficulty. That concept envisions the ability to dynamically allow unlicensed operations within licensed spectrum bands based on the detection of communications traffic. The fundamental task of determining and controlling the influence of a transmitter's emissions upon a remotely located receiver is an enormously complex problem.[43] In the attached Appendix, Motorola identifies some of the technical hurdles that must be overcome before the potential benefits of the interference temperature concept might be realized. While we fully support further analysis and study, this concept is far from being ready for routine deployment in the real world as a reliable spectrum management tool.

B. Receiver Performance Specifications Must Be Balanced with Operational and User Needs

The Task Force recommends that the Commission can enable additional spectrum access by adopting, even on a voluntary basis, minimum receiver performance parameters.[44] Generally, such performance specifications are determined for "in-system" interferers, which drive intercept points, compression point, phase noise, channel selectivity, and band selectivity. Specifications are typically determined by industry associations, such as the Electronics Industry Association ("EIA") or the TIA, based upon criteria such as expected deployment scenarios, user density, realistic (*i.e.*, affordable) selectivity, and phase noise. Because receiver performance

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42 *See id*. at 26.

43 While the general solution to controlling interference is difficult, under some circumstances this complex issue can be resolved, as evidenced by studies underway for the 5 GHz band by the ITU JRG 8A-9B. These studies have illustrated that when a mobile device detects the power from high-power radar systems and then relocates to another channel that is not in use by the radar, interference can be controlled.

44 *Id*. at 31-32, 65 (Task Force Policy Recommendation 16). Motorola assumes that the term "tolerances" in this context refer to the ability of the receivers to tolerate interference.

specifications are so system dependent, Motorola believes that specifications common to all receivers are inappropriate. Indeed, it is hard to envision how a common minimum receiver performance specification, especially one incorporating a selectivity parameter, could be applied across all air interfaces.

However, when appropriate to help resolve specific spectrum incompatibilities, industry-developed receiver specifications can serve as a useful tool.[45] The Commission must always be cognizant that imposing overly stringent receiver design specifications inflates the cost, and thus hinder public acceptance, of new products. To a large extent, the adoption and success of a technology is influenced by a combination of cost and user requirements (*e.g.*, handset size, talk time, etc.). Imposing additional dynamic range, sensitivity, or selectivity demands on otherwise low-cost architectures could potentially hinder customer acceptance of new products. Furthermore, while physics will limit the degree of improvements that can be made, technological advances may provide new options as to how possible improvements can be made. Therefore, any Commission guidelines should address the results desired, and avoid the temptation to dictate the design of specific receiver elements.

Finally, Motorola observes that a requirement for appropriate spectral masking of transmitters is equally important as receiver selectivity in controlling interference and increasing spectrum efficiency. Moreover, spectral masks offer the advantage of minimizing out-of-band emissions at the transmission source while, in contrast, increasing channel selectivity in a receiver serves only to limit the impact of interference once it has occurred. Spectral masks therefore generally provide a more efficient and appropriate solution to out-of-band interference.

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[45] *See* Comments of Motorola, Inc., WT Docket No. 02-55, May 6, 2002, at 20-21; Motorola 800 MHz Reply Comments at 24-25.

Whether addressing receiver or transmitter parameters, the Commission must consider users' operational requirements and must balance the relative costs of any guidelines with the benefits obtained in a real world setting.

IV. SPECTRUM USAGE MODELS

A. There Is No "One Size Fits All" Approach to Spectrum Management

Motorola is pleased to see that the Task Force agrees with our comments that that there is no "one size fits all" approach to managing spectrum.[46] Each of the three spectrum usage models that the Commission has utilized to date – command-and-control, exclusive use, and unlicensed "commons" – retains viability in appropriate circumstances. Accordingly, Motorola supports the Task Force's recommendation that the Commission adopt a spectrum policy that balances the three basic spectrum rights models.[47] This includes consideration of applying certain components of each model when regulating specific radio services. For example, the Commission must not rely solely on market forces to regulate commercial mobile radio services but, instead, it must apply some aspects of the command-and-control model of regulation to such services in order to ensure a coherent market environment.

B. The Commission Should Continue to Allocate Spectrum for Public Safety Using the Command-and-Control Model

Motorola commends the Task Force for recognizing that the continuing critical need for dedicated public safety spectrum licensed under the command-and-control model. The Task Force appropriately acknowledges that public safety systems require a higher degree of

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46 *See* Task Force Report at 36; Motorola Comments at 8.

47 *See* Task Force Report at 37.

robustness and reliability than commercial systems.[48] Motorola also agrees with the Task Force that "attempting a sweeping transition of existing public safety spectrum to an exclusive use or commons model could be highly costly and disruptive to existing public safety uses, and does not appear to offer countervailing public interest benefits."[49] Based on these findings, the Task Force recommends that the Commission should continue its present policy of dedicating spectrum for public safety use.[50] Motorola supports this recommendation.

Motorola does not agree with the Task Force's implicit suggestion that the existing allocations of public safety spectrum are sufficient and thus no further allocations of dedicated spectrum are necessary.[51] Instead, the Task Force suggests that public safety users obtain access to additional spectrum through alternative methods, such as spectrum auctions, easements during times of emergency, or a priority access mechanism.[52] In Motorola's view, none of these alternatives are an acceptable alternative to additional allocations of dedicated spectrum.

First, acquiring spectrum through the public auction process is not a viable option at present, as the Task Force itself acknowledges, because the cost of suitable spectrum is simply far too high.[53] While the Task Force speculates that this option may be feasible "eventually" if the cost of spectrum is "driven down" to a sufficient extent,[54] Motorola does not see this as a realistic prospect in the foreseeable future, particularly in light of the fiscal constraints currently

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48 *See id*. at 43.

