UNITED STATES OF AMERICA

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FEDERAL COMMUNICATIONS COMMISSION

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INTERFERENCE PROTECTION

PUBLIC WORKSHOP

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FRIDAY,
AUGUST 2, 2002

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I N D E X

Introduction 3

Spectrum Policy Task Force Overview - Paul Kolodzy, Senior Spectrum Policy Adviser, Office of Engineering Technology, FCC 3

Panel I: Interference Challenges
Moderators: Mr. Dale Hatfield, Independent Consultant and Keith Larson, Chief Engineer, Media Bureau, FCC 7

Panel II: Advanced Technology
Moderators: Brian Woerner, Professor, Bradley Department of Electrical Engineering, Virginia Tech University and Ronald Repasi, Assistant Chief for Engineering, Policy Division, International Bureau, FCC 79

Panel III: A Better Process
Moderators: Charles Jackson, Jackson Telecommunications Consulting and Thomas Stanley, Chief Engineer, Wireless Telecommunications Bureau, FCC 137

Adjourn 204

P-R-O-C-E-E-D-I-N-G-S

(9:09 a.m.)

MS. VAN WAZER: My name is Lauren Van Wazer and I'm Deputy on the Spectrum Policy Task Force. I'd like to welcome you to the second in a series of four workshops addressing spectrum policy issues.

This workshop will address interference protection. I'd like to say that we're providing sign language interpretive services. If there's anyone who would like such services, please identify yourselves.

(Pause.)

With that, I'd like to introduce Dr. Paul Kolodzy, Director of the Spectrum Policy Task Force.

DR. KOLODZY: Good morning, and welcome everybody to our second of four workshops that the Spectrum Policy Task Force is running on our investigation of new ideas and concepts for looking to the future for spectrum policy.

Yesterday, we had a wonderful workshop

on license spectrum and experimental licenses and we had a lot of interaction between the audience and the panelists and I'm looking forward to that same kind of interaction today. In fact, I think they set the bar fairly high for this panel to try to reach to try to maintain this type of interaction. I think those kind of interactions provide us better insight into issues and ideas that are out there in the community that we might be able to draw upon on some of our thought processes.

Let's put the first slide up. Whoops. Looks like you don't have my briefing slides.

Let me just do it extemporaneously. First of all, the Spectrum Task Force, this is the second out of four workshops. The first workshop again, like I said, yesterday, was on license and experimental. Today is on interference, a very interesting and very important topic. In fact, if you look at most spectrum issues that come up within the Commission and industry, it all boils down to a lot of interference and the issues

associated with how to define it, how to determine if somebody has been harmfully interfered with or not and how to prevent it. So this group will try to actually address many of those issues.

We'll have a workshop again on Monday, the Monday workshop will be on spectrum efficiency and ideas of how to actually get more efficient use of the spectrum and what kind of ideas and policies that might want to be looked at for new efficient methods of using the spectrum.

And the final workshop will be on August 9th, Friday, and that will be looking at spectrum rights and responsibilities and that will actually take a look at what kind of models and what kind of ideas you look at in a sense of how to define rights and responsibilities for spectrum users.

The reason this task force was put together is first of all, it was started by Chairman Powell, announced in June, and basically it was trying to look at how to look across the entire spectrum and ask the question are there

better ideas to take us into the realities of the 21st century. And we have tried to look not across just a single domain, but actually, we try to look across all the uses. And so therefore, I think you see in the panels you see today and from yesterday and the future, we have all the different uses and users and representatives from those groups here to discuss these important topics.

The task force is organized with myself and Lauren Van Wazer as my Deputy. Special Counsel is Maureen McLaughlin and Senior Technical Advisor is Mike Marcus. The Task Force Council is made up of senior folks across the bureaus that deal with spectrum policy and management issues from the International Bureau, from the Wireless Telecommunications Bureau, and from the Media Bureau. Also, the Offices of Plans and Policy and the Office of Engineering and Technology are also represented. So therefore, we have a very, very diverse group. And in fact, you're going to see today that our panel co-moderators are also one from each of those organizations, so you can

actually see they're represented quite well today.

The focus of today's meeting again is on interference and what I'd like to do is welcome everybody here and try to actually promote interaction. And I'm going to continue to say that and if I don't see interaction, I'm going to try to promote it myself from the sideline.

What I'd like to do now is introduce a lot of the moderators and co-moderators today. First, I'd like to introduce Dale Hatfield. He's now a private consultant, but I think that most everybody here knows of his background, both in industry, academia, as well as government and both being at NTIA and being the Chief Engineer and head of OET here prior to last year, I believe. He is co-moderator -- his co-moderator is Keith Larson who is the Chief Engineer of the Media Bureau. And he will be co-moderating this first panel.

The second panel will be co-moderated by Mr. Brian Woerner and he is from Virginia Tech and his co-moderator will be Ron Repasi who is the Assistant Chief of Engineering in the International

Bureau.

And this afternoon, our final panel will have Charles Jackson, Chuck Jackson from Jackson Telecommunications Consulting and his co-moderator within the FCC will be Tom Stanley who is the Chief Engineer of the Wireless Telecommunications Bureau. So you can see a lot of technologists here trying to actually talk about a very interesting and very contentious topic which is interference protection.

And with that, I don't want to hold up this group any longer. What I'd like to do is hand over the microphone to Dale Hatfield, because he has some introductory remarks to try to put some context around this workshop today.

Thank you.

MR. HATFIELD: Thank you very much, Paul. It's really nice to be back here at the Commission. I really appreciate your inviting me to co-moderate the panel today and I also, of course, want to add my thanks to the panelists for coming here and helping us out.

I honestly and sincerely believe that this panel topic is probably the most important of all because it underlies everything else. It's very clear that if we're going to accommodate millions of new devices, new systems and so forth, that we're going to all of us have to cope with additional levels of interference and that just seems to be a given. And how we define, how do we live with this increased interference and it seems to me the devil is in the details. It's easy and I've done this, I'm guilty of this as saying well, gosh, the secondary market would work a lot better if we have a more clearly defined set of rights and everybody can nod and say yes, that's certainly true and I'll invest more if I have a clear defined set of rights and so forth. Here again, that's absolutely true, but where it gets difficult and that's where economists tend to look at us engineers and say, okay, define those rights. As my good friend and colleague here, Bruce Franca says, you know, that's the hard part. That's the hard work.

I hope we'll address that issue today, how do you get more specific?

Clearly, I won't invest in my house if the state can come in and seize the property any time it wants to. I won't invest in my house if somebody can come in and take over a bedroom and not pay rent and so forth. So clearly, there's economic incentives that depend upon the rights that I have. I won't invest in new spectral efficient technology if the benefits of my investment then accrue to someone else probably.

These are all things that go what, go back to that defining that spectrum protection that I have, what rights I have. And as I said before, I won't buy and sell on a secondary market unless I have a pretty good idea of what I'm buying and what I'm giving up when I sell. Here again, coming back to the importance of getting these rights defined properly.

I've been thinking about this. In fact, I commented here before that one of the troubles of being an old man is it's difficult to

think of something new to say that I haven't said before, but let me say it anyway because I've come -- after I was here at the Commission again for three years, I've really come to believe that we have to think a little bit more about the receiver side. The longer I was here, it's kind of not a transmitter problem, it's really -- the things that held us up, the things that I held dear that I was trying to push here, generally speaking, that I thought were good policy, were held up, what, because of receiver problems. So I think reluctantly, in my mind, I think we have to come around and think more about the receiver side. In other words, two things. On the transmitter side, I'm saying the obvious and on the transmitter side, how much interference I'm allowed to produce, but on the receiver side how much interference am I obligated to be able to absorb?

Coming at it sort of from a different standpoint, I sort of look at trying to solve the spectrum problem, the congestion problem in sort of four ways. We have four alternatives, if you will.

One is reallocation. The second is more efficient use of the spectrum. The third is more sharing and the fourth is Mike Marcus' favorite and that's to go up higher in frequency. And I think as a society, we're going to have to use all four approaches. And spectrum, the interference protection applies as a role in all of those, but it's particularly important in the sharing area and when we talk about sharing I sort of divide the sharing ideas into three parts. First is, voluntary sharing. That's where I come to my Keith. He owns some spectrum and I say Keith, you know, here's this super new software-defined radio that tunes for light and I'm going to be able to operate at a power. I know where I am, I know where you are. I'm not going to cause you interference and you say gee, that sounds like a great idea. Give me $10 million and I'll be glad to share with you. And that -- okay, that's a voluntary sort of sharing. But here again, as I said before, I probably sound like a broken record, that depends upon us being able to negotiate

something in terms of what rights, what my rights are and what his rights are and our corresponding obligations.

The other is, of course, involuntary sharing and that's where it really gets sticky is when I paid for spectrum at an auction here, what bundle of rights were conveyed to me and then later on, the Commission says oh Dale, by the way, even though you paid for it, we want you to share with somebody else. Here again, it comes back to that set of rights, what rights were conveyed to me and how do we go about distributing. In other words, if I've got four dB of extra margin, and the Commission says okay, you've got to give two dB of that margin to fit in somebody else. Here again, what are the rights involved? What is the interference protection that I'm entitled to. And of course, the sort of third way of sharing here is I don't have a good name for it, but it's the -- it's sort of the de minimis sort of sharing saying that I'm going to operate devices like Part 15 devices that are at such low power that they won't

cause interference. Sort of using my property analogy, you know, the airplane is at 50,000 feet flying over -- it's flying over my property, but it's not bothering me. Or, in Colorado, where we come from we sell mineral rights. Mineral rights are conveyed separately from the property rights, so I don't own the mineral rights where my house sits on and you know, somebody could be mining coal underneath my house 300 or 400 feet down and it wouldn't bother me, and so that probably is not infringing on my ability to enjoy my property on the surface.

Well, I think I've droned on long enough, but what I think -- one of the points I was trying to make is that these interference rights, how you define it, how you deal with it and so forth, it's just critical, no matter whether you're sort of

market-oriented in your approach to spectrum management or you think what we need to do is a better job of engineering using traditional methods or whatever.

Thank you.

MR. LARSON: Thanks, Dale, for giving us a clear perspective here on what we're going to talk about today. Good morning, ladies and gentlemen. I'm Keith Larson and I too, have a few opening remarks.

I'm privileged to lead the Task Force's Interference Working Group. This is a multi-bureau, multi-disciplinary group of hard-working men and women. We have some engineers. We have some lawyers and economists, at least one economist. There are some of us who have been around the Commission quite a while and seen a lot of things happen and I'm pleased to say we have some very bright younger people as well, the future engineering brain trusts of the Commission and I think it's good to get them involved right away in some of these difficult issues.

I was looking around the room here. I think this is a historic occasion. In the building, not in the room, but in the building, I believe we have as many as five individuals who at

one time or another have run the Commission's Office of Engineering and Technology. Now that's historic. For engineers at the Commission, that's kind of like when all -- ah, we have another one. That's kind of like

-- that's kind of like when all the former Presidents get together for an occasion for a photo op. Where's my camera? But will all of you in the room who are either a current Chief Engineer, Ed Thomas or former Chiefs, raise your hands. Okay. Not me. Great. Thank you.

All right, the word interference came up quite a bit in yesterday's unlicensed and experimental workshop. And interference is all we're going to talk about today. It's a complicated thing. On the one hand, unwanted interference is something that nobody likes. It sometimes can be a nuisance. Other times it can be terribly economically destructive and even life threatening. Yet, interference is a hard thing to get your arms around because of its many variables. Several of these were talked about in one of

yesterday's sessions. There's the dimensions of time, space, geography, coding in a digital environment and I would add things like frequency, receiver performance, transmitter power and height, wave form, the effects of multiple emitters, the compounding effects of noise, weather and our atmosphere. And as the result of increasingly sophisticated transmitter and receiver technology, with the ability to detect and adjust for signal degradation, I think interference management is also going to increasingly have an economic dimension, a balancing if you will, of technical and economic factors.

Interference can be an elusive thing to its victims who may realize that something isn't quite right, but don't know what's going on. Let me illustrate here. As a kid growing up in northern Minnesota back in the 1950s and 1960s, we got our first TV set, I think in 1956, a black and white set. And the station we watched was about 100 miles away. And the picture was always snowy. Okay? And so we cultivated the fine art of

picking the people out of the snow back in those days. However, sometimes there was more snow on the screen than on the ground in the Minnesota winter and so we got out the playing cards. The point of all of this is that we were content with just getting a passable picture, the only kind of picture we'd ever known. When things got really bad, we didn't know what was going on. We suspected it had something to do with the great distance to the TV station, but we didn't know. We don't know whether my Dad got stuck with a lemon TV, whether the weather was the culprit or whether some kind of an interference was the problem like our next door neighbor running the vacuum cleaner or something. And like many other people, we never complained about it. We just lived with it.

I think those days are long gone. People now have access to much more reliable communications services, high technical quality services. I think folks are probably less tolerate of signal degradation and outages. Interference is very serious business.

Moreover, the Communications Act directs the Commission as the public interest requires, to make regulations that it deems necessary to prevent interference between stations.

Historically, various approaches for dealing with interference have evolved for each of the many Commission radio services, typically based on the expected use and technical characteristics of the time the services were created.

When I joined the Commission a wile back, I think there was something like 70 different radio services and they all had their own interference characteristics. And now, of course, there are even more services. Some of the approaches that are involved and our working group, the first thing they did was to go through the rules, canvas the rules and kind of create a matrix of all of the interference approaches that are used for the different services.

Common approaches involve limits on transmitter power and out of band emissions, but there are a whole bunch of other things. There are

signal strength limits that service area boundaries, distance separates between stations; prescribed minimum desired/undesired signal strength or carrier interference ratios. Negotiated interference agreements are often relied upon as is industry frequency coordination.

I would also point out that interference is going to continue to be serious business here at the Commission. The Commissions draft strategic plan for the Years 2003 to 2008 include as a spectrum policy objective, the vigorous protection against harmful interference.

The panels in today's workshop are designed to explore different aspects of what we generically refer to as interference management. The panel here this morning will probe for problems with current approaches and generally consider how the Commission should deal with future challenges, the kind of challenges that are presented by Moore's Law and the rapidly changing world of diverse and highly dense emitters.

The second panel this morning is going

to focus on the extent to which we might get some relief from advanced technologies. And the afternoon is going to look at other ways that the Commission can better manage interference, recognizing that interference impact affects not only spectrum policy decisions at the Commission, but also the Commission's licensing and enforcement activities.

So I would encourage you all to stay for all three panels.

The format this morning and for the other panels is going to be entirely interactive. A moderator will ask the panelists to respond to one or two questions in a topic area and following that, the audience will have an opportunity to ask questions or otherwise join the discussion, after which we'll move on to another line of questions. And as Paul mentioned, we encourage and we expect a lively and robust discussion on these issues.

Now let's meet our distinguished panelists. On my far left we have Andrew Clegg. Andrew is from Cingular Wireless. He's the lead

member of the technical staff there. And I guess, Andrew, you're kind of representing the wireless industry on the cell side.

Next to Andrew we have Rebecca Cowen-Hirsch from the Department of Defense.

Next to Rebecca, we have Glen Nash who is the President of APCO International, the public safety group. He speaks for the public safety issues.

Then over to Dale's right is Rob Briskman who is with Sirius Radio a digital satellite radio service and Rob has satellite background here nd he's going to be representing the satellite industry.

Then we have Paul Steffes from Georgia Tech University. He's a Professor there. And he was the, I believe, Paul, if I'm not mistaken, you were the past chair of the Committee on Radio Frequencies. Right. He represented radio astronomy interests there in that former capacity.

And then on Paul's right we have Larry Miller who is the President of the Land Mobile

Communications Council. Larry is also the Frequency Coordination Manager for the American Association of State Highway and Transportation Officials.

On Larry's right is Lynn Claudy. Lynn is the Senior Vice President of Science and Technology at the National Association of Broadcasters. And Lynn represents the interests of radio and television broadcasters in this country.

All right, panelists, ready to rumble here? Before looking at the future challenges of the Commission here involving interference management, I'd like just to start with the present. From your point of view, are there spectrum uses or users for which the Commission's current interference management approaches are either working relatively well, in fact, or are there are others for which the interference rules and processes are either not working at all or are being overly stressed by user demands?

Let's start with you, Glen, on that. How is it going on over there in the public safety

world?

DR. STEFFES: In general, it's going fairly well. The interference rules really require cooperation amongst the parties to get together and agree to work out their problems. We have a frequency coordination process that emphasizes minimizing the potential for interference and for public safety, it really is critical that we not have interference situations.

Having said that, we currently do have a very serious interference problem at the 800 megahertz band that arose out of a well intentioned Commission action in the early 1980s to interweave the spectrum and have various groups trying to share the spectrum that did result in some problems with frequency coordination, that has led to these interference problems that we're experiencing. So I think to the extent that we are able to utilize the frequency coordination process to take a look at what people are doing, you have the cooperation of the community, (a) to provide systems that cover their jurisdiction without reaching far beyond that

and yet do provide coverage for their own jurisdiction.

We really don't have a problem. Where we've gotten into trouble is when people don't want to play the game.

MR. LARSON: Thank you. Andrew the same question from your perspective.

DR. CLEGG: From our perspective, being in the mobile, wireless mobile industry, I think I'd like to start with an example of where I think things worked pretty well because it might help in modeling how things are done in the future. And that is the PCS spectrum and the technical rules that were adopted on the PCS spectrum.

Back in the 1994 time frame when that spectrum was just being built out after the auction, it was recognized that the Commission had a rational clearing policy in place for that band and that band would basically be cleared by a relatively certain date and at a cost that was relatively straightforward for the operators to calculate. So the fact that we needed the spectrum

was going to be cleared or could be cleared worked in the favor of the PCS band.

The Commission also subsequently, for the service rules and the PCS band, issued relatively flexible technical requirements. There were very few technical requirements levied upon the PCS operators. There were EIRP limits. There were 47 dB microvolts per meter field strength limits at the boundary and there was the meg 13 dBm per megahertz out of band emission limits. And that right there pretty much sums the total technical constraints on the PCS operators. Within those constraints they were allowed to deploy any technology they wanted to on the PCS block and that flexible use of the spectrum, I think, worked out quite well in the band and the industry came together and basically worked quite well on the PCS band.

So I think the way the PCS spectrum was allocated, a fair amount of spectrum with a good clearing policy and then rules that allowed for fairly flexible use within that band, I think that

was an example, interference-wise of where the Commission's process has worked well.

MR. LARSON: Okay, Andrew, if you would receive any interference other than internal interference where would that likely come from?

DR. CLEGG: Most of the interference that was not caused by our own system occurs at our geographic boundary where we have to coordinate with the co-block operator in the adjacent geographic boundary and there were industry groups like the National Spectrum Managers Association that addressed coordination procedures for coordinating frequencies at the geographic boundaries and also, frankly, like we do on our cellular operations, a lot of the frequency coordination is done fairly informally. Our engineers know the engineers from other companies and where our systems come together, if there's a problem, one of our engineers calls up one of their engineers and says hey, your choice of frequencies on this cell aren't quite compatible with ours, let's shift them around a little bit.

So it was done on a fairly informal basis as it was in the cellular band. So that's the extent of most of the interference problems we've had in the PCS band. I think it was a good model.

MR. LARSON: So would you say the coordination process there is working pretty well?

DR. CLEGG: It was. I think a combination of having an industry group to address whatever coordination procedures should be in place and also just the informal work between the companies, I think it worked pretty well in that case.

MR. LARSON: Okay, thank you. Lynn Claudy, turning to you, from the broadcaster's point of view, you've taken some spectrum hits here in both the UHF TV band. The Commission just reallocated channels 52 to 59 for new emerging uses and earlier the channel 60 to 69 bands were reallocated to public safety and other new commercial services. And you've also taken, I think, a 30 percent or so spectrum hit over in the

2 gigahertz band involving the electronic news gathering frequencies that are used by broadcasters.

In addition, the Commission is rolling out the digital television service, I think, something like 500 stations now on the air and in the process of accommodating all of the broadcasters with a second channel during the DTV transition for digital. The Commission created a concept of a de minimis interference where a DTV broadcaster is permitted to cause a certain amount of interference to analog, existing analog television.

In view of all of that, how are things going in the broadcast industry and what are your concerns?

(Laughter.)

MR. CLAUDY: Well, there's a great lurid history of broadcasting and service allocations in the Commission and since broadcasting has been around for so long since wireless services were available, I think every

technique in interference management has -- there is some example of that in broadcasting. So as a historical example, one can study broadcasting and become quite a student of spectrum management generally.

The biggest issue in broadcasting now is clearly the transition into digital services. Of course, that's midway for television and impending for radio. I think the Commission really did go a long way in the digital television service to develop new techniques, new ways of thinking about service and interference, especially in the modeling area. And that has really pushed the frontiers forward for what was an old service into the new technology era.

Now, the challenge will be that we will find out, as one always finds out with models, they have their limitations, they weren't exactly perfect. We didn't design an interference free service area. We do have areas of de minimis interference in some areas where it will be more than de minimis. So interference is going to be a

fact of life as we move to the implementation phase or further into the implementation phase.

And I think the challenge for the Commission there is how to adapt to that, to take the specific instances of interference and in some cases harmful and egregious cases and being able to work with the parties to provide the enforcement function that the Commission has with a degree of precision and timeliness and I think this is where the rubber meets the road as we go from what we figured out what the channels are and we know what the bandwidth concerns are and the interference concerns, but bringing that into the practical world and letting the parties thrive in the commercial world is going to be a big challenge for the future Commission.

MR. LARSON: Thank you. I'm not aware of a whole lot of interference problems that we've had so far with the roll out of DTV. There have been some and to my knowledge, in most of these cases anyway, the broadcasters have been working with each other to try to work out the problems.

Is that being your sense as well?

