
September 2004

INTERDEPARTMENT RADIO ADVISORY COMMITTEE

IRAC Representatives Effectively Coordinate Federal Spectrum but Lack Seniority to Advise on Contentious Policy Issues



Highlights of GAO-04-1028, a report to congressional requesters

Why GAO Did This Study

The National Telecommunications and Information Administration (NTIA) within the Department of Commerce manages the federal government's use of the radio frequency spectrum with coordination and policy input from the Interdepartment Radio Advisory Committee (IRAC), comprised of 20 federal agencies that use spectrum. In recent years, the use of spectrum in wireless applications has expanded dramatically, leading occasionally to contentious disputes between government and commercial users over access to spectrum.

Considering IRAC's key role in spectrum management, Congress asked us to (1) describe the evolution of IRAC and (2) obtain IRAC agency representatives' assessment of IRAC's spectrum coordination and policy advice, role as an advisor, and whether IRAC needs to be reformed.

What GAO Recommends

GAO is recommending that the Secretary of Commerce: (1) seek IRAC's assistance in establishing a set of best practices for training and succession planning to guide agencies' participation in IRAC; and, (2) establish a special IRAC committee comprised of senior level agency officials as needed to provide policy advice on contentious spectrum policy issues. In commenting on the report, the Department of Commerce indicated that it would prefer that a senior level advisory group be convened outside of IRAC.

www.gao.gov/cgi-bin/getrpt?GAO-04-1028.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Mark L. Goldstein at (202) 512-2834 or goldsteinm@gao.gov.

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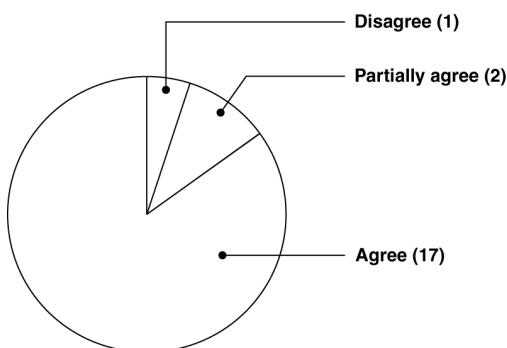
What GAO Found

The mission and placement of IRAC have evolved over time. IRAC began in 1922 by assisting in the assignment of frequencies to federal users and coordinating federal government spectrum use. In 1952, IRAC's mission was expanded to include responsibilities for formulating and recommending policies, plans, and actions for federal government spectrum use. Initially advising the Department of Commerce, IRAC has reported to or through various different entities, including at different times the Federal Communications Commission (FCC) and the Office of the President. Since 1978, IRAC has directly advised the Department of Commerce's NTIA. Currently, IRAC is comprised of a full committee, six standing subcommittees, and various ad hoc committees and working groups.

In interviews with GAO, IRAC agency representatives made the following key points in assessing IRAC:

- IRAC is effective in accomplishing spectrum coordination tasks, but its effectiveness is at times limited by representatives' uneven level of technical knowledge. This problem could worsen, as one-half of the 20 current IRAC representatives are currently eligible to retire.
- IRAC's ability to advise on national spectrum policy issues is limited because of representatives' lack of seniority within their agencies.

Most IRAC Representatives Agreed That the Formulation of National Spectrum Policy Must Occur at a More Senior Level Than Current IRAC Representatives



Source: GAO.

The chair of IRAC (an NTIA senior executive) is in agreement with representatives on these points. He said that he has gone outside IRAC directly to senior agency executives when he needed advice on contentious spectrum disputes such as those related to the introduction of new commercial communications services that would use federally controlled spectrum. A federal task force recently released a report that identified similar issues regarding IRAC's effectiveness and areas in need of reform.

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United States Government Accountability Office
Washington, D.C. 20548

September 30, 2004

The Honorable Tom Davis
Chairman, Committee on Government Reform
House of Representatives

The Honorable Christopher Shays
Chairman, Subcommittee on National Security,
Emerging Threats, and International Relations
Committee on Government Reform
House of Representatives

The Honorable Adam Putnam
Chairman, Subcommittee on Technology, Information
Policy, Intergovernmental Relations, and the Census
Committee on Government Reform
House of Representatives

Over the past several decades, the development and use of wireless telecommunications and information technology has expanded dramatically, greatly increasing the use of and demand for the radio frequency spectrum.¹ Cellular telephones, wireless computer networks, and global-positioning system receivers are quickly becoming as common to everyday life as radios and televisions. Wireless communications have become critical to private industry and a variety of government missions—ranging from scientific research and public safety to homeland security and warfare. As a result, the radio frequency spectrum has become crowded and, in the future, may no longer be able to accommodate all users' needs.

Radio frequency spectrum in the United States is managed using a dual organizational structure. The National Telecommunications and Information Administration (NTIA) within the Department of Commerce

¹The radio frequency spectrum is the medium that makes possible wireless communications, such as mobile phone, radar, and radio and television broadcasting services and is accessed by government and commercial users. The radio waves used by wireless devices are a form of electromagnetic radiation made up of a series of waves of electric and magnetic energy that move together through space. Although the electromagnetic spectrum is vast, 90 percent of use is concentrated in the lowest 1 percent of the frequencies because the characteristics of those frequencies are favorable to many applications.

manages the federal government's use of spectrum, and the Federal Communications Commission (FCC) manages all other uses. In carrying out its responsibilities, NTIA relies on the assistance and advice of the Interdepartment Radio Advisory Committee (IRAC). Chaired by NTIA, IRAC is comprised of representatives from 20 federal agencies that use spectrum. IRAC helps coordinate federal use of spectrum and provides policy advice on spectrum issues.

Some recent, contentious disputes over who should have access to specific parts of the radio spectrum have occurred between government and commercial users. Because of IRAC's key role in spectrum management, you asked us to (1) describe the evolution of IRAC and (2) obtain IRAC representatives' assessment of IRAC's ability to coordinate federal spectrum use and provide policy advice, its role as an advisor, and whether IRAC needs to be reformed. To describe the evolution of IRAC, we reviewed relevant historical documents and interviewed key current and retired government officials. To obtain IRAC member opinions, we conducted interviews with each of the 20 IRAC representatives. We designed interviews that included a combination of closed-ended questions and open-ended questions, which provided an opportunity for the IRAC representatives to make additional comments. We also interviewed other FCC and NTIA officials, including the current chairs of the IRAC full committee and six standing subcommittees. Lastly, we also relied on audit work from our previous reports on spectrum management in forming our conclusions and recommendations. A list of related GAO reports on spectrum management appears at the end of this report. We conducted our work from October 2003 through June 2004 in accordance with generally accepted government auditing standards. This report summarizes the information we provided to your staff during our June 30, 2004, briefing. The briefing slides are included in appendix I. Key contacts and major contributors to this report are listed in appendix VII.

Results in Brief

IRAC's mission and placement have evolved over its 80-year history. IRAC was organized by federal agencies that were seeking a way to resolve issues related to federal spectrum use in a cooperative manner. IRAC's initial mission was to assist in the assignment of radio frequencies to federal users and to coordinate federal government spectrum use. In 1952, IRAC's mission was expanded to include formulating and recommending policies, plans, and actions for federal government spectrum use. Since its formation, IRAC has advised the entity responsible for exercising the authority of the President to assign radio frequencies to federal

government users and consequently, has reported to or through several different entities since its inception, including the Federal Communications Commission (FCC) and the Office of the President. Since 1978, IRAC has advised NTIA within the Department of Commerce. In our interviews with the 20 IRAC representatives, 15 said that the appropriate agencies were represented on IRAC. Additionally, 17 of the IRAC representatives said that coordinating with FCC through a liaison appointed by FCC was appropriate.

