Introduction To Industry 4.0 And Industrial Internet Of Things

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Lecture – 39
IIoT Analytics and Data Management: Cloud Computing In IIoT – Part 1

In the previous lecture we spoke about understanding analytics, the basics of analytics, the basics of machine learning, how machine learning positions itself with deep learning, artificial intelligence, data science and so on. So, that is basically the analytics; that means, you have the data and you have to make sense out of the data; you have to get intelligence out of the data, the intelligence that is latent inside the data you have to get that intelligence out for that you need to use all these machine learning, deep learning AI techniques and so on.

But the question is where do you store the data? One thing is storing the data, how and where you are going to get the infrastructure that is necessary for the processing of the data, how you are going to get it, how you are going to get access to it, how much of this data will be made available, how much you have to pay for it, when do you buy whether you at all you buy or not? So, buying the computing infrastructure I am talking about so that is a challenge.

So, that is where this cloud computing technology has been proposed, so this is a technology that has become very popular now. So nowadays people are have reduced, most of these organizations, the businesses; they have reduced buying the computing infrastructure, but are taking help of many of these online computational resources that are available through subscription models.

So, you could subscribe you could basically register yourself to any of these computational platforms you could subscribe to these platforms pay for whatever you are using and could use their platforms.

So, essentially what you have? Is you have a scenario at present today if you have some computational needs you really do not need to go and buy a server, a computer or a high-end machine or whatever it is sufficient nowadays in most of the cases to basically subscribe yourself to some of these online computational resources and try to use them.

So, that this will make it clearer in the next few moments, but let us try to get an overall understanding of the things.

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So, before we do. So, I just wanted to give you a recap of what we have in terms of IIoT and industry 4.0, we talked about sensing, communication, networking and computing. It is this computing that that basically attracts the cloud technologies, so where cloud can make the business processes much more simplified and much more efficient and powerful and also cheaper. So, this is where this cloud technology becomes helpful.

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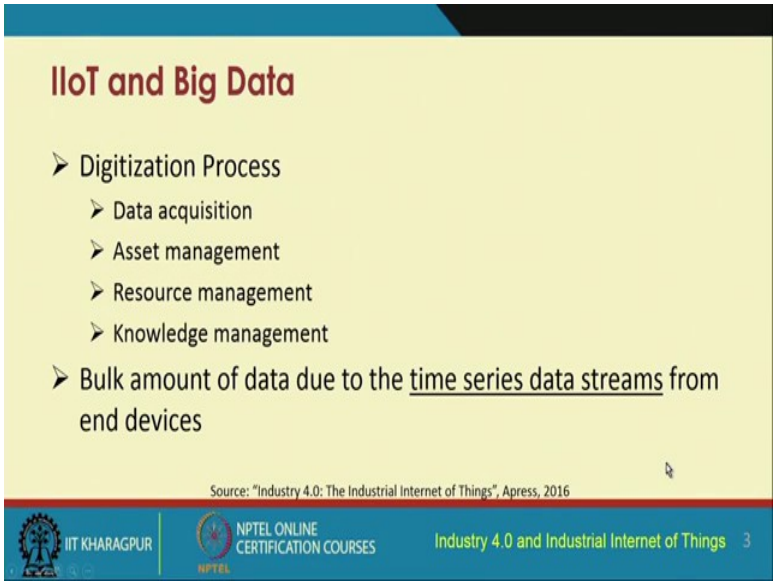

So, when we talk about digitization, so the digitization process involves acquisition of the data in the context of IIoT, acquisition of data management of assets, management of resources, knowledge management and so on. So, in the context of IIoT we are essentially talking about a scenario, where we are talking about volumes of data that come in large velocities and they have different other characteristics as well. And these are like time series data coming from different field devices, different machines, different IoT devices and so on which will have to be stored processed and so on.

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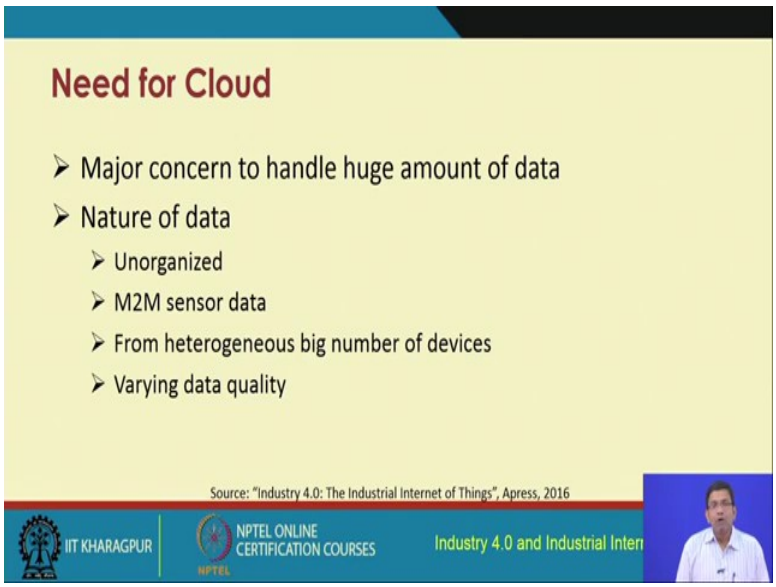

So, how do you handle that kind of data; that is where this cloud becomes necessary. So, cloud technology will help you to handle huge volumes of data; not cloud alone, cloud with different other data management techniques like the ones that we have already spoken in our analytics lectures. So, cloud will help you for storage and for processing; that means, running different computational jobs.

And for that we do not really have to go and buy a very expensive computer a expensive server and so on, we could simply get ourselves logged into some online cloud service providers and we can hook our system that we develop which basically are a combination of different IoT devices throwing lot of data to that cloud and this cloud is going to do the rest.

So, the nature of data that we are talking about in IIoT are unstructured unorganized data which cannot be stored in the form of relational tables, data which are coming from

different machines, sensor data, actuator data and so, on, data which are coming from different-different other heterogeneous machines, data where the quality of the data varies with time.

