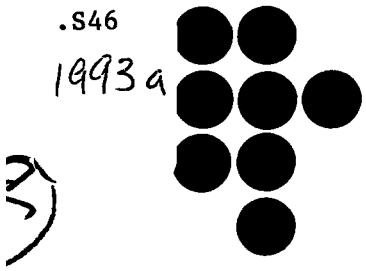

COMMUNICATIONS FORUM

"Spectrum Allocation for Personal Commnunication"

February 25, 1993
4:00 to 6:00 p.m.
Bartos Theater
20 Ames Street
Massachusetts Institute of Technology
Cambridge, Massachusetts

MIT COMMUNICATIONS FORUM
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
COMMUNICATIONS FORUM

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Speakers:

Charles L. Jackson, Principal
Strategic Policy Research, Inc.

Dr. Robert M. Pepper, Chief of Office of Plans and Policy
Federal Communications Commission

Karen Colannino, Legislative Assistant
House Subcommittee on Telecommunications and Finance

Moderator: Henry Goldberg, Senior Partner
Goldberg, Godles, Wiener, and Wright

Rapporteur: Kelly Greenhill, M.S. Candidate
Political Science Department, M.I.T.

Introduction by moderator HENRY GOLDBERG: The subject of today's forum is spectrum allocation for personal communications services. I would like to take a few minutes to set the stage here because it is not entirely clear what personal communications services may be. The proceeding that is currently going on at the Federal Communications Commission (FCC), which involves the Congress, began about two and a half years ago. Someone approached the FCC, and said there was a need for something called Personal Communications Services (PCS), which they defined as an extension of the portable telephones that we are all familiar with, and use in our homes. There were some experiments and operations in Europe, in which expanded portable telephone use was beginning, and this company thought the United States was ripe for it as well.

The FCC then started a proceeding, and the proceeding very soon expanded. In the interests of full disclosure, I will admit that I was in part responsible for the expansion because, on behalf of Apple Computer, I filed a petition to expand that proceeding to include radio spectrum that could be used by a fast growing segment of the computer industry-portable, briefcase, notebook computers. So the proceeding began with expanded telephone service, expanded to include computers, and has just taken off since then. It includes lots of talk about something called personal communicators, which I guess would be a convergence of telephones and computer technology. I have even seen one estimate that says that the personal communicator devices, something I suppose we'll all be carrying, could very well be a $7.4 billion industry by the year 1997. Whether it will be 1997 or sometime in the twenty-first century depends on the proceeding that is going on right now at the FCC.

A spectrum allocation proceeding is one of the FCC's most political proceedings. Since there isn't any loose spectrum lying around, it usually has to be taken from some interest group, and given to someone else.

In this instance, the FCC identified some microwave frequencies that were being used principally by railroads and public utilities for point to point communications, and said we'd like to reserve these for new technologies, such as personal communications services. There ensued a bitter political battle, which took place mainly in the Congress, with the railroads and utilities fighting the loss of their frequencies every step of the way. The battle ended when the last Congress ended, and the FCC's vision prevailed, in that the spectrum will be reallocated. But the political toll was fairly high, in that the new technologies may not get the spectrum for anywhere from three to eight years. When they do get it, they will have to share with some favored microwave spectrum users. And in order to actually get to use those frequencies, they will have to pay to relocate the existing microwave users to, perhaps, higher frequencies, or to fiber optic cable. There are many issues associated with this proceeding. There are some hundred and fifty companies that have participated in it. It is virtually a who's who of who's who in telecommunications, from cable TV companies, computer companies to telephone companies and cellular companies.

We have a well-qualified and distinguished panel of experts to discuss these issues today. These are people who have been in the thick of the proceeding. I would like to lead off with Robert Pepper, whose is in the thickest of the proceeding, because he is the Chief of the FCC's Office of Plans and Policy. His was one of the key offices responsible for the initiative to find radio frequencies for this technology. Robert graduated from the University of Wisconsin in Madison, where he also went on and got his doctorate. He worked a little at Harvard, and was a professor and head of the communications program at the University of Iowa before he taking over the Office of Plans and Policy. He was an assistant to an FCC commissioner, and before that, ran the Annenburg Communications Program in Washington, and worked at the National Telecommunications and Information Administration at the Department of Commerce. Robert...

ROBERT PEPPER: Thank you, Henry. I think that if we look back at the beginning of the PCS proceeding, and look at what has happened since, I think this is an excellent example of what happens when the government sends a signal that it is interested in

something. When the FCC opened a Notice of Inquiry into personal communications services, a little more than three years ago now, most of the activity in PCS was being done in Europe. There were some people here who were beginning to look at the technologies. We had a petition before us for a company with an experimental license. What has happened since has actually been quite remarkable. We have in excess of two hundred experimental licenses out there, and we have people actually investing real dollars in technologies to provide services because they now understand that the government is willing to go the next step, and make spectrum available. Without the first signal that the Commission was interested, there was a real chicken and egg problem. Without the signal the Commission was interested in allocating spectrum for PCS, industry was not willing to invest in the technology, the trials, the experiments, the lawyers, the consultants, and the whole process necessary to deploy a new technology. So the role of government becomes terribly important, and not only because we actually have our hands on the spectrum, and determine who is going to get it. Merely the fact that we opened up a proceeding, and said we are interested in a new technology to provide these kinds of services, and are interested in questions about where in the spectrum these services ought to be, unleashed an enormous amount of activity within the U.S. telecommunications and electronics industries. So, you need to keep that in the back of your mind as we talk about some of these broader issues in terms of spectrum allocation.

What I would like to do is take just a very few minutes, and talk about some of the key variables that we are looking at with regard to industry structure, in creating a new spectrum-based industry, and how these various factors interrelate with one another and how they affect one another. The first one is the definition of PCS; how do we define this service? I think Henry's definition is a pretty good one, but it is a pretty broad one, and I think that reflects what the Commission has done. We have essentially said that personal communication services are services that are mobile, that are portable, and that are designed so that one user can communicate with another user. The difference between portability and mobility, I would argue, is velocity. If you can take something and move with it from your home to your office, it is portable. If you can use it while you are moving very rapidly, I would argue that that's mobile. We permit both with the personal communications services.

Therefore, if you think about it, the only thing you can't do with personal communication service is broadcasting, point to multipoint; also we have also said it cannot be used for fixed microwave services. That is, in large part, because we are moving fixed microwave users in order to make spectrum available for the personal communications service. You will note that I did not say anything at all about voice, data, or video; there are no restrictions on the use of the spectrum of this service for different applications.

So, in the future, I can think of personal communications services such that I might call Henry up with my little phone. I am not a consultant, I am a bureaucrat, so I have to fake it. *[At this point, Dr. Pepper took out his wallet, and used it to simulate a pocket-sized personal communicator.]* I will talk into it [the communicator], then put it in my pocket. Somebody up here probably has a little Motorola Microtech, or something which is about the size of what the PCS phones are going to look like. But, at some point, I will look into my little wallet-sized phone, and it will be a screen with an image, and I will see Henry, or be able to download a document. This is the whole notion of the personal digital assistant, that we have heard so much about from Apple.

So, the definition of PCS is a fairly broad one, and it is purposefully broad because we don't know in advance which segments, or which niches of this personal communications market will be the ones that capture people's imaginations, which will capture the kinds of applications that people will want to buy and use. We have a relatively broad definition of PCS, with a lot of flexibility built in for the entrepreneurs who are developing the service. Therefore we expect there to be a range of services, ranging from something that you could think of as competing with your cordless phone (in other words, a wireless tail on a wired loop), all the way up to something that would be very high

velocity, to compete with the existing cellular phone, (except maybe have some additional functions built into it); that becomes important, I'll come back to that. It is a range of services, and it is likely that we will see various niches in this market develop. We would hope that various niches develop, based upon the availability of spectrum and licenses to provide service.

We also, in defining this, incorporated it as a result of Henry's petition on behalf of Apple, and the people in the computer industry that supported it, as well as people in the business of wanting to provide wireless PBXs who supported it. We incorporated what we referred to as an unlicensed PCS, which would include devices that would not have a license, but which would function much more like your cordless phone. You go to the store, you buy it, you plug it in, and you use it. You don't need a license, but there are certain technical parameters, within which it must operate. We also broadened the scope to include what we referred to as narrow band PCS. In a moment, I will talk about where we are talking about most of this, which is at the two gigahertz (GHz) band. But there was spectrum available that had been unallocated in the 900 megahertz (MHz) region, that some people had proposed using for advanced paging services, paging services with some text, which would leave you messages, and so on. We incorporated the 900 MHz into the PCS definition to provide for a narrow band version of PCS, as well as the broad band version of PCS. Most of what I'll talk about, and what I think everyone else will talk about today, will be primarily around the two GHz band, primarily on the license services, although I expect we will deal somewhat with the unlicensed services.

