while the analysis will often favor market-oriented approaches, there are instances where the analysis will support regulation.

E. "Good Neighbor" Incentives

In addition to improving access to spectrum through flexible use policies, as discussed above, it may be desirable, where possible, to group technically compatible systems and devices in close spectrum proximity. One of the challenges presented by permitting additional flexibility within assigned spectrum is the potential for incompatible adjacent systems. For instance, low-power systems or devices with a high sensitivity to interference could be grouped with similar systems, and systems or devices with high power could be placed elsewhere. System or device spectrum incompatibility can require additional constraints in the form of guard bands, consuming valuable spectrum, or expensive filtering systems to avoid adjacent band interference. The Task Force believes that the Commission should consider making spectrum policy decisions encouraging like systems or devices to be grouped in spectrum "neighborhoods" with like systems. At the same time, it is important to be mindful of the importance of allowing flexible use of spectrum.

The Task Force recommends that the Commission rely primarily on its general spectrum management authority to consider whether future allocations should be grouped based on mutually-compatible technical characteristics. Specifically, such a "good neighbor" policy would group future systems or devices by specifying comparable maximum levels of power and compatible interference protection levels. For existing services, flexible use policies could create the incentive for spectrum-based systems or devices to migrate to compatible bands based on marketplace forces. In some limited instances, however, there may be particular types of systems or devices, public safety for example, that require more direct regulatory intervention (*e.g.,* through creation of guard bands or other direct regulation of out-of-band interference) because the marketplace may not independently encourage such compatibility. In addressing those issues, however, the Commission should be careful not to compromise or undermine the overall concept of flexible use. Over time, the Commission could consider whether the tightening of out-of-band emission limits in services would obviate the need for allocations to be grouped.

F. Periodic Review of Rules

The Task Force recommends that the Commission consider adjusting its regulations on a periodic basis to prevent rules that are calibrated to older technologies from inhibiting access by newer, more efficient technologies that develop over time. For instance, as discussed below, it may be possible to adjust interference standards over time based on technological advances. Public Workshop participants, as well as parties that commented on the Public Notice, generally agreed that it would be useful to set term limits on Commission rules so that the rules would be revisited automatically on a periodic basis.

While the Task Force concludes that the Commission should subject spectrum regulations to periodic re-evaluation, it is also important that such reevaluation occur at

sufficiently spaced intervals so as not to undermine the stability of current spectrum users' business plans and investment. The Task Force continues to believe that a level of certainty regarding one's ability to continue to use spectrum, at least for some foreseeable period, is an essential prerequisite to investment, particularly in services requiring significant infrastructure installation and lead time. Therefore, any periodic reevaluation of rules, and any resulting implementation of new rules, should be on a predetermined schedule, *e.g.*, every 5 to 10 years. Specific timetables for review of rules need not be the same for all services, devices, and spectrum bands, but can vary based on such factors as service provider and customer investment requirements, apparent public expectations, and anticipated speed of technological development. In addition, periodic review of rules to accommodate new technologies should be distinguished from the license renewal process, which focuses on licensee qualifications and compliance with Commission rules. Thus, licensees in bands that are subject to periodic review should nonetheless be entitled to a strong renewal expectancy if they meet the renewal criteria set forth in the Commission's rules.

G. Enforcement

The Task Force believes that in order for the Commission to be able to meet the increasingly complex spectrum management demands being presented by the enormous growth in spectrum use, the Commission must devote sufficient resources to monitoring spectrum use and enforcing the spectrum management rules. The Task Force recommends that the Commission undertake an examination of its field offices' and monitoring facilities' needs and consider providing additional funding and resources to accommodate the spectrum management proposals made in this Report. In addition, the Commission should ensure that it has sufficient resources to independently obtain critical spectrum management data for decision makers and the ability to implement the proposals discussed in this Report. In addition, the Commission may want to seek a review and possible increase in its statutory forfeiture authority in order to provide additional incentives for spectrum users to comply with the Commission's rules.

Recommendations.

- Permit broad, highly flexible use within technical parameters of the allocation.
    - Permit traditionally narrow services to lease excess capacity to other services.
- Investigate rule changes that enable the lowering of permitted power in urban areas and the increasing of permitted power in rural areas.
    - Permit high-power digital television broadcasters to operate single frequency low power distributed transmission systems within their present service area.
    - Promote the co-location of high power transmitters.
- Foster technologies for uniform signal strength generation throughout a service area
- Consider user fees or other steps to stimulate improvements in efficiency when marketplace is inadequate.
- Promote shift to hybridizations with wireline delivery whenever appropriate.
- Group future allocations based on mutually-compatible technical characteristics (power **flux** density and sensitivity to interference), and improve the out-of-band interference performance of transmitters and receivers over time so as to reduce the need for this kind of grouping.
- Conduct periodic evaluations of allocation parameters with respect to evolving technology and uses.
- Time-limit spectrum rights and subject them to periodic review.
    - Every 5 to 10 years, review spectrum rights and obligations, interference criteria, and definitions, and modify if appropriate.
    - But spectrum users should be entitled to rely on rules remaining constant between periodic reviews.
    - Licensees should still have strong renewal expectancy.
- Ensure that the Commission has sufficient resources to independently monitor and enforce spectrum management rules, including possible increase in statutory forfeiture authority.

VI. Interference Avoidance

A. Interference Challenges[35]

As the Commission considers how to provide opportunities for an ever-increasing array of spectrum-based technologies and services, one recurring and often thorny issue is how to protect users against harmful interference.[36] Ensuring adequate interference protection has been a key responsibility of the Commission since inception and continues to be one of its core functions. Section 303(f) of the Communications Act of 1934, as amended, directs the Commission to make regulations "it may deem necessary to prevent interference between stations" as the public interest requires. Sufficient interference protection is a necessary and fundamental building block in any spectrum policy. Indeed, without adequate interference management, new spectrum-based services could be prematurely thwarted and, correspondingly, mature services might not be able to reach their full potential.

Managing interference has always been challenging. Despite the fact that the Commission has had extensive, and generally successful, experience in managing interference issues, these issues have been increasing in technical difficulty and prevalence due to the changing RF environment generated by new devices and new technology. Interference management requires more than determining the ways in which to engineer around potential degradation to a radio signal. Rather, interference management necessarily involves technical and economic tradeoffs. For example, although requiring licensees to use more selective rather than more sensitive receivers may improve interference management because such receivers are less vulnerable to adjacent channel interference, it may also increase the cost of the communications systems by requiring more infrastructure.[37]

This already challenging issue has become even more difficult as a result of the increasingly intensive use of the radio spectrum. There are now fewer and fewer opportunities to allocate unused spectrum for new services and, correspondingly, fewer and fewer bands in which interference is not a significant issue. Interference management has become more difficult because of the greater density, mobility and variability of RF emitters and because users have been granted increased flexibility in

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[35] For a more extensive discussion, **see** Interference Protection Working Group Report section entitled "Future Challenges Warranting Consideration of New Interference Protection Paradigms."

[36] "Interference" is defined as follows, according to the Commission's rules: "The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could he extracted in the absence of such unwanted energy." 47 C.F.R. § 2.1. "Harmful interference" is defined as follows: "Interference which endangers the functioning of a radionavigation service or other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with these [international] Radio Regulations." 41 C.F.R. § 2.1.

