Constellations Podcast

Episode 158 – Space-Based Networking Infrastructure, Broadband Communication Ecosystem and the Speed of Light Is Too Slow

Speaker: David Witkowski, Co-Chair of Deployment Working Group, IEEE Future Networks – 28 minutes

John Gilroy: Welcome to Constellations, the podcast from Kratos. My name is John Gilroy, and I'll be your moderator. Today, we'll be talking to IEEE senior member David Witkowski, who serves as the Co-Chair for the Deployment Working Group at the IEEE Future Networks Technical Committee. David and I will be having a conversation focused on LEO satellites and space-based networking infrastructure. So David, we're going to jump right in here. Can you tell us the purpose for the IEEE working group that you co-chair?

David Witkowski: Thanks for the opportunity to be here today, John. The Future Networks Technical community is a group that was , essentially a group of futurists who exist within the IEEE structure. So what we do is look at the questions of where will things go down the road, how will things evolve and how might they evolve. Taking into account all of those options and trying to put, effectively, a roadmap into the future direction for communications technology within satellite, cellular, wifi, and all those things. Then later on, the standards groups will solidify those into actual standards that can be implemented by vendors.

John Gilroy: Yeah, it's almost like a time machine backed 25 years with a wifi consortium and people in Paris are trying to figure this thing out and no one knew what the standard was going to be, and then they kind of got it. And this same thing you just described is what happened, didn't it?

David Witkowski: Well, wifi is an IEEE standard, 802.11 is an IEEE standard. So yes, most people aren't familiar with the IEEE, but they're certainly familiar with wifi and they may not realize that the IEEE touches their lives every day.

John Gilroy: I remember 25 years ago with all those debates and throwing chairs and screaming about standards, it was quite a battle. Anyway, so the IEEE, why are they interested in LEO satellites? Aren't they doing stuff on the ground? Come on now.

David Witkowski: Well certainly, I mean as the communications ecosystem evolves, there are a number of different technologies that will connect people to the internet, and satellite is one of those. As we've seen over the years, there have been many attempts to use satellites for broadband communications. Prior to the past few years, they've not really, no pun intended, gotten off the ground. With that

being said, satellite has always been one of the things that we believed would be in the mix. Of course, as Starlink has been very successful in moving their network forward and probably the most successful to date that is actually financially approachable for not the average user, but perhaps the upside of average user, it is likely going to be in the mix. And as the third generation partnership project, which is the group that sets the standards for things like LTE, for the 4G network, for new radio, for the 5G network, they are considering satellite in the development of future releases of the 3GPP standard.

John Gilroy: ou brought it up, 5G. So, the incorporation of a satellite segment into this 5G ecosystem has been gaining momentum here. Especially with the advancement of LEO and Constellations such as Starlink and OneWeb. So do you think this momentum will help close what some are calling this digital divide?

David Witkowski: I think satellite broadband is already helping to close the digital divide. I know in the area where I live, we have some urban areas, but most of our county is unincorporated and rural. Where my office is, just up the hill from us, there are a few people that don't have broadband, and Starlink has been a solution for them. Now, this is not 5G, but there was recently a demonstrated data connection from a LEO satellite directly to a smartphone. Of course, Starlink uses terminals that you place at your home, on your RV or whatever you want to use. Getting directly to a handset is another order of magnitude complexity in making a connection. But AT&T and AST Space recently made a connection directly to a handset, and so that was kind of a milestone because they were able to achieve a 10-megabit connection. It's not broadband, but it's something and hopefully in the future as we move forward, we'll see that continue to grow and expand in capability.

John Gilroy: Well, let's focus on the future. You're a futurist here so let's focus on the future. So do you think there will eventually be a global network on the ground that's supported by LEO capabilities and how far off is that?

David Witkowski: So right now what we are seeing is that LEO data broadband connections are actually feeding ground networks. So some communities who live in rural areas are creating community co-ops for themselves, and they are using Starlink as the connection. Then they from there, will distribute it out throughout their community using a variety of technologies, whether it's ethernet, wifi, or point to multi-point sort of millimeter wave technologies, and then ultimately getting to wifi or ethernet for their devices. So I think LEO broadband has already begun serving ground networks, and we will continue to see that in the future. The real question goes to the capacity of the network, whether or not the LEO network can handle that amount of traffic. That's one of the big questions.

