Introduction to Internet of Things

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Lecture – 13
Connectivity Technologies – V

We will now in this particular lecture cover two important protocols Zwave and ISA100.11a. These are two very important protocols that, in addition to zigbee HART wireless HART Bluetooth RFID NFC are also used for building IoT systems; however, whereas, zigbee is more popular for all sorts of all sorts of IoT systems use in IoT systems. Zwave is particularly attractive for building home automation systems. And as you know by now in this course that home automation is one of the important application areas of IoT. Home automation, home automation includes what? Home automation includes things such as having some kind of a robot, or having mobile phones that will do number of different things, different day to day functions at homes can be done spontaneously and so on and so forth.

So, how can it be done? This is what home automation does. So, automating different functions in at home, is something that is of primary concern of home automation. So, I was talking about Zwave. Zwave is a technology which comes from the Zwave alliance. So, this Zwave alliance in the same way as we have a zigbee alliance we also have a Zwave alliance. And this Zwave alliance is particularly pushing for making this technology very attractive to support different home automation appliance applications. Different home automation functions.

And we are going to look at how using Zwave we could be able to improve the automation of different functions using different IoT devices at home.

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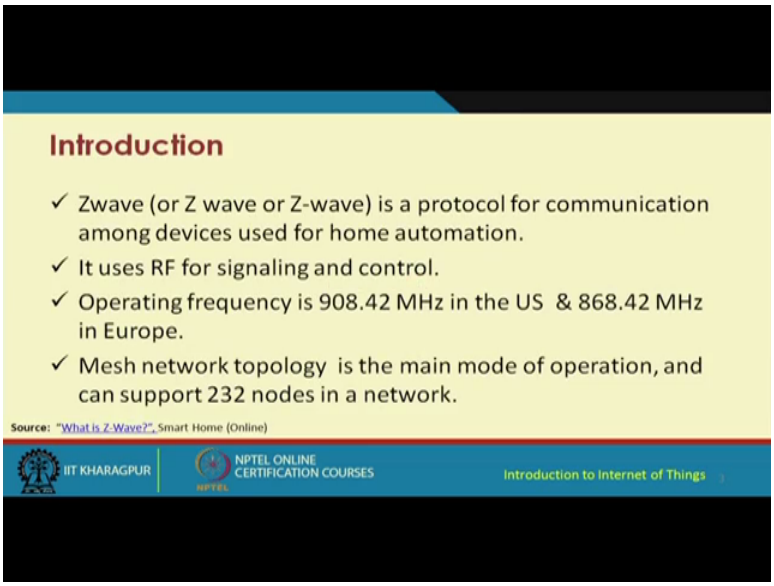

So, we look at this Zwave. Zwave is also written in different ways, we could be writing Zwave altogether or using a space in between z and wave, or using a hyphen in between z and wave. And this is a protocol that is used for communication between different IoT devices for home automation as I just said before it uses RFs for signaling and control. And the operating frequency for it is different from the ones that we have seen. We have seen that primarily the other things like HART or you know NFC etcetera, they all operate in the 2.4 GHz band.

And for Zwave the operating frequency is 2 megahertz in US 868.42 megahertz in Europe, and for different other countries I will show you in a short while. That for different other countries there are different other frequencies of operation. So, in Zwave there is some kind of a mesh network topology that is formed and maintained between different nodes which can be up to about 232 in number in a single network. Now let us look at some interesting points in Zwave.

