Introduction to Industry 4.0 and Industrial Internet of Things

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Lecture – 29
Key Enablers of Industrial Iot: Connectivity – Part 2

In the previous lecture, we have gone through the specific requirements for supporting industrial communication. We have seen that the regular protocols that are there for use for other types of non-industrial scenarios are not usable, for say, in the industrial context. And, we have seen, what are the industry specific requirements in the previous lecture.

There are different protocols such as the Modbus TCP the fieldbus suite of protocols, which have been proposed in order to have support for communication between master devices, slave devices, and so on in an industrial communication scenario. So, we will go further and we will have a look at few other different protocols.

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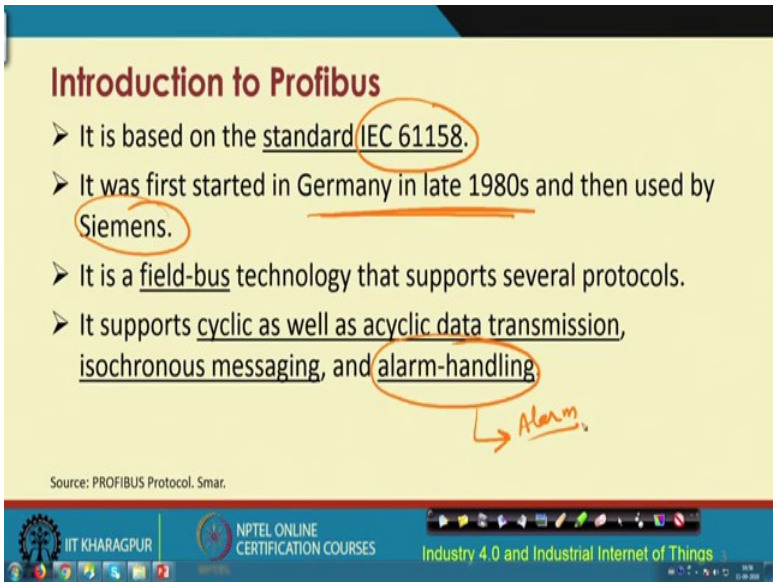

The next one is the Profibus protocol, which is basically the process field bus; this is the full form the process field bus Profibus protocol we are going to go through now.

So, this particular protocol is based on this; it is based on this particular industry standard, the IEC 61158. This Profibus protocol is a field bus technology protocol and supports several other protocols.

So, and incidentally I should mention over here that, this was first proposed in Germany in the late 1980s, and was used by Siemens. So, it supports both cyclic communication and acyclic communication. Asynchronous messaging is supported and is very much attractive for use in scenarios, where alarm-handling will have to be done, the communication for alarm handling will have to be done.

So, Profibus protocol is very much useful, in those kind of scenarios.

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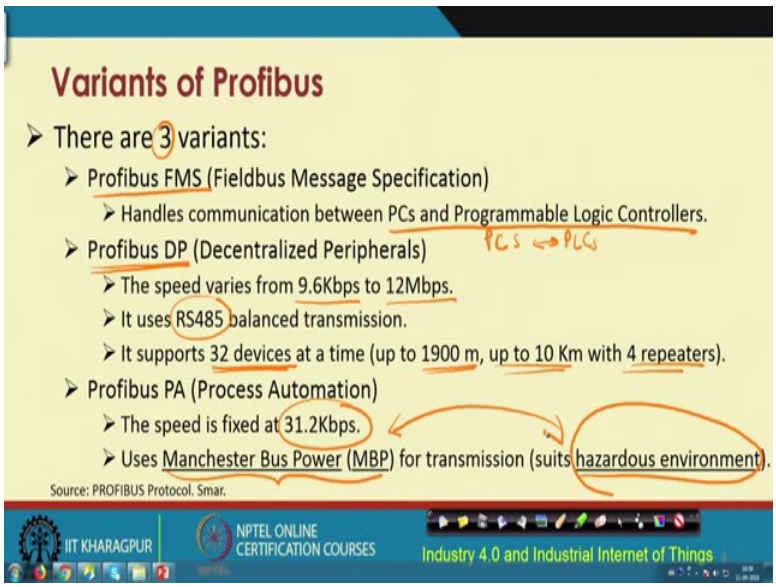

There are three different variants, three different variants of Profibus protocol. The first one is Profibus FMS, which stands for Fieldbus Message Specification. This basically handles the communication between the PCs and the PLCs. This is PCs and PLCs, this particular communication is supported by the FMS variant of Profibus.

Next is the Profibus DP, DP stands for Decentralized Peripherals; it basically supports RS 484 communication, RS 484 communication supporting up to about 32 devices at a time. At the same time 32 devices, up to 32 devices, could be connected supporting about 1900 meters, up to 10 kilometers 4 repeaters this kind of thing can be done, it uses the 484 RS 484 transmission and speed varies from 9.6 Kbps to 12 Mbps.

Then, comes the Profibus PA; PA stands for Process Automation and here this PA basically supports a speed of about 31.2Kbps. It uses the Manchester bus power MBP, this (MB) MBP is very useful for hazardous environment. Because, it has been built in such a manner that, this MBP will still work even if there is a hazardous environment, this MBP will still transfer data in such kind of environment.

