Report: Second Meeting of FCC Technological Advisory Council II

0.0 Executive Overview

The Federal Communications Commission Technological Advisory Council held the second meeting of its second two-year cycle on Monday November 5, 2001 in Washington, D.C. (FCC TAC II, Meeting 2). 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 thirty-three members who were selected because of their professional and technical expertise, some of whom participated in the first TAC.

The TAC is organized into five working groups to address spectrum management, optical networking, consumer and home networking, access to telecommunications for the disabled, and network security. Chairs for each group have been designated. Groups worked between the meetings, reported findings developed in the interim, and expanding on each area during roundtable discussions at this 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 the TAC for the Intelligent Radio "Bill of Rights." The TAC raised funds from its members to conduct a study of the noise floor. Basic data is needed to determine if the proliferation of new devices is changing the interference environment in ways which will require Commission action. The study is being implemented by the Naval Post Graduate School in Monterey, California. A member of the team reported that there will be a literature search, modeling of noise sources, and a measurement plan. The American Radio Relay League (ARRL), in cooperation with the TAC, will perform some real world measurements of noise. TAC also expects to establish a relationship with DARPA so that efforts can be mutually leveraged.

The FCC is concerned about the status of industry standards for *optical networking*, the transitioning of networks to optical, interconnectivity among systems of different designs, and especially the dearth of on-ramps and off-ramps into the home and workplace. To aid the Commission, a technology road map with timeline is planned covering current broadband access, transport, and interconnection technologies, and future enhancements. Barriers and incentives to deployment of broadband service will be listed to provide a sound technical foundation for FCC discussions. Based on the experience and knowledge of the group, the TAC will address the total broadband problem, covering all the issues and bottlenecks ranging from rural service to technical and construction barriers, to copy control, and everything in between.

Many different kinds of *consumer and home networks* are being proposed and introduced. Issues of interoperability and compatibility between residential systems and intelligent networked appliances are beginning to arise. With a proliferation of unlicensed band RadioLANs at high usage "hot-spots" there becomes an issue of RadioLAN and third generation commercial wireless interoperability, including spectrum allocation and roaming protocols. The usefulness of many types of networks in the consumer

domain will be lost if information can not seamlessly flow through from one to another, or worse, if they mutually annihilate each other. Open standards play a key role. Other important issues are the trustworthiness of the new networks, especially their ability to function in the E-911 modes in times of stress, and the realistic technological enablers and options for the preservation of consumer confidentiality and the protection of intellectual property, all topics now on the priority list for TAC consideration.

Work on *access to telecommunications for the disabled* is to point out technical issues the FCC needs to be aware of in preparing the Commission for its actions. A strong interface with the newly chartered Consumer Disability Advisory Committee will be established. Documents containing lists of features or functionalities that need to be preserved or replaced as technology advances will be written and published in widely-read engineering journals delineating how people with disabilities may be affected by lack of attention to accessible design so that future technologies can be launched with accessibility built-in from the start.

Network security is understood to include issues of integrity, confidentiality of communications, and the technical enablers for the management of content rights. 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. An overarching question that remains to be discussed and answered is whether or not this work should be continued within the TAC by virtue of being adequately covered by other groups sanctioned by the Commission. We should take care not to duplicate the work being done in the NRIC (Network Reliability and Interoperability Council). TAC will have to monitor and have liaison to the FCC NRIC to determine what the future of this TAC group should be.

The next formal TAC meeting will be on Wednesday December 5, 2001.

Prepared by J. A. Bellisio

Approved by R.W. Lucky November 28, 2001

Report: Second Meeting of FCC Technological Advisory Council II

1.0 Introduction

As announced, the second meeting of the Federal Communications Commission Technological Advisory Council II (FCC TAC II, *or TAC*) took place on Monday November 5, 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 second one of its second two year cycle. This meeting was originally scheduled for September 20, 2001 but needed to be postponed because of the unfortunate events in our country. 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/**. At this meeting, working groups presented findings developed since the last meeting and used them as a basis for the open discussion of items of interest to the Commission.

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 the last meeting to address each of the five areas, and chairs for each group began work before this meeting. Annex 5 lists the chairs of each group and TAC members who are participating.

This report is a reorganization and distillation of discussions at this second 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 and draws on some of the drafts prepared between meetings, but does not, per se, necessarily represent the final recommendations of the TAC as a whole.

The next formal TAC meeting will be on Wednesday December 5, 2001. The dates of subsequent general meetings are: March 20, 2002, June 12, 2002, September18, 2002, and December 4, 2002.

2.0 Agenda as Announced

TECHNOLOGICAL ADVISORY COUNCIL II

Agenda –Second Meeting

Monday, November 5, 2001
Federal Communications Commission Meeting Room
The Portals, 445 12th Street, SW
Washington, D.C.

I.	Welcome (10:00 AM)	Julius Knapp, FCC Designated Federal Officer (DFO)
II.	Introductions	Robert Lucky, Chairman.
III.	Opening Remarks	Chairman Lucky, Commission Representatives, and TAC Members.
IV.	Reports from Working Groups	Working Group Chairs.
V.	Break (12:00 to 1:00 PM)	
VI.	Reports from Working Groups (continued)	Working Group Chairs.
VII.	Other Business	Robert Lucky, Chairman.
VIII.	Adjourn (3:00 PM)	Julius Knapp, DFO.

