UNITED STATES OF AMERICA

FEDERAL COMMUNICATIONS COMMISSION

NATIONAL BROADBAND PLAN WORKSHOP

TECHNOLOGY/WIRELESS

Washington, D.C.

Thursday, August 13, 2009

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P R O C E E D I N G S

MR. KNAPP: Good afternoon. Could I please have everybody please take their seats?

Welcome. If you weren't here this morning, we had two great sessions this morning and we've got a couple more great sessions on tap for this afternoon. We're going to be focusing in the first group on mobile broadband, and in the second group we're going to be focusing on rural solutions as well. We've kept this at a pretty crisp pace, so I'll keep my remarks pretty short. Just as a reminder once again, if you turned the cell phones on over lunchtime, turn them off. A brief announcement for the folks who are listening in over the Internet. They can participate by Webx, or by sending questions to fcc-events@fcc.gov, as well as at this time Walter Johnson is the holder of cards for questions from the room.

With that let's go ahead and get started. We've got 5 minutes for comments from each speaker and then we're going to try to engage

in conversations. Rashmi Doshi is reminding me I also want to welcome somebody I've known probably more than 25 years. Karl Nebbia who runs the Spectrum Office at the National Telecommunications and Information Administration, and of course NTIA and our federal government partners share in responsibilities for spectrum management and we're thrilled to have him here with us. With that, Kris, why don't you kick it off for us.

MS. RINNE: I'd like to make a few comments. I'm Kris Rinne. I'm the Senior Vice President of AT&T, and I'd like to give you a few comments about mobile broadband and the state where AT&T is at this point in time.

One of the questions you asked was what did we see as some of the primary areas that need to be focused on, and the demand for data that we're seeing on our wireless networks is exploding at an incredible pace, and that technology in and of itself will not be the total solution. Therefore, what we would propose in a national broadband plan, it needs to be designed to

encourage and facilitate the efficient use of networks as well as the ongoing sustainable private-sector investment. Some of the areas that could touch on that are strong network management tools, ensuring that spectrum policies are efficient, reducing the potential for interference and avoiding requirements that make the networks less effective.

At the end of the second quarter, 36 percent of AT&T's 62 million postpaid customers had integrated devices. That means some sort of QWERTY keyboard either soft or hard. It was a result of that evolution where we're seeing tremendous growth in our wireless data networks.

This next slide shows you the growth that we've seen over the last 3 years. It's been a 5,000 percent growth as customers use their phones for email, Internet surfing, watching videos, downloading music and games and continuously using that capability. To address that, AT&T uses the 3GPP family of technologies also known as the GSM family of technologies that

gave us the ability for worldwide global capabilities as well as the backward capabilities to our previous generation of technologies. We currently have HSPA deployed in some 350 metropolitan areas and will be expanding that in 2009. And we're in the process of implementing a 7.2 upgrade into that HSPA infrastructure and we'll be moving to LTE in the near future as well.

Often when we talk about an LTE we focus on speeds and it does give us the opportunity for higher data rates, but it also gives us the ability to lower the latency, improve the spectral efficiency as long as we have broad contiguous bands of spectrum, and it gives us the opportunity to simplify the network or flatten the network. All of those things are true as long as we have contiguous blocks of spectrum and that we address the nearby band interference. It depends on the antenna configurations that we utilize, and of course the speed that an individual customer might see as impacted by the vehicle motion as well as the other users on the cell since it is a shared

network and the terrain associated with that.

In summary, AT&T has focused on delivering the industry's best wireless experience. We have invested $20 billion over 4 years in network upgrades, spectrum and acquisitions. We plan to spend $17 to $18 in 2009, probably the highest of any company in the U.S., to extend and enhance the wireless and the wired networks. And this year we'll add some 20 markets to our HSPA infrastructure and augment our networks with another 2,000 new cell sites.

I look forward to the questions and comments from our fellow panel members throughout this afternoon. Thank you very much.

MR. KNAPP: Thank you, Kris. Sten?

MR. ANDERSSON: Good afternoon. I'm Sten Andersson and I'm responsible for wireless network solutions for Ericsson North America. Let me make a few comments about Ericsson since some of you might not be familiar with us. We've been around for around 130 years around the world selling telecommunication solutions. We have

business in 140 countries around the world. We have broad telecommunications portfolio including wireless and wire line products, access, backhaul, core network and so on. We are a leader in LTE technology for wireless and have been so for many years pushing the standards and development and research around LTE.

The first slide outlines on a high level the evolution of wireless as we see it. You have on the top line the GSM wideband CDMA and HSPA technologies. Today they are serving close to 4 billion subscribers around the world. We have then the CDMA technology serving a little bit less, but around 10 percent roughly. Then we have the Chinese TDCMS standard being built out in China. Those three technologies are coming together in an evolution in one technology and that is LTE. It's an FDD and TDD technology.

A couple more words about HSPA. As I mentioned, 300 million subscribers around the world are served. We have more than 1,500 HSPA devices around the world supplied by more than 150

different handsets and devices vendors. So there's a pretty tremendous -- built up. A couple of points on FCC policy, and I have listed some of the inputs here that we think are important. Number one is economy of scale. We believe that we suggest it's a necessary characteristic to spread broadband around the world to groups of people who maybe cannot afford wireless broadband or broadband at all today. We have global harmonization as another important item, that the spectrum around the world gets harmonized and you can actually sell the same radio product as well as the same device all over the world which helps drive down the cost. The users might want to travel between countries and have the same service, but that's not necessary to get the benefits, it's the economic financial benefit that I'm stressing here.

LTE serves both FDD and TDD. We believe FDD is a better technology for the reason about power. You have a higher power level so you get a little bit better coverage. TDD however is a good

technology and LTE covers TDD when TDD is needed. We also support wider bandwidth allocations. The more bandwidth you have available, the higher speeds you can accomplish and you get better efficiency. With the growth of data in wireless, we believe that more spectrum is available and spectrum needs to be made available somewhat urgently. It takes many years to deploy new spectra as you know. Then there are some technical rules that we think should be investigated and analyzed as we move from more narrow band technologies to technologies that are wider and wider spectra.

A few comments. LTE in high level points is an OFDM-based technology but a very able bandwidth from 1.4 megahertz carriers, CDMA, then you can have 3 megahertz, 5, 15 and 20 megahertz. It's flexible. The devices and equipment can move between the different sizes. Advanced antenna solutions, diversity beam forming, multilayer transmission.

A couple of words about the devices. I

want to point out one device in the middle there. It's a module that's being installed in laptops today, a high speed HSPA module, and as that market is growing and the price is coming down for chip sets and modules, we see the migration into more and more devices and the price point for those modules is very critical to get them installed in more and more devices and drive the spread of broadband.

The next slide outlines the evolution. Kris showed that, but I want to spend a minute or 10 seconds on LTE Advanced. That's a wideband technology. We can have up to 100 megahertz of spectrum and accomplish very high bit rates. You can see 1 gigabit per second is the peak rate. There are a couple of benefits I want to highlight, and you can read them yourself. It achieves mobility across technology platforms. You can roam and hand over between CDMA and LTE for instance between HSPA and LTE and so on, so you have that full flexibility.

I appreciate to be invited here. Thank

you do much for your time. I look forward to questions.

MR. KNAPP: Thank you, Sten. Barry?

MR. WEST: Thank you. I did not bring a presentation, but I just want to take you back 25 years ago to remember the advent of the commercial mobile phone. I remember very well people saying why would you need a mobile phone? The fixed phone is going to do just fine. Here we are 25 years later and I just about guarantee everybody in this room and most people who can afford on the planet have a mobile phone and would not give it up.

We also have another phenomenon that has occurred in the last 10 years that's called the Internet. The Internet has totally changed everything about human society, and particularly about the way we get to information and the way we share information. If you look at the developments that have occurred since the Internet, in every field, I particularly like to reference medicine, the rate of change is

unbelievable. It's exponential. As soon as something is known by someone, it's posted on the Web and we all know about it. The next phenomenon is going to be the mobile Web. The way people get to the Internet is going to be via mobile devices. Why? Because basically that's what human beings want. We want that ability to be with us at all times.

Having said that, how do you achieve that mobility? It was interesting. I know Ericsson just can't use the word WiMAX, but there is actually another technology out there. They're all fundamentally the same. We're all moving to OFDM. Why are we moving to OFDM? Because it supports a wider channel better. I love the idea of a gigabit of throughput. It's going to go perhaps half the distance across this room in a practical environment, but it's a noble thought. Also where do you get 100 megahertz of spectrum? So one has to be pragmatic. But in the same way that we had to provide for a voice channel was literally 12 to 20 kilobits of capacity or channel

on an individual basis, there are many, many services on the Internet that you can serve with data rates of 3 to 5 megabits on the downlink and 1 to 2 megabits on the uplink. That is not the throughput rates at which WiMAX or any of these other technologies achieve on a sector basis, but it's important because it affects the economic factors. We can get these wonderful, big data rates, but we have to make sure the economics work. Otherwise it will never take off.

So WiMAX is a viable technology. It is here today. It's an extension of the WiFi family. There are already millions and millions of devices out there accessing the Internet using WiFi, WiMAX is the next natural evolution of that, and so we are going to see competing technologies. And quite frankly, the economics and customers will decide who the winners are in this race.

I do think it's very important that the regulators around the world, and it's my privilege to meet with a number of them, realize that the economy is going to grow again as a result of the

Internet and mobility and everything that can be done to encourage that, the way the rules are written, I just urge every regulator in this room to really put your minds behind it and get it going because it's just another phenomena and it is what is keeping me from retiring. I just couldn't miss this opportunity. So thank you very much.

MR. KNAPP: Thank you, Barry. Scott?

MR. CORSON: Than you very much for having me here. I wear a slightly different hat from some of the folks on the panel. I'm really more from an R&D background. I was a wireless network architect at Flarion before we joined Qualcomm, and I pretty much pursue the same function at Qualcomm now.

This is more sort of a futuristic kind of pitch. I'm really not a physical air guy, although I'm going to be reflecting the comments of a lot of the experts I talk with daily.

First a general comment. From a mobile broadband perspective, the consensus view at least

at Qualcomm is that unlicensed spectrum doesn't cut it. We've love to see fruitful use in that application, but we can't figure out how to make it work. That's just a first comment. The second comment would be that information theory pretty much shows us that all he technologies are trending toward a limit and that limit is not easy to surpass as far as we understand. It's getting to be where the technology doesn't matter so much, it's simply about the availability of licensed spectrum in which to deploy the technology. The problem is there's not enough of that as far as we can see either and so we need more. In order to make better use of the spectrum that is there, of course is it gets to the reuse game. You need to increase reuse. Every means needs to be employed to make that happen to stretch the licensed spectrum further because it is extremely valuable. That takes you really to essentially from what we can see two paradigms. Of course, one is the continuation of the smaller cell splitting kind of paradigm. The most recent evolution of that is

the movement toward the use of femtocells. It's the natural thing to do and we're starting to see that activity coming online soon. Another avenue that we're certainly looking at is the use of direct communications between devices themselves without having to go through an intervening infrastructure such as a base station or a femtocell. So just to make some of these points concrete, where we are today more or less is the macrocell people understand that, the device connects to the cell tower however far away it is. Soon will come the notion of a femtocell. It's happening now and these are obviously WiFi sized or even smaller kinds of base stations essentially but which are deployable in homes and small businesses. Then what I'm talking about as something that we're looking at for the future is actually direct communications now between devices, and I don't just mean handsets. I'm showing my favorite little icon of a computing device which is the original Macintosh which I still think is a nice icon, and I just mean a

general device. It could be a handset, it could be machine to machine. It doesn't really matter what it is.

What do we as Qualcomm I guess you could say think should be a part of a national broadband plan? We think that more licensed spectrums should be available through auction fundamentally. That's something we think needs to be there. That takes many years to have happen. In the mean time, extensions of 3G can be deployed which have high spectral efficiencies which even approach what's achievable with LTE. And of course, LTE is coming along as well.

Some of the things that can be done near term with some of the stimulus money would be to amend the e- rate linkup and Lifeline Programs to make some monies available for extending mobile broadband. That's not a difficult thing to do. It takes policy changes. Then finally regarding the spectrum that we would like to see deployed, we believe technology neutrality is very important. It's a key to innovation. It's

generally bad policy to tie the useless spectrum to particular technologies. Again thanks for having me. I look forward to questions.

MR. KNAPP: Thank you, Scott. Milo?

MR. MEDIN: Thank you for inviting me hear to speak, and I look forward to any questions afterwards.

Wireless service in the U.S. today has not yet proven out as a substitute network for wire line broadband services such as cable, modems and DSL. I believe there are a couple technologies that could help change that and enable wireless service to make a substantial impact on the state of broadband adoption and availability. First I'm going to talk about time division duplexing or TDD and why it's easier and why making it easier to employ TDD networks advances broadband goals. Then I'll discuss why technology advances on the CPE side can help enable new models for broadband service deployment which can help increase available speeds and coverage. Lastly, I'll talk about some of the

policy challenges that are going to have to be overcome.

The first technology is time division duplexing or TDD for short. Most cellular systems use frequency division duplexing or FDD as they've evolved out of providing voice services which are inherently symmetric in nature. TDD is really optimized for data, and let me share why. First off, TDD enables flexibility in allocating spectral resources between the upstream and the downstream instead of being fixed at fifty-fifty with a traditional FDD system. This lets operators use more of the capacity of the system for downloading, a better match for Internet use. TDD is also better able to take advantage of adaptive antenna techniques such as beam forming and spatial division multiple access because the same frequencies are used for transmit and receive, enabling significantly higher precision in computing antenna weights resulting in narrower beam widths. That can add more than 15 dB of gain to a system, dramatically increasing range and

increasing cell capacity by about 300 to 400 percent. I believe this shift is essential in making wireless broadband economics work within the constraints within the backhaul market in the U.S. TDD/CPE can also be simpler and cheaper since diplexing filters aren't required, and TDD removes the requirement to have paired spectrum, greatly simplifying the process of relocation of spectrum from federal users. TDD has some spectrum policy implications, however, since the need to assign spectrum on a national basis or at least in large block sizes to maintain synchronized timing along license boundaries. Also if adjacent FDD operations contemplated practical technical rules to prevent harmful base to base as well as mobile-to-mobile modalities should be adopted such as the rules at the recent 700 megahertz auction and in the OET analysis and AWS-3 proceeding.

If the primary goal in using wireless technology is to deliver broadband data, then explicit spectrum allocation for TDD use should be

the answer since it is better suited for this application than FDD systems. Secondly, advantages in the form of programmable radios are going to enable new types of broadband service models that will create new options for extending coverage and employment of higher speed networks. Software defined baseband technologies are coming that enable a single radio to communicate using multiple air-link protocols, for example, a single baseband chip that can speak LTE, WiMAX and WiFi and perhaps even 3G protocols. Highly agile broadband RS stages are also coming such as products from companies like BitWave which are not limited to a specific set of bands, but can communicate over a whole swath of spectrum like 700 megahertz to 3.8 gigahertz in a single chip. This is a big deal because it will remove the need for global harmonization of spectrum and enable more innovative, entrepreneurial deployments without suffering the cost penalty associated with low-volume solutions. Together they're going to allow a device vendor to create a product that

doesn't talk just to one carrier's network, but will allow opportunistic communication in both licensed and unlicensed spectra in very different bands based on what the user desires in terms of getting higher speeds, cheaper access, et cetera. This is going to enable specialized networks to use scraps of spectrum to cover off areas that may have no service today as well as deploy overlay networks that can offer higher speeds and additional competition and help upend the current carrier- centric model that we see in wireless in the U.S. today. All of these technologies are shipping now or in advanced stages of development. However, to maximally exploit these technologies, FCC processes need to change to make it easier to deploy these new kinds of networks and types of equipment and to do so without inflicting significant costs and delays along the way.

