The Potential of Vehicle Data

Sam Abuelsamid (00:04):

Hello, I'm Sam Abuelsamid, Principal Analyst with Guidehouse Insights, leading our e-mobility ecosystems research. And I'm joined today by Brian Carlson, Global Marketing Director at NXP for automotive processing. Brian, welcome. How are you today?

Brian Carlson (00:16):

Hey, great, Sam. Looking forward to talking to you again. Thank you.

Sam Abuelsamid (00:21):

Let's dive right into it. About this time last year, in 2020, we were talking about the opportunities around vehicle data, as you were about to launch the S32G line of vehicle network processors. Looking back over the past year, what has stood out or surprised you since that launch?

Brian Carlson (00:36):

Yeah, definitely a lot of things have changed. And actually, I think the last time we talked about this, we were just about to launch in January of '20. Actually, it's been two years and COVID warps time, I guess, so it's been a while since we talked, but it seems like it was just the other day. But amazingly, things have really changed incredibly in the automotive industry. And then since then, we've launched our S32G2 product line, so definitely there's been a lot of changes.

(00:57):

I can step through some of those because they are really dramatic. We talked about, conceptually at the time, that we were about to announce the S32G2 processors back at CES in 2020, and how this would enable new types of applications that could take advantage of vehicle data and enable new services. I think it's gone way beyond that and actually, there's been a revolution if you look in the industry, on multiple fronts, beyond just the mega trends that we know of, of course, of more and more autonomous capabilities, electrification, which is coming on very strongly over the last two years, and then connected vehicles.

(01:37):

Specifically in the connected vehicle areas, this is really gaining a lot of attention and is really driving a lot of these new capabilities because without the connected vehicle data, you can't really have electric vehicles and more autonomous vehicles that can do their functions, improve over time to be monitored, and to really make those successful. We're seeing that the connected vehicle is really fundamental to everything that's going on in the industry right now.

(02:04):

There's more and more use of the data. We're seeing a whole ecosystem develop around connected vehicle data. It's, in this last two years, what I would call the emergence of Connected

Vehicle 3.0. Back when we were talking, we were pretty much in Connected Vehicle 2.0, where data was being brought up to the vehicle, maybe monitored, doing some vehicle health, and fleet monitoring. But as we introduced these capabilities to bring edge processing into the vehicle, where we've really seen the huge shift, is more to leveraging machine learning, bringing data to the cloud to run real time models, to train machine learning models, and then having the ability to deploy those back in the vehicle. What we've seen, is now intelligent, updateable connected vehicles, and that's really what's really changed, and we're starting to see those vehicles coming out to the market, actually starting this year.

(02:59):

I would say dramatic shift in how quickly vehicle data is being accepted and driving new business cases. Things like usage-based insurance, that's now becoming a reality. We're seeing ... Even one of the OEMs just this week announced they're going to be leveraging connected vehicle to get into usage-based insurance. We're seeing interest across the board with 5G, telecom operators now, other ecosystem partners, data exchanges. I think the key thing is, we knew the data explosion was coming and what's happened over the two years, is that the whole ecosystem and business opportunities are really starting to happen now. And we played at least a part in that, by bringing this S32G that we launched or announced in January of 2020.

Sam Abuelsamid (03:41):

Over the past two years, obviously with the pandemic, we've had a lot of secondary and tertiary effects that have come out of that and one of the big ones has been disruptions in supply chains. And particularly for the automotive industry, the supply chains for semiconductors. That, in part, has driven a change in the relationship between OEMs, tier ones, and semiconductor providers.

(04:09):

Part of that, you talked about the acceleration of some of these changes. One of the things that's been accelerated, is a lot of automakers that were a little bit reluctant about moving towards next generation electrical and electronic architectures, E/E architectures, are accelerating those plans to bring those forward into new vehicle programs in the next few years and changing the types of chips that they're using. What has all this disruption meant for architectures and for NXP?

Brian Carlson (04:33):

It was an eyeopener, I think all the way to the top, the executive level of OEMs. We've heard stories that the whole industry wasn't aware of all the underlying technology, and how long it takes to get semiconductors, and how many semiconductors are really in the vehicle they're driving these things today. There has been a fundamental shift.

