Female Voice: Let me just—Dale Hatfield was the chief of the Office of Engineering and Technology at the FCC and chief technologist. Do they still have a chief technologist?

Dale Hatfield: Yeah. I think the position is vacant right at the moment, but I believe it still exists.

Female Voice: Uh-huh. OK.

Male Voice: It's sort of a—well, never mind.

Female Voice: No. I'm very interested.

Dale Hatfield: I mean the sort of position -- like it was in my case, the -- it was a holding position. It was a place to put somebody until you can put them where you want them to ultimately be. [unintelligible] make any sense.

Female Voice: And, you were at -- and, you've done a lot of consulting over the years. Is that right?

Dale Hatfield: Yes.

Female Voice: And, now, you are a professor at the University of Colorado at Boulder. Is that right?

Dale Hatfield: Yes.

Female Voice: And, still consulting?

Dale Hatfield: I'm still consulting.

Female Voice: And, were you ever at NTIA too?

Dale Hatfield: Yes. I ran NTIA at one point. So, I'm sort of an interesting character in the sense that, as you know, the spectrum management or the spectrum is divided between the NTIA -- actually the President delegated to the NTIA, and Congress, and the FCC. And, I've been one of the few people who -- I headed that agency at one point. And, then, at OET, the Office of Engineering and Technology at the FCC, is the part of the agency that handles spectrum allocations, not the service rules and so forth, but allocations. So, I've been sort of lucky. I've seen both the executive branch side and the FCC independent regulatory side.

Tom Whitehead: Dale, they say [unintelligible? it?] is a little bit like the spread spectrum technology, in that he fits square-peg holes, round holes, triangular holes. He is as close as you get to a Renaissance man in the world of communications, and technology, and policy. Two things you need to understand about Dale. One is that he knows more about technology, spectrum, and how those things interact with policy than anybody I know. There are policy [unintelligible]. There are engineers. There's nobody that understands the richness of the interplay between policy and technology the way Dale does.

Dale Hatfield: Gosh, how do you -- how do I live up to that?

Female Voice: Do you use a flash drive there?

Dale Hatfield: [unintelligible]

Female Voice: [unintelligible]

Tom Whitehead: Yeah. And, the second thing I was thinking to say about Dale is that he is a superb teacher. He is far better than me and better than almost anyone else I know at getting across these complex ideas to us mere mortals. So, --

Dale Hatfield: Boy, am I in trouble now. I'll roll up my sleeves for that.

Tom Whitehead: You should take advantage of Dale. He's also an informal guy, so you should take advantage of interrupting him from time to time with questions.

Dale Hatfield: Absolutely.

Tom Whitehead: You can vamp until the thing's ready. I guess it's ready.

Female Voice: Should we close all the lights, or just put it -- Dale, do you want all the lights closed?

Dale Hatfield: All right.

Female Voice: Is that too…?

Dale Hatfield: Some of the lights I guess would probably be better.

Male Voice: I think you can see him.

Female Voice: I can see him [unintelligible]

Dale Voice: I probably don't need my notes, but…One of the more interesting things, just to sort of continue the conversation with it, is what's happening internationally in this area. The F --CC? here, in this country, we're not

free to do just anything we want to because radio waves do not respect political boundaries. So, what we do has an impact on Canada and Mexico and vice versa. And, too, when you take off from a plane from Dulles and land in London, it's sort of nice the idea that the pilot can talk to the ground from this end and also be able to talk to the ground on the other end. So, there are international treaties involved here that the U.S. is signatory to. And, so, therefore, what the FCC does and what the NTIA does, generally speaking, or actually [unintelligible], it has to consistent with our treaty obligations. So, I'm not going to talk much about that.

But, there is this international framework that is over this. And, some of them are the most difficult issues now with localization. For example, in Intel, wants to [unintelligible] a product that not only works here, but works worldwide, hopefully on the same spectrum. And, as you can imagine, because there's trade involved and so forth, this gets sent in this sort of political sort of thing. [Walter Whiteband], who's a technology [unintelligible] -- in technology right now, where other countries are taking a more conservative view. Is this because it's a U.S. technology and other countries are a little hesitant about it, or is it because they have genuine concerns about interference? It's a question, not to the students to answer, but there's a -- you can see right away that just international framework -- this international framework as well as this [unintelligible]

Female Voice: We're having a spectrum problem here, which is a -- of course, we created this. For some reason, this isn't picking it up over there. So, he's going to call his engineer.

Dale Hatfield: OK.

Female Voice: And…

Dale Hatfield: OK. Let me sort of jump into a little bit more formal part of it. And, I'll try to go as far as I can by waving my arms rather than drawing pictures. The purpose, of course, is just to give you some background in spectrum policy, and sort of a high-level view of the tensions and so forth that are in the spectrum management area. So, basically, what I'll do is I'll spend quite a bit of time on background just to make sure that we all have some common understandings. Then, I'll talk about some of the challenges to the current system, challenges produced by growth, new technology. I'll talk about advances in wireless technology. Tom just touched on that. But, not only is technology causing us problems because it's creating additional demands for spectrum, but it's also providing devices that are smarter, more intelligent, cognitive, and things like that, which can long term help to solve the problems. So, I'll touch on those, as Tom did a little bit. I'll talk a little bit about the constraints and criticisms of the current approach. Here, again, Tom touched on those as well.

But, basically, if you just had to summarize it, the communist countries -- I did a lot of work in central and eastern Europe beginning in the 1990s. The reason those countries did so badly economically is that trying to manage resources from a central location, determining how much copper you need in one part of the country, and how many tomatoes you need in the other part, even if you're well-intentioned people, trying to do that centrally is extremely difficult and runs into all sorts of problems. Well, that's how we've managed spectrum primarily is by that centralized control method. And, you see all the problems that the communist countries had, distribution of resources, bad pricing, over-consumption, under-consumption, all those things, you see it in spectrum as well. And, it just -- and, I'm not making a political statement here, it's just very difficult, even if you're well-intended, to manage a scarce resource in a central manner.

I'll talk a little bit about the proposals for reform and, again, there are pros and cons. And, then, if there's time, of course, I'm more than willing to just have an open sort of a free-for-all.

I guess the -- sort of starting on the background and, of course, the fundamental question is what is spectrum? And, I'll leave Dr. Whitehead to tell you what it is. It's hard to explain, of course, the reason I'm joking. It is a conceptual tool. It doesn't exist in some sense, but it -- the way we describe -- it's a description of a set of physical phenomenon. And, we know that electric and magnetic waves -- magnetic fields, produce electrical -- called electrical magnetic waves that propagate through space at different frequencies. The set of all possible frequencies are referred to as electromagnetic spectrum. Now, if this timing's not right…

Male Voice: [unintelligible] this camera.

Female Voice: That's the thing?

Male Voice: Yeah. The camera's plugged in where the plug was plugged in. So, that's what the problem is.

Female Voice: Oh, it was just a plug issue.

Dale Hatfield: [unintelligible]

Male Voice: We get our first technologist, real technologist, here and then we show off our technology weaknesses.

Dale Hatfield: It's called -- when you get to -- I think it's called [GMU] presentation I think.

Female Voice: But, your point is well taken because, as we've talked about a lot in this class, what happens is the FCC, whether it's the definition of public interest, or what they can do with spectrum, these vast grants of authority that they've been grappling with, and then the courts try to --

Dale Hatfield: Yep.

Female Voice: -- constrain them someway. How could it be just everything?

Dale Hatfield: Part of it, and that's a bigger problem, is cell phone policy is so interdisciplinary by its nature. And, how do you take people who don't have a technical background and have them understand things like electromagnetic waves? And, vice versa, how do you take somebody like me, who understands a little bit about the electromagnetic waves, so I understand the technology --

Male Voice: [unintelligible] spectrum now?

Dale Hatfield: Yeah. That's it. Hey. And, there's the slide I want, number four. OK.

Male Voice: Is there a -- there isn't a clicker, so [unintelligible].

Female Voice: Your remote doesn't work?

Male Voice: Hmm?

Female Voice: The remote doesn't work.

Male Voice: The remote's for the projector itself. It's not for him.

Male Voice: That's good. That'll work [unintelligible]

Dale Hatfield: I'm in [unintelligible] I think I've covered…Yeah.

Female Voice: Dale, I wonder if it would be easier for you to sit in that seat. And, that way, you would be able to see the…

Dale Hatfield: Oh, yeah. OK. Tom you want to trade?

Tom Whitehead: Sure. Just take whatever you want.

Female Voice: Or, if you want -- so that you can see what's up there too. I'm sorry.

Dale Hatfield: This is just a diagram here that illustrates -- this is all of electromagnetic spectrum. This is the radio spectrum which we're dealing with here. It isn't showing up too well, but you see infrared, the visible light range, X-rays, and gamma rays, and so forth. So, we're just focusing on this particular range of the spectrum. I've used this term frequency, and you also hear us talking about microwaves, and shortwaves, and things like that. You can talk about the dimensions in this resource. You could talk about it in terms of frequency, or you can talk about it in terms of wavelength, and their direct relationship between the two.