John Gilroy: One question I have is kind of a five-hour answer question, and maybe I should put up my feet and smoke a cigar while you answer it but talking about value here. What is the real value of using a satellite communication network and

what's the importance of reaching people in rural California, Alaska, or rural Ethiopia?

David Witkowski: Yeah, broadband is certainly a thing that is a requirement for life in the 21st century. Right. I mean, it's just as important as electricity, gas, water, sanitation, I call it the fifth utility. It is a thing that you really would have a hard time getting by without, and people who don't have it struggle. So for people who live in rural areas, it is critically important. As we are seeing a lot of housing crisis in California and other areas of the country. You see people moving out into the country, they need to be connected. People who live in other countries who don't have connection will see the digital divide that prevents them from participating in life in the 21st century.

So there is a lot of value in bringing broadband to those locations, and it is easier to do so with a satellite network than it is to do it with terrestrial networks because just simply the construction cost, not to mention the permitting, the environmental impact reports, if you're going to run fiber in a trench along the ground out in the woods, you might have concerns about impacting a habitat of an endangered species, or you might have to put up poles where poles don't exist, and that takes money, time, and effort. Satellite can serve those people directly just because it's over their heads at all times.

John Gilroy: I'll be in California in August, and there's a little thing you have out there called mountains.

John Gilroy: I mean, talk about a barrier. I mean this is terrible. I wouldn't try to place fiber through any mountains out there, California, Oregon or anywhere in the United States.

David Witkowski: That is really a challenge. I mean, the state's plan of record for what they call the Middle-Mile network, the California Middle-Mile network is basically fiber and they are planning on going along a number of highway routes using the highways as rights of way in order to build that network. And many of those routes do go through the mountains. So that is a significant challenge for them.

John Gilroy: Yeah. In the satellite community, there's a lot of talk about something called a seamless network where users can roam from terrestrial to satellite without batting an eye. So are there standards your team is working on to make this vision a reality?

David Witkowski: So our team is not working on standards. We are not a standards group. We're a futurist group, but we are setting the groundwork for the discussion around which standards will be formed. So primarily those discussions are occurring in two places. One, I mentioned earlier, the 3G partnership project, which is on the cellular side. So they are beginning to look at the question of 5G as a support for

direct from space to ground communications. Then on the wifi side, we have the 802.11 standard, and that then turns into an enhancement of that standard primarily to support what's known as offload. So as some of your users may have, for example, used wifi calling, if you're on a wifi network, you have a bad cellular connection, you can now make a phone call using a wifi connection. Roaming, if you will, will occur from the cellular network to the wifi network using a standard that's out called Hotspot 2.0 or Passpoint 2.0.

And what we're seeing in some of the networks that I actually run myself, not through IEEE, but through my company, We implement offload in those networks so that for example, if the employee of a tech company in Silicon Valley goes into the building, they don't even have to attach to the wifi network, but their carrier will allow them to roam onto the wifi network, and that is supported by those advanced wifi standards. So as you have set up a satellite network, you then would have a third opportunity for roaming, which would mean you would go from perhaps your home in the mountains where you would be connected directly to a satellite. As you came down into the city, you would then connect to the terrestrial cellular network. As you arrived at your office, you would connect to the wifi, and if everything goes according to plan, you'll be able to hold a call through those transitions and not even notice that anything has changed.

John Gilroy: Well, I guess if we're going to talk about networks, I guess we've got to talk about mobile network operators. They're called MNOs in the business, and MNOs seem to be pretty far ahead of the satellite industry when it comes to network management. We're talking about things like automated end-to-end services, virtual and software-defined networks, and the stuff that keeps data traffic flowing. So do these concepts translate to satellite service providers as well?

