Cloud Computing
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Lecture – 39

IoT Cloud

Hello, so today we will discuss one of the another aspect of cloud computing rather another company and technology where could computing can be an enabling technology to have better services and better delivery of the services, so that is what we will discussed today about IoT cloud.

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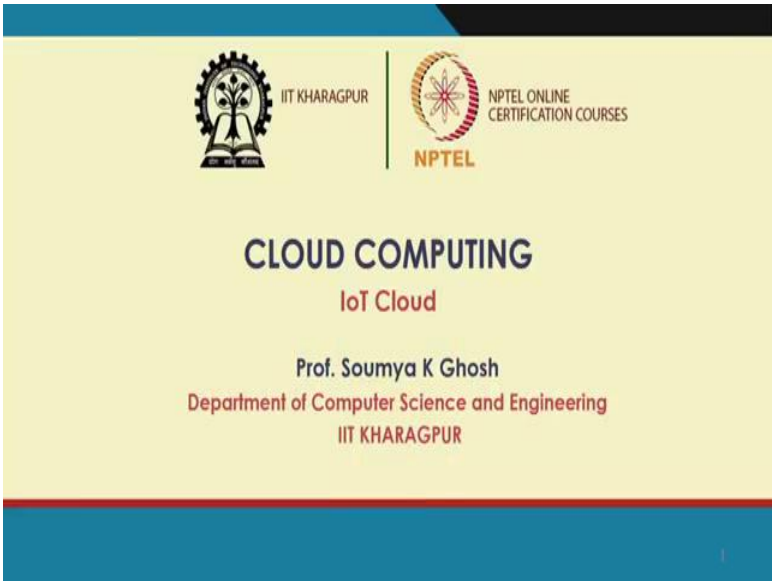

So, as we know that IoT is a buzzword that is Internet of things right so that means, anything rather anything and everything is now becoming Internet enable. So, that may in other sense that there are sensors less we see in a sensor cloud also, and there can be other type of a different variety of sensors which are enabling it to be a connected to the Internet. So, anything and everything is connecting to the Internet, and there is a huge volume of data, different variety of services which are being possible with this sort of mechanisms. So, we would like to see that this IoT cloud that is amalgamation of this cloud technology or cloud philosophy with this IoT, how we it is likely to help the overall performance of this services of Internet of things or cloud services.

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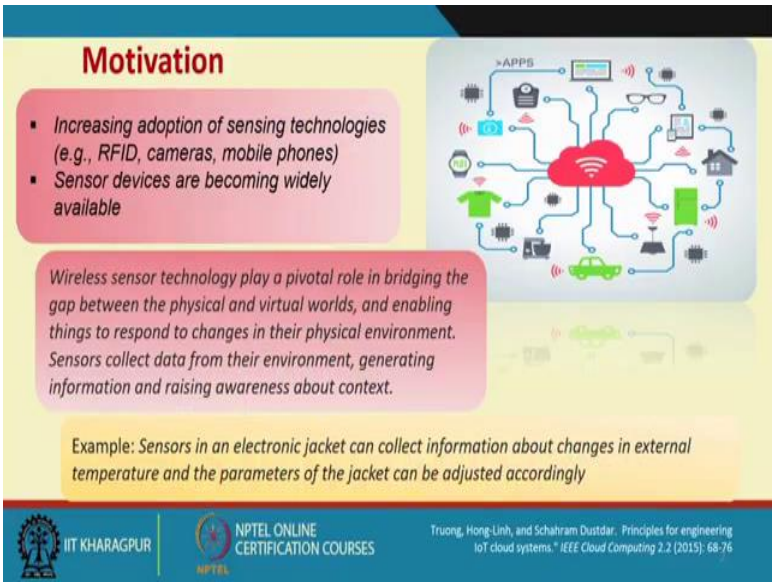

So, if we look at the motivation is clear that increasing adaptation of sensing technology RFID, cameras, mobile phones and everything and anything and everything. So, sensor devices are becoming widely available across different type of mechanisms. So, when we talk about sensor cloud, we are more concerned about that the sensing device itself where what we are looking at these are sensing devices which are ubiquitously available. So, there may be very thin line between things, but it has a different way of handling, and more are some most of the cases are more application oriented type of things.

Like wireless sensor network or technology play vital role in bridging the gap between physical and virtual world, so it helps us to take the physical world to the digitized world and enabling things to respond to change to their physical environment. So, I say that the my ac will be air containing system will be changing based on the temperature of the things right; the temperature sensor activates the air conditioning process or it increases or decreases the temperature or the air conditioning controller system is being controlled or being activated by these sensors. So, this sort of activities, where the sensors in turn activating some other things, so those types of things are there.

So, what we see that sensor collect data from their environment generating information raising awareness about the context. Like we see here there is a variety of sensors right variety of so called objects or things, and they are having different sort of connectivity sometimes where or mostly wireless with these rest of the things. So, sensors in a sense

is a like for example, sensor in a electronic jacket, a person wearing a electronic jacket may can collect information about changes in the external temperature and the parameters of the jacket will be sending like, it may the jacket may heat appropriate based on the fall of temperature and so on and so forth.

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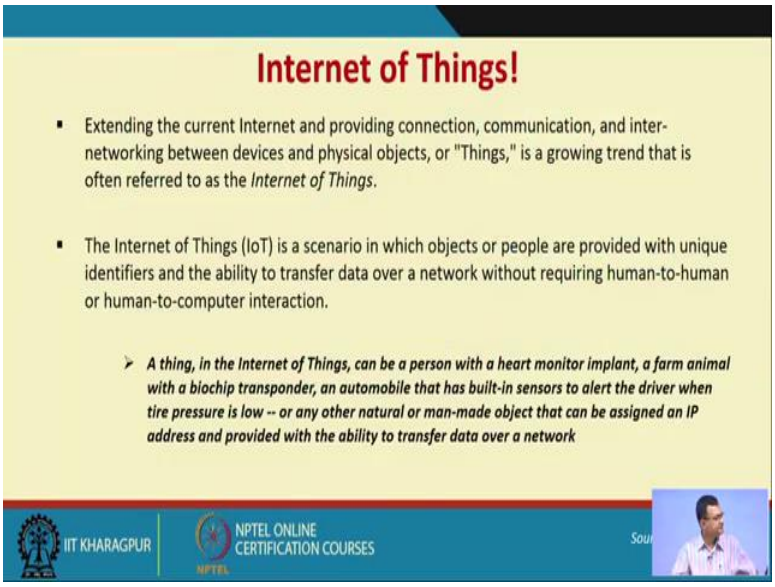

So, Internet of things like as we hear about it for in our every literature talking about whenever we talk about sensors and other things. Extending the current Internet and providing connection, communication and intern networking between the devices that is the physical objects or sometimes call things is a growing trend and often referred as IoT or Internet of things.

