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PRESENTATION

Lilian Veras

Welcome everyone to the Intel Network Builders webinar program. Thank you for taking the time to join us today for a presentation titled Private Mobile Networks and the Future of Edge Computing.

Before we get started, I want to point out some of the features of the BrightTALK tool that may improve your experience. There's a Questions tab below your viewer. I encourage our live audience to please ask questions at any time. Our presenters will hold answering them until the end of the presentation. Below your viewing screen you will also find an Attachments tab with additional documentation and reference materials, including a number of websites and documents mentioned in this presentation. Finally, at the end of the presentation, please take the time to provide feedback using the Rating tab. We value your thoughts and we will use the information to improve our future webinars.

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Intel Network Builders partners have been working to accelerate network innovation by optimizing their solutions on Intel technologies. These industry leaders are recognized in our Winners' Circle program and Alef is a gold partner. Learn more about our INB Winners' Circle program by clicking on the link in the Attachments tab.

Today, we're pleased to welcome Ganesh Sundaram from Alef. Dr Ganesh Sundaram is a leader in wireless technology with over 20 years of rich experience in technology creation, having worked extensively on opportunities globally. As a founder of Alef, he has made several foundational contributions and was recognized in 2019 at the Edge Computing Congress with the Award for the Biggest Individual Contribution to Edge Compute and Development. Prior to founding Alef, he had multiple secure wireless solutions initiatives at Bell Labs in New Jersey. He has developed several foundational technologies, leading to new standards, products, and deployments and has authored over 50 patents relating to mobile data networking, architecture, security, cryptography, resource and mobility management.

Welcome, Ganesh, and thank you for taking the time to join us today. So, over to you to start off.

Dr Ganesh Sundaram

Thank you very much. I've been looking forward to this presentation and interaction. But before I get started, thank you for that warm welcome and the introduction, and many, many, many thanks to the Intel program, the Network Builders program for featuring us today and I'm looking forward to this interaction with this team on this call today.

So, with that, let me just jump in and start to talk about how we got here. So, like I said, we're going to talk more about edge computing and how this all fits together in the context of private mobile networks, and that's me. And as I said, sponsored by the Intel Network Builders Partner program.

So, with that as the background, let me just jump in. My goal today is not make it a tutorial, but really make it a conversation so that we can, how do I say it, keep it simple. But there's something profound going on here. You've probably heard clichéd ways of looking at it as keep it simple-stupid. No, this is certainly not stupid, there's something profound going on here, but I'll try to keep it simple.

The idea behind the edge is not new. It's been around for a while, but as expansive as I would like to call it, I would like to think of edge and the contributions many of us have made towards this space as encompassing the next generation of the internet. So, how do we contextualize it?

The simplest way to think about it is we started with the desktop internet, then we moved over to the mobile internet, now we are in the middle of the edge internet. This is the first time that it's not a device-defined internet architecture, but is really driven by many things that are happening in the internet, and I want to talk a little bit about the drivers behind edge internet-- behind the edge internet before we get into specifics around the private mobile networks et cetera.

So, in a nutshell, I've organized this presentation in a way that we can get through a lot of material, but I want to keep it at a leisured pace so that the simplicity can be retained, and if there are any questions-- and I've already received at least a dozen questions, I don't know if I can cover all of them through email and other social channels, I'll try to. But having said that, the main points that I want to drive home on this particular slide is around, what are the drivers? Let's start with the drivers as far as the edge internet is concerned.

Obviously, the 5G moniker is hard to ignore. Many of us have been following the fifth generation of wireless, there's a little bit of an acronym soup, if you will, in the first bullet. NR stands for New Radio, and you have these open radio access network technologies. Then you have the 5G core, as they say. SA stands for Standalone, Non-Standalone. There's a lot to unpack with respect to 5G, and it's a very distributed systems architecture. And so, that's a major driver behind the edge internet.

