Introduction to Internet of Things
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Lecture - 18
Sensor Networks- V

So finally, we come to the last lecture of the series on sensor networks. So, here basically I would like to highlight some of the concepts of mobility. So, more specifically I would like to explain the concept of mobile sensor networks.

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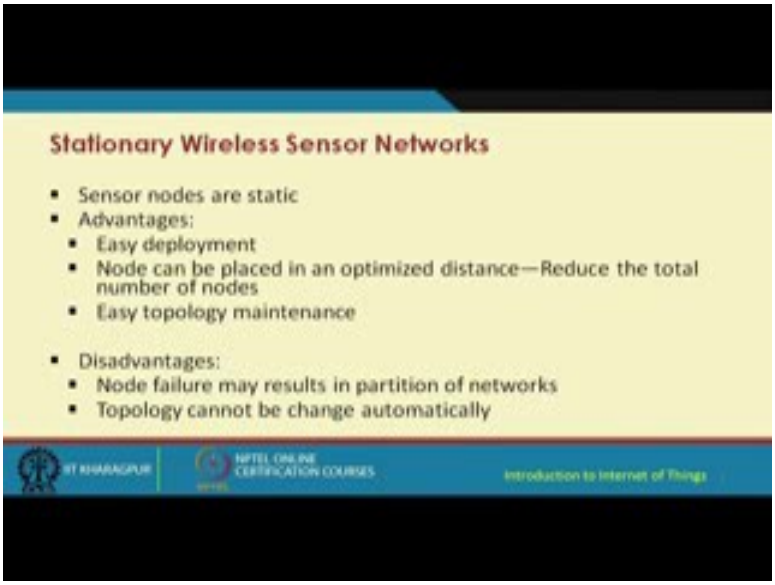

So, let us first look at the static variant sometimes it is also known as the stationary sensor network. So, here basically as the name suggests the nodes are stationary or static. So, they do not move; once deployed they will maintain their positions at later instants of time as well. So, the advantage is basically it is easier to deploy sensor nodes in a stationary sensor network, the nodes can be placed in an optimized manner, then it there maintenance of the topology is easier and so on and so forth.

The disadvantage is that if there is a failure in the static sensor network then it is likely that that point of failure can partition the network into two or more fragments, two or more partitions. So, it is quite likely that there can happen. And particularly if it is a critical node, so in that node failing means that you know it is likely to partition the network. So, one part of the network will not be able to talk with another part of the

network. And topology cannot be changed automatically is also another disadvantage of a stationary sensor network.

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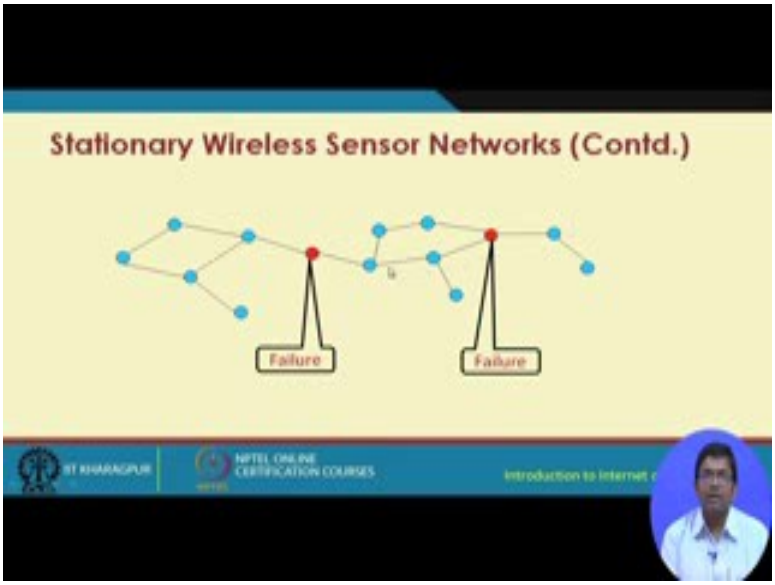

So, let us consider a state stationary sensor network as shown in this particular slide. So, we have these red colored nodes as points of failure because if this particular node dies for one reason or other for example, the hardware in it has failed it has stopped functioning or maybe that you know the battery that was powering that particular node it is exhausted.

