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Date: October 28, 1999

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Subject: FCC Technological Advisory Council Second Meeting Report

To: Members of FCC TAC

Attached is the Report: Second Meeting of the FCC Technological Advisory Council. The meeting was videotaped and that tape serves as the official minutes. This report, prepared as a document to aid in the work of TAC, contains an encapsulated version of the meeting and is being posted on the public web site. Comments and improvements are always welcome. You may wish to join one or more focus groups if you have not already done so. Please check your own personal information so that errors may be corrected on an ongoing basis. If you have not already provided us with secondary contact information (e.g., your secretary), please do so.

Robert W. Lucky
Chairman
FCC TAC

Jules A. Bellisio
Executive Director
FCC TAC

Att.
Report: Second Meeting of the FCC Technological Advisory Council

Report : Second Meeting of the FCC Technological Advisory Council

Executive Overview

The Federal Communications Commission Technological Advisory Council (FCC TAC) held its second meeting on April 30,1999 in Washington, D.C. The Council is to provide scientifically supportable information on those emerging technologies that could fundamentally impact the work of the FCC. In response to five specific requests from the FCC, the TAC at its first meeting organized three focus groups with moderators to address: spectrum management; network interconnection and access, and access to telecommunications by persons with disabilities. Each of these groups reported out findings developed in the interim and expanded each area during a roundtable discussion. It is planned that the groups will work between the approximately three formal meetings per year of the TAC to provide expert advice relative to the FCC requests.

The Spectrum Management Focus Group is organized into three subworking groups. The ultrawideband radio (UWB) subgroup reported on this emerging technology. UWB transmitters typically emit very short time duration pulses which spread very low spectral profile energy over many gigahertz. Current regulation of the electromagnetic spectrum is implemented by assigning specific portions of the spectrum to a specific use. Because UWB devices appear to encroach on already allocated spectrum significant controversy has resulted. The TAC is attempting to reduce this controversy by collecting technically defensible information on impacts and advantages. Whether or not existing spectrum management policies restrict the development or deployment of this technology is one key issue which this group will address.

The software defined radio (SDR) subgroup discussed SDRs which can be programmed and reprogrammed either locally or remotely to emulate a variety of signal waveforms, communications protocols and etiquettes. SDRs can be continuously aware of their local position and radio environment to intelligently and adaptively remold themselves into the most appropriate device tuned to the time and place. SDRs make it practical to consider replacing some spectral rules with etiquette based algorithms. Experiences with etiquette and its applicability and impact with SDRs will be studied by the SDR group. The group has recommended that there be a systematic collection and analysis of information on SDRs, and that, in cooperation with industry, experiments planned to test and demonstrate those principles needed for informed regulatory modifications.

The FCC needs to develop a more complete understanding the current state of the radio noise environment. The noise environment subgroup's problem somewhat analogous to the characterization of air pollution and they report that similar techniques may be applicable. Knowledge is needed to determine if current rules are adequate, too restrictive, or are

overlooking an emerging crisis. The group is tasked with determining how much information already exists and can be made available without a major effort.

The FCC has a mandate to promote competition. The lack of a generally available method of allocating the total set of allowed end-to-end telecommunications "impairments" in an interconnected network is perceived to be an impediment to competition as providers who are in complete control of the entire connection may claim that only they can provide reliable levels of performance. If quality and performance measures are standardized with combining principles well understood, then networks can be parsed into separately and competitively supplied segments. The network interconnection and access focus group will review the progress and plans of the industry's effort to solve this problem without the need for government intervention.

The Commission is required by statute to take special action relative to people with disabilities. A desirable outcome of the TAC would be a general awareness and sensitivity to the problem by designers at the early design stage, and a course of action which would allow them to include attributes which would: allow accessibility to a broad spectrum of people with one ore more disabilities; actually improve the value to the general population (e.g., television's closed captions); and would not devalue the product if not needed. One proposed approach to motivating the work of this focus group would be to first describe scenarios of how new telecom services might develop, then analyze how difficulties with access by the disabled might emerge. From this, more generic recommendations of how to avoid similar problems could be for proposed.

