Cloud Computing

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Lecture - 38
Sensor Cloud Computing

Hello. So, we will continue our discussion on cloud computing. Today, we will discuss on a topic which is very much relevant in today's context that is sensor cloud, right. So, what we have seen or what we are seeing or having these days, it is a world of sensors, right. It is you know enormous number enormous variety of sensors around us, right, it may start from temperature sensor or sensing pressure sensor to atmospheric different atmospheric parameters to if you can look at that camera as a sensors there are other different biological sensors which senses different aspect of our human physiology and other things, right. So, there are different aspects of sensors and it is a ever increasing phenomena, right.

So, what we have? We have a set of sensors which senses or accumulates information about environment about our health condition or about a particular device or so and so forth and based on the informations. So, there is at the back end there is some intelligence or decision making systems which takes some call and activate or actuators are activated. So, we have a sensors and set of actuators in and in between, there should be a either physically or logically a decision support system or a intelligent systems which takes something, right, like if you look at our modern cars which are a bunch of sensors some somebody was saying other day that if the time is coming when where a particular car may have more sensors than mechanical parts right it may be a joke, but it says that the amount of proliferations of sensors for a monitoring management and activating different-different mechanisms and processes around us, right.

So, what we try to see that there is a amalgamation or there is a there is whether there is a need to integrate this sensors with cloud infrastructure right or having a cloud of sensors which has a property of emulating the properties of cloud, right, like what we have seen that the different properties of cloud which is making popular whether this type of ubiquitous sensors or a huge volume of huge number of sensors can emulate a sensor

cloud which is much more effective than individual sensors right or that we will try to look at.

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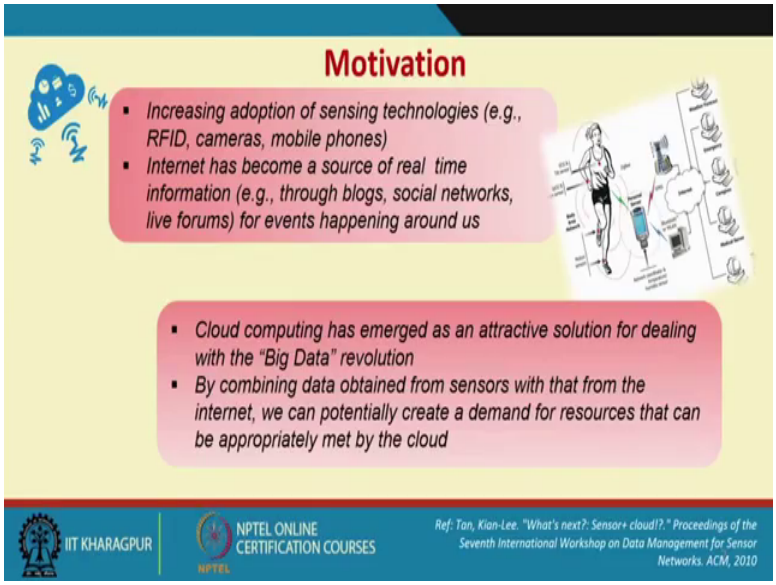

Again as we see that it is more of an overview which we will open up the scope for you to read more somebody interested in research activity, etcetera to look into the things. So, what we see increasing adaptation of sensing technologies right that it is RFID camera mobile phones are nowadays sensors. So, locations as we have seen that different meteorological parameter are being sensed. So, internet has become a source of real time information on the hands internet has become a real time through blogs social network for events happening around us, right.

So, 2 technologies which are extremely pervasive and it is has become both of them eventually become a part of our day to day life, right, on the other hand, cloud computing has emerged an attractive solution for dealing with big data revolution which can able to manage and able to take a call on this type of huge or weak volume of data; so, by combining data obtained from sensors; we that from the internet, we can potentially create a demand for sources that can be appropriately made by cloud, right. So, what we are trying what we are trying to look at that whether we can have this amalgamation of this the technologies or the or the processes which are collecting data, there is a way of dispersing or dissipating the data that is a accessing the data. So, both sensors internet cloud coming together to make our need or to full fill the different aspects of our either

day to day or commercial or industrial requirements of the thing, right. So, so rather we have referred a one of the pioneer paper that what next it is a whether sensor plus cloud is the things which are coming in this particular decade.

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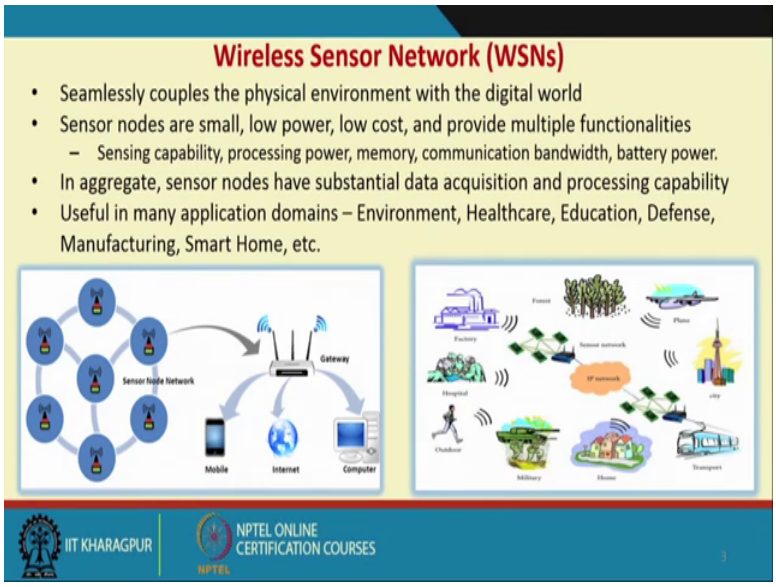

So, already we know about wireless sensor network, I believe that you have more or less it is known just to put some points. So, it is a seamlessly couples physical environment with the digital world. So, it is what it is there; there is a wireless sensor networks which has different sensor nodes or modes sometimes we say which collects information and those are digitized and pushed through the scene to the central infrastructure; so, what we do that whatever the physical environment is there is being captured and coupled with the; our digital world. So, sensor nodes are small low power low cost and provide multiple functionalities, right.

So, typically there are small they are power hungry cost wise also not. So, costly and as different type of functionalities like sensing capability sometimes it has a processing capability memory communication bandwidth battery memory power and these are the different type of components of the things. So, sensing and processing at times or transmitting or store and hold like memory and then push it. So, communication bandwidth and it requires a management of the battery power in aggregate sensor nodes are substantially data acquisition processing capability usually when it use in a

aggregation mode, there are primarily using acquisition of the data and processing some sort of a processing and push it to the next node or to other node.

So, useful in many applications and we have we know already that environmental health care education defense manufacturing smart phones and anything where you require some sort of a sensing and monitoring of the things. So, what we see here; there is a battery of sensor node; these are been organized in a particular fashion, but that can be ubiquitously thrown and can reorganize among themselves there are some gateway with which it connects to the rest of the world right and this can be different type of things like it can be management of forest planes city transport and so on and so forth.

So, it finds application in different aspects like. So, it is a either a the equipment itself as a having a sensor thing like if I say a car or a airplane. So, those are different sensing units doing it or they are sensing and sending data like a temperature center moisture sensor or; hey sorry, humidity sensor say velocity sensor they basically collect information send it out and with all different sensors collected information a call is taken by the management or the management or the control unit, right.

