Constellations Podcast

Episode 39 – Spectral Fingerprints, Laser Communications and the emerging Space Economy

Speaker: Justin Oliveira, CEO of Analytical Space – 26 minutes

John Gilroy: Welcome to Constellations, the Podcast from Kratos. My name is John Gilroy, and I'll be your moderator today. Our guest is Justin Oliveira, the co-founder and CEO of Analytical Space. Analytical Space is a satellite communications company based in Boston that's leveraging hybrid RF laser communications technology. Before founding Analytical Space in 2016, Justin worked in the White House, in the Office of Management and Budget where he oversaw NASA's human spaceflight and aeronautics research program. Well, that's a pretty cool place to be. Prior to that, Justin worked at NASA on their space shuttle and constellation program, and was involved in revamping NASA's strategy capability. Justin has a wealth of knowledge. I saw his background. It's really incredible. He has a wealth of knowledge in the space industry, and today, we'll talk about new developments and strategies in the earth's observation market, and how laser communications can be an effective way of solving the data bottleneck problem.

John Gilroy: Well Justin, you've ... I said before, you've got a great background here. Ten years working at NASA and the White House, what was your role on the government side of the space industry?

Justin Oliveira: Yeah, well so thanks again for having me, guys. I started my career- I was a grad student at Florida Tech, and it was a time when constellation, which was the program to kind of go back to the moon was ramping back up. I got hired actually to work on a propellant system design and kind of computational physics related topics.

John Gilroy: Well I can do that.

Justin Oliveira: I joined with really specific skillset and technical area, first in my career at NASA out of Kennedy Space Center, and kind of journeyed and branched into different things, and I'm a generalist, by desire and passion. Usually I like to learn enough to get in trouble and then learn something new. So a place like NASA is a really great place for somebody like that because you can just ... There's so much work. There's not enough people. There's not enough resources. And so you can really journey into these different areas.

Justin Oliveira: So, I did that. I focused a lot on after the shuttle programs and constellation programs ended, the agency was trying to re-figure out what it wanted to do. I got as involved as I could possibly be with tech development and R and D, and a

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lot of SBIR and STTR work, because what really excited me the most was I really liked working on the projects at NASA but what I found fascinating were these small business teams working on these cool innovative new things.

John Gilroy: SBIR, boy, it brings in the magic, doesn't it?

Justin Oliveira: It does, yeah.

John Gilroy: So what made you decide to leave the public sector and jump to space entrepreneurship?

Justin Oliveira: Yeah, so I was at a point in my career where commercial space was starting to be a thing again, right? It's gone through phases over the last 30, 40 years, but you know, SpaceX has been making a lot of progress. There are all these new commercial companies. The more I got into the policy side of space, the more I got into the how do you execute on the space industry. I kind of realized that there's just some problems that the government can't solve, that commercial industry is maybe better to solve. And sometimes those are things that are architectures and things that are important like communication. Sometimes they're things like launch.

But for me, what I saw was, I realized that NASA is the type of organization where they're always going to want to focus on the things that are hard. It's the next thing that's hard. They're not interested, necessarily, in allocating all their resources to fixing and making a new economy, like a space economy. So that's what more excited me was how can commercial companies create and make grow and boom a space economy. So that's what really excited me to maybe want to leave NASA. I was really happy there, but I was excited more about this idea of the space economy.

John Gilroy: I mentioned the 10 years at NASA and the White House, and if you look at those 10 years, you know, there've been a lot of changes in the last decade.

Justin Oliveira: That's right.

John Gilroy: It looks like the pace of change has accelerated instead of slowing down. What are the biggest changes that you've seen in this industry in the last 10 years?

Justin Oliveira: I think the big thing we've seen in the last 10 years, especially with the advent and more adoption in smallsats, and things like that are, of course component technology. Right? So better, cheaper, more reliable, and in some cases higher volume, more volume in terms of production, parts. That's made a massive impact on the ability to do things like CubeSats and smallsats.

