



Episode 34 – Concierge Satellite Services, Resilient Launches and the Cosmic Girl
Speaker: Dan Hart, President and CEO, Virgin Orbit – 22 minutes

John Gilroy: Welcome to constellations the podcast from Kratos. My name is John Gilroy and I will be your moderator. We are recording this today from the floor of the small stat conference in lovely downtown Logan, Utah, and we're lucky enough today to have our guest, Dan Hart, President and CEO of Virgin Orbit. Today, we're going to talk about Virgin Orbit and their rocket launch system that is meant to provide more accessible, affordable, small satellite launch services than are currently available. Dan Hart is the President and CEO of Virgin Orbit, and he will talk with us about this new service, and what it will bring to the small sat industry.

Now, Dan has spent 34 years at Boeing, and various satellite and launch vehicle programs before being personally recruited by Sir Richard Branson to run Virgin Orbit. Well we're lucky to have you here, thanks for coming.

Dan Hart: Hey, well great to be here.

John Gilroy: Let me give you a real toss, a little softball question. You can run with this for the next three hours if you want, but I think many people are aware of this and some art, but Virgin Orbit hopes to reduce the cost to enter space by building rockets capable of launching small satellites from the bottom of a customized 747. Most distinguished feature is that it'll be up seven miles in the air and it sends into space from there. Tell me more about this. Give me about five hours on this, this is fascinating.

Dan Hart: Well, you know, the Holy Grail in space launch has always been to try to get to aircraft like operations, and there's been a lot of different approaches attempted. And so we're taking the most straightforward. There's been a lot of discussion about re usability. Well, our initial stage of Boeing 747 has been the workforce for commercial aviation for a long, long time. It has an incredible support capability. And our ability to take a rocket under the wing of a 747 fly it about 35,000 feet, drop it and have it ignite in free air, separates us from a lot of the range constraints that a lot of systems have, and the scheduling complexities gives us huge flexibility.

And we don't have a launch pad to clean up with after we do a launch, we are the true clean pad. It's thin air.

John Gilroy: You know, you walk around the conference here, this is small sat. A lot of young people, a lot of people trying to get inexpensive way to get up in the air and

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traditionally it's been ride share, but when you're in ride share, you're limited to a geographic area and a timetable that may or may not fit your business plan.

Dan Hart: That's right. And what we're seeing is as small satellites develop and really take on their own real business plans, they need to get to where their business requires them to be, when they need to. And so the early days of small satellites was a lot about experimentation and just getting some access to space and that's great for experimentation, and that'll continue on. But as systems develop, and businesses develop, as missions for government organizations developed, they're becoming more and more demanding.

And our approach is concierge service. Take you where you want to go to, when you want to get there.

John Gilroy: Now the reason this is so exciting is that I've been at this booth the last two days and earlier this morning, a young man from BYU approached the booth. A computer science major, that's fine. And he said, "Who're you going to have on?"

"I have Dan Hart from Virgin Orbit."

"Oh, this is great. We're participating in that."

And I go, "What do you mean? You're just a bunch of college kids at BYU. How are you participating in this big program?"

"Well actually we have a 1U, a little satellite we're putting up there."

I mean you really enabling a lot of the young people to get their feet wet and make mistakes, figure out what to do. And you're launching the careers of thousands of people with these small satellites.

Dan Hart: That is a symptom of where we are in the small satellite transformation that's going on. And it is incredible to see juniors, sophomores in college building satellites with the clear expectation and knowledge that they're going to get to orbit and operate in space. Now, when I was going to college, had I gone to my advisor and said, "You know, I'd like to build a satellite for my senior project." He would have giggled and then change the topic.

John Gilroy: Let's call the Dean on this guy.

Dan Hart: Exactly.

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John Gilroy: Hey, tell you what, we'll take and let you see a picture of these guys, these white suits building a satellite.

Dan Hart: Yeah.

John Gilroy: So you can see maybe the picture.

Dan Hart: Yeah.

John Gilroy: So Launcher One is going to ride on the jet liner called Cosmic Girl.

Dan Hart: Right.

John Gilroy: Another real memorable name. What status is it right now?

