



Episode 171 – Standardization, Reconfiguring the Ground Segment and Meeting Gigabit per Second Demand

Speaker: John Taylor, Chief Engineer, Swedish Space Corporation – 23 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 John Taylor, Chief Engineer, Swedish Space Corporation.

John, the digital transformation of satellite technology and ground systems has opened the door to new options that weren't previously possible. Traditionally, satellite operators and service providers would spend millions in CapEx to build their own ground systems. Today, we'll be talking about the evolution of ground systems, including ground segment as a service, or GSaaS for short. During today's podcast, we'll discuss the technology behind ground systems supporting software-defined space. Our guest, John Taylor, is Chief Engineer for Swedish Space Corporation. He has spent the last 24 years responsible for development of the ground system solutions, integration, and support for multiple NASA, U.S. Space Force, and commercial missions around the world. Today, he joins us to explain the details on what's driving this new spin on satellite service delivery and how it all works. How it all works, that should be the title of the show. John Taylor with how it all works. Let's jump in real quick now. In August 2022, Euroconsult Ground Segment Market Prospects report, GSaaS providers have been starting up and investing massively in ground infrastructure. What are some of the technology triggers driving the market toward the as-a-service model?

John Taylor: Well, I guess it's a lot of the many new players that are getting into space and the fact that the agencies like ESA, NASA, the Space Force are now working to commercialize and work with commercial providers. What I see with our customers going back a bit, the USN founder, in fact, when I came to Universal Space Networks, which is now Swedish Space, when we were acquired by Swedish Space Corporation, Pete Conrad had a vision to have a service concept and commercialize things that were traditionally done, like getting access to space, which was traditionally done by big agencies and governments.

And this was in the mid-nineties, but even at that time, it was still slow-going, and in recent years, just even in the last five or maybe 10, the number of ground station providers and the number of people that want to get to space, whether they have their own assets or they're leasing assets, is just increasing dramatically and customers want easy access to space, they want easy onboarding of new missions and repeatability and obviously, at a lower cost. So

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we're trying to do that as a lot of other providers are trying to do that. So I think that's what the big drive is.

John Gilroy: So Pete Conrad, is that the astronaut, Pete Conrad, or am I getting him confused with someone else?

John Taylor: Yeah, he was the third human to walk on the moon back in November 1969. Unfortunately, he had passed away right before I started with the company.

John Gilroy: Wow. He's like the Ben Franklin of satellites and space, isn't he? Wow.

John Taylor: He actually started several companies. One was a reusable launch vehicle and a software development company and then a ground station provider company, and so great legacy there, and unfortunately, I never got to meet him, but a pretty amazing person. Everyone I talked to that knew him was pretty impressed with him.

John Gilroy: Fantastic legacy, I would say. Wow. This is great. So what are some fundamental differences in traditional ground system implementation and deploying a ground system as a service model?

John Taylor: Okay. It depends how far you go back. There was a time when a traditional ground station was very fixed hardware and software as well, but it was very fixed configurations and solutions permissions, and in time, this evolved into where hardware was more configurable, but it was still discreet racks of equipment, and then I'm going to say around 20 to 25 years ago or so, they started to build these where it was very DSP based boxes that were hardware, but they were firmware, but they were very software driven and very configurable, allowed a lot of flexibility.

But they still only really supported low data rates and whatnot, and then a few years later, they were supporting higher data rates, higher bandwidth, things like forward error correction, which had to be done in hardware a few years earlier was now able to be done with software, and then this continued to evolve as obviously computer hardware and things got better to where software-defined radios, which is really changing things now is because they allow an analog signal to basically be digitized.

John Taylor: And then you can basically handle it anywhere. You can demodulate it anywhere in a cloud on the station and it allows a lot of flexibility in terms of how you build an architecture for ground stations because it doesn't limit you to a physical piece of hardware. It also is nice from a hardware perspective because the digitizers are rather inexpensive and computers are computers. You can put the software on any computer where now if a modem fails, we have to

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have a backup unit. So it allows portability, redundancy, configurabilities, definitely a game changer.

John Gilroy: So John Taylor, if we're going to make a T-shirt of this interview, it's going to be evolution, not revolution, all building on each other and building and building to where we are today.

