

Report of First Meeting of the FCC Technological Advisory Council

Executive Overview

The FCC Technological Advisory Council (TAC) held its first 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, TAC organized three focus groups with moderators to address: spectrum management; access to telecommunications by persons with disabilities; and network interconnection and access. These groups will work between the approximately three formal meetings per year of the TAC to provide expert advice relative to the FCC requests.

Current regulation of the electromagnetic spectrum, which assumes a fundamental scarcity of this resource, is implemented by assigning specific portions of the spectrum to a specific use. The TAC spectrum management focus activity should explore those new technologies, such as ultrawideband or software defined radios, which might allow the FCC to update this regulatory model so as to promote more efficient usage.

The Commission is required by statute to take special action relative to people with disabilities. One objective of the focus group for this issue would be to make all designers of equipment consider how their products might be used by persons operating under constrained conditions. This would not only minimize the need for (and cost of) ancillary assistive apparatus by persons with disabilities, but make the products more valuable to the general population. Television closed captions are an example of an assistive introduced to compensate for a disability but found to be more generally useful by everyone.

Efficiently defined interfaces at network interconnection and access points are required to make communications both universally accessible and to fairly implement competition. The problem of defining interconnection points and protocols, which this focus group must deal with, is exacerbated by the proliferation of new technologies, nonequivalent architectures, and an ever expanding set of service requirements. TAC should provide guidance to the FCC on the efficacy of (and special issues created by) new technology which may be introduced both in access and core networks of all types (wireline, fiber, wireless satellite, etc.). A minimum set of interoperability standards for each layer of the protocol stack may be recommended.

Each of the three focus groups and their subgroups will have publicly accessible websites to assure openness of work in progress, and will report back at the next TAC general meeting on September 22, 1999.

Prepared by J. A. Bellisio

Approved by R.W. Lucky

May 26, 1999

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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 first meeting of the TAC took place at Friday, April 30, 1999, at The Portals, 445 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 I*).

Designated Federal Officer (DFO) Stagg Newman opened the meeting, and in remarks by FCC Chairman William Kennard and Commissioner Susan Ness, the purpose of TAC was strongly endorsed with the expectation that the deliberations would remain technologically focussed and aimed at the greater good of the nation as a whole.

TAC is organized under the Federal Advisory Committee Act (FACA). Some major aspects of FACA rules are reviewed in this report to help with the organization of activities, but TAC will depend on the legal guidance of the FCC to be sure of continuing FACA compliance. Considerable technical work will need to be done between meetings. To preserve mandated transparency and accessibility, primary interactions will be via public websites.

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 meeting to address each of the three areas. The membership and directives to these groups are described. This report gives a summary of the meeting's roundtable discussion, which followed an extended presentation of each FCC request. The results of some activities that took place shortly after the formal meeting are also reported here. It is expected that first recommendations will be available by the next formal TAC meeting on September 22, 1999.

2. Agenda

Technological Advisory Committee Agenda-1st Meeting
Friday, April 30, 1999
Federal Communications Commission Meeting Room
The Portals, 445 12th Street, S.W., Washington, D.C.

10:00 am	Opening	Stagg Newman Designated Federal Officer
10:05 am	Welcome and Remarks (opportunity for remarks by other commissioners)	Chairman William Kennard
10:15 am	Introductions of Council Members with Brief Remarks (if any)	Council Members
10:45 am	Overview of the FCC, the Federal Advisory Committee Act	Rebecca Dorch, Deputy Chief ,OET
	Key Technological Issues Confronting the Commission	Stagg Newman, Chief Technologist, FCC
11:25 am	Introduction of the Issues That the FCC Has Identified	Chairman Bob Lucky
11:30 am	Description of Each Issue, Followed by Group Discussion	Stagg Newman and delegate
12:00 pm	Break	
12:30 pm	Issues, Continued	
2:00 pm	Open Floor Discussion for any Suggestions for Technological Issues that the Commission Should Consider	Chairman Bob Lucky
2:30 pm	Assignments, Organization and Going Forward	Chairman Bob Lucky
3:00 pm	Wrap Up - Meeting Adjourned	Stagg Newman, DFO

3. Membership of the Technological Advisory Council

Except as indicated, all of the following were present at the First 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 - President, R&D and Creative Technology Walt Disney Imagineering

*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/Vodafone.

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 first meeting***

Annex 2 is a set of short biographies of each member.

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

4. Summary of Remarks by Commissioners

FCC Chairman William Kennard described how the need to remake the way the FCC deals with technology was the genesis of the TAC. FCC regulations must be kept relevant to the fast pace of technology, and the Commission simply can not keep up using just in-house resources. Engineers are inherently problem solvers, and many have come forth volunteering to help the Commission. With the full expectation that the members of the TAC will act as “honest brokers”, remaining objective with the best interests of the country and consumers as the first priority, Chairman Kennard charged the TAC with producing recommendations on some of the Commission’s most pressing problems.

Commissioner Susan Ness expressed her hope that the TAC would be instrumental in keeping the FCC “ahead of the curve” during a period of technological revolution of monumental proportions. Change breeds not only uncertainty but opportunity. TAC insights will help turn this opportunity into a benefit for the consumer. TAC will be a success if it can help the commission think through problems before they arise in a regulatory context.

5. Overview of the FCC and the Federal Advisory Committee Act

Rebecca Dorch, Deputy Chief , OET, described the mission of the FCC at a very high level. It is an independent regulatory agency, not an executive branch agency such as NTIA or FAA. It was established by Congress to implement the Communications Act of 1934, as amended many times. Its goals, unchanged since 1934, remain to:

regulate interstate and foreign commerce in communications by wire and radio so as to make available, so far as possible, to all people of the United States, without discrimination, ... a rapid, efficient, nation-wide, and world-wide wire and radio communications service....

FCC hallmarks are: impartially, transparency, and participation. This means that rules, orders, opinions, public notices, etc. are all published and that public comment is sought on proposed rules, applications, and licenses. Any person or entity has a right to present their views in rule making proceedings. Written records, meetings, and web pages are open to the public.

Impartiality considerations keep the FCC and regulated industry separate by way of rules covering financial interest, conflict of interest, gifts, and post-employment. Just the perception or appearance of impropriety are significantly important.

The TAC has been established as a federal advisory committee under the Federal Advisory Committee Act. (1972). *See Annex 3*. The Act permits government agencies to establish and utilize committees for the purpose of obtaining collective or consensual advice or recommendations on issues or policies within the scope of the agencies responsibilities. A few

key requirements are balance in terms of membership with charters approved by GSA and filed with Congress. TAC is not empowered to establish regulations. It can be terminated after two years , but is renewable for successive two year periods. A key consideration is that meetings must be open to the public and called and convened by the DFO or Alternate DFO. A DFO must be present at all meetings. There must also be 15 days advance notice and public notice published in the Federal Register. TAC should not plan on having any closed meetings or impromptu closed sessions. All deliberations, consensus building and decision making must be made in the open. Records and documents, such as transcripts of meetings, minutes, appendices, working papers, etc., must be available for public inspection and copying. The FCC TAC Web pages will serve this purpose.

Working groups (subcommittees, focus groups, etc.) are convened to gather information, develop work plans, perform studies, do research, collect data, draft reports, and discuss preliminary findings. They are not considered advisory committee meetings and thus not subject to the Public Notice and Open Meetings requirements of FACA unless they are: large enough to constitute a quorum that could form a consensus for the parent committee; function as the parent advisory committee by making decision; make consensual proposals that would be binding on the parent committee or would function as the parent committee's own recommendation without debate; or provide recommendations directly to the agency.

Because real time “chat rooms” on the Internet could potentially become large enough to constitute a quorum (12 members for TAC), we should not use this vehicle but will use open web pages instead.

It is also noted that FACA requirements do not apply to meetings where the intent is to solicit experiential or anecdotal information -- where there is no consensus advice or recommendations from the group expected or solicited at the meeting.

Finally, all current TAC members fall within the category of “representatives.” As representatives they are not subject to certain government-wide conflict of interest, ethical and financial *disclosure* requirements.

Violations of the FACA rules can result in the FCC's inability to use TAC reports or rely on TAC information or recommendations in decision-making. This overview is merely to make TAC members aware of some key issues. The FCC staff will be made available for expert advice. Contacts are listed in Annex 3.

