Introduction to Internet of Things
Prof. Sudip Misra
Department of Computer Science & Engineering
Indian Institute of Technology, Kharagpur

Lecture - 20
Machine to Machine Communication

Machine-to-machine communication we are going to cover in this particular lecture. Machine-to-machine communication is one of the very vital very important concepts in building internet of things. When we are talking about internet of things autonomous behavior is something that we strive to imbibe or test we try to inculcate in this networks that we develop. And for this basically what we have to do is we have to ensure that with minimal intervention how we can achieve different tasks. So, we are talking about sensors, we are talking about actuators, we are talking about mobile phones, we are talking about robotic devices, ground robotic devices, rovers etcetera, etcetera, UAVs and so on. So different types of machines.

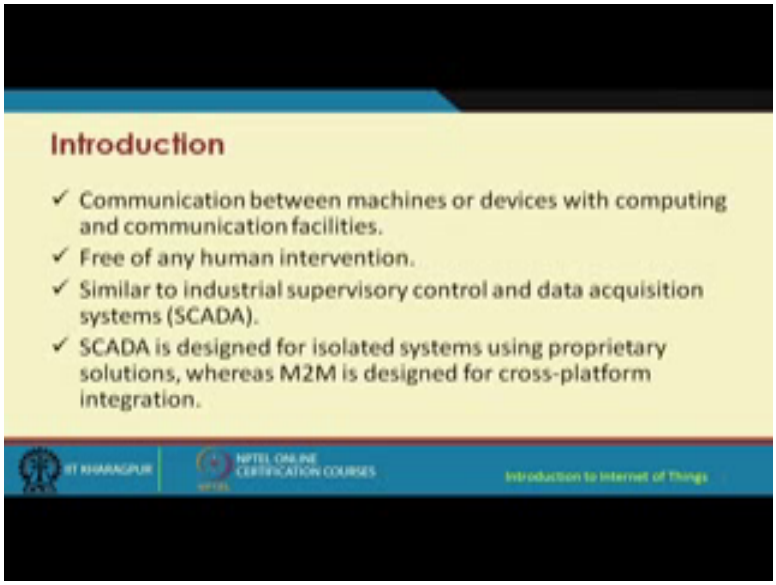
And the whole idea of machine to machine communication is that with minimal or strictly speaking no human intervention how we can have communication between two machines, so machine-to-machine communication right. So, this is what we try to achieve in machine-to-machine communication and machine-to-machine communication is considered to be one of the most important building blocks for internet of things. So, IoT based systems have to operate autonomously if it is let us say if we are considering something like a home automation. Let us consider this particular scenario.

Let us say that we have you know elderly care in a smart home and the elderly people they have mobility impairments typically not necessarily, but it is quite common that there are mobility problems with elderly people. And in a smart home environment what might so happen that there might be some robotic devices, which can be helping these residents of a home to undertake different things. So, we can have a ground robot for example, for example, it can go and open the door of a refrigerator, this robot can go and it can open the door of a refrigerator. Then this particular robot it can even take a milk pot out of the refrigerator, then pour the milk into a glass that milk can be put into a microwave oven. And as you can see that there is no human intervention at all,

everything can be done with the help of machines interacting with machines. I will give you one more example in this particular context.

Let us say that the in the robot has opened the refrigerator and it finds that there is no sufficient milk then either the robot or the refrigerator can automatically send an SMS to the milk person. So, what happens machine-to-machine again there is no human intervention, no human has sent that SMS to the to the milk person. So, this becomes an example of machine-to-machine communication. So, that is why I was telling you that machine-to-machine communication has become very much attractive for IoT based applications involving applications such as smart homes, smart cities and so on. Let us go ahead and look at some of these concepts.

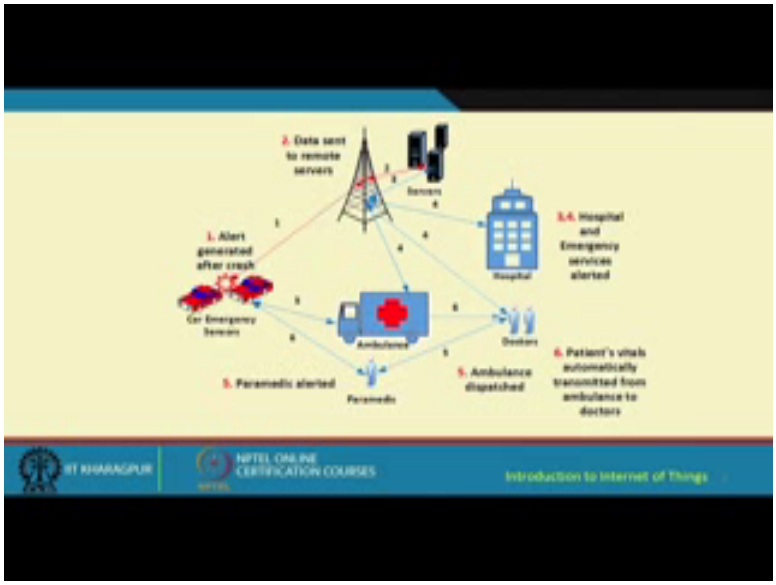
(Refer Slide Time: 04:18)



