Introduction to Industry 4.0 and Industrial Internet Of Things

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Lecture – 34
Key Enablers of Industrial IOT: Processing – Part 2

In the previous lecture we talked about the importance of analysis of the data that are collected through these implementation of IIOT systems. We looked at the data characteristics and thereafter we went through the different research works that are being undertaken. And the different proposals correspondingly that are there; in order to implement effective efficient processing systems to be implemented and deployed in practice.

So, let us look at few more solutions. We have gone through quite a few of them, but let us look at a few more solutions and see how this processing component is becoming important in all of these different solutions that are being proposed. So, farm beats is a solution that is proposed by Vashisht et alin 2017.

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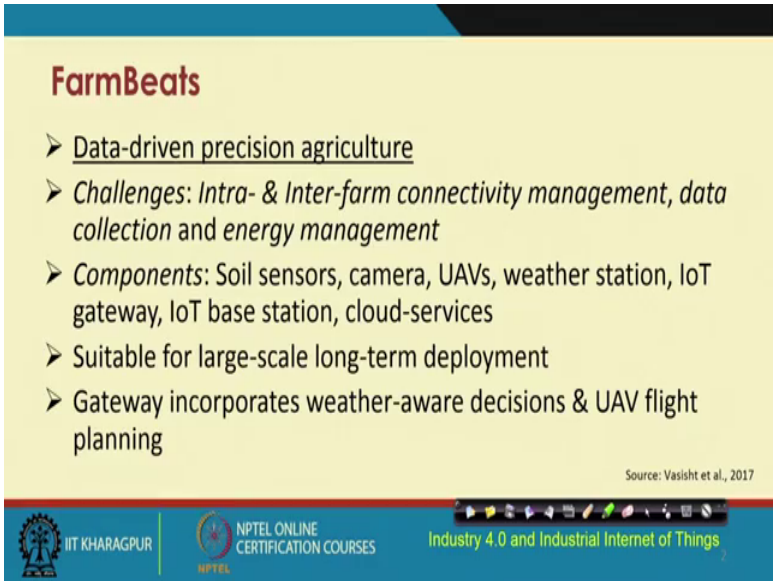

So, there basically this particular work is talking about the use of data driven architecture for; precision agriculture. Precision agriculture talks about that through the use of different sensors and autonomous systems how the precise decision making can be done for different agricultural problems.

So, in this particular work farm beats they talk about the use of different sensors such as; the soil sensors, cameras, UVAs weather stations, IOT gateways, base station, cloud services etcetera. And together they come up with an integrated architecture which can be used for deployment in agricultural farms in order to have an efficient mechanism for collecting data. And also correspondingly processing of the data as soon as possible the data are collected as quickly as possible the data are collected processing of the data and eventually feeding it back to the user for further use.

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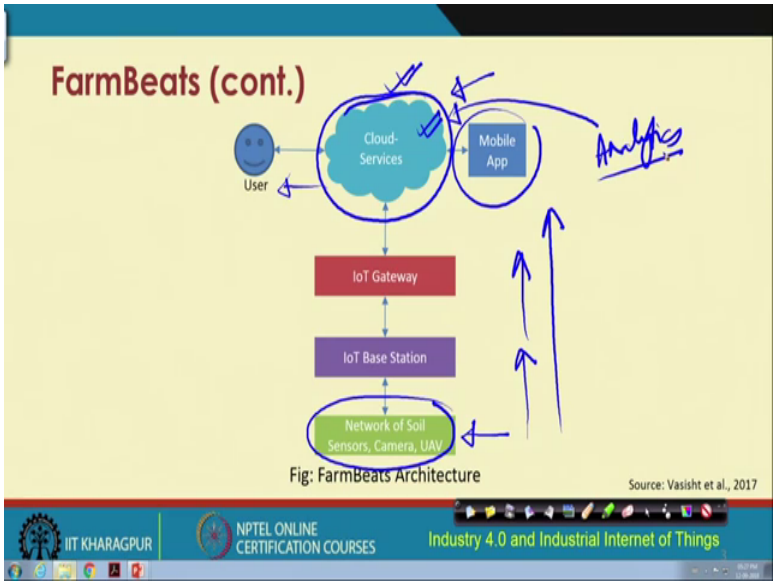

Fig: FarmBeats Architecture

So, this is this farm beats architecture that they talked about Vashisht et al. And here as you can see at the very bottom what we have are the different sensor such as the soil sensors, cameras, UVAs and you could talk about different other sensors. And as we go higher up we have the base station the gateway and so on. All of these data basically that are collected from these different in devices will go through this particular network hierarchy.

And will come to the cloud and at the cloud this different analytics will be performed and through different apps or through websites and so on this data are going to be made available to the users. So, as we can see over here this is the integral part in this particular architecture. Here we are talking about this cloud surfaces. So, precision agriculture talk talks about precision agriculture talks about making meaningful inferences out of the data that are collected as quickly as possible.

Using a processing engine typically in the form of cloud based architecture use of cloud based architecture for prompt efficient effective mechanism for decision making is what precision agriculture basically talks about. And this is implemented in this particular lecture the processing part and the analytics part is implemented using this cloud based services. So, this analytics is performed in this particular component of this their architecture.

