

Report: First Meeting of FCC Technological Advisory Council II

0.0 Executive Overview

The newly constituted Federal Communications Commission Technological Advisory Council held its first meeting on Wednesday, June 13, 2001 in Washington, D.C. The Council is chartered for two years at a time, and this meeting of FCC TAC II was the first general meeting of TAC's second two year cycle. As described in previous meeting reports, the Council is to provide scientifically supportable information on those emerging technologies likely to impact the work of the FCC. The Council now has over thirty members who were selected because of their professional and technical expertise, some of whom participated in the first TAC.

As a result of this meeting, the TAC is now organized into five working groups to address spectrum management, optical networking, access to telecommunications for the disabled, consumer and home networking, and network security. Chairs for each of these groups will soon be designated. Groups are expected to work between general meetings, then report findings developed in the interim in anticipation of expanding on each area during roundtable discussions at the next meeting.

Spectrum management, building on work of the first TAC group, includes issues associated with the noise floor, software defined radios (SDR), ultrawideband (UWB), and the proposal previously made by TAC for the Intelligent Radio "Bill of Rights." Focusing on the larger problem of the impact of new innovations on all of spectrum management, the TAC is starting by considering emerging overlapping issues such as unlicensed operation, spectrum overlay, reuse and reallocation, convergence of licensed and unlicensed appliances, and migration strategies and economic drivers for new regulatory paradigms.

The FCC is concerned about the status of industry standards for *optical networking*, the transitioning of networks to optical, and the implications for interconnectivity and for devices that are connected to optical networks. We may not be experiencing the benefit of all of the capacity of the emerging huge optical backbone because of a dearth of on-ramps and off-ramps, especially with respect to links that connect into the home, office, or other workplace environments. There are issues of the management and interconnection of optical networks, interoperability between systems of different designs, and the ease with which competition can be fostered.

The FCC has chartered a new Consumer Disability Advisory Committee to address *access to telecommunications by persons with disabilities*. At least two TAC members are joint members with this new group which is primarily focused on very near term issues. The TAC will take a complementary longer term view as to what technology might do to relieve problems in this area.

Many different kinds of *consumer and home networks* are being proposed and introduced. Issues of interoperability and compatibility for residential systems and intelligent networked appliances are beginning to arise. There have been proposals for residential gateways, but they usually just give the provider control of the home and don't necessarily promote interoperability or competition.

Considering the whole communications and entertainment environment in the home and accounting for Internet access, telephone access, and interactive TV, the Commission needs to remain vigilant as to emerging problems that may stifle competition or be deleterious to the interests of the general public.

Network security is understood to include issues of robustness, integrity, confidentiality of communications, and the technical enablers for the management of content rights. We also need to be concerned about the personal security of the individual at the end of the line. With the introduction of geolocation into cellular telephony, it may be possible for a malicious interloper to determine the physical location of any user. The protection of intellectual property (I.P.) is another issue that needs greater analysis. The protection of I.P. and personal security issues overlap, in that if the owners or the originators of I.P. can track who is using their I.P., they have massive information about individual user's use. Since the TAC is a *technical* group, it should provide guidance as to which policies would be technically implementable and effective, with the actual selection of policy left to the political process.

The next formal TAC meeting will be on Thursday, September 20, 2001.

Prepared by J. A. Bellisio

Approved by R.W. Lucky

August 26, 2001

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1.0 Introduction

As announced, the first meeting of the Federal Communications Commission Technological Advisory Council II (FCC TAC II, *or* TAC) took place on Wednesday, June 13, 2001 at The Portals, 445 12th Street, SW., Washington, D.C. Designated Federal Officer (DFO) Mr. Julius Knapp, Deputy 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 first one of its second two year cycle. At this meeting, new members were introduced, there was a review of topics of current interest to the Commission, and during open discussion the list of general items for TAC consideration was formulated. 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/> .

The general items for ongoing TAC consideration fall into five major areas, spectrum management, optical networking, access to telecommunications for the disabled, consumer and home networking, and network security. Each of these areas is explained in more detail in this report. It should be understood that the topic areas are intentionally broad and subsume all of the interest areas of the previous instantiation of the TAC. Working groups were formed at this meeting to address each of the five areas. Chairs for each group will be selected before the next meeting. *Annex 4* lists TAC members who have volunteered for each group.

This report is a reorganization and distillation of discussions at this first meeting of TAC II 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 next formal TAC meeting will be on Thursday, September 20, 2001. The dates of subsequent general meetings are: December 5, 2001, March 20, 2002, June 12, 2002, September 18, 2002, and December 4, 2002

2.0 Agenda as Announced

TECHNOLOGICAL ADVISORY COUNCIL II

Agenda –First Meeting

Wednesday, June 13, 2001
Federal Communications Commission Meeting Room
The Portals, 445 12th Street, SW
Washington, D.C.

Welcome (10:00 AM)	Julius Knapp, FCC Designated Federal Officer (DFO).
Introductions	Robert Lucky, Chairman.
FCC's Excellence in Engineering Program	
The Federal Advisory Committee Act	Paula Silberthau, FCC Office of General Counsel.
Topics to be addressed by the Council	Julius Knapp, DFO and Deputy Chief, Office of Engineering and Technology.
Discussion of topics	Robert Lucky, Chairman.
Lunch (12:00 to 1:00 PM)	
Discussion of topics to be considered and other topics that the Council may wish to consider.	
Organization	Robert Lucky, Chairman.
Noise Floor Study	Bruce Romano, Associate Chief – Office of Engineering and Technology.
Other business	Robert Lucky, Chairman.
Adjourn	Julius Knapp, DFO

3.0 Membership of the Technological Advisory Council TAC II

Member biographies can be found in *Annex 2*.

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

TAC Chairperson:

Robert W. Lucky – Corporate Vice President, Applied Research, Telcordia Technologies

TAC Executive Director

Jules A. Bellisio - Independent Consultant

Members of Council:

Kwame A. Boakye - Vice-President, Technology, Harris Corporation

*Fred M. Briggs - Chief Technology Officer, WorldCom, Inc.

*Susan E. Estrada - President & Founder, Aldea Communications, Inc.

David J. Farber - Professor, University of Pennsylvania

*Bran Ferren - Co-Chairman and Chief Creative Officer, Applied Minds, Inc.

Larry Goldberg - Director of the Media Access Group, WGBH

*Richard R. Green - President and CEO, CableLabs

Eric C. Haseltine - Executive Vice President of Research and Development, Inc., Walt Disney Imagineering

*Dale N. Hatfield - Director of the Interdisciplinary Telecommunications Program, University of Colorado at Boulder

*Christine Hemrick - Vice President, Strategic Technology Policy, Cisco Systems, Inc.

Dewayne L. Hendricks - Chief Executive Officer, Dandin Group, Inc.,

Charles L. Jackson - Independent Consultant

*Kevin Kahn - Intel Fellow, Director, Communications Architecture

Kalle R. Kontson - Vice President, IIT Research Institute, Division Manager, Center for Electromagnetic Science

Gregory D. Lapin - Chair, ARRL RF Safety Committee

Paul F. Liao - Chief Technology Officer and President, Panasonic Technologies, Inc.

Wah L. Lim - Vice President, Corporate Technology and Ventures, Hughes Electronics Corporation

Willie W. Lu - Principal Wireless Architect, Siemens-Infineon

*David C. Nagel - Chief Technology Officer, AT&T Corp. President, AT&T Labs

Kevin J. Negus - Chief Technology Officer and Vice President of Business Development, Proxim, Inc

Stagg Newman - Senior Telecommunications Practice Expert, McKinsey and Company

M. Niel Ransom - Chief Technology Officer, Alcatel USA

Dennis A. Roberson - Corporate Vice President and Chief Technology Officer, Motorola

Andrew G. Setos - Executive Vice President , News Technology Group

*Nitin J. Shah - Executive Vice President for Business Development and Strategy, ArrayComm, Inc

*Gerald Sharp - Vice President and Chief Technology Officer, ionex telecommunications

Douglas C. Sicker - Director of Global Architecture, Level 3 Communications, Inc.

Barry Singer - Senior Vice President, Philips Research, Managing Director, Philips Research USA

Jessica Stevens – Chief Executive Officer, Telegen Corp.

Gregg C. Vanderheiden - Professor/Director, University of Wisconsin, Madison

*Robert M. Zitter - Senior Vice President, Technology Operations, Home Box Office

Designated Federal Officer

Julius Knapp - Deputy Chief, Office of Engineering and Technology.

****Not present at this meeting.***

About 40 members of the public were present at the meeting and comments from the public are reported as appropriate. The meeting was webcast, videotaped, and carried by closed circuit television throughout the Commission's offices.