(04:55):

We were talking about, two years ago, that we saw a shift coming. We saw the shift coming maybe in two waves over the next 10 years, but what we have seen is that I would say majority of the OEMs are accelerating and moving very quickly to restructuring or redesigning their

vehicle architectures faster than we originally thought. I think a lot of that came out of COVID, realizing not only that they needed to have a way to move away from more of a hardware defined model, which are adding new boxes to the vehicle.

(05:30):

I think we talked about that a little bit back then, that we were already seeing the pains of that at OEMs, even in manufacturing, to be able build these cars because they had to have so many boxes, the cables were two and half, three inches thick. It was actually impacting the manufacturing cost, and time, complexity, et cetera. We see that really rapidly increasing because to realize the future of around the mega trends we talked about, they have to fundamentally have new architectures to do that.

(05:57):

That means more powerful processors, integration, what you hear about ECU consolidation, moving a lot of these boxes that were dedicated functions into software functions or virtual ECUs within larger, more powerful system on chips with multiple processor cores in it.

(06:15):

That plays exactly into what NXP's strategy has been, to move to these more powerful processors that can consolidate, whether it's within the gateway, don't make controllers, or now with the shift, we're seeing more and more zonal architectures, which means converging a lot of these boxes. You're talking a hundred boxes or more sometimes, into maybe a handful of boxes that are more powerful with more powerful processors that can do that. The key there is safely and securely. That's really plays into what NXP is doing with our S32 family, like the S32G that we talked about, to bring more of those functionality into software.

(06:51):

And then, that builds onto this whole thing that we'll probably talk about also, is software defined vehicles. As I mentioned, it's moving from a hardware centric view, to a software centric view, and the big buzz is about software defined vehicles. I think most of the major OEMs are really emphasizing this now, that we need to make the shift. They're making significant shifts in investment and development and we've been working with Ecosystem, with our silicon, to help them make that dramatic shift to a software defined vehicle.

(07:20):

It has major implications. A lot is going on, but the common denominator, all those shifts and all those major changes to vehicle architectures, is the software and new processors that can actually help them address that and take vehicles into the future. That's where NXP has really been focused within the vehicle.

Sam Abuelsamid (07:41):

Yeah, you mentioned the software defined vehicle and we're hearing from a lot of OEMs about their plans to leverage that, to try to generate new revenue streams. Recently, we heard about General Motors talking about trying to double their revenues over the next decade, through

software and services. Just a few days ago, Stellantis talked about adding $20 billion euros a year in new revenues by 2030. This is all a really important shift in not just the technology, but the business model for the auto industry. What are some of the specific exciting use cases that you're hearing about, that can leverage this more advanced compute and the software that can run on it?

Brian Carlson (08:20):

Yeah, it's a great question. And I'm glad you brought up about the investments, because I was going to talk about that too. We're really seen a fundamental shift, I think that's really accelerated this year, more from I would say concepts, technology, evangelism mode in the last two years, into reality. These are huge committed programs, typically, as you mentioned, on the order of $20-$30 billion investments to make this happen, but the return is huge. As was indicated, $20 billion a year, just from Stellantis. If you look at the whole market opportunity for services, there's a lot of different estimates from different analysts, but typically the $200 billion to $300 billion range. I mean, we earlier heard numbers of $750 billion, which I think is really high. I think this $250-$300 billion per year opportunity for connected vehicle services is where we're converging now. It's a huge opportunity. Investment up front, but huge opportunity on the back end.

(09:13):

But what's happening is, now that people see a path to get to the connected vehicle, and what I'm talking about is not just taking 50 or 80 things that are going on in the vehicle, and bringing those up to the cloud, and processing them, which is what's going on today with Connected Vehicle 2.0, but having this ability to process the data on the vehicle edge, which now allows them to get intelligence to effectively process the data, whether it's with machine learning and inferencing, whether it's reducing the data either compression or with intelligence, to be able to find the redundancy and find those needles in the haystack, because you can't ship two, three, four terabytes of data of the cloud. It's not cost effective, it's not viable.

(09:51):

What we're seeing is, with the ability now with what we're doing with S32G, for example, is putting that processing in the vehicle to be able to do all of that, do it cost effectively. And by the way, now we don't have to send all the data to the cloud, reducing the cost, but also helping address the privacy concerns of bringing data up to the cloud. It can be processed locally and decisions can be made within the vehicle. What that's driving, is a lot of interesting applications because now you have a centralized place that has access to vehicle wide data that can be processed officially. It can be done real time, low latency, and privately.