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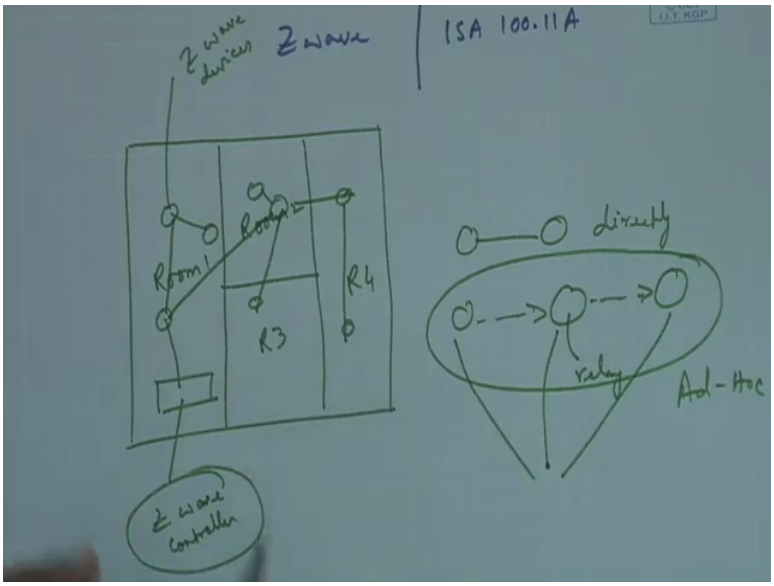

So, we have let us say, we have we are talking about home automation. In a particular home there could be different rooms. Let us say this is room one room 2 room 3 and room 4. In Zwave if we are using Zwave, there is something called the Zwave controller. And there are different Zwave devices that are there. So, typically in a single home there is only one Zwave controller and there could be different. So, these are all Zwave devices one Zwave controller and one or more; that means, several Zwave devices. These Zwave devices they could be either connecting directly or they could be connecting with the help of a relay node in between. So, this is one Zwave device, this is another Zwave device and this could be a third Zwave device. And this could be something like an ad hoc mode of communication. So, this is how Zwave basically functions.

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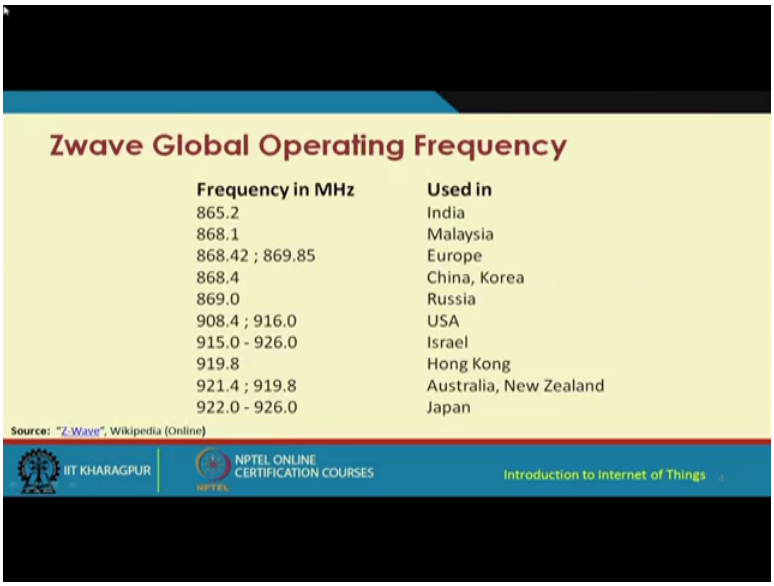

So, I was telling you that in US 908.4 and 916 frequency bands. In Europe 868.42 and 869.85 megahertz frequency band. And for other countries these different frequencies of operation are shown over here in this particular table. So, as we can see that for India it is 865.2 megahertz operating frequency.

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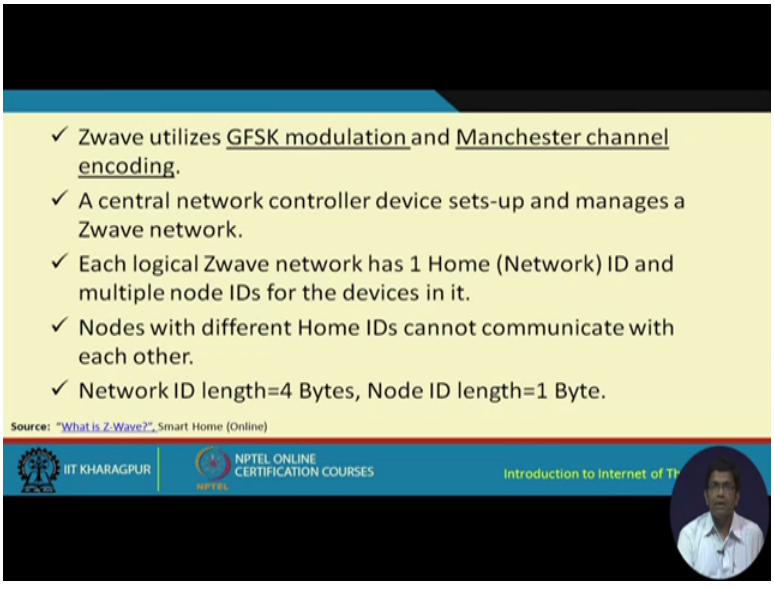