So, it is a scenario in which objects or people are provided with unique identifiers that means has been identified and the ability to transfer data over a network without requiring to human-human or human to computer interactions so that means, these devices are enable itself to communicate data to the Internet so called. So, thing in the Internet can be a person with a heart monitoring implant or a farm animal with a biochip transponder, or a automobile that is built in sensors to alert driver when the tire pressure low or it is some man functioning some of the any devices or it can be a natural or manmade object that can be assigned in a IP address and so on and so forth. So, that something that is uniquely identified IP address may be one of the mechanism to do that so that it can communicate with these unique things right. In case of a sensor normal

sensor deployment, I may not have a unique identifier. I am more concerned about the data, which is going to the things right. I am more concerned about here though the data is important, but I still I can I uniquely identify a thing or a object.

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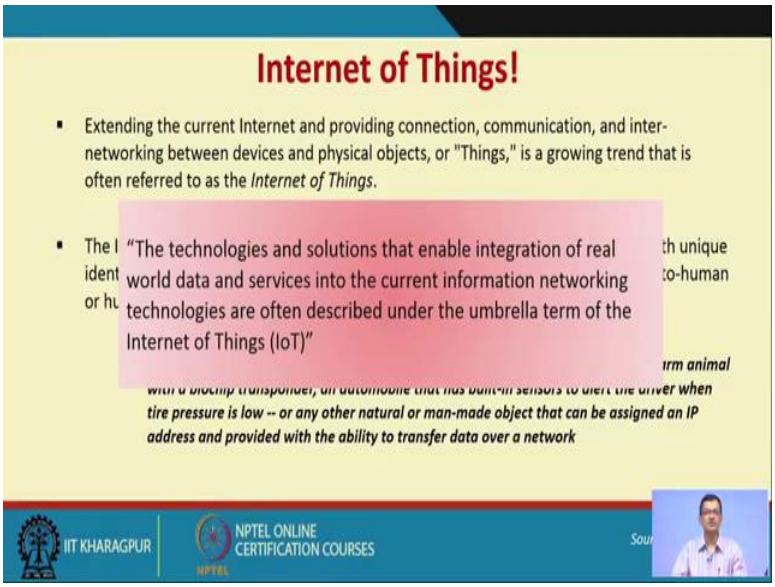

So, technologies and solutions that enable integration of real world data and services into current information networking technologies are often described under the umbrella term called Internet of things right at that is the core of the whole thing.

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So, day-to-day so called more objects or more things are being connected right. So, we see starting for from vehicle to some of the devices in a lab, where the device in a lab or even some filtering mechanisms or a lighting systems or lights right which are based on the things may be controlled by the things all are they all are communicating in case of smart grid also. And these access control and lot many things. So, home daily life devices are getting connected, businesses, public infrastructure, health care and etcetera, etcetera. So, it is a long list and everyday things are being enabled. So, we have the ability to control the devices actuates some other devices based on the sensed by some other some other applications and so on and so forth.

So, here it may not be always sensing. So, it is I can have it to actuate a thing like I can say have a controller circuit which is being actuated by something by external things like I switch on the lights, switch on the fan or activates something by using a application on the mobile. But the light or the electric switch is being is a thing or is the IoT device where it access a IoT device. So, it is it is not exactly sensing in the terms the environment, but in terms it is being activated by some through a Internet.

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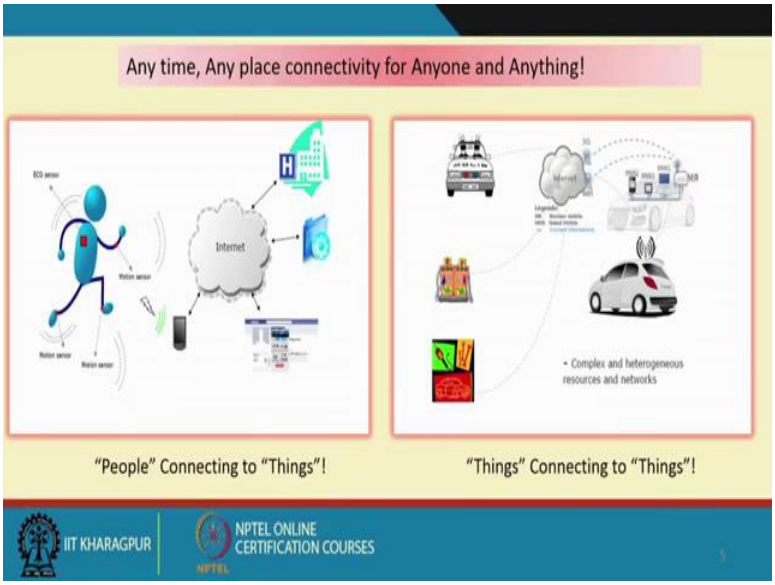

So, it is in other say I can say any time, any place connectivity for any one and anything. So, something like that right any time, so any place, location, space, time to anyone and anything so any objects and type of. So, let people connecting to things like it is connected may be to the hospitals to other type of a several mechanisms, and type of

things may be through a mobile device or it can be things connected to a things like a car connected to another car or petrol station, or mechanics, or workshops and type of things. So, a particular objects if it is malfunctioning or it triggers something to some other network and so on and so forth. Like if it is low on petrol not only it flashes the message to the driver, also at the same time it searches that what is the nearby petrol or gas station and who can do the things, similarly if requires say something to be done in the workshop and type of things.