4.0 Summary of Remarks by Representatives of the FCC

Peter Tenhula, Senior Legal Advisor, Office of FCC Chairman Michael Powell, spoke for the FCC Chairman who sent regrets that he could not be at the TAC meeting. The Chairman has made a very strong commitment toward recognizing the need for the Commission to have an independent technical capability to assess technical issues placed before it. He has made a commitment to increasing the Commission's technical resources and staffing and, as such, Mr. Tenhula spoke about the FCC's Excellence In Engineering Program and sought the TAC's group and individual support. Advances in technology are driving communications policy issues, so the Chairman has determined that the Commission must have a stronger fluency in the language of technology, and not depend entirely on those who are regulated for on-the-job tutorials while making decisions. It is why the Commission is implementing a new extensive recruitment, development, and engineering training program to make sure the agency possesses independent technical expertise.

Over the last six years, the FCC engineering staff has decreased by 30%. In four years, 40% will be eligible for retirement. The Commission is challenged to convince qualified candidates to enter government service. To address the situation, the Commission, with the help of the Office of Engineering and Technology, and others, are developing this agency-wide Excellence in Engineering Program with three main components. First, of course, is recruitment and retention of quality engineers utilizing creative ways to gain greater personnel and pay flexibility to attract technical talent. They are also looking for ways to ensure that technical workers continue to develop through training programs, development, and job rotation.

The second part of the program is upgrading lab facilities in Columbia, Maryland by examining cooperative arrangements with other state-of-the-art labs in the area. Finally, the FCC is training nonengineering staff, lawyers, economists and the like, in the areas of advanced technology using an internal "FCC University." using FCC experts and guest lecturers. They have launched an intranet site for FCC employees with 25 courses, including three courses specifically targeted at the nontechnical staff.

Engineers looking for an opportunity to serve their country in public service can call the FCC's job hotline: 202-418-0101, or visit www.fcc.gov/jobs

5.0 Continuation of the TAC and the Federal Advisory Committee Act

The first two-year charter of this Council, the FCC TAC, expired during December 2000 as planned. Following on previous recommendations by the then current TAC to continue the activity in the future, the TAC was rechartered by the Commission. This next instantiation of the Council (TAC II) will conclude in 2002.

Paula Silberthau, Attorney for the FCC Office of General Counsel, spoke about implications of the Federal Advisory Committee Act (FACA) that apply to the activities of the TAC. FACA was established to provide openness in government, better accountability, and diversity in the advice given the government. These are all conditions that will be clearly met by the composition of this committee. The TAC is advisory only. Recommendations to add or remove regulations would have to put into effect by the agency, but only if it so chooses.

Meetings are to be open, and they are to be announced in advance in the Federal Register and other media as appropriate. A “meeting” does not just embrace meetings where people are physically present. It also includes meetings by teleconference or other electronic means. Phone meetings do not circumvent the open meeting requirements. There can be closure of all or parts of the meeting for the special cases of meetings that would involve trade secrets of specific private organizations, or involve classified government materials or foreign policy matters involving national security. Issues such as these should be discussed in advance and permission sought to close a portion of the meeting.

At the point where a final report is developed and submitted to the full group, that report would be subject to record retention requirements. One of the working distinctions between a working group that doesn't have to announce its meetings and the full group that does, is that the working group would be making proposals that have to be subsequently debated and examined by the full group. Proposals should never be made with the understanding that what the working group proposed would be rubber stamped and distributed without discussion.

Additional FACA and related information sources are referenced in *Annex 3*.

6.0 Topics of Interest to the Commission

Julius Knapp, DFO and Deputy Chief, Office of Engineering and Technology presented what was, in effect, a charge from the FCC about what the Commission would like TAC to address this year. There was also opportunity to go around the table and collect ideas for things that members would like to put on the table to be considered. Briefly, the topics the FCC has in mind for further work start with spectrum management and a continuation of the work that occurred in the first round of the TAC, particularly emphasizing software-defined radio technology and other technologies that hold promise for improving spectrum management. Secondly, as an adjunct to the first, is the continuation of the electromagnetic noise floor study. Everybody has recognized the importance of trying to get a better understanding of the trends with respect to the noise floor and perhaps its long term impact.

Another topic area that the FCC had asked the first TAC to look at was the accessibility of telecommunications services by persons with disabilities. One of the very positive events that occurred since that first request is that a separate advisory committee to focus on disability issues has been chartered and they have already had their first meeting.

There are three new areas that the Commission thought would be worth exploring, and they are all network related. One is the development of a better understanding of the impact of what is going on with respect to advances in optical network technology. Where is that headed? What is the impact for the capacity of networks and the availability of broadband service? And, what issues could arise with respect to the interconnection of networks?

Secondly, the FCC is interested in the current thinking designed to ensure network security, integrity and robustness, especially as the nation evolves into networks of networks. How do we ensure that all the pieces are up and running so we can rely on them? And lastly, more from the standpoint of consumer devices where we have various types of systems evolving for both network operators and consumers, the Commission is concerned about how all these pieces are to fit together. As we go into homes and businesses and find deployed wireless technologies, set-top boxes and a plethora of new interconnected appliances, what challenges will the consumer face with different protocols, interfaces and languages as used by different products?

7.0 Topics for TAC Consideration

Following the presentation of FCC interests by Mr. Knapp, there was an open discussion of topics that the TAC could fruitfully address. It was generally agreed that the TAC would focus on five major subject areas, spectrum management, optical networking, access to telecommunications for the disabled, consumer and home networking, and network security. The spectrum group would include issues associated with the noise floor, software defined radios and ultrawideband - all topics considered by the last TAC group. These issues are “just” technological enablers that will help form the solution to the overarching problem of spectrum usage. Network security is understood to include issues of robustness, integrity, confidentiality of telecommunications and the technical enablers for the management of content rights.

Issues and possible actions associated with each of these five primary focus areas were discussed by the entire TAC. The following report sections are synopsis of those discussions.

7.1 Spectrum Management

The spectrum work seemed to be one of the TAC’s most productive areas last year. TAC focused on software-defined radio (SDR) and ultrawideband (UWB), talked about the noise floor, and had the intriguing proposal for the Intelligent Radio “Bill of Rights.” Looking toward future work, we should separate discussions of enabling technologies from the policy implications precipitated by application of those technologies. Focusing on the larger problem of rethinking all of spectrum management because of new innovations, we might start by considering some of the emerging issues, many of which overlap. Issues include unlicensed operation, spectrum overlay / reuse and reallocation, convergence of licensed and unlicensed appliances, and migration strategies and economic drivers.

7.11 Unlicensed Operation

Unlicensed radios, very low cost and typically (but not always) short range, have the potential to become a pervasive part of our communications environment and are closely associated with the home networking issue. Currently, it is common to hear that we need more radio spectrum for this type of application, but we actually have no idea of how to make an analytic or compelling case for it. There

may be some work by economists that have looked at the economic benefit of unlicensed spectrum in terms of innovation and industry growth sectors. We may want to look at this dimension from a quantitative perspective to see how much economic benefit there really is. It is very fundamental to the FCC mission to understand what's going on because in two extreme views we hear that unlicensed usage threatens to “take over the world,” while at the same time we hear talk of an inevitable melt down resulting from unconstrained and incompatible overuse. There is great value in the unlicensed service, that is, the notion of being able to enter service without going through a regulatory process.

Unlicensed radio seems to be an enormous success, but with the proliferation of more and more systems, we are in effect participating in an unplanned experiment in real time and are not sure how to predict the final outcome. We already have a problem with a lot of incompatible sharing partners. There's no rule that one has to run 802.11b protocols. People could use other protocols that don't listen before they speak, creating serious conflict problems. The Commission will be faced with a lot of interesting challenges, and TAC should give it a “head's up” on this issue which is fundamental to telecommunications. On the other hand, the Commission should perhaps hesitate a bit before trying to act from a regulatory point of view. Industry may well recognize these problems and may come up with innovative solutions before these problems are fatal. They are a serious issue, but they drive innovation, and products will be differentiated based in some respects on their abilities to survive in these very high interference environments. Many in industry would rather see less than more regulations and feel the unlicensed bands should have a minimum amount of regulations. We need to look at the direct benefits and tremendous ripple effects throughout our economy that have resulted from this country being the leader in providing unlicensed spectrum.