John Gilroy: It's the size of a shoebox.

Justin Oliveira: Super tiny, yeah. And our first satellite Radix is about the size of a shoebox, really small. I mean, that's just ... I started messing around with CubeSats at NASA when people thought they were cute, educational tools, and only really in the last five or six years have people started to take them serious, as we can do PRIME science. We can actually do real applications with CubeSats. And a lot of that's been made possible by standardization, by new parts and components being built, but the other really big part of that is launch. You know?

Justin Oliveira: The better discretization of the launch curve is been huge. It will continue to grow and enable the space economy, which is ... People like Analytical Space can't afford and don't want to buy half billion dollar massive rockets to launch their tiny little satellites. They need a smaller price point in the market where they have maybe 100 kilogram capacity. And so, companies like Rocket Lab and Vector and Virgin, that are either demonstrating or super close to these capabilities, they're going to unlock this massive huge amount of the market, and it's really ... Those things are really what's accelerating the growth in the market of these smallsats. It's really a mix of things, but I think really the launch industry ... Launch is now like a real thing. You can go and you can buy, and be in flight in nine months. You can go to-

John Gilroy: That's incredible.

Justin Oliveira: ... go to somebody, pay them money, you can have a satellite if you have it ready in time in nine months. That's incredible. You couldn't do that 10 years ago.

John Gilroy: So Justin, to prepare for this interview, I went to Twitter, and even today, there's so much stuff going on in space and satellites. You can't believe it, you know? I guess, every day it looks like there's a new constellation that's announced.

Justin Oliveira: I know.

John Gilroy: You know? So what are the advantages of these LEO and MEO Constellations over the traditional single satellite?

Justin Oliveira: Sure. I think the big advantage ... and I think you're starting to see more of this. People are caring more about this idea of latency. The advantage of a Geobird is it's really far away, it gets really good coverage over a large region of the earth, but it's super far away, which means that latency is ... The roundtrip time is really, really high. So if you're doing applications that are latency sensitive, like maybe sensing, or you're doing in-the-loop decision making, and things like that,

for autonomy and infrastructure, and these cool applications, you just can't do that through GEO-based communications. You need something that's either cellular-based or you need something in lower earth orbit where the latency can be kind of comparable to terrestrial fiber. So I think that's where you're seeing a huge application area there.

Justin Oliveira: And I think just generally, too, there's I think a huge economic benefit. While the concept of operations of a constellation in LEO, are maybe a little bit more complicated because of the dynamics and things, than say, GEO, it's cheaper to get there. Right? And the requirements are arguably a lot easier than a GEO satellite, so you can build a constellation of 10, 15 LEO satcom satellites and they're much cheaper. It's cheaper to get them there. And I think overall, the business models are just more affordable. You can do more in LEO than you can in GEO.

John Gilroy: Well, I'm sure in Google Trends, smallsats trending, CubeSat, microsats, so what's the role for the traditional satellites? The old GEOs?

Justin Oliveira: I think there's always going to be a role for traditional GEO in the world. Broadcast to something that is really kind of probably the one application area that's maybe not best done on a LEO constellation, because you need a lot of coverage. You may not need a lot of throughput, but you definitely need coverage. So things like broadcast, whether it's radio or video, these things where latency doesn't really matter but having the maximum amount of coverage, maximum set of ears. You know, you're trying to cover a large market so you can subsidize and amortize all the cost to get you there. Those are going to be the markets where I think GEO always has a spot.

John Gilroy: Justin, I have a sister in Los Angeles. Her house was evacuated because of the fires, and Malibu is evacuated because of the fires too, so I want to talk about earth observation here.

Justin Oliveira: Sure.

John Gilroy: I mean, it's really important. It seems like a lot of the innovation in the sectors come down to a lot of power and resolution for earth observation sensors, so how much better is the resolution from a few years ago?