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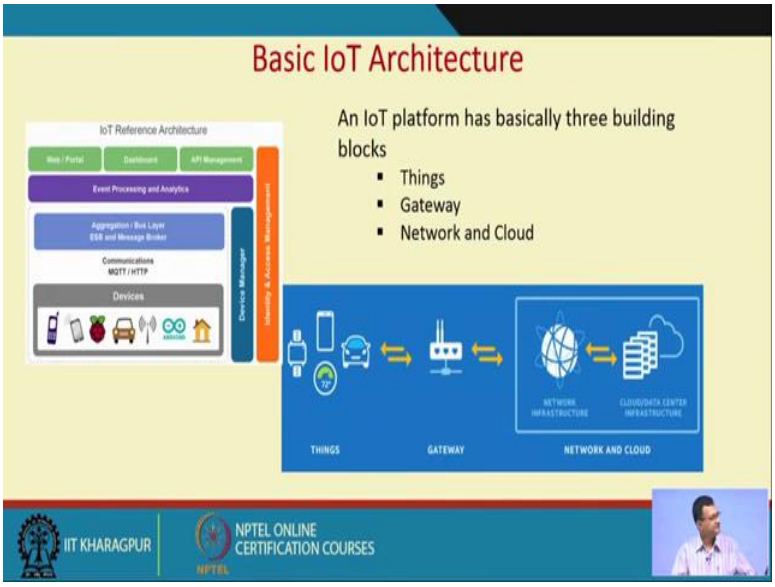

So, if you look at the basic IoT architecture, so what it requires on the things, it is the objects or the needs a gateway to connect to the rest of the world that is network or cloud and type of things. So, it is a things gateway network and cloud. So, whether it is a car or mobile device, a smart watch or a temperature sensor or any type of things which can go through a gateway and connect it connect to the things. So, these gateway provides a connectivity with the rest of the thing rest of the Internet, it can be cloud, it can be other infrastructure and type of things.

So, if you look at so the devices at the bottom end. So, there is a communication path either through MQTT or HTTP some protocol aggregation and bus layer with ESB and message broker. So, aggregation bus layer. So, there may be enterprise service bus and sort of things and message broker. It goes to the event processing and analytics based on that whatever it sense is good for a event processing analytics. And there are web portal

dashboard API management at the top of the layer right. So, these are different structures. So, these are device manager, these are identity and access management at the across the whole vertical. So, this is this is broadly the generic or basic IoT architecture which more or less all devices follows, all devices confirm true that whichever or rather that I should say all things quote, unquote things confirm too.

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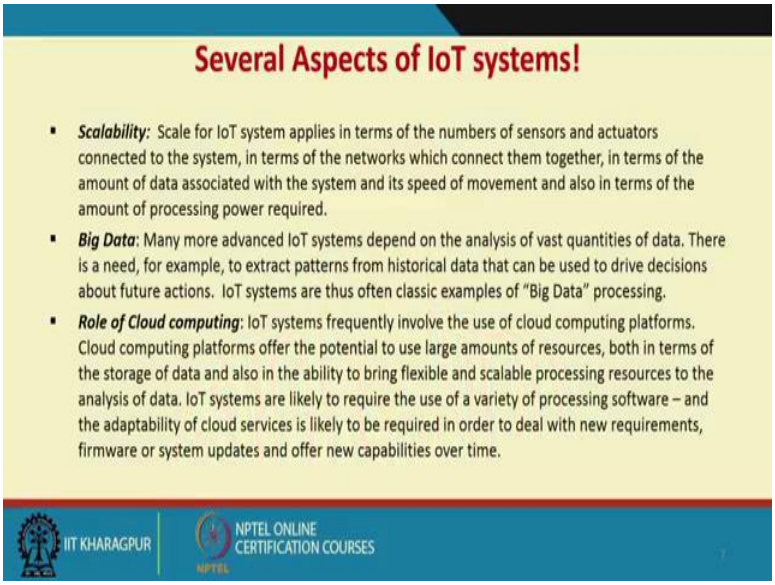

So, there are several aspects of IoT systems, one is scalability issue that scale for IoT system implies that in terms of number of sensors and so on and so forth, if it is increasing then how to handle. That is a big data issue that there are so many IoT devices and many of them are having sensing or data acquisition type of things, or event transmitting the data that is a huge volume of data which needs to be processed and there is a big data analysis and processing issue. And we find a role of cloud computing out here, so that not only in terms of the scaling in terms of IoT frequently involve use of cloud computing platform of our potential of large amount of resources, both in terms of storage, data and also ability and flexibility to scaling operations. So, there is a need for aspects of cloud type or cloud sort of mechanisms.

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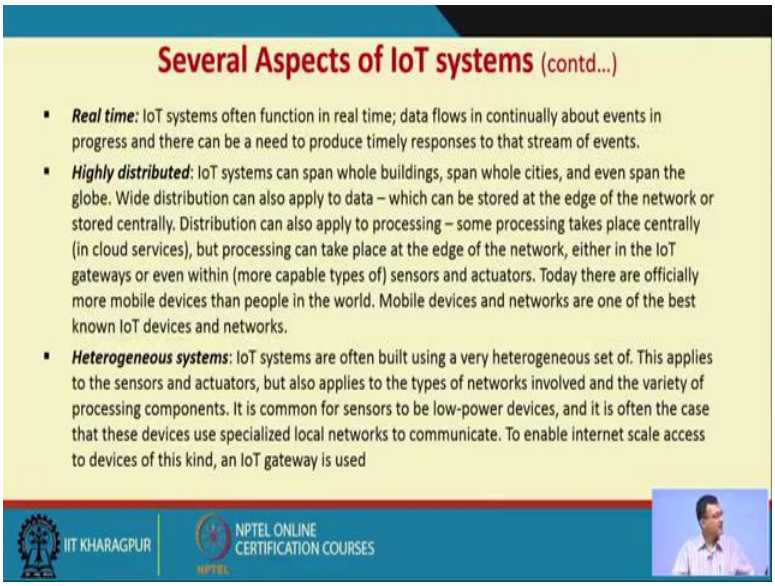