Dan Hart: First of all, I have to say the Cosmic Girl is the name of the aircraft that was given when she went into service for Virgin Atlantic. So even though it's a great, terrific name, it is pure coincidence, she happened to have the right kind of maintenance record and we inherited the name from our great sister company. Cosmo Girl today is up in Victorville. She's about to go into a next set of flight tests with the pylon. And the pylon is a large structure that holds the rocket.

So over the next few weeks we will fly with the pylon. We will fly with a rocket attached. And just verify and anchor our aerodynamics before getting to launch later this year.

John Gilroy: Normally when you think of putting something up in space, you think about the time to the first flight. But now people are thinking about flight one, flight two. And you already have a grid. You have a plan for the next several years for when these flights are going to take place, don't you?

Dan Hart: That's right. I mean if you walk down into our factory today and you walked into the integration area, you would see three different rockets in various stages of integration. And so our approach is to start right off not as an experiment, but as a rocket system that is designed for producibility. So it's designed with simplicity in mind to keep the costs low, to give the producibility high and the operability high. And so as we go forward, a second launch is right behind the first launch in our factory.

John Gilroy: Amazing. And the article I read about you this morning talk about 6, 12 and 24, some kind of progression, the next few years-

Dan Hart: Right. We are planning a steep increase in launch as ... I mean, the market is clearly there. We're here at the Small Satellite conference and there are a huge

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number of small satellite constellations that are being planned, and our manifest is filling up very nicely. And so we're seeing the pull. Launch is a choke point still. And we'll be very happy to come in and relieve some of that strain.

John Gilroy: We're going to go back to Long Beach here. I have a friend whose son works for SpaceX in Austin, and there are other activities in Seattle of course. But why Long Beach? Was there a previous facility there? Previous manufacturing facility?

Dan Hart: Well, yeah, the answer is yes. I mean we're on land that used to be Douglas Aircraft and then later was Boeing. Okay, so we're right next to a Long Beach Airport. Most importantly though, the talent pool in the aerospace tradition in the area in space and aircraft is quite high. So we've got a great mix where we can pull rocket people, satellite people, aircraft people, as well as people who have just grown up with that and have a real passion to get into aerospace and to get into space in particular.

John Gilroy: The guy who's organizing these conferences, Pat Patterson, we sat down yesterday with a podcast where he talked about launching from altitude and that's what he's talking about here. And he was very, very optimistic about it. But if we try to put this into more realistic terms, there's some efficiency over ground based launch, but it increases the mass to orbit capability by maybe 10%. Are there other advantages to being launched from 747?

Dan Hart: There are some areas of simplicity that are introduced by air launch. You're getting out of the thick atmosphere. And so the kinds of loads and maximum dynamic loads are lower generally. The other things though, because we're air launched, we don't have to operate in a space range. And so we don't have to have all the equipment and the communication equipment onboard, that lowers the cost, lowers the complexity, lowers some of the scheduling conflicts. And then from a flexibility standpoint we have customers who want to go to sun-synch. We have customers who want to go to low inclination.

We can now take the launch site, if you will, anywhere we want to because we're traveling on a 747 with huge range.

John Gilroy: And so it eliminates one factor of weather in many ways, doesn't it?

Dan Hart: Right. It does. And we go above it and we can go around it.

John Gilroy: So there's a phrase that you used earlier, it's called "concierge service to orbit". Is it that customizable? Really? Here's a piece of paper, tell me what you want?

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- Dan Hart: It really is. We have a variety of customers both in terms of spacecraft size, as well as certainly orbits. We have customers who want a package, numerous, very small, cube sat size satellites, other customers who want to put something the size of a refrigerator into orbit. And we can customize a mission for any of them. And we can customize the flight profile. And as I said before, get to any inclination.
- John Gilroy: So you walk around the conference here, and in fact, sitting at this table here, I see Marines walking by, the Naval Academy has a booth upstairs. There are air force people walking by. The military is looking for inexpensive and rapid access to space. This could be option B here, couldn't it be?
- Dan Hart: Yeah, I'd say it's option A.
- John Gilroy: Of course you would.
- Dan Hart: And, there's another aspect of this, of course space has become an incredibly important part of our militaries capability to project power. And, you've heard it in the news lately, and resilience in space, and resilience in launch is very important. So the ability to launch from any point is a very interesting proposition for the air force, for the DOD, as well as the intelligence community. When you're at Cape Canaveral and there are locks coming out of the vent valve on a rocket, everybody in the world knows exactly what's going to happen next. Our system is a little different.
- John Gilroy: So by resiliency, you mean being able to respond quicker or as a backup, or have two backups? Or what does this term resiliency mean to you?
- Dan Hart: You know, from a launch standpoint it's very much flexibility. As you just said, it's being able to respond very quickly. Being able to do your mission planning quickly, and get to any orbit. If there's a hot spot in the world, to get assets up there very quickly. If an asset in space is somehow disabled, to be able to very quickly and very inexpensively, get another asset there right away. And what's very interesting is those values are both interesting right now for the US government, and our allies, as well as the commercial world, because as these large constellations go into effect, the ability to keep availability of their systems in space and have the right kind of spares and the right kind of capability in orbit will be very, very important both commercially and for the government. So there's this really nice nexus right now between what commercial and government need.
- John Gilroy: I come from the world of software, software development and one of the phrases in agile software development is fail early, fail fast, correct, move on, pick yourself up, change, pivot, move. And it's a very fluid situation. It seems

