Introduction to Internet of Things
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Lecture – 57
Case Study: Agriculture

Having gone through the different concepts of IoT, the basic concepts the networking concepts, the communication concepts, the connectivity establishment concepts, the practical hands on IoT in the previous lecture we will now go through a case study of how IoT has been used. And this particular case study is on agricultural use, so agricultural use of IoT more specifically on use of IoT for smart irrigation and this is basically based on a project that I have executed along with my colleague Professor N S Raghuwanshi from the Department of Agriculture and Food Engineering of our Institute IIT Kharagpur and here I am going to show you how IoT can come as help for building systems that can make irrigation smarter.

So, it is a smart irrigation management system the system that we have developed the name is AgriSens AgriSens system and this is accessible this particular system is accessible publicly through the URL agri sys; agrisys dot iit kgp dot ac dot in.

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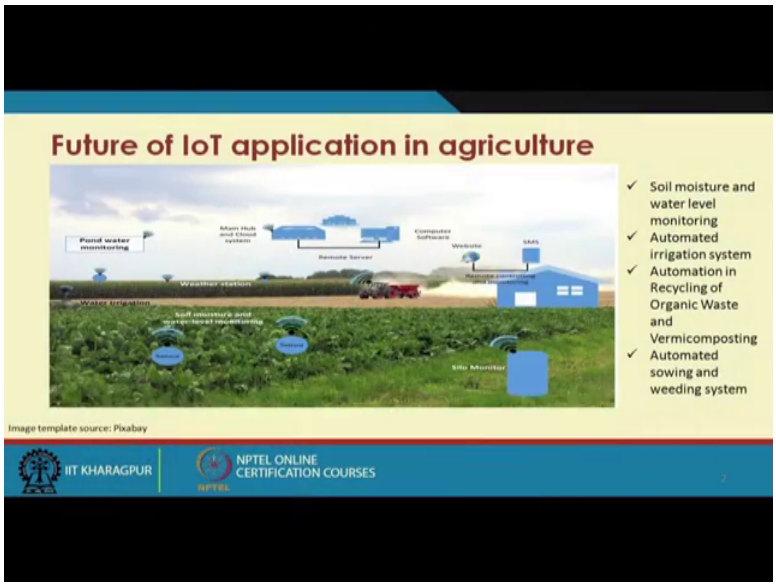

So, let us look at some of these different aspects of this particular system. So, before we go further I would like to show you a hypothetical scenario through this particular figure.

So, what is going to happen the use of IoT in agriculture what is going to happen in the future? So, the picture that we see in front of us is an agricultural field a hypothetical one where there are different types of sensors that are planted sensor such as for soil, moisture and water level monitoring for automated irrigation performance performing automated irrigation.

Automated recycling of organic waste vermicomposting automated sowing and weeding and so and so forth, so many different things automated systems fitted with sensors fitted with different actuators these are going to be used for making agriculture smarter. So, we in this particular project in the AgriSens system we have developed the system with a focus on water management using IoT smart water management. So, how do we do it?

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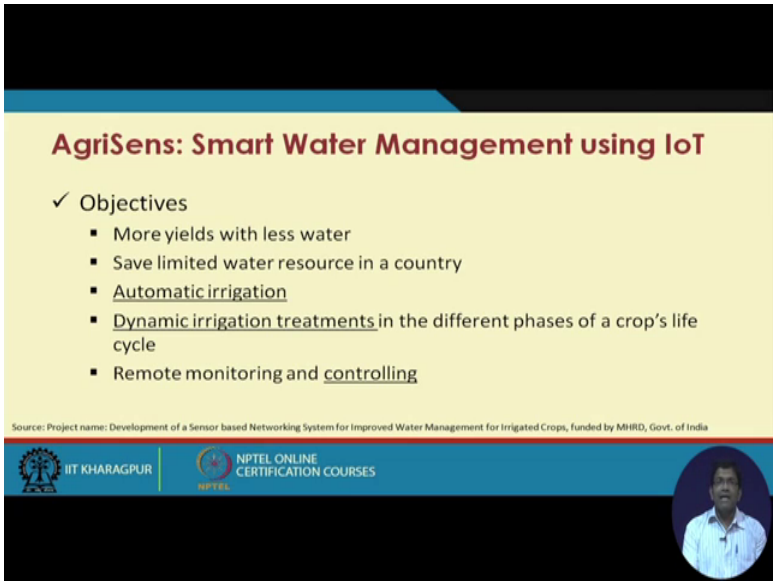

So, the objectives of this smart water management system the AgriSens system are that how less water can be used for getting more yield in terms of crop productivity; that means, and typically you know. So, what happens is for plants such as rice; that means, paddy plants wheat and so on. These basically are dependent on the soil moisture the water level in the soil and so on and so forth and many other climatic factors.

