address this. We talked about the Internet model, and I think we've got to be a bit careful, and I just wonder how you folks feel about that.

The Internet actually has an underlying architecture, and it does have a minimal protocol, and you could call that a set of rules. How they evolved is another thing, but they do exist. So are we talking implicit in this that we do need an architecture and a set of minimal rules? Is there support for that, or opposition to that position?

MR. CHAMBERLAIN: There is an underlying set of rules, and that is nature, where there's airways, propagation. They are under --

AUDIENCE MEMBER: Networks are not nature. Servers, and bridges, and airports are not nature.

MR. CHAMBERLAIN: No, I understand that, but in today's Unlicensed Spectrum there is nature. Nature has a way of limiting. There's power limits right now. There is -- those things tend to limit the amount, how do I say it, conflict between users.

As in the Internet model, those people that try to go against nature usually are defeated, so I mean, I think there's no need for set of

rules. I think as many of the panelists have pointed out, as people violate nature, they are usually rudely awakened.

PROF. LESSIG: I think -- I mean, this is to emphasize something David was just saying, that it would be ideal if we could get to the position where we had an equivalent to the TCP/IP protocol in the context of the use of wireless. We don't know what that would be right now. I mean, even one of the original architects of the framing of the end-to-end argument says we don't know what that would be right now, so if we don't know what it would be right now, but we agree we ought to be getting there, I think the answer comes back to leaving enough place for the experimentation to discover what that would be. And if we did get to that neck in the hourglass that facilitated the widest range of experimentation on the bottom or the top of the hourglass, then we would have something that we could say that is the Internet, and that does facilitate the same kind of end-to-end innovation the Internet did enable. That's, I think, where we should be going, because the critical feature of David's end-to-end argument that, from my perspective is, it by architecture

eliminates the possibility of the network owner benefitting or entrenching its own incumbent position against the next great idea. It's an architectural solution to the problem that I was suggesting the FCC had to address.

DR. LUCKY: Well, I'd like to comment on that too, because David raised another point in that same discussion about the role of the IETF. And this is more than just an underlying architecture. It's a process for standardization that was different than the telecom industry had previously. The telecom industry had a long drawn out process where, you know, standards would be evolved before the service was done.

In the IETF, you had experimentation, and only when a protocol was observed to behave well was it actually standardized, but the experimentation went on. And the IETF process for standardization was very very interesting.

MR. REED: Yes. And there's a famous phrase which is rough consensus and working code, which points out the essential different; which is that, you know, you build the code and see if it works. And then you get a rough consensus around the standard, which means that there probably are a

lot of people that aren't quite ready to adopt it, but you move forward anyway and address those as you go on. That's very different than any historical communications process in the wired or wireless area, and I'd claim that, you know, is a huge reason why the Internet has eclipsed all the competitors that were trying to build network services, but limiting their aspirations and trying to design the answer before they knew what the problem was.

DR. LUCKY: Contrast that with 3g, with ISDN, you know, with all these things which were, you know, standardized long before they were actually introduced. And then by the time they ere introduced, maybe they weren't wanted any more.

MR. REED: Right. Iridium is actually an exciting example of that, where the most brilliant -- I would claim Iridium was a brilliant technological thing. I, you know, bow down to the people who did Iridium. The one question that they didn't answer at the beginning is what would it be useful for, but yet they designed it, you know, for a particular use.

DR. MARCUS: Can we get Michael at the other end?

MR. CALABRESE: Yeah. You know, on this basic question of do we need more unlicensed? The answer is essentially yes, but I think it's important to distinguish, we need to do two different things. Okay? Because it's important to distinguish between today's wi-fi technologies which are not, you know, are not really ultra -- they're not ultra wideband. It's a type of hub and spoke architecture that can operate. It does operate on a kind of a channelized sort of basis, and for that we may well, and that's what most of the commentors addressed, was that we probably need more space for that kind of wireless networking. But that's very different from what many of us are talking about here, I think as open spectrum. In other words, the potential for ad hoc user controlled networking, cognitive radio, SDR, to dynamically share spectrum and have, you know, the actual user serve as repeaters between nodes, and that's what's based on the sort of Internet-like design principles. And that requires a whole different regulatory trajectory, one that's looking at sharing, and on what we referred to earlier as underlays. So really the Commission, I think, needs to go in two very different directions

simultaneously to create the environment to promote innovation and economic growth, and greater democratic communication unmediated among citizens. And that is both greater space for the sort of wireless networking technology, such as wi-fi, as those develop, but while still maintaining, preserving its authority to periodically refashion license rights so that as cognitive radio and so on develop, and we can use ultra wideband effectively, that we're not "trespassing" on some sort of vested interest of licensees, because I think the interference protections are something that is going to have to evolve over time.