So, we have communication between machines or devices with communication and computing facilities and ideally or strictly there is no human intervention, there is no human intervention at all. Now, I do not know whether you are already aware of or not traditionally there used to be the SCADA systems. This SCADA systems are supervisory control systems that used to be typically used in industrial plants and so on. So, for you know supervisory and control operations functioning and so on, but typically these used to be not wireless, but wired. So, M2M can be thought of as the wireless variant of SCADA wireless variant of SCADA this is just you know conceptually I am just you know making a comparison with SCADA.

But it is not like you know its wireless SCADA is M2M it is not like that, but you know conceptually we can think of m to m as a wireless variant of SCADA. So, SCADA is designed for isolated systems using proprietary solutions whereas, M2M is designed for cross-platform integration this is very important typically SCADA is used for a single proprietary solutions and on the other hand M2M tries to connect you know cross platform integrate cross platform between different different technologies supporting different platforms. So, even like you know Windows, Linux, android you know all of them different devices supporting different platforms that kind of interconnect can also happen with M2M.

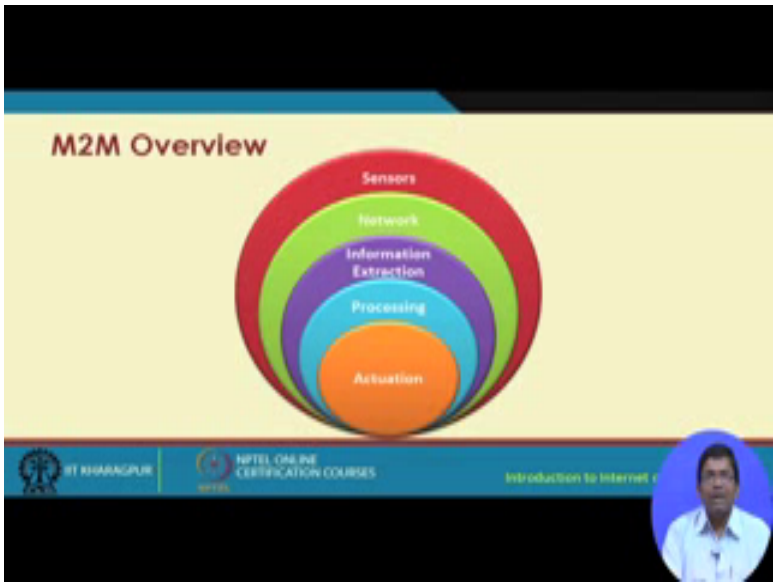
(Refer Slide Time: 06:08)



So, let us consider this particular example where it is some sort of a scenario of offering emergency services on the highway. So, let us say that two cars in this particular example scenario we see that two cars these cars fitted with different types of sensors, emergency sensors collide these cars collide. So, after the crash an alert is generated, an alert is generated and the data is sent to the remote servers. From these servers through these base station that data would be sent to the hospital and emergency services to the patients you know to the doctor sorry to the doctors it can be sent to the ambulance, it can be sent and so on. And accordingly ambulances might be dispatched doctors might be put on alert, paramedics might be alerted and so on.

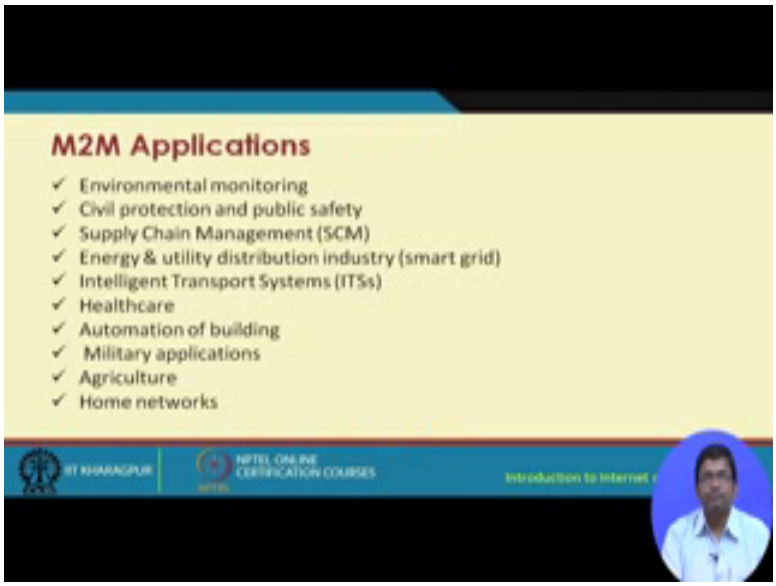
And as you can see over here like this actually the scenario continues; as you can see over here know where the human came into picture. So, everything human came into picture means that humans can be the receivers like doctors receiving the information is something, but humans were not operators or not they did not function any operation on the network right. So, this is completely M2M scenario that has been shown in this particular figure.