A very interesting and important concept is Zwave does not use FSK modulation directly. What it does is it passes through a Gaussian filter. So, essentially what happens is it becomes Gaussian FSK modulation. And the channel encoding scheme that is used

is Manchester encoding, this is one concept. The second thing is as I was mentioning earlier, there is an entity a single entity called the network controller the central network controller, that sets up and manages a Zwave network. Each logical Zwave network has one home ID and multiple node IDs for the devices in it. And that home ID basically corresponds to a single network ID.

So, essentially because there is only home ID which is unique to a particular home. The other networks in other homes will not be able to communicate through between these different homes. I hope that my point is clear. So, what I am saying is that every home has it is unique home ID or network ID. And in that particular home only that other Zwave devices will be able to communicate. So, they will not be able to communicate with other homes, the Zwave devices in a particular home will not be able to communicate with other homes.

So, we are restricting this communication of Zwave devices to specific homes. So, nodes with different home ids cannot communicate with each other. And we also have to keep in mind that, the node ID length in Zwave there is one byte, and the network ID length is 4 bytes.

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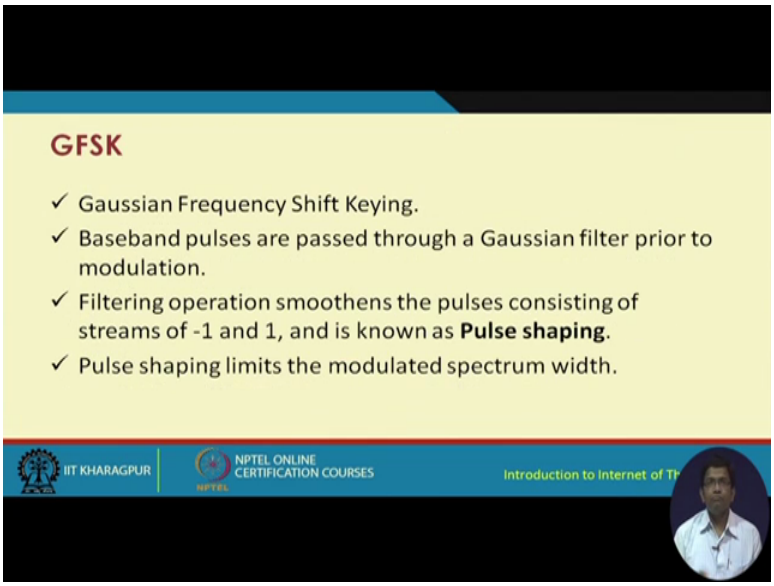

So, I was talking to you I was mentioning about these GFSK modulation, which is Gaussian frequency shift keying. So, what happens is there is a Gaussian filter prior to FSK you pass it pass the signal through a Gaussian filter to smooth en to smoothen the

pulses. So, that you have will formed pulses which will occupy limited spectrum width and this process is known as pulse shaping.

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So, in here in this figure as we can see this is a typical figure of a home. In this home we have different rooms. We have bedrooms, we have a living room, we have a kitchen, we have bedrooms and so on. And as we can see that if we have to implement Zwave, we need a Zwave controller and these different red colored and green colored nodes which are the Zwave n devices, the Zwave nodes. So, the controller basically sets of connectivity between each of these different nodes, as we can see in this particular example. The controller has one hop communication with these green colored nodes; however, the controller to these red color nodes are multi hop, they are not within the one hop communication range.

