Introduction to Industry 4.0 and Industrial Internet of Things
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Lecture – 03
Introduction: IoT Connectivity – Part II

We have gone through the IEEE 802.15.4 standard in the previous lecture and the different protocols that are based on this particular standard like ZigBee and wireless heart ZigBee.

In this particular lecture we look at one of the very popular technology, basically the Z-wave. The protocol is useful particularly, for home automation application, home automation application, and security systems.

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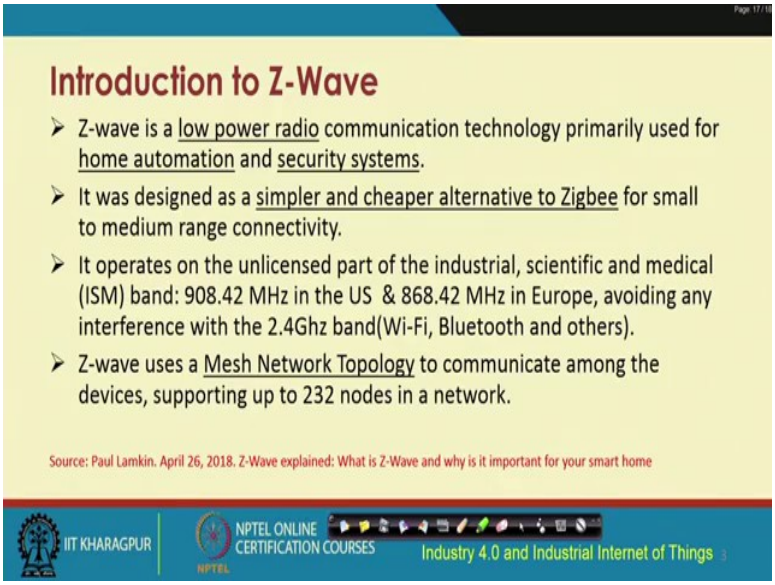

IEEE 802.15.4 are based on the communication technologies which require low power, which have low power, radio communication requirements. Home automation nowadays is very important to build home automation kind of applications. Even for industrial applications, you might be able to find the usefulness of using this particular technology.

Unlike, ZigBee, Z-wave is simpler and cheaper, used for small and medium range applications. Z-wave operates in the ISM band like in the US, it is specifically the 908.42 megahertz band, in Europe it is 868.42 megahertz band and it avoids any interference with

the 2.4 Gigahertz band that is used by Wi-Fi, Bluetooth and different other protocols and standards.

Z-wave uses a mesh network topology to communicate among the devices, supports up to 232 nodes in a network. This is quite sufficient for home automation application, even for industrial applications Z-wave supports about 232 nodes. So, let us look at how Z-wave works.

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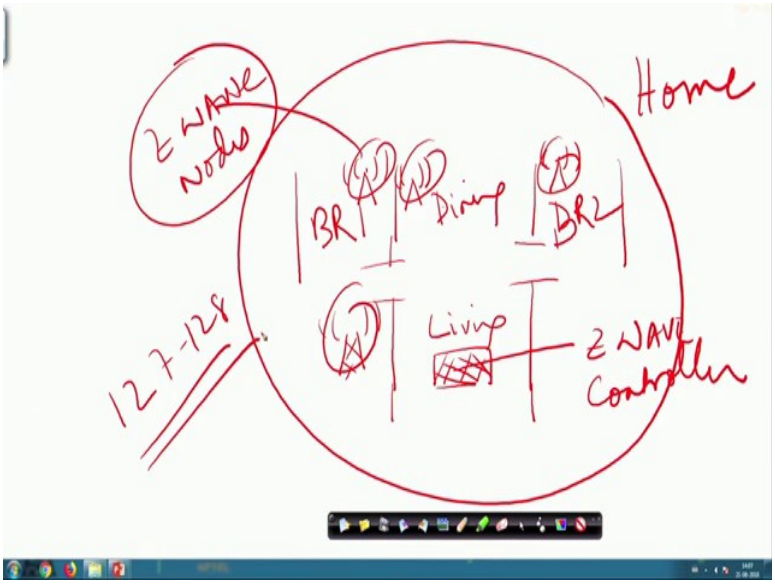

Let us say, we are talking about some kind of a home with a living room, two bedrooms, and a dining room. In home automation, using Z-wave you can install something known as the Z-wave controller device, which can be a single controller device in the entire home. And there could be different Z-wave compliant communication devices in the different rooms. So, these are like Z-wave communication devices or the Z-wave nodes commonly known as Z-wave nodes. Therefore, one Z-wave controller in the entire home and multiple such Z-wave nodes in the different rooms, and up to about 127 or 128 Z-wave nodes can be connected using a single controller.