(Refer Slide Time: 08:01)



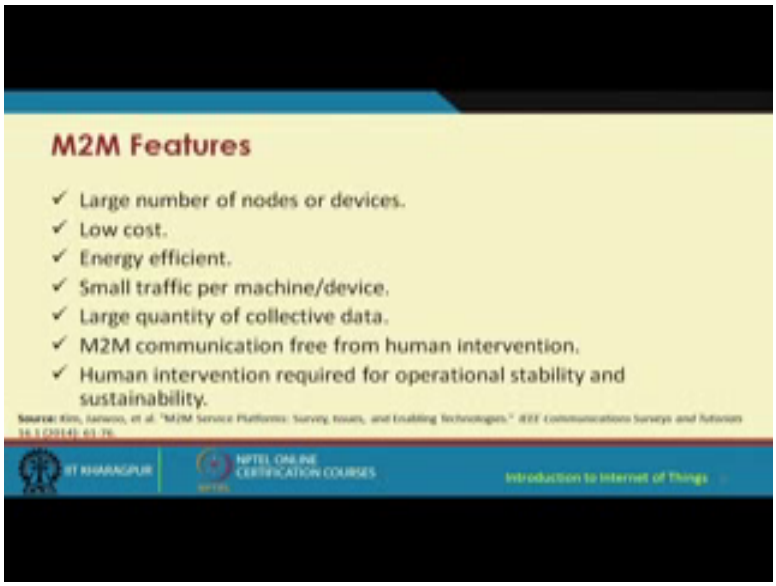
So, in M2M when we are talking about M2M, we are talking about sensors, sensors producing data through the network, information is extracted out of the data that is received, it is processed and if required some actuation is done maybe opening of the valve in an agricultural field if the soil moisture level has gone down.

(Refer Slide Time: 08:28)



There are different M2M applications, environment monitoring, civil protection and public safety, supply chain management, energy and utility distribution as in smart grid, smart grid separately common. In smart grid what we are doing we are using ICT involving sensors, actuators etcetera in a traditional smart grid, so in a smart sorry in a traditional power grid. So, in a traditional power grid we already had flow of electricity in a smart grid we have sensors etcetera, etcetera which are throwing in lot of data which have to be communicated. So, we have communication and networks on top of the traditional power systems, power flow or energy flow. Then we have intelligent transportation systems, healthcare, automation of buildings, military applications, agriculture, home networks all these are different, different applications of M2M.

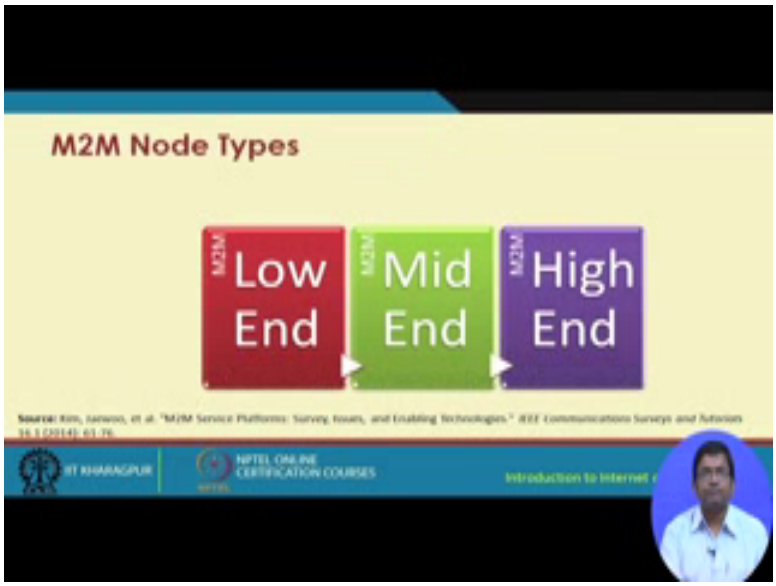
(Refer Slide Time: 09:25)



Let us now look at some of the features of M2M. Let us say the number of nodes that are required. In M2M we are talking typically of large number of nodes or IoT devices which are able you know which where there is no human to intervene they talk to each other directly. These are low cost or energy efficient, these nodes are energy efficient the network as a whole is energy efficient and typically low cost because these nodes are also very small in size, very cheap to buy commercially and so on.

