Constellations Podcast

Episode 199 – Software-Defined Satellites, Follow-Me Beams and Always-On Customer Connectivity

Speaker: Carmel Ortiz, SVP of Technology and Innovation, Intelsat – 23 minutes

John Gilroy: Welcome to Constellations, the podcast from Kratos. My name is John Gilroy and I will be your moderator. The satellite industry is embracing software-defined networking, to reach new heights, and deliver on the promise of connectivity anywhere, at any time. A great example of this transformation is the transition to software-defined satellites that enable more dynamic business models, and can shift capacity on demand, to meet changing customer needs. Here to discuss software-defined satellites, the capabilities they offer, and the advantages they bring to address today's market challenges is Carmel Ortiz, Senior Vice President of Technology and Innovation, at Intelsat.

Carmel is a proven engineering leader, with over 30 years of experience in the telecommunications, satellite, and digital media industries. As a complement to this interview, we will put a link in the show notes, to the Satellite World podcast, that focuses on how software-defined ground supports these new flexible payloads. Okay, Carmel, let's jump right in here. How is the satellite market evolving and driving the need for software-defined satellites?

Carmel Ortiz: Oh, that's a great question, John. And I think you did a pretty good summary there in the beginning, sort of describing what they are, flexible delivery of capacity. But when we talk about the satellite market, and how it's evolved, what we've seen over the past few years, is nothing short of a transformation of our industry, and the markets that we serve. There's been revolutions in launch capabilities. The advent of reusable rockets has changed our economics, dramatically. We have the emergence of LEO constellations like Starlink and OneWeb. Those brought simple to use, low latency broadband data, to a more mass market, and have enabled multi-orbit services. Flat panel antennas, electronically steered antennas, are supporting mobile terminals, reducing form factors, simplifying installation for the customers. And finally, there's been a major convergence between terrestrial telco, and satellite markets, as evidenced by the standardization of 5G for non-terrestrial networks, otherwise known as 5G NTN.

And these standards are going to allow our somewhat bespoke satellite industry to unlock that telco scale. So imagine tens of millions of existing handheld devices and smartphones being able to roam between satellite, and ground-based 5G networks, seamlessly. So the industry looks a lot different than it did four years ago, but it's all really good news. It's the rising tide lifting all boats.

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And what these transformations have done is brought satellite communications into the mainstream. We've gone from being an exotic technology, to being really a household name. Let's face it, before Starlink, there wasn't a lot of cocktail conversation about SATCOMs, right? So all these new applications are putting pressure on the supply of satellite capacity. To meet that ever-growing demand, we, as operators, need to deploy huge amounts of additional capacity, but we need to do it with economics that are attractive for us, and our customers, and that's what software-defined satellites give us.

John Gilroy: I was just thinking about 30 years ago, when you were at Georgia Tech, and you started your career, it was kind of an almost esoteric field, and everyone probably knew everyone's home telephone number. But now on LinkedIn, this morning, there was a story on LinkedIn about handheld phones going through satellites, so it's really getting to be commonplace. It's almost like everyone... A common conversation is satellite, "Hey, go to Starbucks, and talk about satellite." It's something. It's really getting there, isn't it?

Carmel Ortiz: Yeah, absolutely, and we love that. I mean, all of these new applications, and this kind of rise in awareness, it's great, but it's also putting pressure on the supply side of satellite capacity.

John Gilroy: Right, yeah.

Carmel Ortiz: So to meet that kind of ever-growing demand, we as satellite operators, have to think about deploying huge amounts of additional capacity, and we need to do that with attractive economics. And that's where software-defined satellites come in.

John Gilroy: Yeah, there's all kinds of innovations. I mean, we can just go to a satellite show, and there's so much, you can't even keep up with what's going on. So if you try to look at the mountaintops, so what technological innovations have made software-defined satellites possible?

Carmel Ortiz: Yeah, so it's funny, I was talking to some of the folks around here, on this exact topic, recently, and it's not a single technology. It's really the confluence of a number of things. To start with, there's the development of advanced analog to digital, digital to analog converters, and signal processing capabilities. Those signal processing capabilities in ASICs, basically, in chips. Those have been really pivotal. So all those innovations together, have transformed the way that we handle signals in space, from, as you said, the days when Intelsat was formed 60 years ago, to cover the moon landing, until now. And even things like phased array antennas, that have been available for decades. They were initially limited. You couldn't form a lot of beams. They were bulky. They required a lot of hardware, but that technology has also evolved. So we're at a point now, where all of this stuff has come together, digital signal processing, more flexible beam forming, and we can do all of that stuff now, directly on a satellite.

