Advanced IOT Applications
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Lecture - 40
Introduction to First Responder networks

So, let us now look at what other applications IoT can provide for you know, socio kind of a socio techno technical problem, that the IoT can sort of solve. One thing is if you look around us and every day you read newspapers, you realize that people are dying for so, many reasons ok. It is possible that there is a cylinder burst people die, there is a fire inside a home people die, there is a bad dilapidated building it collapses or partially collapses people die right.

And many people have not been rescued, because the rescue operations did not come in the first place in at in early time, in a as quickly as it should have. So, that could have also that is also a cause for more deaths then what would have normally occurred. I think IoT can play a very important role there. And, essentially try to solve this try to provide a solution assist in providing a good solution. This prompted US government to start, what is known as an independent network called the first responder networks. The first responder networks are typically clubbed with what is known as a tactical network.

So, I think we should not be mixing the two let us keep it just to first responder networks. Essentially first responder networks primary objective is to save lives in buildings, in homes and so on and so forth. When there is an outbreak of some sort of an incident, it could be fire, it could be you know some other reason why inmates in the home cannot come out, there is perhaps a personal attack on them by some individuals. So, it anything can happen.

So, these people are supposed to go there, this first responder responders are expected to go there and rescue human life bring human life out. Now, it if it is a large building there is an issue of knowing where there are humans, that is people you are trapped. And, first responders themselves have to go inside is not it and they have to rescue people. So, whoever is controlling this operation of rescuing people has two problems on hand; one is to know where humans are trapped. Second problem is where are these first responders who were entered the building to rescue them ok.

So, both are is a so, it is a two kind of a problem. And, first responders once they enter the building, they require a lot of help and guidance from people who are managing the rescue operations from outside to be told what to do? Whether they should proceed or not proceed or whether they should come back and take another turn and go and look for humans there anything you know. So, you need that full orchestration mechanism to be in place before you actually rescue anything.

Therefore, it goes back to what in terms of any course on of that nature goes back to a very important thing, which is localisation again. And, this time you have to localise first responders very accurately from outside and you should be able to guide the first responder to a few things, to a few locations. And, accordingly help the first responder to rescue the humans who are trapped there.

So, this brought the whole issue of the problem of developing or to develop the country should develop a fantastic technology, which caters to the local needs of people depending on the architectural styles of different buildings, and be able to accurately localise the responders first so, that they can intern save humans inside the building. This is a very important area of research, which have the indoor localisation problem is a very important area of research when it comes to first responder networks.

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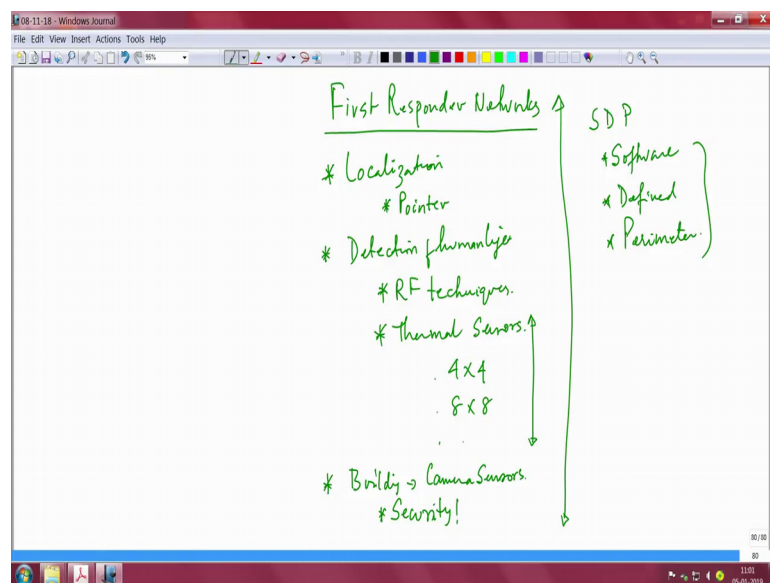
So, I can say first responder networks relate to localisation ok. Although, we did a course of localisation modules on localisation, it was not approached from the problem of trying

to build a first responder networks, but this is important. This is you have to these are a hard problem. Again, it goes back to say what is a good technology that essentially will sort of help us to build.

You know a good accurate way of precisely locating first responders inside a building. Alright, there is a technology there which has come out from NASA, and that technology is called pointer, I want you to look this up pointer to give to get to a feel of how sophisticated algorithm one can have in trying to localise these first responders. It is not just about localisation of responders, other thing is you need detectors, you need detection of human life right, you need detection of human life which means, you need sensors which are which sort of sense people under a derby for instance the somebody is buried under a derby.