Overall, IRAC representatives have a generally positive view of IRAC, but a majority identified problems in a few areas. Regarding IRAC's accomplishment of spectrum-coordination tasks, IRAC representatives agree that the committee effectively assists in coordinating government spectrum use, but 8 of 20 representatives commented that some agency representatives lack sufficient technical knowledge and/or understanding of emerging technologies. This concern was also shared by 4 of the 6 IRAC subcommittee chairs. The current chair of IRAC, a senior-level manager at NTIA, also told us that he is concerned about the technical knowledge level of some agency representatives as well as the large number of current IRAC representatives who are eligible to retire (10 representatives out of 20 are already eligible to retire, and 3 additional representatives will become eligible in less than 5 years). He said that he has explored the possibility of training and certifying spectrum managers at agencies. Regarding IRAC's ability to provide policy advice, NTIA officials and IRAC representatives said that IRAC representatives are not senior enough to effectively provide policy advice on contentious spectrum issues. Currently, only one of the 20 IRAC representatives is a member of the Senior Executive Service.

Seventeen out of 20 representatives said that national spectrum policy formation must occur at a higher level than that held by current IRAC members. The chair of IRAC agrees that current IRAC representatives are not senior enough to provide high-level policy advice. He told us that because of this, he has gone outside of the IRAC framework by directly contacting senior executives from relevant agencies when he needed advice on contentious national spectrum policy issues that can occur when both government and commercial users desire use of the same areas of the spectrum. Recently, specific instances of such issues include the introduction of new commercial communications services, such as third generation wireless (3G) devices, that require federal agencies to relinquish control over some spectrum. In terms of IRAC's ability to successfully promote the needs of government spectrum users, IRAC must rely on NTIA to negotiate with FCC in disputes between government and commercial users. Ten of 20 IRAC representatives raised concerns about the ability of

NTIA to adequately represent federal users in these disputes, and 16 of 20 representatives think that a new process is needed for reconciling competing demands. However, there was no consensus on specific reforms to improve government-commercial dispute resolution.

In order to improve the effectiveness of IRAC's contribution in spectrum management, we are recommending that the Department of Commerce develop a set of best practices for training and succession planning to help guide the agencies' participation in IRAC, and establish a special IRAC committee comprised of senior executives from member agencies to provide high-level policy advice as needed on contentious spectrum policy issues, such as those requiring either commercial or government entities to share or relinquish spectrum. In commenting on the draft of this report, the Department of Commerce supports career development programs to provide training for new spectrum managers and the establishment of a senior-level group to provide advice on contentious spectrum policy issues. However, the Department of Commerce feels that such a group would be better positioned to address unresolved issues if it were convened outside of the existing IRAC. (See letter at app. VI.) We did not change the recommendation because we believe IRAC would create a good foundation for such a group.

IRAC's Mission and Placement Have Evolved Since 1922

IRAC's role and placement have evolved over the last 80 years. IRAC was organized by several agencies in 1922 that, during a period of rapid growth in the use of radio services, recognized the need for interagency cooperation to resolve problems arising from the federal government's use of broadcasting and radio services. The first interagency committee meeting attended by interested federal agencies initially set out to regulate and guide the radio broadcasting operations at the Washington Navy Yard and any others that might be established by the federal government. In June 1922, the committee decided that its scope should extend beyond broadcasting and that it should be advisory to the Department of Commerce in all matters of government radio spectrum regulation.² In a 1927 letter to the Secretary of Commerce, the President affirmed IRAC's advisory role and its mission to assign frequencies and coordinate federal government spectrum use. In 1952, IRAC's mission was formally expanded

²Originally named the Interdepartment Advisory Committee on Governmental Radio Broadcasting, in 1923 the committee was renamed the Interdepartment Radio Advisory Committee.

to include responsibilities for formulating and recommending policies, plans, and actions for federal government spectrum use. Since its formation, IRAC has advised the different entities responsible for exercising the authority of the President to assign radio frequencies to federal government users. Consequently, IRAC has reported through or to the Secretary of Commerce; the FCC Chairman; the Telecommunications Advisor to the President; the Director, Office of Defense Mobilization and its successor agencies; the Director of Telecommunications Management; and the Director, Office of Telecommunications Policy. By executive order, in 1978, the Office of Telecommunications Policy was abolished and its spectrum functions were transferred to the Department of Commerce. Commerce formally established NTIA in 1978, and since then, IRAC has directly advised NTIA. See figure 1 for a more detailed timeline of IRAC's evolution.

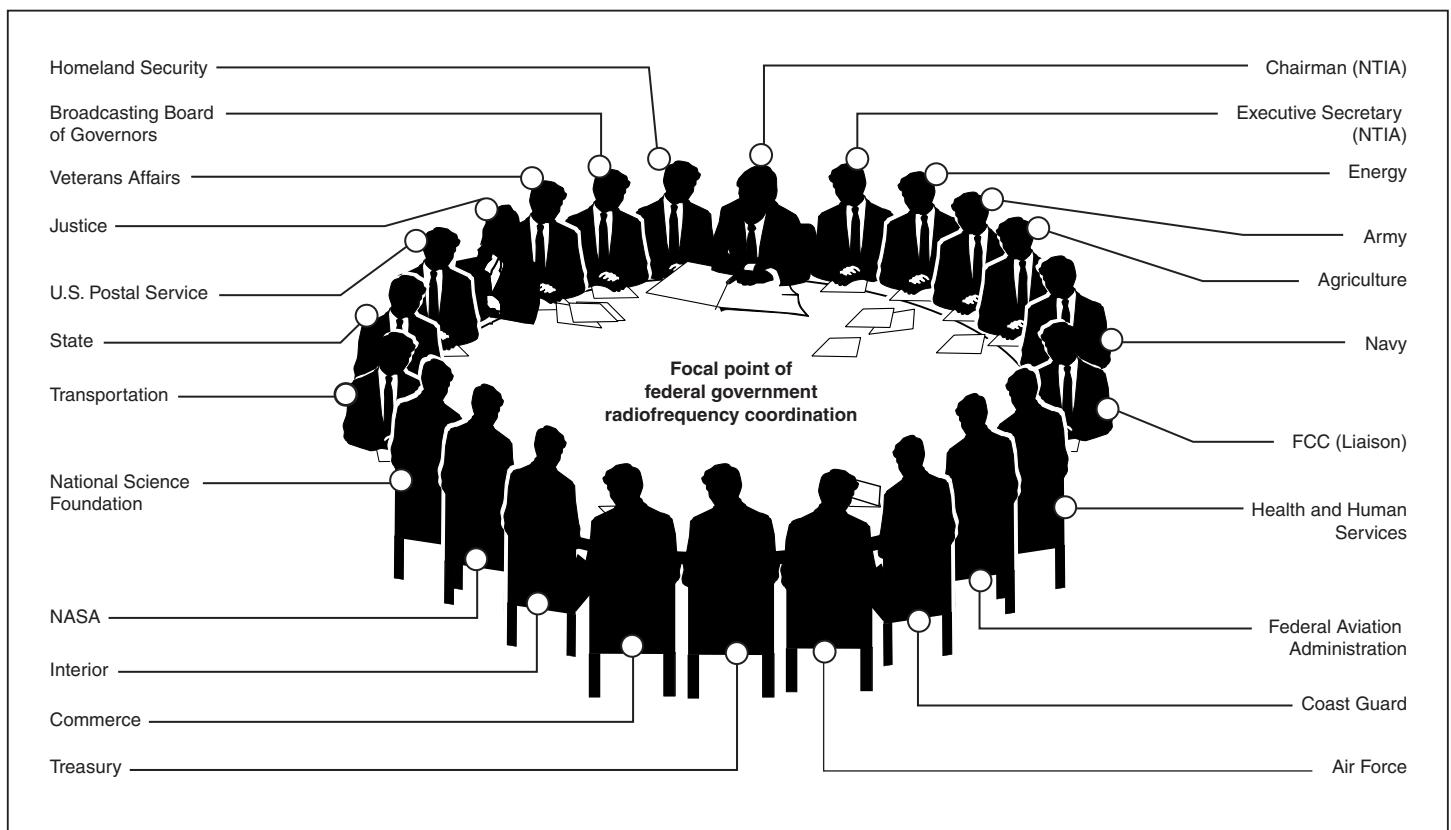
Figure 1: Timeline of Key Dates in IRAC's Evolution