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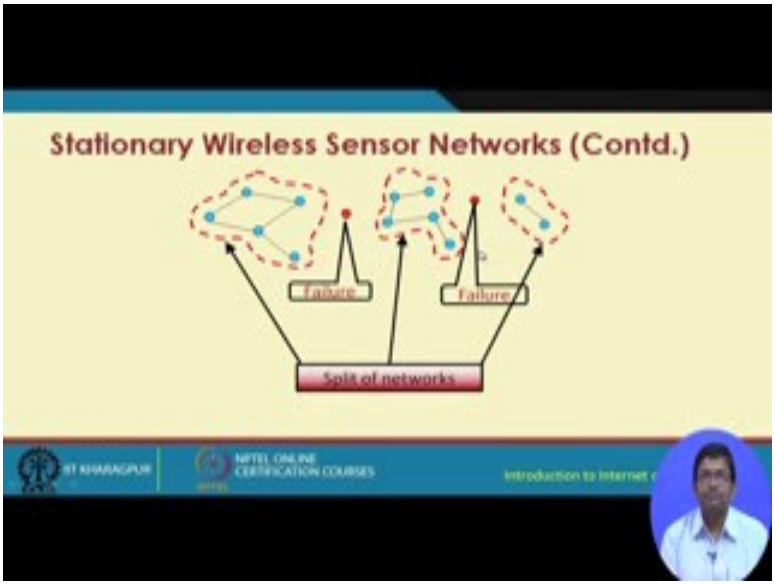

So, what is going to happen? As a consequence these nodes are positioned in such a way that these network partitions will be created. So, three network partitions would be created if these two nodes fail. So, as a consequence what is going to happen is that we would have three partitions or three split ups of the network due to these points of failure.

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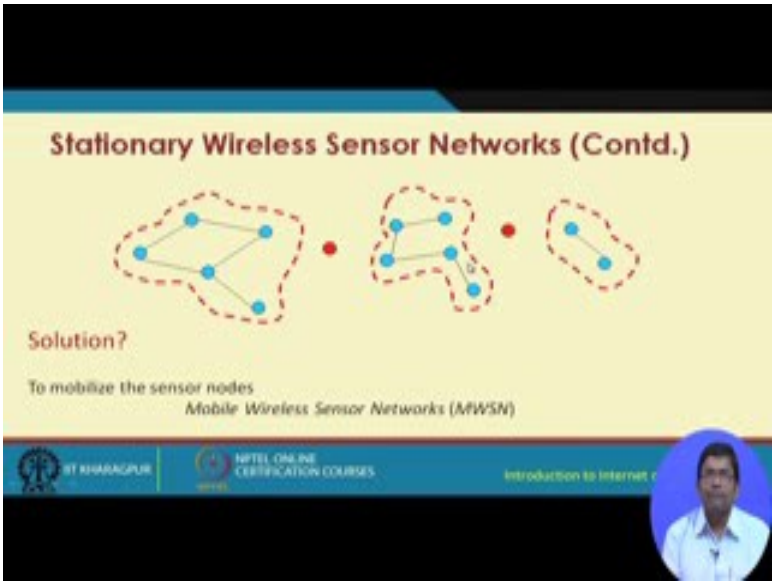

So, what is the solution? So, one way to address this is to have some node maybe some external node, external to this particular network or among these if we can have one of these nodes mobile nodes which can move. Then what it can do is one of these nodes let us say this particular node can come and take the position of these red colored node and this network will be joined these partitions will be joined. Likewise maybe this node can come over here and likewise these two partitions can be joined. So, these three partitions can be joined if some of these nodes one of these nodes is mobile.

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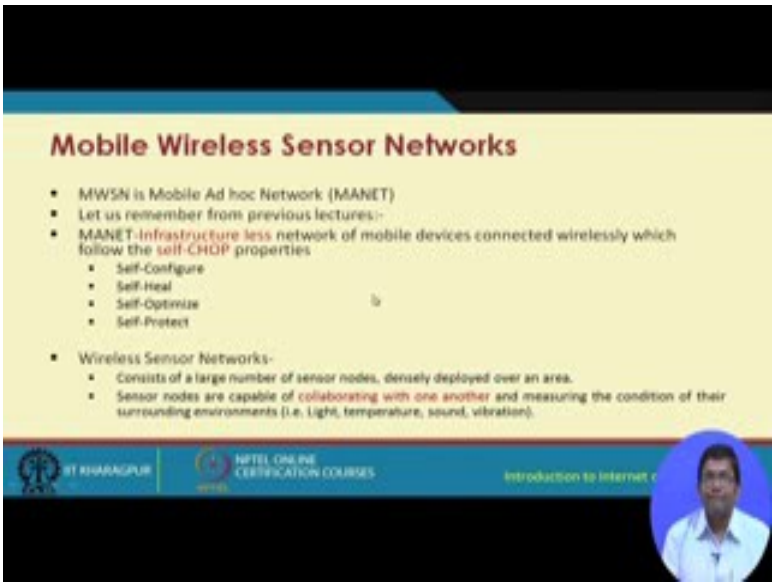