7.12 Spectrum Overlay, Reuse and Reallocation

In the real world, in addition to the frequency domain, there's both a spatial domain and a time domain to the usage of spectrum. Many of us have heard the anecdote about probing the spectrum with an analyzer. If we set up a receiver and scan across the entire radio spectrum, 10 hertz to 10 gigahertz, we will usually find, at most locations, a great deal of it unoccupied. On the other hand, the allocation charts tell us that none is available. The reason for this apparent discrepancy is that most spectrum is allocated on a dedicated basis over considerable geographic areas and to a specific usage. No account is taken of idle time or other factors unique to the license holder. The previous TAC group considered several stratagems to capitalize on this presumed inefficiency. Technology enablers included the SDR, the *cognitive radio* that was self-aware of its environment and could unobtrusively seize fallow spectrum and use it until higher priority usage recalled it, and the UWB radio which purportedly could overlay signals without significantly raising the noise floor. The SDR could be absolutely crucial especially with both respect to the unlicensed spectrum and flexibility of spatial reuse. A lot of the challenge can be handled with a new set of protocols, what we have called a radio *Bill of Rights*, that would allow innovation, but within certain parameters as specified in the Bill of Rights. We had a good start developing this idea with the TAC in the past, but there's a lot of work still to be done. A difficulty with regulation in the past is that it's been like the Ten Commandments -- *thou shall not do this and that*. We need to start out like the original Bill of Rights, that is, delineating the fundamental rights of a wireless device in a positive sense. The TAC took a first cut at the Bill: Any wireless device has a right to transmit anyway it wants, as long as it does not interfere with anyone else. Article II and subsequent articles took on the issue of actually assuring that one was not interfering with everyone else. It was an interesting rethinking of the whole approach toward regulation, and that work should go forward.

7.13 Convergence of Licensed and Unlicensed Appliances

Most people use their cell phone in the office or in the home as a substitute for a wired (cordless) telephone. Some observations have shown that, of cellular subscribers, people use their cellular handsets only 15% of the time on the highway. In these venues, it should be possible to reach these users using short-range unlicensed technology. This is the basis of the *convergence* being considered here. Multimode handsets which could automatically and adaptively switch to the appropriate mode would, in principle, greatly reduce the burden on the licensed part of the spectrum. Several companies have started working on this issue, but the connection with potential FCC action is problematic. It's obviously a very important issue to get better spectrum utilization, but the success of a convergence scheme like this depends on the development of effective business and regulatory models that provide incentives to operators to implement the idea. We don't generally regulate *receivers* in the same way as we do transmitters - an interesting point that this Council brought out last year. A system involves both a transmitter and receiver and if one regulates receivers also, one can cause some very interesting things to happen. It may be the way to motivate manufactures to build handsets that switch to short-range, spectrum-saving alternates when users are near usable ports, even though this might mean a loss of revenue for the cellular carriers. Nevertheless, we need to be very careful about increasing the number of regulations to, for example, receivers until we understand all of the possible repercussions. Costs for consumers should not be increased unnecessarily if there are better alternatives. There has to be some kind of assured pay-off, because the economic issues drive this and, in some sense, are more important than the regulatory issues. Frequently technology, regulatory issues and economics become intertwined, as in this case.

7.2 Optical Networking

The FCC is concerned about the future development of optical networks, the transitioning of networks to optical, and the implications for interconnectivity and for devices that are connected to optical networks. This is a rich and fertile area. We're beginning to have a huge optical backbone with a tremendous amount of raw capacity. The difficulty is that we're not experiencing the benefit of all of that capacity, because we have a dearth of on-ramps and off-ramps, especially with respect to links that connect into the home, office, or other workplace environments. There may also be an issue to consider on the management and interconnection of optical networks. We could also expand the subject into a number of areas on the local access side. The industry is once again getting excited about fiber to the home, but there are differing standards and techniques. Some of the questions are: Will there be interoperability? Can competitive providers come and get part the business and, if so, how will it be manifest? What will be the role of DSL (digital subscriber line)? How does a competitive provider gets access to lines?

The charge to this group is to give the Commission a "heads-up" on those things which unexpectedly might impact regulation. We therefore need to first focus in on the expected characteristics of dense wavelength optical systems and various types of dark fiber deployments, for instance. We then need to focus on issues that the Commission needs to be aware of because they may render the current paradigms upon which regulations are based obsolete. If one looks at the basis of much of Title II of the Communications Act (Common Carrier Regulation and Interconnection Principles for Unbundled Network Elements - the network boundary issue), one finds that for an all optical network, the Commission hasn't fully dealt with the complete set of implications that will exist. One would hope that in many areas, the marketplace will work things out and we will not need to re-encode all the

regulations that have been promulgated for the world of copper, traditional circuit switched networks, and the like. Giving the Commission a heads-up would be a valuable roadmap, so that the first time two carriers fight about wanting to interconnect, the Commission will have current thinking at hand as to what that means.

As an example, we will need to be ready to understand all the implied pros and cons as technology reaches the point where dark fiber begins to reach nearly every home as a public conduit that anyone can access with any wavelength. Does this type of plan result in a rational regulatory situation, or does it lead to such massive operation and maintenance problems that we will have a truly undesirable condition? This is the kind of guidance that TAC should want to make available to the FCC in anticipation of likely competitive developments.

A number of cities, as in the Canadian Canary system, are beginning to talk about putting in optical roadways, if you like, the way they put in sewers and pave streets. That will create a whole new set of scenarios related to the condominium ownership of fiber. There are housing developments, for instance one in Texas, where an operator will partner with the developer to put in fiber to the home because it brings a certain value to that subdivision, but will sell access to others. What rules and regulations by which they can do things like this is yet to be determined. Part of the Commission's mandate (47 U.S.C. § 157) is to encourage the development of advanced communications, but this is only done with enlightened rulemaking. What are often blocking are *municipal*, not federal, regulations of what can go in roads, for instance.

There is also an issue of social optimization. Recall that the money operators spent for the radio license spectrum in the U.K. would have put fiber into every home. Somehow we wouldn't want to see that kind of thing happen here.

7.3 Access to Telecommunications by Persons with Disabilities

The FCC has recently chartered a different committee to look at access to telecommunications by persons with disabilities. It is our understanding that that the new group is primarily focused on very near term issues and that perhaps the TAC should a look at the longer term and to what technology might make possible. Of course, we expect a close liaison between the two groups with complementary work being harmonized. At least two TAC members are joint members with the new Consumer Disability Advisory Committee.

The Consumer Disability Advisory Committee is concerned with the very here and now. It is looking at FCC regulations that have been implemented under Section 255 of the Telecom Act and others rules that are just now being enforced. That group is very consumer oriented. The TAC has the ability to look over the horizon, even the near horizon. One example is that the FCC has required that 100% of television sets become closed captioned by the year 2006, but there is probably a point where we'll see a large proportion of television programming appearing as streaming video on the Internet which is not required to be captioned at all. What happens then? Very few people would like to see regulation of streaming video on the Internet, and yet it's a decision that Congress and the FCC had made with respect to conventional and digital television. The important thing will be to be able to tap the minds of the TAC participants and to be able to present some valued wisdom to the FCC.

7.4 Consumer and Home Networking

With respect to the interoperability of consumer devices, the FCC is reacting to the different kinds of networks being introduced into the home. Issues of interoperability for home boxes and intelligent networked appliances have arisen. As networks evolve from the consumer's standpoint, what problems might be posed as to the devices being able to interoperate?

The home network issue seems to have been around for a very long time and we've yet to settle on a reasonable general solution. One would imagine that the emergence of wireless networks in the home is something that the Commission should be interested in because of potential interference problems among living units, especially as people begin to use the unlicensed bands. We have seen proposals for residential gateways but one of the problems is that they usually don't actually promote interoperability. They just give someone control of your home. Today, the problem is expanding. We need to account for Internet access, telephone access and interactive TV. The whole communications and entertainment environment in a home may or may not be managed by one central box or even mutually be compatible with each other.

In the entertainment business, convergence is seen going on at multiple levels, where it seems clear that everything will be connected to everything else, either via communication paths or memory. It used to be that a video was on a VHS tape and audio on a cassette, but now all these functions have been compacted together. The same is true of the interconnectivity. The way we look at it that the classical distinctions between the different media types is rapidly disappearing.

We spend a great deal of time talking about physical interconnectivity, the layer one issue. But even if two things that work at layer one, they may not work at the higher protocol layers. That's the sort of thing where we have previously let the market play itself out.

At some point, the Commission will be forced to deal with the issue of distinctions between whether a certain service is or is not a telecommunications service. As voice-over-IP gets more robust, some believe that the whole concept of separating telephony and data can no longer be enforceable because the usage of the network for various services will be indistinguishable. The one thing that TAC can do is cast out far enough, maybe optical space gives us a place to cast to, where the issues will arise with a vengeance and yet far enough out so that we are not embroiled in current conflicts. This could be the best way of using the capabilities of the TAC without getting in the middle of ongoing warfare.

Another issue related to consumer equipment is that of human safety. How many devices can one put on a desk before one violates the FCC regulation for personal exposure? A very simple case once brought up was that of a ham radio operator operating in a perfectly legal mode and having someone come into the room with an active cell phone operating just on the edge of its allowed power level. The combined energy absorbed will violate the limits in a way not simply addressed in the regulations. There are many years of good research that have been put together on the general topic of exposure and we are assured that all present equipment complies with the rules that have resulted.