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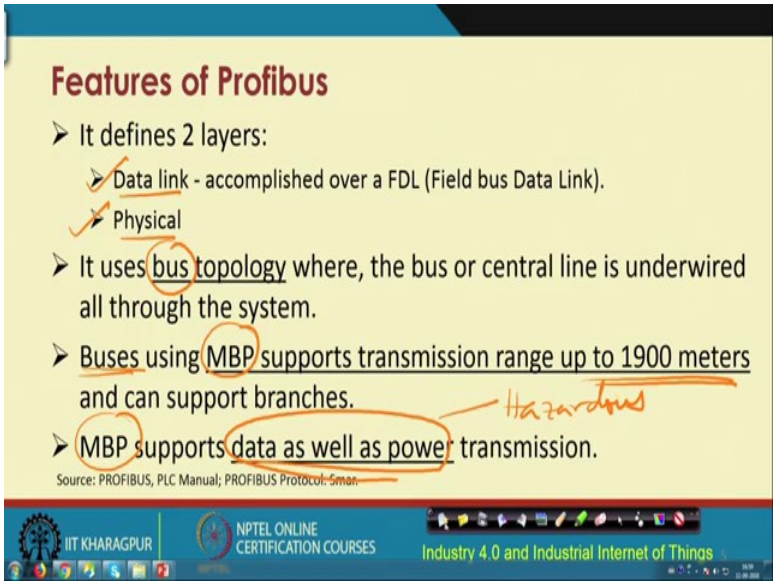

Profibus has two layers; one is the data link layer and the other one is the physical layer. In terms of the topology, the bus topology is very popular in Profibus and these buses use this MBP, that we have seen earlier at Manchester Bus Power Technology, to support communication of, up to about 1900 meters. So, this MBP technology Manchester Bus Power technology supports data as well as power transmission, both can be done in hazardous environments.

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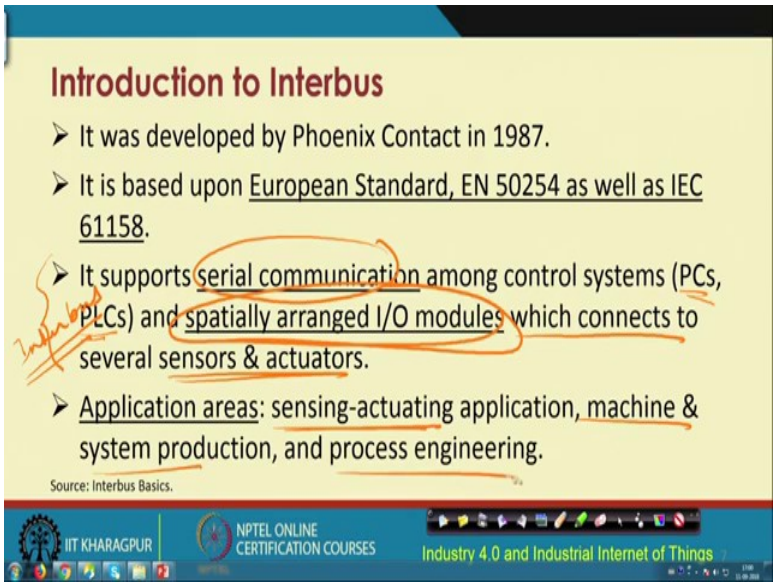

Next, comes the inter bus protocol. So, this particular protocol was developed in 1987 by the company phoenix contact. It is based on the European Standard, EN 50254 as well as the IEC 61158. Supports serial communication, in this case, serial communication between PCs, PLCs and specially arranged I/O modules, and these specially arranged I/O modules will in turn connect to different sensors and actuators.

So, basically the spectrum of communication in inter bus is quite widely varied, so PCs, PLCs, I/O devices, sensors, actuators, and so on. So, all kinds of communication is supported by inter pass. In terms of application areas, sensor actuated applications machine system production process engineering all these sorts of applications are supported.

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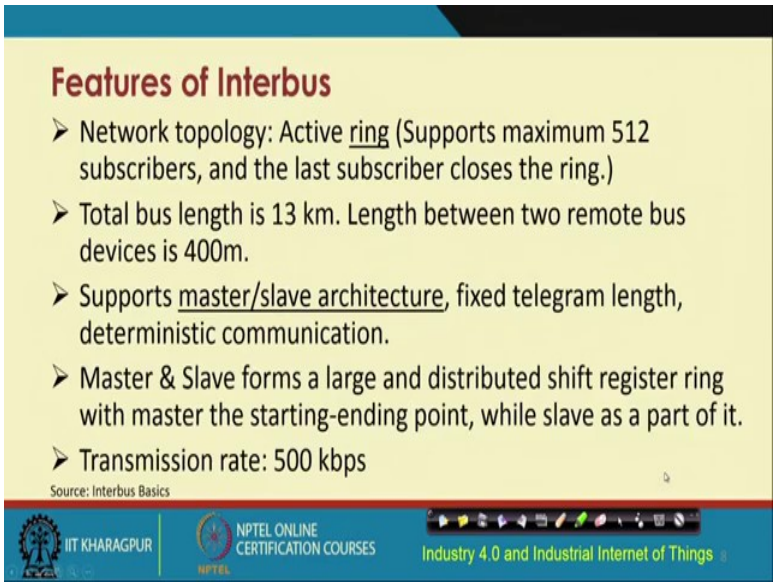

In terms of other features, network topology that is supported is the ring topology, which will provide connectivity to about 512 subscribers. The total bus length is 13 kilometres, which is quite long as you can see. So, 13 kilometres of operation is quite helpful for industrial requirements. Master slave communication architecture like, before is still being used and the transmission rate that is supported by inter bus is 500 kbps.