6. Requests From the Federal Communications Commission to the Technological Advisory Council

The FCC has requested that the Technological Advisory Council commence work in the following five subject areas:

I. SPECTRUM MANAGEMENT

REQUEST: Please assess and report to the Commission the current state of the art for software defined radios, cognitive radios, and similar devices and, to the extent possible, predict future developments for these technologies. Please also suggest ways that the availability of such devices might affect the FCC's traditional approaches to spectrum management, as well as ways the agency could facilitate experimentation and commercial deployment of such devices.

BACKGROUND: Historically, in the U.S. the range of usable frequencies for communications between 30 MHz and 300 GHz has been divided between federal government exclusive use (1.42%), non-federal exclusive use (5.52%) and shared use (93.1%). Of the most heavily used frequencies between 30 MHz and 3 GHz, 14% are federal government exclusive, 30% are non-federal exclusive and 53% are shared. Within this overall structure, blocks of radio frequencies have also been designated (allocated) both domestically and internationally for the provision of specific services such as fixed, mobile, broadcast, satellite, maritime mobile, et al. The Commission, while adopting more flexible spectrum use allocations, has also identified unique frequency ranges for specific types of services and has established technical parameters and other rules to govern operations on designated frequencies. Manufacturers and service providers, in turn, developed products and systems that conformed to those requirements.

At the Commission's recent En Banc Spectrum Management Hearing on April 6, 1999, several panelists suggested that the Commission's current approach to spectrum management may prevent spectrum from being used in the most efficient manner. New developments that were identified by panelists included software defined radios, cognitive radios, next-generation unlicensed devices, and ultra wide-band wireless technologies. Several panelists also suggested that radical rethinking and changes to current spectrum management policies are essential if the American public is to benefit from the technologies that are being developed in this country and if the United States is to continue to be a world leader in communications. These suggestions included proposals that the Commission investigate much more decentralized forms of spectrum management where intelligence in the end user devices would play a much larger role in ensuring efficient use of spectrum.

II. ELECTROMAGNETIC NOISE

REQUEST: Please assess and report to the Commission the current state of knowledge on electromagnetic noise levels and the effects of such noise on the reliability of existing and future communications systems, and recommend whether the FCC should pay closer attention to electromagnetic noise issues. If electromagnetic noise is a significant concern, please suggest technical approaches for obtaining sufficient information on the subject.

BACKGROUND: Electromagnetic noise and interference limit the performance of all communications systems. The external electromagnetic noise environment is composed of both natural noise sources (including extraterrestrial, i.e., galactic and solar, as well as atmospheric

sources) and man-made sources.¹ Two major sources of man-made noise are electric power transmission and distribution lines, and automobile ignition systems; other man-made sources include rotating electrical machinery, switching devices, appliances, light dimmers, arc generating devices.² In addition, radio systems can emit harmonics and other spurious emissions that can cause interference to other communications systems.

The U.S. civilian government has not systematically assessed electromagnetic noise levels since a limited study over 20 years ago.³ During this interim, the commercially viable range of radio frequency devices has significantly expanded.⁴ Our understanding of noise levels in these newly utilized bands is incomplete. Adding to the uncertainty is the existence of only limited academic or empirical studies elsewhere on the state of the noise floor.⁵ A recent Canadian study suggests relative stability in the noise floor over the past 20 years,⁶ a fact which, if true, may be attributable to a significant decrease in noise contributions from power lines and automobiles over this period. Anecdotal evidence, however, suggests a rising level of radio frequency noise, perhaps attributable to the proliferation of consumer devices.

The regulatory limitations the Commission places on intentional and unintentional emissions are premised on long-standing assumptions about the relative ambient environmental noise. Given the dated nature of the Commission's knowledge underlying those assumptions, as new and

¹ Smith, Albert A., *Radio Frequency Principles and Applications: The Generation, Propagation, and Reception of Signals and Noise* (IEEE 1998) Chapter 5 at 111, 125, 127.

² *Id* at 130.

³ A.D. Spaulding and R.T. Disney, "Man-Made Radio Noise, Part 1, Estimates for Business, Residential and Rural Areas," U.S. Dept. of Commerce, Office of Telecommunications, Institute for Telecommunications Sciences, OT Report 74-38, June 1974. *See also* E.N. Skomal, *Man-Made Radio Noise*, Van Nostrand Reinhold Co., New York, 1978.

⁴ Rather than using primarily the 30 MHz to 3 GHz bands, communications devices now utilize spectrum up to and including the oxygen absorption bands at 70 GHz.

⁵ *See* Smith, *op.cite.* note 2; "Long-term survey of the background electromagnetic environment in Switzerland" by Bauman, J., Behrman, and Garbe.H. (Bern, Federal Office of the Environment:1991); and "GPS Risk Assessment Study; Final Report" Applied Physics Laboratory, The Johns Hopkins University: January 1999 (Report VS-99-007).

⁶ W.R. Lauder, J.M. Bertrand, and P.R. Bouliane, "An Update of CCIR Business and Residential Noise Levels," *1994 IEEE International Symposium on Electromagnetic Compatibility Record*, Chicago, Aug. 22-26, 1994.

innovative radio communications devices emerge it is becoming increasingly important that the Commission base its decisions on a reliable assessment of the noise floor within the United States and its territories. In examining technical limitations, the Commission must determine whether certain restrictive limitations should be relaxed because the incremental noise contribution is insufficient to justify the economic and innovation burdens associated with the restrictions, or whether certain limitations should be continued or even increased because the incremental noise increase could impair the efficacy of existing systems.

As we head into the next millennium and as the Commission grapples with new and innovative communications technologies, it is essential that the Commission better understand the state of the current noise floor, the direction electromagnetic noise is headed in the overall environment, and the impact of radio emissions on the efficacy of telecommunications systems.

III. ACCESS TO TELECOMMUNICATIONS BY PERSONS WITH DISABILITIES

REQUEST: Please evaluate the current technical trends in telecommunications services and report to the Commission any changes that might decrease, rather than increase, the accessibility of telecommunications services by persons with disabilities. Please also recommend how the FCC might best communicate to designers of emerging telecommunications network architectures, the requirements for accessibility.

BACKGROUND: Telecommunications networks in the United States are going through major technological changes. These changes include shifts from analog to digital transmission, from circuit switching to packet switching, from narrowband to broadband, from intelligence and control within the network to more intelligence and control in powerful processors at the edge of the network, and from wired to wireless communications in many applications.

As observers have pointed out, these developments hold out the promise of significantly increasing the ability of people with disabilities to access and use information more readily and to interact more widely with all members of society. Properly applied, the technology can make their disabilities invisible or irrelevant and thereby allow them to more fully participate in, and contribute their talents to, the community at large. On the other hand, these technological developments can prevent persons with certain disabilities from gaining access to needed information, from using the information, and from communicating more readily. A key provision of 1996 Act is Section 255, which addresses the needs of the 54 million Americans with disabilities by requiring telecommunications service providers to ensure that service is accessible to and usable by individuals with disabilities, if readily achievable.

IV. NETWORK INTERCONNECTION

REQUEST: Please assess and report to the Commission, from a technical/economic perspective, telecommunications common carrier network interconnection scenarios that are likely to develop. Descriptions of these scenarios should include the technical aspects of cross network (i.e., end-to-end) interconnection, quality of service, network management, reliability, and operations issues, as well as the deployment of new technologies such as dense wave division multiplexing and high speed packet/cell switching.

BACKGROUND: One key to the explosive growth of the Internet has been widespread interconnection through open interfaces. A central part of the Telecommunications Act of 1996 was directed to creating competition to incumbent local exchange carriers ("ILECs") by requiring network interconnection and network interoperability. In particular, Section 251(a) of the Act requires all common carriers to interconnect and Section 251(c) imposes additional interconnection obligations on ILECs, including the requirement that ILECs interconnect with other carriers at any technically feasible point. Section 256 of the Act charges the Commission with the responsibility of taking appropriate steps, on a continuing basis, to ensure that appropriate planning will occur in order to achieve interoperability among different networks.

Today, the Commission addresses the interconnection of circuit switched voice networks of ILECs with other local exchange carriers and interexchange carriers through detailed regulations, and the Commission regulates the interconnection of point-to-point private lines among ILECs and other carriers in a similar manner. In contrast, the Commission has chosen not to impose identical regulations concerning the interconnection of Internet protocol networks, and the Commission has not yet been called upon to impose technical regulations that are uniquely directed to the issues that are associated with optical interconnection.