49 *Id*. at 46.

50 *See id*. at 43, 65 (Task Force Policy Recommendation 26).

51 *See id*. (stating that the Commission should explore mechanisms for meeting public safety needs other than through dedication of spectrum on a command-and-control basis").

52 *See id*. at 43-44.

53 *See id.* at 43.

54 *Id*.

facing state and local governments across the country. The primary method of meeting the spectrum needs of public safety users must continue to be through the dedication of appropriate and sufficient spectrum for public safety use.

In the alternative, the Task Force Report suggests that public safety users could obtain temporary access to additional spectrum during times of "extraordinary" regional or national emergencies either through "easement rights to non-public safety spectrum" or through a "priority access" mechanism on a call-by-call basis.[55] These options, however, fail to address the reality that the very times public safety needs the greatest communications capacity often coincide with the times when commercial system capacity needs are also at a peak point. If, in fact, commercial systems have such extra capacity during these times, then the spectrum could have been reallocated to dedicated public safety. However, the experience on September 11, 2001 and during other disaster scenes indicates that commercial systems, as well as public safety systems, are capacity constrained during such times.[56] In short, there is no adequate substitute for dedicated public safety spectrum allocations.

Motorola notes that the need for additional public safety spectrum has been well documented. The *PSWAC Final Report* found that existing allocations of dedicated public safety spectrum are insufficient to meet the public safety community's existing voice and data service needs, to permit deployment of advanced services, to provide adequate interoperability channels, or to meet future voice and data needs given projected population growth and

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55 *Id*. at 44.

56 *See, e.g.*, Public Safety Wireless Network Program, *Answering the Call: Communications Lessons Learned From the Pentagon Attack* at 11-12 (Jan. 2002).

demographic changes.[57] The *PSWAC Final Report* recommended that the Commission allocate approximately

[57] *See PSWAC Final Report* § 2.1.10.

97 MHz of additional mobile spectrum for public safety use.[58] In Motorola's view, the PSWAC's assessment of the need for significant additional allocations of dedicated public safety spectrum remains valid today, and many public safety organizations have expressed similar comments in this current proceeding.[59]

Unfortunately, the Task Force Report makes no mention of the acute need for further allocations of dedicated spectrum for public safety use, even though it is one of the most important issues facing the public safety community, particularly in major metropolitan areas. More than five years ago, the Commission acknowledged the "critical need for more public safety spectrum in the United States," and the PSWAC's recommendation for additional spectrum.[60] In December 1997, at the direction of Congress, the Commission took an important first step toward implementing the PSWAC recommendation by allocating 24 MHz of spectrum for public safety use in the 746-806 MHz band.[61] Even though five years have passed since that allocation, this spectrum remains unavailable for public safety use in 40 of the top 80 markets

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58 *See id*. §§ 2.2.1, 4.4.1. Both the PSWAC Spectrum Requirements Subcommittee and the PSWAC Steering Committee made this recommendation. *See id*. Notably, to reach this estimate of the amount of spectrum needed, the Subcommittee assumed "aggressive" improvements in efficiency that can only be achieved by universal replacement of existing public safety equipment. *See id*. § 4.4.10.

59 *See, e.g*., Comments of APCO, July 8, 2002, at 7; Comments of the International Association of Fire Chiefs, Inc. and International Municipal Signal Association, July 8, 2002, at 3; Comments of Statewide Wireless Network, New York Office for Technology, July 8, 2002, at 8; Comments of The Public Safety Wireless Network Program, July 8, 2002, at 16.

60 *Reallocation of Television Channels 60-69, the 746-806 MHz Band*, ET Docket No. 97-157, Notice of Proposed Rule Making, 12 FCC Rcd 14141, ¶ 8 (1997); *see also Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Services*, MM Docket No. 87-268, Sixth Report and Order, 12 FCC Rcd 14588, ¶ 79 (1997); *Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service ("WCS")*, GN Docket No. 96-228, Report and Order, 12 FCC Rcd 10785, ¶ 74 (1997).

61 *See Reallocation of Television Channels 60-69, the 746-806 MHz Band*, ET Docket No. 97-157, Report and Order, 12 FCC Rcd 22953, ¶ 12 (1998). This action implemented Section 3004 of the Balanced Budget Act of 1997, Pub. L. No. 103-55, 111 Stat. 251, and a spectrum allocation recommendation in the *PSWAC Final Report*. *See PSWAC Final Report* at 59.

due to the presence of incumbent broadcast operations.[62] Although clearance of the 700 MHz band is unquestionably a complex issue, the Commission must find a solution promptly so that Congress's mandate for additional public safety spectrum can finally be put into effect throughout the nation.

Last year, the Commission allocated an additional 50 MHz of spectrum for public safety in the 4940-4990 MHz band.[63] Once rules are finalized and this spectrum can actually be accessed, public safety users will have the opportunity to deploy new broadband wireless solutions. Motorola thus urges the Commission to move quickly and finalize the service rules for the 4940-4990 MHz band and make it accessible so that this spectrum can begin to serve public safety organizations.

So despite these recent Commission actions, public safety is not yet in any better position from an operational perspective than they were when the PSWAC recommendations were submitted in 1996. Since the Commission has already rejected the notion that commercial carriers can satisfy these identified needs,[64] it is imperative that the Commission completes the implementation of the spectrum recommendations in the *PSWAC Final Report* and consider further public safety allocations as part of any long-range spectrum plan for the United States.