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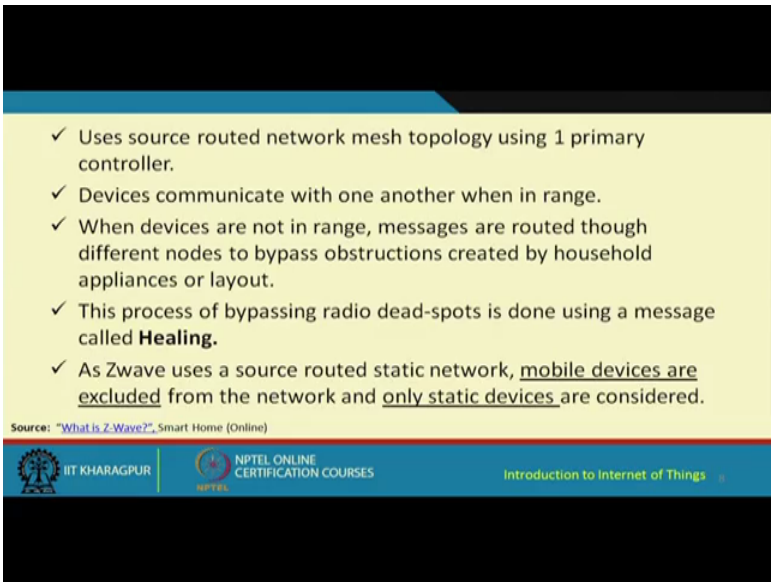

So, if this controller has to communicate with this red colored node in this particular room then it has to do via this green color node. Zwave uses mesh topology and it also uses source routing. So, source routing means that even before the packet is sent, the entire route is basically encoded or embedded before the packet is sent forward. So, before the packet is sent the entire route information is embedded to it. So, the entires route is known to the source and is given to the packet. So, the packet will know how it will traverse through the entire network or until it reaches the intended destination. So, the devices they communicate with one another when they are in range when the devices are not in range, as I was showing you using those red colored Zwave nodes in the previous figure.

The messages in such a case are routed through different nodes to bypass the obstructions that are created by household appliances or layout. And this is very important because, you know so, there are so many physical obstructions in the in the home. Right, there are walls between different rooms etcetera. So, what happens is there will be these different nodes, which will be acting as sort of gateways or relay nodes to facilitate communication between these remote Zwave nodes that are not within the direct transmission range with the controller.

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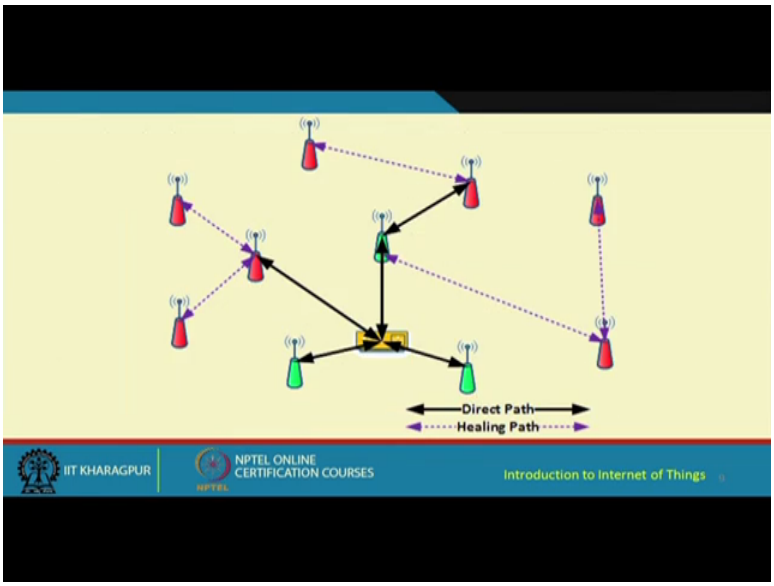

and now we have remove the sketch of the rooms and this is what is shown over here. We have the green color nodes and this one which are within the direct communication range the direct path. And then there are these nodes which are within not within the direct communication range, and there they can communicate with the help of the healing path. So, this is known as the healing path, and this is known as the direct path. Zwave and zigbee how do they compare?