The exploding demand for bandwidth, together with rapid advances in optical and other telecommunications technologies, imply that the technical interconnection issues of tomorrow may be very different from those that the Commission has addressed in the past. In the future, the Commission will be called upon to decide where competitive market forces, rather than regulation, will meet the requirements of the Act. If market forces are not then sufficient to address the Act's requirements in one or more areas, the Commission will then have to determine how best to address that issue.

V. NETWORK ACCESS

REQUEST: Please assess and report to the Commission the technical viability and likely time frames for the future availability of broadband access technologies to small businesses and residences, both in rural as well as urban/suburban areas. Please include assessments of digital subscriber lines using twisted pair copper loops, cable modem technology, optical fiber to the customer, broadband terrestrial wireless, satellite, digital power line, and other broadband access

technologies. Please also identify any impediments that may exist to the successful deployment of each of these broadband access technologies. Please address both the physical transport of information between the customer and an external network and the logical control and signaling structure (including functions related to customer service and network management) associated with those functions.

BACKGROUND: Section 706 of the 1996 Telecommunications Act ("Act") charges the Commission with determining the extent to which advanced telecommunications capabilities are available to all Americans and, as appropriate, with taking pro-active steps to ensure deployment of advanced telecommunications capabilities throughout the United States. On January 29, 1999, the Commission submitted its first report on this subject to Congress. The report concluded that competitive market forces were working quite well for medium to large business markets, particularly in large metropolitan areas. The report further concluded that there was evidence that the deployment of advanced telecommunications capabilities to small businesses, residential Americans, and rural America was beginning, but that the deployment of advanced services to those customers would need careful monitoring to determine whether action by the Commission should be taken in the future.

To enable the Commission to assess more accurately how it should prioritize resources to achieve broadband access to all Americans, the Commission needs a thorough and accurate assessment of all new access technologies, particularly with respect to those access technologies that promise "break-through" performance.

To place this issue in perspective, when the Act was drafted in the mid-1990's, contemporary speculation suggested that video on demand from telephone companies and cable telephony from cable companies would lead to rapid local competition in both narrowband and broadband services. At the same time, however, little apparent effort was devoted to analyzing the effect of the Internet on the provision of, and demand for, narrowband and broadband access services.

Today, the United States is faced with a dramatic range of new technologies (including Internet based technologies) that have the potential to provide both broadband and narrowband access. Understanding these technologies -- and what the FCC can do to enable viable access technologies to thrive -- is essential to enabling the Commission to address its statutory mandate successfully.

Note that in FCC 99-5, the Report to Congress on Advanced Telecommunications Capabilities, that the Commission observed that the record, while sparse, suggests that multiple methods of increasing bandwidth are or soon will be made available to a broad range of customers. On that basis, the Commission sees no reason to take action at this time on the issue of writing regulations related to interconnection among broadband access systems offered by cable operators and Internet service providers nor among Internet service providers.

7. Summary of Roundtable Discussion of Issues

Following the presentation of the FCC requests, members of the TAC roundtable discussed each issue. Results of that discussion are distilled and organized here to serve as a basis for future work. It is the intention of the summaries to reflect the individual views of the various TAC members, rather than represent a consensus per se.

7.1 Spectrum Management

Current regulation of the electromagnetic spectrum, which assumes a fundamental scarcity of this resource, is implemented by assigning specific portions of the spectrum to a specific use. TAC should explore those new technologies which might allow the FCC to update this regulatory model so as to promote more efficient usage. In particular, there is anecdotal evidence that at any given time and place typically only a small portion of the radio spectrum is in active use, and for those channels that are in use, only a few are limited by the background noise level. In principal, therefore, it should be technologically possible to make greater use of the spectrum by exploiting these presumably unmined dimensions.

New technologies have been proposed to capitalize on these observations. Intelligent software-defined and controlled radios (e.g., cognitive radios) reportedly can dynamically seek out and inoffensively use otherwise unoccupied pieces of spectrum. Ultrawideband radios add new channels with very broadly spread signals. Ultrawideband thus not only reclaims otherwise unused spectrum but, by slightly raising the background noise level, reuses spectrum in active use by others. The FCC request for information on the status and impact of background noise from both intentional and unintentional sources will directly impact the future of ultrawideband. Some of the other points made by the TAC roundtable were:

- A systematic assessment of what is known about the current background noise level is required, together with an analysis of the effect of noise level on different systems. It will probably be necessary to recommend a measurement program.
- The roles of regulation and standards need to be revisited. New technology is removing much of the scarcity which motivated current regulation, while standards for new types of digital radios and modulation systems, if not properly configured, could severely impact our ability to make more efficient use of the spectrum. These issues are not constrained to the USA but require global harmonization.
- We need a complete inventory of all of the technologies beyond simple frequency division which allow sharing of the spectrum between various services and applications. For those techniques which result in incompatibilities with current or other proposed uses, technological fixes should be catalogued. Experiments should be proposed to resolve ambiguities and validate assumptions.
- What services will be enabled and what will be the value of the public benefit from increasing the available bandwidth?
- There is a broad range of reliabilities, blocking probabilities and communications dropout

rates required for different applications. How do metrics for these parameters relate to the various protocols and etiquettes that may be proposed? How do we take quality of service into account? Can mission critical applications ever share spectrum with less sensitive uses?

- Although the isolated application of technologies such as ultrawideband may be relatively innocuous, the scaling laws for high usage must be well understood before widespread use is sanctioned. Management algorithms and etiquettes based on scaling laws and interference effects will need to be promulgated. Experience with resource sharing in the Internet will be invaluable.
- When multiple users share the same band, the noise floor for all users rises and the cost which might rightfully be attributable to one of the users is, in effect, transferred to another. “There is no free lunch”. For heavily occupied portions of the spectrum, it is still questionable if a net long term gain in capacity will actually be achieved if some of the newer technologies are deployed on a very large scale. Spectral sharing may also impinge on the property interests of spectrum obtained at auction. Can a responsible transition plan be proposed?
- Intelligent devices such as cognitive radios could be programmed to locate themselves in space and time, consult databases, measure the local environment, and select from menus of power levels bandshapes and coding techniques to fit the available spectral space. Complex management stratagems could be implemented so as to harmonize with other users with other priorities or requiring different qualities of service. Signals could be designed so the origin could be located, identified and be held accountable. With the speculation of all of this functionality, TAC must give to the FCC technologically defensible assessments of feasibility, timescale, complexity and futureproofness so that new regulatory concepts will be soundly based.

Finally, understanding and measurement of the noise floor could lead to a relaxation of Part 15 requirements to the benefit of implementers of circuits of all kinds.

7.2 Access to Telecommunications by Persons With Disabilities

A possible and beneficial outcome of a TAC analysis of this problem would a comprehensive set of “awareness points” against which new designs could be measured. The objective would be to incent designers of new equipment to consider at the conception stage how all products would be used by persons operating under constrained conditions. This would not only minimize the need for (and cost of) ancillary assistive apparatus by persons with disabilities, but make the products more valuable to the general population. Television closed captions are an example of an assistive introduced to compensate for a disability but found to be more generally useful by everyone.

- The Commission is required by statute to take special action relative to people with disabilities. Because some of these issues relate to the design of customer equipment, and because of differences in the scope of regulation for different communications modalities, the FCC will have to carefully define the terms of reference for this work.
- There is the general feeling that as we evolve to a new infrastructure, many of the difficulties of adaptation for the disabled can be avoided if the problem space is correctly articulated in

advance so designers will have clear objectives.

- There are many categories of people requiring assistance (e.g., visual, hearing, etc.) and many citizens have multiple disabilities. If we add to this requirement benefits to the nondisabled, it makes good economic sense for designers to consider how their products will be used by all persons who may be operating under constrained conditions.
- There is an ongoing concern that as new technology is introduced the problems of the disabled will be magnified. As an example, cooking range adjustments using pushbuttons coupled to digital readbacks instead of tactile rotary knobs are unusable by the blind, and could be the forerunner of all appliance controls. Conversely, the introduction of new technology could be the vehicle for vastly easing the problems of the disabled.
- TAC should recommend what needs to be accomplished and not how to do it. TAC could consider how one might structure (for products or infrastructure systems) a “Usage by the Disabled Impact Statement.”
- As America’s population ages, it is likely that most of us will become citizens with disabilities.