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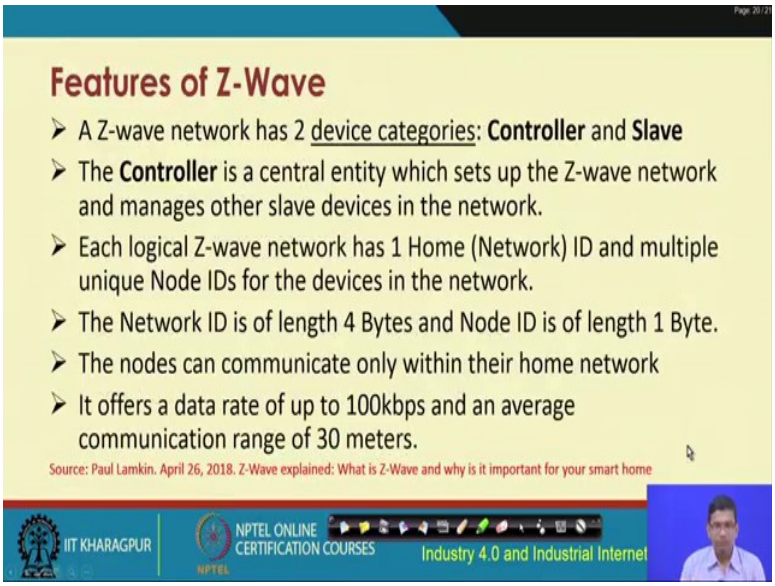

There is the controller node and the slave node. The controller is a central entity which sets up the Z-wave network and manages other slave devices, the Z-wave nodes, in the network. Each logical Z-wave network has one home ID, the network ID, and multiple unique node IDs corresponding to the slave devices in the network.

The network ID is of length 4 bytes and each of these node IDs will be a length of 1 byte. The nodes can communicate only within their home network and the data rate that is supported is up to about 30 meters. The data rate is offered is up to about 100 kbps. 100 kbps in a range of 30 meters is good enough for home automation applications, small industrial applications. So, that is why Z-wave is a very popular technology. It is low cost, simpler technology compared to ZigBee and can be used to support different home and industrial automation applications.

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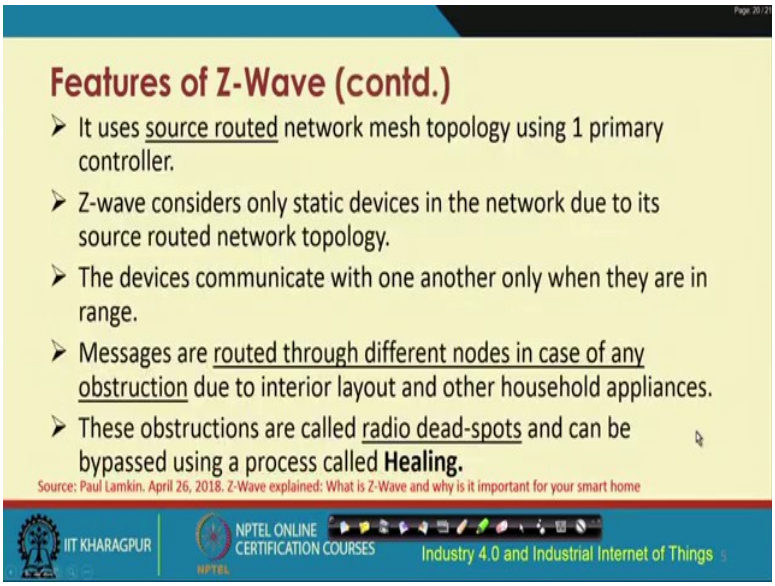

The routing scheme used is source routing. Source routing means a source node sends, determines the route in the network and then sends the packet from the source node to the entire network using the routes.

Z-wave considers only static devices in the network due to its source routed network topology. So, messages are routed through different nodes in Z-wave, in case of any obstruction, due to the interior layout and other household appliances. These obstructions are known as radio dead spots, and these can be bypassed using a process in Z-wave which is known as healing.