David Witkowski: They do, but with certain limitations. For example, of course, the time delay that it takes for a signal to get from ground to space is non-zero. On a terrestrial network, you notice delay primarily because of the processing of the network and the equipment dealing with the data as it transits. In satellite, you have to wait for that signal to make it to space and back. So there is a delay because the speed of light is, it's finite, it's fast, but it's finite and that creates issues with latency in the network. That of course can appear in a variety of different ways, not the least of which would be if you were on a phone call or a webinar, a Zoom call or Teams or something like that, you would probably notice a delay that you would not get if you were on your home network.

So it does translate, the mobile network operator paradigm does translate to a certain extent, but with the caveat that we will have to be aware of the delay that could occur in the network. For your older listeners, right, they may remember when you would make a transatlantic telephone call years ago and you'd call your grandmother in Poland and say, "how are you?" And then two

seconds later you would hear her say, “oh, I'm great. Good to hear from you.” and it took time for that.

David Witkowski: Because that was a satellite-based phone system. Of course, that was geosynchronous satellite, but the same concept applies.

John Gilroy: When you said speed of light, I was reflecting on the interview I did with a guy named Vint Cerf. He was working on deep space internet. I said, well, Vint, what's the biggest challenge you have with deep space internet? He says, well, the speed of light's too slow.

John Gilroy: I mean, that's what a physicist would say too because I would not even attempt to make that statement, but wow, it's too much.

David Witkowski: Yeah.

John Gilroy: In my world of cloud computing and technology, scalability always comes into discussion. So what about scalability and LEOs, is there challenge there?

David Witkowski: There certainly is. I mean, with regards to just for example, the issue of managing the satellite constellation, dealing with deorbiting where you need to move a platform out of orbit because it has failed. The space debris of course can be an issue if you don't deorbit. Space seems very vast, but it is actually an orbit. There's quite a bit of debris that's already there. So scalability is an issue. Really when it comes to satellite, I think that the challenge that you have is, of course, the cost of getting to orbit, the launch platforms. Of course, SpaceX is making a lot of inroads in that. From where I live, I can see Vandenberg launches so when it's not foggy, I can see some. In fact, last night there was a Vandenberg launch of SpaceX or Starlink satellites. So I watched that last night just around midnight.

They sent up, I think 42 more. And I always like to watch the launches because I'm a space geek. But it really gets down to this question of when you launch a satellite, you're really frozen in time. There's no way for me to send a technician and a truck up to space and upgrade a satellite. It doesn't work that way. We don't have an orbital repair platform anymore because we've closed down the shuttle program and probably wouldn't have been viable to do that at scale anyway. But the bottom line is when you launch a satellite, you're really taking a snapshot in time, and it is frozen at that point. There's very little that you can do to upgrade that satellite, absent of some software changes.

But if you evolve to a new standard, you add, 6G comes into the mix, well, guess what? All that 5G satellite up there now has to be either end of life or it's just going to continue to be 5G until the satellite fails. So scalability is an issue, but I

think also keeping up with the pace of technology is probably one of the biggest headwinds that a satellite constellation faces.

John Gilroy: The Constellations Podcast was launched back in 2017. It was a small step for man, but a giant leap for podcasting. Today, thousands of people from all over the world listen to Constellations, and thanks to you, we've grown into more than just a podcast. Sign up for the Constellations newsletter to receive articles on current industry issues, podcast summaries and contributed blog posts at constellationspodcast.com.

John Gilroy: When we started this podcast four or five years ago, I never thought we'd include Apple in the discussion, because their tentacles reach everywhere. So do you think there'll be a role for direct-to-device communications in the future? Has Apple proved this out and what are the limitations inherent in this concept?

David Witkowski: So Apple's implementation of direct to device is really limited to sort of emergency text messaging, and it's a pretty bandwidth limited system. You are able to send a text message to a satellite. It takes a while for it to go through. You can't send photos, you can't send videos. It's not multimedia. It's really help, here I am and that is good for what it's intended for. Direct-to-device is really proved out more by the AT&T AST Space test recently, which was a 4G test that was able to get a 10-megabit connection down to, I want to say it was a Galaxy or Samsung Galaxy device. So that was pretty compelling because again, while 10 megabits is not broadband, at least you would have some multimedia capability. The biggest problem that you get into with that at scale is the ability of the network to deal with large numbers of users.

