

Report : Seventh Meeting of the FCC Technological Advisory Council

0.0 Executive Overview

The Federal Communications Commission Technological Advisory Council (FCC TAC) held its seventh meeting on Wednesday, December 6, 2000 in Washington, D.C. As described in previous meeting reports, the Council is to provide scientifically supportable information on those emerging technologies likely to fundamentally impact the work of the FCC. The TAC is currently organized into three focus groups with moderators to address: spectrum management; network interconnection and access; and access to telecommunications by persons with disabilities. Each of these groups reported out findings developed in the interim and expanded each area during a roundtable discussion.

The TAC is chartered for two years at a time, and this meeting was the last one of TACs first two year cycle. Progress on the subjects outlined in the original charge from the Commission was reviewed and, as described in this report, it was generally agreed that the objectives set for the TAC at the time of its constitution were met. It is the current intention of the FCC to recharter the TAC for a second two year interval, but the composition of the membership has not yet been announced.

Representatives of the Commission, looking back over this first period of the TAC, expressed their appreciation for all the work done by the members, and described how positively the agency regards the work performed. The TAC has provided valuable input on several major current proceedings including wideband and software defined radio. With respect to the future, much of the challenge that the Commission faces is in terms of the technology related issues that the TAC is addressing, which include spectrum management, issues related to the proliferation and the fragmentation of networks, and access for the disabled.

Dr. Paul Kolodzy of the Defense Advanced Projects Agency (DARPA) spoke about spectrum issues and work that has been stimulated by DARPA to solve many of the same problems that are TAC concerns. The military is not only supporting such research but is also looking to the commercial world to take advantage of what's being done there in research and development. The mutual leveraging of commercial R&D and DARPA-promoted technologies is quite beneficial because this confluence gives the military a commercial off-the-shelf source.

The Spectrum Management Focus Group is organized into three working subgroups. Previously, a resolution was adopted whereby individual TAC members or their companies would give funds to the FCC for the purpose of facilitating the *noise environment subgroup's* noise floor study. Funds in the amount of \$88,000 have now been received, sufficient to start the first phase literature search. A task for the next TAC group will be the implementation of this study.

Joseph M. Nowack of Motorola Labs gave an overview of the next major generation of mobile cellular systems, fourth generation (4G), to be deployed around the year 2010. Some of the key challenges of 4G relate to spectrum requirements, coverage, capacity, and services. Active 4G

research areas include broadband adaptive antennas, new system design concepts and redesign of the air interface.

A prime objective of the *software defined radio (SDR) subgroup* would be a set of recommendations to provide a basis for the regulation (or nonregulation) of the intelligent “cognitive” SDR. We have referred to this as the *SDR Bill of Rights*, that is, a fundamental and durable set of rights and responsibilities for intelligent devices that would form the basis for operating protocols and etiquettes. It is envisaged that, at least at the start, there would be a coexistence between shared and classically allocated spectral regions. To further this work, it now seems appropriate to propose a set of experiments to more fully understand the issues and provide a proof-of-concept demonstration. Researchers from the public safety, defense, and commercial communities should all be invited to participate.

There has recently been a significant increase in the availability of 802.11b wireless LAN at airports and the like with many more installations expected. At the same time, there is an expansion of other unlicensed services and there is already anecdotal evidence that spectral congestion is producing performance problems. We can only speculate if this clash will result in a “meltdown” and unusable service. The TAC will be monitoring the consequences of an unplanned real-time experiment of uncoordinated spectral sharing with incompatible etiquette rules.

The Access to Telecommunications by Persons with Disabilities Focus group reported on the year 2000 work which involved three areas: identification and exploration of issues and options; identification and creation of awareness pieces (problems from the past that we can learn from); and future scenarios (what might be coming and what the implications for people with disabilities might be).

Over the last two years the Interconnection and Network Access Focus Group tried to look at the area of ISP (Internet service provider) interconnection, the issue of open publication of peering criteria, and whether the emerging requirements on quality of service would make it less likely that companies would interconnect, given that there are no standards yet for interdomain quality of service.

Each member had one last chance to describe some of the issues that might be on their mind or items for the new TAC next year. All agreed that the major topics of the current TAC should be continued, with spectrum issues including the planned noise study at high priority. It was also recommended that the TAC place on its new agenda the security and robustness of networks, exploration of the enabling technologies to improve personal privacy, the analysis of ultrawideband and overlay systems using metrics for stealth and antijam developed by the military, and more effort relating to the convergence of broadcast, telecom and local mass storage technologies. The Bill of Rights initiative needs to be brought to completion. The TAC should provide early warning of where current rules will find themselves at cross-purposes with the advance of technology. Operationally, knowledge transfer to the FCC staff needs to be strengthened and formalized. The use of invited expert speakers should be expanded.

Representatives of the Commission thanked the TAC members for volunteering their services. All members of the TAC agreed that participation was an intellectually rewarding and personally enjoyable

experience, and thanked the Commission for inviting them to be members.

The next formal TAC meeting will be on Wednesday, March 28, 2001.

Prepared by J. A. Bellisio

Approved by R.W. Lucky

February 26, 2001

Report: Seventh Meeting of the FCC Technological Advisory Council

1.0 Introduction

As announced, the seventh meeting of the Federal Communications Commission Technological Advisory Council (FCC TAC) took place on Wednesday, December 6, 2000 at The Portals, 445 S. 12th Street, SW., Washington, D.C. Alternate Designated Federal Officer (ADFO) Mr. Dale Hatfield, Chief, Office of Engineering and Technology, Federal Communications Commission, opened the meeting. The TAC is chartered for two years at a time, and this meeting was the last one of its first two year cycle. Progress on the subjects outlined in the original charge from the Commission was reviewed and, as described in this report, it was generally agreed that the objectives set for the TAC at the time of its constitution were met. It is the current intention of the FCC to recharter the TAC for a second two year interval, but the composition of the membership has not yet been announced.

This report is a reorganization and distillation of discussions at the seventh meeting written to facilitate the ongoing work of the Council. A complete videotape of the meeting serves as the verbatim minutes (see Annex 1). This report reviews the presentations and remarks made at the open meeting, but does not, per se, necessarily represent the final recommendations of the TAC as a whole.

