Ray Rogers (00:06):
I'm Ray Rogers.

Brad Keppler (00:07):
And I'm Brad Keppler.

Ray Rogers (00:08):
And you're listening to Fix This, a podcast exploring tech ideas and solutions to some of today's largest challenges.

Brad Keppler (00:15):
As December comes to a close, we're looking forward to 2021. The new year gives us a chance to reset, get inspired and think about what's possible.

Ray Rogers (00:25):
Speaking of limitless possibilities, today we are talking all about space. With so much left to discover, the potential really is endless.

Brad Keppler (00:35):
Space can be inspiring. Whether you want to see earth from a new perspective or learn about the new frontier, the cloud is powering innovation not only here on earth, but beyond too. Our colleague, retired General, Clint Crosier, is the Director of the New Aerospace and Satellite Business here at Amazon Web Services. Clint joined Ray to deep dive on how the cloud can be used to power solutions to help us better understand our world and space.

Ray Rogers (00:58):
Clint, can you tell us a little bit about yourself? What really started you on this career path and why space?

Clint Crosier (01:06):
Probably first became captivated with space as a little boy during the Apollo missions, like many of that time. I think that's sort of how my journey has taken me to where it has. I spent the last 33 years with the US Air Force and the US Space Force flying satellites and launching rockets, and over that time, I've been part of some really, really exciting things.

Clint Crosier (01:27):
I had the opportunity to command the unit that operates the worldwide GPS satellite constellation. I had the opportunity to command Buckley Air Force Base, which is where we fly all of our missile warning satellites protecting US citizens here in the US and US allies all around the globe. I had an opportunity to launch Titan and Atlas rockets, putting satellites on orbit for NASA and NOAAoah and national security users. Over the last 18 months before I retired from the Air Force, I had the real honor of being the lead architected planner for the standup of the US Space Force.

Ray Rogers (02:03):
Why should we all care about space and why should we all care about learning more about it?

Clint Crosier (02:08):

Almost every culture, almost every continent has some sort of legacy or folklore or something associated with space, we're fascinated by it as humans. Space is key to an even greater understanding about the world we live in. Data from space powers our lives every day, whether people know it or not. Whether it's drawing money from an ATM or putting gas in our cars, or navigating to a new location or checking the weather report, those functions all rely on space.

Clint Crosier (02:35):
So, we're at this really unique part of history where we receive real-time information from space. Think about it, right to the palm of our hands. And is this not true? We expect it in split seconds, not days or hours, and that's a very demanding request, but it's also very possible, especially through the cloud and cloud operations. So we ask ourselves across the board, how can we continue to use space to make the world a better place? That's why I think it's applicable to so many.

Ray Rogers (03:07):
On that note, here at AWS we recently announced the launch of the aerospace and satellite business unit, which of course you are the leader. So, what are some of the top goals for this part of the business? What can people expect to see from us?

Clint Crosier (03:19):
The formation of our ANS aerospace and satellite (A&S) business demonstrates our long-term commitment to the space enterprise. I've been given the liberty to hire dozens of space experts across every mission in space. Our team has experience working for NASA and the Air Force and the Space Force, the intelligence community and myriad commercial companies that design, build and operate spacecraft. So, our team literally has hundreds of years of collective experience hands-on working inside the space industry.

Clint Crosier (03:48):
What we've been able to do, and what we're focused on going forward is to work side-by-side with our customers with a deep understanding of their mission segment and their needs, and really help them solve their most important challenges to unlock the future. We believe the cloud and cloud-based technologies will be transformational in unlocking future space capabilities. We certainly have clear ideas about key technologies and trends and space mission needs, and we're working all of those right now.

Ray Rogers (04:18):
What are some of the common obstacles or challenges that come to mind here?

Clint Crosier (04:23):
At the basic level, some of the common challenges that the space industry faces is true of most businesses, avoiding large capital expense, avoiding having to operate large infrastructure and systems that you don't need every day, having to manage all that infrastructure on your own and take your time, energy and effort away from your differentiating mission capability.