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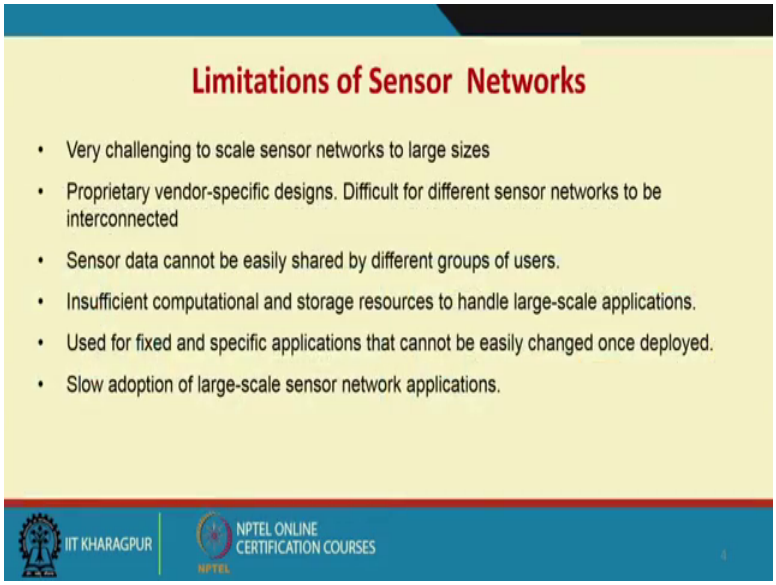

So, there are typical limitation in sensor networks that we already we understand that is a very challenging to scale sensory network to large sizes suddenly scaling up or scaling down this sensor networks is a major challenge, right. So, you whatever you have deployed in the physical sensor is there suddenly instead of collecting a say I want to

increase I am collecting temperature or acquiring temperature and suddenly increase it to a all larger scale and to on to collect a large thing it is scaling up is different even changing the granularity is different, right.

So, proprietary vendor specific design in most of the cases difficult for different sensor networks to be interconnected. So, there is another problem interoperability sensor, they not data cannot be easily shared between different groups of users because the everything if this isolated, then it is extremely difficult to think share first of all there is a problem of the proprietary formats. Secondly, there is no there may not be there may not be mechanisms to how to share data. So, I have a bunch of sensors collecting and putting somewhere and another bunch of sensors and putting somewhere and those need to be talking to each other; right. So, that needs to be enforced, right.

In sufficient computational storage resources; in sensors to handle large scale applications, right, if I have a more complex application, it is difficult to do on this use for fixed and specific application that cannot be easily changed once deployed. So, usually the sensor requirement are for fixed and specific applications that cannot be easily changed or deployed slow adaptation of large scale sensor network applications. So, if we have large applications. So, the immediate deployment and adaptation becomes a challenge.

So, these are some of the things which are we see; so, to say with this type of sensor network including wireless sensors networks, right.

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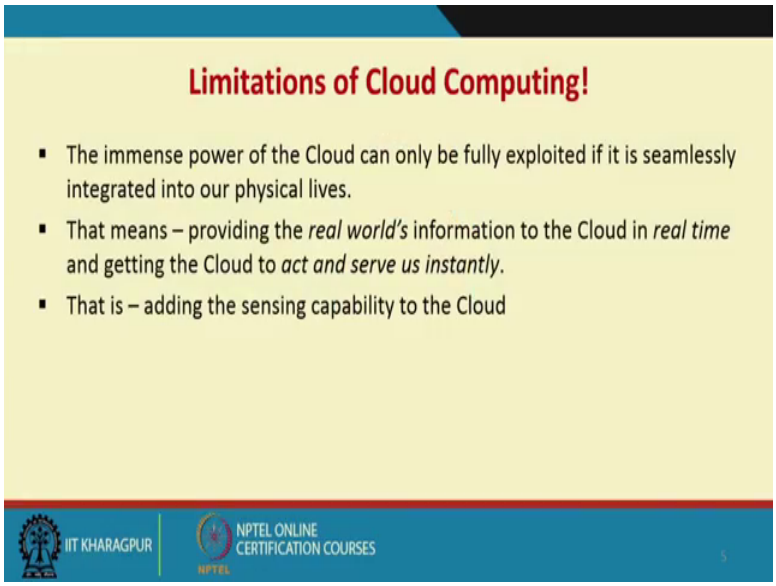

And similarly, if we look at the there are in terms of the cloud other than all the limitations we have looked into there are other typical limitation like immense power of cloud can only be fully exploited or fully appreciated; so, to say if it is seamlessly integrated with our physical lines, right. So, it is it is not that when I demand I take things that it takes a some sort of a real world situation and process it on real world things, then only that actual power of the cloud is manifested or appreciated by the community at large.

So, what it means that providing a real world's information to the cloud in real time and getting cloud to act and serve us instantly right that is one thing or another thing adding the sensing capability to the cloud. So, cloud as such as the infrastructure wise just waiting and waiting for something to use it rather than it has a it has coupled with this sensing capability which sense do some processing and react to the things, right. So, having this sort of sensing capability will give a definitely extra age to these sort of a cloud computing.

So, to say it is if not; if we do not want to tell you the limitation of cloud, but to make a cloud really useful and effective we need to do this, right.

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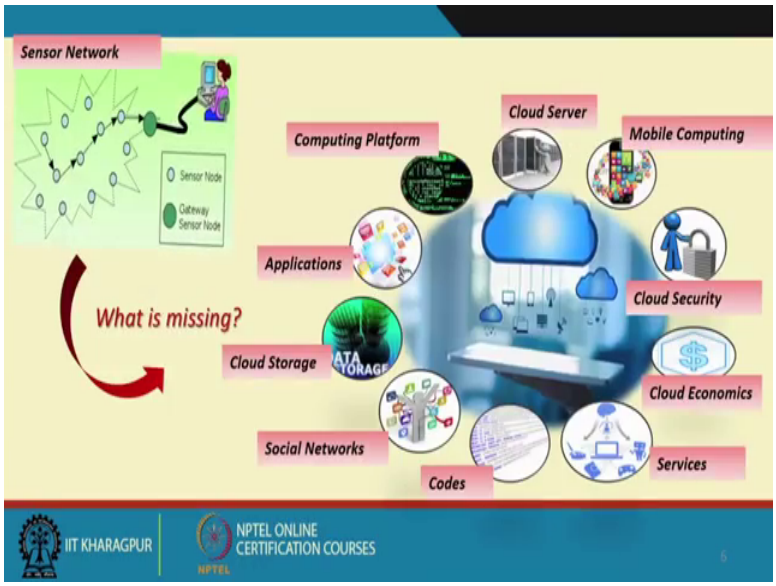

So, one side we have sensor networks typically we know that there is a bunch of sensors there is a way there is a sink node or gateway through which it is connected to the rest of the world and this there are different way of looking at the this sensing things like they can follow a particular path to the; say to the sink or they can form different clusters make the cluster hate and so on and so forth, there are technologies what you can see in the sensors network or on the other side if you look at the cloud infrastructure we have different sort of things like there are cloud server cloud computing platform several cloud level applications mobile computing cloud security aspects economics and so on and so forth, right and different models and different level of manifestation are there.