1920	1930	1940	1950	1960	1970	1980
Mission changes						
1922-IRAC is established as a committee to regulate broadcasting at a Navy installation.	1927-The President affirms IRAC's spectrum assignment and coordination mission.		1952-IRAC's mission is expanded to include formulating and recommending policies, plans, and actions for federal spectrum users.			
Advisor changes	1932-IRAC reports through the Federal Radio Commission (FRC) beginning in 1932 and the FCC in 1934 when FRC authorities are absorbed by FCC.	1940-IRAC reports to Defense Communications Board created for wartime and emergency communications.	1951-IRAC reports to the newly created office, Telecommunications Advisor to the President (TAP), after a study citing growing spectrum demand and lack of a national communications policy.	1962-After TAP is abolished in 1953, a study notes a gap in long-range planning and policy-making. The position of the Director of Telecommunications Management (DTM) is established by executive order. IRAC reports to the office of DTM.	1978-OTP is abolished and its spectrum functions are transferred to NTIA within the Department of Commerce after a study of EOP organization and staffing needs. IRAC reports to NTIA.	1970-The Office of Telecommunications Policy (OTP) is established in the Executive Office of the President (EOP) to address the rapid change and growth in telecommunications. IRAC reports to OTP.

Source: GAO.

As shown in figure 2, IRAC is currently comprised of 20 federal agencies that use radio spectrum, a chairman and an executive secretary from NTIA, and FCC as a nonvoting liaison.

Figure 2: The Federal Agencies Currently Represented on IRAC



Source: NTIA.

Note: The NTIA represents other agencies that are not member agencies of IRAC or are not represented by IRAC members (for example, the Department of Treasury represents the Federal Reserve System).

In addition to the full committee, IRAC mission responsibilities are also carried out in six standing subcommittees, as well as a number of ad hoc committees and working groups.

- Frequency Assignment Subcommittee: Assignment of frequencies in government bands of spectrum.

-
- Spectrum Planning Subcommittee: Planning spectrum use and certifying major government systems that will use radio frequencies.
 - Radio Conference Subcommittee: Coordination of U.S. government positions for international conferences where agreements are made regarding the global and regional allocation of spectrum.
 - Space Systems Subcommittee: International registration of government satellite systems and development of procedures for implementing space-related provisions of international agreements.
 - Technical Subcommittee: Addresses issues that relate to the technical aspects of the use of radio spectrum, including the development of new technical standards and recommendations on better utilization of the available spectrum.
 - Emergency Planning Subcommittee: Formulation and review of emergency preparedness planning for government spectrum-dependant systems.

Both the IRAC full committee and six IRAC subcommittees are chaired by NTIA. From our interviews of IRAC representatives, we found that most IRAC representatives are satisfied with the agencies that are members of IRAC, the FCC liaison function, and the subcommittee missions. Specifically, 15 of 20 representatives said that the appropriate agencies are represented on IRAC. Seventeen IRAC representatives believe that coordinating with FCC through a liaison appointed by FCC is appropriate,³ and 15 representatives agreed that most of the time, IRAC and FCC work well together. Thirteen of 19 IRAC representatives said that the missions of the IRAC subcommittees are appropriate, given current and future spectrum needs.

³Up until 1952 the FCC participated in IRAC as a voting member. However, since that time FCC has appointed a liaison that assists in providing coordination on spectrum issues with NTIA.

IRAC Representatives' Assessment of IRAC Is Mostly Positive, but Some Are Concerned That an Uneven Level of Technical Knowledge and a Lack of Seniority Limit IRAC's Effectiveness

IRAC representatives generally agree that IRAC is effective in coordinating federal government spectrum use but are concerned about training and succession planning. IRAC and its subcommittees perform various mission tasks related to coordinating federal government spectrum use, including frequency assignment, certification of spectrum-dependent equipment, coordination of U.S. government positions for international conferences, and registration of U.S. government satellite systems internationally. In our interviews with IRAC representatives, they generally agreed that IRAC is effectively accomplishing these spectrum coordination tasks. For example, 17 of 19 said that IRAC is very or mostly effective at assigning frequencies in government-controlled spectrum, and 13 of 17 said that IRAC is very or mostly effective at equipment certification for federal agencies. However, training and succession planning issues could limit IRAC coordination efforts. Eight representatives commented that some agency representatives lack sufficient technical knowledge and/or understanding of emerging technologies. This concern was also shared by 4 of the 6 subcommittee chairs, who believe that more technically knowledgeable representatives would improve IRAC's performance. The potential shortage of spectrum specialists in agencies could also limit future IRAC coordination efforts. Ten out of 20 representatives are already retirement eligible, and 3 more will become eligible in less than 5 years. These concerns are consistent with the human capital findings in our 2002 report on needed improvements in spectrum management.⁴

Greater concern was expressed about IRAC's ability to fulfill its mission of providing high level policy advice on national spectrum issues. NTIA officials and IRAC representatives said that IRAC's effectiveness in this area is limited by the representatives' lack of seniority. Seventeen out of 20 representatives said that national spectrum policy formation must occur at a higher level than that held by current IRAC members. According to NTIA, only one agency on IRAC has assigned a member of the senior executive service as the agency representative to IRAC and 13 of the 20 representatives said that the assistant secretary who oversees spectrum management in their agency has little or no direct involvement in spectrum management. The chairman of IRAC (an NTIA senior executive) agrees with the majority of IRAC representatives that current IRAC representatives are not senior enough within their agencies to provide

⁴GAO, *Telecommunications: Better Coordination and Enhanced Accountability Needed to Improve Spectrum Management*, GAO-02-906 (Washington, D.C.: Sept. 30, 2002).

policy advice on issues requiring either commercial or government users to share or relinquish spectrum. He told us that he has gone outside of the IRAC framework when he needed advice on such contentious policy issues, such as those related to the introduction of new commercial communications services. For example, the IRAC chairman said that he directly contacted senior executives from the relevant agencies after he was unable to obtain from the IRAC representatives viable advice on how to make possible the introduction of commercial 3G and ultra wideband services. Both services would require federal agencies to share or relinquish spectrum under their control.⁵ The IRAC chairman said that he supports more involvement of senior agency executives in IRAC.