The mission and operating principles of the TAC were described in the Report of the First Meeting of the TAC (April 30, 1999), available on the FCC web site <http://www.fcc.gov/oet/tac/>. As described in that report, the FCC made five official requests to the TAC for technical work. These requests fall into three major areas: spectrum management; network interconnection and access; and accessibility for disabled persons. Focus groups with moderators were formed at the first meeting to address each of the three areas. At this seventh and final meeting of the first TAC cycle, representatives of the Commission provided feedback on the overall effectiveness of the TAC, and the activities of each of the groups was reviewed. The meeting's roundtable discussion, which followed each presentation, and resulting action items and recommendations intended to be carried forward to the next instantiation of the TAC are also reported. Additional and more extensive information relative to each of the working groups can be found on the web sites for those groups. *See Annex 4.*

The next formal TAC meeting for the newly constituted membership will be on Wednesday, March 28, 2001.

2.0 Agenda as Announced

TECHNOLOGICAL ADVISORY COUNCIL Agenda –Seventh Meeting

Wednesday, December 6, 2000
Federal Communications Commission Meeting Room
The Portals, 445 12TH Street, SW
Washington, D.C.

10:00 AM	Opening and Remarks by Alternate Designated Federal Officer	Dale Hatfield, ADFO
10:20 AM	Introductions of Council Members with Brief Remarks	Council Members
10:30 AM	Observations on the Accomplishments and Report on the Rechartering of TAC	Dale Hatfield
10:50 AM	Results on Noise Floor Study Funding	Jules Bellisio
10:55 AM	Invited Briefing: "Spectrum Issues"	Paul Kolodzy
11:35 AM	Report of Spectrum Focus Group	Charles Jackson
12:00 N	Break	
1:00 PM	Report of Spectrum Focus Group (Cont.)	Charles Jackson
1:45 PM	Access to Telecommunications by Persons with Disabilities Focus Group	Gregg Vanderheiden
2:30 PM	Report of Interconnection and Network Access Focus Group	Marvin Sirbu
2:40 PM	Assignments, Organization and Going Forward	Bob Lucky, Chair
3:00 PM	Wrap Up - Meeting Adjourned	Dale Hatfield, ADFO

3.0 Membership of the Technological Advisory Council

Except as indicated(*), all of the following were present at the seventh meeting:

TAC Chairperson:

Dr. Bob Lucky – Corporate Vice President, Applied Research, Telcordia Technologies

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 Telcordia Fellow, Executive Director, Applied Research, Telcordia Technologies

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

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

*Mr. Bran Ferren – President, Applied Minds

*Dr. Richard Green – President and CEO, CableLabs

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

Mr. Dewayne Hendricks – CEO, Dandin Group

Mr. Ross Ireland – Senior Vice President, Network Planning & 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 – Chairman of Board of Directors, LinkAir Communications.

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

*Dr. Wah Lim – Vice President, Corporate Technology and Ventures, Hughes Electronics Corporation

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

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

Dr. Stagg Newman – Senior Telecommunications Practice Expert, McKinsey and Company

*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 – Chief Technology Officer, Level 3 Communications.

*Dr. Pat White - Senior Advisor, Safeguard Scientifics, Inc

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

Designated Federal Officer

*Mr. David Farber, Chief Technologist, Federal Communications Commission.

Alternate Designated Federal Officer

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

****Not present at seventh meeting.***

About 40 members of the public observed the meeting and comments from the public are reported as appropriate.

4.0 Summary of Remarks by Representatives of the FCC

The currently constituted TAC is reaching its defined lifetime of two years and will need to be reconstituted. Mr. Dale Hatfield, looking back over this first period of the TAC's existence, and also expecting to retire on the Friday following the meeting, expressed his appreciation for all the work done by the TAC. It was one of the first initiatives that he supported when he returned to government service. Because of rapid technological changes, Mr. Hatfield expects that the importance of the subsequent TACs will only continue to grow. He gave some feedback on TAC accomplishments and how he feels the agency regards the work performed. He reminded us that the Commission only speaks collectively as a body through written documents such as notices of inquiry, notices of proposed rule making, and memoranda of opinion that have been approved by three or more votes by the Commission. Using that criterion for impact and effectiveness, the Council has provided valuable input on several major current proceedings including wideband and software defined radio. Deliberations on the latter, with a notice of proposed rule making on the current agenda, have taken into account influential comments of the TAC both formally and informally. TAC comments have been very well received by the individual commissioners. For example, in terms of innovative ways of fulfilling spectrum management responsibilities, the open discussions helped decision makers familiarize themselves with new management models and decentralized forms as spectrum allocation. Similarly, ideas relative to disability access discussed at the TAC come up almost daily in the Commission's internal discussions.

With respect to the future, much of the challenge that the Commission faces is in terms of the technology related issues that the TAC is addressing. First is spectrum management. The Chairman, and other Commissioners, have spoken about the multitude of difficulties faced in the spectrum area. The Chairman has talked about the possibility of a "spectrum drought" and the need to do everything possible to avoid anything which would curtail the expansion both expected and desired in the wireless area. Advanced spectrum management techniques will be a work item of absolutely the highest importance for the next TAC.

Mr. Hatfield continued by remarking that an area that caused him significant concern was related to the proliferation and the fragmentation of networks. Although going on for good technical and economic reasons, this evolution has precipitated massive systems engineering problems. As an example, consider the compatibility and interoperability issues in the digital television arena where set top box manufacturers, consumer electronic devices makers, the broadcasters themselves, cable companies, and other players are all providing very important system components. With so many competing interests each trying in their own way to optimize the networks, the Commission is left with a major challenge to protect the interests of both the public and the actors.

Disability access was another area of Mr. Hatfield's concern. With all the new technology that we are all so familiar with, there is the danger, perhaps, of making changes in the network that will actually make it more difficult rather than easier for people with disabilities to be able to participate fully in the technological revolution. On November 30, 2000 the Commission announced the formation of a Consumer Disability Telecommunications Advisory Committee, which will be looking specifically at

disability access issues - broadly defined. The charter includes addressing some of the technical issues. It would be very good if the new TAC established a reasonably formal liaison between themselves and this new advisory group which is expected to be named shortly. A good way to accomplish that might be to have whomever is leading that effort also be a member of the TAC. A simple thing would be to hold some joint meetings. The TAC focus has been technology, but hearing from the actual users would be immensely valuable and would facilitate the key issue of coordination.