So, there is there is a missing link which we want to connect like making these sensor overall as a sensor cloud or connecting with the rest of the things which the cloud support which exactly the sensor cloud infrastructure or sensor cloud network try to address like.

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So, like; if we look at a say a typical scenario like this sort of things where there are multiple parties multiple information are being exchanged these different type of resources are being different type of equipments specially mostly most cases our mobile phones are used to capture this informations, right.

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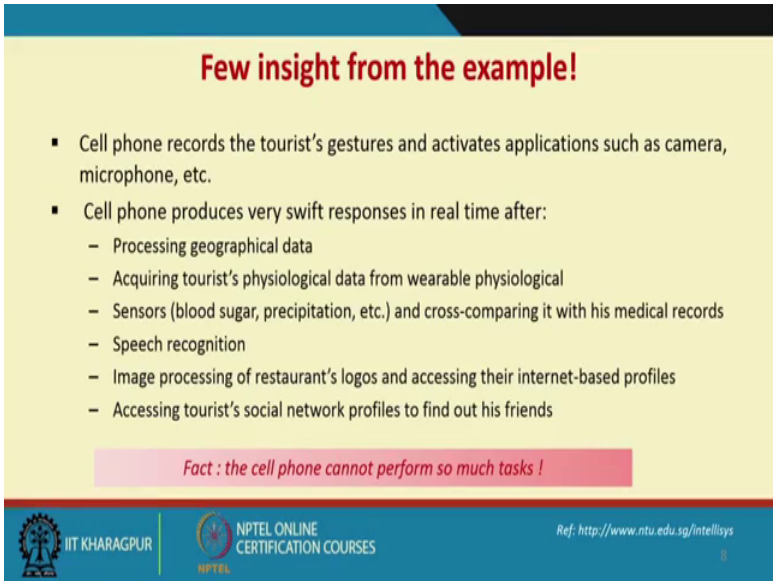

And if we look at the cell phone is somewhat omnipresence and records the tourists gesture activities applications such as in camera microphone etcetera which could have been captured cell phone produces very swift responses to real time after the processing

geographical data to show that if it is interfaced with the geo cloud type of things acquiring tourist physiological data and wearable physiological sensors. So, physiological sensors like blood sugar etcetera and cross comparing with the medical records like. So, if somebody is need some medical help this automatically instantiated or before the some something serious happens there are speech recognition system to find out things image processing of the some restaurant logo or accessing internet based things accessing tourist social network profiles to find out his friends, etcetera.

So, what we see that even though is a simple scenario of visiting a particular place, but there are several type of sensors at different levels which are there some are the physically doing that some are may be doing some derived informations, right. So, it is a its according like whatever been posted in the social network finding the friend etcetera it is also trying to do some data information and try to couple with this physical information its location if at all; we are trying to do monitor its a other type of infrastructure those type of things are being used to that type of things.

So, the fact the cell phone cannot perform all the task which is needed right that we see that the cell phone cannot perform. So, we need require some of the something which is which is required for; which is something more, then this or coupling sensors with cloud philosophy.

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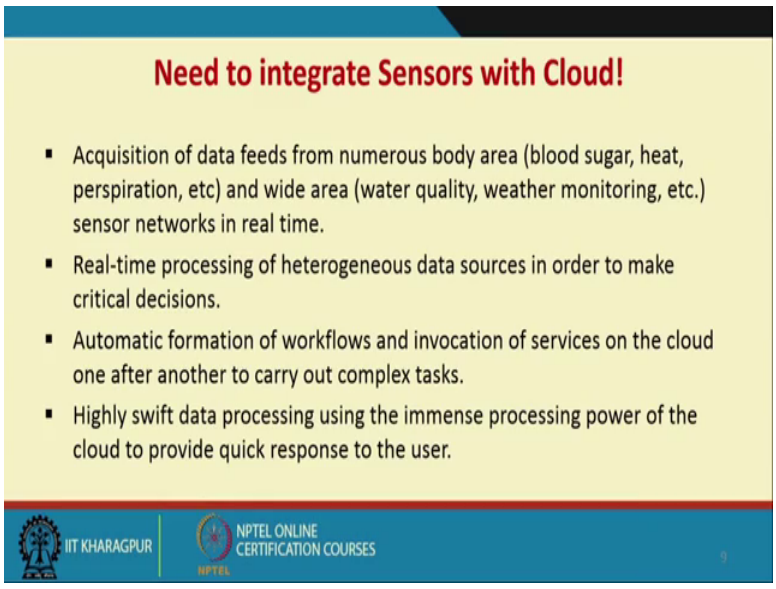

So, there is a need to integrate sensors with cloud right the acquisition of data feeds from numerous body area networks right like a different type of body parameters and wide area like water quality monitoring that is a small or large scale things what we need to do that sensor networks in a real time type of things.

So, what we not need to do that it is not only real time informations, but also real time processing of the informations is there is a requirement which is coming up where sensors integrating as sensors with cloud may give some results; real time processing of heterogeneous data sources in order to make critical decision, right. So, we need to do some real time processing of heterogeneous data sources coming from different type of sensors like something coming from the body area network or sensors which are taking a more health related data accompanied by the other type of things like may be the overall environmental things along with some of the sensors which gives that like related to the heights and. So, and. So, forth and try to take a call integrating those reason.

These are the different heterogeneous sensor informations which need to integrate. So, automatic formation of work flows and invocation of services in the cloud one after another to carry out complex task tasks highly swift data processing using immense processing power of the cloud to provide quick response. So, one side we have a capability of wide variety of sensors collecting information another side; what we have that computing power and the ability to interoperate between different type of heterogeneous data from the cloud we want to integrate together.

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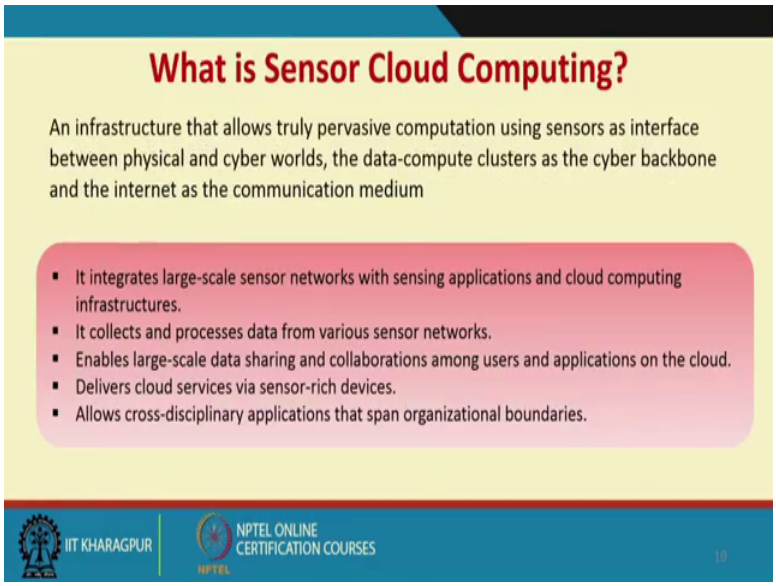

So, if it comes to a scenario of what we say sensor cloud. So, what if you try to look at a the sensor cloud does an infrastructure that allows truly pervasive computing using sensors as interface between physical and cyber worlds the data computing clusters as a cyber backbone and internet are the communication media, right. So, what; let me repeat its a infrastructure that allowed pervasive computing using sensors as an interface to the physical and cyber world right and data computing clusters at the cyber backbone at the internet as the communication media. So, it is a amalgamation of this different technologies to realize a or to basically support a real time application or real time processing of informations, right.