(10:29):

We're seeing really interesting applications. One that really comes to mind, is in the insurance industry. And I mentioned OEMs are starting to enter that, where they can start to leverage the processing of the vehicle and the data to provide insurance services directly. That's really important because in the past, they were very limited what they can do. If you would've talked

to me two years ago about insurance, I said, "Yeah, maybe," but we weren't engaged with insurance. A semiconductor provider like us now, are fully engaged with InsureTech insurance companies, as an example of a new application that's really interesting. And our technology is interesting because it allows them to do some very extensive, risk management, first notice of loss, and all kinds of algorithms, real time running in the vehicle, that allows them to give very competitive insurance rates. We're seeing reductions in the order of 10 to 30% for customers, so they benefit by signing up for the service. It gives the opportunity for OEMs to make money directly or by licensing that data to insurance companies.

(11:29):

And it also ties into the whole claim process of making that experience faster, more efficient, which saves a tremendous amount of cost for not only the insurance company, but also benefiting the consumer or the driver buy a better on that. That's a huge one, I would say, is the whole usage based insurance.

(11:46):

The other thing that's really exciting, is we're seeing this data exchange concept, where this real time data is captured, brought to the cloud, and then to be able to be exchanged in the cloud with other consumers of data, not just the OEM or the insurance, but things like smart cities, smart cities to control pollution, to have a better driving experience for relieving congestion, for having improvements within the city in department of transportation. We talked about this a little bit earlier, I think, about there's a lot of data out there about where there's potholes. We can tell you where there's road conditions that could cause safety issues. Not only notifying the city or department of transportation, but using that crowd sharing of all that data from the vehicles throughout the city, to share that with other vehicles, so that they can have a safer journey also, learning from other vehicles on the road.

(12:31):

Another area that's really interesting is in first responders, this is an area we're seeing that's emerging quickly, where they want to get as much data as they can up front when there's an accident. Interesting things, technologies that even NXP is involved in, is how we can even monitor the conditions of passengers in the vehicle, like heart rate, respiration rate with new sensor technology. We can get additional information about the crash impact from the sensors assessing potentially who had seat belts on, how they were injured, and provide that information. And talking to first responders, they say this is really important and critical information for them to help save lives. If they can get that information, they're estimating with lower response times and more information, saving 10,000 lives a year. There's a lot more sensor technology coming into the area of tires, beyond just pressure, that allows you to have real time monitoring of tire wear, how tires are being stressed, how they're performing. That could be fed into not only the autonomous driving area, but fed up into the cloud, drive things like tires and service, where maybe I pay a monthly fee for tires for life.

(13:34):

So interesting new services that are based on sensor data and driving value back to the consumer. The key thing though, is that this data, flood of data and intelligent the edge to process it intelligently and reduce the amount that has to go to the cloud, will really open up a lot of opportunities because it now becomes economically viable to do some really advanced new services with this type of approach of cloud plus vehicle edge processing.

Sam Abuelsamid (14:02):

I think a fascinating thing, listening to your response to that, a theme that runs throughout almost all of what you just said, is predictability. Whether that is predictability for fleet managers, with tires, understanding the condition of tires on a fleet of trucks, or predicting for those emergency responders, what the condition of any potential injured people would be when they to the site of an accident, and being able to get right to addressing the real problem there. And of course, predicting, in real time as a vehicle is driving down the road, to help to avoid some of those crashes in the first place. That predictability that you can do with this kind of processing, I think is an amazing improvement to what we've been doing so far.

Brian Carlson (14:46):

I'm glad you brought that up way. By the way, one thing I forgot to mention, is we're seeing a tremendous interest in the commercial vehicle area. Just like you said, I've been talking about data is the lifeblood of commercial vehicles. If you look at what they're doing, from an operational point of view, from a safety point of view, from a driver log in point of view, they have all kinds of recorders. They have data recorders, logging recorders, and their operations. It's a huge industry. It's very fragmented, a lot of different players out there, but they all have the common need for vehicle data.

(15:17):

And today, they've been pretty limited, with more Dongles, limited number of parameters, but all these things we're talking about, leveraging the edge, we're seeing a huge momentum there also in commercial vehicles because they can justify this even faster than passenger vehicles, because that comes a little bit slower. They can move quickly, get benefits rapidly by having access to this type of technology, processing at the edge, being able to converge a lot of the services today that they may be doing only in the cloud, which can be limited. So we work with cloud providers and telematics type providers, to provide more integrated solutions that can leverage that edge. I would say commercial vehicles, it's a pretty broad market from the large 18 wheelers, all the way down the fleets of vans that are out there making deliveries, or repairmen, et cetera.