Justin Oliveira: I think the big thing that's changed over the last couple years, really in the last decade, it's not that the optics themselves are getting better. Of course, there's been improvements in the actual optics, like the physical telescope parts of an imager, but what's improved is a lot of the sensors that go to the back of that telescope that turn the photons into bits, basically. So that's improved. That technology has gotten better. It's gotten cheaper.

But the real area where you've seen a massive growth over the last 10 years is, in these more especially wider sensors. So like hyperspectral sensors. Typically when you see a picture on the internet or your phone, it takes pictures in three wavelengths, red, green, and blue. And so, most traditional imagery is RGB. Whether it's superfine resolution or really coarse, it takes three different kind of wavelengths and it merges them together to make a picture. Superspectral, which is a newer term we've heard recently, which is basically like kind of multiband.

With these hyperspectral sensors, what they're basically doing is they're taking the visual part and some of the parts that aren't visible, and they're breaking it into a bunch of bands, and they're taking pictures, basically, in all those bands. What it allows you to basically do is create a spectral fingerprint for whatever you're looking at. If that's a fire, or it's a body of water that has algae in it, or it's plants, and you want to know what type of plants, you can do that. You can disseminate that from a spectral fingerprint.

John Gilroy: Amazing.

Justin Oliveira: That's one of the areas that's exploded over the last 10 years, is technology getting better and cheaper.

John Gilroy: So we got this explosive growth in the high resolution. We got numbers of satellites out there, all kinds of constellations, more and more data, so what can all this information be used for?

Justin Oliveira: Exactly.

John Gilroy: Fighting forest fires, I don't know.

Justin Oliveira: Yeah. The hyperspectral's a really good example because you can really do a lot with that. With RGB imagery, you can maybe fly over a certain region of the world, and you can say I think that might be a cornfield. Right? I'm not 100% sure. I'm pretty sure it's corn, but I can't really tell much other than it looks like it might not be water. I'm not really sure. A hyperspectral sensor can tell you, "Oh that's not corn, it's soybean, and it's starved in these nutrients," or something like that. So it's super tactical data.

It can be monetized and sold, and people like farmers can take that data and they can act on it, as opposed to, "I think you might have under-watered corn." "Well, I don't have corn. I have soybean. Why are you telling me I have corn?" So the data is just much more useful, can be used for these applications in farming, water quality. And that's just ... that's hyperspectral. There's all these other cool instruments that are being deployed on remote sensing platforms

like synthetic aperture radar, all kinds of neat examples for that. But the big advantage to SAR is you can image through clouds and at nighttime, because it's a radio-based image, basically, rather than a visual-based image like through optics.

John Gilroy: I went to your flashy website here this morning, and what it says is that you're developing secure, reliable, high-speed data connection for earth observation satellites. So what's wrong with the stuff they have now? I mean, why do you need to replace it?

Justin Oliveira: Yeah. The biggest challenge right now is these ... Generally, the trend we're seeing is ... and we spent a lot of time speaking with all these remote sensing groups, is there's a shift to these more data-intensive products, whether it's going to finer resolution, so rather than having say a five media resolution pixel, going down sub-media resolution, or going multiband. Right? So going from RGB to that example where you maybe take the visual and near visual range and you break it into 60 data points, right? A lot of data, massive amount of data.

Justin Oliveira: And so, what we're seeing is there's a huge shift to creating and having larger datasets, but the technology and the concept of operations to get that data off the platform down to the ground where it can be used, hasn't really changed much in the last like 40 years. The technology has gotten incrementally better, so there's been sort of sustaining innovations made in radio technology that have allowed you to go maybe slightly faster, right? But there's no real breakthrough in concept of operations and architectures to kind of blow open that communication challenge. And so, that's what we're focused on doing is we're trying to provide more throughput capability, and offload capability to these remote sensing satellites, and augment what they get through ground stations.

John Gilroy: You know, I looked very carefully at your website ... Now, it's one thing to be in the wait list for Hamilton, but on your website, there's a wait list to be on the beta testing for some of your equipment. I mean, you've got a better mousetrap here, don't you, Justin?