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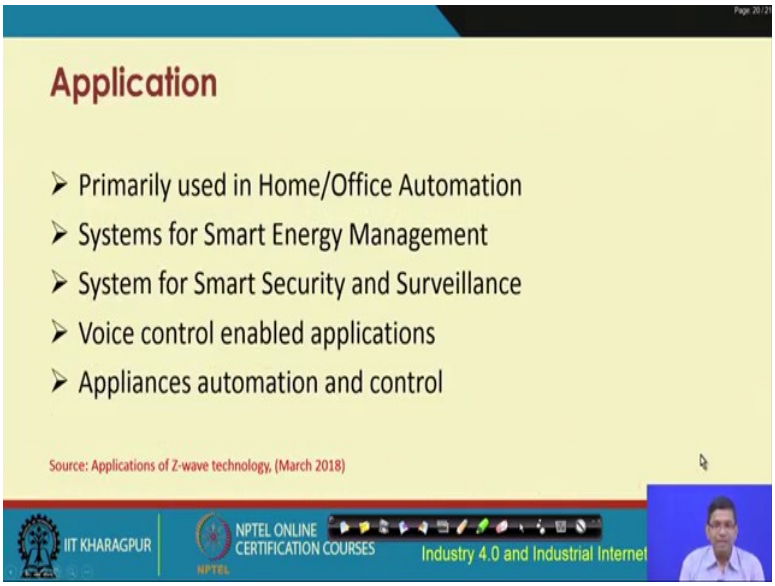

Applications where it can be used are home and office automation applications, smart energy management applications, home security, industrial security, industrial surveillance applications, voice control enabled applications, and appliance automation and control.

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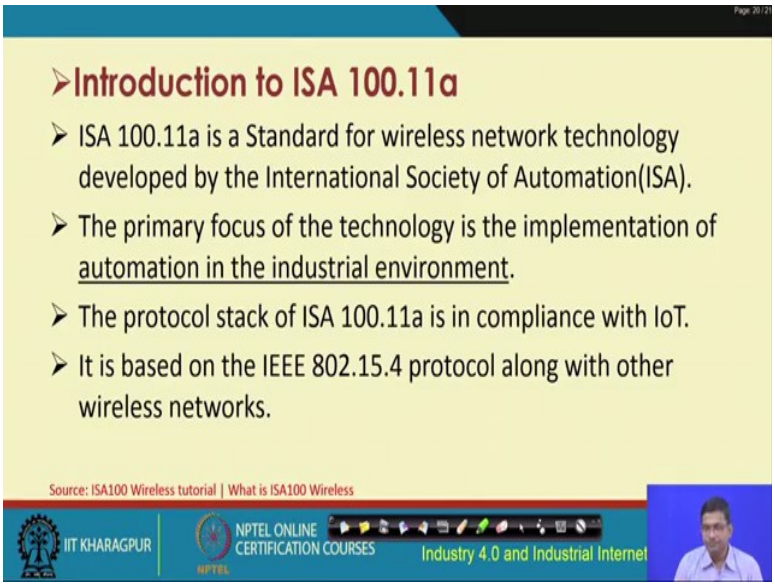

Now, let us look at another very interesting and popular standard which is known as the ISA 100.11a, which belongs to the ISA 100.11 series. This is used for wireless network technology and was developed by international society for automation. So, this standard

primarily focuses on automation in industrial environments and obviously, this standard is based on 802.15.4.

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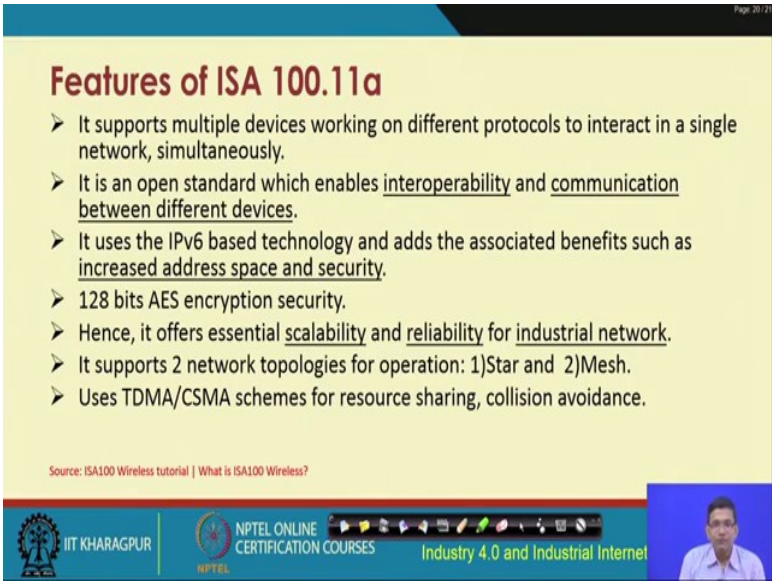