7.3 Network Interconnection and Access

Fairly implemented competition can solve most problems, but we have found that rules are required to efficiently define interfaces between entities if the playing field is to be made universally accessible. The problem of defining interconnection points and protocols is exacerbated by the proliferation of new technologies, nonequivalent architectures, and an ever expanding set of service requirements. TAC should provide guidance to the FCC on the efficacy of (and special issues created by) new technology which may be introduced both in access and core networks of all types (wireline, fiber, wireless satellite, etc.)

- The Internet has replaced regulation with competition. It created interoperability and fostered competition by defining a minimalist interface at the lowest possible level for the purpose. This is a good model, but we should recall how this structure grew from the greenhouse of the Arpanet.
- We should structure results so as little regulation of interconnections as possible is required. Only interfaces that are universal in a simple way and relatively agnostic to technological evolution are likely to be viable. We want to enable competition among totally different kinds of infrastructure.
- A good model for interconnection rules would probably include the minimum level of specification at each logical layer needed to insure interoperability. Specifications, for instance, at just the physical layer would be inadequate if service guarantees required signaling interchange also. By the same token, it should be possible to interconnect systems without exposing all the layers, or with some upper layers missing.
- Interconnection standards should allow for the compatible insertion of unique proprietary elements so that the entire market will not become commoditized. Standards which permit multiple options to achieve exactly the same result should be avoided. Rather than promoting freedom, alternate modes usually hinder progress by adding cost and creating confusion
- When voice was the only service, universal service was easy to understand. Voice now is just a data type. We need to explore the options for defining what we mean by universal

access. If groups of services are bundled or provided by nonregulated technologies, the cross-subsidy structure built into current regulations will need revisiting. TAC should confine its deliberations to technical issues, but these issues inevitable have policy considerations that we need to be aware of.

8. Procedure for technical work

Members of TAC are invited by the FCC as individuals to participate as volunteers. They may not be represented by alternates on the TAC, however, anyone may attend the open meetings as a member of the public.

Work items are initiated by written requests from the FCC. TAC members or the public may suggest new items for the Commission's consideration. After initial presentation and roundtable discussion at a regular TAC meeting, focus groups are established with a designated "moderator" to continue work on one or more of the requests. Individual TAC members may volunteer for any focus group. Each focus group establishes a publicly viewable web site so work in progress can be posted by the moderator. A first task for each moderator is to propose the "terms of reference" for the group. The FCC will modify the terms of reference for the work that will be performed, as appropriate. That document, after iteration and approval by the DFO, defines the scope of work for the group and the expected deliverables.

Moderators may choose to create subgroups or consult outside experts for input. It is expected that certain preliminary work will involve personal communications, but every effort will be taken to assure openness via the website as documents reach maturity. In any case, work of the focus groups will be nonbinding input to the full TAC which, after open discussion, will be responsible for recommendations to the FCC. These recommendations, which may contain a spectrum of opinions, will take the form of annotated viewgraphs with supporting documentation.

9. Additional issues suggested by the group

- What effect will new technology have on reliability? What critical infrastructure protection issues should be addressed?
- What techniques are available to provide universal number portability across *all* systems?
- What special problems might arise from nontraditional forms of infrastructure, such as atmospheric platforms?
- What advice can we give to the FCC in dealing with issues which are so intrinsically complex that total knowledge becomes impossible?
- How should we approach the total globalization and emerging borderless nature of telecom?
- What does technology enable in the area of privacy preservation and trust management?

10. Going forward plan

Focus Groups have been formed with moderators designated. *See Annex 4.* Moderators should propose exact terms of reference immediately for DFO approval. Work plans for each group should be established targeted for initial readout at the next general meeting, scheduled for September 22, 1999. There is a specific request that more complete findings on spectrum management be available by the September meeting so the FCC can start a Notice of Inquiry. It is expected that the total Council will meet formally approximately three times per year.

Prepared by J. A. Bellisio

Approved by R.W. Lucky

May 26, 1999

Annex 1: Meeting Videotape

A VHS videotape of the April 30, 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: Biographies of members

BRUCE M. ALLAN
Vice President and General Manager
Harris Corporation

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JOSE M. ALVAREZ CABAN
Assistive Technology Specialist
Puerto Rico Assistive Technology Project

Mr. Alvarez is an Assistive Technology Specialist working for the Puerto Rico Assistive Technology Project (project sponsored by RESNA) at the University of Puerto Rico, Medical Science Campus. He deals with issues of accessibility of telecommunications for Spanish speaking persons with disabilities and their special need to access different types of technologies. He also advises the Puerto Rico Government, Communications Central Office in accessibility aspects for persons with disabilities in their implementation of the Puerto Rico information System (PRIS). He also writes guidelines to make the government's web pages accessible to blind and handicapped individuals. Jose also advises the Puerto Rico Government, Education Department, Technology Committee on computer accessibility for students with disabilities in all public schools in Puerto Rico, which includes adaptation of computers and software to be accessible for students with special needs; Bank Popular de Puerto Rico on accessibility aspects for their consumers with disabilities in their ATM machines, electronic banking software, and its web page; University of Puerto Rico on accessibility aspects related to its web page and students with disabilities. Mr. Alvarez also gives training and seminars to persons with disabilities, parents of persons with disabilities, related professionals and government office employees related to accessibility and Assistive Technology. Mr. Alvarez is currently working on a Master's degree thesis that is related to accessibility of visual technologies (like ATM machines, Windows

GUI Operating Systems and Internet web pages) for blind persons. He is part of the W3C mailing list group and the SIG 19 Committee.

Jose, who is legally blind, represents the interest of Hispanic consumers with disabilities and special needs by making recommendations to companies and providers of telecommunications equipment and services to improve their accessibility for persons with disabilities. He has designed a Spanish web page specially to help handicapped individuals access the Internet and other types of technologies. The web page has been in several news stations, recently appearing in the BBC news agency of Londres and was reviewed for its accessibility information for persons with disabilities to access new technologies in Spanish language. The web site is: <http://home.coqui.net/jalvarez/>. Mr. Alvarez also writes computer programs designed for blind individuals, which are in Spanish, to help blind individuals overcome their English language barrier (most Assisive Technology software is in English).

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JULES A. BELLISIO
Chief Scientist and Fellow-Executive Director, Applied Research
Telcordia Technologies(formerly Bellcore)

Jules A. Bellisio, Chief Scientist and Executive Director, Applied Research, Telcordia Technologies, manages the research program as it relates to emerging networks. During his engineering career, which started in 1962 at Bell Telephone Laboratories and has included design for manufacture as well as exploratory development, he has worked on a broad spectrum of electronic and transmission problems ranging from data modems to lightwave systems. At Bell System divestiture, he joined Bellcore to establish the Digital Signal Processing Research Division. In his current assignment, he is developing many of Telcordia's next generation consulting and engineering opportunities, especially in the area of wireless. He is the originator of the "sliding payload" concept central to SONET/SDH transmission systems, invented the phase-frequency locked timing extractor widely used in baseband digital repeaters, and was the principal engineer of the digital television lightwave system used for most of the contribution quality TV feeds at the 1984 Olympic Games. Bellisio and his staff have made key contributions to Broadband/ATM standardization and to HDTV, video compression and ADSL systems

Bellisio was born in Brooklyn, New York; he received the BSEE degree from the Polytechnic Institute of Brooklyn, the SMEE degree from the Massachusetts Institute of Technology, and was awarded the Ph.D. from Yale University. Dr. Bellisio is a Telcordia Fellow, a Fellow of the IEEE, a member of the Society of Motion Picture and Television Engineers, and a member of the European Association for Signal Processing. Jules and his wife Carol, a college professor, live in rural New Jersey and have three daughters.

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VINTON G. CERF
Senior Vice President, Internet Technology and Architecture
MCI WorldCom

Vinton Cerf, also known as “Father of the Internet,” is Sr. Vice President of Internet and Architecture and Technology. His team of architects and engineers design advanced Internet frameworks for delivering a combination of data, information, voice and video services for business and consumer use. Prior to rejoining MCI, Mr. Cerf was vice president of the Corporation of National Research Initiatives (CNRI), vice president of MCI Digital Information Services where he led the engineering of MCI Mail, and prior to that Vinton was with the U.S. Department of Defense’s Advanced Research Projects Agency (DARPA), where he played a key role leading the development of Internet and Internet-related data packet and security technologies. He holds a Bachelor of Science in Mathematics from Stanford University, Master of Science and Ph.D. in Computer Science from UCLA, honorary doctorate degrees from Swiss Federal Institute of Technology, Zurich; Lulea University of Technology, Sweden; University of the Balearic Island, Palma; Capitol College and Gettysburg College. Cerf also holds an appointment as distinguished visiting scientist at the Jet Propulsion Laboratory, where he is working on the design of an interplanetary Internet.