3.0 Membership of the Technological Advisory Council TAC II

Member biographies can be found in Report: First Meeting of FCC Technological Advisory Council II, *Annex 2*. (**http://www.fcc.gov/oet/tac/**). Annex 2 of this report gives member e-mail information, and Annex 3 lists FCC staff contacts.

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 - Principal Consultant, Telemediators, LLC. (Telcordia Representative)

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 - President and Chief Executive Officer, Platform Solutions Group, Palm, Inc.

*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. Live RealAudio access to the TAC meeting was be made available through the FCC web site at: **http://www.fcc.gov/realaudio/#nov5/** . It is expected that in the future all TAC meetings will be available from this site.

4.0 Topics of Interest to the Commission and for TAC Consideration

TAC is focusing 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 includes issues associated with the noise floor, software defined radios and ultrawideband - all topics considered by the last TAC group and the technological enablers that form the solution to the overarching problem of spectrum usage. Because optical networks demand broadband connections to final users to realize their full potential, the evolution of broadband access using *all* available technologies is under the umbrella of the optical group. The consumer networking group is looking at the total problem of interconnection everywhere (except for internodal networks) in the consumer domain, not just in the home. Network security is understood to include issues of integrity, confidentiality of telecommunications and the technical enablers for the management of content rights.

During the interim, working groups, with chairs, were formed for each of these five primary focus areas (Annex 5), and discussions held by the groups between the meetings were expanded upon by the entire TAC at this meeting.

5.0 Spectrum Management

Dewayne Hendricks, Chair of the Spectrum Management working group, reviewed progress on the TAC-sponsored noise study currently under way. The spectrum work seemed to be one of the TAC's most productive areas of first TAC group. TAC focused on software-defined radio (SDR), ultrawideband (UWB), and had the intriguing proposal for the Intelligent Radio "Bill of Rights," but the funding of a noise study, to be described, was a very tangible legacy of that group. The TAC embarked on a process of raising the funds from its members to conduct the study, and about $88,000 was turned over to the FCC. After a long process, the study has been implemented via the FCC contract with the Naval Post Graduate School (NPGS) in Monterey, California. One of the members of the study panel retained by the Naval Post Graduate School, George Hagn, was invited to give a report on the noise study. As will be described, there have been many changes to the study concept between the time TAC turned it over to the Commission and where it is now.

Other important events relative to noise issues were meetings between an organization that represents

the amateur radio community in the United States, the American Radio Relay League (ARRL) (http://www.arrl.org), and the FCC Office of Engineering and Technology (OET). As a result of this interaction which involved Dale Hatfield and Saj Durani, then both of OET, and Jim Haynie the President of the League, the ARRL has decided to embark upon actually doing some real world measurements of noise. A few months ago they announced the Amateur Radio Interference Assessment (ARIA) Program. Contrary to what its name may imply, this will be a set of measurements made by radio aficionados of noises and interferences of all sorts, not just interference produced by radio amateurs. Chris Imlay, General Counsel of the ARRL, and also an amateur radio operator, was invited to make a presentation on ARIA.

5.1 Noise Study

George Hagn, with a long career working on man-made radio noise, reported on the TAC sponsored Noise Study being performed by the Naval Post Graduate School. Professor Richard Adler is the principal investigator. The other participants besides Hagn are George Munsch, a retiree from Southwest Research Institute in San Antonio and Ray Vincent, a retiree from SRI International. This group has worked over the last 15 years for the U.S. Navy at U.S. Naval security group interception planning sites specifically trying to discover, identify, geolocate and mitigate noise sources at those sites. See Annex 4 for study performer contact information.

A first step in the Noise Study will be a literature search. One of the questions will be to ask if the noise level as measured now is the same as it was when previous data was taken. Is it increasing, or has it even decreased? The Commission has a vital interest in this information to understand if they are regulating the right things. Are they really regulating the significant noise polluters or are they regulating other things which have only an indirect impact? And for the things that are being regulated and for which there are limits already, are they about right, or are they too tight? Could they be loosened and still obtain spectral and economic efficiency?

The schedule for the TAC noise study, started in August of this year, includes the progress briefing at this meeting, and a final briefing at the TAC meeting on March 20, 2002. The final report will be available shortly after that.

The statement of work consists of three items. A literature survey, with the Commission expressing that its primary interest was in frequency bands above 400 MHz and with an upward bound of 18 GHz. It includes an examination of the literature for different noise models, then assessing the models for applicability in describing the noise either that has been observed or will be measured, including the noise that will be measured by the ARRL. The third deliverable will be a design of a noise measurement system.

The final report will direct the user through what are found to be the truly salient papers in the field, and will permit the study user to get a feel for the literature. It will be provided in a form suitable for posting. So far about 2,000 references have been examined and new material is still turning up. Unfortunately, few of the data found cover the frequency range above one GHz where the new bands are and where the highest level of interest is.

In the original conception of the noise study, it was proposed that models of particular noise generators

be first constructed, then a prediction of the noise environment at any given time and place be created by combining a census of likely sources with the models for each source. The methodology is analogous to the way air pollution is projected. The result could then be tested experimentally. Models to describe the sources can be either empirical or analytical. Furthermore, the models can either describe some overall characteristic of the noise, such as power spectral density or impulse statistic, *or* can describe the impact of noise on some particular class of detector. After some discussion, there was a strong feeling that the latter impact-type model might be too specifically bound to particular detection and decoding systems to have general and lasting value, and that the more general statistical characterization of noise sources might be more appropriate.