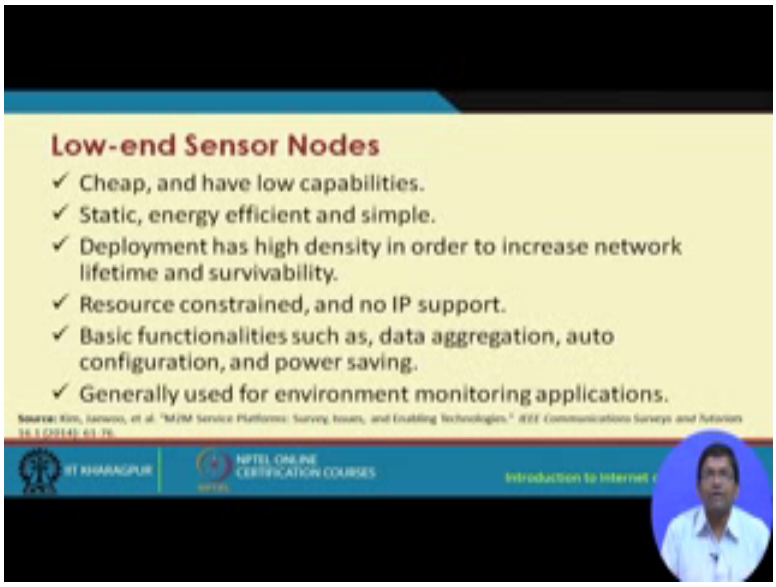
So and there is small traffic that is generated per machine or device, then large quantity of data are collected and the M2M communication is free from human intervention it is free strictly. But you know in practical applications actually sometimes there might be some minimal human intervention, but strictly in M2M basically you know there should not be any human intervention at all. Then human intervention is required for operational stability and sustainability only.

(Refer Slide Time: 10:35)



There are different types of M2M nodes. We have the low-end nodes, we have the mid-end nodes and the high-end nodes. Let us look at the features of each of these one-by-one.

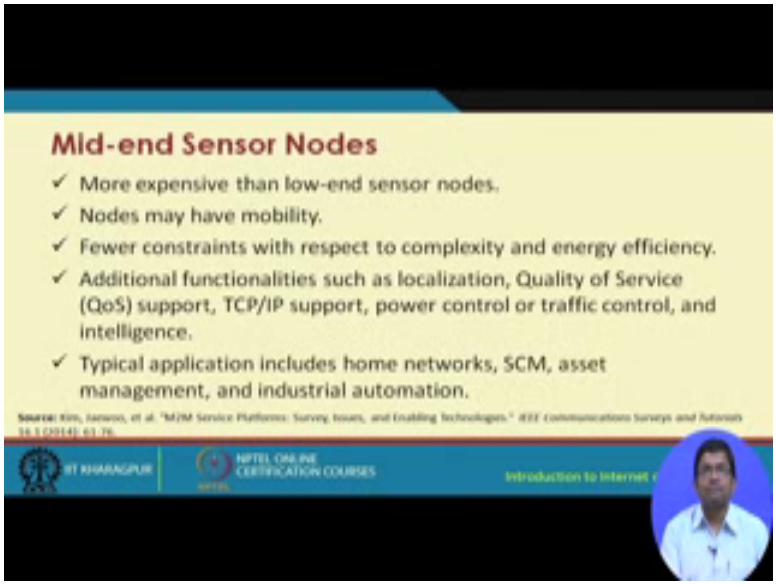
(Refer Slide Time: 10:45)



In the low end sensor nodes we have we are talking about nodes which are low in cost with a cheap and also quite justifiably, they have low capabilities their specifications are very, very limited. Then they are typically static energy efficient and simple these low end nodes deployment of these nodes has high density in order to increase the network

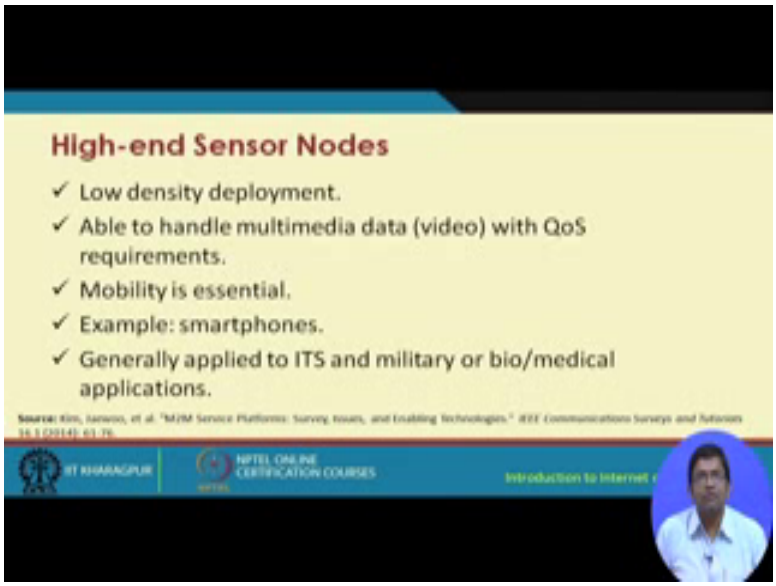
lifetime and survivability because these are small with small space etcetera, etcetera you need large number of them to be deployed in a highly dense manner. These nodes are heavily resource constrained, there is no IP support basic functionalities such as data aggregation, auto configuration and power saving are supported, and these are generally used for environmental monitoring applications.