And, let me illustrate that. We talk about waves. It's sort of visualized in ocean waves, on the ocean, and visualize that you were sitting in a boat that sank or out somewhere. And, as the waves come in, of course, you would be tossed up and down, up and down. The intensity would go up and come down. The amplitude of the water would come down. And, if you timed it, when you were at the crest of the wave, you went down to the trough, and you come back to the same place again in the crest, the time -- the number of times that you do that in one second is simply a frequency. So, you're sitting on the boat, you're going up and down, and

just count how many times you go through one complete cycle in a given second, and that is known as the frequency -- the number of cycles -- the number of complete cycles in one second.

Now, imagine, then, this same thing, that you're in an airplane flying overhead, and you look down, and you could see the crests of these waves. And, in theory anyway, you could measure the distance between the crest, the distance between the crest of one wave and the crest of the next wave. And, if you measured -- but, measured that, of course, that would be in feet or meters or whatever. Now, if you think about it just a moment, that's called a wavelength, the difference between the crests. The distance between the crests, that's a wavelength. But, if you think about it just a moment, of course, those are related. If the crests of the waves are far apart and moving towards shore, you're going to what? Be bobbing up and down slowly. On the other hand, if there was a real chop and you've got lots of crests very close to each other, you're going to bob up and down faster. So, all this -- all I'm saying is that frequency is related to wavelength.

And, when you talk about shortwaves, what do we mean? It just means that the distance between the crests is shorter. Microwaves means what? Really close together. So, it doesn't matter whether we measure -- which we talk about, frequency or wavelength. And, this will come -- this will be shown in a moment why this is important. But, two notions, frequency and wavelength. Any questions? I can't see you so well, so feel free to…

OK. I'm just used -- you have to be really careful here. You can be terribly misled drawing analogies. OK. But, let's use the analogy with waves -- continue using it in the radio context. If I'm sitting in a swimming pool absolutely quiet, and I started moving my hand back and forth like this, I could create waves. And, those waves would then go

across the swimming pool. And, if there was a bobber on the other side of the swimming pool, that bobber might start going up and down. When you think about it, I can communicate in a rather crude fashion that way, couldn't -- by generating waves with -- the person on the other side would wait until they saw the bobbers go up and down and say, "Oh, my goodness, Dale is signaling me in some way." So, I create the waves by moving my hand back and forth in the water.

A radio transmitter operates basically that way. What it does is it -- what you're doing is pushing current into an antenna, an electric current into an antenna, pulling it back, pushing it out, and pulling it back. And, if you do that at a high enough rate, what you do is create radio waves rather than the water waves that I mentioned you produce in the swimming pool. That radio wave then spreads out just like that wave does in a pond. You drop a pebble in a pond and the wave spreads out. Here, I'm dropping lots of pebbles in the pond. I'm generating waves. They spread out. Of course, they get weaker the further they go, don't they? Until, finally, they just sort of disappear. The same thing here, the radio waves are launched. They spread out. They get weaker. And, then, when they intercept an antenna, the opposite thing occurs -- the opposite process occurs.

Here, I use electricity to generate waves. There, the antenna, it picks up those waves and it creates current that's picked up in the receiver. That's sort of like the -- the receiver's sort of like that bobber that suddenly is put in motion by the waves that I created in the swimming pool. I've said that you could communicate in crude forms, that "one if from land, two if by sea" -- that sort of notion, a very simple communication system. And, as Tom said, the first systems here are the simplest thing that you could do, is what? Just turn the transmitter on and off. Well, if we agree in advance that a short pulse of -- turning it on a short time, and then turning it on a long time, in other words a dot and a dash, means the letter "A," we can

communicate, can't we? So, all I'm going to do is turn the transmitter on and off. And, dot-dot-dot would be an S, dash-dash-dash would be O, and dot-dot-dot again would be S. That would be SOS. I'm in distress. And, we can communicate by changing some characteristics of these radio waves.

And, as Tom was saying, of course, we'll not have time to go into this, but you can change the amplitude. You can just turn it on and off [unintelligible]. Or, you can change the amplitude. You can change the frequency. You can change the failures or timing of the signal, and in that way carry information. So, that's basically what the radio wave does. It -- that's basically how it worked is that we've changed some characteristic of the wave. Then, we extract that -- those changes at the other end and can communicate over a distance without the use of wires.

It's the challenge to me to see if I can do it without reading the notes. Let's say a little bit about the nature of this resource. Well, it's a rather unique resource when you think about it. We burn coal today, and we burn it today, we don't have it tomorrow. We burn oil today, we don't have it tomorrow. Radio is interesting. I can broadcast on channel 4 here in the D.C. area all day today, and what? I've got just as much [unintelligible] as I had today, I have tomorrow. So, it's an infinitely renewable resource. But, interesting, like air, water can be polluted. We've all had the experience of turning on a radio, especially an AM radio near a fluorescent light or something and what? That fluorescent light interferes with or pollutes the radio signal that we're trying to receive. So, it's a -- sort of like a unique resource.

As I said before, it's both a national and an international resource because it doesn't obey political boundaries. Radio waves continue right on into Canada whether we want them to or not. As I said before, it's infinitely

renewable. It's a really nice resource in that sense, but like air and water can be polluted. And, the resource can be shared in three -- at the most basic level, three different dimensions. I can share spectrum and frequency meaning that, if I broadcast on channel 2, which is 54 megahertz to 60 megahertz, and you broadcast on channel 3, which is 60 to 66, we don't interfere with each other because we're using different frequency ranges. But, on my cell phone in here, I can be having a conversation with a cell tower. You can be having a conversation with a cell tower. And, we don't interfere with each other because we have been assigned to the system different channels. So, we can share spectrum in terms of frequency. And, that's all channel 2, channel 4, channel 6, your television stations, all that is doing is identifying the channels. And, they don't collide with each other because they're sort of like occupying different lanes on the highway.

Also, when you think about it, I can use spectrum. I can share them geographically. I can broadcast on channel 4 here in Washington, and I can broadcast on channel 4 in New York. Why? Well, because they're so far apart, these radio waves get weaker as they go towards New York, so I don't bother -- here, I don't bother New York and New York doesn't bother me normally. So, I can share in the frequency dimension and I can share in the space dimension. And, third, of course, I can share what? In the time dimension. In theory, we could have two broadcast stations on channel 4, one would broadcast between noon and midnight, and the other would be broadcast between midnight and noon the next day. So, we could share spectrum in the time dimension as well. In fact, there's a -- something you may have heard, time division multiple access. That's your cell phone technology where we could have two cell phones in this room communicating back to a base station on the same channel. But, I can use a slice of time from my conversation, you can use a slice of time for your

conversation, and they don't collide with each other because they operate slightly different time periods.

So, spectrum can be shared in all three of the dimensions that I mentioned. Now, unfortunately, there's not enough spectrum to go around. And, while from an engineering standpoint, you could come to me, I could always figure out a way of what? Shoehorning in one additional user. I promise you I can do that. But, it gets what? Increasingly costly and complicated for me to do so. And, in that sense, spectrum has scarcity of value. We can't accommodate everybody who would like to have it all the time. Therefore, we have to -- as a society, we've got a common resource here and we have to decide how to manage it.

Now, in my sort of academic -- if I put my academic hat on, this suddenly got fascinating to me and there's some wonderful books about how societies around the world go about sharing common resources -- fascinating stuff. You've got a pasture. You've got herdsmen who want to share the pasture. How do you divide the resource when you have more people that want to herd their cattle than the range land will sustain? In water in New Mexico -- I have a house in New Mexico and that's a vital concern is who gets the water. And, of course, as I said before, in our society in most cases, we allocate resources, scarce resources, what? In the marketplace. Spectrum has traditionally been what? A big exception. It's a resource, a scare resource, just like copper. We don't have a national copper commission that allocates copper among radiator manufacturers and manufacturers of wire. Why? Because it goes in the marketplace. That's not been true of spectrum and that creates some of the pressures that we'll talk about.

I don't have it -- at my university, they have a whole course on this next topic and I'm going to do it two minutes. Radio waves, as you change the frequency, have different characteristics. This chart goes from very low frequencies to very long wavelengths, up to the top where you're getting into very short wavelengths and very high frequencies. Frequencies down here in the 70,000 cycles per second range, 70 [unintelligible] range, so [unintelligible]. Surprisingly enough, that spectrum was really good for communicating with submarines. If you're in the navy, and you've got nuclear submarines running around, and you want to push the button that says launch for God's sake [unintelligible]. OK. You've got to communicate with something that's underwater and that's difficult to do. As it turns out, these frequencies down here have the characteristic they penetrate into water fairly well. And, indeed, there's marine communication systems -- they use systems way down here. The antennas are huge. The wavelengths are long.