[37] Generally, selectivity is achieved by adding filters to the front end of a receiver, and these usually increase the receiver noise figure – decreasing its sensitivity to RF signals.

their spectrum use. As a result, the complexity of predictive interference models has increased dramatically. Whether a user operates a fixed or mobile communications system affects the technical variables required to assess interference. Many types of mobile emitters have very low signal levels. Although the energy radiated by a single emitter might not be likely to cause harm, the cumulative emissions of secondary/unlicensed emitters and out-of-band emissions of primary licensed emitters and emitter types (radio telemetry, unlicensed devices, cell phones, etc.) could result in interference and, thus, must be considered. Technological changes in a communications system – for example, the type of waveform used to transmit a particular signal – also affect assessments of interference. As a result, comprehensive interference predictive analyses are not always possible, calling into question the adequacy of the Commission's current interference framework to manage increasingly congested RF environments in the future.

Commenters and participants in the public workshop were divided on the need for new definitions of what constitutes acceptable interference and harmful interference. Some appreciated the flexibility attendant with the Commission's current case-by-case approach. Others, frustrated by what they see as the uncertainty associated with such an *ad hoc* approach, advocate the adoption of more quantitative measures for interference management. These parties contend, for example, that the current definition of *harmful interference* is subjective and does not reflect modem technology and communications markets. On balance, the Task Force concludes that the current general definitions of interference sufficiently address the broad operational and technical characteristics of the many communications services contained in the Commission's Rules. Rather, in lieu of suggesting that the Commission change or refine its definitions related to interference management, the Task Force believes that quantitative metrics can be used to augment and clarify the application of existing definitions.

The Task Force believes that, although the Commission's rules and processes for managing interference have historically been effective in many bands, current interference management approaches and tools need to be reexamined. As supported by the record and described in greater detail in the report of the Interference Protection Working Group, the rapidly changing technology and RF environment will challenge the continued effectiveness of such current approaches as predictive interference modeling, technology compatibility testing, and spectrum use decisions based on a qualitative knowledge of the local environment. Moreover, given the increasing flexibility in the types of spectrum-based services and, correspondingly, more intensive use of the radio spectrum, the Task Force believes that the Commission should adopt, wherever feasible, a more quantitative approach to interference management or quantitatively augment its existing rules. Quantitative standards reflecting real-time spectrum use would provide users with more certainty and, at the same time, would facilitate enforcement.

B. Adopting Quantitative Standards: Interference Temperature

The Task Force recommends that, as a long-term strategy, the Commission shift its current paradigm for assessing interference – based on transmitter operations – toward operations using real-time adaptation based on the actual RF environment through interactions between transmitters and receivers. In general, it is the ability of a receiver to select and receive a particular signal that determines whether the signal has been degraded by interference. The environment in which the receiver operates should be considered; *i.e.*, the total amount of undesired power -- generated by other emitters and noise sources – that is present at the receiver. Thus, the Commission's rules should specify a more accurate measure of interference that takes into account the cumulative summation of all the undesired RF energy available to be captured by a particular receiving antenna for delivery to the receiver.

To achieve this objective, as well as to transition interference management to more accurate real-time measurements, the Task Force recommends that the Commission adopt a new metric, "interference temperature," to quantify and manage interference. The interference temperature measures the RF power available at the receiving antenna per unit bandwidth.[38] Conceptually, as illustrated in Figure 1, interference temperature

[38] The idea of an interference temperature as a measure of the "noise" power in a particular band and location is synonymous with the concept of antenna temperature: the "equivalent temperature of the power received at an antenna." ***See,*** for example, Wolfram Research at http://scienceworld.wolfram.com/physics/AntennaTemperature.html. Antenna temperature **is** a component of the total noise temperature of a receiver system, which also includes the thermal noise generated within the receiver

Interference temperature, expressed in units of degrees Kelvin, can be calculated as the power received by an antenna in watts divided by the associated RF bandwidth **in** Hertz and a term known **as** Boltzman's Constant (equal to 1.3807 watt-sec/°Kelvin). Alternatively, interference temperature can be calculated as the power flux density available at an antenna **in** watts per meter squared multiplied by the effective capture area of the receiving antenna in meters squared divided by both the associated RF bandwidth **in** Hertz and Boltzman's constant. An "interference temperature density" can also be defined as the interference temperature per unit area, expressed **in** units of 'Kelvin per meter squared, and calculated as the interference temperature divided by the effective capture area of the receiving antenna. This quantity could be measured for particular frequencies using a reference antenna and, thereafter, would be independent of receiving antenna characteristics.

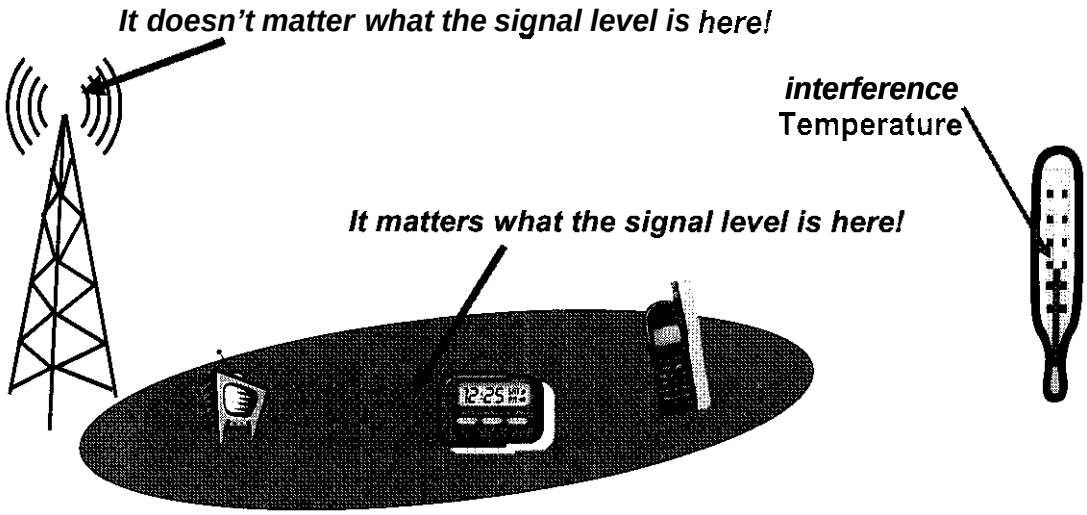

Figure 1

measurements would be taken at various receiver locations to estimate the real-time condition of the RF environment. The degree of certainty of the estimate of the environment would depend on such factors as transmitter signal ranges, uniformity of signal levels over an area, the density of temperature measuring devices and the sharing of the data taken by nearby devices; *e.g.,* through "*ad hoc* cooperative wireless networks." Measuring devices could be designed with the option to include or exclude the energy contributions of particular signals with known characteristics; for example, the emissions of subscribers of licensees assigned the spectrum on an exclusive basis in a particular geographic area.

The Commission could use the interference temperature metric to establish maximum permissible levels of interference, thus characterizing the "worst case" environment in which a receiver would be expected to operate. Different threshold levels could be set for each band, geographic region or service, and these thresholds should be set after the Commission has reviewed the condition of the RF environment in each band. This review should include actual spectrum measurements of the RF noise/interference floor. In addition to obtaining better data regarding the noise floor, the Commission should adopt a standard methodology for measuring the noise floor. Further, the Task Force recommends that the Commission create a public/private partnership for a long-term noise (interference temperature) monitoring network and for the archiving of data, for use by the FCC and the public.