MR. CLAUDY: I think it's a dance that's just -- where the music is just starting to play. I'm not saying there's going to be a huge problem, but in the cases where that does occur and it will occur also in radio and as more -- it's not just within the broadcast band, but as new entrants come into the band, and we have more mobile transmitters and the emergency, if unlicensed devices proliferate more and trying to figure out the cumulative effects of all that kind of interference, especially with a new service in broadcasting coming in, the interlinking of all of that, I think will evidence itself in a myriad of ways. So it's not just a digital broadcaster is hurting some existing analog broadcaster or vice versa.

MR. LARSON: Okay. How are things going in your part of the world, Larry, as far as problems are going, as far as interference is concerned?

MR. MILLER: Well, my part of the world

is the same world as Glen lives in down there. We're actually a public safety frequency coordinator and when we talk about interference, I think there's a big misconception on the part of the users as to what harmful interference is as opposed to nuisance interference. And sometimes we get complaints and the guide essentially says hey, I'm hearing a guy of my channel and once I read the rules to him, how the applicants and licensees are required to cooperate and make adjustments, etcetera, and 90 percent of the time, once they realize that, they are about to work with the other parties, reducing antenna heights, transmitter power. Sometimes, you even have to take somewhat extreme measures of using directional antennas. Obviously, tune the squelch on the receivers and things like that. And for the most part that solves a vast majority of the problems.

Now when you reach a situation where that you can't quite educate the people as to the fact that they do have to share and cooperate, that's probably where we would like a little bit of

a stronger hand from the Commission. We would like to be able to just refer that to the Commission and say we've done all we can and then if the Commission were to issue a letter to the complainant stating this is what you really need to do, I think that would probably make a happy ending to most of these complaints.

MR. LARSON: So far things, I think, sound like they're going pretty well. Certainly, there must be some major problems here that we have yet to uncover.

Any of the other panelists want to jump in at this point and discuss that, that issue?

DR. STEFFES: I think a lot of us are afraid of the future as much as we are of the present.

MR. LARSON: Uh-huh.

DR. STEFFES: Just because we know the rate of growth is so significant that the minimal pressures now will become major pressures within the next four years.

I represent, of course, and again I'll

mention my comments are my own personal comments and not those of the National Academy of Sciences of the Committee on Radio Frequencies. But I will say that we have seen just an explosion in usage of spectrum around the passive services. And again, I'll remind you what passive services are, the things like radioastronomy and sensing of the earth's atmosphere and surface with passive and will receive only type equipment are typical sensitivity levels are about a trillion times higher -- well, let's see that would be 10^{12}, call it 90 dB, a billion times more sensitive than a typical radio receiver. So we're even far more sensitive than the space communication receiver. So we are in a situation where we are constantly paying attention to the growth of the spectrum usage and even a minimal out of band emission from something like a GLONASS navigation satellite can completely shut us down.

Whenever an earth-remote sensing satellite operating in the earth-remote sensing band at 10.68 gigahertz flies over Cleveland, it

basically doesn't even try because you know, there will be out of band emission from the adjacent fixed service and it's very weak and they're doing -- they're operating within their license, but basically these folks, you know, were that sensitive.

So we've seen incidents, obviously, when Iridium is very busy, we see their out of band emission, even though that was an incredible activity as far as trying to coordinate the licensing and out of band emission requirements for Iridium relative to the neighboring L band passive radioastronomy use. So I think we've seen a small problem. As a matter of fact, right now, our wonderful International Space Station, the Russian segment has a transmitter on it that is not quite allocated. And we see that at 1429 megahertz. Don't ask me how it got there. But my comment is that those of us that are most sensitive are most afraid of the future. And we're very concerned with out of band emissions.

MR. LARSON: So as hard as the

Commission is trying to protect the integrity of your operations over there with the very sensitive communications that you receive, perhaps radioastronomy is kind of a barometer here, maybe of things to come.

DR. STEFFES: Yes. And to draw a parallel with the land management concept that the two of you have brought up and Dale brought up initially, I think that if you will, we're kind of like the National Parks of the spectrum world. We're the ones that are most sensitive to pollution. We're most sensitive to environmental change, that sort of thing because of the sensitivity.

MR. LARSON: We'll soon go to the audience for questions and comments, but I want to just tap one other kind of a subissue here with Rob Briskman. Rob brings, I think, a little bit of a different perspective here to the discussion. Rob represents a newly emerging service, satellite digital radio, fresh from an FCC proceeding and I think it's still an

on-going proceeding here involving certain issues.

Rob, in your view, how transparent are the Commission's processes here for interference particularly in connection with trying to put in a new service. Are there room for improvements here, or do you think things are okay as they are?

MR. BRISKMAN: Well, I'm going to answer that in a very long answer, since my right hand here neighbor claimed the rights to maximum sensitivity.

(Laughter.)

Let me give a little bit of history since I am representing, Keith, the satellite industry here. The first commercial satellite which I launched was Early Bird in 1967. That's only 35 years ago and it was operated, as you know, at 4 in 6 for fixed service. In this 35 years, of course, and now many hundreds of satellites are used for all different sorts of things, communications, direct TV to your homes, a GPS for navigation and position determination. You mentioned Iridium and you on and on and on.

So I suppose, Keith, as a general answer, I think the Commission should be congratulated on coming up with the processes and rules that have allowed the satellite industry to grow this rapidly in 35 years and I'd like to single out the IB which was called something else back then, but is now the IB for doing most of this work.

Now the second arm of this, of course, is sensitivity. Without debating the radioastromers who do require a very high sensitivity, so do satellites. And why? I suppose for two engineering reasons. One, the economic cost which Dale will get back to of putting satellite power, transmitter power, is extremely high. And therefore, any system design tries to minimize that. This creates, obviously, receivers are very, very sensitive and this creates a very high possibility of getting interference.

Getting back to Keith's comment, of course, the current and newest service is what's called SDARs at the Commission which is a digital

audio radio service to cars. Again, it's extremely sensitive because it uses receivers that are, if you like, noise figure, I believe are a little bit one below 1 dB noise figure. If you like kelvin, it's about 160 degrees kelvin and they use omni directional antennas. So it does make it extremely sensitive to interference.

So what I'm still saying is that the efforts and procedures that the Commission, including this one, have been effective. There are concerns, and by the way, this is not only SDARS concerns, other satellites, having to do with out-of-band emissions and this has been mentioned by at least two or three of the other panelists. Without belaboring the point, I did last night go through the rules and one finds that in our band, others can put anywhere from a range of 40 dB difference in out-of-band emissions. In other words, there's a rule for wireless. There's rules for ultra-wide bands. There are rules for other Part 15/18 devices and the out-of-band emissions limits are all different and although this second, I don't

think there is a major problem. It is one that the Commission must address and address soon before there is one. Thank you.

MR. LARSON: Thank you, Rob. Well, we're finally I turn to you here and then we'll go to the audience. Welcome and I'm happy to tell you today that I'm not here to try to take away some federal spectrum here from the Government. That's not the purpose of this panel and also, I'd like you to go back and report to your superiors back there in the federal Government side, how well under control things are on the FCC side of things or seem to be.

(Laughter.)

And what civil proceedings we have here.

(Laughter.)

How are things over there on the federal government side. Are you grappling with the interference issues, just like we are here?

MS. COWEN-HIRSCH: Absolutely, and let me tell you that the Department of Defense has

addressed interference from the get go because we use such a wide plethora of systems and a very finite amount of spectrum, interference criteria is a way of life for us. And what we do very significantly different than Commission rulings is that we don't place the entire burden on the transmitter side. It is essential for our receivers to be able to have -- find discrimination and to ensure that their interference tolerance enable their mission to be complete.

Now we also have receivers that are wide open and highly sensitive, satellites as well as sensors in the most generic sense and what we do to overcome the interference because it's not a question of whether you will have interference, but when and to what degree. And what you do with technology to be able to get through that interference to accomplish the mission and get your information transmitted from point A to point B. So in the case where we have our wide open transmitters, we often use signal processing techniques and certainly technology is opening some

wide areas of exploration in that area, to be able to discriminate the information, to be able to address the noise issues.

So when we have a platform, whether it's a ship or an aircraft or a satellite that's in a highly dense environment and there's nothing more dense than an electromagnetic environment than a battlefield, the ability to address interference issues and to overcome them and to minimize them, two very, very different disciplines is critically important to the Department of Defense.

We used to, in our material solution, demand receiver standards. We have changed our acquisition processes such that receiver standards are not the mandate, but they are, in fact, a way of life in terms of ensuring that technology addresses the interference environment in a battlefield situation.

Now, all of our missions are not accomplished on the battlefield. Our missions are also accomplished here within the United States and so we're very sensitive to the potential for

interference from commercial applications, whatever they may be. We use the same technical solutions to begin to address what the regulatory arena may not, for lack of a better word, enforce. So the interference criteria and the way we address it technically, as well as taking advantage of when and where time and geography of how we use our systems mitigates the interference situation when we're operating with similar systems and certainly with dissimilar systems.

MR. LARSON: My co-moderator has a follow-up question.

MR. HATFIELD: Rebecca, this is new information to me from back when I was at NTIA on receiver standards. I just wanted you to clarify. You say it's no longer -- receiver standards are no longer mandated, but are a way of life. How does that translate into the real world?

MS. COWEN-HIRSCH: You mean the real world outside the Defense Department?

MR. HATFIELD: No, no, I mean --

(Laughter.)

MR. HATFIELD: No, I mean because I've been recently more an advocate of looking at the receiverside and I've sometimes used the Department of Defense as an example that you tended in the past to look harder and now you're saying it's not a mandate, but it's a way of life. What does that mean in practical terms if I'm designing a DOD system?

MS. COWEN-HIRSCH: Absolutely, very good question. In prior years of acquisition and when we were doing our purchasing and building of systems, there were military standards or mil standards that were levied against the provider or against the company that would be building the system for us. Because we are allowing new technology solutions, we do not levy specific standards and it's just a streamlining of acquisition and that was the previous Administration, at least in part, was their direction. This actually has been significantly advantageous for us because rather than telling someone how to do their job, we base all of our

requirements on operational requirements, so rather than forcing or directing a specific standard against which a system must be designed, we actually have an operational requirement whether it's threshold or different requirement for the data throughput such that you leave it up to the individual company and the technological solution to establish how those requirements could be met. So instead of levying a standard that the receiver meet a specific criteria, you've got a throughput requirement that indicates your quality of service, if you will, that will translate into the commercial industry. You would define what those quality of service requirements would subsequently be and allow the technology to drive the solution. It introduces greater flexibility. It also allows us to leverage where industry may be in some cases exploring new opportunities that wouldn't necessarily be consistent with an old antiquated mil standard, but would provide the necessary operational capabilities. So it basically is a quality of service requirement.

MR. HATFIELD: Could I follow up? Taking Paul's admonition to be provocative, what prevents a system from being designed that meets the requirement, but squanders spectrum? I mean I thought that's the reason you looked at receivers is to make sure that the receiver wasn't squandered and I always use you as a poster child and now you're telling me that maybe -- and Andrew, the same thing. I am probably a very strong advocate of flexibility, but the trouble is the flexibility, you can design a system what I call fragile systems, systems that are too darn sensitive to interference in which you play, and then you say everybody around you. Now you've got to cut down your out-of-band emissions because I've put a system that's what I would say is under designed. Where do you do the design review to make sure that the person is not meeting the requirement, but is squandering spectrum?

MS. COWEN-HIRSCH: From the very get-to. Not only is it the quality of service for a particular system, but it's that that system must

operate in the intended environment, so there are environmental considerations so that you can address either existing out-of-band emissions, but also take into consideration whether it's the noise environment, if you're operating in the presence of ultra-wide band or whatever the new system, you have to take the environment into consideration. And looking at -- it is absolutely essential that spectral efficiency be one consideration. Now the military has some unique situations. There are missions that we accomplish such as -- or requirements that we have like anti-jam, that is very significantly different than the broad open industry requirements. So it is not only -- we cannot tolerate because the plethora and the wide variety of systems and the finite amount of spectrum into which we are restricted because we have not addressed the breadth of sharing potentials in the broadest concept across the spectrum in total. We are restricted in the finite amount of spectrum that we do employ that we need to begin to -- we need to be fine stewards of that

spectrum and we are to allow the mission to be able to be accomplished.

MR. LARSON: Okay, thank you. Receiver standards are going to be a really important thing down the line. I think it's something we're going to be talking about more even in this panel here as we get into other segments of the panel, but the audience, you've been extremely patient here, listening to the panelists get their discussions. Now it's your turn.

Anybody have any problems that they can put their fingers on or things from your point of view, members of the audience. Are things working pretty well or are there areas that the Commission should be concerned about, about its present processes? And then after that, we'll move to our next segment on dealing with future challenges, but again, let's keep it focused on the present right now.

Questions?

(Pause.)

Yes. Please identify yourself by name

and affiliation, if you could, please?

MR. DELMORE: I'm John Delmore. And I have just a quick question for Glen Nash.

Mr. Nash, you mentioned with regards to interference. The FCC's require licensees to cooperate with each other. And I think that's what you said. Correct me if I'm wrong. If you did say that, could elaborate on how that's currently working out with public safety licensees, cooperation between public safety licensees and other licensees that may be causing interference to them, the degree of cooperation that exists and that sort of thing?

MR. NASH: Sure. Again, within the public safety community, I think there's a fairly good amount of cooperation between the licensees. And quite frankly, as I said, that begins at the frequency coordination process to minimize the potential for interference, but once it occurs, the two parties getting together and finding an amicable solution and as Larry indicated, that making adjustments in power output, making

adjustments in antenna patterns, implementing CTCSS and other techniques to minimize the effects of nuisance interference, those are all things that we do on an everyday basis.

As we start to experience interference coming from outside the public safety community, I think that's one area in which the practices become a little less precise and followed. The rules don't specifically require good coordination between the different frequency coordinators and so at times we do see some conflicts, the parties on each side of a frequency boundary or a geographic boundary doing their own thing, saying the rules allow me to do this and it's almost as if -- they think there's a Faraday shield that goes up and nothing crosses over which isn't reality. So that's when we do start to get some conflicts.

Certainly, as time has gone on, and starting getting into the future challenges and I'll minimize my comments here, but we're seeing the changes in technology are having an impact on the interference equation. So again, many of us

realize that we're all in this together. We have to work together in order to make it work because if we don't work together, it isn't going to work. So you just have to be a part of, as I made the comment, play the game, be a participant in it because that makes it better for all of us.

MR. DELMORE: Can you elaborate on the particular changes that you're referring to?

MR. NASH: The question was getting into changes in technology.

What we've been seeing over the last few years is a trend from single user/single frequency type systems to multiple user type systems and so you go to TDMA, you go to CDMA, you have many users using a much wider bandwidth. And from a spectral efficiency standpoint that may be very well good. From an interference standpoint what you need to really -- the underlying performance of filters is an issue of bandwidth and so as you make the bandwidth, either the transmitter or the receiver has to be wider in order to accept the desired signal. It also is

wider and is open to more undesired signals. So that's just one area in which we've seen what I believe really is an increased susceptibility to interference is by going to these technologies that require and operate at wider bandwidths.

We're also seeing radios that have many more individual frequencies in them. When I started in this industry 30 years ago, a 4-channel radio, that was a highly capable radio. We tuned the front end of it. The maximum frequency spread was maybe a megahertz. We now routinely have radios that are operating with 200 plus frequencies in them. The front ends of those now have to be tuned so that they operate over 10 or 15 megahertz and 800 megahertz with trunking systems where you're dynamically assigning channels.

Again, we've had to open up the receivers in order to accept a much broader range of possible inputs. That has an impact on receiver performance, as far as its ability to reject to undesired signals. So I think as we've seen these moves towards having radios that are much, by

design, are wider in bandwidth, the engineering trade off we're making is that by design, they're more susceptible to interference.

MR. LARSON: Anybody else have any comments or problems they want to bring to our attention here at this point before we move on? Yes, in the back?

MR. EPSTEIN: Good morning, Bart Epstein from Latham and Watkins. And I have a question about the expectation of users. I'm reminded of when I had my first car which I bought for $200, prearrived with quite a number of dents and the first time I bumped into something I looked and I couldn't even tell which dent was new because it had so many already. But now with my new car, if I have a dent, my expectations have changed and that dent is not acceptable at all. And it strikes me that either there is or there should be an understanding at the Commission that certain uses of the spectrum consumers and businesses and the military have different expectations of what's acceptable.

When consumers start spending several thousand dollars for a digital television or they upgrade their car stereo to receive satellite signals, they're expecting high quality, uninterrupted digital signal which they're often willing to pay a premium for as opposed to free or over-the-air signals which although greatly improved, still occasionally have interference problems.

Is that something which the panel thinks the Commission should or should not be doing? It seems like a lot of the disputes we have are based on expectations and once we have -- once we have set an expectation, the public is awfully unhappy being disappointed.

MR. LARSON: Anybody want to respond that here?

MR. BRISKMAN: Amen.

(Laughter.)

MR. BRISKMAN: Yes, the Commission, obviously has to address these matters. They're difficult matters. Some are, I suppose the word is

subjective, which makes it very difficult again, but they have to be considered. People and hopefully, won't object, and occasionally had a dropped call, miscall, I don't think that's a problem. But as you say, a person who's paying for a service, has great expectations like digital television or satellite radio. I think that has to be a very high criteria for quality of service. And the Commission has to address these matters.

MR. LARSON: And as I said in my opening, the Commission plans to vigorously address interference issues like this.

I was looking at the clock here and we have a lot of ground to cover here. Do we have any other questions first on this, on the current problems before we move on? Yeah, in the back, Peter?

MR. PITSCH: Peter Pitsch with Intel Corporation. I just wanted to ask a question following up on Andrew Clegg's description of output oriented interference restrictions and how well that seemed to work.

Is that an approach that would have application elsewhere, problems in extending it elsewhere?

DR. CLEGG: I think as long as you allocate spectrum so that the services that are in that spectrum are fundamentally compatible, I think you can follow this technique where you give the licenses out, you put as few technical restraints as possible and as long as the services are fundamentally compatible, I believe, generally, things will work out like they have for the PCS band. The problem at 800 megahertz is you've got systems that are fundamentally incompatible. You've got other examples of, for example, trying to put terrestrial repeaters for some of the satellite digital audio radio systems. Some people may argue that that use of that spectrum is incompatible with the wireless communications service spectrum. But generally, I believe that as long as the Commission is careful to allocate spectrum to compatible services and give those compatible services exclusive access to that

spectrum, I think this technique of flexible allocations are putting as few technical requirements on the licensees, I think has proven to be quite effective in PCS and I think it can be effective in other bands as well, other services.

MR. LARSON: Okay, I'll take one more question here before we move on. Yeah, go ahead, sir.

MR. RAPPAPORT: My name is Gene Rappaport with Winstar Communications. I'd just like to express support from the commercial industry for the remarks Mr. Hatfield made that when you buy a spectrum license at auction, and then you expect certain interference protection goes along with that license that you've paid money for, but many cases you then have to spend years trying to protect those rights from interference both on the domestic basis and on the international basis, so there has to be some accommodation between the rates that you require and the interference protection that you then have to fight for on an

on-going basis. Thank you.

MR. LARSON: Thank you. Let's refocus the discussion here. Let's now look toward the future here. Way down the line, you know, 5, 10, even 20 years ahead, and Dale, I'll turn it over to you.

MR. HATFIELD: Okay, I think the stage has already been pretty well set in terms that we know that with increased flexibility people can choose different wave forms, they can choose lots of different modulation techniques and so forth and we're seeing also because of flexibility they can do that and we're also, of course, seeing this proliferation of devices and so forth. So when you look, because of these changes, when you look towards the future, what sort of challenges do you see and why don't we start down -- I'll start down here on the right, Lynn, and ask you looking forward what do you see the major challenges that will face the Commission, things that are maybe just beginning to emerge?

MR. CLAUDY: Well, I'd go back to your

remarks earlier that that maybe it's time for the Commission to look closer at receiver standards. I think that is an area where there hasn't been a lot of Commission involvement and it's been marketplace only, at least in the broadcast case and the market place may not work some of those issues out ultimately. So if you really desire interference free service in the areas where you think you have that, and that's an important public interest goal, there has to be some involvement to make sure that that indeed happens and not just happens by happenstance.

So I think receivers standards is a new area for the Commission to really look at. I agree with the comments of taking like services and putting them in the same bands and that the interference management problem becomes more tractable by doing that. There will be increased pressure on services like broadcasting to be extremely spectrum efficient. The reclamation of the spectrum in the VHF/UHF bands, the reclamation of spectrum for the mobile satellite service and

the two gigahertz band. There will be a lot of continued quests toward doing more with less and I think that again goes back to receivers being smarter, adaptable and having more tools available to operate either in a smaller bandwidth or with a more rich interference environment. So that's again a driver for the Commission to look at both the transmit and the receiver side.

MR. HATFIELD: One of the things that might be useful to explore later on is the difference between the broadcast service where you buy the television set in a single transaction and don't have any further relationship with the service provider compared with the cellular example where there's a continuing relationship and a financial relationship between the customer and the provider. I think that distinction is an important one and a lot of the things I saw here when I was at the Commission related to where the person made the single transaction. You've got a million TV sets, hundreds of millions of -- you know, and it gets very difficult politically to change things.

Larry, can we go on down? Moving right down the line.

MR. MILLER: Okay, thank you. I'd like to second those comments regarding receiver standards and I guess from the land mobile perspective, I think the Commission has tried some things. Obviously, everyone always wants more spectrum. I think the Commission tried with re-farming to generate more voice paths in the existing spectrum. But I don't think they did it aggressively enough. They depended on the market place to encourage and essentially manage the transition to new technologies. It hasn't happened.