As you go up in frequency, and the wavelengths get shorter, the signals -- the lower frequency signals tend to sort of fold around buildings. But, they can't get through the windows. These long wavelengths can't get through buildings and so forth very well. So, they don't penetrate into buildings very well. As you go higher in frequency, the buildings then tends to begin to block the signal, sort of like you can't see a light around a building. You got a light on one side. It can't get around the building. It's in the shadow. The same sort of things begin to happen in radio. But, if you got a window, the radio signal can get in through the window. As you go higher in frequency, just keep going up, you eventually get to where the wavelengths are so short that even like water drops will interfere with the radio waves. If you had a satellite dish, you may have noticed sometimes you get a really heavy rainstorm, your picture will start freezing on you, breaking up, and freezing. Why is that? Well, it's

because that rain cell is between you and the satellite, and the satellite signal, microwave signal, can't get through it.

So, around here we have some nice properties. Up here, it begins to be blocked and more of a -- [unintelligible] and atmospheric conditions. Then, there's what we call beachfront property. And, you'll see that term used. There's a sweet spot here, and engineers -- different engineers would argue about where it starts and stops, but roughly the frequency range, about 300 megahertz, which is in the TV -- is roughly in the TV bands, up to about 3 gigahertz, 3 billion cycles per second. That's the sweet spot. And, it's sweet because there the signal pretty well behaves. It goes into buildings pretty well. It goes around buildings pretty well. The antennas that you have to have on your cell phone are relatively short. So, that's sort of the ideal spectrum.

And, when I was at the FCC, the most bitter battles were over that spectrum. Right now, this digital television transition, which you may have talked about already, the reason -- one of the reasons that that's such a bitter battle is that spectrum is right. If you came to me and say, "You have your pick of any spectrum you want. What would you like?" What would I say? Ah, 300, 400, 500, 600, 700 megahertz, right in that range is ideal for the reasons that I [unintelligible]. It's not that the higher frequencies are not usable. It's not that the higher frequencies are not valuable. They are. And, it's not that the lower frequencies aren't valuable and desirable. It's just that's there's a really nice part. This is the seafront and this is the beachfront property. And, that's where all of your battles are, is over this spectrum.

So, that's radio propagation in two minutes. This is a topic you might ask -- at night time AM, you can get reception from several thousand miles away and in the daytime you don't. Why is that? We could spend hours

[unintelligible]. But, the point -- but, there is probably a point here. And, one of the points is that that variability in how radio signals propagate -- if you had a chance to read the one paper, I think one of the things that people who advocate property rights solutions to spectrum has not fully appreciated the statistical nature of it. That doesn't say we shouldn't [unintelligible] a property rights system. It just says what? Defining those rights and enforcing those rights may not be as simple as people would hope because of this variability.

OK. I'll just skip over this. By the way, I can make these available if it would help. I can e-mail them to you if you'd like. OK. Definition of spectrum management [unintelligible] all activities associated with regulating the use of the radio spectrum. It includes the structure and processes for allocating, allotting, assigning, and licensing of this scarce resource, as well as enforcing the rules and regulations. I've forgotten where I stole that definition from, but I think it's a pretty good one.

Let's, then, talk about the importance of spectrum management. Let me just ask a question, a very fundamental question. Would you have a cell phone if the FCC hadn't allocated spectrum for cell phone use? No. It created a whole industry, right? If it had never gotten around to it, you wouldn't have a cell phone. One of the things I think most people would say, that we really benefit by a fairly competitive market in cell phones. I mean you have five, six or sometimes more carriers in a given market. We have tremendous competition and it benefits, defining prices and increased functionality. Was that by accident? No, because the FCC decided what? To allocate spectrum not to just the one, or assign spectrum not to just one or two people, but what? As many as five or six. So, spectrum really is a determinant of industry structure and industry performance. And, it literally determines whether a particular service will exist or not.

Dr. Whitehead and I go so far back as MCI, Microwave Communications Inc. They got in the long-distance business. But, to be able to do so and to be able to compete with the telephone company, they had to do two things. First of all, they had to get the FCC to give them spectrum, right? You can't operate a microwave system unless you have spectrum to do it and a license. So, first of all, they had to get the license. Then, second, they had to get the Certificate of Public Convenience and Necessity, Section 214 of the act. They had to get also what? A certificate to allow them to provide service. But, they couldn't have provided service without what? Having spectrum.

Moreover, spectrum -- how much spectrum -- you can always -- an engineer can always trade off spectrum. It's sort of like emissions from a steel plant. If you tell me that, Hatfield, you can produce steel, but you can pollute as much as you want to, I can make steel a lot cheaper than somebody who what? Controls the emissions, the pollution. The same way with spectrum. If you let me squander it, I can make a cheap system. It may not be good for society as a whole, but you can see, if you allocate spectrum to me in a way with rules that allow me to pollute or rules that allow me to not use it efficiently, then I can produce low-cost services. On the other hand, if you burden me too much, it may make it uneconomic and so forth. So, not only how much spectrum that I allocate, but the rules and regulations around it are important, terribly important.

Moreover, unlike land, you know…I've got a small shopping center that's not doing very well and I put in a new metro stop, and now I decide, "Gee, I'll get rid of this little mini shopping center and I'll put in a great big high-rise building." That sort of thing happens in the marketplace pretty routinely. Here again, rules -- FCC rules may say that spectrum is only to be used for this purpose, so you have restrictions. The point that

I'm making is that spectrum management decisions can't be separated, as in the case of MCI, from the larger public policy decisions regarding telecomm policies in general. I didn't say that very well. But, also, spectrum management has a tremendous impact on the economic performance of our society -- just think that fact -- when I teach a class like this, I often have students do a little log of how many times they use radio in a given day, meaning you walk out to your car -- you're going to walk out of this class and you're going to do your little clicker for your car. You're going to open your car door. How does that work? Radio. Right? Your alarm clock turns on in the morning -- clock radio. I mean it's just over and over. And, you go over and sit in the coffee shop and use your wifi. You're using radio all day long. And, of course, so spectrum is extremely important to the economic performance of the society and increasingly so.

And, of course, the part that I haven't said too much about is also critical to what? To the safety of life and property. I mean can you imagine a police department operating without a radio system? You look and see what happened in Katrina. You lose your communications and you're really in deep trouble. I'm doing some work with the Department of Defense and they have a wonderful curve of showing the -- some of their terminology sort of bothers me. It's how much bandwidth is required to support one war fighter. In other words, if you take history and look at how much communications you had with the soldier you know…back to Civil War times and you plot it, it's a hockey stick in growth in bandwidth. In other words, once the bandwidth per solder is going right through the ceiling, and then you say, "Well, why is that?" Well, they have these things like in Iraq, unmanned aerial vehicles that fly over. In other words, if you're driving down the road, there's an unmanned airplane flying ahead of you watching what? And, sending that information back. Well, that requires a [unintelligible] on a bandwidth.

So, anyway, the point is that spectrum is -- and how we manage it, is extremely important to our economic and social well-being, and of course the safety of life and property, to national security and national defense.

And, we see some real battles now that are going on right now, right as we speak, of what? How much spectrum should be allocated for public safety, and military purpose, and how much should be for commercial purposes. So, I can't sort of hardly over-emphasize the importance of how we go about this.

OK. I've sort of been in the what we call simplex mode here, Tom. Let me pause and see if there's any questions or comments to this point? I'll get into more interesting stuff. This is just background for now. I'll get into some of the current debates more.

Female Voice: The issue of spectrum scarcity -- I mean I've heard people say or I've read, "Well, spectrum isn't scarce anymore because of technology and the ability of more and more different types of equipment to make the spectrum, in some sense, infinite or that could everybody could use it, or slice it up into smaller pieces. I mean do you -- I think I know your view, but I was wondering if you could comment on that. I mean I think, for example, the rationale for regulating broadcasters in terms of scarcity, people say, "Well, other things are scarce too. So, we don't necessarily use that rationale to regulate." That's one argument. But, the argument that, "Well, it's no longer scarce because of engineering capabilities" -- I was just wondering if you could address that.

Dale Hatfield: Yeah. And, I'll have a little bit more to say about it later. But, I think it's very, very important to distinguish in your mind between what is? real scarcity and administrative scarcity. What we're facing mostly right now is administrative scarcity. Tom could bring a receiver from home, take

you up on the roof of this building, and you could tune across, and you would find that there's a surprising amount of spectrum that's not being used. In fact, there is a company here, right here in Northern Virginia, called Shared Spectrum that did measurements in New York during the Republican Convention, one of the times when really heavy use of spectrum, and they found large swaths of the spectrum that are not being used. So, what it says is -- this is really important when we're thinking about this. What this says is it's an administrative problem. It's how we're managing it rather than a true scarcity.