Prepared by **J. A. Bellisio**

Approved by **R.W. Lucky**

October 28,1999

Report: Second Meeting of the FCC Technological Advisory Council

1. Introduction

The FCC formed the Technological Advisory Council (TAC) to help provide the technical expertise the Commission needs to stay abreast of innovations and new developments in the communications industry. As announced, the second meeting of the TAC took place on Wednesday, September 22, 1999, at The Portals, 445 S. 12th Street, SW., Washington, D.C. This report is a distillation of that meeting written to facilitate the work of the Council. A complete videotape of the meeting serves as the verbatim minutes (*see Annex 1*).

Designated Federal Officer (DFO) Stagg Newman opened the meeting, and Dale Hatfield, Chief, Office of Engineering and Technology, Federal Communications Commission thanked the TAC for volunteering to help keep the FCC abreast of developments in our rapidly evolving industry.

The mission and operating principles of the TAC were described in the Report of the First Meeting of the TAC, available on the FCC web site http://www.fcc.gov/oet/tac/ . As described in that report, the FCC has made five official requests to the TAC for technical work. These requests fall into three major areas: spectrum management; network interconnection and access; and accessibility for disabled persons. Focus groups with moderators were formed at the first meeting to address each of the three areas. At this second meeting, the activities of each of the groups was reviewed and is now summarized in this report. The meeting's roundtable discussion, which followed each presentation, and resulting action items are also reported. Additional and more extensive information relative to each of the working groups can be found on the web sites for those groups. *See Annex 4*

The next formal TAC meeting will be on December 13, 1999.

2. Agenda

Technological Advisory Council--Second Meeting--

Wednesday, September 22, 1999
Federal Communications Commission Meeting Room
The Portals, 445 12TH Street, SW
Washington, D.C.

10:00 AM	Opening	Stagg Newman Designated Federal Officer
10:05 AM	Introductions of Council Members with Brief Remarks (if any)	Council Members
10:30 AM	Report of Spectrum Focus Group	Chuck Jackson
11:30 AM	Report of Interconnection and Network Access Focus Group	Marvin Sirbu
12:10 PM	Break	
1:00 PM	Access to Telecommunications by Persons with Disabilities Focus Group	Gregg Vanderheiden
1:40 PM	Discussion on Focus Group Procedures for Technical Work	Chair Bob Lucky
2:40 PM	Assignments, Organization and Going Forward	Chair Bob Lucky
3:00 PM	Wrap Up - Meeting Adjourned	Stagg Newman Designated Federal Officer

3. Membership of the Technological Advisory Council

Except as indicated(*),all of the following were present at the Second Meeting:

Chairperson:

Dr. Bob Lucky – Corporate Vice President, Applied Research, Telcordia Technologies, formerly Bellcore (Bell Communications Research).

Members of Council:

Mr. Bruce Allan – Vice President and General Manager, Harris Corporation,

*Mr. Jose M. Alvarez Caban – Assistive Technology Specialist, Puerto Rico Assistive Technology Project, University of Puerto Rico.

Dr.Jules A.Bellisio,***TAC Executive Director***, Chief Scientist and Fellow, Executive Director, Telcordia Technologies, formerly Bellcore (Bell Communications Research).

*Dr. Vinton Cerf – Senior Vice President, Internet Architecture and Technology, MCI Worldcom.

*Ms. Susan Estrada – President and CEO, Aldea Communication.

*Mr. Bran Ferren – Executive Vice President for Creative Technology and Research Development, Disney/ABC.

Dr. Richard Green – President and CEO, CableLabs,

Ms. Christine Hemrick - Vice President, Technology Communications, Office of the CTO, Cisco Systems, Inc.

Mr. Dewayne Hendricks – General Manager, Wireless Business Unit, Com21.

Mr. Ross Ireland – Vice President – Engineering, SBC.

Dr. Charles E. Jackson – Independent consultant.

Mr. Kalle Kontson – Division Technology Manager, Center for Electromagnetic Science and Vice President IIT Research Institute

Dr. William Lee – Chief Scientist, AirTouch/Vodaphone.

*Dr. Paul Liao – Chief Technology Officer, Panasonic and President of Panasonic Technologies.

Dr. Wah Lim – Vice President for Technology and Development for Hughes Space and Communications Company.

Dr. Robert Martin – Chief Technology Officer of Bell Labs, Lucent.

*Dr. David Nagel – President AT&T Labs and CTO for AT&T,

*Mr. Glenn Reitmeier, Vice President, DTV and Web Media, Sarnoff Laboratories.

*Mr. Dennis Roberson – Vice President & CTO, Motorola.