There are a number of variables that become important in the Commission's consideration, and they all really go to the efficiencies of the service and the capabilities of the service, in terms of this range of service niches. They include the block size: How big a chunk of spectrum do you need to provide a viable PCS service? Each of the two cellular licensees in each market received 25 MHz , (initially 20 MHz and then we added five to each block). There was nobody else in there, and they each got 25 MHz of unallocated spectrum. One of the questions we asked was, how much spectrum do you need for PCS that would provide the equivalent to the unoccupied 25 MHz that the cellular people started with? We asked questions about a range of 20 MHz up to 40 MHz, noting that this spectrum is not unoccupied. As Henry has already pointed out, in virtually every place, there are incumbent fixed microwave users. And, these are very important microwave users when it comes to the railroads, the pipeline companies, the utilities-industries that provide alot of very important services. In some cases, the services are related to basic life and safety kinds of functions, so it is important that they not just be displaced. In fact, the proposal worked out through the political process is that they will be held harmless, that is, they will be moved at somebody else's cost to higher frequencies if necessary, and be held technically harmless. In other words, the system they will operate at the higher frequencies will be technically as good, (meaning they will be able to provide the same functionality, reliability, etc.,) as their current facilities. So, the question is, how much spectrum does one need, acknowledging that it is not empty, and there has to be a transition period?

Second question. How many licenses do you want? Clearly, we want to have a competitive market. Clearly, we want to have a balancing between having enough service providers in PCS so that there will be competition, so that consumers will benefit, and that we have a range of services offered. The question on the other side is, if we have too many licensees or operators, will it be difficult for them to raise the capital necessary, to make the investments necessary to provide the service? And later on, we can get into whether or not that should be a constraint or not, because maybe what we need to do is just give out more licenses than we know will survive, and allow those that can raise the capital to build, and then those that don't make it, can use those frequencies for a different kind of service. Or we can reallocate it, reassign it. So, there is a real question, a tension in there, in terms of you don't want too few, you may not want too many, or you could make the argument that you do want too many, especially if there is the flexibility of allowing some of those operators to move on to other things, or give the spectrum back, or do other things

with it. What cuts in kind of a funny way with the next issue, which is eligibility, is this number of licenses. By the way, clearly what the Commission said was that we don't think two is enough because we believe that we would have been better off with more than two cellular operators in each market, and so the Commission essentially asked the question, should it be three, four, or maybe more? Let us know.

If you view PCS in part as a competitor to existing cellular service, so that if one or more of the cellular providers becomes a competitor with an incumbent cellular provider, the question is raised, should a cellular provider, in its local cellular market, be permitted to obtain a PCS license? There are significant trade-offs here. Based upon a study that we did in our office, (if anyone is interested, I can send it to you), a working paper by one of our engineers, David Reed, who looked at scope economies and providing PCS. He found that there are, in fact, significant scope economies in providing PCS with existing cellular operators, cable television operators, and local exchange operators. Now if there are significant scope economies, that means if the cellular operator provides a service, it can be provided at lower cost then if they weren't providing it. Therefore, you have a tension between wanting more competition and the benefits of competition, and losing the gains the consumer could get through lower prices, better service, etc. And it is a tension. If the number of licensees is large enough, you don't care whether cellular operators have PCS because they can develop a different niche service. There will still be competition to cellular, and it might be a win-win. If you have a very few number of cellular licenses granted, then maybe you do want to worry about the eligibility of cellular licensees getting those licenses.

Another issue under industry structure is how big a geographic area do you grant the license for. We granted cellular licenses based upon 734 little areas, called MSAs and RSAs, (Metropolitan Statistical Areas and Rural Statistical Areas). One of the things we found with the cellular experience is that it was wrong (cellular people still like to say it was right), but based upon our analysis, it was wrong. Look at the way cellular operates today, not the way it was licensed, but the way it operates. It operates in regional areas because through trading, acquisition, swaps and so on. People tend to use a mobile service in a wider area than just some of these little areas, so we now have not only licensees with regional-type licenses (the regions vary in size). But we also now have brand names, Cellular One, which is an agglomeration, (like contract in many cases), of different cellular licensees operating a nation-wide brand name service called Cellular One. The wire line carriers, (all but Southwestern Bell), announced that they will have a new brand name nation-wide service called Global Cell, or something like that. So there will be a second nation-wide brand name service. We don't think 734 is probably the right number. The question is, should it be a nation-wide license, should it be a regional license, or should it be some kind of local license, but with an area larger than one of the little 734? That becomes important in terms of industry structure and who gets to play, and so on. We can talk about that.

And then finally is the question of how does one grant the licenses. How do you give them out? Historically, the FCC has granted licenses in two methods: comparative hearings and lotteries. Comparative hearings take a very, very long time, and it is almost impossible to make distinctions based upon alot of the criteria we would use. In fact, we have granted licenses based upon how many spaces there are in a parking lot because there is essentially no way to make distinctions. The Commission has also used lotteries that sped up the process, but still took a long time. We then ended up with alot of lottery application mills, and you then have alot of windfalls. So, for example, in Columbia County, Wisconsin, (which as anyone from Wisconsin knows), there are not a whole lot of people, but it happens to be on one of the interstates. Within six months of obtaining a construction permit, the cellular licensee turned around and sold it for sixty-two million dollars. In Cape Cod, within three months of obtaining the cellular license, the licensee turned around and sold it for $47 million. In effect, the lotteries led to a set of private auctions, where many of the licenses were sold to the highest bidder.

So, there are problems both with comparative hearings and with lotteries. The Commission had proposed, but had not obtained much support for auctions or competitive bidding in the past. That may have changed last week with President Clinton's call for spectrum auctions. And in fact, the President's budget identifies $4.1 billion being generated for the public, as opposed to private windfall, as a result of competitive bidding out of spectrum auctions. The $4.1 billion, I understand, is based upon PCS licenses. In the past, of course, the licensees were paying for these licenses in sort of the after-market. The public never benefited, even though it is the public's airwaves. Public auctions would benefit the public, and there are some important political and social questions related to the auctions, but I think those should not be show-stoppers. Those can be worked through, and worked out, to everybody's satisfaction. Except for the people who have always in the past gotten licenses for free, and now are going to have to pay, they are not real happy. In any case, those are the major industry structure questions facing us as we go through our deliberation.

HENRY GOLDBERG: I also want to point out, Robert, that there is no health hazard in holding your wallet up to your ear, except in Washington, where it may be grabbed and taxed.

Chuck Jackson, is MIT's gift to all of us in Washington. Though he got his undergraduate degree at Harvard, he got the rest of his degrees, including a Ph.D., at MIT. Chuck has had a continuing distinguished career in Washington. I first met him when he worked as an expert for the House Telecommunications Subcommittee. He went on from there, to found his own telecommunications consulting firm, basically which is what he has done in various forms since that time. He has authored and co-authored many studies on public policy issues in telecommunications, and has testified before the Congress and the Federal Communications Commission on many telecommunications issues, including personal communications services.

CHARLES JACKSON: Thank you for the introduction, Henry. Just to put it in perspective, this is the Course Six view of PCS, and I actually have a Course Six-type question when we come along here. Well, this is my introductory slide. The point I am going to try to focus on here is what the FCC can do, and what we can do here in America to get a PCS service that really serves public needs? How do we make PCS efficient? How do we ensure that the PCS industry is sufficiently competitive, whatever that means?

I can give a counterexample, however, of sufficient competition where government intervention got the wrong answer. This was in the United Kingdom, when they invented the public telepoint service. This means that you can use your cordless phone at pubs, at tube stations, railway stations, things like that. It was a public service, and it was a nice idea, particularly when it was thought up, because they had really crummy pay phones. But the British government went on to license four firms to provide the telephone network service. Well, four had to be exactly the wrong answer. It turned out all of them finally withdrew from it. The right answer was perhaps thirty-one, which was the technological limit. There was a five bit field in there identifying the public network service provider, and if you have got a five bit field, don't license only four. Or conversely, license only one, and make sure they are going to succeed. But four seems to me to be the government doing exactly the wrong thing. It's sending the signal that a firm has a pretty good chance to make a profit. We know that four is the optimum number. Whatever the optimum number was, I doubt if it was four.

The general parallels between my talk and Bob's comes from the fact that we are looking at the same questions. The FCC's general framework for approaching PCS, and the kinds of technical rules they are proposing to adopt, I think are quite sound-the total bandwidth that is available, the region in the spectrum, the focus on the key economic issues. For example, what issues are going to affect how the service is delivered to consumers, and as far as I can see, these are the four top issues that will determine the

nature of the PCS service that is made available. *[Dr. Jackson referred here to his slide on the key economic issues in PCS.]*

It is the third one, which I will get to in a minute, the benefits of contiguous spectrum, that is actually a Course Six type question. I actually have an opinion about that, but if people think I am wrong, I would love to hear some discussion, maybe some persuasion. If we assume a fixed total band width, then there is a question of how much band width each licensee gets, or to put it in Bob's terms, how many firms do we license in each community to provide PCS services? The Commission has talked tentatively about making 90 MHz available. If you license that in chunks, the same size as cellular, you could get three licensees, and have a little left over for a small licensee, or something extra. Maybe you decide that we want many more competitors in there, and therefore you would divide it into much smaller chunks.