Justin Oliveira: Yeah.

John Gilroy: Something's going on.

Justin Oliveira: We do. We have a really great list of beta testers so far. It's a really nice mix of some civilian, government groups, and commercial groups, so we're really excited to work with these kind of different organizations, because they have different challenges and some of ... have different constraints of how you work with them. And then, they also make up this really great composite of

traditional imaging companies doing this RGB imagery, all the way through to the hyperspectral and these synthetic aperture radar groups. So we had a massive over-subscription to the amount of people interested in doing testing on this beta flight, and being a beta customer, and we had to very carefully pick which groups, so that we could best show the capability, but at the same time, really we kind of want to break the satellite. We want to put it through the ringer and put all these use cases through it, and so we picked a really nice cohort of testers for this. If we get to it, and we have time, we'll hopefully be able to get to others, but we have many more satellites to come and we'll be able to make everybody happy.

John Gilroy: You know, Justin, thousands of people from all over the world listen to this podcast, Constellations. Now, if you're listening, and would like to get alerts when new episodes are available, just simply go to Google and type in Constellations podcast. Wind up on top, Kratos there, click on that and give us your email, and we'll send you out the next time we have Justin on the air, with a waiting list like this, you can have all kinds of new things in the next few years, ah?

John Gilroy: Now, from my understanding, the market for earth observation data is pushing for a high throughput and low latency data downlink. So what kinds of applications can be unlocked, advances in throughput and latency of data-like communications?

Justin Oliveira: Yeah. What's interesting is the low latency is something that's a new element. So, just as a quick primary, remote sensing satellites, they like to be really close to the earth because they get the best images and they have revisit rates, so they can kind of collect a lot of data, amortize their cost, and make money. The challenge with that is that because they're kind of lower earth orbits, they're moving around the earth constantly, they have this ... every 90 minutes they orbit the earth. The earth is mostly water. If you kind of do out the math, and you look at how they operate, you really only can get it for a couple hours a day of time where you can connect to a ground station and downlink data. So, our first focus in the short-term is to focus on blowing open that amount of connectivity time, giving more throughput.

The other area of interest is because you kind of come in and out of these ground stations, and you may fly over some part of the world and then go over the ocean for a large period of time, is there's a huge time between when you create the image, or the data product, and the data in space, and move it to the ground to then create a data product and you sell it to customers. What we found is that there's all these really cool applications that could be pretty large economic opportunities. They can't be unlocked unless you have access to a data relay network. So it's things like being able to route weather data faster, so that you could inform aviation weather models. Right now, there's some

massive statistic, like we're talking like many dozens of billions of dollars a year that get wasted on fuel for routing airline traffic around storms. If you could increase efficiency just by a couple of basis points there, it could be a massive amount of savings for airlines. These weather models, if you could route this weather data in under 15, 20, 30 minutes, you can enable these use cases, and so there's massive market opportunities there for companies like us to kind of enable these applications.

John Gilroy: It's almost like mid-'90s router technology.

Justin Oliveira: Right.

John Gilroy: What's the most efficient path for this particular packet?

Justin Oliveira: Yeah, exactly. Yeah.

John Gilroy: You have one satellite up and one coming up in December. You're slowly building this network, is that right?

Justin Oliveira: Yeah. We have Radix up, and then the next satellite building up, the launch is most likely January. It's a PSLE flight. We're not the primary customer on that flight, so we show up and we say, "Here, our satellites are ready." And they say, "Great." The main customer that paid for most of the rocket is-

John Gilroy: You're flying standby, buddy.

Justin Oliveira: Yeah. It's very much standby. I think right now, the latest date is sometime in mid-January or something like that. But yeah, we're super excited. And next year we got a lot. We haven't made any formal announcements yet on the number of satellites we're flying, but it's going to be an exciting year next year with finishing up testing with our first satellite, and then moving into operations and work with our second satellite, and then getting ready for the next batch.