Dr. Marvin Sirbu – Professor of Engineering and Public Policy, Professor of Electrical & Computer Engineering, Professor – Graduate School of Industrial Administration, and Chairman of the Information Networking Institute, Carnegie Mellon University.

Dr. Gregg Vanderheiden – Professor – Human factors Group, Dept. of Industrial Engineering, University of Wisconsin, and Director of Trace Research and Development Center.

Mr. Jack Waters – VP of Network Engineering, Level 3 Communications.

Dr. Pat White - Director, Telecommunications Practice, AD Little.

Mr. Robert Zitter – Senior Vice President, Technology Operations, Home Box Office.

Designated Federal Officer

Dr. Stagg Newman, Chief Technologist, Federal Communications Commission.

Alternate Designated Federal Officer

Mr. Dale Hatfield, Chief, Office of Engineering and Technology, Federal Communications Commission.

Not present at second meeting*

A set of short biographies of each member can be found in the first meeting report.

About 75 members of the public observed the meeting. There are no comments from the public to be reported.

4. Summary of Remarks by Representatives of the FCC

Dale Hatfield, Chief, Office of Engineering and Technology, Federal Communications Commission, welcomed the TAC and thanked them for their efforts so far. The TAC, established to help the FCC keep ahead of rapid changes in the industry, was reminded of the critical importance of the three primary areas as outlined in the first meeting. Mr. Hatfield's office has prime responsibility for matters of spectrum allocation. The office has, so far, avoided any major crisis but understands that as technology becomes more complex the challenge of preventing future problems becomes progressively more challenging. Furthermore, the proliferation of new demands and services has brought issues of network integration to the forefront. The Commission also feels strongly about its duty to increase the accessibility of communications to the disabled and will be looking to the TAC for guidance as to how this mandate can become an integral part of every appropriate design process.

4. Report of Spectrum Focus Group and Group Discussion

Chuck Jackson reported on the activities of the Spectrum Management Working Group using the presentation of Annex 2. The web site is quite active and contains several contributions from the public. The Group is divided into three subworking groups, and the roundtable discussion of the meeting was organized around each of these areas, summarized in an encapsulated form below:

5.1. Ultrawideband Radio (UWB)

Ultrawideband radio is an emerging technology utilizing transmitters which typically emit very short time duration pulses which consequently spread energy over many gigahertz of the radio spectrum. Such radios are often characterized as simple, inexpensive devices which by virtue of their low spectral energy profile can function without impact on other services which may be sharing the same spectrum. Apparently, an important feature of commercially viable ultrawideband devices is their relatively lightweight realization. Efforts to include sophisticated spectral shaping or other customized or dynamic modifications seriously risks reducing the attractiveness of the concept. Because UWB devices appear to encroach on already allocated spectrum significant controversy has resulted, controversy which the TAC should attempt to reduce with defensible technical information.

UWB radios can be used for at least three purposes (which should be addressed separately): short range ground and object penetrating radar; small local area networks; and last mile applications where signals are expected to travel some distance. The radars, and to a lesser extent the LANs, are intentionally geographically contained and are not as contentious as the longer distance proposals where overlapping spectral use is an issue. It is this last case that will require the most attention. Not only will it be necessary to estimate the impact of individual UWB sets for this application, but also the scaling laws to account for a proliferation of devices.

- Experiments will be needed to validate theories and claims. It would be convenient if

Part 15 rules would allow such research, but there was a strong feeling that policies would have to be modified to do this work properly

- Assuming experiments and some new experimental radiation rules are needed, it may be feasible to carve out a relatively large block of spectrum in some geographically remote location to proceed with the work. It may be possible to identify an isolated area where we can loosen controls and minimize collateral damage.
- Most proposed UWB transmitters have been relatively simple devices. What could be done if intelligent, cognitive, software defined techniques (see discussion following) were introduced, and would be the complexity impact be so large so as to destroy the elegance of the proposed systems?
- Rules make a distinction between intentional and unintentional radiation. Do we need to revisit this concept for the case where a proposed intentional UWB transmitter will emit less radiation than the unintentional radiation of the device that it is serving?
- UWB is just one of many potential new technologies which may require rule changes. We should become fully aware of all the contenders and make an impact and benefit analysis before we finalize changes.

5.2 Ultrawideband Radio-*Action Items*

- Define the state of the art for ultrawideband radios.
- Project their likely evolution.
- Identify policy implications.
- Do existing spectrum management policies inefficiently restrict the development or deployment of this technology?
- What is the best way to identify the apparently large body of information that exists for UWB, and how can it be classified?