So, it integrates large scale sensor network with sensing applications and cloud computing infrastructure it collects and process data from various sensor networks enables large scale data sharing and collaboration among users and applications of cloud delivers cloud services by sensor rich devices allows cross disciplinary application that is span organizational boundaries like it says lot of things, right. So, it says that what we are discussing that to make it the whole thing ubiquitous and omnipresent and to serve a variety of applications.

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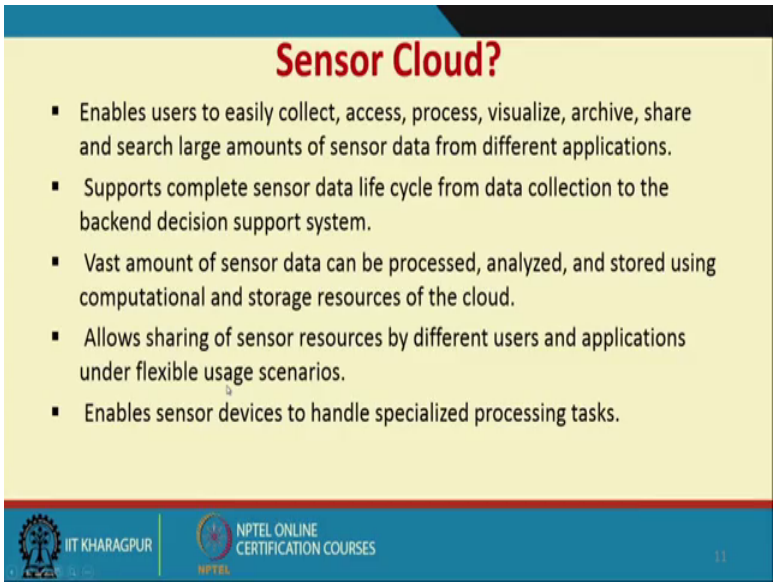

So, just to reinstate that enables user to easily collect access process visualize archive share and search large amount of sensor data from applications supports complete sensor data lifecycle from data collection to the decision support system as we are discussing vast amount of sensor data can be processed analyzed and stored using computational and the storage resource of the cloud, right. So, it is as a cloud as by virtue of it that having a huge infinite storage theoretically I can store this huge volume of data for further processing. So, many sensors are sending it is really a data challenge or a big data problem allows sharing of resources by different users and applications under flexible usage scenario enable sensor devices to handle specialized processing task.

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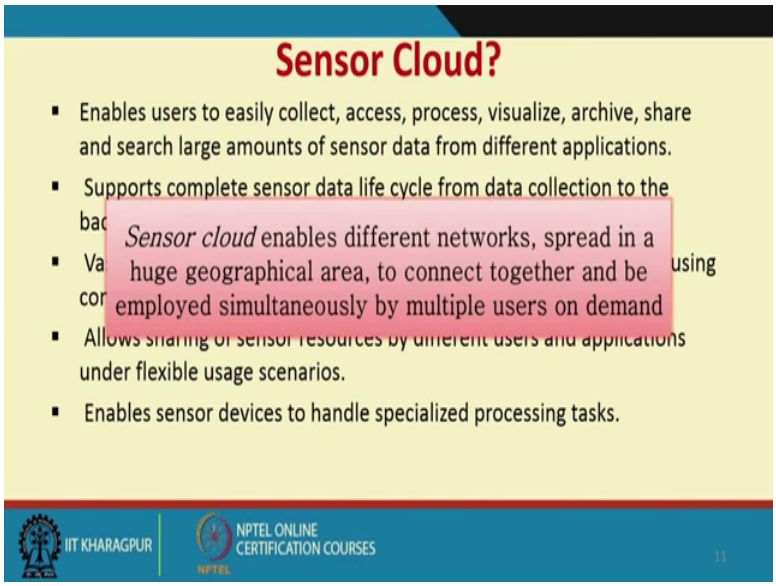

So, this these are sensing processing actuating type of services. So, sensor cloud enables different network spread in huge geographical area to connect to together be employed simultaneously by multiple users on demand, right. So, if you can see that from the sensing technology we are in the; we are trying to incorporate or what we trying to do in the sensor cloud is putting that good properties or good use of this cloud in to this sensing overall sensor network infrastructure.

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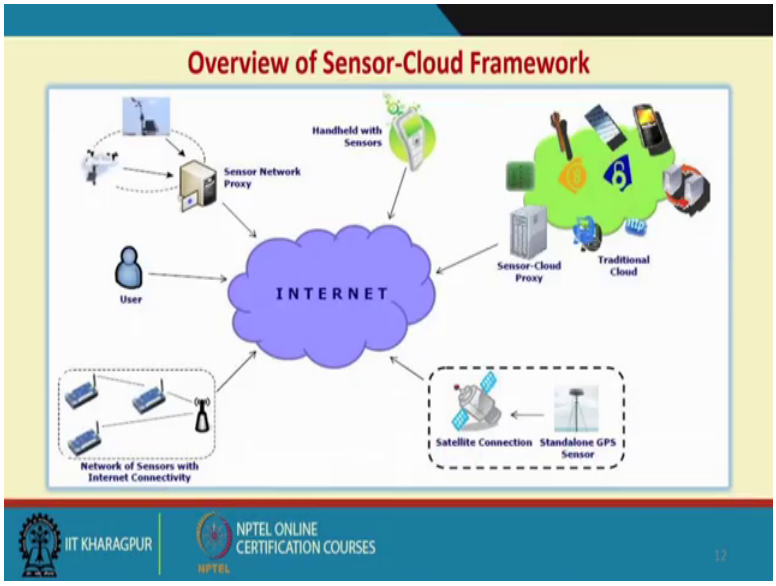

So, you can have a something overall overview of the things one side is sensor network where it; there is a sensor network a proxy which proxies it for the rest of the network. This handle devices or the handle sensors like mobile phones another type of things there is a traditional cloud we have a sensor cloud proxy which handles it and there are satellite connection standalone GPS sensors, there are network of sensors which capabilities different sort of things are being connected over the internetwork.