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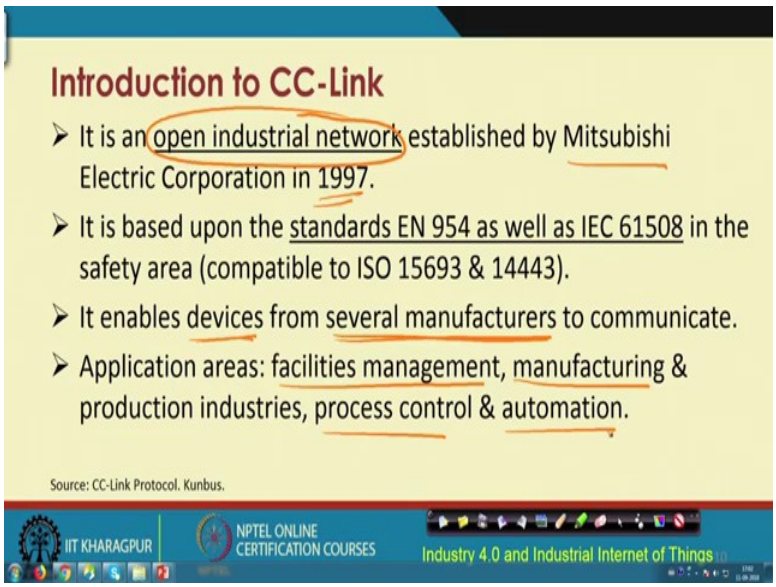

Next comes, this protocol the CC link CC stands for Control and Communication. Control and communication link protocol, CC link. This is basically an open industrial

network protocol. So, here actually we are talking about all different types of protocols, different companies came up with Siemens, Mitsubishi electric corporation etcetera.

So, all Schneider electric, all of these different companies came up with their own different protocols to help with satisfying the different specific requirements that they had, which eventually became popular got standardized and being widely used for industrial communication at present. So, this particular protocol was proposed by Mitsubishi in 1997, the CC link protocol. And, it is based upon the standards EN 954 as well as IEC 61508, and is compatible with ISO standards 15693 and 14443. So, it enables the different devices thought that are produced by different manufacturers to be able to communicate. This interoperability between these different devices is supported to a large extent by this particular protocol, the CC link protocol. In terms of the application areas; that are supported facility management, manufacturing production, process control automation, these are the different application areas of support by CC link protocol.

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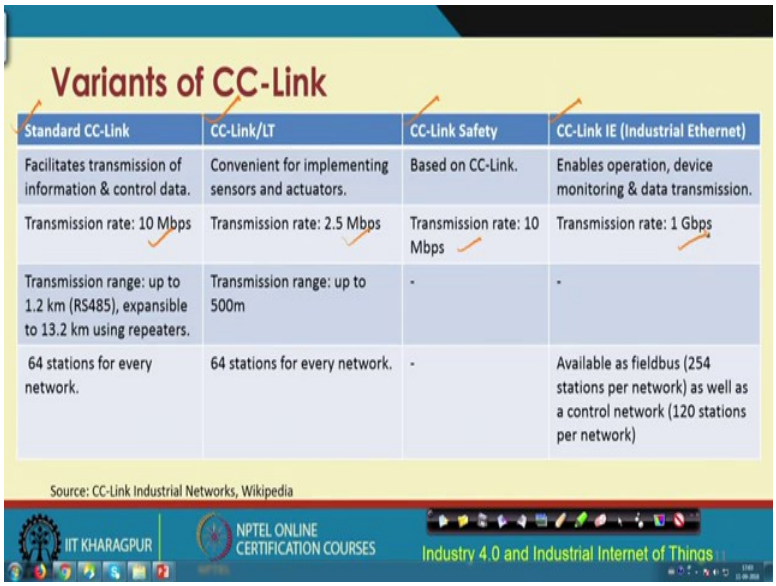

These are the different variants of the CC link protocol, the standard CC link protocol, then we have the CC link LT, CC link safety, and CC link Industrial Ethernet. So, CC link standard facilitates transmission of information and control data. CC link LT provides convenient implementation of sensors and actuators and connecting between

them. CC link safety is based on the CC link protocol and CC link IE enables operation, device monitoring and data transmission.

And, the corresponding data transmission rates are given over here 10 mbps for standard 2.5 Mbps for CC link LT, safety is 10 Mbps and industrial Ethernet is 1Gbps, and the other features are listed over here.