So, we have a mobile wireless sensor network which is basically a sensor network, a stationary sensor network conceptually integrated with a mobile ad hoc network. So, this is not physically integrated conceptually. So, take the features of mobile ad hoc networks, take the few features of stationary sensor networks put them together and then you get the mobile wireless sensor networks. And as we know that MANETs mobile ad hoc networks are infrastructure less and infrastructure less. So, basically what happens is the topology basically becomes dynamic dynamically changing topologies that basically invites following properties like self configuring, self healing, self optimizing, self protecting and so on. So, these have to be there these are infrastructure less networks these do not have any centralized entity which will control the network management functions. So, this self job properties basically are going to take effect.

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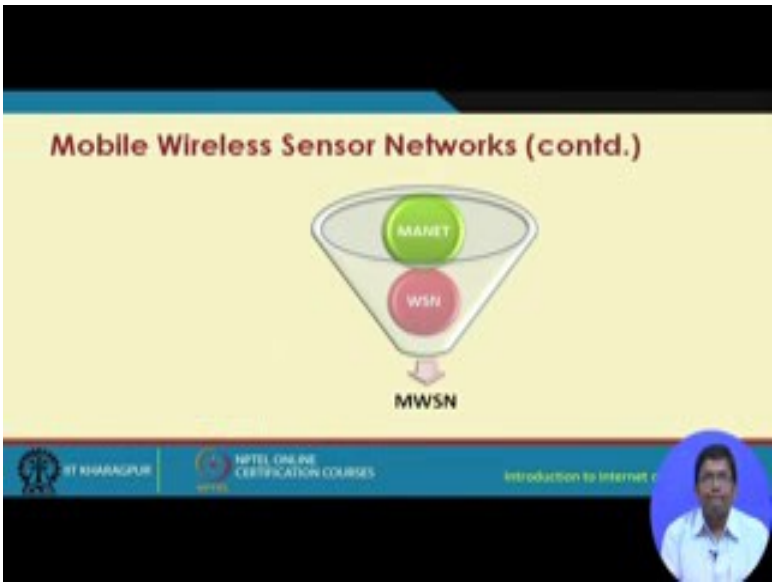

So, this is what I was telling you little while back. So, mobile wireless sensor networks are basically a conceptual integration of MANETs with wireless sensor networks.

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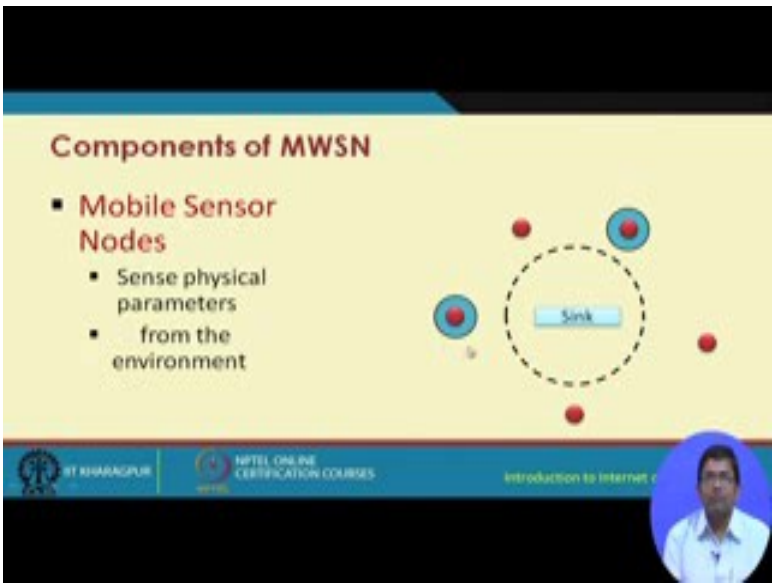

So, components of a mobile wireless sensor network one is the mobile sensor node the nodes themselves could be mobile. So, these nodes we have a sink, these nodes can move all around the sink. So, the sensor nodes, these mobile sensor nodes they would be sensing some physical parameters from the environment like the way it is shown over

here. So, this node this red color node is sensing some physical parameter around the environment.