5.3 Software Defined Radio (SDR)

Software defined radios should be understood to broadly to include concepts such as cognitive radios and multistandard radios. SDRs can be programmed and reprogrammed either locally or remotely to emulate a variety of signal waveforms, communications protocols and etiquettes, and can be continuously aware of their local position and radio environment to intelligently and adaptively remold themselves into the most appropriate device tuned to the time and place. SDRs can be realized either as fast digital signal processors acting on a digitized version of the signal, or as one of a variety of purpose built modules selected and linked to cover various operating regimes. At the current state of the art, it is not possible to build a totally general SDR, but it is possible to include sufficient new functionality so that it is appropriate to start revisiting the spectral allocation paradigm with an eye toward introducing more of an etiquette based management scheme.

- A SDR, in terms of its *transmitted waveform*, does not introduce any possibilities that were not previously possible with ordinary technology. SDRs can, in principle, recreate

all known transmit waveforms including (in the future) UWB.

- Although some radios today can be aware of their environment and can switch between transmit waveforms and protocols (e.g., dual mode cell phones), the *scale* upon which SDRs could be environmentally aware and programmably adaptable does seem to qualify them as producing a quantum change in technology.
- SDRs make it practical to consider replacing some spectral rules with etiquette based algorithms.
- Technology is a moving target. Introducing etiquette will create yet another legacy for the future. We should clearly consider all options and benefits before moving to a new regulatory paradigm.

5.4 Software Defined Radio- *Action Items*

- Do we need changes in regulation either permanent or experimental? What have been experiences with etiquette?
- Does the current equipment authorization procedure impede new innovation?

5.5 Noise environment

The FCC needs to develop a more complete understanding the current state of the radio noise environment. This issue is somewhat analogous to the characterization of air pollution. Knowledge is needed to determine if current rules are adequate, too restrictive, or are overlooking an emerging crisis. As with the measurement of air pollution, measuring everything is impossible, and haphazard sampling is inconclusive if not useless. A very well thought out approach is needed.

- A suggested approach, not unlike that used for air pollution, would have the following steps: (1)catalog the sources of radiation,(2) generate a theoretical model for the effect of each source, (3) use a controlled experiment to validate the individual models, (4) merge model predictions with a statistical census of sources and spot check with experimental data, (5) iterate and tune.

A proposal along these lines has been received. It should be understood that the purpose of the proposal was to outline and calibrate the effort that may be required, and in the event the activity is approved normal procurement procedures will apply.

5.6 Noise environment – *Action Items*

- How much can we say about the noise floor without a large effort? What information exists today and how can we get it. Should we issue a call for any data which may be in private files and could be made available?

5. Report of Interconnection and Network Access Focus Group and Group Discussion

Marvin Sirbu reported on progress of this focus group. The FCC has a mandate to promote

competition in the backbone network business, and also stimulate the deployment of new competitive access networks with advanced capabilities The lack of a generally available method of allocating the total set of allowed end-to-end telecommunications "impairments" can be perceived as an impediment to competition. These impairments are, for example, transport and switching delay (latency), message priorities, quality of service, number and kind of A/D/A conversions and codings, and the like. Customers will demand that these performance parameters be quoted in advance and then kept under control. If standard metrics do not exist, and at the current time they do not, then providers who are in complete control of the entire connection will be incented to claim to their customers that only they can provide reliable levels of performance. This is viewed as an impediment to desired competition. If quality and performance measures are standardized and the combining principles well understood, then networks can be parsed into separately supplied segments with the assurance that end-to-end connections will work with predictable characteristics. Different entities can compete for each network segment with the measurable performance of each component becoming a negotiable commodity.

A similar situation exists for administrative messages which must be passed between administrative domains for purposes of network management and for the implementation of certain types of services. If such messages and protocols are kept unique or proprietary, there will be a strong disincentive for new entrants to offer components of network services because they will be disadvantaged relative to the end-end suppler. It is from this background that many of the TAC issues arise.