As a final remark, Mr. Hatfield expressed his concern about the ability of the commission to continue to attract technically-trained people in a marketplace where the Commission is at a severe economic disadvantage. The ability of the agency to absorb and use TAC deliverables depends upon having technical people within the agency equipped to fully assess output and make the proper recommendations to Commissioners.

Commissioner Furchtgott-Roth reinforced the notion that the TAC has proven extremely valuable to the Commission's work.

5.0 Continuation of the TAC

The two-year charter of this Council, the FCC TAC, expires as planned at the end of year 2000. Dr. Kent R. Nilsson, Special Counsel and Deputy Chief, Network Technology Division, FCC Office of Engineering and Technology, discussed the current state of affairs. Following on previous recommendations by the current TAC to continue the activity in the future, the TAC has been rechartered by the Commission. The next Council will conclude in 2002 and will consist of individuals yet to be appointed or reappointed. Nominations, solicited in Public Notice DA 00-2490, released November 6, 2000, are now being considered. Although there will be a natural rotation of members, it is likely that some of the current members will continue. There will be a newly constituted Council before the next meeting on March 28, 2001, however, no selections have been finalized at this time. We should also understand that the terms of office of both Mr. Farber and Mr. Hatfield will end before the next meeting and successors to those positions have yet to be named.

6.0 Invited Briefing: *Spectrum Issues*

Dr. Paul Kolodzy, Program Manager in the Advanced Technology Office, Defense Advanced Projects Agency (DARPA), was invited to speak at the TAC meeting. Annex 2 is the speaker's biography. In his presentation, *Spectrum Issues*, Dr. Kolodzy started with some history of DARPA. At the time of the presentation Dr. Frank Fernandez was the director of DARPA, the role of which is to solve national level problems in support of national security. In simple terms, the entire charter is to develop high-risk technology so as to "avoid surprise". It is a very small organization, about 120 people, with about a \$2.5 billion budget. It used to be that the defense community developed technology that commercial interests later took advantage of. Now it appears that the commercial world is getting ahead of the military; consequently, the military is looking to the commercial so they can take advantage of what's being done in research and development, if not necessarily in products.

With respect to spectrum issues, it is clear that the military has an ever expanding appetite for data just

as well as the commercial world. The technical approach that DARPA is exploring is obviously similar in some cases to that of the commercial world, and currently in three areas: higher frequencies for more bandwidth; improved utilization; and sophisticated spectrum management. This involves the signal processing, beam forming and smart antenna technologies associated with mobile communication. DARPA is looking at improved methods of channel definition and more powerful interference determining and rejecting techniques. Spectrum utilization and its management has far-reaching applications. Instead of having allocations with respect to just space, having allocations with respect to space, time, frequency, and coding in a multidimensional space, what we in the TAC have called the cognitive software defined radio technology, will have dramatic implications on spectrum usage in the future.

DARPA has a program called Small Unit Operations and Situational Awareness System (SUO/SAS). It's a software definable radio system spanning 20 megahertz to 2.5 gigahertz. It is done without having any fixed infrastructure. There are no conventional base stations associated with this concept and it's a network system that works across a wide frequency range. The reason this can be done is because of unique integrated electronic subsystems. The military needs these characteristics because soldiers tend to go into a variety of locations. They do not typically stand out in the open. They go into culverts, tree-lined areas, bushes, inside of buildings and they have to be able to have communication across all domains. Frequency agility associated with the components is critical. The commercial world likely will take advantage of DARPA-promoted technologies in the future. This is quite beneficial because when this happens the military will have a commercial off-the-shelf source.

The high frequency components DARPA needs go out to 100 gigahertz and beyond. Right now, 40, 50, and 60 gigahertz lightweight, efficient integrated components are under study. Researchers need to go into areas of the spectrum that are not now being utilized very well and ask the question: Can we develop components for that area?

But this doesn't answer all of the questions that need to be answered for the military. For instance, an infrastructure with large, permanent base stations usually doesn't suit the military very well. There are also still not fully resolved issues of multiple access, low probability of detection, antijam, bandwidth efficiency, and difficult to detect or "featureless" waveforms. The military also needs to exploit diversity while being mobile and handling interference. In the area of networks, there is considerable concern about the interaction between internet protocols and mobility.

Dr. Kolodzy spoke extemporaneously about a recent European Union summit meeting on 4G (fourth generation) cellular radio that he attended in Ireland. It has been estimated that investments of \$145 billion have been made for the combined total of first generation and second generation cellular infrastructure. The cost estimate for third generation is approximately \$800 billion, with \$400 billion of that (\$200 billion supposedly in Europe alone) just for the acquisition of spectrum rights. It has been pointed out that for what was paid for spectrum in the UK, they could have put fiber into every home, bringing up a serious question of proper social optimization. Furthermore, the question of likely return on investment looms large.

Another issue to consider are the drivers for data rates in a fourth generation (4G) system. As currently

understood, we are going from a voice system to a 2G system, then to a data centric 3G plan. Are there more data requirements driving fourth generation? Although the European community was uncertain, it was very clear 4G was not thought of to be pushed by ever higher data rates, but rather the application layer was the assumed driver for fourth generation. In some current research, instead of having the users talking to network/application providers, they look at the application provider as being in-between the network provider and the user. The network provider is viewed almost as a commodity option. Users sign contracts with the application providers who then act as the primary conduit for the users. It was observed that that this could lead to an architecture somewhat like the WAP (wireless application protocol) configuration with a gateway between the communicating parties. Some feel that this represents a serious blunder in system philosophy in that the loss of transparency can defeat critical functions such as the ability to do digital signatures.

At the conference Dr. Kolodzy was reporting on, some were surprised at hearing that the data rates for 3G may not be much higher than 2.5G (for mobile application), so that the gap between wireline and wireless from a speed standpoint will be increasing, *and* many of the E.U. people at this particular conference didn't see a need higher speeds for mobile. Apparently they believe that the market model does not *yet* show that there's a need for higher rates.

In concluding, Dr. Kolodzy reiterated how DARPA tries to look at things in a very different way. The result may be that in trying to avoid unpleasant surprise, surprising technology is created for others.