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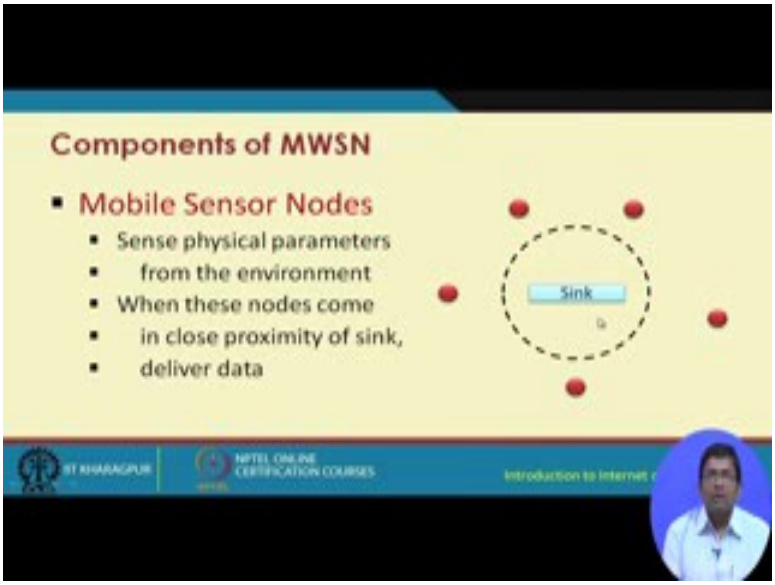

So, they sense the physical parameters from the environment, when these nodes come in close proximity of the sink they would deliver the data as shown

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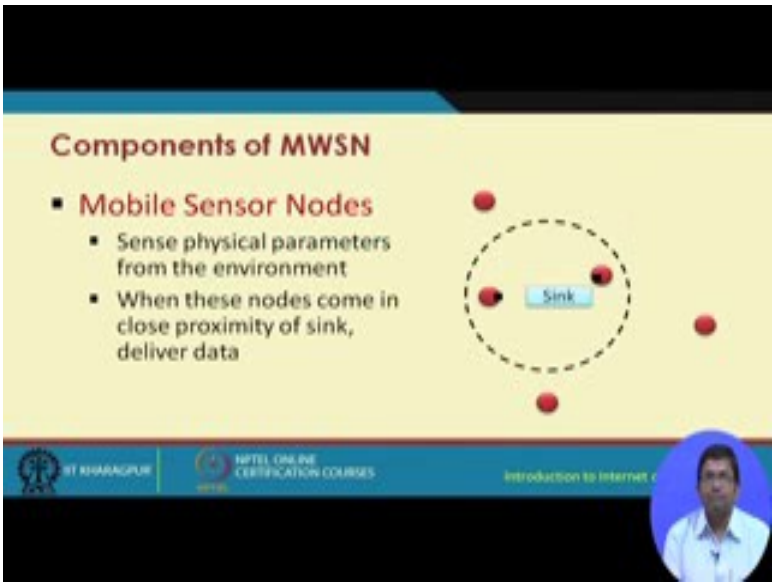

So, in this particular figure as we can see what happens is these two nodes they have come within the communication range of the sink node, and once they come into the communication range of the sink node they would deliver the sense data. So, maybe they

have sense that data somewhere outside this range then they have moved and then they dump that data once they come into the proximity of the sink node.

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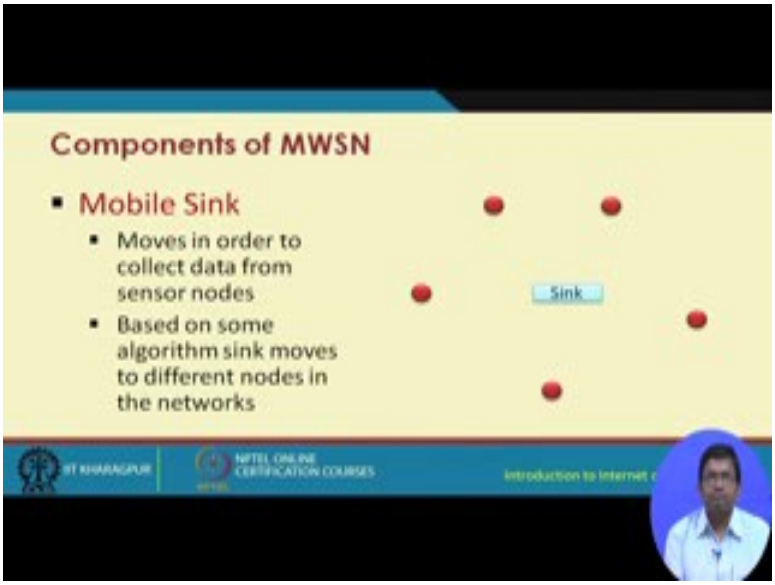

Then we have the mobile sink, which moves in order to collect data from the sensor nodes the sink itself this. So, these sensor nodes in the earlier situation in the earlier example we had considered that the sensor nodes can move; here actually in this particular figure we show that the sensor nodes are all stationary, the sink node can move and can collect data from each of these sensor nodes.

