Future of Enterprise Computing

Company Participants

- Anurag Rana, Senior Analyst Software and IT Services
- Crystal Valentine, Vice President, Technology Strategy

Presentation

Anurag Rana {BIO 7440273 <GO>}

Good morning, everyone. My name is Anurag Rana, and I'm the Senior Analyst for Software and IT Services at Bloomberg Intelligence. Today, we have an exciting session to talk about the Future of Enterprise Computing.

Before we get into that, let me do some housekeeping items. Today's presentation will be recorded and available for playback. You can access the replay via the link sent to you in the email from Bloomberg Webinars. And the bottom of the slide window, you can adjust the volume and maximize your screen. Ask a question by submitting one to the right of the slide, we will address questions at the conclusion of the presentation. A copy of the slides will be distributed in a post-event email.

With that pleasure, I want to introduce our guest speaker today, Crystal Valentine, PhD. She is the Vice President of Technology Strategy at MapR. And before that, I just wanted to give one quick word on Bloomberg Intelligence. We are part of the Bloomberg family and provide in-depth research and data on industries, companies, government, ESG, credit economics. We have about -- we cover about 135 plus industries, about 1,800 plus companies and we have about 300 plus third-party data providers. We had close to 300 people in the team right now, and our content can be accessed on the terminal through the BI GO.

With that, I will pass it on to Crystal, that can guide us through the rest of the presentation.

Crystal Valentine {BIO 20867216 <GO>}

Great. Thank you very much, Anurag. (Technical Difficulty) we're going to advance through the first couple of slides here. Okay. Good morning, everyone. Thanks for joining. So I'm Crystal Valentine, and I'm going to start today by just giving a brief framework through which I think it's helpful to analyze a lot of the market trends that we're seeing, especially the emergence of new technologies and new paradigm in enterprise computing and what that means for the legacy technology vendors. And as you're thinking about companies and whether they are our secular tailwinds or headwinds, I hope that this framework will be useful.

So from a large picture, what we're seeing is a really remarkable fundamental shift in the way the enterprises are thinking about spending money on technology, and we go through this type of shift or transformation about once every 30 years or once a generation. And if you look at the macro picture, global technology spend is about $1.5 trillion excluding telcos and devices, and it grows at relatively the same rate as GDP growth, but primarily flat. But if you break down the technology spending into its constituent components and you differentiate between spending on next-gen technology versus legacy technology, you see two very different stories taking place.

The next-gen technology, which is inclusive here of cloud computing infrastructure, as well as on-premises sort of scale-out art [ph] infrastructure technologies is growing year-over-year. And by contrast, legacy technology investments are not just slowing their growth but are actually starting to shrink. We actually pass that inflection point a few years ago in 2015, but you actually see a decline in the growth of the core assets for legacy technology company.

And from a technology perspective, we think about what can explain this shift, it's more than just the opportunity to save money using cheaper infrastructure or cheaper devices, instead there are something much more fundamental taking place. Still a couple of trends that are pretty well studied and well understood at this point are converging to create this shift. The first one being the rapid growth in commercially available computing power. If you're familiar with the trend known as Moore's law that's especially what this is referring to that, essentially the power of the commercially available transistors, the number of calculation per second on a per dollar basis that is commercially available in the market. It doubles approximately once every 18 months, and so that equates to about a 40% compounded annual growth rate. And if you -- this chart, which shows that growth, which has a (inaudible) scale on the Y-axis, actually includes in the upper right some NVIDIA GPU chip. Those are precipitating and continuing on this trajectory that we know as Moore's law.

At the same time, we have a massive acceleration in the volume of data that's being collected to be analyzed by enterprises. A study by McKinsey estimated that in 1987 there were about three exabytes of data, whereas in projecting forward to 2020, we are looking at about 44 zettabytes of data, which is 44,000 exabytes of data. And, of course, as data volumes are growing in this phenomenon has also been well studied, we also see an increasing diversity of data types that we're collecting. So it's no longer just the structured CRM or ERP data set that at large enterprises are collecting that are growing, but instead it's largely coming from unstructured sources such as weblogs or sensor data of a high definition video, beep audio files, et cetera. So, data volumes are growing at an enormous rate and it's even more complicated because they're diverse data types.

