Design for Internet of Things
Prof. T V Prabhakar
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Lecture – 01
Introduction to IOTs – Part I

What is important at this stage is to exactly understand what we mean by this internet of things what is the definition of IoT. By far the best definition I could ever look up and understand is from the ITU, what that definition actually says is that it is a global infrastructure for the information society. So, when you say we leave in this information society right, when you say information society it is all about creation of information, manipulation of information, access to that such information right. So, it says global infrastructure for the information society enabling advanced services by interconnecting, physical and virtual things based on existing and evolving interoperable information and communication technologies, amazing definition. Perhaps well done and quite concisely put.

Look at what all it says, it says physical objects and virtual objects, what do we mean by virtual? Virtual are those objects which are intangible you do not see them right. For example, you can talk about a paper which is something physical that you see when you say E-paper or you say E-book its virtual right. So, that is a virtual object. So, it says inter connecting physical and virtual things based on existing and evolving interoperable information that is already what is there plus what are the new things that we are likely to bring in technologies which are likely to bring in. So, that they are evolving and intra (Refer Time: 02:01) information and communication technology. So, that is really the key here.

So, now, let us; so if that is indeed the definition of a what an IoT is, everything around us is a thing what you see around you are actually things, you can talk about this chair which is a thing and you can be talking of this computer or a laptop which is another thing and you want the chair to talk to this computer how do you enable that. Look at what is funny about the, look at what are exactly, what actually I have said. I said a chair and a laptop these are 2 heterogeneous objects and you can just look at how these 2

heterogeneous objects actually work or actually you can enable. One simple idea you can say is if a person sits on this chair the laptop switches on right. So, that is something that one thing can inform the other thing that it has to switch on.

A very simple IoT system 2 physical objects talking to each other with no human intervention for the betterment of many many things like what. It could mean savings in power for instance the laptop switches on only when the person sits on this chair which means there is a sensor connected to the system which senses the presence of a human and once it senses that it gives a signal to the laptop and says now there is a human why do not you switch on right. All through the laptop was off which means you are saving a lot of power right, you are saving a lot of useful power and that way you enable 2 things to talk to each other and exchange useful information for the betterment of mankind right in a very large context for the betterment of the whole system, the whole universe here. So, that is really a very nice definition of what ITU actually put in.

You could actually be even trying to connect virtual objects right. So, it is also says virtual objects, for instance when the person sits on this chair the laptop switches on and opens the E-book. So, now, what is actually happening is the laptop which is a physical thing is triggering a virtual book which actually does not exist, right, in terms of a tangible presence. So, now, the human is actually accessing a virtual object through the laptop which is a physical object. So, all of this actually falls into the paradigm of what, ITU actually defines for what an IoT definition is all about. So, let us leave it at that stage and not get in to hopefully this is a nice way of putting what the definition of an IoT system is and then let us move on to understand this from a very practical perspective of how you can actually put together a nice IoT system in place which will do all the important required, which will meet all the important requirements for us.

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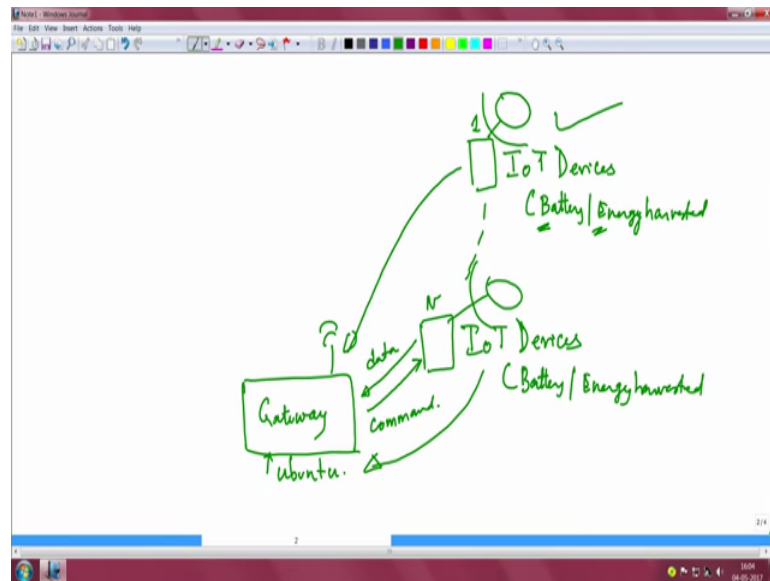
Let me show you this picture. This picture essentially has IoT devices you can see this one device here and you can have n such devices all over right and these IoT devices you can see or either battery driven or energy harvested you could be doing it both ways. All these IoT devices basically are essentially a basically equipped with sensors which sense something from the environments here right, some environment here there all sensing those environments. Basically all these sensing environments are analogue by nature, but nowadays you can also be looking at analogue information directly sensed data is directly processed and digital information being available digital data being available directly to these IoT devices.