Geographic extent of licensees, Bob has already touched on that, but I will just make one observation because it is fundamental to the process. That is, why is the Federal government deciding the geographic extent of this business? The answer is when it passes out licenses in the beginning, it is almost impossible not to. We made a decision in cellular to pass it out in relatively small chunks, but chunks much larger than previous practice had been in radio licensing and mobile licensing. And we've seen in the operation of that industry, these chunks have been combined. People like MaCaw have gone out, and bought literally hundreds of them, and assembled much, much larger operating areas than the FCC originally licensed. Now, you could imagine a market scenario, an auction scenario. If the FCC had auction authority, they could divide the PCS spectrum up into 734 little regions. But they could entertain contingent bids. If you want to bid for some region that is larger than the FCC packages, fine, enter the bid, and what the FCC will do is grant, not the highest bid in each community, but that set of bids, which in total maximizes the revenue from passing out the spectrum, maximizes the value that the bidders place on it. That kind of choice in a comparative hearing process is unthinkable. You'd have one guy come in and say, well, I have this great idea for service west of the Mississippi. Somebody else says, well, I have this dynamite idea for service in Los Angeles; these would really be incomparable units. One of the advantages of cutting the pie into small units, or geographic areas, is that it makes it possible to do things like comparative hearings. I want you to observe that calculating the winning set of bids is a typical covering problem. You know, zero-one integer, linear programming and it is NP complete. So, the calculation problem is non-trivial.

In regard to contiguous spectrum, I'd like to come back to that, I think there is a strong argument that PCS spectrum should be allocated in contiguous, rather than separate chunks.

And finally, I think that the unlicensed service that Bob was talking about, is very important. It doesn't get much focus, but this is the part of the PCS spectrum that will support wireless PBX extensions, local area networks, various kinds of portable computer interconnection, personal data assistants. And I think that if it is done carefully, it will also support unlicensed service providers, such as firms that are much like the CT2 operators in the U.K., or in other countries. But the idea is of a public data network, with a terminal in all the airport lounges in America, so that when you go in, you could log in and get tied in to various public data networks, without trying to find an outlet in the airport. You could just turn on your computer, and do it. It would be very convenient, and this spectrum will probably be the backbone for that.

With regard to bandwidth per licensee, the FCC asked questions about three licenses at thirty versus five of eighteen. In that range, the kind of answer I get is that engineering can't offer alot of insight. This is a graph that shows the trade-off between number of service providers and technical efficiency.*[Dr. Jackson refers to graph entitled "Relative Spectrum Efficiency Decline with additional entrants.]* There is no cost issue in economies of scale; it is purely technical. There are substantial queuing losses when you don't have very many channels. Back in the 70s, when the Commission was looking at

this, they gave up alot of efficiency when they went from one to two service providers in cellular. The theory was, though, that more competition made up for it. The same kind of analysis is more gentle with the narrow bandwidths that are required today, so that you get more channels per unit of bandwidth.

The other issue that comes up here is economies of scale, and here you can think of some easy bounding assumptions. If, for example, you think radios are going to be quite expensive, there aren't going to be alot of economies of scale because if you have twice as much spectrum, the number of radios you are going to need is still going to be a function of the number of active conversations you have, not the bandwidth you have. Conversely, if you think the cell-site costs are going to be the only problem for you, you are going to have to go out and rent those from an electric power company or a bunch of landlords. And as cell diameters get smaller and smaller, the system operator has less freedom in where to place the base station. So, the landlord has more opportunity to extract something. Right now, when you have got a cellular system, you might have a slot of half a mile or a mile within where you put a cell-site, and you can argue with many potential landlords. If you have 500 meter diameter cells, you have very little flexibility in which landlord you deal with. In that case, it doesn't matter what policies the Commission comes up with; the economic rents are going to be extracted by the landlords. If you assume that the cell-site costs dominate, then you get a situation where, if you have twice as much spectrum, your PCS system costs half as much.

Next is geographic extent. This is an area that is quite important. The FCC asked questions about how big a PCS enterprise should be. Alternatives included the current licensing scheme, the Rand-McNally major trading areas, of which there are about fifty, fifty-one, and nationwide. Or you can think of states, RBOC regions, nation-wide licenses. My own view is that small license areas are quite inefficient. We have seen this in cellular, with cellular clustering we now have many situations where multiple cellular licenses are served by a single switch. That is, that the economies of scale in switching are sufficient to allow you to serve multiple systems. There is a situation in the Midwest, where at least 11 or 12 RSAs are served on one switch. The article in the trade press that described this, referred to it as "Minnesota, Land of Ten Thousand Lakes and one cellular system." There is other overhead that can be shared more efficiently, and in larger units.

But if the Commission passed out fairly small license areas, that would delay competition. Basically what you'd have is that the people that got those licenses would somehow need to get together and consolidate, either to contract or to consolidate. There is frequency coordination cost between the regions, or along the boundary of the regions. I think this coordination will be a much greater problem than it was with cellular.

Finally, you have to think about the strength of the competitors over the next decade. If you assume that maybe ultimately you'll get consolidation, you'll get a system operating. But how strong a competitor will it be if its growth is stymied for a few years, and what does it say for the total benefits to society if the PCS enterprises really aren't up and functioning at their best for an extra half decade?

What kind of things cause delay? With small licenses the standards choice issue is going to be difficult. I would predict that the FCC will not mandate a PCS standard. It has indicated so far that it doesn't intend to. I think that the standards choice issue in PCS for the mobile and portable services is very hard. We have multiple standards floating around that are quite different. DCS 1800 versus Qualcomm CDMA versus IS-54 translated up the spectrum. The vision of a committee of 734 lottery-winning dentists and surgeons choosing a standard is unsettling. If the current Administration manages to raise the marginal tax rate, we'll find even more people trying pool their money into these tax scams. The thought of that committee picking the right technical standard is mind-boggling. I imagine it would take them a long time to do it, and they would probably do it wrong.

We have a difficult problem with national marketing. I think Bob mentioned the fact that we just saw, in the trade press last week, the announcement about approximately 83% of the customers in North America that are served by the wire line licensees in

cellular. These firms got together to create something they call the Mobile-link Alliance. They agreed on common standards, like what you dial to indicate that you are roaming, what you dial to get information about your service, and established common conventions on the use of the service, and on interconnection. Well, this is ten years after most of these entities got their licenses. It is a long time, and it clearly indicates that there is a market need for nation-wide consistency in the service.

Similarly, if you had small licenses, there is work that needs to be done before licensees can do roaming. You need to agree on technology, contractual agreements, building infrastructure to support it, common communications standards. Again, it is something that inside the firm is relatively easily accomplished, but is very hard to accomplish between the firms. The same sort of thing goes with manufacturer commitment to technology. Why should a vendor ramp up production of a particular standard if they are uncertain about the customer's commitment to that standard? But, similarly, if you are a committee of four dentists from Des Moines that has the Cape Cod PCSD, you might just say, let's not invest too much in infrastructure now, until we know which technology is going to be a winner. We do not want to have an orphan technology; we want to invest in the right one. Let's forego the chances for three or four months profits, in order to make sure our capital investment is safe.

Another issue that I think is a significant problem for small cellular regions is inter-region coordination. One of the things we had with cellular was that the interference was perfectly symmetric. When cellular was first licensed, the AMP standard was mandatory for all service providers. The Commission has now given service providers the authority to use flexible technology, although they are required outside their geographic area to create no more interference than they would if they were using AMPs technology. If you have no chosen standard, and you are a PCS licensee in your region, and you decide to invest in a low power technology, (let's say, something similar to the Bellcore framework advisory), you really need to worry if your neighbor installs some kind of higher power gear. The Commission's proposed rules for power limits are quite high. But though the proposed rules were developed analogously to the rules that were developed for cellular, the FCC adjusted the power level upwards to allow for increased path attenuation at the higher frequency. I think that the protection level is up by nine or eleven decibels. The signal that you can see at a region boundary is quite a bit hotter than is allowed in cellular, even though the trend in technology has been to develop mobile and portable communications gear that can operate at lower powers than with cellular. We would be well served if the Commission would go to a significantly lower power level at the boundary; that would make this issue less of a concern.

All in all, I think that bigger licenses are better. The logic is fairly clear. I think Bob indicated his view that the Commission recognizes 734 license regions is inappropriate, and a smaller number would be appropriate. I think the number that best serves the public interest is one, but five is better than fifty, two is better than five, one is better than two.

And if you think about geographic licenses, you can also think of it in a different fashion. There are two ways to look at what Craig MaCaw has done. He may have obtained one or two licenses at the beginning directly from the FCC, but he bought the rest from the original licensees. MaCaw's actions have indicated that clusters of cellular licenses are more valuable than stand alone licenses, and serve the public better, and provide more economic value. Or they imply that he saw further than most, and that cellular was undervalued when he bought it.

My third point here, with regard to contiguous spectrum, (and I'd love to have argument or support on this), the way I developed my view on this was that a client had another consultant who told him that contiguous spectrum was a good way to go, and they asked me to do a little report on it. I wrote a report with the pros and cons on each side, and I didn't really come to a conclusion. I hadn't come to a conclusion in my own mind, and I sent it to the client, who read it and said, "Well, I read your report, and it is

overwhelmingly clear that contiguous spectrum is the way to go." I went back and read it, and convinced myself that I must have argued that. But it sure crept up on me because I didn't have a prejudice at all when I wrote it.