Some of the features of 100.11a ISA standard are listed in the slides. The first one is that it supports multiple devices working on different protocols to interact in a single network simultaneously. A good protocol for supporting interoperability and communication between different agents and devices. It uses the IPv6 based technology and adds the associated benefits such as increased address space and security. The encryption scheme that is used is AES encryption for offering security over 128 bits. Because of the different features of this technology is good for use in industrial of applications, it supports scalable and reliable solutions.

The kind of network topologies that are supported are star and mesh. The MAC protocols used are TDMA or CSMA/CA based MAC protocol.

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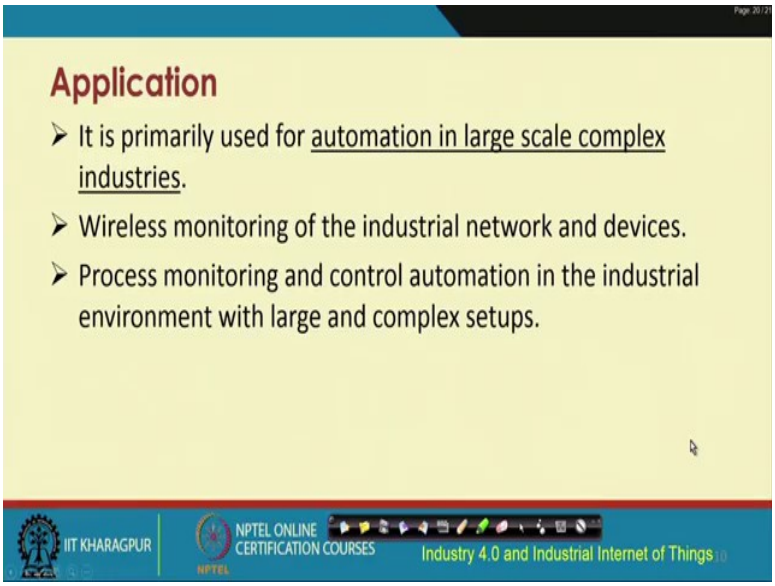

So, applications are automation in large scale complex industries, wireless monitoring of industrial networks and devices, process monitoring and control automation in the industrial environments with large and complex setups.

Now, let us come to another very interesting popular technology for implementing IoT which is the Bluetooth.

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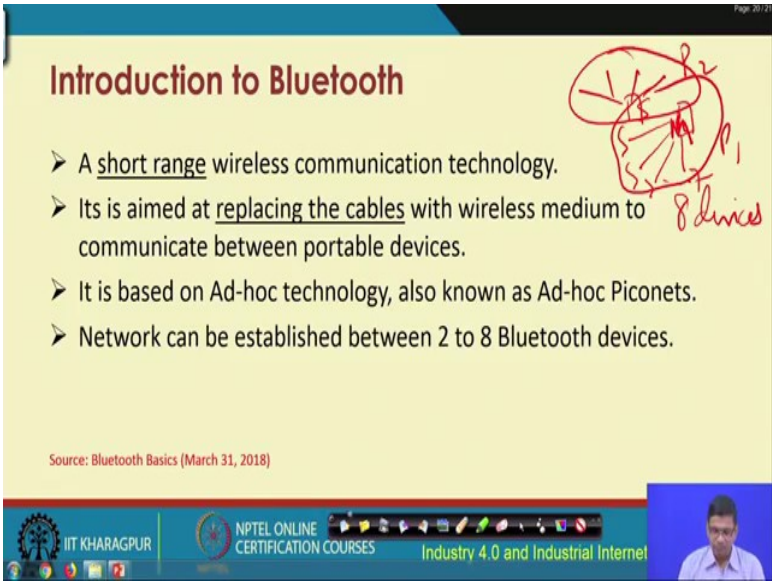

Bluetooth is used for setting up wireless network of different peripherals of a particular computer, headphones, and mobile phones. Bluetooth is a widely used technology which can help in setting up IoT based networks and network systems.

Bluetooth technology offers wireless communication in short range. Unlike ZigBee, which we discussed earlier, is good for medium range communication. However, ZigBee does not offer good data rates. On the contrary, Bluetooth offers better data rates much more improved data rates compared to ZigBee. So, there is a tradeoff.