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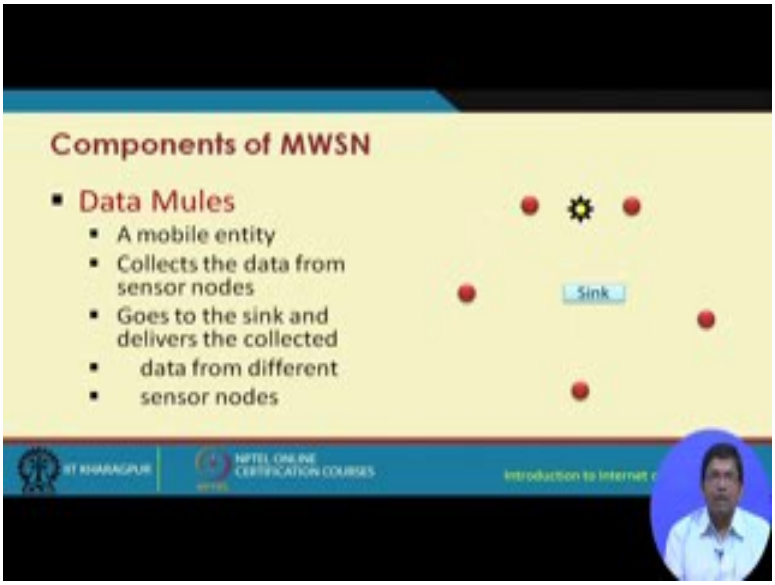

Then we can have data mules future mobile. And these are like external entities which collects the data from the sensor nodes goes to the sink and delivers the collected data from the different sensor nodes. So, this mule can go in close proximity to each of these red colored nodes. And thereafter once it has you know finished collecting the data from these red colored nodes it will come in the close proximity of the sink node and will deliver the message to the messages all these messages to the sink node.

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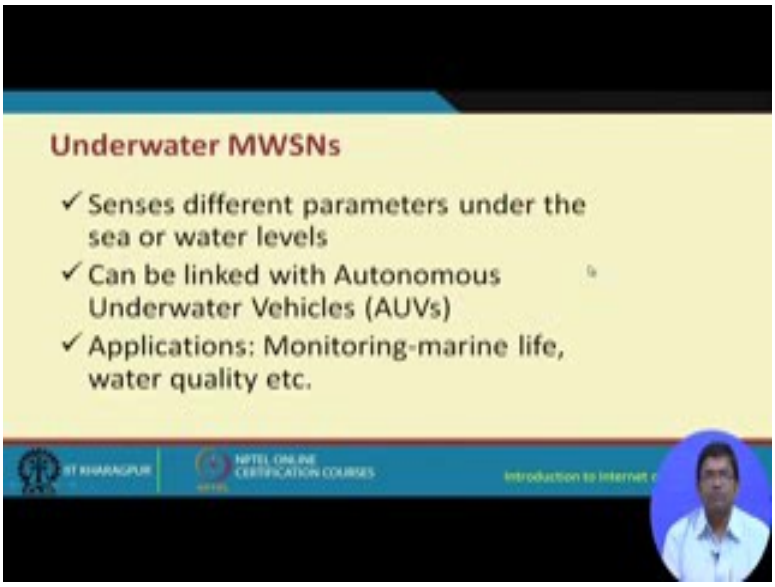

Now this mobile sensor network it can be used either in the terrestrial environment maybe by fitting sensors to robotic devices or can be used in the aerial environment, flying sensor networks. For example, the sensors the nodes themselves they fly or it can be an underwater sensor network that means that the sensors are fitted to underwater mobile devices like autonomous underwater vehicles, rovers and so on. So, the examples could be to monitor the marine life or water quality. So, we have use of underwater mobile sensor networks which can autonomously automatically sense and remotely send the sensed parameters of different things such as the sea level, water level you know water quality marine life and so on and so forth.