It's helpful to point out that FCC priorities have traditionally been oriented around tasks like merger reviews and incremental tweaks to current regulations, whereas new service

approvals take exorbitant periods of time as the last chart I have in the deck shows out. If rapid exploitation of new technology and service for broadband is a new priority, then FCC processes should reflect that. For example, FCC proceedings on new services should shift the burden of proof so that it is on the opponents of new services and technologies as opposed to the proponents. As it stands today, the timeframes for deploying new wireless infrastructure is greatly out of whack with the development cycles for devices and services that use that infrastructure. As the only member of this panel here from Silicon Valley, I must emphasize that compressing decision-making times for telecommunications policy is the single biggest advance that the FCC could make to enable our nation to be the global leader in broadband the way we in the Valley have made us the global leader in computing and the Internet. Thank you.

MR. KNAPP: Thank you, Milo. Tom?

MR. ANDERSON: My name is Tom Anderson.

I head the architectural organization within the wireless CTO at Alcatel-Lucent. I'd like to talk about a few major points that I believe are key to the national broadband plan that is under consideration here.

First I want to add to Kris Rinne's remark relative to spectrum, and I think Scott as well mentioned the need for spectrum, so I think it's going to be essential that we have additional spectrum on the market, large blocks of spectrum. Although a lot of work is going on in my organization and in organizations the globe to increase the efficient of the spectrum and spectral efficiency in how to use broadband more efficiently, fundamentally we're not going to be able to keep up with the growth rates that Kris talked about without more spectrum. So I think that's a key consideration.

Scott also talked about femtocells and small cells, and to expand upon that I think it's going to be critical that as we deploy wireless networks we will see the need for smaller cells

and not just femtos and certainly small base stations in the home for example, but also small cells to cover hotspots. This makes more efficient use of the spectrum and provides higher data rates. But from a policy perspective, we want to make sure that we look carefully at the state and local zoning regulations that may provide restrictions that are not necessary and may impede the deployment of these kinds of networks that would really facilitate the kind of broadband network that we need to build today. It's something that we need to look carefully at and I think should be part of the plan.

I think building on what Sten mentioned, the third component here is the ecosystem. In order to get the cost profiles that we need so that customers have very low- cost devices but very capable devices, high-feature, high-functionality devices, and in order to provide an infrastructure that has a cost profile that we can deliver the services so that service providers, AT&T and others, Clearwire, can provide services

and the applications at a cost-competitive price point. Having a global ecosystem of not only devices but spectrum sharing as well, if we could use a common spectrum as I think Sten mentioned, I know that's very difficult, but to the extent that we can share within technology a common worldwide ecosystem, we can get the economies of scale to get the price points right to really make broadband affordable for all. With that I'm through.

MR. KNAPP: Thank you, Tom. Sascha?

MR. MEINRATH: Thanks. I work at a policy institute here in D.C. I'm sort of our token public interest representative on this panel. The Open Technology Initiative which I direct promotes policy and regulatory reforms to support open architectures and open source innovations, and we're looking at promoting universal, affordable, ubiquitous communications networks and are committed to maximizing the potentials of these networks for the communities that are least served, the poor and the rural and

other underserved constituencies. So in the immortal words of Monty Python, now we're ready for something completely different from the rest of these presentations.

I'll start by saying simply that we are living through a critical juncture in telecommunications history. We have this trifecta of societal shifts that are combining to create the perfect storm for advancing policies that better meet the needs of all U.S. residents. First, we've got these technological advances which a number of the panelists have pointed to that could better connect people and have dramatic possibilities for increasing the utility of communications networks. Second, we have customers everywhere clamoring for access to advanced services and new applications and this is driving multimedia production and information dissemination writ large. Third, we have these generational shifts that are happening right now where the country's key decision makers have the potential now for generating seismic changes in

our country's regulatory and policymaking environment.

Taken together, these should be driving a communications renaissance, something akin to the introduction of the printing press or the telephone or the Internet itself. But instead, what we're seeing is this systematic entrenchment or vested interests who are diligently working to prevent many of the most innovative technologies from ever seeing the light of day who are engaging in draconian attempts to limit media production and stifle information dissemination, and as Amy Schatz actually just yesterday reported in the "Wall Street Journal," are launching an unprecedented lobbying effort to stagnate and prevent meaningful and much needed reforms.

So here inside the Beltway I would say that we are gearing up for an epic battle that's going to be waged in the very near future between the forces that are looking to create a participatory, democratic, more distributed digital public sphere, and forces that are seeking

to reestablish a command-and-control regime over next- generation telecommunications infrastructure.

As the populace shifts from wire line to mobile communications as their communications norm, wireless technologies are at the very heart of this battle. And instead of building next-generation networks focused on lowering costs for customers, maximizing user control over the services and applications that we have bought and paid for, providers are architecting systems that maximize billable moments on their networks, commoditizing every new space and function possible. Instead of fostering interconnectivity of networks and interoperability of devices, the forces of command and control are seeking new ways to capture market share, generate path dependencies and limit customer churn. So handset exclusivity and the lockdown of cellular phones and PDAs are certainly systematic of this business model. But so too are the myriad limitations we've already seen to prevent users from doing

everything from streaming audio and video on their wireless devices, preventing Google Voice, preventing Skype, et cetera. And historically over the past 75 years we have seen dramatic increases in wireless capacity and we systematically been opening up higher and higher frequencies as the technologies have made these bands viable, and the allocations for these new uses have paralleled these reforms. However, assignments to license holders in years past, having been based on the cutting- edge technologies of their day are remarkably inefficient by today's standards and through today's technologies. So today as several people have pointed out, cognitive- and software-defined radio technologies allow us to infill throughout the public airwaves. Dynamic reuse of empty spectrum and underutilized frequencies could incredibly bolster what's available. And this opportunistic spectrum reuse has the potential to dramatically decentralize and improve communications at the same time. It's one of the

most powerful tools available for breaking the current strangleholds we now face over how we communicate.

I would say that leadership from Congress and from private industry and from the public interest sectors is desperately needed to assure that these necessary transitions are graceful instead of unmanageable and are libratory instead of harmful. And the FCC through its incentives and regulatory fiat has the responsibility to ensure that the public airwaves serve first and foremost the best interests of the residents of the United States. Thank you.

MR. KNAPP: Thank you, Sascha. That's a great lead-in. I was wondering if anybody else, particularly the folks who are investing in the expansion of the current wireless technologies have any reactions or response to the points that Sascha had raised. I can start calling names.

MS. RINNE: I have a comment.

MR. KNAPP: Go ahead, Kris.

MS. RINNE: To the point in terms of

continuously driving efficiency, the investments that we've made over the last several years as we've migrated from analog, to TDMA, to GSM, to HSPA and then ultimately LTE, within those same spectrum bands because of the freedom we have from a technology neutrality standpoint, but we've been driving those efficiencies and we leverage cognitive radios and soft-ware defined radios in order to drive down the costs in order to benefit the because in terms of lower costs and provisioning those services as well as driving the efficiencies in that technology in those spectrum bands.

MR. KNAPP: Others?

MR. WEST: If I could just jump in. I like the sound of some of the things you talk about, but we've had WiFi around for a long time and in an unmanaged state, WiFi is absolutely a fabulous tool but the interference reaches a point where from my house I can see seven WiFi nodes and I can't use my WiFi. I think some form of management policy is absolutely essential and

therefore managed spectrum -- I'm not saying that other spectrum might have different uses. For instance, one of the clear problems that we're going to face is literally hundreds of thousands of cell sites because of the need to aggressively reuse the spectrum and provide capacity at an unprecedented rate. That means that we have one hell of a backhaul problem and that might be where you can use some of these techniques because you don't have the same propensity for interference that you would do at the actual customer level. But I actually think that the downlink and the uplink from the customer should be in a managed spectrum.

MR. CURTIS: Let me follow-up though on that because some of this is a little bit disappointing for several of the panel speakers because they said we need more spectrum, more spectrum. Nobody gave a concrete example of where we get that more spectrum. Hopefully Julius can give us another 100 megahertz, between 700 and 701 on the radio spectrum.

MR. KNAPP: Not mine to give.

MR. CURTIS: Let me ask a specific question to Scott and a more general question to all the panelists. We know multi-node, multi-band devices are more and more easy to build. For the peer to peer and the femtocells, why don't we do that on an unlicensed spectrum and we only use the licensed wide-area spectrum for the full mobility long reach, get it on the ground or unlicensed as soon as possible? That would be a specific question and any of the other panelists answer. Then the more general question to all of you is you want more licensed spectrum? Tell us what we should be doing. Who do we take spectrum from to get more licensed spectrum?

MR. CORSON: I guess the question was initially directed to me so I'll take a stab at it. I don't know where we get more licensed spectrum. I know it's of great value so it would be great if more were made available. I'll try to articulate why it's of value. WiFi is great. So is Bluetooth. I love the fact that the iPhone is

opening up now and enabling Bluetooth-enabled iPhones to talk directly to each other. That's a great thing. But the thing with unlicensed spectrum, it gets to the point that Barry mentioned that that's interference. In the unlicensed world or when you view creating value of unlicensed space, you don't really own the spectrum, you own the geography within which the spectrum exists. So to the extent that you own a lot of geography, you can deploy unlicensed technologies in those geographies that have certain interference characteristics and you can create value to some extent, but once you don't own the geography anymore, and I'm thinking now of any densely populated area where really the propagation and interference of these technologies interact, you have a lot of difficulty creating value now in these very uncontrolled spaces. So that's why I would say that unlicensed is great stuff. We all make use of it I think to some extent. But the fact that you don't have managed interference limits the utility that you can

create with it. I think that's really the gist of my comment.

MR. CURTIS: The FCC just did the TV white space rulemaking. Could that be used for your peer to peer and your femtocells so you don't use your licensed spectrum?

MR. CORSON: White space brings another host of challenges. Some are regulatory in nature. Some of the policies which are required to make use of the white space are difficult from an engineering perspective to make the technology useful because of incumbent uses and things like that. And there are other less-obvious problems that make the white space issue challenging particularly again as I said for these mobile, broadband, longer-range kinds of contexts. As you bring communication ranges down, many things become more feasible not just for white space but for unlicensed technologies as well. But in the less- coordinated area out there, in the mobile world, there are a lot of practical issues.

MR. CURTIS: I agree with the mobile.

Nomadic is a different issue.

MS. RINNE: A comment on the femtocell. The purpose of utilizing the licensed spectrum there is similar to the concept we've been using for years in terms of continuously cell splitting, and a femtocell, think of it as kind of an underlay/overlay network, so you could do a lot of femtocells to get those minutes off of that macro network and do it at a very, very lower power so that you're not creating interference for that macro network and then that allows you more capacity for serving customers on that macro network. So it gives you an efficiency without depending on the customer or a client in the device to move to a WiFi solution or some other type of solution in order to get those minutes and bits over to the femto.

MR. CURTIS: So since most cell phone transactions originate inside buildings or campuses, if we rapidly deploy femtocells, then you get more than a doubling of capacity automatically so you need less spectrum.

MS. RINNE: I wouldn't say a doubling, but I'd also point to the 5,000 percent growth in the utilization on the data side, so that doubling won't cut it.

MR. WEST: I know where you're going with that, Stagg, and that's kind of funny, but the growth in data is unbelievable. It's not unreasonable to see people using a 10 gig, 15 gig, 20 gig in the not too far distant future, and the sheer bandwidth that is required to deliver that in a timely way as the service is deployed to the customer without taking them back to the world of dialup is really important, and that's the chaos, if you like, that you get from an unlicensed environment. I well remember citizen's band radio which I thought was phenomenal. I made a lot of new friends with CB radio. But after about 5 years it went out of use because it was totally unusable. I guess there are pockets of it around.

MR. CURTIS: The problem I'm hearing you say is not only do we need more spectrum, we need much more spectrum and there is only one person in

the room who might be able to give us that and that's Karl over there. He has all the DOD spectrum. So I come back to where do we get the spectrum?

MR. WEST: The other thing that we need to be able to do is to more aggressively reuse it.

MR. KNAPP: Let me hit on that point too, not to sidestep Stagg's question, but there is a lot of spectrum already being used by wireless networks. This morning we heard a little bit about you invest in a technology, it gets out there a few years and you're looking to recover your expenditure over the course of 15 or 20 years. How much of this can actually be implemented in the existing spectrum where we're taking advantage of things like software-defined radio? Kris, I do want to come back to the extent that that's being used. The smart antennas and so forth. Don't be mistaken. I'm not saying this is not part of what would be examined, but what happened if you didn't get the spectrum? What would you do to make the most out of what you've

got?

MR. WEST: You're back to aggressive reuse. I'd just like to point one thing out. We all look at the technology and say this is the driving cost. In a macro cell layer the actual hardware, the equipment that delivers the service, is probably less than 20 percent of the cost of the cell. So inasmuch as we need to get to the position where we can get leasing and zoning in a much easier way, you'll spend as much money on leasing and zoning as you spend on the equipment, and the need to cell split and roll out more cells, that delay is a lot of times what causes the operators to have service issues in a particular area. They've got the money to roll out more services but they just can't do it fast enough, and that applies to all operators.

MR. KNAPP: Go ahead, Sascha.

MR. MEINRATH: I think one of the issues at play here is that when you have a hub-and-spoke mentality of what these bundles should look like, then when you break it down to femtocells, you're

very small hubs and spokes. As Scott pointed out, this sort of peer-to-peer architecture really changes the dynamic of what these networks are capable of in the capacity limits of available spectrum. To me, what was interesting or perhaps most interesting was when Scott was talking about the future being these peer- to-peer technologies, instead of seeing two Mac icons, I would have liked to see two walkie-talkies because we were there once. We used to be able to do peer-to-peer connectivity at a very basic level, and we can do that today. I remember 10 years ago talking about I want to build metro scale mesh networks, and people said it doesn't scale and you'll never be able to do that, and we built them. They're alive today. They're doing well. They're scaling up to thousands of nodes covering entire metropolitan regions all using unlicensed. And not just that, but having larger capacity on the junk band using open-source mesh technologies than the extremely expensive hub-and-spoke cellular infrastructure in those same communities.

In many ways I think, and this has been alluded to, dynamic spectrum access helps a lot. Distributed systems and peer-to-peer architectures help a lot. Automated power control helps a lot. There is a whole number. Beam forming helps a lot. There's a whole bunch of different ways to do this, but one has to let go of this notion of a central point of control on these networks.

MR. KNAPP: Milo?

MR. MEDIN: I think there are two answers. The spectrum that exists today that's being serviced with the 3G networks have fundamentally lower bits per second per hertz per cell generation than OFDM systems whether you're talking about LTE or WiMAX, and if you can aggressively move those networks to these next-generation systems augmenting them with some of the adaptive antenna techniques that are coming available, you'll get a lot more capacity out of the cell site for the same amount of spectrum. At the same time, it does I think as move to these kinds of frequency agile broadband RF stages we

can start looking at both unlicensed and licensed frequencies to offload things opportunistically in certain locations the way people do with WiFi today. 3650, to me that is a band that is neither fish nor fowl right now and the Commission should think about what set of rules would really enable that spectrum to be used for offloading capacity in these kinds of more dense configurations found in office buildings, et cetera. It could be useful for that.

When I worked for NASA there was a saying, with enough thrust, anything can fly. There is a certain mental viewpoint that says we'll just do more of what we do now and we need more spectrum so that we can do more of what we do now more. That just is not going to fly. The physics run into that. We need to be much more aggressive about next-generation technologies, SDMA can improve spectral efficiency even more, so there are a whole set of challenges. TDD networks I will point out are better to take advantage of these techniques than FDD systems. One of the

changes as we get to these more programmable radios is that we can move to CPE hardware that's more flexible, that can take advantage of these kinds of technology changes and offload opportunistically to both licensed and unlicensed spectra.

MR. KNAPP: I want to come back to Sascha's point for a moment. You had mentioned use of mesh networks. Can you site some examples of a successful network because we've heard mixed reports?