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62 *See Motorola Spectrum Policy White Paper* at 23; *see also* Comments by the State of Arizona, ET Docket No. 02-135, July 8, 2002, at 2 (stating that the 700 MHz spectrum is still unavailable for public safety use in Arizona).

63 *See The 4.9 GHz Band Transferred from Federal Government Use*, WT Docket No. 00-32, Second Report and Order and Further Notice of Proposed Rule Making, 17 FCC Rcd 3955, (2002).

64 *See id*. ¶ 28. The Commission rejected the argument that "the needs of public safety agencies can be met solely by acquiring service from commercial providers," implicitly confirming the conclusions of the PSWAC Spectrum Requirements Subcommittee and the PSWAC Steering Committee that commercial wireless services are not suitable for mission critical communications needs. *See PSWAC Final Report* §§ 2.2.1, 4.4.6.

C. The Commission Should License Spectrum Below 6 GHz Primarily Using Either the Exclusive Use or Command-and-Control Models

The Task Force recommendation that the Commission should license spectrum below 5 GHz primarily using the exclusive use model (or the command-and-control model for public safety spectrum)[65] and consider expanded use of the commons model in higher spectrum bands, particularly above 50 GHz.[66] These conclusions are generally consistent with the views expressed by Motorola in this proceeding. In the *Motorola Spectrum Policy White Paper*, Motorola explained that additional spectrum should be allocated for future wide-area mobile services to meet, for example, the increasing demand for broadband mobile wireless services.[67] High speed, wide area services are difficult to provide using short-range unlicensed systems and therefore spectrum must be provided on an exclusive use basis.[68] A number of technical and economic considerations favor the use of lower frequencies, *i.e.*, below 6 GHz, for future wide-area mobile services:

- *Transmit power is proportional to the data rate*: Thus broadband services are more readily accommodated at lower frequencies.
- *Infrastructure cost is inversely proportional to cell size*: Large cells are less costly and more economically viable than small cells.
- *Path loss is frequency dependent*: Larger cell sizes are possible at lower frequencies.
- *Propagation becomes line of sight at very high frequencies*: Signals lose the ability to penetrate or travel around objects at high frequencies, and this effect becomes significant above 6 GHz.
- *Doppler effects increase with frequency and vehicle speed*: Lower frequencies minimize Doppler effects, which is a significant factor for vehicular users.[69]

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65 *See* Task Force Report at 38, 43.

66 *See id*. at 39-40.

67 *See Motorola Spectrum Policy White Paper* at 14.

68 *See id*. at 15.

69 *See id*. at 15-17.

Frequencies below 6 GHz, and ideally spectrum below 3.7 GHz, are therefore better suited for wide-area mobile services.[70] Accordingly, while it is appropriate to retain existing commons spectrum below 6 GHz, future allocations in these bands should be licensed on an exclusive use basis for commercial systems (and on a command-and-control basis for public safety systems).[71] Any additional future uses of these exclusive use bands should therefore come through the application of secondary market arrangements. Such arrangements would provide for secondary use of this spectrum while enabling incumbent licensees to maintain the necessary interference protection.[72]

D. The Commission Should Recover Broadcast Spectrum for Reallocation for Mobile Services on an Exclusive Use or Command-and-Control Basis

Motorola agrees with the Task Force's conclusion that opportunities exist for the reallocation of broadcast spectrum for other uses, including licensed mobile services. The Task Force stated that "broadcast spectrum can be recovered for reallocation and reassignment to more flexible uses" as the transition to digital television continues.[73] Notably, this recovered spectrum would be in addition to the 700 MHz spectrum that the Commission has already

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70 *See id*. at 17.

71 Motorola does, however, support the petition for rulemaking filed by the Wireless Ethernet Compatibility Alliance (now known as the Wi-Fi Alliance) to allocate the 5470-5725 MHz band for use by radio local area network ("RLAN") devices. *See* Motorola Comments at 14. The benefits of a globally harmonized band for these devices puts this request in a unique position and adequately justifies an allocation of spectrum for unlicensed devices below 6 GHz.

72 Motorola believes this approach is preferable to an underlay commons allocation, which would allow unlicensed use without consultation with incumbents. In such circumstances the potential for harmful interference from unlicensed systems is significant, and this prospect would limit innovation and deter incumbents from making the investments necessary to develop and deploy new technologies.

73 *See* Task Force Report at 45.

reallocated for fixed and mobile services.[74] We emphasize, however, that the first priority should be clearing the broadcast spectrum in channels 60-69 which has already been reallocated. Public safety users have already waited seven years for this to occur. Half of the top 80 cities are so encumbered with co-channel and adjacent channel television stations that public safety users cannot access the spectrum. Moreover, the Commission has not established in any definitive date when this spectrum will be cleared. The Commission must take action to clear existing television stations from this band as soon as possible. In addition, the Commission should immediately stop licensing additional broadcast use in channels 60-69, even on a secondary basis.[75]

Motorola submits that recovery and reallocation of broadcast spectrum is entirely appropriate given the declining number of television viewers that receive a signal over the air. The Commission recently reported that, as of June 2002, 89.9 million households (representing more than 85% of television households) now obtain their television signal through means other than over-the-air broadcasting and this number continues to rise every year.[76] Motorola recommends that the Commission explore ways to reallocate additional broadcast spectrum to other services, particularly mobile services, on an exclusive use basis. As discussed above,

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[74] *See id.*

[75] Public safety officials recently noted that the Commission continues to license Low Power TV stations within the 746-806 MHz band (Channels 60-69), with the caveat that they will need to cease operation once public safety uses the band. That is small comfort, however, if the public safety community eventually has to dedicate resources to ensure that the caveat is honored. A more appropriate spectrum management approach would be to cease granting any new broadcast licenses in the 746-806 MHz band.