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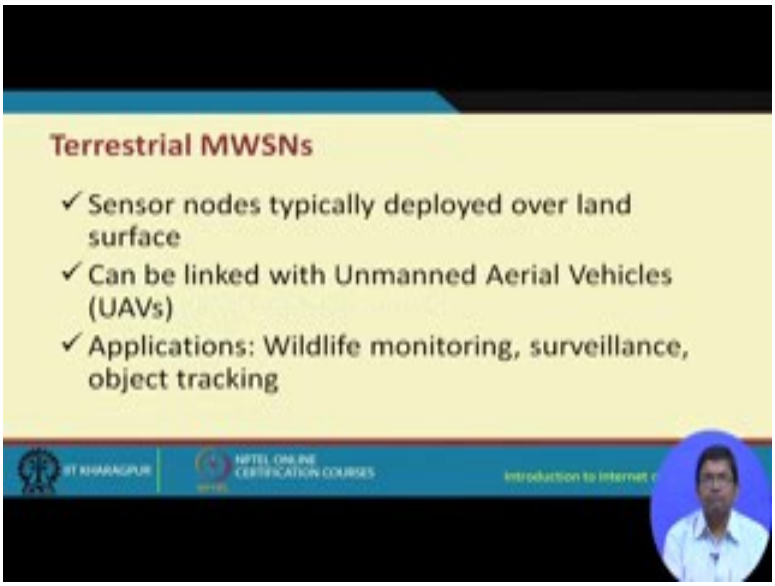

Terrestrial wireless mobile sensor networks sensor nodes typically deployed over land which can be linked with AUVs; that means, the autonomous unmanned aerial vehicles and the applications would be wife wildlife monitoring, surveillance, object tracking and so on.

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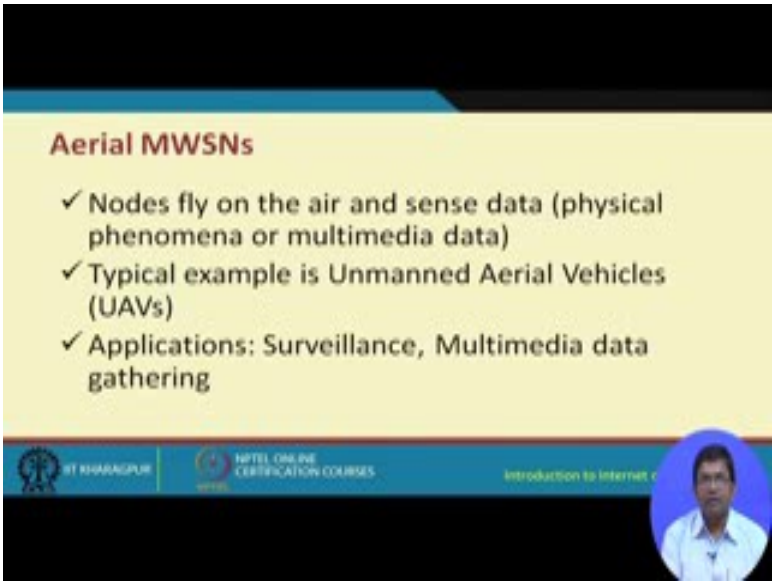

And the aerial version I told you where the nodes they fly. So, when they fly they sense and they form a network through which the data are sent to the surface station. So, the

typical examples is unmanned aerial vehicles fitted with sensors; applications include surveillance, multimedia data gathering and so on.

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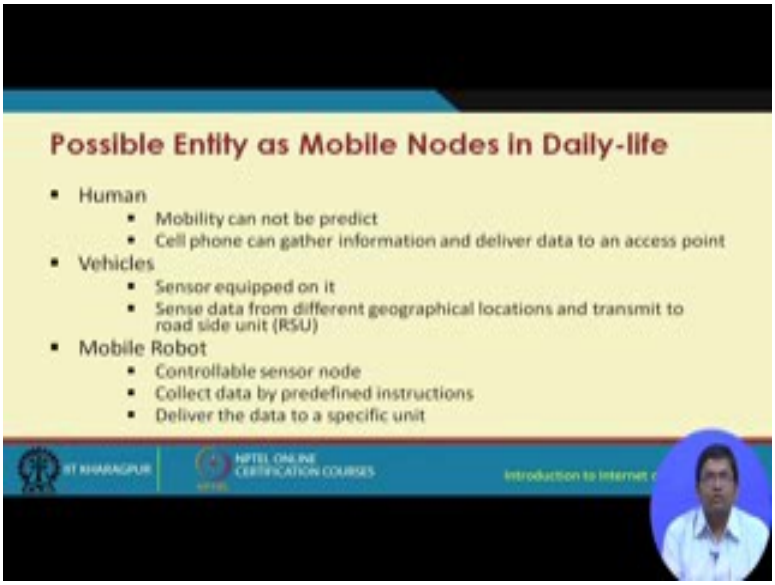