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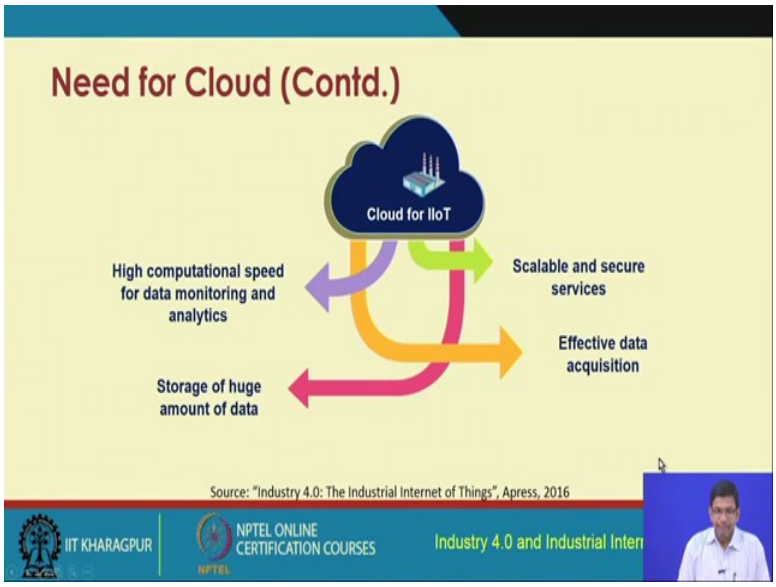

So, there is a need for cloud. And these are the reasons why cloud will be needed. The first thing is that cloud basically gives you a platform for high computational speed, for data monitoring and analytics; second benefit is storage of large volumes of data is possible with cloud in a very simplest manner.

Third is scalability and security of services, so basically because there is a separate, cloud service station a cloud service provider who has their own different processes. So, even if one CPU fails there are other CPUs which will be here to take over. So, it is a scalable and reliable and also secure service cloud based service. So security part let me tell you security and privacy there are lot of issues with it.

So, some people believe that cloud basically is not a good platform for securing your data or offering privacy of the data. Because people think that you do not know where your data is going to be stored is going to be processed and so on, anywhere in the world it could be done and because you do not know some people have lot of concerns about the security of the data, the privacy of data and so on.

But in general the people believe that cloud based platforms will give you, a reliable platform, a scalable platform and a secure platform for storage and handling of data and also the acquisition of the data with cloud can be made much more efficient.

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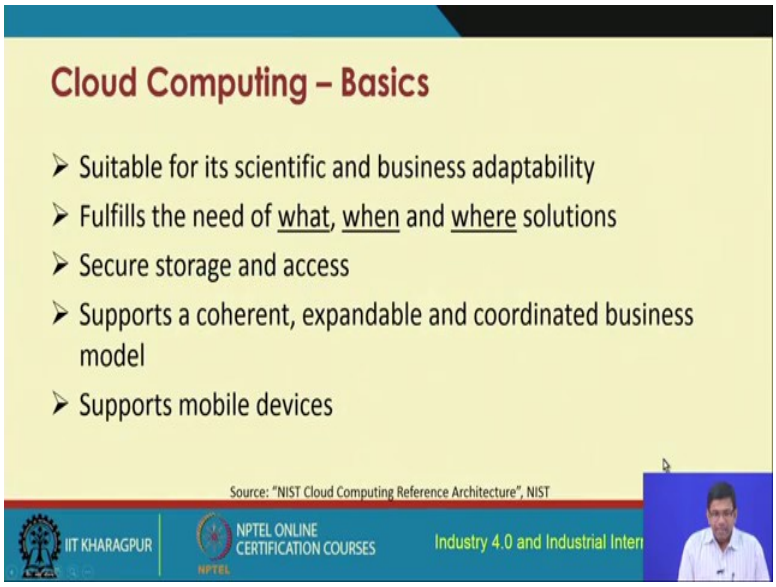

So, before we go in further, let us talk about cloud computing in little bit more detail. So, cloud is suitable for number of things, for running your high-end computational jobs, scientific jobs and so on. For business operations cloud will be helpful. So, basically cloud fulfills the need of what, when and where solutions, offerings, and different types of storage access to computational power software platform and so on different types of accesses and so on.

Supports a coherent, expandable; that means, scalable and coordinated business model. So, basically expandable means what? That some part of your job if it requires that you need more storage that also can be expanded very easily. You could just subscribe to whatever additionally you need and automatically nesting this manner you would be able to get those services.

Cloud platforms are supported by the present day mobile devices that also makes cloud very attractive. So, before I go any further I would like to make sure that you understand the utility of cloud, why cloud is so popular, why cloud is necessary? So, cloud computing; what is it? I would say that cloud computing is computing offered as a utility service. So, computing offered as a utility service means what?

We know of different utility services utility services such as electricity, utility services such as water and so many different other utility services such as LPG connections, so we know of all these different utility services. So, for all these different utility services electricity, water or LPG connections at home what happens is that we have the necessity to light our bulbs at home, to run our air conditioners, to run our fans and so on.

So, we have this necessity for that we have the necessity for electricity, but that electricity we do not really have to generate ourselves. So, what we are doing is that there is an electricity service provider and that electricity service provider, we have to subscribe our electricity services to the electricity service provider.

The service provider will then remotely give that connection of course, there is a requirement of having a physical electric connection to our prospective homes or offices, but given that is in place in what happens the remotely the electricity service provider is going to send the electricity and we can enjoy this electricity. So, we can run as many bulbs that we want, we can light as many bulbs that we want, we can run as many air conditioners that we want and so on.

We are least bothered about whether the electricity is going to get over, if we have more requirements of electricity we keep on running more we do not bothered that I have very little amount of electricity and I do not want to run more. So, that is utility as a service and the beauty about it is that we keep on enjoying as many units of electricity as we need and we will be billed for the number of units of electricity that we have used. So, pay per use concept is applied in all these utility services.

So, I took the case of electricity the same applies for water as well, so water, electricity and many different other services basically follow the pay per use model because we have meter, we are getting meter service and we will be billed based on the number of units of the meters of conjunction that we will have for each of these utility. The same concept was extended further, people thought that if electricity can be offered as utility, if water can be offered as utility and people can subscribe to this services without worrying how to generate electricity and so on.

And they will get billed based on the number of units of electricity that they are going to use or other utilities that they are going to use, why cannot we adopt the same model in computing. So, traditionally what used to happen? That if you have a huge computational

job or something where you have different computational requirements you would have to go to the market, you will have to procure the different equipments the big servers you will have to procure you have to buy them you have to pay money upfront and then install them and then you will be able to use those equipments.