John Gilroy: So if you're talking to one of your neighbors during the snowstorm, or something, and you want to maybe give a general description of software-defined satellites, and how they differ from the ones that go on the moon. So how would you set this difference up between a software-defined satellite and a traditional satellite?

Carmel Ortiz: Yeah, yeah. So the easiest way to think about it, like when I first started in the industry over 30 years ago, they published books of satellite coverage, right? So if we launched, if Intelsat launched a satellite, we would publish coverage maps. So we would plan, and design these satellites, years in advance, and we'd say, "This is where we think the customers are going to be," so we sort of draw lines on a map and say, "We're going to design the satellite to put capacity down, in this area." And we did that, and we'd launch, but essentially, we were taking bets on where the customers are going to be. And if you make the wrong bet, you end with an empty satellite beam, or one of my colleagues down the hall here calls them, "unloved beams," or beams that don't have any customers inside of them, because we made the wrong bet.

So what's different about software-defined satellites? So in the same way that your smartphone now is completely flexible, and you can add apps, and change the color of the screen, and all that, we're doing that on orbit now. So SDSs basically are fully flexible, so we can launch the satellite, and yes, it has a defined kind of overall field of view on the ground, but we can define flexibly where the beams are on the ground, and we can do that dynamically, after it's launched. So we don't have to make those bets. We can just put the satellite up there, and we can look and see where our customers are, and put the beams down, where it's needed.

John Gilroy: Carmel, we have listeners all over the world. Some listeners are really into the technology, and they can talk beams, and flat panels, for hours and hours. And then there's some more business-oriented people, and interested in customers. So how do customers benefit from the capabilities of these software-based satellites?

Carmel Ortiz: Yeah, it's funny. We get that question a lot, because obviously we're Intelsat, as a satellite operator, and we think of things from our perspective as an operator, but we also have customers. And so I think when we think about it, putting ourselves in our customer's shoes, I'd say two primary benefits. So number one is capacity available, when and where our customers need it. That's the critical thing. We can put this capacity down, where the customers are, and they can be sure that they're always going to be connected. And then the second one is really one of economics. So we can provide the service more economically, basically, with these software-defined satellites. They're much more efficient.

We talked about the unloved beams before, those are not very cost-effective, right? And so from a business standpoint, we really want to have our satellites as full as possible, and not have a lot of waste. So you're making sure the capacity is available to the customers when they need it, and being able to do that with good economics. Those are the two major benefits.

John Gilroy: I know a lot of software developers, and this is a fun argument to get into. "It's all about the data." "It's all about the app." It goes back and forth, and you can understand arguments on both sides of it. Let's talk about the apps here, the key applications. So what key applications, do you see these flexible satellites supporting for the customers?

Carmel Ortiz: Yeah, so it's really... I mean the sky's the limit, as they say, but it's really serving a lot of our traditional markets. We do something that we call terrestrial network extension, so providing connectivity services, and cell backhaul services, where there are no cell towers, in large land masses. Think about land mobility, and connected vehicles, all around the earth, connected fleets, precision agriculture. We can get into that a little bit more later. But really, for Intelsat, because of our business area, we think about how the SDSs can really help our airline customers, provide in-flight connectivity to passengers. So if you think about it, the inherent dynamics of the airline industry, with the SDSs, we can form beams, we can move them around, over the course of the day. We can follow the flight paths, and the peak demand areas. One of the biggest challenges in providing in-flight connectivity are hub cities, right?

So you have all of these airplanes that are kind of converging in one region, at one time, and with software-defined satellites, we can park a high throughput beam over a major hub city, to alleviate the congestion. So that's really important, particularly for the airlines as they continue to expand their services, and look at going towards free models, where you can... Anybody that's on a plane can have connectivity. But really, it's any application. And particularly wherever demand is dynamic, over time, and geography, basically moving demand is ideal for the SDSs. So that includes maritime services, connected vehicles, even government mobility applications.