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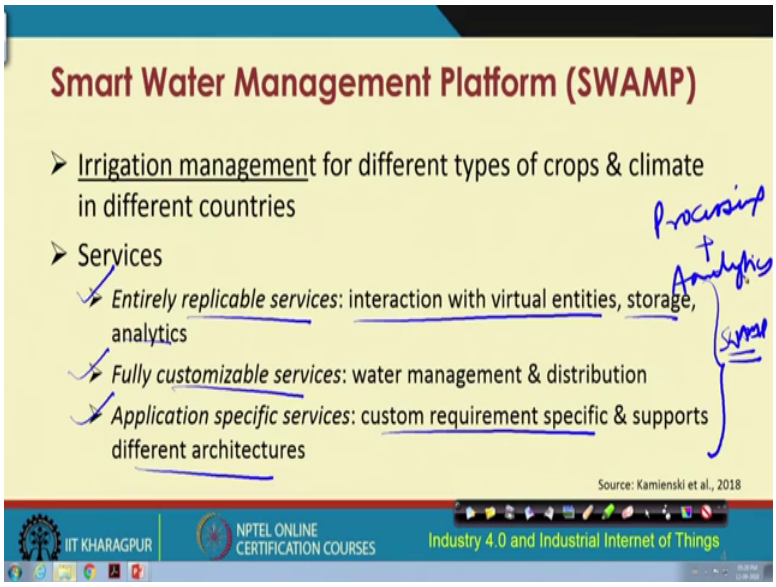

Next comes another work again with respect to in the in the domain of agriculture. So, the SWAMP is a smart water management platform. Here basically they are talking about the authors they are talking about the irrigation management. Irrigation management based on the different types of; crops, climatic conditions, different regional variations and so on.

With the help of different types of sensors which will be again collecting different types of data from different locations and so on. And this data will be analyzed and different services are going to be offered to the end users replicable services which will give interaction with virtual entities storage and analytics. Different other services such as customizable service for water management and distribution and application specific services for custom requirement specific support and support for different architecture.

So, these are the different types of services that this particular work by Kamienski et al in a very recent work talks about. And this is part of the SWAMP architecture. So, as you

can see over here processing and analytics for precision agriculture is basically emphasized through these different works.

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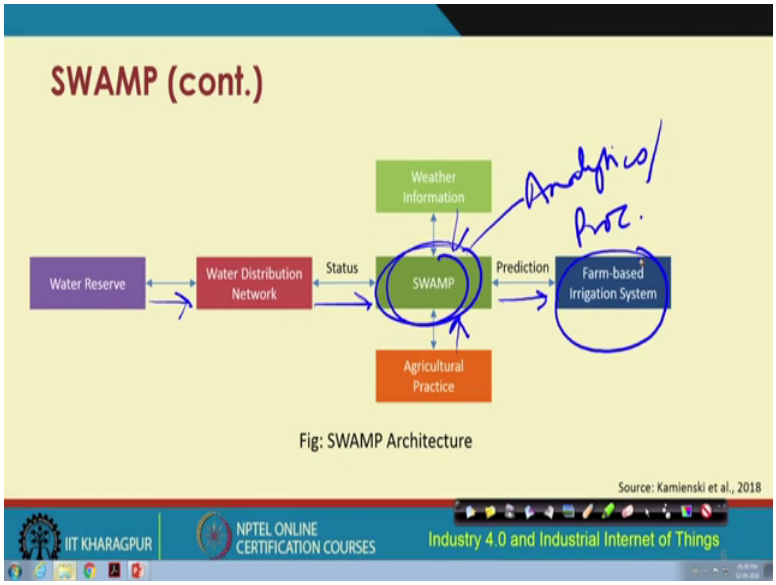

So, this is the SWAMP architecture and in this architecture as I mentioned already. So, as we can see these are the different components which are interacting with SWAMP agricultural practice weather information status about you know the water distribution. And data about data from the water reserve water distribution network their data everything fed together at SWAMP and decisions being made.

That means, decisions means that again analytics use of analytics and processing and these will help in making different predictions. So, predictions with respect to farm based irrigation you know when to irrigate what to irrigate which equipments will be better and so on. So, all of these things can be done with the help of SWAMP and similar other architectures for precision agriculture.

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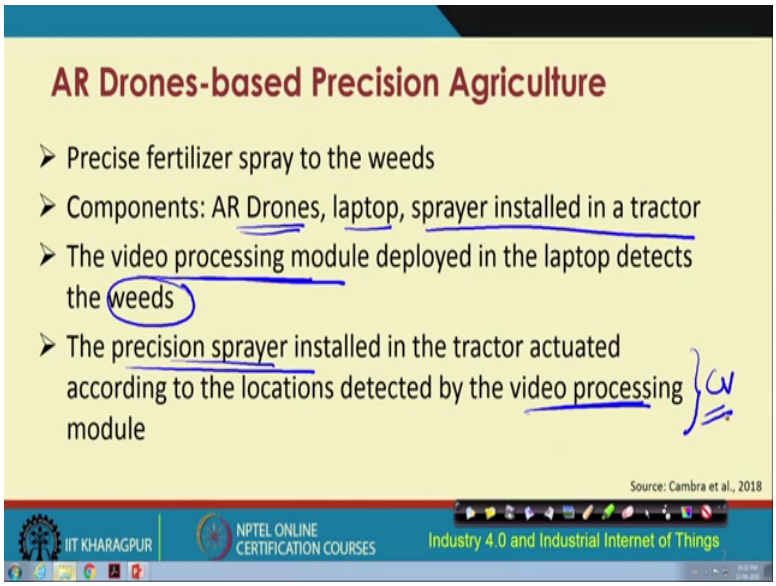

AR drones basically the parent drones and so on. So, these drones can also be used for precision agriculture and nowadays use of drones has become very common. And in our research lab the SWAMP research lab in the department of CSE at IIT Kharagpur we are also using drones along with our colleagues from agricultural department at IIT Kharagpur we are using drones of different types for precision agriculture.