7.0 Report on Noise Floor Study Funding

At the June 28, 2000 TAC meeting a resolution was adopted whereby individual members or their companies would give funds to the FCC for the purpose of facilitating a noise floor study. As reported at the last meeting, the minimum amount of about \$100,000 estimated for the first phase literature search has now been committed. All of these contributions were made unconditionally and were not intended to influence any regulation. At the time of the writing of this report (subsequent to the meeting), a total of \$88,000 had been transmitted to the FCC in three enclosures using procedures described in the previous report. No other contributions are expected at this time. The members and organizations who currently have had their commitments sent to the FCC in association with the TAC Noise Study are:

Dr. Richard Green on behalf of CableLabs in the amount of \$10,000;
Ms. Christine Hemrick on behalf of Cisco Systems, Inc. in the amount of \$10,000;
Mr. Dewayne Hendricks on behalf of Dandin Group, Inc. (DGI) in the amount of \$1,000;
Mr. Ross Ireland on behalf of SBC in the amount of \$10,000;
Dr. Charles E. Jackson, Consultant in the amount of \$1,000;
Mr. Kalle Kontson on behalf of IIT Research Institute in the amount of \$2,000;
Dr. William Lee on behalf of LinkAir Communications, Inc. in the amount of \$1,500;
Dr. Paul Liao on behalf of Matsushita Electric Corporation of America in the amount of \$10,000;
Dr. Wah Lim on behalf of Hughes Electronics in the amount of \$10,000;
Dr. Bob Lucky and Dr. Jules Bellisio on behalf of Telcordia Technologies in the amount of \$10,000;
Dr. Robert Martin on behalf of Lucent Technologies in the amount of \$10,000;
Mr. Dennis Roberson on behalf of Motorola in the amount of \$10,000;
Mr. Robert Zitter on behalf of Home Box Office in the amount of \$2,500.

Also enclosed with the funds were letters from each of these individuals or companies memorializing their intent to donate these gifts to the Federal Communications Commission in accordance with the Commission's statutory gift acceptance authority found at section 4(g)(3) of the Communications Act of 1934, as amended, 47 USC § 154(g)(3), as implemented by the Commission's rule at 47 C.F.R. § 1.3000-3004. Each offeror confirmed that the offer was unconditional and was not contingent on any promise or expectation that the Commission's receipt of the gift was to be used to benefit the offeror or in any regulatory matter.

7.1 Noise study - Action Items

The spectrum working group leadership is currently searching for a performer for the proposed study and will make a recommendation as soon as practicable. This will result in a work item for the next instantiation of the TAC.

8.0 Report of Spectrum Focus Group

Charles Jackson introduced Joseph M. Nowack, Member of the Technical Staff, Communication Systems and Technologies Labs, Motorola Labs, who gave an overview of fourth generation (4G) cellular systems, especially relative to spectrum requirements. In simple form, 4G is just the next major generation of mobile cellular systems to be deployed around the year 2010. There is considerable disagreement, however, as to what should be the main focus of 4G. Possibilities include the wireless Internet, higher bit rates, cost reduction, new user services, wireless-wireline integration, new air interfaces (or a strict limitation to a single global interface), a completely new network, and advanced opportunities for service providers. The domain of 4G extends beyond that of 1G, 2G, 2.5G and 3G. It could coexist with 2G and 3G. 4G is not necessarily defined by the bit rate, but by a significant advance in system capability beyond what can be achieved with 3G.

Figure 1 depicts various domains of application proposed for 4G commercial wireless.

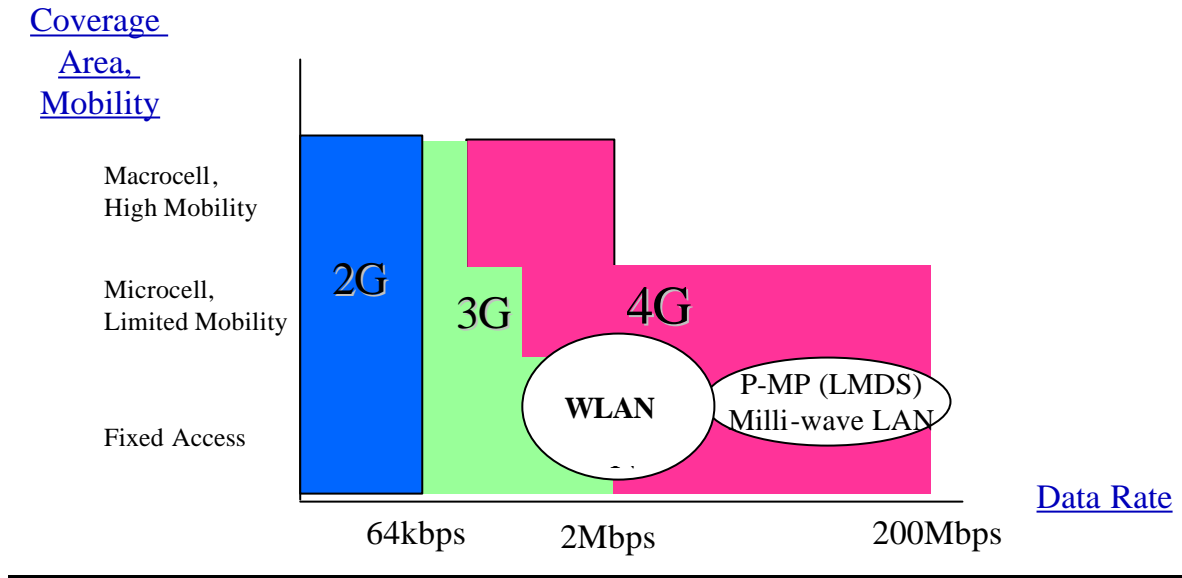


Figure 1: A view of 4G

Some of the key challenges of 4G relate to coverage, capacity, and spectrum. Transmit power limitations and higher frequencies limit the achievable cell size. Current air interfaces have limited peak data rate, capacity, and packet data capability. Location and availability are key spectrum issues, especially considering that lower carrier frequencies (< 5 GHz) are best for wide-area coverage and mobility.

If we consider the increase in the number of cell sites needed to cover a fixed geographical area, calculations show that if we increase the data rate by a factor of 10, we need about three times as many base stations (keeping other parameters constant). The same simple model predicts that we will need about ten times as many bases if we increase the carrier frequency by ten. This coverage problem then becomes a main design driver. The carrier frequency has a larger impact on cell size than data rate. In order to enable wide-area coverage, 4G needs “mobile friendly” spectrum (ideally less than 5 GHz). Mobile devices have low transmit power, limited antenna gain, and predominately non-line-of-sight propagation. Fixed wireless systems are more easily able to take advantage of higher carrier frequencies because with no movement there is low Doppler and we can afford higher transmitter power with power consumption and heat dissipation is less critical. Line-of-sight operation is also more likely with a fixed high-gain, high-elevation antenna.