But, just the hand is out or only the leg one part of the leg is out this is in a situation where there is a building collapse or a partial building collapse. The human is alive, but you want to know where the humans are in a heap of derby and you are looking for human life there. So, you may want to look for certain signatures, which are available for you know for, which can accurately say that there is human life under the under the derby. Several I would say R F techniques available are available ok.

R F techniques are available micro wave and R F micro wave techniques are available, for detecting you get you extract signatures from the R F signal to come and to come and say that to conclude, that indeed it is there is a human or no human.

Advantages, it is non-invasive, you can do it from some distance and you could essentially, you know go after once the signature says that there is human life you could go there and rescue people. But, that is just one way it is an expensive technology and IoT definitely will look for other alternatives, if it is IoT solution will look for alternatives.

One other alternative is related to thermal sensors ok, when I say thermal sensors these are heat sensors which detect heat radiation coming from human body. And, they are so, they can absorb this radiation and sort of you can run some simple algorithms to conclude that there is a human, or whether it is something else.

Because, when you talk about heat and heat IR radiation, several objects will be surprised that if you put an IR sensor, the thermal map may be very prevalent, even if there are no humans insider, because several objects giveaways this IR radiation, sometimes tables, chairs, and so on they will all give you a lot of clatter. And, they are it could be just that when the building is has collapse and say if fire is excited at some point, that fire heat itself can you know overwhelm the I R sensor and detection can go completely a stray.

So, you have to be careful about your design of algorithms. And therefore, thermal sensors are good, but you will have to take care of this, you know these what should I say a lot of false alarms, which come by just the heat radiation. So, you can look at them there are array of thermal sensors available you have 4 cross 4 thermal sensors, and then there are 8 cross 8 thermal sensors, and one can move on to higher, you know array of sensors and the sensors can essentially detect a human life. Well we tried a little bit here and I do not have a mature solution at the moment, but it is definitely something that you can try.

The good thing about these thermal sensors are 4 cross 4 or 8 cross 8 are there low in energy consumption. They are small in size, they can be mounted on any small you know sort of a bug right. And, then install put inside on you know install it on the bug, and let the bug, battery driven bug go inside and you know sort of get hold of the thermal map and use the data for analysis of humans or otherwise.

So, these are things that are very much possible. A third possibility exists that the building the building already has whichever building is under attack, or building is under fire, or whatever has some sort of camera sensors already. Because, nowadays you know applying video cameras there is quite common, in several buildings.

And, this camera sensors can aid giving you pictures, live pictures in the event, in the event you know give you give live pictures to this first responders. But, the first problem that will come is how do you trust this, how does the camera system, trusts the first responder, that it he or she has come to rescue them and there for share the pictures.

So, that indeed is in is really a problem. So, I as mentioned to you right on day 1, that we will talking about first responder networks and you will be saying how to save human life and all that. But, very soon will get bogged down to technologies which will enable

such things. And, often it is the it is these technologies which can you know sort of be a big hurdle in succeeding and coming out with a very good first responder solution ok.

So, sometimes it is the other way, there is a very good technology, but there is no proper use case. And, in sometimes there is a very good use case for application, but technology does not allow you to be a to apply it in a free and fair manner, and transparent manner, and in a trust full manner. Trust has become a major issue, why should we camera sensor share it is data for a to a first responder without knowing who the first responder is right.

We as humans know that so and so, as a first responder, but about how does the camera know? So, here is the problem. This all brings us to some new things which are coming up in the area of first responder networks with the IoT there security of the solution becomes very very critical. Therefore, here I would say building camera sensors, but security solutions, security has taken a 4 front of everything. Now, I will point you to something that has come up recently just to answer this problem of security. And, that is related to what is known as SDP, it stands for Software Defined Perimeter ok.

This is this is a very nice framework, which is coming up in a big way and that will allow, because you have a software defined perimeter, you have the ability to add, you have the ability to add devices in a secure manner. And, therefore, you will be able to share data rather in a secure manner ok.

So, you have devices to be added and sharing of data. Traditionally, if you look at IoT and security, while there are so, many possible solutions that people talk about cryptography itself is quite mature. But, crypto analysis is something that people you know continue to you know find it exciting a lot of challenges in crypto analysis breaking keys and so on.

But, cryptography itself I do not think any major you know changes have happened in the last one decade the same set of algorithms are popular. And, it is only where the crypto analysis, where there is a lot of challenges how to what kind of compute you require, what kind of algorithms you require if you want to break keys. So, that is what people are putting effort on.

And, of course, I mentioned to you that devices device identity, unique id generation of unique id these are harder issues which IoT should try to in the IoT framework we have

to try and solve them. If, you want to look at you know first responder networks and so on. Traditionally, IoT devices cannot be in let us say you know in a secure part of a network it cannot be, because it is looking for services or it is offering services. So, all of them will have to be outside the other side of the firewall right. And, therefore, there is always the risk of IoT devices being you know attacked.