And the third trend that has been somewhat problematic relative to the first two trends, the growth of computing power and the growth of data, that's being collected is that, fundamentally storage access speeds or I/O speeds have lagged, growing at a modest -- a much more modest rate about 20% compounded annual growth rate compared to the 40% compounded annual growth rate that competition

speeds are growing. So today a commercially available hard disk drive or even SSD drive can achieve no more than about 550 megabytes per second I/O speed, that means the time it takes to read or write data from persistence storage into memory of the processor. And, in fact, the fastest data speed that you can get using, for example, AWS is about 500 megabyte per second. That's the fastest I/O speed that you can achieve commercially.

So, as compute has gone faster, as data volumes have increased, our storage density has gotten greater and cheaper, but these storage access data, right, that has meant that, in fact, data storage or data access has been the bottleneck. And that has motivated a shift in architecture. So, in the legacy world, we saw predominantly what are known as scale-up architectures, where you would have multiple applications potentially running on things like relational databases that would be accessing data stored in a SAN or traditional NAS storage device or array. And here the bottleneck would be the controller to that -- or the controllers to that device. You have multiple applications, all trying to access a shared data storage device. And essentially, it was that -- that data I/O speed that that became the fundamental bottleneck.

In order to transcend that bottleneck then, we've seen a shift to scale-out architectures and here scale-out is synonymous with a large -- with the idea of running your applications instead on large cluster, sometimes thousands of commodity Linux servers, and this is inclusive of both on-premises, scale-out infrastructure technology things like hadoop-based platforms, as well as public cloud infrastructure as a service, that is also a scale-out architecture. And the benefit of leveraging a scale-out architecture is not only that commodity Linux servers are relatively inexpensive, but you're now able to parallelize that fundamental bottleneck, that data access, because you have computations and data storage distributed across a large cluster of nodes, meaning that each processor can in parallel read from its local storage device, such that the I/O can be parallelize across the size of the cluster.

So, next-gen architectures have helped to overcome the I/O bottleneck. And as I mentioned before, they also have the benefit of running on relatively inexpensive commodity hardware. And what this has fundamentally done is, change the value of data, and what I mean by that is that, it has been known for some time that there is value in data, there is value in being able to analyze data in order to optimize your business. And what I'm showing here on the left is the legacy value model of data. So if you look at the orange curve at the top, that's simply demonstrating the notion that if you go from having no data to some data, it's quite valuable. And going from some data to incrementally more data, adds more and more value. At some point though, you reach the law of large numbers and you get diminishing returns in adding incremental values, so that curve flattens out going towards the right.

However, using legacy scale-up architectures, you had a fundamentally exponentially growing soft curves, the cost of storage during managing data grew exponentially with the amount of data you had under management, that's the green curve. So then the net value, which is the value minus the cost is an upside down curve and you can do simple calculation to find out where that curve is maximum, and that's the

optimum value -- that's the optimum volume of data that you should manage in order to extract value from that data without incurring too higher cost.

Today, leveraging next-gen infrastructure, the scale-out infrastructures, the orange curve, the value of data hasn't changed, but what we have changed is the cost curve of managing and storing data. The cost is now a slowly growing linear function in the size of data under management. And it's indeed the case that's going from an exabyte of data under management to two exabytes of data under management, roughly doubles the cost of the infrastructure required to manage that data. So, now, we have a different net curve, that's the value minus the cost, and the optimal value -- the optimal volume of data that we should store and manage in order to extract value is now much further out to the right, it's a much larger volume of data that we can now really leverage to the benefit of the company.

So, as a final thought, I think of the world in terms of what I believe to be axiomatically true and axioms that, I think are true, at least, today are that data essential to disruptive applications, so we know that data is the leverage point for gaining competitive advantage, the most disruptive companies and business models are built on data-intensive applications.