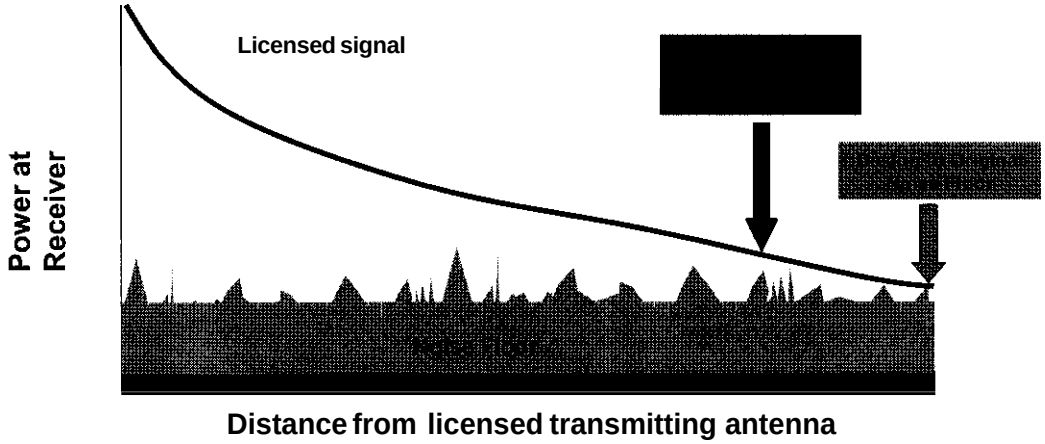

Figure 2

Figures 2 and 3 illustrate significant benefits of capping the permitted interference temperature. Figure 2 depicts a possible scenario resulting from the current open ended nature of the RF noise floor. A communications system has been designed to operate to a distance from the transmitting antenna at which the signal strength approaches the level of the noise floor that existed when the system was established. Over time, the noise floor can rise unpredictably – this due to additional interfering signals, perhaps including out-of-band emissions from new users and further aggregation of unlicensed devices. As a result, signal coverage can be degraded without warning. Additional interfering signals will progressively worsen coverage. Figure **3** modifies the scenario by placing an interference temperature cap over the service area.

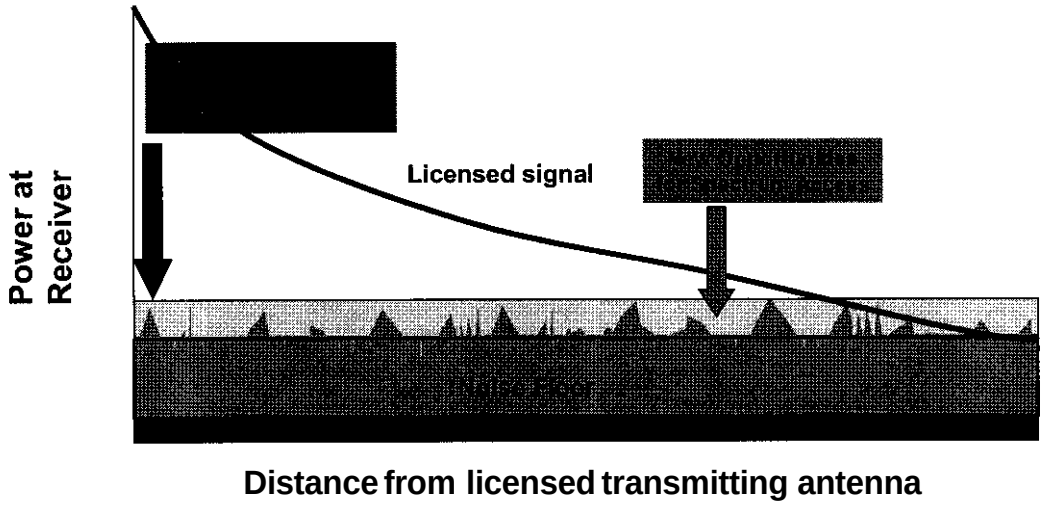

Figure 3

The Task Force believes that two key benefits will result from the application of the interference temperature metric: First, licensed spectrum users will obtain certainty with regard to the maximum permissible level of aggregated noise, or interference, in their band. The interference temperature would quantify the level of acceptable

interference in a particular band. For example, any transmissions from other sources that increase the noise level above the interference temperature would be considered "harmful interference" in accordance with Commission rules. Second, to the extent that the interference temperature in a particular band is not reached, other users (*e.g.*, unlicensed devices) could operate in the same band – with the interference temperature serving as the maximum cap on the potential RF energy they could introduce in the band. This would thus increase access to the band for other users or devices.

Interference temperature sensory and control mechanisms could be used to maintain both in-band and out-of-band emissions within permissible limits. For example, a low power unlicensed RF device could be designed to scan its particular frequency band before transmitting. Its built-in "thermometer" would record interference temperature data and compute the appropriate statistical aggregate value. The device would then project the increase in interference temperature due to its operation over its nominal range. This value would be compared with the permissible limit. If its operation would exceed the limit, the device's controller could execute an appropriate response such as reducing power, switching to a different transmit frequency (if available) or, perhaps, continuing the scanning/sensing process to locate an opportune time to transmit. The technology now exists to build such sensory control systems. Automated transmitter power control, for instance, is used in certain types of wireless and satellite communications systems. Cordless telephones also adapt to the environment by selecting an unused frequency.

Interference temperature mechanisms would serve in conjunction with existing out-of-hand emissions on adjacent frequencies. In the future, however, it is possible that interference temperature mechanisms could serve as an alternative to out-of-band emissions limitations. Indeed, depending on spectrum use characteristics and the severity of emission limits, some users might find the temperature sensory control approach to be more economical than expensive transmitter filtering. It could also permit operation at higher power levels in areas or frequency bands with low interference temperature levels.

In sum, where it could be applied, the interference temperature metric, in conjunction with sensory control systems, could significantly enhance interference management. Incumbents would be provided greater certainty regarding the maximum permissible level of interference in their particular bands. Interference temperature limits would also provide a "worst case" characterization of the RF environment and, thus, establish benchmarks for communications equipment and system designers; *i.e.*, the limits could assist designers in balancing the numerous technical and economic tradeoffs involved in radio system planning. Effective enforcement of these interference temperature limits is also an essential component of this concept, in order to ensure successful interference management. Finally, continuous monitoring of the interference temperature would enable the Commission to maintain current data on the RF environment.

C. Additional Methods of Interference Control

In addition to interference temperature, there are several other ways in which the Commission can improve interference management. As noted earlier, Commission regulations for controlling interference set forth permissible technical operational parameters for transmitters. Receiver robustness generally has not been taken into account in Commission regulations. On those occasions when it has been necessary to consider receiver quality, the Commission either applies a set of worst case receiver parameters or uses general receiver characteristics for its analyses.[39] This transmitter-centric policy is not necessarily efficient in today's spectrum environment.