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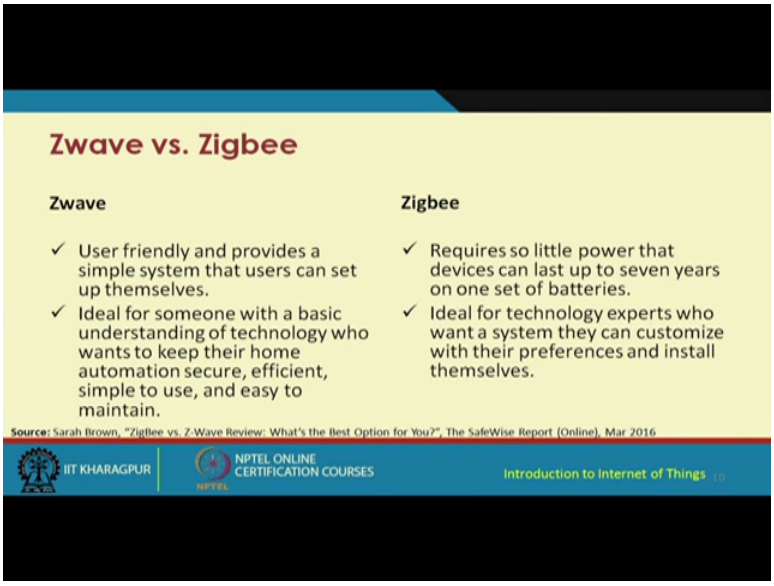

So, Zwave is user friendly. It provides simple system that users can set themselves. On the other hand zigbee requires. So, little power the devices can last up to 7 years on a single set of batteries. Zwave is ideal for someone with a basic understanding of technology who wants to keep their home automation secure efficient simple, And easy to maintain.

On the other hand using zigbee. Zigbee is ideal for technology experts who want a system that can customize with their preferences and install themselves. So, lot of sophistication can be done with the help of zigbee. On the other hand Zwave is more user friendly more customer friendly.

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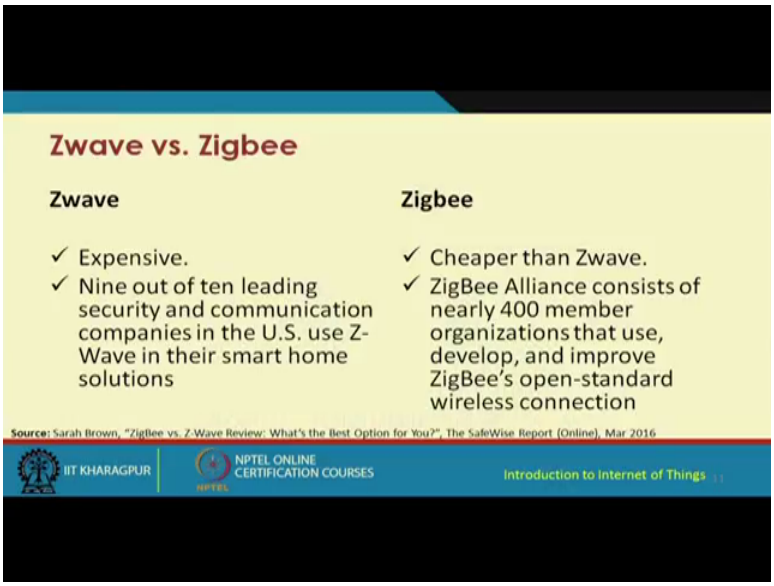

But a limited set of things can be done with the help of Zwave compare to zigbee. Zwave is expensive compare to zigbee. And 9 out of 10 leading security and communication companies in us use Zwave for smart home solutions. On the other hand for zigbee there is zigbee alliance that consists of more than hundred member organizations that use develop and improve the open standard that is offered by zigbee.