So, in a nutshell, if you look at the technologies that have come together on 5G, for the first time, as far as I can tell-- and at least I've gone through this multiple generations of wireless technologies-- the radio multiple access technology did not change when we went from 4G to 5G. In fact, every other previous generation, there's been a change in the radio technology. However, there's been a significant architectural revolution that has taken place and that has given rise to a lot of new things that are possible with respect to the next generation of wireless.

Having said that, I've singled out edge computing for its architecture and the hierarchy that it brings into it for a good reason. Some of us started practicing edge computing and edge internet, in general, before there was even 5G. So, obviously, in our view, 5G needs the edge, but edge doesn't require 5G. In a nutshell, we've been able to apply many of the distributed internet principles where we can take advantage of latency as a new currency, even in previous generation networks, so the architectural underpinnings of edge computing, notwithstanding how the value chain has come together et cetera will be more interesting to us, and so I'll talk about it in the next slide.

So, there's an architectural revolution around computing that has been taking place which I consider to be complementary and different from cloud. It is not a replacement. But at the same time, it is a very powerful way to look at how this has led to the edge internet, in general.

Now, connectivity technologies around 5G is one big driver. Edge computing is another big driver. One of the other things that everybody asks about is, who cares? Why now? And so, fundamentally, it comes down to some of the use cases that the edge makes possible, and they are centered around machine vision, there are some augmented reality and virtual reality use cases, which are packaged under 3D Internet in my bullets there. You have artificial intelligence, machine learning, Internet of Things with respect to connected intelligence. IoT has been around for a while, but the use of IoT in high definition systems where you have lots of new use cases around video and video analytics, and Intel has been a big partner in that ecosystem. There's a whole ecosystem around autonomous systems. Don't just look at autonomous cars, but autonomous systems more broadly. A lot of these use cases come together, come to fruition and we can realize it once we start thinking under the moniker of edge computing and the edge internet. Now, having said that, there are other drivers like hybrid work, CBRS in particular, Wi-Fi 6, digital transformation in enterprises et cetera. So, view these four bullets around the drivers as who cares and why now? A lot of these things are happening simultaneously.

And I want to belabor one more point here. Many of us who have been around the block with respect to the internet, this is not the first time multiple simultaneous trends have come together. In fact, if you go back about a dozen years when fourth generation wireless, that is LTE, so-called LTE was being rolled out, the cloud was on fire. So, that was another simultaneous trend. The device ecosystem was really completely reshaping the market. We went from a few phones to lots of different smartphones, but mainly aided by the Android and the iOS ecosystems. So, that was a simultaneous trend. Then there was a fourth simultaneous trend around video becoming a central component of many, many apps. And then there was a whole developer ecosystem that came together that created an internet economy around all of these things, that could synthesize all these trends and create trillions of dollars of economic opportunity for all of us.

I believe, and many of us who are practicing in this trade believe that we have such a moment right now again. And it's almost hard to believe that just a dozen years from the previous simultaneous trend movement, we have another opportunity to make something like this happen. So, this, in my mind, solidifies why we should pay attention to this so-called phenomenon called the edge internet.

Now, having said that, let me walk you through, oh this is great, it's peel the onion, get into the next layer of detail. Is there a value chain that's forming around the edge, and how does it look like? How can we stratify things? I want to get into the next layer of detail while keeping it simple again.

There's something profound going on here and that is if we pattern match it again to the previous trends, previous cycle of simultaneous trends, let's look at the cloud. The cloud kind of started in many ways, and we can learn from that. And the first layer that got started was the infrastructure-as-a-service movement. Then various platforms came together and then software solutions were built on top of it.

Around the edge internet, something very similar is taking place. You have a different set of constraints around the infrastructure, you have edge data centers, you have a lot of fiber that is being lit up. There's a lot of hardware-as-a-service, storage-as-a-service opportunities, and many, many, many managed services that are coming together. Intel had announced a partnership about a year ago, I think, around silicon-as-a-service. A lot of these things, the giants have been driving innovation, taking advantage of some of us who have been innovating around important opportunities. And we'll get into the layers of opportunity around innovation in a moment.

