

This filing relates to the proposed business combination between Tailwind Two Acquisition Corp., a Cayman Islands exempted company ("Tailwind Two"), and Terran Orbital Corporation, a Delaware corporation ("Terran Orbital"), pursuant to the terms of an Agreement and Plan of Merger, dated as of October 28, 2021 (as it may be amended, supplemented or otherwise modified from time to time), by and among Tailwind Two, Titan Merger Sub, Inc., a Delaware corporation and direct, wholly owned subsidiary of Tailwind Two, and Terran Orbital.

The following is a transcript of an interview first made available on March 4, 2022.

The Space Show

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Introduction Audio:

The views and comments expressed on the Space Show by its guest callers and listeners belong to them. The Space Show and its host serve only as a platform and are not responsible for others comments or views. All topics discussed on the Space Show are primarily for educational purposes. [Music Intro]

Dr. David Livingston:

Good morning, listeners, welcome to our Friday morning spatial program. I'm your host, David Livingston, thank you for tuning in. We have an interesting program today. I'll tell you about it in just a minute. First, a couple of very, very quick announcements. Were on the 60 minute format. So watch your clock, if you want to give us a call, again, our toll free number 866-687-7223. Or if you want to send us an email for our guest, drspace@thespaceshow.com. And then the program will be archived later today. Don't forget Jim Muncie returns to the show on Sunday. And then all of the newsletters will be published this weekend. So you can see the full schedule coming up for the coming week. And I'm happy. Well first, let me do just a couple of announcements to save some time. You can listen to this program live, go to listen live. And it's up at the top and you'll be able to follow the instructions for a live show, podcast, and then archives as well on the website. And if you have any questions just email me at drspace@thespaceshow.com. And then don't forget, we're a nonprofit 501c3 with One Giant Leap Foundation. And listeners just like you today, you help support the space show so that we can have great guests on the program. And as a 501c3, if you're a federal taxpayer, you do get a tax deduction for your gift. And you need to check with your state to see if they recognize other states 501c3 programs and we are for the moment, California 501c3, but that may change in the near future. And we have a big box up at the top of the show for a top of the homepage for PayPal. And that's the easiest way to support us. But if you do go old school and want to mail a check, it's to One Giant Leap Foundation, and it mails to box 95 Kipper on California 9492. So for today, I'm very happy to introduce to all of you Marc Bell. He is a Co-Founder, Chairman and CEO of the leader in small satellites Terran Orbital, their website is terranorbital.com. Marc has a lot of experience in this field. And to save time, I just want to direct you to his bio, which is on our website right now. So you can check it out. But he has a lot of experience with Globix Corporation, the Global Internet Exchange, and a lot more. So I think you'll find his bio very, very interesting. But we want to talk about small satellites and Terran Orbital with our guest today. Marc, welcome to the Space Show. How are you?

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Marc Bell:

Good. How are you? Thank you for having me.

Dr. David Livingston:

A pleasure. Nice to meet you. Tell us about Terran Orbital. How do you actually define the small satellites? What is your business niche so to speak?

Marc Bell:

So Terran Orbital is the company that I started just under 10 years ago. We are the pioneers of new space. And I can say that definitively as we are the people who invented the CubeSat. The CubeSat was invented by Dr. Jordi Puig-Suari and Bob Twiggs and Dr. Suari had founded and built a CubeSat at a company called Tyvak Nano Satellite Systems that we acquired back in 2013. So this whole new space revolution began here at Terran Orbital.

Dr. David Livingston:

Ah interesting. What made you think that that was going to be the way of the future way back when?

Marc Bell:

I was invited to go about down to SpaceX for a tour, and I was looking at how someone was telling me they could put a school into outer space jokingly, and I asked him, why would they throw a school bus into outer space? And they laughed. And I said, no, seriously, if my iPhone has more computing power than the space shuttle, why is anybody building a satellite the size of a school bus? And they're like, What are you getting at? I'm like, I'm thinking of building really, really small satellites. And with that I went on a mission to learn more about the CubeSat, which was an educational demonstrator, started by two college professors, and I flew up to Cal Poly San Luis Obispo to meet Jordi. And I was very, I asked if he wanted to come work together. And he was excited. But he said, I had to buy his company, Tyvak. So we acquired Tyvak, then merged it into Terran Orbital, and back then Tyvak was selling parts to enable colleges, universities and startups to build CubeSats and CubeSat is a satellite that you can hold in the palm of your hand. And our very CubeSat that we built, it has actually been sent to the Smithsonian and will be on permanent display starting next year. So we're very excited about that. And Jordi is being inducted into the Space Hall of Fame at the Space Symposium in the first week of April, for his accomplishments in developing it. And so we decided to stop selling parts and start building satellites. But we realized that, you know, with he didn't have an open format. So everybody was able to use the CubeSat. Anyone could build one, so all these companies, Planet, BlackSky, Spire, and so many others wouldn't exist today if it wasn't for Tyvak and the parts that we developed. Then you fast forward 10 years later, you know, the US government is saying how 50,000 satellites are going to be launched over the next 10 years. Everybody's fascinated with launch SpaceX, Rocket Labs, it's exciting to go see a launch. But no one ever talks about who's going to build it. And we are the last independent manufacturer of small sats based here in the United States. But to us a small sats now are predominantly in the 150 to 500 kilogram range, because we realize while CubeSats are one use, two use maybe five or six use, and they're functional, they do things. But in order to be very functional and provide a lot of added value in low Earth orbit, you really need a larger form factor to have enough electricity, enough batteries. As you go around the Earth, you don't always have to be in sun synchronous orbit, and you have enough power when you're, when you're in the dark side of the Earth at night, you could still do whatever you're trying to do, and still do whatever you're trying to do, and broadcast it back to the ground without having the

sun powering it. And it's exciting. And we're a one stop solution provider. So we go ahead, we build 5g, Internet-of-Things. Radar, electro optical imaging, synthetic aperture radar, RF, but we're predominantly a military contractor. So we are big in the A and D space. Our primary customer is DoD and the intelligence community. We do a lot of work for NASA, which is really amazing. But our bread and butter is military.