Bluetooth is particularly aimed at replacing the cables. So, there is a cable replacement protocol which I am not going through over here. If you look at the Bluetooth protocol stack, you will see that there is a cable replacement protocol that is supported by Bluetooth. So, this cable replacement protocol will help for communication between these different wireless portable devices. Bluetooth helps in forming Ad-hoc networks where there is no centralized controller. The devices can connect with each other in short range using this Bluetooth technology.

There is a concept of Piconet, called scatter nets. In a particular Piconet, like this, a very similar to the cells in a cellular network, are present within. In a Piconet, there are master and up to about 7 devices. Within a Piconet 8 devices can be supported. There are different slave devices, up to 7 devices can be connected to the master.

For example, Piconet 1, Piconet 2, can have different Piconets, all of which are interconnected together. So, this forms the scatter net.

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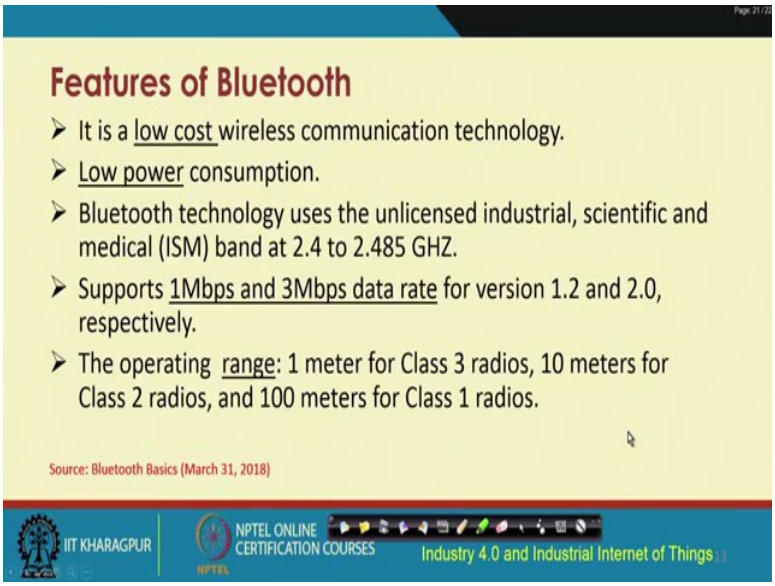

Bluetooth offers low cost wireless communication, low power consumption. Because of the lower power consumption, Bluetooth is attractive among IoT applications, which are typically power starved, energy starved. It is used in the ISM 2.4 to 2.484 gigahertz, 2.4 to 2.484 gigahertz band.

It supports data rate of between 1 Mbps to 3 Mbps depending on the version of the Bluetooth that is used. 1 Mbps in the version 1.2, 2 Mbps for version 2, and 3 Mbps. The operating range is 1 meter for class 3 radios, 10 meters for class 2 radios and 100 meters for class 1 radios. Therefore, different radios will give different communication range of Bluetooth.

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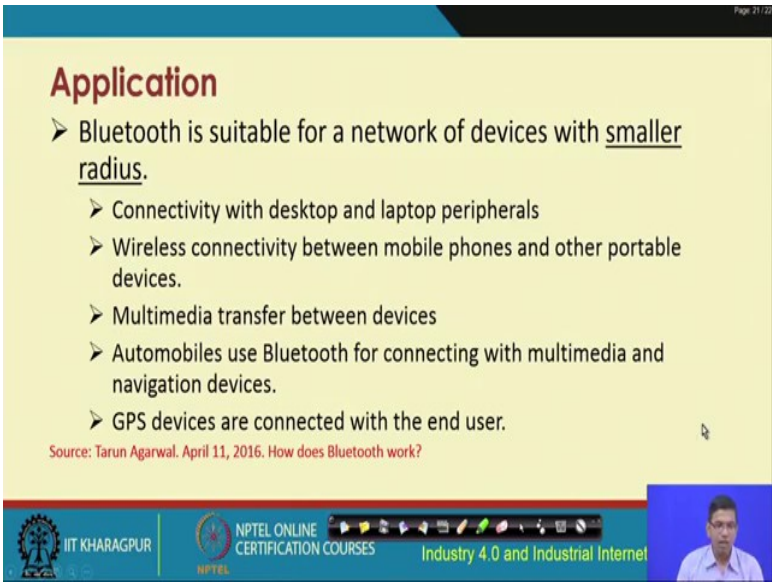

Application where Bluetooth is suitable for use are networks or devices which will have smaller radius of communication range. Therefore, connectivity with desktop and laptop peripherals can be supported with the help of Bluetooth. Multimedia transfer between devices is also a very attractive and widely used application of Bluetooth. Automobiles will use Bluetooth for connecting with the multimedia and navigation devices, GPS devices, are connected with the end user.