Most parties support the need for the development of receiver standards or guidelines, or, in the alternative, minimum receiver performance requirements. Indeed, many of the parties asserted that, from a purely technical standpoint, interference susceptibility, as well as increased spectrnm efficiency is highly dependent on the quality and selectivity of the receiver used. Parties supporting receiver standards assert that such standards would promote spectrum sharing and system interoperability, and would provide common performance parameters that all equipment manufacturers must achieve. A few opposing parties assert that receiver standards could stifle innovation and could present administrative and enforcement challenges. Even those parties opposing receiver standards support, in varying degrees, the adoption of minimum receiver performance requirements.

The Task Force recommends that the Commission consider applying receiver performance requirements, either through incentives, regulatory mandates, or some combination of incentives and mandates. The Task Force generally prefers the use of voluntary receiver performance requirements, over mandatory standards. Thus, while receivers could he manufactured that do not meet the voluntary performance requirements, the Commission would not protect users of such receivers against interference resulting from failure to meet the performance requirements. Voluntary receiver performance requirements could he promoted through industry groups, or incentives could be developed for the use of advanced receivers. Receiver performance requirements may be particularly appropriate when the marketplace does not adequately promote receiver performance (*e.g.,* when the service provider does not control the manufacturing of the receivers). Receiver performance requirements also may serve as a useful transition mechanism for interference management until the Commission is able to implement interference temperature thresholds for particular bands. While the Task Force believes that the Commission currently has the requisite statutory authority to promulgate receiver performance standards, it also recommends that legislation more explicitly granting such authority be enacted. Also, it would be useful to conduct a study to evaluate receiver performance in the current RF environment.

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[39] For example, the Commission adopted provisions for interim interference protection of analog signals in the Multipoint Distribution and Instructional Television Fixed Services from a new service in an adjacent frequency band. In so doing, the Commission assumed a typical numerical value for a key interference rejection characteristic of the receiving equipment, based on information provided by a manufacturer of that equipment. ***See Memorandum Opinion and Order*** in GN Docket No. 96-228 (1997).

With the coming advances in technology, the Task Force does not believe that minimum receiver performance requirements would necessarily stifle innovation. In the future it is expected that, to a considerable extent, interference problems will be eliminated or adequately mitigated by flexible software solutions built into the receiver; for example, software-controlled filter responses. Further, it is likely that, in the future, manufacturers will design receivers with a more reliable expectation of the environment. On balance, the Task Force believes that the potential benefits of minimum receiver tolerances – whether through Commission mandates or incentives – outweigh the risk that such actions could stifle innovation.

There are many other steps that the Task Force recommends that the Commission should take to control interference. These include:

- Promoting the increased use of automated transmitter power and frequency control – such as the long-term sensory control mechanisms suggested in conjunction with the interference temperature metric and, in the near-term, increased use of automated transmitter power control that would adjust the power to match the amount that is actually needed to provide service; for example, in point-to-point microwave systems.

- Promoting the use of advanced antenna technology and system design techniques that would enhance the uniformity of transmitted signal strength levels through a service area,

- Consider the tightening of out-of-band emission limits over time, so that widely disparate uses of the spectrum can have less interference impact on each other.

- Harmonizing the references to interference in the Commission's regulations:

    - to ensure a consistent understanding of the impact of interference qualifiers such as ***harmful,*** and to remove or clarify undefined terms such as ***objectionable;***

    - to improve the consistency of technical terms and units related to interference management.

- Developing technical bulletins that explain the Commission's interference rules for all radio services – with web site access to not only a particular service's interference rules, but also with links to related information contained elsewhere in the Commission's rules.

- Developing a "best practices" handbook – a compendium of available information broadly relating to interference management, which could include, for example:

    - current industry guidelines for coordinating spectrum use;

- steps that could be taken to resolve interference problems;
- a discussion on how to best use FCC databases and related tools

D. Transition

As an additional interference management paradigm for the long-term, and to augment current approaches, the Commission should pursue use of the interference temperature metric, in conjunction with self-enforcing sensory control mechanisms. The Commission should also consider developing a program to test the concept on a limited basis. The Task Force recognizes that there are hurdles that must be overcome before the interference temperature metric could serve as a useful management tool. Foremost among these is the need to acquire data on the RF noise floor for different frequency bands and geographic regions. To that end, the Task Force recommends that the Commission undertake a systematic study of the RF noise floor.

Moreover, in addition to obtaining requisite data regarding the noise floor, there are many factors that the Commission would need to consider before setting an interference temperature for a particular band. Some potential factors that may be considered are: (1) nature and extent of incumbency; **(2)** the nature and types of the services (for example, the criticality of services like public safety); **(3)** the susceptibility of services and existing equipment to interference; (4) state of development of technology; and *(5)* propagation characteristics.

In the near term, the Commission should consider establishing receiver performance requirements to supplement its transmitter-centric interference management approaches. Use of modem receiver filtering and related digital system processing techniques could enhance interference management in the near-term, while the interference temperature concepts are being developed. Receiver improvements could also facilitate interference mitigation and more efficient spectmm use in situations in which the interference temperature approach would be inapplicable; *e.g.,* as a safeguard against "blanketing" interference.[40] The Task Force recommends that the Commission pursue receiver performance issues in a *Notice of* ***Inquiry.***

[40] Blanketing interference occurs when an undesired signal on a frequency different than that of the desired signal is sufficiently strong to overpower the front end amplifier stage of a receiver, thereby preventing proper operation of the receiver.

Recommendations:

- Quantify acceptable levels of interference through "interference temperature" concept (long-term objective).

  Obtain better data regarding noise floor:

  - Adopt standard method for measuring noise floor.

  Create a public/private partnership for long term noise (interference temperature) monitoring network and archiving of data for use by FCC and public.

  Include minimum receiver performance requirements in regulation (either through (1) additional incentives, **(2)** mandates, or (3) some combination of incentives and mandates) to be used until can migrate to "interference temperature" regulatory scheme and to be used for the long term where use of interference temperature would be inapplicable; *e.g.*, for systems in which licensees do not have control over receivers.

- Move to interference-limited policies.

  Issue Notice of Inquiry to characterize current and future receiver environments and to explore issues to consider, such as, minimum performance parameters and protection for legacy receivers.

- Award contractual study to evaluate receiver performance in current environment.
- Promote voluntary receiver performance requirements through industry groups.
- Consider incentives for use of advanced receivers.
- Promote transmitter enhancements for interference control: (a) foster technologies that enhance uniform signal levels throughout a service area; (b) promote greater use of automated transmitter control systems; and (c) consider tightening out-of-band emission limits over time.
- Improve communications on interference issues with public.
  - Harmonize interference language in FCC rules and affected international rules.
  - Ensure consistent and appropriate use of interference terminology.
  - Develop technical bulletins that explain interference rules for all radio services.
  - Develop best practices handbook.
- Add language to the Act expressly allowing the Commission to establish rules or performance requirements for receivers.
- "Interference temperature" concept should form the basis for better defining interference rights.
- Accompany clearer interference definition with effective enforcement.

VII. Spectrum Usage Models

A. Comparison of Alternative Spectrum Usage Models

The Task Force examined the Commission's spectrum policies and rules in relation to three general models for assigning spectrum usage rights:

- "Command-and-control" model. The traditional process of spectrum management in the United States, currently used for most spectrum within the Commission's jurisdiction, allocates and assigns frequencies to limited categories of spectrum users for specific government-defined uses. Service rules for the band specify eligibility and service restrictions, power limits, build-out requirements, and other rules.