There is considerable disagreement on the service mix and capacity requirements that should be

assumed for 4G. We can, however, make some observations on the kind of transmitted content that may impact broadband wireless. Successful wireless services are frequently preceded by growth of a wired demand. We can expect that growth in telephony, dial-up internet, and DSL (digital subscriber line) or cable data will be precursors to a demand for mobile telephony, WAP (wireless applications protocol) based services, cellular data, and 4G broadband wireless. Content is rapidly expanding to serve the cable/DSL connected consumer. Many sites are focused on video delivery of “broadband” video (typically 300 Kb/s and faster) such as MovieFlix, VideoSeeker, QTV, and Quokka Sports. Also, combinations of existing content may be valuable to mobile information consumers, such as: expressway travel information (real time web cameras, traffic status and advisories); entertainment selections (movie trailers, ticket reservation, TV guide, video-on-demand); and business guides (stock market information, real-time video briefings, breaking news).

Some of the active 4G research areas include broadband adaptive antennas, new system design concepts and redesign of the air interface. With 4G still in a formative stage (commercial 2010), we can already speculate as to some of the 4G air interface characteristics. We can expect higher bit rates than 3G (20 Mb/s < peak < 200 Mb/s), higher spectral efficiency and lower cost per bit than 3G, an air interface and MAC (media access control) optimized for IP traffic (IPv6, QoS), and adaptive modulation and coding with power control, with frequency bands below 5 GHz preferred for wide-area mobile services.

8.1 Software Defined Radios (SDR) and Future Spectrum Management Regulations

A prime objective would be a set of recommendations to provide a basis for the regulation (or nonregulation) of the intelligent “cognitive” SDR. In the past we have referred to part of this as the *SDR Bill of Rights*, that is, a fundamental and durable set of rights and responsibilities for intelligent devices that would form the basis for operating protocols and etiquettes. It is envisaged that, at least at the start, there would be a coexistence between shared and classically allocated spectral regions. To further this work, it now seems appropriate to propose a set of experiments to more fully understand the issues and provide a proof-of-concept demonstration. Researchers from the public safety, defense, and commercial communities should all be invited to participate. Among the many issues needing resolution is an understanding of the vulnerability of such a system to malicious attack.

8.2 Noise and Unlicensed Operation

Progress on funding for the proposed noise study was reported above. As described by Dewayne Hendricks, there has, since the last meeting, been a significant upswing in the availability of 802.11b wireless LAN at airports and the like. Many more installations are expected. At the same time, there is an expansion of other unlicensed services such as Metricom and there is already anecdotal evidence that spectral congestion is producing performance problems. We can only speculate if this clash will result in a “meltdown” and unusable service. Maybe we will have a situation like Yogi Berra’s popular restaurant: “It’s become so overcrowded that no-one at all goes there anymore.” We are about to have an unplanned real-time experiment on the consequences of uncoordinated spectral sharing by different services using incompatible etiquette rules. We have heard that in order to insure satisfactory operation of the University managed 802.11 system at Carnegie Mellon University, the administration

has banned the on-campus use of all spectrally competing devices. We may be approaching the era where intelligent cognitive radios will be a necessity. We should always remember, however, that this emerging spectral conflict problem is really the result of the enormous success of unlicensed operation, not it's failure.

9.0 Report of the Access to Telecommunications by Persons with Disabilities Focus Group

Gregg Vanderheiden reported on the year 2000 work of the focus group and gave an overview of items described in previous reports. There were three main areas of concern: identification and exploration of issues and options; identification and creation of awareness pieces (problems from the past that we can learn from); and future scenarios (what might be coming and what the implications for people with disabilities might be).

Several topics are being discussed as issues and options. Technology supplantation, or the replacement of old technology by new, creates an issue when existing rules for a particular function are defined with respect to specific or obsolete technologies which are then "supplanted". An example would be IP telephony. There are also issues associated with the migration of TTY to text messaging or Internet chat, required support for Emergency 911, and the responsibilities of networks and carriers when distributed solutions are implemented.

The group considered a number of future scenarios, including captioned telephony, silent communication features, and the role of sign language and speech teleconferencing. The advent of "assistants on demand" including video description services for video conferencing, cognitive assistants, and home based assistants all give the potential of creating a new window to the world for the disabled.

As part of an effort to forestall unexpected consequences of the introduction of new technology, the group considered the production of lists of "awareness points." These would be documents to be used during the design phase of new products to sensitize engineers as to the unique needs of the disabled and the pitfalls to be avoided. Some evolving technology areas which have historically precipitated unexpected problems for the disabled include compression, TTY compatibility, stripping of captioning (in compression), and various difficult to handle speech issues (hard of hearing, impaired speech, noisy environments, foreign accents). The group also reviewed barriers which have appeared in the past with respect to both technology and disability type, and looked at the ongoing trends in assistive devices and functions.

The focus group has made recommendations for the next TAC. They advise meeting with the FCC staff to review the three types of materials being worked on (issue, awareness, and scenario) and to see if the FCC has other unmet needs or suggestions. A note should be put out to industry and consumer groups about same questions as above. And, there needs to be a discussion about coordination or relationship with the new Disability Advisory Group.

10.0 Report of Interconnection and Network Access Focus Group

Some of the things that this working group accomplished over the last two years were summarized by Marvin Sirbu. The group tried to look at interconnection and access issues. On the interconnection side, there were a number of contributions and group discussions. In the area of ISP (Internet service provider) interconnection, some members of the group came to the conclusion that today it's not currently a problem. ISPs are interconnecting, but there was an argument that ISPs should openly publish their criteria for peering. We had discussions on whether the emerging technology for quality of service would make it less likely that companies would interconnect, given that there are no standards yet for interdomain quality of service. The conclusion by some was that this is still not a problem now but that it may emerge as an issue in the future. It seems that several of the members feel that nothing can be done about it now other than watchful waiting to see that no problem develops.

The other area discussed in this group was the interconnection of features in the emerging voice-over-IP soft switch marketplace. The "soft switches" have open APIs (application program interfaces) to allow third parties to write new features. The problem of feature interaction between these soft switches may require new industry procedures which are above and beyond the current mechanisms already in place for resolving feature interaction in circuit switches.