Second, the data volumes are continuing to grow in part because data -- because of this shifting value model, the shifting value curve of data and these scale-out architectures are fundamental to that.

And then finally, that -- with existing technologies today, we see that data movement or data access is the performance bottleneck, which has certain implications, meaning that solutions or architectures that minimize the amount of data that need to be moved in order for the application to perform are going to out -- are going to be better than ones that require large data movements, whether it's over network or whether it's that I/O data access movement from persistent storage to the main memory of the computer.

And I'll pause there and that concludes my overview and we can transition to the question-and-answer portion.

Questions And Answers

A - Anurag Rana {BIO 7440273 <GO>}

Thanks, Crystal. One of the things you have mentioned in your area is about the next areas of development, which could be the forms of AI and machine learning. So, when we look at an IT infrastructure of a company today, we can talk about it, whether it's a start-up or a new workloads versus a legacy company with an older business model. Which way do you think the world will eventually evolve, whether it's going to be a public cloud model, or a private cloud model or a hybrid cloud model? And how do we envision all the legacy technology spending, which you've mentioned is about $1.5 trillion? How do you envision that shaping up, let's say, over the next 3, 5, 10 years?

A - Crystal Valentine {BIO 20867216 <GO>}

Sure. I think that legacy technology, which is primarily characterized by on-premises deployment is indeed in secular decline. I think that the public cloud infrastructure offerings offer both performance, as well as economic benefit, at least in the short-term for most companies. What we're seeing though is different rates of adoption depending on what size companies were analyzing. So small companies and to some extent, medium-sized companies as well have less technological baggage, potentially they have less -- have made fewer investments in large legacy deployments and therefore it's easier for them to rapidly adopt cloud needed technologies, and embrace a cloud-first strategy.

Larger enterprises, Fortune 500 companies, large banks and telecoms, et cetera, have a different calculus, they have typically made decade worth of investments in legacy technologies, whether it's on-premises data warehousing projects, or if it's on legacy ETL software investment, that are both very expensive by embedding them decades of business logic. And it is not straightforward to refactor that existing software technology, and shift it into a public cloud offering. The most straightforward path for doing that is, for example, through a Teradata customer to leverage the Teradata cloud, but that is not something that I personally would categorize as a true cloud-needed technology, in fact, it's a legacy technology, but it's simply a managed services offering.

So, I think that, so the larger enterprises have a longer journey to the public cloud, but they are also becoming savvy about the idea of cloud vendor lock-in, and that's a consideration that's coming into the minds of some of the larger companies, because they're thinking ten [ph] and sometimes longer time horizon out into the future, and they want to understand what their relationship with Azure, AWS, or Google is going to look like, and how that's going to impact their business going forward.

I will also just make another note that I believe that a lot of the conversation about the growth in public cloud infrastructure is missing one critical aspect, which is that, while it's true that growth in public cloud computing is fast and it's accelerating, it's actually estimated to be only around 16% to 19% compounded annual growth rate, which is lower than the 35% compounded annual growth rate of the growth in data volume. And a large part of the reason why public cloud is growing slower than data volume, you'd think that it would be a little bit closer, it's simply because a lot of the data and processing is actually occurring on the edge, in edge devices, things like connected cars and then even lesser known technologies like smart jet engines where some of the new jet engines, for example, generate about 36 terabytes of data per engine hour. So that's an enormous volume of data that's being generated and processed on the edge and that will never make its way into the public cloud infrastructure, so it's important to keep that in mind.

A - Anurag Rana {BIO 7440273 <GO>}

So that's fairly amazing and perhaps we can start peeling up the public and the hybrid area and then maybe we can move to the edge computing. So, when we look

at -- we can take a look at a legacy bank that has, as you said, a lot of IT baggage that they have to deal with. Strategically, what is the best option for them? I mean, should they move portions of their workload to their public cloud? Should they move non-critical applications as is or refactor them? Or they go with the hybrid cloud strategy, the one that, for example, AWS and VMware together are pitching or what Microsoft is pitching or what Oracle is pitching? If you were sitting in some of these banks, what would be your mindset, or what would be the strategic direction that you would take?