So, the whole objective is that how can we monitor the soil conditions how much is the moisture content of the soil how much is the water level the stagnant water level particularly that is useful information for paddy crops paddy plants and how we can automate the irrigation process whenever the soil becomes dryer. So, if it becomes dryer

below a certain threshold level how to automate this particular thing. So, automated irrigation how do we perform with the help of this these different sensors.

So, what we do is that based on these different sensed information through the soil moisture sensors water level sensors from the field we learn certain analytics based on the data that is received, and then if it is found out by the system autonomously by the system without any human interference if it is found out by the system that the water level has gone down or the soil moisture level has gone down or those are all climatic conditions are no longer prevailing. Then to take some actions, the actions can be in terms of sending some control signal for example, switching the pump on to irrigate the field and so on and so forth and there can be done remotely as well as well as autonomously automatically.

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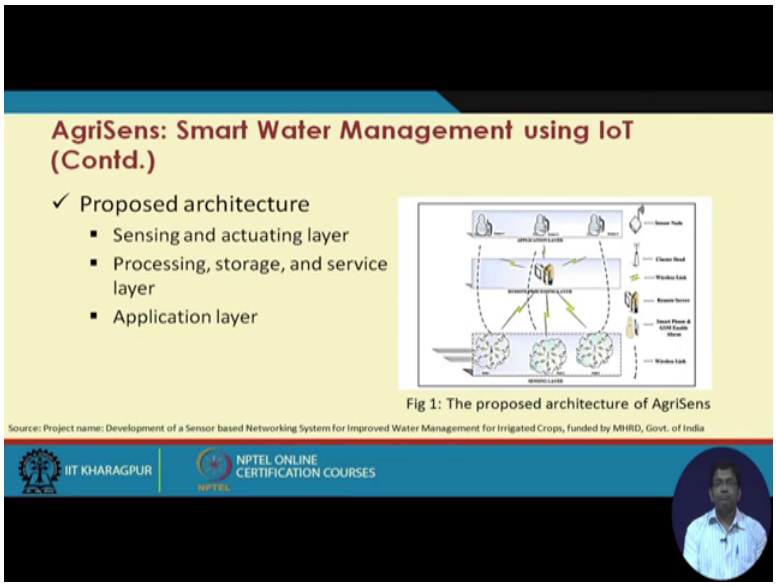

So, this is what the AgriSens system does. So, this is the proposed architecture of the AgriSens system for offering smart water management. So, we have different layers of the system so we have the sensing layer the remote processing layer and the application layer the sensing layer basically has different types of sensors soil moisture water level etcetera which through data from different clusters this through data through their cluster heads to the remote processing server and different analytics and run and those data are made available to the different applications in the application layer.

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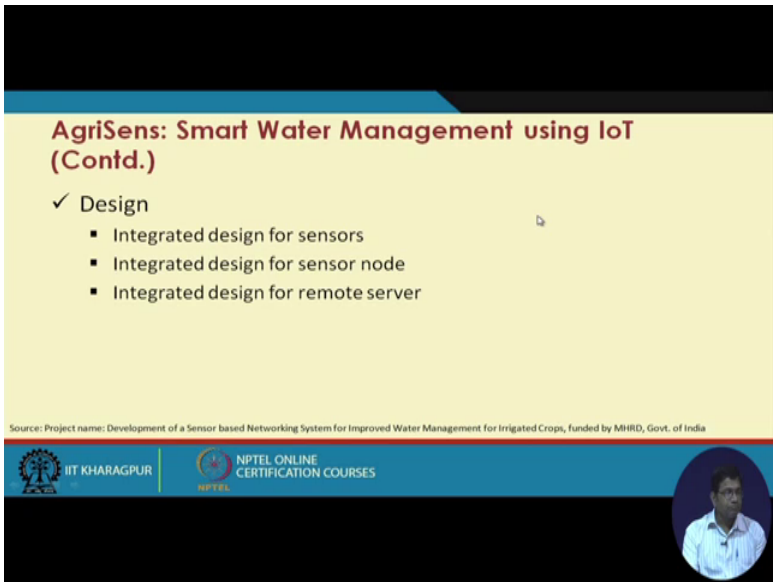

So, this particular project involved different objectives such as the design for the sensors, designing the sensor node as such and the design of the remote server and the communication framework. So, as part of this project what we did is we developed a sensor that can be used for monitoring the water level in the field. So, this is this particular sensor which we have developed in our lab for monitoring the water level in the field.