(Refer Slide Time: 11:42)



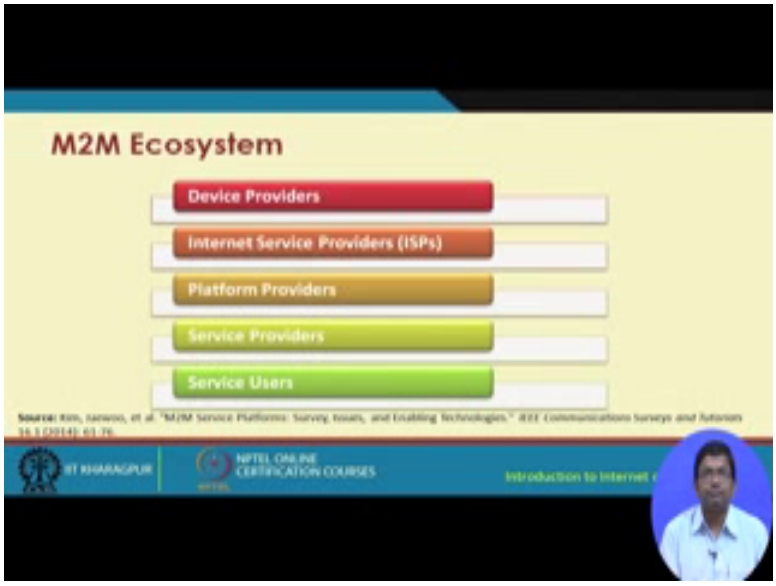
Mid-end sensor nodes relatively more expensive than the low-end sensor nodes have some degrees of mobility have fewer constraints with respect to resource complexities or you know computational complexities, energy efficiency and so on. And they support different functionalities for example, they are not like low-end nodes with bare basic you know functionality not like that. They have some little bit more functionality with respect to like localization, quality of service support, TCP, IP support or control traffic control intelligence and so on. Typical application includes home networks, supply chain management, asset management and industrial automation.

(Refer Slide Time: 12:28)



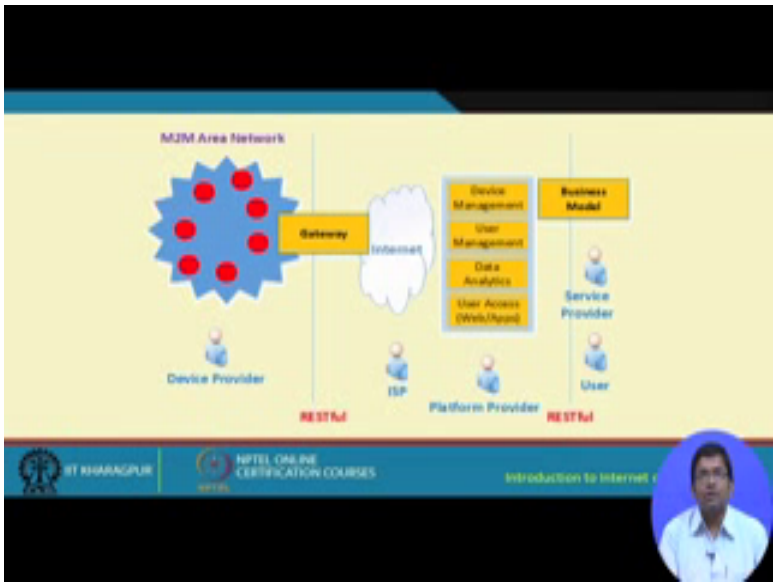
High end sensor nodes low density of deployment, they are able to handle multimedia data or video with quality of service sometimes even quality of service guaranties also they can offer. Then mobility is essential for these nodes you know so like you know these are like full-fledged nodes with lot of different capabilities including mobility as well. So smartphones are good examples of these types of nodes. Then we have these nodes typically used for military or biomedical applications.

(Refer Slide Time: 13:00)



When we consider the M2M ecosystem as a whole we have different components of it. We have device providers, we have internet service providers, platform providers, service providers and service users.