[76] *See Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, MB Docket No. 02-145, Ninth Annual Report, FCC 02-338, ¶ 5 & App. B (rel. Dec. 31, 2002).

lower frequency spectrum, such as that below 700 MHz, is ideally suited for mobile services.[77] The Commission should incorporate the reallocation of increasing amount of broadcast spectrum into its long-range spectrum management plan.

V. PROMOTING ACCESS TO SPECTRUM

A. Additional Designations of Spectrum for Unlicensed Use Should Generally Be Restricted to Spectrum Above 10 GHz

Motorola supports additional allocations of spectrum for unlicensed use and recommends that the Commission make future allocations in frequencies above 10 GHz with an exception for the 5 GHz band, as noted above.[78] Unlicensed applications, which typically involve short-range communications between devices, are well suited to higher frequencies.[79] At frequencies above 10 GHz, there is also reduced potential for interference between unlicensed systems, larger bandwidths are available for high-speed applications, and signal propagation characteristics are well suited to communications within buildings.[80] Limiting future unlicensed spectrum allocations to high frequencies dovetails with our view, and the Task Force's recommendation, that lower frequency bands should be licensed primarily on an exclusive use basis for commercial services.[81]

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77 *See supra* § IV.C.

78 *See supra* note 71.

79 *See supra* § IV.C.

80 *See Motorola Spectrum Policy White Paper* at 18.

81 *See supra* § IV.C; Task Force Report at 38. For public safety and most private use, as addressed previously, the command and control model is the most appropriate licensing approach. *See supra* § IV.B.

B. Secondary Market Arrangements Offer the More Appropriate Means of Providing Secondary Access to Exclusive Use Spectrum

Motorola believes that secondary market arrangements would provide the most appropriate means of providing secondary users some access to exclusive use spectrum. In particular, Motorola believes that secondary market arrangements are preferable to government-defined easements as a means of permitting secondary spectrum use. Under a secondary market approach, incumbent licensees would be able to determine the conditions under which secondary users would have access to their spectrum. This ability to manage spectrum access would ensure the prevention of harmful interference to incumbent operations. Easements, in contrast, would not allow incumbents any ability to control the parameters of secondary use and thus raise the potential for unintended harmful interference.

In Motorola's view, the easement approach would raise many of the problems and concerns identified in the preceding section regarding interference temperature and in Motorola's October 28, 2002 *Spectrum Holes White Paper*. Although the Task Force suggests that easements could be used to create spectrum usage rights for unlicensed devices in bands where an interference temperature has been established, significant problems would need to be addressed before such an approach is undertaken. As discussed in Appendix A, the interference temperature at a primary user's receiver is highly dependent upon the proximity of the secondary user and path loss to the primary user's receiver. The mobility of the primary and secondary users makes determination and control of interference difficult due to temporal changes in the relative path losses. The Commission would also need to consider the potential impact of increasing numbers of secondary users over time and the difficulty in reducing harmful interference levels once the secondary users have commenced operations.

As Motorola has noted, the opportunistic or dynamic secondary use of licensed spectrum — through either cognitive radio techniques to find "spectrum holes" in exclusive use bands, or the use of protocols that enable a secondary user to vacate spectrum if a primary user commences operation — presents numerous problems and at best are merely theoretical concepts at this time.[82] For example, the identification of spectrum holes for possible exploitation using cognitive radio[83] or spectrum-sharing protocols is complicated by many factors. Motorola has described some of these in its *Spectrum Holes White Paper*.[84] One of the fundamental problems is that received power measurements at a single location do not indicate accurately whether a spectrum hole exists that can be exploited without harmful interference to primary users. To address this "hidden terminal" problem, a secondary user would need to measure frequency use throughout the exclusion zone centered at the secondary user's location.[85] Many other potential problems would need to be addressed, including the detection of spread spectrum signals that operate at very low signal-to-noise ratios or signals with non-continuous waveforms (*e.g.*, TDMA).[86] In Motorola's assessment, the opportunistic or dynamic use of spectrum holes will be difficult. Motorola, however, is actively conducting research in an effort to further assess these issues.

Motorola therefore concludes that secondary market mechanisms provide a more appropriate means of allowing secondary access and improving spectrum efficiency. As the

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82 *See supra* note 43.

83 *See Motorola Spectrum Policy White Paper*, App. B; *see also* Joseph Mitola III, *Cognitive Radio: Making Software Radios More Personal*, IEEE Personal Communications, Vol. 6, No. 4 (Aug. 1999).

84 *See Motorola Spectrum Holes White Paper* at 4-5.

85 *See id*. at 2-4.

86 *See id*. at 4.

Task Force notes, band managers or frequency coordinators may facilitate the negotiation and implementation of secondary market arrangements. Motorola also notes that ongoing research programs are studying enhanced spectrum management concepts that combine third generation cellular architectures with broadcast systems with the goal of more efficient spectrum utilization.[87] These advanced spectrum-sharing procedures make use of a centralized radio resource manager. Motorola believes that centralized radio resource management or other network-based coordination may be the most promising approach to improving spectrum efficiency while preventing harmful interference. Even then, the practicalities of allowing unlicensed operations, which are normally characterized as "no control," to overlay commercial licensed services requires further study.