For the design of a noise measurement system, there are generally two different objectives that researchers have had in the past. One is the identification and location of a source, which is typically done by "fingerprinting" the source with a commercially available three axis display which displays amplitude versus frequency versus time. It shows the frequency and time dynamics of the actual waveform the noise source is emitting. One can identify a car or an electric drill because they have different spectral signatures. These techniques are good for identifying sources but not really good for getting the kind of data needed to predict performance of digital systems.

A different kind of system is needed to measure the noise statistics for the purposes at hand here. It has been proposed that model parameters of the kind originally promulgated by Middleton be used to characterize the impact of the noise and interference on certain types of detectors, but this strategy should be revisited. If one looks at different systems, it is clear that CDMA or ultrawideband systems, for instance, perform very differently from other kinds of systems. To try to collect performance parameters for particular detector types, whatever they might be, is unlikely to help us predict the performance of future systems. It may be far more valuable to just get base-line measurements and see how they progress with time.

5.2 Amateur Radio Interference Assessment (ARIA) Program

There are about 685,000 amateur radio licensees in the United States and about 175,000 are members of the American Radio Relay League. With the widespread deployment of amateur radio volunteers, a comprehensive measurement plan could yield real world data in urban, rural, and suburban environments. The ARRL ad hoc Spectrum Strategy Committee (STRATCOM) was created in September, 2000 by the ARRL President and produced a report in January, 2001 (www.arrl.org/announce/reports-01/Spectrum_Strategy.doc). A result was ARIA, an ARRL voluntary program to measure radio noise in certain bands above 400 MHz. Amateur radio bands and part 15 bands are largely coincident between around 400 MHz and around 6 GHz. Noise in those bands could contribute to an interference environment for the amateurs. One emphasis ARRL has is to evaluate challenges from unlicensed part 15 devices and the anticipated continued proliferation of devices especially around 2.4 GHz, such as Bluetooth, IEEE 802.11b RLANs (Radio local area networks) and cordless phones. The ARRL would like to develop data and strategies for enhancing the productive use of key frequency bands above 30 MHz.

Amateur bands and some Part 15 Applications above 400 MHz, just to give a general idea of the situation, are shown below:

Amateur Band	Some Part 15 Applications

420-450 MHz	Devices at 433 MHz
902-928 MHz	ISM, phones, sensors
1240-1300 MHz	Periodic radiators
2300-2310 MHz	Part 15 general limits
2390-2450 MHz	ISM, phones, Bluetooth LANs, unlicensed PCS
3300-3500 MHz	Vehicle ID, Part 15 general limits
5650-5925 MHz	ISM, NII, RLANs

A comparison of the usage status of these bands is:

Amateur status	Part 15 status
International and domestic allocations	No allocations or assignments
Licensed	Unlicensed
Most secondary, some PRIMARY	Must not interfere *and* must *accept* interference
≤1.5 kW Transmitter output	≤1 W
No antenna limitation	Antenna limits

Anecdotal reports from active microwave users, especially at 902 to 928 MHz and at 2390 to 2450 MHz are that the noise levels are significantly increasing in those bands. It would seem as though just a significant increase in the raw numbers of devices will make amateur use of those bands difficult, or even impossible.

The objectives of the ARIA study are to characterize, locate, and measure radio noise in the bands above 400 MHz in which amateurs have allocations, especially around 2.4 GHz on a long-term basis. Their motivation is to be able to continue to productively use the bands in which they already have allocations in a way that is mutually harmonious with other users. A three-year observation interval is probably the minimum required for real world measurements to provide a meaningful data trend. The immediate studies would be largely anecdotal but might establish a baseline in various different environments for the longer-term study. The results would be provided to the amateur community and to the TAC, and possibly also to the ITU (International Telecommunications Union). A later step, after the study is completed, would be for the ARRL to use the data to identify interference mitigation techniques that might facilitate cooperative sharing between unlicensed devices and amateur radio stations in the same band. The ARRL's Manager of Technical Relations and test methods expert, Paul Rinaldo, (prinaldo@mindspring.com) confers with the ITU on these issues.

The test methods include drive around and walk around evaluative measurements in various different but categorized environments. Long-term fixed station, stationary tests will have results posted to a web site. There may even be participant-devised tests.

As for ARIA resources, there are many qualified and geographically dispersed volunteers. Five members are signed-up right now, but it is anticipated that there will be quite a few more participants and several hundred people will probably participate in the short run. Reporting will include operating frequency, antenna type, date, time, location and both noise and signal data. ARRL is developing some

fixed station test setups and is improving the test plan using the technical lab staff that the ARRL has in Connecticut. A final report is targeted for 2005. Early results already show the presence of significant noise and interference problems both in Los Angeles and the Bay area in the 2.4 GHz region. Needless to say, this work is expected to be complementary to the previously described TAC project at the NPGS.

5.3 Spectrum Issues – Going Forward

The coordination effort between the TAC funded study and ARIA is essential and must be reinforced. We will need to revisit some of the methodology for work at the NPGS. The modeling proposed may be excellent for fine-grain predictions with specific systems, but we may be dealing with the more gross effects of interference between systems in close proximity and not generalized background noise. Possibly we should consider measuring, as prototypes of what the future may hold, emerging "hot-spots" such as the Carnegie-Mellon campus. It would be interesting if some type of software-only surveillance package could be given to technically inclined Radio-LAN users so that observers everywhere could be recruited as measurement partners.