As an **action item**, we request that during the next meeting we have a half-hour talk about the general issue of the effect of electromagnetic exposure on living creatures. Mr. Roberson has volunteered to arrange such a talk.

7.5 Robustness, Integrity and Security of the Network

In the past, security and reliability issues got most attended to with respect to the telephone network. We're evolving to other types of networks and relying on them to an increasing extent. On the wireless side, for example, there is Emergency 911. But we need to frame this issue more broadly. As we move to other kinds of networks, we need a taxonomy of what kinds of security issues are apt to arise. Closely related are issues of the maintenance of the confidentiality of communications made by individuals, and the management of intellectual property rights of the owners of content of all types.

We need to understand if we are developing a new infrastructure that inherently has very bad security problems and inadvertently counting on it to carry everything. There are a lot of people who believe that that has already happened and are worrying seriously about it. It's something we want to look at and give advice to the Commission as to how bad the problem is. It might not have an obvious cure, but they should at least get a heads-up before catastrophe strikes.

We also need to be concerned about the personal security of the individual at the end of the line. With the introduction of geolocation into cellular telephony, it may be possible for a malicious interloper to determine the physical location of any user. We need some structure that guarantees the circumstances upon which particular information sets will be available at each shell of the network. People should be assured that if they use their cell phone they're not going to reveal a class of information to others who have no right to have it.

There is another issue which needs to be understood much more deeply. It is the protection of intellectual property (I.P.). The protection of I.P. and personal privacy issues overlap, in that if the owners or the originators of I.P. can track who is using their I.P., they have massive information about individual users use. So those two issues are intimately intertwined both philosophically and technically.

Another outcome is that many I.P. owners would like to establish are mechanisms by which the use rules can imbedded in the material. Thus, if someone purchases a copyrighted book, picture or sound, they will not be able to use it in ways that they didn't contract for. But for both privacy and intellectual property, it is beyond the scope of TAC get into the policy of how social and business goals are selected. TAC should focus on what is feasible and what is not feasible from a technical standpoint. Then, the people whose job it is to create policy will have a basis upon which rules that are technically sound can be constructed.

As someone in Hollywood has said, "There are no bits like show bits." Those who manufacture lucrative entertainment bits are very concerned about how they are transmitted, and the media set includes broadcast networks, television and radio, CDs, cable, and now the I-Mode phone. I.P. owners are not just concerned about getting bits to consumers, but that they be adequately protected in a number of ways. When intellectual property is the only thing you are selling, the I.P. problem needs to get first order attention.

8.0 Procedure for Technical Work

Based on past experience, we find that work between general meetings proceeds most expeditiously if individual topic areas are assigned to subcommittees, and those groups have physical meetings to prepare presentations for the following meetings. In addition, there is another operating possibility, something that we haven't quite done in the past, and that is to prepare technology roadmaps for the

FCC. Maps are not necessarily focused on particular problems, but paint a picture of much of what's happening in a particular area technologically. Maps could be documents outlining where we see technology going and what issues might arise. They could be a logical output for one or more of the working groups.

As a result of FCC input and discussions at this meeting, five general subject areas were defined. *Annex 4* is list of the groups and TAC members who, at the meeting or subsequently, expressed interest in participating in those groups. With the aid of our federal officers and the TAC Executive Director, the TAC Chairman will appoint chairpeople for these subcommittees before the next meeting. At our next meeting we'll be able to focus on some of the issues and exactly what the different groups will do. A useful thing that each group might do before the next meeting would be to list key questions that they might be addressing and, whether or not they meet, communicate with each other so that the chairperson from each of the committees can come up with a working draft of issues and an approach. Remember, however, that we see these five defined areas not as five little niches, but as trying to span the whole field in some way. At each meeting we will hear reports from each group which has discovered some interesting information. We might not necessarily hear from every group every time, because there may not be sufficient time.

We have found in the past that the success of TAC meetings is strongly dependent on the personal participation of each member. Consequently, will intend to continue our policy of not permitting either substitutes to attend for members or participation by teleconference. Of course, all meetings are open to the public and all persons are welcomed to participate as audience members.

Annex 1: Official Meeting Minutes

A VHS videotape of the June 13, 2001 meeting serves as the set of comprehensive minutes of that meeting and represents the official archive. Copies of the meeting tape can be obtained from the Commission's contracted copier, In Focus. They may be reached by phone at: 703 - 843 - 0100 ext. 2278.

This report is a reorganization and distillation of discussions at the meeting written for the purpose of facilitating the ongoing work of the Council, and as an informal summary for those who may be interested. It is *not* the minutes.

Annex 2: Biographies of Current TAC Members

Jules A. Bellisio *Independent Consultant*

Jules A. Bellisio is the Principal of his own consulting practice, Telemediators, LLC. Previously, he was Chief Scientist and Executive Director of Emerging Networks Research, Telcordia Technologies (<http://www.telcordia.com/>), where he remains a Telcordia Fellow. Currently, he consults on the system and physical layer aspects of digital communications and related emerging technologies with a focus on mobility and wireless. 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 what is now Telcordia to establish the Digital Signal Processing Research Division.

Bellisio was born in Brooklyn, New York, received the B.S.E.E. degree from the Polytechnic Institute of Brooklyn, the S.M.E.E. degree from the Massachusetts Institute of Technology, and was awarded the Ph.D. from Yale University. He is the originator (US Patents) 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.

Dr. Bellisio is a Telcordia Fellow, a Fellow of the IEEE, a member of the Society of Motion Picture and Television Engineers, and of the Internet Society. He was the President and Chairman of the Board of DAVIC, the Digital Audio Visual Council (<http://www.davic.org/>), and is currently Executive Director of the Federal Communications Commission Technological Advisory Council (<http://www.fcc.gov/oet/tac/>). He is also a member of the National Academy of Sciences Intelligent Transportation Systems Standards Review Committee, the ATSC (Advanced Television Systems Committee), the Software Defined Radio Forum, and the TV-Anytime Forum.

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Kwame A. Boakye
Vice-President, Technology,
Harris Corporation

Dr. Kwame Boakye is Vice-President, Technology for Harris Corporation. In this position, he is responsible for providing leadership and management of Harris' technologies and technical assets and for maximizing Harris' effectiveness in relevant industry technical forums, standards bodies and associations. He joined Harris in 1998.

Prior to Harris, Dr. Boakye was Vice-President, Technology Planning for AT&T Paradyne where he transferred from Bell Laboratories in 1990. There, he also held positions as Chief Technical Officer and Chief Architect. In addition, he has served as consultant on Information Technology, New and Emerging Technologies, Technology and Development and Strategic Planning for United Nations Agencies and a number of institutions, on networking products and technology development for Lucent Technologies and serves on the industry advisory boards of a number of universities.

Dr. Boakye began his career at Bell Laboratories in 1973 as a Member of the Technical Staff in the Network Planning Department. He was involved in traffic flow studies, network design and network optimization. In 1977, he joined the University of Ghana where he headed the Computer Science Department. He returned to Bell Labs in 1982 as a Member of the Technical Staff in the Network Capabilities Department, then became Technical Manager, Data Communications Development and finally Technical Manager, Data Architecture Planning.

Dr. Boakye received B.S., M.S., and Ph.D. degrees in Electrical Engineering from Columbia University.

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Fred M. Briggs
Chief Technology Officer,
WorldCom, Inc.

As Chief Technology Officer, Fred Briggs is responsible for all of the engineering and information systems for WorldCom's global operations. His responsibilities include WorldCom's local-to-global-to-local fiber optics network over which extensive data networks (frame relay, ATM, IP) run. He also is responsible for wireless engineering, strategic accounts engineering, and technical support services for the company's international joint ventures such as Avantel in Mexico and Embratel in Brazil. With over 20 years of experience designing and implementing data and voice communications solutions for enterprise customers, Mr. Briggs is a key leader in the development of the data services that WorldCom offers to its customers. As CTO, Mr. Briggs also participates in the company's strategic planning, meets with enterprise customers to discuss WorldCom's strategy and how to meet the customer's needs, and works with vendors, research laboratories, and standards bodies on emerging technologies.

Before assuming his current position, Mr. Briggs served as MCI's Senior Vice President of Network Services Engineering, during which time he oversaw the engineering of the communications networks for the FAA and NASDAQ. Prior to that, he was Senior Vice President of Network Operations. Mr. Briggs also served as Vice President of Data Services Engineering and Vice President of Data Services for MCI International, where he was responsible for international messaging and private line services. He joined MCI in 1983 to work in the company's international network planning organization.