In a lot of cases the users and I know from my personal perspective, I used to work for state government and if I went in to the budget director and says I need a certain amount of money to upgrade my system because I want to improve performance, etcetera, no matter how much documentation I had, it was kind of a hard sell, but if I said the FCC just issued a rule and by

this date I have to do this, somehow the money was found. So I think with respect to the efforts of the Commission on re-farming, additions of date certain that all systems have to operate within certain bandwidths, that would be a good step forward. You need receiver standards because my experience as a frequency coordinator is that when you try to intermix new narrow band digital modulation schemes with the older wide band analog, you can run a path profile in a computer model and it looks like it will work, but when they plug the equipment and turn it on, you don't get the same results. So I think again, receiver standards would help them in that area.

With respect to the 700 megahertz spectrum, the way the rules are written, it's fairly ambiguous as to whether the broadcasters, the incumbent broadcasters really ever have to vacate and I think in order to get the kind of commitment from governmental entities and perhaps even the band manager users, the Commission needs to be a little more aggressive to make sure that

when land mobile systems are constructed in those bands, that the television broadcasters have, in fact, vacated, so that the new MOUs can use that spectrum.

And that's as much as I think I need to say, but I'm sure you have a lot of other commenters here.

MR. HATFIELD: Yes, the thing that jumps in my mind too is the difference between where you have exclusive use like in the cellular case where efficiency gains accrue to you in terms of more revenue where you're in a public safety, nonprofit sort of organization where it doesn't necessarily accrue to you.

Paul?

DR. STEFFES: Well, the first thing I wanted to restate was how happy the passive community has been with the support we've received from the Commission. I think when I was quoting problems I wanted to state that over the years that I've been involved with this the Commission has been extremely sensitive to the highly sensitive

nature of passive science, use of the radio spectrum.

However, the problem, of course, for the future is complexity. Obviously, the number of users and the management of the problem becomes dramatically enhanced. I was talking with Paul Kolodzy before and we were saying that it's at least a six dimensional problem meaning spatial, x-y-z, frequency, time and wave form and of course since the wave form can be infinitely complicated, you can make it an n-fold problem which it basically has more variables than you have numbers.

So as a result, the complexity issue, I think, presents the Commission with an especial challenge and I think that a lot of the solutions will be technological and those technological solutions for compatibility of services can, in fact, be found in many cases. However, in a lot of ways, the holistic problem needs to be looked at a top level. In other words, not just solving one service's compatibility problem with an adjacent one, but giving the Commission the technical

resources it needs to look at the higher level problem. What is the current level of spectrum usage nationwide? You know, the NTIA, thankfully, back in the 1990s made a few studies of certain urban environments and suburban environments, but those were just first steps. We really don't have good metrics on what's going on technologically and I think that that might be one of the biggest contributions the Commission could gain or one of the biggest assets the Commission could gain in the next decade.

MR. HATFIELD: Thank you. Bob?

MR. BRISKMAN: I have to support grouping of like usages, but just to be honest about it, I hope I'll live that long to see it. So going to more practical ways to address the long term problem, one thing I have not heard and which I think would help everybody is more severe requirements on filtering and one thing nobody has talked about yet is severe requirements on how much filtering there is at the transmitter because that is what is generating the interference to begin

with. And therefore, if you have requirements there, this is the so-called out-of-band interference, you're helping everybody on both sides of you throughout the spectrum. This is sort of polluting the commons, I suppose, is the acute way of saying that.

And secondly, of course, let us talk and this is my last point on the receiver, there are modulation techniques that are more resistant to interference than others. Unfortunately, these almost always require for the same through put more bandwidth and obviously bandwidth and spectrum have become very difficult to get and very expensive. So people are because of that design systems to get the maximum capacity out of the spectrum and to do otherwise would probably be uneconomic.

On the other hand, certainly they could filter the receiver so that it would receive little to no out-of-band interference. So I would recommend that.

The last point I would like to make is again a new point. I would think that most of the

new services, not all of them are digital. And another criteria of control or specification is bit error rate and the nice thing about bit error rate, it's not subjective, it's measurable. One should look at that as another took that the Commission could use in the allocation of frequencies and the result of interference to a digital signal. And hopefully, there could be some reward for those that design their system to be more resistant to interference. Thank you.

MR. HATFIELD: Yes, thank you. Glen?

MR. NASH: As I've already indicated, I think the trend is towards technologies that in many ways are working against us on this interference issue. And the public wants those technologies, industry wants those technologies. They're new, they're better and yet, we're not recognizing the fact that they carry with them a certain cost and one of those costs is in the interference area.

One of the things I would really like to see the Commission look at for the future is we

develop a vision about what it is we're trying to accomplish and having a vision recognize that it's going to take time, it's going to take effort to attain that vision and the fact that it's going to take time and effort is not a reason to not make the effort. And I think I've seen that a little bit. We tend to say that well, television broadcasting could be a lot better, but we have 200 million legacy television sets out there, so we really can't do anything because we have all these legacies out there. Well, yes, we can do something. We can have a vision, work toward something better, recognize that the legacies out there are going to make the conversion take longer, but if we don't have the vision, if we don't start down a path toward something better, we will never get to something better. And so we really have to start the process.

The other thing is that I think many cases, all of us in our individual industries are making choices about what we do, how we design things and we're doing that, if you will, in a

vacuum. We look at our own little community and we say this is best for us, this is what we're going to do and often times, we don't look outside to see what is the impact on others.

PCS, one of the advantages they've had is that often times those decisions were made within a company. They were given a block of spectrum and something to do and so decisions they made were within the company. What we find in other industries and public safety, I think, is a real good example. There are thousands of individual public safety entities out there. Today, I'm here and Larry, you're here. We represent associations that represent those industries, but the associations do not own and operate radio systems. We can make recommendations and suggestions that we say are good for the industry, but when it comes down to actually implementing it, we have no authority to implement anything.

So we do need to be aware that decisions have to be driven from a higher level.

They have to, as Larry indicated, it's much easier when the FCC says this is the way you're going to do it because it is in the best good of everybody that it be done this way. We really need that because when you get down to those individual people, making decisions on themselves, they tend to look at only their own best interests and often time they don't make the best decisions in that case

MS. COWEN-HIRSCH: Well, in terms of challenges for the future there are so many. It was identified, Paul identified that there were at least six dimensions. I think there are at least two more. One is the economic benefit and since I'm from the public sector, I will not comment on that, but also there is the priority issue and that's something that we know a great deal about.

But looking towards what the challenges facing the FCC and certainly the NTIA and the public sector are how do we respond to this new advent of technology? How do we address what is going to be required in terms of a new sharing

etiquette, the bill of rights?

We haven't talked a lot about this in this panel and I'm certainly going to tease something up for the next panel that will address the technologies and that's the issues associated with opportunistic use and dynamic reallocation, software defined radios. How do you begin to address what those systems bring into the mix in terms of exploitation of this finite resource?

The current service rules simply do not allow for that flexibility. I'll toss a bone over here. Flexibility certainly allows for greater opportunity to explore the use of this finite resource. But you need to look at the quality of service trades and the opportunities for secondary benefits to be able to do that.

Receiver standards certainly worked for the Department of Defense in the past and once standards became not the mandate, we certainly took into place those considerations in our design and our material solutions. So standards are one way to do it if you want to levy a requirement against

somebody, but quality of service begins to say what can you tolerate, what is your probability of interference and what's the impact of that, what wave forms do for you, what they do not? So there's some areas that we'll definitely look at, that will challenge you.

One thing, when you get into the advent of software defined radios and they are here, when you look at opportunistic sharing and reallocating systems, you need to look at having behavior confidence. That's something that we simply haven't addressed to date. In the federal sector we look more at a hardware certification than a behavior confidence that the software and the technology presents for us. So that ought to give us something to wrestle with for the next several years.

MR. HATFIELD: Yes, indeed, thank you.

DR. CLEGG: I think I can predict the future fairly confidently that we're going to see as far as interference, we're going to see the same that we see today, but we're just going to see a

lot more of it. I mean that's basically what we're going to see. And it's going to be a gradual thing. It may not be so obvious on a day to day basis, but the interference will increase.

I'm a little more optimistic in that I think that the same technological advances that are allowing us to do all sorts of new things that we could do before and perhaps creating more interference than we had before, along the same lines, the same technological advances are allowing us to do things to mitigate interference that we could do before and I think that's more the topic of the next panel, but I think in the long term, I just am thinking about what we as a cellular and PCS operator are doing as far as interference, both infra-system interference and interference from others. We're working on or have already deployed power control as tightly as we can, dynamic frequency allocation. We're using MIMO, multi-in/multi-out which is a space and modulation diversity scheme for improving performance and facing environments. We're working on single

antenna interference cancellation algorithms. We're working on adaptive antennas. And we're certainly always working on or at least the handset and bay station manufacturers are always working on various DSP implementations that address and can mitigate some of the interference.

So I'm hoping that in the long term, at least a partial solution is the same technology that's creating more interference will also help us try to adapt to it.

MR. LARSON: We'd like to now welcome Martin Rofheart, did I get that right? Martin's the co-found and CEO of Xtreme Spectrum, an ultra wideband service provider.

Martin, we had a lively discussion yesterday on the unlicensed bands and things like that, people trying to underlay services under other services. What do you see the challenges for the Commission down the road, 5, 10, 20 years from now from your point of view?

DR. ROFHEART: Well, that's a huge problem and it's hard to envy the Commission having

to manage it. So you'll get companies like you've just heard which resonate very strongly with organizations like mine where our companies will turn over technology on 6, 12, 18-month windows and at the same time we live in an environment and certainly the Commission more than we even live in an environment where systems are fielded for 10, 20, 30 years. Literally, that's 20 dB of dynamic range in technology turnover. And that's sort of at the crux of why it is so complex for the Commission to manage.

Exactly in line with the set of comments we've heard here, ultra-wide band is sort of the ultimate from an unlicensed technology perspective in using signal processing and error-correcting codes and modulation methodologies in order to recycle and clean up a spectrum and use those very advances in the ultimate and wide-end front ends that receive all interference from all users to use signal processing and advances in semiconductor processes to clean that up and build a very robust system. And ultimately, the best

metric and the most satisfying one is end user market acceptance. The customers, the marketplace, all of us when we go out and shop, are the folks that make the decision about what quality of service really means and have embedded in that buy decision the economics as well as the six dimensions and more of the problem.

MR. LARSON: Should we go to the audience?

MR. HATFIELD: Yes, why don't we turn to the audience unless there's some panelist that has a burning sort of comment.

MR. LARSON: The panelists can question each other too, if you like.

MR. HATFIELD: Exactly. If not, why don't we go to the audience?

If not, I've got a question or two. Yes, please, over here?

MR. EMERSON: I'm Daniel Emerson, I'm representing the National Radioastronomy Observatory.

I'm a radioastronomer. Some of the trainings that

we see in the future are very worrying indeed to a radioastronomer.

In designing a communication system to be interference immune and everybody seems to accept that the interference environment is going to get worse, with a communications system you can design at both ends. You can choose the appropriate modulation wave form that can then be demodulated in a way that makes it immune to interference.

The passive services don't' have that choice. Nature has decreed what sort of wave forms are there for us to detect. We just don't have that freedom of choice to play around with the modulation techniques.

Now some of the advanced technology coming along, the more efficient use of the spectrum, unfortunately, it's a law of nature, I guess, that the more efficient you make a wave form, the more it looks like a natural signal. The more complex wave forms we're hearing about look like Gaussian noise, if you don't have the key to

demodulate them. Gaussian noise is exactly what the passive services detect.

So whereas in the good old days when the spectrum was used very inefficiently, if you had an interference in your radioastronomy band, had a huge strong carrier, you could excise that, you could recognize it. With the new technologies it's much more difficult to use these excision techniques that we could have applied. We did apply in the good old days. So I'm worried that not only is the level of interference, the number of interfering sources are going up, it's getting harder and harder for the passive services to apply technology techniques to get rid of this interference. So it's a double whammy for the passive services. And I'm worried about that.

One thing that can certainly help is, as has already been mentioned on the panel, filter technology, the reduction of out-of-band emissions at the transmitter with better filter technology. That has to help us all. Thank you.

MR. HATFIELD: Other questions,

comments? I'm sorry, come close to the mike, please?

MR. SHEPARD: Hi, I'm Tim Shepard. I'm an engineer and I've been thinking about how to engineer systems perhaps in a context where there was no regulation of emissions and this is a very fascinating area.

I'd first like to -- one thing I'd like to point out about the previous comments about radioastronomy is there are actually freedoms in radioastronomy to place your receivers wherever in the world you'd like or perhaps even off of this world and perhaps you could use some of the flexibility you have in some of these six dimensions to mitigate the interference. And there also seems to be no limit on the amount of directional gain you could use to increase your signal-to-noise ratio. Of course, there are costs with that and then we have to discuss -- and that gets into -- it's impossible to figure out the question of the benefit of radioastronomy versus the economic benefits of what other -- what the

technologies can do for our society.

Now, if that wasn't provocative enough, I would like to hear especially from the panelists, because I think in some sense we've got on this panel a very good representation of all of the legacy systems and in some sense have a lot of receivers out there and it does take 30 years perhaps to change, if we came up with something, if we came up with a way of not requiring receivers to bear more of the responsibility or perhaps even all of the responsibility of mitigating interference, perhaps every system in the world should be an anti-jam system and then what do you need an FCC for?

You needed an FCC, 70 years ago when frequency-selective filters were the only technology you could use to separate radio signals.

Is there any hope of perhaps moving all of the burden to the receiver and perhaps at that point we can eliminate the problem of regulatory interference as getting in the way of what somebody

would like to do.

MR. HATFIELD: Hear, hear.

MR. SHEPHERD: I filed comments, I filed a comment in the proceeding, pointing out that if you think about 100,000 people going to a football stadium and you think about the narrow acoustic spectrum, and start thinking like a traditional radio system engineer or perhaps a regulator, you might think that you'd have to regulate who is allowed to speak at the football stadium because, of course, if everybody spoke at once then it would totally destroy the spectrum and it wouldn't be a communication anymore, but we all know that we can still have a conversation with our neighbor. And even if everybody talks at once, the public address system can still be engineered so that it's effective despite the fact that everybody is cheering the team on the field. Etcetera.

I'd actually like to hear from the panelists. Is there any hope of getting there in 20 years? I sometimes like to think about what spectrum regulation is going to look like in a 100

or a 1,000 years, but can we get there in my lifetime where we can basically do what we want in this spectrum?

MR. HATFIELD: I think some of this will be for our next panel as well, but I'd sure be anxious to get any reactions. Yes, please?

DR. ROFHEART: So Tim, there's a de facto regulation in the fact that the broadcaster, the one in the public address system is the only one that's allowed as a sole use at high power and it's only the individual speakers in the stadium that are the unlicensed speakers that are very low power, that amazingly reflects exactly what the Commission has wound up with.

(Laughter.)

DR. STEFFES: Another comment, since the question was made about remoting radio telescopes to the far side of the moon, I think the point is that the spectrum, like land, is not uniform. You have to manage it because certain aspects of the spectrum are different than others, any more than we'd say that a highly polluting

chemical plant can be located in any arbitrary land position. There are just parts of the spectrum and times in the spectrum that are more important than others and so uniform management is not an efficient use of the resource.

MR. HATFIELD: Other comments? Okay, a question back here then? Or a comment?

MR. WARNER: I'm David Warner from the Commonwealth of Virginia, Department of Information Technology and I'm coming from the public safety kind of perspective and I've heard terms like managing interference, this is going to be the wave of the future. I've heard comments that expect more interference.

From the public safety side, I guess what my concerns are and what I've heard echoed by our public safety and Department of Defense panelists is the rights, a bill of rights for different systems. I can understand what the cellular industry -- and that they have customers, they have to make a profit. They're in an environment that they're trying to serve, but they

don't always cooperate and the interference is the backlash of that in the sense that they've put up a system that they know may cause interference with the public safety which is a different type of architecture.

I think we do need to have a bill of rights that the rights of the individual whoever that individual might be, whether it be cellular or public safety, has to take into account the rights of the rest of the people that they're going to impact. So that's our perspective.

MR. HATFIELD: I think just to comment myself here, there -- as I tried to say, I think it's probably rights and obligations, both, because I don't think you -- I would doubt if you would advocate if the public safety entity put it in a totally wide open receiver that would just be susceptible to almost any interference anywhere, you wouldn't suggest that that's a good idea, so it seems to -- I don't believe you would, I would guess you would, so it seems to me there would have to be some -- I think what we're talking about here

is balancing the obligations of the people who are transmitting with some obligations on the part of the receiver, not to be susceptible, so susceptible to interference that you can't allow other people to do things that are economically beneficial as well. It's a balance. It's a trade off, it seems to me.

MR. WARNER: Can I follow up? Perhaps when they design a system, let's say in the Washington, D.C. area, a perfect area to pick, is they need to notify before they put the system up, and before they give expectation to their corporate managers, they need to say well, we need to work with public safety because our systems are not compatible. We have the same spectrum, but we have dissimilar architectures. So they go in there. They set it up and they do some field tests and it's -- it can save a lot of headaches and it can brief the people who are in the corporate structure and say look, we want to have the build out here, but it is going to have some adverse effects. Perhaps we need to add a few transmitters in other

areas, so as not to cause interference to public safety which is dealing with life and property.

DR. CLEGG: If I could respond. First of all, unfortunately, Nextel isn't here to address some of these questions --

(Laughter.)

But I'll try to help them out a little bit, the best I can. Honestly, the vast majority in your example of the interference is not caused by the cellular industry. It's caused by the SMR industry, specifically, Nextel. That's widely recognized in the entire proceeding.

We as a cellular company actually do now take into account, at least in areas where we've had problems, the potential impact of public safety. I was reviewing last night some cell site plants in Maryland where they specifically indicate on here that this particular site may cause some problems, especially if Nextel is co-located there and that we need to follow up on that with public safety as that site is deployed.

So we actually are -- we really are

becoming a lot more sensitive to that, but I also have to echo Dale's comment that the problem is at least half do to the design of the public safety radio receivers. And in fact, it's the combination of the spectrum allocation with the interspersed Nextel and public safety channels with the design of the public safety radios. Those two components right there basically explain 99 percent of the problem. But we are, of course, willing to work with public safety to mitigate interference on a case by case basis, the best we possibly can.

MR. WARNER: By your very statement, you know that that's the problem, but yet systems are implemented with the foreknowledge that interference is going to be a result. I'm getting back to the "bill of rights" that was introduced by our Department of Defense panelists. I think there needs to be some up front cooperation and this can be transparent to other industries as well.

As Mr. Nash stated, you know, we're all in our little world, but there are other people out there who are impacted by the decisions and by the

things that we do and that's -- and yes, there are cellular, I have seen and maybe Mr. Nash can affirm or otherwise dispute, but I have seen from interference reports that there are more cellular companies that are starting to interfere as well, and yes, you are correct that Nextel is the main one, but there are cellular providers who are causing problems and I have to deal with that from the state perspective.

Thank you.

MR. LARSON: Thank you for your comments. We're starting to run a little bit short on time on this panel. Time always seems to move too quickly. I had another area that I wanted to tee up and I'm probably going to have to buck the larger part of the discussion to our third panel this afternoon.

Could I get my next slide put up, please?

(Pause.)

Where I was hoping to go here, there is it, the definition of interference itself. This is

one of the questions that we raised in the June 6 public notice. And we got a lot of comments on it. Should the Commission change its decades old definition? Will this help us deal with our spectrum allocation decisions that we have to make with our licensing processes? Will it provide a more clearly defined interference rights to users and service providers?

The current definition is subjective. It does not reflect modern technology per se. And so we asked whether or not it should be changed. Commenters were kind of divided on this. There were folks that said look, this is an ITU definition that's used around the world and for the purposes that it serves, it's a good definition, don't tamper with it. Perhaps what's needed here is to interpret the definition of interference and the definition of harmful interference in the light of particular services.

There are other folks that said you need a new definition. You need a new definition that reflects modern technology. Other people said

you don't need one definition, you need many definitions that are tailored toward particular classes of spectrum users. But the current definition handicaps us a little bit because harmful interference is defined in terms such as "serious degradation" which begs a definition of its own in communications services. "Repeated interruptions", what does that mean? That's probably different for different services.

And I think in the afternoon panel, I think one of the issues I'm hoping that you guys can explore will be the definition of interference, how should that be changed, if at all, perhaps. We've heard some discussion today of metrics. Maybe the definition could include a metric, desired, undesired signal ratio, bit error ratio, raising the noise floor, that kind of thing.

And so that's an issue that I hope will be discussed this afternoon. We've also heard about some discussion of the importance of receiver standards. And receivers will be discussed in the next panel and perhaps even in the afternoon panel

to some extent. There have been discussions of the benefits of grouping like users. You could construct a tree, I suspect. It would be a hard thing to do where you would branch out the users, for example. You might have those users who transmit point-to-point services versus those that transmit point to multipoint. There's a whole bunch of ways to do it. Those that require the use of a propagation model and those that don't. That's something else that perhaps can be taken up in one of the subsequent panels today as a possible way of meeting the Commission's challenges.

And then there was something else that was discussed yesterday which might be interesting as a way of doing it. How about the idea of just characterizing an environment and saying these are the signal levels that you can expect in this environment, design the equipment accordingly.

And so with that, I leave you with those thoughts.

Dale, did you have any concluding thoughts here?

MR. HATFIELD: No, I thought your last point was an excellent one, I think, regarding characterizing the environment.

MR. LARSON: Any closing thoughts from any of the panelists here? We have time. We have a couple of minutes.

Glen?

MR. NASH: I'd like to add to your consideration of interference. Is part of the equation needs to be the consequences that result from interference? On one end of the scale and some of the things that we've had in discussions with the different land mobile user groups is that there's a recognition that some user groups, interference is an inconvenience. You have to delay your conversation, you have to move to another location. It has an impact, but at the other end of the scale, we like to think public safety is there, is that interference can result in the loss or damage to life or property. And so the consequence of having interference, I think has to be part of the equation because some user groups

can accept interference more than other user groups can. And then certainly Larry brought up earlier the issue of the difference between what we in the public safety market refer to as the difference between nuisance interference and destructive interference which again comes in a little bit of your definition of harmful.