A - Crystal Valentine {BIO 20867216 <GO>}

Yeah, that's a great question. And, in fact, I was asked that question not very long ago by the CIO, Chief Information Officer of a large US bank based in New York. And the question to me was exactly that, what is the future of data? How should I think about cloud as a viable location where I can place my data? And the motivation behind that question was that he was very cognizant of the fact that the cloud -- data has gravity and once your data is in the cloud, it's where it becomes -- there is a (inaudible), and there is a plenty of reasons why you don't want to go through the hassle of moving that data. And our belief that which is that most of the cloud vendors actually charge you to move your data out of the cloud.

But his question was, how do I think about the cloud 10 years from now? What is my relationship with Azure or AWS going to look like? And every once in a while you hear stories about large customers that actually hit an inflection point and they decide to leave the cloud altogether and re-purpose their on-premises data centers to take over again, because the volume of data that they had under management was so great. The cloud was no longer an economically viable option for them.

So, my response to his question was that, the only strategy that makes sense is to be try to develop cloud-neutral application. That's the only way that you can actually be resilient to changes in cost or other unexpected interruptions in your relationship with a particular cloud vendor. So if you develop what are known as cloud-neutral applications that can run the same on-premises as they do on AWS, Azure, or Google, or could even leverage a combination of both public cloud infrastructures, that sets you up in a position where you have optionality going forward where you can shoot to shift your compute or data consumption between public cloud vendors or in your on-premises data center as prices or other considerations dictate.

A - Anurag Rana {BIO 7440273 <GO>}

Crystal, one other things that you mentioned about the data charge, it has been coming up lately a lot in our discussions with the industry contacts. Perhaps, give us a little more detail or enlighten us more because I've also heard some ISV is trying to figure out which vendor to go for, depending on how the data is charged? Perhaps, even give us a little bit of a basic as to how cloud vendors are charging when data leaves or comes in their data center, anything around that would be interesting?

A - Crystal Valentine {BIO 20867216 <GO>}

Sure. Yeah. So it's complicated to actually make an estimate of how much you're going to be spending once you decide to deploy your application, for example, on

AWS or Azure. It's a complex analysis, because it's a function of many different factors and the only real way to know how -- or project how much you're going to be spending is to actually run a benchmark, to actually deploy the applications to the cloud and then check to see what your monthly bill looks like and then extrapolate from there.

So the factors I go in to determining them, you are paying for cloud, of course, are combination of the amount, the volume of data under storage, there are different tiers of storage capabilities that they offer with different I/O speeds and different SLAs that they guarantee with different prices attached to each of them.

There is also a charge per virtual machine per instance. That is essentially a unit of computation, a unit of computing power that you're leveraging. And there are different pricing models as well, you can either use a pay-as-you-go or you can sort of reserve certain instances for your exclusive use on a yearly basis. But the data movement is actually one of the hardest task to understand. So, for example, within AWS, there are many different geographical -- what they call geographical regions throughout the world and the reason that you would -- you have optionality to choose which geographical region you would like to leverage when you're building a cloud application and there are actually different prices between different geographical regions depending on supply and demand.

The challenges that one of the main drives [ph] of leveraging public cloud infrastructure is that, if you have a truly global application, right, if you're a large multi-global banks, for example, and you have customers in Europe, as well as North America, you would love to be able to minimize the latency or the time it takes for a customer interacting with your website or your ATM between the time it takes for the data to leave that that web-based application or the ATM to make it to the public cloud to be minimum. So you actually want to leverage the combination of geographical regions, combination, for example, of North America and European regions.

The challenge is that, moving data between those regions, which inevitably have to happen when you're trying to aggregate across all of your customers, for example, Talking Money [ph]. So there is a fee, essentially a tool for moving data between geographical regions and sometimes there is even a tool for essentially moving your data from the public cloud back to your on-premises data center. So there are many sort of hidden fees and for a sufficiently complex application, it can be really difficult to get your head around what the total cost is going to be.