As an advisor representing government spectrum concerns, IRAC must rely on NTIA to negotiate with FCC in disputes between government and commercial users over the use of spectrum. Most IRAC representatives believe there should be a better way to resolve these disputes. When new wireless technologies require access to government as well as commercial spectrum, NTIA and FCC must cooperate in order to determine which entity will have access to what spectrum. While IRAC must rely on NTIA to negotiate with FCC to make those determinations, 10 of 20 IRAC representatives have concerns about NTIA's ability or willingness to support the needs of government agencies. Some representatives told us they did not think either NTIA or the Department of Commerce is able to protect the interests of government users; others told us that government users could not be well represented by an agency whose primary mission is to promote commercial interests. In addition, 14 IRAC representatives told us that their primary concern in the next 1 to 3 years will be either the availability of spectrum to fulfill agency missions or the threat of harmful interference from new technologies. Although almost three quarters of the 20 representatives said that they believe that IRAC's advice does influence NTIA's recommendations to the Assistant Secretary of Commerce, 13 representatives were able to cite important instances in which NTIA's final position differed significantly from IRAC's advice. Of those instances in which NTIA and IRAC differed, 7 IRAC representatives cited recent decisions on issues of spectrum availability, such as 3G services, or interference from new technologies, such as ultra wideband. Most IRAC representatives said that a new process is needed to resolve disputes

⁵Third generation or 3G services enable handheld communication devices to provide both voice and high-speed data. Ultra wideband devices employ very narrow or short duration pulses to create wideband transmissions.

between government and commercial users, but there was no consensus among the representatives on what specifically would improve the process.

IRAC representatives have varying opinions on whether IRAC needs to be reformed, and if it does, what those reforms should be. Eight of the 20 representatives agreed that IRAC's organization and membership were well suited to meet current and foreseeable challenges; 6 partially agreed with that statement but thought some changes would improve IRAC.

Specifically, 4 representatives thought agency representatives should be more knowledgeable or more senior, and 2 representatives said that IRAC would be timelier in its decision-making if there were fewer members. Six representatives did not believe that IRAC's organization and membership are well suited to meet current and foreseeable spectrum challenges.

The current IRAC chairman told us that he has instituted a number of improvements in the past year designed to improve the efficiency and effectiveness of IRAC. For example, the agendas for IRAC meetings are made available electronically for representatives to review before meetings and IRAC meeting minutes are now posted much faster than in the past. The chairman remains concerned about the knowledge level of some of the agency representatives and the number of IRAC representatives who are eligible to retire. To improve the long-term participation by agencies, he has explored the possibility of training and certifying spectrum managers.

A federal task force led by the Department of Commerce was conducting its work concurrently with our review and completed its report on a wide range of spectrum issues in late June 2004.⁶ The report included three recommendations that fit within the scope of this report. It recommended: (1) the government develop training programs for spectrum specialists; (2) the Department of Commerce form a policy and plans steering group comprised of assistant secretary-level officials from other agencies to provide advice on spectrum policies, strategic plans, and contentious issues; and (3) the existing White House Policy Coordinating Committee should be used to address spectrum issues that could not be resolved by the previously mentioned policy and plans steering group.

⁶*Spectrum Policy for the 21st Century—The President's Spectrum Policy Initiative: Report 1 Recommendations of the Federal Government Spectrum Task Force*, Michael D. Gallagher, Acting Assistant Secretary for Communications and Information, U.S. Department of Commerce, June 2004.

Conclusions

IRAC representatives generally concur that IRAC's current structure and membership are effective in dealing with key spectrum coordination tasks that are at the core of its mission, including assigning frequencies, certifying equipment, coordinating agency positions for international spectrum conferences, and managing satellite issues. IRAC's effectiveness in these areas could be strengthened by increasing the level of technical knowledge of some members and ensuring that agencies can provide qualified representatives to replace current members as they reach retirement.

When it comes to dealing with contentious policy issues requiring negotiation between government and commercial users, however, IRAC representatives questioned the effectiveness of IRAC's current structure and membership. There is a strong consensus that more senior-level agency officials need to become involved in providing NTIA with advice on contentious spectrum policy issues. While NTIA officials seek out such senior-level advice as needed, this is an *ad hoc* process that occurs outside the current framework of IRAC.

Recommendations for Executive Action

In order to improve the effectiveness of IRAC's contribution in spectrum management, we recommend that the Secretary of Commerce take the following two actions:

- Direct the Assistant Secretary of Commerce for Communications and Information to seek IRAC's assistance in establishing a set of best practices in human capital for agencies that participate in IRAC that include information on the appropriate knowledge and training levels for IRAC representatives, goals for continuing education in emerging technologies, and agency succession planning.
- Establish a special committee within IRAC comprised of senior-level agency officials to be convened by the Assistant Secretary of Commerce for Communications and Information as needed to provide policy advice on contentious spectrum policy issues, such as those requiring either commercial or government entities to share or relinquish spectrum.

Agency Comments and Our Evaluation

We provided a draft of this report to NTIA, FCC, and the current IRAC member agencies for their review. The Department of Agriculture, the Department of the Treasury, National Science Foundation, NASA, and the

Broadcasting Board of Governors all said that they support the report and its recommendations. The Departments of Justice, Health and Human Services, Veterans Affairs, and the U.S. Postal Service and FCC did not have any comments on the report. The Department of State (see letter at app. II), and the Departments of Defense and Homeland Security offered technical comments that we incorporated as appropriate.

The Department of Energy (DOE) supported the best practices in human capital recommendation but indicated that a panel of independent experts should rule on contentious issues (see letter at app. III). As there was no consensus among the IRAC representatives as to how to resolve spectrum policy disputes between government and commercial interests, we chose not to make a recommendation on the issue. DOE also stated that the report did not identify that IRAC representatives and NTIA officials do not always share the same goals, an issue DOE views as a key contention with regard to spectrum management. We did not change the report because it already notes that fifty percent of IRAC representatives have concerns about NTIA's ability or willingness to support the needs of government agencies. The Department of the Interior also agreed with the recommendation to improve IRAC representatives' technical skills but disagreed with the recommendation to establish a senior-level committee to provide advice on contentious policy issues. It indicated that such a committee is not warranted because IRAC has no decision-making authority (see letter at app. IV). We chose not to change the recommendation because 17 of the 20 IRAC representatives and the IRAC chairman believe that more senior-level involvement is needed in formulating national spectrum policies. The Navy said that it agreed in spirit with the report's recommendations but suggested revising the wording of the second recommendation (see letter at app. V).

The Department of Commerce agreed with our recommendation for establishing best practices in human capital for the IRAC member agencies, but also indicated, as did the Department of Transportation (DOT), that a high level policy task force should be created within Commerce but outside IRAC per the Federal Spectrum Task Force's recommendation (see letter at app. VI). The primary difference between the Federal Task Force recommendation and ours is that the Federal Task Force recommended that a group of senior agency executives be formed outside of IRAC to advise on policy issues, and we recommended that the group be formed within the structure of IRAC. We chose not to change the second recommendation. As IRAC has been a stable, successful foundation for spectrum coordination for more than 80 years, we believe that senior-level

executives of IRAC member agencies will be most able to provide useful advice on contentious spectrum policy issues.

As agreed with your offices, we are providing copies of this report to the appropriate congressional committees, the Department of Commerce, FCC, IRAC member agencies, and others who are interested. We will also make copies available to others who request them. In addition, the report will be available on the GAO Web site at <http://www.gao.gov>. If you or your staff members have any questions about this report, please contact me on (202) 512-2834 or at Goldsteinm@gao.gov. Key contacts and staff acknowledgments for this report are listed in appendix VII.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Mark L. Goldstein".

Mark L. Goldstein
Director, Physical Infrastructure Issues

Briefing Slides



Interdepartment Radio Advisory Committee (IRAC): Evolution, Effectiveness, and Reform

Briefing to Committee on Government Reform, U.S. House of
Representatives

June 30, 2004



Objectives

1. To describe the evolution of IRAC.
2. To describe IRAC agency representatives' assessment of IRAC
 - Mission,
 - Spectrum coordination
 - Spectrum policy
 - Role as an advisor, and
 - Needed reforms, if any.



Scope and Methodology

To address these objectives, we did the following:

1. To examine the evolution of IRAC, we reviewed relevant historical documents and interviewed key current and retired government officials.
2. To document IRAC member opinions, we:
 - Conducted interviews with the 20 IRAC member-agency representatives. The interviews included a combination of closed-ended questions and open-ended questions, which provided representatives an opportunity to make additional comments.