- "Exclusive use" model. A licensing model in which a licensee has exclusive and transferable rights to the use of specified spectrum within a defined geographic area, with flexible use rights that are governed primarily by technical rules to protect spectrum users against interference. Under this model, exclusive rights resemble property rights in spectrum, but this model does not imply or require creation of "full" private property rights in spectrum.

- "Commons" or "open access" model. Allows unlimited numbers of unlicensed users to share frequencies, with usage rights that are governed by technical standards or etiquettes but with no right to protection from interference. Spectrum is available to all users that comply with established technical "etiquettes" or standards that set power limits and other criteria for operation of unlicensed devices to mitigate potential interference.

There is, of course, some overlap among these models as well as variations that combine elements of each. For example, spectrum users that are regulated on a command-and-control basis may have some of the same rights as spectrum users who are subject to the exclusive use model (*e.g.*, exclusive and transferable rights, interference protection). Moreover, spectrum that is subject to the exclusive use or commons model may nonetheless he subject to some degree of command-and-control restriction (*e.g.*, limiting usage based on international allocation restrictions). Nonetheless, the key distinction between the command-and-control approach and the other two models is that the former typically imposes significantly greater usage restrictions on spectrum (and sometimes on the eligibility of spectrum users), thereby restricting flexibility of spectrum use to a far greater degree than either of the other two models.

Commenters and participants in the workshops generally criticized the costs and inefficiencies imposed on spectrum users and the public by command-and-control regulation, and argued that these costs could be substantially reduced by moving from

command-and-control regulation to more flexible, market-oriented approaches, whether under an exclusive use model, a commons model, or a combination of the two. Some commenters, however, argued in favor of retaining a command-and-control approach for certain services (*e.g.*, public safety) on the grounds that exclusive reliance on market-based spectrum usage models would undervalue or thwart the provision of such services. Moreover, while most commenters and workshop participants favored expanded application of flexible, market-oriented spectrum policies, there was a significant split between those who favored an exclusive use approach and those who favored a commons approach.

Commenters who favored the exclusive use model argued that it promotes economic efficiency because its key characteristics – clearly defined rights, exclusivity, flexibility, and transferability – are necessary for efficiently allocating any scarce resource among competing uses. They also argued that without exclusive rights and interference protection, spectrum users would face uncertainty and would lack the incentive to invest in new technologies or services. These parties also tended to express skepticism regarding the commons approach, contending that a spectrum commons would result in overuse, interference, and underinvestment.

Supporters of the commons model argued that this approach leads to greater technological innovation and spectrum efficiency than an exclusive use approach. Because no spectrum is exclusively held, spectrum commons users have incentive to create spectrally efficient frequency-hopping technologies, whereas licensed spectrum typically sits idle when the license-holder is not transmitting. Furthermore, proponents of an open, commons approach claimed that spectrum scarcity might actually be reduced under such a regime because of the efficiency-enhancing possibilities and fundamentally different spectrum demands of new system architectures such as mesh networks. Commenters also contended that even in spectrum that was otherwise subject to an exclusive use approach, a commons approach should be used to create "underlay" rights for low-power, non-interfering devices.

Despite this split, most commenters and workshop participants supported the proposition that in spectrum policy, "one size does not fit all," and that the Commission should therefore strike a balance between the exclusive rights and the commons models. For example, many commenters suggested that granting flexible exclusive use rights to spectrum users did not preclude the Commission from imposing some regulatory limitations on use, analogous to zoning restrictions that are placed on property owners by local governments. Other commenters argued that unlicensed spectrum should not be seen as a complete replacement for licensed spectrum, but that some spectrum should be set aside for unlicensed use in the same manner than some land is set aside for public parks.

The Task Force agrees with the consensus view expressed by participants in this process that "one size does not fit all" in spectrum policy. An examination of the exclusive use and commons models as they have been applied to date suggests that each model has encouraged different equally beneficial types of technical and economic

efficiencies. In broadband PCS, for example, licensees have developed centrally managed wireless networks that cover large geographic areas and accommodate large numbers of mobile customers. The licensing of multiple users has also led to significant competitive benefits in the CMRS market. More recently, the designation of hands for open access by Part 15 devices has fostered the emergence of "smart" low power devices that can support sophisticated applications such as peer-to-peer networking. This has resulted in a significant surge of economic investment in these services or devices use over the last several years.

The Task Force therefore recommends that the Commission base its spectrum policy on a balance of the three basic spectrum rights models outlined above: an exclusive use approach, a commons approach, and (to a more limited degree) a command-and-control approach. It is further recommended that the Commission fundamentally alter the existing balance among these models – which is dominated by legacy command-and-control regulation – by expanding the use of both the exclusive use and commons models throughout the radio spectrum, and limiting the use of the command-and-control model to those instances where there are compelling public policy reasons. Thus, to the extent feasible, the Commission should identify more spectrum for both licensed and unlicensed uses under flexible rules, and should transition existing spectrum that is subject to more restrictive command-and-control regulation to these models to the greatest extent possible, as discussed in Section D below.

In proposing to reshape the balance among the three models, the Task Force recognizes that the models themselves are not pure and mutually exclusive approaches to spectrum management, but rather are representative approaches on a broader continuum that may be subject to variation in particular instances. Thus, for any given spectrum band or proposed use, the Commission may find it beneficial to incorporate elements from more than one model. For example, as discussed further below, spectrum that is licensed under an exclusive use approach could also be subject to an "underlay" easement that is available to low-power unlicensed devices using a commons approach. Similarly, services that require some dedication of spectrum on a command-and-control basis (*e.g.*, public safety) may benefit from partial application of the exclusive-use model to enable them to lease spectrum capacity to others when it is not otherwise needed. **As** a general matter, however, the Task Force believes that there is considerable room to move from the largely *ad hoc* regulation of particular bands that has evolved historically to a more consistent and comprehensive application of these models across the radio spectrum as a whole. If these models are consistently applied in all Commission spectrum policy decisions, it has the potential to significantly reduce the artificial scarcity of spectrum that currently exists as a result of barriers to access. This approach will have the beneficial effect of reducing the cost of obtaining exclusive spectrum rights in the market and will also help to alleviate congestion of spectrum that is made available on a commons basis, thus mitigating the risk of the "tragedy of the commons" – oversaturation resulting in inefficient use.

B. Application of Exclusive Use and Commons Models

The recommendation to move towards greater reliance on exclusive use and commons models requires that the Commission determine the appropriate balance between these two models. Ultimately, wherever there are competing uses for a resource – that is, wherever there is scarcity – some mechanism must exist for allocating that resource. **A** mechanism based on markets, such as an exclusive use model, will he most efficient in most cases. However, government may also wish to promote the important efficiency and innovation benefits of a spectrum commons by allocating spectrum bands for shared use, much as it allocates land to public parks.

There are a number of variables that may be relevant to this determination with respect to any particular hand, but the Task Force believes that the key factors to be considered are (1) spectrum scarcity, and **(2)** transaction costs associated with moving spectrum from less efficient to more efficient use. In this context, "spectrum scarcity" means the degree to which particular spectrum is subject to competing demands for use so that the demand exceeds the current supply; and "transaction costs" means the expenditure of time and resources required for a potential spectrum user to obtain the spectrum access rights from one or many parties necessary to its proposed spectrum use.