There's a certain amount of interference you can live with, but you hit a threshold where again it becomes destructive to what you're trying to do, to what the mission is.

MR. BRISKMAN: I have one last comment, it might be helpful. We all have said that we expect to see more interference. Right now, I suppose our only avenue of recourse at the Commission I suppose is the Enforcement Bureau which also, by the way, I compliment and does a good job. But I suppose my thought is and I've heard this before, the possibility of having active spectrum manager that tries to actively work these interference problems and get them resolved rather than just the question of enforcement which is

right now, if it interferes, you shut them down.

Anyhow, that's a thought I'd like to inject. Thank you.

MR. LARSON: Thank you, Rob. Any other panelists have any concluding statements here?

Okay, if not, we thank you, panelists for being here today and sharing with us, taking out of your valuable time and we're going to take now a 15 minute break until 11:15 and then we'll pick it up again with the advanced technologies panel. Thank you very much, ladies and gentlemen.

(Applause.)

(Off the record.)

MR. REPASI: Well, good morning, everybody. I see that everybody has pretty much made their way back in from the break and I thank you for being timely. I want to open up Panel II. This is the Advanced Technologies Panel in the Interference Workshop. This panel will -- this segment of the workshop will go on until 12:30. And at 12:30, we'll take a lunch break. So I'd like to accomplish a lot in the next hour and 10

minutes or so.

Before I do, I would like to introduce the panelists. I want to thank the panelists, one, for being here. I understand that some of them had to cut vacations short and it's a pleasure to have them on the panel and I really truly appreciate the participants that we have here.

To my left is co-moderator. Maybe I should introduce myself first. I'm Ronald Repasi. I'm with the Federal Communications Commission, International Bureau. I'm the Assistant Chief Engineer for the Policy Division in the International Bureau.

To my left I have Brian Woerner from Virginia Tech. He's a Professor at the Bradley Department of Electrical Engineering.

Further down the line here, we have Jack Rosa, who is president and CEO, Vice Chairman of the Board for Hypres, Incorporated.

To Jack's -- this could be confusing -- to Jack's left is another Jack, Jack Wengryniuk from Hughes Network Systems. He's the senior

director of regulatory affairs for Hughes Network Systems.

To my right, you remember Dale Hatfield from the previous panel. Thank you, Dale, for participating as well on Panel II. Of course, you know he's the independent -- an independent consultant and adjunct professor for the University of Colorado at Boulder.

To Dale's right we have Doug Lockie. Thank you, Doug for being here. Doug is founder and Executive Vice President for Endwave Corporation.

And to Doug's right, we have Ray Pickholtz from -- he's a professor at George Washington University School of Engineering and Applied Science.

Thank you all, again, for being available today.

I'll just a little bit of an opening remark, what we're trying to accomplish here, how we've set up the segments and the panel. We're going to have three segments that we'd like to go

through in Panel II. One segment is what are the driving forces for the advances in technology that we've seen to date and what do we see as the driving forces in years to come, and even 20 years out.

What are the capabilities of the systems that are designed out there today and what do we expect the capabilities of those systems to be in the future?

The third segment, I'd like to address, how the Commission's rules have affected the advances in technology that we've seen today which I think would be a good lead in to Panel III which is going to be looking at a better process in dealing with the interference environment and so forth. So I'd like to understand from the panelists and from the audience what in the Commission's rules to date has driven or given them flexibility that individuals have needed to make the advances that we've seen to date.

I think the way we'll break this down is Brian is going to co-moderate the first segment

on the driving forces for the equipment, for the advances and technology, but I wanted to point out that this panel is a little bit smaller than the other two panels, so what I'd like to do is if there's an opportunity for Brian to comment as a non co-moderator, I'd like to give him the opportunity to participate in the panel from that perspective as well.

So Brian, if you'd like to take on the first segment?

MR. WOERNER: Thank you, Ron. I guess our first segment, as Ron indicated, will be in the area of driving forces. How we have gotten to the current technology situation within the communications area and certainly over the last few years we've seen a lot of things change. We've seen the way that we look at interference change as was indicated in the first panel session.

We've also have seen the role that the regulatory process takes in looking at that interference change. I think first of all, we'd like to ask our panel members to make a few remarks

about what they see the current driving forces are which have helped radio technology to the point where it is right now. And maybe we'll start at the far end with Jack Wengryniuk.

MR. WENGRYNIUK: Good pronunciation there. Well, I currently work for Hughes Network Systems and I guess like the previous panel list, Ron Briskman, I'm representing the satellite community here today.

Let's see, the satellite industry, as was pointed out by Rob in the last panel, started some 35 years ago with fairly simple satellites. You had what we had bent-pipe satellites. The signal came up, was frequency translated, came down on a different frequency. Fairly large beam coverage, either global beams that covered the entire field of view or hemispherical beams that covered very large land masses.

What you see today are something that's considerably more sophisticated, particularly in higher frequency bands you see extensive use of spot beam technology. You see the use of what's

coming in the use of digital on-board processing. You see the use of frequency reuse over and over again, being facilitated by some of these new technologies.

All of this is primarily being driven by the need to try and squeeze more and more capacity out of the spectrum. Essentially, from the satellite perspective there are certain limitations to what can be done in terms of protecting itself from interference and what you've seen really is the drive from the satellite industry to try and get essentially more revenue out of what's being put in space and the way you get more revenue is to squeeze more capacity out of the spacecraft.

Now having said that there are limited things that the satellite industry can do in terms of interference. What you've also seen in the satellite industry is a move from a thermal noise limited environment to an interference limited environment. And so again, there are certain limitations within which that satellite industry

operates, but really what's happening to day is the limitations to satellite performance are really driven by the interference environment as opposed to the noise environment.

MR. WOERNER: How would you define that interference environment? Is it very "bursty" or is it uniform using the term that we talked about earlier today?

MR. WENGRYNIUK: Yes.

(Laughter.)

MR. WENGRYNIUK: There certainly is sort of a what you could call more or less stable background noise environment which is from the thermal noise and from sort of interference from adjacent satellites, maybe from terrestrial systems that are always there, and then, of course, you have sort of sporadic interference events as well or diurnal variations in interference as the capacity that's being carried by adjacent systems varies throughout the course of the day. So you see both the temporal component as well as the static component.

MR. WOERNER: We'll move on to Jack Rosa.

MR. ROSA: I'll try to address this from two aspects. One is a CEO of a high tech company, what I think we can do for the world and the second from the standpoint of -- I'm also on the board of directors of the SDR Forum and what the SDR world thinks we can do.

There's no doubt that demand for increased capacity is with us. If you just examine in bios communication the requirements for higher data rates and the attendant features that come with that. It's easy to say give me 384 kilobits. It's hard to produce that. And the reason it's hard to produce that is because you have to have carrier-to-noise ratios and we like to call them Eb over zero, but a 20 dB would be better than what you're getting now with voice. So easy to say, hard to do.

But there are, from a demand aspect, many initiatives going on now. One of the most prominent, I believe, which wasn't mentioned that

much this morning, is in defense. Defense is taking the massive leap of faith and they're now going through attempt to build these -- people talk about bandwidth, 2 megahertz to 2 gigahertz radios that handle 30 or 40 different wave forms. It is truly a noble venture.

(Laughter.)

And the industry is struggling with how are you going to solve that problem. In fact, the best we look for today is can we do as good as the old systems were. Maybe the first step is not improve anything, just is it as good as the old system.

But there is some expectation in various places that we can achieve a higher level of performance. Advanced technology will bring that.

It's interesting to watch the transition. As you can see from my gray hair, I've been in business for quite a while and in my youth they used to talk about doing calculations in leak margin based on C to Ns and S to Ns, okay? Now all

we talk about S to I or C to I. So the migration has gone from worrying about noise to worrying about interference.

So we're sort of doing it to ourselves.

New technologies, as we talked about which is the advanced services and so forth, bring with them another set of problems. But I think the next generation of technologies have solutions to those problems and I'll save that for the second part.

MR. WOERNER: To what extent are economic factors a limitation on what we can do with software radios? To what extent are those radio technologies going to be expensive and how soon can we count on the cost coming down?

MR. ROSA: Well, there's wide expectations on what STR can do. As with any new technology, it's the great hope. This is going to come in and solve all my problems. I can buy a radio for a dollar. It will get rid of interference and so forth.

Now, sometimes the expectations far

exceed the reality situation, but most of us in the business feel that there is significant gains to be made. There are certainly opportunities here to improve the situation.

The extent to which we can improve it would be a function of to some extent economic issues, people's willingness, like Defense, to take the leap of faith and to realize the economic benefits and that is as much driven by political factors as it is by economic factors.

I think the meat is there. It's how much do you want to eat is the question.

MR. WOERNER: Thanks, Jack. Maybe we could move to the far end of the panel and ask Ray Pickholtz for some opening remarks?

DR. PICKHOLTZ: Thank you. I guess because you wanted a little more provocation --

(Laughter.)

I'm an academic, but I also have a lot of experience in industry, having built things for a long time, but I'll take an academic tact to begin with. The concept of interference, the

conventional approach is interference is undesirable, get it down to a minimum or eliminate it and the burden is largely on the transmitter. That's been the attitude. But in fact, there are lots of different kinds of interference. Not all of it is bad. In fact, we know now how to use interference. I'll give you an example. Intersymbol interference. Actually, with the use of intersymbol interference, you can actually improve performance and it's done commonly every day, right now, in most of CDMA handsets. And you can gain 3 to 5 dB that way.

Similarly, the concept of interference is not very different from the concept of thermal noise which is basically you have no a priori knowledge about that you can exploit. But in fact, if you have a system of cooperative users, typically, a multi-user environment, you can actually exploit the fact that there's a lot of a priori knowledge about the nature of the interference and either eliminate it or minimize it to the point where it's not very important. So the

problem of going from S to I, S to N to C to I goes back to S to N. That is the only thing that you really can't avoid is the thermal noise effects, whether it be at the front end or some other means.

In fact, we know for about 50 years due to a fellow by the name of Claude Shannon, that there's a way of transmitting things so that you get the maximum possible spectral efficiency out of the system with virtually no degradation at all, providing you don't make a hog of yourself, and most systems today are somewhere between 5 and 10 dB from that limit and it's not the limitation due to interference.

So does this -- are the techniques known for exploiting the ability to eliminate or reduce interference or make it work for you and the answer is yes. There are literally by now thousands of papers and archival journals, but it's gone beyond that. I was very pleased to hear in the last panel somebody actually talking about building some of these systems and I know, I've traveled to Japan where people are building things

like adaptive arrays. They're building multi-user detectors. They're building interference cancellation schemes, all of which translate into more revenue for the people who are doing it because let's face it, "it's the interference, stupid." The concept here is that to the extent that you can avoid interference and not treat it as if it was noise you can increase the capacity and therefore get more revenue.

So that's my opening provocative statement. I just want to make one comment. Putting back my hat of a practical person, is this difficult? Yes, conceptually, there are some difficulties, but once you understand how to make chips, you can make these chips -- just as cheaply. You can put 300,000 gigs on a chip just as easily as you can put 20 once you start making them in large amounts.

So I think we're at the threshold of being able to do some of the techniques which would get us to the point where we have an interference, we view interference as not something that's

absolutely to be avoided because you're not going to avoid it. It's a question of whether you simply live with it or something about it and that requires a lot of sophisticated digital signal processing, a lot of coding, possibly cooperation between users and adjacent bands and maybe certainly users within the same service provider. But they're coming, I have no doubt. At a later time, I'd be happy to tell you specific numbers and details of what could be achieved.

MR. WOERNER: Thanks, Ray. Maybe we'll move on now to Doug Lockie.

MR. LOCKIE: Well, first of all, I'd like to thank the FCC for beginning this initiative, and I also request that you all keep it going. My experience on this interaction, getting ready for this is it's really valuable to the nation and to the industry. So please keep it going in one form or another, looking ahead to spectrum management as opposed to reacting as we usually have to do.

This whole thing about technology and

what's making advances, I suppose you could say a couple of things started in the last 20 years anyway, have really started this. One is going solid state in most of the communication systems and another thing is these doggone computers and I'll say tongue in cheek, it's all Intel's fault and it's all Cisco's fault and I'll come back to that in a minute. And it's a positive feedback thing here.

As we went from analog radios to digital radios, there's this huge step function and it keeps stepping on up. And I'll say that in two ways. In the old days in the carrier to noise, carrier to interference ratio, you just had no solution except limit your filter and have lots of signal with respect to the noise or interference. Now we can signal process an awful lot of that away. And that wouldn't be possible without modern cost effective computers. All the computing power we had in the Air Force when I was in it in 1969 through 1970 is now today on one single chip coming out of Intel, the Itanium which started off life at

800 megahertz, now running 200 gigahertz. That's an entire super computer, 64 bits, running on one single chip. We'll probably be able to buy that at Fry's or Circuit City or Radio Shack for $100 in five or six years, but that's a 320 million transistor chip and you can buy it in a computer today for $5,000. Huge.

Once you got that computing power, not only did it benefit the radio communications, but it also started making it so that we could build antennas that we could either shape the function instead of having a sectorized antenna that looks like this, with a 3 dB window. You can make that antenna now so it looks within a half dB and then the side lobes fall off like a rock.

And then, you can use that computer to design practically antennas that have things like a cosecant squared pattern, so that you can make a constant flux from the antenna all the way out to the edge of the pattern which would go a long ways to helping this safety band problem where Nextel went off and put out a whole lot of cell sites all

over the country in a cellular fashion and then the safety community finally got some spectrum at around 800 megahertz and they can only afford one transmitter or two transmitters per region, so they're always out at the end of their transmission with a very low signal and you've got all these high powered transmitters, so we could use these cosecant antennas to minimize the amount of power you put on the ground right next to the transmitter and maximize the amount of power you put out at the edge of the footprint and that would go a long ways to helping this.

So you've got this combination of computers and solid state and technology feeding on each other, but now let me tell you what the problem is those guys at Cisco and Intel created for us. And Cisco doing the ethernet kind of things. We now need gigabits in the local loop. You used to need a half a megabit, so that you could have a computer talking to the internet and give your screen a refresh. But computers want to talk to other computers at some major fraction of

the computing speed.

And today, that's gigabits. So we're flat lined in terms of DSL giving everybody a half a megabit to the internet when your computer is screening for gigabits. So it's a never ending thing of now what we need to take the next generation of productivity forward in the country is to open up the local loop to gigabits so that our computers can talk to each other efficiently and it's never going to stop. It's always going to be an interesting slope to be climbing up, but it's also going to -- should be improving the efficiency of the country.

MR. WOERNER: Are the driving factors that you see at that high range of the frequency spectrum, 10 to 100 gigahertz, are they similar to what we're seeing in other regulatory issues at the lower end of the frequency?

MR. LOCKIE: You know, it could be if you're in a point to multi-point situation, but once you get to say 20 gigahertz or so, most of the time what you're doing is pencil beams. And let's

make this 20 gigahertz to 260 gigahertz because that's where the good atmospheric windows are and we've now got the ability to generate radios up in those frequencies.

There, what you've got is spectral efficiency probably now starts becoming how tight can you make your beam. And what we know is all the way down to a quarter degree, we don't have to track the antennas in a typical application. So one of the things that probably what we want to do is try to incite, incent people to put as tight a beam as you can which means a bigger antenna and more careful side lobe control, but we now have the computers to design those kind of antennas and take the cost down.

So the big thing up in higher frequency is how do we get spatial re-use and maybe we decrease the spectral efficiency at the expense of doing that so that we still have cost-effective systems and then later on as the technology comes along and as the business phase grows, then you can start improving the spatial efficiency in a more

conventional sense.

A point on that, we could do this down at 900 megahertz for cellular. If we could grow a 70-foot antenna, we could have a 1 degree beam width. By the time you get to 100 degrees, a 5-inch antenna is a 1 degree beam width. By the time you get to 260 gigahertz, about 2.5 inches gives you a degree and so you can have thousands of antennas at each node and re-use the spectrum, half of that, every other beam, every other polarization, so there's a huge amount that can be done on these higher frequencies for opening up the number of bits transmitted per hectare squared.

MR. WOERNER: Maybe we could move to Dale Hatfield?

MR. HATFIELD: Sure. Speaking last, a lot of what I was thinking about saying has been said, so let me try to do something a little bit useful, maybe stepping back, just a little bit from what's been said in terms of what does advanced technology enable and the basically what we're talking about in some ways, I think, and this was

covered in the panels yesterday, of course, is moving a lot of that intelligence out to the edge of the network and getting away from that old hub and spokes, centralized controlled-type system. And there's two things driving that. One is just the internet model itself that if you have the intelligence at the edge, then ordinary folks in their basements or garages can invent services and create new services and we obviously have seen that so that's a driving force for putting the intelligence out there at the edge. And I'm reflecting David Reed and so forth. But the other thing, moving that intelligence out there at the edge enables us to do is be much more dynamic in the way we go around, the way we go about managing spectrum. And that's the intriguing part to me.

Ray's already talked about that, moving that intelligence out there. It allows you to do these sort of interference cancellation techniques, cooperating transmitters, all the sort of thing -- cognizant radios, all the sort of things that we've heard about. And sitting here looking at Paul, you

sit here on these panels and sometimes somebody says something that changes the way you think about the world. I had one of those at the NTIA spectrum forum. The allocation chart, if you put it up here on the wall, the FCC allocation chart, it's got all these colors and all this balkanization and so forth and somebody then put up where we want to get, the allocation chart looks like this. And all it was was a white chart. And that sort of fascinates me. What it means is that you're moving to a very dynamic, very dynamic system where you can get, where you can pick up this capacity that's available.

We all know, everybody knows this. If you put a receiver on top of this building and take a look around, you find lots of spectrum that's not being used at this moment. And this is moving intelligence at the edge, the edge of the network will allow us to capture that, but it requires us to get away from thinking about this rigid sort of spectrum allocation thing that we've had so far.

So all I've done is sort of picked up

on what people have said before me. Moving that intelligence out to the edge allows us to think much, much differently about structure management than we have in the past.

MR. WOERNER: Thanks. Just quickly following up on what -- a little bit of what Ray said, I think the way we look at interference has kind of changed in the last several years. Historically, we've looked at interference and regulated it from kind of a worst case standpoint. What are the C to I ratio need to be to make the system work? How low do the interference levels need to be in adjacent bands in order to not produce harmful effects? What some of the new advance technologies we've heard about, look at interference, is more from a statistical standpoint. Is the interference too high from a long term average viewpoint? We've heard several different technologies. Error correction codes that are able -- as long as we don't have a long burst of interference to recover things. Code division multiple access systems that are able to

handle levels of interference as long as those interference levels over the long term are not too high. Ultra-wide band technologies which potentially have the ability to be kind of CDMA systems on steroids with much higher capabilities. And software radio technologies that we've heard both Jack and Dale talk about that allow us to as long as the whole spectrum isn't full, select those parts of the spectrum that we're interested in. So there's an opportunity to exploit some of these new technologies in this new interference environment.

MR. WOERNER: I think at this point it may be worthwhile to open it up for questions from the audience at the end of this segment.

(Pause.)

MR. REPASI: Okay, well, if there are no questions at this moment perhaps I can move into segment 2 and if there is a question that somebody thinks of during that time and would like to go back at the end of segment 2 and refer to some of the points made in segment 1, that's fine.

What I see out of segment 1 was very

similar to what Brian has just summarized, but I wanted to point out that one thing that I didn't hear as far as driving factors is the end user, what the end user's requirements were. It's interesting that a lot of the statements that were made, people were thinking along the lines of what the interference environment is and what the operating environment is that I'm going into and what can I do to cope or live within that environment and still meet my system design requirements. But at no point did -- having 4,000 megabits per second go to the end user come up in that discussion. I thought that was fairly interesting.

It's a good lead in to segment 2 because now we get to talk a little bit about the characteristics of the systems that are out there, the technologies that are out there. We know what some of the driving forces were in coming up with those, but what exactly are the capabilities? We heard some of the processing speeds, what we expect in the next couple years that we'll see at Circuit

City, for example. But I'd like to focus a little bit more on how to deal with interference specifically. For example, are there techniques being used out there in the radio communication systems that bring uniformity to signal wave forms. And to distribute the power a little more efficiently and we heard a little bit about the cosecant squared antenna. We can maybe bring that a little bit further.

But taking that perhaps a step further, and looking at the intelligence built into the system in dealing with self-interference and whether or not there's any intelligence in systems today and whether we anticipate there to be in the next couple of years or 10 years out for there to be a way for these systems to detect who's around them causing them interference, causing your system interference and how we would anticipate dealing with that from a system design and try to mix things up a little bit here. Perhaps we'll start with Ray at this time and work our way towards the center of the panel.

DR. PICKHOLTZ: Yes, I think certainly that's true. I just want to make a comment that there have been lots of improvements in the last 10 years. I'll call them naive improvements, things like better filters, beam-forming antennas, Qualcomm's CDMA 1S95. They are naive improvements because they do not extract all the possibilities that are there.