The access area was not a topic addressed in great detail, although in the last three months, some documents were circulated about fiber-to-the-home which led to discussions on this issue.

Among the issues which will need to be addressed, going forward, is the issue of whether the model we have now for near-term broadband, which is to allow a number of competitive providers to flourish - wireless, DSL, cable modem - is going to be a viable model for fiber to the home. It's not clear that the investment in trenching and deployment can be successfully amortized if an operator has significantly less than 50% market share, suggesting that having multiple players is not a viable option. This is something that has to be further discussed during the next TAC cycle.

11.0 Observations, Recommendations and Conclusion

Given that this was the last meeting for this current group of TAC members, Bob Lucky, TAC Chair, took the opportunity to thank everybody for their service, then gave each member one last chance to describe in their own words some of the issues that might be on their mind or things that might be items that the new TAC should grapple with next year. Those observations and opinions are condensed and paraphrased here. As the roundtable discussion progressed, many of the members echoed and reinforced remarks made previously by colleagues.

Vint Cerf:

There are three suggestions. One, is to continue to work on the accessibility question, because it's vital that we not disenfranchise people who could take advantage of new telecommunications technologies. Secondly, we should focus some time on the spectrum sharing question, which we've not thoroughly examined, and finally, the point that came up earlier and has not been addressed very much, are the

national security aspects of robustness and vulnerability of our communication systems. And although, normally, that's not the charge of this group, one might ask whether it could become one of the topics of concern for us in the future.

Reaction by Kent Nilsson of the FCC:

There's another federal advisory body called the "Network Reliability and Interoperability Council" (NRIC). It has four focus groups, one of which deals with best practices and another, interoperability. The FCC has discussed internally what the appropriate allocation of those issues between those two focus groups ought to be, and at the moment, it is directed to the best practices focus group. However, the TAC may have a lot to potentially contribute in ways that the other group won't, because the skill sets are different. That's something the Commission will have to give some thought to.

Christine Hemrick:

There is a question for Dale's successor and the Commission as to how they best see utilizing the collective knowledge, and sometimes wisdom, of the TAC members. In the last two years, it has always been a bit of a question as to whether the FCC only wanted to hear from the TAC on technologies that had immediate policy implications, or whether there was interest in using the collective body to give a future perspective without the implication that the group was asking to invite regulation or the intervention of the FCC. For example, there are a lot of very interesting things happening in the area of content networking, knowledge of which could be useful to the Commission when thinking about the long-term future but for which there are no immediate action-oriented policy ramifications.

Dewayne Hendricks:

Speaking to the wideband technology spectrum overlay issue, it looks like UWB rulemaking is stalled. There isn't clarity about what ultrawideband is. Manufacturers come to the commission and just speak to their own self-interest and about their particular approach. The commission has been left with the difficult position of trying to piece it all together and come up with first principles about what UWB is. We can observe that the military designs systems that are stealthy and covert. They have a whole set of metrics that they use to characterize those systems. Because the commission has been struggling to use a technology-neutral approach, we should talk to DARPA and see how they characterize systems and what metrics they use. We should be aware of low probability-of-detection and anti-jamming metrics that look at the both emitter and receiver in very specific ways. DARPA could help a lot once we get some things declassified. We should invite DARPA to come to the next meeting and talk about how they look at wideband systems and how they characterize them, then ask some of the UWB companies how they would characterize their systems according to these metrics.

Ross Ireland:

In the area of access and interconnection, it would be useful to take a look at some of the technologies that we think will evolve there, particularly in the packet world and in the optical world. Both of those worlds are changing very dramatically in the public networking space. If you take a number of examples of what's happening, you're going to find that as the future rolls out, you're going to bump into current rules which make it very difficult to categorize new technology. This group ought to look at some examples and ask: Do rules make it easy or difficult to be able to deploy this technology? Is it an advanced service? Is it a core service? That drives you to sort out who owns the asset, and how you

might manage it. It might drive you to a different set of rules or models. There could be the unintended consequences of existing regulation that puts a company at a disadvantage when introducing a variety of technologies.

Charles Jackson:

The area of shared spectrum and unlicensed operation is where the TAC could come up with important recommendations and suggestions. The other area that much of the focus of the discussion has focused on is what you might call telecommunications or individual communications rather than mass media. But in fact, mass media is very important, and changing technologies are going to have major impacts on mass media. Networks are going to evolve into mass media. The TAC should look at some of the issues associated with the evolution of mass media and the evolution of personal media towards mass media and vice-versa.

Kalle Kontson:

The shared spectrum issue and how technology can support shared spectrum is something that's worth pursuing. We've made some progress but there's lots more to be done. The TAC should also seriously consider Department of Defense activity and leveraging some of the work that's going on there.

There's a major trend in the convergence of service. There's also a convergence going on in the user community, in the commercial sector, in the public safety area, and in the military. All users are using the same assets and converging onto a common infrastructure and technology base. There's a lot to be learned from looking at how to leverage and share technologies, and having complementary relationships with entities in the user community.

Bob Martin:

We should examine the solution to the fragmentation of the networks as a kind of end-to-end design problem. The TAC didn't work this issue hard enough with respect to both packet and optical networks. A good way would be to pick a couple scenarios, analyze them, and come with the "what-ifs?" The idea of getting people in from DARPA, and perhaps get some perspectives from what's happening in Japan, in the EU, and from similar groups is a good one. They're going to look at the problem differently, and we might get a perspective that might not have occurred to us. The Japanese are going after some of the mobile services in a way that some of us hadn't thought of, and they might be running into some issues that we have not quite thought of yet.

Stagg Newman:

The TAC needs to be looking at where future technologies are going and seeing other ways that the Commission's rules need to be changed to enable those technologies. We need to make sure we don't impede the introduction of technology in the marketplace because of obsolete rules. Some of the changes would be in the spectrum area. In addition to working on overlays and shared spectrum, we need to consider how to change the rules to enable the more flexible use of the technology. We need to discover where rules are out of date with the technology.

