Constellations Podcast

# Episode 129 – Laser Terminals as a Global Market Disruptor, the Adoption Across SatCom and Creating Mesh Networks in the Sky

Speaker: Bulent Altan, CEO, Mynaric– 26 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 Bulent Altan, Chairman and CEO of Mynaric. During today's podcast, we will discuss laser terminal technology as a market disruptor, the adoption of laser across the global space network, and how its implementation will impact the future of space communications. To go over this fascinating topic, we have invited Bulent Altan, CEO of Mynaric, a new company innovating laser communication terminals for ground, air, and space. Bulent, let's first talk about the landscape of global network technologies. Can you tell me briefly about some of the currently available technologies for communication?

Bulent Altan: John, first of all, thank you very much for having me on the podcast. I'm really honored to be here talking about constellations and optical communications, and their impact on the whole constellations push as we see it. Since the dawn of wireless communications, radio frequency based communications have been the dominant, if not the only major way, of communicating reasonable amounts of data. These RF based communications have given us everything from radio, early broadcast TV, aviation and maritime communication, communication for our civil, military, and government needs, and more.

Bulent Altan: First, they were analog in nature, but over time, with the advent of digital technologies, the overlying communication of RF also became digital, giving us capabilities such as Wi-Fi, cell networks, and much more. These applications, in large, are to stay, and RF based technologies are well suited for these wide area and wide geographical coverage situations. It is here to stay for these kinds of applications. But, optical communication lasers have been in use for some time now, giving us point to point communication. As one can imagine, not all communication needs to be a sender and a whole group of receivers scattered over a large area. Just like in wired and wireless communication, we have cases where we need to communicate between two points with very high bandwidth, high security, low power and mass, and immunity towards jamming through adversary means.

Bulent Altan: This is where laser width technology has been utilized in the past, similar to our use in fiber networks. The terrestrial implementations have been simple as they have not exceeded over two vast distances so far, but limited very often by the limitations also in horizon, and therefore have been simple to implement. Yet, as we now build networks which span more than the surface of the earth, we must look into networks covering airplane usage, airborne usage, stratospheric usage, and space or building constellations. Optical communications has to cover vast distances while remaining reliable, we need to connect fast moving objects. This is where free space optical technology, like the one from Mynaric and companies like Mynaric, are developing.

John Gilroy: In previous interviews, you've drawn a parallel between the early days of the internet and what's going on right now in space. And so, do you think this is really valid? Do you think your children look back and go, "Well hey, my dad was in the second wave" or something?

Bulent Altan: Absolutely. I think the current parallels to the internet are quite immense. If you think about it, when we first started the internet, it was a form of military communication that connected multiple nodes, in a resilient way, to prevent certain nodes from going off. It was really DARPA that made ARPANET back in the day, and over time it's evolved into this resilient network that connects pretty much everything in the world as we speak today. That networking really brought tremendous use cases revolving what used to be computers, now, to PCs, and handheld devices. Now we can't fully think about anything not connected. In a backdrop like that, we believe that space-based constellations will play a big role in getting into places where having that wired communication is not possible or feasible. Digging trenches and laying down cables made up of fiber or copper is not cost effective, and that's where space is going to play a big role in which optical comms will be building the backbone of.

John Gilroy: Bulent, among the prominent disruptors entering the global communications market, laser terminals seem to be at the forefront. Can you please explain for the general listener what a laser terminal is?

Bulent Altan: Of course. So what we understand about a laser terminal, or more accurately named free space optical communications terminal, is that it's a device which simultaneously transmits and receives a laser beam over long distances while using an outgoing laser beam to communicate vast amounts of data to the communication partner, using that receiving beam to receive data from it. In the crudest form, it would do that by turning on and off that laser, which we call on/off keying, to modulate data onto that laser beam. You can complete tens of gigabits per second of communication that way.

Bulent Altan: Going beyond that, when you want to achieve hundreds of gigabits, it does use more advanced modulation techniques to communicate that. For example, you would send the laser beam with data modulated onto it over those vast distances, achieving hundreds of gigabits of data. This can connect two satellites to airplanes, a satellite and a ground station, and other communication nodes. What makes these terminals unique is their dynamic nature. The terminal can accommodate very fast motion, if you think about satellites, they are are traveling at 17,000 miles an hour. It can accommodate high levels of vibration to the point that the vibration doesn't take the laser beam away from the communication partner. And it does all of that in a very high speed while keeping low power and a high security character.

John Gilroy: Bulent, I know you have an advanced degree from Stanford University and could go toe to toe with mathematicians on this, but just say you're talking to a software developer in the Midwest somewhere, could you share with us how technology makes laser communication work?