So, we have different applications, but let us look at this particular work by Cambra et al and it is a very recent work published in 2018; that means, very recently it has been published. And here basically they are talking about precise fertilizer spray to the weeds. And this is a very important and a challenging problem. Because the problem is that you need to have precise spray of weedicides in such a way that only the weeds will be sprayed and the other places will be minimally affected right. So, this is a very important and a challenging problem as well.

So, complex event processing mechanisms will have to be implemented if you want to address this kind of problem. So, here in this particular solution they are talking about the use of AR drones laptops a sprayer installed in the tractor video processing modules. And this video processing module basically helps in this spraying of the weedicides on the weeds.

And also the use of the precision sprayer which is installed to the tractor. And is actuated according to the locations that are detected by this particular video processing module.

So, here actually this particular solution they are using computer vision mechanisms for the decision making and analytics.

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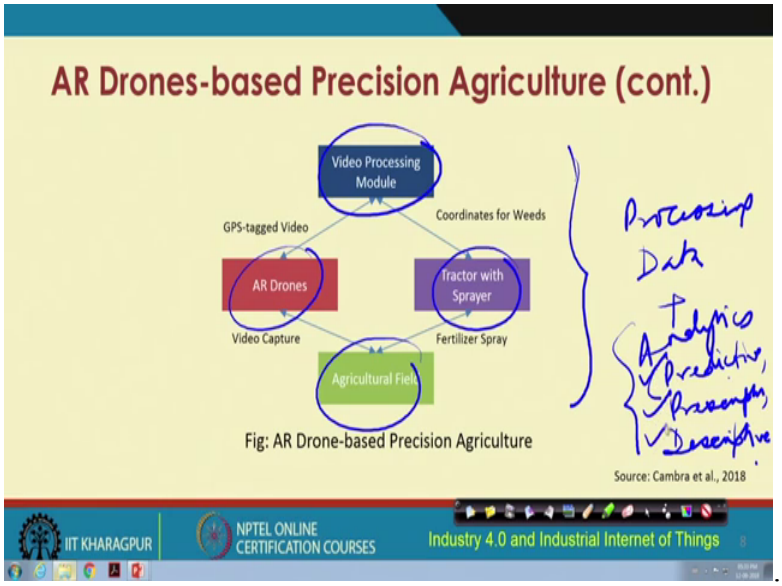

So, this is this overall architecture pictorially it is shown over here. So, we have these different you know interactions between these different components. This is this video processing model that I was talking about earlier. So, drone's video processing module tractor with sprayer which can be actuated and agricultural field and the overall flow of data between these different components are shown over here.

So, data and the processing of the data again is very important and suitable analytics will have to be performed. These analytics could be again predictive or they could be prescriptive or descriptive. So, this architecture basically does not talk about so many different things of analytics. But gives a common architecture where we could extend to implement all these different types of analytics using their solution.

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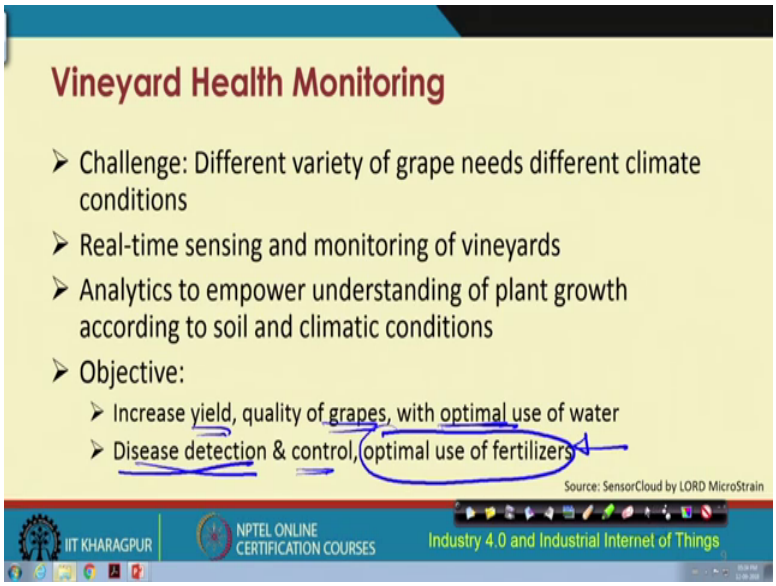

Another one again from agricultural you know agricultural application domain this is for; vineyard health monitoring. So, the challenge in vineyards is that there are different varieties of grapes which will have requirements for different climatic soil and different you know conditions. So, it is very important to have real time sensing and monitoring of the vineyards.

So, the objective is to have to increase the yield increase yield quality of grapes and optimal use of water. And at the same time decrease the incidences of the plant diseases and control them and consequently based on the predictions optimally use the fertilizers and spray them.

So, this is the vineyard health monitoring solution and the corresponding source for this particular work is also given over here. In case you are interested you are encouraged to go through this particular literature.

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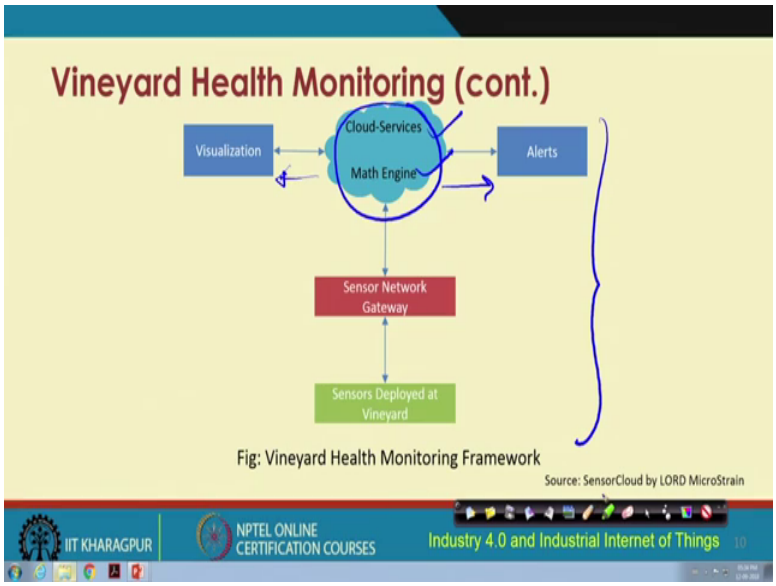

