Constellations Podcast

Episode 99 – LEO Mega-Constellations, Squaring Up With GEO, and New Market Opportunities

Speaker: Erwin Hudson, VP, LEO, Telesat – 26 minutes

John Gilroy: Welcome to Constellations, the podcast from Kratos. My name is John Gilroy, and I'll be your moderator. Our guest today is Erwin Hudson, Vice President of LEO at Telesat. With the decrease in launch costs and the increase in smallsat production in recent years, comes the rise of low Earth orbit mega-constellations, such as SpaceX Starlink, OneWeb, and Amazon Project Kuiper.

These LEO constellations have created a new paradigm which stretches the scope of what satellites can accomplish, like offering lower latency with more ubiquitous coverage around the globe. Yet these mega-constellations come with their own set of challenges.

Joining me today is Erwin Hudson to provide some perspective. Erwin is the Senior Vice President of LEO at Telesat, a Canadian satellite operator historically known for their big operations in GEO, yet venturing into LEO with their newly announced constellation, Lightspeed.

Erwin, I can tell from your extensive background that this is not your first time at the rodeo. You have led engineering and technology efforts at companies like Northrop Grumman, Maxar, WildBlue Communications, and VSF. Erwin, can you tell me a bit about your background and how it has prepared you for your work at Telesat?

Erwin Hudson: For sure. I grew up during the NASA Mercury, Gemini, Apollo programs, and I think I was in high school when the moon landings happened. And I just always wanted to be a satellite guy, always wanted to work on space stuff. I got degrees in electrical engineering and I got my first job at TRW in Los Angeles, which later became Northrop Grumman.

And back in the '80s that was the coolest company in the whole world, I think. And they had a concept which was quite different than many other companies, and that is that young kids out of university could be systems engineers. You didn't have to wait until you had 20 or 30 years of experience, you could actually engineer an end-to-end system, and system engineer was a science all of itself.

So I was trained at TRW. I spent almost 20 years there as a systems engineer, and I was a system engineer on NASA's tracking and data relay satellite program, for example. It was beyond the leading edge in the '80s and '90s, it was really incredible.

Erwin Hudson: And I was chief engineer for a number of military programs that were developed at TRW, and they were all greenfield systems. So we had satellites, ground systems, user terminals, control systems and all that. Using those skills that I learned at TRW, I was one of the founders of WildBlue Communications in Denver. And a small team of us, quite literally like 25 engineers, we built a nationwide Ka-band consumer broadband system. And at the time I think there were 20-some companies that had filed to do that.

We were certainly the least likely to succeed. And yet we were the first ones to actually accomplish it and one of only two to ever accomplish it among the early filers. And so we went on the air. We sold that company to Viasat, that's sort of how I became a Viasat employee. You're seeing that most of the current GEO systems today are basically built on that same WildBlue technical model. And they've extended it, it's got higher data rates, more capacities and all that, but it's not fundamentally different.

I also worked on a big greenfield project in Australia. We built a nationwide Australian system and it took us about three years. And it serves the Outback, provides education and remote connectivity in the deserts and all kinds of crazy places in Australia. And so I came to Telesat. I was just really attracted by Telesat LEO, it is a system project, a system development. The technologies that we've been talking about for years in the satellite business, like big on-board processors and phased array antennas, and lasers and all that, that stuff is ready now.

It wasn't ready 10 years ago, it wasn't ready 20 years ago, but it's ready now. And so, we've been able to do some really cool stuff and take these emerging technologies and develop a system that just has some amazing capabilities. And it's going to be able to deliver a whole new level of performance to people who need satellite connectivity.

John Gilroy: It sounds like, to me, you were the Ben Franklin of satellite comms and all these great ideas. And finally, the technology is allowing you to fulfill some of the dreams you had years ago.

Erwin Hudson: I mean, like laser comm, for example, people have been experimenting for 20+ years. There have been some military applications, but no one's really exploited it commercially and today it's quite available and quite affordable. And I think it's going to be really cool to have a full global mesh, where every satellite is connected to all its neighbors in space, and we can route data quite literally around the globe. And I think that the commercial capabilities that it enables will really make for a whole step forward in what people can expect from a satellite.

John Gilroy: Let's jump up to 2021 and talk about LEO here. LEO has been a hot market for the past several years, so is there enough market demand for so many LEO constellations?