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Dr. David Livingston:

What can a 150 to 500 kilo small sat do? Is it limited? Or can it do what a big satellite does?

Marc Bell:

It can do what a big satellite can do. What used to cost a billion dollars now costs \$10 million. What used to take eight to 10 years to build now takes 12 to 24 months to build. And you know, people like SpaceX made it affordable for satellites to get into space. People like us made it affordable to build a satellite that they're gonna launch.

Dr. David Livingston:

So if you're building for DOD and intelligence and other agencies, I don't expect you to be able to say much on this, but I'm curious. How are you protecting them from other nefarious actors? Well, Russia did an A-Sat test around late last year. Who knows what's going on over Ukraine? I'm sure most of what's going on is not in the press. So how do you protect them if you're building for DOD and can you say anything about that at all?

Marc Bell:

Yeah, well, if so we built the majority of what we build the low Earth orbit. You know, General Hyten once said, you know, you know, he's tired of building big juicy targets in space. And so the government used to do is build these massive geosynchronous satellites that sit there that are big sitting ducks. We are travel in low Earth orbit and granted we build Mid-Earth orbit. We do build Geo. We are even building a mission to the moon. We are launching shortly. two missions to the moon, lunar IR and Capstone. And we are, but really low earth orbit, we're traveling it's six kilometers a second. And think of that is three times the speed of a hypersonic missile, we're going really fast, we're really hard to catch. And because you watch constellation, not just one off, you have lots of redundancy built in. So even if they knock out just one of my satellites, it doesn't make a difference.

Dr. David Livingston:

That's pretty fast. six kilometers per second in Leo, what's the life expectancy of these small sets.

Marc Bell:

So the way to get the cost down, one of the things is, you don't build them to be radiation hardened. So they last about five years that we totally we build them to last a minimum of five years in orbit, they can last six, seven or eight, but five years is what they're built for. So they last five years, they last five years in orbit, and they will, since the radiation from the sun will burn up the battery, we will then de-orbit them and send them back to Earth. So we try to be socially, we've added the social responsibilities for exactly we're leaving no impact in space, no debris, everything deorbit and zero footprint in space.

Dr. David Livingston:

I have a question already for you. Todd is in San Diego. And he said, I know you're not building star links, but are they on the order of what you're talking about?

Marc Bell:

Yes, I think we're much larger than Starlink. But we both felt like the size of the refridgerator in your kitchen.

Dr. David Livingston:

And that's considered a small sat. Correct? It seems pretty big to me, but. . .

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Marc Bell:

As long as you could fit in the back of your Chevy Suburban, it's a small sat.

Dr. David Livingston:

Okay, so I guess that's a good key, right? Do you have international customers? Or is this an ITAR product?

Marc Bell:

I know we've got customers we actually have a factory in Italy that just does international work. And so we sit we have a Chinese wall between us, for lack of a better term than that, between the US and Italy. So the ITAR products never leave the country, they're built in Italy.

Dr. David Livingston:

Fascinating. So are you are how do you get your funding? I mean, are you a public company or a SPAC or how do people... can people buy stock in you? What's the story on funding?

Marc Bell:

Sure, so last fall, Terran Orbital reached an agreement to merge with a company called Tailwind Two which trades today under the ticker symbol TWNT. Tailwind Two is a special purpose acquisition company, or SPAC. And if and when the transaction closes, the shares at TWNT will be exchanged for shares of our company Terran Orbital, and

merge with Tailwind Two, we're expecting that merger to take place. And on March 25 of this month, if all goes as planned. Our vote is on March 18. But the SPAC is just a vehicle to go public. We could have done an IPO, we could have done a direct listing. But we thought the SPAC had the highest likelihood to close. And before then, funding came from Lockheed Martin has been our largest funding source. After that it was Beach Point Capital and then myself and my partners.

Dr. David Livingston:

What's the symbol it's going to trade under when it goes to the SPAC?

Marc Bell:

You're gonna love this – LLAP

Dr. David Livingston:

LLAP...

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Marc Bell:

You know that stands for?

Dr. David Livingston:

No, but you're gonna tell me right?

Marc Bell:

Live long and prosper.

Dr. David Livingston:

Really? How cool is that? I would not have guessed that but. So it's 'P' not 'T', right?

Marc Bell:

LLAP – the P is 'Prosper'.

Dr. David Livingston:

I bet some of my listeners might have eventually figured that one out, but I would not have figured that one out. So you must be a Star Trek fan.

Marc Bell:

I am a huge Trekkie, and I am very, very, very thrilled to have gotten the stock symbol and we joke that this is a Trekkies dream come true. I was a Trekkie as a kid and now I'm actually building real vehicle in space.

Dr. David Livingston:

Where do you see this all going? And in five years because for CubeSats in general, I would imagine there's not a lot of barriers to entry because there's so many players getting into it in the market with imaging and who knows what else? Where do you see all of this in five years from now?