There are technologies that have been devised, CT2 is the most widely known example, but there are others around, where time division duplexing is used on the channel, instead of pairs of frequency-duplexed channels. If you think about local area networks, Ethernet or something like that, which is a base-band system, it uses something similar, in carrier-sense multiple access, where you have the same pool of transmission capacity, and you use it in one direction, and then turn around and use it in the other direction. This has the advantage of avoiding diplexer filters, and also allows you, (in terms of mobile radio communications), if you have a fixed site that has multiple antennas, to get antennae diversity with a single frequency (because you are operating in the same frequency in both directions), so that you can combat multipath that way. It is also very useful if you have asymmetric services. I know when I use a data terminal connected to a host or network, I think the ratio of characters flowing out to me is ten or a hundred times what I type in.

There is some negatives with this approach. One is that it is an untraditional way of doing things. It is usual to have a transmit/receive separation, and the contiguous spectrum creates substantial problems for filters and traditional receivers. So if you are either someone used to traditional radio regulations, or you are a manufacturer whose expertise and product lines were designed for traditional designs, contiguous spectrum posed difficulties. The FCC has proposed transmitting the base to mobile and mobile to base frequencies by 80 MHz, which exactly parallels the separation today in most of the microwave radios operating up in this band. So, this would mean that PCS communication should interfere with only one microwave system. If you separate the band, you have more complicated buyout scenarios; it makes the microwave transition significantly more difficult.

With regard to unlicensed PCS, it is potentially very important. You can use it for wireless, local area network, cordless phones, service providers, perhaps wireless drops; there are many clever things that can be done. I don't think 20 MHz is enough spectrum. The FCC has proposed 20 MHz; I think we need more. I can't think of a good way to justify this analytically, though. The kind of study you need would show, for example, a gain in GNP in the year 2003 from 20 MHz of $1 billion, but if you expand it to 30 MHz, the gain is $4.8 billion. CT2 in the U.K., which is actually used in a number of countries now, used only four MHz, and was alleged to be able to support quite large user densities. But Ethernet, on the cable, uses 10 MHz there to deliver throughput that is a little less than 10 megabits per second.

I think also this unlicensed service is going to require active regulation. The FCC has to develop and impose technical standards, I think the industry is calling them "etiquettes", that will ensure that interference is controlled by smarts in the equipment. There have to be dynamic spectrum-sharing rules built into the equipment, rules like "listen before you talk on a frequency". I think this service will require continuing regulation, although it will provide very substantial benefits. By continuing regulation, I mean that the Commission can't just turn the spectrum over to the industry, and let it go.

I think that broad geographic licenses, the broader the better, will substantially serve the public interest. There is clearly controversy about national licenses, and I think that controversy flows out of two roots. One is that it is not the usual way of doing business at the FCC. The FCC has now granted a few nation-wide licenses, but historically, they typically licensed areas coinciding on the coverage of single transmitters. In cellular, they licensed over broader geographic areas. They also licensed significant bandwidth, more than one single radio station. They ultimately gave the cellular carriers technical flexibility. I see cellular as the grand rehearsal; I think we should do it better this time.

The other problem with nation-wide licenses is (if you think about it in a purely political context, the Commission is going to give away very valuable tickets, you make more people happy politically if you give away a thousand little tickets that are only worth, say, a million dollars, than if you give away one great big billion dollar ticket. Then, you do make one person really happy, but that person only lives in one state and one Congressional district. So, there is a pressure on the political process, if you are going to give these things away, to give them away to many people, and spread the joy. I think this poses a substantial political impediment to adopting nation-wide licenses.

Thank you very much.

HENRY GOLDBERG: Thank you, Chuck. I see politics has reared its ugly head, right at the end of your presentation. I hope it is no reflection on our next speaker, who is not Gerry Waldren, but is Karen Colannino, who works with Gerry, and is substituting for him today. Karen is a telecommunications legislative assistant with the House Telecommunications Subcommittee, led by Ed Markey, from the Seventh Congressional District, which is right around the corner here in Massachusetts. Karen is working on PCS issues for the Subcommittee, as well as a number of other telecommunications issues. Karen...

KAREN COLANNINO: Thank you. I am here to offer the Congressional view and the political approach that we have heard so many great things about for the past hour and a half. Basically, what is going on on Capitol Hill, and more specifically, what Chairman Markey and the Subcommittee on Telecommunications, and Chairman Dingell of the full Committee are doing. Spectrum allotment is something that Chairman Markey holds very dear to him, since it provides for the emergence of new technologies, and basically, that is his mission as chairman of the Telecommunications Sub-Committee.

I should give you a brief history of the politics everyone has mentioned. Last year, after the FCC's proposed rule-making, Senator Hollings of South Carolina offered an amendment to the Senate Appropriations bill, restricting access from emerging technologies to the two gigahertz (GHz) that we are referring to. Senator Hollings offered this amendment, restricting access to the spectrum, in an effort to protect the existing microwave users, which were mentioned before as the railroads, petroleum and pipeline companies, as well as the utilities. And he wanted to protect them for twenty years. Now, twenty years in this industry is a lifetime, and it is a detriment to the technology and the industry.

Chairman Markey, and other members of the Subcommittee, opposed this provision on two grounds. The first was that it was a substantial detriment to emerging technologies; they would be restricted access to the spectrum for twenty years. The second reason was that it is not Congress's job to hold the responsibility of allotting for spectrum; it is the FCC's job, and one of the many reasons why the FCC was created. So for those two reasons, Chairman Markey urged Speaker Foley to get significant influence on the conference process. The amendment was not offered on the House side, only on the Senate side, so the conference process would be the only way to stop it. After working with the FCC and the sub-committee members, the agreement was made, as Bob had mentioned, we will be looking for three to ten years, where the PCS will be gaining access to the spectrum. We recognize that if the domestic PCS market is not flourished, we will suffer domestically and internationally. That is an issue of grave concern to Chairman Markey. The domestic manufacturers cannot develop and test their facilities without the spectrum needed, both domestically and internationally. We are not undermining, in any way, shape, or form, the existing frequency users. Studies have indicated that the existing microwave users could use the spectrum they need on a higher frequency, and in fact, many of the existing users are using frequency at higher levels, and using it efficiently. So, with that in mind, we are not trying to strip the existing users of the spectrum they need

to carry out their jobs, but just trying to efficiently use the spectrum we have since it is a limited resource.

For example, with the understanding that spectrum is a scarce resource, we have proposed legislation (Chairman Markey as well as Chairman Dingell have proposed legislation), HR 707, the Emerging Telecommunications Technology Act of 1993. This requires the Secretary of Commerce to identify two MHz of spectrum that can be turned over from government to private use, just like the 50 MHz that was reallocated in 1968 to the cellular industry, which has provided thousands of jobs in a $10 billion industry. We also recognized the fact that the ten years that it took to license the cellular industry lost billions of dollars to our American economy. So, in our efforts to have the PCS industry flourish, we need not take alot of time in licensing. HR 707 is supported by the American Association of Railroads, which was one of the big lobbying forces behind Senator Hollings, who proposed the detrimental amendment. So, because they are supporting this legislation, knowing that more spectrum would be efficiently used, anyone who is interested in spectrum is a supporter of this legislation. Not only would it provide for new industries and new jobs, it will also give the existing spectrum users the frequencies they need.

Many questions and concerns are surrounding the PCS industry, and the most critical concern is the licensing question. Other questions are whether we should treat PCS as a common carrier, and should they file a tariff. Those are issues we are working with the FCC on, and are issues that will definitely flourish as the industry gets on its way. By passing HR 707, (which by the way, passed the Subcommittee, the full Committee, and is reaching the House floor on Tuesday), we are taking concrete steps in allowing PCS, and other emerging technologies, the spectrum they need, as well as cleaning up the spectrum that is sometimes inefficiently used. Chairman Markey is investigating the issues that are surrounding the possible emerging technologies, with the hopes of having the public benefit from these new jobs and these new technologies. And that's it. If you have any further questions about the politics on Capitol Hill, you can throw them up.

Q. by moderator HENRY GOLDBERG: What is the status of auctions on that legislation that is coming to the House floor? Hasn't the Administration said they want to see the spectrum auctioned off to raise, what did you say, Bob, $4 billion for public treasury?

KAREN COLANNINO: The Administration has stated that effectively this bill, HR 707, is minus the auction provision, but further legislation is being worked on, and it is certainly a contentious issue, but we are working on further legislation for the auctioning of spectrum.

ROBERT PEPPER: My understanding is that in the HR 707, they consciously did not want to deal with auctions because both Chairman Markey and Chairman Dingell said that there would be subsequent legislation dealing with the issue, sort of a separate but parallel track. In the Senate, which has the Steven's Bill, the companion to 707, which is Senate 335, does include an auction experiment for up to 30 MHz, which is what was discussed last year, and passed out of the Senate subcommittee last year. So, I think that it is moving forward, and there are just different vehicles; they'll work it out. As Karen points out, these are some very contentious issues, though I don't think they are show stoppers, I think they can be worked through to make sure there are the right kinds of safeguards. I think you will see legislation this year pass auctions.

What is interesting is that people tend to forget that the first president to recommend to Congress that we have special auctions was President Carter, in his budget message to Congress in 1979, so this is not something radical or new. It has been around for a long time, people have given it alot of thought. But sometimes things need time to move forward, to work out the problems, and people need to feel comfortable with them because it is a departure from the way they have done things in the past. Also, Karen is absolutely

correct. I would just point out that it was Chuck and one of his colleagues who did the 1986 study that pointed out the billion dollar loss because of the ten year delay in cellular. And again, this is what we are trying to avoid in PCS. The House was extremely helpful in allowing us to move forward last fall with PCS, in the face of some of the opposition that came from the other side of the Capitol.