John Taylor: Yeah. From my perspective, it's definitely that. The software and the way that the hardware's evolving, the footprint of the hardware. In terms of being able to provide a service and some of the things we talked about earlier about easier onboarding and things like that, you need that ability to be flexible. Other things that are going to change, I think, in the commercial side, things that I'm working on is backing and procuring larger antennas and we're looking at phase array antennas and optical. There's other things too, that are going to change from the traditional ground station as different frequencies and capabilities are needed. So I think that, yeah, it's fun and trying to keep up.

John Gilroy: Well, a lot of fun is looking at those satellites up in the sky and many satellite operators want to fly satellites and sometimes the ground connection is the last thing in their mind. So what common mistakes do operators make when thinking about the ground segment that can maybe slow down the mission?

John Taylor: Yeah. So with the agencies historically, they would usually start very early and there'd be a lot of rigor and risk aversion and discussions and things like that, and they wanted to know pretty much everything, and now where we see it is, especially with some of the newer players, that they come in too late or to the process where the spacecraft is already designed and maybe it adds different custom capabilities or requirements that drive things that maybe they didn't think they needed. But if we can consult early on usually and test and things like that, usually, those things are mitigated, but that's usually what I've seen where if they come in late and things are already fixed and they can't change and sometimes it adds some challenges, and one of the advantages too now with some of the vehicles and spacecraft, they're becoming more flexible as well because there's basically SDRs on the vehicles now or there are starting to be. So as that happens, things can be reconfigurable, whereas maybe they were fixed in the past.

John Gilroy: I tell my students that in order to be terrific, you got to be specific. So I'm going to have a specific question for you. So the specific question is, can you give me an example or two about how mission operations work differently through the GSaaS model versus a traditional one? Maybe compare and contrast, with the new and the old.

John Taylor: Yeah. So traditional, very early, a lot of meetings, a lot of formal reviews. We've had customers that they want to know what brand modem we're using and

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what model number it is in the meantime between failure of a power supply on an up converter, which is getting very detailed, and again, a lot of customer requirements. Even within the agencies, each organization inside the agencies work differently, and of course, that gets multiplied with some of the commercial players as well.

So it added a lot of requirements, additional costs and complexity, and it wasn't really like a service. Maybe this is correct or not, I don't know, but I look at it like a cell phone. When you go in, you get your phone, it's on the system, you don't care what brand of antenna they're using at the cell towers or anything like that as long as it works and there's one around you. So it's maybe not that easily stated because they're very complex systems, but from that perspective, the ground system as a service, they want to get access, they just want access to space, they want access to their assets and get their data or whatever their mission is, and I think this is happening now. I think the ground station as a service approach will be able to allow for easy onboarding. Standard interfaces, that's a big one. Higher automation, scheduling, reporting, all those things will be done more in software and it's happening now, but we're definitely in a transformational period. It feels like we're trying to fly the plane and rebuild the engine kind of thing. So we're constantly trying to look at what customers want, how they're moving.

John Taylor:

This whole idea of digitization, digitalization, and just trying to move with customers because they're doing it and we're trying to move with them. So that's a big difference, but we talk about having our control rooms that are unstaffed. Our stations can already be unstaffed and I know our customers are talking about automated cloud environment, architectures, virtual mission operation centers that are fully automated and don't require human intervention to run. So I think that's how I see operations working differently where traditionally, we have people 24/7, we still do, and there's a lot of interaction with each customer for their supports and whatnot.

John Gilroy:

Well, John Taylor, you may be surprised to know we have hundreds of thousands of listeners all over the world. Many are engineers and you know those engineer types, they want to ask how. Let's talk about this how problem. How does it work? So what is the technology behind all these mysterious ground services? How does that all work?

John Taylor:

So it's in different areas, but you always hear about software and you hear about automation, you hear about AI. I don't know if AI just, we don't ever want to limit that it wouldn't need it, but sometimes I don't know if it's needed at the moment, but I think we could find lots of reasons to have it to add robustness and things. It's just at this time, I don't know if we're ready for it, but automation's a big one and using tools like REST APIs and things where we have our APIs and we basically give that information to customers.