There are few more things many of the cases it is a real time phenomena. So, the processing etcetera requires some sort of a real time intervenes. So, IoT systems often function in real time, data flows continually about events progress and there can be a need to produce timely responses to the stream of the events, so that data being collected being processed to be need to be actuated at the at a real time. Highly distributed as we look at that whole lot of devices a variety of devices, it can span over a from a single room to buildings to even to a large much more larger geographical area like a campus or a city and type of things. So, it is a highly distributed and as it is distributed automatically heterogeneity come into play like there can be different objects, different type of devices and the type of data they transmit or consume or is they there can be a variety or heterogeneity on those type of things.

So, IoT systems are often build using very heterogeneous set of different devices and type of things. These applies to sensors to actuators, but also applies to type of network involved in the variety of progress like some may using WiFi some may ZigBee Bluetooth and type if things and it a whole lot of interoperability issues need to be addressed out there so that in order to address this sort of issue, this IoT gateways are required, so that it is addressed at a more localized fashion. So, whatever it communicates, it communicates with the gateway which is more localized fashion right say I say that there are several IoT devices in this room and I have a gateway which take care of this devices. So, rest of the world or outside the room they are not bothered about

this how the heterogeneity of the data formats, they are processing mechanisms, the communication paradigm which they do inside the things, the gateway takes care and the gateway represents or handles the interoperability or the heterogeneity issue of this IoT devices.

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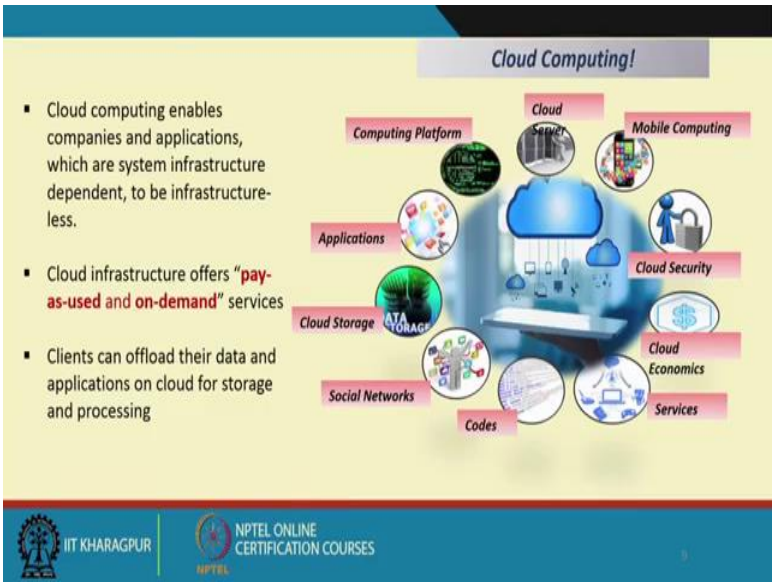

On the other hand, we have seen a lot of a cloud computing aspects. So, computing enables companies or enterprises applications which our system infrastructure independent to be infrastructure free that is one aspects. It offers pay as used and on demand services, which is pretty amicable for this type of IoT things. Clients can upload the data and application on cloud for storage and processing that is another these are the issues which are which provides. And as we have seen already that there is a number of applications or number of features of cloud right like a mobile computing to aspects of security to social networking and so on and so forth.

So, cloud computing enables services to be used without any understanding of the infrastructure. So, if it is the service provider takes SaaS type of things anything say at the SaaS level its do not bother about the what is the underlining infrastructure or the infrastructure or the platform and so on and so forth works using economy of scale. So, it has a economy what we say it works with the using he economy of scales, and it is extremely beneficial for several applications specially this sort of applications where these IoT type things are there. Data and services are stored remotely, but accessible

from anywhere, like as we are seeing that anywhere, anything anybody type of things, so this is again amicable for this IoT operation or IoT paradigm.

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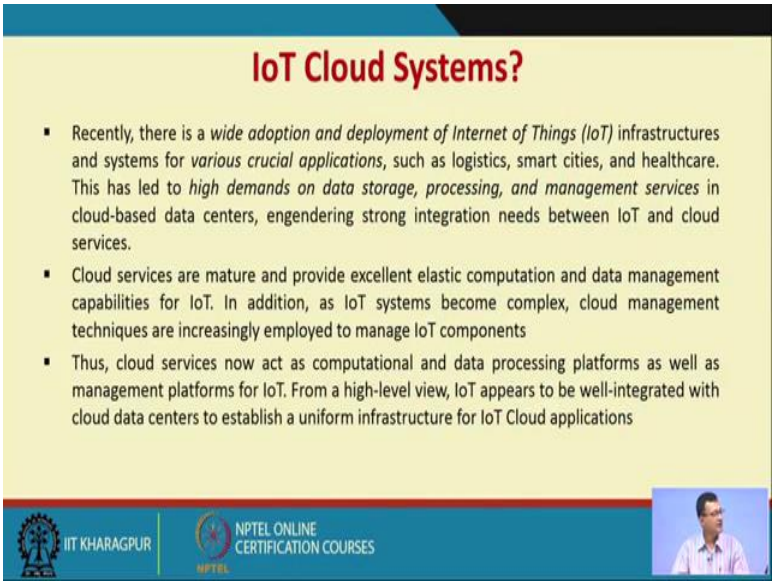

So, why not then IoT cloud, so that is the things which naturally evolved; it is not like that we some we are trying to put them together, it is natural evolution to or merging of this two concept of the things. So, there is a wide adaptation and deployment of Internet of thing infrastructure what we see for various crucial application like logistics, smart city health care say even parking car parking and so forth. So, this led to high demand on data storage processing and management in the cloud based a data centers right. So, this IoT devices individually handling will be difficult and even then you have to have something some infrastructure which can handle those things why not the cloud.