Scope and Methodology (cont'd)

- We also interviewed other National Telecommunication and Information Administration (NTIA) and Federal Communications Commission (FCC) officials.

GAO conducted its work from October 2003 through June 2004 in accordance with generally accepted government auditing standards.



Summary

- Over the last 80 years, IRAC has evolved into a body that advises NTIA in the Department of Commerce on spectrum coordination and policy issues among other tasks.
- According to IRAC reps:
 - IRAC does most of its mission tasks well, but
 - IRAC reps are not senior enough to provide adequate national policy advice.
 - IRAC is limited in what it can achieve in disputes between government and commercial interests.
 - IRAC's membership and organization are well-suited to meet current and foreseeable future spectrum management needs.



Background

- The radiofrequency spectrum is the medium that enables wireless communications, such as mobile phone, radar, and radio and television broadcasting.
- Spectrum is managed in this country through a dual organizational structure consisting of the NTIA, which manages spectrum for federal government users, and the FCC, which manages spectrum for all other users. IRAC is a committee of federal agencies that use spectrum that advises NTIA.¹

¹ NTIA is an agency within the Department of Commerce.

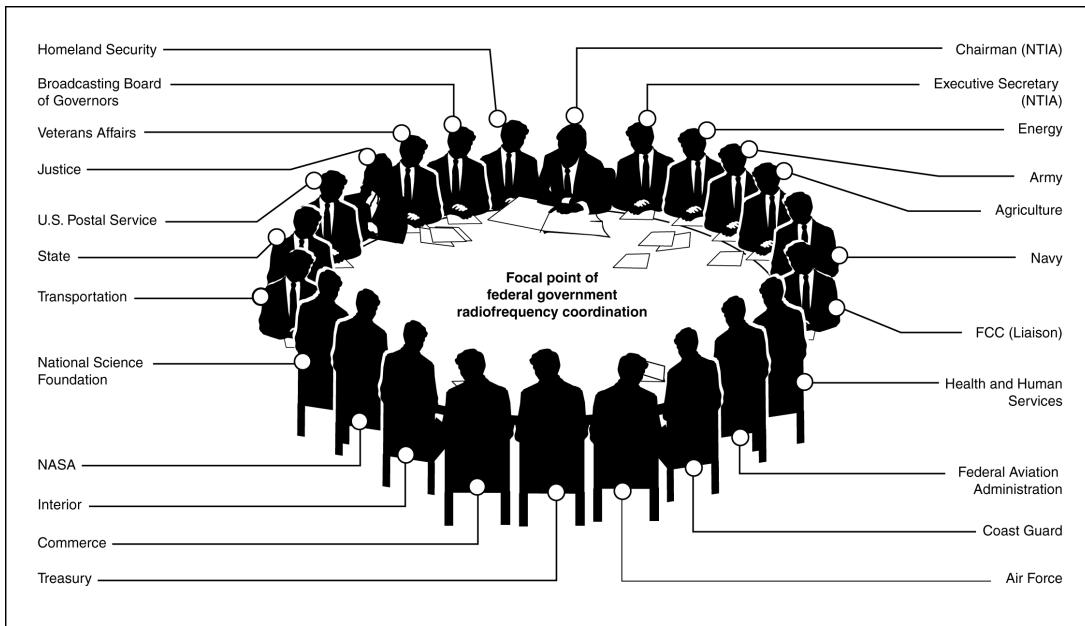


IRAC's evolution

- IRAC began in April 1922 as a committee of federal agencies to assist in regulating radio operations at the Washington Navy Yard and future government radio facilities. By 1927 IRAC was responsible for assigning frequencies and coordinating federal government spectrum use.
- In 1952, IRAC's mission was formally expanded to include responsibilities for formulating and recommending policies, plans, and actions for federal government spectrum use.
- Initially advising the Department of Commerce, IRAC has also held an advisory role in various parts of the government including FCC and the Office of the President. Since 1978, IRAC has advised the NTIA within the Department of Commerce.



IRAC is currently comprised of 20 federal agencies that use spectrum

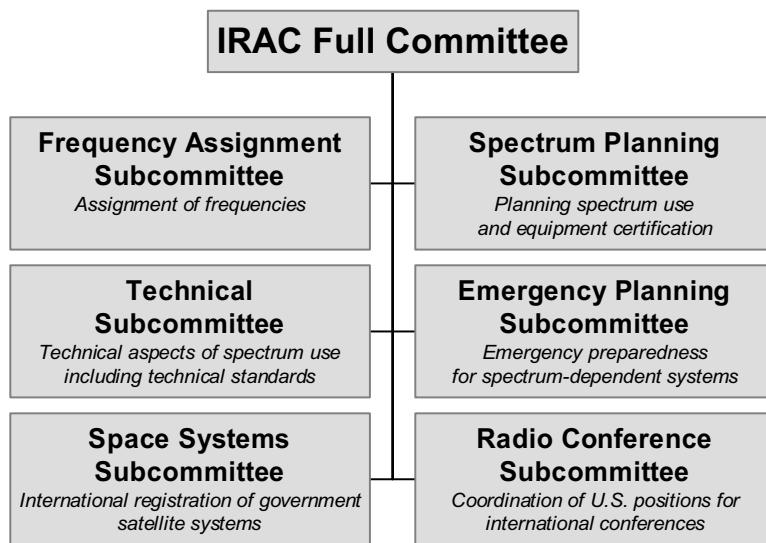


Source: NTIA.

Note: FCC liaison between the IRAC and the FCC is effected by a non-member representative appointed by the FCC. The NTIA represents other agencies that are not member agencies of IRAC or are not represented by IRAC members (for example, the Department of Treasury represents the Federal Reserve System).



Evolution: IRAC consists of a full committee and six subcommittees



Source: NTIA.

- In addition, IRAC includes a number of ad hoc committees and working groups as needed. These can be chaired by NTIA or agency reps.

Note: NTIA chairs the full IRAC committee and each subcommittee.

9



Most reps satisfied with current agencies represented and subcommittee missions

- Fifteen of 20 reps agreed that the appropriate agencies are represented on IRAC.
- Seventeen IRAC reps believe that coordinating with FCC through a liaison appointed by FCC is appropriate, and 16 reps agreed that most of the time, IRAC and FCC work well together.
- 13 of the 19 IRAC reps said that the missions of the IRAC subcommittees are correct, given current and future spectrum needs.



IRAC's Mission: Findings

- IRAC reps agree that IRAC effectively assists in coordinating government spectrum use, but that IRAC reps are not senior enough to provide advice on national spectrum policy.



Mission: IRAC's Current Mission

Assist the Assistant Secretary [of Commerce] in assigning frequencies to U.S. Government radio stations and in developing and executing policies, programs, procedures, and technical criteria pertaining to the allocation, management, and use of the spectrum.

Source: [Manual of Regulations and Procedures for Federal Radio Frequency Management](#), at Para: 1.3.4 (May 2003 Edition, January 2004 revisions).



**Mission: IRAC and its subcommittees
perform various mission tasks**

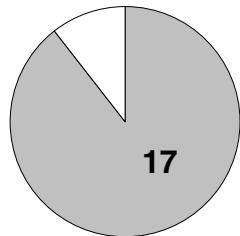
In coordinating federal government spectrum use, IRAC mission activities include:

- Assignment of frequencies
- Certification of spectrum-dependent equipment
- Coordination of U.S. government positions for international conferences
- Coordination of U.S. government satellite spectrum worldwide



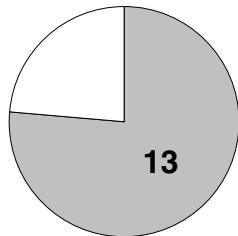
Mission: How effective is IRAC at accomplishing the following tasks?