Erwin Hudson: Just like I was talking about, when GEO broadband started there were certainly a lot of people that wanted to do that. And there were a number of potential entrants into the market. Each one had a different idea, a different strategy, different architecture. And in the end a few were successful and most of them never got to market.

And so, we at Telesat, we really believe that we're addressing the right segment of the market and we're deploying the right technologies. We are focused largely on aeronautical, maritime, government, mobile backhaul, remote communities. Those are the, I think, markets that we believe are best served by a LEO satellite system. Largely markets where really fast, snappy internet experience is highly valued. And they are in the sense kind of bulk markets, in the sense that we are not optimized to serve large numbers of small customers. We've designed our system for enterprise-grade industrial-strength SATCOM.

John Gilroy: Okay, you just mentioned aeronautics, you talked about mobile backhaul. So where do you think these markets are headed in the future?

Erwin Hudson: Well, I think LEO has historically done... it started out with Iridium and Globalstar, kind of in the '90s, largely focused on narrowband applications like voice and data. And that evolved into IoT, data internet of things, narrow bursts of data. But the new LEO systems that are being developed are really largely around broadband data, internet access, and mobility.

And a large part of that is... GEO satellites have been doing broadband connectivity for a long time. I mean, even in the early days people just use ordinary C or Ku-band transponders to deliver internet. And then it evolved into a bespoke Ka-band, multibeam satellite systems. But the dilemma with GEO satellites, of course, is the round-trip delay.

It was more than half a second. And that's a big challenge for internet in particular, for any service where there's real-time interaction between the user and the network. And even though web pages oftentimes look like they're not two-way, I mean, the truth is there is as many as a 100, 200 interactions between you and the server for just about every web page that you see. And it's that back and forth over this long GEO delay that makes it essentially impossible to deliver the quality of service that high-speed internet customers really want.

And so the solution to that is just to move the satellites down closer to Earth, and we're about 30 times closer to Earth than a GEO satellite. And so our round-

trip delay is obviously 30 times less. And so, instead of half a second, we're down to like 10, 20, 30 milliseconds of delay, which is kind of comparable to what fiber systems have. And so, these broadband LEO systems can provide a true fiber quality connectivity that is affordable, it's wireless, it's mobile. You can't do it with GEO, and I think it's something that's desperately needed in the marketplace today.

John Gilroy: Let's jump from QoS, Quality of Service, to space debris mitigation. I think efforts at space debris mitigation had been ramping up over the last few years here. With so many small satellites being launched into LEO, so what are you guys doing to mitigate space debris? What do you think the space industry still needs to do?

Erwin Hudson: Well I think that the space industry is doing a lot of good stuff. There have been some new guidelines for example, out of the FCC, covering proposed requirements and guidelines regarding how to deal with debris. And I think we're compliant with all of those emerging guidelines, as well as doing additional things, I think in addition to the guidelines. But our satellites are certainly designed to minimize any risk of debris, and we do a whole bunch of stuff to make certain that we protect the space environment. We've been in business for 50 years as a space operator. Outer space is where we do our business, and we have to make certain that we protect outer space so we can continue to do business there.

And we want to do it in a way that's not just for ourselves, but for the whole industry and for future generations. And so, let me just give you a couple of examples of things we do. For example, we launch into the lowest orbits that we can possibly launch into, and the reason we do that... And then we use our own engines to raise ourselves up to where we want to be. For our low polar satellites, thousand kilometers, we'll launch into somewhere around 400 kilometers and then we'll, over a period of a few weeks, we'll work our way up to a higher orbit. And the reason we do that is, if the satellite is dead on arrival, then it's down at a low altitude. It'll naturally decay, over some period of time it'll be gone. Where if you launch it directly into a higher altitude, it would be there for a very long time before it naturally decayed.

And we've got GPS and Galileo receivers on board, so we know exactly where we are to a fraction of a meter at all times. And then we've got microwave tracking as a backup, just in case. And so, we know where our satellites are with ultra precision. And we share that information with all of our competitors through standard methods that have been set up to share orbital data among satellite operators. The most reliable thing on our satellite is the deorbit system. We've got multiple thrusters, we've got multiple control systems, fully redundant, so that at end-of-life the thing that we're absolutely certain is still going to be working is our ability to deorbit, which is super important.

Erwin Hudson: And, belt and suspenders on top of that, we have grappling hook capabilities on our spacecraft as well. So a future space tug could come along and connect to us and pull us out of orbit, if it was absolutely required in the future.