Marc Bell:

We don't do that anymore. We don't build CubeSats anymore. We're building, you know, satellites, you know the size of a small refrigerator to the size of a large refrigerator in the kitchen. You know, we don't do a little thing to hold in your hands anymore. Okay, you know, we're building much more functional things with a lot of power. We do 5g from space, Internet of Things from space. We do electro optical imaging, we do hyperspectral imaging with Delta Gamma trader, Software Defined synthetic aperture radar, we do communications. We're a satellite manufacturer. And we're really a contract manufacturer for people like Lockheed, or the DOD, the IC community, NASA, hire us to solve problems from space. So people come to us with a problem they wish to solve from space, we help design and build a constellation to solve their problem.

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Dr. David Livingston:

So that side of the business, the contract side, how do you see that in in five years, so in do things in the economy today, influences like the national debt influences like inflation, excuse me, interest rate raises, that they promised they're going to give us a great gift and other things going on in the economy, how does that affect your contracting business? And in five years, what would you guess?

Marc Bell:

So, you know, we're very lucky on multiple levels. First, you know, the, the NDAA, or National Defense Authorization Act, is the act that funds the DOD and the IC community. It is the only thing in Congress that the Democrats and the Republicans have almost unanimously agreed upon in the past six years every year. And in a time that we now have a Democratic controlled Congress, and a Democratic White House. The Democrats did what the Republicans usually do, is actually doing it the DoD put in for its funding. They gave the DoD \$25 billion more than they requested. And that's usually a Republican trick. That's how much bipartisan support you truly have. For what for national security and what's going on today in the Ukraine, really highlights the need for assets in space, for intelligence gathering, for real time information on what's going on around the world. And we see demand going through the roof.

Dr. David Livingston:

Who do you have as competitors?

Marc Bell:

We had a lot of great competitors. They all got they all got acquired like Blue Canyon got acquired by Raytheon, Millennium got acquired by Boeing. So we say we say like the Borg. They got assimilated. So all that high cost structure of Big Primes got pushed down onto their acquisition, which made them non competitive, but we still compete when we are prime. We work hand in hand with Lockheed. We have a strategic cooperation agreement with Lockheed Martin, that we do a lot of programs together with. We're on SDA's tranche zero, and we just won SDA tranche one, we continue to win more and more programs. We win, because we're cost effective. And we're priced competitively. And we and unlike most of these startups, we've been doing this longer than everybody else, putting small satellites into space.

Dr. David Livingston:

Fascinating. I have an email from Jerry and Jerry is also in San Diego. Interesting. And Jerry says, how fast is the technology changing? So something you maybe did two years ago or three years ago? Has it already been passed by with new technology?

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Marc Bell:

Yeah, it's just like your iPhone. It keeps changing. So you know what the great news is because it only takes us 12 To 24 months to design, build and launch a satellite. And it is video technology, we keep these satellites very current, because they're also only built because remember, a satellite used to cost a billion dollars to build it in 10, eight to 10 years. So now divide that billion dollars up by \$10 million. You can build a lot of satellites for the same amount of money. So you then stagger that over a couple of years. And you always have current technology in orbit, because I already saw a satellite the other day that they started working on over 15 years ago. And there's a big satellite program and done by one of the big primes. But my iPhone had more computing power than that satellite. But that's just the nature of the beast. And so we are we are revolutionizing how the military look at small sat.

Dr. David Livingston:

Pretty interesting is your iPhone as reliable as big satellite.

Marc Bell:

My sat is a far more reliable than the iPhone. Because I have to. I have to reboot this thing. Every day. Kills me.

Dr. David Livingston:

Yeah, well, you know, I'm lucky if mine even even works where I live. So maybe that has more to do with the company than the iPhone. I'm unsure about this. You have Jane in Seattle. And Jane says, What are employment possibilities in your company, especially for fresh hires out of school? And what do you look for?

Marc Bell:

So if you go, if you go to terranorbital.com, there's a career section, I have 184 job openings as of last night. Some of those jobs that are posted multiple are for multiple people. We love people at school, we love people who have 20 years' experience. We only hire the best and the brightest. So we always look for people who are super smart. And most people here have an advanced degree. Mostly you are eligible if you have the electrical engineering, mechanical, structural, thermal, aerospace experience. It is a lot of very, very smart people roaming the halls of this place, I can proudly say, I am the dumbest guy in the building. And I always want to remain that way. Because if there's someone here is dumber than me, they shouldn't be here.

Dr. David Livingston:

Barry's in Denver, Colorado. And listeners. As you know, I make this appeal on every single show. We much prefer phone calls over email 1-866-687-7223. But Barry in Denver chose email. So Barry says, we hear nonstop, no matter what news you listen to about cyber threats here and there. So are you vulnerable to cyber threats, both in terms of your satellites, but also your company? Are you a hacking target, for example, since DoD is a customer?

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Marc Bell:

So we never comment on things like that. I can say in general, that every defense company is always a target. And our satellites in space, keep in mind, they're moving really fast. And so for ground stations to lock onto them, It's very difficult to they are moving at six kilometers a second. But we take cybersecurity very, very seriously. And then I other than that, I have no comment.

Dr. David Livingston:

Do you have any kind of orbiting servicing with your satellites is it cannot be done with with LEO satellites. We hear a lot about companies working on orbiting servicing for satellites. I know that's probably in higher orbit. But how about for you and LEO?

Marc Bell:

Yeah, no, we actually do MEO, we do LEO, we do Lunar, we operate everywhere. So there is no domain in space that we don't operate in. LEO just happens to be what everybody talks about. Because that's where the most activity is going on. The really exciting stuff is flying by further up and further out. And then we have a mission to the moon, where we were going to help map the moon with infrared. That will be launching in May, we have another mission to the moon, we're going to help build the feeding station constellation for the first moon base, where the satellites will always be set the relay stations that will always be facing the Earth. So they'll be in constant contact with the earth all the time.