MR. MEINRATH: Mixed reports, yes. Open-source mesh doesn't really have a PR marketing firm behind it. It's like people like me talking in venues like this. FunkFeuer in, Vienna, Austria, and in Graz, Austria, both have metro scale mesh networks. They're both fairly large. They're metro scale. In Berlin, you've got a mesh network there, Freifunk. How many nodes? It's hard to say because it's entirely distributed and unowned, but it's a backhaul of about 600 nodes there. In Guifi.net in Spain has

about 6,000 nodes covering a lot of the Catalan region in the northeast of Spain. You've got Freifunk in Berlin. You might notice that a lot of these aren't in the United States and that's because in the United States we all know that mesh doesn't work. It just works in Europe apparently. But you've got Djursland.net. That's covering over 2,500 square kilometers. It's larger than a metropolitan areas. These are all using open-source technologies following completely different models than we're used to today.

What I want to point out and make very explicit here, this is not a dichotomy where everything needs to be open source, mesh, and not licensed and architected. These things must coexist. There is effectiveness in having both of those different models at play in our electromagnetic spectrum and for our communications needs, but there needs to be adequate space for both and clearly some of the problems that are faced in the licensed world using these specific business models have been

solved or at least alleviated using different architectures or different business models.

MR. KNAPP: Reactions? Go ahead, Sten.

MR. ANDERSSON: There was one comment that we don't want to continue to do more of the same.

MR. MEDIN: More thrust.

MR. ANDERSSON: I would say that the vendor industry and research institutions are putting billions of dollars into wireless technology development researching how to build effective networks. The bits per hertz is increasing day by day more or less. We are building networks different ways. If there is not enough spectrum or limited spectrum, we build a macro network maybe to calibrate to the lower spectrum or to operate and then you add on smaller cells with the higher spectrum for capacity. There are all kinds of tools that we're using, both research and development in the radio based station, but even more on the device side because the device side is often what limits the capacity

and the utilization of the spectrum, and of course you have some power limitations and size and so on. So I think that there is a lot of research going on and I think that the improvements that we have seen in wireless technology over the last years has been tremendous and I expect to see it in the coming years also. So I think that we are working hard to do what we can to utilize the spectrum to the very, very, very, very best.

MR. KNAPP: I have a question, I've got several of them, and they've been great questions. It's more of a follow-on to what we were getting at before. Are any of you considering subsectorization using beam forming to achieve a three- to five-time improvement in capacity? I think this is directed not just at the new implementations of LTE and WiMAX, but is there any benefit there for the legacies? It's hard for me to say legacy. It feels like 3G just got here. Thoughts on this from anybody using beam forming on the existing systems or plans for that?

MR. WEST: Just to comment, we're using

simple MIMO techniques at this point in time. Some of the issues around beam forming are the antenna arrays and you get back into the zoning issues. In order to get through zoning you need simpler arrays rather than more complex arrays. However, the processing power that we're seeing now in base stations particularly on the uplink side help with the beam forming technologies and I do think there is going to be a role for beam forming, it's not just not economical and at this point in time, but we will see benefits from it. I'm certain of that.

MR. KNAPP: Milo?

MR. MEDIN: Let me just add that I think from a macro cell network architecture perspective, if you use beam forming and SDMA you can aggregate capacity at a cell site which puts you into a different cost range for backhaul. I have yet to find a commonly deployed facility that costs on a dollar per bit basis than a T-1 line. And I will tell you you can't build a true data network that's not subsidized by voice revenues if

it's trunked by T-1 lines. You couldn't do it in 1995 when we did cable architecture at home, and you can't do it today. It doesn't work. So we have to move out of that range where you're trunking facilities with just enough capacity that the only facility that makes sense is a T-1 line. Those business models don't work. Technically they work, but from a business perspective they don't work.

MR. KNAPP: I had another question on my mind as well. The question is framed do the underserved areas require additional spectrum allocations, and if yes, why? But I guess I'd expand on that a little bit. The way we've seen the wireless technologies rolled out generally has been in the big cities first and that's been the pattern as we've moved from analog from second generation to third generation. Would we expect to see anything different as we move to the next-generation technologies, LTE, WiMAX and so forth? Is there any benefit in them that makes it more likely that we're apt to see coverage in the

areas that aren't covered now?

MS. RENNI: Typically to your point, Jules, we do implement those in the metropolitan areas first, and if you look at the HSPA technologies, as you get farther and farther to the cell edge, it becomes more edge-like in speeds. So moving that into a rural area doesn't really benefit the entire radius of that cell site. As we look at the LTE, the fact that we've got 700 that we can implement in, that helps obviously in terms of that coverage as well. And then also some of the OFDMA technologies that we're looking toward and the MIMO capabilities in the device and the infrastructure will help to extend that, but there will still be limits on that cell edge.

MR. MEINRATH: If I could add to that and building a little bit on what Milo was saying, the costs that are associated with deploying especially in rural areas to the backhaul, this is a clarion call for special access to be addressed which I know is something that's being talked

about quite actively, but needs to happen if you want to spread connectivity to rural areas. I would also point out that this intersects with the white space end, that because television stations cluster in the metropolitan areas and don't serve a lot of the rural areas, you have tremendous amounts of spectrum and what this really points to is the need for a systematic, empirical audit. We really do need to know what's in use and what's not and where it is. According to the best available data which is not about a half-decade old, the National Science Foundation did pay for a study that was actually conducted by Shared Spectrum which I guess will be here on the next panel, and what they found is at the height of the RNC in New York City which was the most used space for spectrum, their one-time measurement there over the course of a weekend showed about 13.1 percent of the spectrum being used. When I first learned that I was stunned. I'm sure when people hear like you're saying that the vast majority, the supermajority of spectrum in any given place

at any given point in time at any given frequency is most likely unused, that's a really depressing statistic. Until we get the data that we need to make informed policy about what's actually in use and what's not, we can argue until the cows come home about whether there is space or whether there isn't. But I'd much rather have our decisions being based on knowledge that we glean as to what's happening on the ground in these rural communities and everywhere today.

MR. KNAPP: Anybody else? This is a fair point? But is there anybody else on different expectations on coverage in rural areas that we might see out of LTE or WiMAX?

MR. ANDERSON: I would agree with the other panelists that in rural areas you don't have the congestion issues that you have in the urban areas, so clearly in the urban areas you have the congestion, you have the cry for more spectrum, you have the cell splitting, you have the interference, you have the focus of the technology to make very efficient use of it. In the rural

areas the problem I think is less spectrum and more the infrastructure available to actually reach the communities and households that are very far apart, and given the nature of radio transmission, it's just hard to reach those high data rates.

With technology, it's certainly improving, but as Kris said, even with 3G and 4G technologies, there's not much you can do when that signal to noise ratio is so low at the cell edge that you just don't have the theoretical room to send a lot of data regardless of the technology simply because you're at that limit that Scott spoke about earlier.

MR. KNAPP: Karl, did you have a question?

MR. NEBBIA: I wanted to ask with respect to the other spectrum users around the bands that you are currently working in, most of those spectrum users look nothing like you. They are radar systems, they are satellite navigation systems, they're passive systems, all these types

of things that have been designed to fit in the bands that they're in to convey a signal a certain distance, longer distances at shorter frequencies and so on. So there is some possibility as we go through this process of looking for more spectrum. Many of those people are going to say we need to be where we are, but we recognize the time issues that Sascha has been mentioning. From the standpoint of the approaches that you're looking to take, is there a possibility of sharing spectrum on a time basis whether through unlicensed activity or through a licensed approach that you have? Or making more decisions about using spectrum in certain areas and not using it in other areas so that you're making more geographic allocations of the spectrum that we have, because in many cases these folks may not be able to route themselves up, certainly not in the timeframe that you're looking for?

MS. RINNE: Spectral efficiency is impacted by interference, so one of the advantages that Barry has pointed out of licensed spectrum is

you know what you're competing against or where the interference is coming from and in a single managed network you know where that interference is. So complementary technologies, I'd point to the 5 megahertz WiFi where that's shared with radar where it's known. It doesn't move. It's fixed.

MR. NEBBIA: Sorry, that's not true.

MS. RINNE: Not as frequently I guess as mobile, I guess, Karl, would be my point. So when you know those things, it is possible to be efficient in terms of the reuse.

MR. WEST: I would argue that the cellular operators are probably the most efficient users of spectrum anywhere, and I think the nature of the question was we got all of these other inefficient users of spectrum, what can we do to either borrow or work with? I think the important thing there is you must know the rules. You've got to know that if I've got it from 9:00 to 5:00, I've got it from 9:00 to 5:00 and they're not using it if that is the nature of what you were

suggesting. Again, that could be an area where the FCC literally can help by making spectrum available particularly adjacent to the currently congested and heavily used bands. I think that's well worth looking at.

It's true that when you look at all the spectrum we've got, it always amazes that one 5er can carry so much more in terms of spectrum than the entire usable radio spectrum. It is somewhat of a crime almost that we aren't efficiently using the entire band everywhere, so I think that is again a study that should be done, how can we possibly open that up either through collective programs as you suggested or literally looking at the economics of shifting some of these smaller players. Maybe there's a way. We're looking at a stimulus package to try and grow this country's economy. Is there a way where some of that stimulus money could be used to reposition? People whose entire business plan require the status quo. They don't have the money. They don't make the kind of money to move themselves.

Maybe this is a way again where the government could look to doing something proactively in this particularly difficult time.

MR. KNAPP: Tom?

MR. ANDERSON: Another consideration particularly around innovative spectrum usage is the impact on the device ecosystem. We have situations today where operators in the U.S. own spectrum but they can't find devices to light it up and use it. We also have to be careful about finding some spectrum, but finding out that we can't get devices for that or devices that are usable by the public that the public wants use. So there has to be a balance between spectrum that we can find and clear or use in a sharing way, but also devices that can use that spectrum and getting an ecosystem for those devices.

MR. MEINRATH: To this I would add that the New America Foundation just recently released a White Paper looking at NTAA spectrum use and looking at how you might go about beginning the process at the very least of sharing spectrum in

ways that are mutually beneficial to both NTAA overseeing agencies, general public, private industry, et cetera. There are certainly a number of ways in which we could be shared use that have to date been politically unfeasible but it's a political problem much more than a technological one.

MR. WEST: If I could go back to the question about the economics of rural coverage. I do believe the fourth-generation OFDM technologies with their flat IP architecture does change the economics, but it doesn't fundamentally change the economics unless you can solve the backhaul issues. Again investment in fiber to every village in the country would be a good move because that could then enable wireless last mile solutions in those at an economic rate. And if you are putting the kind of money that every major operator puts in to building any kind of wireless network, it is not for the faint of heart and you have to look to where do you get the best return for that investment and inevitably it becomes the

urban areas. It's not that the suburban and rural areas are not attractive over the longer term, it's just a case of where you make your maximum return. So if you can solve the economic problem of backhaul because I think that is the major difference, then I think that rural will get coverage much faster. It's a bit like in the early days before electricity was universally available, the government just decided it was everybody's right to have it, and I think that something similar in terms of broadband access, it doesn't matter how it's provided, every American wherever they live should have that right.

MS. RINNE: But it needs to be focused on the go- forward technologies to your point.

MR. WEST: Yes. Absolutely.

MR. RINNE: Ethernet and fiber as opposed to TDM, T-1, T-3s.

MR. NEBBIA: May I just ask one related question? Is there some upper limit in terms of frequency? As Tom was saying earlier, is there a frequency limit that you think is realistic for

consideration for the next generation or next couple generations of broadband in terms of the spectrum? I know of the bills that are floating around that one is now at 10 gigahertz, the other one is down at 3-1/2. Is there some distinction there that's important for us to understand?

MR. WEST: I don't want to hog the thing, but I'm building a 3-1/2 gig network in Europe, a WiMAX network in Europe, and in my view it's viable for a mobile network. When you start getting above 5, that gets really challenging in any form of mobility. If you're looking at mobility as a prime state, then I think it's hard to get above 5 gigs, but in terms of the use of the higher spectrum maybe in terms of backhaul, that is very practical.

MR. MEINRATH: I would also add for networking, as you go higher in frequency you get more proximal in your coverage area. So if you're talking about what we can do for next-generation multimedia in the home or device connectivity and peer-to-peer networking, you actually want higher

frequencies because you want less distance and therefore less congestion in those frequencies. So it's higher is better at least to 10 gigahertz, but preferably more.

MS. RINNE: For the personal networks versus the macro networks you want those lower.

MR. MEINRATH: For the personal networks.

MR. ANDERSON: In combination you can think of network architectures where the macro network are covered by the lower frequencies because of the reach and the hot spots and the small cells can be targeted at higher frequencies which then certainly don't interfere with the macro network, so there's an advantage there, but also have that limited reach as you pointed out that can provide advantage. So having a variety of spectrum that you can use to your advantage, because one size does not fit all, one frequency pan (?) does not fit all, one technology does not fit all. But having the set of tools unencumbered that we can use to really build networks will

really help a lot in providing broadband to a larger audience.

MR. MEINRATH: And we're rapidly heading toward a period where radio technology advances to the point where your radio will automatically define what frequency it will used based on where you're trying to get to, like is it proximal, is it distal, like how much capacity you need to be pushing through the function on that device. This was science fiction 10 years ago and is rapidly become reality and will be here in the next 3 to 5 years.

MR. NEWMAN: Let me be a little bit of a skeptic, or let me ask the question a different way. I was wearing an FCC hat, it was a decade ago, and Tom's predecessors were talking to us at Bell Labs. They showed us charts that said wireless capacity would be going up much faster than Moore's Law over the next 10 years. I felt pretty good. What happened in the last 10 years? Was it policy mistakes? Was it that the engineers couldn't deliver? I have lots of charts that show

the promises versus reality, but that's one of the more stark ones because you're saying that the new technology is almost here and I was hearing that 10 years ago. What's different?

MR. MEINRATH: If you build an architecture that's hub and spoke, you inherently limit the capacity of that network in that frequency. It has to span that whole frequency. If you have a distributed network where you're only going specific hops, for example, if you're using routing protocols, optimized LIN state routing protocols, things that are proactive and reactive at the same time in setting up pathways for data flow, you can cram a whole lot more capacity into that same frequency covering that same area.

MR. NEWMAN: Companies like -- Networks were giving us that pitch 10 years ago also.

MS. RINNE: But I would point out if you look at what we've done in those 10 years in migration from analog to digital, that was about a threefold increase to TDMA or GSM, and then that

migration from GSM to UMTS, HSPA, is probably another fourfold increase in terms of being able to use the broader spectrum bands, broader carriers, et cetera, so an increase, all things being equal, but all things are not equal in terms of the growth in customers, growth in minutes, growth in bits going over that network. So within that 850 spectrum we've made significant progress in terms of the efficiency of getting that to HSPA, and then you've got to allow for some turnaround space before you can start introducing the next generation of technologies and that LTE technology, you have to have 10 megahertz of spectrum or more for it to match the spectral efficiency of the HSPA. So it's not as if you can just shut it down and introduce the new. It's the constant evolution.

MR. NEWMAN: Let me try to be more specific. The cellular industry has made excellent progress and I praise you all and I use you regulatory at about a 30 percent category I think performance improvement. I may not be quite

right on that price performance. What I'm asking is 10 years ago I was hearing about alternative technologies, MIMO, Blast, ad hoc networking, mesh networking, that within the next decade was going to be that disruptive huge change. Was that just 10 years too early and we're now close to that or are there policy problems that are going to keep us from getting there or is that just promised pie in the sky?

MR. MEDIN: I think part of the issue is signal processing has gotten a lot better. To do some of these techniques in the real world takes a lot of horsepower in the base station and since the base station cost is actually not that large as a part of the total cost of building a system, you can afford to spend more money on base stations that have this kind of computational heft to go do that. But part of it also is we live in a world where we don't have a lot of shall I say entrepreneurial network construction in local areas. Everybody waits for the big standard. They wait for global harmonization. This adds

viscosity to the technology integration process, more so needed than just to shake the bugs out of the system. I think the really cool thing about these new kinds of radios with new kinds of broadband RF stages is that we can actually do evolution in smaller pieces at a time, that you will be able to download new parameters to devices and have them opportunistically use networks, networks that may not have existed when the device was built on spectrum that may not have been identified when that device was built. That's a very different way of thinking than the way the world works today, but I think the devices are getting more and more powerful and we will see that kind of model happen.