So, what can be mobile, what can be mobile in a mobile sensor network? We can have different types of examples of mobile entities from daily life one is the humans, humans can be mobile and the mobility of humans are unpredictable. For example, if somebody is walking with the cell phone on and then we want to gather the information of the cell phone then it is unpredictable to you know so it is unpredictable how the human being is going to move and consequently it is unpredictable to predict the mobility of the cell phone. For vehicles, for example, sensors are typically used in cars and different modern day vehicles so that becomes vehicular sensor network where these vehicles are fitted with different sensors the sensed data from the different geographical locations and transmit to the roadside unit. And then we have the mobile robots which are controllable sensor nodes that collect data by predefined instructions and deliver the data to a specific unit.

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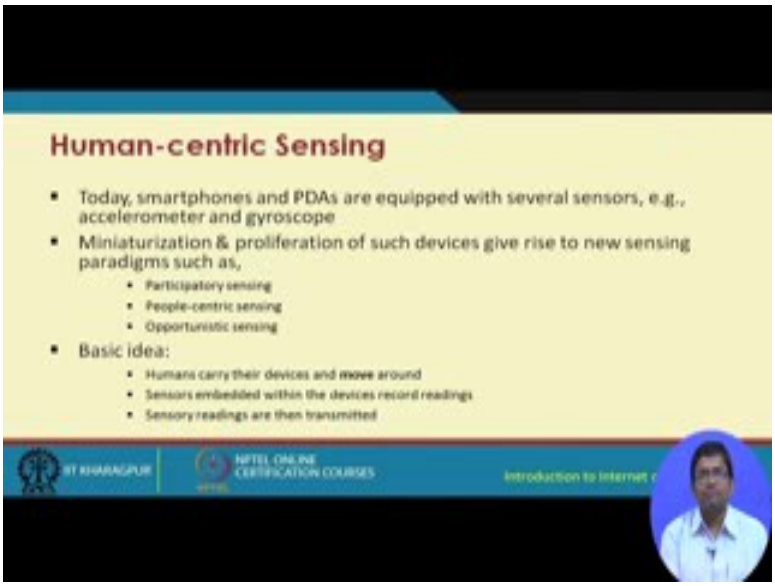

Human-centric sensing is possible because of the use of smartphones and PDAs which nowadays are equipped with several sensors typically even up to like several sensors there are lot of smartphones. So, these sensors could be like accelerometer sensor, gyroscope sensor and so on which are commonly available in the modern day smartphones and PDAs. So, miniaturization and proliferation of such devices give rise to new sensing paradigm such as participatory sensing, people centric sensing and opportunistic sensing. Participatory sensing in participatory sensing a crowd, a group of people each having their smartphones equipped with sensors turn on their respective sensors in their mobile phones and then consequently what is going to happen is we are going to form a human-centric sensor network a human centric mobile sensor network.

Then we have the people-centric sensing very similar to the example that I just told you. So, basically you know the previous example I had talked about using peoples people moving. So, a every you know people they can also sense you know we have eyes, ears etcetera. So, through which we can also sense the people can also sense so that becomes people-centric sensing. And then we have opportunistic sensing which basically is that peripheral a particular node moves in that to a different location then opportunistically it is going to sense and then opportunistically it is going to deliver the message if another node comes in proximity.

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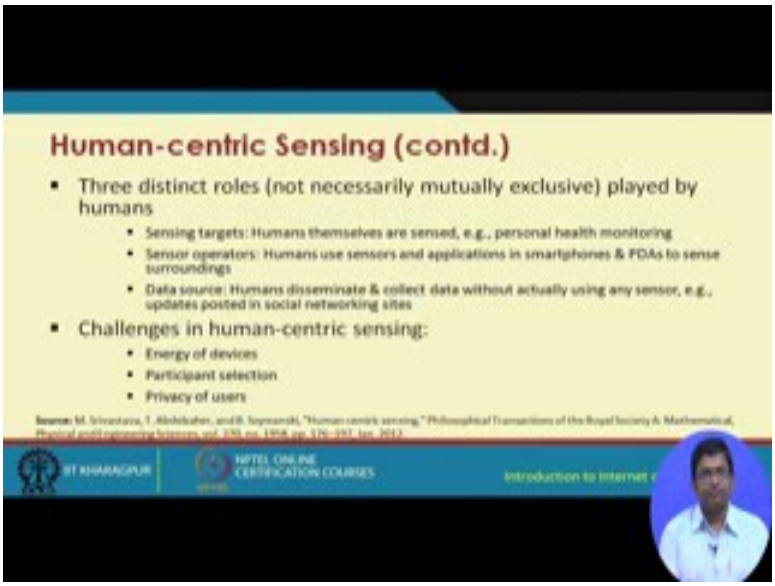

So, the basic idea is that humans carry their devices and move around sensors embedded with the devices, record the readings and the sensory readings are then transmitted. There are three distinct roles played by humans, one is the sensing of the targets, second is the sensing of the operators and third is the acting as a data source.