We should attempt to establish a relationship with DARPA so that efforts can be mutually leveraged. A current DARPA initiative has an objective of increasing spectral efficiency by 20-fold. Finally, issues of software-defined radio (SDR), ultrawideband (UWB), and the proposal for the Intelligent Radio "Bill of Rights" are still of great interest to the Commission and will require continuing TAC attention.

6.0 Consumer and Home Networking

Paul Liao, chair of the Consumer and Home Networking group discussed the technological trends and some of the implications of those trends on the policy areas that might be within the scope of the FCC. The group defined that scope to include any technology capable of connecting two or more devices (either local or remote) to exchange data and which must meet FCC licensing requirement for use in the home. By "home" we actually mean home, car, shopping mall, or wherever a consumer might be. As a way to identify technological trends and possible policy implications of importance to the FCC, scenarios were proposed for consumer and home networks, and those scenarios were intended to be used to get a sense of what might be the relative priorities, as viewed by TAC members, of different issues.

As a way of setting the stage for the work, a short video put together about three years ago by Panasonic was shown. This video looked at a vision of consumer and home networks as embodied in a model home (called the *home information infrastructure house*) which is still on display in Japan. Although somewhat dated, the video covered many of the applications of consumer and home networks, and was a good way to introduce the discussion on the technology trends and potential FCC policy implications of those trends. The video was similar to others of this genre in that it showcased such concepts as a family communication center, multiscreen, multivideo entertainment systems, an in-house home server, and connectivity to a digital satellite broadcasting network. The house became both a learning and working environment by virtue of rich two-way communication with the outside world. Networked appliances were featured, and as an example, a panel displayed an updated list each time ingredients were removed from the refrigerator. Clearly, the interoperability between multiple local special purpose networks will become an issue.

An interesting aspect of the house was a daily health care monitoring device which accumulated personal information on each occupant by means of a toilet system equipped with sensors to measure the user's weight and other vital health parameters. Data continuously accumulated and recorded in the server could be sent by the external network for medical consultation and expert advice. It is easy to see that many new issues of privacy and personal security loom on the horizon.

The issues facing the Consumer and Home Networking group were grouped into four broad technology trend categories (proliferation of wireless networks, IP telephony and communications, "peer-to-peer"/P2P, and network managed services). Within each category, some industry or technological issues were identified along with some of the potential FCC policy areas that might be impacted. As means of moving forward, the consensus of the TAC was sought as to the priority of each issue by considering four perspectives: speed of the technology trend, estimated impact of the technology trend on FCC policy, importance of the technology trend to the current FCC agenda, and overall TAC priority (the actual desire of TAC members to further investigate the issue). Using this structure as a means of organizing the work of this group, some TAC members contributed to a prioritization of possible focus areas. Discussion of the general topics under consideration follows.

6.1 Proliferation of Wireless Networks

Among the biggest issues here seem to be spectrum allocation and interoperability between wireless LANs and the cellular network. There is a growing proliferation of unlicensed band RadioLANs at high usage "hot-spots." The idea is here that independent entities are installing 802.11b ports to give everybody within range free access to the Internet. When somebody wants to have high-speed data connectivity or multimedia connectivity, are they inclined to get it through these free hot-spots or via 3G (third generation commercial wireless)? The IETF (Internet engineering task force) has for several years been discussing mobile Internet protocol. Mobile IP in this context could even allow roaming or handoff between RadioLANs and various cellular protocols. The question of whether hot-spot networking is an alternative to 3G is something that the FCC is interested in. There is an issue of spectrum allocation and interoperability between these different LAN protocols and cellular protocols, and all kinds of questions about roaming agreements.

6.2 IP Telephony and Communications

Along with the usual issues of IP telephony, the recent attack on our nation demonstrated the importance that consumers place on getting information through the Internet, hence, security, robustness and interoperability with other networks is becoming increasingly important. If the Internet really becomes a mission-critical communications medium as in the time of the September 11 attack, we will need to outline those attributes of essential systems that the Internet is likely to introduce, then look to see if there are any gaps requiring attention. As more and more products including common home appliances become connected to the net, we also need to consider the issues of addressing and how quickly we should migrate to IPv6 to have enough numbers. As IP telephony begins to supplant POTS (plain ordinary telephone service), there are questions of both regular E-911 functionality, and also "inverse 911," that is, emergency notification. Since IP networks may have QoS (quality of service) attributes, we can even consider doing what is not now possible, prioritizing traffic during emergencies - thus coupling QoS and E-911 issues.

There is also the problem of security. We can include in security denial of service, theft of service,

impersonation, spoofing, unauthorized tapping, etc. We will need to determine how much of this topic is being productively addressed elsewhere.

In a more general way, the TAC could provide some projection to the Commission as to when IP telephony will reach a level of technical maturity and penetration to be a true near-ubiquitous alternative to POTS. This threshold will be critical, because at that point many of the technological assumptions underlying some key regulations will be overturned. Also, if we combine this evolution with the trends described above in wireless access at hot-spots, we now have an alternative to usage of the licensed wireless spectrum. Fostered by the correct interoperating protocols, this *convergence* of networks allowing diversion of traffic from one band to another and from paid to free access can have a strong effect on both spectral usage efficiency and business models.