Clint Crosier (04:44):
The cloud certainly provides that to space businesses like we do other businesses, but the overwhelming challenge that our customers tell us about, which is unique to space, is the limitation of what we call SWaP, size, weight, and power. There is just a limit to the number of things you can put on a satellite

and then successfully be able to put it in order based on weight and gravity and fuel and all those things. So, SWaP is a really important challenge that every mission faces.

Clint Crosier (05:11):
Then bandwidth, the limited ability to move data back and forth between the earth and space and beyond. Every day satellites orbiting the earth are collecting petabytes of data, and so helping customers make sense of that. That huge amount of data is really become a challenge for most in the space industry, and that's where they need help. Working on the cloud allows them to use space data and make it more accessible, more affordable, more actionable and in near real-time.

Ray Rogers (05:43):
Yeah, and so what are some of the most inspiring use cases that you know of?

Clint Crosier (05:47):
As we've learned more and more about space, and as we've pushed technology about what it can do, we have learned to apply space data in so many other ways. We have companies that are using space-related data. We've got companies who are using space data to determine when a ship is going to pull into a harbor and have crews ready on the docks to unload it within 15 minutes of the time the ship pulls in, because they've been monitoring it across the ocean.

Clint Crosier (06:13):
We have companies that use space data to help determine soil concentration and water levels in soils to help figure out where the best place is to plant crops. We've got companies who are using space data to determine globally where key elements of the population are existing, where they live currently, so that they can map out COVID relief and COVID distribution plans. But all of those things are fascinating, and none of those did we understand or realize 20, 30, 40 years ago. That's why it's so exciting as we look in the future, all the things we'll be able to use space data for that we don't even realize today.

Ray Rogers (06:51):
So speaking of the future, let's talk about the next frontier, so to speak. What most excites you for the future and how can the cloud really help us push the boundaries when it comes to space?

Clint Crosier (07:02):
Everything about space excites me. I'm a self-proclaimed space geek as we like to call ourselves, but seriously, from my view, the cloud and cloud-based technologies are probably the most fundamental and critical pieces of this new digital world that we live in. The cloud enables everything it means to live in a digital world and will enable everything we want it to become.

Clint Crosier (07:25):
I think that's especially true of the space domain, given the very nature. It's remote, it's distant, it's vast. When we put a satellite up in space, we can't drive over and check on it the next morning, right? It's out there and it's away from us. So, I see the cloud fundamentally changing how we approach exploring and learning and operating in space in this, as you called it, next frontier. This is an exciting time with NASA going back to the moon and Mars, and ESA, the European Space Agency going to the moon and Mars and so many other things, I think probably the most exciting time since the original Apollo missions.

Clint Crosier (08:03):

So in terms of pushing boundaries, one of the areas where the cloud really will make a big difference is artificial intelligence. As more companies launch more satellites and push more data, we need to innovate about how we process that data. The other thing that's really exciting as we think about how complex space systems are and how much money and time we invest in the front-end of designing a satellite or designing a rocket or a complex spacecraft.

Clint Crosier (08:31):
Now we're starting to see digital experimentation and digital twining capability, which really can only be done at scale and at speed on the cloud. So as we look at those capabilities, they can save lots of cost and time and help us move forward more quickly, which every company wants to do in the space environment too.

Clint Crosier (08:50):
So as the missions in space become more and more complex, we need more and more to be able to simplify those processes, and that's what AWS and the cloud is good at. The possibilities, like the number of stars in our universe, truly are endless, and so we just offer, again, to the stars through the cloud, and that's what we're trying to help our customers do.

Brad Keppler (09:16):
Satellite earth observation data can give us valuable insights on many different things, like conservation efforts against deforestation, how our oceans are changing and more, but one challenge has historically been how to get that information back down to earth in a timely manner.

Ray Rogers (09:31):
With AWS Ground Station, organizations like Capella Space can downlink satellite data to decision-makers as quickly as possible. Faster data means faster decision-making.

Brad Keppler (09:42):
Ray chatted with Capella Space Founder and CEO, Payam Banazadeh, to learn how the cloud has helped them process huge amounts of data more quickly than ever before.

Payam Banazadeh (09:53):
At Capella, we are building earth observation satellites that can do imaging in all weather and light condition. That's a pretty unique capability that we're building here at Capella.