And this is this overall architecture and as you can see over here. This is also this processing engine which consists of the cloud as well as the math engine. So, this is what you know this particular work talks about. And so interaction with the visualization component and generation of alerts this is what is supported in this vineyard health monitoring solution by micro stream.

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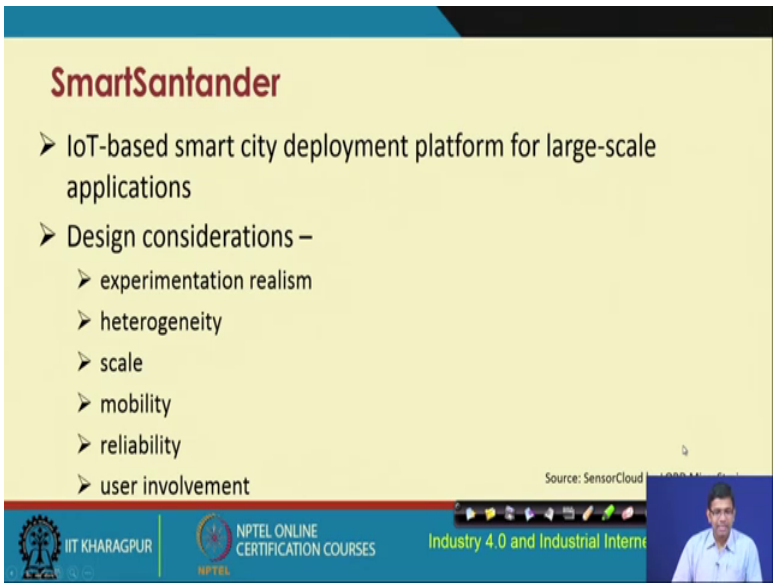

Another work is the smart santander. So, this is a IOT based smart city development sorry deployment platform for large scale applications where; the design considerations

are with respect to the experimentation, realism, heterogeneity, scale, mobility, reliability user involvement and so on.

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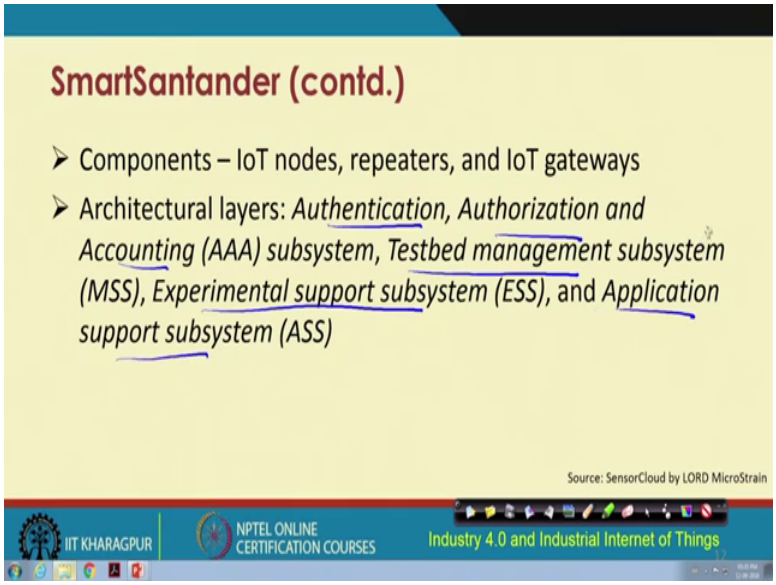

And they have come up with an architecture which uses different components such as the different IOT nodes the sensor enabled IOT nodes the repeaters IOT gateways and so on. And it has different architectural layers such as; authentication, authorization, accounting, testbed management subsystem, experimental support subsystem, and application support subsystems. So, each of these subsystems they have their own different functionalities.

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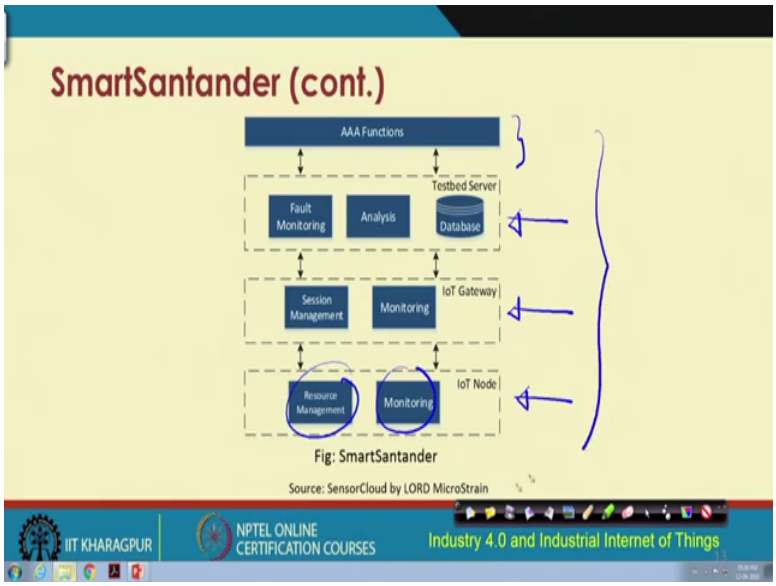

And this particular work they talk about the involvement of all of these different components to arrive at a common solution. So, at the very bottom is the IOT node, then is the gateway and the testbed server. And these different functionalities that are going to be you know supported on this particular architecture. And the corresponding different components are also shown over here in this particular figure.