Now just sticking with cellular, there's 3G coming up. I don't know if 3G will ever survive. Maybe it will be 4G before 3G comes, third generation. But many of the people who are serious about 3G, especially in the Far East, have actually built systems with more than simply a multi-sector antenna with a very large number of sectors and narrow beams. And more than simply having adaptive filters and adaptive power control, but actually have included some of things I mentioned before, namely true multi-user detectors, that is to say, they're fairly sophisticated devices that recognize that there is a priori knowledge that you can use to

help you overcome the environment that you and your partners sharing the spectrum are actually causing. It's not as if it was totally unpredictable Gaussian noise. And to the extent that you can take advantage of that, and you can, the technology keeps moving. There are much better building blocks now. We talked a little bit about making software radios. In principle, at least, you can make software radios so that standards and weight forms don't count. You just transmit the number of the particular standard of thousands that are stored in a RAM somewhere and the algorithm for decoding it is right there. So that's in principle. I don't know of anybody who is building that in practice, especially over multi-broad bands. There's, of course, a semiconductor revolution, advanced signal processing, but last but not least, a very deep understanding of the limits of communications. I'm talking about communication theory, that is, what is possible to do and what's not possible to do. How far can you go and how far can you actually -- how close to the

limits can you get and it's remarkable that many of the systems that have been simulated and in some cases put in a laboratory environment, have gotten within a fraction of the dB of the theoretically possible. And I'm not just talking about Shannon. I'm talking about space-time coding which offers the possibility of literally growing spectrum where none existed before, multiplier factors. You know, you have 10 megahertz of spectrum, over 100 megahertz and suddenly it's not 100 megahertz, it's several gigahertz of spectrum because you can re-use it again and it's not simply the naive approach of using space by very narrow antenna beams.

So those are the kinds of things that are there. The technology is there because of the signal processing capabilities, because of semi-conductor advances and so on.

And I just want to make another comment. There are some constraints. I've heard them this morning. There are people who, for example, represent the public safety use of spectrum. And as soon as you say "public safety"

especially since 9/11, that becomes sacrosanct. But in fact, I believe firmly that public safety people have an even greater obligation to operate more efficiently because they get more through with less interference in a more corrupted environment which is likely to happen when you have a crisis. So there's an obligation as well

-- as well as a responsibility, as well as a right for public safety people using a spectrum to use it more efficiently.

I don't want to dominate the conversation any more, but simply say that we have been very slow in adapting innovations, very, very slow. And there are lots of reasons for it, not the least of which is legacy reasons, the lawyers and the economists and all tell us about how -- what could be done and what can't be done and the reasons for it. I've read some of the papers. They're very elegantly written and they're almost convincing until you snap out of it and realize that there are other ways of looking at things.

I'm an engineer. I started my career

working on -- in the beginnings of NTSC color television. And although it doesn't show by my gray hair, it shows by my no hair.

(Laughter.)

And I started by designing color television sets, and in fact, I have an old one somewhere that still works with the signal today and has all kinds of ghosts and all kinds of bleeding of the colors and so on and one could say well, we really can't do anything because there's so much of an investment of these hundreds of millions of sets that are sitting in attics and basements and other things that are -- you can't change those things overnight. But the Commission has to find ways of making rules, if nothing else, some kind of a gradual transition to implementing new things. The thing that comes to mind that is perhaps most impressive to me as a young engineer that NTSC was a compatible system, that is to say, if you had a black and white set, you could also receive color if you had a color set, but you could also see -- and there's at least one other system

that I confess in full disclosure that I'm involved in and that is IBOC, the in-band, on-channel AM and FM broadcasting system which allows people to continue to use their crummy old analog FM and AM receivers. By the way, AM and FM radio and television are the last holdouts in the whole electronics world. So if the Commission can make sure that innovations can handle those transitions while allowing innovations to be introduced at the same time, that would be great. And I have some ideas along those lines. I'll save them for later.

MR. REPASI: Thank you, Ray. I think that your points are well taken on the differences in the services too. I think that in panel III this afternoon, we may get into a more in-depth discussion about the driving forces for some of the specific services that the Commission regulates. And broadcasting is one of those services where there might be some capabilities in other communications services that you're not able to extrapolate those same types of benefits into some of the other services. Legacy equipment is one of

those factors.

Doug, how about you? Could you offer a few comments on this subject?

MR. LOCKIE: Well, I'll go back to this never ending cycle between processing power and what it does to and for us. I look at a lot of business plans. I haven't made my investors any money yet, so in exchange I look at a lot of business plans for them. And please God, let the market go up one of these days.

At any rate, and we're seeing business plans coming through now with 1024 QAM, 2048 QAM, 10,000 PSK kinds of modems and -- sorry. That's my Palm and my phone. At any rate, your first reaction is put these guys into the loonie bins, guys and gals. And then you go through the thing and say well, they're just taking digital processing and we've got all this process capability going on in general purpose computers, but if you go in and do a pipeline computer based on say maybe an FPGA, you can take 10 instruments and stick them into the knob of the instrument and

by the time you click from one channel to the other on say a spectrum analyzer or a network analyzer or a bit-error rate tester, you've loaded a new program into this FPGA and it's become a pipeline process that maybe has a 100 to 1,000 times more processing power than the previous general purpose computer there. Where does it all stop? But the interesting things that these modem companies are doing is that okay, we can't build the oscillator that's clean enough to support 10,000 PSK and the digital processing guy says that's okay. I'll equalize out the noise in your oscillator. You just give me 2/10ths of a nanosecond delay which maybe is an antenna that's spaced that far apart and the signal coming in, I'll listen to what the oscillator is doing buried down there in the data stream and I'll equalize out the noise in the oscillators. Now you use a crummy old dirty oscillator and still have your 10,000 PSK. Maybe. And they'll do the same things in the nonlinearities in both propagation path and in the amplifier generating the signal. So there's all

that stuff coming along. Well, as that's coming along, you could be building that into variable rate modems that adjust to whatever the spectrum is doing, whatever the noise environment is doing. One interesting thing though and I want to point this out to the FCC, you guys have got a lot -- guys and gals -- have got a lot of power out here and maybe once in a while you need to practice a little tough love. Now with this -- and I'll use broadcasting as probably the largest number, what have we got? Several hundred million TV sets in America and one of the little things that hangs us up on going forward is the factories that are there to design the analog front end. It's a discrete thing and it costs $10 or $11, but it's still an analog front end. It's remarkable what the factories in Taiwan and Thailand, wherever, do to automate or not automate the front end of a TV set, but we've still got a front end on a TV set that's this big by this big by this big and it's got 80 analog discrete components, filters, passers and stuff. It could be a chip the size of the tip of

your pen. And probably will be in a few years. And so one of the things the FCC could be doing is saying, 5 years from now, 8 years from now we're going to be with a digital front end that has all these capabilities in it in terms of interference mitigation and you've got 5 or 6 or 8 years to do it and if you haven't done it by then, we're going to audit your taxes or something.

(Laughter.)

There's a lot of ways that you can incite and incent people to go out and work on these things, but -- well, so there's a lot of other things you can do in the analog world as well, but never to downplay, gee, when you buy your TV set you also, you also buy a cellular and a wi-fi and an ultra-wide band and the capability is there to make this stuff to go off and happen and it will happen over a period of time, but there's probably a lot we can do to skootch it along faster, with some gentle suggestion and rules.

MR. REPASI: Your gentle suggestions are well taken.

Dale, how about you?

MR. HATFIELD: I'll be very brief. I would again, as I did in the last panel distinguish between the situation where the improvements benefit the licensee, like in cellular where if I'm more efficient, I can put in more subscribers and make more money. In a situation where we have, for example, in television where that control is not exercised, and I think there particularly, the advice that the prior two panelists gave, the Commission being a little bit more aggressive is probably well taken. I'm -- here again, people have heard me say this so many times, but I'm going to say it again is in 1977, something like that, when was it? We had an RF monolithic study and it showed that if the Commission at that time had stepped in and just tightened up the selectivity a little bit on television sets, we would not have the problem we've had today. In fact, we could keep the analog, we could recover, we could recover that spectrum, had the Commission stepped up to it. Now I'm not saying whether at the time that was a

good or bad decision because you multiply a couple of bucks times the millions of television sets that have been made here, that is real money. But it illustrates, I think, it illustrates where the Government could, especially where the benefits don't accrue to the licensee, could step in and have some real strong benefits. I'll just repeat, we wouldn't be having the difficulties we have today over that price spectrum if the Commission had gone ahead.

I'm not attacking anybody, I was actually here at the time at the Commission during part of that and there was pressure, receiver manufacturers didn't want the extra costs. There were problems with the Communications Act, did we have jurisdiction, the ability to require receiver specs. But I'm just reinforcing what I heard. I think the Commission can, without intruding too much in the marketplace, have a real positive benefit here in terms of recovering spectrum that we so desperately need.

MR. REPASI: Thank you, Dale. I think

that one of the purposes of these workshops and the Spectrum Policy Task Force in general is to have guidance available to us at the Commission so that any decisions we make today are the best decisions we can make that will be still relevant 10, 20 years from now and still working fine.

Why don't we go to the other end of the table and start with -- and begin, continue on with Jack Wengryniuk on what his views are from the satellite perspective, what is done on the satellite side as far as dealing with the interference environment or the operating environment when new applications, for instance, are -- you want to deliver new applications to the public, what do you have to go through on the satellite system operator to adjust to the new environment.

MR. WENGRYNIUK: Well, you also asked about the, sort of the equalizing of power, the interference environment and what has happened in that regard.

Satellite systems by their very nature,

are spraying down power from space and so you're getting more or less a uniform distribution of power across the surface of the earth which is from a satellite sharing with satellite perspective is a good thing, because you don't have the kind of hot spots that you might have in the terrestrial world.

The transition from analog to digital communications, the virtually wholesale transition from the old TVFM or FTMFM types of signals which had highly variable power spectral densities, as you were to scan across the spectrum, to the digital world where you have a more or less uniform distribution of power, even for different bandwidth carriers because it automatically scales the power to the energy per bit, has helped to sort of again normalize the interference environment amongst systems and within systems, the intra-system interference as well. The types of advances that I spoke of earlier in the satellite world with high levels of frequency re-use, dual polarization, etcetera, have increased the levels of intra-system interference that the satellite network provider

has to deal with.

One of the difficulties that we see certainly in the satellite world with the introduction of new services and part of this is driven by the advances in digital communications as well, or the digital processing power is you take a signal and you encode it as much as you possibly can so that it uses as few bits as possible to transmit the communications channel or as small bandwidth as possible. The problem with that is is that system now becomes highly susceptible to errors because you have a lot of interdependency from one bit to another because you're taking advantage of the redundancy and the signal that you're encoding. And so whereas for a voice signal, you may be able to tolerate to talk in technical terms, bit error rates of 10^{-3}. For a video highly encoded video transmission, you may require 10^{-6}, 10^{-7} bit error rate. So you become much more susceptible to interference of the same types of things that you're doing to improve your spectral efficiency and in some cases reduce the

amount of interference you may cause to yourself, also make you more susceptible to interference. So there's this balancing act that's continually at play and of course, all of this is happening on top of or beneath the desire of the satellite provider to provide as much service as possible to the public as low a cost as possible and of course, to make as much money as possible. So it's this balancing act of all of these sort of competing forces in trying to find out what is the best point at which to strike that balance in the provision of service.

MR. REPASI: Thank you, Jack. Yes one of the tradeoffs, I think in the design of satellite systems too is there's only so much energy you can soak up from the sun. And the trade offs are between power and bandwidth. We're going to higher orders of modulation or error correction and so forth. That all requires more power or more bandwidth. You've got some tough choices, I think, in that type of environment.

Jack Rosa, from a software defined

radio standpoint, what do you see kind of being the next step in what SDRs would be able to offer as far as playing a role in system, communication system design as far as mitigating or eliminating interference to improve performance?

MR. ROSA: As I said before, the capabilities are there to solve many of these issues. What I heard several times, in fact, was that we are slow to adopt. We are slow to progress and so forth. And in some cases some people believe that wave form complexity is beginning to out pace Moore's law, so we need the next step and the next generations of technology to get there.

To get to the bottom line, I think the most significant thing the FCC can do is to become a proactive player in advancing the course. Business models will take care of themselves. It's interesting. To pick up where Jack left off, is that in satellite communications you pay for bandwidth. You pay for power, okay? And people -- you optimize those tools. You get the right amount of power and bandwidth, so you don't pay any more

than you need to. And then you try to get the best you can out of that, what you just paid for.

So the economic factor draws that equation, that is, if I can get all the bandwidth I want, why do people want to go from digital analog radio. I don't like the digital TV system, because now you can get three or four in one transponder rather than have just one transponder being in your life. So there's lots of opportunity here to move forward. Those are just modest -- those are what you call the no brainers. We knew how to do that years ago. But there's a lot more to be gained, significantly more to be gained and so even in spite of the attempts of Mr. Gates and Cisco to push this to the edge which is the opportunity, I believe the potential, the technology that exists today or is being developed today to deal with every one of these problems. Spectral management. If you had a fast enough machine you could monitor the spectrum continuously. You could put in intelligent controllers, so-called bandwidth on demand. That technology can be accomplished now.

From every aspect, from adaptive antennas to -- the technology exists to solve all these riddles. And it's -- I think the role FCC can play again is to do -- take actions proactive actions, be proactive and try to support the development of these technologies. The economic gains will come later.

In addition to that, you should consider and maybe I'm jumping ahead to the next activity which is incentivize people to do it. It's not going to happen naturally and when there's economic gains to be made you can do it.

I had some slides I wanted to show. For instance, it is possible, for instance, to take transmitters and almost totally purify them, directly at RF. It's possible to build correlation-based maximum like modulators, okay? The optimum filter, the textbook -- it's possible to build spectrally pure carriers, okay? All these techniques are available, but it's all invested in the next generation technology.

Software-defined radio will give you

the maximum flexibility where wave forms are defined by numbers. It's not quite -- Defense is moving in that direction, but it's not quite down to just punch a number in. But if you know what the template is of the wave form, and very complex wave forms too, by the way, they're dealing with 30 wave forms, some of which are incredibly complex, hopping inside of half inch bandwidth is not a piece of cake. But it's possible to do it. Very possible. In fact, it's do-able. We know it's do-able.

But somebody has to advance the cause. In that case, you have a monolithic structure. It is now, at least. They formed the Joint Office to make this happen. They're going to spend several billion dollars to prove they can do it, okay? There is no corresponding monolithic situation, I think in other areas, there's a semblance of it. Maybe FCC can be the driving force that puts that together and it becomes a monolithic force that makes it happen.

MR. REPASI: Thank you very much, Jack.

One of the things that we haven't touched on in this panel and I don't expect to is the -- whether or not complexity, system complexity equals costs. I mean we take something from a Defense-oriented -- when you take something that billions of dollars have been invested into the research and development of software defined radio, for example, but you take that to the commercial side, that, I think is a pretty difficult transition, something that we'll be facing at the Commission as well.

At this point, I'd like to open up the panel to the public for comments if they have any comments or questions for the panel here.

Yes sir, in the back.

MR. STEVENSON: Thank you, Carl Stevenson. I'm with IEEE 802.18 and I work Gear Systems. I'd just like to echo what Mr. Lockie was talking about before in terms of reducing interference and even improving spectrum efficiency by sort of holding incumbents feet to the fire a little bit in terms of keeping up with technology. As it goes right now and the example of

television, with NTSC was a prime example. There's been many, many years where you've had a legacy system that's essentially been protected from needing to make any progress towards more efficient use of the spectrum just because of the fact it was there.

I'd also like to comment on what Mr. Hatfield said earlier in terms of starting to lean towards receiver standards. Receiver standards, at a minimum, give you the ability to figure out what you have to protect against in terms of being able to share spectrum with incumbent users. And while I don't believe that legacy receivers should receive indefinite protection against anything new that may come along, I recognize the fact that you can't force the issue too rapidly. The transition can't be draconian. It has to take into account reasonable equipment life cycles and so forth. But you also need to recognize that the upgrades to new technology will also provide benefits to the users that are required to keep up with the times.

Thank you.

MR. REPASI: Thank you. Questions?

DR. KOLODZY: Paul Kolodzy. I have a question for the panel that you might be able to address since this is technology. You have possibly two ways to look at interference. One is technology in which to avoid interference and the other one is technology to mitigate interference or to deal with it, to handle it within your systems. What I don't understand, I hope the panel can comment on is number one, is which way, where is technology really leading us and where would you see our first sets of advantages or advances that could actually help in the area of interference? Should we be putting more emphasis toward trying to avoid it or should we be putting more emphasis on how to mitigate it?

MR. REPASI: Anybody want to answer that?

DR. PICKHOLTZ: I think the answer is both. It depends on the circumstances. Some of the comments I made about the new technologies that are there to not only mitigate it, but possibly

eliminate it, apply primarily to those situations we are operating a common shared spectrum in a multi-user environment so that you know something about the nature of the interference you're trying to either eliminate, avoid, mitigate, use, what have you. There are other circumstances where the only thing you can hope to do in a short period of time is to minimize the amount of interference that's generated. That's the traditional point of view, putting masks on transmitters and things like that. But even those in principle, the first one, the first category is not in principle. The first category is something that we can actually implement today and people are implementing it. And the bottom line is, in fact, economics. You don't implement it because -- they're not implementing it because there's some FCC edict that's telling them they've got to do this in order to operate more efficiently. Since their revenue stream is dependent on having a spectrally efficient system, they actually get more for what they have or what they've purchased in the event of

an auction. So some of the most sophisticated techniques that are yet to be seen in the environment of the general economy, are fairly imminent. That is, those systems that operate in a multi-user environment. And I might add, although I mentioned satellite -- cellular -- I think satellites might fall into a similar category because you can have interference sharing between spot beams and similar things. It's essentially the same idea.

So the question then leads to what could be done, what kind of techniques. I had a bunch of slides, but I'm not going to do that. There is a body of techniques that are ready and waiting that are well within the capabilities of the current technology to exploit. In some instances, perhaps mostly in legacy systems where there's no incentive to exploit them it's going to take a while unless there's a push by the Commission to do it.

But the bottom line question is, and I'd like to take this up because I think there's a

need to say it, of what the Commission can do in a larger sense and I think it depends very much on the nature of the services that are being used. For example, I personally think that the Commission ought to expand the unlicensed bands and there are plenty of places I can tell you where there's a lot of wastage, because the unlicensed band has a nice, neat idea of -- it's a Darwinian system which it's almost like the invisible hand of Adam's where the survival of the fittest encourages people to use the most advanced technology to not only exploit the most that they can get for themselves, but to avoid the deleterious effects of the other people using the spectrum. And I would like to see more of that. There's, of course, a lot of people around who would not like to see that, but I think that there's a lot of merit to that.

I also think that the Commission can press those users who up until now have had no real economic or other incentive to improve, to share the burden of making themselves more spectrally efficient. And by the way, most spectrally

efficient does not automatically imply, as I sort of heard a sense of that, not only imply a degradation of performance. If you compress signals and then properly encode them, you're going to get both a reduction in the amount of bandwidth that you use or another way of putting it a larger spectral efficiency and at the same time get a greater performance value as measured by any measure you want, frame error rate, bit error rate or other means, subjective or otherwise.

And there are certain things that are different like broadcasting. I have already mentioned NTSC. There's got to be a little bit harder push on the part of the Commission to speed up digital broadcasting and by that I mean things that are already in place like digital television, HGTV, but also radio broadcasting which is already started with XM and Sirius, but soon, hopefully, IBOC, which is right in the current radio spectrum.

And then finally, the thing that will make it possible, and this is very controversial, maybe the next President or the current President

should appoint as the next Commissioner an engineer on the Commission.

(Laughter.)

MR. REPASI: Thank you, Ray.

(Laughter.)

MR. REPASI: I think we would agree on the panel that -- not about the next appointment of a Commissioner --

(Laughter.)

-- but agree that dealing with interference and the interference environment is a two-sided process, one you want to mitigate it from the transmitter standpoint, do what you can to make your system as clean as possible so that other users in your band and other users adjacent to your frequency band aren't impacted by your operations. But at the same time, you want to look at what can be done on the other side of the system to figure out what can be done on the reception side to avoid receiving interference from other users in the same spectrum and other users in the adjacent spectrum and I think that's one topic in segment III that

we'd like to pick up in the next 10 minutes or so.

MR. WOERNER: Yes, I think Ray's remarks really lead into that. There is certainly a huge variety of very sophisticated signal processing techniques out there and they do a very good job of coping with self-interference. They are capable of interfering with legacy systems. And I guess the final question we want to pose to our panel is how the FCC rules affect technology and development. Are there -- is there a sufficient push to improve the performance? Is there a sufficient pressure on legacy systems and we'll go down our panel and we'll start here with Jack.

MR. WENGRYNIUK: Well, again, from a satellite perspective since that's the only industry I've worked in for 25 years, the FCC's rules, certainly over time, have evolved such as, in my opinion, to push satellite systems. Take for example the KA band where you've got a requirement for 2 degree spacing, a requirement for use of adaptive power control, a requirement with the

FCC's rules to essentially tolerate an interference-limited environment. Certainly, with the desire to get as much, to squeeze as much capacity out of the geostationary orbit and to use the geostationary orbit as effectively as possible, the FCC's rules have, in fact, in my opinion, pushed satellite providers where they probably wouldn't otherwise have gone because of the costs and technical complexities involved. So in that sense I would say that the Commission's rules, have in fact, pushed the satellite industry.

MR. WOERNER: Historically, most of the regulation has primarily focused on the transmission end where -- what signals can be admitted and what bands, to what extent do you think it is appropriate to regulate the receiver side of the system?

MR. WENGRYNIUK: Well, certainly, this is speaking personally now, I believe there is a -- there should be a responsibility on the part of the receiver to take reasonable steps to protect themselves from interference, proper filtering,

that sort of thing, to suppress adjacent band signals. There's only so much you can do with interference that occurs within your band.

Dr. Pickholtz spoke of some of the things you can do if you had some a priori knowledge of where the interference is coming from. But when it's coming from a different service or a different system that you have no knowledge of, there's only so much that you can do to mitigate that.

In the satellite area again, because of the very nature of the service, we're receiving very weak signals from space. We tend to have fairly sensitive receivers and fairly high quality receivers. Even in the consumer market, there's a certain quality standard that has to be met in order to get any sort of a reasonable quality of signal out. So in that sense the satellite industry is almost self-policing, but certainly from a broader sense, I would think that there should be some consideration given to receiver standards.