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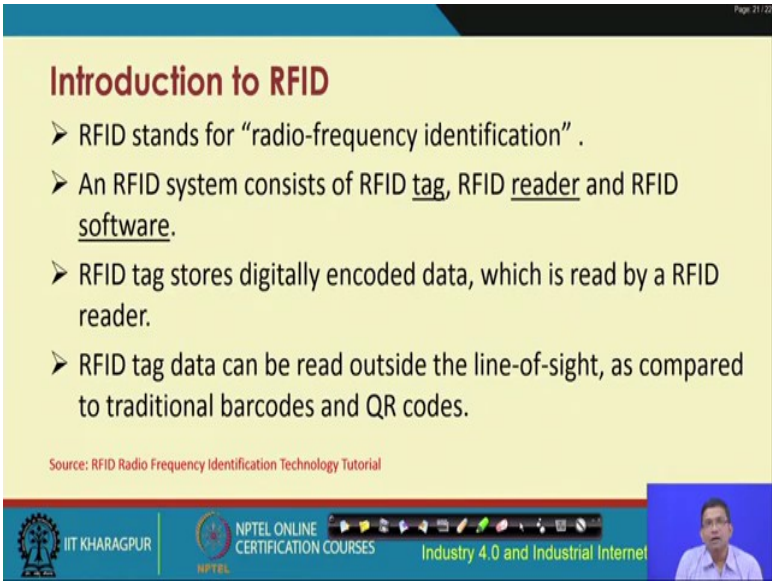

RFIDs are very attractive, popularly used. RFID tags are also used in shopping malls. For example, RFID tags are attached to different items such as clothing, other items on sale in the shopping malls. RFID reader can read from these RFID tags. This is how the RFID works. RFID stands basically for radio frequency identification. There are 3 components, one is the tag itself - the RFID tag attached to different things, RFID reader which can read from the tag, and the RFID software which will power this entire thing to operate. RFID tag stores digitally encoded data which is read by RFID reader. RFID tag data can be read outside the line of sight as compared to the traditional bar codes or the QR codes that are frequently used.

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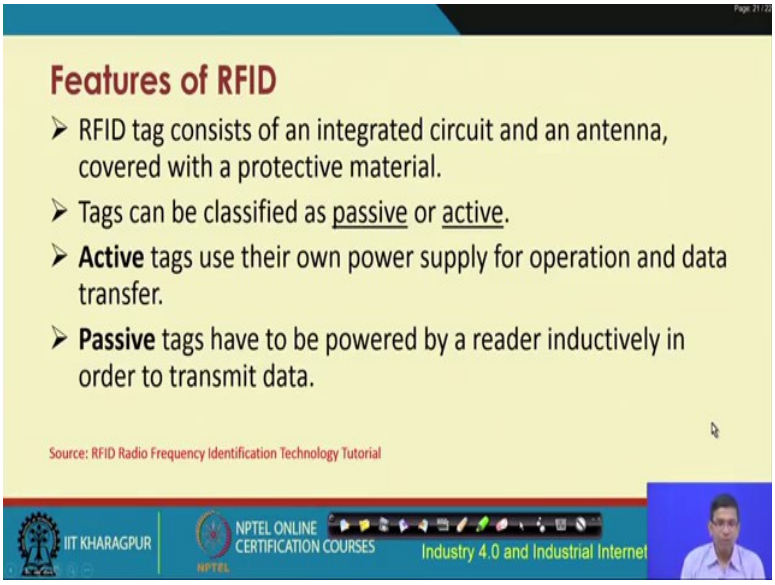

RFID tag consists of integrated circuit and an antenna, which are covered with a protective material. RFID tags can be classified as passive tags or active tags. Active tags are the ones which has their own power supply for operation and data transfer. Passive tags are the ones which do not have so and these will have to be powered inductively in order to transmit data.