But just riding on the theme of the value chain, the infrastructure-as-a-service movement around the edge is similar but yet different from the cloud. Why? Because the infrastructure and the data centers that are needed for the edge have a different set of constraints. You have lots of very small data centers with power constraints translating to compute constraints, but in the cloud, you have tens of thousands of servers offering a lot of compute in one location.

So, the constraints are different. The problem statement is different, because the currency that we are trying to optimize towards is reducing latency.

Now, let's assume that we take this for granted, that the infrastructure-as-a-service movement is coming together very well and there's tremendous amount of proof around it, not just evidence. That's a separate talk. Let's talk about the platforms and who is bringing what platforms together.

Clearly, compute management and orchestration is a massive platform and opportunity as far as the edge is concerned. Again, riding on the theme I just talked about around infrastructure, when you have lots of small data centers, the compute orchestration principles turn out to be totally different compared to the cloud. Well, we can learn from what we did in the cloud, innovate on top of it, and bring something new to the edge. And that's already happening. Giants are getting involved in that.

And then you have to look at what are the workloads that the edge is going to support, not just what are the solutions, let's just talk about the software workloads. We're going to talk a little more-- a lot about it in the later slides, but there are a lot of networking and mobility functions that are getting created as a platform with open APIs and things like that. Open RAN is an example. Again, Intel has been a huge proponent of Open RAN through their products and there's a very interesting segue into how all these platforms are both miniaturized, but at the same time, managed simultaneously across all these locations.

So, just like it happened in the cloud, you needed-- we need platforms-as-a-service, and the game is just beginning. I would count at least a couple hundred companies who are working on the platform layer, each one looking at a different piece of the puzzle. If I had given the same presentation maybe two years ago at the start of the pandemic or something like that, I would have admitted to you that it was a bit of a blind man and the elephant situation. That is no longer the case. These pieces are coming together.

On top of it, lots of edge solutions, I already mentioned some of them in the previous slide as part of the drivers, but let's not forget the fact that lots of other solutions are also possible. And the leading candidate around private 5G is what I really want to spend a little more time on today.

Once you have the stratification and value chains getting established, there's an opportunity for value enhancement and a participative economy starts to get formulating around these different components of the value chain.

Having said that, let me jump into-- and I'll speed things up, because I want to give the context and spend a little more time on the context-- there's a virtual connectivity revolution taking place right now. And anybody who has been to MWC week before last or anybody who's been following the news for the past few months would notice giants are getting involved. And the reason is there is a movement around enterprises controlling their own destiny and starting to think about owning their own private mobile networks.

Obviously, the movement has a lot of momentum behind it because of the supply opportunities. Suppliers are getting into it. But the reason many of us are participating in this economy is because there is demand from the enterprises. But what is that one thing or two things that actually really puts it over the top, specifically in the United States? And I would say in Germany and a few other countries also is the fact that the FCC approved a band of spectrum called CBRS. I told myself I'll expand on as many acronyms as possible. CBRS stands for Citizens Broadband Radio Spectrum, and the idea is just like you could take advantage of Wi-Fi, which is free spectrum, CBRS is also the same nature as far as an enterprise is concerned. However, there is one major difference, and that is it is managed spectrum.

So, if an enterprise wants to deploy their own mobile network on that slice of spectrum, you can actually appeal to these spectrum administration service providers, the so-called SAS providers, and they will be able to allocate frequency on-demand for that enterprise owner, and this can happen literally in a matter of minutes.

So, no complicated process of bidding for spectrum and getting it. You could, that's not precluded. But at the same time, if you want to participate in this economy and have your own private mobile network, the spectrum is available. It is called Shared Spectrum Opportunities. Your neighbor and you will not be encroaching into each other's spectrum, so it's really managed spectrum. And this has been virtually leading a revolution of sorts that is actually making it possible for enterprises to control their own destiny.