Q: Has any thought been given to the idea that the amount of spectrum that is actually going to be needed if PCS really takes off may greatly exceed that which will be originally allocated? Has there been any advanced planning about how you could extend the initial extensions because, in some cellular areas, for example, it is already completely over-congested, and we could see the same thing happen in PCS?

KAREN COLANNINO: What we say about HR 707 is "for everyone, but for no one." So, anyone who is out there using spectrum for their particular industry is supporting this legislation, knowing that as their industries prosper, and as other industries grow, they will need additional spectrum. In terms of having a bill ten years down the line that will allot more spectrum, and take more spectrum from the government for private use, we don't have that legislation right now. But, knowing full well that we need to make sure that the FCC is constantly, effectively monitoring frequencies in the spectrum, we are aware of that. Just as we are taking some spectrum from government use to private use, we know that the government is no longer using this spectrum efficiently, and it can be put to be use somewhere else. So, to answer your question, yes. Not specifically, but fundamentally, yes.

Q: Could that mean PCS will end up having two bands as opposed to one?

ROBERT PEPPER: If you think of PCS as something broadly defined, there is alot of fungability across spectrum and service areas. So, for example, cellular licensees under today's technical flexibility rules, have the ability to take their 25 MHz, and they are already beginning to provide services that look like PCS, using their existing spectrum. Also, the areas in which cellular is very congested, L.A., New York, and so on, while there are transitional problems of where do you move people while you are becoming more efficient, using new technologies, (such as TDMA or CDMA), can get multiple re-use of these frequencies, increase the use dramatically, and therefore reduce some of the congestion. What is interesting, also, is in terms of cellular congestion, is that in California, based upon one estimate I've seen 80% of the cellular equipment sold in California are little walk around handsets, that are transportables, not in car sets. So, they are not being used necessarily at high velocity. What they are being used for are PCS-like services. So you have to ask, if we now have a new PCS service, and some of those uses of cellular migrate to PCS, will there be less congestion on the high-velocity cellular service. But again, they are really substitutes for one another in many ways. There won't be a few cellular services over here, and a number of services called PCS over there. Instead, there will be six, seven services that are mobile and/or portable, and are competing with one another in some part of that continuum.

CHARLES JACKSON: Can I respond to that question a little bit, too? I think that if you look at the total capacity, the kinds of projections you see are conservatively eight or ten times capacity increase in cellular. When you go to digital techniques, similar capacities per MHz in PCS. Right now, I understand, in a place like L.A., cellular systems are sort of running out of steam, in the neighborhood of 300,000 to 400,000 subscribers. Growth is very hard, you run into sections where congestion is a real problem. If you were to assume capacity increased by an order of magnitude, plus whatever spectrum the Commission frees up, that is a substantial jump. You could divide that between more subscribers, and heavier usage per subscriber.

Q: Ninety MHz of spectrum for the railroad seems like an awful lot. What is it being used for?

ROBERT PEPPER: It is not just railroads. It is railroads, gas lines, pipelines, utility companies. They use them for fixed microwave services, for example, different kinds of pipeline monitoring as well as voice and data communication for pipeline companies. It is very important because if there is a pipeline break, or if electric utility lines come down, it is the way they monitor their entire network. These networks are, in some cases, 30 years old. At the time, they had to operate at two GHz because the technology was not available to operate at the higher frequencies, and except for very long hops, they can move their existing network services to higher frequencies, such as six GHz, from the two GHz band without any loss of reliability or service. But, it is a very important application. And no, it is not that any one railroad has 90 MHz. In fact, they typically have 10 MHz licenses.

HENRY GOLDBERG: Let me have two points of moderator's privilege. Number one, I am reminded by Professor Sapolsky that this is all being recorded and transcribed, so if people have questions, it would be useful if they would go to the microphones to ask them, so everyone's question will be suitably recorded.

The other point deals with just this question on how much spectrum is being used by railroads, utilities, and the like. Again, I come from the bias of having some clients who would like to see a lot more unlicensed spectrum, so people using personal communicators or portable computers, or what have you, could just turn them on and use them, and network as they do when they are in their offices. There, the feeling is that the fixed microwave services have, yes, an inordinate amount of spectrum, that most of their uses are not mobile (I mean, they are along tracks and pipelines), and alot of railroads have gone to fiber cable. Like Amtrak, for example, who has a whole system, from Washington almost up to Boston, of fiber that they use for their communications purposes.

Good public policy would say, if you have a fixed use, and there is a backlog of mobile uses, (people out in Silicon Valley, who are just vibrating with ideas to have more communications capacity added to computing devices), it doesn't make any sense to have this long transition period. Three to eight years, I think Karen said, which was the political compromise, and this is too long to let the utilities continue to use this. And then, to get the new technology people to pay for their transition to other spectrum. This is not happening in other countries. In other countries, they are requiring people with fixed microwave uses to get off the spectrum, and make room for people with mobile needs.

KAREN COLANNINO: I'll respond to that. We share your concern. We feel the railroads and utilities should be allocated other frequencies on the spectrum to provide the services they need. In fact, these utilities can use a higher frequency. Chairman Markey has worked with the FCC in the political compromise, and you tend to give that a negative connotation. It is not that at all; it does take time and money to for these existing users, the incumbents, as they've been referred to, to have new technology to operate on higher frequency, and that does take time. They need to purchase all this, and we're not saying they should bear the costs themselves. We do think the emerging technologies should bear some of the cost in purchasing this new technology. But, we do share your concern that we should be able to turn on our desktop computer, without a wire, wherever we need to. We share your concern there; it is not a political compromise for the sake of a political compromise, it is more for the efficiency of it all. Just being able to operate on a higher frequency does take time, and alot of technology.

ROBERT PEPPER: Let me just also say that the three to eight year time frame was a proposal. In other words, it would be a range of time. There is a transition period, and what we put on the table were, in fact, involuntary moves, where a new licensee for PCS

would come in and could force an incumbent to move. They would pay for them to move, force them to move. The question was, should that forced move begin in three years, or should it be some longer time, up to eight years. The compromise is putting in the range of time. I will never speak for people who vote without knowing how they are going to vote, but I can say that, at least at the time that the Commission adopted the three to eight year transition period, at that time, the inclination was that it should be towards the lower end of that time period.

If you think about three years from the time that we create the rules for moving, plus the time to go through the allocation process, and the new users begin to buy the equipment to start their service, you are just about at three years anyway. Or at least at two years, and then you have a year for voluntary negotiation. So the three year time for the licensed services, we believe, is a non-binding constraint on the new PCS providers. That may be a different case in the unlicensed area, where it is not a question of negotiation. For the unlicensed use, it is going to have to be clear. Everybody agrees. The incumbents agree, and the unlicensed proponents agree that there cannot be any fixed microwave users left in that 20 MHz band. But the point is, I think, a different case. But the three years should not be a binding constraint on the mobile, portable-type service.

Q: Could you describe a scenario where a vigorous PCS industry emerges closer to that three year time frame, and what actually has to happen for that scenario to play out? And, if it were to play out within a three or four year period, who are the players likely to be, and what are the products likely to be offered? Also, please describe a scenario where it takes closer to eight years to play out? And again, how would that affect industry structure and products? And just for fun, what is the probability on which scenarios are more likely to happen?

ROBERT PEPPER: You sound like someone from the investment community. First of all, the eight year scenario is relatively easy. What makes that happen is that the FCC does not allocate spectrum to PCS for a long time. That is not something that the FCC wants; it is not something Congress wants. People are not looking at this as something that is going to take a decade to roll out. I think people are looking at a service for which they believe there is alot of demand today, and it is something people want to permit to happen as soon as possible, given all these constraints you've heard about today.

CHARLES JACKSON: Yet, there are alot of other people who do not want it to happen. They are quite comfortable with the way things are, and would be quite content if it took eight years to roll out. So, ...

ROBERT PEPPER: Name some.

CHARLES JACKSON: I'll name one that I don't know from personal direct knowledge, but that I've heard attributed to him taking that position. That is Craig MaCaw, and certainly, when I think of his incentives, I believe that would be correct, though I don't know for a fact that it is true.

ROBERT PEPPER: There are many other players out there, who would prefer there not be alot of new competitors in a variety of markets. I think this goes back to something that Chuck talked about, which is, we try to keep our eye on improving and advancing consumer welfare, not necessarily producer welfare. Alot of what we end up doing in the FCC is refereeing between industries, and often times, public gets lost in that. What we have to do is continuously remind ourselves to look at these new industries that will benefit users. Now, you don't want to disrupt existing service providers because they have customers also. But, you can't make all of your decisions based upon producers winning

and losing, at the expense of users, consumers, small business, residential customers, and large users. That is sort of a context.

The three year scenarios would work as follows: the FCC has to finish its several phases in its two proceedings. One is the Emerging Technologies proceeding, in which we create this band in two GHz, which is more than just 100 MHz (90 per license, 20 per unlicensed PCS). It is a broader band, in which we would be establishing the procedures by which the incumbent microwave users would move to higher frequencies. So, part of that proceeding also looks at the higher bands: four, six, ten, and eleven GHz, to channelize frequencies at the higher bands to provide a user friendly home for any fixed microwave user, who moves from the lower frequencies to the higher frequencies. We need to complete that, we need to finish the rules on the moving, how the negotiations would work, how compensation would work, etc. That can be done within this year.