Amazon also has, for example, a number of sort of homegrown tools that they offer to their customers. Each one of which has different fee associated with it. And some of them are not particularly cost-effective, which I think surprises a lot of people, for example, the Amazon data warehousing product, which is known as Redshift. It's by no means inexpensive and tends to be a large expense for customers who choose to leverage it. And, of course, it has its own lock-in problems, which is very reminiscent of the -- some of the problems with the legacy data warehouses.

A - Anurag Rana {BIO 7440273 <GO>}

Yeah. This is -- I mean, this one of the most interesting things that we're seeing as public cloud growth has gone up as people are trying to realizing that it's not as cheap as it's written, or, I guess, it's marketed. And it begs to think about it that, the way I look at it is, the public cloud infrastructure was built in a way that provides high amount of scalability, back-up your agility, all those things that a legacy IT infrastructure lagged. So if sometimes, I think if I am a large bank thinking about the future of IT for me, why won't I want to create a private cloud with exact similar specifications that how an AWS looks like and try to meter it internally to different departments or different areas in the same way, just like what I would do on a public cloud and never be worried about lock-in or any of those issues? How hard is to create such a network, or is there a cut-off that below this much revenue or these many employees, it does not make sense to try to do it yourself?

A - Crystal Valentine {BIO 20867216 <GO>}

Yeah. I don't know exactly what that cut-off is precisely. But I would hazard to guess that we will see at least for the foreseeable future the Fortune 500 companies maintain their own IT organizations with their own on-premises infrastructure and with their own system that essentially annihilate the agility and usability of the public cloud infrastructure options. And they will do that for a number of reasons, partially because of cost, because at some point, you're right, the economics of deploying really huge volumes of data in the public cloud start to fall apart, partially also because of security, especially within financial services we see a lot of more conservatism around embracing the public cloud for mission-critical applications and for sensitive customer data.

And -- but for -- I'm not sure that the cut-off is going to have to do so much with the size of the company as that will be the age of the company. And so, we're going to see companies that are relatively new, that are relatively young, that are still what you would consider large consumers of data to embrace public cloud in a way that sort of the larger banks and Fortune 500 type companies wouldn't and here, I'm talking about companies like Netflix or Uber, they embrace cloud-native architectures and paradigms from the beginning. And to a large extent that's what said, their ability to innovate so rapidly and has more to do with just the infrastructure offered by the public cloud, had to do with fundamentally different paradigm for developing applications that enables agility.

So it wasn't just that the public cloud infrastructure was agile, but it was a fundamentally different way of writing applications. But those types of companies even though they have huge data deployment has embraced cloud-native and that has been largely to their benefit, it becomes much easier for them to add new features and functionality to integrate modern technologies like machine learning and artificial intelligence, because they've embraced this modern next-gen application architecture that includes leveraging public cloud.

A - Anurag Rana {BIO 7440273 <GO>}

So in that same case, one of the more interesting, I would say, examples that came across to us recently was Dropbox, I mean, they started their life under with AWS and now they have their own private cloud. And from what I saw that their profitability has improved, I mean, in part due to the shift in doing it themselves, could that be a model that others follow and say, hey, pharma company that does a lot of data transfer between regions or in between on-premise or other areas, I might create my own network rather than using a public cloud source?

A - Crystal Valentine {BIO 20867216 <GO>}

No, I think, it depends on what the core competency of the company is that's under investigation. Dropbox is somewhat unique because fundamentally what they're offering is the storage service. If the fundamental of what you're offering is a storage service and your job as an operator is to optimize the cost of storing on behalf of your customers. Companies now that have much more interactive and sophisticated applications, companies like Uber and Netflix and many others are really benefiting from much more sophisticated features and functionality that has to do with the fact that the applications that they're writing are still much more sophisticated than what Dropbox is running. So, for them, it's really a competitive advantage to be able to leverage a machine learning to train models quickly to deploy, model to production quickly and whereas Dropbox leverages certain modern paradigms like machine learning to a much, much lesser extent. So, I think, Dropbox is somewhat of a special case there.