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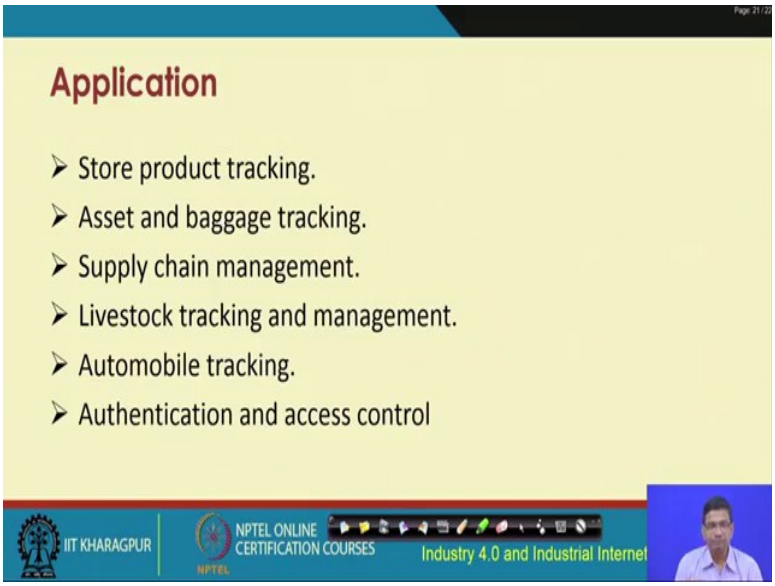

Applications of use of RFIDs are-storing, product tracking, store product tracking, asset and baggage tracking, supply chain management, livestock tracking and management, auto mobile tracking authentication and access control.

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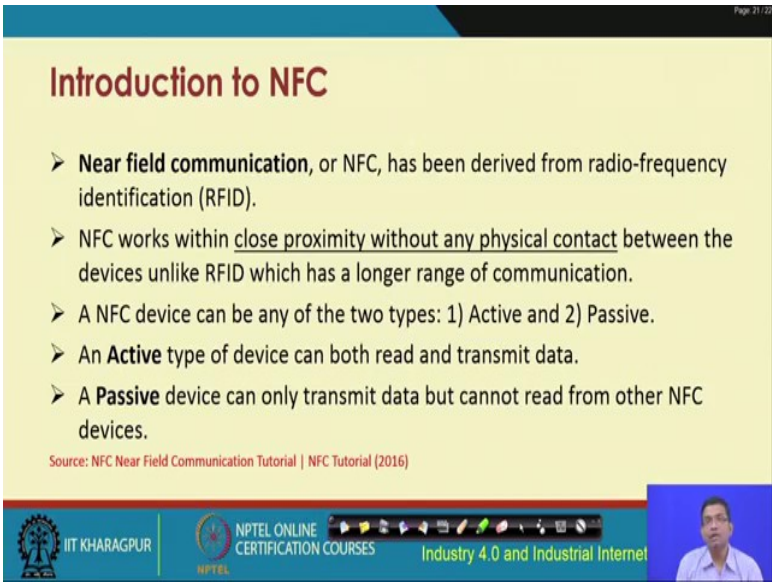

NFC technology also work very similarly, but has a difference. This NFC technology has been derived from the RFIDs. The NFCs unlike RFIDs will work within close proximity, with any physical, without any physical contact between the devices. RFID reader and the tag can keep little bit separated, but NFC devices will have to be kept in very close proximity.

NFC device can be of two types-active device or passive device. An active type of device can both read and transmit data, and a passive device can only transmit data, but cannot read from the NFC devices. So, this is the difference between the active and passive device concepts.

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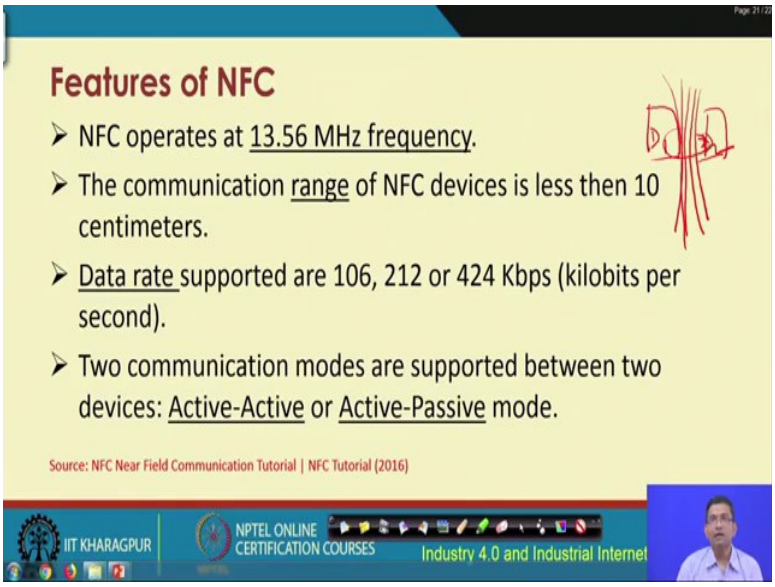