1. Factors Favoring Exclusive Use Model

The exclusive use model should be applied to most spectrum, particularly in bands where scarcity is relatively high and transaction costs associated with market-based negotiation of access rights are relatively low. The exclusive use model is appropriate because where spectrum is subject to competing demands, and therefore more likely to have a high market value, this approach creates the strongest incentives for parties to put spectrum to its highest valued use. In addition, where rights and responsibilities are clearly defined and effectively enforced, the characteristics of this model – *e.g.*, exclusivity, flexibility, and transferability – generally provide a clear framework for market-based assignment and negotiation of access rights among spectrum users, thereby limiting transaction costs.

These variables suggest that in the lower portion of the radio spectrum, particularly bands below 5 GHz, the Commission should focus primarily, though not exclusively, on using the exclusive use model. The propagation characteristics in this portion of the spectrum (which can support a wide variety of high- and low-power, fixed and mobile uses), combined with the high level of incumbent use (including government as well as non-government uses), result in a large number of competing demands for a relatively small amount of available spectrum. These factors tend to weigh in favor of an exclusive use approach with flexible rules because it provides a mechanism for spectrum users to choose among the full range of technically feasible spectrum use options based on market forces. Moreover, the typical transaction costs associated with negotiation of access rights tend to be relatively low in relation to the value of this spectrum.

Even in situations where usable spectrum is scarce but transaction costs are potentially high, the exclusive use model still may be most appropriate, though other

variables may also come into play. The presence of high transaction costs means that some transfers of spectrum will not occur, and some valuable uses therefore will not appear in the market. However, wherever scarcity exists, there will he competing claims to the resource, and the exclusive use model is most effective at balancing these competing claims. Moreover, the greater the scarcity, the greater will be the incentive for parties to find ways to overcome these high transaction costs. In contrast, as discussed below, a commons approach may be less effective in cases of high scarcity, despite its advantages in addressing high transaction costs.

Finally, while these factors weigh in favor of applying the exclusive use model under the above-described circumstances, it should be emphasized that they do not preclude the introduction of unlicensed "underlays" into exclusive use bands. **As** discussed below, the criteria that favor use of the commons model apply to potential underlay uses of spectrum below the interference temperature threshold, and may apply in some cases to opportunistic uses above the threshold, depending on the nature of the proposed use.

2. Factors Favoring Commons Model

The commons model should be applied to significant portions of the spectrum, particularly in bands where scarcity is low and transaction costs associated with market mechanisms are high. The commons approach makes increased access possible by replacing the negotiation of spectrum access rights among rights holders and prospective users with a commons model governed by user protocols and etiquette. These protocols promote efficiency through spectrum sharing, typically by requiring commons to operate at low power for a short time in limited areas, which allows multiple users to operate on the same spectrum. This approach also promotes technological innovation by providing a spectrum environment in which to develop new technologies. Users do not pay for access to the spectrum, so they will channel their investment exclusively into developing robust technology that can function in this environment and continue to function as the environment grows more congested.

Where both spectrum scarcity and transaction costs are low, the commons model again may be the most appropriate, though this situation is less clear. Under these circumstances, the presence of low transaction costs would add to the efficiency-creating characteristics of the commons. On the other hand, it also is possible that the exclusive use model would provide comparable benefits, as the price will be close to zero if spectrum is abundant. With low transaction costs as well as low price, interested users should have unrestricted access to the spectrum they need.

The variables described above tend to tilt in favor of expanded use of the commons model in higher spectrum bands, particularly above 50 GHz, based on the physical characteristics of the spectrum itself. In these bands, the propagation characteristics of spectrum preclude many of the applications that are possible in lower bands (*e.g.,* mobile service, broadcasting), and instead favor short-distance line-of-sight operation using narrow transmission beams. Thus, these bands are well-suited to accommodate multiple devices operating within a small area without interference.

Moreover, administering these uses on an individualized licensed basis would involve very high transaction costs.

The Task Force does not advocate the wholesale conversion of all spectrum to a commons approach as some commenters appear to advocate. Although the commons model is in many ways a highly deregulatory "Darwinian" approach, as its proponents point out, productive use of spectrum commons by unlicensed devices, particularly in lower spectrum bands, typically requires significant regulatory limitations on device transmitter power that preclude many other technically and economically feasible spectrum uses that rely on higher-power signal propagation over longer distances, or that require greater protection from interference. In addition, some commons proponents themselves state that setting aside additional spectrum for use on a commons basis is not essential to the continued success of unlicensed technology because the technological capability exists to prevent congestion from occurring in existing unlicensed hands.

This does not, however, mean that only higher band spectrum should be subject to a commons approach. The record shows that the Commission's dedication of some lower band spectrum to unlicensed uses, *e.g.*, 2.4 GHz, is yielding significant technological and economic benefits in the form of low-power short-distance communications and emerging mesh network technologies that should be further encouraged. The Task Force therefore recommends that the commons model continue to he applied selectively to other lower spectrum hands.

In addition, the commons approach has potential applicability in the creation of underlay rights across the entire range of spectrum for low-power, low-impact devices. To the extent that the Commission establishes "interference temperature" rules for particular hands, as discussed in Section VI above, the spectrum environment that is created below the temperature threshold has the characteristics that weigh most heavily in favor of the commons approach: low scarcity due to technical restrictions on the power and operating range of devices and high transaction costs associated with negotiating access. Therefore, the commons approach should presumptively be used for operations below the interference temperature threshold. In addition, the commons model may be appropriate for some opportunistic, non-interfering uses of exclusively licensed spectrum above the interference temperature threshold, although this approach raises more significant challenges. These issues are presented in greater detail in Section VIII.B., below, in the discussion of secondary markets and government-granted easements.

An important caveat must accompany any recommendation for a commons model: although there are indications that technology can go a long way to forestall scarcity concerns, if scarcity eventually does arise in particular spectrum hands in the future, then the commons model may need to evolve to address the problem. Because there is no price mechanism in the commons model to use as a tool for allocating scarce resources among competing users, there is always the risk that free access will eventually lead to interference and over-saturation, *i.e.*, the "tragedy of the commons." These problems can be overcome to some extent through regulatory guidance, requirements such as power and emission limits, and sharing etiquettes. But if actual spectrum scarcity

still occurs, rights may need to be redefined and market mechanisms (*e.g.*, band managers) introduced because without them there are insufficient incentives to avoid overuse.

C. Limited Use of Command and Control

The command-and-control model should be applied only in situations where prescribing spectrum use by regulation is necessary to accomplish important public interest objectives or to conform to treaty obligations. With respect to the command-and-control model, as noted above, the Task Force recognizes that continued use of this approach may be required in situations where prescribing spectrum use by regulation is necessary to accomplish compelling public interest objectives. However, such objectives should be carefully defined, and the amount of spectrum subject to a command-and-control regime should be limited to that which ensures that those objectives are achieved. Many spectrum users will claim that they warrant special consideration and thus deserve exemption from any reform of their service allocation rules. It is therefore critical to distinguish between special interest and the public interest, establishing a high bar for any service to clear prior to receiving an exemption.