Now, having said that -- how can I say this politely? There have been people writing who have said that spectrum really isn't scarce [unintelligible]. I don't think it's near that simple. And, some of the things that they point to, if you dig deeper, you find that they have problems too. For example, some people say spread spectrum will get rid of it. Spread spectrum has interference the same as any other system does. There's really no -- it has different characteristics, but interference is still an issue. So, in my own mind, and I think the people who are the most honest about it, will say, "Yeah. We probably still do have a problem in places like New York City in this sweet spot, in this beachfront property." There are probably still scarcity issues there. Now, having said that, coming from New Mexico, you got on the Navajo Indian reservations, spectrum is not scarce down there. And, there's no reason that we ought to have rules and regulations that apply to New York City also apply in Navajo land.

And, in the past, our system, the administrative system, has been too rigid often to recognize that things in New York are different than the situation in Navajo land, and we ought to have different rules and regulations. Now, to the commission's credit, the commission is beginning to recognize some of that and have different rules. But, going back and just

summarize, is distinguishing between a truce scarcity and an administrative scarcity. And, the problem right now -- we have a huge problem with administrative scarcity. Long term, I think there are some legitimate scarcity issues on the [unintelligible]. But, there's a really neat technology, mesh network technologies and things Tom may have talked about it that are helping this. As a matter of fact, when you step back, one of the challenges that we have as policy makers -- or I used to have as a policy maker -- is how do you make our system flexible enough to be able to incorporate these systems that can help you lead spectrum to these new technologies?

And, there's some interesting issues. Some of the research, some of the stuff that I'm interested in, is some of these radios that are so much more powerful. They're so powerful that people can do bad things with them. And, how do we make sure that when you get a radio, that can be any kind of a radio I want to be, that I don't just turn on the FAA channel and pretend to be an air traffic controller for awhile? Wouldn't that be funny? I mean I'm thinking extreme situation here, but there's an element of truth to what I'm saying. How do you actually see when you've got a lab that looks at a radio and says this meets the specifications, but I can take it home and do a new software hack on it, and create a radio that does something entirely different tomorrow? You can't believe at the FCC labs the consternation that that sort of thing is causing. How do you test a radio that can be one thing today and something different tomorrow?

You have -- you know…it's sort of like security is using the software. You've loaded it with one set of software. If you change that software, it violates your equipment approval thing, and you have to go back and get it approved. These are really tough issues. And, as lawyers, you get into this. These are the sort of issues -- you'll be representing a manufacturer that wants to build this great, flexible radio, but has to go through this

process of the FCC. If they're tough on you, you're going to have trouble selling your radio. And, if they're too loose, then as a society, we have problems of people doing things they shouldn't be doing with radios.

OK. The steps in spectrum management -- when people used to ask me what do you do at the FCC in the spectrum area. Well, there's really four things -- four basic things. One is allocations, service rules, assignment, and enforcement. Let's go through and define them just a little bit more than Tom touched on. Allocation -- and Lisa touched on. Allocations -- you have to be really careful. It's sort of analogous to zoning, right? You've got some land, and you divide it up, and you say, "This is going to be residential land. This is going to be heavy industry. This is going to be office buildings and light industry, schools." You divide it into categories, and why do you do that? Well, one reason, generally speaking, you don't want a rendering plant next to a residential neighborhood, right? You try to do things that are compatible use. The second [unintelligible] here, the FCC takes this spectrum, some is very suitable for certain uses, some is more suitable for other uses, so it allocates it among these different uses. That's the allocation step. That's the zoning step.

Now, the city planner here in Arlington -- of course, we don't have much undeveloped land left. But, I would make a decision of what the land should be zoned for, and then you have to have rules regarding the use of this land. For example, how far the building has to set back. Can you build a fence right at the property line? There's all these sort of official building codes, plumbing codes, all these sort of things. So, there's rules and regulations that apply to that particular area in the zoning. And, that's what we call service rules at the FCC. That would be things like how much power you're allowed to use, how much control you must assert over spurious emissions, like the interference [unintelligible] from your radio, but even things like how many channels should you be able to own,

who should be able to own it, can you own a TV station and own a newspaper in the same town, all those sort of content-related issues that Lisa knows much, much more about than I do. So, those are what we call the service rules. And, like I say, that's sort of analogous to the rules that you would have in land use in terms of setback requirements, those sort of things. In fact, you have the equivalent of setbacks on [unintelligible] you say how much energy in your channel you have to keep [unintelligible] so you don't spread out onto somebody else.

The assignment stuff I heard you touch on is, now I've got this land zoned. I've got the rules for the use of the land set up. Now, I have to decide what? Who gets to live on that land? Who gets to build the factory? And, of course, in our society, that's generally done how? In the marketplace. In the old days, in spectrum, we used comparative hearings. We would actually have people come in and each person would say why they were the best, a beauty contest in some ways -- and say why they would be best suited to use this particular allocation. And, there might be multiple channels; but, if you want to broadcast on channel 4, you would go through that comparative hearing. There's a long history here and a longer class, and maybe you've already touched -- we could go through the advantages and disadvantages of various ways of making that decision. Who gets to use it? Like I say, in my end it's what? Just marketplace, right? The person who's willing to pay the most gets it. OK?

Over the years, we have tried to use other techniques and gotten frustrated for lots of different reasons. Now, in the assignment step, we generally use auctions. There's some exceptions, but we generally use auctions. It goes to the highest bidder. Now, there's some interesting issues here of what you're buying when you pay for spectrum at auctions. Sometimes, people use shorthand and they say the FCC is going to auction off spectrum. Here again, be careful not -- I mean while you're here, but what

your really auctioning is what? The right to use the spectrum. You're not -- you don't get it in [unintelligible] simple, right? You've got to -- it's a right to do something with -- it's a right to do something. It's not spectrum in the sort of sense we use it for property rights. It's more of a license to use that spectrum.

Now, that's the assignment step. By the way, I want to -- sometimes, people make the mistake of confusing assignment and allocation, and I insist that my students don't use those terms interchangeably because it causes a lot of confusion. You don't allocate a channel to WETA, you assign it to WETA. This allocation is the step that you say, "I'm going to use this range of spectrum for television." That's allocation. Now, in the popular press, you see these terms used almost interchangeably, and it's sort of dangerous in my mind. It causes a lot of confusion. So, assignment then is deciding who gets to physically use it.

And, then, of course, once you've made all these rules and so forth, you have to a means of enforcement. That's a whole title of what -- we won't be spending a lot of time just talking about the enforcement steps. But, those are the major steps, allocation, service rules, assignment, and enforcement. In some services, you have an additional step between the allocation and the service rules, and that's an allotment step, and that's an additional step in there, sort of like dividing the land up into lots. The same way here. You might decide that we want to make sure that Washington, D.C., has a television channel, so you allot it to D.C., but you don't decide who gets it yet. And, this is to prevent -- was used to prevent, for example, all the television stations from going to the major urban areas. You allotted in advance to make sure Denver got one and Cheyenne got one because, if you didn't, maybe Denver would get them all and Cheyenne wouldn't have one. So, you go through an allotment step first, and then do the assignment after that, decide who gets the Cheyenne

station, and who gets the Denver station. So, sometimes, there's an allotment step in here that we use as well.

Why don't I pause? We'll get to more interesting stuff.

OK, agencies -- you probably already covered this. But, here in the U.S., the management of the radio structure is split between two agencies, the Federal Communications Commission, your state and local government, and private sector use of the spectrum -- commercial use of the spectrum. And, of course, the president, for federal government uses of? the spectrum. Now, this is a wonderful, wonderful issue to talk about. Should we have one agency instead of two? What would be the problems if we had one agency? And, there are separation-of-power issues, all kinds of interesting things. Tom can talk a lot about that. Some people have proposed to change the system. It is a system that we have -- if there's time at the end, and you'd like to talk a little bit about that, we could. What are the advantages and disadvantages? It's almost invariably on an exam when I teach this. I always throw that as a question [unintelligible]

Female Voice: And, when the president -- who delegates his authority to [unintelligible]?

Dale Hatfield: Yeah. In fact, this is stolen from the president's spectrum policy [unintelligible] and it's sort of a nice diagram showing the FCC. Now, let me pause here and -- when we say that the FCC is an independent regulatory agency, what does that mean? It's independent in what sense?

Male Voice: The president can't just fire them.

Dale Hatfield: Pardon?

Male Voice: The president can't just fire the commissioners.

Dale Hatfield: Yeah. I think -- it's independent, but we sort of -- there's three branches of government. Is it part of the executive branch? No. Right? The -- if the president calls the secretary of defense and says, "Jump," what's the secretary of defense say?

Female Voice: OK. How high?

Dale Hatfield: How high. Yeah. The President cannot tell the chairman of the FCC what to do. He's independent. Now, he may try to influence him in lots of different ways. That's a whole other conversation. But, short of what? Real malfeasance, you know…perjury, robbing a bank or something, once you're there and commissioner or a chairman, it's very hard to [unintelligible]. Is the FCC part of the judicial branch?