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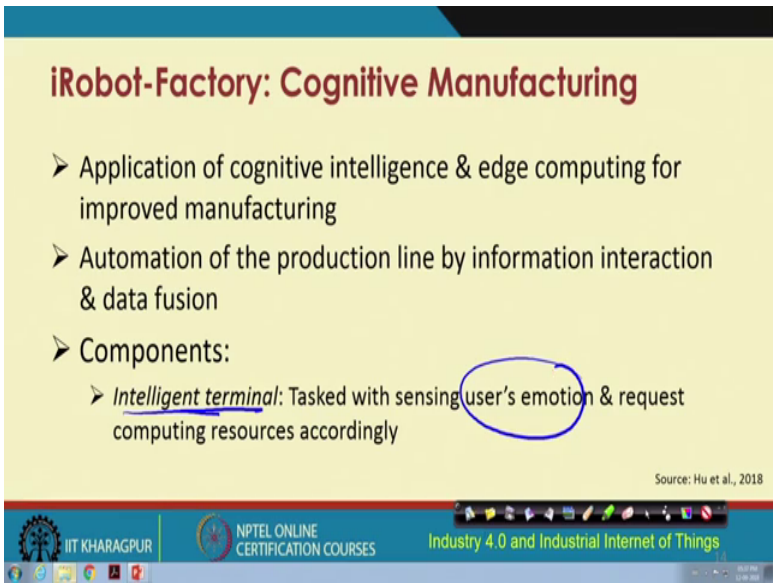

iRobot factory is a solution that is proposed very recently by Hu et al and here they are talking about cognitive manufacturing. So, cognitive means intelligence, intelligence

means computation, computation means you know computation means like you know lot of processing we will have to be done right lot of processing. And if we are talking about cognitive processing that basically is computationally intensive.

So, analytics is very important in this kind of situations or this kind of scenarios. So, this is the work which uses different components such as the cognitive or the intelligent terminal which is tasked with the sensing of the users emotions and requesting computing resources based on the perception of the emotions of the users and different other components.

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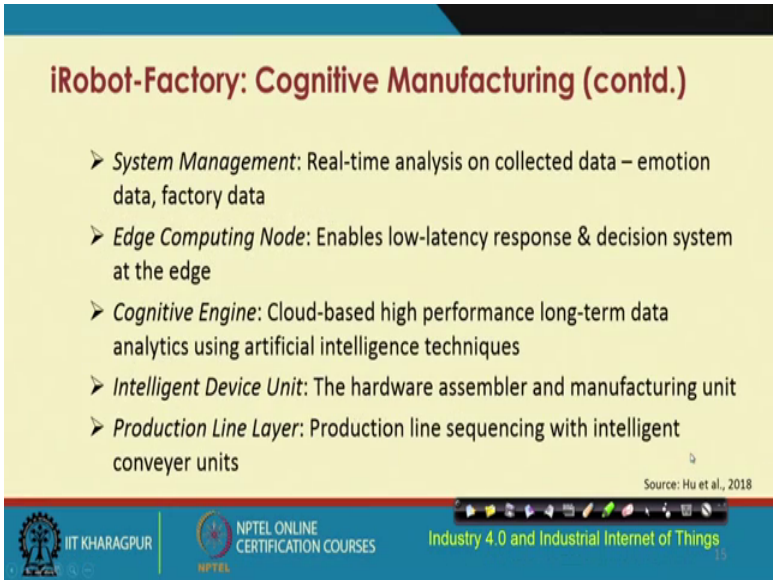

Such as the system management, edge computing node, cognitive engine, intelligent device, unit and production line layer. So, all of these are different components of this iRobot factory. And the I am not going through the individual descriptions of each of these components. And it is already given to you and it is very similar actually all these different types of architectures they are conceptually they are very similar.

And the only thing is that the there is some application specific problem specific requirements which have been implemented through the different use of different components and so on. So, I am not going to go through each of these, but is given to you to you know if you are interested you can go through and understand in further detail.

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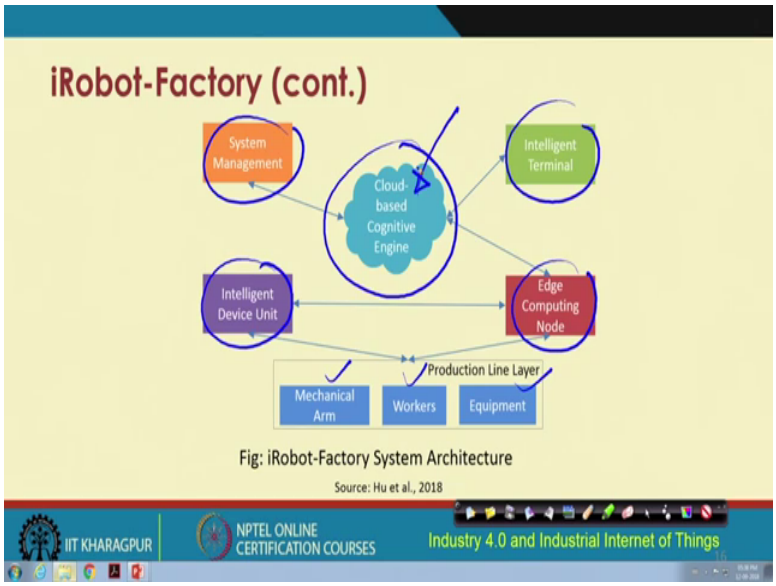

And this is this iRobot factory system architecture and here as we can see we have this production line layer which has the mechanical arm workers and equipment components. Then comes this layer of intelligent decision unit and edge computing, and the intelligent terminals, and system management components.