A - Anurag Rana {BIO 7440273 <GO>}

Yeah. Fair enough. Another thing you touched upon in your presentation was edge computing. And this is another, I would say, driver that could lead to more IT modernization of legacy infrastructures in our view, because today if I was to think about it, if we are going to have a lot of data that gets generated on the edge and doesn't make it back to the public cloud, it reminds me kind of my old on-premise client server world. And if I really, a company that is going to use a lot of sensors, or a lot of computing at the endpoints, I might as well have a private cloud network that has a lot of processing power in those endpoints. What's your kind of take as to the marriage between a private and a public cloud in this particular case?

A - Crystal Valentine {BIO 20867216 <GO>}

So, there is no one size, but it's all decision for IoT application. But I think, if I can just give you another visual here on the relative growth of data being generated and process on the edge. First is, within the data center, this is just an abstract, sort of contextual drawing, but we talked about the growth of data being approximately a 35% compounded annual growth rate, but if you break that down between data that's growing within the data center and the public cloud, and data that is being generated and process on the edge, again you see two different stories and the edge is growing at this point much, much faster than even the size of the consumer Internet.

So, data being generated on-board cars, autonomous driving vehicles generated about three or four terabytes of data per vehicle hour, as I said, that doesn't even compared to -- for examples, Pratt & Whitney's Geared Turbofan engines, which

generate about 36 terabytes of data per engine hour. That data is actually largely never making into any public or private data center. That data is largely being generated on-board the vehicle or on-board the planes looking for anomalies, looking for a problem and helping them make real-time decision. And then only a very, very small percentage of that data is being aggregated and sent back to a data center for subsequent retrospective analysis

So, the decision of letter to leverage public or private cloud infrastructure when you're developing an IOT application, really depends on what the nature of the application is and how sensitive you are to, for example, security concerns and latency issues, which is the other primary concern. If latency is particularly important to your application, you might either have to set-up multiple private data centers around the world, or you might have to leverage multiple different geographical regions, within the public cloud infrastructure as one example.

A - Anurag Rana {BIO 7440273 <GO>}

Cool, thanks. Just a quick reminder, if you have any questions, please type it out and we will address them.

Crystal, one of the things that we talk about a lot, there is a lot of marketing hype around it, around AI. How should we think of AI? I mean, do you think of the evolution of this as a -- has to tied to a public cloud platform, I mean if you really want to be good at it, do you really need to have a AWS and/or a Google kind of a structure? Or you could do that on an premise world? What are your thoughts on who's kind of leading the race at this point? And, I mean, I don't envision a standalone operation or a standalone application, it's -- it occurs to what's it's going to be more embedded into the applications people are building. But as you compare different platforms, what's your first take or initial take on it?

A - Crystal Valentine {BIO 20867216 <GO>}

Yeah. So, obviously, artificial intelligence, machine learning are massive secular trend. Today, the -- all of the cloud vendors are trying to develop tools and platforms to leverage their cloud infrastructure for machine learning applications, for example, but most of those tools that are available in the public cloud are either open source, meaning they can be deployed on-premises, as well as they can be deployed in the cloud or are really not that interesting. So, so far, we have some pretty rudimentary tools being offered, for example, from AWS and Acer and Google actually probably has the most sophisticated one at this time, but they're largely open source.

We have some rudimentary tools that the public cloud vendors are making available to incentivize net new application being implemented on leveraging their infrastructure. And, of course, if you use their tools you are going to likely rely on their APIs and therefore, lock yourself into that particular public file vendor for the foreseeable future.

In practice, the most sophisticated machine learning applications that are being leveraged in the enterprise and here I'm talking about things like the deep learning models that go into autonomous driving or even the machine learning models that

go into making recommendations on Netflix. Those are not leveraging any of those cloud branded tools. They are typically very much homegrown. They're leveraging open source software but they're highly customized in order to do anything that's particularly interesting or disruptive, you end up having to hire a team of experts, a team of PhD to write highly customized code and that is the no way sort of cookie cutter, which is what the public file vendors are offering to date. They are offering relatively low featured cookie cutter tools to help really basic machine learning applications.