Bulent Altan: So, besides generating and amplifying a laser beam that it has enough power to reach a communication partner multiple of thousands kilometers away in space, the main challenges go into the dynamic compensation that I mentioned in the previous question. What makes laser communication powerful is how narrow the outgoing beam is, resulting in most of the energy used landing on the communication partners' receiver.

Bulent Altan: This not only allows energy efficient communication, but also means that even the tiniest of vibrations can cause laser beams to veer away from the communication partner, as well as that the movement of, for example, a satellite, can cause it to leave the incoming beams area. This means that both terminals need to track each other accurately, with multiple orders of magnitude, more so in RF based technology, and keep the beam concentrated by staying on top of one another. It also means very accurate optics, internal to the terminal, which also maintain accuracy over vast temperature ranges and quick moving mirrors that take out the movement by taking out the vibration and software system that control everything multiple hundreds of times per second. This really advanced control system is the unique heart of what builds it, Mynaric, and other free space optical terminals.

John Gilroy: So, last night, I told my wife I was going to interview Bulent and talk about laser communication between satellites and she said, "Wow, I can't imagine the math involved in that?" So, there's positives and negatives to everything. So Bulent, what are the pros and cons of laser communication versus the current available communication technologies?

Bulent Altan: As in any technology, optical communications is a complementary technology to a pre-existing one. As such, it isn't here to replace radio based communication, but enable new cases, or maybe, in certain cases where RF is falling short, take over those. The main advantages of optical communication is the immensely higher frequency and security due to the fact it isn't omnidirectional, meaning it doesn't go everywhere except the communication partner physically. So, it can't be hacked, it can't be interfered with, and it is also impossible to jam. In today's world, we see radio based communications being jammed quite frequently by adversarial forces. On top of this, optical times are very unique because of its low power usage and size.

Bulent Altan: To put this into numbers, for the same amount of power and mass that we build our terminals today, if we compare what is being used in space for an intersatellite link in RF technology, you are getting about six to eight megabits a second with the same power as size. Now, when you compare it to our Mk3 terminal, we get one hundred gigabits a second. So, the changes in throughput are tremendous. But, there are places where optical comms is not a perfect fit. In communication use cases, which go through the atmosphere, clouds can stop optical communications as they would stop the light transmission. This is something to take into account for unique cases.

Bulent Altan: Secondly, optical communication implementations are point to point today. Although there are multi-point communication technologies for optical content preparation, they are still many years out, so in order to cover a wide area you would need to use a radio frequency. So, for example, a communications constellation satellite would need a connection that would ground thousands of users. Like a one member Starlink satellite, that would be done in radio frequency. But, for that same satellites point to point communication to a neighboring satellite, gateway, or ground station, would use optical communication, concentrating the thousands pieces of communication from multiple users into a single laser beam and handing it up. That's the reason why we say we built the backbone of these constellations.

John Gilroy: So you just mentioned the speed of the transition and the size of some of the transition here. What about the types of data, is this one type, or all kinds of types? What role does that have in this discussion at all?

Bulent Altan: Our terminals and underlying technology is built easy to use and transparent. When our customers use our terminal and a link is established between the two communications nodes, the complexity of keeping the beam onto one another and taking out the vibrations in motion is, to a certain extent, hidden from the customer. As for the satellite, our terminal really looks like a simple cable between the two satellites. That really allows an easy implementation using the networks, the protocols, the infrastructure that we built on the ground to do communication exactly in space as well.

Bulent Altan: So, you hand off the new data and we carry it over, much like a cable, and try to make it as easy on you as possible. That means any kind of data can be transmitted over the multiple thousands of kilometers of our terminals. In our CONDOR Mk3 case, that's up to 8,000 kilometers, and in our larger case, the CONDOR MEO terminal, it's up to 40,000 kilometers in distance. Those hundred in gigabit and underlying data can be anything. That is, I want to say, one of the largest elements for making sure that this technology can penetrate all these networks. They make it easy to use for our customers, really mirroring what has been done on terra firma, aviation, and space, making sure that the internet doesn't need to be reinvented but reused in space networks.

John Gilroy: Bulent, thousands of people from all over the world have listened to this podcast. Go to Google and type in "Constellations Podcast" to get to our show notes page. Here, you can get transcripts for all 100 plus interviews. Also, you can sign up for free email notifications for future episodes.

John Gilroy: You know, Bulent, this is the Constellations podcast so I got to ask a question about networks here. What global communication network applications can laser terminals be used for?