All of which are interacting with this cloud based cognitive engine. So, as we can see a time and again that for these different architectures different solution. This cloud based cognitive engines are being used.

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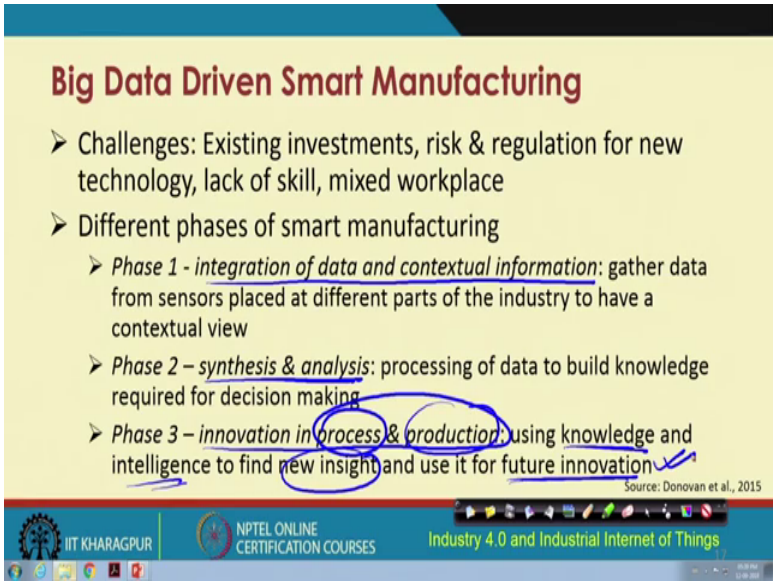

Another work from 2.15 by Donovan et al it talks about big data driven smart manufacturing. So, the challenges that they have addressed are that there is existing investment risk and regulation of new technology lack of skill mixed workplace and so on. So, all of these are different challenges in the manufacturing sector.

So, you want to address these challenges with the help of some kind of a smart manufacturing system. So, there are different parts of the smart manufacturing system. One is the integration component of integration of data and contextual information. Second is the component that deals with the synthesis and analysis of the data. And the third component talks about innovation in the process and the production.

So, process component and production innovation will come through the use of knowledge and intelligence for deriving different new insights and correspondingly making different predictions which will lead to different innovations in the future.

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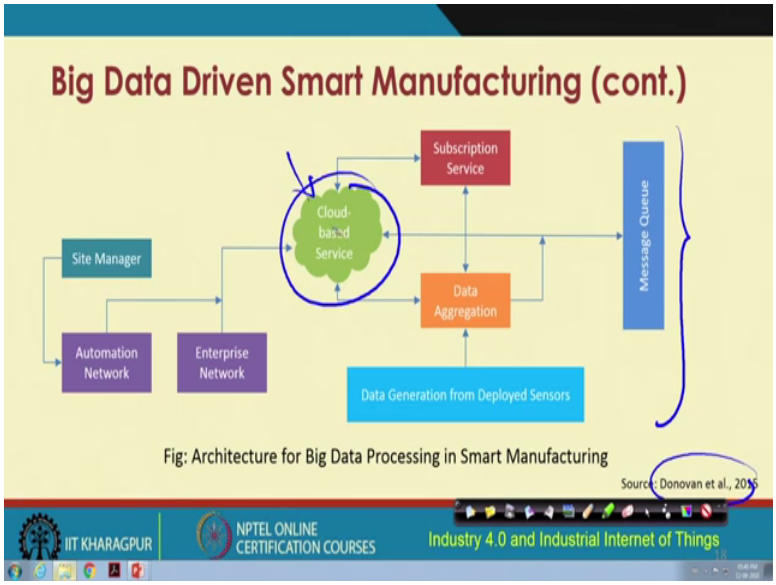

This is this big data driven smart manufacturing architecture. So, all these different components that we talked about and different other components additionally have been shown over here. So, again I am not going to go through, but this is quite self explanatory.

And if you are interested you can go through the corresponding literature the source is given over here. But again as we can see over here this is again data intensive knowledge

intensive analytics intensive and so on. And all of these kinds of processing are done at the cloud.

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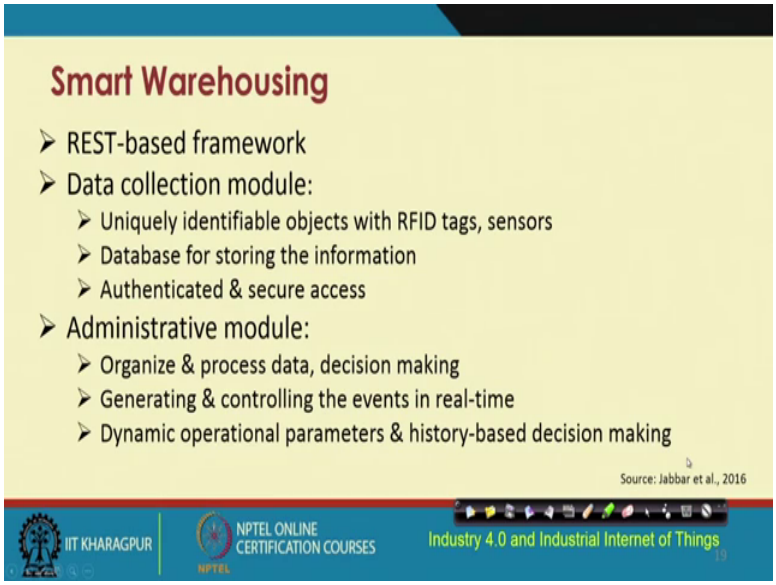

Smart warehousing here the authors are talking about Jaber et al they are talking about the use of a rest based framework. This framework collects the data the data collection module is there which uniquely identifies the different objects with RFID tags and sensors. There is a database component for storing the information and for authentication and secure access. And there is an administrative module which talks about organizing organization of the data processing of the data decision making and so on.