(16:05):

It's a huge opportunity also in the commercial vehicle area and even extended into smart agriculture. We see other types of vehicular applications that can leverage this data in agriculture, mining, heavy equipment. And even into things like avionics. We now provide packages to support avionics, so they can also leverage the data within airplanes also, which is a really interesting area in drones, for example.

Sam Abuelsamid (16:29):

Any of us that have ever opened up and taken a look at our cell phone bill, understand that data is not free. Can you talk about some of the unexpected challenges of dealing with vehicle data?

Brian Carlson (16:40):

Yeah, definitely. I think you hit one of key points, is about the cost, right? It sounds great. Yeah. I can connect the car. I have terabytes of data, but you're not going to be sending all that data. And in reality, probably 95% plus of that data, I don't care about or I want to make decisions. If I can make decisions on the data locally at the edge, and then provide those indication up to the cloud, or if I want to be able to do intelligent data processing right there at the edge. Say there's a hard breaking condition, and we want to look across the fleet of maybe some issues in the breaking. Was it a false positive? Maybe there's a condition where there may be a fault or a vulnerability in one of the modules within a fleet of vehicles and the OEM wants to be able to find that, that needle in the haystack, only when that condition happens.

(17:28):

Today, they have no way to do that and they can't send all the data to the cloud for millions of vehicles all the time. The challenge is the cost, and how that's being addressed now is leveraging the edge processing within the vehicle, like with the S32G, to be able to put that intelligence there, to leverage machine learning, to be able to make decisions, and to find those needles in the haystack, and provide data to the cloud.

(17:51):

We have use cases and work with partners where we can do visual data, whether it's Lidar radar type data, reducing up to 75%, which is huge because you want to train machine learning and be able to do that efficiently. And actually, a side result of that, which we announced when we did the fusion project with industry partners, is that if you only bring the data that really makes sense to the cloud, it actually can reduce your machine learning time significantly from days to hours. The result in machine learning model is more effective, more accurate. And when it runs in the vehicle later, that whole loop of collecting data, bring it to the cloud to train, and then redeploying an improved model, that model has lower latency also, so it provides significant advantages to do that pre-processing, finding the needles in the haystack on the vehicle before bringing data up to the cloud. It reduces data significantly.

(18:44):

We've shown that we can reduce all the can traffic in the vehicle by about 96% with our partners. That gives significant access to that data by the OEMs, whether they want to drive that into digital twins to model in the cloud, to do prognostics, as you were talking about predictive. That's a huge thing right now, vehicle health, predicting when components will fail, which will help them assess if there's a problem in the fleet or to be able to optimize the supply chain, so that they can have those parts available at the right place at the time.

(19:15):

There's so many benefits of it, but the challenges have been, first of all, the cost. In Connected Vehicle 2.0, it's all about driving data to the cloud and then processing it there. That's not viable going forward because the amount of sensors, the data within the vehicle beyond sensors within the control units, it's just not viable. As I mentioned about Connected Vehicle 3.0, that's how we address that challenge, by bringing machine learning, processing at the edge, and working collaboratively with the cloud in an intelligent partitioning of processing. I think that's the first thing with the cost and working together to do that. The other thing was just getting access to data. And having a processor like the vehicle network processors that S32G2 are, allows you now to have centralized access to all the vehicle data. It's the gateway to the whole system or becoming more and more the vehicle computer within the vehicles, so it has centralized access with high data throughput, access to all the can, all the ethernet interfaces.

(20:11):

That's been the other challenge, is getting physical access to the data. So now, having this type of technology to now have access to the data and to address the cost issue, to make it viable to process and leverage data throughout the vehicle, to create these new opportunities for business, for cost reduction, and ultimately a better customer experience. That all ties into the whole software defined vehicle aspect also. It's an all-encompassing type of approach that is really significant, versus today's vehicles.

Sam Abuelsamid (20:42):

Yeah. As we go from having hundreds of thousands, or maybe a few million vehicles on the road with this connectivity capability, to having hundreds of millions of vehicles on the road, those data costs are going to explode. It can cost OEMs hundreds of millions or billions of dollars a year, just in data transfer and cloud storage fees as well. All of that adds up and being able to do that smartly from the vehicle, it sounds like that can be a huge boon in managing those costs and allowing these technologies and services to be more accessible to consumers and fleets.