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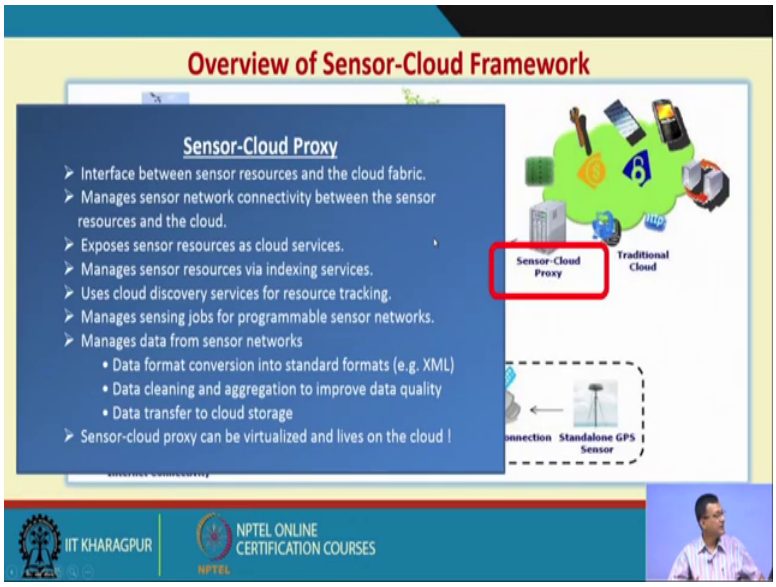

So, sensor cloud proxy it primarily interface between the sensor resources and the cloud fabric manages resource network connectivity between the sensor and resources which proxies on behalf of this; this say your sensors resources which can be heterogeneous which can be which homogenous type of things. So, it handles data format conversion like using technologies like XML interoperability data cleaning and aggregating data transfer to the cloud storage and so on and so forth.

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Sensor network proxy; for sensor resources that do not have different connection to the cloud this acts as a proxy. So, it is unlike, it is not; it cannot be expected that all sensor network will have that connection to the cloud and able to interface to the cloud. So, that is why we have a proxy where by which it is connected to the cloud, right, there are different other use cases like one is the traffic.

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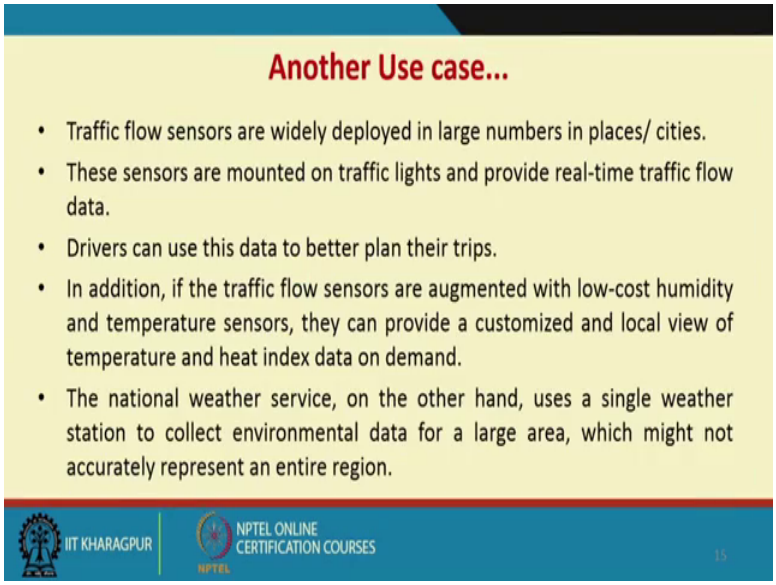

We can say that traffic flow sensors that deploy large number in place city places like large cities right these sensors are mounted on traffic lights and provide real time traffic flow data, right.

So, these are on traffic lights systems on signaling system they can be mounted and real time things driver can use these data for his route planning right you see that there are this amalgamation of information and taking a call for somebody from the sensor things is there in addition if the traffic flow sensors are augmented with low cost humidity and temperature sensor that can also provide customized local view of the temperature and heat index on demand, right. So, it is also support the metrological department which other ways have fix number of sensors, right.

So, I can have a rough ideas, I have that precision sensor of the med department which keeps more precision and I have this local sensors which are on the lamp post and traffic signal and lights which keeps me a much more real time scenario of this temperature. So, the same type of infrastructure with little augmentation we can have different layer of informations or in other sense you can see that you have virtualized these things into different type of things, right, I have a one side that metrological departments looking for the med type of things traffic management department looking for that what is the overall traffic managing things I can have drivers on the road which uses for road planning and so on and so forth, right.

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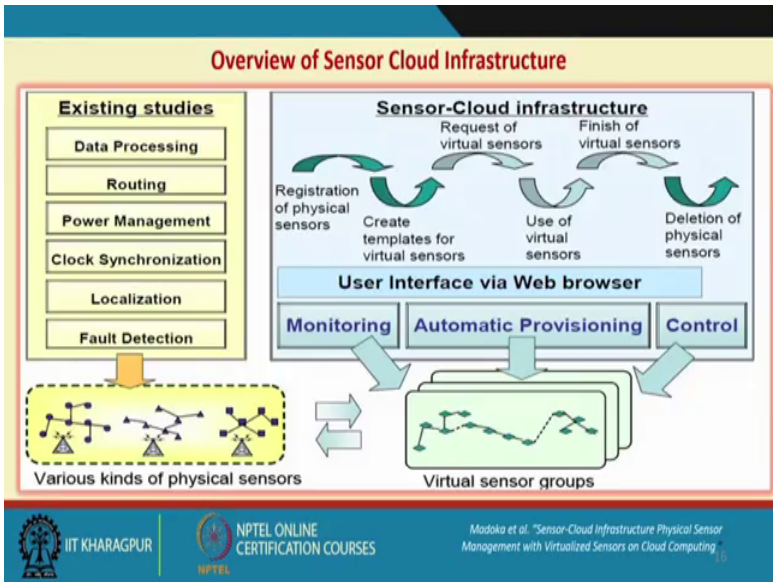

So, we can have one over view of the sensor cloud infrastructure like there are the standard way of looking at it data processing routing power management clock synchronization localized fault detection this is which are their basic physical sensors which has to be there and I basically what we try to do is a having a virtualized scenario or the physical layer over that as we have seen in the cloud a virtualized scenario which helps me in looking at different type of user related issues, right.

So, I have now a set virtual sensors or virtual sensor groups which can answer to the different category of applications like as we are discussing one may be med type of one may be traffic type of applications one may be action management type of things and something may be overall looking at that other phenomenon like how is that lightning or how is that overall environmental situations of that particular place.

So, we talk about virtual sensors what here is as we have said it is a emulation of the physical sensor that obtains its data from the underlying physical sensor as we have seen virtual machine, etcetera.

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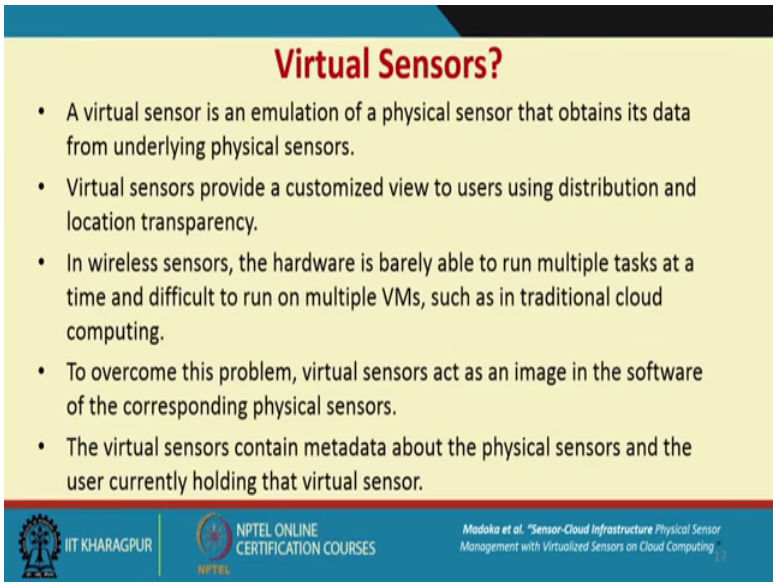

So, it is emulating the machines from the underlining the physical machines, right. So, virtual sensors provide customized view to the users using distribution and location transparencies right in a sensor wireless senor these hardware is barely able to run multiple task at time and difficult to multiple VMs and as in a traditional cloud to overcome this problem virtual sensors acts as an image in the software of the

corresponding physical sensors right. So, that is as we have seen that in case of our cloudy cloud things also.