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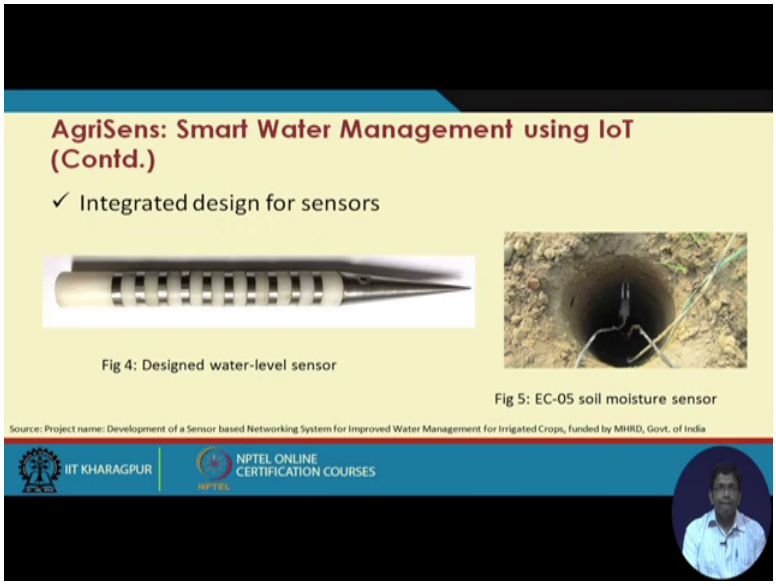

So, another sensor which we did not develop, but we have procure is the EC 05 soil moisture sensor which in this particular figure as you can see in this particular picture as you can see has been put it has been you know dug inside the surface of the earth.

So, soil moisture sensor is basically put inside is installed inside the level the level of the mud level of mud or level of earth. So, it is inside it is dug inside.

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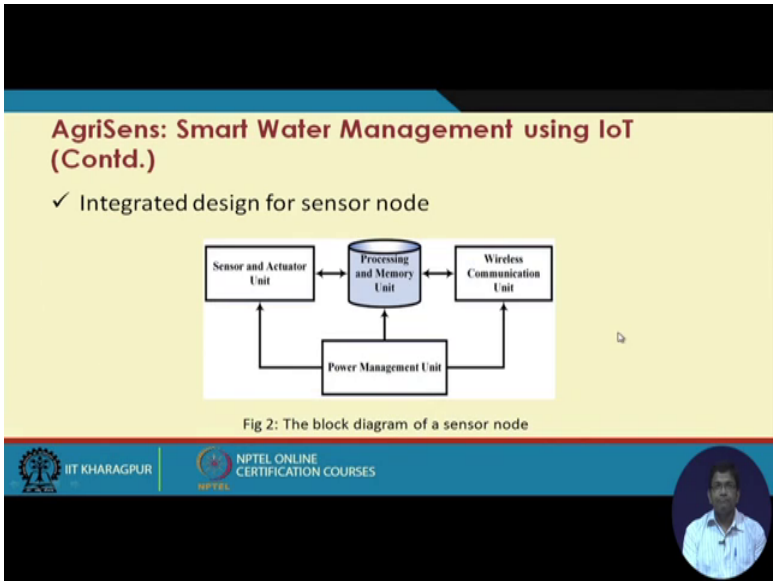

So, this is the overall design of the sensor node. So, here basically what we have is apart from the sensors and actuators we have a processing unit and the memory unit we have wireless communication unit and we have the power management unit.