Essentially, you could be processing the analogue information analogue dada into digital data and making it available directly onto these devices. So, essentially it is sensing some environment. All of them are pushing data to what is known as this gateway device. Now what is the difference between this IoT device and this gateway device?

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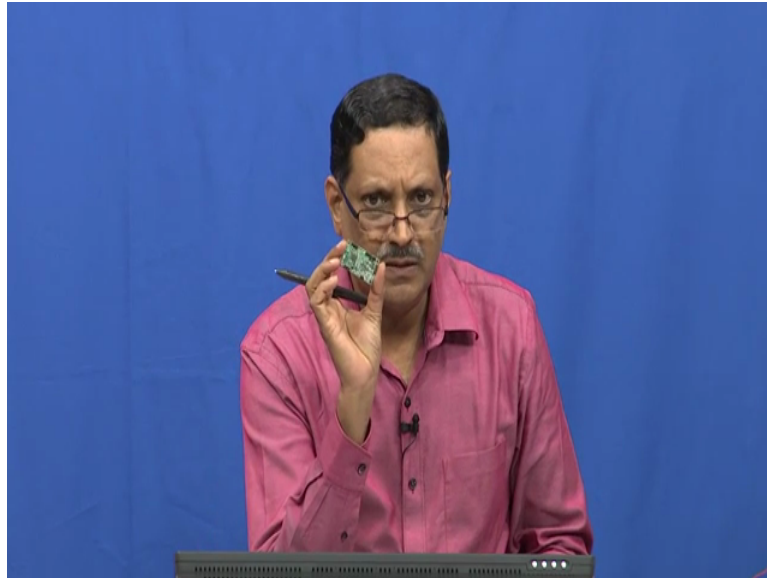
Well you can imagine that a IoT device maybe might not even exceed this size this is a small PCB which has some circuitry here has a chip here, has some connectors here and has some sort of a storage here and typically you can be talking of size which is maybe something like 2 and half centimetres, no I would say let me put the length in place about 5 centimetres in length and roughly 2 or 2 and half centimetres in its breadth.

But if you really talk of a, these are this is I would say the maximum size of what an IoT device can actually look like, but if you look at the gateway device I think they just maintain proper proportion I will remove this gateway and show this gateway a little bigger. So, now, I will say gateway alright. So, this gateway essentially is bigger in size and if you want to know what is compared, what do you mean by bigger in size compared to an IoT device you must have come across many many of these you know off the shelf boards which are available this which includes the raspberry pi is a very good example of a gateway device, beagleboard is one such example, odroid is another example, beaglebone is another example, Edison from Intel Edison based board could be another example, Galileo based board from Intel is another example.

So, you have a bunch of these boards which can or arduino based boards for instance I forgot arduino very important component available, important hardware which is

available and very popular in its usage. So, arduino embed for instance which uses arm cortex at 100 megahertz processors, this also called the embed boards which are there. It could be Intel Edison board, it could be Intel Galileo board, it could be teiza, beagleboard, beaglebone or it could be raspberry pi any of these devices which looks slightly bigger in size can actually form a gateway device. And what should it run? It should run an embedded OS typically something like open source ubuntu. So, sorry this u looks little strange, let me write it again this is ubuntu. Typically it can run an operating system an embedded operating system like ubuntu and it also it is basically Linux distribution, ubuntu is basically Linux distribution and it runs all the required necessary packages which will allow us to connect out.

So, what is the paradigm here? The paradigm is IoT devices are continuously sending data to this gateway device and for what purpose, well if you have to really come and look at what purpose is this data getting transferred from IoT devices to gateway you have to understand that in an IoT system there are some essential blocks. And let me start putting down those important blocks.