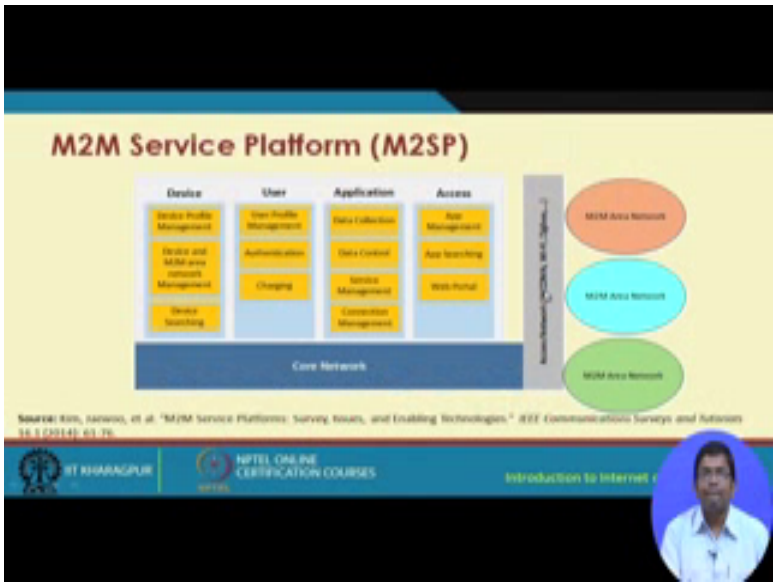
(Refer Slide Time: 13:19)



So, let us look up look at each of these in detail in this particular figure. So, in this particular figure what we see is we have this M2M net area network and we have the device provider the device provider is the one which basically provides these devices which basically is the owner of these devices. So, this is basically the M2M area network. Then this M2M area network sends the data from this M2M devices, IoT devices through this gateway to the internet which is basically handled by the internet service provider. And when it is passing through it we have this restful architecture that basically takes care of it. The restful architecture is a low-end you know low resource consuming resource limited environment it is useful.

And in this case we are using it between as an interface between the device provider and the internet service provider. Then from the internet service provider it comes to the platform provider which takes care of functionalities such as device management, user management, data analytics and user access. And then again through a restful architecture interface you know it is sent to the service providers and the users and the corresponding business model is taken care of at this particular stage.

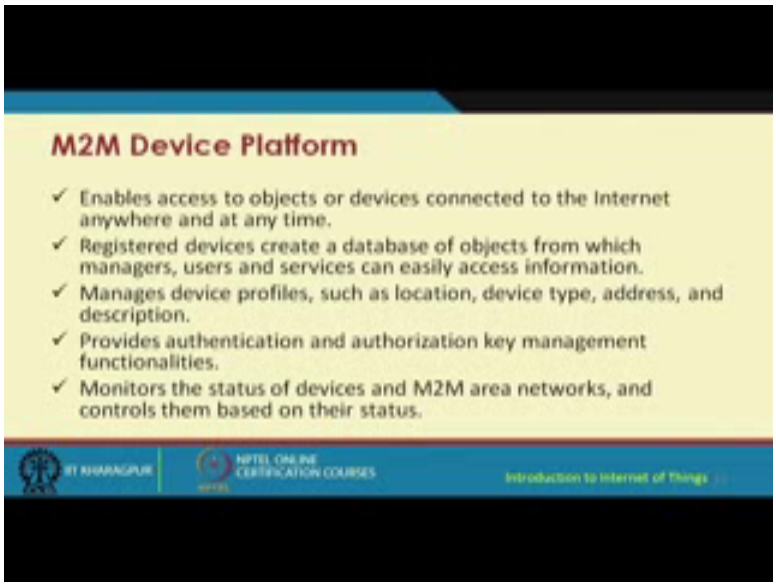
(Refer Slide Time: 14:48)



So, when we talk about this service platform we have the M2M service platform in short it is called the M2SP and in this M2M service platform we are talking about different functionalities of devices, different functionalities of users, different applications and access all these different functionalities right. So, functionalities with respect to device include the device profile management device and M2M network management and device searching. User profile management, authentication and charging are taken care of by the user. Data collection data control, service management, connection management by application. And app management, app searching web portal in the access control

