



Episode 128 – The Space Ecosystem, Benefits of Virtualization and Unique Opportunities in SmallSat

Speakers: Josh Duncan, Principal Systems Engineer, Blue Canyon Technologies – 21 minutes

John Gilroy: Welcome to Constellations, the podcast from Kratos. My name is John Gilroy, and I'll be your moderator. Today we're going to talk about the business of being a complete end-to-end spacecraft company that can support all types of space missions. This includes manufacturing readiness, software designed payloads, and the challenges to a proliferated space. With me today is Josh Duncan, Business Development Specialist at Blue Canyon. When it comes to commercial space, we are starting to see fewer experiments and more operational missions, the renaissance era of commercial space is here, wouldn't you agree?

Josh Duncan: Yeah, I would definitely agree and that's something very exciting for Blue Canyon that we've been preparing for the last five years or so.

John Gilroy: I like the word renaissance because it means rebirth. I guess the implication is that in the '60s and '70s this was a hotly contested world and it's kind of gone into remission. Now it's being re-birthed here in the 2020s, isn't it?

Josh Duncan: It really is. I think one of the exciting things is that the commercial marketplace has allowed for a lot more players, outside of the traditional government players, to reap the benefits of participating in space.

John Gilroy: The space industry has been witnessing a significant paradigm shift with the adoption of small satellites and constellations over larger legacy spacecrafts launched in smaller quantities. What's causing this shift? Do you see it continuing?

Josh Duncan: Yeah, that's a great question. I'd like to say that small sats are completely taking over the world because I'm a player in that realm. I think there's still a lot of room for other regimes and large spacecraft as well, but I think what you're seeing is the value of proliferation in LEO really being demonstrated in the marketplace right now. One of the examples that comes to mind is, there's always going to be use cases and business cases for MEO and GEO-based large spacecraft, but the economies of scale available and the price points available in LEO are really changing for the possible. You're starting to see the price points, the quantities available, and the scheduled durations all come down, people are actually coming up with more nuanced and more unique heterogeneous architectures that weren't really a viable trade in the past.

Josh Duncan: The things that you see is that it takes all the pieces of the ecosystem for that to happen. If you have, for instance, a commoditized bus like BCT provides, but there

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aren't corresponding payloads available or there isn't a sufficiently affordable and high cadence launch capability, then you really don't have an architecture, but what we're starting to see is all those pieces are now coming together. So you're getting a cost effective, agile, and really powerful proliferated solution out the end of that supply chain.

John Gilroy: There's another phrase that's used in your world, it's called 'manufacturing readiness.' So when it comes to manufacturing readiness, we talk about small satellite systems, and this whole concept is very attractive to the military. Can you talk about what it means to proliferate and be replenished to support strategic military missions?

Josh Duncan: Yeah, for sure. So I think one of the keys with manufacturing readiness is that we're beginning to leverage commercial and commoditized products that are highly mature. What that buys you, from a cost and scheduled perspective, is the ability to get a series of capabilities on-orbit quickly. Then you mentioned replenishment, that's one necessity, especially as you start moving towards components that are more two to five years of lifetime, you're going to have to replenish. But the other thing that I think is really exciting for people like us at BCT, but also the end mission users, is the ability to do technology insertion. So at every opportunity, whether it's a replenishment opportunity, or a plan tech insertion, you are actually adding capabilities to the constellation. So to me, that's one of the powerful ideas of proliferation in LEO.

John Gilroy: Josh, I live in the Washington, D.C. area and everything here is an acronym, so when you tossed out BCT, I was going to go to my DoD reference guide and think about what that was! The BCT just refers to Blue Canyon Technologies, right?

Josh Duncan: Correct. I Apologize. I'd love it for BCT to be in the DoD acronym list but I don't think we're quite there yet.

John Gilroy: Yeah, I'll just go down the street and talk to some General and have them slip that in there. Let's go back to talking about satellite systems. I mentioned manufacturing readiness and small satellite systems, so can this strategy replace a big satellite mission?

Josh Duncan: Yeah, to me, replace is a big word, I think there are use cases where that truly makes sense. I mean, for years we've been thinking about how do we replace the big juicy targets with a set of disaggregated satellites that together provide a similar capability, but are harder to defeat? So I think that's certainly one piece. As I mentioned before, I don't think it's a complete remove and replace, but it's more about looking at a creative architecture that employs multiple different classes of assets, even potentially in different orbital regimes as well, and using those as a collective to deliver an end product out the other side of the pipeline that takes the best assets and the best artifacts of each one of those design and architectural choices and meld them together, which is both exciting, but also certainly a challenging architectural nut to crack.

John Gilroy: I think you just defined the term you used earlier, you used the term heterogeneous, and that's exactly what we're talking about here. It's that best of class, mix and mash, whatever it takes to accomplish the job, doesn't it?