Bulent Altan: So the immediate application that comes to everyone's mind are broadband constellations everybody talks about. There are many of them out there, and if you try to count them, there will be way too many. And I don't want to forget anyone out there, but they have been growing quite rapidly. These constellations are now talking about thousands and even tens of thousands of satellites getting broadband connectivity into every single nook and cranny of this earth. If you look into mobility cases today, like when you are on a plane, on a ship, in not so densely populated areas, when you are doing an internet of things out in the North Sea, or maybe doing wind farms, you need connectivity everywhere, and you need it in a broadband fashion. And these are constellations that really build and close that digital divide that exists between densely, and not so densely, populated areas. These are the constellations we enable today. That's really the first use case we can think of, but it doesn't just stop there.

Bulent Altan: There are many other constellations out there. If you look at it, there are hundreds of observation satellites out there, some of them forming real constellations. Our optical communications technology can also connect our observation satellites with each other, forming a mesh network in the sky and making sure that the latency from a time image is taken to the time it's transmitted to the end use, taken from hours to just seconds. By having a mesh network, a satellite that does not have a ground station in view can take the data it gathered from its earth observation sensor and hand it over to a neighboring satellite. That satellite can then hand it over to its neighboring satellite until the data arrives at a satellite that a ground station is able to view and downlink at. I think this in itself will bring yet another revolution in earth observation. The first revolution being constellations, like the ones of planets and with a synthetic aperture radar and high spectral imaging, and the second revolution coming with us, the real time nature of the communication.

Bulent Altan: Besides that, there are other applications that we see as and we support today. For example, relay satellites. Relay satellites are in a higher orbit, allowing singular satellites to bounce their data off of these high flying satellites and then back to ground stations. This, again, enables low latency communication rather than having to wait for a ground station to appear. Of course, we are seeing a lot of the military and government networks for communication in areas where there is adversarial powers doing radio frequency jamming. Optical communications offers a very advantageous solution, not just in bandwidth, but also in resilience and geolocation because of loss in GPS capability. And then we are seeing longer term use cases, such as orbital outpost news stations, both in earth orbit and beyond, but also computation centers that are looked to be put in orbit, which require tremendous connectivity.

John Gilroy: Well Bulent, I'm taking notes here, as are many of my listeners, and I'm running out of ink. I got IoT, Earth observation, SAR, I got image, I got comms, I got relay, I've got to find a new pen here or something! Usually you look at all these applications, so which applications have the highest growth potential?

Bulent Altan: Well, I think if you look at the numbers, of course, the communications and broadband constellations have the numbers. Today, when you look at the number of satellites in space, just a little bit more than two years ago, it was less than 2,000 active satellite in orbit. And it was really the communications constellations and the broadband constellations that more than doubled that number in a short amount of time, and that trend is only going to continue to increase.

Bulent Altan: So our number one customer base is, of course, the communications constellation. Each one of these satellites needs multiples of our terminals to build their mesh network in the sky. Very often, they host four of our terminals to allow communication between satellites, to the front, to the back, to the left and to the right. Really making a beautiful orthogonal mesh network around the sky, efficiently sending data in each direction. And then you multiply that with the number of satellite being launched. That is a tremendous number of terminals, which is, again, the reason why Mynaric's focus has been to make these terminals cost effective and mass produced. Those two parameters are so important to our customers, especially because for communications constellations, what's needed is quick production for tens of thousands of terminals in a year.

John Gilroy: Bulent, we've touched on this kind of, on edge, conversation on security. And I'm in the Washington DC area, you've got the DOD up the street here, we've got to talk about security. You've mentioned that the signal can't be jammed, but my research shows that when you use radio frequency, people can detect that with a laser communication that's undetectable. So, that puts you at an advantage in some ways in a defensive posture. So you know it can't be hacked, you can't even see if you're transmitting, so it's very desirable for people in the intelligence community or department of defense, I would assume.

Bulent Altan: Absolutely. I think radio frequency communications have come a long way. They are amazingly intricate state of the art antennas that concentrate most of their energy towards their communication partner. But even then, there is still rest energy going into every direction. These can be detected by an adversarial detector, meaning that you can give away your location. And then of course, if your adversary knows which frequency you're communicating on, they can use that frequency to transmit a much higher power signal to jam your communication.

Bulent Altan: Optical is different, it can only really go in the intended direction. The beam is very narrow, and therefore cannot be picked up by anyone else but your intended communication partner. That means when you are doing satellite to satellite communication, your communication partner is not going to be jammed from another angle through an adversarial force. Or, when you're doing ground station communication, the intended photons, really the beam, is just going to land on your ground station a few meters around. And I think when you're operating an optical ground station, if someone pitches a tent and puts a giant telescope a couple of meters away from yours, you'll recognize that.

John Gilroy: Bulent, I know you've spent some time in LA, and last time I was in LA, I saw a lot of Teslas. My big conclusion is that you really can't have electric cars without charging stations, and you really can't have laser communications without something on the ground. So, what infrastructure is necessary on the ground to support laser communication terminals?