Cloud services are mature and provide excellent elastic computation and data management scalabilities for IoT that is it has the potential to give data management scalability in addition and as IoT systems become complex, cloud management techniques are increasingly employed to manage IoT components. So, IoT systems not only the hardware wise, the systems in the processing wise are becoming complex. Cloud services now act as a computational data processing platform as well as management platform for IoTs right. So, the cloud platform can very well be a processing platform as well as data management platform for this type of IoT systems

may be in a localized manner may be more globalized manner or on a larger geographical spread or more complex type of situations.

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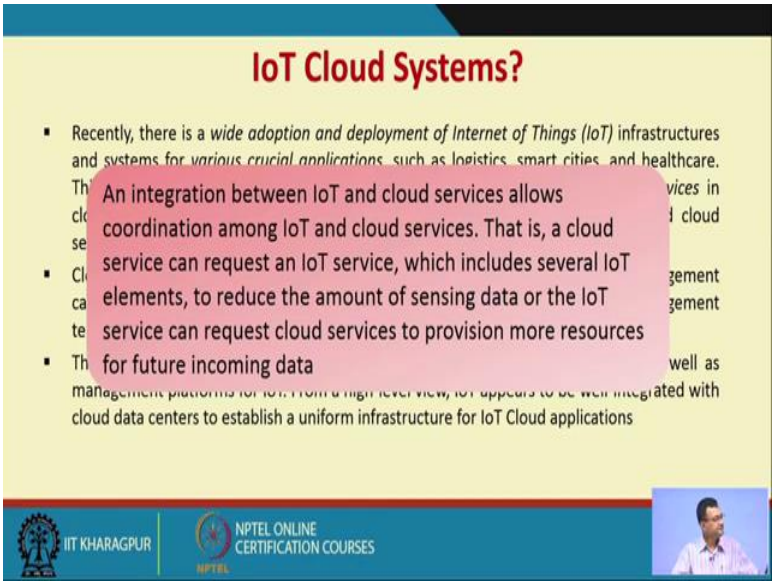

So, what we see that integration between IoT and cloud services allowed coordinating coordination among IoT and cloud services in a seamless way. That is, a cloud service can request an IoT service which include several IoT elements to reduce amount of sensing data or the IoT service can request cloud services to provision more resources etcetera. So, it is it is what we say sort of a quote unquote helping each other to provide better services to enterprises to individuals or other type of services which uses this IoT services.

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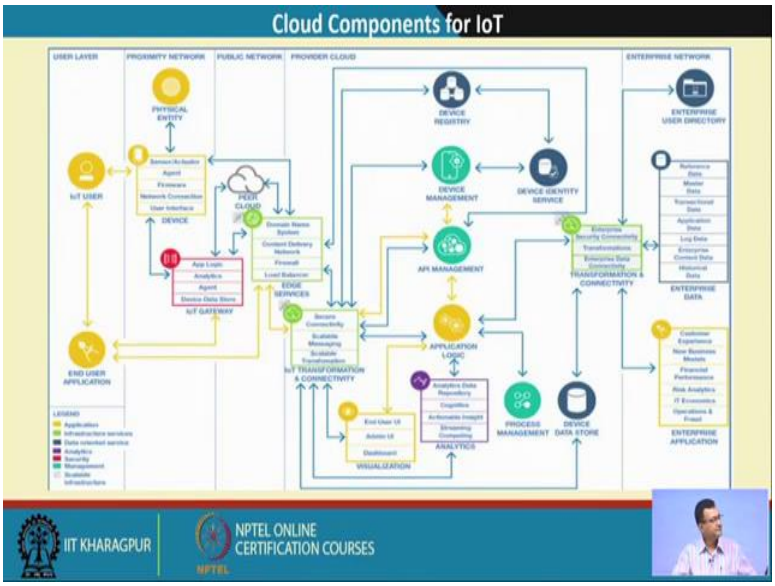

So, if we look at try to look at the cloud components for IoT, so there are you can see there are several verticals one is the user layer, where in end user applications or IoT users are there then we have a proximity network which are more near to these user layer. There are sense sensor actuators, agent, firmware, network connectivity, user interface, devices and so on and so forth. Here we have this IoT gateway, which connects this part with this public networks. So, the IoT devices or applications which are connected by the proximity network which can be again having heterogeneous type of things different IoT devices can do can connect to the things this IoT gateway connects to the rest of the world. So, peer cloud through a peer cloud to the other type of things.

So, what it goes as a application logic analytics agent device data store, these IoT gateway connect to this may be a DNS system or a content delivery CDN, firewall local load balancer and type of things. So, this in turn connects to this things which connects it to the provider cloud or a CSP - cloud service provider, which has all its cloud components already we know that can be a device registry, device management, API management which are there in that IoT cloud. So, application logic which helps in doing analysis analytics where the analytics data repository cognitive applications or cognitive mechanisms actionable inside streaming computing all this analytics related things can be there right and these interns can connect to a enterprise network. So, it has a user directory and so on and so forth.

So, if you see there are different layers. So, user layer proximity network through a gateway connected to the public network, these connect to a provider cloud and if required it goes to a enterprise network for accessing other type of services like I say that that I have a car, which detects some anomaly. It uses some gateway to connect to the cloud it with different type of not only from the or not only from different data from the cloud other environmental data these does some analytics then it may trigger to that particular car manufacturer or car related service provider or workshop. And goes to that enterprise and then gets a feedback and so on and so forth. So, make some, what we say corrective actions on the things like providing may be a service vehicle or sending alert to the driver and so on and so forth. So, there can be this sort of aspects.