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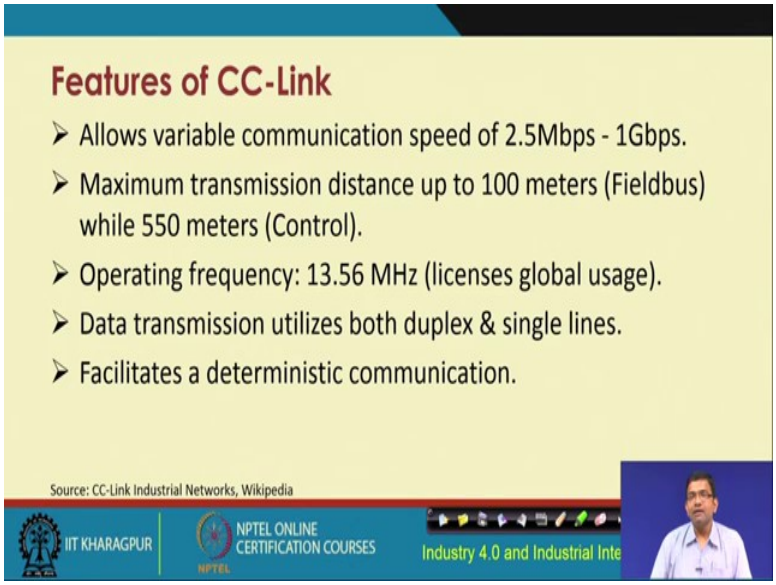

So, overall the communication speed is quite varied in CC link 2.5 Mbps to 1Gbps, transmission distance that is supported is 100 meters for field bus and for control 550 meters, operating frequency is 13.56 megahertz. And, it supports both duplex and data transmission in the form of duplex, and single transmission lines. And, overall the deterministic communication is supported by CC link.

Before we go to this protocol device net we will go through overall how this CC link protocol works. We have in CC link, we have these different devices, let us say the slave devices.

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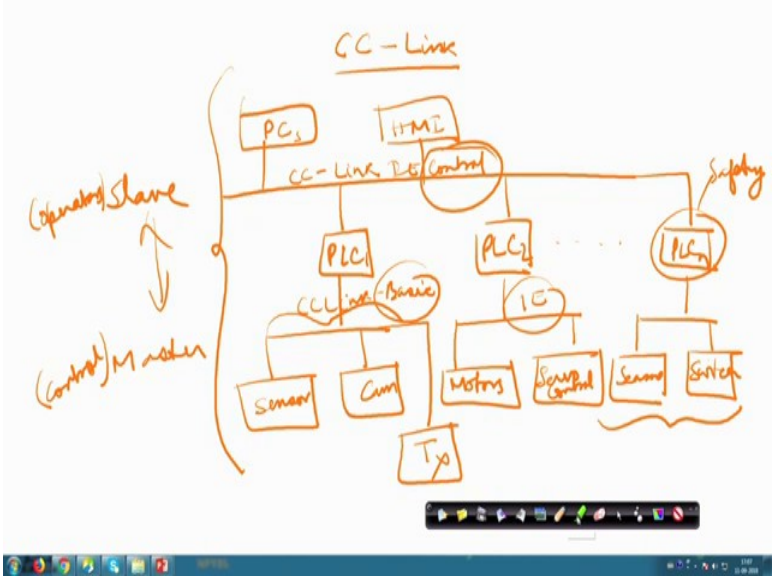

We have the controller devices, the master devices, these slave devices will be operated by different operators and these master devices by the controllers.

So, we have different bus, we have these PLCs PLC 1, PLC 2. PLC n, we could have different PCs industrial PCs we could have HMI devices, HMI and so on. So, we have different PLC supporting different things for example, this one could be for catering to safety requirements, these ones could be for different other things.

So, this protocol would be CC link protocol over here over this particular bus, CC link and CC link IE control. Then, we could similarly have this particular PLC connect to different sensors, for example, sensor 1, sensor 2. Different cameras likewise cameras, camera 1, camera 2, different other may be transmission devices and this part we could use CC link basic.

For this part, we could even use motors connection with motors, motor drivers then different other for example, different types of motors maybe servo control servo control and so on. Here we could have the CC link IE version being used. And, we could even extend it further and we could have PLC n catering to different other kinds of sensors or different switch gears; so different things we could extend.

So, what I wanted to show you over here is different types of this protocol the IE control basic, then this one over here like this would be used in the different buses, connecting

the master and the slave like this master in the slave, in this particular manner. So, let us now proceed further and to look at the DeviceNet.

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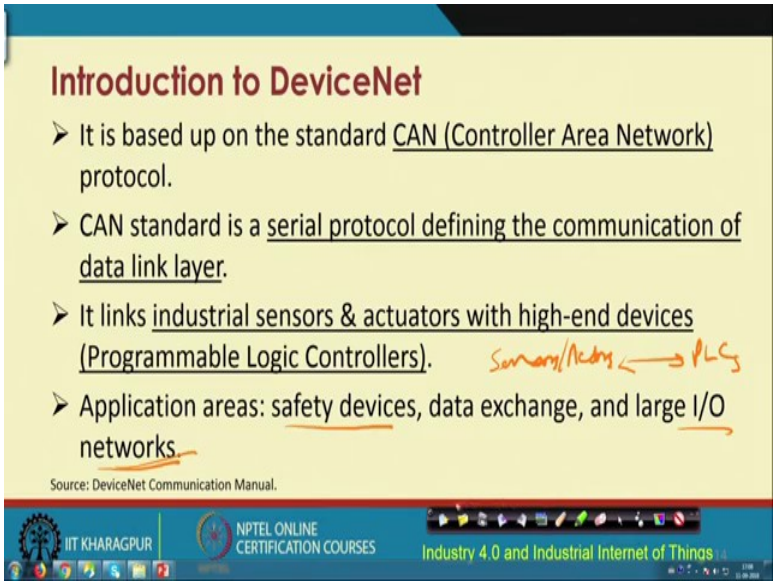

So, Device Net is based on the standard controller area network protocols, CAN protocol. So, it is based on the CAN protocol. And, this CAN protocol provides a standard for serial communication in the data link layer and it links different sensors, actuators, with PLCs and so on. So, device net can help you in this communication between the sensors, or the actuators, and PLCs. This particular protocol could be used and this particular protocol is based on the CAN protocol. So, safety devices, input output networks, could all take help of the devices and DeviceNet protocol.