MR. WOERNER: Great. Jack Rose, maybe you'll share some perspectives on the implications of this discussion for regulation.

MR. ROSA: Maybe I can address a couple of points that were made along the way and pick up on them. I think it's time, I think it's radically time to move from what I would call the myopic view to a holistic view. The FCC is predominantly focused on taking care of transmitters. In fact, the definition up there was sort of archaic. So it's time to move on to the -- what the environment is today.

And we need to look at both. We have -- if you want purified transmitters and making the receivers less susceptible and the technology again exists to do both of those. And there are optimum gains to be made. Now one of the two things that the FCC can do. The one point I tried to make before was this perception that high tech, next tech is going to cost more. The indications, in fact, are it's going to cost less. In fact, dramatically less. I don't mean just 10 percent

less, maybe half to one third, one fifth of what we pay today for systems. So the expectation, by the way, of the Defense Department, if you pile up all the radios they buy, you're talking big bucks. Anyone who wants to buy one for $50,000 that does all these tricks and it's a cheap one. So the art and the science exist to get there. They exist in the commercial world and exist in the Defense world. But are the incentives to go and do this? That's what the question is. Why would I want to move forward. I see this as two components. One is the FCC again taking the homogenizing this and becoming the driving force to accelerate the course, to cause it to happen sooner rather than later. Let's get proactive rather than reactive, my message there.

Second is just business sense. You must have incentives. And maybe some simple things like a -- how much you spread into other spectrums is a function of your licensing thing. I've got a simple picture that's at a level and if you get to this level, you pay X dollars a month and if you

get to this level, you get -- maybe at some point you get y dollars back, in fact.

(Laughter.)

Penalties and incentives, if you will. You can readily determine what those thresholds are, okay? It's not rocket science either, by the way. It's very simple. You make the penalties and incentives attractive enough that a reasonable business man will make a no brainer decision. In one year, if I can get my money back, then I'll go do it. See? You need to have something that makes sense from a business aspect.

I think in issues like that which I know are -- these are dramatic from the way we behaved in the past is what it's going to take. It's going to take some radical departure from conventional thinking, to accelerate -- to speed up the film, to accommodate what the world wants.

MR. REPASI: Dale, do you have a few brief comments?

MR. HATFIELD: Since I was on two panels, I'm going to yield my time to my

distinguished colleague to my right, except for making one -- I have to say that maybe we ought to look at sort of interference trading rights to just like you have pollution trading rights.

(Laughter.)

There may be some opportunity here, but to people at the edge to say gee, it's cheaper for you to fix it than it is for me and I'll pay you to fix it.

We may want to allow some economic type forces to get into that trading as well.

MR. LOCKIE: I have two comments here and before I ought to pass off some credit for them. Often, we come up from Silicon Valley to the FCC with some ideas, you know, and often we end up in Mike Marcus' office because, particular millimeter wave community and often he offers us another suggestion that is maybe one or two or three or 20 dB better than the idea we walked in with. So Mike, I'd like to thank you for all your help over the years in passing off ideas. Some of this stuff is yours.

Two things, one I recommend that we look -- there's a lot to be said for the old -- a lot to be said for software-defined radios and all this stuff that we can do in the processing world to make things better. There's still no substitute for antenna gain and side lobe control and frequency control to orderly fashion reuse spectrum and make things better. So not to downplay that, just build on top of it. But along those lines, I think there's one thing we really want to explore and we're pushing this in the NPRM 7181 and 92 gigahertz is electronic filing and electronic coordination. This is another example. When we got computers now that for 500 bucks, you can buy a computer that can keep track of all the spectrum and every transmitter received around the world, so I would suggest a couple of things. We take a page from the radioastronomy community and the way we're doing filings there that every geographical area is a website, heartbeat. And that every new license coming in has it's own URL and with V6, Version 6

of the internet with unlimited numbers of addresses, it's a heartbeat.

In the process of all that, and some of you want to take a look at some nice things going on, go look at Donald Draper's software. It's nascent. You need batteries, you need some assembly and don't do it just at home, but this is a beautiful example of very cost-effective mapping software and electromagnetic software that we should be able to build on top of that and not have to waste $3,000, $4,000 or $5,000 per filing doing this coordination. Phone calls back and forth, missed calls, a lot of expense tied up there. We ought to be able to minimize that down to a few hundred dollars per site license. I recommend we look at that some more.

The other thing is I recommend that the FCC start looking at what are the basic physics of each spectrum band and what it's good for and I'll make a suggestion here and I hope Jack Valenti doesn't put out contract on me here, but two of the most valuable chunks of spectrum according to

physics for mobility for 3G, for 4G, for 5G, is VHF and UHF television. Now it's also some of the most important spectrum in the country in terms of keeping the economic base going, because that's how you get a pair of jeans to cost $90, 50 percent of it goes to advertising, but at any rate, if we could figure out a way, if there was a way to get the VHF and UHF broadcasting community to say hey wait, I'd like to give back my spectrum and get some of this new stuff, and I have a suggestion for what that might be and probably other folks will be able to come up with better ideas, but if we went off and built a satellite with about a 300 or 400 foot antenna, can't do that today, because it's just too hard. A rocket is only 12 feet wide at the top and the antenna is limited to 12 feet if you want a cheap satellite. But we can build antennas today a couple hundred feet in diameter and we can probably expand that out to 400 or 500 feet and if you had an antenna that big, you could have a thousand simultaneous spot beams. Now if you had a thousand simultaneous spot beams and with

that kind of antenna gain, you only need a quarter watt drive in each one of them instead of 25 watts. Well, you could have power up for 10 watts or to 5 watts on each one of those and so you'd pick up 15 or 18 dB of link margin for when it's raining and it's only about 10 percent of the country has got rain going on at any one time so the satellite's average power would remain pretty constant and you could go to 62 QAM or 256 QAM and so you could have 100 channels for local broadcasting and every spot beam. You could have 100 channels of educational and you could have 800 channels of video that's just what we're watching today and you could probably upgrade it all to HDTV as we went from 256 QAM to 1024 QAM.

So I think there's a lot that we could do in terms of not sponsoring, suggesting or catalyzing ideas like this to take back some of the spectrum that's maybe being not wasted, but not optimally used in terms of what the physics would like you to do with it.

Before you laugh me off the stage, I

ran this by Tony Tether, the other night and I said Tony, what do you think of this and he said we've already done far more than that. I said oh, that's interesting. How do we get you to DARPA to get involved with this? We'll make it a software developed, defined radio and that would be all behind you. So now I'm going to modify my satellite to make it also software defined and then we get DARPA involved in it as well.

(Laughter.)

A couple of thoughts.

MR. REPASI: Well, maybe I can open it up. Does anybody have any closing thoughts?

DR. PICKHOLTZ: Well, I have another alternative to the VHF/UFH buy out. Buy them out and give them a fair charge to make it compatible with cable system. I have a Yagi on my roof I haven't used in 10 years, so cable is pretty good. Not as good as it should be, but it's pretty good.

I just want to say one closing comment. This comes from my favorite editorial, way before the FCC was formed. It's a lesson from the past.

It's form the Boston Post, 1865, probably some of you know it. "Well-informed people know it is impossible to transmit the voice over wires and that were it possible to do so, the thing would be of no practical value."

(Laughter.)

MR. WOERNER: I'd like to thank our panelists and hopefully the predictions made today are a little more accurate than that one.

(Laughter.)

I think it's going to be an interesting discussion after lunch, I think on the regulatory implications to some of this.

MR. REPASI: I'd like to make a couple closing remarks too. I think that the Boston Post article was on point because it mentioned wire line. It didn't say anything about wire less.

(Laughter.)

Wire less possibility --

MR. WOERNER: There's another saying from Marconi, but I won't go there.

(Laughter.)

MR. REPASI: I too want to thank the panelists for coming from all over the country basically to participate in this very nice effort to have you guys here. I also wanted to point out that we've got about an hour, or a little bit less than an hour before the next panel will start, if everybody could be here at 1:30 to reconvene for Panel 3. Dr. Tom Stanley will be co-moderating that with Chuck Jackson, so a lot of exciting things to continue on with in the afternoon session.

Thank you.

(Applause.)

(Whereupon, at 12:30 p.m., the workshop was recessed, to reconvene at 1:35 p.m.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

1:35 P.M.

MR. STANLEY: Welcome to Panel III of this look at interference protection. Earlier panels picked up the subject of interference challenges and also what advanced technologies can do. Here, we're trying to focus at something a little bit differently. It's a look at the regulatory process, what we do with interference. The FCC really doesn't design radio systems. We really design regulatory systems that people design radio systems within.

So what we'd like to do here is kind of look at our own regulatory process and how we manage the interference function.

The FCC actually touches -- using interference, touches a wide array of activities. For example, not just allocations and sharing, where which services can fit with which and what services can actually share the same bands where interference protection is fairly obvious. But in our definitions of service rules, how flexible we

can be, but also licensing and coordination, the actual site by site coordination of facilities to include even international ones and even an enforcement. And let's say the lives of people we touch, it's not just existing services that are trying to grow and existing services offering new features, but also new ideas coming to the marketplace, people trying to seek establishment in the telecommunications world.

All these basically come back to interference protection to some degree and the FCC's ability to define it and enforce it.

Let me introduce our panel of that broad array of people whose lives we touch. I think we have most of those dimensions with us today. But first let me introduce my co-moderator, Chuck Jackson. Chuck is a well-known telecommunications expert in the Washington area. It's probably not widely known, but actually Chuck's Ph.D thesis, as I recall, actually touches on spectrum management going way back --

DR. JACKSON: Don't tell them how far

back.

(Laughter.)

MR. STANLEY: All right. Let me introduce the panelists and I'll do it alphabetically, I guess, starting on my right. Phil Barsky is regulatory spectrum management and systems engineering consultant for XM Radio. XM Radio, as we've heard earlier, is one of two licensees that offer digital radio service in the United States.

Steve Baruch is a member of the law firm Leventhal, Senter & Lerman. Steve is also a very familiar face here at the FCC. Steve represents a variety of satellite entities. We see Steve a lot also in particular in some of the ITU preparation work. I mean, I think of V band and I think of Steve Baruch. He just kind of goes together.

Also Mark Crosby. Mark is the president of Access Spectrum. Access Spectrum is a very important and new development, relatively speaking, in the Commission's process of looking at

different ways of getting people access to the spectrum. In addition to that, and we'll get back to the guard band manager idea a little bit later, Mark actually was president of ITA before the name changed to then CERCA. So actually he has a long and deep history of involvement with the frequency of coordination process.

Dave Hageman. Dave comes to us, he's vice president of operations, wireless operations at a company called Poka Lambro Telecom. And that's actually a wireless cooperative in the middle of the country. And I'm going to ask him to tell us a little at the right time what that stands for. Dave brings some of what I call the rural perspectives of wireless operators to the table.

Nancy Jesuale brings the metropolitan orientation to the table here. Nancy is director of communication services for the City of Portland.

Richard Smith, spectrum radio management consultant. He's a consultant who, I guess, spends a great deal of time traveling recently. Most of us know Dick. He was the chief,

our top cop for enforcement in what used to be called the Field Operations Bureau and later ran the Office of Engineering and Technology.

And John Storch is executive director for engineering and technical operations for Western Wireless, a wireless carrier bringing us some wireless carrier perspectives coming from Washington State.

A variety of things that had come up earlier in our discussion, I'm not even sure we can even get to all of them, but we're going to try to sort of touch on several of these topics.

Let's start with the first notion as to what the FCC really does. We can argue over the definition of interference and whether or not we should get a new one or not. But let's lay that question aside just for the moment and look at it maybe from a slightly different perspective. Maybe it isn't the definition of interference, but it's really the FCC's decision process when we decide on an allegation or service rules or whatever particular action we take. Interference is usually

implicitly there. Sometimes it's so implicit that you can read the text and you won't find the word interference. You might find and therefore we think sharing is possible. And it will be in one sentence, and if you read fast you can go right past it. But it's there. And there they'll be height and power or field strength or some other technical specifications. Sometimes there won't even be a discussion of certain kinds of potential for interference, adjacent channel out-of band.

So at times it's said that we are ad hoc in our decisions. Too ad hoc. We address the issues before us. The lawyers tell us don't say anything more than you have to. And as such over the years, we have sort of let's say a fabric of decisions, rather than sort of maybe a body of that says interference is a very well defined thing.

So I wonder if the panelists would shed some light on what they think when the Commission basically makes allocation decisions, sharing decisions, and you've certainly been a part of this, or in the coordination area.

Are there things that we're not clear about or perhaps we could do a better job, and if so, how? And I'll take volunteers for this but maybe I'll start with Phil.

Phil, in our decisions, are there holes of commission, omission, sins rather?

MR. BARSKY: I've been involved with the FCC since 1959 as an amateur. And surely, I haven't agreed with all the decisions and have not been involved as deeply in the process as I have been with XM.

I think there's nothing wrong with the process. Perhaps because of the complexity of systems and what's going on, some of the methodologies might have to be augmented. For example, we were just talking about in-band sharing. Well, to XM we had to do some special things between us and Sirius. So we're right adjacent to one another. In addition, we had to do some things within our band. Our satellite receive band for our repeater is 2 megahertz away from the transmit frequency of the repeater. We had to come

up with some very, very fancy transmit filters.

So we had to do some things in-band, but most of the things that affect us have to do with

out-of-band emissions from other services. And it didn't become a real issue, or it doesn't become a real issue until you look at the relative deployments and architectures between two systems, or intended architectures between the two systems. For example, one of the architectures I look at is what's going on inside the automobile. Another architect is what's going on inside of a house or a building. What are architectural differences between certain wireless neighbors and doors? To look at the question of whether you're going to interfere or not, you have to understand what your neighbor system is, or what its deployment is, vice your deployment to understand just how much energy each one is going to put at each other's receiving antenna.

And if you boil it down to my very, very simple -- I'm from Brooklyn originally, the

very simple definition of interference is how much of my energy am I putting at that receiving antenna versus the signal that, very early in my case, I was on channel 1 or the old six meters and my neighbors were trying to receive channel 2. So as long as their reception of channel 2 was stronger than my signal on channel 1, or six meters, I was okay. In a lot of cases that wasn't the case and I had to help the neighbors out in filtering in their TV sets.

I believe with the ubiquitousness of 802.11, hot spots that have been coming in vogue -- bluetooth, piconets, and personal area networkz, and ad infinitum and it's just an explosion out there, I think that adjacent services that are close enough to interfere with each other must look at the deployments of each and the architectures of each to evaluate the interference potential. And I think that's probably what's different these days.

MR. STANLEY: Steve, from a legal perspective, somehow we could be saying a lot more about other aspects of interference, but frequently

the record isn't there. It's astonishing sometimes that only after a major decision is made to share is attention put out to power. And we get recons for love the decision, but hated the power. And so again, recon a few more dB, please.

Should we be doing more proactively?

MR. BARUCH: Well, Tom, when I stopped and thought about what it is that could be done or whether how this process works, I guess the first think I asked is is the process broken? And I had a hard time coming up with the answer to that, but the answer to me is not really. I think it works and I think it works right. And here's why. You start out with allocation level decisions as you're looking at gross compatibility of one service with another in a particular frequency band of range of bands. You have to take into account things like the existing services, evolution of the existing services, adjacent services and other sorts of compatibility. But you can do that on a gross level without getting into too much in the way of how actual systems that would operate in that band

would be able to in fact coexist with one another.

So I think on that first level you can look at it in a very broad sense of class compatibility if you will. When you have to get down to protecting existing systems, and that should be the obligation of the Commission of making a determination as to whether to allocate spectrum to something else is what is the impact going to be on existing licensees in that frequency band regardless of how they were licensed. You start to become more focused in the challenge. And at that point, you do have to get into questions of specific compatibility and more detail.

I think you used the descriptive term that there's a criticism that the Commission's processes or allocation in the assignment processes are too ad hoc. And I don't think that that's the case. I think they are necessarily ad hoc because each sharing scenario that's being considered is different from the one before it and it's very difficult, if not impossible, to generalize the

results of one particular inquiry to others.

MR. STANLEY: Ad hoc is not necessarily a negative term. Correct?

MR. BARUCH: Not in my view. I think the more detail you get into, the more complicated the sharing, once you've made the general compatibility determination, the more ad hoc it's going to be. I think there's a couple of examples that I could point to. One of fairly recent origin, which is the Commission's decision to authorize the use of non-geostationary satellites in the Ku band. That was a very difficult situation because there's millions of users of geostationary Ku band satellite services, FSS and DBS services. And those had to be very carefully considered, but that was one. The allocation was made. The assignments were made. And here, what you're left with is something that's not really translatable to other sharing examples that the Commission is going to consider.

But it was the right approach to take

in that particular case. There are numerous others where that level of detail is there, and I'll end this introductory answer by just saying that as time goes on, there's very little virgin spectrums. So every time you're going to get into a case of considering an overlay of another service, you're going to have to get into these types of difficult issues, difficult compatibility determinations.

MR. STANLEY: Mark, is it the definition or the process, if we had to focus to make something better where would we start?

MR. CROSBY: Well, I agree with a lot of what Steve said. I guess ad hoc is a good term. But every allocation is different. And every technology that may go in there is a little different. So there isn't necessarily one set of rules that I think you can apply ubiquitously across all your allocation decisions. And I think you have to somewhat careful if the Commission were to skew it's process to try to identify and adopt technical rules to the ninth degree to try to identify and come up with the procedures or

mechanisms to protect interference. You could probably do that.

The downside is that the decision process would take so long that the public doesn't want the spectrum. I mean, there's a limit how far you can probably study this. I think you do the best job you can and I think it's dependent upon the allocation and the only thing I might add, as well, is I think assuming the assignment is done by auctions, the people that are participating in the auctions, you know, they have an obligation too to know what's there and who the incumbents may be and who the adjacent channels -- you can do so much, but they have to do -- the onus on them to look for, to protect it, to look at what the technology they're deploying, to protect

-- some of this responsibility rests with them as well, I think.

MR. STANLEY: Just proceeding I guess along the lines, another aspect of our decision making is it is fairly prolonged and in detailed although again the ad hoc-ness is what contributes

to this.

David, from a perspective of a carrier and a operator, to what degree do you see the Commission taking so long to get new ideas to the marketplace and also getting changes made? Is that a problem and should we look at it?

MR. HAGEMAN: I'm going to say something and it may surprise a lot of people, but in the rural areas, interference is not much of an issue. Capacity is not much of an issue.

We have a completely different perspective of how we look at things than everyone else does. Yes, in some cases we do have interference and there are using the technologies that we deployed and the reasons we put those there. The FCC rules address those adequately. But you know, we've been talking here about lots of different technologies. Lots of different ways of doing things. We have CDMA, GSM, TDMAs, different kinds of modulation rates. QPSK, QAMs. QAM rates are going higher and higher.

We're talking about many different

technologies, many different things here. The one size fits all rule can't apply equally to all of those.

I agree with what Mark says about we have a lot of different things happening here, and each one of those needs to be looked at differently because the interference that you apply to one technology or one type of thing can't work for all.

I would think that the Commission should take that into consideration in that, you know, if you pass a standard that says this is going to -- this technology or modulation scheme or particular receiver is going to be reused to provide this particular service, that that gets addressed particularly to what's taking place there.

You know, for us, the change in technology is kind of a problem. I've heard some people talk about well, the legacy systems and incumbency systems and the safety people and from a small provider here, we can't afford to change

systems every three years.

We're caught, right now, look at your computers. You have a computer that's great today but tomorrow it's worthless. And we're starting to see communication systems do that. And we can't afford that. It appears that the large carriers are dictating many of the things either by market or by how they interact with us. If we keep changing technologies to make spectrum more efficient, then you're going to basically regulate or force a lot of the smaller people out of business is what you're going to do. Because a lot of the safety people out there probably have systems that they've been using for many, many, many years. And they may be analog. We're still running analog in cellular. The vast majority of our subscribers are analog.

We're faced with if you change technology or force us into another technology, we're going to have to change all that out. The Commission defines some carriers as small carriers are 500,000. How about 6,000? It's really hard to

make a business case for that.

MR. STANLEY: Well, the Advanced Technology Panel made it clear that with antenna science running ahead and with space time coding and so on, it's going to be really, really great out there.

I guess you're raising the issue as to how that might be paid for and how implemented in a reasonable fashion in places where it's not a pushing, driving force.

MR. HAGEMAN: It's actually those types of things today are just not required in a rural environment.

MR. STANLEY: Nancy, switching from rural environment, interference in cities is an issue, and the Commission's definitions of interference and its processes over the years have tried to manage this.

What's your reaction to what you're hearing here?

MS. JESUALE: Well, I think that we've all learned something in the past two years about

the actual sort of tactical on-the-ground results when interference forces an incumbent off the air and when the incumbent happens to be the people that respond to your 911 calls, you know it makes a big splash and it's a big deal.

I think that we have to understand, the Commission needs to take a point of view that the real tactical problems of local government, if they are to be the providers of public safety first response services are important. And they're not theoretical. Their experiences are maybe even more important than the theoretical solutions. So I know as we experienced Nextel basically turning our public safety radios into bricks, I had to go talk to the police chief and the OSHA investigators and the mayor and council and explain what we're going to do about it.

And I'm sure if we had written you all a letter, you all would have wondered what we were going to do about it too. And I'm still wondering what we're going to do about it. And that's the problem.

MR. STANLEY: We have a task force.

(Laughter.)

MS. JESUALE: So this has been a very real learning experience. And I think what we could do with it is apply it into the future and understand that when we commingle players, and we cause a potential for interference, however remote it may seem, we need to be thoroughly convinced of what the response will be in the worst case scenario. Because the worst case scenario might happen and is happening now, it's happening in almost every city. Every local government is either implementing 800 megahertz trunked radio systems or has implemented them. Portland is sort of odd because we were the very first trunked radio system in the country. So we're a mature system.