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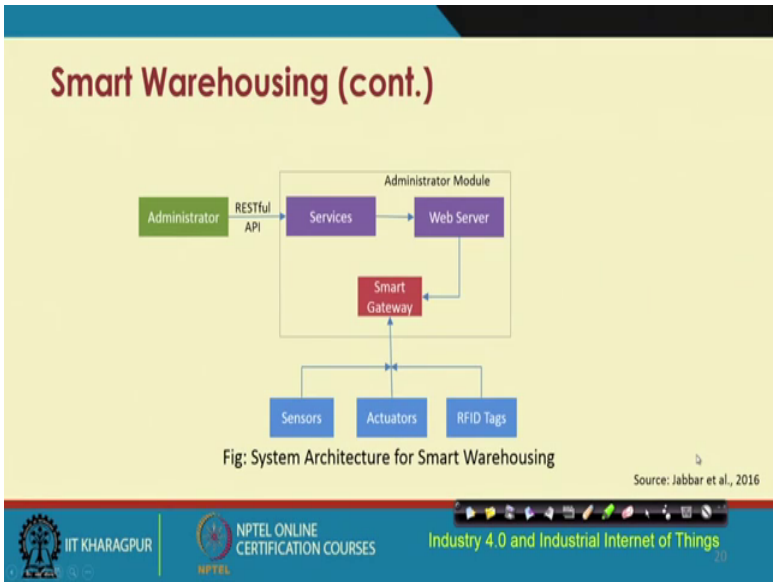

This smart warehousing architecture is shown over here. So, here also as we can see there is this smart gateway that is used the web server a service component all of these are going to do different types of processing and analytics. So, which analytics are going to be done this might be a question that might come to your mind. So, what type of analytics?.

So, this is where basically we can take help of the different types of analytics and EI techniques that we talked about in one of the previous lectures. So, we you know so these solutions which basically make it keep it open about the type of analytics that could be implemented. But any of these analytics like the predictive prescriptive descriptive any kind of analytics could be implemented in most of these architectures and the specific solutions that could be used are left open.

But one could use any of the different types of computational intelligence mechanisms based on may be fuzzy logic neural networks deep learning and so on. So, any of these could be used different optimization techniques could be used. And different predictive techniques such as game theoretic techniques and so on could also be used to come up with some optimal solution to a particular problem based on the data that is received.

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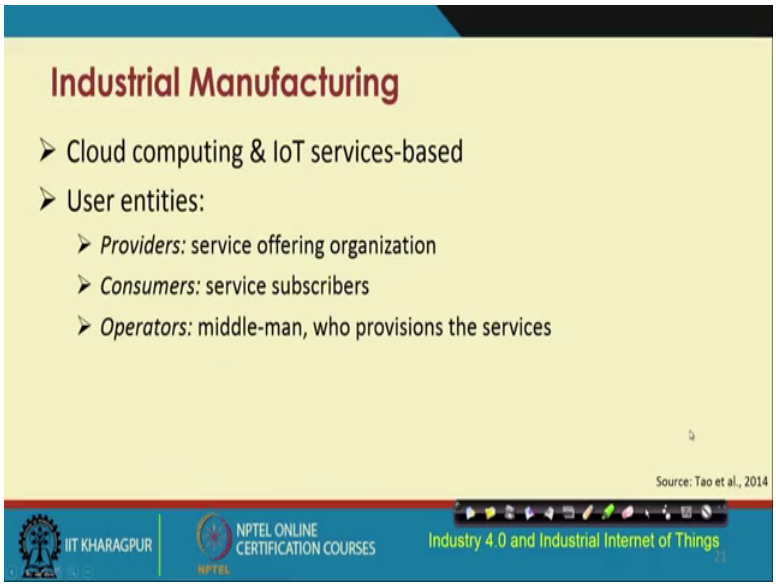

So, like this there are different other solutions industrial manufacturing solution by Tao et al., in 2014. Here they are talking about a cloud and IOT based solution for industrial manufacturing where they are using different entities such as; the providers the consumers and the operators. I do not need to go through the meaning of each of these different entities because it is quite self explanatory.

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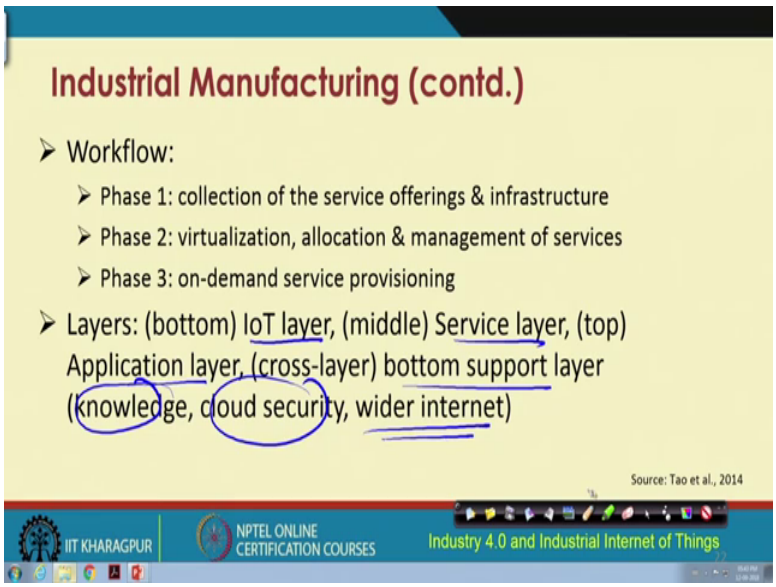