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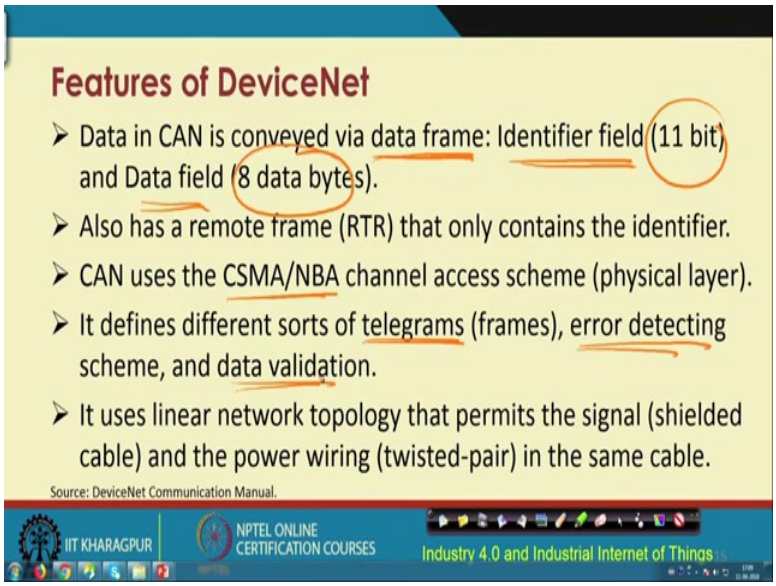

So, there are different features of DeviceNet. The data in Controller Area Network is conveyed with the help of data frame. So, this is nothing new so, in the form of frames. These frames have this id field which is of 11 bits and the data field which is of 8 bytes.

So, this basically uses the CSMA, NBA channel access scheme, in the physical layer and defines different sorts of telegrams, which is basically some something like the frames. Error detecting mechanisms and data validation for supporting different parts of the network topology.

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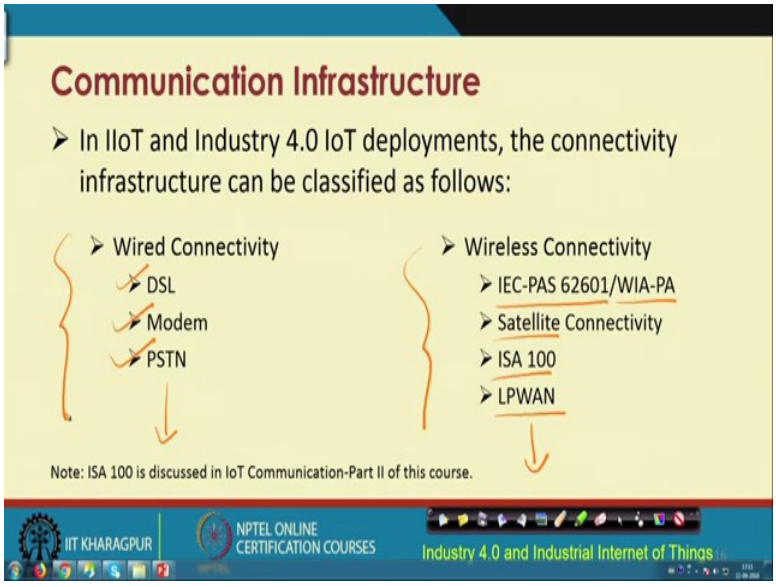

Now, these are some of these popular industrial communication protocols that are used.

There are many other protocols that are also there. We have also discussed if you recall about the ISA 100 protocol, that we did at the time of covering the generic IoT communication protocols. So, at that time the ISA 100 series of protocols was discussed. So, that is basically well is that is for providing wireless connectivity and, that is what we discussed for use with general industrial wireless connectivity, particularly, low power connectivity, support for low power devices, and that can be done with the help of this is a 100, it supports industrial applications that is the interesting part of it.

In terms of wired connectivity; these different technologies are there traditionally. One is this DSL, MODEM Technology and the PSTN for telephone networks. In terms of wellness this IEC pairs 62601 WIA-PA, Satellite, ISA 100, which I just mentioned and LPWAN. These are the different wireless connectivity protocols and these are the different technologies for wired connectivity.