So, that basically delays the business requirements, business processes will be delayed. Second thing that will happen is you have to have lot of upfront investment for this computing infrastructure, as a third thing that is going to happen is that if you have further requirements you cannot expand further. So, instead imagine a scenario that there is a service provider for computing, you have a computing service provider which we call as the cloud service provider now.

So, this computing service provider will give you all these resources through online subscription. And through online basically you would be able to login to different portals and be able to run your computational jobs based on your certain requirements, this is basically the concept of cloud computing; computing as utility is what cloud talks about and you basically can enjoy in this kind of model as much of computational resources that you need, if you have less resources to start with, if you have requirements for less resources to start with you use less if you have more requirements you use more.

So, you can basically it's an elastic kind of model based on your requirements you can expand or decrease the amount of resources that would be required and accordingly you will have to pay for units of usage of the computational resources. So, this is basically the whole idea or the story of cloud computing and how it evolved and what are the benefits of cloud computing.

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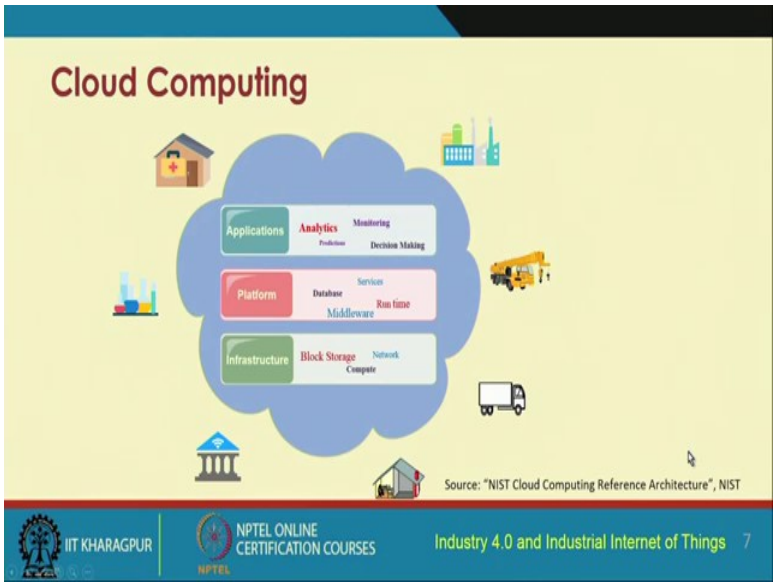

So, cloud computing; there are different models of cloud, there are different-different models, it started with three different models. So, whether it is home, hospitals factories or whatever there are different computational resources available in the form of cloud and you will have infrastructure; that means computing infrastructure in the form of computational resources CPU, storage, network and so on.

So, that is the infrastructure computing resource, then you have the platform resource which is basically in the form of the development, platform, the middleware services, database runtime and so on the platform resources. And on the other resource is basically the application resources or the software where we are talking about different software performing, monitoring, decision making, analytics, predictions, and so on. So, all of these computational resources software, platform and infrastructure can be made available on a pay per use kind of basis.

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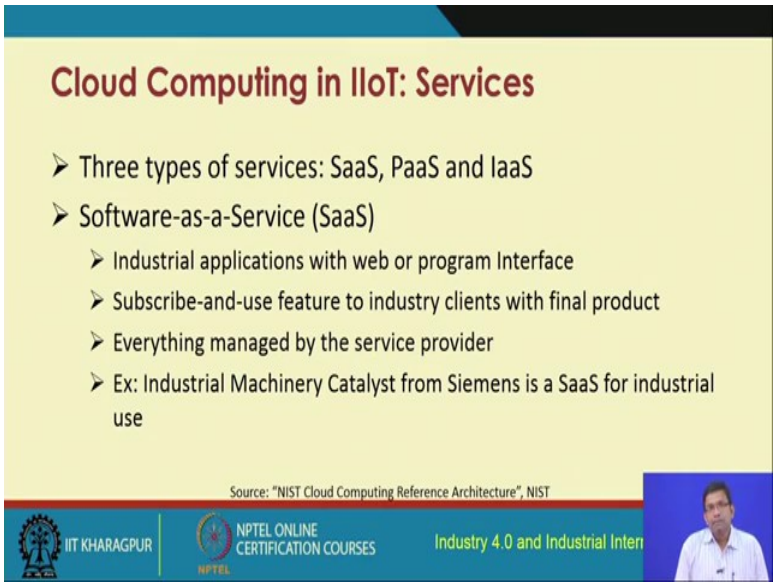

So, now I was talking about all these different cloud models and the services, so to start with there were three fundamental services one is the SaaS Software-as-a-Service, the next one is PaaS which is Platform-as-a-Service, and the third one is IaaS which is the Infrastructure-as-a-Service.

Software-as-a-service basically over here we are talking about industrial applications with web or programming interface and based on the requirements of the industry clients, there are different software that could be used can subscribe to and these will serve for coming up with the final product. So, these software will be made available for these different development or different use.

And so everything this software as a service basically, is managed through this software service provider. So, there has to be service provider who is offering all these services and he is basically billing us for whatever we are using. Examples from the industrial domain are, Industrial Machinery Catalyst that was developed by Siemens, that is a SaaS cloud for industrial use; industrial machinery catalyst is the name of the SaaS cloud from Siemens.

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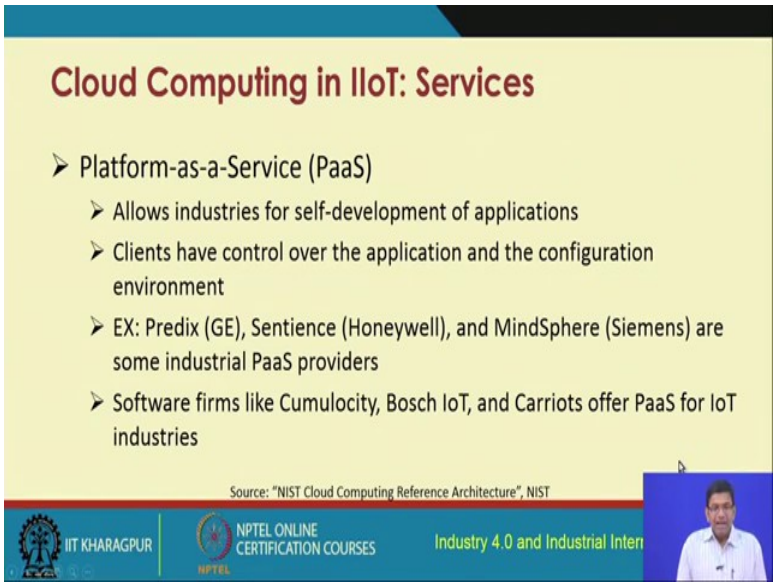

Platform-as-a-service; as this name suggests this service gives development platforms to the industries, development platforms to whoever, but in the industrial context basically the industries. So, the clients over here have control over the applications and the configuration environment that they have. So, there are different platform services are available and so the developers, particularly developers they could be interested in using any of those available platforms and they do not really have to deploy that platform everything is available online through online access and they could start using them.