Dennis Roberson:

Beyond the shared spectrum issue, the issue of interoperability of systems above the spectral level

emerges. There is the whole problem of networking and retaining a connection while maintaining a conversation, for instance, while going from Bluetooth to 802.11 to a cellular network. Accessibility is clearly something we also need to continue work on. Additionally, the noise study we inaugurated is certainly an important one for us to follow through on because there's a long ways to go to actually derive benefit. Also deserving a great deal of focus for the future is the *Bill of Rights* work that's been going on. It's really an important idea, an important concept, and an important beginning, but still has a very long ways to go.

In terms of new items for the TAC, the international aspect bears considerably greater focus whether it's harmonization or a directed choice not to harmonize with the rest of the world. Japan's been mentioned, but China is also important now that China is beginning to be a force in these matters.

The new TAC needs to revisit the whole concept of establishing definitions on things that we view as commonplace. The telephone has been mentioned in this context, but what is a network, really, and what is ultrawideband? Going along with this would be the publication of white papers by this group, that is, TAC-authored position papers on some of these topics to provide reference information for both the FCC and then, perhaps, the greater world. The use of outside speakers is something we ought to continue procedurally by having one solid outside speaker on a thematic basis at every meeting.

There are two other items that are, perhaps, the most challenging of all. One of them is establishing a bit more formality in our engagement with the Commissioners themselves and with the Chairman. The TAC could improve rigor with a yearly report or similar mechanism. The final and most challenging item of at all is the need to find some means of establishing a funding model for this group, so that when there are initiatives like the noise study there would be some way of instituting action. Having some means of addressing funding is critical to moving to the next step beyond the part-time activity of the TAC. It would be something that would add more meat and more reality to the group.

Marvin Sirbu:

We're in the midst of a transformation of networks from the traditional circuit-oriented to a packet orientation. A lot of the language of regulatory distinction of our telecom information services is going to be problematic when telephony services are carried by packets. We will have to decide whether they're information services, which are not regulated, or telephony services which are subject to various rules. Some of this may not be entirely within the purview of the Commissioners themselves, but may require a revision of legislation. We are already seeing this as ISPs begin offering telephony services. Because they're not certificated, they're not entitled to guaranteed access to the SS-7 databases or directories, for example. We see a company like Metricom not getting access to poles, rights-of-way, or communication devices because they're providing an information service, not a telecommunication service, and don't qualify. There are going to be a continuing series of problems that need to be explored and cases where regulation may need to change.

The other area of interest is the long-term direction of broadband access. Fiber-to-the-home would provide us with unlimited capacity for an indefinite future, but we don't know how to get there. We don't know whether the competitive model that we've been using up till now will operate, or some other model more akin to how we got cable in place (a single franchisee) has to be explored. We need

to consider what the implications of that are for regulatory structure, for open access, and a number of other issues.

Gregg Vanderheiden:

The overall integrity and security of networks that was mentioned a bit earlier is extremely critical. One of the big concerns as we head forward is that we can do a lot of really amazing and wonderful things but all at the expense of robustness. This is a general problem, but it's particularly critical for people with disabilities who come to depend upon these things very much. They're not in as good a position to recover from a failure or to find some other way of doing some things.

TAC efforts on disability access is something that needs to continue, but we need to figure out how to bring it to another level. The group should explore broadening the offline membership (if not the TAC membership) to bring in participants with other backgrounds to provide a broader base from disability side. Technology interoperability is a really important area. It's a key for flexibility. Currently, there are indications that companies are isolating individual issues and treating them separately. We need a more holistic view that includes disability access. This impacts FCC interoperability mandates.

We have voice conversations and we have text chat. If text chat is on a TTY it is telecommunications, but if it's not on a TTY is it still telecommunications? If I'm on my phone having a conversation and you're talking to me on a regular hand phone, but on my end, it's translated into text and I type back because if I'm deaf, that's telecommunication, but if I'm not deaf, it's not telecommunication! This means that if we want the people who are deaf to switch technology, they may have to give up "telecommunication". We thus have a huge definitional problem. We have been tying a lot of the regulations to old technologies. When we switch to voice over IP, even if it looks exactly the same to the people who pick up the phone, there's a question as to how to classify the activity. We need to start looking at the policy implications of technology advances.

Bob Zitter:

One of the more significant TAC initiatives, if we look several years in the future, will be the *Bill of Rights*. It has a long way to go, but if we're talking about everything that we are, that seems to be the template for how the various systems and devices might interact.

We would be well-served in the next TAC to not just recognize mass media, but to focus a little bit more on the issues that are coming about from the convergence we've all recognized between mass media, telecommunications, and information services. As we see television and other mass services more and more becoming on-demand services using the telecommunication networks and the internet, issues of quality of service become more important. Consumers have come to expect from traditional mass media quality that doesn't exist in the networks that they're going to be using. And lastly, in terms of this TAC being a resource, there's a great resource here that probably could be used a little bit more outside of the heat of any particular proceedings.

Jules Bellisio:

There are new FCC rules that have to do with the geographic positioning of cell phone users promulgated in order to implement Emergency-911 service. This brings up the issue of personal privacy. It will soon be technically possible to transmit to others detailed information about your location that in nonemergency situations you might not want other people to have - for security or any other reason. We should be addressing the technical enablers that would allow certain protective barriers to be put into the dissemination of this kind of information to protect people's privacy. We need to take into account the "personal space" of people, and not allow a situation to evolve where everything that can be found out about a person can be widely distributed without that person's knowledge or control.

Another set of issues has to do with the usage of spectrum in the future, and the combination of the use of the spectrum for mass media and telecommunications. There are two technological developments here that could have a big impact. One has to do with the emergence of technologies like Napster and Gnutella which, among other things, change the character and directional volume of traffic that we expect to see in the network. Another technological development is the emergence of very inexpensive high-density storage that could be placed in customer equipment, as we see today with TiVo and ReplayTV. The implication is that there is there is another dimension to the usage of spectrum. For many types of services, we don't necessarily have to transmit at the time of intended use. There's a time-shifting advantage. This results in an efficient use of broadcast that could couple it very tightly with intelligent telecommunications, but these are two industry segments that we currently deal with separately.

As far as TAC operational issues, the idea of producing position papers is a good one as a means of formalizing transfer to the Commission. Position papers shouldn't just analyze one position. We should put all the reasonable alternatives on the table together with the likely technological consequences that we see spinning out from each alternative. Finally, the TAC should invite an overseas member to the group to give, for example, the view of the European Commission or the Japanese.