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that your system could allow these young men from BYU to put up something, have it fail. Oh, okay. Try again, and figure out something.

Dan Hart: Right.

John Gilroy: So what happens is no one has the answers. They test and move, and test and pivot, and try to come up with new agile ways to solve problems. And this could be an option that no one ever thought of. Instead of waiting two years to be launched from Cape Canaveral, let's launch from London next month. I mean, flexibility.

Dan Hart: No, that's absolutely right. I mean, the environment, the ecosystem is changing dramatically. And there used to be this kind of a trap. I've got a moderate valued space craft. I really don't want it to fail. So I'm going to do this additional activity, and that additional activity costs money. Now it's a very expensive spacecraft. I don't want that to fail, so I got to do some more, and now it's a really, really expensive spacecraft.

And there's this trap that we used to be in. The modern small satellites and low cost launch can couple together to get you a real experience in space very, very quickly.

John Gilroy: The previous podcast we sat down with Carolyn Bell from NSR and we talked about predictions of the number of satellites in the next two or three years and she's talking in thousands. And for someone like me, I think thousands of satellites, there's got to be issues with collision avoidance. Can your system possibly address that because it's so flexible?

Dan Hart: We've been doing a lot of thinking and having some interesting discussions there. Number one, of course, we all know the Department of Commerce has picked up the gauntlet for space control, as we have air traffic control today. So having the sensors, the coordination in place and the control of space will be very important, as well as the norms of behavior that are expected of everybody will be foundational to that. That said, our focus, number one, is we want to make sure that we don't become a debris problem. So we work on de-orbiting our stage in a timely fashion.

We've also been working with ... There are a number of companies popping up to handle debris and we do expect there'll be debris problems, because satellites fail sometimes, sometimes they fail in a way that you can't dispose of them effectively. And it will be important to take satellite wreckage, or debris out of useful orbits. And so I think that, that will be a very important business as we go forward. As a dedicated launcher, we expect that we'll be able to go on

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very targeted missions to very specific orbits and help some of these companies get to their targets that then eliminate debris problems.

John Gilroy: In my world of software development, there's software defined networks, there's software defined wide area networks. This concept of virtualization has really given a lot of flexibility and opportunities for the people in software world. What about virtualized solutions? And does that affect your way that you can make a case for people?

Dan Hart: Well, if I understand you correctly, I mean we're talking about moving things like the cloud in space, data storage in space, space based processing. All of that is in the cards. What's really fascinating and exciting is, we're seeing in space, systems developed much the way that things developed on earth where you started with large monuments and then you developed more agile capabilities and solutions around them. And I think the monuments will still be there. The monuments will continue to come along and there'll be large investments. But what will happen is there'll be an ecosystem developed around, and between those that provide services to those large communication hubs, services across, and laser communication links across to different regions as well as, of course the typical up-down communication to the ground.

So we're going to see layers of a capability and infrastructure in space much the way it was built on earth with fiber and RF networks, and all of the consumer electronics around them.

John Gilroy: In my world there, this cloud, and people say, well, the cloud gives you the ability to scale that you couldn't even conceive of before. Do you think that's viable for your solution for the information coming down from the different satellites that are out there?