Some of the examples from the industrial settings are Predix from GE, Sentience from Honeywell, MindSphere from Siemens and some industrial these are some of the industrial PaaS cloud providers. Software from like a Cumulocity, Bosch IoT, Carriots they offer platform as a service for different IoT industries.

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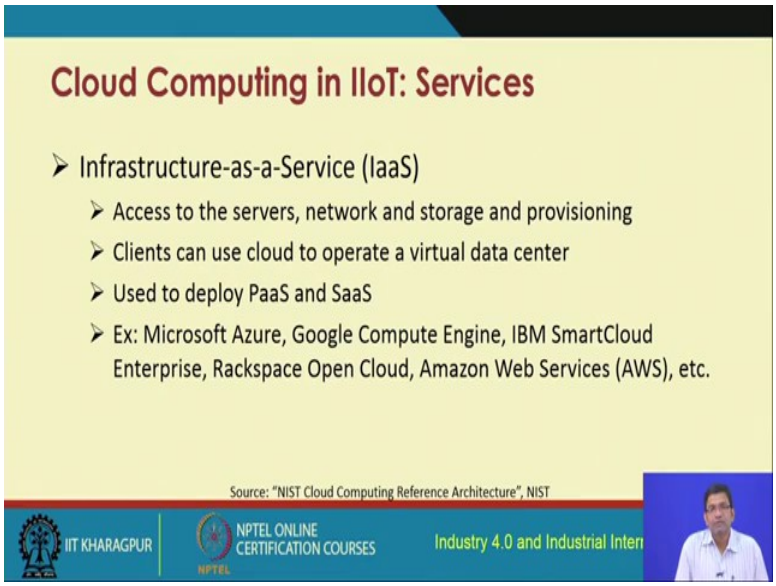

Infrastructure-as-a-service, here we are talking about the actual computational infrastructure, the network infrastructure and so on. So, here we are talking about making these computational infrastructure storage, computers and networks etc., offering those as services to the clients based on their requirements. So basically some examples are Microsoft Azure, Google Compute Engine, IBM SmartCloud, Rackspace Open Cloud, Amazon Web Services which is basically in way combined platform it has the IaaS and few different other service models are also implemented in Amazon web services and so on.

So, these are some of these examples of different types of cloud computing models and the services that they offer.

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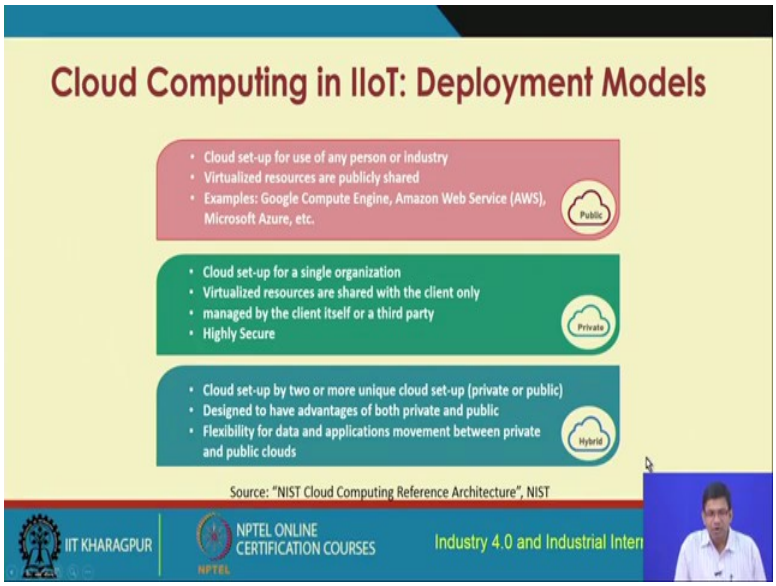

So, these are the different models another classification of these, but before that I wanted to show you something very interesting. So, let me show you an example of the Amazon cloud.

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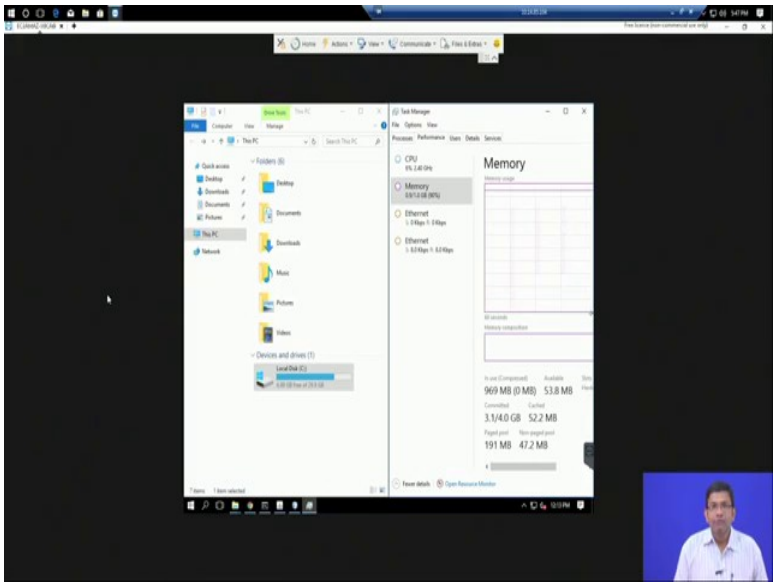

So, here as you can see this is just an instance of this cloud that we are subscribe to and I just wanted to give you and a instance of how it looks like. So, these are the units of CPU, memory, Ethernet, and so on to which we are subscribed. And also this basically shows the hard disk storage space, so you could get in go back and so on. So, it looks

very similar to the way it looks for your own PC, but remember that this is not our own PC this is basically how it looks to the cloud access that we have for the remote computational infrastructure.