And let me add just on top of being a good citizen of outer space, we've also designed our satellites to minimize any reflected light. I know that there's been quite a bit of discussion lately about optical astronomers down on Earth being concerned about glint and flashing... little flashes of light that come off of satellites, that affect their ability to peer into the heavens. And we've gone to great lengths to try to minimize any part of the satellite that might reflect light like that.

John Gilroy: You know, Erwin, thousands of people from all over the world have listened to this podcast. Go to Google and type in "Constellations Podcast" to get to our show notes page. Here, you can get transcripts for all 90+ interviews. Also, you can sign up for free email notifications for future podcasts. Well you know Erwin, we're in the middle of COVID here. People go home and they watch Netflix. And they may watch science fiction, and in science fiction they talk about warp speed, but I want to talk about Lightspeed. This is Telesat's first LEO constellation. Well, first of all, congratulations. What's unusual about Lightspeed? What is this constellation planned to accomplish?

Erwin Hudson: Well, I think that, we've been a GEO satellite operator for all of our history and we have a fleet of 15 geostationary satellites today. We serve most of planet Earth, at least all of planet Earth that GEO satellites can see. And that's certainly been a very good business, but our customers have been telling us over the last several years that they need higher data rate, they need lower latency, they need full global coverage. Airplanes want to fly from Chicago to Beijing, or ships want to fly... go up through some of the Northwest passage, for example. And so, how do we deal with that? And I think that's what's led us to develop our LEO system.

And our LEO system was developed, I mean, a lot of the features like I've talked about, the technologies, are all related to what customers need. Global connectivity, the ISLs and the orbits allow us to do that. Being able to get high data rate in the smaller terminals, or get into an aircraft or a maritime, a merchant vessel for example. Being able to do onboard processing and provide higher quality links in the smaller antennas, for example, small mobile antennas. I mean, all that stuff has been built into Lightspeed so that we can offer, I think, the highest quality broadband connectivity. And we can connect pretty much anywhere to anywhere at gigabit, multi-gigabit rates. And I think that's what's going to be the real thing that compel customers to come to Lightspeed.

John Gilroy: You spent some time in Australia, and so you're probably familiar with British English and they use this word cheeky. So I have a cheeky question here, so

don't take any offense here. You know, you've historically been a GEO company, so why not launch more GEO satellites? I mean, why even invest in LEO?

Erwin Hudson: Well, we are going to launch more GEO satellites. I mean, we've got a very good business. Our GEO business is healthy. We've got, as I said, a fleet of 15 satellites in orbit. We'll continue to maintain and replenish the fleet. We'll continue to serve our GEO customers with the same high quality of service that we've always provided.

But I think we see the growth in SATCOM is really moving toward internet connectivity and hundreds of megabits and gigabit data rates. It's moving toward better serving mobile platforms. And so, in order to grow our business into these other aspects of SATCOM that demand things that's just too difficult of GEO, we've chosen to invest in LEO and to continue growing our business in LEO as well.

But to be clear, we're certainly not abandoning GEO. On the contrary, I think we're doubling down on SATCOM and we are expanding our business so that we can offer GEO services for broadcast and other things that are best served by GEO. But for these, all these emerging markets, in terms of two-way connectivity and broadband internet, we believe we'll have the best service available to the market with Lightspeed

John Gilroy: There certainly was a lot of competition for your business and a multi-million dollar contract here. So it looks like Thales Alenia Space has been chosen as a prime contractor for this constellation. So what new technology is being used to enable a constellation like Lightspeed?

Erwin Hudson: Well, I think, and I mentioned earlier, I think, we chose Thales Alenia Space after an extensive selection process. They've got probably the best LEO constellation experience. For example, they were recently the contractor for the Iridium NEXT constellation, and they've got access to the spacecraft vehicle and payload technologies that are really important to us.

As I said, the key technologies on the spacecraft, we've got the optical inter-satellite links. Each satellite communicates with the satellites ahead and behind, as well as the satellites to his left and right. So every satellite has four laser links. So every satellite in constellation creates like a giant spider web around the Earth connecting everything together. And that technology comes from Thales' optical division in Switzerland.

The onboard processing, we're using software-defined radios. We've got software-defined network. We've got routing switching on board the spacecraft. Compared to the technologies that we had back when I first started doing

satellites, I mean it's just absolutely amazing what we can do on board the spacecraft today, with modern digital technology. We have the equivalent of a supercomputer on board every single satellite.