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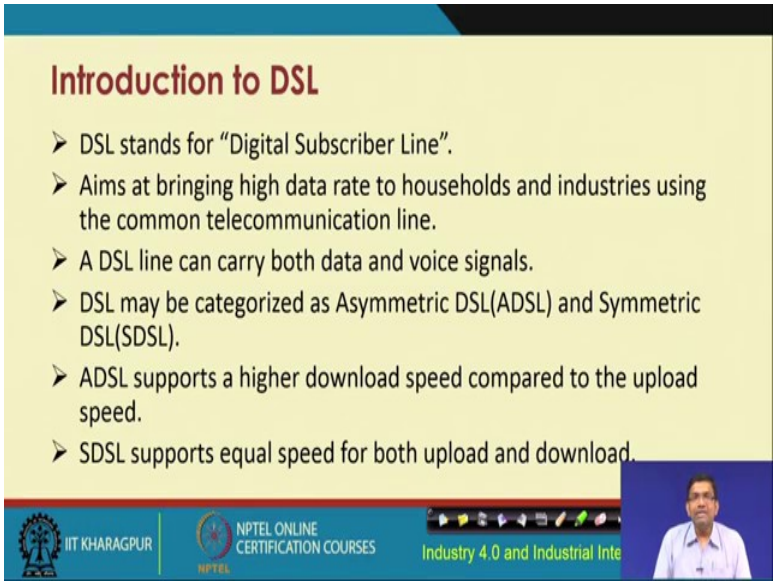

We will look at each of these very briefly. DSL I think many of you are already familiar with DSL, although we tend not to use DSL much anymore. DSL stands for Digital Subscriber Line. And, this particular technology became very popular in order to convert the conventional telephone, analog telephone communication lines. In order to send data over those analog telephone communication lines, this particular technology, the DSL technology was started.

So, this DSL technology can support both communication of voice like, the telephone signals, telephone voice signals as well as the data both can be supported. And, it has two parts the ADSL and the DSL, sorry, SDSL; it can be operated in 2 modes ADSL or SDSL depending on the particular device, that is there. So, typically it will support both.

So, ADSL is more commonly used in the households. Basically, ADSL modems were quite popular. Nowadays, actually people have also, they are not using ADSL based modems anymore, but still it is good to know what are these because some of these industries might still be using these legacy modems. ADSL why it is called asymmetric because, it supports a higher date download speed compared to the upload speed.

So, there is an asymmetry between the download speed, and the upload speed, which is equal in the case of SDSL, equal upload and downloads speeds.

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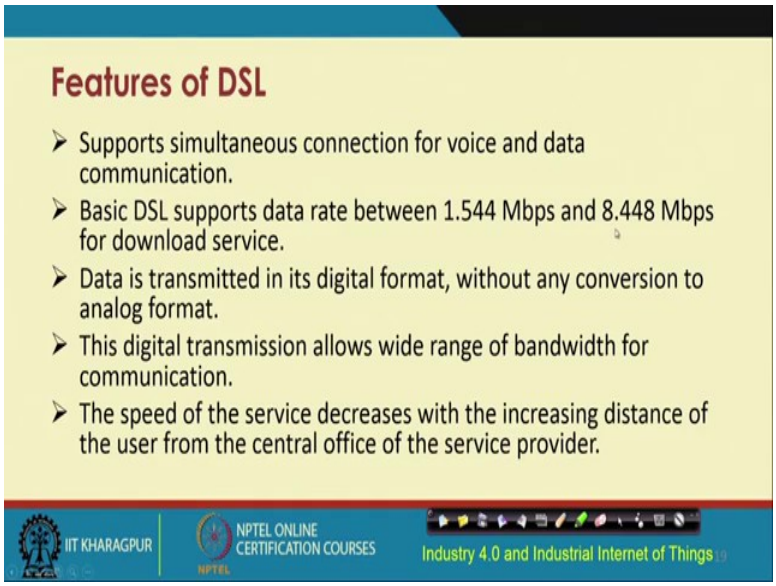

So, the basic DSL supports data rate of 1.544 Mbps and 8.448 Mbps for download surface. Data is transmitted in digital format, without any conversion to the analog format. And, this digital transmission allows wide range of bandwidth for communication.

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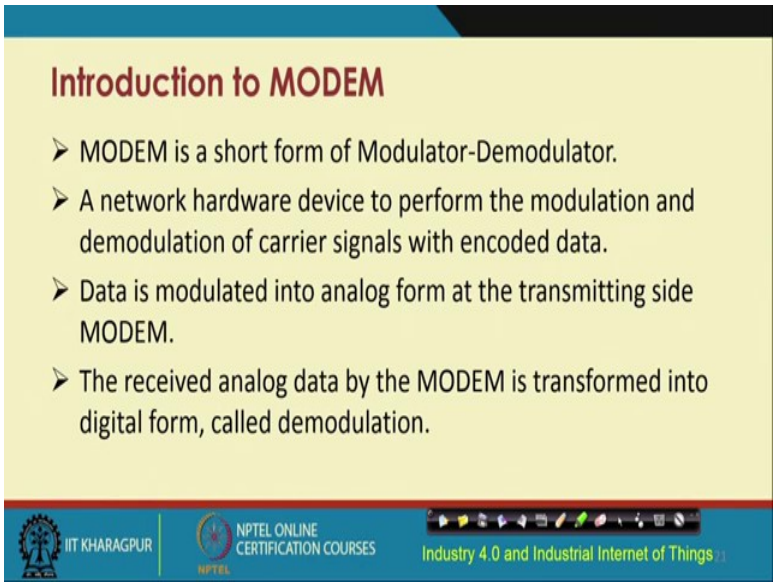

MODEMs are quite popular, MODEM technology, MODEM stands for Modulator-Demodulator, which is basically a device that will do modulation and demodulation of carrier signals, with the encoded data. And, this data is modulated into analog form at it is transmitting site and the received analog data, by the MODEM is transformed into the digital form at the demodulator side.