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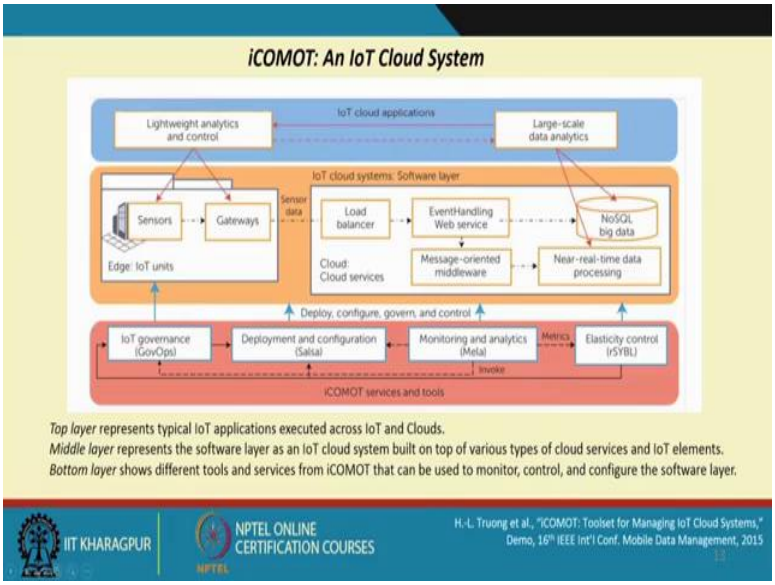

So, there is iCOMOT. So, one it is from particular one publications an IoT cloud systems, what we see that different layers right at the top layer represent a typical IoT application executed across IoT and clouds. So, it is the top layer which is a typical light weight analytics and control, large scale data analytics. So, this is at the top layer. The middle layer represents the software layer as an IoT system build on the top of various type of cloud services in the IoT elements. So, this is the middle layer where the sensors, the gateways on the IoT client side, there is load balancer, event handler, message oriented middle ware and there are other cloud related databases like no SQL databases, near real time a real time data processing.

At the bottom layer shows the different tools and services from iCOMOT that particular framework that can be used to monitor control configure the software layer. So, this is more for deploy, configure, govern and control at different type of services. So, this is a typical one example of an IoT clouds system or IoT cloud framework.

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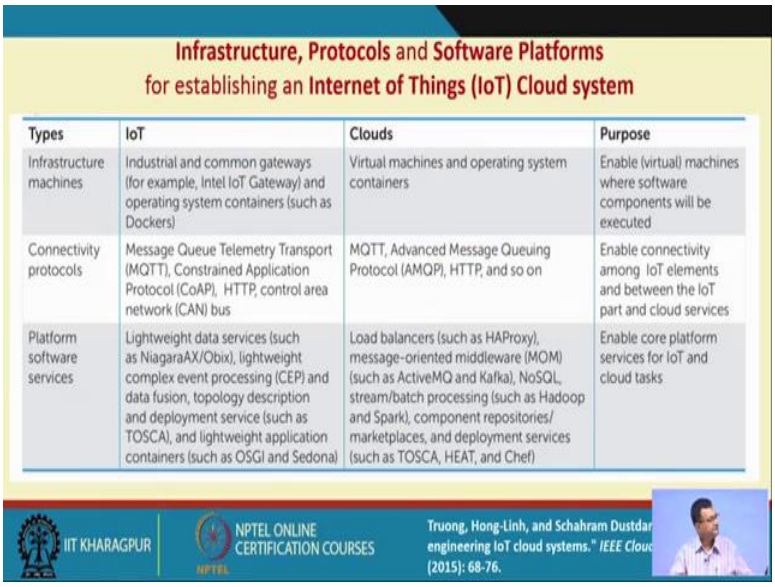

So, there are if we look at the infrastructure protocol and software platform for enabling an Internet of thing cloud systems. So, infrastructure wise in IoT industrial and common gateways, for example, Intel IoT gateway may be thing and operating system containers such a Dockers these are aspects. In case of a cloud virtual machines and operating system containers, so purpose is to enable virtual machines where software components will be executed.

So, connectivity protocol MQTT that is message q telemetry transport constant application was CoAP, HTTP different protocol which is there in the IoT for connectivity protocol in the case of cloud also we have MQTT, AMQP and HTTP and so, for the purpose is enable connectivity among IoT elements between IoT part and the cloud services. So, it this connectivity protocols allows that how to connectivity will be there. There are platform software services which enable core platform services for IoT and cloud task and we have different type of services they are light weight data services whereas, there are load balances such as ha proxy and so on and so forth. So, that means,

for if we look at the different types of infrastructure protocol and software platform which are there is a coupling between this IoT and the cloud to have a unified reason.

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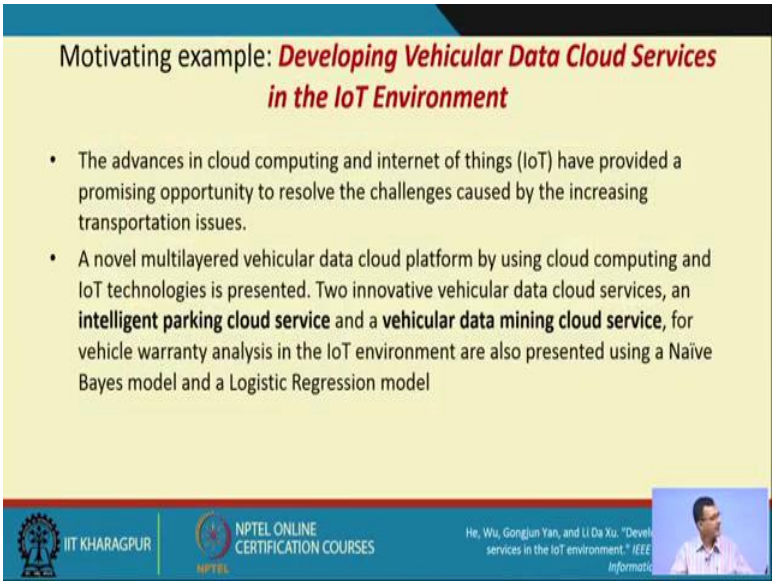

So, there is a small example that developing regular data clouds services in IoT environment. So, advancement cloud computing and IoT have provided promising opportunity to resolve challenges caused by the increasing transportation issue. So, transportation worldwide is a major challenge that how to have safe driving with proper traffic management and so on and so forth. So, multi layered regular cloud platform by using cloud computing and IoT technology has been presented in this work. Two innovative vehicular cloud services like intelligent parking services and vehicular data mining cloud services for a vehicle warranty analysis etcetera are some of this motivating example.