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Josh Duncan: It really does. The idea of augmenting what's already there, as well as considering the best approach for what assets to use to replace aging assets, that's a pretty dynamic trade space right now, and we're excited to be a part of it at Blue Canyon. I think there continues to be room for the traditional players as well and there's a growing competition which keeps us all on our toes.

John Gilroy: Josh, I facetiously mentioned the DoD, but it's five miles up the road from me here. So are there defense organizations that are adopting small satellite systems for missions?

Josh Duncan: Yeah, I guess I hesitate to speak for the Department of Defense, but I think we do see those indicators. One of the things that's out there in the public domain is the architectures that SDA is pursuing, and I think that's a clear kind of market indicator in it of itself. I think we're seeing similar things in the civil and commercial realms as well, where the value of small sats is transitioning from solely a demonstration capability to recognizing the value of the data and products coming off of those demonstration missions and really validating that this is a valid architectural choice to make in the operational room. So that shift, it takes place at different cadences, perhaps in those various verticals, and even within different organizations within the DoD. So we're excited to watch that adoption curve take place at its various cadences and be ready to provide those high performance solutions when each organization is really ready to make that adoption.

John Gilroy: Well, Josh, I did my homework. I looked you up on LinkedIn and you've got a degree in engineering, and you've got a certificate in software development, it seems like you're the perfect person for me to ask this question to. So, what is the importance of a virtualized test infrastructure to support this manufacturing readiness?

Josh Duncan: Yeah, that's an interesting question. To me, the manufacturing readiness ultimately is a multi-disciplined problem, right? You need a solid design on the hardware side, but also on the process side, the procedure side, and supply chain, all of that needs to come together. Otherwise, you don't end up with a true rate in manufacturing and a mature environment out the other end. So I think to the extent that virtualized tools help arrive to those designs and processes, that's really important. I think at the end of the day, you also can't beat the experience of having actually executed manufacturing, uncovering the problems that are bound to occur and developing strategies to solve them. So that experience of been there done that and to get to that heritage is also really important. When you talk about the virtualized infrastructure, I think there are interesting implications on the design of a spacecraft, as well as a design of a test environment for sure.

John Gilroy: I'm sure the military is looking at flexibility and being able to test things ahead of time before deploying them. So I imagine this whole idea of simulation and virtualized tests is something the military has been discussing, is that correct?

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Josh Duncan: I think we've been beginning to see that. In various solicitations, we're beginning to see terms like digital twins, we're seeing interest in model-based engineering, and then we're also seeing the space war fighting analysis center be stood up. To me, that's a little bit more looking at the big picture architecture and how you lace all these disaggregate resources and data sources together. I think that's a really tough nut to crack and I think that's a key area where modeling is going to play a big role across the industries. It's been interesting to see that the government is beginning to welcome industry into evaluating trade and threat space in order to solve these problems at an operationally relevant timescale compared to the more traditional development life cycle that has been in space to date.

John Gilroy: Josh, 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 100 plus interviews. Also, you can sign up for free email notifications for future episodes. Well Josh, I'm going to ask you to take off your mechanical engineering hat and put on your software developer's hat. Software-defined satellites are becoming available for larger satellites that will be placed in MEO and GEO. So, what about the small satellites we've been talking about?

Josh Duncan: Yeah, that's interesting. I don't quite have a robust software development hat, but I have built a lot of ground architecture, and one of the interesting things there is, as you mentioned, the idea of a software-defined satellite, I think has its roots in what happens in ground-based IT. A lot of those technologies are now accelerating into the space domain as well. One of the forcing functions in my perspective is the fact that a lot of the actual hardware that we're beginning to deploy, especially in small sats, has its base in ground-based IT and we're starting to adopt actual hardware that's very similar in a way that isn't traditional. So, that's accelerating some of those techniques.

Josh Duncan: So, when we talk about a software-defined satellite. To me, you want to start robbing the best of what we've discovered in data centers where virtualizing the compute, virtualizing the network, and virtualizing the storage allow for more flexible deployment of your technologies, as well as kind of an optimization of them. You're using the resources that you have as fully as you can and you have the opportunity to adjust once on orbit, which has traditionally been a really scary thing. Luckily, BCT, even at the hardware level on the bus, we've always kind of had that mindset of providing flexibility there. I think it extends as you start putting high performance compute and storage on top of a bus.

Josh Duncan: We have Seeker, for instance, in the Raytheon family providing those functions. Then you start thinking about payloads. Instead of deploying their processing on hardware, they're virtualizing that processing as well, which allows them to adjust to the threats, if it's a DoD case, to the adjusting of science needs or commercial needs once on orbit, which I think it's part of what makes this idea of a software-defined satellite really exciting.