VI. MOTOROLA SUPPORTS THE USE OF AUCTION PROCEEDS TO FUND THE RELOCATION OF GOVERNMENT AND NON-GOVERNMENT INCUMBENTS

Motorola strongly supports the Task Force's recommendations that Congress should enact legislation to authorize use of auction funds to pay relocation expenses of incumbents,[88] and that the Commission should support existing legislative proposals on this issue and propose the expansion of these measures to include non-government incumbents.[89] Motorola has consistently advocated such an approach in the past.[90] This legislation is essential for two reasons. First, it would provide certainty to incumbent licensees that they will be reimbursed for

87 *See id*. at 5.

88 *See* Task Force Report at 67 (Task Force Policy Recommendation 31e).

89 *See id.* at 69 (Legislative Recommendations).

90 *See, e.g.*, Comments of Motorola, Inc., ET Docket No. 00-258, Feb. 22, 2001, at 15; Reply Comments of Motorola, Inc., ET Docket No. 00-258, Mar. 9, 2001, at 8.

all costs associated with relocation, and it would thus encourage incumbents to relocate voluntarily. Second, such legislation would provide much needed certainty to prospective licensees regarding the cost of spectrum for new services.

Motorola notes that several bills to establish a Spectrum Relocation Fund were introduced in the last session of the 107th Congress.[91] Moreover, in July 2002 the Department of Commerce submitted proposed legislation to Congress that would create a Spectrum Relocation Fund for federal entities.[92] While these legislative proposals extended only to federal agency incumbents, Motorola supports the Task Force's recommendation to fund the relocation of private incumbents from auction proceeds. This action would appropriately extend the benefits of such legislation to all entities affected by spectrum reallocation.

VII. THE COMMISSION SHOULD TAKE ACTIONS TO MINIMIZE THE COST OF SPECTRUM

Motorola believes that the adoption of a long-range spectrum planning process, which will establish guidelines for spectrum policy over a 5-10 year period, will provide the wireless industry with greater certainty that spectrum will be made available in a timely manner for services that will be economically viable.[93] A long-term view would require the Commission to identify sufficient spectrum needed to meet projected demand for a new service, and then address the actions necessary to make that spectrum available within that time frame. The long-range plan also would address relocation of displaced incumbents and the grant of experimental

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91 *See* H.R. 4641, 107th Cong. § 202 (2002); H.R. 5638, 107th Cong. § 4 (2002).

92 *See* Letter from Theodore W. Kassinger, General Counsel, Dept. of Commerce, to The Honorable Richard B. Cheney, President of the Senate, July 23, 2002 (enclosing draft bill titled the "Federal Spectrum Relocation Payment Procedures Act"), *available at* http://www.ntia.doc.gov/ntiahome/congress/2002/legistransmittal7232002.htm.

93 *See Motorola Spectrum Policy White Paper* at 18.

licenses to facilitate timely equipment development. These measures would provide the market with greater assurance regarding the viability of introducing new services, which in turn should encourage investment by manufacturers and service providers, and ultimately reduce the cost of spectrum.

Nevertheless, the Commission should also explore alternatives to allocating spectrum by auctions. While auctions provide a short-term benefit to the U.S. Treasury, they drain resources from service providers and thus increase the cost of deploying new services. Ultimately, imposing these significant up-front costs on new service providers harms the public more than it benefits from the collection of auction of revenues. One example is the 3G licensing process in Europe. It is now abundantly clear that licensees paid far too much for new spectrum in many auctions, which is significantly impacting the ability of the winning bidders to deploy 3G services. While public revenues from the auctions were substantial, the high costs incurred by licensees have delayed the rollout of services and reduced investments in future equipment and service improvements. Furthermore, the recent decision of the U.S. Supreme Court in the NextWave case highlights the limitations on the Commission's authority to regulate and control the use of auctioned spectrum in the context of a bankruptcy proceeding.[94] Therefore, the Commission should consider alternative approaches that provide greater marketplace certainty. Accordingly, Motorola urges the Commission to explore alternative licensing mechanisms and to seek legislation that would grant the Commission flexibility to license spectrum by means other than auctions.

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94 *FCC v. NextWave Personal Communications Inc*., No. 01-653 (Jan. 27, 2002).

VIII. CONCLUSION

Motorola commends the Task Force on the release of its Report. It contains many valuable recommendations for consideration. Motorola urges the Commission to move quickly to implement the key recommendations that are discussed in these Comments.

Respectfully submitted,

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APPENDIX A: INTERFERENCE TEMPERATURE

I. Overall Concept

The concept of interference temperature as proposed is to quantify and manage the interference temperature at the primary user's receivers in order to establish maximum permissible levels of interference. The determination or prediction of the level of interference that a non-primary[1] user's transmissions will cause at another location is an immensely difficult problem. This level of interference at the primary user's receiver is a function of many factors including the transmit power of the non-primary user, the propagation loss between the non-primary user and the primary user, the antenna pattern and gain of the non-primary and primary users, and the aggregation of interference from multiple sources. The maximum acceptable level of interference is a function of the required Carrier to Interference ratio ("C/I") of the primary user's receiver and the receive power of the primary user's desired signal. Furthermore, the location of the primary user's receivers may not be known, thus further complicating the problem. Many of these factors are discussed in greater detail below.

Motorola believes that imposing a fixed interference temperature cap, as suggested in the Task Force Report,[2] would not be the best means of managing interference. A fixed cap would allow a uniformly degraded noise floor, which would restrict the range of a transmit-power limited system based on C/I. This would negatively impact the primary user by causing holes in coverage that would need to be compensated in some way (*e.g.*, by utilizing lower throughput, more densely deployed infrastructure, etc.). Instead, it would be better if the interference cap were based on the enforcement of a minimum C/I at the primary user's receiver. This would result in an interference temperature cap lower than the fixed cap in fringe regions (due either to range or other propagation effects like shadowing) and prevent holes in the primary user's coverage. See Figure 1, which is an edited version of Figure 3 from the Task Force Report. The shaded box represents the original fixed interference cap, while the C/I-limited cap is at the fixed level unless that level compromises minimum C/I. The cap could be constrained by a negotiated C/I and sensitivity degradation, which could be allowed to vary from region to region.[3] The non-primary users would be required to determine the relevant interference constraints before attempting to transmit in the spectrum. Motorola believes this alternative approach would appropriately minimize system impact on primary users.