In general, command-and-control regulation should be reserved only for spectrum uses that provide clear, non-market public interest benefits or that require regulatory prescription to avoid market failure. For example, radioastronomy may need to have dedicated, protected spectrum bands for the foreseeable future, due to its highly sensitive applications and the fact that its benefits accrue to society as a whole and only over the long run. Public safety and critical infrastructure may also require dedicated spectrum at particular times to ensure priority access for emergency communications. Other areas where limited use of command-and-control may be justified include international/satellite, public safety, and broadcasting, which are discussed in greater detail below.

Subject to these exceptions, the Commission should eschew command-and-control regulation, and legacy command-and-control bands should be transitioned to more flexible rules and uses to the maximum extent possible (whether under the exclusive rights or the commons model). The Task Force's recommendations with respect to transition mechanisms are discussed in greater detail in Section D, below.

1. International and Satellite Issues

A number of commenters stressed that the United States should make a better effort to harmonize its spectrum management policies and allocations with those of the rest of the world, when possible. To the extent domestic policies and allocations complement international decisions, U.S. consumers and businesses will reap important benefits such as more international roaming and better economies of scale with regard to equipment manufacturing. These commenters also pointed out that while the satellite, maritime, aeronautical, public safety and radioastronomy services have long required and benefited from extensive international coordination, terrestrial services like third generation wireless and radio local area network (*e.g.*, Wi-Fi) services are also becoming increasingly ubiquitous requiring the same level of international coordination.

Other parties commented on the importance of the Commission considering how spectrum-based services and devices using spectrum that has international treaty implications are affected by spectrum use models, often reducing the amount of flexibility available to users domestically. It was stated, for example, that the Commission should take account of the effect that interference caused by licensees offering newly flexible services would have on existing cross-border interference agreements with Canada and Mexico. The Task Force also noted that spectrum used for satellite services typically requires extensive international and global coordination under the International Telecommunication Union's Radio Regulations, inherently limiting a licensee's flexibility. Commenters asserted that a broader regional perspective on spectrum management by the Commission could speed deployment of services to U.S. consumers by resolving cross-border coordination and regional policy issues earlier.

The Task Force also noted that in the Open-Market Reorganization for the Betterment of International Telecommunications Act of 2000 (ORBIT Act), the Congress passed legislation excluding spectrum used for international and global satellite services from assignment through auctions. In order to provide more flexibility in allocating and licensing spectrum used for satellite services, the Task Force recommends that the Commission consider a statutory proposal for Congress that would assess and re-examine Section 647 of the Orbit Act to consider permitting, but not requiring, the Commission to utilize competitive bidding to resolve mutually exclusive applications for global and international satellite services.

Conclusions/recommendations. International considerations must be taken into account in two ways:

- First, because regional and world wide harmonization of band use can have significant advantages both in terms of truly ubiquitous services and economies of scale, in developing domestic spectrum policies and allocations, the Commission should consider the potential impact on international objectives, among other objectives.

- Second, U.S. consumers could benefit from improved (*i.e.,* quicker and more flexible) spectrum management coordination with the United States' regional neighbors, especially Canada and Mexico.

- In addition, the Commission should assess and re-examine Section 647 of the Orbit Act to consider permitting, but not requiring, the Commission to utilize competitive bidding to resolve mutually exclusive applications for global and international satellite services.

2. Public Safety

The Task Force sought information regarding what spectrum use models the Commission should employ to ensure public safety access to spectrum. Most

commenters and workshop participants who addressed this issue agreed that there are some important differences between the spectrum needs of commercial systems, which require high system capacity to support large numbers of users and applications, and those of public safety systems, which require less average capacity but need very robust and reliable communications, particularly for emergencies. Public safety spectrum users also typically have different funding mechanisms, are inherently more budget-constrained, and have longer equipment replacement cycles than commercial users.

But commenters and workshop participants also suggested that changes in spectrum policy could encourage greater efficiency on the part of public safety providers. For example, some public safety agencies indicated that they are becoming more innovative through creative licensing schemes, such as forming partnerships between state and local agencies and utilities and federal agencies. By sharing costs and spectrum with others, public safety entities have the potential to obtain more technologically advanced wide-area systems than they could afford on their own.

Some spectrum should continue to be dedicated on a command-and-control basis for public safety use. In light of the above considerations, the Task Force recommends that spectrum currently set aside for public safety use remain subject to the command-and-control model. Eventually, if the cost of spectrum is driven down by enhancing access and reducing scarcity, it is possible that public safety users could acquire spectrum in the market on the same basis as non-public safety users, but these conditions do not exist currently and should not form the basis for meeting the core spectrum needs of public safety entities.

At the same time, there is considerable potential for introduction of market-oriented policies that would help rather than burden public safety, and that would allow for more efficient use of spectrum to meet both public safety and commercial spectrum needs. The Commission therefore should explore mechanisms for meeting public safety needs other than through dedication of spectrum on a command-and-control basis.

Public safety users should have flexibility to lease their dedicated spectrum capacity that is available during lower-use periods to commercial users with a "take-back" mechanism when public safety use increases. Public safety spectmm use is typically highly variable, with periods of low traffic and occasional usage "spikes" during certain times of the day or week or during emergencies. Accordingly, there is benefit to be gained from permitting public safety entities to lease some of their spectrum capacity to commercial users during low-use periods, under an arrangement whereby the spectrum can be reclaimed immediately when needed for public safety use. The potential for this type of shared use will increase as smart transmitters and receivers are developed that can be shut down immediately upon command.

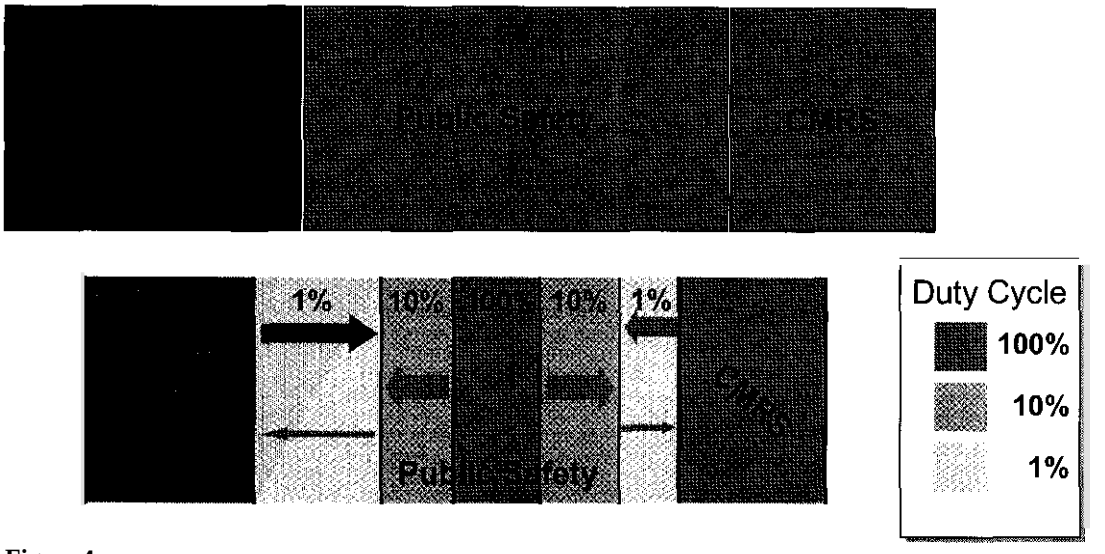

Figure 4

For major regional or national emergencies, additional public safety spectrum needs could be addressed through enhanced easement rights to non-public safety spectrum. In extraordinary national or regional emergencies (*e.g.*, terrorist attack, major natural disaster), public safety providers may require priority access to spectrum resources significantly beyond the amount of spectrum required to handle their normal emergency workload. Because of the extraordinary nature of these events, permanent dedication of spectrum to public safety to meet these contingencies is likely to be highly inefficient. An alternative would be to address these needs through an easement mechanism that would enable public safety users to operate on non-public safety spectrum in such extraordinary emergencies, but to revert to operations on public safety dedicated spectrum when the emergency subsided. ***See*** Figure 4.