The reasons notwithstanding on why they need mobile networks, let me just try to-- the use cases are driving the adoption, but there's a much more fundamental reason, there are four bullets that I capture which I call as the 4 Cs of Private 5G, which is, first, clearly coverage is much, much higher, better with respect to the 3GPP-based mobility networks compared to Wi-Fi, by design, because the transmit power and things like that are slightly better. The constraints around the standards design were actually different.

Second, the capacity of these networks, every decade goes up, and just like you have-- on the compute side you have Moore's Law thanks to Intel-- on the capacity side...

[Technical difficulty]

Lilian Veras

Hello, Ganesh, it seems like we're having-- your voice is breaking. OK, let's see. It seems like he was disconnected, so let's give it one or two minutes to see if he can log back in to finish his talk.

Dr Ganesh Sundaram

There seems to have been an internet outage here.

Lilian Veras

Hi, Ganesh. Yes, I just realized. Your voice started breaking and then you were—

Dr Ganesh Sundaram

Yeah.

Lilian Veras

You logged off.

Dr Ganesh Sundaram

I don't know what happened. It just said, my dongle said, so I'm continuing.

Lilian Veras

No problem, I'm glad you're back.

Dr Ganesh Sundaram

Yes, thank you.

So, the 4 Cs, as I was saying, one is about capacity-- the second is about capacity, the first one was coverage. The other two are much softer, and that has to do with every enterprise would like to control their own destiny, but the problem is many of these mobile network standards were designed and created with telco functionality in mind. That's why you have the coverage and the capacity advantages. But sometimes that becomes a problem when you're trying to roll it out at an enterprise level, and you have to have enough IT controls around it.

So, what that means is you have to live with the telco, enhance the telco functionality, but be able to create the IT controls so that the day-to-day operations and management of it is actually under the control of enterprise IT teams. It should be that simple.

Having said that, no two enterprises are going to have the same types of use cases, the same types of functionality, and so they would like to customize these networks so that they take advantage to the maximum. It's going to be an iterative process for any enterprise, but having said that, please keep in mind that now we're trying to roll out, say, 4G or 5G networks on edge platforms, and these private 5G networks or mobile networks are solutions that run on these edge platforms. And the drivers for these are around the 4 Cs. Maybe we've justified it enough, one could ask the question, is it that simple to take control? Is it that simple to customize? Well, the answer is no.

Let's admit the problem then maybe we can solve it. 5G is complicated. But there are patterns, there are learnings that we have from the cloud, from earlier generations, there are opportunities to address the technology friction through what are known as APIs. And the end goal of this particular philosophy in this slide-- and we'll get into the layers of detail in the next few slides-- is any enterprise IT manager ought to be able to launch these private mobile networks in minutes, literally in minutes. We're talking-- customization can take more time, but even then it shouldn't take you more than, say, 30 minutes, 45 minutes, 60 minutes, it shouldn't take more than that.

So, with that in mind, we have-- we started thinking about, as an industry, how do we address the technology friction. Because the market movement has been addressing the business friction around adoption of private networks, around 5G and private 5G, but the technology friction had to be addressed sort of simultaneously. And we'll talk a little bit about that in the next few slides.

Now, let's assume the technology friction and the business friction are addressed, then what happens? We graduate from having, say, a handful of public mobile networks in the United States to virtually millions of interconnected private mobile networks. To me, this is so profound. So, I've tried to keep it as simple. I know there's a lot to unpack here.

But nevertheless, if we accept the value proposition for some of us who are new to this, and we accept the fact that the business friction has already been addressed and the drivers are well understood, and the technology friction is getting addressed and it has been addressed to some extent, because we do have lots of proof points and evidence that it is getting addressed, then we look at a world, in a few years, where every enterprise is going to have their own private mobile network, which can coexist with Wi-Fi. But at the same time, it can interact with public mobile networks. And to me, this is a very, very fascinating process and metamorphosis that's taking place. It could be a very defining trait of the edge internet in particular, where you have lots of these smaller private mobile networks interconnecting with each other, and seamlessly devices, whether it's an IoT device or a smartphone moves in and out of various networks seamlessly without having to go through expensive processes. And yet it will be customized and controlled by individual IT organizations.