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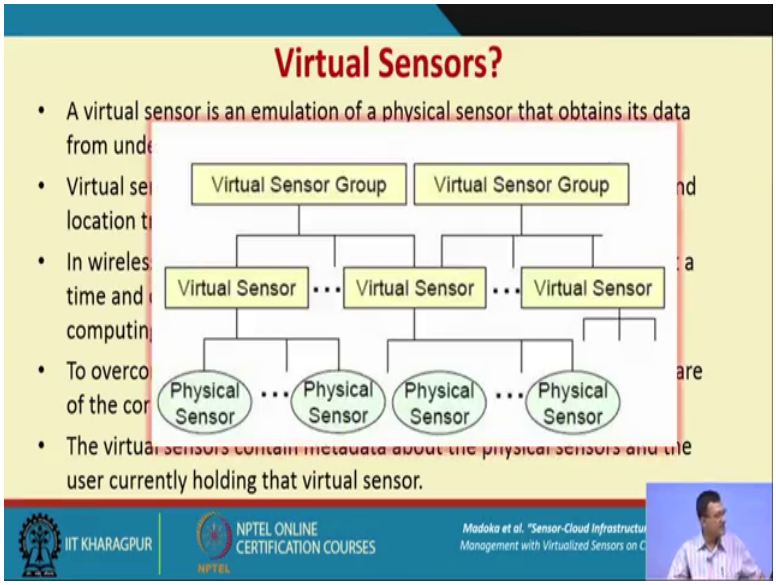

So, virtual sensors contain metadata about the physical sensors and users currently holding the physical sensors. So, we have a virtual sensors layer. So, there are physical sensors over that we emulate this virtual sensors and there are different virtual sensor group which uses that it may so happen one physical sensors may be contributing to the physical sensors. So, one to many-many to one many to many and this type of things scenario may come up.

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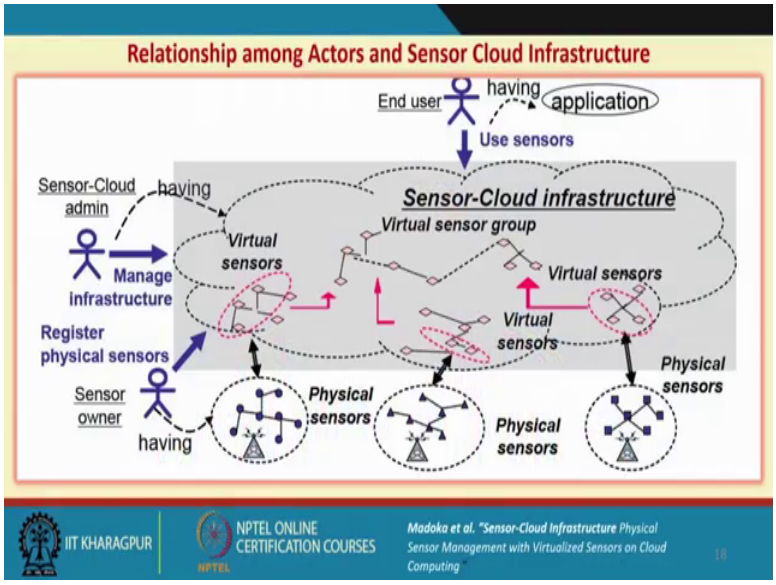

So, as we are discussing. So, there are sensor cloud admin. So, this is a sensor cloud infrastructure which has different physical sensors have virtual sensor groups which have underlining physical a virtual sensors which are coming from the physical sensors and then we have end users which are more-more looking for this more inclined to the applications or more bothered about the applications which talk to this uses this sensing network to look at it.

So, there is a management of this sensor cloud like registering physical sensors management mange infrastructure and that it may happen the sensors because this sensors are low powered manage by different type of in different situations. So, sensors may come up or can go down and type of things.

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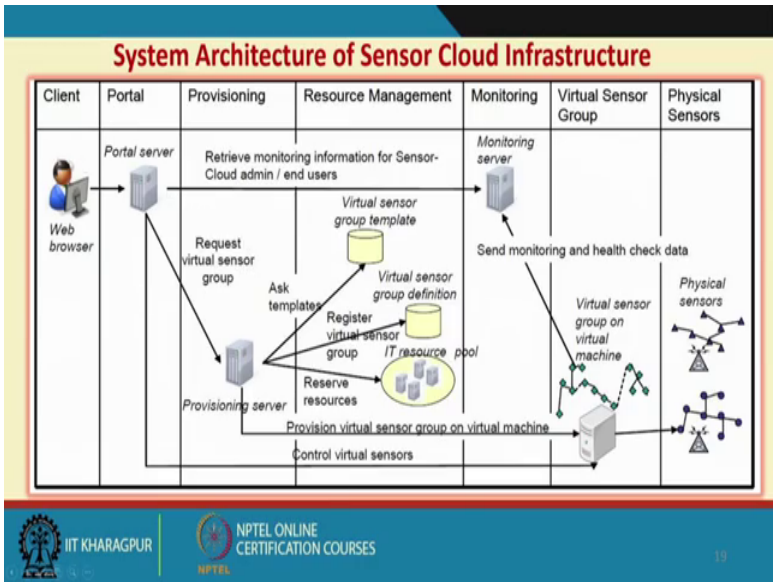

So, this sensor cloud need to be managed appropriately and the something; if we look at the client the portal it goes for a provisioning resource management monitoring virtual sensor group physical sensor groups and. So, and. So, forth this overall architecture if we look at in other way it is; so, client request to they to a particular portal servers which intern go for that process the query it needs to look at the different virtual sensors which can answer to the queries and which intern look for the physical sensors and so on and so forth.

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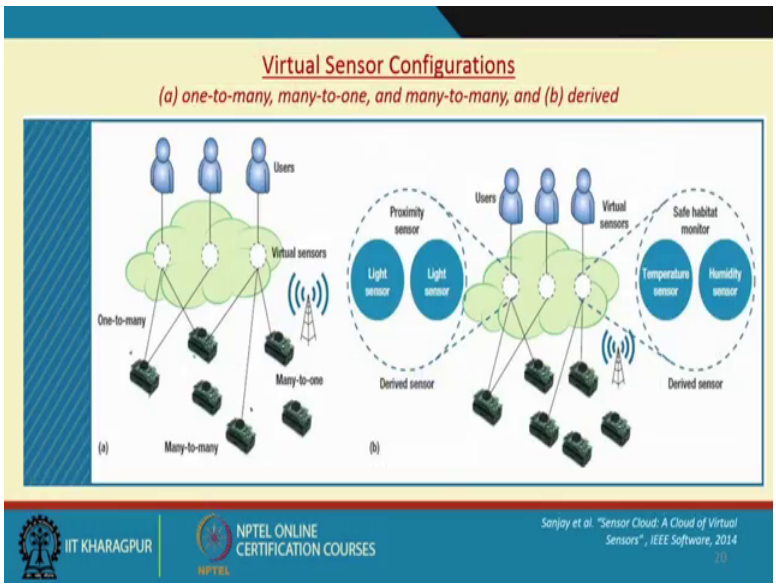

So, as we have discuss discussed there are virtual sensor configuration it can be one to many-many to one many to many and can be derived, right. So, there are several scenario many to many one to many, then we have this derive type of scenarios.