3. Broadcasting

The Commission has traditionally allocated spectrum specifically for broadcast use, based on statutory public interest considerations and the free over-the-air nature of broadcast service. Many commenters argue that these characteristics distinguish broadcasting from other market-based uses of spectrum, and that the Commission should therefore continue to dedicate some spectrum specifically for broadcast use on a command-and-control basis. Other commenters contend that the continued dedication of spectrum for broadcasting, and particularly for commercial broadcasting, is increasingly anachronistic as the public gains access to alternative sources of programming and information from cable television, satellite services, the Internet, and other outlets.

The Task Force concludes that for the time being, there are valid reasons to continue applying the "command-and-controy model to existing broadcast spectrum. Broadcast service is traditionally not subscriber-based; rather, it provides "universal" news, information, and entertainment services to the general public. As such, broadcasting has consistently been a central focus of Congress and the Communications Act, which regulates broadcast content and behavior by placing certain public interest

obligations on broadcast licensees.[41] In addition, localism and diversity of ownership are two important public interest objectives that have been associated with broadcasting to a greater degree than other spectrum uses. Finally, the broadcaster's relative lack of control over receiver equipment affects the rapidity with which technological advances can be introduced into the marketplace and assimilated by consumers – a factor that has complicated the DTV transition.

The transition of broadcast to a digital world, which is already under way, should help to increase the efficiency and flexibility in use of broadcast spectrum. As broadcasters convert to digital, some broadcast spectrum can be recovered for reallocation and reassignment to more flexible uses, as in the case of the 700 MHz band. The Commission has also allowed for some flexible use of broadcast spectrum,[42] and should consider additional ways to allow greater flexibility consistent with broadcasters continuing to meet their core public interest responsibilities. In addition, the Commission can take steps to make "white space" in the broadcast bands available for other uses.

Over the longer term, the Commission should periodically reevaluate its broadcast spectrum policies to determine whether they remain necessary to accomplish the public interest objectives they are intended to promote. In particular, such reevaluation should consider the extent to which the public interest benefits provided by dedication of spectrum to broadcasting under a command-and-control regime can be provided through the application of more flexible, market-oriented spectrum policies. It is likely that there will be a continued need to set aside some spectrum for non-market based broadcast uses, such as non-commercial and educational broadcasting. Assuming that technological advances continue to occur and that scarcity of access to spectrum resources decreases, however, it is equally likely that the continued application of command-and-control policies to commercial broadcasting spectrum could be substantially relaxed, or may not be needed at all, to ensure the public availability from multiple sources, including alternative technologies, of the types of information and programming that commercial broadcasters provide.

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[41] These include requirements that broadcasters provide "reasonable access" to candidates for federal elective office and afford "equal opportunities" to candidates for any public office, children's educational programming requirements, restrictions on airing of indecent programming, and provisions relating to the rating of video programming, and equal employment opportunities rules. *See* 47 U.S.C. § 312(a)(7), 47 C.F.R. 573.1944 (reasonable access); 47 U.S.C. § 315, 47 C.F.R. § 73.1941 (equal opportunities); 47 U.S.C. § 303(b), 47 C.F.R. §§ 73.671, 73.673, 73.3526 (children's educational programming); 18 U.S.C. § 1464; 47 U.S.C. § 303, 47 C.F.R. § 73.3999 (indecent programming); 47 U.S.C. § 303(w) (rating of video programming); 47 C.F.R. § 73.2080 (equal employment opportunities).

[42] Broadcast spectrum can be used for ancillary or supplementary services that do not interfere with the primary broadcast signal, *e.g.*, through use or leasing of the vertical blanking interval to provide telecommunications services. ***See*** 47 C.F.R. § 73.646. In the digital context, broadcasters may provide ancillary and supplementary services such as subscription television programming, computer software distribution, data transmission, teletext, interactive services, and audio signals so long as such services do not interfere with the required provision of free over-the-air programming. **See** In the matter of Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service, *Fifth Report* **and** *Order* at para. 29 (citations omitted). ***See also*** 47 U.S.C. § 336.

D. Transition Issues

As discussed above, this report recommends that the Commission move towards assigning flexible usage rights in spectrum within its jurisdiction, whether under an exclusive rights or a commons model. However, the practical reality is that most spectrum within the Commission's jurisdiction is already occupied by incumbent spectrum users. Moreover, most of these incumbents are governed by legacy command-and-control regulations that substantially limit allowable uses of the spectrum. Therefore, successful implementation of the recommendations in this report requires the Commission to consider how to migrate away from restrictive legacy licensing regimes to more flexible rights models that create opportunities for new, more efficient and beneficial uses. Specifically, the Commission must determine which bands should he transitioned to expanded flexible rights models and how the transition should be accomplished.

1. General Transition Considerations

In determining whether and how to transition legacy command-and-control bands to more flexible rights models, the Commission should focus first on initiating transition in those bands where additional flexibility will provide the greatest benefits at the least cost. In general, the greatest benefits will be realized in those bands in which the current regulatory regime has led to significant underutilization or inefficient use of the spectrum. However, the Commission must also weigh the potential cost of transition, both in terms of its impact on incumbents and on the public.

Assessing these potential costs and benefits, the Task Force notes that there are some bands where the Commission has already taken steps to implement a flexible rights approach. These include exclusive-use bands that are already licensed under flexible use rules or are allocated for such use (*e.g.*, broadband PCS), and bands that are dedicated for use by Part 15 unlicensed devices (*e.g.*, 2.4 GHz). Because many of the benefits of flexibility have already been realized in these bands, and spectrum uses have developed accordingly, there is not a significant need for fundamental regulatory changes in these bands in the near term. However, to the extent that the Commission enhances flexibility in the long-term as recommended in this report, such changes are potentially applicable to these bands and would likely not impose significant costs in light of the regulatory steps the Commission has already taken.

The Task Force also does not recommend fundamental regulatory changes in the near term with respect to spectrum that is currently dedicated for public safety use, or with respect to currently allocated broadcast spectrum. In the case of public safety, attempting a sweeping transition of existing public safety spectrum to an exclusive use or commons model could he highly costly and disruptive to existing public safety uses, and does not appear to offer countervailing public interest benefits. Nevertheless, the Task Force does recommend consideration of measures discussed above to empower public safety users to make their existing spectrum available for other uses when it is not in use for public safety purposes. In the case of broadcasting, evolution towards greater flexibility is governed for the time being by the statutorily-mandated DTV transition