Prior to joining MCI, Mr. Briggs held operations management and engineering positions with AT&T and Mobil Chemical Co. He served in the U.S. Navy as an engineering officer on board nuclear submarines.

Mr. Briggs holds a Bachelor of Science degree in electrical engineering from Oregon State University.

WorldCom (NASDAQ: WCOM) is a preeminent global communications company for the digital generation, (generation-d) operating in more than 65 countries with year 2000 revenues of approximately \$40 billion. WorldCom provides the innovative technologies and services that are the foundation for business in the 21st century.

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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 that include CENIC, the University of California, California State University, Hughes, AT&T InterNIC, Network Solutions, Cisco Systems, AT&T Jens, 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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David J. Farber
Professor,
University of Pennsylvania

Prof. David J. Farber is the Alfred Fittler Moore Professor of Telecommunication Systems at the University of Pennsylvania holding appointments in the Computer Science and Electrical Engineering departments and is a faculty associate of the Wharton and Annenberg schools at UPenn. He was responsible for the design of the DCS system, one of the first operational message based fully distributed systems and is one of the authors of the SNOBOL programming language. He was one of the principals in the creation and implementation of CSNet, NSFNet, BITNET II, and CREN. He was instrumental in the creation of the NSF/DARPA funded Gigabit Network Testbed Initiative and served as the Chairman of the Gigabit Testbed Coordinating Committee. His background includes positions at the Bell Labs, the Rand Corp, Xerox Data Systems, UC Irvine and the University of Delaware. Prior to his one year appointment as Chief Technologist for the Federal Communications Commission, he was a member of the US Presidential Advisory Committee of Information Technology. In addition, he is a Fellow of both the ACM and the IEEE and serves on the Board of Directors of the Electronic Frontier Foundation. He is a Visiting Professor at the International University of Tokyo and a Fellow of the Asian Research Center and the Cyberlaw Institute. He is the Founder and Editor of the influential "network newspaper" Interesting People with a readership of over 25,000. He serves on many industrial Advisory Boards including AT&T, COM21, Etenna, KDRL (SG) and NTT DoCoMo. He holds an Honorary Doctor of Science from the Stevens Institute of Technology where he is also a Trustee.

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Bran Ferren
Co-Chairman and Chief Creative Officer,
Applied Minds Inc

Bran Ferren is a designer and technologist working in entertainment, product development, engineering, architecture and the sciences. He has founded several successful companies starting with

Synchronetics in 1970, then Associates & Ferren and The Bran Ferren Corporation which were sold to Walt Disney in 1991. The focus of A&F was design and the invention of new technologies for the Industry, Government and the Entertainment Industry. Clients included IBM, Phillip Morris, DDB, The National Archives, NASA, Strand Lighting, Unisys, ABC Television Network, Many arms of the US Government, The Canadian Government, The Optical House, Warner Communications, and The Walt Disney Company. Throughout this period he has also maintained an active consulting practice advising business clients on applications of new technology and creative business models.

When A&F was acquired, he became Senior, and then Executive Vice President of Creative Technology for Walt Disney Imagineering. He was then promoted to President of Research & Development for Walt Disney in 1998. He left Disney in late 2000 to start Applied Minds Inc., with partners Danny Hillis and Doug Carlston.

Ferren is a board member of The International Design Conference in Aspen, and a senior advisor for science, design, advanced technology, and innovation management to many US Government organizations. Currently held positions include National Security Agency Advisory Board, National Reconnaissance Office Technical Advisory Group, Army Science Board, Chief of Naval Operations executive committee, Defense Science Board, Senate Select Committee on Intelligence Technical Advisory Group, Security and Exchange Commission Advisory Committee on Technology, National Imagery and Mapping Agency forum, and the Federal Communications Commission Technological Advisory Committee.

His technical design and engineering work has included many advanced digital control systems, high performances electro-optics, large scale simulation design, simulator design, film and digital imaging systems, robotics, 3D machine vision, acoustic phased arrays, virtual reality technology and high mobility ground vehicle design. He has been the lead design consultant of technical facilities for many private companies, as well as the US Army and US Navy. He has 14 technology related patents awarded, with many more pending.

He was nominated in 1986 for an Academy Award for his special visual effects work for the film Little Shop of Horrors. The Academy of Motion Picture Arts and Sciences gave Ferren two Technical Achievement Awards, as well as the Scientific and Engineering Award for an Advanced Concept Optical Printer, used for special effects cinematography. He has received the New York Drama Desk, LA Critics circle and Maharam Foundation awards for his work in theater. Recent awards include the 1998 Wally Russell lifetime achievement award for lighting design and a 2000 Kilby Award for significant contributions to society.

A popular guest lecturer, Ferren has addressed over 100 prominent professional groups in the business, entertainment, and scientific communities. His writings have been published in places such as the New York Times, MIT Technology Review, and Encyclopedia Britannica. He attended Hunter College elementary school, the American University of Beirut community school, The MacBurney School in NYC, East Hampton High School, and MIT while resisting a variety of methods to educate him.

He is currently completing the editorial work on a large format Fine Art photography book called Eleven Seconds, and his MaxiMog Global Expedition Vehicle was recently exhibited as part of the WorkSpheres exhibition at the Museum of Modern Art in New York City.

Larry Goldberg
Director of the Media Access Group,
WGBH

The Media Access Group is a division of Boston public broadcaster WGBH and consists of The Caption Center, Descriptive Video Service and the CPB/WGBH National Center for Accessible Media (NCAM). NCAM is a research and development facility devoted to the issues of media technology for the disabled. Mr. Goldberg helped establish an industry group that designed FCC specifications for closed-captioning for the U.S. analog and digital television systems. Mr. Goldberg was deeply involved in the passage of two new FCC reports and orders for video description and digital television and closed captioning. Mr. Goldberg is known for his patented "Rear Window" system for displaying hidden captions for deaf people in movie theaters, amusement parks and other public attractions. This system is used in conventional movie theaters, IMAX theaters and more than 30 Disney theme park attractions.

Mr. Goldberg received his B.A. cum laude from the University of Southern California in 1976, where he focused on Cinema Studies and Broadcast Journalism. He then went on to graduate school at the New York Institute of Technology, where he studied computer graphics.

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Richard R. Green
President and CEO,
CableLabs

Dr. Richard R. Green is President and CEO of Cable Television Laboratories, Inc. (CableLabs). In this position he heads the organization responsible for charting the cable television industry's course in technology.

Prior to CableLabs, Green was senior vice president of broadcast operations and engineering at the Public Broadcasting Service, from 1984, where his contributions included construction of national network origination and transmission facilities. For the 1-1/2 years before that, he helped organize and establish the Advanced Television Systems Committee, a multi-industry-supported organization founded to develop voluntary national standards for advanced television.

From 1980 to 1983, Green was director of the CBS Advanced Television Technology Laboratory in Stamford, Connecticut. In addition to his work at CBS in digital television and high-definition TV, Green participated in the international standardization efforts that date from the late 1970's and chaired the committee that eventually developed CCIR (now ITU-R) Recommendation 601, a world-wide television standard for digital signals. He is currently chair of ITU Study Group 9, which has the lead responsibility for preparing international standards that affect cable networks. While at CBS, Green helped to produce the first series of experimental programs mastered in HDTV in the United States.

From 1977 to 1980, Dr. Green managed ABC's Videotape Post Production Department in Hollywood, and from 1972 to 1977 did basic research in laser technology for the Hughes Aircraft Co. in Los Angeles. Green served as a senior staff scientist for Boeing Scientific Research Laboratories (1964-1972), and as an assistant professor at the University of Washington (1968-1972).

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 is the author of more than 55 technical papers on topics ranging from TV production to electro-optical and laser research. Most recently Green was voted CED's Man of the Year and selected by ElectronicMedia as one of 12 people in the U.S. media to watch in 1993. He received the 1999 Vanguard Award, the cable television industry's highest award, for his achievements in technological development.

A native of Colorado Springs, Green holds a B.S. degree from Colorado College (1959), an M.S. in physics from the State University of New York in Albany (1964), and a Ph.D from the University of Washington (1968).

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Eric C. Haseltine

***Executive Vice President of Research and Development, Inc.
Walt Disney Imagineering***

Dr. Eric Haseltine is Executive Vice President of Research and Development, Inc. at Walt Disney Imagineering. His responsibilities include oversight of the corporate R&D organization and the Virtual Reality Studio. During his nine years at Disney, Eric has played a key role in developing advanced head mounted displays, paperless animation systems, Enhanced Television, and several novel optical special effects.

In addition to his management responsibilities, he still gets to play around in the lab, where he designs and develops advanced prototypes of display systems and other interactive entertainment components. Eric also serves as a Contributing Editor at Discover magazine where he writes a monthly column and companion web site on the brain.