Dr. David Livingston:

So what about orbital servicing and life extension and things like that, that we hear a lot about?

Marc Bell:

We spend a lot of time talking to people with customers on how to build geosynchronous satellites that you can swap out boards in space, make them upgradable in space, we spent a lot of time doing research on that, and helping customers work through solutions. That's all.

Dr. David Livingston:

Do you have any debris mitigation plans? Or is that another niche in the business left to other companies?

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Marc Bell:

No, we believe you have to do it all. We do it all. So we do what's called space situational awareness, where we help map out space debris, and we have satellites to do that. And we're also working on collision avoidance that we have. If you ever go on an airplane. And as you know, in the cockpit of all airplanes today, it's something called a TCAS, the Travel Collision Avoidance System. And if they have another plane, it's coming into kind of feels like there's gonna be a collision, it tells you pull up, go left go, right, it gives you screens with instructions on which way to go. So we're working on building that sort of TCAS into our satellites. So when it sees an object coming towards it, it knows where to move, move out of the way and move back into position all on its own. This is a thing of this artificial intelligence and space, satellites, making a decision where to go to avoid the object that's coming through it, and then go back to where it needs to be.

Dr. David Livingston:

Pretty impressive and you design these yourself, that you're not contracting out. design are the any of the manufacturing on the satellites, everything is in house, is that correct?

Marc Bell:

We make 85% of our components in house we are working on vertically integrating. So my goal is within three years 100% of everything we build in house except for solar panels, which we'll always get from Lockheed Martin.

Dr. David Livingston:

And you're launching on all launchers that that's probably not your choice, then it's whoever contracted you choice, right?

Marc Bell:

Correct. The customer decides where he wants to launch A majority of our launches are on SpaceX. They're very reliable, right. But we use Rocket Labs as well. And you know, we are the customer drives the bulk of that program.

Dr. David Livingston:

Have you done any on foreign launchers or Arianna or any other possible options out there?

Marc Bell:

We have in the past, not going forward. We don't as our client base goes almost exclusively to the DOD. Not exclusively, but majority DOD and I see, and that is the US launch tends to be the best. And also, it's more cost effective, since we build the majority of satellites here in the US. We do have an Italian facility. So it it's built in Italy, we can launch in Europe, but all the ones built here in the states we launch in the states.

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Dr. David Livingston:

Where is your manufacturing done in the US?

Marc Bell:

We have facilities in Irvine, California. And then we offices around the country.

Dr. David Livingston:

Fascinating. So once you're a SPAC, and I guess that's the end of March, right?

Marc Bell:

Well, no, we will never be a SPAC. A SPAC is a four letter word in this world. We're merging into a company that happens to be public. And they happen to be a SPAC. But people confuse SPACs with the companies they are acquiring. So we tell you most people don't focus on the target. And there are a lot of companies out there that merged into SPACs today that never should have gone public. They weren't you know, we're very different. Or we're very normal. We're a real company with real revenues, real backlog, real pipeline and real management. I announced just recently, over \$170 million of new contracts and awards I announced just a week and a half ago. You don't see any other new space startups doing stuff like that. And that's just the last few weeks. So you know, we are very much a real company. And we can take advantage of the public capital market.

Dr. David Livingston:

So I was driving at and so maybe my assumption is wrong. And you can correct me that you this would lead you to being listed as an exchange traded fund. But it sounds to me

like you feel beyond a regular stock exchange listing.

Marc Bell:

Yeah, we will be on the New York Stock Exchange. We'll be on the world's biggest exchange.

Dr. David Livingston:

Do you see the use of commercial assets in this Ukraine thing going on, which seems to be new to many, many people, you know, I'm seeing articles about it and tweets and this and that. And the other and a lot of people seem almost surprised. The role of commercial SATs. And what they're doing over Ukraine, is this a game changer for the industry?

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Marc Bell:

It is proving the fact that the world needs more ISR, you know, intelligence, surveillance and reconnaissance satellites. And, you know, so Ukraine is in dire need of data. And with data, you know, you think about it, you know, we've had peace in Europe for 60 years, you've had peace with Russia, you know, and because we were all an open book, you know, until Trump, we had overflight, they could fly over us, we could fly over them. They saw our nuclear missile silos we saw theirs. When you have full transparency, that's how you prevent a war. And in this case, you know, there wasn't, you know, the Ukrainians do kind of got stuck in the middle of a political pissy match between United between NATO and Russia. And, you know, it's, it's very much unfortunate what's happening over there. There's no reason for it. In this day and age, you would hopefully become more civilized as we mature the civilization.

Dr. David Livingston:

Well, live long and prosper on the web. So the commercial satellites is for the most part, is there? Is their data quality enough for for all of these purposes that we're sort of talking about today? Do they come up short in in some of the the work that they attempt to do? Or are they as good and as what used to be government only?

Marc Bell:

It's not as good. You know, it's okay with the threshold, but it's helpful. So, you know, we got all these commercial companies that are held trying to help Ukraine, and I applaud them for providing the data. You know, I wish they wouldn't share it with the New York Times, because anything they post to CNN, The New York Times the Russians see as well. So that kind of defeats the purpose of intelligence, than that's just the media trick that they're doing. But if they truly want to help, they should provide the Ukrainians the data, and be quiet about it. Because it is data and it is useful in whatever resolution it is.

Dr. David Livingston:

They need to learn to be quiet. And I think SpaceX says too, because, you know, I'm reading all about how they're supplying Starlink and ground equipment to everybody. I think they're just going to be a target. And, and they're not immune. They're not immune from being a target, because they're commercial.