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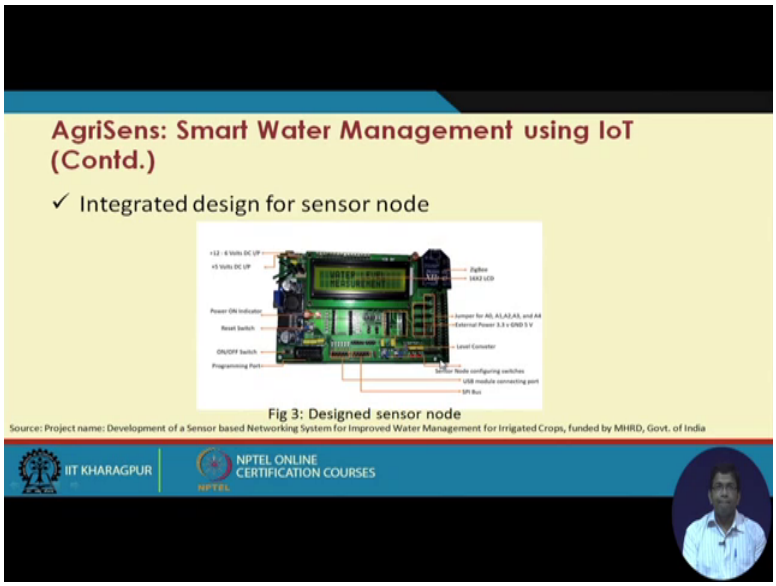

So, this is the integrate design of a sensor node that we have developed this is this one node and this node basically as you can see over here it comes with an LCD and it is powered by Zigbee for communication and Zigbee in one of the previous lectures on connectivity technologies we have already gone through Zigbee. Then it also has a power supply it has different power supplies then it has a power on indicator a reset switch the on off switch and different sensors can be fitted to this particular core.

So, this is the censor board that we have designed and which can be used for agricultural purposes smart irrigation purpose.

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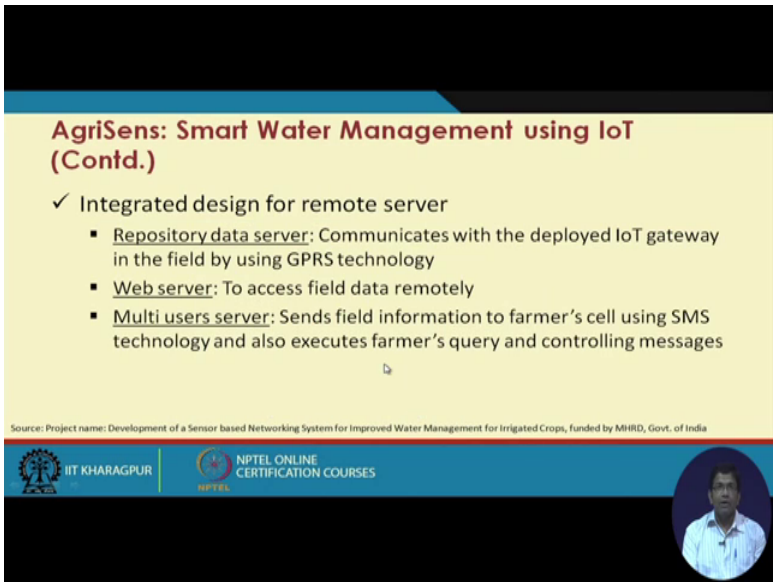

Then the remote server basically it has a repository which can take all the data from these different sensors these IoT nodes through the IoT gateways and there is a web server which basically stores in the field data remotely; that means, the web server are typically stored away from the field and that is where the data are all stored for use in the future. And there are multi user servers which basically send the field information to the farmer's cell using SMS technology, and also executes the farmers query and controlling messages. So, basically this basically helps in informing the farmers about the field conditions with the help of SMS and different sending different SMSes.

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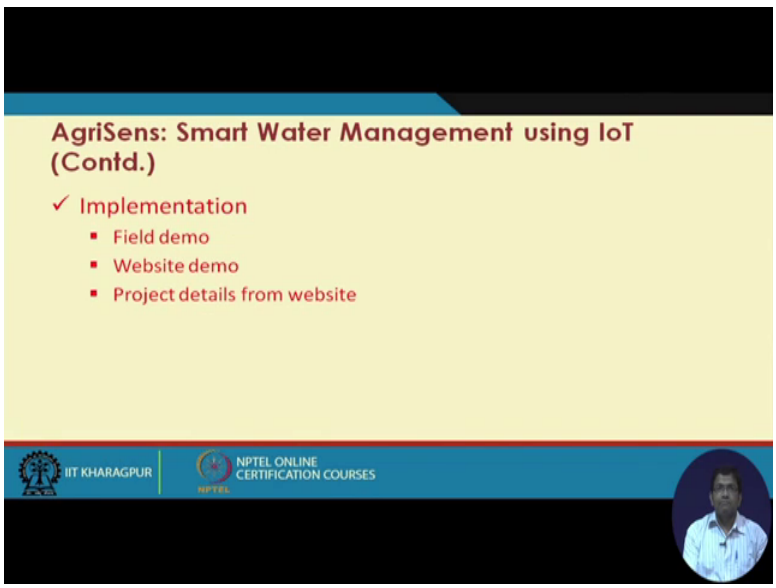

So, we will now look at a field demo and thereafter I am going to show you few other different aspects of this particular system. So, I am going to now take you to the field and show you how the system is deployed and how it functions at the field.