Prior to joining Disney in 1992, Dr. Haseltine was an executive at Hughes Aircraft Co., where he held a series of posts in the Human Factors, Flight Simulation and Display System areas.

Eric came to Hughes in 1979, after completing a post-doctoral fellowship in Neuroanatomy at Vanderbilt Univ. Medical School.

Dr. Haseltine holds a Ph.D. in Physiological Psychology from Indiana Univ. and a B.A. in Economics from U.C. Berkeley.

He has published in the fields of Sensory Physiology, Neuroanatomy, Flight Simulation, Training Systems Development and Display Systems Engineering, and holds a number of patents in optics and electro-optical imaging.

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Dale N. Hatfield
*Director of the Interdisciplinary Telecommunications Program,
University of Colorado at Boulder*

Dale N. Hatfield is currently the Director of the Interdisciplinary Telecommunications Program at the University of Colorado at Boulder. Prior to his current position, Hatfield was the Chief of the Office of Engineering and Technology at the Federal Communications Commission and, immediately before that, he was Chief Technologist at the Agency. He retired from the Commission and government service in December 2000. Before joining the Commission in December 1997, he was Chief Executive Officer of Hatfield Associates, Inc., a Boulder, Colorado based multidisciplinary telecommunications consulting firm. Before founding the consulting firm in 1982, Hatfield was Deputy Assistant Secretary of Commerce for Communications and Information and Deputy Administrator of the National Telecommunications and Information Administration. Before moving to NTIA, Hatfield was Chief of the Office of Plans and Policy at the FCC.

Hatfield was the founding director of the Telecommunications Division at the University College at the University of Denver and, for many years, taught telecommunications policy on an adjunct basis at the University of Colorado at Boulder.

In 1973, Mr. Hatfield received a Department of Commerce Silver Medal for contributions to domestic communications satellite policy and, in 1999, he received the Attorney General's Distinguished Service Award. In 2000, he received the PCIA Foundation's Eugene C. Bowler award for exceptional professionalism and dedication in government service and the Federal Communications Commission's Gold Medal Award for distinguished service. More recently, he received the Distinguished Engineer award from the University of Colorado at Boulder. He currently is a Fellow of the Radio Club of America. In February, 2001, the Federal Trade Commission appointed Hatfield Monitor Trustee in the AOL/Time Warner merger.

During his previous period in the private sector, he was on the Board of Directors of Cushcraft Corporation, Pittencrieff Communications, Inc., Data-marine International, Inc., and KBDI TV-12 Public Television in Denver, and was on the Editorial Board of Communication Law and Policy.

Hatfield holds a B.S. in electrical engineering from Case Institute of Technology and an M.S. in Industrial Management from Purdue University.

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Christine Hemrick
Vice President, Strategic Technology Policy,
Cisco Systems, Inc.

Christine Hemrick is the Vice President for Strategic Technology Policy in the Office of the Chief Strategy Officer at Cisco Systems, Inc. Her organization provides leadership in policy issues that result from new and emerging technologies, and in communicating Cisco's technology strategy and vision.

Ms. Hemrick joined Cisco Systems in January 1991, and has held a number of positions there including Director of Cisco IOS Marketing and Vice President and General Manager of the Internet Appliances and Applications Business Unit.

Prior to joining Cisco, from 1985 to 1990, Ms. Hemrick was District Manager for Data Communications Planning at Bellcore (now Telcordia). From 1983 to 1985, she was a Senior Staff member at the National Telecommunications & Information Administration (NTIA) of the U.S. Department of Commerce. Before joining the NTIA, she held positions at GTE Telenet (now Sprint) and Digital Equipment Corporation. Ms. Hemrick's career in data networking and telecommunications spans more than 25 years, including experience in customer support, software development management, network architecture and planning, international technical standards, marketing, telecom policy, and general management.

Ms. Hemrick is a member of the Board of Directors of the Cisco Learning Institute and was appointed by U.S. President Bill Clinton to be the co-chair of the Presidential Advisory Committee on Expanding Training Opportunities. She is also a member of the Technological Advisory Council to the U.S. Federal Communications Commission (FCC), and serves on the Advisory Board of the San Francisco Women's Technology Cluster, a San Francisco based business incubator for new, high technology companies.

Ms. Hemrick received a B.S. degree in Mathematics from North Carolina State University.

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Dewayne L. Hendricks
CEO,
Dandin Group, Inc.

Dewayne Hendricks is CEO, of Dandin Group, Inc., a Fremont, California based company which does research and product development in the area of broadband wired and wireless data devices and services. He is also a member of the Federal Communications Commission (FCC) Technological Advisory Council (TAC <<http://www.fcc.gov/oet/tac>>). Prior to that he was General Manager, Wireless Business Unit, for Com21, Inc. Before Com21, he was Co-Principal Investigator on the National Science Foundation Wireless Field Tests for Education project.

He was formerly the CEO and co-founder of Tetherless Access Ltd., which was one of the first companies to develop and deploy Part 15 unlicensed wireless metropolitan area data networks which used the TCP/IP protocols. He has participated in the installation of these networks in other parts of the world such as Kenya, Tonga, Mexico, Canada and Mongolia.

He has been involved with radio since his teens when he received his amateur radio operator's license. He holds official positions for several non-profit national amateur radio organizations and is a director of the Wireless Communications Alliance, an industry group which represents manufacturers in the unlicensed radio industry.

More information on Dewayne is available at <http://www.dandin.com/>.

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Charles L. Jackson
Independent Consultant

Dr. Charles L. (Chuck) Jackson is an electrical engineer who has done substantial work in spectrum management. He works as a consultant. He is also an adjunct professor at George Washington University where he has taught graduate courses on mobile communications and wireless networking. He has also written on other topics in telecommunications policy.

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 an 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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Kevin Kahn
Intel Fellow
Communications Architecture Director,
Intel Architecture Labs.

Dr. Kahn is an Intel Fellow, the corporation's highest technical position, and currently the Director of Communications Architecture for Intel Architecture Labs. He helps drive communications strategies and policy for the corporation. Some of his primary current focuses are broadband access to the home, home networking, wireless LANs, and Internet issues bearing on these topics. Throughout his 25-year career with Intel, he has worked in system software development, operating systems, processor architecture, and various strategic planning roles on programs involving most of the processors Intel has developed during the period. He has held both management and senior individual contributor roles. He was the co-chair of the Universal ADSL Working Group, an industry alliance dedicated to accelerating the deployment of consumer ADSL services for higher speed Internet access, and served as a member of the Board of Directors of the DSL Forum. He serves on a variety of NSF and NAS committees and panels, and is a member of the FCC Technological Advisory Council. He holds a B.Sc. in Mathematics from Manhattan College, and M.S. and Ph.D. in Computer Science from Purdue University.

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Kalle R. Kontson
Vice President, Chief Sector Scientist and Operations Manager
Center for Electromagnetic Science,
IIT Research Institute

Mr. Kontson is a Vice President of IIT Research Institute (IITRI) and Operations Manager for IITRI's Center for Electromagnetic Science in Lanham, Maryland. He also concurrently serves as the Chief Scientist for IITRI's Spectrum Engineering Sector headquartered in Annapolis, 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, Joint Service Advisory Group and has served as a member of the FCC's Technological Advisory Council since its formation in 1999.

Mr. Kontson has over 28 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 performance optimization and design methods to high capacity digital systems for video and wireless Internet access networks. Mr. Kontson has a Bachelor of Science and Master's 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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Gregory D. Lapin
Chair,
ARRL RF Safety Committee

Gregory Lapin represents the ARRL RF Safety Committee on the TAC. He is a Registered Professional Engineer who works as a consultant in the telecommunications industry and volunteers his time in several RF Safety and communications-related venues.

Dr. Lapin received the B.S., M.S. and Ph.D. degrees from Northwestern University in Biomedical and Electrical Engineering. He spent nine years as Director of the Brain Imaging Research Laboratory at Evanston Hospital and Research Professor of Neurology and Biomedical Engineering at Northwestern University, performing studies on the formation and treatment of brain tumors.

Dr. Lapin has participated in the development of the IEEE C95.1 standard, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," by reviewing past research on the biological effects of electromagnetic energy. He is a Senior member of IEEE and a member of the Bioelectromagnetics Society.

As a licensed radio amateur for over 30 years, Dr. Lapin has had considerable experience dealing with electromagnetic interference and experimenting with different forms of modulation. He writes a

monthly column about RF Safety and has published numerous articles on the topic. He is a frequent speaker on electromagnetic bioeffects. He also serves as an advisor on communications issues to local community and public safety organizations.