Dan Hart: Well, I think it is. Of course, we're in the transportation side, so we're really talking now about our customers and their business propositions. But having the ability to, in a very short order, connect in space to systems that allow you to store your data and access capability both in space and terrestrial, will definitely become an important capability and infrastructure that'll be made use of.

John Gilroy: Another infrastructure question. Kind of boring but real practical. Because you can have a geographic variability from where you can launch from, do you think that'll help them, your customers solve their ground antenna network requirements? Would that improve it or help it or any impact in that area?

Dan Hart: You know, I think ground antenna networking will get simpler with frankly some of the capability we just talked about, because cross links will become more

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available and prevalent. So if you don't have a specific station, you'll probably be able to for a much lower cost, get your data down. That said, again, if somebody wants to go somewhere from a launch point, we'll be able to find a way, an airport and a trajectory to get them there.

John Gilroy: But here we are sitting in small sat, and people run by the booth all the time. And we had the people from Made in Space, the Atlanta company that does 3D printing, and I've done some research and there's some 3D printing that's involved in the way you manufacture some of your parts and your engine. This is really crazy. This is so advanced. Tell us about that.

Dan Hart: Yeah, well we're applying 3D printing to our engines primarily. And it's really a game changer because there are some processes that have been fine-tuned over the ages, but that are very time consuming, very expensive, and 3D printing lets us get around those very, very quickly. But the most exciting thing on 3D printing is the next generation, and the one after that. Because there are people coming into the industry that have never experienced it without 3D printing. Okay. And we're starting with 3D printing. When we started it was, how do we make this design that we've already built? And how do we make it faster, or better, or cheaper, or more reliably?

The next generation is how do I take 3D printing and come up with new designs that are not constrained to those original thoughts of, well, how would I hog out this piece of metal? Or how would I cut it? And so we're seeing new parts. We have a part, for instance in our propulsion system that has, I don't remember the number, but like a dozen different parts coming together because some of these people who are taking the design approach right from the start in 3D printing. That's the really exciting thing in the industry.

John Gilroy: And let's go back to the student from BYU at the end of the interview. Then you get bright, creative young minds, undergraduates, who are digital natives and assume it's there.

Dan Hart: and they're going to drive us forward.

John Gilroy: It's going to take to the next level that I don't know if people can conceive of where it's going to go. It's going to be so exciting. I don't know, I never dreamt of ... They're talking about 3D printing in space, printing satellites. I mean, it's just incredible.

Dan Hart: Yeah. As Richard Branson often says, "It's much easier to say yes." So you hear those ideas.

John Gilroy: Yeah. Run with it, run with it.

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- Dan Hart: And the answer is yes. Let's try it.
- John Gilroy: Crystal ball time. So, what else is on the horizon for Virgin Orbit? Where do you think your future is headed?
- Dan Hart: Well, right now we are really laser focused on getting the first flight and starting commercial operations. And we will go there. We will ramp up production and then, we're having a lot of discussions here at small sat with a lot of different satellite companies, who want additional capabilities, whether it's additional mass classes, whether it's some additional flexibility and services. We have a flexible platform. We also look at reusability in other aspects. We look at services. There's a lot of focus to go and expand humankind over to lunar and Mars. And we think we can play an important part there as well. So, space is a vast area, and a vast discipline. And we plan on playing in a number of those places. We've also recently signed some agreements with some governments, in the UK, in Italy with a company. And so we do look at expanding globally as well.
- John Gilroy: Now at the small sat conference, I think there's 40 different countries represented here, hundreds of companies, just walking around the show here. Just give us an idea, anything strike your fancy, something interesting or distinctive or something new that you'd expect to see.
- Dan Hart: I think the thing I marvel at here is you could walk down the aisles here for a half an hour and you could build a satellite with the equipment-
- John Gilroy: You get a big old shopping cart.
- Dan Hart: ... that's here. In a heartbeat. The other thing, back to the students, I mean, there are students, there are rows of posters. And there are students explaining some breakthrough, really incredible concepts for what satellites can do over the next year, five years. And we're going to see these ideas take hold. And we're going to see these ideas in orbit over the next two, three years. And it's going to be a game changer.
- John Gilroy: Well it definitely will, and I want to be there because who can predict what's going happen? It can be so exciting and new. 3D printing is just amazing. Unfortunately, Dan, we're running out of time here. I'd like to thank our guest, Dan Hart, President and CEO of Virgin Orbit.