MR. WEST: You are in a Catch-22 position though. In order for a more complex device, more complex chip set, to be affordable, you have to have high volume. To have high volume you have to have the networks there. So you're kind of in a Catch-22. You end up with very expensive small-volume processes versus less-agile

but much cheaper broad standard-based things. So I think over time what happens is if the business model is there then the technical solution is there and will follow, but I don't think you can lead with a technology solution.

MR. MEDIN: I agree with that, but I would say if you're building a radio that talks to six bands or seven bands, at some point going to the more agile broadband RF stages becomes more cost-effective than adding yet another band of discrete RF devices.

MR. WEST: Yes, but if you're looking to get a chip set into a camera which is selling at $100 and it adds 50 cents to the bill of materials, I tell you the consumer electronics industry just won't put it in there unless they can see a return. But what I think will happen is that you're going to see the standards and I do believe it's going to be the OFDM standards and I think WiMAX is going to have a huge role in this and obviously LTE is going to be in there too. You're going to see the volume growth in that and

then we're going to face the spectral limitations and then you're going to say we've got business cases and we've got revenue streams that support it, we can move to other technology solutions then. I don't personally believe you can implement a technology solution unless you can find a route to getting high volume.

MR. KNAPP: We've been getting great questions both by email and the audience. I want to make sure we get some of these in. One question was, Suppose a world where the technology allows the use of multiple bands of spectrum, licensed, unlicensed, low frequency, high frequency. How do the FCC rules and the carrier's business models need to change to take full advantage of that? The way I think about it is when we started out it was analog cellular, we had one band and then we went to PCS where we had dual band, then we worked our way up to quad, and now the technology is such that we're seeing what I described as a lot of the handsets are like Swiss Army knives, they have WiFi, Bluetooth, near

field.

MS. RINNE: AGPS.

MR. KNAPP: You name it. It's amazing how much is being packed in there. How does that change the dynamic as we think about spectrum? Instead of one band now I've got this array of bands in a smart device. How does that affect things?

MR. RINNE: Getting back to Barry's point about you've got to see your way to global volumes or high volumes, there is a role where the spectrum if it's not aligned from a global standpoint, that impacts those overall volumes. So if you look at the devices we sell today, they have five different bands in them. Three of those are so that you could do global roaming. Two of them are what would be required for domestic use because they aren't aligned around the globe. As we introduce LTE capabilities, the way we have set up the 700 and the AWS, that's going to require slightly different bands than we may see in other parts of the globe, so that does have an impact in

terms of those costs. Now we can still see our way to global volume because of the underlying technology, but it does impact that.

MR. MEINRATH: I'd be very interested to hear how the business models of the rest of my co-panelists here would be affected if this were a reality and they couldn't lock down the network edge to edge so that you could actually roam to the network of your choice. The potential is there to radically shift the locus of control to end users, to customers, to those of us paying our monthly bills to be able to make the most effect, efficient use of my money and swap into different networks and use different technologies. But what we've seen certainly in the United States is really a locking down of those end-user devices to prevent that from happening and to ensure that the functionality is a relatively limited subset of what these devices are capable of delivering.

MR. WEST: I would say that certainly isn't the case in the world of WiMAX, and I don't think it will be the case in the world of LTE

either because WiFi will be a natural partner in that. Chip sets are coming out now which are WiMAX and WiFi and when you're in a WiMAX area when log on to the WiMAX network, when you're in a WiFi area you log on to that, so that there is customer choice. I agree that we should keep an open IP stack. The real success of the Internet has been its openness, but I don't think you're seeing any of the carriers now in the traditional view of the lockdown. We obviously have to make a return for the investments that we've put in there, but in terms of allowing different modality in the devices, you're seeing it with Bluetooth, you're seeing it with WiFi and you're seeing it in all of the standards now. So I think that's kind of a stick we've been beaten with for a long time and I don't think it's relevant anymore.

MR. KNAPP: So then if that's true, then everyone on he panel is against handset exclusivity?

MR. WEST: Against handset exclusivity? Deals are made all the time. They made a great

deal, but I wish it would have been my company.

MR. KNAPP: This is my spot to get in another question that we had. It's essentially the same question, What effect does monopoly of devices, and you fill in the blank, have on the usage of mobile devices for accessing the Internet effectively? So it's more or less building on the same point. Are there any responses to that?

MS. RINNE: There is a significant cost that goes into subsidizing of the device to make it affordable to a customer. Also there are a lot of exclusive deals that don't go well, and there are some exclusive deals that go well, and you take the risks in both of those and you invest in advertising and building out capacity of networks and building new functionality of the networks to utilize that capability and you take that risk. When it fails, no one challenges it. When it succeeds, you ought to have the opportunity to enjoy that.

MR. WEST: By the way, you can use the Apple iPhone on the Clearwire network. Did you

know that?

MR. KNAPP: I didn't say what X was.

MR. ANDERSON: Just one more point to that. When you look at the growth in data on mobile networks from mobile devices, it is highly dependent on the capability for that mobile device to actually provide some value that would cause the customer to use the data. We've all got phones that we own or have had that just actually could data, but we can't use them that way because the phone is such that you can't practically browse the Net with it or whatever. So having that device ecosystem and having devices, and sometimes it may take partnerships and deals in order to pull that ecosystem together, but I think that jumpstarts the whole industry to be where we want to be and that is a place where we have the devices ubiquitously that you can really drive the data growth and provide real value.

MS. RINNE: And it's stimulated innovation too.

MR. ANDERSON: That's right. Exactly.

MR. KNAPP: Rashmi?

MR. DOSHI: I have a question. I guess it's related going back to femtocells and others, but nobody really talked about fixed mobile convergence or the devices that are converging between the two. Do panelists think there is going to be an impact or is it just a fad?

MR. ANDERSON: Fixed mobile convergence, we did talk about the use of WiFi and macro technologies in the same device and I think that leads to what some might interpret as fixed mobile conversion. So I do think we talked about it.

MR. DOSHI: What does it do to the technology evolution in terms of network architecture? There's a lot of talk going on at UMA for example as an alternative. I'm just trying to understand what does it do to the network because it goes to some of the device communications, it goes to the femtocell. If I'm using local spectrum essentially in most cases unlicensed to talk and using that to backhaul, essentially the user is paying for the backhaul

cost in that particular case. Now you've shifted some of the traffic off the cellular backhaul network to a fixed network. How does that evolve as we go along? We talked about the ability to use different spectra, but I didn't see any real model in terms of saying that's what's going to happen longer term.

MR. ANDERSON: At least for me I think that was implied because all of the 4G technologies are really data technologies. They don't have a circuit voice technology built into it. So when you look a voice services, you mentioned voice, it's going to be VoIP over that data technology and you're to use VoIP over the WiFi network if you're connected to WiFi and you're going to see that fixed mobile convergence but it happens not because you're force fitting UMA or circuit technology into wire line, but because you've finally got a technology, a layered network where you've got data technology for transport, you've got servers and control mechanisms in the network say VoIP or whatever on

packets on IP and devices that could move across networks more seamlessly to handle that. So I think that mixed mobile convergence happens more as a natural consequence of effectively using the spectrum you have rather than being forced in a way that you know you're actually doing fixed mobile convergence.

MR. WEST: I'd like to point out that people will install their own WiFi access nodes. You go down to Best Buy and you can buy one for under $100, take it home and plug it in and it works. It's fantastic. So effectively they build out coverage in the building. If that were such a great solution on its own, we wouldn't have mobile broadband networks. It clearly isn't. So you need this combination of the two, but in IP, they're both native IP basically, it just happens. So I think that this actually is really good for both the operator and the customer because the device is relatively cheap, it's mine, I own it. I don't really think about I'm paying for my backhaul at home, that's true, and I'm also paying

for my mobility, and I'm getting value out of both. From a technology viewpoint, I think it's a great pairing because you don't have to blast in from the outside, you keep the interference levels down, and I think it's just naturally going to happen more and more. Cellular networks of all types, either data or voice, are really geared around what I call the ground plain. It's very difficult to do high buildings. We've all done tilting of antennas up. It's not effective, so you end up putting internal building DAS systems in place which are very expensive. So I actually think this femtocell solution where people are buying their own access point is just manna from heaven.

MR. DOSHI: I know we're running out of time, but just a question related to that and probably directed to Scott who said that unlicensed doesn't work. In fact, what you just painted is a potential picture where unlicensed works in the local environment and has a potential to do that. Aren't we seeing this as a

complementary approach in technologies and how can we build on that given that the spectrum is scarce? What are things that we ought to be doing to help that as a policy matter?

MR. CORSON: I think you misunderstood what I said. I said unlicensed doesn't work as a mobile broadband solution.

MR. ANDERSSON: If you only use it on the wireless access it's unlicensed, of course, then your access is total capacity.

MR. DOSHI: We are exploring the issue that spectrum is scarce and the real bottom-line question is how do we structure spectra that can be better used between unlicensed and licensed? The examples we've been throwing around with WiFi and WiMAX or WiFi and 4G working cooperatively, the real question is how can you do more of that?

MS. RINNE: I don't know that it's a regulatory issue. I just speak for AT&T alone that has 20,000 WiFi hot spots and many of the smart devices we're introducing have both 3G capabilities and WiFi capability and an automatic

client that takes advantage of a WiFi hot spot when you're within coverage.

MR. NEWMAN: Let me ask all of you as a homework assignment, come back to us with how do we get more spectrum. Scott would also be interested and the peer-to- peer is pretty exciting. What does that require for us to think about from a policy standpoint?

MR. KNAPP: There are just a couple of things I wanted to try to get in with the remaining zero seconds left. We talked a little bit about how high on the spectrum we could go. What about on the low end? Is there any floor below which it doesn't become suitable?

MR. MEINRATH: When the antennas get very large.

MR. KNAPP: So translated to frequency.

MR. ANDERSON: I think you've got 850, you've got 700, and I can't pick specifically, but as you start going lower than that, the antennas get large but also the propagation distance is such that it becomes counterproductive because you

have too much interference. The cell radius is so large that with the amount of spectrum you have you're not providing much data at all. I think that tends to be the tradeoff.

MR. MEINRATH: I did want to correct one thing which is it's not that unlicensed doesn't work. It's that at that power level at that frequency it's very difficult to make a mobile broadband network. I would say that if you were to put those same constraints on licensed, we'd all be saying licensed doesn't work. The reality is these two types, and many more actually regimes, light licensing, et cetera, have to coexist in a very dynamic ecosystem to meet all the user needs that we're seeing coming out of this digital era.

MR. KNAPP: I can't close without coming back to Kris. You mentioned SDR. I thought you said early on that you were using it.

MS. RINNE: On the infrastructure side.

MR. KNAPP: On the base station side?

MS. RINNE: Yes.

MR. KNAPP: How is it being used?

MS. RINNE: So that you've got a single component that would be able to be set up to be either the 1900 or the 850 or an HSPA or ultimately an LTE capability.

MR. ANDERSSON: And you are seeing photos coming out on the network side where you have a radio base station with a radio that can run as DSM, might have been CDMA or LTE. So you have no flexibility. The problem is the spectrum still with one spectrum.

MR. KNAPP: This is a nice setup for a segue into our next panel. I want to thank all of you. It was a terrific discussion. Don't disappear. We may be back with some follow-up questions for you all. I'd like to give them all a big hand. We'll resume at 10 after 3:00, a 10-minute break.

(Recess)

MR. KNAPP: If everyone would take their seats. Good afternoon. For those of you who have been here all day, this is the final session of

the day. We've had terrific panels. It's been a long day. This gives new definition to the last mile. But I think we all have enough good energy to finish with a flourish.

This last panel of the day is going to focus on rural broadband. Some of these technologies, by the way, happen to work great in urban areas as well. I will repeat for the whole who are watching online, they can send in questions by Webx. We'll have cards here with Walter Johnson for questions from in the room. Or we are taking questions by email to fcc-events@fcc.gov. I know all the cell phones are already off for the day. With that, we'll just move through the speakers. We've got a 5-minute clock here and I'll ask you to stay within that timeframe, and then we'll follow that up as we have the rest of the day with questions and discussion. With that, Mark, if you can lead off.

MR. DANKBERG: I'd like to talk about satellites in the role of delivering broadband to

the home. We at ViaSat are very sensitive to the notion that satellite is perceived as a broadband service of last resort. It's the thing that you get if you can't get anything else. We have been an equipment manufacturer for a long time and what we're looking at is trying to understand why that is the case and whether that can be changed. Is satellite service considered a last resort because it comes over a satellite or is there something about it? Can you measure something that you can improve and make satellite actually a good choice for broadband?

So what we started from is what do people want from broadband? This first slide has a couple of important points. The left-hand chart is a little bit hard to read, but you can look this up yourself. It's from a Consumer Electronics Association survey of what do people want when they switch from dialup to broadband, and by extension when they go from one level of broadband to a higher level of broadband. This is not a surprise. What you see at the top of the

list, what they've done is sort it by what would you do if you had broadband versus what you do now, the top choices all have to do with media and video. What people want broadband for is not, and this is just customers, what they want it for is not to get necessarily faster Web browsing. As a matter of fact, Web browsing becomes lower on the list. It's not to get VoIP although a bundle is nice. It's really I want more media and video.

This next chart is data from Cisco about Internet backbone usage and that makes two very, very important points. One is you can see the amount of usage on the Internet is growing very, very fast. That's due to two factors. One is obviously more people are connected to the Internet. But the other factor is the amount of usage of those already connected. What you can see from that which is completely consistent with the first one is that people are using it for media and video and that Web browsing and things that people normally associate with fast Web, VoIP, even gaming becomes a small fraction of the

total volume. The other thing is the way they measure Internet usage is not in speed or we're running out of speed. What happens is it's volume. What you measure are terabytes, exabytes, even zettabytes of traffic and that the measure of the Internet infrastructure is its ability to deliver high volumes of traffic.

On the next slide what I want to do is put that in the satellite context. The issue with satellite in this context is not that it can't delivery speed, it's that it doesn't have the bandwidth to deliver volume. You need a lot of throughput. So what we've looked at, and we at ViaSat are launching a satellite, but there are others who are doing this as well, is very high capacity satellites. This is we think unprecedented in wireless. We're getting an order of magnitude improvement in throughput, about 100 gigabits per second from a single satellite. So one of the things we've tried to show how big of a change this is is to show all other satellite capacity over the United States and compare that

to the throughput of one satellite. This has enormous implications for the capital efficiency of satellite.

When you think about the economics, the way you make money in satellite is having subscribers, so that next chart on the upper right shows if I give these many gigabytes per month in the busy hours to subscribers, how many subscribers can I have with the given satellite? What you'll see is that blue line shows now we can support on the order of millions of subscribes even delivering multiple gigabytes of capacity per month. We think that's a game changer. Then when you look at the lower left-hand corner, and what that shows is our estimate of how much volume people use naturally over the Internet. These are median volumes and it's over all sources of broadband in the United States. It's really driven by cable and DSL and it shows that on the average in the busy hours, traffic has grown from about 2 gigabytes up until 4, 5 or 6 gigabytes a month range. Satellite has only been able to

provide a fraction of that. With these very high capacity satellites we think we'll be able to deliver those volumes cost- effectively. Then that last chart just shows how you translate that into general population. Everybody knows that a small fraction of users use a very high fraction of the bandwidth, and so what this will let us do is serve those numbers of users that use small amounts of volume but deliver a cable quality experience for the things that people want. One of the things that we'd like to get to is some discussion about what are the standards for delivering broadband service? Let's not just talk about speed, let's talk about volume and gigabytes and then how capital efficient is that. What we think we can do to sum up is that the industry can make satellite be very, very cost- effective on a total capital cost per volume of bandwidth delivered. Thank you.

MR. KNAPP: Thank you, Mark. Jim?

MR. O'CONNOR: Good afternoon. My name is Jim O'Connor. I'm the Director for CPE

Planning and Engineering with Open Range Communications located in Denver. I'd like to give a little background on Open Range. We're not quite the household name yet. We closed on our first round of funding earlier this year, $367 million, comprised of private equity from one equity partner and also a loan from the Department of Agriculture Rural Utilities Service Program which is designed to provide funding for broadband deployments in underserved and unserved rural markets. Our goal is to complete coverage to over 500 markets in 17 states over the next 5 years. That's the term of our loan. It's an aggressive plan. We're in our initial site selection and construction right now. We'll start with commercial service later this year. We're deploying in licensed spectrum and we'll have some comments about that later. I know there were some very good comments in the previous panel about licensed versus unlicensed. We're deploying with WiMAX technology. Our device is a self-installed indoor CPE that supports both voice and data.