Mr. Cerf was previously the founding President of the Internet Society, and now serves as its Chairman of the Board. He is also a member of the U.S. Presidential Information Technology Advisory Committee (PITAC) and the Advisory Committee for Telecommunications (ACT) in Ireland, on the Board of Directors for the Endowment for Excellence in Education, Gallaudet University, Interprophet and Hybrithms Corporations and is a fellow of the IEEE, ACM, and American Association for the Advancement of Science, the American Academy of Arts and Sciences and the National Academy of Engineering. Mr. Cerf is the co-designer of the TCP/IP protocol. In December 1997, Mr. Cerf and his partner, Robert E. Kahn, received the U.S. National Medal of Technology for founding and developing the Internet. He is also the recipient of Marconi Fellowship, the Alexander Graham Bell Award, the NEC Computer and Communications Prize, the Silver Medal of the International Telecommunications Union, the IEEE Alexander Graham Bell Medal, the IEEE Koji Kobayashi Award, the ACM Software and Systems Award, the ACM SIGCOMM Award, the Computer and Communications Industries Association Industry Legend Award, the Yuri Rubinsky Web Award, the Kilby Award and the Yankee Group/Interop/Network World Lifetime Achievement Award.

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SUSAN E. ESTRADA
President & Founder
Aldea Communications, Inc.

Susan Estrada an innovator and entrepreneur, an Internet pioneer, was named a "thinking nerd" by colleagues. Seeking to support growth of the Internet, Susan founded Aldea Communications, Inc. in July 1993. Aldea's focus is on strategic Internet communications strategies. It provides professional and technical services to its clients which include CENIC, the University of California, California State University, Hughes, AT&T InterNIC, Network Solutions, Cisco Systems, AT&T Jense, Pacific Bell, and Bell South. In addition to client services, Susan focuses on seeking out research and development opportunities for Aldea with regard to the future Internet. She has a deep interest in emerging Internet technologies and making those technologies work to solve real-world problems. Current areas of interest include allocating, accounting, and billing in a QoS-enabled Internet. Aldea's current projects focus on higher education and the next generation Internet. Susan, along with other Aldea's staff, is providing administrative and technical support services to The Consortium for Education Network Initiatives in California (CENIC), which includes working with knowledgeable technical folks at CENIC's universities to develop plans for research and design of its high performance network, CalREN-2. Aldea created the content and design for the web sites *InterNIC Academic Guide to the Internet* and the *InterNIC Guide to U.S. Universities* under AT&T's InterNIC Directory and Database Services NSF cooperative agreement.

Susan wrote *Connecting to the Internet, An O'Reilly Buyer's Guide*, in August 1993 (a Barnes and Noble bestseller.) Susan founded CERFnet, an Internet service provider, in 1988. During her 5-year tenure as the CERFnet executive director, she was instrumental in CERFnet's user growth from 25 university members to hundreds of corporate members and thousands of individual users. CERFnet developed a number of notable firsts for the Internet including the first deployment of dialup IP, accounting reports for customers, interconnection enabling commercial traffic via the CIX, and high quality service. She currently is an elected Trustee of the Internet Society and an appointed member of Pacific Telesis's Telecommunications Consumer Advisory Panel (TCAP) and the U.S. Federal Networking Council's Advisory Committee (FNCAC). Susan was a founder of the Commercial Internet Exchange (CIX), on the U.S. Federal Networking Council's Advisory Committee (FNCAC), and a former area director for the Internet Engineering Software Group (IESG) and the Internet Engineering Task Force (IETF). She is listed in the 1998-1999 Edition of *Who's Who in Executives and Professionals*. As a parent of two children, Susan is strongly committed to enhancing educational programs using communications technology. Susan played an instrumental role by co-founding the Global Schoolhouse and organizing the California branch of Tech Corps.

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BRAN FERREN

President, R&D and Creative Technology Walt Disney Imagineering

Bran Ferren is President, R&D and Creative Technology Walt Disney Imagineering, a new resource for new technology invention and creative input for the entire company. Ferren's responsibilities, which include a broad range of assignments, also include overseeing all R&D activities on both coasts. Mr. Ferren is a nationally recognized award-winning designer/technologist working in theater, film, special effects, product design, architecture and the sciences. Prior to his current position, Mr. Ferren was a consultant to Walt Disney Imagineering while heading his own firm founded in 1978, Associates & Ferren. The company specialized in research and development, creative design, engineering, and execution of projects and systems for the visual and performing arts, as well as for industry and the sciences. A&F became a part of Walt Disney Imagineering in 1992.

Mr. Ferren attended Massachusetts Institute of Technology. He holds memberships on the Government-University-Industry Research Roundtable of the National Academy of Sciences and the International Design Conference in Aspen's (IDCA) Board of Directors. He is also a member of the Army Science Board, The National Reconnaissance Organization Advisory Council, the National Security Agency Science Advisory Board, the Senate Select Committee on Intelligence Technical Advisory Group, and is also a voting member of the Academy of Motion Picture Arts and Sciences and the Academy of Television Arts and Sciences. Bran has won numerous awards for his work in film and theater, including the Academy of Motion Picture Arts and Sciences, the New York Drama Desk, the Los Angeles Critics' Circle and the Maharam Foundation Annual Theater. Also, a popular guest lecturer, Mr. Ferren has addressed over 100 professional groups in the entertainment, business and scientific community.

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RICHARD R. GREEN

President & CEO

CableLabs

Dr. Green is President and CEO of CableLabs and has held this position since CableLabs' establishment in 1988 as an R&D consortium of cable operators. In his current position, he heads the organization responsible for charting the cable television industry's course in technology.

Dr. Green is a member of Phi Beta Kappa, the American Association for the Advancement of Science, and the Society of Motion Picture and TV Engineers. He holds a B.S. from Colorado

College, a M.S. in physics from the State University of New York in Albany, and a Ph.D. from the University of Washington.

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CHRISTINE HEMRICK
Vice President, Technology Communications
Cisco Systems, Inc.

Christine Hemrick is Vice President of Technology Communications, responsible for strategic technology planning and communications at Cisco Systems, Inc. She has also held a number of other positions at Cisco, which included Director of IOS Marketing and Vice President and General Manager of the Internet Appliances and Applications Business Unit. Prior to joining Cisco, she was District Manager for Data Communications Planning at Telcordia Technologies, formerly Bellcore; Senior Staff member at the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce; served as Head of the U.S. delegation to the CCITT Study Group VII, responsible for international data communications standards such as X.25, X.400, and Open Systems Interconnection. Before joining NTIA, Ms. Hemrick also held positions at GTE Telenet (now Sprint) and Digital Equipment Corporation.

Ms. Hemrick has achieved peer recognition as a technical expert. Her experience working on technical issues both for the government and for different segments of the telecommunications industry give her the kind of broad perspective necessary to develop an integrated approach to the convergence of once-distinct services. As a member of the Council, she will represent the interest of high technology companies (such as Cisco) that are designing, constructing, and deploying equipment for advanced telecommunications systems, especially those involving packet-mode communications.

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DEWAYNE L. HENDRICKS
General Manager
Com21, Inc.

Dewayne Hendricks is General Manager, Wireless Business Unit at Com21, Inc. Prior to that, Mr. Hendricks has held the positions of Founder/President/CEO of Tetherless Access Ltd., Warp Speed Imagineering; and Veritas Technology, Inc.; Co-principal Investigator for NSF funded Wireless Field Test Project; Consultant for Premenos Corp., Apple Computer, IBM, and Clinton Woodworth Associates, and also Manager of System Software at Two Pi. He has held assignments such as designed and implemented a TCP/IP package for the Apple Macintosh,

designed and developed a PROFS to Apple Macintosh electronic mail application; designed a major time-sharing operating system based on IBM's VM/370; developed the product plan and architecture for a database back-end processor; designed and developed predecessor of the VM/VS Handshaking feature in IBM's VM/SP control program among many others.

Mr. Hendricks received a B.S. in Psychology and Mathematics from Wayne State University in Detroit. He was listed in MicroTimes Magazine's "Top 100 List" and Upside Magazine's "Top 100 People in the Industry." He was also Chairperson for Tucson Amateur Pack Radio (TAPR) Regulatory Affairs Committee and the Part 15 Coalition, FCC Regulatory Committee and a member of American Radio Relay League (ARRL) Future Systems Committee.