Frequency assignment



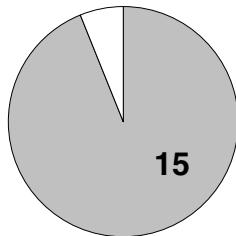
n = 19

Certification of equipment



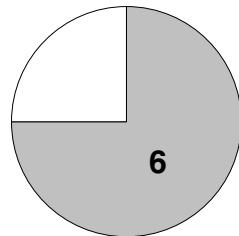
n = 17

Coordination of government positions for International Conferences



n = 16

Satellite coordination



n = 8

[Gray square] Very or mostly effective
[White square] Somewhat or not effective

Source: GAO.

- Several reps commented that IRAC is a unique forum for resolving disputes among government users.

Note: Not all IRAC agencies participate in all of these activities; e.g., only eight agencies told us they participate in satellite coordination.

14



Mission: Training and Succession Concerns Limit Coordination Efforts

- Eight reps commented that some agency reps lack sufficient technical knowledge and/or understanding of emerging technologies. This concern was also shared by 4 of the 6 subcommittee chairs, who believe more knowledgeable reps would improve IRAC's performance.
- The government could face a shortage of spectrum specialists. Ten reps out of 20 are already retirement eligible, and 3 more will become eligible in less than 5 years.²

² We also highlighted human capital concerns in spectrum management in a 2002 report. See GAO-02-906.



Mission: IRAC's National Policy Advice Is Limited By Reps' Lack of Seniority

- According to NTIA, only one agency on IRAC has assigned a member of the senior executive service as the agency representative to IRAC.
- Thirteen of the 20 reps said that the assistant secretary that oversees spectrum management in their agency has little or no direct involvement in spectrum management.



Mission: IRAC's National Policy Advice Is Limited By Reps' Lack of Seniority

- The chairman of IRAC (an NTIA senior executive) told us that he has gone outside of the IRAC process when he needs advice on national, controversial policy issues.
- For example, the IRAC Chairman said that he directly contacted senior executives from the relevant agencies after he was unable to obtain sufficient policy advice from the IRAC reps on the controversial issues of Third Generation Wireless Services (3G) and Ultra Wideband (UWB).³ He said that it was this advice that helped broker an eventual compromise on these issues.

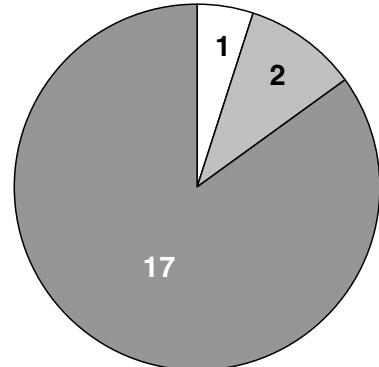
³3G and UWB are new commercial, wireless services that required the use of government spectrum.



Mission: IRAC reps are not senior enough to provide national policy advice

When asked: *Do you agree or disagree that the formulation of national spectrum policies must occur at a more senior level than current members of IRAC?*

Most IRAC reps said that national spectrum policy formation must occur at a higher level than that held by current IRAC members.



- Disagree
- Partially agree
- Agree

Source: GAO.



IRAC's Advisory Role: Findings

- As an advisor, IRAC must rely on NTIA to negotiate with FCC in disputes between government and commercial users. Most IRAC reps believe there should be a better way to resolve these disputes.



IRAC's Advisory Role: Current situation

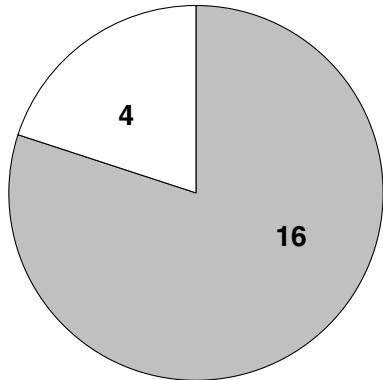
- IRAC has advised the entity responsible for exercising the authority of the President to assign frequencies to federal government users. Since 1978, that has been NTIA in the Department of Commerce.
- When new wireless technologies cross government and commercial boundaries, NTIA and FCC must cooperate in order to determine who will have access to what spectrum. In some cases, like 3G, these negotiations can become contentious and protracted.⁴

⁴See GAO-02-906 for a more detailed discussion of this subject.

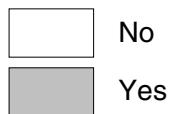


IRAC's Advisory Role: Resolving government/commercial disputes

- Is a new process for resolving government-commercial disputes needed?



- 16 of the 20 reps said yes. Ten of these reps explained that they have concerns about the ability of NTIA to adequately represent federal users in disputes with the commercial sector.
- There was no consensus on what might improve the process.



Source: GAO.



IRAC's Advisory Role: IRAC Reps Have Concerns about NTIA's Support

- Fourteen of 20 IRAC reps told us that their primary concern in the next 3 years will be the availability of spectrum to fulfill agency missions and the threat of harmful interference from new technologies.
- Fourteen reps said that they believe that IRAC's advice influences NTIA's recommendations to the Assistant Secretary of Commerce.



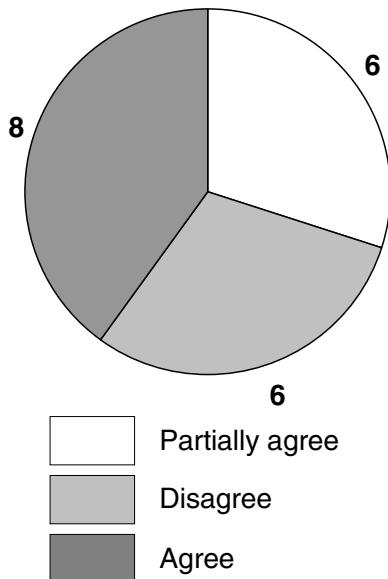
IRAC's Advisory Role: IRAC Reps Have Concerns about NTIA's Support (cont'd)

- Thirteen reps were able to cite important instances in which NTIA's final position differed significantly from IRAC's advice.
 - For example, seven reps commented that NTIA's position on UWB differed from IRAC's advice.
 - The IRAC Chairman said that NTIA takes IRAC's advice very seriously, but it is under no obligation to accept the advice.



Reforms: Rep Opinions Are Mixed

IRAC reps' opinions varied on how well-suited IRAC's organization and membership are to meet current and foreseeable future spectrum management needs.



- Those who partially agreed felt that IRAC adequately coordinates spectrum use but 4 reps felt that agency reps should be more knowledgeable and/or at a higher level of seniority; 2 felt that IRAC membership should be decreased.

Source: GAO.



Reforms: Views and Actions of Current IRAC Chairman

- The Chairman told us that in the past year, he has improved communication among members and tried to make IRAC meetings and processes more efficient. For example, meeting minutes are posted to the internet within 12-24 hours, in contrast with the situation in the past in which minutes might not be posted for weeks, even months, after a meeting.
- He concurs with members' perceptions of IRAC's ability to handle various aspects of spectrum coordination but not provide high-level policy advice.



Reforms: Views and Actions of Current IRAC Chairman (cont'd)

- He has explored the possibility of training and certification for spectrum managers due to unevenness in the training and seniority level of the current IRAC reps.
- He is concerned about member agency succession planning for IRAC reps. He said that the agency practice of promoting a subcommittee rep to the full committee IRAC rep is not always the best practice because different skill sets are required.
- He also believes that the current IRAC reps are not senior enough to provide high level policy advice. He supports strategies for promoting greater involvement by agency senior executives.