6.3 P2P (Peer-to-Peer)

The ability of every consumer to become a broadcaster certainly has the potential to radically change the communications business. Issues ranging from copyright protection to impact on network reliability and community standards for decency will arise. Already, many in the industry believe that the copyright issue is the key to a successful transition to digital TV.

6.4 Networked Managed Services

Applications ranging from home security to home appliance maintenance, from entertainment to home energy management, from distance learning to multimedia communications could all be provided by service providers through standardized, openly available network interfaces into consumer home networks. However this easy-to-use type of access needs to be balanced against issues of security and unforeseen interactions among the multiplicity of services that the future will bring to consumer networks. As consumer devices become intimately connected and managed by networks, the traditional demarcation between the service provider network and the consumer network, such as that used in telephony, becomes blurred. Some of the lessons learned though the CableLabs OpenCable and CableHome initiatives to define the open interfaces to cable services may be useful here.

6.5 Consumer and Home Networking – Going Forward

As a means of prioritizing the work of this group, some members were asked to rank the various topics as to their view relative to four criteria: speed of the trend of the technology, estimated impact on policy decisions of the Commission, perceived importance to the current FCC agenda, and sense of what should be the overall priority for the TAC. A highly ranked issue was that of 802.11b and 3G interoperability, including spectrum allocation, roaming protocols and agreements. There was an overarching feeling that there would be many types of networks in the consumer domain and that much of the usefulness of these new systems would be lost if information could not seamlessly flow through from one to another, or worse, if they mutually annihilated each other. Open standards play a key role. Another highly ranked issue was that of the security and trustworthiness of the new networks, especially their ability to function in the E-911 modes and in times of stress. Not unrelated to this are the realistic technological enablers and options for the preservation of consumer confidentiality and the protection of intellectual property.

The number of study items will need to be reduced so as to sharpen the work efforts. The Commission needs to understand the issues arising from an interconnected, multistandard environment and what industry is likely to do of its own volition. There is no desire for the TAC to promote a plan for regulation, nor should it be even assumed that Commission's interest in an issue is a precursor to regulation. The TAC will be most useful if it gives the commission a heads-up on emerging issues, and outlines what the various technologically-based options are.

7.0 Optical Networking

Some of the FCC concerns in the area of optical networking relate to the transitioning of networks to optical, the implications for interconnectivity within optical networks, characteristics of devices that are connected to optical networks, and, very importantly, the dearth of on-ramps and off-ramps of all technologies to broadband core networks. As with all of the TAC groups, work should be relevant to what the Commission is required to do under the Telecommunications Act. Some of the relevant sections of the Act are:

Section 251.
§251a. General Obligation to Interconnect. Thus far it appears as though this has not been tested in the optical domain.

§251c.2. Additional Obligation of ILECs. Interconnection of telephone exchange services and exchange access services.
§251c.3. Unbundling.
Section 254. Universal service.

Section 256. Coordination for Interconnectivity. At this point the Commission has mainly dealt with §256 in the context of network reliability, where the concern is that the proliferation of high capacity optical systems increases the impact of failures. The Network Reliability and Interoperability Council (NRIC) has historically addressed these issues.

Section 706. Advanced Telecommunications Incentives. In essence the question is whether there anything the Commission could do to incent the deployment of optical services, *if* it chooses to do so. Generally speaking, actions should be agnostic to any specific technology, but rather should promote the capability for services.

The TAC certainly does not want to get involved in rulemaking related to the above issues as that is not its purpose. What may be of use to the Commission are technology roadmaps with plausible timelines. Then the Commission can then use the roadmaps as a technological basis for its work. The work should also be consistent with the Commission's agenda. Specifically, some priorities that we believe are relevant to this group are the encouragement of innovation and investment, the replacement of regulation with market forces where possible and reasonable, and the overall streamlining and rationalization of the regulatory environment.

The work of this group has been organized into three sub areas: optical network interconnectivity, strategies for lowering barriers to fiber deployment (e.g., regulatory obstacles and uncertainties dampening investment), and broadband access. Another possible topic might be a study of what other countries are doing in this area, including technical and economic issues, benchmarking, and lessons learned.

7.1 Optical Network Interconnectivity

As with traditional networks, networks constructed with fiber optic transmission paths are commonly provisioned with segments supplied by different equipment suppliers or multiple operating entities. *Interconnectivity* addresses those issues that arise at the interface points between these different network segments. Consistent with the Commission's mandate, it is in the national interest that optical networks be deployed with well-defined open interconnection points so as (1) to allow new entrants as well as incumbents to participate, (2) to allow suppliers to competitively offer equipment with the assurance that it can be combined with products from others to build a complete network, (3) to assure customers that systems are guaranteed to work even if not procured from a single turnkey operator, and (4) to provide a maintainable, reliable, future-proof networking environment for customers.