Female Voice: Um-um.

Dale Hatfield: No, although it has some judicial-like responsibilities in determining things like whether you violated its rules and so forth. But, it's not part of the judicial branch. Is it part of the Congress? Is it part of the legislative branch? No. But, its powers are delegated to it by who? The Congress. The Congress could decide, if it wanted to, who got to broadcast on channel 4 here in the D.C. area, right? They could if they wanted to. But, they have in the spectrum management area delegated a lot of responsibility to this independent regulatory agency called the FCC. And, we can talk about -- there's wonderful stuff if you read [Hunt's] book and so forth, Conversations with the White House. Tom can talk about that too, the relationship between an independent agency and the president.

But, in other words, it's an independent agency with power delegated to it by Congress on the one side, regulating spectrum in the commercial side,

and NTIA administering spectrum on the federal government side with a very, very -- in fact, one of the oldest I think inter-agency advisory -- I think it is the oldest interdepartmental sort of committee in government. It goes back 30 some -- to the 30's or 40 -- anyway, with the advice of the Interdepartmental Radio Advisory Committee or IRAC. One of the things, when Tom was head at OTP, one of the things that under -- under OTP at the time was the spectrum management stuff and that was done with the help of IRAC.

Female Voice: I've got a question to ask.

Dale Hatfield: The first meeting I ever attended in Washington, D.C., was an IRAC meeting.

Female Voice: I've got a question for you.

Dale Hatfield: Sure.

Female Voice: On IRAC, I go back to the chart, I notice -- although there may be benefits to having [unintelligible] and FCC separate, there is overlap between what it is that they're doing in reality. I mean there's clear divisions there, but it's clear that law enforcement -- the difference between federal and state law enforcement is not as clear as it could be on paper.

Dale Hatfield: There seams -- and that's what you're saying is there -- this creates seams. And, you have to ask, are the benefits of those seams worth it compared to the disadvantages? And, for example, if spectrum management issues were under the executive branch in the White House, one of the things you would worry about is, because it involves broadcasting, you would have to give the executive branch a little bit more influence over

broadcasting. Now, you'd have to ask the question, is that a good idea or not? Some people would worry that if it was on the executive branch, given the strength of DOD, that the spectrum would what? Tend to migrate towards DOD national security issues at the expense of commercial uses. And, these are the sort of things, if you're trying to analyze it, saying you'd want to address whether you'd want a combined agency or not.

But, very definitely, there are seams here. And, as it turns out, a lot of the spectrum is shared. They share it. If you go to the chart and you look, a lot of the spectrum is shared. And, that's done by coordinating between the two agencies. I can tell you wonderful stories about the battles here. I have scars on my back from the battles. A lot of this is hidden to the public. This is -- some of this is not very transparent. Usually you -- I have to be careful how I say this -- because on the government side, you've got national security issues and so forth. This is not very transparent.

Female Voice: [unintelligible] do you have another question?

Female Voice: Well, it's just --

Dale Hatfield: -- Did I evade your question successfully, or…?

Female Voice: No. I don't know that it's very well formed in my mind. I just -- it's very easy to say federal to the left, state and local to the right, but -- and, you mentioned Katrina and that's what I'm writing my paper on, at least in part. And, you see the way things fall down. And, I'm wondering if this is contributes to that problem or not.

Dale Hatfield: Yeah. I'm going to be careful here. But, the problem with Katrina and E911 and a whole bunch of issues to me is not just the federal, state -- like you just said it, but also terrible jealousies among individual jurisdictions. For example, in Boulder, the county doesn't want to share a piece of the E911 answering point. The city doesn't want to share it with the county and vice versa. So, we end up with two call centers in Boulder because these people won't coordinate together. And, they each want to control their own communication structure. You know…if I'm the police chief, I want to control the resources that allow me to be successful, and I'm not about to turn that over to the sheriff's department unless what? There's some sort of higher pressure down.

And, my experience in this area is that, generally speaking, local officials don't like the feds dictating what to do. And, so, you have this terrible dilemma here -- is we end up with all these seams because the sheriff's department can't talk with the local police department, because the sheriff says, "I cover the county. I want a system like this." The city guy says, "I want a system like this." And, the two don't talk to each other. And, so, those are the seams. And, so, it's not only at the spectrum level between the feds and the state and local. It's all this other seams as well and it makes it extremely messy. We don't have a national police force. And, since we don't have a national -- if you have local police forces, and you divide your police force among very small jurisdictions like that, that's the penalty you pay.

Female Voice: How is it…?

Dale Hatfield: I'm very pessimistic. I've been doing it 20-30 years now. I get very pessimistic about this interoperability thing because there's so many fiefdoms and so much independence among so many. I'm going to be careful here. I'm going to be stepping on some toes I'm afraid.

Female Voice: Well, so you're saying you feel that those kind of interoperability problems may be more of a human "condition"…

Dale Hatfield: Absolutely. It has nothing to do -- Tom and I can sit down here in an afternoon and we can design an interoperable system. It has nothing to do with the technology whatsoever. It has all to do with jealousies with the agencies. People don't want to give up their traditional control and all of that. It's not a technology issue. Oh, there's some technology things we need to overcome, but it's trivial.

Tom Whitehead: And, manufacturers also have a vested interest in perpetuating particular systems that use their standard.

Dale Hatfield: Yes, I could go on and on about that. The AFCO 25 standard and its control, there's -- it's intellectual property issues. There's one manufacturer. He has about 80% or 90% of the market here that creates all kinds of problems as well. You're right Tom. I mean a whole different subject.

Female Voice: Is it a spectrum issue?

Dale Hatfield: A spectrum issue? You know…only to a limited extent. And, the reason I'm hesitating is that part of it is these sort of video applications now use up a lot of spectrum. And, if you're talking about normal sort of voice and [unintelligible] data, probably not much of a problem. You throw in a lot of video into that, and the public safety people are arguing, as you probably know, that they need spectrum for being able to do video surveillance, drug deals and all those sort of things. And, you throw much video in there and your demand against [unintelligible] on your -- your

requirement against [unintelligible]. No [unintelligible]. It's not primarily a spectrum issue. It can be helped and be fixed a little bit by spectrum.

It's not prime -- here, again, Tom and I could sit down in an afternoon and design a nationwide interoperable system and say every police department in the United States has to use this system. And, you know what's going to happen. We'll do that at 900 and I promise you North Dakota's going to come in and say, "Well, out here we use 150 megahertz not 900 megahertz because out here we only have to have a fourth as many base stations to operate at 150 megahertz. What in the hell? You feds come in here and talk to us. I have to put in a 900 megahertz system when it's 150 megahertz and the system will talk four times farther."

Female Voice: And, that's -- I mean…

Female Voice: Is there -- towards the idea of letting people keep their fiefdoms, but still trying to build a bridge towards interoperability, is the technology there to say, "OK. Fine. Operate at 150, but have a switch somewhere built in that would convert your stuff?"

Dale Hatfield: Ahh. Yeah, there is. And, this gets back to this -- if you drew up and have a whole set of interoperability issues, and the back office connection that you have to allow a person who's using a 150 FM system to communicate with an APCO 25 900 megahertz system, you have to put -- the trouble when you do it too much of that -- from the [unintelligible] standpoint, we do the [unintelligible] involved and stuff like that, there's always some quality issues when you go across these interfaces that make it difficult. But, yeah, you're right. The question is, that -- now that's where it gets too complicated, see? Now, we're beginning to lose the seamlessness because now we've got seams. We've got a 150 system. We've got a 900 system.

We've got a seam. Now, we've got to work across that seam. How do we work across that seam? The new technologies can help. Sure.

You have to be careful. All those technologies have some degree of centrality to them. And, if you do that, then you got to worry about if somebody takes out the central control. There's some really -- these are really interesting issues. I need to move on or I'm going to -- I don't mean to discourage the questions at all, but I probably need to…

OK. The allocation in the service [unintelligible] stations, of course, are made through an FCC rule-making process which you're all familiar with, Notice to [unintelligible], all those sort of things. Commerce -- this just has a little bit more about NTIA. This is a little detail. The NTIA doesn't issue licenses. It issues authorizations. The FCC issues licenses.

OK. Let's -- then, that sort of completes the background. And, so, in the time remaining, what I'd like to do is talk about some of the challenges to the existing system. I've already touched on some of those. And, also, talk about some of the [unintelligible] proposals that are out there. A question -- I've already talked about the problem -- is that just look at your own use of things. Cordless phones and [unintelligible] everywhere [unintelligible]. More users -- look at cellular growth -- a lot more users. Moreover, a lot more uses, all kinds of different things that we didn't do before like mobile data, [unintelligible]. And, of course, greater bandwidth because now we got our cellular phone to not only just talk, but we e-mail each other, or chat with each other, and we also now send pictures. I arrive in Washington and want to show my wife, "Gee, look at the Washington Monument." I take a picture of it and send it to her. OK. What's that doing? That requires an awful lot more bandwidth.