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They configure to what we are doing and they can schedule and visualize what availability is out there, schedule supports and they can build automation on their side, and so I think that's the driver because it also will lower operating costs, and I'm not exactly the expert on all the different things, but I can also see the stations as well. We're doing some stuff investigating and doing some studies on phased array antennas instead of replacing some of our smaller antennas with phased array.

John Taylor: So if that can help us be more flexible, support more spacecraft from a single aperture, it should give us some ability to provide a better service and support more customers with a limited number of assets. So I think there's definitely hardware technology with SDRs, the spacecraft themselves, changing the technology there, and then of course, as everybody says, software, software. A lot of software will be doing a lot of this as opposed to what used to be in hardware.

John Gilroy: Yeah, makes sense. I'm glad you mentioned REST API because I've talked to some network technicians that go no, the API is the new network, and so you're right up to speed with what's going on in the cloud community. That's good to hear.

John Taylor: I was just going to say we have multiple customers that are doing it and they seem to like it and it does allow for easier onboarding, and some of the things we're trying to work for with the whole GSaaS type approach. It's definitely, we're starting to do it now. We're transforming it, as we said earlier.

John Gilroy: Well, I know John Taylor, you're an Eagles fan and a lot of challenges for the Eagles, get to Super Bowl this year, and parallel, there are some challenges in building a GSaaS network. So how can those challenges be overcome?

John Taylor: Yeah. So there's different types of providers, but I guess I'll speak from our experiences here. There's a lot of barriers, both investments and financial. As an engineer, we'll say we need this or need that. So there's the idea of trying to develop things while we're actually trying to operate an active network with a lot of customers of multiple different orbits, multiple different types of customers. Standardization, that is internally, we've talked about it and as with customers, we talk about it.

That's probably one of the biggest things of standardizing how we schedule and giving customers access to their assets to get to space, having standardization is really, really big, and then of course, predicting. Sometimes people ask me, should we build this? What frequencies, what size of antennas, things like that, and some of these assets are very expensive and if we just say, okay, we need to build it because they say we're going to want, say, like Ka-band and lunar missions, we know we need 20-meter antennas. That's a challenge because

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they're expensive and so you have to, obviously as a business, you got to make your money back. So I think that's what I see, at least from my perspective.

John Gilroy: We've been doing interviews here at Constellations for about five years and you see all kinds of trends, and if you look at the trends going on today, one trend is that some of these large operators are moving to multi-orbit capabilities. So John Taylor, what are some of the differences in how ground systems communicate with different orbits, and going further than that, how is it different to communicate to the moon? So we've got multi-orbits and then the moon.

John Taylor: Okay. So in my 24 years here working at SSC, we have a ground station infrastructure that's global. So we've been supporting LEO to lunar and even to L1 and L2 orbits, which is a million miles away. So we really have been doing that. So from my perspective anyway, a lot of the systems and the operations are similar. Site locations, if it's a low inclination or a polar orbit or maybe if it's lunar, visibility to the moon line of sight.

And then of course, so antenna sizes and frequencies and things drive and constrain the ground station solution. It's not to say that something going to the moon or say manned space flight or something like that isn't more critical because it is and how you may approach it from a risk aversion is different, but operationally in how we approach it is the same and we have a lot of experience doing that. So the systems itself, I could see from a ground station as a service, I can see them being similar, but you just have to have, again, the antenna performance, the modem capabilities, and the frequencies to do it.

John Gilroy: So let's go from the multi-orbit down to the waveform itself and talk about that. So we are seeing operators use new and multiple waveforms for satellite missions. So what trends have you seen towards digitization of ground technology to support these various waveforms?

John Taylor: So most of our modems, even the modems that are software firmware based are very upgradeable to support, whether it's a forward error correction, a modulation scheme. They're definitely configurable and upgradeable, and then of course, the software-defined radios as well. That's another advantage because adding those things are easier to do.

But they do allow a lot of flexibility where, again, in the past, when you would build something and it was, I use the term hardened, they tend to be fixed. Our modems go through like an obsolescence period, and usually, when they do phase out, the newer modems have the capabilities. So we're allowed to basically keep up with technology as it evolves and even in the last few years, different things that are happening are definitely forcing us to change.

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John Gilroy: If you describe satellites to kids in grade school, you talk about them going around the earth, but I think very few school kids realize that there's tens of thousands of passes each month and this generates just a huge amount of data. So where does all this data go and how is it handled?