- Without interconnection agreements it is hard even for a major supplier to deploy a new network because during the transition interim some tandeming of networks is inevitable.
- There is likely significant industry interest in solving this problem in the private sector and the FCC needs to be aware of the current situation before attempting to mandate a solution
- The industry should be given a chance to reach consensus on methods for QoS (quality of service) and SLAs (service level agreements) as a starting point for solving the general "any-to-any" problem.
- The problem of feature interaction and the implementation of services using several vendors operating across administrative domains is related to this general problem and is a technically complex and not fully resolved issue.
- Although the FCC is interested in promoting competition, it is beyond the mandate of the TAC to recommend ways of monitoring the market to see if an economically noncompetitive situation is developing.

6.1 Interconnection and Network Access - *Action Items*

- What is the state of the art in QoS and SLAs ?
- Can we begin to list *all* of the interdomain management issues?
- What technologies exist to facilitate the deployment of open switching platforms?
- What standards exist or are planned by various industry groups to address the interconnection problem?
- What are the time scales proposed by industry to solve different parts of the interconnection

problem? Will some sort of regulatory intervention serve a useful purpose?

- Are current deployments in the access area (e.g., digital subscriber lines and cable modems) discouraging the deployment of more capable, futuristic alternatives, or are they a logical and necessary stepping stone to the "ultimate access network"?

6. Report of Access to Telecommunications by Persons with Disabilities Focus Group and Group Discussion

A desirable outcome of the TAC work relating to Access to Telecommunications by Persons with Disabilities would be a general awareness and sensitivity to the problem by designers at the early design stage, and a course of action which would allow them to include attributes which would: allow accessibility to a broad spectrum of people with one ore more disabilities; actually improve the value to the general population (e.g., television's closed captions); and would not devalue the product if not needed. Gregg Vanderheiden demonstrated some examples of new access enabled systems which came close to fulfilling all of these objectives. One proposed approach to motivating the work of this focus group would be to first describe scenarios of how new telecom services might develop, then analyze how difficulties with disabled access might emerge. From this, more generic recommendations of how to avoid similar problems could be for proposed.

- There needs to be a more general understanding among the working group as to what the desired behaviors of customer equipment and networks are relative to this problem.
- For each attribute proposed to enhance accessibility, there is usually a single, most appropriate place for implementation. We should use care so as to allow the solution set to impact only those parts of the communications chain where the benefit / cost is highest.
- This problem is mainly a matter of issue awareness and motivation at the early stages of design.
- Access is mainly an interface problem. We should start at the CPE and work our way up to the network.
- There is a broad spectrum of disabilities, including compound disabilities. Access can not be provided for everyone. There needs to be an analysis of cost relative to the size of the population receiving benefit.
- Some examples of cost are awareness training for both designers and craft, impact of myths and false steps, burdens placed on the nondisabled user, and tracking expenses of mandates and regulations.
- Some regulatory intervention is probably necessary because the motivation to include access capabilities is not as strong as competing competitive pressures

7.1 Access to Telecommunications by Persons with Disabilities - *Action Items*

- Can we list the issues faced today and those that may emerge in the future?
- What are the overarching principles relating to this issue?

Can we propose a road map to get from where we are now to where we want to be? What should we do at each step?

7. Going Forward

Each focus group leader should summarize the action items as they see them for their group, and specific actions should be assigned as an individual responsibility to persons in the group for reporting at the next meeting.

The next scheduled formal meeting is December 13,1999.

Annex 1: Meeting Videotape

A VHS videotape of the September 22,1999 meeting serves as a set of comprehensive minutes of that meeting. Copies of the tape can be obtained from the Commission's contracted copier, ITS. It can be reached through ITS' web page.

http://www.itsdocs.com

or by phone at 202-857-3800

Annex 2: Spectrum Management Group Status Report , September 22, 1999

A copy this presentation is at:

http://www.jacksons.net/tac/Status22Sept99.ppt

Terms of Reference

- Spectrum management issues generally
- Specifically

–Ultrawideband radio
–Software defined radio (SDR)
–Noise environment

Benefits of Wireless

- Provides access to emergency services.
- Lowers costs.
- Changes the use of time.
- Creates new options.

–Observations of a prominent authority

Organization

- Software radio

–Kalle Kontson

- Ultrawideband radio

–Dewayne L. Hendricks

- Noise environment

–Dennis Roberson

General Activities

- Web page
- Comments/White papers

Ultrawideband Radio Tasks

- Define the state of the art for ultrawideband radios.
- Project their likely evolution.
- Identify policy implications.
- Do existing spectrum management policies inefficiently restrict the development or deployment of this technology?