DR. MARCUS: All right. Peter.

MR. HADINGER: Let's see. I guess I had a problem with just assuming that the Internet model basically said that you should just leave it wide open and let it go. I think that certainly there were a lot of rules that were established at the beginning, and over time that have made the Internet a successful model. But it's also important to realize that most communication world does not happen by Internet. In fact, you know, I would guess there's considerably more bandwidth on fixed analog voice lines that are connected to old

telephone switches. And certainly, between scuzzy devices or IDE devices inside my computer, they're not using the Internet protocol, but they are communicating and they have a protocol that's been worked out for their particular type of communication, which is optimum and efficient, perhaps, for what it's doing.

And I would suggest that within kinds of services that are like, similar things develop. It's certainly true in the satellite industry, where through some intelligent forethought, I think, there were certain bands that were set aside for satellite use, and over time very smart individuals have gotten together and spent very, very long periods of time not speaking in analogies, but actually speaking in technical terms, trying to come up with rules. And, in fact, once those rules do get established, there is a certain amount of locking into those rules that forces conformance, and possibly keeps people from doing new and innovative things that they might want to, but nonetheless is good for the whole, in that they share extremely well within that kind of service.

And again, I would really emphasize

that as we look for rules by which to do this, we should find those types of things which are in the same class, and allow the rules to develop among aficionados of that class for the same kind of service.

DR. MARCUS: Okay. Why don't we have one more question from the audience, and who -- over here, and then we'll go to the next topic.

MR. LANGSTON: Tom Langston with Ericksson. I would suggest that for non-communications devices, we do not need more Unlicensed Spectrum, for non-communications devices. We all seem to agree that for communications devices, we do need more bands and more rights.

DR. MARCUS: Where would you get the bands from?

MR. LANGSTON: No. I suggest we do not need for non-communication. I don't have a comment on where we would get new bands for communications devices. That's up for discussions.

MR. REED: I have a quick comment related to that, although it's a side issue. It turns out that one of the difficulties with some of the new technologies, it's hard to separate

communications from non-communications uses. Just like it's hard to separate IP from voice now, and so forth.

We may not need new bands. As I point out, I'm not for new bands, but for example, ultra wideband technologies or various wideband technologies provide location detection services, if you will, that compete very effectively with GPS, or radar, or whatever, and especially in environments like indoor things. And we ought to recognize that the best paradigm for those kinds of technologies is unlicensed. We ought to make sure it's a somewhat different kind of unlicensed, but may also be networked. And we ought to make sure that by focusing on communications, we don't bar experimentation with those kinds of mixed applications over time.

DR. MARCUS: Okay. Bob is going to go on to the next block of questions now.

DR. LUCKY: Yeah. You'll find that the blocks of questions are so similar, that whatever comments you had to questions will still be relevant, so let's not worry about it. I think, you know, there are only a few gut issues here that we're nibbling around that are tricky.

Now the next set of questions, for example, deals with first, will it meltdown? We've already been talking about that a lot. How do we know that a tragedy to the commons has occurred? And I actually would like to talk about that a little. And then the question, should we implement a Spectrum Etiquette that would reduce interference among Part 15 devices? And should the FCC have a larger role in etiquettes for unlicensed band, so let me just take a few of these. Now 11:00 we're going to have a break.

DR. MARCUS: No, 11:15.

DR. LUCKY: 11:15. Okay. Fine.

Okay. Let me just, because this is a question that bothers me a lot. How do you know that we're getting a meltdown? Now somebody made the comment earlier that, you know, the EPA measures pollution, so they're measuring what they regulate. And the FCC is not measuring what it's regulating, so what should we measure? And how do we know if this is melting down? David, you look like you want to say something.

MR. REED: Yeah. I really do. I think Dewayne already pointed out that measuring what's regulated is important. I've been thinking, and a

lot of people have been thinking about how do you do that given the cost. And I actually think the best way to do that is to measure it at the user.