At the same time, we need to move forward with the rule-making on allocating some of that emerging technology spectrum for PCS, creating a new service called PCS, defining it, determining and answering the questions I teed up: the geographic scope of the licenses, the block size, the definition of service, eligibility, the regulatory treatment, and so on. We need to answer those questions. Again, that can be done within this year. Once that is done, we now have a structure. Then, we can begin granting licenses. Whether it is going to be some form of improved lotteries, (we are looking at ways to reform the lottery process, so that we can try to eliminate as many of the defects as possible) is an open question; that is another forum on sort of allocation issues. It will either be reformed lotteries or competitive bidding, and it will take some time to grant the licenses, probably over the next six months, and it could be completed quite rapidly. So, we're looking at two years of establishing rules, allocating spectrum, beginning to assign licenses, having firms begin to buy equipment, beginning to negotiate with the incumbent microwave users, so that they can either voluntarily move, or after some period of time, be forced to move, and that is within that three year time frame. That is the kind of process we are thinking about with respect to rolling out PCS services.

HENRY GOLDBERG: And Bob, don't forget about health care reform, and whether dentists and doctors will be able to file applications in the future.

ROBERT PEPPER: Well, actually if we can have competitive bidding, and we want to have a fair lottery process, so it is not just the four dentists in Des Moines, we actually can have a process with a negative check-off on your income tax form. "I do not want to be entered in the PCS lottery." And then, you see, we might have a rule that if you win it, you have a performance bond of 90 days, and you build it. Or, you have to transfer it in a private auction within 90 days under some FCC auspices, so that it is fair, and then, maybe, instead of four dentists in Des Moines, it is a poor working mother in Roxbury; that is only partially tongue in cheek.

HENRY GOLDBERG: I was taking notes, what do you mean, "tongue in cheek?"

Q: I haven't heard any of the panelists address the point Mr. Goldberg made that rather than relocating current users, it seems a number of them already have existing right of way. So the money would be better spent to wean them off of fixed microwave, and get them out of the spectrum completely, and get them to use either leased lines from existing telecommunications companies, or build their own along their existing right of ways, in which case, you have the added benefit of having someone else pay for capacity they could also time-share by renting out, so they could not only have an incentive for moving off by having their costs paid, but they could also turn it into a money maker, and free up a limited resource in the bandwidth by moving to fiber optic, or other fixed cable technologies.

CHARLES JACKSON: I'll offer just a couple of observations on the transition process, in response to that question. That is, if you think about this from the point of view of the microwave licensee, that individual or firm may have just spent some money on a brand-new microwave system. In the extreme case, you have got someone who just replaced a 30 year old microwave system. And having just invested a couple hundred thousand dollars, they read in the paper the next day that the FCC is going to take their spectrum away, and they are a tad peeved.

There are also a bunch of people who got relocated because the Commission made spectrum available to DBS in the late 70s, and it still isn't operating, but they've got alot of costs, and they are kinda peeved, too, especially if they moved down to two GHz, and then, this is happening to them. They are irrationally testy about this issue.

The idea that the costs of this displacement be reflected back on the people who get the benefits doesn't seem to me to be either unfair or inefficient. You want somehow, when people decide how much PCS costs, to take into account the costs of moving those people out. Now, if you want to also say (as an aside), gee, we never should have licensed two mile shots in two GHz spectrum in urban core, that may be true, but the system is a sunk cost. That is a decision we made maybe twenty years ago that we should not have made because it is inefficient way to use the spectrum. If you were to think about this as analogous to real estate, what the proposal, as I understand it, is to say is that the incumbents have something pretty close to a property right, and during the first three years of this period, the PCS provider wants to move them out, they have to buy their property right out. If they can work around, without interference, fine, then they get to go ahead. But, they can buy them out just as if you are building a development, and there is somebody who owns some real estate you want to use, you buy them out. To serve the pubic interest with regard to an effective transition here, there is an eminent domain proposal, which says, after three years, if the PCS licensee wants to move someone out, they have to pay them the fair value of moving them out. That is determined by the costs of an equivalent system, either fiber or microwave, somewhere else.

It seems to me this compromise is not unreasonable; I think it is a fair approach to dealing with the incumbent. It can go very fast, if there is substantial value to be delivered. The PCS provider can make very attractive deals to the incumbents. If you had a 25 year old microwave system, and a guy says, I want you to move, I'll give you a brand new system and $50,000, you might be tempted to say, sounds good to me. So, it is unclear how fast it would take to unwind. I think what has been forward here is a transition policy, and it reflects something akin to a property right of the incumbent

ROBERT PEPPER: The question, I think, was why not fiber; why instead radio? It is one of the things we've explored with the incumbents, especially the utilities, the railroads. As you point out, they have rights of way. It is not precluded, I mean, they could go to fiber. They are uncomfortable with that, though, because they believe that fiber (because of back hoe cuts and other problems) is not as reliable as microwave. They believe very strongly, especially for services related to health and safety, that they need THE most reliable systems. So, until they feel comfortable with fiber, (and some of them do in some limited places because they already use it), I don't see the Federal government forcing them off of their microwave links. Now, using other frequencies for microwave, yes, but not forcing them on fiber if they are not comfortable.

Q: I was a little surprised at the amount of frequency being allocated under 707, and it leads me to wonder what kind of contingency planning has been done. Being in the commercial world, where we are interested in supply and demand, there is a real question about what happens if the demand for PCS greatly exceeds the supply. Has any thought gone into the possibility that the demand is much greater than anyone is currently expecting?

KAREN COLANNINO: HR 707 does not grant the spectrum to the PCS industry, just to clarify that point. I don't know if you misunderstood that; it is just taking away existing spectrum that the government is using, and allowing it for emerging technologies, not specifically just for PCS.

In regards to the PCS spectrum, we were speaking of, it is gross to your basic premise of letting the marketplace figure out how much spectrum we need. We will be allocating the spectrum to accommodate that, and that is the very reason we have the FCC to make sure we have the proper amount of spectrum, and that spectrum is being used efficiently. There may be a possibility down the road that we need more spectrum for that particular industry, or any other industry. As we see, the cellular industry is now claiming the need for more spectrum, so we see that happening. HR 707 may mean we give up extra frequency that we find valuable now, but ten years down the line may not be as efficiently used.

I think there was a question over here that was similar to that. You know, we can't say now that 10 years down the road PCS may need more spectrum because there may be a whole new industry that will come in, and just be 10 times more efficient. So, it is a thought that we keep in the back of our mind, but for the industry, 10 years is a lifetime.

CHARLES JACKSON: I'd like to respond to that, too. My reaction is that (though I haven't read 707, I read last year's bill), it talked of the reallocation of 200 MHz from the low five GHz from the Federal government's exclusive use to the civil economy. And 200 MHz is substantial spectrum; it is not a small amount. So, I guess my reaction would be that, sir, I didn't quite understand your question. 200 MHz is a whole bunch.

Q: I am particularly concerned about the unlicensed spectrum that has to be particularly cleared of the current incumbents. Has there been any estimate of how much it would cost to re-engineer all of these microwave towers to move up to six GHz, because I don't see how people are going to be able to efficiently buy out that 20 MHz of spectrum for unlicensed PCS?

ROBERT PEPPER: I will tee it up, and then Henry can answer it since he is an advocate for the unlicensed. Number one, we selected the 1910 to 1930 because it is the least used in the two GHz band. There are the fewest fixed links in that band, so it is the easiest, if you can figure out the process. The question that we asked the unlicensed advocates to answer before we can move forward is, number one, who is going to pay? And related to that, how do they figure out how we are going to deal with free-rider problems? There have been a number of ideas floating around. Let there be a consortium of all equipment vendors, computer companies, the PBX makers, and so on. They get together, and come up with some kind of proposal to create an industry clearinghouse or industry group. They say, we will pay all of the incumbents to move. Then comes along another computer company, that is a start-up, or wasn't part of the consortium, and says, as an unlicensed firm, I am going to make a device, put a gizmo in it, and use those frequencies. I am not going to pay for it; I don't have to. So, there are some problems that have to be worked out. There has been alot of creative work on the part of the equipment manufacturers to try to answer that question. I think the important question is, is 20 MHz enough? If it is not enough, and you have to get into some of the other spectrum in this band, it is going to be alot more congested, more difficult, and alot more expensive to clear it out.

HENRY GOLDBERG: All true. That is a huge problem. Even with the 20 MHz that the FCC has proposed now, there are estimates that range up into the billions of dollars, if you had to move all of those people to six GHz. It is very difficult, on the unlicensed side, to start pooling that kind of money. It gets even more difficult if, as Chuck said, you need more than 20 MHz. Then you have you are going to have to move more microwave users. Essentially you are dealing with a question of public policy. You could take the land for

the Callahan Tunnel by having people contribute money, that's what tolls are, but the way it was done was that government used its taking power, paid fair compensation, and then, through tolls and taxes, tried to make up the money. It is very, very difficult if you don't have a situation in which there is a Craig MaCaw, or a licensee who has a direct interest. While, as Bob said, there are a number of good ideas coming up, no one has come up with a solution quite yet.