Ultrawideband Activities

- Received White papers on Sept 15, 16.
  - Posted on web site.
- Have had little discussion.
- Status of FCC proceeding
  - Notice of Inquiry 1 Sept 98
  - Comments (~40) and reply comments (~30)
    - Available at www.uwb.org/standards.htm

Software Radio Tasks

- Define state of the art for software radio.
- Project the likely evolution.
- Identify policy implications.
  - 5 to 15 years timeframe
- Software radios should be read broadly to include concepts such as cognitive radios and multistandard radios.

What is a Software Radio? Software Defined Radios

- Two different views
  - Lucent/Bell Labs
    - We believe that the basic answer to the first question—Is the software radio a quantum improvement that will drive a new spectrum allocation paradigm using ultra wideband spreading —is no.
  - Shrum, Kontson, Davis
    - An early, workable spectrum management policy for SDR and SWR is needed in the United States.

A Current Problem

- How will the FCC authority ensure that the “software” is correct initially and not modified later without authority to do so?
- Downloading new user services
  - How to ensure regulatory compliance?
- How can we simplify the certification for radios capable of operating on multiple standards or multiple modes?

A Future Issue

- The most significant, specific allocation issue for SDR may involve the "control channel" or “control algorithms” for negotiating spectrum access, downloading software changes, etc., as proposed by some in the IMT-2000 activity.

Fundamental Issue: Certification

- Challenge to regulators
  - The user or system operator can modify or completely reconfigure a system or system element.
  - Modifications must be certifiable or trusted.
  - Who should certify?

Recommendation A

- FCC should begin an inquiry regarding the implications of software radios.
  - Regulatory framework
  - National position for ITU, etc.

Recommendation B

- FCC should establish a National SDR Planning Committee, pursuant to the provisions of the Federal Advisory Committee Act, to advise the Commission on a variety of issues relating to spectrum management and regulation of radio systems using SDR and related new technologies.

Planning Committee Responsibilities

- Formulate detailed views for the FCC’s inquiry.
- Recommend technical standards and certification procedures.
- Provide long-term policy recommendations on the use of software radio technology to achieve significant improved efficiencies in the use of the radio frequency spectrum.

Recommendation C

- FCC and NTIA, in cooperation with industry, user groups and associations, Federal agencies, and other involved parties, should organize and support experiments involving the design, application, and actual spectrum-use demonstrations of SDR technology to provide critical input to the development of appropriate national spectrum management and access policy.

Discussion

- FCC Notice of Inquiry
- FCC Planning Committee
- FCC/NTIA/Others experiments

RF Noise Environment Tasks

- Summarize current knowledge on noise levels.
- Identify the effects of noise on the reliability of communications systems.
- Identify man-made noise that causes harm.
- Identify issues or causes of man made electromagnetic noise that justify FCC attention or action.
- Suggest technical approaches for obtaining sufficient information on the subject.

Noise Environment Activities

•Two drafts of paper by Roberson

•Proposal by IITRE

Roberson's Points

•The state of knowledge of electromagnetic noise levels

•Man-made causes of noise affecting wireless communications

•The effects of noise on current and future communications systems

•Issues and causes of interference that justify FCC attention

•Types of noise causing concern and approaches for gaining sufficient information on them

Proposal

•IITRE proposal for literature survey

Discussion

•Does the TAC support funding of project like in proposal by NTIA, NSF, DOD, etc.?

•Does the TAC recommend that FCC issue NOI on certification issues for software radios?

Additional Topics

•Should any elements of ultrawideband or software defined radio technology should be demonstrated or otherwise presented to FCC?

•Are there important complementary technologies deserving mention?

Annex 3: FCC staff

FCC staff available to address questions from the TAC:

Contact Stagg Newman as the DFO. With respect to specific Federal Advisory Committee Act (FACA) questions, a resident expert is FCC attorney:

Paula Silberthau, at: PSILBERT@fcc.gov
Phone 202-418-1874

Additional FACA information is at the Office of Government Policy web page at:

http://www.policyworks.gov

Annex 4: Focus groups , moderator, and group web addresses for interaction.

Spectrum Management (Charles L. Jackson, moderator)

http://www.jacksons.net/tac

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Accessibility for Disabled Persons (Gregg Vanderheiden, moderator)

http://trace.wisc.edu/docs/fccadv/disability.htm

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Network Interconnection and Access (Marvin Sirbu, moderator)

http://www-fcc.ini.cmu.edu/FCC/index.html

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