We wanted to answer some of the questions that the FCC was asking about. Some of the deployment challenges, and this has been mentioned earlier, but site acquisition in the rural markets is not easier or faster than in the urban areas as you might think. The approval cycle of zoning and planning commissions can actually be quite long if they're only meeting on a monthly basis and you have to go through several design iterations or several site selections. In fact, some of these municipalities even though being quite small already have considered or implemented height restrictions or in some cases even prohibitions on sites. It's not immediately apparent to a lot of lay people why the cell site out by the highway a couple miles away from town that might be providing great 2G digital cellular service in town isn't an ideal site for broadband service in town where you're trying to serve everybody with the highest rates possible.

Another factor is that access to the backhaul networks, the IP networks that we need to

reach our core network are often practical only with several hops of microwave radio. So even though we typically cluster several small markets into one market, backhauling that market to the fiber typically involves a quite large pipe, 100 megabits or greater and distances of tens of miles. So that's an issue that we have to deal with in designing our networks is getting to the backhaul.

The indoor CPE with self-install is a requirement for mass marketing of this to customers. It allows phone orders and Internet portal orders. The products themselves have to be simple to install and easy to use. The customers can take it out of the box, plug it in, go through an ordering process if they haven't already punched in that information on the Website and be up and running within a couple minutes. I think the experience of the industry from the early part of this decade with deployments of the 25 band is that truck rolls really are not scalable and they're too expensive. So we've decided and I

think it's conventional wisdom that you've got to have a self-install CPE in order for the economics to work.

Lastly, the CPE performance and cost, functionality and reliability just be superior. Typically there is no store nearby where these devices could be returned to if there is a problem, and obviously we don't want to load up the customer care network with phone calls. So we've taken a lot of care in making sure that the device is easy to use and will be reliable.

On some of the technology questions the FCC was asking for, a lot of these have come up in the previous panels, so I think we have a like mind even though we're focusing on rural markets. We see the licensed spectrum as being required to provide the contracted quality of service to the customer and that typically involves commitments on uplink and downlink bit rate, possibly jitter latency. And also to ensure that the operating environment is under our control. We do think though that the unlicensed spectrum with suitable

power limits could be useful, but we haven't identified any bands yet that have the characteristics that we could use for primary coverage from the tower site to the customer.

MR. NEWMAN: Is the 3650 statement a statement about regime or frequency?

MR. O'CONNOR: I think it's a little of both, but I think the power limits are the primary detriment to 3650. The CPE cost is a primary factor in the practicality of integrating additional bands or air interfaces into one device. The Swiss Army knife would be great, but currently every additional band you add is at least another filter or two. With receive diversity you've got two chains so you've got additional filters. Over time we expect that technology advances are going to make it easier to integrate additional bands and technology, but right now because cost is such a driving factor, it's not practical to speculate on additional bands you might use and integrate them into your device ahead of time.

On the unlicensed spectrum we do see that as being useful for in-home distribution of the broadband pipe that we provide with our licensed service. As I mentioned earlier, WiMAX is our technology and we see it as being very suitable for rural deployments. The WiMAX cost curve and technology roadmap are going to benefit from the widespread deployments worldwide that we see going on right now and the large ecosystem of multiple tier 1 vendors and other vendors who are eager to supply equipment for this market. Lastly, the backhaul networks really could make use of additional spectrum especially below 10 gigahertz for connecting the sites to the fiber facilities. Thank you.

MR. KNAPP: Thank you, Jim. Richard?

MR. KEITH: Thank you, Mr. Knapp. Jim, good presentation. My name is Richard Keith. I'm Global Director of Strategy for WiMAX and LTE for Motorola. Part of my job at Motorola is to provide means by which to commercialize new and exciting technologies like WiMAX and LTE. Earlier

in a previous session we heard from Barry West of Clearwire stating that the business model is what makes all things come true. So what we've decided today to do for you is to share with you the results of some 400 business cases we've done for actual customers, the results of linked budget and other analysis we've done across some 30 plus commercial installations of WiMAX utilizing OFDM technology, and also introducing LTE into that.

First of all, we wanted to focus on the voice of the customer, Motorola's customers, the carriers, the deliverers of technology who have been telling us this is what they need to be commercially successful. For one thing, it's challenging for them in some aspects in rural in the sense that some of the existing carriers for example have a world centered around mobility. The idea of serving a fixed customer is often for them to do. The model is slightly different. The way that you deploy is completely different, even the back office equipment. Second, the user experience and expectation that they get from

their customer case is largely based on DSL-like speeds. So we've been talking heavily up here in previous sessions about enormous amounts of speeds being required, but in most of our cases we're not seeing that much of a demand. We're seeing that a meg on the downlink is quite sufficient in some cases to get launched with new technology.

Some other aspects shown here about spectrum flexibility is a key aspect of that as well, not only, reusing what you could call urban spectrum in rural applications that's underutilized potentially. These two aspects have a lot to do with the new OFDM technologies which have the ability to adjust their bandwidth dynamically to whatever spectrum is available, and that's going to be a huge advantage going forward as well.

Then we take a look at some of the key drivers that affect our business model. Clearly the place to look is directly at the device load because in the end as we've been designing these networks, the uplink limitation of the physical

device structure seems to be what's creating coverage in throughput, and I'm sure that Jim will agree that that has a lot to do with his in-building coverage of CPE and WiMAX as well. We've found similar results globally. So what you find is that most mobile networks you see today especially in light urban environments might have a radii of 700 meters, and we'll call that base one for the purposes of this slide. When you move all the way to the right what we find out for the specifics of this panel in a rural deployment model, the outdoor CPE which delivers about 500 milowats, a virtually unlimited power supply and near line-of-sight capability in contrast to line of sight, actually delivers potentially 75 times the physical area coverage that the same physical access point would provide when deployed in a mobile aspect. So imagine the difference of coverage you get and you're trying to monetize the physical asset or the deployment of the site, the cost of the site, Barry was right, 17 to 20 percent is typically the cost of the base site,

but it's all about backhaul, you have fewer sites, lower OPEX. It may be that we have to take a look at rural and examine the opportunity that both hybrid system of fixed indoor CPEs as well as fixed outdoor CPEs can supply.

I'll very quickly take you over what we did in actual deployments for a customer in France. We took a look of the physical topology of about 67 million subs in France. That covers about 560,000 square kilometers. What you find is if you take a look at the chart and if you look beyond the words you'll notice that in the top 80 percent of the cumulative area, nearly 75 percent of the population -- 20 percent -- nearly 75 percent of the population live and naturally that's the place where our existing mobile networks are deployed. That 80 percent of the physical area available for coverage, hitting about 25 percent of that particular subscriber base. So then what we did was we overlaid that with some of the characteristics and link budgets that we've recently uncovered on several of our

models, and this is what we discovered. We took a look at two different aspects, indoor versus outdoor, and then the comparison of what you might call premium spectrum which would cost our carriers a lot more at 700 or 800 megahertz, all the way up to the impact on the business model of 2.5 or 2.6 gigahertz and how does that vary. The results of that analysis come back that not surprisingly, when it comes to indoor building coverage the 2.6 gigahertz is encumbered by the fact that you may have a 15 or 18 dB path loss going through a building wall, the standard wood residence. That has a dramatic impact on the fact that 800 does that a lot better, no doubt about it. But here was the surprising aspect. When you applied outdoor CPEs we found out that those CPEs could actually travel in some cases in the coverage of a single site of somewhere between 400 to 600 square kilometers depending on the physical topology of the ground. In France, that's a lot of coverage area for a single-deployed monetized asset. You're hitting a lot of subscribers. So

the bottom line or the summary conclusion is how many subscribers does it take to close a business model for this particular customer given a 20 percent uptake at about 1 meg downlink and about 256 K uplink? This customer, if you take a look at the green letters, we noticed that for the indoor 2.6 you need at least a pop density of 500 people per square kilometer. If you move down and are fortunate enough to get 800 megahertz, 100 people per square kilometer can close your business case on a break even. If you move to outdoor or do a potential hybrid solution of a combination of the indoor and outdoor, what you'll find out is that you can actually take it all down to as few as 15 people per square kilometer because that's the size of the cells, they're so enormous that you can find a way to monetize the asset, and anything to the right of that would be increasingly profitable on return of investment. So at the end of the day we walked away with the summary conclusion that there are ways to serve what these customers of ours believe is physical

access to customers of a 1 megabit downlink, and you can do it profitably to a greater percentage. It's just the question of using the technology we see coming already today as well as we see coming tomorrow to move into rural broadband. Thank you very much.

MR. KNAPP: Thank you, Richard. That's fascinating. Vanu?

MR. BOSE: Thank you, Julius. I don't have any slides, but I want to talk a little bit about rural because we're a software radio company and we've focused our technology on solving rural connectivity problems. Fundamentally the rural coverage problem whether it's voice or data is just an economic problem. You're covering fewer people, you're generating less revenue and eventually at some point it doesn't cover the OPEX of the site, the backhaul and the maintenance.

To put that in perspective, if you look at the four major nationwide carriers in the U.S., on average 80 percent of their revenue comes from 30 percent of their cell sets. Those are the ones

in Manhattan and Boston and Miami. The flip side of that is the bottom 15 percent of their cell sets which are the least productive, the rural ones, generate only 10 percent of their revenue. So those are marginal. Most of them have about 20 percent of their cell sites which are flat out unprofitable. They don't generate enough to cover the OPEX. So asking them to extend that model deeper into rural to improve our coverage just doesn't work.

Where technology comes in is technology has to transform the economics of rural coverage. But I want to be careful with what I mean by technology here. If we end up with a solution that says for rural we need different frequency bands or different standards or different handsets, it's dead on arrival because rural can't generate enough volume to sustain its own ecosystem. It's got to ride on the GSM, CDMA, Wi-MAX handset base and frequency base. Technology has to provide a way of delivering it more efficiently.

Even today but certainly in the past there just hasn't been enough volume and business there for it to focus a lot of technology on the rural problem. The good news there is that the majority of growth in cellular and data networks in the world is in developing countries. The next billion subscribers are going to be in developing countries which have significantly large rural populations. In India, for example, of its 1.1 billion people, 70 percent of them live in rural conditions. So there is a lot of energy now being focused on solving those problems and we're actually focused there and see the solutions that we develop there being able to come back and provide cost- effective voice and broadband solutions in the U.S.

I'll just give you a couple of examples of some of the things that we're doing. The challenge in India is the average revenue per user is about $6 now compared to $51 in the U.S., and that's in the urban areas. In the rural areas it's $2 to $3. But these guys make money, they

are very profitable, because they have looked hard at doing things differently. So on the last panel backhaul was mentioned many times as the biggest single cost. Airtel which is the largest and most profitable operator in India looked at that and they went out and built their own microwave backhaul and crushed that cost. Europe is doing a lot of microwave backhaul. We don't do a lot of here in the U.S. And if you look at a lot of rural cellular networks, they are still connected by T-1s which somebody mentioned was the most expensive technology per bit, and I think I agree with that. They crushed the backhaul cost and their biggest OPEX now is power. So one of the things we're doing, we have what's called a SuperPicocell. It's a very small GSM base station we're deploying in Nepal. The radio is 25 watts. It runs off of solar. It has an IP backhaul that's been tested with cable modem, satellite, Wi-MAX, microwave and fiber. You can plug it into anything to get a cheap backhaul, whatever is available.

Finally, the most significant difference which is really going to transform the economics is something that I think you heard from the major carriers yesterday that they're not ready to do here. It's network sharing. Fundamentally once you get to the point where your economics are marginal, everyone can't afford to build their own network. If you build one shared network you have the cost of one network supported by the revenue stream of multiple networks and it can be made profitable. A little bit in Europe, in Ireland and Spain and also Australia there are some examples of 3G sharing. The operators were very reluctant. They had to do it there because the economics for them were so bad they were forced into these very unpleasant sharing agreements. India is a little different. As they look out to rural they acknowledge as the CTO of one of the operators told me that there is no way we can all build our own networks and make any money. We're going to have to share. Fundamentally in the past building your own network caused you to use some

of your competitive advantage. It used to be that you bought a cell phone because of who had the best nationwide coverage? With all the roaming agreements in place they're all kind of the same. I know Verizon might disagree, but Sprint does roam on Verizon so you can use it wherever they are. And you buy handsets now not because of coverage but because of who's got the best pricing, who's got the coolest phone, et cetera. So my feeling is even though carriers who are reluctant to it now, ultimately economics wins and if your network coverage is not giving you a competitive advantage, then fundamentally sharing that and crushing that cost is going to happen. It's going to happen in developing areas in Europe first, but will come here as well, and that's really going to help push rural coverage significantly.

MR. KNAPP: Thank you, Vanu. Kelly?

MR. DUNNE: Thanks. Kelly Dunne, the CEO and co- founder of Digital Bridge Communications. I'll describe a little bit about

Digital Bridge. We're the second-large Wi-MAX operator in the U.S. next to Clearwire. There's quite a gap between them and use, but we focused specifically on smaller markets and started doing this many years ago before it was cool, and it is suddenly very cool to be in rural America which I'm thrilled about. We focus on the smaller markets with a differentiated product offering. We rolled out Wi-MAX, one of the first operators to roll out Wi-MAX technology, and our mission was and we proved out that this does create a sustainable business model which I'll talk about in a second in small, less- dense markets, and this is the fundamental aspect of this technology, not only Wi-MAX but all 4G technologies is the capital efficiency which I'll talk about as well.

Most recently we created a national partnership with the NRTC which is now an investor in Digital Bridge, but they represent 1,500 rural telcos and electric co-ops. So we have a national presence and an agreement to roll out next generation, fourth generation wireless

technologies to these smaller rural areas in conjunction with our larger builds.

As was described on the panel before and from a real-world practical capability, we break our business down into the first mile, middle mile and last mile, and what creates the next-generation type of telecom company is the ability to leverage new technologies and evolutions. So first of all, in the first mile we had the benefit of not inheriting any legacy systems, built an all IP/ASP business model back office, and we do innovative things such as we hire home-sourced agents to be customer care agents for Digital Bridge in the markets we deploy. That's one example. The second piece is the middle mile, and I agree with Barry West and several of the panelists here that we have had to turn down deploying into markets that did not have cost-effective backhaul. I think it is the biggest single challenge. The good news is you can use the combination of wireless technology, point-to-point technology, to extend the fiber

local loop up to 20 or 30 miles. We've recently used some Motorola radios that are fantastic and they 2.5 gigahertz which we have a lot of. We have a very deep spectrum position in all our markets, at least 100 megahertz, and we're able to use some of that spectrum position to extend the fiber loop and to get into towns we normally couldn't get into.

The last piece is the last mile, and this is really working within the community from the ground up being seen as a local provider integrating and finding out where the needs are for the local community and figuring out ways to connect hospitals, universities and all those locations that higher and higher demand needs.

Some of the facts and some of the proof points of the last 2-1/2 years of work in this area in the 15 Wi-MAX deployments we've done to date, first as was mentioned before, self-install absolutely drives the ecosystem, absolutely drives the business model. It was the biggest risk when we first entered this. Seventy-five percent of

all our customers are installed self-installed. That changes everything. That makes it a very scalable, very investmentable business model, and to have CPE that's working 2 to 2-1/2 miles out from the base station is a significant improvement. On the outdoor we have as far as 4 to 5 miles, but that only represents about 25 network of our customers, but those are customers who can't get anything other than satellite which is a great technology as well, those folks who can't be served with a trestle network. The ease of use to install is less than 3 minutes. I think that's important. I like to say with no insult to my mom, and hopefully she's not watching on the Web, but even my mom can install it. It really is that simple. It's a 3-minute install, it's plug and play, and it is really that that has been driving the initial adoption.