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1 The terms "primary" and "non-primary" are used in this Appendix to identify the intended and interfering users, respectively. In most cases, these will be licensed and unlicensed users, respectively.

2 Figure 3 of the Task Force Report and the accompanying text imply a fixed interference noise cap. *See* Task Force Report at 29.

3 This approach implicitly assumes that the performance degradation of the primary user's system can be adequately described by interference power ("I") alone, which may not be valid for all types of modulations. In such cases, other characteristics of the interferer's modulation may need to be considered.

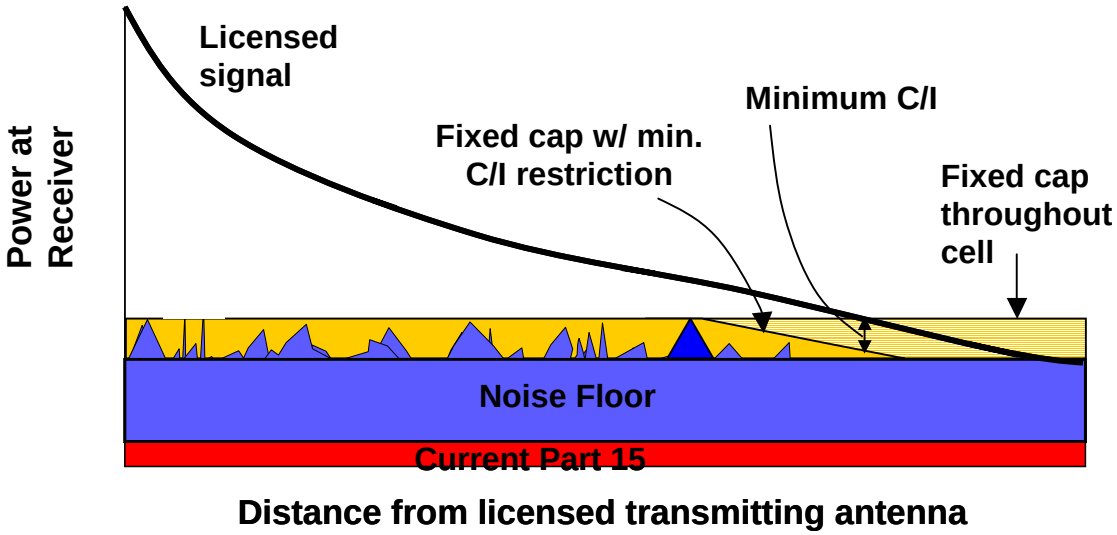

Figure 1

The interference temperature at the primary user's receiver may vary considerably as a function of propagation loss between the primary and secondary users. Figure 3 of the Task Force Report shows aggregated interference below the interference temperature limit.[4] This well-behaved aggregation would be expected if many sources of low-level interference were relatively distant from the primary user's receiver. Thus, the result would be very appropriate for an orbiting satellite receiver with interferers located on the surface of the Earth. It may also be appropriate, although less so, for a tower-mounted receiver with interfering users relatively distant from the primary user. However, if the interferers can be located in close proximity to the primary user's receiver, as would be expected for mobile receivers, the interference impact from a single non-primary transmitter can increase dramatically. This potential scenario is shown in Figure 2 below. Furthermore, if the deployment of secondary users increases over time, the incidence of interference temperature above the interference cap at the primary user's receiver would also increase.

[4] *See* Task Force Report at 29.