And, I already talked about DOD requirements. I've talked about public safety requirements. All pushing what? Towards more pressure on the resource, especially in urban areas. OK. Well, how do we…? This is not new. Tom and I can talk about the silent crisis, which was -- what Tom -- about 19 -- early 70's -- the invisible -- talk about the invisible resource, and how we were reaching a crisis in spectrum management. This problem's been around forever. And, so far, we've dodged the bullet and done fairly well.

How have we done it? Well, reallocation. When you look at PCS spectrum, we took away from some private microwave people and gave it PCS. But, boy oh boy, the easy allocation, reallocation decisions are pretty well done. Look at the battle we're having on UHF television today to get it into public safety hands. The easier reallocations have been done. It's very, very difficult now to dislodge people involuntarily, to take spectrum away from one and give it another. It's sort of like these battles, you know…you've got some little houses out there, and you want to tear them all down, and build something else in the city. Man, you run into all kinds of fierce opposition. And, that's what's happening here too. Reallocation is tougher and getting increasingly tough. People recognize how valuable the spectrum they have and they hire legions of lawyers and consultants -- what? To hold onto it.

Move higher in frequency -- this is additional. I can remember when most land mobile stuff was at 150 megahertz, then at 450, [unintelligible], now it's 900, now 1.9 gigahertz. We keep moving up, but we've about what? Reached our limit there because as you go higher and higher, you get into these raindrops, fog begins to interfere. So, you're limited to extremely short ranges. So, your ability to go higher in frequency to solve the problem is getting more limited. Not that doing so isn't important. It is. But, it's not going to solve the problem.

Increased sharing -- ok. That's another thing. OK. I've got spectrum and you figure out a way that you can fit some other user in. There again the scars on my back from my recent tour at the FCC were over sharing battles. A company called NorthPoint, and we've talked about NorthPoint. NorthPoint wanted to come in and offer a service using DBS spectrum. And, what did the DBS people say? Not no, but hell no.

Female Voice: Over our dead body.

Dale Hatfield: Over our -- yeah. Exactly. Litigated, right? Went through the court. Oh, what a mess. I can't tell you how many scars I've got because somebody wanted to share and people were fighting. So, sharing -- involuntary sharing is really tough. Improved technology -- I wish I could say more about that, but that is helping as I said before. But there's even limitations there, at least in the short term.

We've already touched on this. Let me give you -- let me jump all the way to the bottom line. I don't have time to go through. But, when Tom and I grew up -- I'm actually older than Tom -- the number of radio frequencies that you could operate on was very limited by the technology. I can remember the first two-way radio I had. It had a crystal which determined the frequency and it was in a little oven. And, I think they cost at the time about $75 bucks. And, if you were really rich, you could operate on two frequencies, OK? Well, now we can generate -- for 50 cents, we can generate any kind of frequency you want. So, we have much more flexibility.

So, a lot of our original rigid allocation rules, not only reflected sort of the economic situation, and the strength of different people, it also reflected the technology as well. You couldn't operate just anywhere you wanted to

because the technology wouldn't let you. You couldn't change the mode in which you operated either because of technology constraints. The software defined radio support that -- this has all changed.

But, let me just drop to the bottom line here. What we're seeing is, before we managed spectrum centrally out of Washington. OK. Now, we're getting smart. We're moving some of the requirements out to the edge of the network just like the Internet. What's different about the Internet? Telephone network -- the intelligence was in the [unintelligible] and you had a very dumb device on your desk. The Internet's the opposite of that. You've got an extremely dumb network, and you've got the intelligence, the applications, the services are created at the edge of the network. The same thing is going on here. We're moving more intelligence out to the edge of the network, and using the devices there, and giving the devices more responsibility.

Even your little, stupid, cordless phone at home has that capability. What does it do? It turns -- you turn it on and it searches through and says, "Oops. The neighbor's using that channel. I don't want to use that one" and finds one that's not being used. So, by shifting, the problem with this system is centralized, but we can use devices, the intelligence in devices at the edge to move more of the responsibility for spectrum management to the edge of the network. Now, the question -- the challenge for us -- I shouldn't say us anymore -- the challenge for policy makers here in Washington is how do you encourage that sort of technology to relieve some of the problems associated with the centralized system? So, that's -- where?

Male Voice: [unintelligible] that one.

Dale Hatfield: Sorry. We could very easily spend a whole lecture just on these different technologies. OK. Constraints and Criticisms of the Traditional Approach -- we've already done that. It's still primarily an engineering-oriented, centralized command and control system exercised through network licensing and requirements focused on eliminating or minimizing interference. By the way, there's a wonderful paper, if you're interested in pursuing this. Paul [Mirchey] from the FCC, he wrote a really good paper on interference. What is interference? If you're going to have property rights, you better define what interference is. And, boy oh boy, that's -- is a [unintelligible] can of worms.

Let me just give you -- just to sort of help you with that. The DBS on the NorthPoint issue, NorthPoint says, "Well, we're going to come in and we won't bother the DBS people." And, the DBS people [He means NorthPoint here, I think] said -- did their studies and said, "Oh, no. You're going to reduce the -- our reliability from 99.999 to 99.995 and, therefore, that's negligible. That's not interference. That's not harmful interference. Therefore, let us share." What did the DBS people come with? "Wait a minute. We're competing with cable for high quality signals. We can't have -- we can't tolerate that sort of [unintelligible] per year. You'll bankrupt us if you allow that kind of interference level."

And, that's the sort of decision that you get made -- that the commission is making. And, you can imagine, it's a lawyer's paradise, right? You can go out and hire experts and do all kinds of studies. You get these [unintelligible] studies and you end up paralyzing the agency, right -- because the decisions are so hard and they're so politicized. And, you get what? Delay. And, in an area of high, rapid-technology change, as a society, can we tolerate those sorts of -- NorthPoint is still not settled, right?

Female Voice: They've had some -- the case got --

Dale Hatfield: -- It was sent back.

Female Voice: Yeah.

Dale Hatfield: Yeah.

Female Voice: By the FCC.

Dale Hatfield: I was working on it in what? '97 and '98. We're now seven years later. By the time they settle it, what? The technology, what?

Female Voice: [unintelligible] be gone.

Dale Hatfield: It'll be gone. Yeah. I mean, you know…

Female Voice: But, that same sort of issue came up with the low-power television versus the broadcasters. There was an initiative of Chairman Kennard that he wanted to allow people to broadcast low-power television, like a church would use a very low-power and broadcast just for like two blocks -- three blocks around it -- sermons in the morning, or people broadcasting out of their garages, their vans, or things like that, just to kind of get more spectrum out to the people kind of thing. And, they said, "It will be low power. It won't interfere with the broadcasters." But, the broadcasters…

Dale Hatfield: And, we were vindicated. I have scars on my back from that, too. I mean they -- Congress ordered [Minor] to do a study, and they said the FCC is right and there won't be interference. But, you have a commission there now who's not very interested in hearing [unintelligible] in this report. By the way, meanwhile in New Zealand, it's about this exact low-power thing

and they have -- if you're a union and you want to have a station that covers your union members in a small town, you can do it. Not here. An excellent example. I always say we're facing tremendous pressures.

OK. One of the criticisms of the command and control system, excessive rigidity produces administrative scarcities -- proven over and over again. Stifles technical and service innovation -- I've got a great new technology, but the service rules may prevent me from introducing it. I can broadcast in a better way, but the rules don't allow me to do it. I invent something new. I have to go to the FCC and say, "Mother, may I? May I do this?" And, it takes time. It especially takes time when you're going to do something innovative that may impact on a competitor, right? Because the competitors -- here, again, I'm not attacking attorneys. You [unintelligible]. But, you hired a consultant -- the attorneys that try to stop it.

Lacks incentive for efficient use of the resource -- if I think the public safety -- as director here in Arlington, and I've got 10 extra channels that I don't need, am I going to turn them back? No. They don't cost them anything. I got them from the FCC. They're free. Why would I give them to somebody else? Why would I give them to my friend over in the District of Columbia? There's no incentive.

This -- for people who don't pay for use of the resource, creates a very -- it's a voluntary and involuntary sharing of them. The secondary market [unintelligible] that you -- tries to address it, but that's only a small part of the total spectrum. What that says is, "My business plan -- I'm going to serve northern Virginia, but I don't want to serve southern Virginia. Can I sell the spectrum that I don't use in southern Virginia to somebody else?" In the marketplace, you would have that, right? I'll buy a big plot of land I decide I don't use. I want to subdivide it and sell off parts of it that I don't

need. Generally speaking, what? The FCC rules and regulations don't allow me to sell areas, geographic areas, where I have the right to allow me to sell that off. Or, if I have 20 megahertz here in Arlington and I only need 15, there was restrictions on my ability to sell the 5. And, that's what the secondary market [unintelligible]. But, here again, keep in your mind, the secondary market in my opinion was a very innovative thing that the FCC does. It only applies to a limited amount of the spectrum. A broadcaster, for example, can't say, "Well, gee. With new compression techniques, I only need 1 megahertz. I'll sell off the additional 5 I have."