It's perfectly reasonable in a networked world, increasingly networked world to have devices reflect back to the user, and even reflect back into a network in, you know, issues with congestion and interference. It would make sense to me to collect that information at some place like the FCC, or some other neutral ground, some manufacturers, who can then take action collectively on what they learn.

DR. LUCKY: Well, let me --

MR. REED: Well, just let me finis one sentence. This is sort of analogous to the idea that, you know, in most cases of pollution, you can actually see the pollution. In the case of radio, you can't see the congestion, but you can feel the affects of it in the service that you get through the device. And, you know, that's probably the best place to detect it.

Now it's not necessarily the best place to correct it but, in fact, most often the device can also correct it, but it's useful to notice how much -- how often it's correcting it, as well.

DR. LUCKY: Well, you know, I've thought about that, and we could. There are millions of wi-fi cards out there, 802.11 cards, and we could have them report back to some central site on the conditions that they see. But let me imagine for a moment that we actually do that, and that you have all this data, what do you do with it, and how do you know if it's melting down?

MR. REED: That was your other question.

DR. LUCKY: Yeah.

MR. REED: Well, I would claim it's melting down if it's not scaling. You know, basically you can predict what ought to be the case, you know, in terms of what you expect the market place demand to be, and so forth. And if it's really not, you know, getting fixed, and conditions are getting worse for everyone, then either the market place is broken, that is, the people are not solving the problem for themselves, not buying the new stuff, and that would be useful information to know.

But basically, detecting the problem is different from assigning, you know, the fix or the cause, and I'm not sure -- you know, I think the

market can do the fixing, but sometimes it's useful to have the data and just publish.

DR. LUCKY: I'm still not sure when the data tells me I've got a problem. Okay. I want to go there. A lot of people want to talk. Let me start with Larry. I was looking at him.

PROF. LESSIG: All right. So I agree that we need -- it would be great to set a kind of study at home project to see what the actual state of the world is, and it would be a relatively cheap one to fund. And I agree with Dewayne that this is something we ought to push, but I think that the way you frame the question begs the question, because we shouldn't be thinking about meltdowns in any particular part of the communication system. We should be thinking about the communication system as a whole, and so there's a favorite stickman in one of the papers about propertizing spectrum about the Internet, where they say yeah, yeah, the Internet is great, but you wouldn't rely on the Internet -- the Internet would be terrible if what you're trying to do as a surgeon get high quality images beamed to you about the patient across the world, and so therefore, the Internet is a failure because it can't do that. And the

response to that is, why would you ever use the Internet to beam images of some surgery that's going on halfway across the world. There are other communication systems you should be using for that type of communication. And so, if you think about meltdown in a particular area, you could probably identify places where there are congestion going on, given particular types of uses or particular bands. But it would be bizarre to think that the communication system as a whole was melting down because people who can't -- who need higher quality service, who need better reliability in a particular context need to be able to shift, and do shift to other forms of communication that could answer their needs.

So it seems to me the very question makes it sound like we are necessarily facing a tragedy of the commons here when, when you think of the communication system as a whole, I can't conceive of how you would have a tragedy of the commons for the system as a whole.

DR. LUCKY: Okay. Other comments?

MR. CHAMBERLAIN: I think one of the ways the Commission can take a look at whether they feel we're having a meltdown or not is actually

look at the marketplace. As new technologies come out and as they grow, what's going to happen is, these companies will grow right along with the technology. The marketplace will see -- you'll see a huge acceptance of these things. And then these companies will be coming to the Commission and saying, we've got this issue. We've got a problem. Let's work it out. Let's figure out how we can make this system work. And I think the marketplace can react far quicker and analyze this situation far better than say the Commission could by using some kind of technical means.

DR. LUCKY: So you wouldn't -- you don't think we should measure anything.

MR. CHAMBERLAIN: I think you should be good listeners to the marketplace and to the companies out there.

DR. LUCKY: Dewayne.

MR. HENDRICKS: I don't agree that the market can do that, because again, I've looked at the historical record, and you've seen companies cry wolf, you know, for some time, and they really didn't back it up in their filings, because they didn't really know the answer either.