Penetration rates have been fantastic and I think that's been the most encouraging. We have many of our smaller markets that have reached 20 to 30 percent penetration in less than a year.

Some of the underserved markets reached above 20 percent in the first 60 days, and I think that's a very compelling proof point of not only the demand out there but the ability to deliver and where the pent-up demand is.

Then mobility/portability is we're delivering a differentiated product. Whether it's OFDM or whatever technology, the end customer really doesn't care. It's does it serve their needs, is it mobile, is it a differentiated technology, is it priced right. Those are the things that drive the demand.

A couple key issues to bring up is that spectrum access and availability, this has been talked about a lot. Specifically I think there is a huge opportunity with 2.3 gigahertz and 700 megahertz especially in the Wi-MAX space. There are already profiles available. There is a lot of spectrum that we have. We're working with 700 megahertz holders and there's a huge opportunity to make dual devices that work in 700 and 2.5 and 2.3. I think the FCC has to make some changes in

2.3. They've been sitting on the table for about 10 years. I won't get into that right now, but that really needs to be addressed because that opens up huge spectrum opportunities in the most rural places in the U.S. Affordable backhaul I talked about. Interoperability of devices and affordability to the end user. This is what drives everything. Can the people afford it? Is it going to reach them? I think we have an enormous opportunity here, and I'll close with this statement because I want to keep within my 5 minutes, that your access to broadband now for the first time with the evolution of technology is no longer defined by where you live, and I think that's very important. And I think with the stimulus plan and other things, we have a tremendous opportunity to really change the broadband landscape in the next 12, 18 to 36 months. Thank you.

MR. KNAPP: Kelly, that was great. Thank you. Mark?

MR. MCHENRY: I'm Mark Henry. I work at

Shared Spectrum Company. What we do is develop dynamic spectrum access software mostly for the Department of Defense. The next chart shows what DSA is. DSA is software on the radio that looks for channels that are temporarily not being used either in time or in space and lets the radio use it. It was mentioned by Sascha a while ago that we made spectrum measurements in New York, there are some measurements over there, but the spectrum is really empty. If you go out to a rural area, it's a challenge to measure almost any signal with a few percent use, so the spectrum is absolutely empty in rural areas.

What we have now is we have many projects for DOD to put our software in operational radios. The DOD has really adopted this. DSA has become a cornerstone of how they're going to do radios in the future for a variety of reasons. The next chart shows the benefits of DSA. I used to be a program manager at DARPA. I sat there 4 years and every company brought in their toys and all their greatest ideas. There is

nothing that has the value added that DSA does. There is a list of benefits there. For the rural application, the biggest benefit is you can operate in the lower frequencies which really improves your link range. There is almost no knob you can turn to increase link range better than operating at lower frequencies.

The next thing it does is it hunts for frequencies that work. If you have antennas that have a certain frequency dependence of multi path, you can gain another 10 or 20 dB by hunting for the best frequency that will close, so you can improve link range again. The third big benefit is reducing hardware costs. A lot of radio cost is for the rare case when you have an adjacent channels and there's a co-site problem so they have to put these filters in there. That's rare. So what DSA does is that when you hit this rare event, it just goes to the next channel. DOD is now extremely interested. In fact, forget spectrum because we can reduce the cost of radios like by half or it's a gigantic amount by putting

this cognitive thing in there, so that reducing cost is big. There are other benefits about pooling and so forth that are not really applicable to the rural, but DSA is the next big thing in comms.

The next chart shows I call it the most-important chart you'll see today, but the Motorola guys and all these people are saying the same thing, and that is the key thing is coverage. What is different about rural? The issue is the population density is much, much less. So I made a little spreadsheet here. Assuming you can only close a half a kilometer was your link and you want to cover, there's a certain congressional district, I don't think we named it, but it's a rural congressional district and if you only had a half a kilometer and you had to use that, it would cost $1.4 billion assuming the cell site costs 50K, and cell sites could cost 300 or 400K. It's absolutely unaffordable. If you could close 15 kilometers, it's a million dollars and you have 600,000 people you're serving with a million

dollar deployment. The entire rural thing comes down to this link range question, and your backhaul cost and your equipment, everything, scales with that distance. So we think that radios have to be delivered that 5 or 10, 50 megabit capacities to 5, 10, 15 kilometer link ranges. If you don't do that, it's never going to work. If you can do that, it's going to be trivial to take the urban technology and make it work in rural.

The next chart is the second-most-important chart you'll see today, and this is the raw physics of what it takes to increase link range. I just took a Wi-MAX radio that was kind of baseline in terms of how many dB it can close. Our prototype radios close 131 dB with omni antennas. You put a 10 dB antenna on one side and you can close 140 dB with 2 megabits. So if you have to go 15 kilometers, I wish I had a pointer, and 15 kilometers is this red line, if you have to close 15 kilometers, you need to operate at 250 megahertz. If you can't operate

down there, you're read. This is a terrain model. It's flat earth with foliage, and there's a reference down here. There are other terrain models with defraction but you're going to get the same result, that you need to lower and lower and lower. So the best thing the FCC could do is to enable operation below 500 megahertz if they want to do rural. It just changes the economics an order of magnitude.

The next chart shows our conclusions. The first thing is if people are getting ready to spend billions of dollars to do rural deployment, I think there are technologies out there that could change the economics by factors of 10 and they ought to take some of that stimulus money and figure out what technologies would really change the economics. We made spectrum measurements in New York City, and I assert in rural it's empty, but the FCC should go measure. They should know for sure. And any band that has low usage should be prime for DSA or some other technology to use it. It should be merciless if it's not being

used, if it's not being used it's available. We're not going to move people out. You don't have to move people out with DSA. You just have to let us exploit the holes, and for a small investment you could make measurements and you would know exactly what to do where. It would be painfully obvious.

MR. KNAPP: Thank you, Mark. Brett?

MR. GLASS: My name is Brett Glass and the title slide here has actually if we go back to the first slide where you can find my slides because a number of people had asked me where they can get them. This is our URL and there's where to reach me. I'll tell you a little bit about my background. I'm an electrical engineer. I got my bachelor's at Case Tech, my master's at Stanford. I then founded the world's first WISP or terrestrial wireless ISP way, way back in 1992. Since that time it started as a small rural co-op. It's now growing by leaps and bounds because everybody seems to want to untether themselves from the phone company or the cable company if

they're in town, and out of town they don't have that option. We've been going for 17 years now and we've been growing our coverage by approximately the size of the District of Columbia every year, and that pace is accelerating. We may grow faster. We're not based on Wi-MAX. We are probably the only carrier here that's based entirely on WiFi technology, and we use that to our advantage because it's able if you engineer right to go farther. We do use outdoor equipment rather than indoor equipment, and the antenna technology that we use provides us with an edge in that respect.

The way we do it, we specifically designed it so that we can cover areas of low population density. The net population density of the State of Wyoming where we're located is 5 people per square mile, so we have to take that into account when we deploy. Our deployment cost is substantially less than $100 per square mile. Our speeds are comparable or superior to DSL and satellite. Latencies are lower. The end user

equipment and installation costs are similar to those to DSL and much lower than satellite. And the end user's recurring cost is really not determined by anything else except the cost of backhaul which everyone else on the panel has mentioned is a key hurdle to any sort of rural deployment. The spectral efficiency of the equipment continues to increase which is great. When we moved from 802 to 11B to G we had an incredible benefit to OFDM. The only problem that we have is wireless doesn't help us much with the middle mile as it does with the last mile. When you're dealing with bad weather, when you're dealing with rough terrain even on 6 gigahertz where you can use huge dishes and higher power it really doesn't work. The best thing to do I think is to enable fiber for the backhaul and make that reasonably priced.

The primary constraints on wireless, during the wireless panel earlier today some people said wireless never had the capacity to compete with fiber to the home. That's simply not

true. The primary constraints on fixed wireless coverage and performance and regulatory and economic, they are not technological, and where we get into problems is where the regulatory regimes make it difficult for us to accomplish what we want to. Interference in the Part 15 band since we operate entirely in the unlicensed spectrum is a key problem. Literally a baby monitor is allowed to radiate as much as a wireless broadband provider's access point. This is silly. This is not good policy. We need to look at doing something about that. As we've getting licensed spectrum, the auction regime precludes us from doing that in a number of ways. It has caused also a tremendous wastage of spectrum. If you go out, the other panelists are right, you scan the airwaves and you see there is almost no one using it. A lot of that spectrum is licensed and people are warehousing it and they're not using it. But we have no concept of adverse possession for spectrum, and as a result people can continue to hoard it and continue to do nothing with it. We

can't use the lightly licensed bands as much as we want to because there have been problems with 3650 megahertz regulations. What's worse, we see that we are facing the prospect of additional regulation, the so-called Wireless Network Neutrality regulations, which could further hobble us in ways that are completely unnecessary because there isn't actually any problem that needs to be solved by such regulations.

The thing which really dictates what you can do with spectrum and how well is Shannon's Law. If you take a look here it shows that the amount of data that you can push through a link is proportional to the bandwidth and to the log of the signal to noise ratio. What you have here is a curve where at first you gain a lot from having lower noise and after a while it kind of trails off and you don't get that much more benefit. This knee which I've dubbed Shannon's Knee is key here. As long as you've above the knee, you can share the spectrum with other people and you can make reuse of the spectrum. If you get below the

knee then you can't anymore. Therefore, the conclusion you can reach if you understand what this curve means is that nonexclusive licensing of large swaths of spectrum rather than exclusive licensing of small swaths of spectrum which is what we've been doing in the past is the best way to ensure maximum utilization and efficiency when it comes to spectrum policy.

Here are some specific suggestions to the broadband plan. I only have 12 seconds left, so I'll be as brief as I can. We need to devote more spectrum to nonexclusively licensed applications. I mention two here which are possibly good ones. AWS-3 which is still up in the air, and the D block which did not sell as exclusively licensed spectrum. We should open up 3650, although this may not help everywhere because it's not available everywhere. We should look at increasing the power limits for Part 15 for outdoor broadband so that it can compete with the indoor devices which otherwise threaten to interfere with it. We should revise the auction

rules. We should be careful about how we regulate. And again we should do things about special access, and since my time is up let's talk more about this during the question and answer.

MR. KNAPP: Thank you, everybody. I feel a good bit more optimistic than I did earlier in the day about the solutions for the rural areas. This is more a business model question. How critical is it for the business model to work in rural areas that folks can just pick something up, take it home and plug it in, versus a truck roll or a complicated installation? I'll use the model of I can go into my local electronics shop and buy my modem, go home, plug it in and have it activated, and we heard a little bit before about how somebody can be up and running in 3 minutes. How critical is that to the business models?

MR. BOSE: It's very critical. I can example an example from some of our rural cellular customers. For a major network provider, they typically use a metric of one tech per 60 sites to support and maintain. For some of our rural

carriers, it takes them 3 hours to reach one of their sites. If it's out, it's a 2-day job. So his cost of maintenance goes sky high and you can't really afford to do the same level of support and maintenance on those distributive remote sites. You can't solve everything by people installing their own things at home because you're not going to cover the highways, et cetera, but it can make a significant dent into the overall support and maintenance costs.

MR. KNAPP: Mark?

MR. DANKBERG: I'd like to give you the completely opposite view which is the thing that we think is the most important is total capital cost per subscriber. If you look at what subscription fees are going to be based, it's how much capital you spent on a subscriber. So most of the models, whether it's DSL, terrestrial wireless, fiber, they have very large infrastructure costs and they try to get very low incremental CPE costs. Satellite actually is the opposite. We have very, very low infrastructure

costs and higher CPE costs. But the total capital cost can be lower which for a given level of service can actually deliver higher quality. The issue I'd point out is that if you defer the total capital cost until you get the subscriber, then penetration rate isn't a big issue like it is in many other technologies because you don't have to get high penetration in order to recover the infrastructure capital cost.

MR. KNAPP: Mark, for the satellite, and I'll get to you in a second, Brett, what kind of receive antenna are we talking about?

MR. DANKBERG: It's an antenna that's the same as a satellite TV dish.

MR. KNAPP: So it's a dish mounted outside the home?

MR. DANKBERG: Yes. Just to put things in perspective, what we look at is a service that could deliver 5 to 10 megabits per second on the downstream, 2 megabits per second on the upstream with a 2-foot dish with total capital cost per subscriber of about $600. That's everything.

That includes the CPE, the satellite and the gateway. The thing that we think is interesting is if you're at $600 total, it doesn't really matter that much if $350 of that is at the end is the way I'd put it because the up-front cost is so low.

MR. KNAPP: Brett?

MR. GLASS: Our model is actually very similar to what has just been described for satellite. Our access points are fairly inexpensive to deploy. Earlier in the wired session people were talking about having customer owned tails on their homes. In a sense that's what we have because our customers own their radios and they represent the tail which gets them back to our access point. They buy that at the time. We still lose a little money when we install for a customer, but because they own it we lose a little bit less. They also cover a lot of that initial capital expense, and so the model works very well. We're able to afford to come out there, set things up for the customer and actually

set up the customer's internal home or business network for them which also gives us additional revenue potential and makes the customer a happier customer in the end. So we don't find the truck rolls are a significant problem. It would be nice if we could do some client self-installs, but we can't do it on unlicensed spectrum and get the quality of service we want.

MR. KEITH: I have some statistics to share on that. For some years now we've been selling the Canopy product line. It's a fairly commonly known product. But it is a line-of-sight product and it's exclusively outdoors. What we've found out which is an amazing statistic, the subscriber units sell in the millions, but an overwhelming amount, 65 percent, of those subscriber units, were actually self-installed even outdoors, and it's an outdoor unit which defies logic because we average in in most of our models somewhere between $125 to $150 just for a truck roll excluding all other equipment. I don't know if you find that consistent, but if that's

true, then having that statistic means that you can make products that you can put in that have tones and various installation tools to make it easier for the subscriber to get rid of some of those costs. I don't think that's a unique idea, I just think that it's more plausible than most people believe.

MR. O'CONNOR: I have a comment about that. I think if you captured the increase in system capacity as part of offsetting some of the costs of the truck roll you might find that more installations or a larger percentage of your customers might be eligible for a self-install, maybe an outdoor antenna. I don't know if the truck roll would ever play economically in the rural markets because of the distances, but having an outdoor antenna, clearly if it can be pointed correctly so you don't have to worry if the site goes down and it's not pointing at the next best serving site, but clearly outdoor antennas are going to increase your system capacity enormously but it's got to be done right and it's got to be

done cost-effectively. But, yes, if you can take a credit for the increased system capacity, maybe some of the up-front costs would be more bearable.

MR. KNAPP: We've heard a couple of comments that there's particularly in the rural areas lots of vacant spectrum and so forth and we've got technology that's getting smarter. I think the Commission through the years has tried to address some of this through things like secondary markets and providing for software defined radios. I'd be interested in your thoughts on how any of that is working or not working and what else you think we ought to do not only on the service side, but to help solve the backhaul problem. Mark, do you want to try?

MR. MCHENRY: I think the Secondary Markets Initiative is a very good thing. It is kind of surprising that more people aren't using it. I think the big issue is the volume. There is no cheap equipment that works on all these bands and so you can't get started. It comes back to what the previous panel was talking about, the

cart before the horse problem.

MR. DUNNE: I think in our markets it's a density issue and your coverage issue and capacity. One of the things is when we deploy in markets of 20,000, 30,000, 40,000 to 50,000, we can cover very effectively the high dense between 700 and 1,400 households per square mile. As you get out to the edges, the economics get much different. That's why there is so much promise I believe in dual band radios that leverage 700 and 25 and this is doable within 10 to 12 months if the volume and ecosystem is there. So I think there's a tremendous opportunity to do multiband radios very similar to what's in cellular phones. This isn't a new concept, and the ability to have dual band devices and then within the base station infrastructure the cabinets and the backhaul, et cetera, you can leverage a lot of costs across both of those platforms. And to be able to seamlessly hand off between a 700 megahertz to 25 for example is a great way to start to get a huge coverage area because back from the customer

experience, when they lot into your Website and say where do you cover, if you cover hundreds of square miles like Brett's coverage area, that's fantastic because then people say I can get access in this huge area. I think it's a combination of looking at different spectra and figuring out how to do dual band technology.