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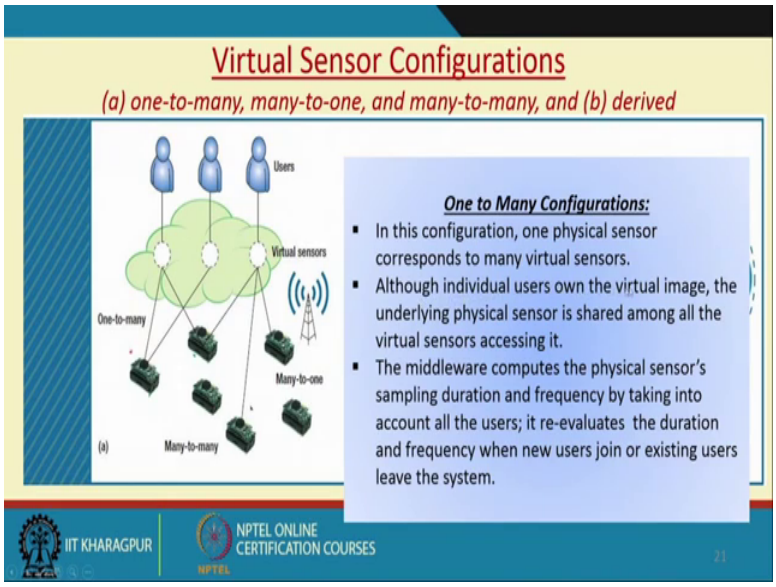

So, in case of a many to one to many; in this configuration one physical sensor corresponding to many virtual sensors although individual sensors on their virtual images the underlining physical sensor is shared among all the virtual sensor accessing it, right.

So, it is the middle ware which computes the physical sensor sampling duration and frequency by taking into account all the users it reevaluates and duration. So, it is basically the synchronization is ensuring by this underlining middleware and type of things.

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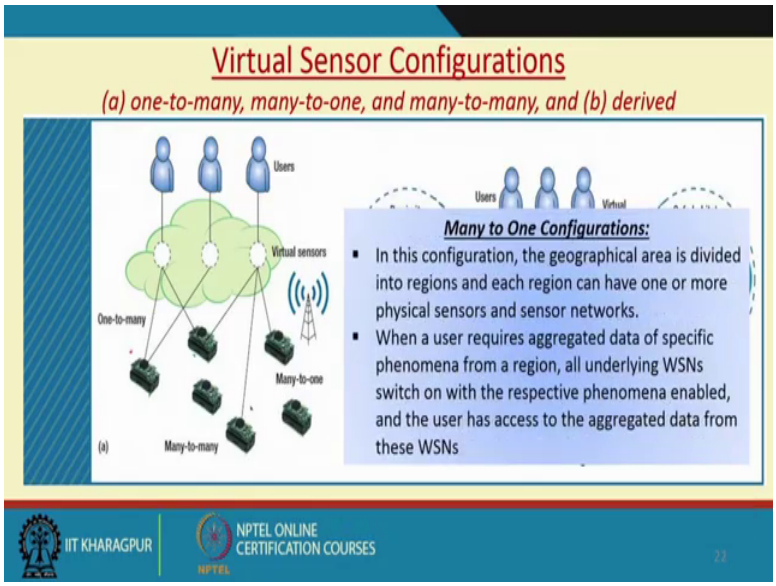

So, it is a; so, where we have one physical sensors corresponding to more than one virtual sensors; many to one in this configuration geographical area is divided into regions each region have one or more physical sensor and the sensory network when a user requires a aggregate data of specific phenomena from a region all underlining WSNs or value sensory networks which switch on with the respective phenomena enabled and the user can access the aggregated data.

So, here what we have a large geographical space why which is different into regions and which has say for wireless sensor network and if there is a aggregated some processing is required then these are switched on and give a aggregated view on the things, right.

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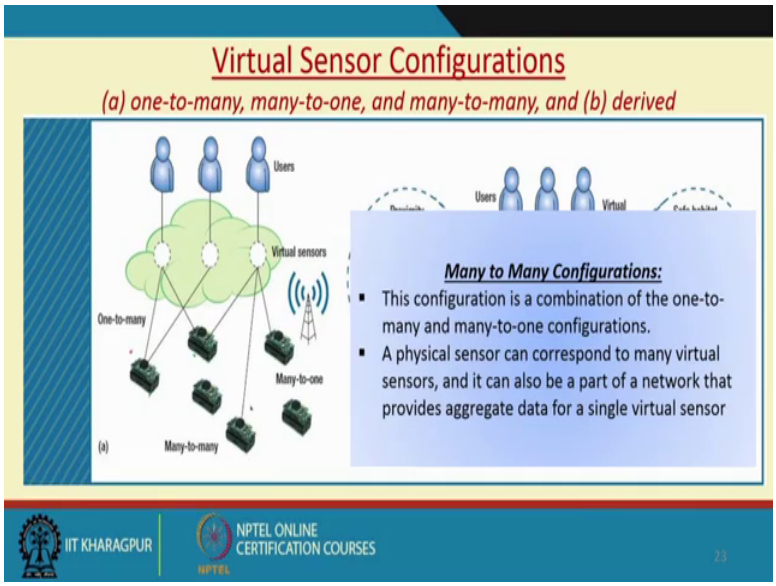

So, it is a scenario of many to one; we can have as a many to combination of one to and many to one type of scenarios.

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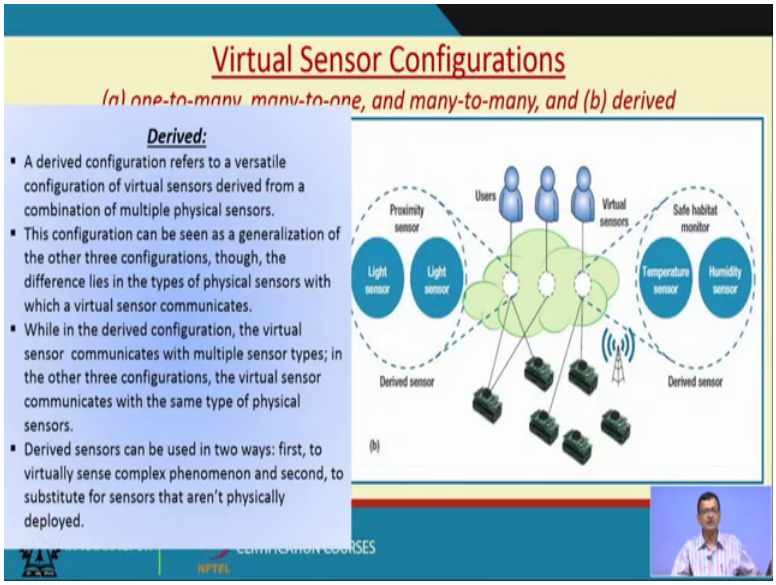

There is a special scenario which is a derived. So, it is a derived configuration refers to a versatile configuration of virtual sensors derived from a combination of multiple physical sensors, right. So, there are virtual sensors which is a combination of the derive sensors like here you say there is a proximity sensor light sensors there are say habited monitor temperatures humidity sensor and these are integrated into to take a call, right.