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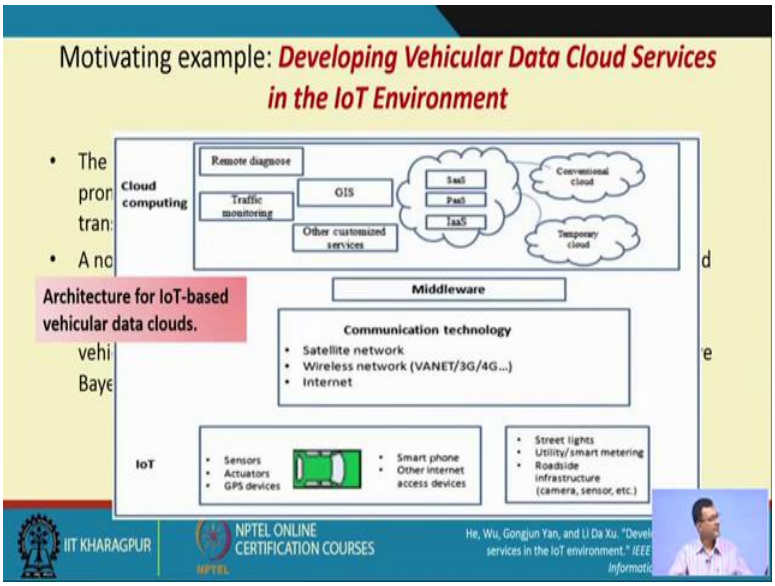

So, if we look at that one side these IoT things are there, we it is architecture IoT based vehicular data cloud. So, different sensor actuator GPS devices smarts phone and other Internet services and we have things like street lights utilities, smart metering, road side infrastructure and so and so forth. So, these are different IoT devices. On the other hand, we have this cloud like remote diagnosis traffic, geographical information system, SaaS, PaaS, IaaS and other things. So, we have a middle layer like which allows this communication technology like satellite network if it is communicating wireless network, like vehicular ad hock network, 3G 4G services and Internet. So, this is allowing this is enabling this merging of information between this IoT devices and cloud for proper decision making or what we can say that meaning full decision making or some sort of a real time or real time decision making.

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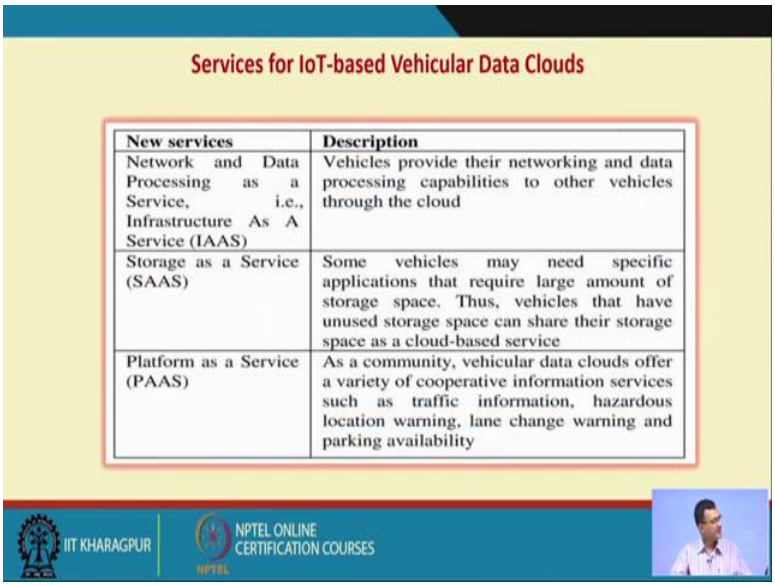

So, if we look at the services of IoT based vehicular data cloud, so there are network and data services as a network can data processing as a service. So, this is a new type of service like vehicle provides their networking and data processing capability to other vehicles through the cloud. There can be storage as a service that is some vehicle may need specific application that require large amount of storage space or a fairly good amount of storage space, which is not there in the may be the OBU or the onboard unit thus the vehicle have the unused storage space can share their storage like other vehicles. Platform as a service as a communicative as a community vehicular cloud offer a variety of cooperative information services such as traffic information hazard location warning lane change warning and so and so forth, what we say in the vehicular ad-hock network terms as a safety related services.

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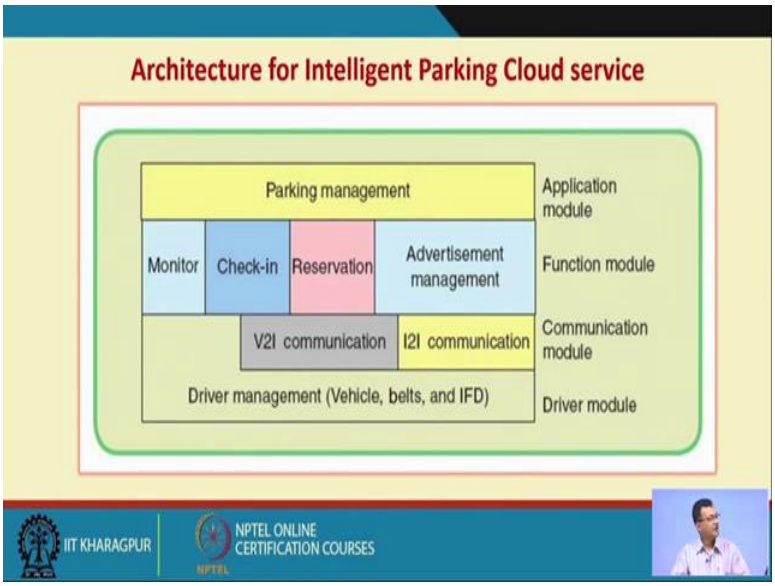

So, similarly another application is intelligent parking using IoT cloud service. Here also we have several things like starting from driver management by vehicle belts IFDs to vehicle to infrastructure, infrastructure to infrastructure, communication there is parking management, monitor checking, reservation advertisement, so there are application module, functional module, communication module and driver module. So, there are different type of modules which are there.