So, this is one thing and so I would also like to show you another one which is basically the infrastructure that you are able to see; infrastructure IaaS. So, if you look over here this is this overall platform that we have also subscribe to, this is basically the Platform-as-a-Service; windows platform as you can see and this is this thing.

I can show you something else, I can show you the software cloud. Another example of the software cloud is basically this Office 365, this is an example of basically office product online Office 365. This is an example of your Software-as-a-Service; like that actually there are many different other software's service models that are made available for different users.

So, now let me go back one second to whatever I was discussing earlier and so we have to looked at these different types of cloud Amazon cloud and Microsoft cloud example have I have also told before like that you have this software cloud like this Office 365 and so on. There are there is another classification of clouds right so cloud one is based on this models whether it is Software-as-a-Service, Platform-as-a-Service or Infrastructure-as-a-Service.

There is another classification based on the deployment model right. So, based on the deployment model the cloud can be classified into three types one is the public cloud, private cloud and the hybrid cloud. So, public cloud are set up for use of any person or industry whereas, the private cloud is set up by some single organization for example, IIT Kharagpur also has its own private cloud and hybrid cloud basically is a combination of both public and private so it is a cloud that is set up by two or more unique cloud setup providers.

So, both public and private and it has that advantages the hybrid basically has advantages of both the public and the private cloud.

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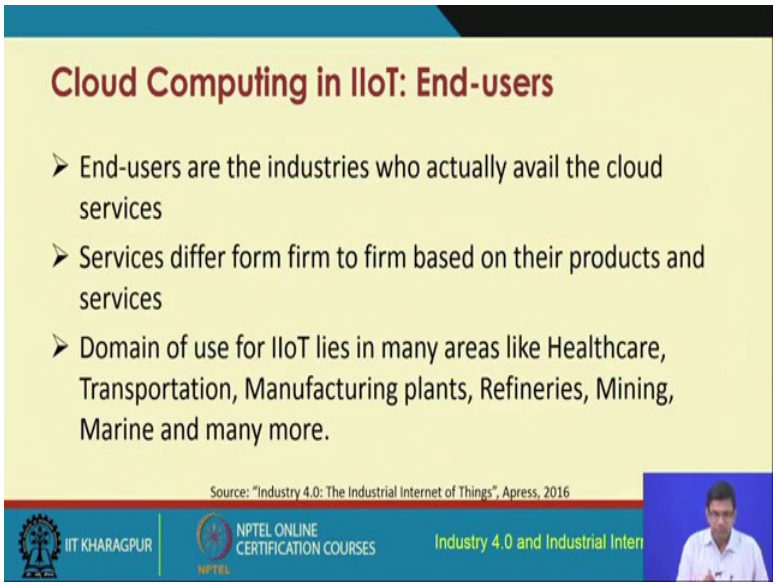

So, end users are very important in cloud computing in IIoT. So, end users in the industries would like to get access to the cloud services whether it is Software-as-a-Service, Platform-as-a-Service, Infrastructure-as-a-Service, the industrial end users need access to the cloud services and these services will differ from firm to firm and are based on their products and services.

So, the domains of used for IIoT lies in many different areas such as healthcare, transportation, manufacturing, plants refineries, mining, marine and many more.

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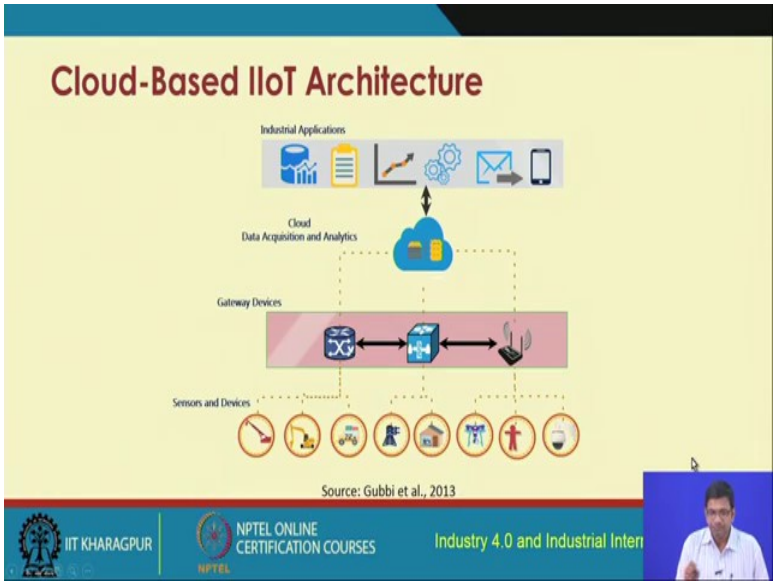

So, this is a cloud-based IIoT architecture so as you can see over here. So, at the very bottom we have these different sensors and different devices then there is a gateway layer which has different edge devices and so on. And then you have the data acquisition layer which is at the cloud and different industrial applications are running on the cloud.

So, this is a combination of IIoT with cloud and so we have a cloud IIoT architecture and essentially for industrial settings of use of cloud this is what is grossly it is going to happen.

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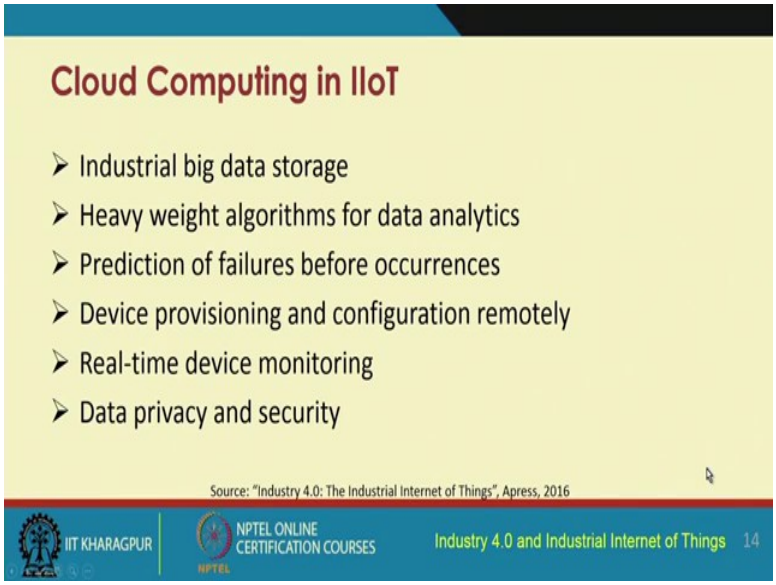

So, cloud computing in IIoT industrial big data storage it is going to offer, heavyweight algorithms for data analytics can be executed. Prediction of failures before occurrences can be done in a much more efficient manner, device provisioning and configuration can be done remotely with the help of cloud, real-time device monitoring can be done, data privacy and security access can be provided with the help of cloud.