MR. O'CONNOR: In our area we've tried to get licensed spectrum and we've called up the spectrum owners and we've looked to see who had licenses that we might be interested in, and invariably they are like Aesop's dog in the manger, but can't eat the hay themselves but they'll be darned if they'll let anyone else get at it. This really seems to be true. The LMDS licensee, LMDS-A in our area, has been sitting on the spectrum for the entire term of the license and now they're petitioning to have it extended. They've never rolled out anything in our area. We've gone to them and we've asked them please partition. We can use this stuff. They go, sorry, we invested in this to maybe use it one day

or maybe use it as an investment that we hope will appreciate, and it hasn't appreciated that much, sorry, we're not interested in selling. I'm beginning to think that we may need a doctrine of adverse possession or if not that have the FCC be truly draconian about taking back licenses that are not used. This is a scarce resource. It may be artificially scarce, but it is scarce and we need to do something about that because people like me can't get what we need to do our business better.

MR. BOSE: I'd like to follow-up on that point because the unused spectrum, we've been in discussions with folks similar to that, and the problem is, because it's scarce, everyone knows or at least assumes that over time that spectrum is going to appreciate in value and certainly the markets have proven that out. The problem is if they license it to you for some use for the next 5, 7 to 10 years, that asset is tied up and you couldn't monetize it. So it's actually better for them financially to not be able to do anything and

be able to turn that into a liquid asset in 10 years rather than having it tied up for someone's use with some kind of ongoing revenue stream. So because it's scarce it's valuable, it will be more valuable in the future, and that gives the perverse incentive not to do anything with it but let that asset appreciate. I think your solutions, fundamentally if it's not being used, the FCC needs to look at it.

MR. KEITH: I want to return real quick to try to make a clarification on the SDR which was the origin of the question, and I agree. But Kris Renni right before she left the previous panel made a clarification about SDR and where it's actually at today and I want to make a point that that's really primarily existing on the infrastructure side. It's limiting to say that it will ever end up in devices, but I will tell you that currently the idea of devices being able to readjust themselves proactively whether it's for economic reasons or what have you, so when we talk about handoffs to a variety of spectrum, at the

device end it may be more challenging to introduce SDR concepts to the device side especially when we get down to portable devices.

MR. BOSE: I guess I should comment on the SDR piece. Certainly the rules have been great there in terms of able to push technology and get some products out that we otherwise wouldn't have. I generally agree with your comments. It's all been on the infrastructure side. My view is that the fundamental limitation is that it always takes more processing power to build something flexible and reconfigurable than single purpose and dedicated. On the infrastructure side, that doesn't matter too much. The marginal costs to put it in faster and beefier are small compared to the whole site CAPEX. On the device side, battery life is still king today. All I do is SDR. I'm not willing to give up half an hour of better to get a flexible handset, and frankly, it would be more than a half an hour. So it's going to take time. Advances in low- power processors, battery system, perhaps lower-power

semiconductors, to really realize SDR on the handset side. However, that doesn't mean that you can't get a lot of the benefit. If you did have an infrastructure that could talk to any device that came out there, you could get a lot of the benefit of this flexible spectrum without necessarily having it locked to a single device; not all of it, but a lot of it.

MR. DOSHI: May I follow-up on that point? I think as recommended earlier, a lot of opportunity though is also with fixed outdoor CPE. There you have continuous power and there you have an opportunity. Is there potential to expand and use that as an alternative? Because I think a lot of the self-install issues were devices that set on desktops and others. On the other hand, you have opportunity to do outdoor installs and use local power.

MR. KNAPP: If I could just couple on to your point, Rashmi. We've got the highest tech stuff for the lowest volume of users, and is that realistic? Yes, it's we're seeing the application

come out now, but how far down the road before it's realistic to see that even fixed uses? Any thoughts on that?

MR. BOSE: I think you could do fixed CPE today.

MR. KNAPP: You could?

MR. BOSE: If it's plugged into the wall, it's not an issue.

MR. DOSHI: The question is economics opposed to technology.

MR. BOSE: I think on the economics side, Barry's point that he made in the previous panel about adding 50 cents to a handset is a big deal, it's not quite the same on the CPE because it's not the same volume and scale of production. So adding $10 to $50 to a CPE, that might be possible. And technically, I think that's feasible, and that's the first place I think you'll see SDR technology on the client side is multistandard, multiband fixed CPE devices.

MR. KNAPP: Mark?

MR. MCHENRY: The DSA software is a very

small part of SDR. Everything on the radio takes a big processor. We're doing a project with DARPA and we're doing four-channel receiver, hand held. The DSA takes a small DSP chip, a $20 chip and a small part of a cell phone GPP. So I don't think the battery life and the cost is the inhibitor of DSA. The DARPA project pretty much proves that.

MR. KNAPP: Other questions from my colleagues? Otherwise I've got some questions from the floor.

MR. NEWMAN: I have a two-part question. We heard a lot of talk earlier today about the need to define what broadband is, that it's more than just speed, it's also how much capacity the user can send over the busy hour, it has to do with latency definition, reliability, et cetera. Wireless at least from a capacity standpoint is probably more limited than cable. So those who in the service business, Richard has been monitoring that, one would comment are you primarily going into areas where there is no wire line alternative, DSL or cable, or are you going in

with a better value proposition? And then if each panelist would comment on what are the critical parts of the broadband definition other than just peak speed?

MR. O'CONNOR: I'll go first on this one. In all our markets, in most markets I should say, we compete with DSL and cable. Often times our reach is a little farther than that. But we're finding 20 to 30 percent come from DSL and 20 to 30 percent come from cable. So I think it is ease of use, it is pricing, it is flexibility, it is portability, and eventually mobility will be a differentiator. I also think the customer's experience and the service level you acquire. We're fortunate that in some markets that the existing incumbent service providers haven't been able to provide that level of service to date and you can come in with a new technology and recreate that customer experience.

As far as speed is concerned, it's interesting because I think there are two issues. First is the speed is in the eye of the beholder

or the eye of the user. Every service operator knows that you have two or three customers who are speed testing every other hour and calling you and saying I've got.2 percent I need to get. But you really need to manage it to a reasonable level and the expectation of that the SLAs are and what the customer experience is. I also think that the way you engineer the network with packet shaping equipment and mitigating certain heavy bandwidth users is part of the equation as well. So it's a very complex engineering exercise designed to overall increase the experience for everyone, and then those folks who need higher bandwidth who use more of the capacity need to pay a higher price. It's that simple. So your ability to manage that is greatly dependent on the investment you make in the infrastructure you build within your network.

MR. DANKBERG: On that issue, the point that we see as being a big differentiator in broadband service is the volume usage which is how many gigabytes a subscriber can use. And while broadband usage is somewhat of a subjective think

when you're Web browsing or doing other applications, if you're trying to watch a video it's very apparent whether or not you've been able to sustain the speed that the video stream needs, and also it's very apparent how long it takes until you can get that video to start if you're going to download it and cache it. One of the things that we're very interested in and concerned about in the concept of the government actually subsidizing broadband infrastructure is that there be some common metrics that allow us to compare what the capital costs are for delivering this given quality of broadband service. What we think is I agree as Kelly said, the market is fragmented and not everybody has the same expectations and it certainly seems reasonable that those who use more should pay more. But on the other hand, if the government is going to get into the business of subsidizing infrastructure, there should be some mechanism to do an apples to apples comparison of what these different technologies are capable of. What we think there is that speed and the fraction

of time that you can deliver that speed and the volume that you're offering to deliver at a given subscription price would an excellent start for doing those comparisons.

MR. NEWMAN: Let me ask you the tough question for satellite. Latency.

MR. DANKBERG: Yes.

MR. KNAPP: Will the high latency characteristics work for most customers?

MR. DANKBERG: I think there have been two big issues for satellite in terms of what its competitiveness is. One is broadband and the other is latency. One of the things that we think is real interesting, and we think life is imperfect, you have to make tradeoffs, that the most desirable technologies can often be the most expensive and that also customers seem to make tradeoffs based on what their desires are and that's why one of the things we started with was what it is that end users want. What we've seen is that if you put in front of a customer who uses video and you give him a choice of a 1.5 megabit

service or a 1 megabit service with low latency, or a 4 or 8 megabit service that has higher latency but can deliver gigabytes of broadband and can stream video, now that customer has the ability to make a choice and say which is more important to me, the volume and speed or latency. What we believe is that different customers will make different choices, but if you look at the growth of video, what we see more and more, and it's evolving over time, you'll see customers in cable networks or even in the telephone networks going through a series of first they had a 1 megabit and then a 2 megabit, then a 4 and an 8 megabit service, what they're really voting for is the video use. So to the extent that you could provide the same speeds and volumes with no latency, certainly that would be preferable, but to the extent that you have to trade off capital costs be it in volume versus latency, we see the market evolving toward taking acceptable latency in order to get excellent speeds and volumes.

MR. NEWMAN: How about a dish that

points toward Brett when they need low latency and toward the sky when they need high capacity?

MR. DANKBERG: Absolutely, hybrid. Especially one of the things that's really, really interesting when we talk about backhaul, because backhaul is really the bottleneck for these wireless services when it comes to delivering high volume. If you look at the Cisco usage charts what you'll see is 90 plus percent of all of the traffic is not latency sensitive, only a small fraction is. So one of the opportunities is to blend backhaul. For instance, video is completely latency insensitivity and if you were to add up video to the PC, video to the home, peer to peer traffic which is basically BitTorrent based video, that's 75 percent right there. So you take that and you say I can serve those with low cost backhaul that's not latency sensitive and then blend in whether it's wireless or even T-1 for those low latency applications, you've have a very cost-effective blend that would serve what customers want.

MR. GLASS: Of course doing this effectively requires you to discriminate between the different streams which means that you actually have to engage in some packet inspection which to some people I think is anathema. I think it's actually a good idea. In any case, my take on the situation is as follows. Stagg, when you started you alluded to the limitations of wireless as if that were a given. The fact is the only limitations on wireless as we can see from that curve in Shannon's Law is how much bandwidth you give it and how quiet the spectrum is. There really isn't any limitation on wireless. In fact, one might say that fiber is nothing but wireless in a very expensive tube that you have to bury.

MR. NEWMAN: Right, but it's got a lot of bandwidth.

MR. GLASS: At 60 gigahertz right now with a paid or unlicensed radios going less than a mile I can easily push between 1 and 2 gigabits out. In fact, one thing I would encourage the Commission to do is to look at finding ways to

facilitate that sort of thing as using the last mile or the last few blocks as a solution, make that easier to do because that's one thing that we're very interested in trying to do with wireless.

We can push gigabits to the home. We just don't have the spectrum to do it. The two things that limit us are, A, we don't have the spectrum, and B, we need to get that from the Internet backbone and so we need to make sure that our backhaul prices are reasonable. So we're coming around to the same issues again and again. We need spectrum, we need backhaul.

MR. DANKBERG: One point I would add just in terms of the spectrum is when I showed that 100 gigabits for a single satellite, this correlation between capacity and bandwidth and spectrum is very real and one of the issues in trying to use spectrum that's good for mobile or that penetrates walls or that propagated long distances is there is not very much spectrum available around 700 megahertz. When you use

carrier frequencies of 20 and 30 gigahertz or 40 gigahertz which are already allocated from a satellite perspective, you have gigahertz to work with and so those gigahertz of already allocated spectrum is what allows to deliver hundreds of gigabits and more to these users, and I think that's just a factor of physics. One of the things that we're looking for is how to exploit that more in terms of what the specifications are for broadband and to take advantage of those gigahertz that are already allocated.

MR. KNAPP: I had a couple of questions from the audience. I'll try to blend these and hopefully I'll capture the thought. They have to do with most of our discussion has focused on fixed and the concern is what do people do for mobile? Is there some way to evolve one into the other? Are there any thoughts on mobile? One of the questions talks about how the introduction of Netbooks for example might drive mobile and people in rural areas have the benefit of these services as well. Any thoughts on this?

MR. O'CONNOR: I'll take the first crack at that. Our markets that we've rolled out phase one of Digital Bridge all are converting to mobile as we speak. Actually, one is converting tomorrow. So what we did is we selected a technology and our vendors and we didn't have to replace any of the CPE when we converted to 802.16e which is fully mobile. It's pretty exciting to be able to sell. We're selling Netbooks and laptops and dongles that are completely mobile in our markets today in markets that aren't used to getting technology first, so the mobility aspect is a very important part of it. And I also think that something to think about is the definition of underserved because underserved is if you live in a big city and get access to broadband on a bus and can't get access to broadband on a school bus in rural America, are you underserved? I think you are. I think that that's a very important element. What we've done in our business plan is build on making all our networks completely mobile and interoperable and

also have them interoperable to the larger markets. So this whole concept of ecosystem, interoperability of devices, interoperability of testing is really, really important because that's going to device infrastructure, the applications and the usability of the product.

MR. NEWMAN: Could you just clarify because mobility and nomadicity mean two different things to me. Full mobility is 100 miles an hour handoffs, et cetera. Nomadicity which is very valuable but doesn't include that. Are you doing both?

MR. O'CONNOR: I'm talking fully mobile. We have the smallest markets in America that are fully mobile.

MR. KNAPP: But not a bus at 100 miles an hour.

MR. O'CONNOR: School buses should not be going 100 miles an hour. Just as an example, I was in Jackson Hole. One of our markets is in Jackson Hole, Wyoming. You're all welcome to come visit. We were streaming video, Skype video. We

had Pandora's video or music and we were on a VoIP call all at once, cell to cell handoff. I wasn't driving, I was in the passenger seat, but that's all I was doing at once on a Netbook with a dongle. So that is incredibly compelling and it also changes the dynamic of the people who live in these communities who are thrilled when they see getting technology ahead of the larger markets, the first time in my telecom history we've ever been able to do this.

MR. KNAPP: This was TDD?

MR. O'CONNOR: Yes.

MR. KEITH: First of all, when we talk about mobility and what it's traditionally been measured by, it's the approach that it has everything to do with the device. So it's not a coincidence that over the past 30 years as the very first cellular markets began to develop, one of the key aspects of mobility is on the day that they wanted to launch service they had to find a way to provide ubiquity of coverage to where that person might go. That also brings in what was

mentioned earlier about the status of volume and the amount of device vendors out there that can produce interoperable devices, that the customer can choose a device over in Rochester, New York and still be able to use it when he moves over to Denver, Colorado.

The new technologies, Wi-MAX and LTE, will definitely achieve that, but it will take a long time for that to occur, and until that time, the way we see mobility entering the market with these new OFDM based technologies is the first types of devices probably have to enable almost from day one dual mode, tri mode capability so that when the consumers want that quality of service, they will not accept the fact that they turn on the device and they cannot get access. That will irritate them because they've already had better than that already. It's better to be slow and connected than to be completely disconnected with a high speed network that you can't talk to.

So I do agree completely, Kelly, with

the concept that I also have seen the faces of customers who have been able to get fantastic speeds, 2 and 3 megabits of downlink in a fully mobile environment, and we see them occurring. I want to point out that they know what they're getting. They know when they buy this single mode device where it works and where it doesn't and they're fully accepting that as they purchase that product. But ultimately where we need to go with this is that multiple mode devices, somebody mentioned earlier the Swiss Army knife, it is an essential aspect of the launch of these new techs. It has to be there.

MR. KNAPP: I have a question from somebody named Repeated Questioner, so I'd better ask it. It says, What innovative broadband technologies, devices, policies or other solutions are being developed to overcome the challenges associated with connecting low income, isolated communities and tribal communities that may not have adequate electrical outlets or wiring, access to a computer or other existing broadband

equipment?