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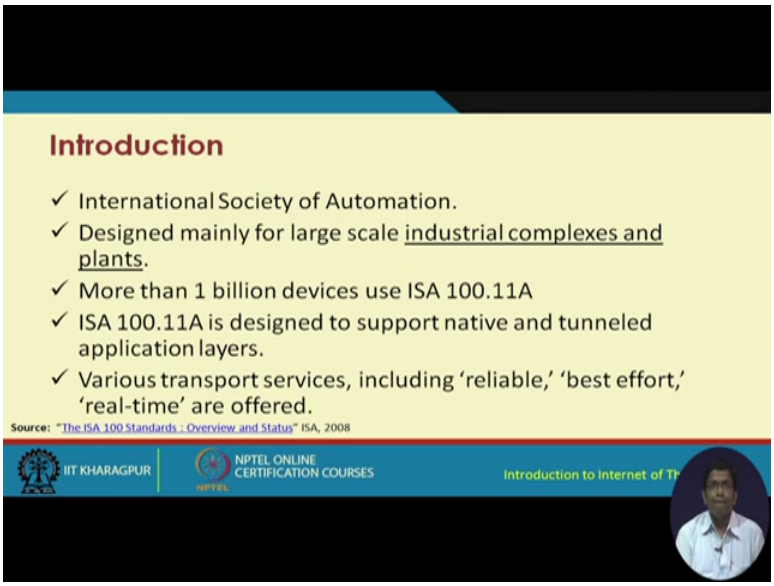

Now, we come to the second very important protocol which is the ISA100.11A. So, it is protocol that has been designed by the international society of automation. And this is particularly used for plants in the industries, industrial complexes industrial plants and so on and so forth. There are more than one billion devices that use ISA100.11a at present it is designed to support native and tunneled application layers various transport services including reliable based effort real time services are offered with the help of isa100.11A. So, ISA100.11a is primarily attractive as a consequence in industrial sectors particularly for implementing industrial IoT systems.

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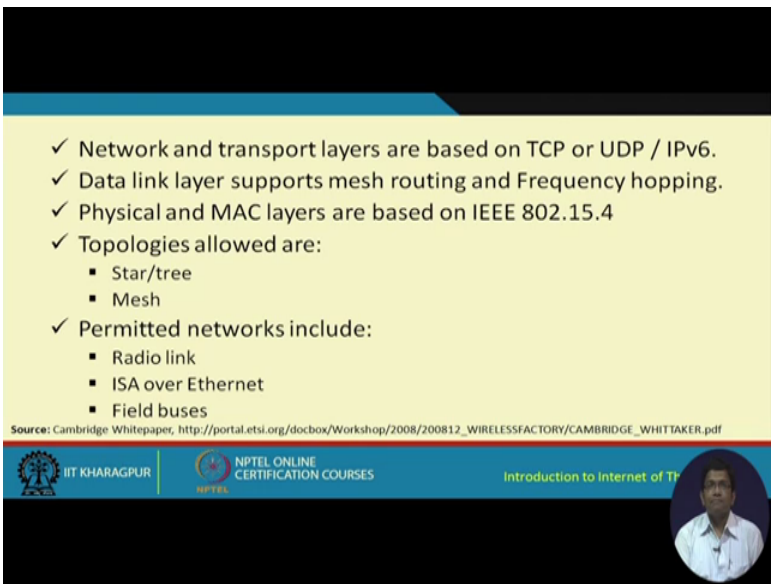

The network and transport layers are based on TCP or UDP or IPv6 and the data link layer supports mesh networking with frequency hopping.

So, frequency hopping spread spectrum is typically used in ISA100.11a. The different topologies that are used for implementing this particular standard is, the star or the tree topology or the mesh topology as well. So, all these topologies can be used for implementing it and the radio that is used beneath underneath is based on 802.15.4 again. The permitted networks in include radio link ISA over ethernet and fill buses. Fill bus means that it is a bunch of wires and bunch of wires you know running between different devices as we see in the data centers or server rooms and so on.