And it was easier to recognize the effects of interference because we had coverage and it went away as opposed to we convinced people to pay $20 per year per assessed 100th thousand value of their house and given it to me and I put up the radio system and it doesn't work at all.

So I think we have to really seriously, you know, it could have been field tested. There could have been more than just sort of a theoretical mathematical experience prior to me standing there at the OSHA investigator's office.

MR. STANLEY: Right. Thank you. Dick, you've been part of the process that helped write these rules. You sort of, I won't say it guilty as much as the rest of us, but what's your reaction to what you're hearing?

MR. SMITH: I think it's a fine system.

(Laughter.)

MR. STANLEY: Not only is it not broke, it's in good shape. How's that?

MR. SMITH: Especially when you and I were chief of OET. It's actually great to be back. I haven't been here in about four years and I feel a little bit like the ghost from Christmas past. I promised my wife I wouldn't tell more than two stories of my experience working out in the field, but I have to relate a couple here because thinking

back over the last 40 years, I do come to the table with the realization that interference protection and the whole area of interference in the spectrum management scheme is an extremely important function for government. I don't see anyone else capable, motivated, willing and able to preform that function.

If there was ever any justification for a federal communications commission, it probably lies in the area of preventing, resolving radio interference. In my mind, there's probably nothing more basic to the good effective spectrum management scheme than an effected interference prevention and resolution process.

I started out at the Commission, this is my first story. I started out at the Commission as a young engineer just out of college. I wasn't always the Bureau Chief. I started in the field, and one day in Los Angeles, I received a phone call from the FAA. They said we have interference to our instrument landing system at LAX and we've had to shut it down. This causes some concern in the

aviation community. So I, with my partner, jump in the car and we roar out with our direction finder, which was at that time not much more than a coat hanger for an antenna.

And without boring you with all the details, we very quickly locate the source of this interfering signal and it was coming from a car parked in a parking lot near an office building. And so I stationed my partner there to watch the car and I went into the building and announced who I was and what I was about. And apparently, the subject of this investigation overheard me and my cord and my partner he came dashing out the back door and ran to the car and jerked open the trunk and ripped out a device in which point my partner approached him and asked him what it was he was doing.

And the end of the story was that he had for some reason wanted to know the whereabouts of his wife and it was his wife's car. So he had bugged his wife's car with this homemade device and had made a poor selection of frequencies.

(Laughter.)

And so we turned him over to other authorities for prosecution. Interference, whether it be by a deliberate act such as this was, or whether it be by some inadvertent or poor design or malfunction of equipment, nevertheless, obviously has great potential devastating consequences in some cases.

And I have to tell my other story now.

Again, as a young engineer, I one day got a call from the Navy and they said we cannot, our pilots who are flying airplanes around the coast of California, cannot use the radios in the planes to monitor their emergency frequency. I think it was 243 megahertz. And they had to turn those receivers off because of this tremendous interference. And so I went out and after a period of time, including using helicopters and cars to DF the source of the signal, found it to be garage door receivers. Not the little hand held units, but the receivers were sitting there cooking away

waiting for a signal, but emitting signals of their own interfering with the Navy.

It was very laborious. The point of the story is it was very laborious to DF each of these individual components. Knock on a door, explain to Harry Homeowner. By the way, one of the doors I knocked on was the door of the actress Ann-Margaret.

(Laughter.)

I remember the story very fondly. It turned out it was not her garage. There were two garages immediately adjacent and after an on-off test we determined it wasn't her garage door. So we let her off the hook after a long interrogation.

(Laughter.)

I then went to the neighbor and had them unplug their receiver. Now it becomes very clear after doing several of these it's like sweeping the waves back to the seashore with a broom. This is a never-ending and never completed task. There has to be a better way. And as a result of that case, we embarked on really the

first of the so-called part 15 regulations that were designed to put the limits on the equipment at the manufacturing and import level. And I think that's a very basic approach that has served this country well over many years now.

If you think about the millions and millions of devices out there, both communication and otherwise that use radio frequencies, the results have been pretty phenomenal that we have not had more serious interference problems than we've had. And I attribute that success primarily to the equipment approval program that the Commission has operated, continues to operate very effectively over the years.

As to any final points as to where do we go from here, I tend to agree that the system is not broken in the sense that we sort of have to throw everything aside and start afresh. But I do think there's a lot of nibbling around the edges that can still be done and needs to be done over a period of time. There probably is no complete comprehensive solution, close the case, this job is

done we can go on to something else.

It is probably a continuous process that we need to maintain for the long term, ever mindful of what I think is very important, never letting the interference genie out of the bottle. If the interference genie, as I say, gets out of the bottle, it's very difficult to go back and recoup. That probably means that if we have to err, we have to err a little bit on the conservative side. And there will be those who maybe take an objection to that. But I can tell you interference resolution is a very real problem and it's very difficult, it's very time consuming, it's very expensive and if not done well it could lead to dire consequences. And I just say keep at it, keep doing a good job, improve in the margins as well as we can, and I think in the long term it will serve you well.

MR. STANLEY: Okay, thank you. John Storch, perspectives from a wireless carrier.

MR. STORCH: Thank you, Dr. Stanley, for the opportunity to participate to the

Commission and for facilitating this dialogue. A couple of points, if you allow me the slight deviation and forum from telecommunications to land use, but I appreciate your earlier comment in regards to the FCC not being the developers, not being the designers of the system, but if you will the planning land use owners in this process. And very similar to let of land use, I think there's an element in this that's important upon the incumbents of the band to recognize the land use map ahead and the realization that the piece of land next to them will have the stadium, will have the mall, will have the interstate, and to properly design their property, develop their property to accommodate that in the future.

To kind of use an example from the city of Portland, was the coverage that they had there prior to Nextel an opportunity of view before Nextel developed their property that if you will blocked their view. Or was it actually impeding upon their land use? And so a similar analogy I think the development of the processes to deal with

how to manage that.

And going to a second point, I think it's important that interference is acknowledged. It's a genie in the bottle. The genie doesn't go away. It needs to managed in that bottle, it needs to be maintained in that bottle, and I think that's an important point to recognize as we develop these processes that it just -- the reality is that the next piece of property, not all developers are right with the same time. The next piece of property will get developed. And how are we going to manage the traffic flow?

How am I going to be able to deal with the fact that I used to be able to make a left hand turn out of my property and now because they had to put in traffic mitigation devices I can now only make a right hand turn out of my property or things of that nature are accommodated.

The last point, I think, or perspective, is the geographic management of this if you will from a regulatory FCC perspective. Fundamentally, there are technological differences

between the systems and networks that make them incompatible. But I think inherent in the geographic management of spectrum there's also some inherent -- Washington State, to relate to it directly, we have everything from the CGSAs to the BTAs to the line A that mysteriously cuts through the middle of King County for no other reason than it just happened to be so many kilometers from the Canadian border.

And I think, if you will, as further regulation is brought forward, other than just simply adopting maps from the Department of Commerce, if you will, but actually there's enough I think if you will electronic technology out there, there's enough technology is geo-databasing that that sophistication needs to be brought into the spectrum management elements as well.

MR. STANLEY: Okay. I hear a lot of I'll say happy customers. There's a spectrum of customers whose happiness is variable. Let me sort of open it to the group here and see if there are other perspectives people would like to mention.

One gentleman in the back, wait until the microphone gets to you and if you could identify yourself please? Not yet.

MR. STEVENSON: This is very interesting. I was especially struck by the stories of what's happened in Portland and then the stories Richard Smith just told about tracking down interference. I think these are beautiful examples of where it is important that we have ways of making sure that important and critical services, aviation or public safety, will not have problems with interference. I don't think it's a problem of regulatory process, there being something wrong with it.

I think both of these cases, both aviation communication and navigation systems and public safety systems are exactly the sorts of systems for which the responsibility for robustness cannot, the need for robustness cannot lean upon regulation. Regulation assumes a willingness to cooperate and follow the law. If we have anybody whose interests are not aligned with that, perhaps

anybody who might wish that either of these systems stopped working they can try to jam.

And the fact that these systems are so vulnerable that sort of inadvertent little technical mistakes cause them to fall over I think points to their fragility, and these are exactly the sorts of systems which should be designed for maximum robustment.

And there are ways of designing anti-jam systems which the military has understood since World War II actually, when they started using wideband FM.

Aviation is very interesting. It's almost the only thing in VHF that's using linear modulation, where the signal to noise ratio shows right in your ears whatever it was in the channel and there's absolutely no processing gain. Even though it's 800 megahertz, the 800 megahertz system is still narrow band FM, a legacy sort of modulation technique and that's exactly the sort of place where a wider band system that offered some processing gain could have provided some robustness

from this sort of problem.

MR. STANLEY: Right. Just to comment on, I guess you made several points and I don't know whether people want to respond, but just one comment really. Very dramatic story as to what happened at 800. I hope at some point someone does the history, because much of the problems now to some degree are reinterpretation of what had been done say decades ago, different time, different constraints, different motivation.

So it would be interesting to see if that data is available, what were the kinds of factors that made people make those decisions and then how did technology grow, the community grow, what happened to create some of these other later problems. Are there any other comments?

MR. CROSBY: I can't resist. I simply can't resist. You'd need a whole another day session on 800 megahertz and how we ended up where we are. And it goes all the way back to Docket 18262. No, that was 470 to 512 I think. 18262 is the 800, 900, but I'll check in there. And I don't

want to speak for Nancy, but you know this designing the robustments and the system initially -- that spectrum was zoned for a specific application and I'm going to use an example like the Mall here in Washington, D.C. And somebody mentions, well you can put too bad, didn't design it right, you could put a stadium. I'd like to see somebody try to put a stadium on the mall.

The Commission has the responsibility, and public safety and critical infrastructure and other types of things, you know, it's a little different. And how you measure value, what is it a commodity or is it a public safety or public interest type of thing. I mean, even if you're going to rezone it, and the 800 thing developed over two decades. You ought to at least have the incumbents have an opportunity at a rezoning hearing or something to see the potential impact. Is it a stadium? What is it?

And so I don't think you can be quite so cavalier with certain types of incumbents about hey, you should have figured two decades ago to

design a robust system to accommodate something you didn't even know was coming in 20 years. I don't think it's fair to those types of applicants to put a guess what, we're putting in a prison, or we're going to put in a stadium. You know, too bad. You should have built a hedge. I don't think that's right.

The Commission still has the responsibility to figure out what's going on.

MR. STANLEY: Nancy.

MR. CROSBY: That's all I have to say.

(Laughter.)

MR. STANLEY: Comment, please.

MS. JESUALE: Well, thank you for your comments. I think that we in the public safety community really feel very strongly that if anybody is going to enter our space, we want to let them in. We want to know they're there. We want to approve that they're there, and maybe we can figure out a way to share. But the problem is it happened the other way where we were overrun and now there's quite a bit of pressure by the new internet to just

move us to a different reservation or you know take our native children and send them to a school and teach them all English or something.

But you know, if you go back to this land use analogy, it's very much like an adult store and a liquor store showing up to the elementary school.

Well, they may have every right to be there but if your kid is in that school, you don't like it. So I have to agree.

I think public safety is different and I hope the Commission will maintain that point of view that protecting citizens and their property is different than commerce.

MR. STANLEY: All right, thank you. Doug Lockie has a question up here.

MR. LOCKIE: I'm sorry, was there another back there? Thank you. Now that was an example of too little transmitter power.

(Laughter.)

The warm up session that we had for this. I'm a millimeter wave guy and for the first

time in my life I went off and found out about this public safety problem. I went off and looked into it a little bit and had my first discussion with peace officers except when I was at the end of the tablet getting a ticket. And looking into that, first of all, let me say that providing more bandwidth real time to law enforcement communities is a very, very high priority.

In California, we're having very few drunk driving cases going to court anymore because they're videotaping a lot of them and the drunk, his lawyer, can't get him off anymore when they look at the video. It's very valuable. In times of stress having bandwidth for peace officers is a huge importance. The same thing for fire and everything.

So let me say that more bandwidth for that community is really important.

Next, after September 11th, anti-jam capabilities in there is a lot more important. We have never gotten invaded in this country before and we're likely to get invaded a lot more in a lot

of different ways including electromagnetically. So putting the infrastructure in the fine jammers and taking them down fast I think is going to be more important.

Now having said that, now I want to say something I hope doesn't get interpreted as anti-peace officer or anti-public safety, but we don't have separate streets for the fire engines. We use the same streets for the fire engines, and when they need the street, they turn on their siren and you get out of the road. And there's no reason we couldn't do that in the public safety community, as well, or at least do some of that. And therein lies a huge solution instantly to this public safety problem. So I think that we ought to establish a Commission within the FCC and others to look into that solution as an interim if not a permanent fix.

MR. STANLEY: Okay, thank you. There was a question in the back we jumped over, please.

MR. STEVENSON: Actually -- Carl Stevenson and Gear Systems and IEEE 802. Actually

I was going to say something very similar to what Doug said in terms of the need for making public safety systems more robust so that they will stand up against attack and will continue to provide the services that they're intended to provide to the public is one thing. Obviously, there will need to be some transition period from legacy technology into newer technologies.

I was also going to suggest that at the same time you're providing more bandwidth for those peak needs when something bad happens and public safety needs a large amount of capacity, being able to collaboratively share that spectrum during the quiet periods would provide a lot of benefit to the public as well. So it's very similar to what Doug was going to say.

MR. STANLEY: Okay, thank you very much.

DR. JACKSON: Okay. It's my turn. And what I'd like to do is follow up on the point that John and Mark made a little bit, and I'd like to sort of pose the question and go down the panel and

see what the response is.

The question really is could the process of enforcement, and the process of using radios be facilitated if we have a more quantitative or uniformly applied definition of interference, that is, if we had some criteria, perhaps announced in advance, saying this is the interference environment, this is the worst case interference environment that your system is going to have to live with, and as long as it's better than that, don't come and complain to us. You can think of it as advance warning or telling people what the development guidelines are in their neighborhood.

And I guess the question is how would something like this relate to a definition of harmful interference. I mean, we saw one session ago the FCC and the ITU's definition of harmful interference, which is in some sense an economic measure when it's interference that you know messes the system up or degrades a very important system.

Should we maybe have a different definition where we'd just say as long as you have less than, you know, x watts per hertz, you aren't interfered with. So we'll start down there with Phil.

MR. BARSKY: In XM's case, when we designed the system we had to do that since there was no definition of harmful interference. We defined what harmful interference was by loss of service. Our system was designed with 99.9 percent availability. So we start at saying I can't accept interference over that, that will block out reception to that particular sort of service level.

In addition, what we did since there wasn't any spectral survey of what's going on out there in bands adjacent to DARS, we actually went out -- we submitted a report to the FCC on our findings and we went out and sniffed. And we said what is our environment? What is there?

In addition, we looked at what was coming and looked at what neighbors were going to be. Since we're licensees and we have our own

frequency and don't have to share, it wasn't the same as your problem. But surely, because we're a very small signal system, surely somebody with significant out of band, and to us significant just means very, very little bit. Significant out of band energy that ends up in the band would kibosh our system link. That was considered.

So we came up with our harmful interference definition based upon the quality of service, based upon bid error rate. But it was specific for our service. We had to understand our service well enough to know what interference we could stand. In fact, we have imparted the wish and want of the DARS community to the FCC to limit out of band interference in our band to a particular level. I hope that answers your question.

MR. BARUCH: When it comes to harmful Inspector and the definition, the international definition which is also the domestic definition, I look at and it strikes me that if you read that definition closely, you could have the same level

of interference from one source being harmful in one case but not harmful in another. Because it does split between safety, radio navigation and safety services on the one hand and radio communication services on the other.

What I take away from that is that any inquiry into harmful interference necessarily focuses on the victim to some degree, more so than perhaps the interferer because that same level of interference can either be harmful or not harmful depending on what is the victim. So when you ask whether the process of enforcement would be helped by more uniformed definition of interference, I don't think it would. I think that harmful interference described that way, which is almost you know it when you see it, is a good ideal. It's out there, but it doesn't answer the question of whether a particular service can accept the level of interference that's being theoretically caused by a proposed new service of actually being caused by a station or another service that's in existence.

So I think when you look at it, when you try to quantify what interference is, you're not quantifying harmful interference, but instead you're identifying the acceptable level of interference, the tolerable level of interference.

When you do it on an allocation level, it's service to service, I think you speak more generally than when you do it in coordinations, when you have existing licensees on a licensee to licensee, either intra-service or inter-service it becomes much more specific. You can identify objective limits of what would be tolerable and not tolerable, but again you're defining acceptable or unacceptable interference, as the case may be, but not harmful.

And I think if the focus is on that in particular sharing scenarios, and that is again a lot of what we've been doing over time in various proceedings. I think that's the right direction. It's not a difficult thing to do. It requires a lot of good faith on both parts to really come

toward the middle and lay your cards on the table, so to speak, as to what is acceptable generally and specifically. But that is the objective I would think.

DR. JACKSON: Mark, do you have an opinion on this?

MR. CROSBY: I don't have any strong feelings on all this. This is difficult. A single definition I don't think is workable. In trying to apply a single definition across the board I don't think works either. I think it depends on is it an unlicensed band or is it a licensed band? And then I think it bifurcates into two other pieces, and that really it's not expectations. The incumbents have a level of expectation when they went in of what the environment would be. And their definition of harmful or hey, I can live with it is something.

But I think you have to accommodate the expectations of interference for the incumbents, and clearly, I think it's wise, I think prudent for the Commission to define for the new people this is

the environment, these expectations, this is the type of interference you may or may not receive and don't cause the following types of interference to these incumbents, and if you do.

I mean, Commission has done a great job on this on the one point of PCS point to point. I mean, I mentioned this earlier in an earlier session, if you want a perfect example of how to take care of business, I mean FCC has done a really good job. You lay the ground rules out. You said, these guys are coming. These are the ceilings that you'll pay and these are the ground rules and once you got real specific all of the rigamorale and all the verbiage sort of went away and everybody went about their business. And it really worked.

So I think it's really dependent on specifications. And the last point is as a band manager, when we're working with customers or putting in systems whether it be voice or data, we participate in and we highly recommend our customers. We go to the site, and you've got to do a lot of work. I mean, you just can't go here, put

this up. All the sites are co-located now, so the problem is getting a little worse. So it behooves the customers -- you've got to go out there and do some work and literally figure out what the environment is, what's coming into this site, what's going out, what are the inter-modulation products. This is getting more complicated and no one should go into this blind. You've got to do some work.

DR. JACKSON: Okay.

MR. HAGEMAN: I was having a discussion earlier about I was involved in PCS early on when it first started. And I was reading through some of the rules and regulations and I was going back to my cellular days and I said well, if FCC comes up with a formula on how you make a 32 dBu calculation. So I went through the rule parts of PCS and I was trying to find that. I never found it. All it said was it made mention of a 47 dBu. So I called a gentleman at the FCC and I asked him about that and he says well, there's a lot of formulas out there that calculate 47 dBus. Okay.

There's my answer.

I think that if you're going to do something that way, you need to have clear, defined measurements. You need to come up with some way that the common person out there, the small carrier, can take a spectrum analyzer or some common piece of equipment with some standard things that they have and say I'll stick this antenna up and I'll make this measurement and I turn this knob and set that switch and bang here's my level. And it meets it or it doesn't. And it needs to be the same for every one.

DR. JACKSON: What's Portland's view on this?

MS. JESUALE: Well, Nextel wasn't transmitting out of band. It wasn't over power. It wasn't in any way illegal for it to do what it did. But it still caused harmful interference to public safety. And our definition of that is this radio doesn't work anymore. It used to work, but it don't work now.

DR. JACKSON: Let me give an analogy to

that, and I'm bringing this up as a technical analogy and I'm not trying to make any particular points about the specific case I'm bringing up. But a lot of people use hearing aids, and hearing aids have in them a capability, many of them called a T-coil which lets them pick up telephone transmissions. Many hearing aids, when operated or when a digital cellular phone, particularly one that uses time division multiple access, is operated near that hearing aid, the hearing aid will pick up a buzzing noise in the background that can be quite objectionable. Particularly older hearing aids. I don't think -- it's probably been remedied mostly now.

Is that a problem of the radio or is that a problem of the hearing aid? I mean are you going to get rid of digital cellular because there are 5 million hearing aids in America that are going to be disabled by it?

MS. JESUALE: You know, we had to take in Portland and many other cities, but I'll just talk about Portland because that's where I am. We

had to take steps to mitigate interference. And one of the steps was not call the FCC and say do something. Because that didn't work. The steps were we replaced every single antenna on every single tower. We modified the Motorola radio products. All 10,000 of them in the field had to be brought in and modified. We had to design the modification. We had to change our power output and we put a lot of political pressure on Nextel.

We called up the newspapers, we went to the state legislature and we embarrassed them into doing frequency coordination with us. And in the end, in Portland, we don't have Nextel interference anymore. But we had to take all these steps and I suppose that if I had a hearing aid like that I'd probably go to my doctor and hope my insurance would cover a new one.

(Laughter.)

And that's where I'm kind of at now, I want to go to my Federal Government and hope that my insurance will cover new receivers, new transmit technology. Because I really think that the City

of Portland could have a better radio system if, we add another $60 million.

DR. JACKSON: Well, I guess John's point is that when you bought that system, if you looked at the zoning rules, you would have said gee, these receivers aren't going to do the job under some scenarios. And you would have at least been able to point to the files saying well, yeah we knew there was a chance this would happen, but we took the risk or something like that. I'll just say it -- am I putting words in your mouth, John?

MR. STORCH: No. Just a slight deviation, I think the zoning did change over time and potentially changed on the City of Portland, but there's also the NIPSKA channels that came in there, post-Nextel, if you will, in the sense of operation. So I think certainly looking in that full environment -- should I jump ahead?