MR. BOSE: The conditions you describe aren't that dissimilar to the network we're doing in Nepal where each village has at best maybe a generator but probably no electricity and absolutely no connectivity in. Our SuperPico cell uses satellite backhaul using VSAT, and it's designed to be low enough power that it runs off of solar with a decent battery. I think, Julius, you may a really good point earlier which was are we trying to use the most cutting-edge technology to solve the problems in the smallest markets? If we are, we're going to lose. That gets me back to looking at trying to address the problems for the next billion subscribers which are going to solve exactly these problems here, the tribal lands, the rural areas, the low-income areas. I say this a lot and it's a kind of a joke, but we have one deployment where we're deployment coverage for 200 rural villages in Alaska and another one where we're just starting doing the villages in Nepal. I often tell people that other than temperature,

there is really no difference. The calling patterns are the same, the lack of backhaul and electricity, it's all the same. So I think it's good news that the rest of the world is doing this. We're going to see a lot more technologies and solutions that are applicable to these problems.

MR. NEWMAN: I totally agree with you. I've spent much of my past few years supporting teams outside the U.S. The question I never thought about until wearing this new hat, are there policy things that we need to be doing in the U.S. to make sure we can take advantage of what gets developed for India, Nepal and whatever?

MR. BOSE: I would make a slightly different question which is what kinds of things can you do to ensure that it's U.S. companies that are delivering those solutions to those growing areas that they can come back here and do that in terms of trade and incentives and cooperation with other governments? That's very important.

MR. NEWMAN: I think both questions need

to be answered, and one benefits our customers and the other benefits our economy.

MR. BOSE: The only fundamental difference that we've run into so far is moving technologies from these areas back here is probably frequency bands and power limits. You could go to the global harmonization argument. I don't even bother even wasting any time on that. I don't think it will ever happen, so let's just move on. That's really the only issue. To be honest, to move something from 1800 megahertz to 1900 megahertz isn't that big of a deal.

MR. KNAPP: Mark?

MR. DANKBERG: I think one thing that's an important aspect of this when we're talking about in some sense subsidizing things is one of the things I think we should be careful about whether we're subsidizing the right or the wrong technologies. How do you tell? I think it's really about economics especially when we're talking about funding people who are disadvantaged because the government if it wants to serve the

most people should do it in an economically effective way. Rather than talking about jumping immediately to what technologies we use, I think one of the most important things to do would be to define what do we want to deliver, what does it mean for broadband in terms of speed and volume? What is the quality of service? Then compare the capital costs to deliver that quality of service. All the time we jump ahead and we talk about what devices we need or what spectrum we need and I don't necessarily see these comparisons of capital cost efficiencies.

MR. CURTIS: Let me jump in on that. I think you will see coming out of this a monumental effort at doing exactly what you suggest, leave the details there for now, but there is going to be a very hard look at a very granular level geographically I mean and technologically at most efficient ways to provide service by kind of technology type, OPEX, CAPEX, full PNL, look at this as detailed as possible. So having said that, Stagg introduced me to the concept of giving

homework to panelists at the last one. The more you all are willing to come in and share the information that a guy like me needs to do the exact analysis you suggest, otherwise I'll find the data some place. I'd rather find it from people who have accurate data than me get it by my own means. That would be extraordinarily helpful. That's exactly the path we're going down.

MR. O'CONNOR: I just want to make an observation and maybe this is to your data point. Two-and-a-half to 3 years ago when we first rolled out our first Wi-MAX networks, the CPE was close to $300. A Wi-MAX enabled Netbook today is $300. I find that amazing. That is literally amazing, and I think that changes everything when you think about something that is your access device but is at a functional use to connect you to the world especially in disadvantaged areas and I think there's a ton of stuff, and Intel and others are doing some very innovative things right now to help drive that. I think that's a great, great solution for a lot of people.

We're seeing modems now because of what's happening in the global ecosystem drop below $100. In our business model, that was always the tipping point, below $100, $70, $80, $50. We're also seeing devices that have built-in WiFi and voice over IP ports with them as well, so that it's a fully functional residential gateway at a very attractive price point. It also allows from a business perspective for the customer to buy their modem, and similar to Brett's model, that they own it, take it wherever they go and you get away from that lease arrangement and that capital intensive part of the equation.

MR. BOSE: Also don't forget as Intel is starting to embed Wi-MAX capability into the chip sets that are in laptops like WiFi is today, the marginal cost to the customer is really zero and it's just there. That's one of the big advantages behind Wi-MAX.

MR. NEWMAN: LTE will also be embedded in similar devices too. Right? That's not just Wi-MAX.

MR. BOSE: Wi-MAX is obviously further ahead because it started sooner and those devices exist today. It may get to the same point with LTE. The difference is in the business model. Laptop providers are happy to embed WiFi because their users can use it in a lot of places. It's not as easy for them to say I'll embed an EVDO modem that's used with Sprint or an HSPA modem that's used with AT&T because you start locking into the service provider and narrowing down the market. Wi-MAX does not narrow the market. As Barry said, it's basically an unlocked technology. As for LTE, it's not clear yet.

MR. NEWMAN: HSPA is in over 100 million subscribers globally.

MR. BOSE: Subscribers. There are phones and there are other devices. Phones you can by from your carrier, yes, if the technology exists, but I think Netbooks, are they going to go in Netbooks?

MR. KEITH: A lot of that data came from GSMA and that's actually correct, it's actually

even higher than that. It goes up every day. The true is let's classify what embedded is. Embedded has now turned into a modular approach. My point is it's very easy. In fact, we were in search at Motorola to find some 3.5 gigahertz Netbooks for some of our customers in Middle East and North Africa and in less than 4 months we had an embedded Wi-MAX product ready to rock, and we also know that the HSPA is the same. It's very likely that the PCIE market is going to enable that. The challenge though is not embedding the technology. The challenge is that LTE exists on well over dozen different frequencies today. The base band will be the same as the PCIE, but the question is how many different antennas will they put in these products because you're starting all the way down from 700 and you're going all the way up to 2.6 and there are lots of them in between and they are supported by major carriers. So if anything, I would classify that the issue isn't embedding the technology in, it's more about whether or not they're going to have to pick and choose what

frequencies they want to support.

MR. KNAPP: Rob had a few questions. Go ahead.

MR. CURTIS: A few short ones. Let's start with the statement on the satellite, Mark. At this point it may be a complete urban myth, but in addition to the latency point, I think there is a perception, no comment on the accuracy of the perception, but I think there is a perception about a price per bit issue and I think there is also a perception about the ability to support uplink. I think those are two other parts of the equation that at some point I'd like to hear more about now would be fine as well.

MR. DANKBERG: I think one of the issues is in wireless. There has been this clear projection of 1G, 1- 1/2, 2, 3, 4, and people say 2G, that was old. That's only talk about 3 and 4. So we're talking about new satellite systems, and unfortunately in the satellite industry things have been muddied. Existing satellite operators want to bundle them all together. So with these

new classes of satellites, one of the points I would make is we're going to deliver 100 gigabits per second to end users for a total capital cost of about $500 million. I would challenge almost any technology to be able to deliver that volume of bits at that total capital cost for infrastructure to the places that we can deliver. So on cost per bit basis, matter of fact, one of the things we do with satellite is we can place our gateways right on fiber backbones, so there is essentially no middle mile cost. One of the things that we can do is compare what our access costs are to the absolutely cheapest in the world peering costs and they're not as different as what you'd think. So I think that's one of the reasons we would like to get to these apples to apples comparisons. I think it will be surprising.

On an upstream basis, the technology that we use in order to get this throughput is essentially lots of small spot beams which means that in the satellite itself you have a high gain antenna. What that allows is much higher upstream

speeds out of a very small terminal with the same amount of power. So we can provide upstream speeds on customer grade equipment, it's blanket licensed, with peak speeds in the 10ish megabit per second range.

MR. CURTIS: Again, filings, visits that dig deeper into this stuff is exactly where we'd like to go on that.

MR. DANKBERG: Yes, we will make as much information available as you'd like.

MR. CURTIS: Vanu, you began to say something in your comments about network sharing. I would love to hear success stories maybe you've seen, specific ideas that might work for the kinds of markets we're talking about. Places we should push harder on. I'd love to peel the onion back and hear at least one more layer than you started off with.

MR. BOSE: Let me tell you why there's a lot of resistance to network sharing first and then why it's starting to happen. There are three fundamental reasons. If you take conventional

technology and share it, you can set one set of network parameters for handovers, quality of service, et cetera, and each operator has their own secret sauce. So there are two solutions. One operator decides and the other is a passive client on the competitor's network. That's not good. Or as they've done in Spain, they form a committee where they both have to agree and it takes 3 months to change a network parameter so that they lose independent management of the quality of the network. Number two is you really lose protection of your user data. It's all coming over one system where your hotspots are visible to your competitor. Number three is you lose the ability to upgrade independently and differentiate your service. Let's say you're both at UMTS. One carrier can't go to HSPA before the other to try to get better service set because you're on the same technology. Those are the challenges. In particular in India they didn't allow sharing because they felt it would be anticompetitive, that everybody would lock down on

technology and one path.

What we're doing there particularly in trial right now is once you get into software, you can start applying the IT technologies to the platform and the technology that's key here is virtualization. So once you're in software, you can apply virtualization and turn one base station into multiple virtual base stations which solves all three of those problems for operators. We're only in the trial phase right now, but if that works then I think that will remove a lot of the barriers to sharing that people see today, that the carriers see. Even though economically it works, there are real concerns on quality, control and competitiveness that the carriers have. I think this technology can address that. It's probably a 12-month period of trial and development.

MR. CURTIS: In that sort of a model which is fascinating, I'd like to dig much deeper into that than this session will allow. What are the piece parts that would be shared?

MR. BOSE: What makes sense to share is the most numerous items because that's where the cost gets driven up. Everything at the site because it's at the site where you have a lot. As you get back into the network it doesn't make sense to share the switches because there are not that many of them. That's where you control you billing and your service delivery platforms so that should be independent.

MR. CURTIS: Share backhaul?

MR. BOSE: Absolutely. In fact, we go IP to the base station anyway, so you just share through different IP sessions. So we're actually planning a network build here where we're working some of the carriers in underserved areas and looking at where they don't serve today building out one network that supports multiple technologies and supporting the major carriers in those areas. The business models we put together, there are some elements we can share with you on cost, are if the carrier built their own network there they'd lose money on that site, and it's not

about CAPEX. If the CAPEX is free you'd lose money every day on the OPEX.

So now the other solution is I could roam with a rural guy who's there who has his own network and that's ridiculously expensive. Most of the carriers today, their roaming costs annually are approaching a billion dollars. So what we're looking at is an economic model where we say we're going to build one network that supports multiple technologies that each carrier can run on and our goal is to provide them the same cost per minute that they have on their urban networks. That means they can go market retail in those areas because that's one of the things where rural gets hurt is even if you get coverage through a roaming provider, the major is not going to market service there because every handset he sells there is just a 5 cents a minute cost to him to his roaming partner. If you can drop the cost so that they can market, what you can bring is the nationwide plans and services into those areas through the major carriers because you're on the

same cost basis.

MR. CURTIS: As I'm on the train on the way home tonight, what are a couple of things that we should think about in terms of making that easier and faster, or maybe that's not something for us to think about.

MR. BOSE: I think you're right in the sense that the argument is primarily economic, does it make economic sense for the carriers to do this? Where they're willing to look at it now is in the really bad areas I think once we prove that it may move in. I honestly don't see a regulatory need there right now. They have spectrum there that we can use to run their network and that may work. I think that going forward as we succeed that may change. Let me take that back. The one place that I think there's a difference is, and we're running into this as we look at the different programs, there are open access requirements. As we're building a wholesale network, we have no retail subscribers. So a definition of open access for a wholesale network

should be Sprint, Verizon, T-Mobile, anyone can come along and use it. That's open. What they do with their own subscribers, that's up to them. So I think open access is different in these areas and is a different level of competition. So I think that has to be teased apart. But that's the only thing I think we've run into thus far on the regulatory side.

MR. NEWMAN: You just answered one of my questions. Would you be willing to offer this as a wholesale open access? I have a question for Brett, Kelly, Jim and Mark. If Vanu is out there operating a network like this that's providing HSPA Plus or LTE mobility --

MR. BOSE: Or Wi-MAX.

MR. NEWMAN: -- and giving you all who are already in the business Wi-MAX or WiFi or satellite respectively, does he become a logical partner or is he a competitor? Would you welcome him?

MR. GLASS: This is fits right into what I was signaling I wanted to say. We designed our

network originally to be wholesaled. From the beginning we set it up so that another carrier could bring bandwidth to our network, use our last mile, and we brand our service so that it would be completely transparent and they could sell it as their own service, they would just use our network of access points that we were rolling out to these rural areas. We got no takers. Absolutely none. All of them had been burned by their experience with being on the ILEC DSL networks and did not ever want to be on anyone else's network again. They went to the extra expense of building out their own access points some of which were on the same frequencies as ours and interfered, but they would not share. I think that there might be some incentives, I'm not sure what, that might get them to do that. But we actually felt like we made a mistake, that we thought that people would buy our wholesale service and then they never did. We're more than willing to share our network. The only thing we're concerned about, by the way, as I mentioned on one of my slides, some of the people

who are advocating what they call wireless network neutrality would require us to allow any device to get on our network. That would be a very bad thing because we engineer every link to make sure that the antenna is adequate and we make sure that it's compatible with our network. You can do terrible things to a network like ours if you put incompatible equipment on it. If you put 802.11b on a 802.11g access point you can slow it down by a factor of 10, so it's very important that we not have people being able to put any equipment they want to on the network. We'll give them a good price on it, but we need to sell it to them and set it up for them. Back to network sharing, we really would like to do it but so far we just haven't gotten any takers.

MR. O'CONNOR: We do it similar, but a little bit different model, and with the NRTC partnership when we deploy into a city of 50,000 to 100,000 with a hub and spoke model from a deployment standpoint and we actually do allow our NRTC partners to deploy in conjunction with us,

you start to enable an entire DMA, a marketing area. This is where there's a huge advantage for the stimulus, et cetera, so a lot of areas that wouldn't normally qualify for a full deployment with some subsidy or RUS funding and we deploy in an entire area, you really can share backhaul costs, you can share marketing costs and you can start that ecosystem and interoperable devices. So that's actually key to more model. So although it's specifically infrastructure sharing, in many areas we're private labeling or co-branding with a partner that enables them to interoperate. So I think Vanu's comments were on track. I think the one thing you warn against is you can't at fourth-generation Wi-MAX or OFDM in the old cellular model. There are better ways to do it and we're actually showing that I don't that roaming is going to be like it was in the cellular days. I think it's going to be much different and much better. It won't necessarily be economically as profitable for operators like us, but if you do it right you're going to really accelerate the

deployment by having this collaborative approach and I think that's key.

MR. CURTIS: That's super helpful. Thanks.

MR. DUNNE: I really can't give you an authoritative answer on that. I'm sorry.

MR. DANKBERG: We're very interested in the wholesale model. In fact, our business model is wholesale. I think that Vanu's point about what the definition of open access should be is very valid. The one point I would make though is things will be much different in a free market environment than they will in an environment where the government is subsidizing as part of a national broadband strategy. In the free market what we've found when we approach people about the possibility of hybrid satellite and wireless or hybrid satellite and DSL is that in a free market, anyone who has invested in their own physical facilities is highly motivated to drive traffic to their facilities and not partner with people that have other facilities. That's just the way it is.

In an environment where the government is subsidizing in order to support disadvantaged or low-income people and capital efficiency is important, at that point I think you can achieve very capital efficient combinations. For instance, high speed, high volume combined with low latency for wireless and DSL, but I think that the government may end up having to force some of those combinations as a condition of getting subsidies because there are these free market incentives to drive traffic to your own facilities that otherwise would inhibit it.

MR. KNAPP: We've run a little bit over. I apologize for that, but the discussion has been terrific and maybe the slogan for these panels should be Leave Them Talking. Our record will continue to be open. I want to thank all of our panelists. Before we close I especially wanted to thank Walter Johnson who put together the panels this morning, and Dr. Rashmi Doshi who put together the panels this afternoon. There was also a lot of other people who helped out putting

all of this together and are going to continue to help out with the sessions we've got ahead of us. So that's it for the day. And thank you to Krista Witanowsky. Thank you everybody.

(Whereupon, at 4:49 p.m. the PROCEEDINGS were adjourned.)

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I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

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