Now I am going to show you one of the implementations of internet of things in agriculture. More specifically this is for irrigation purpose how IoT can be used for irrigation purpose and what we are doing is this is actually by the way developed as a sponsored project of MHRD and IIT Kharagpur and this was being developed along with my colleague Professor N S Raghuvanshi of the department of agriculture and food engineering at IIT Kharagpur.

So, what you see over here is an agricultural field. So, in this field, this field is divided into a 6 by 5 grid and each of these grid elements has a size of 3 by 3 square meters.

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And so in each of these grids what we have is a sensor node and at this point actually you cannot see any crops because the crop the season has gone and the crops have been harvested, but this is the infrastructure that we have. So, this is a solar powered sensor node and if we look here in this node we have through this node actually we have two different sensors - one is a soil moisture sensor which is basically buried in ground and there is another sensor which is the water level sensor. So, the soil moisture sensor basically as this name says that it basically sensors the soil moisture and the water level

sensor is how much is the stagnant water level in this particular grid. So, this is what it measures.

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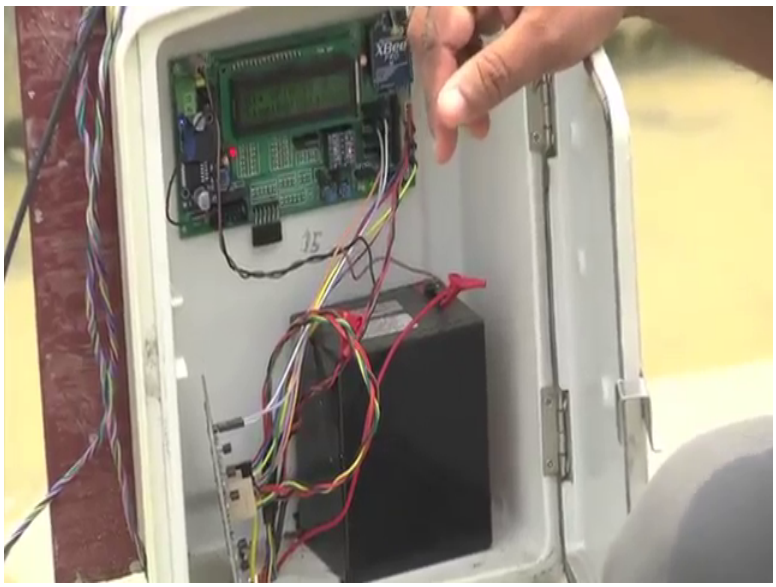

And these two sensor data are sent to this particular node. So, this node basically has you know it is Zigbee power and this data has Zigbee communication with the cluster head. So, here actually what we use is a cluster based approach cluster architecture for sensor deployment. So, from this node from every node that we have here the data are sent via Zigbee to the cluster head and from the cluster head. Cluster head basically supports two types of communication one is the Zigbee communication for intra cluster communication and the other one is the GPRS communication from the cluster head to the control room where the servers are there for further analysis.

So, this is the architecture that we have and so the sensor data you know are being in the sense from these two sensors - one is the soil moisture and the water level sensor and if the water level has gone down or the soil moisture is not adequate enough. So, automatically we have the valves the solenoid valves and the solenoid valves will be turned on, here is one solenoid valve that you can see on your on my left here the solenoid valve and likewise every field has other solenoid valves. So, there is another solenoid valve there.

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So, what is going to happen is the pump you know it is going to turned on will be turned on and the water is going to be you know the field is going to be irrigated by those this solenoid valves. So, as you can see over here the valve has been turned on just now and the field is going to be irrigated with the water because there is no I am not adequate water in the field.