Ray Rogers (10:04):
For those who may be new to this term, what exactly are earth observation satellite images?

Payam Banazadeh (10:09):
A lot of this stuff that we send to space are predominantly focused on exploring everywhere except our earth. We send robots to Mars, we send satellites to go around Venus, but there is also a huge industry around observing our own earth from space. So, there's a bunch of satellites that are orbiting earth and looking back down and trying to capture information about our own planet in variety of different sensors.

Payam Banazadeh (10:35):
So, there's optical imagery. Imagine it's just a much bigger phone in space going around earth taking pictures of earth. There is what we do, which is synthetic-aperture radar or SAR. It's a different sensor,

different instrument, but then we also point down to our earth. As we go around earth, we take measurements, pictures, and that entire industry is called earth observation. It's a pretty large industry and it's getting larger every day, and we're pretty excited about that.

Ray Rogers (11:01):
Is Capella taking images of the entire earth every day or specific regions?

Payam Banazadeh (11:06):
We're being more selective on the places that we want to take pictures, and so we want to be able to take pictures of important areas around the world, and we want to be able to do that much better than once a day, and really be able to understand what's called patterns of life. It's slightly different than being able to image entire earth, so we're more focused on certain areas than some other areas.

Ray Rogers (11:28):
I could imagine that might play into traffic patterns and things like that. How are people able to use this data, or how are organizations able to use this data and what are we learning from it?

Payam Banazadeh (11:39):
With our imagery at the very best resolution that we have, our resolution on the ground is about half a meter, 50 centimeter. That means anything that's less than half a meter in size, we won't even be able to detect. We can't see people, we can't see text, so things that are going to be interesting and detectable for us are mostly manmade objects like cars, like ships, like buildings.

Payam Banazadeh (12:02):
So, if you think through the applications and the reason this is going to be valuable is think about supply chain. Think about just the global pandemic. If we had known how the supply chain around the world was getting impacted by that, a little sooner we would've been able to plan ahead of that a little better. So the ability for us to be able to look at parking lots of a factory, or be able to understand how shipment of goods from one place to another place is getting impacted would certainly allow us to sort of think a little high-level and think through the implications of the shortage of supply chain one side of the world and its impact to another side of the world.

Ray Rogers (12:40):
What sets Capella apart is really that you're using SAR imagery, so you're able to take images, even if it's a foggy day, a cloudy day, a smokey day, if there are wildfires. What exactly is SAR and what is it helping you to achieve?

Payam Banazadeh (12:55):
I think the best way to explain SAR in the least technical way is imagine you take your phone into a dark room, if there is no light, you're not going to be able to get a good picture. The reason for that is optical sensors are what we call passive sensors. They're sort of hanging there, waiting for the light to get into the lens before they can make a picture out of it.

Payam Banazadeh (13:16):
SAR is an active sensor. It means it's actually emitting signals from the sensor itself towards the object that you're imaging. The signals travel, get to the object, reflect back from the object, and then you end up receiving the reflected signal into your sensor and can make an image of out of that. So, that's sort of

at a very high-level how SAR works. Obviously it's a lot more technical than that, but that allows us to have the capability that we have.

Ray Rogers (13:42):
How does traditional satellite observation work and how is that really different from what Capella offers?

Payam Banazadeh (13:48):
Traditionally, these satellites that have been put up by these companies are just so complex and are using sort of the technology of a decade or two decades ago. They're humongous, they're a size of a school bus. It cost a couple hundred million bucks to put just one of them up, and as a result of that, there really aren't that many of them, and that really limits the frequency of your observation.

Payam Banazadeh (14:11):
Our satellite, as opposed to being size of a school bus is size of a mini fridge. So it costs a lot less, it's a lot easier to manufacture, which means we're going to be able to manufacture, produce and launch a lot more of them. Since we're going to have a lot more satellites, it means we're going to be able to look at the same spot a lot more often, and therefore be able to understand the patterns between the first image and the second image, given that the time between those two is going to be much shorter. So, that's one big difference.