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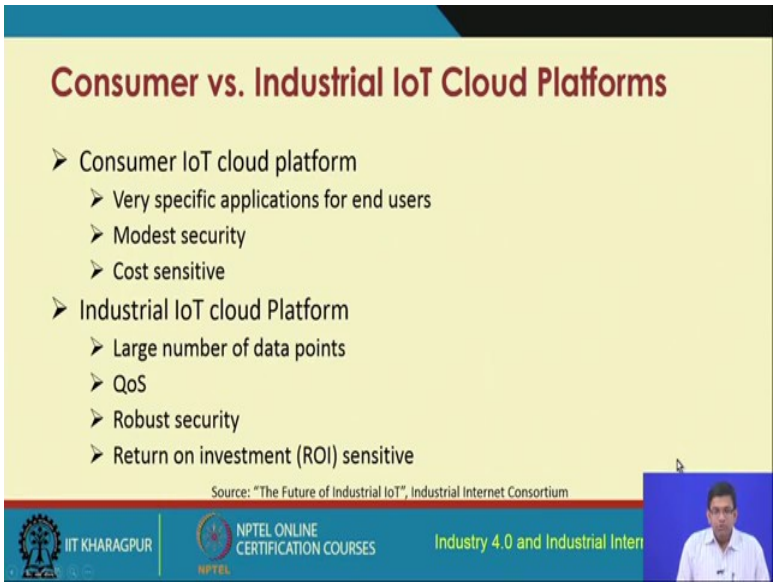

So, consumer versus industrial IoT cloud platforms, consumer IoT cloud platforms have very specific applications for from end users, they have modest levels of security implemented and they are very cost sensitive. Industrial IoT cloud platforms enable large number of data points for plugging in, supports quality of service that is very important for industry scale applications and also offers much more robust security compared to the consumer IoT cloud and also over here in the industrial IoT cloud ROI is very important consideration compared to the consumer IoT cloud.

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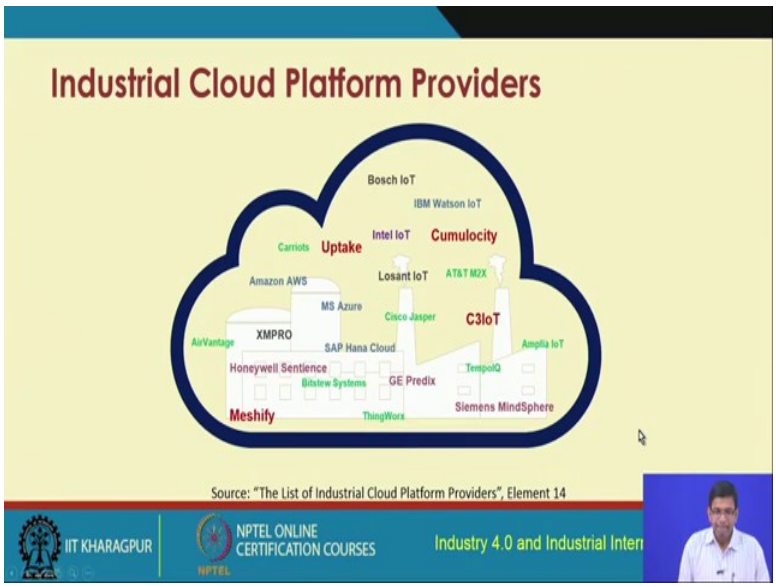

So, these are the different industrial cloud platform providers, so I am not going to through any of them, but so these are some of these examples, ThingWorx is one; there are others like Cumulocity, Uptake, C3IoT, Meshify and many different other providers industrial level cloud platform providers and their names are given. So, many of them as you can see are applicable for IoT; that means they have IoT-enablement. So, this basically are IoT cloud providers.

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So, industrial cloud platform providers so by different industrial companies things like Predix from the GE. Mindsphere from Siemens, Honeywell cloud is also there; different software development firms such as C3IoT, Uptake, Meshify are different other examples.

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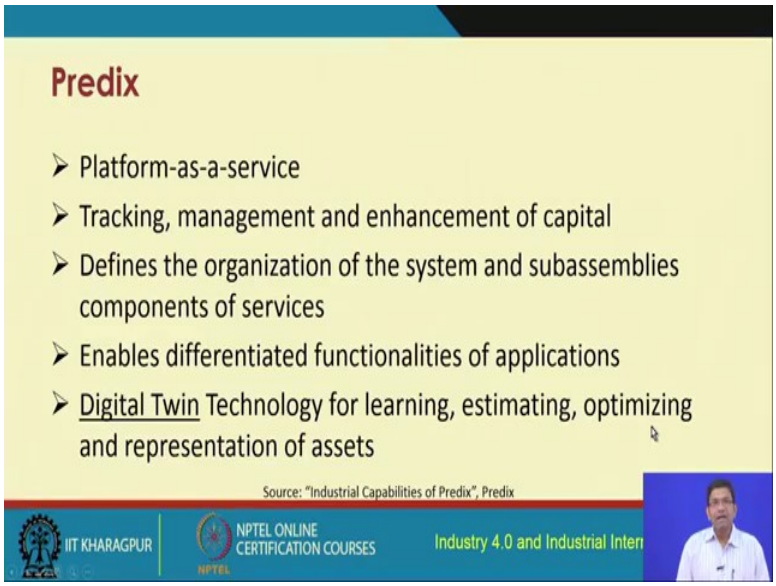

Predix is a Platform-as-a-Service (PaaS) cloud, which can be used for tracking, management and enhancement of capital. Predix basically defines the organization of the system and subassemblies and their components and also Predix basically has the support for Digital Twin which is very essential for most of the industrial manufacturing settings.