Brian Carlson (21:18):

Exactly. I mean, it's fundamental to make the vision of connected vehicles and everything we're talking about reality, right? It's great on paper to talk about it. I can have access to all this data, but the reality is, you have to not only provide that technically, you have provided economically. Also to more and more of cloud processing is important. Now it's an interesting dynamic because, of course the cloud service providers, their business model is more and more compute, more and more storage. The more and more data they get, the more money they make, but the reality is they need us to help them to make it a viable business model. That's why cloud service providers like to engage with us, to provide that key component, that vehicle edge processing, to make this economically viable. And then, we need them because we need the cloud capability. As part of that data life cycle with machine learning, we have to have that processing in the cloud for digital twin models, for machine learning, to enable other applications, data exchange also.

(22:15):

It's a really interesting dynamic between NXP with Vehicle Network Processing with S32G, doing that in the vehicle, and then the cloud service providers that provide all of the amazing capabilities that they have in the cloud, and together optimizing that seamlessly and making it cost effective. If you don't have that type of collaboration or that type of cost effective model, none of this will be viable.

Sam Abuelsamid (22:39):

You talked a lot about what's been enabled so far by S32G2, as you transition now to the G3, what has changed?

Brian Carlson (22:48):

It really ties into everything we've been talking about, so it's a great way to bring this all together. We just recently announced the S32G3 series, within the S32G family. We went to production back in second quarter of 2021 with the S32G2 series, which has been very successful within OEMs worldwide, not only automotive, but in some of these adjacent markets that I've talked about. And in fact, there are vehicles on the road today, production vehicles started shifting in September of 2021, so this is happening now. We're seating the market for the software defined vehicles and new capabilities that we're talking about.

(23:23):

If you look at those trends and what we've been talking about, especially during this COVID time, we see more and more activity towards this ECU consolidation, bringing more intelligence into a more centralized vehicle computer, and that requires more processing, more memory, and other capabilities to take it to the next level. What we did is take a look at G2, how can we advance it? How can we maintain software compatibility, pin for pin compatibility, so our customers can design a product that can scale across their fleet across multiple applications in the vehicle? Not only gateways, but we're seeing this in domain control heavily used as a safety processor within many high profile autonomous drive systems that are in development. How do we provide a platform that scales not only within a family, like S32G2, but now extends the performance, memory, and capabilities into other applications or even higher ECU consolidation applications of vehicle compute applications?

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That's effectively what S32G3 does. It doesn't replace the G2. It extends it with even higher performance. We have over 2.5X, the performance 2.5X the memory, and 2.5X the networking capabilities, up to 2.5 gigabit ethernet, and improved the throughput of our networking capabilities. All of this to address the driving factors of software defined vehicle, which is consolidating a lot of functionality into a single processor. One of our lead customers on it is bringing many functions today that are in many boxes into a single S32G3 processor. That's really a proof point of how this type of technology can support the consolidation that is being required to simplify vehicle architectures. And at the same time, be an architecture that is service oriented, that we can support the software design vehicle needs of the future.

(25:21):

That's really what it's about. It's about more. I talk about it's more. It's all about more, but maintaining software compatibility, pin for pin compatibility, and allowing our customers to go from micro controller up to amazing performance in a system on chip with the same product, just populating different versions, whether it's a G2 family or G3. That's what we're doing, is extending the success of G2 into the future to address some of these new applications.

Sam Abuelsamid (25:46):

We've been putting micro controllers into vehicles since the 1970s, and it's been accelerating ever since. That acceleration seems like it's not even close to being done yet. Brian, you've mentioned several times the idea of a software defined vehicle. It's a term that has come up a lot over the last couple of years across the industry. Can you delve in a little more on what exactly that means.

Brian Carlson (26:08):

Software-defined vehicles is being thrown around a lot in the industry and there may be other definitions around but it is the trend going forward in this new advanced vehicle architecture and the software that's critical to make them a reality. This is going beyond just doing software updates with over-the-air updates. It goes beyond that. It involves the whole development "how do I develop software, how do I deploy software and how do I leverage the cloud with the vehicle, not only in test vehicles but really in production vehicles?" What's key here is that use of the cloud and to have that CICD which is continued improvement, continuous integration and continuous deployment. So you'll hear about CICD. The use of the cloud is a critical component of that, you'll hear about cloud technologies , cloud development. What we're seeing with software defined vehicles is this whole integration of agile approach to software over the life of the vehicle. And that involves not only development on the platform itself reaching remotely into the platform, but also with cloud development tools and having the vehicle edge and cloud working together in a seamless way.