They are talking about workflow in different phases. Phase one collection of the service offerings and the infrastructure, phase two is the virtualization allocation and

management of the services, and phase three is on demand service processing. So, in their architecture they have all these different layers and the layers such as the IOT layer, service layer, application layer, the bottom support layer. That means, the knowledge you know cloud security, internet and so on so all of these different layers are used.

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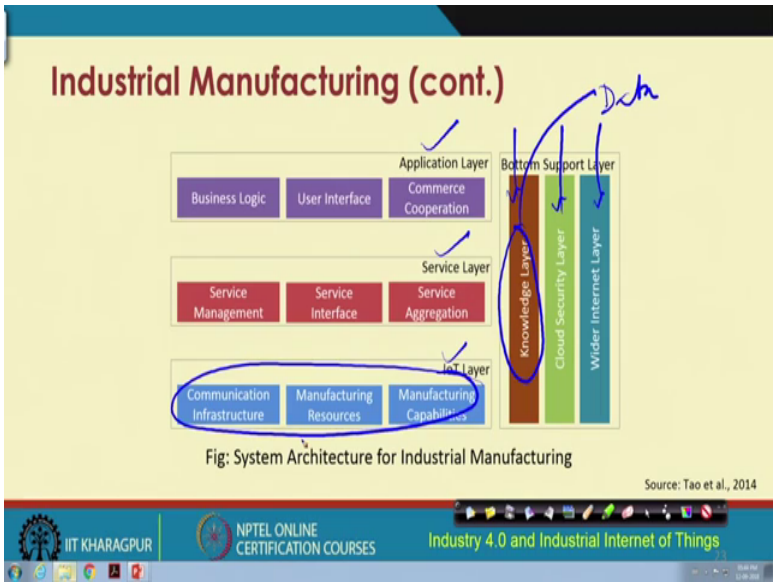

So, this is this overall integrated architecture. So, you know we were talking about all these different layers. Application layer on the very top service layer, IOT layer, and the bottom support layer, which cuts across all of these layers of application service and IOT. The knowledge layer the cloud security layer and the wider internet layer.

So, each of these layers you know so knowledge layer particularly is quite you know data intensive. And in order to get the knowledge out of the different data that are collected from these different IOT devices that are deployed in this particular layer; you need to have different advanced forms of analytics in place.

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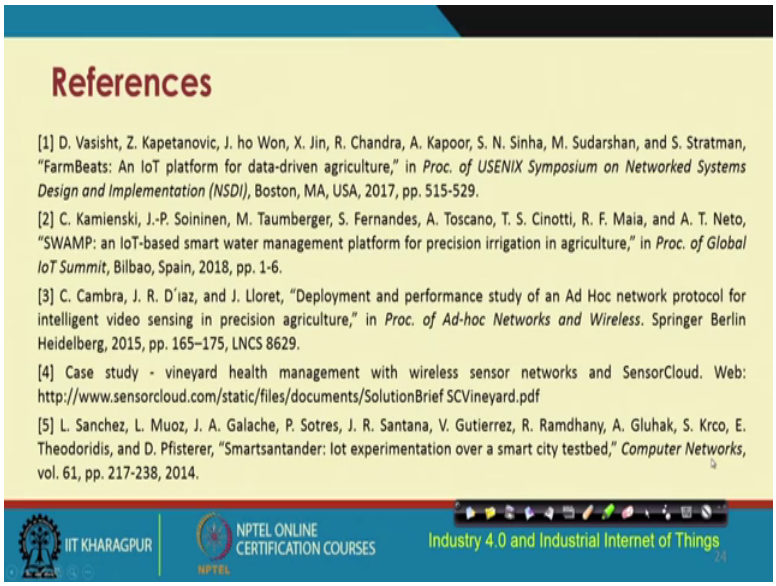

So, like this there are different solutions that are there. So, these are some of the ones that I have just explained. The corresponding references are given to you at the end over here. And if you are interested you can go through whichever is more applicable to you whichever interests you more if you are from if you have interests in agriculture the ones that I discussed at the very beginning you can go through the corresponding literature in further detail.

If manufacturing is one that interests you more you could go through the corresponding literature. We talk which talks about the smart manufacturing solutions and so on. But what is very important in this lecture and the previous one is to understand that we can deploy whatever sensors are required for addressing a particular problem. We can also place the connectivity solutions the communication infrastructure networking infrastructure and so on.

But thereafter how do you know you have to deal with the data that is coming through these different layers from the sensor layer through the connectivity layer the data that are coming will have to be processed adequately. And for this particular processing different solution architectures I have shown you will which will give you a hint about the particular solution architecture that you are going to implement and are going to come up with for your specific problem that you have in hand. And the different types of analytics processing means analytics right.

So, different computational techniques will have to be implemented, different optimization techniques game theory neural networks you know genetic algorithms or you know fuzzy logic or anything you know. So, what is more important for you; so those will have to be implemented and then just mere implementation is not sufficient you will have to from the data you will have to gather the information.

Further gather the knowledge at a even higher level of abstraction and it is that information and knowledge which is going to be useful. So, with this we come to an end of the processing part and.

Thank you.