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ROSS IRELAND

***Vice President, Network Planning & Engineering
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Mr. Ross Ireland is Vice President, Network Planning & Engineering. Mr. Ireland has extensive experience as a technologist with 30 years of Communications Operating and Engineering background. He is Chief Engineer for the SBC 8-state wireline communications business including switching, transport, loop planning and engineering. He has also served as Chairman of the first Network Reliability Steering Committee.

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CHARLES L. JACKSON

Independent Consultant

Before becoming an independent consultant, Dr. Jackson was staff engineer for the Communications Subcommittee of the U.S. House of Representatives; special assistant to the Chief of the Common Carrier Bureau and engineering assistant to Commissioner Robinson at the Federal Communications Commission. He has also worked as a digital designer and computer programmer. After leaving government, Dr. Jackson cofounded both the telecommunications consulting firm of Shooshan & Jackson Inc., whose practice was later combined with that of National Economic Research Associates, Inc., and Strategic Policy Research, Inc. Dr. Jackson has served as an expert witness in litigation on cellular telephony, cable television, and other telecommunications and computer issues and has testified before several state utility commissions and before Congress on technology and telecommunications policy. He has authored or co-authored numerous studies on public policy issues in telecommunications and has written for professional journals and the general press, with articles appearing in publications ranging from *The IEEE Transactions on Computers* to *Scientific American* to *The St. Petersburg Times*. Over the last several years, he has directed or participated in projects on acquisition analysis, market planning, and product pricing. He holds a U.S. patent on an alarm signaling system.

Dr. Charles L. Jackson received a B.A. degree from Harvard College with honors in applied mathematics and M.S., E.E., and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology. At MIT, he specialized in operations research, computer science, and communications. While a graduate student at MIT, he held the faculty rank of Instructor, taught graduate operations research courses, and was codeveloper of an undergraduate course in telecommunications. Dr. Jackson is a member of the IEEE, the Internet Society, the American Mathematical Society, and Sigma Xi. He is an adjunct professor of electrical engineering and computer science at George Washington University, where he teaches a graduate course in mobile communications. From 1982 to 1988, he was an adjunct professor at Duke University.

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KALLE R. KONTSON

Vice President, IIT Research Institute

Division Manager, Center for Electromagnetic Science

Mr. Kontson is Vice President of IIT Research Institute and Division Manager for IITRI's Center for Electromagnetic Science in Lanham, Maryland. His responsibilities include directing projects to apply advanced spectrum management and digital radio systems technologies to enhance both commercial and Department of Defense systems performance, primarily in the areas of spectrum management, spectrum access and spectrum efficiency. He is a member of the US Army Science Board, and was recently selected for membership in the Technological Advisory Council of the Federal Communications Commission.

Mr. Kontson has over 25 years experience in communications theory and engineering, spectrum engineering, and spectrum management and automation systems. He has led numerous engineering projects dealing with commercial wireless telecommunications, including the application of analysis and design methods to high capacity digital systems for video and wireless Internet access. Mr. Kontson has a Bachelor of Science and a Master of Science degree in Electrical Engineering from Rensselaer Polytechnic Institute, Troy, New York, and a Juris Doctor degree from the University of Baltimore School of Law, Baltimore, Maryland.

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WILLIAM C. Y. LEE

Chief Scientist

Air Touch

Dr. William C. Y. Lee is Vice President and Chief Scientist of Strategic Technology at AirTouch Communications. Dr. Lee is recognized worldwide for developing technologies and standards for the wireless industry. Dr. Lee joined AirTouch Communications (formerly PacTel Mobile Companies) in April 1985 to develop improvements in system performance and capacity. In 1989, Dr. Lee headed the technology team that won the PCN license in the UK for the AirTouch Consortium. Prior to joining AirTouch Communications, Dr. Lee worked for ITT Defense Communications Division (ITTDCD). In his position as senior scientist, he focused on the development of advanced programs for various military communications systems. He developed several simulation programs for the multipath fading medium and applied them to ground mobile communication systems. In 1982, he was promoted to Manager of the Advanced Development Department and became responsible for the pursuit of new technologies for future communication systems. Dr. Lee also worked with Bell Laboratories and was with the satellite communication research department where he derived a method to calculate the rain rate statistics that would affect signal attenuation at 10 GHz and above. Early in his career, Dr. Lee worked as a research assistant at the ElectroScience Laboratory at Ohio State University.

Dr. Lee received his Ph.D. from Ohio State University in 1963. He was the founder and co-chairman of CTIA's sub-committee for Advanced Radio Technologies, Dr. Lee was elected an IEEE Fellow, Radio Club of America Fellow, and a distinguished alumnus of Ohio State University. He is a board member of IEEE Vehicular Technology Society. He was named an honorary professor at both the Beijing University of Aeronautics and Astronautics, and at the National Chiao Tung University of Taiwan. Recently he was appointed by the State of California as a member of the California Council on Science and Technology. He is also a member of the U.S.A. National Council of Competitiveness. Dr. Lee has received several distinguished awards which include the Bell Labs Dedicated Service Award, the ITTDCD Technical Contribution Award, the Ohio State Distinguished Alumni Award, the IEEE VTS Avant Garde Award, the IEEE Vehicular Technology Society Service Award and also shared his CDMA Industry Achievement Award with Dr. Andy Viterbi for his technical achievements.

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PAUL F. LIAO

Chief Technology Officer and President

Panasonic Technologies, Inc.

Dr. Paul F. Liao is Chief Technology Officer, Matsushita Electric Corporation of American (d/b/a "Panasonic"), and President, Panasonic Technologies, Inc. Dr. Liao is responsible for technology direction and research and development for the Matsushita Group in North America, including supervision of the corporation's venture capital activity. His key areas of

interest/expertise are telephony and data packet network systems; digital voice/data networking, storage and systems; television production, transmission and reception, especially digital and high-definition TV (broadcast, cable, satellite, etc.); advanced display technologies; computer networks and advanced communications systems. Dr. Liao has considerable experience in managing the technical, personnel and financial resources for success with new products and services. As senior scientist for a large and diverse manufacturing and marketing company, Dr. Liao is skilled at distilling and synthesizing complex information, for both analytical and presentation purposes. Prior to joining Matsushita and Panasonic, he held a number of positions at Bell Communications Research (Bellcore) and Bell Laboratories including Vice President for Emerging Networks; Division Manager for Physics and Optical Sciences Research, Assistant Vice President of the Solid State Research Laboratory, the Network Systems Research Laboratory, and the Network Architecture and Foundations Center. At Bell Laboratories, he conducted research on nonlinear optics, laser spectroscopy, laser materials and microstructures, and served as Head of the Quantum Electronics Research department.

Dr. Liao received a B.S. degree in physics from the Massachusetts Institute of Technology and a Ph.D. degree in physics from Columbia University. He has been involved in technology research and management for over 20 years. Dr. Liao serves on the board of directors of the Information Technology Industry Council (ITI), and is also a member of the Board of Directors for several companies affiliated with Matsushita Electric Industrial Co., Ltd. He also serves as Director for Lightage, Inc. and has testified before Congress on digital television. He is a fellow of International Electrical & Electronics Engineers, American Physical Society, and Optical Society of America. He has been awarded 12 U.S. patents, authored or co-authored more than 75 professional papers, and participates regularly on a range of industry panels and seminars. Dr. Liao is a former president of the IEEE Lasers and Electro-Optics Society, and former editor of the *Journal of the Optical Society of America B: Optical Physics*, and co-editor for the Academic Press Series entitled *Quantum Electronics* and has served as a member of the Board of Trustees of Brookdale Community College in Lincroft, NJ.

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Wah L. Lim
Vice President, Technology and Development
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Dr. Lim is Vice President for Technology and Development for the world's leading manufacturer of commercial satellites. He is also integrally involved in technology issues on behalf of other Hughes Electronics companies, including DIRECTV and PanAmSat. Prior to joining Hughes, Dr. Lim was with Loral Space and Communications, where he was corporate vice president of technology and operations. Before Loral Space and Communications, he was with Northrop Corporation, Electronics Systems Division and before that 10 years were spent with Honeywell.

Dr. Lim born in China, grew up in Singapore, completed a Bachelor of Science degree in physics, and earned a Ph.D. in theoretical physics at the University of Minnesota. He is a well-known technical expert in satellite engineering, operation and construction.