Bob Lucky:

The roll-out of broadband access has been one of the prime objectives of the Chairman. Verizon has a goal of 500,000 digital subscriber lines at the end of this year, and may have even reached target that recently. But when you look at how many new analog lines they added this year, it's actually a lot more than that. So we can ask: "Is broadband really rolling out that fast?" What are the limitations and factors, technological and policy-wise, that limit the growth to what it is today, and what alternatives and possibilities are there? This will be a good topic for the next TAC.

Representatives of the Commission once again thanked the TAC members for volunteering their services. All members of the TAC agreed that participation was an intellectually rewarding and personally enjoyable experience, and thanked the Commission for inviting them to be members.

Annex 1: Meeting Videotape

A VHS videotape of the December 6, 2000 meeting serves as a set of comprehensive minutes of that meeting. Copies of the tape can be obtained from the Commission's contracted copier, **In Focus**. They may be reached by phone at: 703.843.0100 ext. 2278

Annex 2: Biography of Dr. Kolodzy

Paul J. Kolodzy, Ph.D.
Defense Advance Projects Agency (DARPA), Advanced Technology Office (ATO)
Program Manager

Dr. Paul Kolodzy joined DARPA in October of 1999 as a Program Manager Defense Advance Projects Agency (DARPA) in the Advanced Technology Office. Dr. Kolodzy was selected as one of the new 1101 candidates with the purpose of providing a cadre of experienced technologists directly from industry into government service. Dr. Kolodzy's current focus is on offensive and defensive communications utilizing advanced materials, techniques, and on leveraging with advances in the commercial sector.

Dr. Kolodzy's previous duties were at Sanders, a Lockheed Martin Company. At Sanders, he served as Director of Signal Processing in the Advanced Technology Division. In this capacity, he was responsible for focusing on Information Warfare, Electronic Warfare, and Signal Intelligence techniques. He directing classified programs in the development of signal processors and signal processing schemes for image processing.

At Sanders, he also served as Director of Strategic Initiatives with responsibilities for synergistic development of the generation after next Antennas, Receivers, EO, Lasers, and Signal Processing technology. He analyzed and made recommendations on how these advanced technologies would impact systems throughout the Lockheed Martin Company.

Dr. Kolodzy also served at the MIT Lincoln Laboratory for 11 years as senior systems analyst. He was involved in Optical Systems for Laser Radar, Signal Processing, and Target Recognition. He served as Group Leader in the Machine Intelligence Group focusing on Acoustics, RF (SAR), and Optical signatures.

Dr. Kolodzy earned a Ph.D. in Chemical Engineering from Case Western Reserve University, inclusive of EE and CS. Dr. Kolodzy earned his Master of Science Degree in Chemical Engineering from Case Western Reserve University.

Annex 3: FCC staff

FCC staff available to address questions from the TAC:

Contact Kent Nilsson of the FCC, <KNILSSON@fcc.gov>. With respect to specific Federal Advisory Committee Act (FACA) questions, a resident expert is FCC attorney:

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

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

<http://www.policyworks.gov>

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

Spectrum Management (Charles L. Jackson, Moderator)

<http://www.jacksons.net/tac>

Jules Bellisio	jules@research.telcordia.com
Bran Ferren	bran@appliedminds.net
Christine Hemrick	hemrick@cisco.com
Dewayne L. Hendricks	dewayne@dandin.com
Charles L. Jackson	chuck@jacksons.net
Kalle Kontson	kkontson@iitri.org
William C. Y. Lee	william.lee@linkair.com
Wah L. Lim	Wah.Lim@hughes.com
Robert L. Martin	bobmartin@lucent.com
Glenn Reitmeier	greitmeier@sarnoff.com
Dennis Roberson	Dennis.Roberson@motorola.com
Patrick White	pwhite@safeguard.com

Accessibility for Disabled Persons (Gregg Vanderheiden, Moderator)

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

Jose M. Alvarez Caban	jalvarez@coqui.net
Jules Bellisio	jules@research.telcordia.com
Vinton G. Cerf	vcerf@mci.net
Susan Estrada	sestrada@aldea.com
Bran Ferren	bran@appliedminds.net
Dewayne L. Hendricks	dewayne@dandin.com
Charles L. Jackson	chuck@jacksons.net
Paul F. Liao	pliao@research.panasonic.com
David C. Nagel	nagel@ipo.att.com
Gregg C. Vanderheiden	gv@trace.wisc.edu
John F. Waters	jack.waters@level3.com
Robert M. Zitter	robert.zitter@hbo.com

Network Interconnection and Access (Marvin Sirbu, Moderator)

<http://www.fcc.ini.cmu.edu/ECC/index.html>

Jules Bellisio	jules@research.telcordia.com
Vinton G. Cerf	vcerf@mci.net
Susan Estrada	sestrada@aldea.com
Bran Ferren	bran@appliedminds.net
Christine Hemrick	hemrick@cisco.com
Dewayne L. Hendricks	dewayne@dandin.com
Ross Ireland	ri4181@txmail.sbc.com
Paul F. Liao	pliao@research.panasonic.com
Wah L. Lim	Wah.Lim@hughes.com
Robert L. Martin	bobmartin@lucent.com
David C. Nagel	nagel@ipo.att.com
Glenn Reitmeier	greitmeier@sarnoff.com
Dennis Roberson	Dennis.Roberson@motorola.com
Marvin Sirbu	sirbu@cmu.edu
Gregg C. Vanderheiden	gv@trace.wisc.edu
John F. Waters	jack.waters@level3.com
Patrick White	pwhite@safeguard.com
Robert M. Zitter	robert.zitter@hbo.com

Intelligent Device Bill of Rights *ad-hoc* working group (Bran Ferren, Moderator)

Jules Bellisio	jules@research.telcordia.com
David Farber	DFARBER@fcc.gov
Bran Ferren	bran@appliedminds.net
Dale Hatfield	DHATFIEL@fcc.gov
David Hughes	dave@oldcelo.com
David S. Isenberg	isen@isen.com
Kalle Kontson	kkontson@iitri.org
Paul F. Liao	pliao@research.panasonic.com
William C. Y. Lee	william.lee@airtouch.com
Arthur H.M.Ross	a.ross@ieee.org
Marvin Sirbu	sirbu@cmu.edu
Gregg C. Vanderheiden	gv@trace.wisc.edu
Robert M. Zitter	robert.zitter@hbo.com