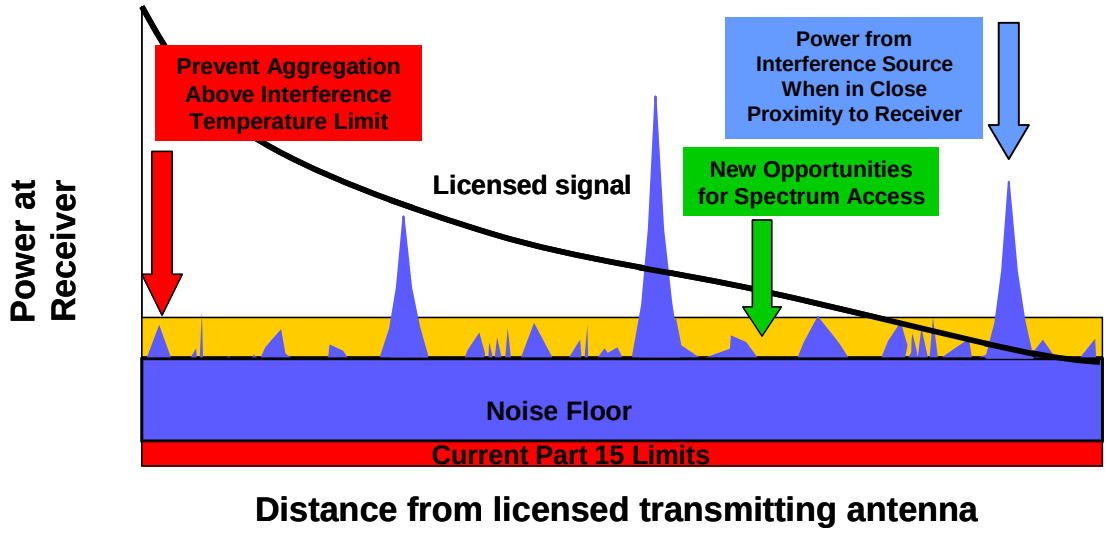

Figure 2

Motorola recognizes that the interference cap need only be respected at the primary user's receiver location, and then only when the primary user is utilizing the spectrum. For highly localized non-primary communications, if there are no primary users in a given region at a given time, there would be no reason to cap the noise floor in that region for the time being. For example, very close to the non-primary device, the interference temperature would likely exceed the cap, but as long as there were no primary users within that small area, the excess temperature would not be harmful. If a primary user enters the region, the non-primary user should be required to sense its presence and immediately adjust its transmit level so as to reduce the interference temperature at the primary user's receiver below the cap. This is more complicated to envision for traditionally unidirectional links like broadcast television. For example, if no one in a geographic area is complaining that television channel 7 is being interfered with, perhaps no one is watching (even though it is broadcasting) and so the spectrum, while *occupied*, is not being *utilized* in that area. Therefore, the interference temperature could be allowed to increase in a localized manner until it is determined that the interference is objectionable (*i.e.*, someone starts watching). The question of how the effects of non-primary user transmissions can be predicted prior to causing interference would need to be resolved.

The task of estimating the impact of non-primary transmissions on a primary user is a daunting one, whether the interference temperature cap is uniform, as suggested in the Task Force Report, or non-uniform, as Motorola recommends above. Motorola submits that the only sensor that can truly report whether the interference temperature cap is being respected is the primary user's receiver — any other measurement device will be inadequate in some respect, as discussed further below. Motorola believes that this burden should not be imposed on primary users and their customers/subscribers. Instead, it should be the responsibility of non-primary users and operators of the "monitoring network" to ensure compliance with the interference temperature cap at the primary users' receiver locations, without impacting or otherwise imposing requirements upon the primary users.

II. Measurement Challenges

There are many challenges to measuring the interference being experienced at a primary user's receiver using monitoring receivers that may have different technical characteristics (aside from receive frequency) than the primary user's receiver. Sensor antenna height is a primary concern. For example, if the monitoring network sensors are at ground level but the primary user's receiver is elevated (*e.g.*, a base station tower or a mobile subscriber in a multi-story building), then the propagation loss between the interferer and an elevated user will be different than the loss between two ground-level users. In this scenario, the monitored and reported interference temperature might be significantly different from the interference temperature observed by the primary user, making compliance with the cap difficult to enforce. This could be addressed by assuming a worst-case (in interference terms) propagation environment (*e.g.*, free space), but this brings up the fundamental issue of range estimation between a potentially mobile non-primary interferer and a potentially mobile primary user. This would impose a requirement on a primary user to report the location of all primary mobile receivers to the monitoring network and all potential non-primary users in real time. Range estimation would be difficult, at best, especially if the sensor network had access to only the transmissions of the primary user because the primary user (as is typical) utilizes different transmit and receive frequencies.

Motorola also notes that the concept of "interference temperature density," described in footnote 38 of the Task Force Report, may lead to problems if the antenna patterns of the sensor and user differ markedly. For example, if the interference temperature-measuring device is equipped with an omni-directional antenna, the resulting reported density would be homogenized, and any hot spots or directional variations would be smoothed out. *See* Figure 3. Here, the dependency of the temperature density versus azimuth angle, time and frequency is alluded to in the function arguments as (ϕ, t, f), though for clarity only the dependence on ϕ is shown in the graph.

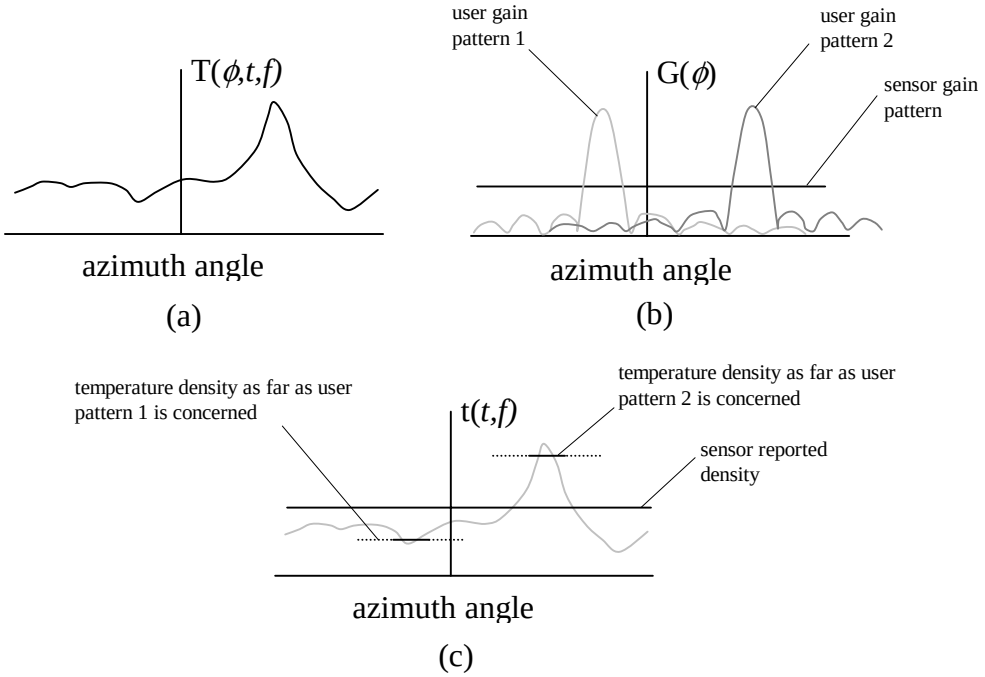

Figure 3. (a) Hypothetical temperature density versus azimuth angle ϕ, (b) assumed user and sensor gain patterns, and (c) effective reported and observed temperature densities (with ϕ integrated out).