Marc Bell:

SpaceX is different for what they're doing. Because the difference is, when you when people say they're trying to help Ukraine Government, by posting Russian troop movements in the front page of The New York Times, you think the people in the Russian Embassy in Washington DC don't read the New York Times or The Washington Post? Of course they do. So as soon as they see that picture they know to move. That doesn't that's not helpful. So the Ukrainians, were telling the Ukrainians is doing what's going on without the Russian knowing what they know. And that's what's helpful.

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Dr. David Livingston:

Interesting that we're having this discussion on I just got a Wired Magazine bulletin – 'High Above Ukraine, Satellites get Embroiled in the War, while the Russian Invasion Rages on the Ground.' Companies that operate data collecting satellites find themselves in an awkward position, Of course, I don't have time to read it. But a lot of people are talking about it.

Marc Bell:

Yeah, but they're using the tragedy in Ukraine to try to pump up their stock price. And I personally find that appalling. I think they should be helpful, do the right thing, and be quiet about it. And that's the right thing to do.

Dr. David Livingston:

So you have an email from John in Fremont, California. And he says Terran can still become part of an exchange traded fund, like the UFO exchange traded fund if they meet the criteria on counting on it. So he's an ETF investor.

Marc Bell:

Well, I hear that sounds great. I didn't know but I didn't even know that the UFO ETF, but I just made a note of it right now. So thank you for that.

Dr. David Livingston:

Yeah, it's, I think, either the first or second biggest, their guy comes on the show all the time, and talks about it and talks economy and tries to sell UFO rather than individual investing. So take your pick and take your risk. That's what I say.

Marc Bell:

Yeah, I mean, there's a lot of space companies out there that should be not out. But we view ourselves as a defense firm. You know, we don't view ourselves as a space

company. We're solving problems from space, not locked in with all these new space companies. That we're in a different world.

Dr. David Livingston:

So that you're not categorized as new space or commercial in that sense at all.

Marc Bell:

We don't consider ourselves that now. Not the way we look at ourselves, we look at we're all over the national security, the national interest. Yeah, we do a lot of civil work for NASA, the the DOD and the IC communities, that biggest customer. That's the most important thing.

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Dr. David Livingston:

How did you end up you know, morphing into the defense industry from from your background and how you started? What's the story on that and from CubeSats? How did you end up going DOD and what you're doing now, this is a fabulous transition.

Marc Bell:

Well, you know, it's actually been a while we started at Globix. We owned 20,000 miles of fiber around the world. So if you have 20,000 miles of fiber around the world, you tend to make a lot of friends in a lot of three letter agencies. And so we maintain those friendships over the decades. And, as we've always viewed ourselves as patriots, and wanting to help keep America safe. In the 90s when we on-boarded. Where we couldn't reach fiber, we started building ground stations throughout Eastern Europe. And we started a company called NetSat Express in order to provide IP transport built by the transponder stations and satellites. So we can reach all these ISPs in Eastern Europe that were cut off from the world because it had no access to the internet. And that was my first exposure to satellites. But it really all started when I was 10 years old, and watched the 24 Star Trek marathon. And that's really helpful.

Dr. David Livingston:

So we'll put that down. 24 hours Star Trek marathon and this is the original Star Trek, right?

Marc Bell:

Yes, there was a story as I was stuck with my father at a convention when I was 10 years old. We couldn't go outside because we were in Florida and it was snowing, but hadn't snowed, in like 40 years. And still, I was still with my sister and I was stuck in a hotel room. And we and we did do a watch TV. And I never saw Star Trek before. Never heard of Star Trek, I was fascinated. And a Trekkie was born.

Dr. David Livingston:

Joscelyn in Phoenix has an email for you. And listeners, again, if you can try the phones instead of email 866-687-7223. She says since you're in LEO, what is your view of LEO getting pretty crowded and jammed with all the satellites and the constellations? On the space show we even talk about Rwanda, seeking authorization for 300,000 LEO satellites, plus whatever One Web and SpaceX and others are planning. is LEO big enough to accommodate this without the risk of collision all the time?

Marc Bell:

Well, think of it this way, the Earth is 60% covered with water, 40% covered by land. On that landmass, you're all on a single plane, and you have 3.2 billion cars driving around and space, you have a plane that's bigger than the Earth because it's larger than the sphere of the earth. And you have 43,000 miles of y. So 43,000 plane miles of plane to go for. So there's a lot of space in space. Space is crowded at all, it's just people have to be more sophisticated. And that's what's happening now is governments and companies have to be more sophisticated, how they manage traffic and space. But no, there's tons of room in space to put tons of objects.

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Dr. David Livingston:

But is all space equal? Is there less than tons of space for desirable places to put stuff?

Marc Bell:

There's a real place that it has there's a lot of rules is geosynchronous. So there's only so many spots that are always over New York city. So you can think about yo your direct TV or your XM radio, or and then all the spy satellites. And so there that just exists in orbiter communications, there are only so many spots in geosynchronous without bumping into anybody else. And that's where that's where it gets complicated, then what happens is, people go ahead and they squat. So even if they have a satellite dead, they leave it there. But no one else could go there until they figure out what else to put there. So it's like real estate. And so it's almost like the metaverse they're buying, they own the real estate in space.

Dr. David Livingston:

Do you see the regulatory regime changing and adversely impacting the business? Or is it going to open up and in, maybe even be easier to function in?