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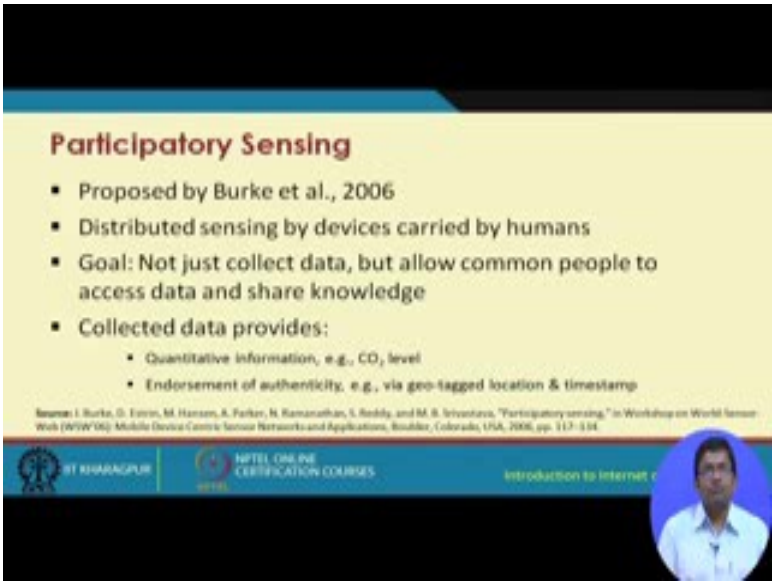

Now, for human centric sensing there are different challenges, challenges with respect to the energy of the devices, then participants selection, privacy of users and so on. So, I already explain to you the concept of participatory sensing which was proposed by Burke

et al., in 2006 as you can see that it is not a very long or you know old concept. And here basically we are talking about distributed sensing by devices carried by humans and the goal is not just to collect the data, but allow common people to access the data and share the knowledge.

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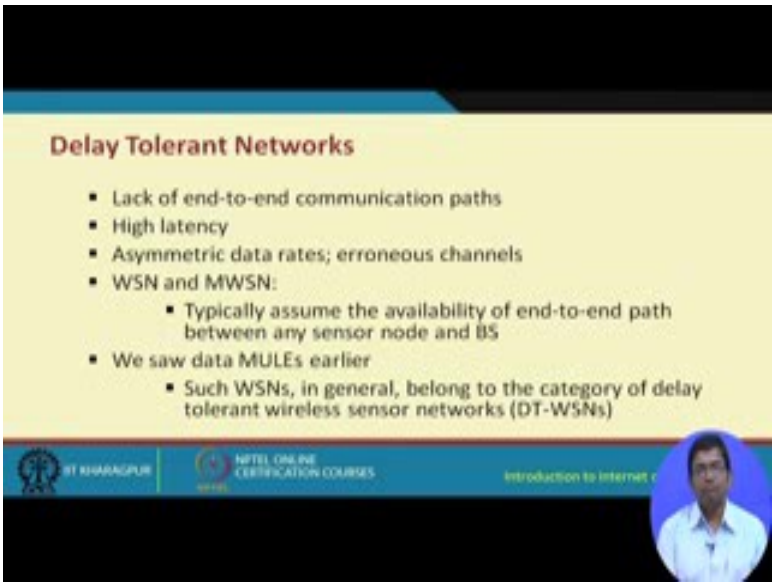

Delay tolerant networks basically you know from one point to another the sense data will take lot of time to get delivered compared to the regular time. So, with this we come to an end of this series of lectures on sensor networks. We have seen that sensor networks are very much attractive and more importantly sensor network I would think personally to be the most effective most important tool for building internet of things and we have covered the different aspects of sensor networks in detail. There is a separate NPTEL course which is on wireless ad hoc and sensor networks where we discuss about the details of sensor networks in depth.

So, we come to an end of all these lectures on sensor networks for internet of things.