Q: I have a solution. I want to talk about the fundamentally administrative nature that this discussion has continued to take all afternoon. Although Chuck, a few moments ago, came perilously close to pointing out that what we really had going here, at least in some limited respect, was a marketplace. But he did give real estate analogies, and suggest how things might be traded and moved around. I am very pleased at what is happening in this area, the attempt to reallocate, though I still regard it as a fundamentally administrative process. The questions that some of the people in the audience have asked about how do know whether you gave enough, what if it turns out not to be enough, and should you switch to cable for certain kinds of things, and to radio for others, I think are fundamentally unanswerable questions. We can imagine what might happen, but we don't know where the market is driving. Two of you up there know what I am about to say, but there exists a mechanism that can assist in answering some of these questions, and that is obviously, the marketplace.

Now, one is not going to go to a full blown spectrum marketplace overnight, but there are certainly pieces of that happening. And, my question for Bob and Chuck, then, is there much going on within the PCS rule-making, to allow some flexibility, some subdividing, some aggregating of property, only the property would be spectrum, in this case, to give some flexibility. So, if 20 is not right, but 25 is, the participants could rearrange it within their own activity area, in order to generate a somewhat more optimal amount of spectrum? That's one kind of question. My other kind of question is, perhaps, for Karen, and that is, have people on the Hill begun to think a little bit in these terms, because we have really been talking these terms all afternoon. I understand the need of the holdout problem, and the reason for eminent domain there, but it seems to me, there is a mechanism here, and that PCS affords a possibly useful opportunity to test flexibility, and thereby give a key to whether you might be a little more comfortable about allowing next year, a UHF TV station, the opportunity to sell out.

ROBERT PEPPER: I was waiting for you, Ken, to bring up that example. PCS has thought about flexibility. I started out talking about the broad definition of service. Historically, the FCC has defined service as very narrow. Here we define it very broadly, so that there is flexibility to develop a range of services. And based upon how people use it, people can use their spectrum more for this versus that flavor as it evolves. So, there is flexibility in service definition. Secondly, we've do not propose to preclude transferability on spectrum, so, for example, if we each end up with 30 MHz licenses, but I only need 20 MHz, and you need more than 30, nothing would prevent me from transferring to you 10 MHz. It is one of the issues we've asked about. It is not, at this point, concluded.

One of the people who works in Plans and Policy, David Reed, has done a paper, I think I mentioned earlier. He proposed a minimum of five 20 MHz licenses, with the ability to transfer. He said, look, we don't know. If you want a high velocity service, it looks like you are going to need 40 MHz. So, what you do is allow two licensees to get together to provide 40 MHz. On the other hand, if you have a CT2-type lower end service, you may not need as much, and you may have the ability to have those kinds of transfers. This is part of the debate.

You also know that we had another working paper, in which we actually developed a model, where we looked at the net impact on public welfare, the consumer welfare. If a UHF television station in Los Angeles all of the sudden began using its spectrum for cellular telephone service, and the net consumer welfare gain was a billion dollars, in that

one market alone. There was something like 14 TV stations on the air in L.A.; the loss of one of those stations that nobody watches was about $140 million. Hence the net gain for a third cellular operator in L.A. was over $1.1 billion because of the demand stimulation at lower prices and higher service quality. On balance, the public would be better off in that kind of benefit-cost analysis if that UHF spectrum were used for cellular service.

We also went on to say that would not be the case in every market. If you have a smaller market, with fewer over the air stations, the loss of one would be much greater, and the gain would not nearly be as great because it wouldn't be congested. I mean, if you are in Cedar Rapids, Iowa, the two cellular operators are not filling up their 25 MHz each. So, the need for the third system would not be as great, and the loss of one of only two independent stations in that market would be quite great. So, it is really on a case-by-case basis, but yes, those are the things we are starting to explore.

CHARLES JACKSON: I'll respond to that. I think that the Commission's notice of proposed rule-making really reflects the modern learning about how to license spectrum. It proposes flexible technical standards.

I think that the geographic boundaries of the regions create extensive uncertainty and excessive externalities. The bargaining place for negotiation between regions should start at a much lower power level, which I think is closer to where the outcome of many of the negotiations would be. But, with that little aside, I think that the Commission created an excellent approach, in that the rights packages that they are proposing to put out for PCS are very well designed. They should be big geographically because there are problems of boundaries, and for the national market reasons I've mentioned. If you think about the transition we are talking about, with regard to existing microwave incumbents, I mean, licensing microwave incumbents the way we did made sense at the time, but we could have done better. For example, if we'd taken that microwave band, and divided it into four bands, and granted one to Motorola, another to G.E., a third to somebody else, and so on, those firms could then have gone out and sold microwave radios, and also provided the spectrum. I suspect that you would have found that the market would have been sufficiently competitive that very few rents would have been captured as a result of the spectrum; it would have been superior radio design. And the transition problem would be trivial. So, if we looked at the future, and say, what happens if PCS is obsolete, and somebody comes out with some new kind of modulation. Hopefully, if we are lucky, and the laws of physics keep it in the same band, then these rights packages that the Commission are putting together will be very well-suited for that. The transition will take place inside the licensee, inside the firm, with no administrator, or inside the market, if somebody else has to come out and either do a deal, or buy the firm. But, it gets it out of the administrative process, so I think it is excellent.

Q: Is Congress becoming more comfortable with that?

KAREN COLANNINO: With respect to what Congress thinks...just by the fact that we are working on HR 707, which does not designate spectrum to any particular user, we are concerning ourselves with the need of accommodating spectrum for marketplace purposes. So, yes, we are thinking ahead. It is not designated for any particular industry, it is designated for any emerging technology. So, we are ahead of that. The legislation that we are working on is for up and coming technology, so we are thinking of it, and we are actually initiating it as opposed to reacting to it, and that is what HR 707 does.

In terms of auctioning, you can put it in the marketplace realm, and that is why we need to seriously consider the implications of auctioning before we put forth a piece of legislation for the sake of marketplace forces. To answer your question, I hope, we are thinking ahead, that is the premise behind HR 707.

ROBERT PEPPER: Also, the compromise with the Hill, in terms of compensating incumbents, reflects a very market-based approach. That was, in fact, a compromise not only blessed by Congress, there were staffers from Congress intimately involved in the process. And it became a real win-win for everybody.

Q: This is for Mr. Pepper. You mentioned that there were more than 200 experimental licenses that had been granted. What is going on there, and is there any information coming out of that process that would help determine the amount of spectrum required?

ROBERT PEPPER: They are almost all technical, but some of them are borderline marketing tests. Alot of information is coming out of those experiments, and is being put into the record for people who are interested. What we are finding from that, and I haven't, frankly, looked at them recently, but it is what you would expect. There are different kinds of applications with different spectrum needs, and the big issue is, does PCS work? The answer is yes, but there are also lots of different flavors of PCS. Perhaps Chuck has looked at the results of those experiments more recently.

CHARLES JACKSON: Well, I have looked at varying degree at some of them, and I think that one of the conclusions is that, with regard to propagation issues, 1800 isn't very different than 800 or 900. There is a little bit more attenuation, but people have developed data, and they are able to show that systems work up there, systems that have been translated in frequency from 800. The conclusion, I think I draw from the experiment is that a mobile service operating at 1800 MHz is a very credible undertaking. It is not a risky technology at all.

Q: I have been attending Communications Forum for thirteen years, and I usually wait around until the end, and try to say something really nasty. I am going to break a thirteen year tradition, and say something positive for a change. I have noticed a pattern that, for example, in the HDTV docket, there was a very narrow definition of doubling the number of lines, and making more pixels on TV sets. It started out with the process, the Commission, and some help from the Hill has broadened, and broadened the computer industry, and I think, made it a much more open and flexible affirmative process. I think some of the initial proposals for PCS were brain dead notions of cordless telephones, and again, the Commission has responded intuitively, and in a forward looking way, with the help of their associates around the Beltway. Perhaps, we could move even faster. I noticed that the Emerging Technologies docket has its own docket designation. I think we need to move away from common carrier broadcast, and welcome in the computer industry as they converge in these technologies. Although you are moving very much in the right direction, move even faster. I welcome any comments you might have on that sort of notion.

ROBERT PEPPER: Well, I started off by saying that we did not define PCS as voice, we did not define PCS as data, we did not preclude images, and I think that some of the people who will be designing some of the most exciting applications will be in the unlicensed area with the personal communications devices. I don't know how you cross the barrier between telecommunications and computers in that environment. So I agree, but I think it is moving quickly. It is moving faster than we can keep up with it, which is good because if we try to figure it out, we'll probably get it wrong.

HENRY GOLDBERG: I think the HDTV example is a good one, of participation by people who don't usually participate in these administrative proceedings, who are not usually around when the compromise is reached in the Congress and the FCC creates a whole new industry. It is very healthy to have that kind of participation. We benefited from it in HDTV, and I think we will benefit from it, in Personal Communications

Services. People at MIT and other places where they don't particularly have axes to grind in the outcomes of some of these issues should participate in the proceeding and make it better.

ROBERT PEPPER: I also want to thank Russell for breaking with his tradition.

HENRY GOLDBERG: We are finishing up, I think, on time. I want to thank the panelists for a very lively discussion and good preparation, and for a trip up on the eve of the snow storm in Washington, which is probably about two inches in Washington. Thank you, and thank you all.