John Gilroy: So we've been bouncing around the topic of laser communications, and normally it's contrasted with traditional RF communications. What is the big advantage? Speed? Security? Focus?

Justin Oliveira: Yeah. The big advantage to optical is really for the amount of SWaP, space, weight, and power, that is inside of the spacecraft. You can get a lot more throughput, and in some cases, 10 times the amount of throughput, because you can think of our laser downlink as a really directional antennae. Antennas have a beam width, and you're pumping all your data through, it's kind of a very similar ... you can think of an analogy. Lasers are really, really thin beams, and you can pump a lot of data through them. Of course, there's challenges with

that, pointing and things like that, but you get an enormous amount of throughput with optical that you just can't ... It'd be really hard to get with a RF system.

John Gilroy: I talked about routers in mid-'90s, and different paths that they had, but these laser communications have been around since the early 2000s, hasn't it? It's not exactly brand new.

Justin Oliveira: Right. Yeah. It has been. It's been around for a while, and you mostly saw a lot of demos initially, doing inter-satellite ... link optically, between satellites. And then, of course, NASA had LADEE where it was doing laser comms from the moon. You had some other advances too, over the last two decades, but in specifically in the last decade. So there's been a lot of work on the government side, but on the commercial side, you haven't seen a lot of- It's a new capability that's just starting now to trickle into the market.

John Gilroy: You know, when you take a look and try to explain this to someone on a flight next to you, going back to Boston, you can say, "Well, geez, you know what we have here is, we may not have optical ground terminal infrastructures set up to take place, so there's a chicken and egg. We're going to develop optical when they get the ground terminals, and the ground terminals aren't going to get optical," and so it's kind of a face-off. How do you split it here? How do you make laser communications viable for downlinks as the ground infrastructure slowly develops?

Justin Oliveira: Yeah, no, it is a chicken and the egg problem. I think that everyone in the industry is sort of trying to figure out how to deal with that, and I think our approach on it is as much the same way of how we approach RF downlink capability in terms of ground terminals, is to work with partners. There's a lot of effort going on right now at NASA on interoperability on how can we find a way for NASA, in its interest and its decisions and investments in the ground and the space segments too, how can we leverage those investments with what the public commercial entities are doing. Is there a way to make our networks interoperable?

So I think, through public/private partnerships with the government, and then by having kind of risk partners in the industry that are ground terminal operators and things like that, I think there's a way for a consortia of groups to come together to solve this little bit of a tragedy of the commons kind of going on with optical ground stations. So, that's what we're interested to see play out too. We're on the end of that too, of wanting to see how a lot of this plays out, but I think what you're going to see is a lot of leadership on the part of the government, the US government in particular, over the next few years, to find a way to put forward, where we can agree on standards, and I think that's going to be a big part of seeing capital go into the infrastructure needed to support

the commercial market, is they want to see standardization. That's the biggest limitation, right? No one wants to make a massive investment in CAPX if they're unsure if the next guy that comes along is going to have different requirements.

John Gilroy: Maybe this weekend you'll get a chance to watch some Netflix, and the reason you can watch it, is because of something called a content delivery network, CDM. I see a parallel exactly with what you're trying to do. It's almost a data relay network, 10,000 feet. I mean, this is the same thing what you're trying to do is just assure speedy delivery of that information from space.

Justin Oliveira: That's right, yeah. What's interesting is ... There's a lot of different applications for data relay services and why people might want to use a data relay, I think beyond just I need more throughput, I need to offload data, or I need to get that data to the ground faster, which are really the two areas that we're most focused on. But, there's this other element too of security. It's interesting, we don't focus on a humongous amount of government business development. Most of our efforts focus on commercial, the commercial groups, because they move faster, and it's easier for us to do testing and work with them in a short-term basis.