So, this configuration can be seen as a generation of other three configuration generalization; basically generalization of the other three configuration lies in the type of physical sensor with a physical sensor communicate; so, it emulates the sensors looking at different other physical sensors. So, it derived a sensing capability from the other physical sensors, right.

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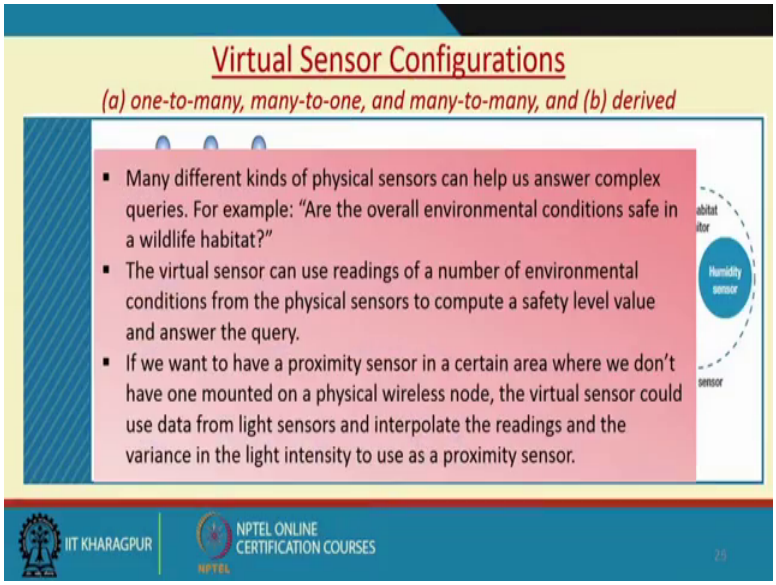

So, these types of scenarios are being emulated. So, there are there can be many different kind of physical sensor that can helps a complex question for a for example, are overall environmental condition safe in a wild life habitat. So, this is a very complex question, right. There is a there should be a definition of what is meant by the overall condition what is the meant by the safety of a wild habitat and this need to be known.

So, virtual sensor can use reading of number of environmental condition from physical sensor to compute safety level values and answer the query type of things, right.

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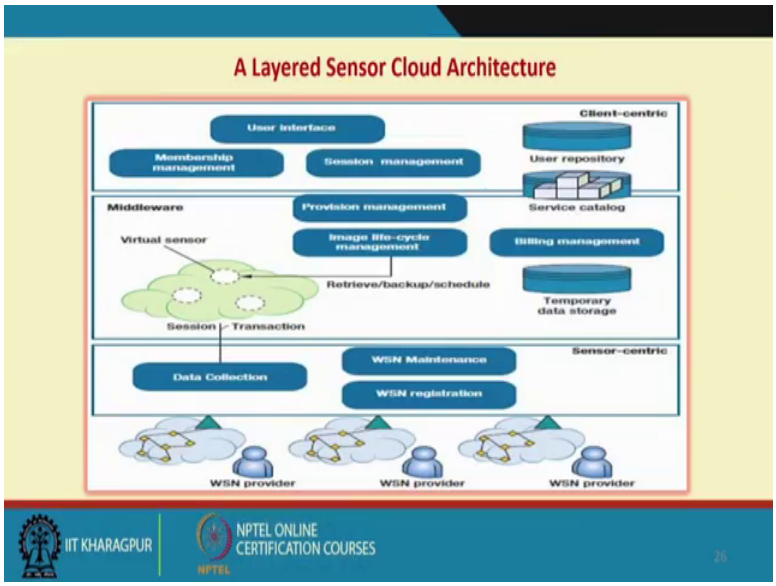

So, there is quite pervasive applications which can use this type of scenarios and if we look at a layered sensor cloud architecture. So, we have different wireless sensor providers right they provide data information and type of things we have a sensor centric middleware which is a WSN maintenance WSN registration type of things and then we have a other middleware where we say as a virtual sensors emulating virtual sensor provision management image life cycle and so on and so forth and then at the top interfaces.

So, these are multiple layer one is that physical underlining layer over there one to have this WSN registration WSN maintenance data collection part over there that virtualization layer and then we have that physical user interface to connect to the things and they are we can have other type of things like user repository data repository session management membership management and so on and so forth. So, there are varieties of things which are can be there. So, if we can if we summarize sensor cloud infrastructure virtualizes sensors and provides management mechanism for virtualized sensors.

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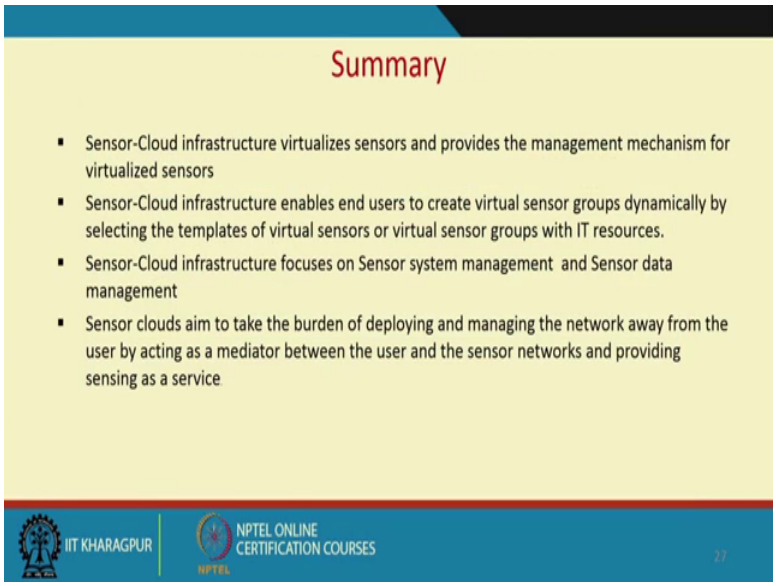

Sensor cloud infrastructure enables end user to create virtual sensor group to dynamically by selecting the template of the virtual sensors or the sensor groups which are there. So, based on the user application, I can select a particular template to work on that sensor cloud infrastructure focuses on sensor system management and sensor data management. So, this is more inclined or the vertical towards sensor data management and sensor system management and aims at to take the burden deploying managing network away from the user acting as a mediator between the user and the sensor network. So, that is; it is a sort of connecting user applications with the deployed data or the sensing environment.

So, as we have started today's discussion that that is that is a there is a omnipresent presence of different kind of sensors starting from our mobile phones to different category of sensors which is collecting huge volume of data which could have been used for processing and supporting different user applications. So, that a virtualization mechanism is supported and evolving a sensor cloud which are which are which may help in addressing different real time applications or serving different real time applications with a variety of heterogeneous sensor collected or sensor acquired data system.

Thank you.