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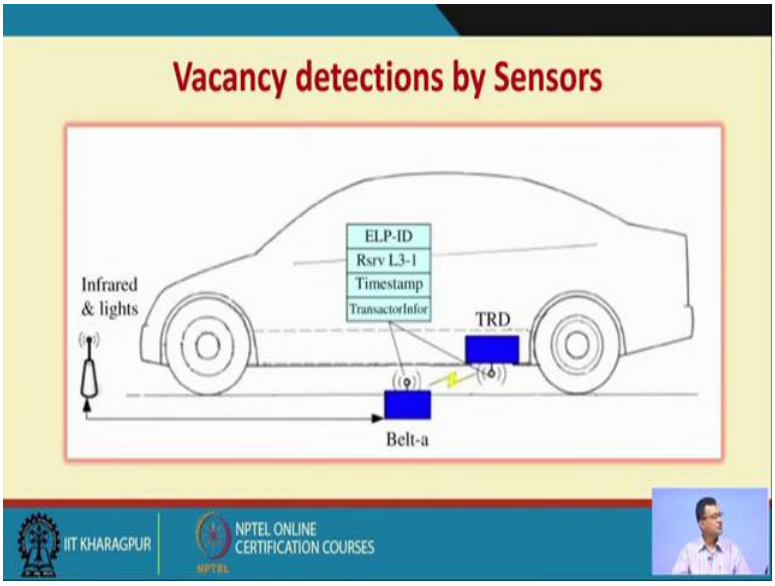

So, a particular car can detect by sensor using it different time stamping that which.

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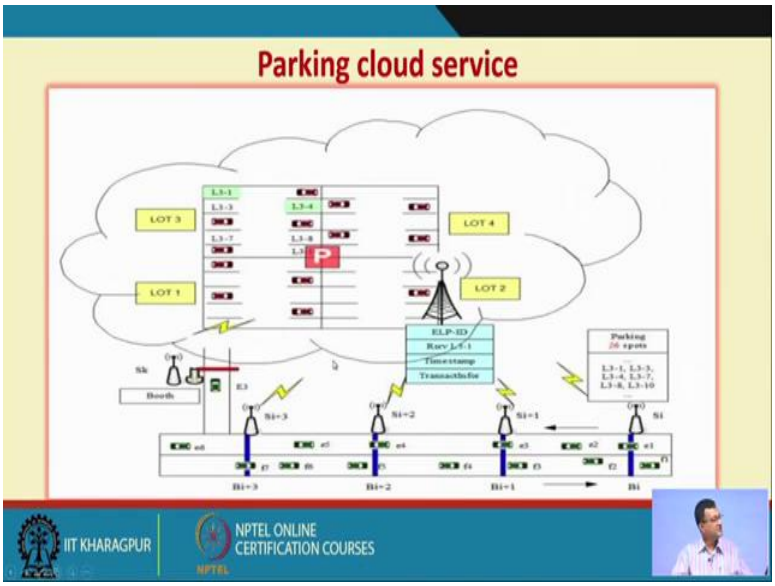

Lane or which lot there is a vacancy and type of things and before approach the pipe parking lot, enabling these IoT through gateway to the cloud can find out that where the vacancies are there. So, this can be one way of looking at that application which has a direct implication of our day-to-day life.

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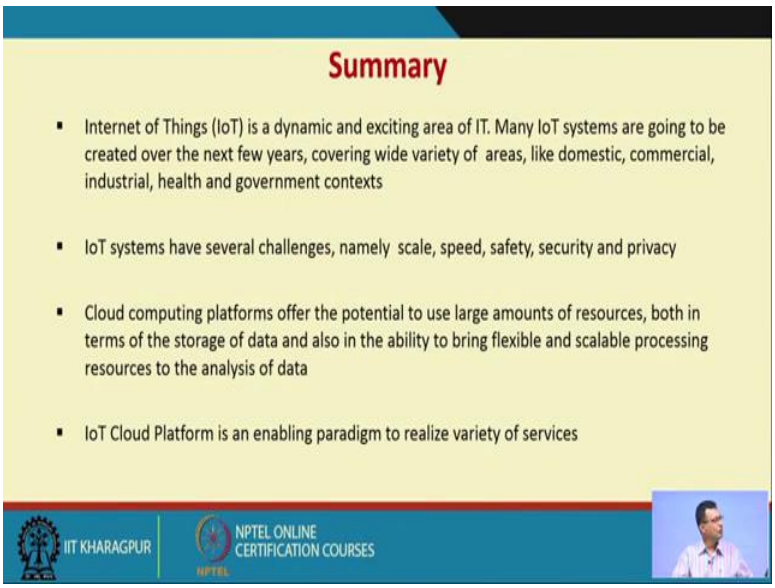

So, to summarize IoT is a dynamic and definitely exciting area. IoT systems are going to be created more and more IoT systems are going to come, and both domestic, commercial, industrial, health and different context and it is going to have a large

amount of processing storage requirements. And it faces thus it faces several challenges like scaling up or a speed of processing safety, security, privacy. On the other hand, cloud computing platforms offer potential to use large amount of resources both in terms of storage processing and have a flexible scalable processing infrastructure.

So, what we see these IoT cloud platform is going to be a enabling technology for our or several futuristic applications, it may be personalized application to some commercial applications to industrial applications, and several type of applications and processing need. So, that is that may be the next things which is coming into the things where it encompasses the cloud, IoT, sensors and different aspects of devices or which can communicate and produce data and communicate to the Internet. So, with these we will stop here today on this particular aspect of IoT cloud.

Thank you.