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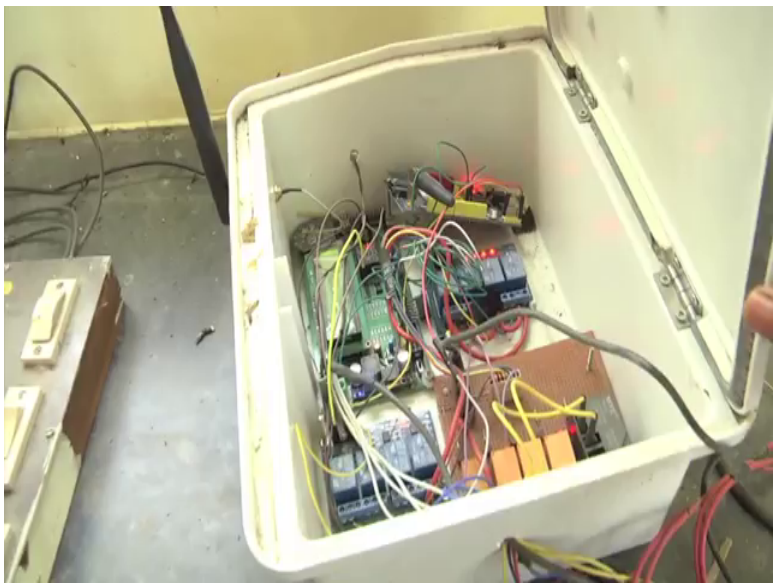

So, as I told you that we are actually following cluster based architecture for the sensor deployment so here what we have is a cluster head this cluster head has support for both

Zigbee communication which is happening through this particular node and there is also support for GPRS communication through this particular board. And additionally we have the different relays as you can see here for turning on the pumps if it is required to irrigate the field and so through this antenna basically this communication is happening with the with the external world. So, this is how the cluster head looks like.

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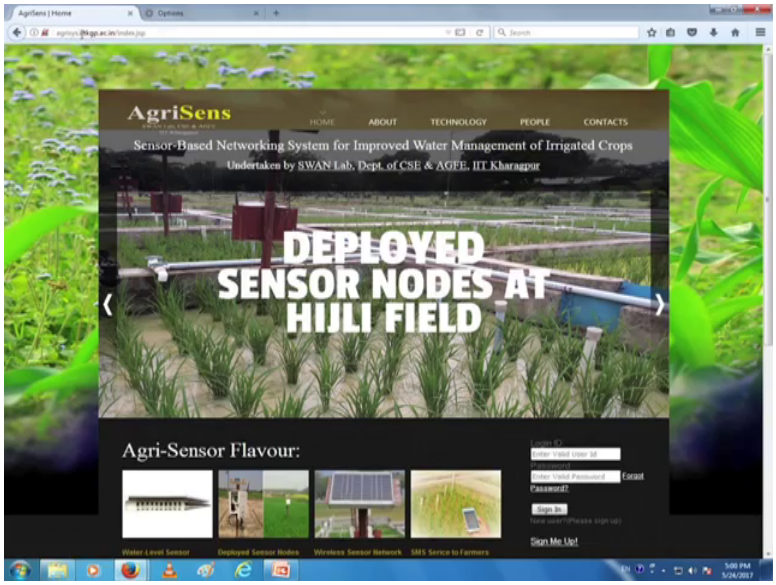

So, now I will show you the web interface for this AgriSens system. So, as I mentioned to you earlier it is accessible through the URL agrisys dot iit kgp dot ac dot in and we have deployed this particular system in two locations one in (Refer Time: 15:31) IIT Kharagpur and the other one in a distant village close to Binapur.

So, this is the overall you know web interface and as we can see over here that it gives lot of information about the water level sensor that we have developed the deployed sensor nodes you can read more, the wireless sensor network that is there and the SMS service that is offered to the farmers. So, more information is available through this site and also through these different links the people that are involved I already mentioned to you that it is being it has been done by our group the swan group of the department of CSE along with the agriculture and food engineering department at IIT, Kharagpur.

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So, here you know we can through this particular portal we can look at the field conditions and the different sensors you know the different health monitoring on the different sensors that are there.