Marc Bell:

I think once you get, you know, space, situational awareness down to a true science, and you have true traffic control and space, and people have true collision avoidance systems, and foreign governments stop being irresponsible and blowing stuff up in space. If you look at what the Chinese did, and what the Russians did, that's just irresponsible. Because they're creating debris in space, that could put other objects and human lives now at risk on the ISS and other things. It's irresponsible, what they're doing, and they need to act responsibly. But once we figure out how to clean up the garbage in space, which will happen, I mean, that is not technologically impossible, it's actually technologically very easy. It's just someone is going to have to have the will to pay for it at this point. To clean up the debris in space, then we'll be things will be seems will be very organized going forward.

Dr. David Livingston:

Timeline for all of that to take place in including acting responsible responsibly?

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Marc Bell:

[Laughs] I don't know 2000 years? 3000 years? We still can't act responsibly in our own planet on the ground. I don't know how we're gonna do it in orbit.

Dr. David Livingston:

Okay, so until that magic day happens. Do you see an increasing Oh, forbearance of regulations to compensate for our not acting responsible?

Marc Bell:

I think there's more, but you're definitely gonna see, you know, more and more regulation, but don't be overbearing because remember, every country's got to agree, the Chinese and the Russians and everything else all have to agree.

Dr. David Livingston:

Yeah, that's gonna be an impossibility. The way we're going now, here's a here's another one for you, Linda's in New York. And she said, right now, today, the US is highly partisan, highly divided on almost all issues. Maybe on Ukraine we're somewhat united. But generally speaking, we are a highly divided country. And one side hates the administration and power. And if and when that changes, then one side will still hate the administration and power. So do you see the partisanship and the politics on the domestic front going on in America? And that has gone on for maybe the past 12 to 15 years, including today, as a detriment to satellites in the space business? Or is it an asset? Or is it neutral?

Marc Bell:

You know, I give Congress a lot of credit, and both parties a lot of credit, that they both have been very unified in their approach to space for the most part, they've both been very supportive of the DoD desire and mission in space. I think I think they're being very constructive. And, and very helpful. So I really can't complain a lot about how I have a lot of other things that I can complain about, but space isn't one of them.

Dr. David Livingston:

So space seems to have a little bit of immunity from what's going on with the rest of the country?

Marc Bell:

Well, I think they all understand that space is space is very, you know, everyone's interested in space. everyone realizes you can solve problems on Earth from space, and everybody very much wants it to succeed. So I think you see the government being very cooperative, very helpful, at least that's what I see, the government being very cooperative, very helpful.

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Dr. David Livingston:

So we don't often on the Space Show get a chance to talk to the defense contractors who who do that. Only, I mean, we have talked to people from Boeing, that usually it's about their commercial vehicles, or ISS or, and we've talked to people from Lockheed, and that was mostly about Orion and their projects, so, but it's a little bit different in talking to you. So one of the things we also talk about, and I'm going to try to tie it together with you, is that the, the general public, is not necessarily particularly well informed on space. And we hear this about space tourism. We hear this about launching rockets, and they're not green. All sorts of different things, environmental concerns, that maybe are not really true environmental concerns. So how do you see space in general, not specifically what you're doing? In the general public? Are we well informed on space and this type of related science? Or is there a lot of room for progress?

Marc Bell:

Unfortunately, there's a lot of room for progress. So it's just getting the general public to understand that first of all, not all LEO satellites are the same. Everybody assumed everybody was in LEO's do the exact same thing, or everybody who's doing a LEO, not all imaging is the same, not all technologies are the same. And trying to get people to understand they're very different products that do different things, but completely different. And they and, you know, it's, you know, it goes back to you know, we have to spend more money in schools on STEM, and educating people in schools. And, you know, there's, but we need more math and science in the classroom, and that will help down the road.

Dr. David Livingston:

You have a listener phone call. So I Hi, listener, welcome to our program this morning. Who are you? Where are you please?

John (show listener who called in):

Hey, David it's John in Fremont.

Dr. David Livingston:

Hi, John. Welcome to the show. Hey,

John (show listener who called in):

so I had a question. regarding sustainability and on orbit servicing and stuff are you working with firms like Red Wire to, you know, outfit your satellites with like dog tags that

are the magnetic systems for deorbiting and or servicing satellites.

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Marc Bell:

We do work with Red Wire, it's a great company. I don't know exactly all the time ahead what we are doing with them with them. We do have our own deorbiting system. I do know that. But that was that was long before Red Wire was created. But those are great guy. They're great guys, and they built a great business.

John (show listener who called in):

How does how does your deorbiting system work?

Marc Bell:

We technically how does it work? I couldn't tell you over the phone. You know, I can tell you that, you know, we are big believers in sustainability in space. And we make sure that all our satellites deorbit when they're when they're when they're done with their useful life. We want to leave no footprint in space.

John (show listener who called in):

Is it explained someplace on your website.

Marc Bell:

It is not

John (show listener who called in):

Okay. Is it a security issue?

Marc Bell:

We'll Yeah, we don't discuss the technical details of our security. Yeah.

John (show listener who called in):

I understand that that makes sense. So, so are you like standardizing your satellite? I guess, bus or structure so that you can mass produce them?

Marc Bell:

We are working towards that goal. So that is a very good question. So we are definitely working to standardizing our buses that we have. We make 65 components in house already. Our own star charters our own flight computers our own reaction wheels. And we view it all as Lego. And well, I also happen to be a big Lego nut, I know, shocker. And, and so we literally make all our components to all plug and play. So whether we're doing 150 kilogram bus, or a 500 kilogram bus, we just literally plug different Lego components, different battery sizes, different power modules, different radios, and play them all together. So everything, a lot of what we do is plug and play. Because we are getting to that point that we want to be able to do everything on a robotic assembly line, and really producing the math. And so we are going to open up in Brevard County, we're going to be building one of the world's largest satellite assembly facilities, it'll be over 650,000 square feet of space. It's almost a kilometer end to end. And that's an industry 4.0 facility, where it will be a lot of robotics and a lot of automated vehicles inside that facility, moving satellites around and assembling them and NASA will be able to we will produce over 1000 small satellites a year out of that facility alone.