So, I think that will -- what we'll probably see is the continuation of mergers and acquisitions by Amazon, and Azure and Google, in particular to acquire more and more companies that are start-ups, that are building tools and frameworks to enable more sophisticated machine learning application development. But we -- today there is not a clear compelling reason to leverage one side over another, I think within academia, Google cloud tends to be a little bit preferred within start-ups that are trying to build a cloud native applications that use machine learning AWS. It tends to be a little bit preferred, of course, Azure is preferred by existing Microsoft customers.

A - Anurag Rana {BIO 7440273 <GO>}

And have you had any experience with IBM's Watson, because they have been working on this thing much longer with their industry expertise and the client base. Have you had any experience with that? Any thoughts on that?

A - Crystal Valentine {BIO 20867216 <GO>}

Yes. So, Watson is not what they would they tell a -- they call it cognitive computing. It's not true artificial intelligence and it's a rather old technology, in fact. Watson is fundamentally what's known as a question answering machine that requires an enormous amount of annual -- annotation of input data typically text corpuses, that -- and then Watson creates a semantic math or semantic model of the entities and relationships that it has observed within the text that it has trained on. And with that semantic model that representation it is able to answer a question. Though it's a relative -- it's fundamentally somewhat rudimentary or at least legacy use of what could loosely be called machine learning, it doesn't excite me particularly from a technological standpoint and it has been particularly challenging to implement and process, there is some very public instances where Watson's fail to produce valuable insight, even after significant investment, including MD Anderson, where it had been implemented to assist in cancer patient treatment. So, to me, Watson is not a particularly interesting or promising technology.

A - Anurag Rana {BIO 7440273 <GO>}

That's a very interesting assessment. Thank you. One other things you just mentioned about Microsoft and this is a discussion we have a lot. So, if you look at the legacy world, it's hard to define some of them call themselves more of a VMware shop, or a Microsoft shop or more closer Oracle or SAP. As you see the new world evolving, are they more prone to go to one cloud provider over the other, given their legacy baggage or frankly, doesn't matter, it just a matter of how much money you're willing to spend and what your relationship is with those companies?

A - Crystal Valentine {BIO 20867216 <GO>}

Yeah. So we are seeing very different sales strategies from each of the cloud vendors. The advantage that Microsoft has and I think one of the reasons that we've seen strong growth for Azure is it, the only company that truly has a hybrid solution. And so, obviously, for existing Microsoft customers, the idea of working with a known vendor is appealing, but in addition they can actually offer a hybrid cloud environment for their customers, that means a combination of competition within a private -- the customers private data center, as well as, Azure public cloud infrastructure, leveraging really similar technologies on-premises and in the cloud. So customers can have a similar experience of developing and running applications on-premises and in the cloud, but they can leverage those varying infrastructures for different motivations, including cost or security consideration.

Amazon doesn't have any kind of on-premises presence so to speak and therefore, they have particularly challenging times approaching larger enterprises that have real requirements around maintaining mission critical legacy applications that are -- have been deployed on-premises for years and years. There also been historically different go-to-market strategies for Microsoft and Azure. Microsoft sales rep had been motivated and in fact, compensated based on the consumption of cloud resource -- of cloud compute resources. So not just selling compute capacity but actually motivating their customers to consume those cloud compute and storage resources that were sold. So that's how the reps have been compensated, which motivated them to work much more closely with partners, ISV partners whose software would consume large amounts of resources of the Azure cloud. AWS had not taken that strategy. I think that might be changing within AWS, but I'm not 100% sure, but certainly, Azure has been a much stronger proponent of ISV partners than AWS has, most AWS partner companies have a somewhat tenuous relationship with AWS.

A - Anurag Rana {BIO 7440273 <GO>}

That's fair. Well, Crystal, I don't have any other questions at this point, it has been a delight listening to your insights. I hope we do this again sometime and a big thanks to all of our listeners. And thanks again.

A - Crystal Valentine {BIO 20867216 <GO>}

Thank you.