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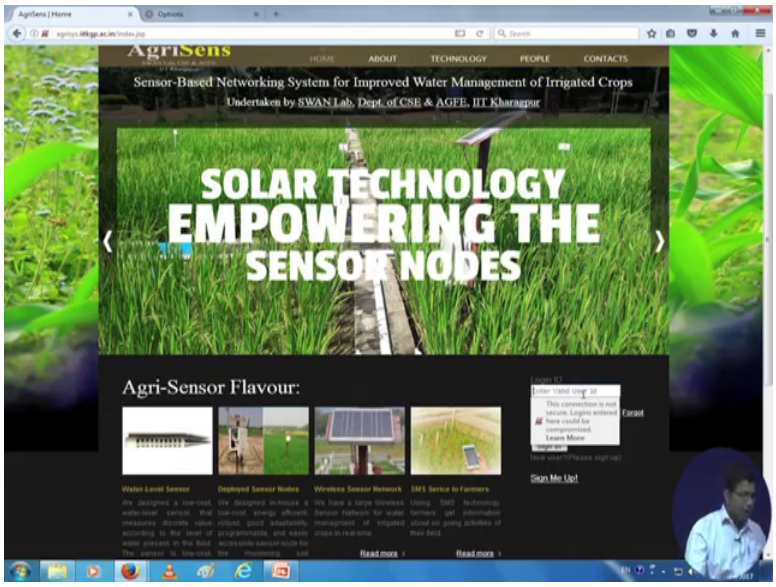

So, if you login using the login credentials, this is basically the node status from one of the fields as we can see these are the different status that I had mentioned and these are the different status that I had mentioned.

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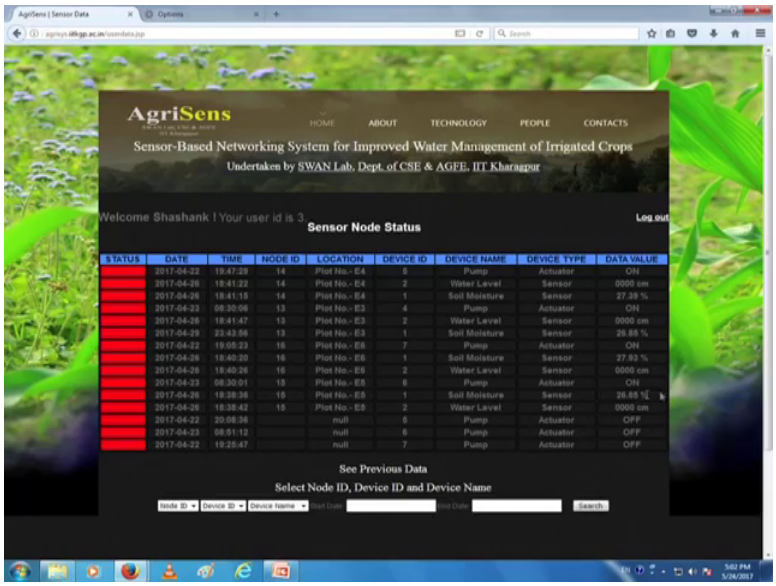

So, we have red colour implying that now actually the clock has already been harvested it was a paddy, paddy field where the sensor nodes are deployed. So, crop has already been harvested that is why it is showing red colour means that the sensor node is not sensing any further data. And also the different status messages you know so can be obtained through this particular portal and previous data also one can see through this and, this basically you know helps in remote monitoring of the field you know even if one is in another part of the world still they you would be able to monitor the field conditions. So, this is how the overall portal looks like.

So, now, I will show you some of the plots of the data that I received at our server.

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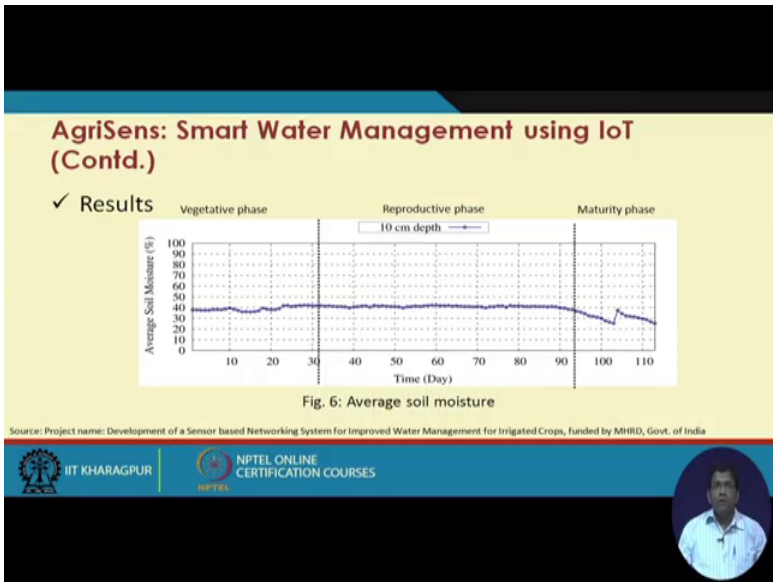