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ROBERT W. LUCKY
Corporate Vice President – Applied Research
Telcordia Technologies

Robert W. Lucky is Corporate Vice President of Applied Research at Telcordia Technologies. Prior to his current position, Dr. Lucky started his career with AT&T Bell Laboratories where he was initially involved in studying ways of sending digital information over telephone lines. He then moved through a number of levels from Member of Technical Staff to become Executive Director of the Communications Sciences Research Division in 1982, where he was responsible for research on the methods and technologies for future communication systems. The best known outcome of this work was his invention of the adaptive equalizer - a technique for correcting distortion in telephone signals which is used in all high speed data transmission today. In 1992, he left Bell Labs to assume his present position at Telcordia Technologies.

Dr. Lucky attended Purdue University, where he received a B.S. degree in electrical engineering, and M.S. and Ph.D. degrees in 1959 and 1961. Dr. Lucky is a Fellow of the IEEE and a member of the National Academy of Engineering. He has been on the advisory boards or committees of many universities and government organizations, and was Chairman of the Scientific Advisory Board of the United States Air Force. He served as President of the Communications Society of the IEEE (Institute of Electrical and Electronics Engineers), and as Vice President and Executive Vice President of the parent IEEE itself. He has been editor of several technical journals, including the Proceedings of the IEEE, and since 1982 he has written the bimonthly "Reflections" column of personalized observations about the engineering profession in Spectrum magazine. In 1993 these "Reflections" columns were collected in the IEEE Press book Lucky Strikes ... Again. He is also the author of the popular book Silicon Dreams, which is a semi-technical and philosophical discussion of the ways in which both humans and computers deal with information. He is also a consulting editor for a series of books on communications through Plenum Press. Dr. Lucky is the holder of 11 patents. He was the 1987 recipient of the prestigious Marconi Prize for his contributions to data communications; awarded honorary doctorates from Purdue University and the New Jersey Institute of Technology, and also awarded the Edison Medal of the IEEE and the Exceptional Civilian Contributions Medal of the U.S. Air Force. Dr. Lucky is a frequent speaker before both scientific and general audiences. He has been an invited lecturer at about one hundred different universities, and has been the guest on a number of network television shows, including Bill Moyers' "A World of Ideas".

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ROBERT MARTIN
Chief Technical Officer
Bell Labs

Robert L. Martin is Chief Technical Officer at Bell Labs, the research and development organization of Lucent Technologies, a leading provider of telecommunications equipment. Mr. Martin plays a key role in pivotal technology development and strategy decisions. He is responsible for evaluating technological innovations in all phases of development and working to bring them to market quickly. Prior to his position as Chief Technical Officer, Mr. Martin held key positions in AT&T Network Systems and Telcordia Technologies, formerly Bellcore. Throughout the industry, Mr. Martin is widely recognized for his outstanding contributions in developing UNIX and for his achievements in the development of telecommunications operations support systems. He is also well regarded for his work in developing system software for the Safeguard Antimissile System. Mr. Martin serves as a member of the National Research Council, principal operating agency of both the National Academy of Sciences and National Academy of Engineering. Because of Mr. Martin's longstanding contribution in the development of new technologies, he was asked to testify before the U.S. Senate Science and Technology Caucus Roundtable in 1997 regarding the role of the federal government in fostering growth in technology.

Mr. Martin received a Bachelor of Science in Electrical Engineering from Brown University and Master of Science and Doctor of Philosophy degrees in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology. He also attended the MIT Alfred P. Sloan School Program for Senior Executives.

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DAVID C. NAGEL
Chief Technology Officer, AT&T Corp.
President, AT&T Labs

David Nagel is President of AT&T Labs, where he is creating a highly focused and innovative research effort for AT&T and overseeing the development of a new generation of Internet and other communications and information services. Also, as AT&T's Chief Technology Officer, Dr. Nagel advises the AT&T Operations Team and Chairman's Office on technology issues and chairs a company-wide Technology Strategy and Development Council. He is also responsible for IP technology development for AT&T. Prior to joining AT&T, Dr. Nagel was Sr. Vice President of Apple Computer where he lead its worldwide research and development group responsible for Macintosh hardware, Mac OS software, imaging and other peripheral products.

Before joining Apple's Advanced Technology Group in 1988, he was a research scientist and head of human factors research at NASA's Ames Research Center.

Dr. Nagel holds undergraduate and graduate degrees in engineering and a doctorate in experimental psychology all from the University of California, Los Angeles. In addition to a number of national and international advisory committees, he has served on the National Critical Technologies Panel and National Research Council Study Symposium. He is a member of the National Academy of Sciences Committee on Human Factors, was named to President Clinton's first Advisory Committee on High Performance Computing, Communication and Next Generation Internet. He also serves on the Board of Directors of the Tech Museum of Innovation in San Jose, California and the Kyle Foundation, and is a member of the Board of Trustees of the UCLA Foundation.

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GLENN REITMEIER
Vice President, DTV and Web Media
Sarnoff Laboratories

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DENNIS A. ROBERSON
Corporate Vice President and Chief Technology Officer
Motorola

Dennis Roberson is Corporate Vice President and Chief Technology Officer at Motorola. He is responsible to the CEO and Management Board for identifying, articulating, and leading the strategic and visionary business-based technology advancements that will be the foundation for the future growth of Motorola. Prior to his current position, Mr. Roberson joined NCR Corporation in 1994 as Vice President of the computer product systems unit. He later became Senior Vice President and Chief Technical Officer where his organization provided technology strategies and directions for NCR and functional guidance for its engineering team. Mr. Roberson's career began at AT&T Bell Labs, as a summer intern, where he designed the first digital display telephone. He then joined IBM as a logic design engineer in an advance systems development unit, and a number of projects that led to the development of the IBM personal computer. In 1986, Mr. Roberson was named Laboratory Director for the Burlington Laboratory and subsequently headed the Endicott Laboratory. At IBM he helped develop the first one-megabit memory chip. In 1988, Dennis joined Digital Equipment Corporation where he headed various software-related initiatives, serving as Vice President of Groupware and Vice President of Software.

Roberson graduated from Washington State University with a Bachelors degree in Electrical Engineering and Physics. He holds a Master of Science in Electrical Engineering from Stanford. Mr. Roberson serves as the Chairman of the Technology Policy Committee and the Science Advisory Board. He has served as the Chairman of the Board for The Open Group, and chairman of the Computer Systems Policy Project Chief Technology Officers Committee. He was a member of the Board of Directors and the Executive Committee of the Information Technology Industry Council (ITI). He was also a member of the Board of Directors of the South Carolina Research Institute, the Cultural Council of Richland and Lexington Counties, the Boy Scott Council, a member of the South Carolina Technology Advisory Council, the National Visiting Committee for the South Carolina Center of Excellence for Advanced Technological Education.

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MARVIN SIRBU
Professor
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GREGG C. VANDERHEIDEN
Professor/Director
University of Wisconsin-Madison

Gregg C. Vanderheiden is a Professor in the Industrial Engineering Department at the University of Wisconsin-Madison, and Director of the Trace Research & Development Center at the University. The Trace Center is the Rehabilitation Engineering Research Center on Information Technology Access, and a part of the RERC on Universal Telecommunications Access (both of which are funded by the National Institute on Disability and Rehabilitation Research). He is also the lead investigator for the National Computational Science Alliance's efforts focused on universal design of computation science and web infrastructure technologies, and principal investigator on over 100 grants and projects in the area of rehabilitation engineering, access to national information infrastructure and next generation information systems, computer access systems, and augmentative communication & writing systems for children and adults with disabilities. Dr. Vanderheiden has been working in the area of access to technology for over 25 years. His early work was in the field of Augmentative Communication, where he coined much of the terminology, including the term "augmentative communication." More recently, he has worked with the computer industry in getting it to build disability access features directly into their standard products. For example, the Macintosh OS has had access features since 1987,

OS/2 and the UNIX X Window system since 1993, and Windows 95, 98, NT and 2000 have almost a dozen Trace Center developed features in them. Dr. Vanderheiden's research currently involves the development and testing of guidelines and strategies for building access directly into the full range of information technologies and telecommunications systems.