John Taylor: So traditionally, customers would come in and say they have a solid state recorder or a recorder on the spacecraft that's capturing data. Let's just use a science data imaging satellite or something, for example. They would record the data and they would do what we call a dump or a download of data, payload data to us, and we've handled it different ways. 20 years ago, storage was a little bit harder to do. Our IT guys, our virtual platform guys tell me storage is easier now.

But on the ground, we can store it at our sites, we can move it to the cloud to an S3 bucket where it can be picked up or we can push it to a customer's S3 bucket. I see it now happening where we're able to grow easier with the demands and we're looking at larger and larger volumes. Again, 20 years ago, 80, 150 megabits per second was a very high data rate. Now, we're supporting missions that are in over gigabit per second.

John Taylor: There is different file acceleration methods we can do. Ways to move data more efficiently, a big file over network, things like that. So that's, again, it's into the software and how things are managed where you break a file up and you can utilize the bandwidth more efficiently using techniques like that, but a driver usually is how quick does a customer need their data? Do they have a 24-hour latency? Do they need to know it within an hour? That all drives the type of solution that we put together in order to meet the requirements of the customer's demands.

John Gilroy: Well, you're not going to stay in business unless they have some kind of a pay model. So let's maybe focus on that here for a couple of minutes. The way it seems to me is that the pay model for GSaaS has been compared to maybe Uber or Airbnb, but really, what's it really like? Is it possible to earmark and assign capacity to different customers at their time of need? Assigning this stuff dynamically, it seems to be mysterious at best.

John Taylor: So yeah, I'm going to say on this one, this is out of my expertise when it comes to that. I try to stay in the engineering world, although try to understand a little bit about the business side of it, but providers that own their own assets, I think they have an advantage at least because they can control what they offer to customers in terms of priority and flexibility. We have a prioritization model. We didn't invent it. It's an industry standard we've adopted and it goes everything from manned space flight to lunar and critical supports to on-orbit spacecraft emergencies all the way down to maintenance and upgrades.

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When you're trying to manage demands, I don't know if this is a good analogy, but if you ever buy an airline ticket from one of those cheaper solutions, I don't know, you usually got to wait 24 hours to find out if you got your support whereas I think if you're working with a provider that owns assets that can actually manage them better and allow bookings and move people around and what's needed to do, I think that it's a little bit better of a service.

John Taylor: The idea that you buy as you go and all that, I think it's definitely where we're being pushed. We have customers that work solely on what we call white space where they basically procure any open space. They'll log in, look at what we have, and they'll pick just white space because the price point might be different, but that's all I'm going to say about that. I don't want to get into that, but I do think having providers that have your own assets is a help.

John Gilroy: Good. Well, earlier, I teased you about the Philadelphia Eagles and it's pretty hard to predict the Super Bowl, but I'm going to ask you to predict this business. You have more expertise in this business than football, that's for sure. So let's look 10 years down the road. So how do you see ground systems evolving?

John Taylor: I think a lot of what's happening now is going to push in the same direction. 10 years is a long time in some things, but then other things seem to move slower. I think the agencies, the bigger agencies will definitely contribute to that, but there's a lot of commercial companies that they have dreams and visions of what they want to try to do and they're working it. We have those customers and they're great to work with because they're excited about what's going on.

I think software, and then it's going to continue to happen. I think that with the commercialization, I think that standardization will continue to be a big part of it so that everybody can play together, and obviously, automation and this idea of a virtual ground station and the idea of virtual mocks and virtual operation centers and where there doesn't require as much human. That's where I see at least the ground station solution going.

I do think that there's going to be a push for a lot of smaller antennas, like a lot of these short term, or I should say lower cost missions, and then in contrast, the larger antennas because everybody wants to go to the moon or they're talking about Mars and that kind of thing. So I think that these are exciting things, but I think it's definitely pushing that direction.

John Gilroy: Well, this has been a pretty complex topic and I think what you've managed to do is give our listeners a deeper understanding of ground segment as a service. I'd like to thank our guest, John Taylor, chief engineer, Swedish Space Corporation. Thanks, John.

John Taylor: Thank you. Thanks for having me. I really appreciate it.