John Gilroy: Carmel, here it is, January of 2025, everyone's projecting out first quarter, third quarter, and, "Give me 10% growth, or you're fired," and they want to grow. And generally speaking, that means new activities, or maybe new projects, new customers. And so what about new business models? Are there new business models, and opportunities, that software-defined satellites enable, for satellite operators?

Carmel Ortiz: Yeah. Yeah, there are, but I'd say, fundamentally, it's really, for us, an expansion of our current business. It's really an across the board capacity injection. It allows us to do a lot more of what we've always done, but at a larger scale, at higher efficiency, better economics, and lower risk, right? So generally, that's just upscaling everything that we do, and doing it more cost effectively. But there are some other kind of interesting opportunities. So you can think about things like repurposing a satellite, after you've launched it. So maybe we can launch a software-defined satellite to serve a particular area on the globe, and over time, maybe we find another opportunity, that's somewhere else on the globe, well, we can shift that satellite somewhere else, and we can change the beam lay down. And that's something that wasn't possible with traditional satellites. So you can customize the beam lay down, for a different geography, and then potentially, serve an entirely different set of markets.

Carmel Ortiz: So I'm not sure we can imagine all the possibilities today, but what we do know is that the software-defined satellites will allow us to have more flexibility, and serve our customers better.

John Gilroy: Well, let's go from our business questions to our more technical questions, and the engineers in the audience will perk up their ears, in this one. So there's this concept called a follow-me beam. So can you explain what follow-me beams are, and the value they provide to a customer?

Carmel Ortiz: Sure. Yeah, so in software-defined satellites, a follow-me beam... So think about it as shining a flashlight, from way up in the GEO orbit. And you're following an airplane, or a set of airplanes, that are flying from New York to London. And so that's really the kind of thing that we can do with software-defined satellites. So you're moving a beam, to track a single terminal, or a set of terminals, as they move. And the benefit is it helps to minimize the need for something that we call beam switches. So normally, when you have static beams that are putting capacity down in fixed areas on the earth, as the airplane flies through those beams, it's going to have to switch from one beam to another. And those switches are generally seamless, but there is going to occasionally be a bit of a discontinuity there, so the follow-me beams really prevents that.

John Gilroy: Okay, I'm putting these things in perspective. Earlier in the interview, you talked about LEO, and I'm thinking about LEO, and GEO, and most of our listeners know what the different terms mean. So how will the capabilities enabled by software-defined satellites in GEO, compare to the service size being delivered in LEO today? Do they work with each other?

Carmel Ortiz: Yeah. Yeah, they do. And this kind of... John, you and I, we could do a whole separate podcast on comparing, and contrasting, the different orbits, LEO and GEO and MEO.

John Gilroy: I know.

Carmel Ortiz: So pros and cons, that's a deep topic of study. But when we think about GEO, so the first thing that we want to talk about... We've talked a lot about economics.

The GEO orbit is fundamentally more cost-effective than LEO, in terms of the cost and efficiency of provisioning capacity. So if you think about a GEO satellite, parked in a particular space, usually over a landmass, or an area of high demand density, and the usage is usually in the high, say 60, 80, 90%. Whereas in a LEO, you have a large number of terminals, much closer to earth. They're covering the whole globe, and the utilization is much lower, because demand is not uniform over the globe. So anyway, again, that could be a whole other podcast discussion.

John Gilroy: I know.

Carmel Ortiz: But anyway, so that economic benefit of GEO is amplified with software-defined GEOs. Because we're within the GEO, able to move the capacity around to meet the demand, we can drive that efficiency even higher. So that's on the GEO side. Of course, LEO, and even MEO, beat GEO from a latency perspective. And look, latency is important to our customers. So each orbit has pros and cons, and so we really believe that the answer is multi-orbit, right? So you asked if they can work together. So absolutely. And we are doing this right now, on our in-flight connectivity services, where we have airplanes that are equipped with multi-orbit antennas, and these airplanes can receive connectivity either from a LEO network, or a GEO network. So we think that's the right answer, is multi-orbit, to give us the flexibility and resilience, that the customers need.

John Gilroy: Yeah, all kinds of changes in the business. We mentioned this several times, and this changes the people involved in this game, as well. And so how will operations change for satellite operators that adopt software-defined satellites, in terms of processes, people and technology?