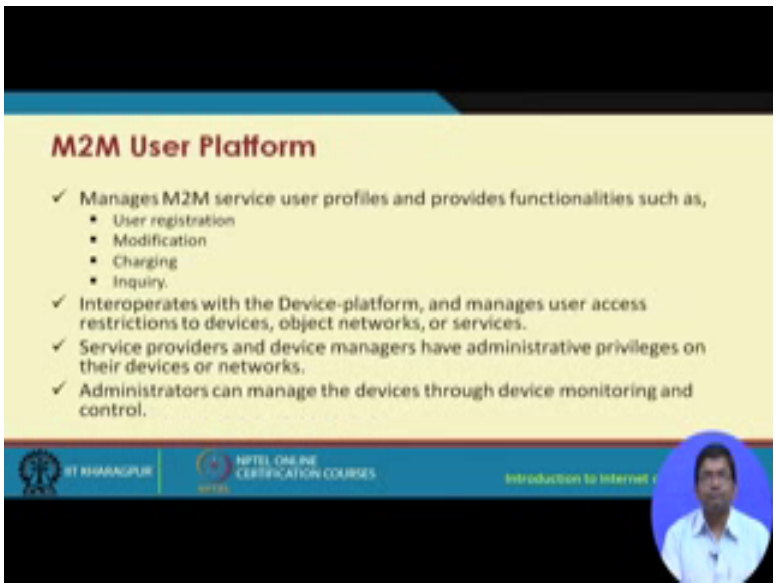
So, all these data are passed through an access network like Wi-Fi, ZigBee etcetera and are sent to the M2M area network. This is one possibility. The other possibility is that from this M2M area network and several such area networks these data are sent through the access network to the core network, which supports these platforms with respect to device, user, application and access. So, both way actually from here we can you know we can either think of it from here when towards the M2M area network or from the M2M area network towards the core network, we can think of both way communication taking place both way. So, the only the flow of the data is different. So, what type of data is flowing that is different.

(Refer Slide Time: 16:48)



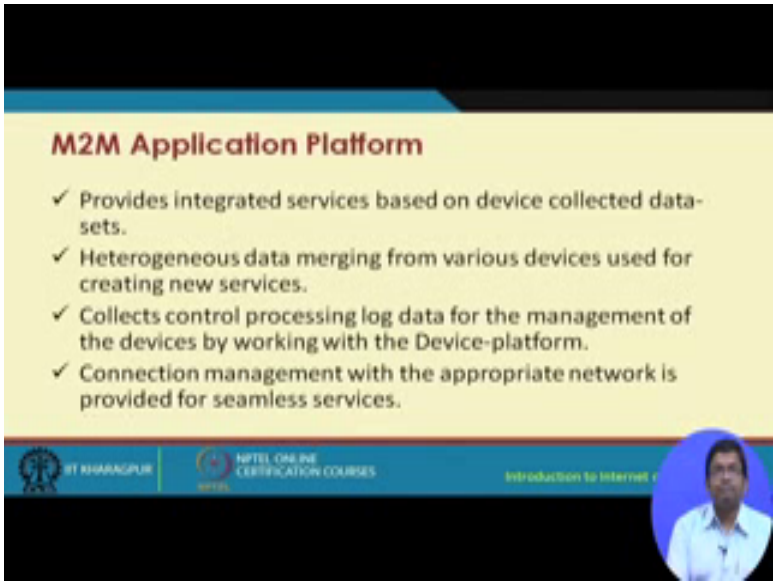
So, when we talk about the device platform it enables access to objects or devices connected to the internet anywhere and at any time. The register devices create a database of objects from which the managers, users and services can easily access the information. The device platform manages the device profiles such as location, device type, address and description. It provides authentication and authorization key, management functionalities and monitors the status of devices and M2M area networks, and controls control them based on their status.

(Refer Slide Time: 17:25)



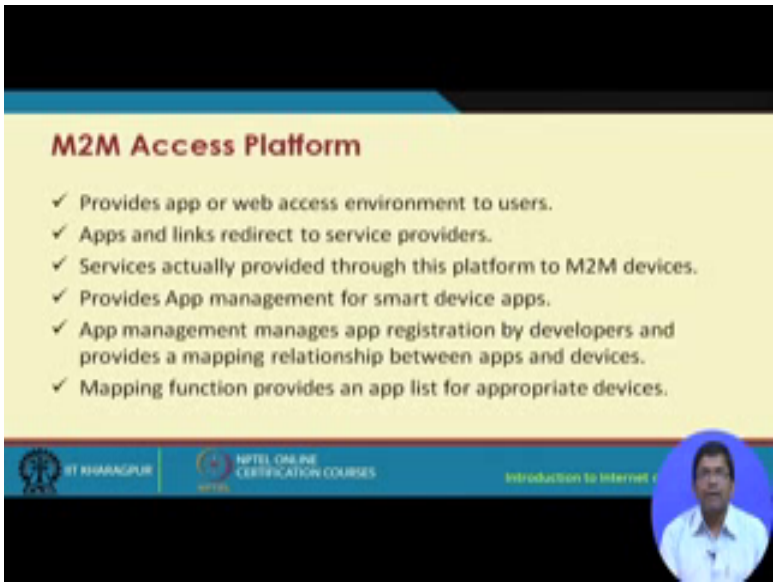
Now the user platform manages the M2M service user profiles and provides functionalities such as user registration, modification, charging, inquiry incorporate. In interoperates with the device platform and manages the user access restrictions to devices object networks or services. And service providers and device managers have administrative privileges on their devices or networks