With that as the background, let me jump into how did we get here. Something as profound as having a million interconnected private mobile networks could not have happened overnight. Some of us made some investments, largely speaking, without knowing when it was going to happen. And let me talk a little bit about the innovation that's gone into it.

One of the fundamental reasons why this was important is, of course, in hindsight it's become clear, it was all about 5G which was driving some of this from a mobility standards perspective. But there's a much more important thing that was happening, which was the cloud. So, how can we start adapting cloud internet principles in a more distributed fashion? And intelligent platforms started to evolve.

So, in a nutshell, what happened is you have all these radio access networks with edge platforms and infrastructure close enough to these radio access networks. As I said, 5G is complicated and it's not just 5G's fault. 4G is also complicated. So, let's just say network cores existed. They continue to exist. We want to be able to intelligently orchestrate various network core functions and move them to the edge without disrupting the network core. Why is without-disrupting a requirement? These are mature ecosystems.

Just because a guy with a ponytail shows up doesn't mean the industry will move the needle. So, we had to work with what was already available and how can we layer innovation on top of it so that the functionality is available at the edge, but at the same time, the controls are available at the core.

So, that was one major area of innovation that took place. And subsequently, the same principles were applied to software and functions that normally reside in the cloud, and components of it were already broken down because of the microservices architectures around software development. And some microservices started migrating towards the edge, specifically the ones that are sensitive to latency. So, again, a lot to unpack, but this is how the early innovation was taking place.

Having said that, architectures are not easy to define, but the industry has settled around two different types of private mobile network architectures. I wouldn't say they're totally different, but at the same time, it's a matter of choice as far as the enterprise is concerned. And here again, instead of getting into the specifics of the architecture, I just want to paint an image.

Let's go back 20 years or a little more when the early Wi-Fi networks were getting rolled out. There were two types of architectures over the years that have evolved, the first one was called Wi-Fi LAN Architectures with controllers and light access points. And then there was the Wi-Fi Cloud Architectures where the controllers started migrating to the cloud.

So, in a nutshell, the private mobile network and the 5G movement has actually been able to leverage some of that thinking, and it depends on the demographic of the enterprise customer and so on and so forth, there are two types of sort of quasi-complementary but large overlap architectures that are evolving. One is called 5G Edge Architecture, and the other one is called a 5G LAN Architecture. And for the purposes of this talk, all I want to emphasize is we are learning from what happened in Wi-Fi, but the details are totally

different. What happens at the edge, what happens in a local area network, what is a 5G LAN service, all that is a matter of detail, but this is some of the early innovations that happened.

Now, having said that, let me jump into the next layer of innovation. Once that happened, people started applying this not just for public mobile networks, but also to private radio networks, and then given the control and the customizations that were needed, layers of programmability were added into this architecture. More and more redistribution of network cores started happening, core functions started happening. Much of it got adopted in 3GPP 5G standards. There are multi-core architectures that are being thought about today. There's multi-cloud support. There's no one cloud that meets anybody's needs. So, how can this new edge internet paradigm, and in particular, private mobile network paradigm be made programmable, work with even further redistribution of multiple core architectures, and work with multiple clouds?

The answer is, well, it's a separate conversation or a separate talk, but at the same time, this is the next layer of innovation that got introduced into the market and the enterprises are able to take advantage of it as we speak.

Now, I know there are questions that I've received that are on open RAN and things like that. I know I have not illustrated, that's another dimension. But you can also think of that as part of the mobility stack is the radio access network. And the radio access network has not just been made open with open interfaces, some distribution of functions has also taken place. And a large amount of it is being practiced around public mobile networks right now. The game is just beginning as far as private mobile networks and open RAN are concerned.

With that as a background, let me get into the next layer of detail on how one could take advantage of all of this innovation, driving towards an explicit product.