To aid the Commission in approaching the interconnectivity issue, the TAC should have the objective of laying out the technologically defensible facts for several different interconnection scenarios. Because there are an enormous number of possible interface and interconnection points in an optically based network, the TAC should first develop a very high level taxonomy covering the full spectrum of possible interfaces. The overview would show possible break points in the physical, optical

(wavelength), and electrical domains, and also include interfaces at various levels in the protocol stack. Not all interconnection points that can be identified are equally useful, easy to achieve or valuable. Many sets of superficially different interfaces will provide equivalent benefits. A prioritized extraction of interfaces that would be most valuable to standardize should be provided. It will be very important to parse networks into separate systems using no more break points than are actually needed. It should be possible for a given entity to develop each segment into a viable independent business. Too few break points will stifle competition, but too many will add unnecessary cost and fragment the industry into segments too small to survive independently. Furthermore, more efficient network designs will result if planners can have the assurance that their globally optimized network "islands" will remain stable and not become unbundled in the future by the insertion of unexpected intermediate interface points.

As a means of approaching this issue, we propose that we develop a high level taxonomy of possible interface and interconnection points between multiwavelength fiber optic networks which would include physical separations at the fiber and electrical level and by individual wavelength, and by various levels in the protocol stack. We will then need a first order estimation of relative difficulty and cost of providing the various interfaces, the estimated value of each interface in achieving FCC objectives, and a prioritization of interface schemes and identification of dissimilar interface schemes which provide essentially equivalent benefits. We could continue with barriers, incentives, and policy implications of alternative interconnection scenarios. It will be important to discuss the status of likely industry activity in either standardizing or providing interconnection points before making recommendations to the Commission.

7.2 Lowering Barriers to Fiber Deployment

At a time when fiber in the core network is proliferating, we find a dearth of on and off ramps to reach this core. What will it take to get a fiber infrastructure all the way out to the edge? Even business buildings, which are lucrative targets for communication services really have a low penetration of fiber. Without even considering homes, the economics of serving with fiber for most buildings today appear quite unattractive. This issue is largely a construction and installation problem, and would exist even if one could drive the costs of the electronics to zero. Data shows that a distressingly small percentage, 3% or 4%, of relatively large facilities, either multidwelling units or business premises, are serviced by fiber today. A study done for Chicago suggests that the actual lengths of the missing links are fairly short, almost half of the unconnected buildings being less than a kilometer from the fiber connection point. The issue is that even though the distances are relatively short, the connection costs still make it prohibitive to get to all of the places where one would expect there is enough telecom traffic in the building to justify a lateral being built. From a cost basis the US may be disadvantaged vis-à-vis many other countries because our linear density of buildings (buildings per linear mile of telecom plant) is so low. The cost of a fiber lateral is typically $50 to $150 per foot, but virtually all of that is in the physical construction cost.

A work item for this subgroup would be to try to generate a road map relative to *all* the costs that are preventing deployment, broken out carefully in terms of the technology costs, physical construction costs and whatever else may be at work. With that kind of road map, we should be able to identify which barriers are the most interesting ones to attack. Then, perhaps, we will be able to recommend best practices for regulatory other processes that can either reduce costs or improve the speed of deployment. A few potential objectives that the FCC might have in this space might be some regulatory

reform that can eliminate, or at least make more rational, the barriers having to do with building access, interconnection to poles, right-of-way, and things of that sort. There may even be jawboning that can be done in terms of promulgating best practices.

7.3 Broadband Access

Optics will to lead to broadband capabilities in the core (transit) network, capabilities that will be stranded unless the whole general issue of *broadband access* of all kinds is properly dealt with in our consideration of optical networking. Broadband access is a combination of facilities and services allowing (residential and/or commercial) end-users to access networks with advanced telecommunications capability. To qualify as broadband, international standards organizations and many other countries (including Canada) consider that a communications network or service must be capable of transmitting at least 1.5 or 2.0 Mbits/sec. However, this is not the case for the US. In its report, "The Availability of High-Speed and Advanced Telecommunications Services", issued on August 3, 2000, the FCC defined advanced telecommunications as an evolving set of capabilities, which currently is an infrastructure capable of delivering a speed of at least 200 Kbits/sec in each direction to the mass market. As we proceed in this area, we should always be aware of the terms of reference being used by the various proponents, because different assumptions about the bit rate that needs to be provided can have a significant effect on overall conclusions. Some of the lower rates can vastly improve existing Internet applications but may be inadequate to support some businesses based on high-quality audio-visual entertainment and information services.

Based on the FCC definition above, the broadband access study proposed in a report delivered for the working group by Peter Guggina (Peter.P.Guggina@wcom.com) should consider at least the following existing technologies:

- Fiber optics (to homes and offices)
- Terrestrial wireless (LMDS, MMDS, Unlicensed Fixed Wireless)
  - Point-to-point, multi-point, and mesh systems
  - Next generation mobile technologies for broadband access
- Satellite and High Altitude Platforms
- XDSL technologies
  - ADSL
  - HDSL
  - RADSL
  - SDSL
  - VDSL
  - Voice over DSL
- Packet
- Cable modems (wired or wireless)
- Primary rate ISDN
- Fractional T1
- Powerline telecommunications
- Free space optics

With respect to these technologies, it would be useful to develop a technology road map to show how

broadband services interconnection and unbundled access could evolve. We should highlight with a likely timeline expected future enhancements in broadband services (including optical switching) that impact capabilities and analyze broadband service deployment barriers and incentives. We should discuss some of the technical aspects related to current policies that strive toward stimulating broadband service deployments, innovation, investment, and the evolution of new broadband access equipment.

There is a long list of potential objectives regarding broadband access.