If the primary user and the temperature-monitoring receiver have antennas with a similar gain pattern, then the reported density would be an adequate representation of the environment. However, if as shown in Figure 3 above, the primary user has a more directional or higher gain receive antenna, especially if it is steerable, then interference temperature experienced by the primary user would be lower than the level measured by the monitor in receiver in some directions, while higher than expected when hot spots fall within the user's beamwidth. The potential for such variations would need to be considered when establishing an interference temperature cap to ensure that the cap appropriately captures the "worst case" operating environment, as the Task Force suggests.[5]

Along similar lines to the antenna gain pattern variations, Motorola notes that problems would be created if the primary user's receiver and the monitoring receiver operate on different bandwidths — for example, if the primary user's network is narrowband (*e.g.*, 25 kHz) and the temperature-monitoring device is wideband (*e.g.*, 5 MHz). In this example, there is a 23 dB

[5] *See id*. at 28. The Task Force Report notes that "the degree of certainty of the estimate" of interference temperature is dependent upon "the uniformity of signal levels over an area." *Id*. The Report also notes that interference temperature measurements would be "independent of receiving antenna characteristics" if measured using a "reference antenna," though this latter term is undefined. *Id*. at 27 n.38. If a primary user's antenna has a different gain pattern than the "reference antenna," interference temperature measurements obtained using the reference antenna would not reflect the actual interference experienced by the primary user.

difference in sensitivity between these two bandwidths. If there are discrete spurious or colored noise sources that are contributing to the interference temperature (in dBm/Hz), this would be averaged and reported over the bandwidth of the sensor. Over most of the band, the actual interference temperature would be somewhat lower than the reported (average) temperature. However, on the particular channels that contain the spurious sources, the interference temperature would be considerably worse than the reported average. Again, if the interference temperature cap is to represent the "worst case" operating environment, it should account for the impact of bandwidth disparities.

Motorola also notes that problems would arise if a non-primary user transmits in a non-stationary manner, such as transmit beam-forming or a pseudo-random frequency-hopping pattern. This would add considerable variation to the noise floor and make it difficult to predict, detect, or enforce an interference temperature cap. Even if there is no intentional time variation, primary and non-primary users can move in and out of shadowed areas, causing sudden changes in the interference temperature encountered by the primary user. These scenarios implicate the broader issue of the time lag involved in detecting and correcting interference above the temperature cap. This has two components: The time taken by a monitoring network to detect that interference has exceeded the cap; and, more importantly, the time taken to adjust the non-primary user's transmissions so that the interference temperature at the primary user's location is returned to a permissible level. Any time delay would necessarily result in harmful interference to the primary user.

These examples illustrate the spatial, temporal and frequency resolution challenges faced by a temperature sensor in a non-homogenous environment. Considering these factors, achieving finer resolution to account for minimum channel bandwidths or minimum antenna beamwidths would appear to be necessary to ensure compliance with a temperature cap. However, if a monitoring receiver utilizes narrow bandwidths and beamwidths, the increase in the number of observation points (both frequency and azimuth sweeps) would greatly increase the total sweep time and would introduce another resolution problem — *i.e.*, the duty cycle between interference measurements at any one frequency and azimuth angle — which would increase the likelihood that maximum actual temperature values are not captured in a time-varying environment (*e.g.*, packet data or, as mentioned earlier, beam or frequency-hopping patterns). This, too, would further extend the time delay before interference above the temperature cap is detected and rectified by the non-primary user.

Motorola believes that monitoring devices capable of excluding "the energy contributions of particular signals with known characteristics,"[6] such as the signals of incumbent licensees, would need to be highly complex. To meet this capability, a temperature monitor would need to be able to demodulate the signal (in the presence of other interferers) or otherwise determine whether the signal possesses the "known characteristics" and make a reasonably accurate assessment of the signal's power, so as to estimate the residual power due to other interferers. In Motorola's view, this would require a more complex device than a simple "low

[6] *Id*. at 28.

power" measurement "thermometer" that the Task Force Report appears to suggest.[7] It would require a receiver back-end capable of demodulating and identifying a large variety of air interfaces, which has not been either a low cost or low power undertaking up to this point in time. Furthermore, to ensure accurate and meaningful measurements, the monitoring receiver would need to be a "high spec" device that has somewhat more sensitivity in the presence of strong interferers than equipment fielded by primary users. This would be particularly essential if the device were needed to exclude signals with "known characteristics" that are only a few decibels above the combination of interference plus thermal noise. The receiver would also require a high degree of selectivity and linearity to ensure that the power being measured and reported for a given frequency channel is due to the on-frequency signal alone, and not due to "bleed through" of out-of-band signals.

In summary, Motorola feels that the estimation of the impact of a non-primary user's emissions will be difficult to assess by either the non-primary user or a third-party monitoring network, neither of which may adequately reflect the sensitivity of the primary user's receiver, nor possess sufficient knowledge of the path loss between the primary and non-primary users. Aside from the considerable measurement and compliance assurance issues identified, any interference temperature cap would need to be structured in such a way to minimize the impact on primary users with regard to system deployment, coverage area, information throughput, signal quality, and all aspects of their radio architecture complexity.

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7 *Id*. at 30.