Reform: The Federal Government Spectrum Task Force

Three Task Force recommendations fall within the scope of our work on IRAC.⁵

- The government should develop training programs for spectrum specialists. This is consistent with our findings.
- Commerce should form a policy and plans steering group comprised of assistant secretaries from other agencies to provide advice on spectrum policies, strategic plans, and contentious issues. This is consistent with our findings.
- The existing White House Policy Coordinating Committee should be used to address spectrum issues that could not be resolved by the previously mentioned policy and plans steering group. We did not find wide consensus for an explicit White House role in spectrum management.

⁵Spectrum Policy for the 21st Century—The President's Spectrum Policy Initiative: Report 1 Recommendations of the Federal Government Spectrum Task Force, Michael D. Gallagher, Acting Assistant Secretary for Communications and Information, U.S. Department of Commerce, June 2004.



Conclusion

- As it is currently structured, IRAC is not the appropriate body to provide advice on sensitive spectrum policy issues.
- Uneven training and knowledge among some reps can limit IRAC's ability to fulfill its mission.
- IRAC reps are not satisfied with the current negotiation process for resolving disputes between competing government and commercial users, but they do not agree on how to improve the process.



Recommendations to the Secretary of Commerce

- Promote human capital best practices for IRAC agencies that include:⁶
 - Knowledge and training levels appropriate for IRAC reps,
 - Continuing education in emerging technologies, and
 - Planning for succession within IRAC member agencies.
- Establish a special committee within IRAC comprised of senior level agency officials to be convened by the Assistant Secretary of Commerce (NTIA Administrator) as needed to provide policy advice directly to the Secretary of Commerce on sensitive spectrum policy issues.

⁶ This is consistent with an existing open recommendation to the Secretary of Commerce from a 2002 report. See GAO-02-906.

Comments from the Department of State



United States Department of State

Assistant Secretary and Chief Financial Officer

Washington, D.C. 20520

AUG 23 2004

Ms. Jacqueline Williams-Bridgers
Managing Director
International Affairs and Trade
Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548-0001

Dear Ms. Williams-Bridgers:

We appreciate the opportunity to review your draft report, "INTERDEPARTMENT RADIO ADVISORY COMMITTEE: IRAC Representatives Effectively Coordinate Federal Spectrum But Lack Seniority to Advise on Contentious Issues," GAO Job Code 543088.

The enclosed Department of State comments are provided for incorporation with this letter as an appendix to the final report.

If you have any questions concerning this response, please contact Hal Grigsby, Director, Bureau of Economic and Business Affairs, Office of Telecommunication and Policy, at (202) 647-2723.

Sincerely,

A handwritten signature in black ink that appears to read "Christopher B. Burnham".

Christopher B. Burnham

cc: GAO – Keith Cunningham
EB – Shaun Donnelly
State/OIG – Mark Duda

**Department of State Comments on Draft Report by the
Government Accountability Office Entitled:
*INTERDEPARTMENT RADIO ADVISORY COMMITTEE:
IRAC Representatives Effectively Coordinate Federal Spectrum But Lack
Seniority to Advise on Contentious Issues.*
(GAO Code 543088)**

The Department of State appreciates the opportunity to comment on the report of the Government Accountability Office entitled: *INTERDEPARTMENT RADIO ADVISORY COMMITTEE: IRAC Representatives Effectively Coordinate Federal Spectrum But Lack Seniority to Advise on Contentious Issues.* Since it is possible that this GAO report will be used for purposes of reform of the IRAC, the report should recognize certain State Department responsibilities that are carried out in the IRAC's ad hoc groups. Further, comments regarding the recommendations flowing from the President's Spectrum Policy Initiative should more closely align with the comments in the report of the Federal Government Spectrum Task Force.

Ad Hoc Groups 170 and 181 -- Coordination with Mexico and Canada

The Department leads IRAC's Ad Hoc Groups 170 and 181. These ad hoc groups were formed in order to implement the Department's statutory responsibility to give full consideration to the views of the Federal Communications Commission, the National Telecommunications and Information Administration, and a number of other federal agencies in coordinating U.S. positions for negotiations of international telecommunications agreements with Mexico and Canada. Given that the report by GAO may be used for purposes of reform of the IRAC, the Department believes that these activities should be included in the report's discussion of the IRAC's organization and functions.

Clarification of Comments from the President's Spectrum Policy Initiative

Certain comments from the Recommendations of the Federal Government Spectrum Task Force flowing from the President's Spectrum Policy Initiative are summarized in the report and minor edits have been provided separately to clarify the substance of those comments.

Comments from the Department of Energy



Department of Energy

Washington, DC 20585

August 23, 2004

Mark L. Goldstein
Director, Physical Infrastructure Issues
U.S. Government Accountability Office
441 G. Street, NW
Washington, DC 20548

Thank you for giving the Department of Energy (DOE) the opportunity to comment on the draft GAO report on the Interdepartment Radio Advisory Committee (IRAC) (GAO-04-1028). In general, the report accurately describes the evolution of the IRAC and identifies many of the shortcomings of the committee.

We agree that the IRAC members need to be technically competent in the area of spectrum management and with the recommendation that the Assistant Secretary of Commerce for Communications and Information seek the IRAC's assistance in establishing a set of best practices in human capital for agencies that participate in IRAC. We believe the National Telecommunications and Information Administration (NTIA) should establish a spectrum management training program that leads to certification through examination. In fact, DOE recommended this to the IRAC chairman last year and proposed that certification could be accomplished through the National Association of Radio and Telecommunications Engineers (NARTE). This program would be invaluable to agencies for training entry level employees in the spectrum management field and would create a pool of individuals that would be qualified as agency IRAC representatives and be capable of managing an agency spectrum program. In addition, we believe that agency IRAC representatives should be certified and hold a rank or grade at a level commensurate with the level of authority to speak for the agency they represent.

However, we do not concur that with the recommendation that NTIA establish a special committee comprised of senior level agency officials. A similar committee has been proposed by the Federal Government Spectrum Task Force in their report to the President entitled "Spectrum Policy for the 21st Century – The President's Spectrum Policy Initiative," and it would essentially have the same function.

In addition, the report fails to identify the core issue that has led to contention in the IRAC. The prime function of an IRAC representative is to formulate, present, and defend agency positions that protect the agency's spectrum assets from interference or from being transferred to the commercial sector through FCC auctions. This is often in direct conflict with the current Administration's agenda and its direction to the NTIA, especially on matters that concern spectrum reallocation to commercial enterprise for



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Appendix III
Comments from the Department of Energy

advanced wireless services or the development of new technology such as Ultra Wideband (UWB). IRAC representatives are evaluated on how effectively they can accomplish these objectives. Obviously, it is not in their best interest to support proposals that may jeopardize scarce spectrum resources or have the potential to cause interference with their agency's critical spectrum dependent systems.

We recommend that GAO consider the establishment of a panel of independent experts that could make informed and unbiased decisions on these contentious matters based on the information presented by the impacted agencies and the proponents for the spectrum reallocation or the new wireless technologies. The panel would weigh the pros and cons of the proposal based on the information provided by both parties and render a decision that would be in the best interest of taxpayers.

If you have any questions please contact Brian Klug of my staff on (202)-586-6095.

Sincerely,



Rosita O. Parkes
Chief Information Officer

Comments from the Department of the Interior



United States Department of the Interior

OFFICE OF THE ASSISTANT SECRETARY
POLICY, MANAGEMENT AND BUDGET
Washington, DC 20240



AUG 23 2004

Mark L Goldstein
Director, Physical Security Issues
Government Accountability Office
441 G St. NW
Washington, D.C. 20548

Dear Mr. Goldstein:

The Department of the Interior (DOI) reviewed the Draft Government Accountability Office (GAO) Report entitled, "Interdepartment Radio Advisory Committee: IRAC Representatives Effectively Coordinate Federal Spectrum but Lack Seniority to Advise on Contentious Issues" (GAO-04-1028).