DR. JACKSON: Go ahead. I wanted Dick to go last on this anyway.

MR. STORCH: Okay, okay. Excellent. I think the issue of bandwidth brought up by the

gentlemen for law enforcement is an interesting one. And it's a perplexion. Nextel, from their own public disclosure and commentary, has brought to light how much of the government and public safety community that they provide service for.

Similarly, on the same system on the City of Portland, beyond the police and fire operators are the trash collectors, are the street sweepers, and if you will, the parks and recreation folks. And so this concept of the fire engine and the siren is kind of interesting, because does this, and I'll use AT&T Wireless and Seattle specifically, but does the CDPD data transmission traffic take priority given the location of that officer down, over his voice transmission which cannot be understood for some reason he is incapacitated from speaking. So you sit there with a quandary to say the cellular system has priority or does the 800 megahertz City of Seattle system have priority, because and that's going to the definition. It's more of who is the user versus the ownership. That system in there happens to be

owned a private organization, or if you will, a governmental organization, the City of Portland.

We provide a degree of telecommunications in the City of Midland to the police department, predominantly data and some voice. So there's ownership but there's also usage, and I think the definition there's huge debate around what is interference, harmful nature and all that. But I don't think the definition adequately addresses, if you will, the priority nature of the usage and how to manage that moment of dealing with your, and I'll call it interference management because again the position of interference is there to be managed, not to be mitigated. It's not potential it's there and it's that genie in the bottle. So let's wrap it up.

DR. JACKSON: Dick, I think you've had more experience trying to deal with real world interference problems than the rest of the panel put together. And I guess we want to stick with the same question, but really given your experience how could the Commission better define interference

so it would be easier for the users and easier for the FCC to deal with?

MR. SMITH: Well, I must admit I have mixed feelings about it because although Mark says he doubts the ability of us to continue or have a single overall definition of interference, I think if that's done in a general way, and I think our current definition is relatively general, that has certain advantages. It is somewhat then for the interpretation by the Commission to be enforced. Cooperation amongst the users is expected, and when the Commission says we determined that this is an interference situation and this party is to take corrective action, we expect that corrective action. The FCC expects that correction action to be taken.

This works pretty well when everyone is cooperative. But I'm thinking in the future that things are going to get more complicated. That spectrum is being suggested to be shared by more diverse than somewhat different systems. Incumbents may be opposed to that sharing and may

not be so cooperative. And we may find court cases cropping up much more frequently than they have in the past.

In the last 30 years of my career, I don't remember more than a half a dozen cases that we actually wound up in court over an issue of definition of interference. There were a few, and we won them all. But in the future, there could be a lot of really complicated protracted litigation type cases involving imprecise, perhaps imprecise definition of interference that would be very troublesome and very difficult to resolve.

I don't think I have a solution to this particular aspect, only to suggest that things likely will get worse and that the Commission should, as it had always in the past, tried to stay ahead of the game and be thinking about that and how to deal with that in the future because I think this has real potential.

DR. JACKSON: I guess we'll take a few questions from the floor now. We have somebody over there?

Could you identify yourself?

MR. WIGGINS: I'm Stan Wiggins, I'm an attorney in the Wireless Bureau. Engineers have a concern with interference which I will characterize for the purposes of this question as a quasi-property right, a right to be protected. In the legal context, property rights have both positive in a sense of affirmative and defensive connotations and in economics rights have even different definitions.

The concern I have as we look forward over the next 10 or 20 years and the rapidity of change that we've talked about today and in the sessions yesterday, in setting aside for a moment the sort of incommensurable differences between public safety and commercial and just look at a commercial set of spectrum blocks for the moment. Don't we need a definition of the rights that we're trying to enforce, protect, affirm, whatever then in a sense is as agile as the technologies? If we define interference rights or, if you will, legal property rights or

quasi-property rights on some basis in 2002, the technology is going to come along in 5 or 10 years and it's not adequate to say well, you should have looked at the master plan and realized that they might build a rendering plant down the street 5 or 10 years from now when you built the house, because the master plan couldn't foresee what's going to be down there 10 years from now. It's going to be technology that no one was thinking about.

This really is just a question, but it does seem to me, and I started thinking about this this morning when the gentleman to my right was talking about living out in Colorado where you have mineral rights below the surface and maybe I'm twisted because I had oil and gas law in law school -- don't ask me how that got me into communications, but it's not without relevance because it seems to me that we really are, we build this whole structure on our concepts of rights, or our attempt to codify concepts of rights. But when the technology is moving this rapidly, I think we really need to drop back a notch and take another

look at it. But that's really just a question for reactions. I certainly don't have an answer to it. I'm not a beautiful mind. I'm a pretty homely mind.

(Laughter.)

DR. JACKSON: Okay, any other questions here? In the back there?

MR. LONGMAN: Wayne Longman, private party. I guess I'd be a little concerned if the FCC came into the role of allocating noise. I think you'd find the same issues with frequency allocations with noise allocations. You'd find fixed mobile and low noise, fixed mobile and high noise and public safety people would get the low noise. So you'd be in effect establishing for certain technologies quality of service for particular users and particular parts of the band.

DR. JACKSON: Okay. I guess time for one more? I'm told one more. Okay. Nobody on this side wants to talk. Go ahead.

MR. FOX: Paul Fox, I'm an consultant in town. I want to go back to the 800 and your

question about detailing the Commission's assumptions on interference. Back when 800 was designed, everyone would have done their calculations for regional coverage. That's indeed, i.e., the single large transmitter in the center of the huge metropolitan service area. That was what everybody expected 800 to be. That was the natural way to serve that market, at least everybody thought at that point.

If the Commission had detailed their calculations, those are the calculations they would have detailed and Portland built their system around that assumption about it. The next part I get awfully hand wavy and I have a feeling Peter Pitsch will undoubtedly tell me where I'm wrong on this. But it seems to me that you could -- part of what happened was that Nextel started reacting to economic incentives and found from their part of a view a more valuable use of the spectrum, i.e., more intensive use of going down to sales. And the problem was was that was unanticipated. They moved in an unanticipated way that created this problem.

So I think what I'm wondering this is not an indicator of the kinds of problems we would have if we start going to market incentives to reuse the spectrum in substantially different ways without having had an adequate definition of property rights developed. As I say, I'm hand waving at this point and I'll shut up at this point.

DR. JACKSON: Okay. Tom? Thank you very much. I guess 800 has got quite a work out here. Let's shift back to a slightly different kind of a line of discussion. And you can correct me if I'm wrong here, Mark. You will whether I'm wrong or not. Paul brought up the history of 800. I just want to remind everybody that when the FCC made 800 available, much of the community said who wants 800? We can't use it. It's too high in the spectrum. It's a stupid waste of time. So just remember that.

MR. CROSBY: Actually, when it first came out, Doug's right, they didn't even do it by

users or class of -- they said, these channels? At the top end is trunk systems, and he's right. They tried to give them away twenty channels at a time. Nobody wanted to take them. And the bottom half of the band, the first 100 channels was conventional. It wasn't by public safety, industrial, business, Nextel -- Nextel wasn't even born or Fleet Call whatever it was. It was a technology application. It was actually at the time very innovative on the part of the Commission. But they started them wisely at different ends of the spectrum. And then they went like that after a period of time.

MR. STORCH: If I may just speak, and again going to the theme of process, a better process, I think it's interesting and 800 and the doors open so we're there. But the reality is, and I think similar to land use there's property rights, and don't ask me where I became a land use person because it comes from siting cell sites --

(Laughter.)

Similar to land use, you know there's

certain rights that do notify the incumbent property owners. And there is a process there. And that's what I mean by a better process. I think most of the rule making that's done by the FCC today, frequency allocation, gets very myopically focused on the individual band. And okay, we'll put up a little guard band. That's good. Instead of looking at the more total picture, and it is. Which is true. It started out conventional here and there, and oh by the way we'll allow some simplex use somewhere in the middle of it and really confuse the heck out of everybody.

But then it transitioned, and they said okay, well these six we'll give to public safety and these six we'll give to industrial and this, and there was no recognition of the other property owners if you will. And there was no process to that that took into account that interaction and what was building of that moment.

So I think it's a good case study to say what is a better process and then take it a

little more globally and deal with that. Because I think by the same token, you can go to when cellular received its expanded spectrum, which was the guard band. And it just said, and if I will if you will allow me, I mean I remember back some of the public commentary there which was very little. People saying yeah, whatever. Just let them slide over to paraphrase it and make light of it. But it was a non-response and the FCC said okay, cellular you can go out and you can have a little bit broader bandwidth and nobody cares. You know, we'll move on.

MR. STANLEY: Speaking of moving on, let me sort of bring up I guess a new topic here. The Commission over the years has used a variety of techniques to try to take on some of these thornier kinds of problems on interference, and that's letting the parties negotiate themselves in not negotiated rulemakings. Or more recently actually an even more innovative concept, a guard band manager.

Let me start with the notion of

negotiated rule making. I guess I didn't realize this until I started talking about this with Steve Baruch, but Steve has been involved in negotiated rule making process going way back to LEOs, big and little, some time ago.

Steve, can you say a little about what negotiated rule making is and how it is an approach that the Commission has followed to deal with interference among other matters, but interference in particular where the parties themselves bringing in their concerns to the table and the tables not at the Commission?

MR. BARUCH: Well, actually the table was at the Commission.

MR. STORCH: Figuratively speaking.

MR. BARUCH: What happened and actually it was ten years ago this month that the very first negotiated rulemaking commenced. It was a little LEO negotiated rulemaking. But Congress in the early 1990s adopted an amendment to the Administrative Procedure Act to create this vehicle for allowing the Commission and other agencies to

conduct rulemakings with all the participates -- pre-rulemakings in a sense -- with all the participants around a table, the various interested parties. The Commission would invite people who had an interest, either in the terms of an application, in terms of an affected spectrum user, other government agencies, in fact, who used adjacent bands were involved in these. Sit them down. Say, you know, give us an idea of what we should do with respect to this proposal to establish a new, in the case of the one 10 years ago, the new satellite service. That was the little LEO satellite service that they were working on which is a 136 and 400 megahertz MSS.

I will say that the first one, because nobody had any idea what it was, you had a couple of parties on the private sector side, applicants, who had spent the prior two years fighting each other tooth and nail with pleadings to the Commission, hyperbole content -- let me put it that way. Not much progress being made. And at the same time there was also the work going on in the

ITU to try and set the stage for allocations to accommodate these systems.

When the Commission indicated its intent to start this process, all of a sudden the applicants dropped their swords and said we have no idea what we're getting into. They sat down with each other, came up with a draft set of rules to put their diametrically opposed positions together and all of a sudden that managed to be accomplished. Came into the Commission and said look, we've done this. You don't need to have a negotiated rulemaking now because here's our agreement. Commission went ahead and it went forward with it. There were obviously other interests involved. One of the things was the Commission wanted to make sure there was room for additional systems to come into that band. Also there was the issue of the good neighbors. Interference from satellite operations both uplink and downlink into other bands that were used in some cases by aviation and other cases by the military.

MR. STANLEY: Was the success of that because largely it was like parties? We heard this really in other aspects of this discussion. It's easier that like parties find it able to come up with thresholds and negotiations and when you bring in somebody who really does live differently, certainly it has different quality of service, negotiations are far more rigorous.

MR. BARUCH: Yeah, I think the key to success there was that for better or for worse, at least inadvertently, the start of that process incentivized people to come together and recognize that there was an objective that had to be achieved. And I think, in fact, in the case of the little LEOs that did accelerate the completion of that rule making process and the allocation easily by a year and a half. That one was a success. The one that followed it was the big LEO negotiated rulemaking. And we were talking, I was chuckling a few moments ago when you talk about 800 megahertz, nobody wanted it. At that point in time, one of the issues to be dealt with there was feeder links

and KA band.

I remember the first meeting of the group that was going to discuss feeder links and KA band. It was basically the two applicants who had some spectrum in that band and NASA. And nobody else had any interest in it. Everybody said what's 20, 30 gigahertz? Give me a break. We're never going to get anywhere near there. The floodgates opened shortly there after, of course. There were three people in the room. We could have had that meeting in a phone booth. But that one did not end up with a uniform solution. It did not end up with a consensus solution.

But I still maintain that what that did was facilitate the decision making process of the Commission as well as soften up the participants for ultimate compromises that had to be made. Why it facilitated the Commission's decision making process is because the Commission was fully involved on a working level every step of the way in the negotiations. They were party to them and even if not making decisions, but observing and

participating and contributing ideas -- you know, what works what doesn't work, in effect making some concession.

So you stripped away the rhetoric and you allowed the parties to get down, again it comes back to an ad hoc negotiation, an ad hoc solution of an interference case. They had to go out. The solution, I mean what the Commission finally proposed ultimately showed up in the form of a notice of proposed rulemaking and went through that process. But it was a much more expedited process on that end than it otherwise would have been if the Commission ended up with a stack of 30 documents each saying, you know, this is our bottom line position, which of course was their starting position. No movement towards the middle. I think it was valuable.

And even it was, just one final note and I'm sorry to take quite so much time, but I will observe that in the satellite side of things in recent years, even though we haven't had negotiated rulemakings, we have had the sort of

"big stick" approach from the Commission and has forced applicants to get together and agree among themselves and present the Commission with the uniform plan of action, to compromise a proposal for assignments. And again, I think that really is sort of an off-shoot of an negotiated rulemaking process, but it does work. And the Commission participates, representatives of Commission observe or are invited to participate in that process and do. And I think it has allowed, at least facilitated licensing, allocations, and shortened the time scale for implementation of systems.

MR. STANLEY: Strictly speaking, at no point would a uniform definition have been useful. It was really the parties themselves with quality of service in mind splitting differences in deciding how to divide up bands and do some of the other rulemaking.

MR. BARUCH: I think each rulemaking, each negotiated rulemaking provided some principles that provided guidance to the following negotiated rulemaking in terms of how things were done. But

in terms of interference itself, completely associated only with the case that was being addressed, because what was acceptable there, the parties were different, the bands were different, the service objectives were different.

MR. STANLEY: Phil, any comments on the process generally?

MR. BARSKY: I'm not getting into specifics, but as you know we're working on something very similar to that and I'm going to say amen. It's specific between two adjacent services and the only way it's going to get done is us figuring out how to live with each other, looking at each other's architecture, understanding each other's point of view, which is very important; having a couple of honest brokers in the room. I don't want to call it a "big stick" from the Commission, but nudging and pushing and cajoling in the right manner has helped. Also, there's got to be a willingness on both parties to come up with a solution. That's very important.

You've got to get past the rhetoric.

You've got to get past the posturing and get into really talking about the issues and wanting to come up with a solution, and then getting down to each of the technical issues, and I'm sure that there were many there and we have ongoing many. I missed lunch today because of a couple. It's really what I like to call in engineering jargon attention to detail. And it's only when the details get worked out between the parties that you're going to have a solution.

MR. STANLEY: Okay, thank you. Let me just change the subject a little bit and bring up the idea of the guard band manager.

Mark, you have the authority of the Commission in several ways in term of making interference determinations and who gets what.

MR. CROSBY: I have to be careful. Peter is sitting in the front row over here.

MR. STANLEY: Would you maybe explain a little about the concept of guard band manager and how interference, in particular with public safety in mind, is really part of what's been addressed

here?

MR. CROSBY: Well, let me clarify. The guard band manager refers to activities that are 700 megahertz and then there's the theory that a new class of FCC licensee could be band managers in just a couple proceedings. The band manager is given, I would say, well, we're given some freedom to, use that word --

MR. STANLEY: Flexibility.

MR. CROSBY: Flexibility. Thank you. To permit the deployment and to facilitate the deployment of numerous types of technologies. And in rural areas there's a different type of need. And we can address, as a band manager, applications in rural would be different in urban areas. And we obviously are motivated to be very careful because people are obviously reimbursing us for the use of our spectrum, to be very careful with the interference.

At 700, we have an obligation to cooperate with, and it's our intention to do so to work very carefully with the public safety

community when they deploy at 700 that are in the adjacent bands. And of course, I haven't had any direct yet. I've only had a few, but we also have an obligation to stay out of the grade b contours of the incumbent broadcasters. Although even that, while you might go boy, that's a problem, you know, you got transmit receive side. So you get a little bit creative and you go, guess what, I'm going to try to do some non-standard pairing so that I can use spectrum here and stay out of the top side.

Or I go -- I can look at and we are. We look at, you know, there's an incumbent on channel 66, but I'm at the bottom of channel 65. And I bet you with some unique engineering, and I'm going to obviously have to talk to the Commission and the broadcast incumbent, but I think we could prove with them reasonably well that we're not going to cause the broadcaster interference.

Much like all the other discussions, the Commission sort of gave us some very specific kind of things. The only thing they told us we can't do is cellular infrastructure. And that was

to be careful with public safety and watch out for the broadcasters. But go and prosper. But to get to the point, I want to point out the beauty of the band manager about the zoning changes over time. So we're going to be reluctant to do long term leases because I don't want to encumber new opportunities, new technologies, other things as the band develops and as technology develops. So we're sort of in the midst of all of this kind of thing but we have -- flexibility is good. The technologies we wrestle, we don't necessarily wrestle, but we're challenged with all of these types of matters everyday as we process requests for our spectrum.

MR. STANLEY: Great. Other comments on these other techniques like negotiated rulemaking, the frequency coordination function, guard band manages, or band manages?

David?

MR. HAGEMAN: Most of the all the issues the small carriers deal with are pretty well specified by the rules. And they worked well for

us. I would tend to think in some of these, if it's negotiated depending on how those negotiations go and who they're with, that a lot of the economic issues need to be taken out of it to what we had it clear that there's a set of guidelines that we should all go by. I don't think there would be any issues with the small guys with sitting down with a large carrier or you know someone else and talking through those as long as we're all on a level playing field.

MR. STANLEY: Sure. Nancy?

MS. JESUALE: Well, I'm thinking about our situation as the situation of public safety and it seems like both those options would be really, really useful if we had access to them. In fact, I believe there is a proposal to swap and reallocate some spectrum in 800 to kind of deal with the problem that is essentially I think a negotiated rulemaking. But it's not becoming a rule. It's going through a secondary process, I guess, which is opening it up for more due diligence and ultimately, it may be adopted or it may be changed.

But that process of sitting down and saying okay, what are you going to do with the other party was very productive I think for all of us. And if we had a band manager, I'd have somebody to go wave my flag at. So that would be great, too.

MR. STANLEY: Dick.

MR. SMITH: Well, as someone who had a hand in enforcement for a number of years, I can certainly endorse anything that reduces or eliminates the number of necessary enforcement cases. Anything like negotiated rulemaking or cooperation amongst the users that can be encouraged is certainly a worthwhile endeavor. The Commission staff and everybody large enough, there will never be enough funds, people to carry out large numbers of enforcement cases. As society gets more complicated, we find ourselves in court more. It would be an impossible task, if there wasn't a large component of cooperation expected on the part of the spectrum users. I just think the

Commission ought to do everything it can to promote and encourage that.

MR. STANLEY: Thank you.

MR. STORCH: I'll concede, I'm not as familiar with the band manager concept. I think conceptually it sounds like a very good idea in the sense of an approved process. It would set for the incumbents an expectation that says hey, you don't have a lease in perpetude here. It's a set period of time so they can appropriately plan and capitalize and deal with their levies or their budgets, especially speaking more to the public safety.

On the same token, it will help potentially some of the more aggressive operators, or if you will, developers to adjust to the needs of the band if you will. Be able to in the scenario of you can only build it for a hundred rooms. In five years, we can revisit it. You can't, if you will. The Nextel scenario is well, they started out at about a 100 rooms and all of a sudden they needed a 1,000 rooms and they just

built it, if you will, I think is the allegation.

(Laughter.)

But I think the concept of that, where it's considered just a frequency coordination, here's your channel, go off and run away. More of a continual process of managing that band I think would be a benefit to all.

MR. CROSBY: Let me, I meant to add one other thing we absolutely intend to do is literally, what you used to do. We're going to go out and look, field test, keep track of things, and we tell them the prospective uses or expect we're going to come out and look. Maybe not this year, but sometime within the term of your lease agreement we're coming out and we're going to check. And you know what I found? Everybody I've talked to says please come out and check because I know you're checking everybody else. And they go I'm now, and this may be a good message for the Commission. It sort of helps the integrity of the whole spectrum process, and people sort of take care of their systems a little better when they

know they might -- and we will.

MR. STANLEY: A visit from Dick Smith.

MR. CROSBY: Yes, you could do some of my things.

MR. STANLEY: I'll give you my card. Well, it's just three o'clock now, I guess, so we know we have at least two people who have to make some plane connections fairly promptly, but I would certainly like to throw the discussion open to questions or comments from the public.

Question here?

MR. LOCKIE: Stephen, I assume that big LEO turned into LMDS and that was a good example of negotiated rulemaking although it took a long time. It points out though somebody made the comment we need the Commission to be an engineer. I don't think that's a case because engineers, we're all terrible managers, as a rule. What we need is a good manager up there. But what we need are good engineers. Get them and keep them within the FCC because they make good referees and the game is great when you've got good referees. And there are

many times during the LDMS negotiations where some engineer would be told by his boss to say up is down and the smart FCC engineer there would say that's not crazy. And that's invaluable. So keep doing that. Get good engineers and keep them.

MR. STANLEY: Other questions or comments please?

(Pause.)

Well, seeing none and hearing none, let me sort of bring this particular panel to a close. I want to thank the audience very much and also thank our panelists. We've had people who have come from afar and actually made some sacrifices to be here this day, and let me sort of sincerely express our gratitude to you all for staying with us like this.

So thank you very much, it's greatly appreciated.

(Applause.)

(Whereupon, at 3:04 p.m., the workshop was concluded.)