- Promote competition in broadband market
- Ensure dominant providers enable open access
- Nondiscriminatory accessibility by the broadest number of users
- The ability of users and information providers to seamlessly and transparently transmit and receive information
- Interconnection directly or indirectly between carriers
- Unbundled access to network elements of an ILEC under Section 251 C 3 standards
- Ensure competitive and technological neutrality
- Ensure service security
- Ensure reasonable and timely deployment
- Minimize deployment and subscriber costs
- Ensure increased availability to rural Americans, low income, schools, and libraries
- Promote competition in multi-tenant environments.
- Open standards interconnection
- Encourage deployment of advanced capabilities

7.4 Discussion on Broadband

Chairman Powell has made the question of broadband access a high priority for the FCC. In his remarks on the 23rd of October, he outlined a number of objectives that are part of his agenda. The first one mentioned is broadband policy. Broadband access is not expanding at the rate that many think is crucial to the economy, particularly the telecom industry, and it may even be that that rate of expansion is declining. If there is anything that could be done to break the bottleneck it would be of tremendous value. The question is: Why isn't it happening and what could be done *within the jurisdiction of the FCC,* if it so chooses, to encourage this to happen? It would be useful for the TAC to explore all of the forces at work, and extract those components that could be influenced by the Commission if it so desired, and also separate those factors that are historically beyond the control of the government. The TAC should provide the insight on obstacles and what can be done about them to bring broadband to the entire country. There is a general sense that more rapid deployment of broadband to consumers will deliver substantial benefits to consumers and our economy.

There are numerous broadband access alternatives and the market has yet to narrow the field to just a few major options. Probably the reason DSL (digital subscriber line) isn't happening more rapidly is a reluctance to invest in the buildout that is required for it. Some operators claim to lose money on almost every line, and the customer care cost is often prohibitive.

Ultimately, consumer demand is the driver for technology deployment, and maybe one of the reasons that people are not pressing for broadband is that the content and services that would attract

consumers is just not perceived to be there. People have not figured out what is unique about broadband versus cable or narrowband Internet. The Hollywood studios are reluctant to make available content for distribution on the Internet because there are serious unresolved digital rights issues that constrain their motivation. The government very much can help in promoting models, methods and procedures to protect intellectual property on the Internet.

There has been a strong rollout of DSL in companies like Bell Canada where deployment seems to match that of cable modem. This has not happened in the US, and we should try to understand why, and if the FCC can have an impact. Two years ago Alcatel had roughly half of their total DSL unit sales to the US. Now it's becoming much less, and other countries are leaving the US behind.

From the cable modem standpoint, most of the speed of deployment problems relate to the difficulty of actually going out and installing and provisioning the equipment rather than a technological or a business issue. There are many more subscribers who want the service than installers can get to. There are about 130 different cable modems built to one standard. And, operators are making money on the service so with additional capital the rollout could be faster.

There are regional differences, too. Cable modems began a much more aggressive rollout in Canada early on. The first companies to supply cable modems were Canadian operators. In part there seemed to be an interest in broadband access in Canada that simply was not as strong as it was in the US. There are European countries that don't have any DSL but have cable modems, so it's difficult to take data from one region and apply it to nonequivalent situations in the US. Markets in different countries produce different business models.

Right now the deployment of (greater than 200Kb/sec) broadband has reached 5%-6% of homes and about 10% overall including businesses. That comes to about 10 million broadband connections with about 5 or 6 million into residences in a very short period of time, about two years. This is a respectable rate, so when we think we have a problem we may be still suffering from miscalibration of the irrational exuberance of the Internet bubble by expecting everything to happen in an unrealistically short time.

Several bankruptcies and the collapse of the Internet bubble slowed down DSL deployment, but at the same time some cable systems quickly reached 40% penetration. Before we decide that all of broadband deployment is too slow, we need to compare the rates with those of other successful introductions. DVD is probably the fastest growing consumer phenomenon, ever. It just reached 30% penetration in the US, but last year it was only about 15%. There is a tipping point, that is, a certain accelerating deployment phenomenon. By comparison, broadband may be on a similar trajectory. A former FCC chief economist said the Wharton school produced a survey showing broadband growing faster than wireless. He stated broadband appears to be deploying twice as quickly as cellular in the mid-1980's and 1990's. Broadband appears to be on a high growth trajectory, and even if it has slowed down a little, it is still growing rapidly.

We ought to be helping the real drivers, the content holders, and getting them comfortable enough to release the pull-through content. A particular technology set that is very important and is really going to be required for the future is copy control, copy management, and digital rights management. In the end, it will constrain growth because we won’t be able to deliver the content needed to make an attractive long term service. In this context, unresolved rights management issues are literally a show-stopper.

7.5 Optical Networking – Going Forward

Development of a technology road map to aid the Commission would seem to be a very useful TAC deliverable. The road map for enabling optical networking should cover current broadband access, transport, and interconnection technologies, and future enhancements (including optical switching) that impact capabilities, together with a likely timeline. A list of barriers and incentives to deployment of broadband service and an overview of technical aspects as related to current policies should also carefully separate those issues addressable by the Commission from those out of their control. The TAC needs to provide a sound *technical* foundation for FCC discussions. There is no single correct answer, so we need to get the all the views expressed and some of the tradeoffs. We should try to test the conventional wisdom relative to perceived demand and deployment rates.

Secondly, the TAC should address the total broadband problem based on the experience and knowledge of the group, covering all the issues and bottlenecks ranging from rural service to technical and construction barriers, to copy control, and everything in between.