So, let's talk about the platform again. If all of this innovation gets packaged in the form of new types of distributed network functions at the edge that are consistent with 3GPP, which is the 3rd Generation Partnership Project or the mobility standards if you're not familiar with 3GPP. And then you apply layers of edge technologies around how we cannot just limit our imagination to moving network functions around, but really start talking about how we can take advantage of some of these technologies for-- sorry about that-- some of these technologies for distributed internet applications.

Following that, I'll spend a little bit of time-- one slide-- on what is the product with respect to a private mobile network. Well, the value proposition is clear, they should just plug into a private mobile network and have their own private mobile network. If they should launch their own custom private edge internet using a platform, that is the example platform I'm going to talk about, we call that the Private Mobile Edge Platform.

What is the approach? Well, 5G is complicated, so why not abstract the functionality. Not only abstract the functionality, expose the underlying software services in the form of APIs, so that there is actual control and IT teams can actually interact with it. In addition, you need this collection of edge data centers, we call them Edge Points that are sort of neutral, it shouldn't matter whether Enterprise A or Enterprise B connects to it. In fact, the more the merrier, so that you can actually have a natural interconnection between these enterprises. And all of this has to happen through APIs. In addition to APIs, to simplify the integration and the connectivity, how about leaving it to developers to start generating the next set of layers of innovation on top of it. We call that the Dev-First Approach.

Again, a lot to unpack, but the idea is given the early areas of innovation that have already taken place, we're now starting to focus on product offers and the value proposition is starting to launch your own custom private edge internet solutions using this platform. And the ingredients and the approach are tied to abstracting functionality across a cluster of edge points that multiple enterprises can connect to, similar to the cloud, through APIs and then let the developer ecosystem innovate on top of it.

So, with that, let's talk about how does one launch their own private mobile network? Literally five steps. I call this as the Five Steps to Private 5G.

First, you need spectrum, that's the first step. Again, there are spectrum administration system providers, SAS as it is called. You go to one of their portals, you acquire spectrum, they will do the management for you. It literally takes minutes, maybe a credit card, and

details. Of course, there's going to be-- once the spectrum has been acquired and allocated to that particular enterprise, there has to be a sort of planning exercise that takes place. It's not something lengthy. Much of this can be done using software tools. We have to talk about RAN installation and commissioning.

Many of the providers of small cells, for example, have created templates by which you can literally light up your own radio access network, I'm talking about 4G or 5G in an enterprise setting. It could be a campus, outdoor, it could be indoors, no costly installation, just plug into an ethernet wall unit and you will have 5G coverage up and running. So, I'm just trying to paint a picture so the audience can understand that steps one and two, as complicated as they sound, which they are if you went down the conventional path, but technology has come to our help and these things have gotten really, really simple.

Then, once you've got the spectrum and the radio network installation and commissioning under control, the next step is to connect to the closest edge point, and have your own mobile packet core or slice of the network, if you will. And the system is up and running, and the connectivity system is up and running.

Any IT manager then goes to step four to be able to set up electronic SIM cards, if you want to go down that path, or physical SIMs, order them, distribute it and start managing it. All of this can be done using APIs. Completely. And those things are available today. And multiple offers exist in the market today.

Having said that, once this is all there, then IT teams can start to look at what are the solutions they can build and what are the tools that they can start to take advantage of across various layers.

Going back to my earlier slide around the value chain, many, many use cases are being thought about in manufacturing, in education, enterprise training, there's some 3D internet use cases that are coming up, there's augmented reality, there's artificial intelligence. Many, many of these solutions are easy to build as long as the enablers are available.

And so, there's this whole low code/no code developer paradigm that we are taking advantage of, and this is part of the simultaneous trends that have been taking place in the market.

So, no excuses for private IT-- enterprise IT managers to postpone this. It is that simple. It's a very consumption model that is taking place in the market. Try it and then buy it. And not only that, it literally takes minutes to be able to get up-- get a network up and running. And you can learn as much as you want. So, the industry, not just Alef, has had an opportunity to bring all this innovation together in such a way that all of this can happen in minutes.