And, other beneficial transactions, swaps where -- leasing. One of the big things in the secondary markets in leasing. I've got spectrum and I want to hold it for the long term. Here, you don't see land right here in this area vacant. You put in a parking lot, right? They lease it to Parking Company of America or whatever it is. They use it for a parking lot for five years until I'm ready to build a building. Generally speaking, before, you could not lease spectrum. So, these are some of the…

OK. So, what are our challenges as policy makers? Reducing rigidities in the current system and taking advantage of the advanced technologies. The vision of a more flexible future is where you give, as I said before, decentralize these responsibilities, maybe almost all the way down to the device level, and get rid of those color charts that Tom was talking about which says this spectrum can only be used for this purpose. What we're looking to is doing much more opportunistic use of the spectrum. For example, when the radio wakes up, looks around and says I don't hear any signals, dips into a database and says, "Well, gee, I'm in a location where channel 3 is not being used. Therefore, I want to talk to Lisa over 10 feet and I'm not going to use over 10 miliwatts of power. I'm not going to cause interference. So, she and I have that conversation outside the constraints of this rigid allocation structure. A very different sort of model

than this top down, centralized, Washington, D.C.-driven decision -- detailed decision making.

OK. What are the competing approaches or models? In other words, everybody -- I think it's fair to say that people in this community may disagree on the solution, but I don't know of anybody that argues that we do not have a problem, that this system is too -- by the way, it's not just the U.S. It's a U.K., lots of other places -- the European Union just issued a paper in this area. Everybody's concerned that this old system is not keeping up with the technology, and it's hurting our economic social well-being.

Competing approaches and models -- there's three models. And, I won't hesitate to -- I don't like that word competing because I actually, personally, think there's a room for all three. The first, of course, is the property rights model and the basically making spectrum more like property. Let it be owned in a more property-like system, and let it be subdivided, used for different purposes, and bought, and sold, and leased, subleased, anything like that, just like in the property market. Get the government out of it. The government would make some sort of a big step in the beginning. Get the spectrum out there in the hands of the public, and then the marketplace would take it from that place on.

It's interesting -- the flip side of that is sort of the opposite of the property-rights model. And, it's management of spectrum -- there's a commons. And, we'll come back and talk about that a little bit more. And, of course, there's some people -- if you look on the federal government side, is saying, "Well, gee. These two approaches are probably never going to work very well for us. We need to do a better job of command and control. We need more sophisticated engineering models and so

forth." I'm not going to say much about that today, but rather address the others.

OK. Move towards the marketplace forces the management and licensing of the resource. In other words, you hand out -- I use -- I like to say -- I don't say property rights. I like to say property-like rights. And, I don't know if in your law school classes whether you -- how deep you dug into the notions of property rights, but from a [unintelligible] standpoint, it's a fascinating area -- exactly what are property rights and so forth? But, anyway, you get something like property-like rights. You get -- those rights are exclusive. Now, when I say exclusive, there -- it gets into issues of easements and some things -- a really nice sort of issues there. And, flexibility of use -- I'm -- unifying licenses is an international term we don't use here in New Mexico, but I do a lot of work there and, actually, unified licensing means that you get one license and you can do anything you want to. Traditionally, our license is what? You get to provide television. You get to provide radio. And, unified licensing means you get a license, like you do in PCS today, and you can offer what? Voice data, image, video, everything except essentially pure broadcasting. You can do anything you want to. That's unified licensing.

Spectrum trading in secondary markets -- we already talked about that. But, that would get spectrum out there in the hands of people just like they do land, and then allow the marketplace to sort it out. There's some wonderful stuff going on in different places. Australia has spectrum trade units. Guatemala, believe it or not, if you want an interesting study here, Guatemala's done some wonderful work in [unintelligible] property-rights system. We begin to hear in the U.S. -- one of my gripes is sometimes we tend to think we won't -- and we sure don't -- but, a lot of countries here are way ahead of us. New Zealand is -- has had a property-rights system

for ages now. The interesting -- some of the problems they're having down there is people getting spectrum and then holding it.

It's interesting. Spectrum is sort of unusual because you don't destroy it by use. If there's spectrum in [unintelligible], if I own the spectrum rights here in Arlington, and I don't use it, if you can jump in and use it, and jump off without ever me noticing, for example, is there any harm done? Is that a traditional trespass? You still got what? The same amount of spectrum tomorrow as you had today. If I jump in and want to use it on the day when you're not, have I hurt you in some way? I mean these are the sort of [unintelligible].

Anyway, so this is one solution. The flip side of this is unlicensed. Like I say, if you read in this area, you find out that there are some very, very nice examples around the world where people manage scare resources on a common spaces. And, you do it with what? Well, you say you can't herd more than 10 cows in the pasture, and no more than 10 cows per family. Or, if you're talking about fishing off the Outer Banks or something, you say what? Your net can't be -- how small your net had to be. You can only fish what? 10 days a year or 20 days a year. You can come up with rules and regulations that allow the resource to be used.

Now, the -- as you know, when you use a resource in common -- But, Boston Commons was what? That was the area people used to graze their sheep on, right? It's a -- if you live in an apartment building, you have your commons, area, right, where everybody shares in the views. Usually, the problem with commons-type thing is what? The tragedy of the commons. In other words, if I have this pasture, and one -- I don't have any rules, one person decides, "Well, gee. I'm going to double the size of my herd, and I can make more profit." Actually, what that person does -- and I say what? Well, I'm not going to let him or her get away with that.

I'm going to double the size of my herd. Everybody doubles the size of their herd, we end up -- we trample the grass all down and we what? We end up with no pasture. That's the tragedy of the commons.

Here, when we talked about common spectrum, we're generally talking about the unlicensed spectrum, the spectrum that's regulated independently by 15 of the commission's rules. And, the stuff that you see now, when you walk across the street to the coffee shop or in this building, if you're using the technology called wifi, that's unlicensed. Anybody can put on a transmitter, an access point, and offer wifi service any place in the country they want to. There's no property right involved. I just can do it as long as I what? Obey certain technical rules that are equivalent to the sort of the size of the fishing net in which I put constraints on the amount of power, an entirely different sort of notion. It's a public park that anybody can go and use as long as what? They obey certain basic rules.

The act of this points to the success of wifi. For example, if I invent a new technology what? I can introduce it tomorrow. If I see a new area that I want to cover, what? I can introduce it tomorrow. If I'm not using any spectrum, anybody else can use it immediately. It gets rid of all the rigidities associated with our traditional system and uses, in other words, these rules and regulations to prevent the tragedy of the commons. And, of course, the question is how successful that is. And, if you read a message, [unintelligible] and so forth, you could read something. It's the commons issues. I mean there's various things that could make it work. One is social marks, right? I don't overgraze because it's a small community and my neighbors are going to get really angry with me. They know me.

On the other hand, if it's an anonymous situation, right, where you don't know me, and I can cause trouble and get away with it, and not have to face you over coffee the next morning, I'm less -- I'm likely to do it. We can use technology. In fact, the Internet has something called slow-start. You know…when -- those of you who are techie guys -- when you start accessing the Internet, your software goes in and sort of senses how congested the network is. And, if it's too congested, it does what? It backs off. If the network is not congested, what? It takes a lot of bandwidth. Well, that's the sort of adjustment. We can build into these radios protocols that makes them behave. In fact, there's a wonderful proceeding at the FCC on 3650 now where the commission is really struggling with this. So, we can use protocols to protect against the tragedy of the commons. Tom and I can talk about amateur radio.

Let's quickly -- oh. Here again, the -- this [Johai Menckler] [can't CQ this name] and people like that who've written extensively [unintelligible] -- the people who've written extensively in favor of the commons approach point to the success of hotspots and so forth, that this is working. And, you see it out in New Mexico, for example, and in Kansas, for example, the local Internet service provider will put an access point on top of the grain elevator. If you ever go through Kansas here, there's a great big, huge grain elevator. It's -- what are they Tommy -- a couple of hundred feet tall -- maybe 100.

Tom Whitehead: [unintelligible]

Dale Hatfield: Yeah. Up -- and you put them. And, you can cover the whole town that way, and provide Internet access for the whole town, and do it without applying for an FCC, why? It does not happen to go to an auction. Is there a possibility of interference? Yeah. When the second ISP can come into town, what? What do you do? Do you sit down across the -- you have

breakfast on Monday morning -- I know these are true stories. You have breakfast on Monday morning every week and you say, "How are you doing?" "Well, I don't have any interference." Or, "Gosh, I'm getting some interference." And, you work it out. You work it out.