So, Digital Twin technology for learning, estimation, optimization and representation of different assets, so Predix basically has many of these support for many of these requirements that are there for industrial manufacturing sectors.

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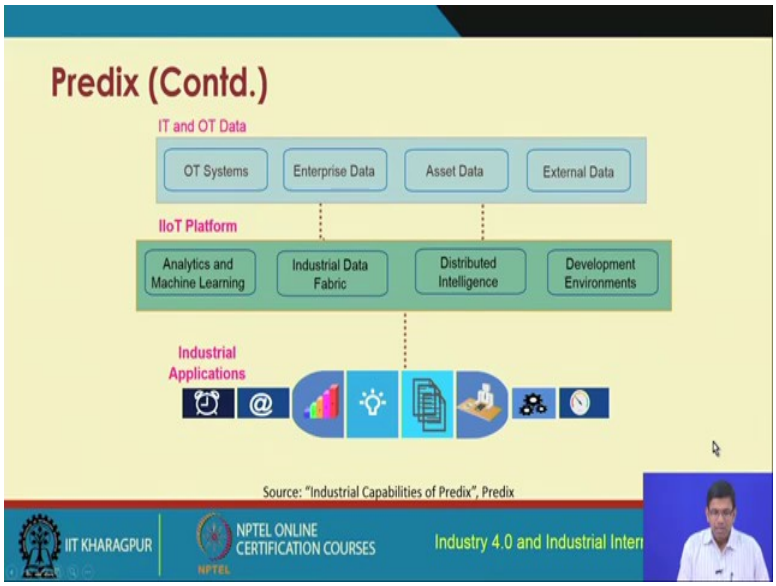

So, this is how this Predix platform looks like at the very bottom as you can see we have this industrial applications; in the middle we have the IIoT platform comprising of different components such as the analytics and machine learning, industrial data fabric distributed intelligence and development environments and the topmost layer shown in this particular figure has the IT and OT; OT is the operational intelligence and IT is the information technology. So, information technology and operational technology so, you have different components such as the OT systems, the enterprise data, asset data and external data. So, this is how this predicts platform structural looks like.

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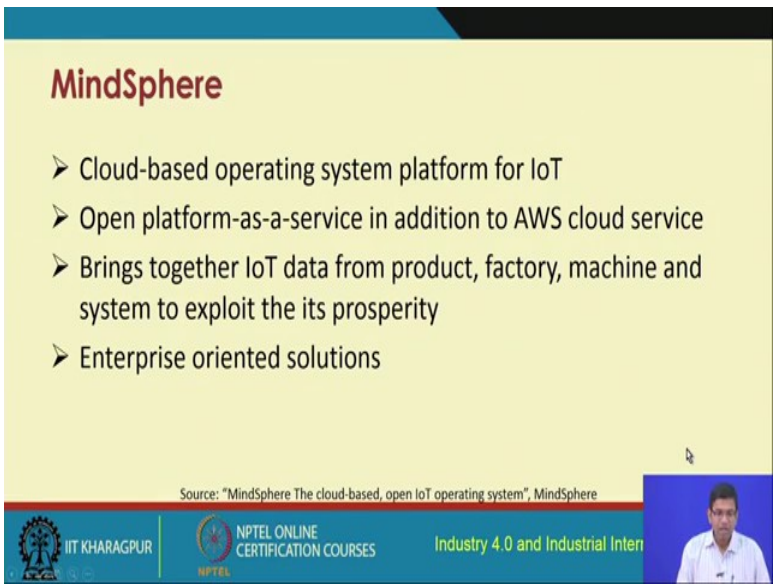

MindSphere is another cloud-based operating system platform for IoT and this is an open Platform-as-a-Service in addition to the AWS cloud service. It brings together IoT data from factory, product, machines, systems and different other industrial machinery and it provides an an enterprise oriented solution.

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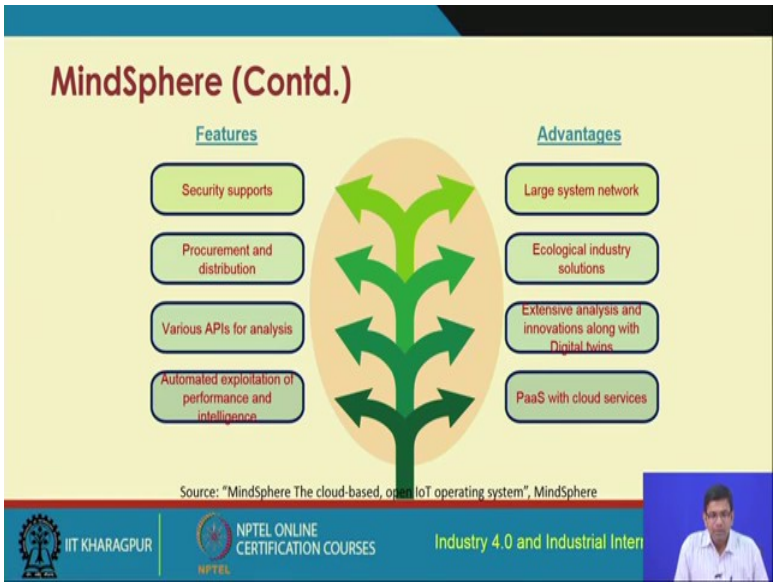

This basically shows the overall features and the advantages of MindSphere; advantages are that MindSphere basically provides large system network, supports ecological industrial solutions has PaaS cloud services for offering and there are many others also. In terms of the features it has security support; support for secured services, procurement and distribution provides various APIs for analysis and automated exploration of performance and intelligence.

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Honeywell also has its own cloud service provisioning for performance optimization, deeper insights into the processes, driving agents and design skills these are different use of the Honeywell cloud service and this is particularly targeted for different oil and gas industries. Honeywell cloud service is a secured, scalable and standard based platform, it supports SaaS business models as well.