Now, obviously, there are degrees of differences between one provider to another. Of course, I'm more privy to the solutions that this company has brought to the table as a founder, but much of what I'm saying does apply more to the solutions that Alef is bringing to the table. But in a nutshell, this is the template. How much time each step takes is going to be different. What architectural choices are going to be different? But the customization and the control can start taking place once these five steps are completed.

With that as a background, let me get into the expanded platform, and literally, I should be able to finish this in the next couple of minutes.

The first level of detail is around the high degree of abstraction and the disaggregation of software stacks that have taken place. Why is the disaggregation of software stacks important? After all, it is the edge internet. It's a solution riding on edge platforms. High degree of abstraction is primarily because 3GPP and 5G is fairly complicated, but all of these can come together, the infrastructure, the platforms, the solutions can all come together, opportunity for intelligent algorithms for cross-layer optimization.

Another trend around the DevOps movement and secure DevOps movement is hyper-automation using APIs. So, we've been integrating many of those into our expander platform. And as I said, we are taking a developer-first approach. We have thousands-- tens of thousands of developers on our platform and what are they working on? Some of the solutions that are being contemplated, above and beyond just private mobile networks as a solution, are around machine vision, edge slicing, autonomous systems, so on and so forth.

Now, this is what we know, but as they say, developer ecosystems are all about, “I can't wait to see what a developer is going to build”. So, we’re open to input and we want to be able to-- others to take advantage of it. And the speed at which a shared economy starts to take place is absolutely fascinating once the platforms are created.

With that as a background, this slide just walks you through the customer workflow. The basics are about connectivity and compute, then you start to build applications and services and then you start to look at value-added services. Value-added services could be in the application domain, it could be in the network domain, it’s a very simple workflow. I've already walked you through the five steps, and you can start to leverage this infrastructure and take advantage of it. The mantra is very simple. Launch any private edge internet service or solution in minutes.

With that, let me open it up for questions. And the message here was intended for a general audience, keeping in mind that this has been-- you’ve probably read a lot about this in many, many places. But I hope this was interesting enough to be able to touch upon many aspects of it and I've focused on private mobile networks as one example, because that seems to be the leading candidate as a solution to be adopted on top of many, many of these edge platforms.

So, let me pause here, open to questions, and happy to take advantage of it.

Lilian Veras

Thank you, Ganesh, for such an insightful presentation. We do have a few questions that have come in while you were presenting, so let’s start with the first one.

Question number one here. “What edge computing application are you excited to see implemented?”

Dr Ganesh Sundaram

That’s a very good question. I've received similar types of questions even through email.

As I mentioned in my talk, the first solution that might end up being the one that wins in terms of early adoption is just as a private mobile network. If you think about edge as the platform, and what is the solution that’s built on top of it, then private networks can be realized on top of it. That’s one.

If you want to look at private mobile network as the platform, and then the question is, what is the leading candidate or what are some of the use cases that get built or rolled into a private mobile network? Then it’s left to the-- it becomes a very verticalized opportunity. For example, there are campus opportunities in universities. There are opportunities in manufacturing that have come up.

There was a question-- and I’ll dig into that-- in terms of 3D internet and augmented reality, metaverse et cetera. So, it is-- the use cases from an application perspective is not going to be common and customization will happen even if it is the same type of solution, but you get the drift. Anything that requires a low latency compute environment becomes a leading candidate.

One other candidate that has captured the imagination in my travel and presentations is around, “Is there an opportunity for edge computing platforms to be a surrogate computing environment for devices which are starved of computing? Is there an opportunity for collaborative computing around sensors?” And the answer is yes. There are many, many use cases that have come up, and a couple of them we've actually prototyped and tested. Happy to expound on it, and we’ll be writing some blogs also on some of these things as we take this forward.

But largely speaking, the immediate opportunities seem to be around verticalized opportunities in terms of private mobile networks. But the leading candidate for edge itself seems to be private mobile networks as a solution.