Finally, we should leverage the experience of pioneers such as the Canadians building the Canarie project leveraging the condominium ownership of fiber. Here is a model for fiber deployment that is working in a number of places in the world and apparently working very well. It's very much an FCC matter as to why we can't do something similar here. We need to understand what the particular virtues are, and what the limitations are, then make recommendations to the Commission on actions to consider.

8.0 Access to Telecommunications by Persons with Disabilities

This working group will build directly on the repository of TAC's previous disability-focused efforts collected at: http://trace.wisc.edu/docs/fccadv/disability.htm. The group's charge is to point out technical issues the FCC needs to be aware of relative to access to telecommunications by persons with disabilities, and then it is then up to the FCC (and Congress) to decide on how to take action.

Almost everything everyone else in TAC is doing could affect issues of disability access so this working group's issues can cut across and be relevant to the other working group's activities. While it is somewhat apparent how disability access may be an issue in home networking, one may wonder where there may be concerns regarding access, for instance, to optical networks. This leads to the question of : "How do barriers arise?" and "Is there a list of features that need to be preserved as technology advances (e.g., closed caption data and video description audio)?" Most of the time, when new technologies emerge and are inaccessible to people with disabilities, it is due to a lack of awareness rather than an intentional and active decision. With awareness-raising as a key to ensuring accessibility in future technologies, the questions then become: "Who do you get the information to?" and "How?" Some of the answers to this may reside in the FCC's bully pulpit role.

Anecdotes abound on problems resulting from a lack of awareness. With e-books (electronic books) an emerging technology that people are excited about, e-book digital rights technology blocks access to people who are visually impaired and rely on screen readers and voice synthesizers. The common reaction almost any time such issues come up is: "I never realized that, how could that be, we never wanted that to happen, what can we do to fix that?" DVDs originally didn't have closed captioning on them at all. Satellite transmission also didn't support captioning. First it was stripped out, then satellites had captions 30 seconds out of sync. Always inadvertent, never intentional, but something that happens almost every time a new technology comes out.

The Access to Telecommunications by Persons with Disabilities focus group is looking for ways to take on an awareness-raising concept of creating documents and information to delineate how people with disabilities may be affected by a lack of attention to accessible designs. It could be a list of features that need to be preserved as technology advances, that is, something that people will use during the development and engineering process to understand that there are certain hidden functionalities, uses, and types of users that that need to be accounted for. A more global challenge is to determine how awareness can be raised regarding accessibility issues so that future technologies can be launched with accessibility built in from the start. With or without regulation, the Commission can play a public sensitization and information role.

Publishing a paper covering this subject for the engineers that design systems is an excellent idea. It will make for a very good IEEE Communications article, and work has begun.

8.1 Access to Telecommunications by Persons with Disabilities – Going Forward

The Disability Access Working Group needs to create a strong interface with the other working groups (especially home networking), and the newly chartered Consumer Disability Advisory Committee described in the previous TAC meeting report. Documents need to be written and published in widely-read engineering journals delineating how people with disabilities may be affected by lack of attention

to accessible design. The documents should contain a list of features or functionalities that need to be preserved or replaced as technology advances. The group should explore other vehicles for raising awareness regarding accessibility issues so that future technologies can be launched with accessibility built-in from the start.

9.0 Robustness, Reliability, Integrity and Security of the Network

There was no report from this group at the meeting, but there are some items discussed here to be considered as a starting point for the group. An overarching question that remains to be discussed and answered is whether or not this work should be continued within the TAC by virtue of being adequately covered by other groups sanctioned by the Commission.

Proposed definitions:

Network integrity: The ability of a network to perform the tasks asked of it. This should broadly include the idea of service integrity.

Network reliability: The ability of a network to maintain an acceptable level of up-time with minimal mean time between failures. This is often described in terms of availability and survivability.

Network security: Protection of networks and their services from unauthorized modification, destruction, or disclosure. It provides assurance the network performs its critical functions correctly and there are no harmful side effects.

9.1 Robustness, Reliability, Integrity and Security of the Network – Going Forward

We should take care not to duplicate the work being done in the NRIC (Network Reliability and Interoperability Council). TAC will have to monitor and have liaison to the FCC NRIC to determine what the future of this TAC group should be.

10.0 Procedure for Technical Work

The preparation of technology roadmaps may generically be one of the most valuable types of deliverables for the Commission. 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.

At the second meeting, each group outlined a broad picture of work that might be done. The next step for each group will be to refine and prioritize work into a manageable work plan, and propose specific deliverables with an achievable time line.

Annex 1: Official Meeting Minutes

A VHS videotape of the November 5, 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: Addresses of Current TAC Members

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Annex 3: FCC staff

FCC staff available to address questions from the TAC:

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

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Other FCC staff associated with TAC are:

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Annex 4: FCC TAC Noise and Interference study

The project team for the FCC TAC Noise and Interference study is as follows:

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Annex 5: Working Groups

Current list of working group membership. Note that the Executive Director is always a member of all committees**.**

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Hendricks, Dewayne, CHAIR
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Boakye, Kwame
Farber, David
Ferren, Bran
Hatfield, Dale
Hemrick, Christine
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:
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Briggs, Fred M.
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Lucky, Robert W.
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Network Security, Integrity and Reliability:
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Access to Telecommunications by the Disabled:
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