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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 14 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, Corporate Technology and Ventures,
Hughes Electronics Corporation

Dr. Wah L. Lim is Vice President, Corporate Technology and Ventures for Hughes Electronics Corporation. This group is responsible for leading the formulation of technology strategies for Hughes Electronics and the coordination with business units on technology developments, new technology assessments and due diligence. In addition, this group identifies, selects and develops new technology and ventures.

Previously, Dr. Lim was with Hughes Space & Communications and Loral Space and Communications. Dr. Lim was 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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Willie W. Lu
Principal Wireless Architect,
Siemens-Infineon

Willie W. Lu is Principal Wireless Architect in Siemens-Infineon and Chair of IEEE Technical Subcommittee on 3Gwireless and Beyond. Willie is also Member of US DARPA 4G Advisory Panel as well as member of European Commission technical evaluation committee. He has over 100 publications in IEEE, IEICE and ACM, in the field of broadband wireless access, wireless mobile Internet, Third-generation wireless communications and beyond, and guest edited over 20 IEEE special issues on Emerging wireless technologies. He is also chair of numerous leading technical conferences including IEEE Globecom, IEEE WCNC, VTC, 3Gwireless, etc and a very well-recognized international expert in wireless communications. Dr.Lu is listed in numerous Who's Whos and elected "The Outstanding People of the 20th Century" by the famous Cambridge IBC of England. Willie has helped review lots of technologies for over 50 start-ups in Silicon Valley.

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Robert W. Lucky
Corporate Vice President – Applied Research,
Telcordia Technologies

Robert W. Lucky was born in Pittsburgh, Pa., and attended Purdue University, where he received a B.S. degree in electrical engineering in 1957, and M.S. and Ph.D.- degrees in 1959 and 1961. After graduation he joined AT&T Bell Laboratories in Holmdel, NJ, where he was initially involved in studying ways of sending digital information over telephone lines. 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. The textbook on data communications

which he co-authored became the most cited reference in the communications field over the period of a decade.

At Bell Labs he moved through a number of levels 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. In 1992 he left Bell Labs to assume his present position at Telcordia Technologies.

He has been active in professional activities, and has 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.

Dr. Lucky is a Fellow of the IEEE and a member of the National Academy of Engineering,. He is also a consulting editor for a series of books on communications through Plenum Press. 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 from 1986-1989. He was the 1987 recipient of the prestigious Marconi Prize for his contributions to data communications, and has been awarded honorary doctorates from four universities. He has also been 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," where he has discussed the impacts of future technological advances. He is the author of the book Silicon Dreams, which is a semi-technical and philosophical discussion of the ways in which both humans and computers deal with information.

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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

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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Kevin J. Negus
Chief Technology Officer and Vice President of Corporate Development,
Proxim, Inc

Kevin J. Negus received the Ph.D. degree in Mechanical Engineering from the University of Waterloo in Canada in 1988. From 1988 to 1998 he held various R&D management positions with the Hewlett-Packard Company where he led the development of RF chipset solutions for systems such as GPS, GSM, IS-54, IS-95, DECT and 802.11. Kevin is now the Chief Technology Officer and Vice President of Corporate Development for Proxim, Inc. in Sunnyvale, CA. At Proxim, the world's largest manufacturer of wireless LAN products for both home and enterprise networking, Kevin is responsible for core technology strategy including silicon development, acquisitions, standards participation and intellectual property licensing. Dr. Negus is also a former Chairperson of the HomeRF Working Group where he led the development of the HomeRF specification for wireless data, voice and streaming media networking in low-cost home networks. He has published more than 50 technical papers and holds several US patents. Kevin's base office is in Hyattville, Wyoming where he and his wife Eva run a working cattle ranch. In addition to being a Member of the Federal Communications Council's Technical Advisory Committee, Dr. Negus has also been appointed by Governor Jim Geringer to the Wyoming State Telecommunications Advisory Board where he is focused on broadband deployment for rural communities.

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Stagg Newman
Senior Telecommunications Practice Expert
McKinsey and Company

Stagg joined McKinsey & Company, Inc., in January 2000 as Senior Telecommunications Practice Expert, where he provides technology advice and strategic technology analysis to client teams across the Firm's telecommunications practice.

Prior to joining McKinsey Stagg served as Chief Technologist at the FCC where he advised the Commissioners and senior staffers on strategic technology issues. Much of his work centered on the FCC's market opening initiatives for advanced telecommunications capabilities. This work included developing policy that encouraged competition in broadband access among cable companies, incumbent telephone companies, new entrant telephone companies and broadband wireless companies. Another theme of his work was "keeping the Internet safe from traditional telco style

Stagg started his telecommunications career with Bell Labs in 1976 and worked for various descendants of Ma Bell in voice, data, video, and wireless networking until his appointment to the FCC in Sept. 1997. From 1994 to 1997 he was Vice President, Network Technology and Architecture, Applied Research at Bellcore where he led the optical networking, wireless, and network access research program. Stagg received his B.S. from Davidson College and his M.S. and Ph.D. from Cornell in Mathematics.

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M. Niel Ransom
Chief Technology Officer,
Alcatel USA

Dr. M. Niel Ransom is Chief Technology Officer of Alcatel USA. In this role he leads Alcatel research activities in North America, sets Alcatel's product strategy for the North American market and is responsible for mergers and acquisition activities of Alcatel in North America. He joined Alcatel in 1997 as General Manager of the Local Networks business unit, a product group encompassing DSL, lightwave access, and crossconnect products.

Before joining Alcatel, Dr. Ransom served as Senior Director of BellSouth's Advanced Technology Systems Engineering Center. Prior to BellSouth, he managed various development and applied research groups at AT&T Bell Labs.

Dr. Ransom is a member of the Board of Trustees of Texas Education Alliance and is a Board Member of the Alliance for Telecommunications Industry Solutions (ATIS). He is co-author of book, *Broadband Access Technologies*, published June 1999 by McGraw-Hill.

Dr. Ransom received his Ph.D. in electrical engineering from the University of Notre Dame (South Bend, Indiana). He also has an M.B.A. from the University of Chicago and Bachelor of Science and Master of Science degrees in electrical engineering from Old Dominion University (Norfolk, Virginia).

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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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Andrew G. Setos
Executive Vice President ,
News Technology Group

As Executive Vice President of the News Technology Group, Andrew G. Setos is involved in strategic assessment and deployment of technology for businesses of The News Corporation Limited. He is also Senior Vice President, Broadcast Operations & Engineering, Fox Television which includes Fox Broadcasting Company, Fox News, Fox Sportsnet, Twentieth Television, Fox TV stations, and Fox Family Channel.

Since joining the Fox organization in 1988, Setos has directed numerous projects and operations for the corporation; some highlights are listed on the attached page.

Prior to joining Fox, Setos was Senior Vice President, Engineering and Operations at Viacom Networks Group, from 1986 to 1988, and Vice President, Engineering and Operations at Warner Amex Satellite Entertainment Company from 1980 to 1986. At these companies, Setos was responsible for development and execution of production and distribution technology for: MTV, MTV Europe, The Movie Channel, Nickelodeon, and Viewers Choice. Before entering the world of cable, he was Chief Engineer, Design and Quality Control at WNET/Thirteen New York where he was responsible for planning and supervising the production technologies for such award-winning series as "Live from Lincoln Center", "Dance in America", and "The

A Fellow of the Society of Motion Picture and Television Engineers, (SMPTE), Mr. Setos has been a member of the Advanced Television Systems Committee and the FCC Advisory Committee on Advanced Television. He was a member of the board of the Advanced Television Test Center and was recently elected to the executive committee of the ATSC. He holds a BS degree from Columbia University School of Engineering and Applied Science.

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Nitin J. Shah
Executive Vice President for Business Development and Strategy,
ArrayComm, Inc

Dr. Nitin J. Shah is Executive Vice President for Business Development and Strategy at ArrayComm, Inc. in San Jose, California. At ArrayComm, the world's leader in fully adaptive smart antenna-based wireless technology (IntelliCell), Nitin is responsible for driving the commercialization of advanced adaptive antenna array technology for spectrally efficient wireless networks. He is in charge of developing the business strategy for the company and the how the company's products integrate into the business of its applications and carrier partners. He is leading the introduction of the i-BURST portable broadband Internet system to the marketplace.

Nitin has been at ArrayComm since January 2000, and prior to that he was Vice President, Wireless Internet Applications at Lucent Technologies (and formerly in AT&T Bell Labs). In this capacity he pioneered key initiatives in network architecture, technology development and applications development for wireless data for Lucent's wireless products for the mobile and fixed wireless access systems. These include both the current Second Generation systems and for the emerging Third Generation wireless systems.