Lilian Veras

That’s great. Thank you, Ganesh.

Question number two here. “What do you see as the biggest hurdle in the adoption of private edge networks?”

Dr Ganesh Sundaram

That’s again another profound question and a very important question. As I mentioned, I think people have talked about the edge internet, in general, and private edge networks for quite some time that there is an awareness. However, the biggest hurdle is not about awareness, the biggest hurdle seems to be around the complexity. And we need to be able to get the message out, just like Intel did in the early days of Wi-Fi that complexities are there for a reason, because 3GPP tries to, as a standards body, it tries to address interoperability across a spectrum of issues. But as long as these complexities can be abstracted in the form of APIs, which they have been, then it’s a matter of taking advantage of it.

So, the biggest hurdle seems to be around complexity, and it can overwhelm. But help is on the way. It’s already there. It’s a matter of taking advantage of it.

A secondary problem that I have witnessed in the market is it’s too expensive. And the answer is, again, no, it’s not. Again, silicon economics has caught up to 5G and private 5G in particular. So, it’s not that expensive, and consumption models have already been put in place. And so, awareness around technology friction or removing-- how we remove it, awareness around elimination of cost, and how cost versus performance equation works out in the favor of private mobile networks, and how IT managers can have an integrated view of their Wi-Fi networks and these private mobile networks is a matter of education. We've been largely successful at that as a company, and also as an industry. Now, let the games begin.

Lilian Veras

All right. Another question here from the audience. “Private network can be realized either over telco spectrum or by CBRS or free bandwidth in specific geos to connect Alef’s edge locations to the core? How will you ensure QoS end-to-end over a network which does not belong to you, like in the case of telcos?”

Dr Ganesh Sundaram

It’s a very important question actually. The answer is there are plugins in standards today. So, ignore private mobile network as far as the question is concerned for a moment. How is end-to-end QoS addressed even in a voice network today? It’s partially through agreements.

Fortunately, for the edge, because these edge points are very close to the end user, we have an opportunity to take advantage of standards. This is called Network Slicing. Of course, there is going to be some experimentation and optimization around how we will be in a position to improve upon it from the basics.

But the third more important thing is we want to make it configurable, and we have made it configurable so that IT, enterprise IT and the CIO office can actually take advantage of it. This is no different from how SD-WANs got adopted. As far as end-to-end is concerned, initially these types of questions started coming up also.

But again, edge is complementary to SD-WAN. Why? Because we are directly taking advantage of computing needs connectivity, and so the leg between the enterprise radio network and the closest edge point is going to be literally milliseconds away. So, there is going to be-- economic benefit is obvious, but realizing the economic benefit is going to be relatively easy, or easier compared to SD-WAN, primarily because there are going to be a set of APIs that we are bringing to the table, and we take advantage of standards around network slicing to be able to prioritize various types of traffic and users and enterprises.

Now, there will be a learning curve, but that’s why we are bringing a developer-first paradigm also, so that... enterprise IT is not going to be alone. When they do it and they customize it, there's going to be lots of opportunities to learn from the developer ecosystem, and it’s all completely standards compliant. And nothing is foolproof to start with, and that is why we are having a dynamic conversation in

the market around the standards also. We're continuously improving upon it, and then newer and newer use cases will get rolled out on top of it.

So, a long answer to a short question, but it comes down to these three principles I talked about.

Lilian Veras

That's great. Thank you, Ganesh, that was our last question.

I'd like to ask our audience to please not forget to give our team a rating for the live recording, so we may continuously improve the quality of our webinars.

Ganesh, thanks again for sharing such great information with us all, and this concludes our webcast today.

Thanks.

Dr Ganesh Sundaram

Thank you very much for the opportunity to present on this platform. A special thanks to the entire Intel Network Builders Partner program, and looking forward to further interactions with the community here.

Thank you.

Lilian Veras

Awesome. Thank you, Ganesh. Bye for now.

Dr Ganesh Sundaram

Bye-bye.