In the draft report, IRAC members noted the need for both more technical and more senior membership. The need for more technical-level discussions is apparent from the nature of the meetings themselves. The meetings are typically very technical, frequent, and long: The agenda can include up to 50 or more technical items, relatively few of which may directly impact a particular agency mission. IRAC uses a three-step process for issue development. (1) The issue is put on the agenda with supporting information at one meeting. (2) At a later meeting, the merits of the issue are discussed. (3) At a third or later meeting, a vote is taken. Issues are frequently tabled while member agencies research technical or policy points. Some agenda items can take months to come to a vote.

The DOI agrees with the recommendation to continue to improve IRAC members' technical skills. DOI recognizes the National Telecommunications and Information Agency's (NTIA) efforts in this regard.

DOI does not agree with the recommendation to establish an executive committee for policy advice on sensitive spectrum policy issues. The need for an executive level body arises only if the IRAC functions as the decision-making authority for issues before it. As this authority rests with NTIA, the IRAC does not appear to warrant this level of involvement from senior agency officials. The DOI will provide senior-level advice to NTIA officials whenever warranted without establishing a separate executive committee.

Appendix IV
Comments from the Department of the
Interior

Thank you for the opportunity to review the draft report. For additional information, please contact Mr. W. Hord Tipton at (202) 208-6194.

Sincerely,



P. Lynn Scarlett
Assistant Secretary
Policy, Management and Budget

Comments from the Department of the Navy



DEPARTMENT OF THE NAVY

CHIEF INFORMATION OFFICER
1000 NAVY PENTAGON
WASHINGTON, DC 20350-1000

18 August 2004

MEMORANDUM FOR DIRECTOR, PHYSICAL INFRASTRUCTURE ISSUES,
U.S. GOVERNMENT ACCOUNTABILITY OFFICE

SUBJECT: GAO Draft Report: IRAC Representatives Effectively Coordinate Federal Spectrum But Lack Seniority to Advise on Contentious Issues (GAO Code 543088/ GAO-04-1028)

We have reviewed the subject GAO Draft Report 04-1028 and appreciate the opportunity to provide comment to the U.S. Government Accountability Office, Director for Physical Infrastructure Issues, Mr. Mark L. Goldstein.

In spirit, we agree with both recommendations in the draft report for executive action. However, with respect to establishment of a special IRAC committee, we ask that consideration be given to the following revision:

"Establish a special committee within IRAC comprised of senior executives from member agencies to be convened by the Assistant Secretary of Commerce for Communications and Information as needed to provide policy advice on contentious spectrum policy issues, such as those requiring either commercial or government entities to share or relinquish spectrum."

You will note that our proposed change reflects terminology found on page 3 of the draft report under the subheading Results in Brief. We believe the phrase '*senior executives from member agencies*' is an important distinction, ensuring Department of the Navy representation in the development of national spectrum policy and resolution of sensitive spectrum policy issues.

The DON CIO point of contact for this matter is Mr. John J. Lussier, (703) 604-7050, john.lussier@navy.mil.

A handwritten signature in black ink, appearing to read "J. J. Lussier" above a horizontal line, with "D.M. Wennergren" written below it.

Copy to:
Keith Cunningham (GAO)

Comments from the Department of Commerce



THE SECRETARY OF COMMERCE
Washington, D.C. 20230

August 17, 2004

Mr. Mark L. Goldstein
Director, Physical Security Issues
United States Government Accountability Office
Washington, DC 20548

Dear Mr. Goldstein:

Thank you for providing the Department of Commerce with an opportunity to comment on the draft report entitled "Interdepartment Radio Advisory Committee – IRAC Representatives Effectively Coordinate Federal Spectrum But Lack Seniority to Advise on Contentious Issues" (GAO-04-1028). I commend the Government Accountability Office (GAO) for conducting an independent review of government's processes for managing the use of spectrum to meet its communications needs.

As you note in your report, President Bush has undertaken the "Spectrum Policy for the 21st Century" initiative to promote the development and implementation of a U.S. spectrum policy that will foster economic growth; ensure our national and homeland security; maintain U.S. global leadership in communication technology; and satisfy U.S. needs in areas such as public safety, scientific research, federal transportation infrastructure, and law enforcement. As a result of the initiative, I recently submitted two reports to the President containing 24 recommendations to improve spectrum management.

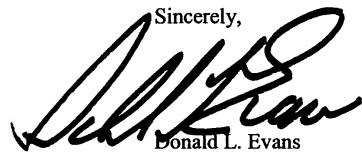
GAO recommends "that the Secretary of Commerce: (1) seek IRAC's assistance in establishing a set of best practices for training and succession planning to guide agencies' participation in IRAC; and (2) establish a special IRAC committee comprised of senior level agency officials as needed to provide policy advice on contentious spectrum policy issues." GAO's recommendations are similar to recommendations in the reports I submitted to the President. I recommended to the President that a career development program should be instituted to provide training for new spectrum management personnel (government and non-government) in need of technical disciplines or continued competency, and that a senior level group be established to provide advice to Commerce's Assistant Secretary for Communications and Information and to help resolve policy issues (not resolved by the current IRAC) that affect the use of spectrum by federal government and non-federal users. However, I recommended that the new advisory group would be better positioned to address unresolved issues if it is convened outside of the existing IRAC.

Appendix VI
Comments from the Department of
Commerce

Mr. Mark L. Goldstein
Page 2

I hope you find these views helpful. If you have any additional questions about the Department of Commerce's role in spectrum management policy, please contact Michael D. Gallagher, Assistant Secretary for Communications and Information, at (202) 482-1840.

Sincerely,



A handwritten signature in black ink, appearing to read "Donald L. Evans".

Donald L. Evans

GAO Contacts and Staff Acknowledgments

GAO Contacts

Mark Goldstein (202) 512-2834
John Finedore (202) 512-6248

Acknowledgments

In addition to the individuals named above, Keith Cunningham, Brad Dubbs, Michele Fejfar, Alwynne Wilbur, and Nancy Zearfoss made key contributions to this report.

Related GAO Products

Spectrum Management: Better Knowledge Needed to Take Advantage of Technologies That May Improve Spectrum Efficiency. [GAO-04-666](#).
Washington, D.C.: May 28, 2004.

Spectrum Management in Defense Acquisitions. [GAO-03-617R](#).
Washington, D.C.: April 30, 2003.

Telecommunications: Comprehensive Review of U.S. Spectrum Management with Broad Stakeholder Involvement Is Needed. [GAO-03-277](#).
Washington, D.C.: January 31, 2003.

Telecommunications: Better Coordination and Enhanced Accountability Needed to Improve Spectrum Management. [GAO-02-906](#). Washington, D.C.: September 30, 2002.

Telecommunications: History and Current Issues Related to Radio Spectrum Management. [GAO-02-814T](#). Washington, D.C.: June 11, 2002.

Defense Spectrum Management: More Analysis Needed to Support Spectrum Use Decisions for the 1755-1850 MHz Band. [GAO-01-795](#).
Washington, D.C.: July 20, 2001.

Defense Spectrum Management: New Procedures Could Help Reduce Interference Problems. [GAO-01-604](#). Washington, D.C.: May 17, 2001.

Telecommunications: Federal Communications Commission Spectrum Management. [RCED-89-62](#). Washington, D.C.: January 12, 1989.

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