Carmel Ortiz: Yeah, so that's a great question, John. It's actually another big question. So the software-defined satellites will dramatically change how we operate. So with all the flexibility in the payload, comes a huge responsibility on our side. So imagine before traditional satellites, the beams are fixed, you launch the satellite, and you operate the satellite, as it is. In the case of the SDSs, we need new tools, new processes, to manage all that flexibility, and we need to do it in an automated way. The scale and the complexity of operating an SDS is too great to rely on our current processes. So we're in the process of retraining, and retooling, and preparing for the SDS constellation. And the key in this tooling is in the name of the satellites themselves. Guess what? Software. So we need our engineers, and our operators, to understand the complex software ecosystem, both on the ground, and in space, and we need to be able to do that in an automated way.

As you could probably guess, AI is going to play a big role here, to help us optimize those big beam configurations, to help us predict the demand, troubleshoot problems, recover from failures. So there's no end to the use cases where AI can really help simplify the problem, so the level of complexity of these satellites requires it. And we've already started a lot of this work, training models to optimize the deployment of capacity.

John Gilroy: A couple of years ago, I would go to trade shows, and I'd see these slide presentations about 5G, and they talk about the ground, and they'd always have, one side has a satellite in it. And so let's talk about 5G. So what role will software-defined satellites play, in terms of realizing the full potential of 5G terrestrial networks?

Carmel Ortiz: Yeah, so this kind of touches on some of the things we talked about before, which is scale. So to really meet the demand, and the promise of what 5G brings us, we need a lot of capacity. So this convergence, that I talked about before, the convergence of satellite, and terrestrial networks, brings significant scale, and increases demand for our industry. So, for example, if you think about consumers with smartphones, and connected vehicles, roaming between terrestrial, and satellite 5G base stations, you can start to imagine the load that it's going to add to the network, both on the terrestrial side, and on the satellite side. So we'll need a huge injection of capacity to meet that demand, and the SDSs really provide that scale.

John Gilroy: Time to look into the future, so gaze into your crystal ball here. So what do you believe this new software-defined satellite world looks like, in the next five years?

Carmel Ortiz: Yeah, so that's kind of a fun exercise, right?

John Gilroy: Yeah.

Carmel Ortiz: So we talked about forming beams, from the software-defined satellites, and one aspect is being able to do it dynamically, but it's also the sheer number of beams that we can form. So we could form some over a specific single terminal, or we can do wide beams. So when I think about five years from now, imagine hundreds, or even thousands of beams, from software-defined satellites, providing capacity around the globe. So let's do a little visualization exercise. So zoom out, a view of the earth, and you have kind of the old planes, trains, and automobiles, right? Tiny dots moving over the globe, that are those planes, trains, and automobiles, and people. The dots are concentrated in some areas, right, and then they're quite sparse in others.

So imagine in the morning, on the East Coast, on the East Coast morning, you'll have all these dots, tons of planes, moving north, and south, but the West Coast is still asleep, so it's pretty quiet over there, right, and as the day progresses, the West Coast starts to light up, and traffic on the East Coast eases. Okay, so those are little dots. Now imagine all these satellite beams, of all different sizes, and shapes, lighting up those tiny demand dots. So some small high-capacity beams over, say New York, Atlanta, the big high-density areas, on the East Coast. And then maybe the Midwest, with broader lower bandwidth beams, covering those more sparse areas. And the beams are moving, and changing over time, maybe every 15 minutes, to follow the dots, and make sure that capacity is always available. And then if you kind of zoom back in, think about the people. Think about the people sitting in the satellite-enabled airplanes, in vehicles, in cruise ships. Some are in cities, some are in rural locations, maybe out on farms, doing precision agriculture, but everybody has the connectivity they need.

So that's the vision. But I think most importantly, I think what's key is those lines between terrestrial, and satellite communications being blurred. So users don't care whether they're connected via satellite, or terrestrial, whether it's LEO, MEO, or GEO, all they know is that they have unlimited ubiquitous connectivity. So that's where we really want to be.

John Gilroy: Wow. Wow, that's very positive and optimistic. I like that. Carmel, I think you have given our listeners a very, very good understanding of follow-me beams, and unloved beams. Never thought we'd be talking about unloved beams, so that's kind of good. I'd like to thank our guest, Carmel Ortiz, Senior Vice President of Technology and Innovation, at Intelsat.

Carmel Ortiz: Thank you, John.