NFC operates in the 13.56 MHz frequency band, and the range of communication in NFC is less than 10 cms. Let us say, that you have in one of these devices D1 NFC device, you have another device, D2. The magnetic field will be generated, thus, D1 and D2 are kept close to each other, less than 10 centimeters apart.

NFC supports various data rates, 106, 212 or 424 kbps. The two communication modes supported between two devices, one is the active-active and the other one is the active-passive mode.

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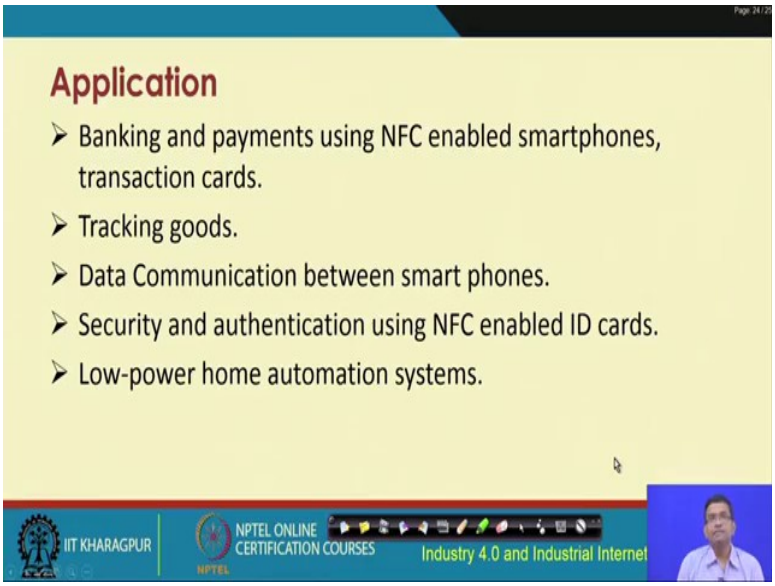

Applications of NFCs are very similar to RFIDs tracking of goods, banking sector, NFC enabled smartphones, data communication between smartphones using NFC, security and authentication, and low power home automation systems.

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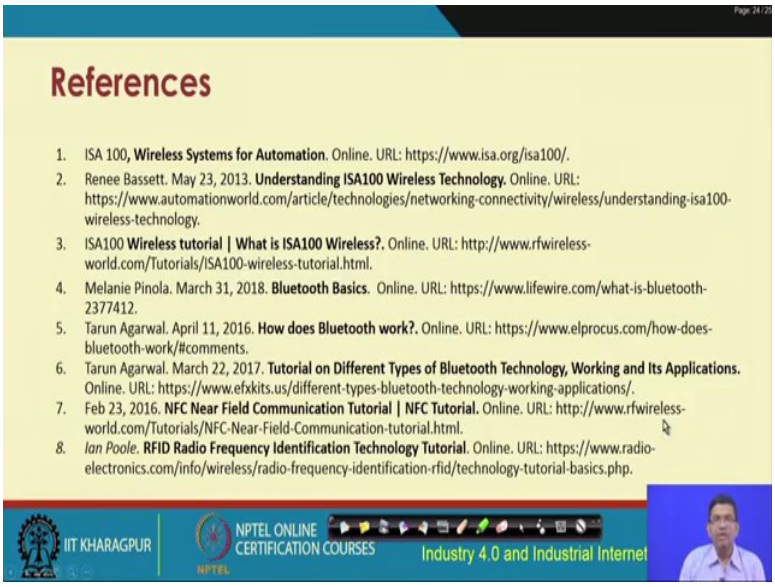

So, with this we come to an end of this thing. We have gone through different connectivity technologies in the previous lecture and this one it started with going through the standard IEEE 802.15.4. Then we discussed about ZigBee, Z-wave, ISA, RFID, NFC and Wireless Hart also.

These are some of these references that you can go through further in more detail. So, with this we come to an end.

Thank you.