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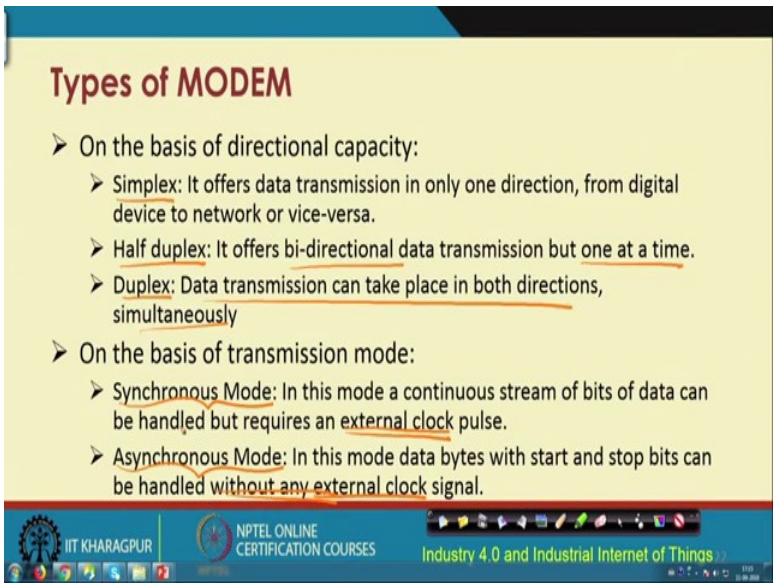

So, there are different types of MODEMs that are supported; simplex modem, half duplex, and duplex. Simplex offers data transmission in one direction, half-duplex

bidirectional, but one at a time and duplex bi-directional and at the same time; that means, simultaneously. On the basis of the transmission mode, these modems can be classified as synchronous or asynchronous.

Synchronous meaning that in this particular mode a continuous stream of bits of data can be handled, but requires an external clock pulse. And, asynchronous basically has start and stop bits that can be handled, without any external clock signal. So, here you want to use the external clock, here there is no external clock, without any external clock. So, asynchronous is without external clock and synchronous is with the help of the synchronization is done, with the help of the external clock.

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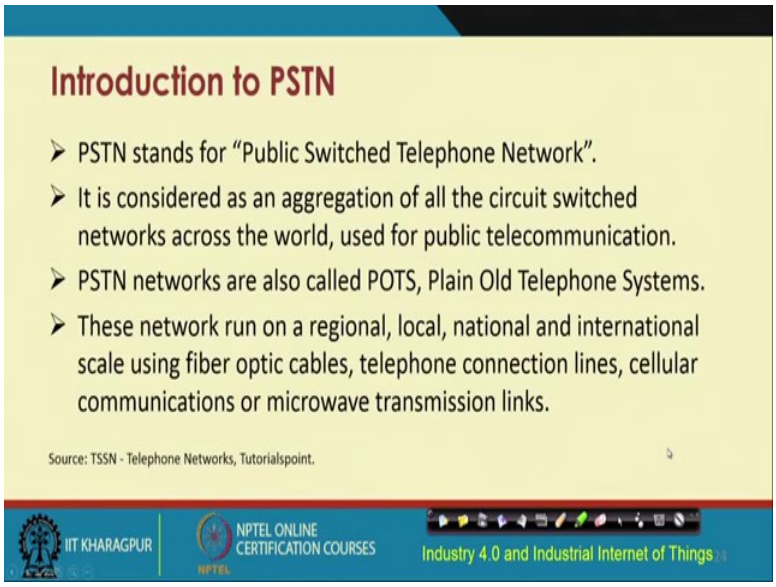

Next, comes the PSTN technology and PSTN basically stands for Public Switched Telephone Network, which is like our old telephone systems. So, this basically technology operates, with the help of something known as the circuit switched networking, which is how the telling the public telecommunication systems work. These networks run on the regional, local, national, and international scales, using fiber optic cables, telephone connection lines, cellular communication, microwave transmission links.

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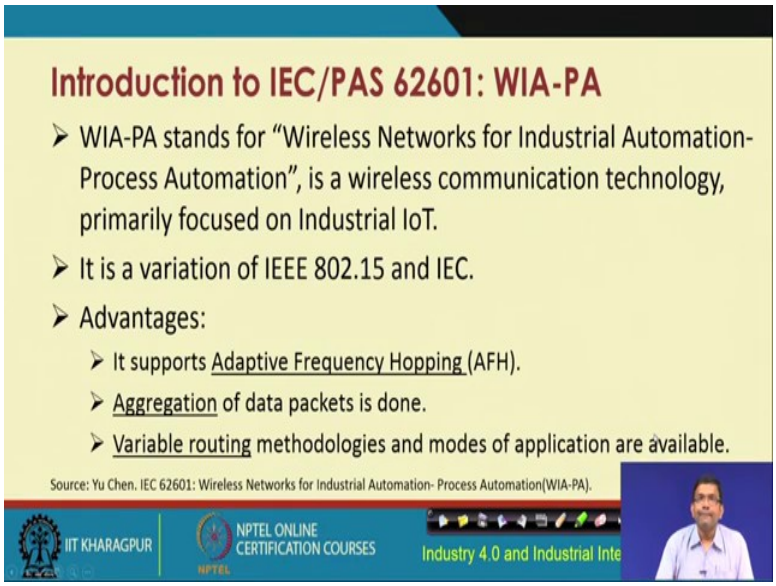

Then, the next one is IEC PAS 62601: WIA PA. So, WIA-PA stands for Wireless Applications for Industry Automation and Process Automation. Industrial automation, process automation, this is a standard wireless communication technology focused on industrial IoT, it is kind of a variant of 802.15 and an IEC standard.