Justin Oliveira: We have a lot of conversations, great conversations with the DOD, and the different defense groups, and what's interesting is the constraints on downlink, right? You can imagine there are parts in the world where even commercial companies, not necessarily just defense, where they don't want to download their data through a ground station in a specific part of the world, because the fiber backhaul passes through a region of the world where it's not secure, right? And so, there's all these fascinating examples that we found of having access to a data relay network that can do optimal routing. Or, even optimal can mean more than one thing. It can mean optimal in terms of latency, but it can also mean security, right?

John Gilroy: Speed, latency, or security, right. What do you want to optimize for?

Justin Oliveira: Exactly. So we found all these kind of areas where there's the value-add and the value proposition is really strong in these different areas. One of the areas is in routing.

John Gilroy: You know, if you look at what's been going on the last six, seven months, you see this whole new space ecosystem. You talked about the commercial companies.

Justin Oliveira: Exactly.

John Gilroy: Launch providers, brand new stuff. Earth observation, brand new stuff.

Justin Oliveira: Yeah.

John Gilroy: IoT, telecom, I mean can the market support such a diversity of companies that we talked about there in the long-term? Or will there be this dreaded consolidation?

Justin Oliveira: I think, first off, one of the big things that brought me to start this company and work on this challenge is I kind of see the space economy as, you know, there are these pillars of the economy that you have to figure out in order for the economy to be like real. One of those is the launch. Getting to space has to be not just possible, but it has to be readily available and there has to be some affordability. The next part is systems and widgets and parts and cogs and gears that make up the things you put in space, have to also be readily available, have economies of scale, and be quick supply chain turnarounds. So you're starting to see that, right?

Justin Oliveira: But the third thing you're seeing that isn't there, which is what we're focused on is, you need a data infrastructure. You need sort of like the data railroad. You kind of think back to the 1800s and building out the railroad across the country. You need that infrastructure in order to help boom an economy. That's where we see, we see ourselves as a big part of this success story going forward for all these companies, is you need the data railroad in order to make all these cool things happen.

John Gilroy: And that's what a content delivery network is, it's the data railroad to make sure the speed's quick all over the world. Yeah.

Justin Oliveira: Exactly.

John Gilroy: Well, you're a relatively young man, Justin. We're going to have you predict what's going to happen in the next five to 10 years, and we'll put it in granite and then hold your feet to the fire on this one. So tell us exactly what's going to happen with your company next five to 10 years. This whole business is just so exciting.

Justin Oliveira: Yeah. For us, the next five or 10 years is going to be really exciting because we think that the remote sensing industry grows massively. I think over the next maybe five years or so, I think you see the remote sensing market grow by at least five to six times the size that it is right now.

Massive increase. These new instruments, these new capabilities, and this new emphasis on better, higher data intensity products is going to really be highly monetizable. It's going to start to really make a lot of these killer apps really come true. And we're starting to see that now with the conversations we have

with different groups. So for us, that's exciting. We love that. We want to grow with that capability, and as that goes. So for us, we don't say, "thousands of satellites." We're not, you know ... Our data relay network isn't designed to be something that massive, but we think some of those concepts are pretty cool. But for us, our constellation is on the order of dozens. We get really excited about that because of the capability and being able to connect to these different assets and make these different remote sensing business models close. We see a massive five, probably five X market increase over the next five to 10 years in remote sensing. And, awesome new launch companies coming. I mean, you just saw the ... I don't know if you ... in the news, the Rocket Lab flight that was successful the other day. I think you're going to see two or three more of those happen.

John Gilroy: Wow, it's just-

Justin Oliveira: Massive amount of new capacity on the market, and it's going to get cheaper and easier to get to space. So, it's going to be exciting, and exciting next decade.

John Gilroy: Cogs and gears will be there, just a matter of connecting them, which is what you're doing.

Justin Oliveira: That's right.

John Gilroy: Great. Well, Justin, unfortunately we're running out of time. I'd like to thank our guest, Justin Oliveira, the co-founder and CEO of Analytical Space.