I have already shown you how the different sensors are deployed in the field and these are some of the results that we have received some of the data that we have received with respect to things such as the soil moisture. So, this is the soil moisture data with respect to the time. So, here actually we have some 115 days data and as you can see over here the soil moisture variation with respect to the different phases of crop growth during the paddy season is basically plotted over here. So, this particular phase is shown to be the vegetative phase and the soil moisture variation is shown in this particular plot. Then we have the reproductive phase where the soil moisture varies like this and then we have the maturity phase and in the maturity phase as you can see that there are some variations in the soil moisture of the field.

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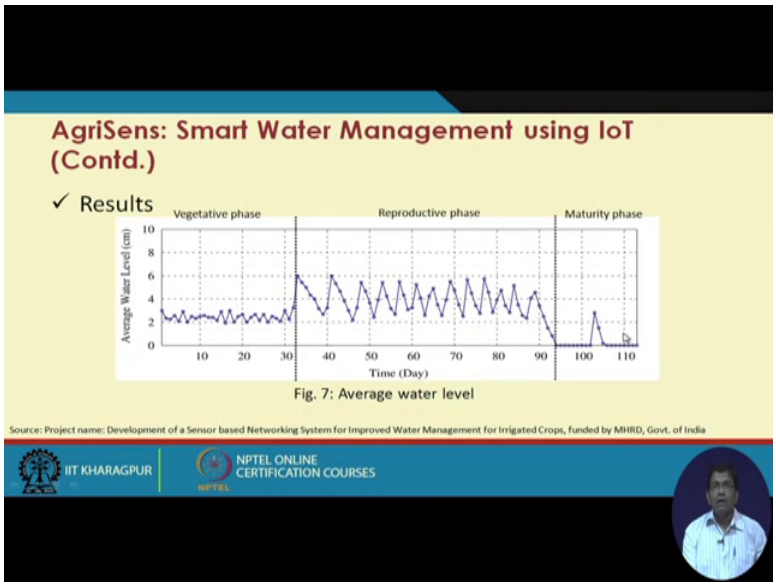

The next one is the water level. So, here actually we can see that in the vegetative phase the water level fluctuations are there, but it is not too much, but then during the reproductive phase the water level fluctuations are quite huge. So, whenever the water level goes down the field is irrigated, again water level goes up, again it goes down and so on and so forth. So, this is the reproductive phase and then we have the maturity phase where the water level variations are as shown.

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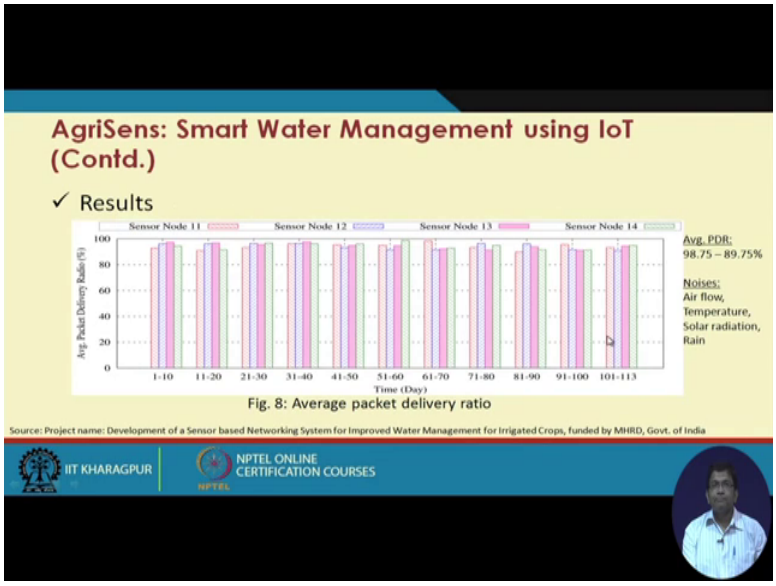

And then this plot basically shows the packet delivery ratio and as we can see over here the packet delivery is not so bad you know it is between like 90 percent to 100 percent. There is some packet drop that has happened and these packet drops could be due to different reasons such as different presence of different noises interference and so on, due to things such as air flow, temperature, solar radiation rainfall and so on. So, these packet drops are quite common, but as you can see that mostly the system overall is quite reliable.

Thank you.