Erwin Hudson: And then, the antennas on the satellite. We have hopping beams, which means that we can hop almost instantaneously from one beam location to another, and we can serve many customers in different locations with a single beam. And provide what appears to the customer to be entirely uninterrupted connectivity, with our phased array antennas which come from MDA. MDA is a Montreal based company, quite well-known for space antennas. But the ability to have many beams on the satellite and be able to serve many customers, it creates for a very powerful satellite capability.

And to build hundreds of these things at the price points that we've been able to achieve, I think is pretty phenomenal. I always say, and just to give you a feeling, we've got over 15,000 gigabits of constellation capacity. It's 15 terabits, more than 15 terabits. And we've got more than 135,000 beam locations that the constellation can serve with very powerful, very focused beams. And we can point several beams into an airport, for example, and provide 20 plus gigabits into an airport.

I mean, so that we can serve aircraft taking off, landing. We can do full gate to gate connectivity, things that we just couldn't do with the GEO satellite capabilities. And it's something I don't think our competitors can do with satellite constellations that are more optimized for consumer, which tend to be broad coverage, a large number of very small customers. I mean, we really optimized this thing to provide a killer service for the most demanding enterprise customers.

John Gilroy: I was thinking about your career starting in Los Angeles in 1980s. What if you had had software-defined networking back then? I mean, it was a dream back then, who would have even thought of something like that, and now it's giving you so much power today, isn't it?

Erwin Hudson: God, I think I'm dating myself, but I worked on computers with magnetic donut memory back in the old days. The tracking data relay satellite I mentioned, which I think is probably one of the coolest satellites I worked on, kind of in the '80s and '90s, I think it had two kilobytes of memory on board the flight computer. And today, we're doing hundreds of gigaflops of processing on board. I remember our highest data rate was 225 megabits and we used to talk about how many times we could communicate the Library of Congress or something, because people couldn't understand how big 225 was. Now we're talking about thousands of gigabits. I mean, good gracious, we can transmit the entire Library of Congress in a millisecond or so. I don't know what the numbers are, but I say

sometimes, when these technologies have moved so far, in the last 15 or 20 years, that it's easy to lose perspective of how far we've come.

John Gilroy: Erwin, I want to expand a little bit more on this contrast, the contrast of a direct-to-consumer broadband and this enterprise-grade LEO. Tell us a bit more about the advantage of going the enterprise route. You talked about a killer, instead of a killer app. Maybe this is the killer app?

Erwin Hudson: Yeah. Well, I think that we started our system and I know people often accuse engineers of building stuff just because it's cool, but I think we went about this in exactly the right way. And we started out with our business development team and our existing GEO customers, and some new customers who would be our future LEO customers. We started with the underlying requirements. We developed a demand model, a global demand model, for the markets we can serve.

And we looked at... Do we want to build a consumer system? Do we want to build an all-enterprise system? Do we want to build some kind of hybrid in between? And we ask ourselves: would the system be any different if we chose consumer or enterprise? In the end, we chose to build an enterprise system.

And we felt like it was the best match for these leading edge technologies. We felt like it created the best overall business plan for our system. And indeed we did find that the design of our system would be very different if we had chosen to go with consumer rather than enterprise. I mean, and I think that some of our competitors have started out saying, "Well, we're going to build a consumer system", and they get a few years into it and they recalculate their business plan. And they say, "Oh, no, wait a minute, we're going to do enterprise now". And I think that's a huge mistake because I think that the technology that best serves an enterprise is very different than the technology that best serves consumer.

And I think that's where we're going to have a huge competitive advantage in the enterprise markets, because I think we're one of the few that really clearly identified the market that we want to serve. And we designed our system from day one, from the bottom up, to be optimized for enterprise. To provide the high data rates to serve the enterprise terminals. And we can sign up to very demanding service level commitments for the quality of service that we can provide. And not the kind of best effort oversubscription that you optimize for consumer, but fully committed broadband data to these very demanding enterprise customers. And I don't think our competitors are prepared to do that.

John Gilroy: You've really given a great cost benefit analysis for launching a multi-million dollar LEO constellation. Our listeners are really going to appreciate that. I'd like to thank our guest, Erwin Hudson, Vice President of LEO at Telesat.