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What this is about is being able to move from that hardware centric world where tier one would develop a specific function for one specific box and have a hundred of those in a vehicle, to now, a platform that consolidates all those functions in a single chip. So that's what is interesting here is you have to have that whole infrastructure to support multiple tier ones providing different functionality all within the same chip running on different portals. Whether it's a container using hypervisar technology with virtualization. This is where the software defined vehicles really becomes interesting because it allows all these innovation we are talking about over the life of the vehicle which [inaudible 00:28:00] to be able to continually update that vehicle with improved algorithms, with new functionality, with new services that the OEMs can offer to the consumers. It's a very holistic area. Software defined vehicles not only update the vehicle but it's also the concept of being able to group all these functions integrated into hardware and

having that development process which involves close activity with the cloud, working hand in hand with the vehicle. This is where we have being focused a lot with our [inaudible 00:28:36] platform as far as the hardware part of the vehicle edge[inaudible 00:28:40] we call the vehicle integration platform or called VIP which is a complete stack that integrates the rapid development on the platform with the cloud connectivity to extend that. And having the ability to do things like containers, hypervisars and virtual machines and providing that environment that is really necessary for the software defined vehicles.

(29:03)

Ultimately for the consumer, it's about my vehicle gets smarter, I get more features offered to me, the OEM, tier ones of other great parts are providing service on the platform, and it's a complete end-to-end ecosystem and [inaudible 00:29:19] software that allows that to really become a reality which was never really possible in today's vehicle architecture that are hardware centric in boxes per function. It's a very common thing you'll hear more and more about software defined vehicles and it's fundamental to these new vehicles that are in design today.

Sam Abuelsamid (29:38):

And of course, a follow-up to that is while you do have to fundamentally change the way you think about software development for the vehicle that also means that you do have to change the way you think about the hardware design when in my engineering days, working on electronic design systems, we always had the bare minimum amount of compute that was required to execute a particular feature like ABS or electronic stability control. There was no headroom to add unto that and that's something you have to change the way you think about designing the electrical electronic architecture of the vehicle.

Brian Carlson (30:11):

Exactly, you have to look at it holistically. The whole idea is to extract the hardware because not only can you move services across, in fact, you can even do services that can migrate from one part of the vehicle to the other, the pay from that that can be great in safety and redundancy if we need to build tasks. You can move tasks seamlessly between cloud and to the vehicle. That will open up the whole ecosystem. So it's that totally different mindset. I came from digital signal processing many years ago and it's done to every structure, every memory and it's optimized, like you were talking about the industry of automotive and that it goes out very optimized with no overhead.

(30:47)

And that's a fundamental thing about the last, I would say, 24 years, is that OEMs are thinking about having more performance, more memory and storage than they needed going out the production line. With the fact that they wanted to add more functionality overtime to be able to provide these services through revenue generation, et cetera. That is a fundamental shift. The hardware has to be able to support all of these isolation technology which is what we do with our devices that we can isolate in hardware, multi-tenets running through parallel, and also safety critical versus non-safety critical. So there are a lot of implications to the hardware now under the covers to provide safety, security, different types of performance like real-time performance, application performance, access to security services. There's definitely a lot of complexity under the covers but with the software defined vehicles, the intent is to extract that, you have to fundamentally have that all under the covers to extract that at the software level so that developers can quickly develop new applications that can be deployed. So they are not strong necessarily now by the hardware itself that's being taken care of under the covers. They can be more free and innovate very quickly and that's what we're talking about. More the agile approach and the vehicles being deployed rapidly to vehicles now having [inaudible 00:32:08] in place and they can stay at the application and innovation level without having to worry about all of the hardware HPCs. They are now being handled a lot of times by in the case of the [00:32:19] like us, and working with tier ones and partners, we provide all of that under the covers and allows the software developers now to innovate on top of that.

Sam Abuelsamid (32:29):

Brian, thank you so much for this conversation. Have a great day.

Brian Carlson (32:32):

I enjoyed talking to you. Thanks for the opportunity.