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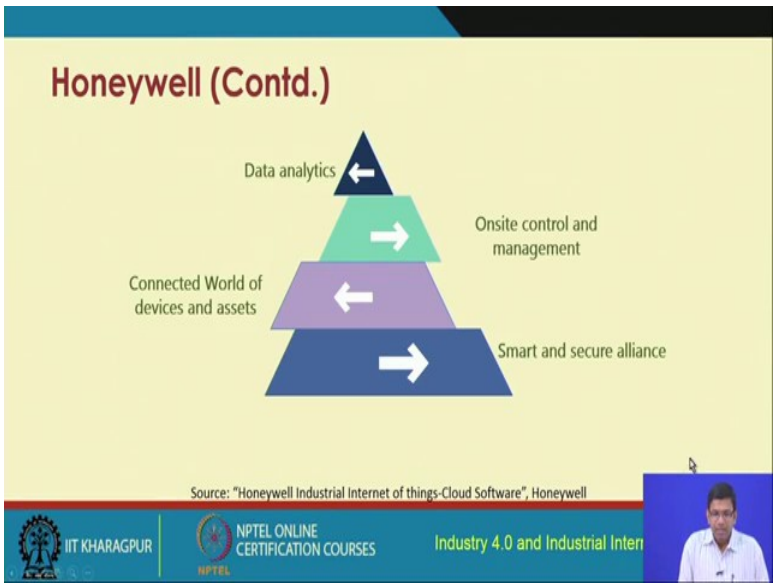

So, this is this Honeywell cloud service and you can do number of different things data analytics can be done, onsite control and management could be done connected world of

devices and assets; that means, IoT basically enablement and smart and secure alliance these are the different features of the Honeywell cloud.

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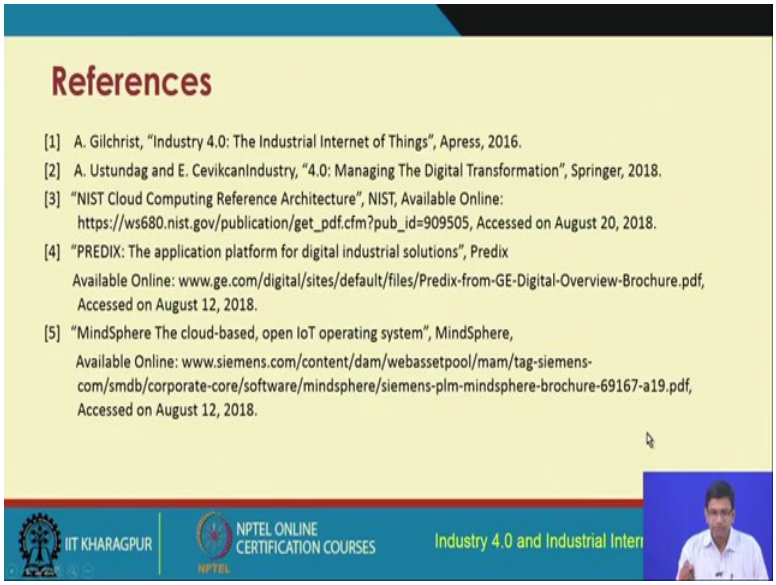

So, with this we come to an end and we have this list of different references of certain things that we have covered. We are talked about some of these different industry level solutions for IIoT cloud and we have also seen that industry specific requirements are different. So, IIoT cloud rather than IoT cloud is more interesting and there are different solutions already in the market that could be used by different industries to who have requirements for support of IIoT; IoT and their deployment.

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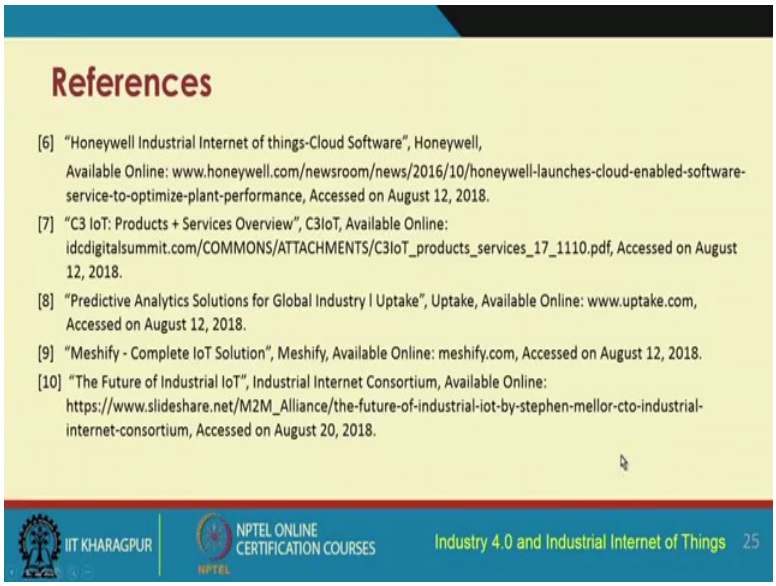

So, thank you these are all these different references.

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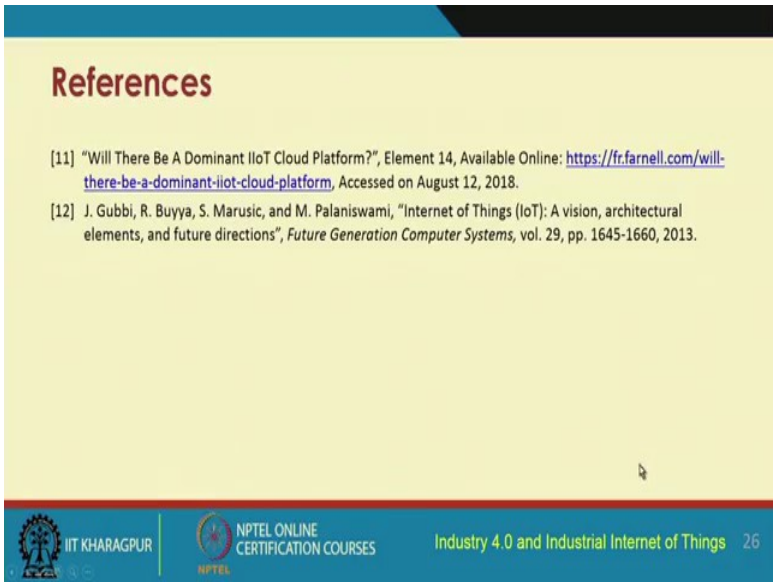

With this we come to an end.

Thank you very much.