Payam Banazadeh (14:39):
The other big difference is SAR, synthetic-aperture radar, which is what we use, traditionally has been very complex to build these satellites and make them cheap and make them accessible. More than 75% of earth at any given time, it's either cloudy or [inaudible 00:14:56], and so majority of these optical imaging satellites don't have access to imaging those 75%, and so they're already limited to just 25% of earth. So that's the next thing that we're changing, which is bringing this reliable monitoring system, where you don't really care about things that are out of your control, such as the clouds rolling in or the day turning into night.

Ray Rogers (15:19):
Does it take any special processing capability to ingest and look at the images from Capella?

Payam Banazadeh (15:25):
It takes a very significant amount of computation on the backend to be able to process the data. This is another reason why it's much easier to do this today compared to 10 years ago, because of the services like AWS, where companies like us can just sort of buy that computational power in the cloud, as opposed to building all of that in-house, which would take a lot of time and resources. But once we process the imagery on our end, our entire effort has been to make it accessible, easy, and super straightforward to be used by the users and the customers.

Payam Banazadeh (16:00):
We have invested and focused a lot on automating all the backend, and so no one really has to pick up the phone and know a lot about SAR in order to order an imagery. We've tried to make this super easy, super straightforward and super fast. So we've built a web application where users can come in, you can literally search where you want to take an image, and then with a few clicks of a button, you can submit that request. All of a sudden your image pops up, and then you can look at the image visually, you can

download it. We've tried to hide all the complexities and make it super straightforward and user-friendly when it comes to how we interface with the customers.

Ray Rogers (16:39):
One of the traditional challenges that we've heard about is the speed of downlinking data. How is AWS Ground Station helping you to address this challenge?

Payam Banazadeh (16:49):
Being able to reduce the latency, the time it takes to put in the request, as well as getting that back is absolutely critical. That is really a function of how quickly that satellite is able to communicate with what we call a ground station. It's literally just a massive dish. Think of your DirecTV little dish, this is maybe 50 times bigger than that.

Payam Banazadeh (17:13):
What's neat about AWS and where we're really excited about using the service is, AWS has decided to essentially put one of these dishes on top of every single data centers they have in the world. What's cool is once you get in a dish, the data center is right there. The data shows up in your cloud, you're processing in the cloud, you're storing in the cloud, customer has access to that almost instantaneously. So, now the latency goes from what typically has been maybe 24 hours, maybe 12 hours to less than an hour. We're hoping that we get that to even faster timelines as we evolve the service.

Ray Rogers (17:51):
Looking to the future, where do you see the most opportunity for satellite data to drive positive change in the world?

Payam Banazadeh (17:58):
When I started the company, the frustration I had and the reason I went down this path of creating Capella was MH370, which was a Malaysia flight, went missing. It was a big plane, 280 some passengers, and no one could find the plane. For me, the concern was and the frustration was how is it that in 21st century a plane that big with that many of our fellow human beings go missing, we still can't find it?

Payam Banazadeh (18:24):
Now fast forward, this company and this sort of capability that we've built, really not optimized for finding planes, but the problem still exists, which is there's a whole lot of things happening on our earth that we have no way of knowing. So, building a non-terrestrial sort of space-based infrastructure that allows us to monitor our planet and understand the differences, as well as the connections between different events around the world, I think is going to be absolutely critical as we move into the next century.

Payam Banazadeh (18:55):
If you think about all the challenges we're going to have, the challenges have become more and more global, and so we have got to have an infrastructure built ready to go for us to be able to understand all these interdependencies around the world. If there's deforestation happening in Amazonia, we ought to be able to tie that deforestation to other impacts that it's having around the world and have the evidence for that to call for action. I think companies like Capella are building this sort of space-based infrastructure for us to be able to do that for the future.

Ray Rogers (19:29):

To take a deep dive on how the cloud helps enable successful space missions, search aerospace and satellites at aws.amazon.com, and check out the AWS Public Sector blog to read more stories at aws.amazon.com/blogs/public sector.

Brad Keppler (19:43):
Thank you to our guests, Clint and Payam.

Ray Rogers (19:48):
If you liked today's episode, please help us spread the word by rating the show, sharing with your friends and family and subscribing for more stories. We'll catch you on the next one.