Spectrum Allocation for Personal Communications

Ensuring Efficient Competitive Outcomes

Massachusetts Institute of Technology
Communications Forum
February 25, 1993

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Key Economic Issues

Bandwidth of each license

Geographic extent of licenses

Benefits of contiguous spectrum

Efficient unlicensed service

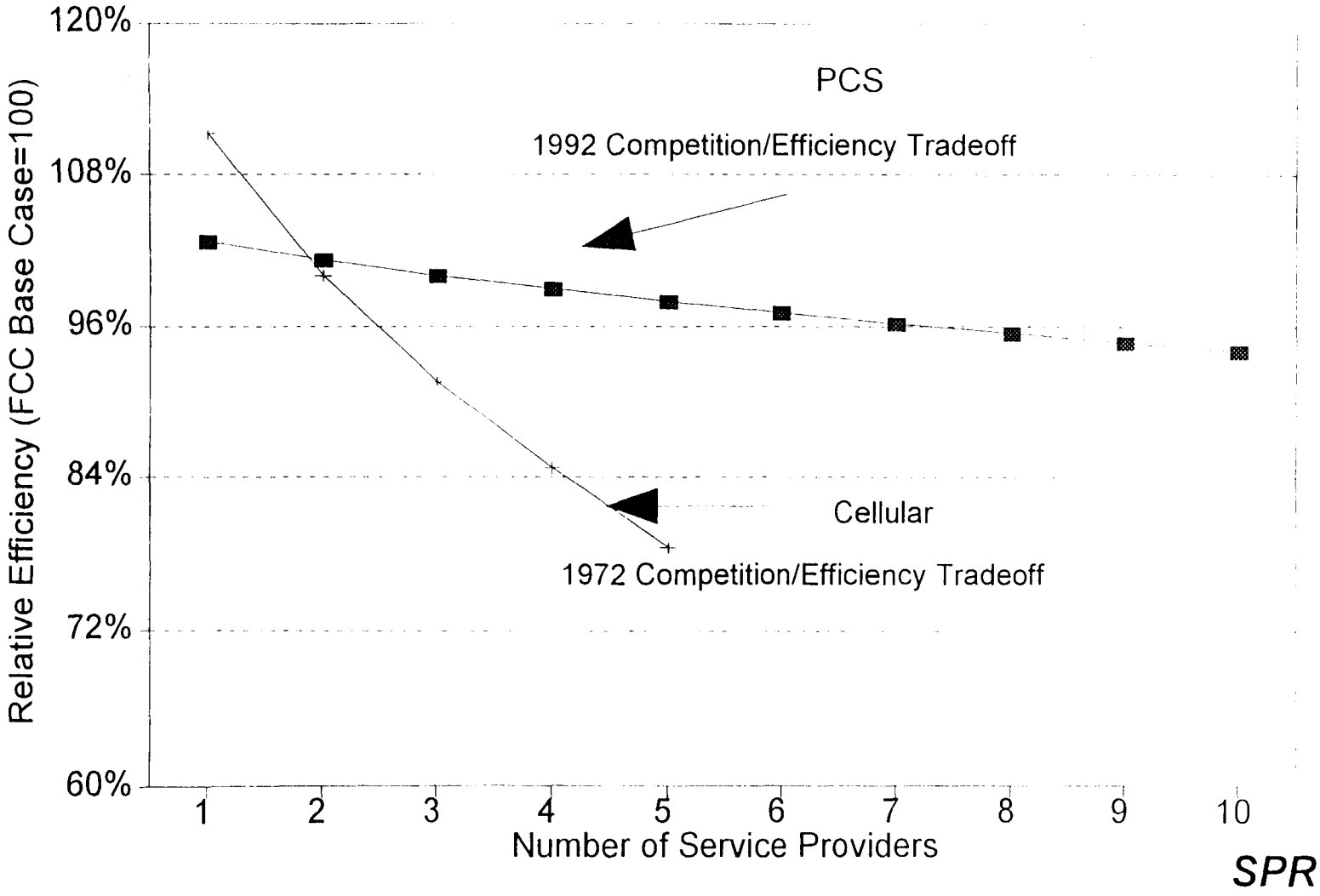
Bandwidth

3 licenses of 30 MHz vs. 5 of 18 MHz.

Queueing efficiency not a problem

Cost structure -- Economies of scale?

Relative Spectrum Efficiency
Decline with additional entrants



Geographic Extent

Inefficiency of small licenses

Delays competition

Frequency coordination cost

Strength of competitors

Delays from Small Licenses

Difficult standards choice

No national marketing

No roaming at first

Manufacturer commitment slowed

Interregion Coordination

Asymmetric -- unlike cellular

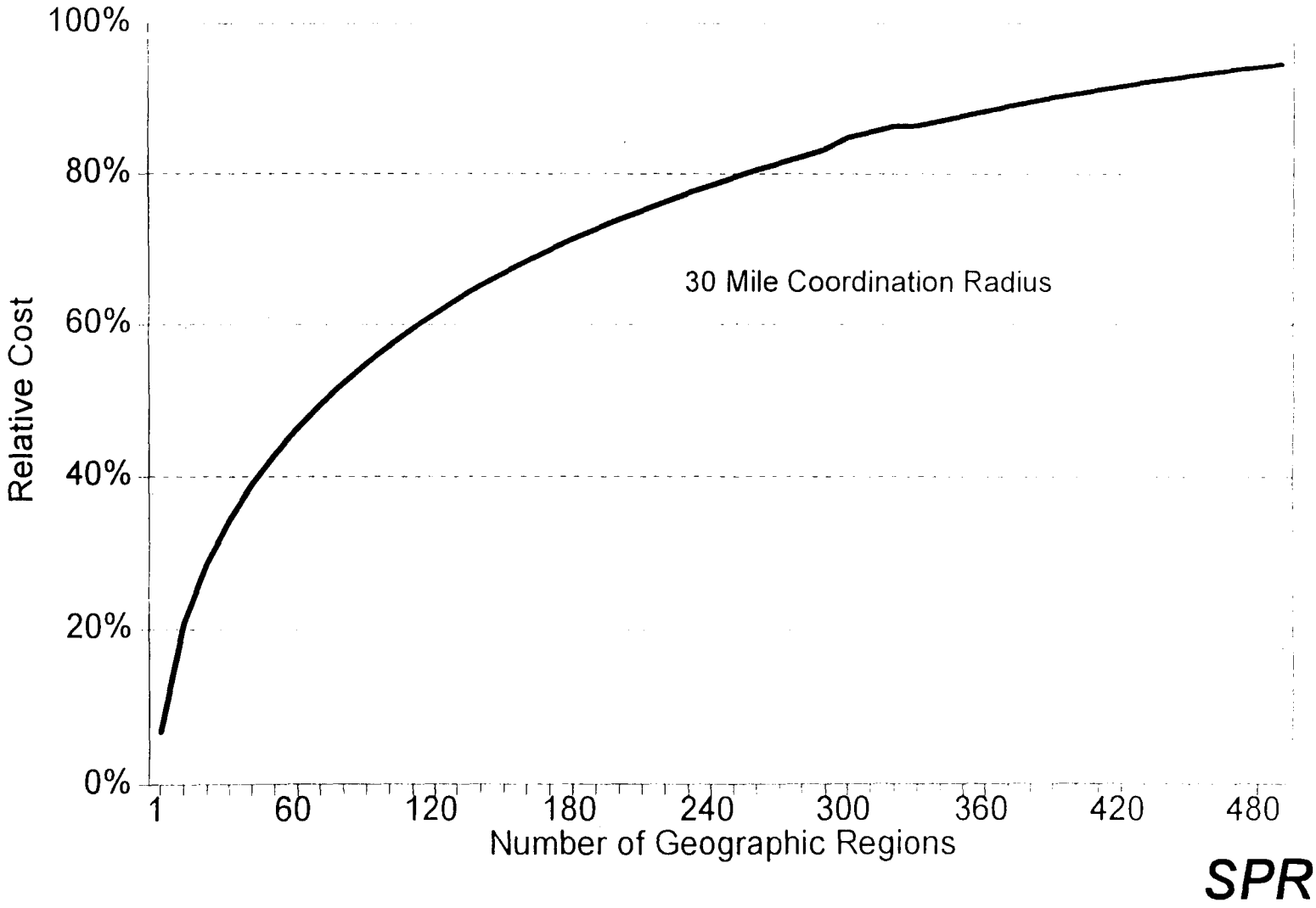
Cellular "regions" larger than MSA/RSA

Uncertainty deters investment

Proposed power limits are high

Transactions Costs

with increasing number of regions



SPR

Competitive Effectiveness

- Why wait for the Craig McCaw of PCS?

- Begin with the geographic units that best serve the public interest.

Contiguous Spectrum

\+ Fits well with TDD

Fits asymmetric services

— Not traditional frequency management

More difficult microwave transition

Unlicensed PCS

20 MHz probably not optimal
Need more

Service requires active regulation

Requires continuing regulation

Promises substantial benefits

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Conclusion

PCS technical rules will determine, in large part, the competitiveness of the PCS service.

Perhaps the most important "technical" rule concerns geographic extent.

Nationwide licenses will speed service growth, enhance competition, and maximize public benefits.