So, advocates of this think that this is really the way we should be going, and there's a certain amount of tension and, of course, improve the command and control system. I think I can finish on the next page. OK. What are the advantages and disadvantages of the license versus the unlicensed? Well, what are the advantages of license? Well, the lowest investment but providing more uncertainty for investors. When you invest in an infrastructure where your title is cloudy, when you buy a new house without title insurance -- unlikely -- unlikely you can get any money on it. So, the license gives you what? A much clearer understanding of what your rights are and, therefore, if you [unintelligible] it ought to facilitate in the marketplace because you reduce the uncertainty.

For the design engineer, when I'm out there in an unlicensed environment, I'm not sure what I'm going to be facing. But, if I can go to the license database on a license service, I can figure out pretty well what the interference environment's going to be, and I can design around that, design to take it into account. And, of course, license provides what? Opportunities for government to get some revenues out of the use of the public resource through the auction process. The disadvantages -- the licensing creates an entry barrier. If you wanted to really compete with Verizon here in Washington, D.C., good luck. But, right? You got to go through that licensing [unintelligible] and getting spectrum is tough.

Stifles innovation in products and services and let's the company buy greater regulatory flexibility.

Female Voice: [unintelligible] Do you need a light?

Dale Hatfield: No, it's something -- whatever this is, it's telling me something.

Male Voice: Ignore it for a second. It's almost done.

Dale Hatfield: That brings up opportunities for spectrum. Boy, this is what they saw in New Zealand. For example, Verizon being a very strong competitor in this market, could buy up spectrum and just hold it and not use it to prevent -- in other words, [unintelligible] behavior. Now, this is getting into the anti-trust laws and some other issues. And, you may be able to control this behavior in other ways. And, of course, there's [unintelligible] had spectrum caps. They limited how much spectrum Verizon is able to hold.

And, it diminishes -- now, this is slide that I use internationally. It diminishes opportunities for local initiatives and microfinance. One of the nice things about the unlicense, as I said before, is the ISP in a small town can offer Internet access. And, you see this in places like Africa and things like that. You just put in this low-cost technology and suddenly you provided [unintelligible] for the village. If you had to go through an auction and licensing process, go through some sort of central authority and so forth, it's much more difficult. In some countries, of course, we have even corruption problems and stuff like that, trying to [unintelligible] license.

One of the reasons IT&G, who I do a lot of work for -- we've been sort of pushing this unlicense is, it allows you what? Local initiative. There's two ways you can build a network, right? You can -- capital investment and build it from the top down, or you can let people take their own initiatives at the local level, make investments, and build the network from the

bottom up. A lot of this new technology lends itself to a more bottoms up approach.

OK. Reform proposals -- it's unlicensed. It promotes rapid innovation and services, right? Because of minimal regulatory restrictions. Boy, was wifi and WiMAX -- is that -- boy, really examples of that rapid technological change. It reduces various [unintelligible] and opportunities for corruption by eliminating the licensing step. It eliminates opportunities for spectrum hoarding. You know…I don't have anything, so it's hard to hoard it. It creates opportunities for local initiatives and microfinancing. This advantage is -- of course, it creates conditions that may lead to the tragedy of the commons.

This is where the debate is. Again, Joe Weiser [Philip J. Weiser?] is in my paper about -- you know … we have some questions about the enforcement stuff that you may need to do may be a little bit more complicated than some people say in terms of enforcing it. May reduce the investment incentives due to lack of exclusivity. Well, when I think of major investment here in Arlington to roll out a wifi network, if I'm not sure that you won't come in and build something on top of me causing interference to me. It reduces opportunities for government to collect revenues.

Female Voice: Most people would think that's an advantage.

Dale Hatfield: Yeah. You can argue both ways.

Female Voice: Right. Right.

Dale Hatfield: I think with the scarce resource -- I mean before we had comparative hearings, what you did is gave the scarce resource to somebody who

would make lots of money on it. And, you say, "Gee this is a public resource, why should they be privately enriched by the use of that public resource without charging them something?" It creates issues of fairness [unintelligible] that pay for spectrum. This is an argument that I get internationally all the time. It's not that we're against unlicensed, but we just auctioned all the spectrum and now you're going to give this unlicensed spectrum to anybody who wants it. That undermines the option that I just had. And, of course, my opinion is they should have said in the auction, "There's no guarantees here. You're getting to use the spectrum and we still have flexibility to do anything we want to." Of course, that would reduce the amount that we get from private [unintelligible] Anyway, sorry I ran a little…

Male Voice: We've got about four minutes where we [unintelligible]

Dale Hatfield: By the way, if there's a -- these are rich, scholarly papers and theses and so forth. This area is just incredible on the number of topics that are out here to [unintelligible]. Yes?

Male Voice: Yes. I have a question. I'm writing my paper on 3650.

Dale Hatfield: Oh, you -- wonderful -- wonderful.

Male Voice: I guess what I'm looking at is simply the proponents of the commons always make the claim that by going to the commons we remove government in the equation. And, as you see it, that's not the case.

Dale Hatfield: No, it's not the case. There's a guy here -- Lazareth [Lazarus? Mitchell Lazarus is a DC-area lawyer specializing in the regulation of new telecommunications technologies] --

Female Voice: [Tom Haybrook]?

Dale Hatfield: -- No. Lazarus who wrote a fairly -- if you'll send me an e-mail, I'll send you a copy. But, no, what we've done is change the method of regulation. We've shifted the regulation to the devices. And, you've got a real dilemma. You see the dilemma there is to prevent the common -- correct the commons-type problems by reducing the quality of service. You have to have some sort of a protocol. Well, as soon as you establish a protocol, and by then your rules and regulations, we're right back where we started, right? It's just another form of regulation. Is it better? Maybe. But, it's certainly not deregulation. And, boy the commission really -- and the commission got itself in a -- it really got itself in a bind, didn't it? It's sort of one of the benefits? of license and the benefit of unlicense, they tried to split the difference and ended up with a mess. You can't -- you know…it's [unintelligible] half pregnant. I mean you really -- we really messed it up, as you see from the commons. That's a good topic. That's a great topic by the way. Yeah.

But, Mitch Lazarus, [unintelligible] attorney, wrote a wonderful -- not a paper, but a presentation in which he essentially said that in transformation of regulation from license sort of forms of regulation to regulate your license.

Male Voice: Do you have my e-mail?

Dale Hatfield: Yeah. If you can e-mail me, Hatfield@colorado.edu and I'll be glad to send it to you. In fact, he would be an interesting guy for you to maybe interview. Any other paper that I can help with? That's the most popular part of the presentation. Can you give me some leads on papers? Yeah.

Female Voice: I've got a question.

Dale Hatfield: Sure.

Female Voice: Going back to your [unintelligible] about interoperability, and the jealousies between them, what was your [unintelligible]?

Dale Hatfield: This is on tape too, isn't it?

Male Voice: I'll turn it off.

Female Voice: You know…are you -- would you recommend a federal role and would a federal role be possible at all for interoperability and even E911? Is that possible?

Dale Hatfield: Well…

Female Voice: I was thinking just the opposite. I'm wondering whether we should have many little FCC's or many little IRAC's in the states kind of forcing everybody to cooperate.

Dale Hatfield: And, of course, the FCC in terms of -- as you probably know, in terms of public safety, spectrum has delegated a lot of the details to the local frequency coordinators to do. But, your question is really a political question, isn't it? I mean it's -- and it's really fundamental. What's the role of the federal government versus the states, and how much can the federal government really dictate? Here, I think we see the price that we paid for not having interoperability. That suggests to me more federal involvement.

But, boy oh boy, when the -- Boulder County where I come from is flat on one side, and the mountain's on the other. And, the sheriff says, "I got

to cover the mountains. My system needs to look different than the city guy down here that's in the flat area." And, you're going to have the federal government step in and say, "OK, this is the type of system you have to operate." See? There's a -- am I waffling sufficient here? I mean I would tend to do more at the federal level, but I think that you have to be very careful. When you do that -- it's the same with spectrum allocation. You don't respond to the unique needs of the community when you dictate from the federal level. Am I dodging that answer? It's a tough -- it's really a tough issue.

Male Voice: But, now, couldn't you deal with that problem to some extent by having the federal government set certain performance and interoperability standards that have to be complied with. And, then, say, all right, within these limited parameters, do whatever…

Dale Hatfield: We've had partial solutions where you have national calling channels and things like that -- let me say, too. There's software defined radios that may help a lot here, where a radio can be a local radio one time and a federal radio the next. It can operate seamlessly and that would help. Yeah. The trouble with most of those interoperability things, you still have to have someplace where you take the audio coming in from one radio and put it in the audio going to the other, and where do you do that if you're in the middle of North Dakota? Where do you do that interface? But, there's -- I try not to -- I did a paper recently for a commercial client, [unintelligible] mobile satellite ventures, where they're using their -- they have a technology which combines the…

End of recording.