I don't know the answer, so I think

it's just put it down as something that you have to continue to experiment to try to figure out what's going to work. But you know the thing is, is that -- here's a thought I had. We don't have a Jules Verne or an H.G. Wells for this field, you know. I mean, if you look at what they wrote about projecting ahead to where we are now, they didn't talk about wireless per se. Okay? And since that time, no one has really -- you know, the science fiction writers haven't really addressed the kind of problems we're talking about here today. Okay? So we don't have any good things to look at to sort of describe this problem.

I mean, Hollywood hasn't tried to do this either. Think about it. Star Trek, communication devices just work. They just plain work. You know, whoever you want to talk from Point A to Point B, unless the script says there has to be a problem, the communication systems work. It's magic. Okay? So, you know, it could be that simple, you know. It really could, but right now I don't know how to get to Star Trek.

DR. LUCKY: I'd just like to comment myself. I mean, we're -- in my company we've been working with the New York City Transit Authority,

and they want to use 802.11 to talk, you know, to coordinate their trains, and so we've been measuring the interference as the train goes through Brooklyn. You know, as a function of the frequency, time and position, and the answer is just what you'd expect. Some time, some frequencies, some places it doesn't work, but I don't know what wisdom to glean from that. I think it's always just like the Internet, sometimes you don't get through. Sometimes the packets don't get through, and that's the nature of the world. Let me go -- Peter, you have a comment on this?

MR. HADINGER: Yes. You know, ideally we'd be able to measure everything and respond in some sort of adaptive way, but there are limits to knowledge in terms of knowing what the problem is. And most of the issue there is that the definition of interference is often set by the person being interfered with. And the person or the entity causing the interference may often be completely unaware of the fact that interference may exist.

Certainly, in the case of an Ethernet where everybody is looking at collisions on a network, everybody can see when collisions happen. But in the case of radio, you may have a system

which doesn't see any interference to itself in the local domain, but something further away may actually be experiencing interference and not be able to communicate that.

I know we looked at, in one particular sharing example of, you know, whether there needed to be beacons or something like that to allow people to indicate when they've been interfered with but, you know, certainly the problem we have today is that services have no effective way of communicating back when interference does exist, and so there's no effective way of measuring it, even if you confine it to systems like wi-fi or whatever. You aren't measuring all the other things which are non-wi-fi.

DR. LUCKY: Michael.

MR. CALABRESE: Yes. I just wanted to make a kind of a contextual comment, which is when we talk about meltdown, as if that's synonymous with, you know, a tragedy of the commons. It's important to realize that the whole idea of tragedy of the commons is really a misnomer, because what it is, is a tragedy of unregulated access. You know, that's what we mean when we talk about tragedy to commons.

All successful commons from the Interstate Highway system, to the Internet, to New England Fisheries have rules of the road, protocols, and/or etiquettes. And so if there is a so-called meltdown, we shouldn't be thinking of it just as an extrapolation of today's unlicensed world. But rather, I would think that it's most likely to be the result of a failure of policy, and not ultimately of technology. Because, for example, congestion in unlicensed is a sign of huge citizen demand, which means we have to make some tough decisions about reallocation, and about sharing, and about interference standards, and the rules of the road themselves have to be scalable.

DR. LUCKY: Larry.

PROF. LESSIG: But again, I think that the problem with this is that this debate about congestion or meltdown is a kind of specter that haunts this field. And most people's reaction to it is not, as you were suggesting, Michael, to say well, what's the set of rules that we can make sure avoids the meltdown, but the opposite traditional answer to a tragedy of the commons; which is, well, therefore, we ought to sell off all the spectrum quickly, because that's the most effective way to

avoid this type of tragedy.

And here, I think the point that Mark Cooper was making earlier about how do we avoid incumbents who will then fight like hell to make sure they don't have to give up the rights which they have acquired, becomes the relevant policy consideration we have to bring in here. The fear about meltdown is exaggerated, I believe. One way to show it's exaggerated is do lots of measurements, and so that's why I think the measurement thing is an important problem. But let's understand why it's being deployed, why the meltdown thesis is being deployed. It's being deployed often by people who would like to push us towards this solution; which is, let's sell off as much spectrum as we can quickly, so that we can use the market to solve this problem of congestion.