Bulent Altan: I think as far as infrastructure goes, it's really at the start of the value chain. It's companies like Mynaric that have to exist and focus on mass producibility and cost efficiency of these terminals. The data sets are there, when you look at earth observation, when you look at the communication constellations today, operating for example, Starlink and OneWeb, you realize that the data demand is there. These satellites generate a tremendous amount of data that require to be moved over vast distances.

Bulent Altan: So the demand is there, it's really the production infrastructure that has to happen, and that's where Mynaric is unique. The fact that we have spent the last few years investing into creating a factory that can build thousands of terminals a year, into researching technology that makes, for example, a precise optical instrument out of metal with really off-the-shelf machining equipment that allows mass manufacturing at a cost effective manner. All of these have to happen. So, our customers really rely on a manufacturer like Mynaric so they can baseline it in their constellation. All of that was investment ahead of the demand curve that Mynaric has put in place, and we show the infrastructure that we have built both in Germany, but also in the U.S., where our LA facilities can support our customers. Now, only when they see the infrastructure and the investments that we have done, do our customers really realize the potential here.

John Gilroy: Bulent I mentioned that electric cars have a lot of challenges with making a transition to electric cars, we know that, but there's also challenges in migrating to laser technology. So, what are the main challenges to this technology, and how can they be mitigated?

Bulent Altan: In most cases, when we look at satellite technology today, and I have already said, when you look at a broadband constellation, the data volume is there. Those thousands of communication links, down to the end user, generate tremendous amount of data, but that needs to be stitched together into a stream that can be given to our optical communications terminal.

Bulent Altan: What we have on earth are fantastically complicated and very powerful switches, these are networking equipment's that can deal with tremendous amount of data. The analog of that has to happen in space as well, but these switches aren't that easy to deploy in space. We have seen the first cases of them, but still generating hundreds of gigabits of data, digitally switching them, and sending them into the right direction is the upstream challenge that our customers have today. But, we see broadband constellations living up to that challenge and doing exactly that.

John Gilroy: So we're going to go from some of the practical challenges of applying this technology. We're going to go up to about 40,000 feet, maybe not to LEO, but about 40,000 feet here. So, from a global perspective here, what are the most important aspects or impacts of the expanded use of laser terminals to the world and humanity?

Bulent Altan: What laser terminals are doing is being the enabling technology behind these constellations. Our first use cases, of course, are these broadband constellations, these global broadband constellations. And if you think about communications in the world today, there are the haves and the have nots. The economy has been very digitally driven, and people in large cities that are well connected have an advantage in being in the workforce. We've seen this more so in the COVID crisis over the last two years, we went away from the offices and are all at our homes doing remote work, and there we've seen the capability differences that exist between people. If we look into that, we need more capability across the population, not just for the half of it, but in all of it. If you can solve the digital divide that exists between people who have access to broadband and people who don't, you're going to see less migration to cities, we're going to counter the mega cities mega trend. You're going to ensure that there is an equality between different geographies and that anyone can be a part of the global digital economy.

Bulent Altan: We will see people from different parts of the world being part of crowdsource campaigns and crowdsource work. Today, when you're, for example, looking to build a logo for your company, you normally do a competition online see people respond to the competition from the smallest villages in the most remotes areas of the world, because we will be able to get broadband there. So we will get out of the digital divide and digitally unite the whole world.

John Gilroy: Another big question here for you, Bulent, and I'm going to wrap it up here. So, what do you hope for the future of mankind and space overall?

Bulent Altan: Well, I've now been in this space business for about two decades, and I've played many roles from rockets, to capsule, to satellites, and now, underlying communications technology. What I really want out of space technology is being able to enable some sort of technology for everything we do.

Bulent Altan: We've seen this with the internet. We see the fact that the internet hasn't just changed the computer industry, it changed the way we work, and I expect the same thing with space technology. It will be an enabling technology for many things we do. As we are here on earth, it's going to make a life on earth better. Earth observations will contribute to our understanding of climate change, communications as I said, and will unite us digitally across the globe, connecting everyone. It will ensure security across our borders, but also, as humanity goes beyond earth, I think optical communications will also play a big role as we have more instances of human settlements across our solar system to connect. And I think, I see that future definitely happening. Mankind is here to explore, here to settle, here to expand. And I think very often we will see that Earth-Mars communication. Whenever that comes, I think it's going to be optical.

John Gilroy: I'm trying to come up with a summary for our listeners on what we've learned from this interview today. And I think there are three words that I've taken away from this interview, optimal communication can provide speed, deliverability, and agility. I think that's a good three-word summary here. I'd like to thank our guest Bulent Alton. He is the Chairman CEO of Mynaric. Thank you.

Bulent Altan: Thank you very much, John. Thanks for giving me the time.