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John (show listener who called in):

Are you doing any 3d printing?

Marc Bell:

We are going to be doing additive manufacturing. So next generation 3d printing. Are you familiar with additive manufacturing?

John (show listener who called in):

Yes.

Marc Bell:

Yeah. So we do that instead of 3d printing.

John (show listener who called in):

Okay, cool. Well, do you train your employees with the Vulcan mind meld? Or how do you get them standardized?

Marc Bell:

It's close, it's close, we tried it that way for a while and it didn't work as well as we thought. So instead, we bought them HoloLens 2s, which is this headset that goes on their head, and it's translucent, and it shows them how to assemble a satellite how to do a job. And then we use Bluetooth enabled tools. So then they get real feedback back. And it's pretty impressive stuff. And it's not quite there. But you know, but they have these these eyewear that people wear. It's very cool. I mean, I was an early adopter of Google

John (show listener who called in):

Wow well that's pretty cool. Well live long and prosper.

Dr. David Livingston:

Anything else John?

John (show listener who called in):

No, that's it. Looking forward to you getting on the UFO ETF so we can get on board through it.

Marc Bell:

John, thank you for calling. I really appreciate it. Okay.

Dr. David Livingston:

Thank you, John. listeners are still time if you would like to give us a call 1-866-687-7223 and you can continue to send email, Dr. space at the space show calm. It sounds like you really have a good time doing what you're doing. Is there something that stands out in your in your work and your company and all of what we've been talking about that that really sends you to the stars more than anything else?

Marc Bell:

You know, I love what I do. I truly love what I do. I work crazy hours. I put in some days like 15 hours a day. And I think it's awesome. I mean, we're literally we're helping to make the world a safer place. I get to play with really cool toys, and I guess I get to watch sci-fi movies and be like, Wow, we do that we do that, we are going to do that. And we really should do that. And that's how we like a movie nowadays. And it's pretty funny. And so it's so exciting to see all the crazy stuff we could do with space now. And watching all these, you know, spy movies, and like, wow, we do that now we actually do that. That's so cool.

Dr. David Livingston:

So you're inspired to create products or improve products by sci-fi movies.

Marc Bell:

Yeah, I'm inspired, I'm inspired by helping to keep the warfighter safe. You know, these brave men and women go out there and put their lives on the line. So we can enjoy the freedoms that we have here. Think about how lucky we are here in our society, if people complain to the things people complain about here is nothing like what they have to complain about in the Ukraine. And we're very lucky and very blessed. And it's because of the hard working men and women in the US military services and in the intelligence communities, we are able to live this lifestyle. And if we could do things to help support that, that makes you feel good at night, I get to sleep at night saying wow, I made a difference. And it's nice.

Dr. David Livingston:

And you have a lot of fun doing it.

Marc Bell:

I have a lot of fun doing it. I have the best job in the world. I'm doing my passion, doing my dream. I'll never get into space. You know, I'm too old to do that. And but that being said, I do the next best thing is I'm putting things into space. And it's great.

Dr. David Livingston:

Speaking of, you're not ever getting into space, I mean, never say never.

Speaking of being old and fat you mean? [Laughs]

Dr. David Livingston:

Well, if they lower the launch cost enough maybe...

Marc Bell:

I can't. My cardiologist would never allow it. It will be a one way trip.

Dr. David Livingston:

Well, they may they may have new meds that you never know.

Marc Bell:

I did sign up for Virgin Galactic, I did put a deposit down. So just in case I have that have that ability. I did put my name on the waiting list.

Dr. David Livingston:

Would you go if they actually called you?

Marc Bell:

If I was allowed to go, yeah, I mean crazy opportunity to go into space. But if I really want to go to if I want to go like this is the next generation ISS. I don't know if I want to I don't know if I want to fly in something that was built by the lowest bidder 40 years ago. That's what that's like giving you a give me an iPhone from when I was a kid. I had this brick phone in my car. I'm not sure I want that back again. But maybe the next space station. Yeah, that'd be kind of cool.

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Dr. David Livingston:

So that brings me to what may be close to the end of the show. And unless somebody wants to send us an email or, or give us a call again. But we've recently been talking on the on the Space Show about private space stations coming online. I know that they're not satellites, but but they are in space. And I've had some recent guests on that think maybe our international partnership with Russia may made window in the space station may come down earlier. And that might not be such a bad idea. Because when the space station comes down, that opens the market for the private space stations to get up there. Whether there'll be a lag in time or not. It remains to be seen. How do you how do you think about or do you think about private space stations? And would that have any significance to your business?

Marc Bell:

They have no significance to our business. I mean, for what we do. I think it's a great for someone to go do it. And you have a lot of people out there, whether it be Bezos, or Elon Musk or one of these other multibillionaires who can actually afford to do it. But it's a massive undertaking. I mean, you think about the Artemis rocket, you know, Artemis rockets cause what, \$11 billion to get off the ground? The other problem going, you know, it's a real financial undertaking. But you know, but the benefits that have come from having the ISS to the scientific community has just been enormous for the past few decades, having the having the ability to do things in space. You know, we own a company called Made in space, another company called NanoRacks, that we sold that both were based on the ISS and still are. And you know, these are, you know, the ISS has real you know, there's real science can be done in space, that you can do in a Zero G environment you just can't do on Earth. And it would be a shame not to have that ability, as a nation to lose that ability. But then again, it was a shame to lose the space shuttle that was a reusable vehicle to go back and forth. They could take payloads back and forth. You know, we spend more money as a country on on the future. And it's very important.