And I think the way to resist that is to re-emphasize Cooper's point, that if you sell off all the spectrum right away in this big band auction-like way, in a context where we don't know what the best answer is going forward, we are quite likely, I think given the information we've been listening to right here, going to be in a position where the cost of buying-off those incumbents will

be extraordinarily high, so high that we won't do it. So we will auction ourselves into a context where we are forced to accept an inferior communication system, when if we just hold off from that, at least right now, we could allow the market and technologies to develop, and demonstrate an alternative to this propertized system, that at least it's possible, I think likely will be superior to their propertized system.

DR. LUCKY: Larry, it's not on our list of questions, but the big band auction kind of hangs over us. And what would happened to unlicensed bands in that kind of a paradigm?

PROF. LESSIG: Well, I think it would create a huge problem for the development of these other types of technologies, in particular, the ones that David was talking about, and for wideband technologies that Dewayne was talking about.

And the biggest reason that it creates this kind of problem is a concept which Michael Heller introduced into the legal discussion, and James Buchanan has picked up in the context of regulatory theory; which is, the problem of the anti-commons, not the commons, but the anti-commons. And the problem with the anti-commons is,

if there are any number of people who have the right to veto your use of a resource, so let's say there are 20 people or 50 people who have the right to say you can't use this resource, then innovators will say it's just not worth it for me to develop new technologies to try to use this resource, because the coordination cost, the transaction cost of using this resource will be too high to make the resource useful. So think about the big band auction now. Right? So we auction off all the spectrum in the world. We have thousands of owners all over the country who own different bits of the spectrum, and then they're going to be in the position of deciding how they're going to make it available. Some will put it into a market, some won't.

The innovator who's trying to use the type of technologies that Dewayne is talking about, thinking about being able to use spectrum across a wideband, that has to enter into the calculation. Well, how am I going to begin to negotiate with each of the spectrum owners in each of the places the spectrum might be owned for this particular context, so I have to develop a technology that's smart enough to know which auction mechanism I'm

going to engage in, depending on whether I'm in Philadelphia, or in San Francisco, or in Wyoming. It just increases the transaction cost so dramatically, that these extremely efficient wideband technologies become priced out of the market, just because of the overhead that you've placed on top of the system.

MR. HADINGER: May I follow-up on that one, just real quickly. This is exactly the reason why in the satellite community for international services, there are no auctions. And it's because there is a huge gain theory problem, if you've got a whole bunch of independent countries coming up with their own auction regimes, and their own spectrum Planning Policies, trying to develop innovative services which can serve a region, yet be subject to the least common denominator of somebody who decided that they want to hold out or whatever, can cause extreme problems. And so, you know, for that reason, we've had a very strong effort to try to make sure that those are determined more on technical grounds, and not on sort of individual country policy grounds.

MR. CALABRESE: I'd just like to add to what Larry said. And I think because of that, it

was extremely significant that in the comments that were filed July 8th, it wasn't just groups. You know, Larry mentioned Consumer Federation of America, we filed for Consumers Union and a number of other groups with us. But also, the major technology companies, particularly equipment makers, software makers and so on, that really were strong in saying that the Commission must preserve its authority to periodically refashion license rights to accommodate changing technology and social priorities.

I mean, the Consumer Electronics Association, for example, is just right on the point we're talking about, stating that:

"To the extent that spectrum is allocated by competitive bidding, the Commission should ensure that such a system does not impinge on the greater deployment of unlicensed devices, the sharing of spectrum among unlicensed and licensed uses, and the allocation of more spectrum exclusively to unlicensed use."

Well, you know, if it was a trend that ran through all the comments from both licensed users and proponents of unlicensed, it was that we must at all costs avoid establishing any permanent

private property rights in the frequencies, because that would just be the death now for innovation, and for any of the things we're talking about here today.

DR. LUCKY: Okay. Other comments on this? Okay, audience. Yeah, lots of comments. Just hand it to an arbitrary person. Sir. Not too arbitrary.

PROF. RAO: Ramesh Rao, UCSD. Bob, I wanted to respond to your question about how would we know that there is meltdown, if everybody with a .11(b) card reported back what they were observing. And I wanted to offer a definition which might resonate, at least for the technical community, and that's the notion of "goodput".

If you measure the number of people that are coming on board this technology, .11(b), then measure the amount of data that they're able to gainfully extract from the network. And if it turns out that you're at a point where, as you add more people you're getting less out of the system that, to me, is meltdown, because if you stay on that trajectory, people are going to abandon this technology, so that was the specific thing that I thought might be worth considering.