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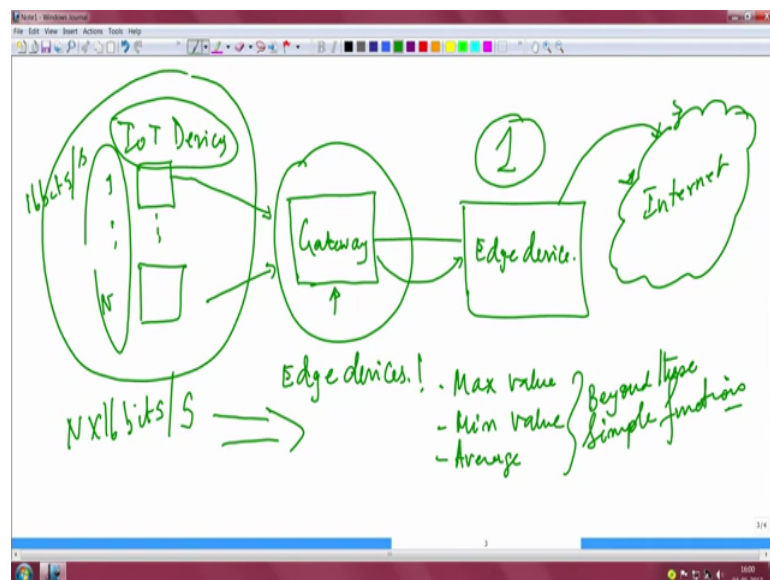
One of the blocks essentially are let us begin with what we understand very well, these IoT devices right, so IoT devices which we know our from 1 to n and we of course, know

that there is this gateway right. So, data is actually going in this direction to this gateway and now we will introduce a new term here. What we will call this gateway? Good essentially not just look like the size of what we mentioned like TI, beagleboard, beaglebone or raspberry pi or Intel Edison Galileo any one of them, but actually a little more bigger it could actually be the size of let us say a typical IP router. So, such a device actually has, this kind of device actually has a bigger name in the context of IoT, and such devices such names are actually called edge devices.

It might turn out that gateways can intern connect to an edge device which means it has to be bigger than that of a normal gateway it is bigger than a normal gate way. It has much more when you say bigger essentially we mean not just in terms of its physical appearance, but also the fact that it can process a lot more data. It can do lot more interesting smart handling of the explosion of data happening from these IoT devices could actually be handled by this gateway device.

It now clearly indicates that you have a choice whether you want to connect this gateway directly out to the internet or you want to pass the gateway to another edge device which in turn connects to the internet right. Either this or this or both right which means the internet system itself can have, let me redraw this and show that this is a possibility to connect, this is a possibility to connect, this is the internet this is a possibility to connect or this is another possibility to connect. Very good and this is essentially what we call the internet right, without getting into the detail, very good. So, why should you have an edge device and why should you have a gateway device, we will come to those details a bit later, but for the moment just assume that you can either do it directly or through this edge devises.

Just to sort of you know make you think a little bit more why these 2 options actually exist let me just give you what is actually happening in today's world. Just look at this picture you have a huge amount of data which is being generated. Assume that 16 bits of data which is coming from an analogue sensor is coming out every second right and there are n such devices, so you have n times 16 bits coming out every second and just imagine the amount of data that you will collect in 1 minute, 1 hour and 1 day huge amount of data, and all the data will either have to pass through this gateway device or

pass through another alternate route.

One simple way is you use this gateway purely because of the fact that these IoT devices do not talk the de facto internet protocol which is essentially TCP IP, they in fact talk something some protocol some simple embedded code which essentially can communicate in its minimalistic way to this gateway and gate way now takes the responsibility of saying ok, you guys have given me data on a protocol that I understand very well. But if I have to push this data onto the internet I have to convert this data into the de facto internet protocol standard which is in the TCP IP. Therefore, you can see now that IoT devices often because of their memory constraint or processing constraint or any one of these being constrained devices are unable to talk standard protocol which puts the pressure on the gateway to do a simple gateway translation protocol translation of taking data from these IoT devices and putting them out on a protocol well understood over the internet LAN, very good.

So, this is one very nice function that the gateway can essentially take responsibility of. Now let us assume you want to make the gateway a little more smarter and you want to tell, let us say there is intelligence on the gateway what kind of data is actually being sensed. It could be let us say data coming from the field, essentially from an agricultural field which could be in temperature, ambient temperature, it could be in pressure, it could be soil moisture, right. And it actually knows what is the kind of data that is being sensed and therefore, what it decides is that ok, now that I know something about the type of data that is being sensed let me do something more intelligent in terms of performing summary of the data that is being collected, in terms of averaging data or picking the maximum value or the minimum value or taking an average and then transmitting the data over this link to the internet.

Often you may do even more complicated analytics on the data you made a lot of processing on the data and that is the reason why gateway often may not be a good choice to give data directly to the internet, instead you ask the gateway device to collect data you collect data and give it to the edge device, so that the edge processing can actually help either duplication, removal of duplication of data or do a lot more complicated processing beyond this, beyond this very important beyond the simple

functions, right.

So, now you have come to this model and I have sort of given you, a sort of a motivation why sometimes it is useful to pass data directly to the internet and why sometimes it useful to pass through a little more powerful edge device. So, which means our first element of the internet of things call it the architecture is finalized, you basically talked about an edge device, alright.