When you're connected to a cell site and you're in an area, there are a certain number of people that are all contending for access to that site. Well multiply that by several orders of magnitude when you talk about space because that satellite orbiting over the Bay Area, New York, Chicago, or a major metro area, potentially sees tens of thousands if not hundreds of thousands of users simultaneously. All of those devices trying to talk to it at the same time. How do you separate out all of those individual data streams into something that can be coherently dealt with and managed, is the biggest challenge that satellite network faces in terms of scalability on the communication side.

Because imagine you were announcing something huge like aliens have landed, we've made contact with another species, and then you say to the audience, do you have any questions? And 10,000 reporters are yelling back at you for questions, you wouldn't be able to do it, right? That's kind of what a satellite experience is in the course of its daily life, its constantly dealing with that, what an engineer would call uplink management, uplink contention. And that's the biggest thing that I think we deal with in that regard.

John Gilroy: I think if you watch spy movies from 2005, you'd always see people in boats with their satellite phone and

I guess satellite phones in the past, they were expensive. S is there a way to bring this cost of communication down?

David Witkowski: Well, I think they are bringing it down. I mean, certainly Starlink again is not cheap, but it's certainly cheaper than Iridium, Globalstar or whatever we had in the past where you were paying a few dollars a minute for a phone call. Your younger users probably don't even have a concept of paying per minute, right? But we remember toll calls and we remember long distance, so yes. So satellites are, at least in the past, were like that. Now I mean, I think as you scale the network up, you can begin to move in that direction of it being lower cost. But right now, of course, what a Starlink subscription is north of $100 a month U.S., well, that's maybe out of reach for some people. So we are better off than we were before, but I don't know that we're where we need to be.

John Gilroy: There's always proprietary language and terms in different businesses, and the satellite business has got special terms too and there's a concept called fixed wireless access. How does that interact with 5G anyway?

David Witkowski: Yeah, well, fixed wireless access is really one of the, what they call the last mile delivery methods, which is able to connect a home without physical infrastructure. So 5G fixed wireless access. There are also systems like Facebook's Terragraph system, which uses 60 gigahertz networks. There are a number of companies out there that do millimeter wave broadband using those higher frequency networks. Some are in the lower frequencies and some use wifi spectrum or what we would call UNII spectrum in the five gigahertz band.

So as fixed wireless access is a way to get people onto the network without having to put wires to their house, it's notable that one of the people in our group at the IEEE is a professor in Sweden, and he has talked about how in Northern Europe they are moving away from fiber as a fixed delivery method because of the costs and the complexity. They prefer to use wireless because it is quicker and easier to deploy, less environmentally impactful, but of course there are trade-offs there that have to be dealt with in terms of the network's stability. Fiber is a great technology. It is very symmetrical, and it's very, very stable, but it is very expensive to deploy.

John Gilroy: Does that guy teach in Uppsala? I know people who teach there.

David Witkowski: No, he's at a University in Oslo. I'd have to remember exactly which university he is. He talked recently about how, it's interesting when you look at the United States, there's a big love of fiber in the U.S.

John Gilroy: Well, I think we have a fiber centric mindset here.

David Witkowski: We do. We absolutely do.

John Gilroy: We talked about it earlier with going through the mountains, and so I guess that's the plan for connecting the underserved locations in the country. I guess if you're in a city, it's a great medium, but it seems like, I don't know, it seems like maybe we agree with the Swedish guy and say, yeah, it's cheaper and more efficient. Is there anything else that maybe is outside of fiber besides wire? I don't know what else it'd be.

David Witkowski: Well I mean, a solution to the connectivity problem is going to require all technologies that are available to us. It depends upon where you are. My company often gets queries from, for example, cities like county governments that say, well, what is the solution to solving the digital divide? There is no “the solution”, there are solutions, and they must be engineered. So you have to think about, well, where are you trying to go? Are you trying to go over distance? Is it foggy? Does it rain a lot? What is the environment that you're in? Because I mean, you could use things like there's fixed wireless access. There's also fixed optical access.