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- John Gilroy: So, when we compare satellite sizes, are there any advantages to having a small satellite? Does it give you any opportunities that you can't get with other ones?
- Josh Duncan: I think one of the advantages we are really seeing as we've standardized our platforms, is the ability to take something closed off the shelf and deploy it, which certainly has its benefits. Obviously, the ability to ride share, the commitment across the commercial launch industry as well as the government's commitment to providing ride share opportunities where the large primary mission provides additional space on the launch vehicle to host missions. Again, it follows the same trend we're seeing, the same tone, which is provide the agility to react to needs in the industry, in the Department of Defense, in the science community, getting them that capability up on orbit as quickly as possible. So smaller is, in a lot of ways, easier, just in some of those logistic areas.
- John Gilroy: I want to bounce back to the DoD. Just up road here is the Pentagon, and there's a Metro stop there. I see all kinds of people in uniforms getting on the train there, that's for sure. I want to focus back on the war fighter, those guys getting off the train. So, we've talked about the small satellites, software-defined small satellites and flexibility. How can one of these software-defined small satellites help the needs of one of these war fighters?
- Josh Duncan: Well, I think one of the things that you see SDA looking to address is there's such an incredible number of disparate assets, on the ground and in the air that all need to communicate. That networking has traditionally been done in a number of stove piped programs. So, the idea of lacing together commercial capabilities, DoD native capabilities together, and providing the best network possible is a challenging space and ground based architecture to embark on. But I think it's an important one when you talk about the resiliency required and the ability to get the important pieces of data to the end user as quickly as possible.
- John Gilroy: Earlier in the interview, we mentioned a proliferative space and some people may be listening to this and saying, "Well, what are the key challenges to a proliferated space going forward for commercial versus defense?"
- Josh Duncan: Yeah, that's interesting. I guess I like to look at the opportunities versus the challenges. But yes, the challenges are there, they're certainly real. From the perspective of the technology adoption curve, we are early in many domains. So there's some of that organizational and architectural kind of inertia in each one of these verticals that needs to be broken down. So I think those are slightly different in the commercial and the DoD paradigms, but they're still there and they're real. We're trying to be really proactive and ready for when some of those log jams break free. So I think that organizational challenge of just adopting something new shouldn't be discounted. Then there are certain technological challenges as well. There are, I think, a mix of expectation and reality challenges as well.
- Josh Duncan: When you think about new space, as I'm talking to people often, there's this expectation that there's an easy button. Now everything's small, fast and easy, it's also super high

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performance and super cheap. So it's kind of navigating and those are still all trades, there's not one right answer for everyone. We're really looking at providing the right technologies and flexible solutions that can be kind of quickly adapted to various use cases and customer concerns. Kind of walking customers through different ways to approach their needs. Reliability has traditionally been, for instance, accomplished through the types of parts you use and redundancy within the spacecraft. Now you can consider things like "maybe I use redundancy at the consolation level versus at each individual piece of hardware level."

Josh Duncan: So some of that is kind of a give and take with the providers of payloads, with the providers of buses, with the people who are dreaming up these architectures and all these come together. So some of these challenges are soft challenges versus actual challenges to deploying hardware. But of course, as I mentioned, the whole ecosystem has to fit together, and all the parts in architecture, launch and comm all have to fit together in order to get an end product out to the user in that kind of responsive timeframe that I alluded to earlier, which is really what we're trying to solve. It's to get capabilities on orbit at the performance and reliability level that the end user needs.

John Gilroy: Josh, I think your company recently had several components successfully launch aboard a mission. I think you folks provided reaction wheels and an integrated altitude control system. So what are those components and why would they be important to a launch?

Josh Duncan: Yes, it's really fun. I mean that's, at the end of the day, what I show up for every morning, is to be an enabler, to get our customers capabilities on orbit. So we are providing those turnkey buses, but also turnkey subsystems as you alluded to, and individual components as well. That's been one of the exciting things about BCT is the diversity of missions that we're able to support because of that approach.

Josh Duncan: So on any given ride share launch, we often have all of those, all the way up and down the stack. A turnkey bus when it makes sense for our customer, but when they have a unique mission and bus design that doesn't necessarily align with one of our standards, we're happy to sell them a high-performance turnkey navigation and altitude determination and control system. So, that kind of vertical integration that we offer gives us the ability to also bring products to bear to the market at each tier of that value chain. We just recently launched, as far as I'm aware, one of the first cube sats to GEO and then on the same launch as you alluded to, there's individual components manufactured by BCT going up as well.

John Gilroy: Well, Josh, you gave a great interview today. We appreciate your time. I just want to thank you for giving our listeners a better understanding of concepts like proliferated space and disaggregation. I'd like to thank our guest Josh Duncan, Business Development Lead, Blue Canyon Technologies. Thanks, Josh.

Josh Duncan: My pleasure. Thanks.