The advantages of this particular protocol is that it supports, adaptive frequency hopping, which makes it more secured, aggregation of data packets, and variable routing methodologies variable routing protocols, are supported by this particular protocol.

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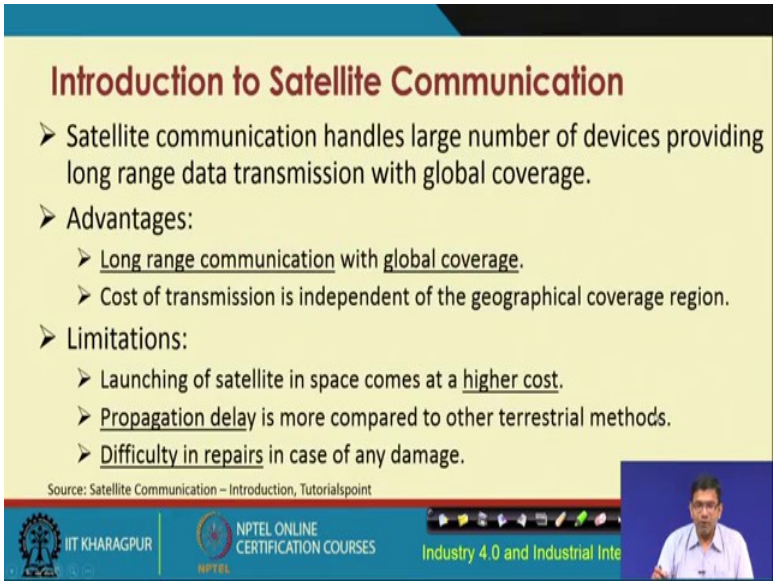

Satellite Communication is a well-known technology, for offering global, long range, communication between different points, but these satellite communication devices come at higher cost. There is higher cost although, it is much more effective in providing global coverage in terms of communication, but the cost of these devices is much higher.

Other difficulties are that there is huge propagation delay compared to the other types of protocols and the communication technologies that are in place in on the terrestrial surface. The last one is that in terms of repairing; that means that if there is some kind of defect that has happened in the satellite communication technology. So, correcting it is much more difficult, because here we are trying to connect the base stations on the earth to the satellite stations.

This kind of error correction and diagnosis is much more difficult over here.

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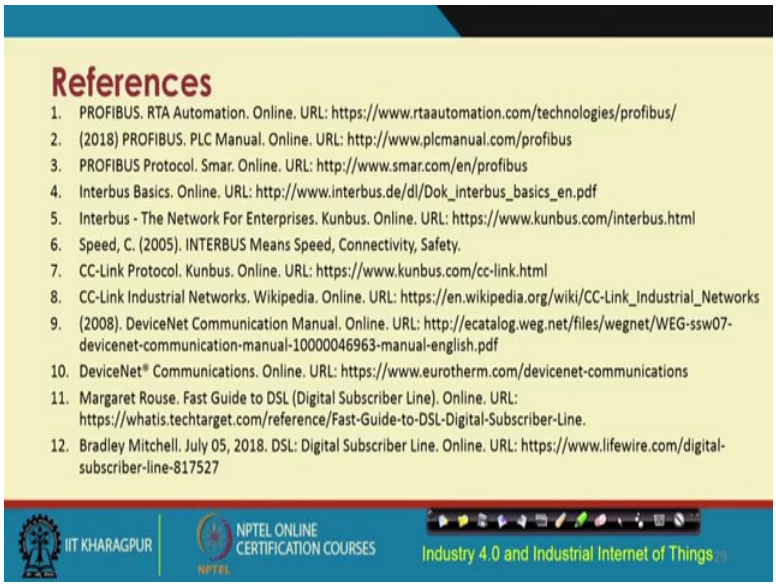

So, these are some of these references for these protocols that we have discussed in this particular lecture. So, I would encourage you to go through these different references and you could search for even more and try to understand these technologies even further with this we come to an end.

We have talked about different protocols that could be used for industrial communication, we have also talked about the use of different wired as well as wireless communication technologies and protocols, for industrial internet connectivity. And, we

have seen that there is much more we could expand even further these are not the only protocols, that could be used; we could even use different other protocols that are out there.

So, large number of protocols are over there. So, we could use them to offer connectivity between these different devices. And, typically it is a client server architecture, master slave kind of architecture, different parts of this overall network supporting, different protocols is what is common across most of these different protocols that we have gone through so, far. But, what is important is irrespective of the architecture, you need to design protocols, you need to use the protocols, which will cater to the industrial requirements of low rate latency, low jitter, and high reliability. These are all very important in terms of industrial catering to the industrial requirements. With this we come to an end of this lecture.

Thank you.