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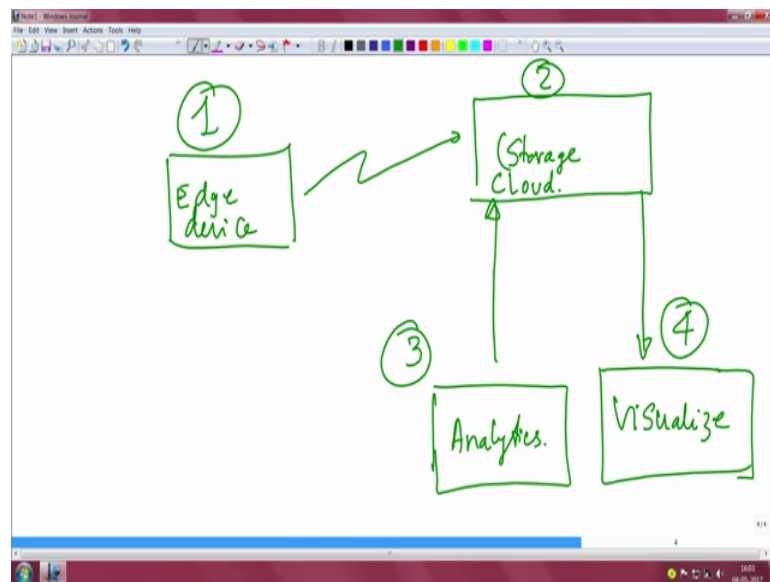
What is the second one? The second one is all to do with complicated let us put down that, first thing is the age device right. Once the edge device uploads data processes the data and reduces the amount of data that is constantly exploding from these devices here, exploding from these device is here, these other data exploding devices and somehow does some sort of summarisation and uploads the data. Remember what it means is it has done some very simple things and sometimes if it is a gate edge device has done something more.

In any case further processing of this data is required which brings us to a very important part of the IoT architecture, storage of the data either locally or on the cloud, it could be either local storage or it could be cloud storage. So, this is the second element you can
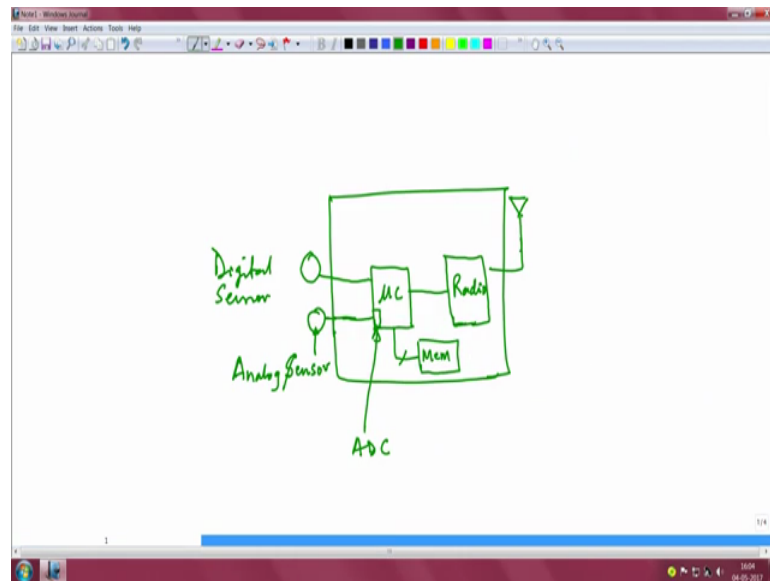
say which is part of the architecture. The third one perhaps once you have rested the data, push the data, stored the data, the racer the data is in the resting condition you want to act on the data and perform another important block called the data analytics. So, you run analytics on the data what use is this analytics on the data if you are not able to use it, if you are not able to visualise it. So, this is the third block, this is the forth block of our architecture which clearly indicates that when you talk of an IoT system you talk of 1 2 3 and 4 all the time. Many many variations exists, many many ways of looking at this whole system can be there storage you need not necessarily be talking of just cloud storage, you could be talking of local storage within the LAN, within the system, within the environment.

In any case there will have to be analytic, so that the data that is stored is made useful you make sense out of the data by running it through analytics engines essentially which will allow you to process the data and of course, everything has to be very useful for us to visualise this data. So, keep this in mind that you have 1 2 3 and these 4 devices, 4 different blocks which form the architecture of an IoT system which means now we have to get into details of each one of these blocks. Of course, our discussion will by and large be around creation design of these IoT devices, how is data transfer to this gateway device. And how do you ensure the data from the sensors are gathered reliably gathered and processed reliably and transferred to these gateway devices.

Let us now see what an IoT device actually contains.

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Thank you very much.