(Refer Slide Time: 17:52)



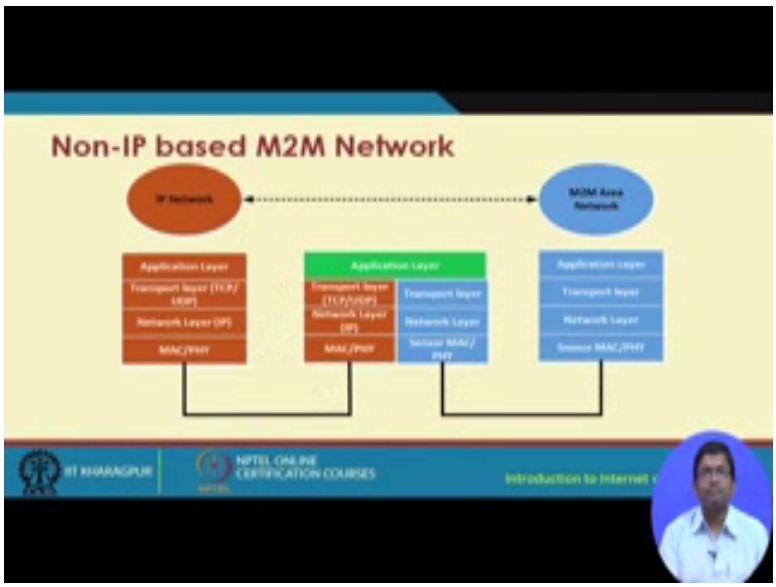
Application platform provides integrated services based on the device collected data. And the heterogeneous data merging is done in this particular platform. From various devices the data that is obtained are used for creating new services.

(Refer Slide Time: 18:11)



Access platform basically provides app or web access environment to users. The apps and the links redirect to the service providers the services are actually provided through this platform to the M2M devices. And this access platform provides the app management for smart device apps.

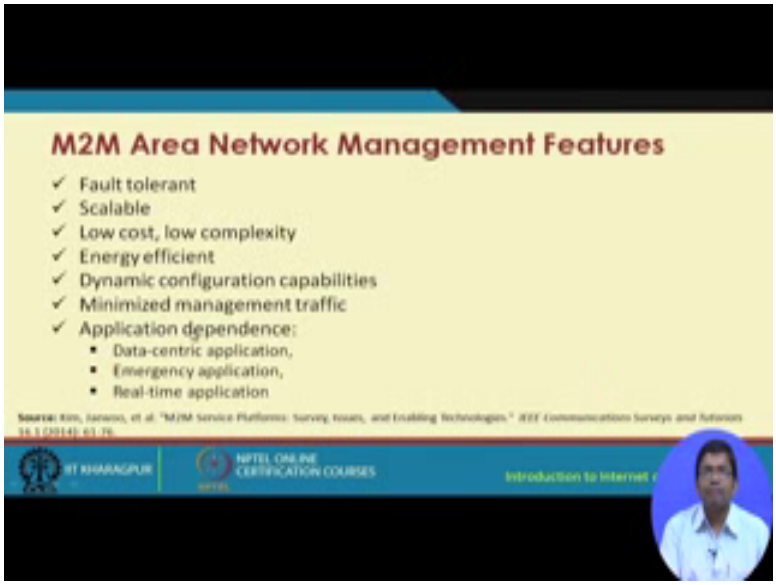
(Refer Slide Time: 18:30)



So, this is a scenario of non-IP based M2M network. So, here what we see is as you can see over here we have a non-IP based M2M area network and here we see an IP based network. And this application layer basically seamlessly integrates these two application

layer basically seamlessly integrates the IP network and the M2M network in this manner.

(Refer Slide Time: 19:25)



Then we have the IP based M2M network where everything was as usual. So, we have the same set of layers application layer transport layer network layer sensor or MAC layer. And this is the same all across M2M area network management features are like this that fault tolerance is a very important if there is some fault system is going to take care of it automatically scalability is another important issue or feature of network management of M2M area networks. So, basically new when we increase the number of nodes M2M nodes or IoT nodes you know that basically does not affect the efficiency quite significantly. So, efficiency is taken care of you know it still remains efficient. Low cost and low complexity are other features if we energy efficiency, configuration capabilities, dynamic configuration capabilities then minimized network management traffic and these are the ones which are important features of M2M area network management.

So, with this we come to an end of understanding more about the basic features of M2M communication. M2M as I said at the outset is one of the important enabling technologies for internet of things and building of IoT based systems. So, in M2M we are talking about two or more machines you know communicating with one another with

minimal or no human intervention at all. So, this as I said is a very important technology for building of internet of things.

Thank you.