Dr. David Livingston:

I have another email from you, and this is Randy in Atlanta. And on the Space Show years ago, it hasn't been mentioned Lately, David, maybe you want to look into this. There were people advocating that we would soon have personal satellites, controlled by our iPhones, or I guess if you have a different brand, that brand of phone. I haven't heard about personal satellites in a long, long time. This was in the earlier days when CubeSats were coming into fashion or in fashion. What do you think? Is there an emerging market for personal satellites of some sort?

Marc Bell:

I own my own satellite. Well, I haven't. I haven't connected to an Xbox controller.

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Dr. David Livingston:

Yeah, but you're talking about your company satellites, right?

Marc Bell:

No, no, me and my partner. we own one ourselves. We built it ourselves. It's a little satellite. It's fun. It moves around. It's kind of fun. You know, what? One of the perks of the job?

Dr. David Livingston:

What can it do?

Marc Bell:

Just takes pictures, but it's fun.

Dr. David Livingston:

Is this going to be something that ordinary folks can do someday? And maybe move it around? Take pictures?

Marc Bell:

Oh, yeah. There is. If whoever wrote in the email wants to pay for it. We'll build them one.

Dr. David Livingston:

What do you think it would cost to build a small personal satellite to go take pictures or something?

Marc Bell:

Build and launch? Maybe a million dollars?

Dr. David Livingston:

A million dollars? And how long would it last?

Marc Bell:

It would last five years

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Dr. David Livingston:

Five years? And could they fly it over anything? Like could they fly it over Ukraine or their neighbor's house?

Marc Bell:

In the US there are laws, so you couldn't do it over the US but Ukraine? Knock themselves out all day long.

Dr. David Livingston:

Wow. A personal satellite and launch for a million bucks.

Marc Bell:

I'm guessing. It's a good guess. But you'll look at Planet?. Planet built their "flock". And they took a commercial satellite, a commercial camera lens, threw it into a three-use that we developed. And they use that to go ahead and take pictures. I mean, how much did the flock salad cost from Planet Labs? I'm looking ... I've never been close to They say it costs a few thousand dollars to make their satellite, which, it's got to be more than that, but even so it's cheap, you can fly satellites cheap.

Dr. David Livingston:

But you need a ground station for the data or can your cell phone be the ground station?

Marc Bell:

No you need a unit ground station for the data. But you can go and hire a case sat or somebody your AWS is going to be your grand station for you. You know, there'll be money to run it. But you know, but you know, out of the reach of you know, there are a lot you know, if you guys like, you know, even guys, obviously guys like Bezos, Musk, a lot of billionaires can do it. But even millionaires, we look at all the guys who pay to go to the ISS. They're paying what \$35 million to get a joyride to the ISS?

Dr. David Livingston:

Yeah, or more. I think some of them paid \$80 million,

Marc Bell:

Yeah, so there you go. So for a fraction of the cost, they can own their own satellite. A fraction.

Dr. David Livingston:

Or I guess instead of a timeshare condominium you can have a timeshare personal satellite.

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Marc Bell:

Right? Um, you can go on Kickstarter and, crowdfund a satellite. There's actually this guy who did it once years ago. They, went to Kickstarter, built a satellite, and they actually built the app for your iPhone. So you could see it. And I don't remember who was I don't remember who it was. I remember this, like five or six years ago, these guys did it. And I wish I remembered who it was. But yeah. It was really it's pretty. It's ... you never know.

Dr. David Livingston:

You know, this has been a really great discussion talking with you. Have we missed anything? Is there something you wanted to, to maybe say on the show that we haven't gotten to or have omitted or something?

Marc Bell:

No. So I really appreciate you having me, David, this has been a lot of fun. More fun than most, I will admit. And I very much enjoyed being here today. So thank you very much.

Dr. David Livingston:

I hope we can check in with you later. Because this is a part of the business we don't get to cover or talk about very much. So I'd love to get back in touch with you down the road and see what may be changing.

Marc Bell:

Let's do it. I love that. That'd be awesome.

Dr. David Livingston:

Okay, well do and I guess it's corny to say live long and prosper so I'll just say stay well and healthy and safe, which is what I usually say.

Marc Bell:

It's not corny, because you want people to live long and you want people to prosper, so this is from the same TV show that created the flip phone. So how bad should it be? Well, there you go. There's some guys at Motorola now saying, Wow, I did that. We watched the show and I did that I finally created that cell phone.

Dr. David Livingston:

And I always tell my listeners and guests to keep looking up. So but you probably do that all the time anyway. Alright, thank you very much for listening. Okay. And listeners, Jim Muncie returns on Sunday. Marc, thank you again. Those of you who sent an email and John for your phone call, everybody have a great weekend. Goodbye from Marc, David and the Space Show.

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Tailwind Two is a blank check company "for founders, by founders" – formed for the purpose of effecting a merger, capital share exchange, asset acquisition, share purchase, reorganization, or similar business combination with one or more founder-led businesses in a sector being disrupted by technological change. Tailwind Two's management team and directors have invested extensively in founder-run businesses, with notable success in the space industry. Tailwind Two is led by Chairman Philip Krim, and Co-Chief Executive Officers Chris Hollod and Matt Eby. In addition to the members of its management team and board of directors, Tailwind Two has assembled an Advisory Board that will help position Tailwind Two as the value-add partner of choice for today's leading entrepreneurs.

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