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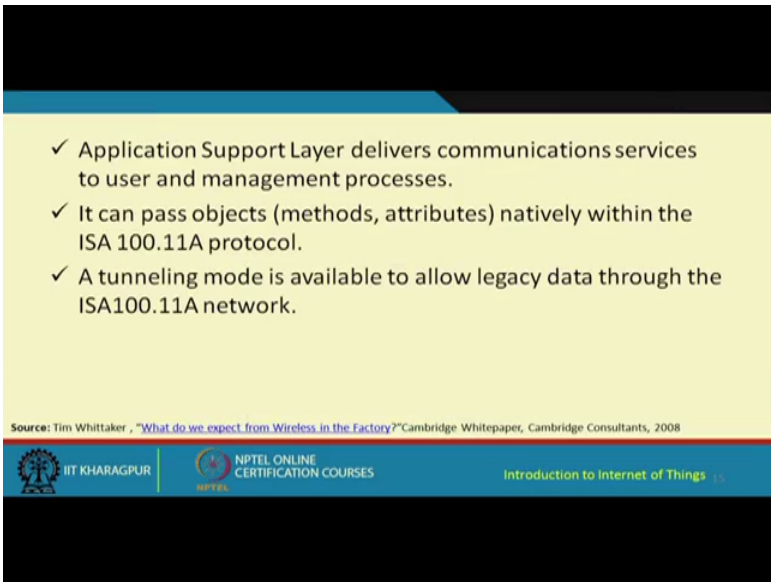

We have these buses and filled buses means between different filled buses we have this high bandwidth high capacity links that run between them. The application layer supports delivery of communication services to the users and the management processes. The this particular thing can pass objects methods or attributes natively within the ISA100.11a protocol. A tunneling mode is available to allow legacy data through this particular network.

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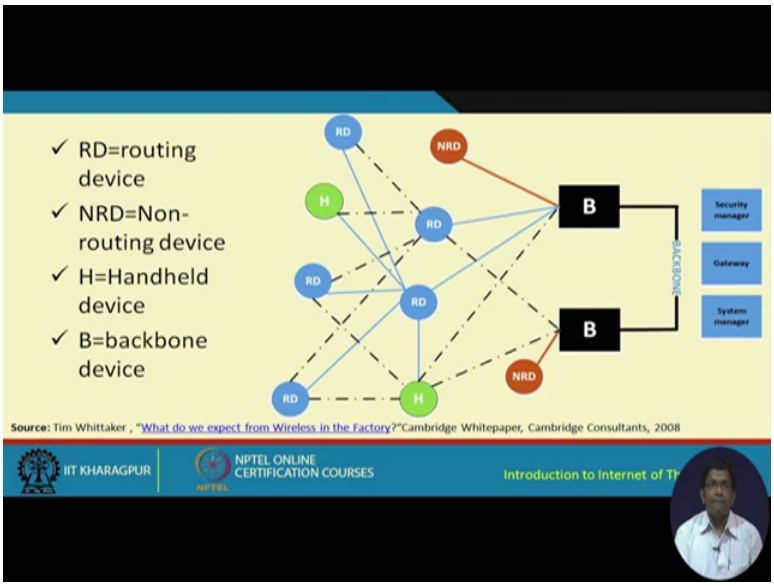

So, what we have is a scenario like this. We have these backbone devices the black colored rectangles here. We have the back backbone devices. We have this non routing devices the red colored ones. The blue colored once are the routing devices and these green colored once are the handle devices, and then we have the security manager the gateway and the system manager which, basically function from beyond the backbone. So, this is the typical architecture of this particular use of ISA100.11a protocol in industries or smart factories.

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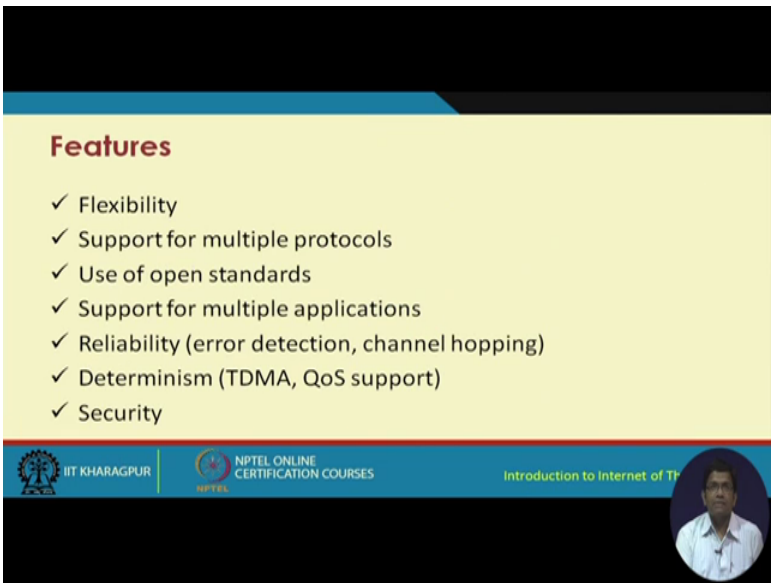