David Witkowski: In fact, you mentioned Vint. He emailed me a couple years ago because they were working on some technology at Google that was using a laser to build a network and the technology was originally used for the Loon network, if you remember Loon, the balloon satellites,

John Gilroy: I remember the balloons.

David Witkowski: Satellites, but they were sort of high altitude and they were using an optical network on those, and they wanted to see if they could repurpose that optical technology for something else. And the query was, did I see any opportunity for that? There were some cases where I thought it could be useful, but there were other cases where it was inappropriate. More recently I was working with a client that we just needed to get a data link across a parking lot. They didn't want to dig up the parking lot because they had just resurfaced it, so we just put in a 60 gigahertz point to point link across the parking lot between the two buildings, and it's been very stable. It works.

David Witkowski: Now had we had a chance to run fiber, I would've said put conduit in the ground and run fiber through it. So what is the solution? The answer is there are solutions and we will have to engineer it to suit the problem that we're trying to solve.

John Gilroy: In my simple mind I want one answer, David, just one answer, but there's no one solution for everyone. Is there? I don't want to sound like a lawyer. I don't want to accuse you of being a lawyer, but I guess it depends. Huh?

David Witkowski: Look, you're not going to take your Mazda Miata to Home Depot to buy wood, right? And you're not going to enter a road race with your Ford F-250 pickup truck. I mean, we have vehicles that serve different needs and different purposes in our lives. Likewise, your mountain bike might be great, but it isn't going to win a road race. And your fixed pedal, what do they call it, the Velodrome bike, isn't going to go bouncing around up in the hills.

David Witkowski: I mean, we use technology to solve problems and to suit the needs and so yeah, there is no one solution.

John Gilroy: I think I have a motto for your committee there, the future committee. It's going to be from Yogi Bear. You know the quote, "Prediction is difficult, especially about the future." That should be your motto.

David Witkowski: That's exactly true. That's very true.

John Gilroy: And one personal question I had for you. Back when you were a young, young guy probably in diapers, there was a guy named Alvin Toffler who wrote a book called Future Shock.

David Witkowski: Oh, yeah. Future Shock. I remember,

John Gilroy: But how did he do? I mean, did he do good job predicting or bad?

David Witkowski: You know what, that's a really good question. Actually I don't think that anyone has circled back around to ask, to score Alvin's success rate. So that's a really interesting question. I'm going to have to look that up after we're done. Was Alvin right, and if not, then how was he not right?

David Witkowski: I think it was interesting because I was on another podcast recently and the host asked me a question which came from his audience, and they had said that he had read an article that some years ago someone predicted that we would each have an individual satellite that would serve us personally.

David Witkowski: And he asked me if I thought that would ever be a reality, and I had to sort of discuss orbital mechanics with him and the idea that first of all, the cost of getting that satellite up there would be huge. Second of all, it would have to be in geosynchronous orbit, which would be extreme cost for fuel and just the launch vehicle, and then it would be so far away, it wouldn't do you very much good anyway. And then if it was a lower earth orbit satellite, I mean, when the

ISS passes over and you could see it when it passes over, if it goes over at the right time, it's only in the sky for 15 minutes, right?

John Gilroy: Yeah.

David Witkowski: So you can imagine, I mean, these Starlink satellites are just burning through, so yeah, you might have a personal satellite. It might be overhead for 10 minutes a day, but I guess if that serves a need for you, then that's fine. I don't think that prediction played out very well. I don't think that was one of Alvin's predictions, by the way. I just thought that was very interesting that it was one of those sort of 1960s eras like popular science articles. Somebody decided that we were all going to have personal satellites, and somebody took that to heart.

John Gilroy: Yeah. Well, David, this technology is changing so fast. It's difficult to understand the options for overcoming this digital divide, but I think you've given our listeners at least some options to consider in what's going to happen down the pike. I'd like to thank our guest, IEEE senior member David Witkowski, who serves as the co-chair for the deployment working group at IEEE, Future Networks Technical Community. Thanks, David.

David Witkowski: Thank you for having me, John.