Prior to that, since 1992, he had responsibility for the development of advanced technologies for wireless communications as the Director of Wireless Core Technology at Lucent Technologies. He initiated projects on distributed computing technology for wireless networks and object-oriented software systems, and led efforts on speech coding and compression technologies for CDMA, TDMA and GSM systems. He also initiated several new product initiatives for fixed and mobile wireless systems. Nitin has been involved in wireless communications systems and technologies since 1990.

Nitin had been with Bell Laboratories since 1983, and initially worked on the development of Gallium Arsenide semiconductor and optoelectronic devices for ultra-high speed electronic and photonic switching systems..

Nitin holds 12 patents, and received his B.A. and M.A. in Natural Sciences (Materials Science and Physics), and his Ph.D. in Microelectronics from Cambridge University in England. He is a regular speaker at industry conferences and events, and has authored or co-authored more than 100 articles and international conference presentations in the fields of wireless telecommunications and semiconductor technology, including books on the intelligent network and compound semiconductors. Nitin was named one of the top 50 Wireless Industry Newsmakers of 2000 by Wireless Week magazine, and received the 1998 RCR Gold Medal for a presentation on "CDMA for Third Generation Systems." In addition, he was elected to the Board of Directors of the Wireless Data Forum in 1998, and was on the Board of Directors member of the Berkeley Wireless Research Center and advisor to the TRILabs Wireless group in Calgary, Canada. Nitin is on the Technology Advisory Board of the Centre for Wireless Communications in Singapore.

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Jerry Sharp
Vice President and Chief Technology Officer,
ionex telecommunications

Jerry currently has executive responsibility for ionex telecommunication's short and long-term technology strategy and the architecture and planning for their convergent telephony networks. His broad knowledge base spans Wireless, Optical, Wire-line, SONET, VOIP, MPLS/ATM, and DSL which when combined with his knowledge of regulatory and business principles for ILEC/CLEC's, ISP's allow him to develop fully integrated business solutions.

Jerry has twenty years of telecommunications industry experience, as Chief Technology Officer of Pathnet, Inc., he deployed the first stand alone "soft switch" on the PSTN and several OC-192 Optical WAN's. At Intermedia Communications he deployed several VOIP IP PBX based solutions. He also designed and implemented the first State Wide multi-protocol WAN for the State of Florida Division of Communications.

He has been published in several industry magazines- Telecom Magazine, Exchange Magazine, ATM/IP Report. He also provides industry support via speaking engagements and memberships such as Future Op 2000, Cisco Connections 2000, Energy Industry Association, Northern Virginia Technology Counsel. His education has extended beyond his Bachelor of Science Degree in Electronics Engineering from Metropolitan State College in Denver, Colorado, where he graduated with honors.

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Douglas C. Sicker
Director of Global Architecture, Level 3 Communications
Assistant Professor, School of Engineering,
University of Colorado at Boulder

Dr. Douglas C. Sicker is Director of Global Architecture at Level 3 Communications, Inc. His work at Level 3 focuses on optimizing future network service architectures, particularly in the areas of IP-based signaling and security. His recent focus has been in the area of IP-based number translations and ENUM-based services. Doug is also an assistant professor in the Telecommunications Program at the University of Colorado at Boulder. Prior to this, Doug was Chief of the Network Technology Division at the Federal Communications Commission. His responsibilities at the Commission included Internet issues, advanced services, cable open access and communications merger proceedings.

Doug is a senior member of the IEEE, as well as a member of the ACM and the Internet Society. He is also the Chair of the Network Reliability and Interoperability Council steering committee, an FCC federal advisory committee that focuses on network reliability, wireline spectral integrity and Internet peering and interconnection. Doug also serves on a number of boards including the Silicon Flatirons Institute. He has published extensively in the fields of telecommunications and medical science. His research interests include network performance, IP signaling protocols and telecommunications policy. Doug holds a B.S., M.S. and Ph.D. from the University of Pittsburgh. His dissertation examined emerging IP signaling and control architectures.

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Barry Singer
Senior Vice President, Philips Research,
Managing Director, Philips Research USA

Dr. Barry Singer is Senior Vice President of Philips Research and Managing Director of Philips Research USA. In this capacity he oversees a research and development laboratory engaged in a wide range of activities which include broadband network access terminals, local area networks, wireless communications, adaptive systems and applications for software for consumer and professional use. Philips Research USA helped establish the coalition that created the US digital television standard and is currently involved in standardization activities in open cable, wired and wireless local area networks and wireless connectivity. Philips researchers are also active in the development of LCD display systems and special purpose ICs for RF, power and mixed signal applications.

Dr. Singer serves on the Research Directors Council which is the chief coordinating body of Philips Research worldwide. He is a member of the Board of Directors of Rainbow Displays, Inc. and has served on the Boards of Beltone, VLSI Technology and Morecom. He has more than 20 U.S. patents

and is the author of numerous papers.

Dr. Singer received a B.S. in Applied Mathematics from the University of Colorado, an M.S. in Applied Mathematics from the Courant Institute of NYU and a Ph.D. in Electrophysics from Polytechnic University.

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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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Robert M. (Bob) Zitter
Senior Vice President, Technology Operations
Home Box Office

Bob Zitter was named senior vice president, technology operations for Home Box Office in September 1991. He is responsible for the company's distribution, origination, production operations and engineering. In addition, he oversees HBO's new technology planning and was responsible for HBO's introduction of digital compression technology in 1992, the development and launch of HBO HDTV in 1999, and the technology aspects of HBO on Demand.

Zitter joined HBO in September 1981 as director of network operations. In October 1983 he was named vice president, network planning. In this post, he was responsible for overseeing the roll-out of HBO's nationwide satellite scrambling program as well as acquiring the company's satellite capacity. In November 1984, he was named vice president of network operations responsible for the operation and implementation of HBO's distribution and transmission facilities. Before joining HBO, Zitter was a cable operator and broadcaster with Schurz Communications, Inc. based in the mid-west, and previously supervised network operations for ABC-TV in New York.

He serves on the Federal Communications Commission Technology Advisory Council, the Television Committee of the Consumer Electronics Association, the Satellite Broadcasting and Communications Technology Advisory Council, and is a Director of The North America Broadcasters Association. He is past president of the Maryland-Delaware Cable Association. Zitter was also, one of the founders of HBO's businesses in Latin America, Asia and Europe.

Zitter has a B.A. degree from Colgate University and an M.B.A. from Frostburg State College in Maryland. He and his family live in Stamford, Connecticut

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Annex 3: FCC staff

FCC staff available to address questions from the TAC:

General Issues:

Kent Nilsson: Special Counsel and Deputy Chief,
Network Technology Division
Office of Engineering & Technology, FCC
KNILSSON@fcc.gov.
Phone 202-418-0845

With respect to specific Federal Advisory Committee Act (FACA) questions, a resident expert is FCC attorney:

Paula Silberthau: Attorney, Office of General Counsel
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Additional FACA information is at the Office of Government Policy web page at:

<http://www.policyworks.gov>

Other FCC staff associated with TAC are:

Julius Knapp, Deputy Chief, Office of Engineering and Technology,
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Bruce Franca, Acting Chief, Office of Engineering and Technology,
BFRANCA@FCC.GOV

Peter Tenhula, Senior Legal Advisor, Office of Chairman Michael Powell,
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Annex 4:

List of committees as defined at the eight meeting and membership as determined at the meeting and subsequently. Note that the Executive Director is always a member of all committees.

Spectrum Management/ SDR/ Noise Study:

Bellisio, Jules
Boakye, Kwame
Farber, David
Hatfield, Dale
Hemrick, Christine
Hendricks, Dewayne
Jackson, Chuck
Kontson, Kalle
Lapin, Gregory
Lu, Willie
Negus, Kevin
Newman, Stagg
Roberson, Dennis
Setos, Andrew
Shah, Nitin
Singer, Barry
Stevens, Jessica

Optical Network Issues:

Bellisio, Jules
Briggs, Fred M.
Farber, David
Hemrick, Christine
Newman, Stagg
Ransom, Niel
Sharp, Gerald
Sicker, Douglas
Stevens, Jessica

Network Security, Integrity and Reliability:

Bellisio, Jules
Briggs, Fred M
Farber, David
Hemrick, Christine
Roberson, Dennis
Setos, Andrew
Sicker, Douglas
Zitter, Robert M.

Consumer and Home Networks:

Bellisio, Jules
Green, Richard
Haseltine, Eric
Jackson, Chuck
Lapin, Gregory
Liao, Paul
Lim, Wah
Negus, Kevin
Roberson, Dennis
Setos, Andrew
Shah, Nitin
Sharp, Gerald
Singer, Barry
Stevens, Jessica
Vanderheiden, Gregg
Zitter, Robert M.

Access to Telecommunications by the Disabled:

Bellisio, Jules
Goldberg, Larry
Liao, Paul
Sicker, Douglas
Vanderheiden, Gregg