The features of this particular protocol include flexibility, support for multiple protocols, use of open standards, support for multiple applications, reliability including error detection channel hopping, determinism using TDMA, QoS support is also implemented in the case of u use of this particular pro protocol. QoS support is very important QoS guarantee is more specifically because, this is what basically ensures the determinism. TDMA we understand time slots predefined people know what is going to happen next. QoS support also is very important, QoS guarantees are important Because, you know we need to know that at least this is what is going to happen in the future by running this particular network using this standard. And security is also a very important feature of this particular protocol.

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So, security is fully been built into this particular standard the ISA100.11a standard. Authentication and confidential services are independently available. A network security manager manages and distributes the keys. So, key management including key distribution key revocation etcetera. These are all taken care of by the network security manager. So, twin data security steps in each node include data link layer encrypting each hop transport layer securing peer to peer communication.

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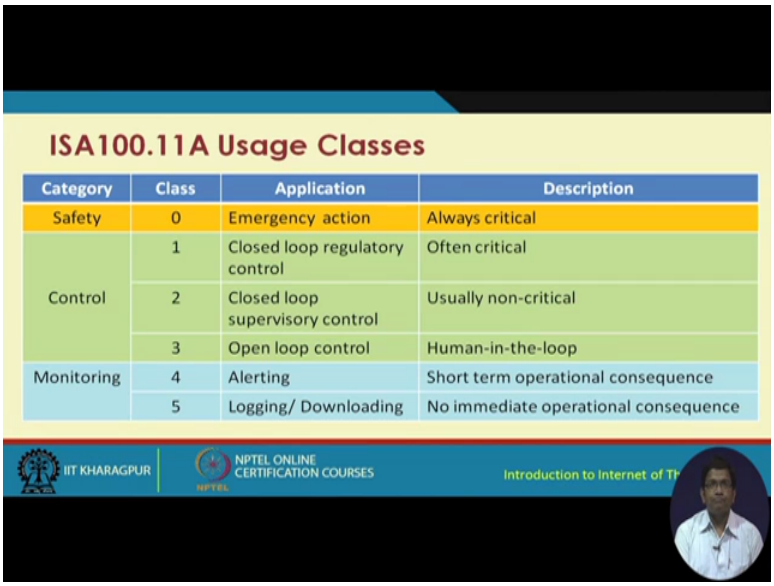

So, these are the different usage classes corresponding to different categories of applications. For safety the classes are 0 and one 0 stands for application such as emergency taking some emergency applications. Emergency action in some critical situation 1 is for closed loop regulatory control which may also be critical. Then we have category control category which has classes one 2 and 3. 1 stands for closed loop regulatory control for closed loop supervisory control, and 3 for open loop control. And then we have the category monitoring where the class 4 basically stands for applications such as alerting and plus 5 which is for logging and downloading. And this particular class the logging downloading class does not have any immediate operational consequence. So, with this we come to an end of this particular lecture. And we have not only gone through the ISA and ISA100.11a protocol, but also the Zwave protocol in this lecture. And we have also gone through previously in the connectivity technologies different protocols set such as zigbee which is based on 802.15.4.

Then we have gone through IPv6. We have gone through RFID we have gone through we have gone through NFC. We have gone through Zwave. We have gone through HART wireless HART, and we have gone through all different types of technologies that can be used for offering connectivity between different devices. These different connectivity protocols they all have their own distinctive features which make them very attractive for use in diverse applications of IoT implementation.

So, we come to an end not only of this lecture, but also the series of lectures on connectivity technologies.

Thank you.