Dr. Vanderheiden received a B.S. in Electrical Engineering from the University of Wisconsin-Madison (Magna Cum Laude), a M.S. in Biomedical Engineering Program, and a Ph.D. in Technology in Communication Rehabilitation and Child Development. He is a member of the Steering Committee of Web Accessibility Initiative (WAI) International Program, the National Information Standards Office (NISO) Digital Talking Book Standards Committee, Cost219 bis, a European consortium on ensuring access to next generation information systems, member of Consortium of Rehabilitation Engineering Research Organizations, founding member of International Committee on Accessible Documentation for People with Print Disabilities (ICADD), amongst numerous others. Dr. Vanderheiden was a member of the Telecommunications Access Advisory committee and the Electronic Information Technology Access Advisory Committee for the US Access Board, and served on the steering committee for the National Research Council's Planning Group on "Every Citizen Interfaces," and co-authored the NRC's More Than Screen Deep Report. At the 6th Annual International World-Wide-Web Conference in 1997, he was presented with the Yuri Rubinsky Memorial World Wide Web Award.

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JOHN F. WATERS, JR.
Vice President, Network Engineering
Level 3 Communications, Inc.

Mr. Waters is Vice President of Engineering, responsible for the architecture and design of Level 3's transmission and data and voice networks. Under Mr. Waters' leadership, Level 3 is developing the "soft switch" that will allow for seamless interconnection between IP networks and SS7 networks. Prior to his position at Level 3, Mr. Waters was a MCI Executive Staff member responsible for the architecture, design and implementation of MCI and Concert's Internet Services. He was also one of the original key contributors who designed and built MCI's initial Internet service. Mr. Waters area of expertise is also in the development of fiber and long haul networks. He has over ten years experience focusing on engineering and design of Internet technology and services.

Mr. Waters holds a B.S. in Electrical Engineering from West Virginia University and a M.S. in Electrical Engineering from John Hopkins University.

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PATRICK E. WHITE
Principal, Telecommunications, Information, Media and Electronics
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Patrick White is a Principal in the Telecommunications, Information, Media, and Electronics (TIME) Practice at Arthur D. Little, Inc. He is also affiliated with the Technology and Innovation Management (TIM) Practice. Mr. White's career spans a broad segment of communications, from R&D to network operator strategies. Early in his career, he helped develop the architecture for the fault recovery capability for a telephone switching system. He later led the software development for one of the world's first digital voice messaging systems. As part of the industry focus on fiber in the loop system for broadband entertainment, his R&D group co-developed the ATM protocol now widely used throughout the voice and data communications industries. Before joining Arthur D. Little, Mr. White was a Vice President of Research and Development at Bell Atlantic Corporation. Mr. White led Bell Atlantic's telecommunications strategy department and was the principal architect of the firm's Internet telephony strategy.

Mr. White is a frequent speaker at communications industry events and has published widely in industry technical journals. He was a past editor of articles on telecommunications switching systems for the *IEEE Communications Magazine* and was a guest editor for a special issue of the *Journal on Selected Areas of Communications* focused on broadband switching. He holds a Masters Degree and a Ph.D. in Electrical Engineering from Northwestern University. He is currently a member of the Advisory Board for the School of Engineering at Northwestern, and a past member of the Advisory Board for the Telecommunications department at Michigan State University. He is also distinguished as the first African American to graduate from Northwestern with a doctorate in engineering. Mr. White is based in Arlington, Virginia.

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ROBERT M. (BOB) ZITTER
Senior Vice President, Technology Operations
Home Box Office

Bob Zitter is Senior Vice President, Technology Operations for Home Box Office in New York. In his position, Bob is responsible for the company's worldwide distribution, origination,

production operations and engineering. In addition, he oversees HBO's new technology and satellite interests and focuses on new business development. He was responsible for the rollout of HBO's satellite encryption in 1985 and for HBO's introduction of digital compression technology in 1992. He is also one of the founders of HBO Ole', HBO Hungary and HBO Asia. Prior to joining HBO, Mr. Zitter was a cable operator and broadcaster with a mid-western based communications group, and previously supervised network operations for ABC-TV in New York.

Mr. Zitter has a B.A. degree from Colgate University and a M.B.A. degree from Frostburg State College in Maryland. He serves on the National Cable Television Association (NCTA)/Cable Labs Science & Technology Policy Caucus, the Satellite Broadcasting and Communications Association (SBCA) Technology Council, North American national Broadcasters Association Board of Directors, the Advanced Television Systems Committee, the Television Committee of the Consumer Electronics Association, and is past president of the Maryland-Delaware Cable Association. Bob presently serves on the Board of Directors of the North American National Broadcasters Union.

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**Annex 3: Advisory Committees Subject to the Federal Advisory Committee Act (FACA)
as
Amended (5 U.S.C., App. 2)**

A committee is an "advisory committee" subject to FACA if it is a committee, board, commission, council, conference, panel, task force, or other similar group, or any subcommittee or other subgroup thereof, which is established and utilized by any agency official for the purpose of obtaining advice or recommendations on issues or policies which are within the scope of the agency's responsibilities. An advisory committee is composed in whole or in part of individuals other than full-time officers or employees of the Federal Government.

The agency establishing an advisory committee must provide for balanced membership. For purposes of attaining balance, agencies shall consider for membership interested persons and groups with professional or personal qualifications or experience to contribute to the functions and tasks to be performed.

Advisory committees are to be established only when they are essential to the conduct of agency business. This depends on whether committee deliberations are expected to result in the creation or elimination of, or change in regulations, guidelines, or rules affecting agency business, whether the committee is likely to make recommendations resulting in significant improvements in service or reductions in cost, and whether the committee's recommendations will provide an important additional perspective or viewpoint impacting agency operations. Advisory committees are advisory only. They are not empowered to establish regulations.

An advisory committee shall be terminated whenever the stated objectives of the committee have been accomplished, the subject matter or work of the committee has become obsolete or excessively costly, or the committee's main functions have been assumed by another entity within the Federal Government. The committee may be terminated by agency decision, but even without such a decision the committee will automatically terminate within two years of its establishment, but can be renewed prior to its charter expiration date.

An advisory committee's meetings shall be open to the public. Fifteen day's advance public notice of meetings in the Federal Register is required. Notices may be less than 15 days if a justification is stated in the notice when it appears. However, in certain circumstances a meeting may be closed if it is determined proper and consistent with the provisions in the Government in the Sunshine Act, 5 U.S.C. 552(b). To close all or part of a meeting, an advisory committee shall submit a request to the agency head citing the specific provisions of the Government in the Sunshine Act (5 U.S.C. 552(b)) which justify the closure. The request shall provide the agency head sufficient time to review the matter in order to make a determination prior to publication of the meeting notice. If it is decided to close any part of the meeting, a statement to that effect must appear in the Federal Register within the 15 day notice period.

The agency head or the advisory committee chairperson shall ensure that detailed minutes of each advisory committee meeting are kept. The minutes must include:

- (1) Time, date, and place;
 - (2) A list of the following persons who were present:
 - (i) Advisory committee members and staff;
 - (ii) Agency employees; and
 - (iii) Members of the public who presented oral or written statements;
 - (3) An estimated number of other members of the public present;
 - (4) An accurate description of each matter discussed and the resolution, if any, made by the committee of such matter; and
 - (5) Copies of each report or other document received, issued, or approved by the committee.
- The chairperson of each advisory committee shall certify to the accuracy of all minutes of advisory committee meetings.

Under section 10(b) of FACA, records and other documents of an advisory committee shall be made available for public inspection and copying. Advisory committees are considered subject to the Freedom of Information Act (FOIA), which sets forth procedures for public access to documents and enumerates those circumstances in which documents may be withheld from disclosure.

Under applicable rules governing advisory committees, 47 CFR 101-6.1004(k), meetings of task forces or working groups convened solely to perform functions for an advisory committee or a subcommittee such as gathering information, developing work plans, performing studies, drafting reports and discussing preliminary findings are not considered advisory committee meetings and thus are not subject to the public notice and open meeting requirements of FACA.

In contrast, any subcommittee or other working group of an advisory committee which functions as though it were the parent advisory committee such as, for example, by (i) making decisions or consensual proposals that would be binding on the parent committee or function as the parent committee's own recommendations or (ii) providing recommendations directly to the agency, would itself be considered an advisory committee that needed to be chartered under FACA and would be fully subject to all the requirements of FACA.

The FCC staff is available to address questions from the TAC:

Contact Stagg Newman as the DFO. With respect to specific 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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Dennis Roberson	Dennis.Roberson@motorola.com
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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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