And, some sort of you know cyber-attack on these devices and all that. Given that situation how will a camera sensor, which is also an IoT device. Can actually fall into this framework that is where SDP comes into the picture. And, I have a nice you know paper which was written sometime back and published in the IEEE and I thought it will be best if I describe that paper.

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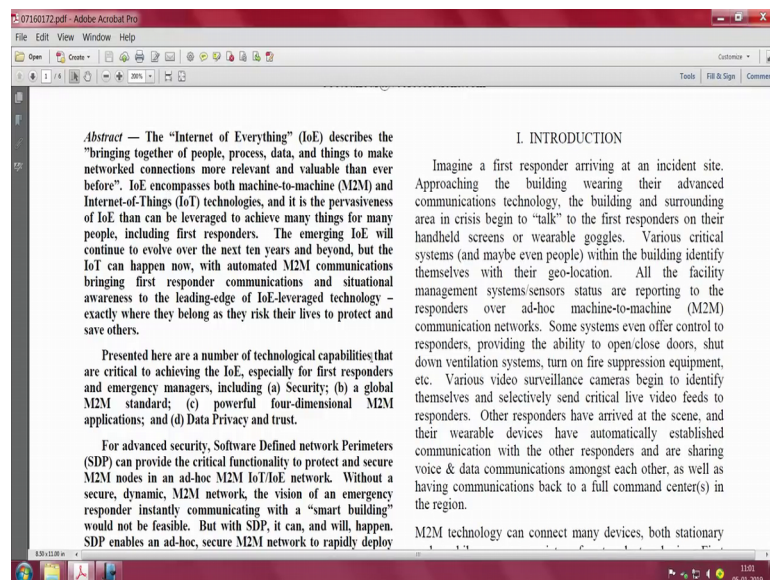
So, let me expand this to 200 percent, 150 percent, 200 percent and then let us see, what they have to say here? Look at what is written here, it says already imagine a first responder arriving at an incident site, and the person is wearing some advanced communication technology he wants to in there is a crisis in you begin to "talk" to first responders on their handheld screens or wearable goggles right, and their conversing amongst themselves ok.

And, then there is they are in a so, there are many critical systems in the building, where even people who are there in the building, and they have to identify themselves, these people have the problem that they have to identify themselves accurately properly, before

any data can be shared from the building alright. So, these are all essentially falling under the machine to machine framework. And so, thy have to these camera sensors have to talk to those systems which are, those handheld devices which are held by these first responders humans. And, security keys have to be exchanged and that to be trusted and then only then the data can start coming out.

It is need not be just the data part, it can also be that there are once you trust you want to open close doors, you want to shutdown ventilation system, you want to open fire suppression equipment, several things including video surveillance cameras, which may want to send a critical live feel. All of that should happen once these responders come there and thing should happen automatically. And, in real time right only then any of these IoT technologies are actually going to be very useful.

As, I mentioned to you all these devices which are part of the building have to communicate to devices which, the first responders are carrying. And, all of that should happen seamlessly meaning, it should be M 2 M ok. So, it should be machine to machine communication and you know there are several IoT protocols which will which support M 2 M communications.
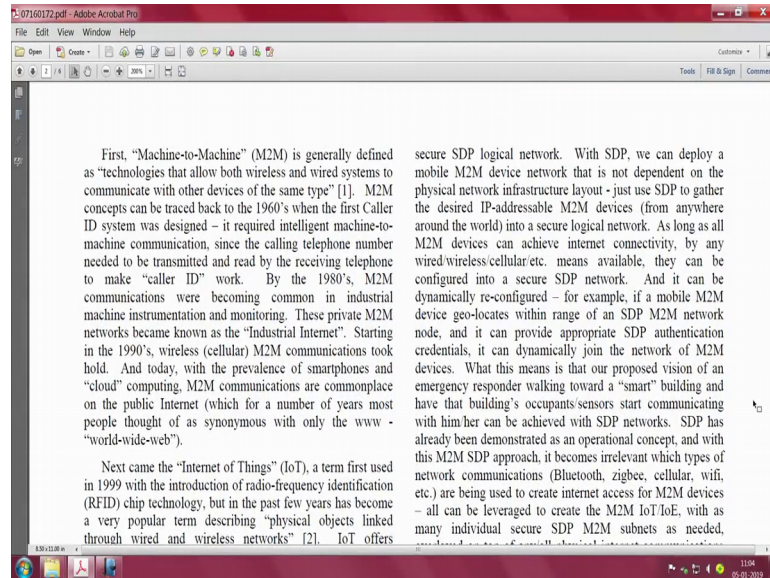
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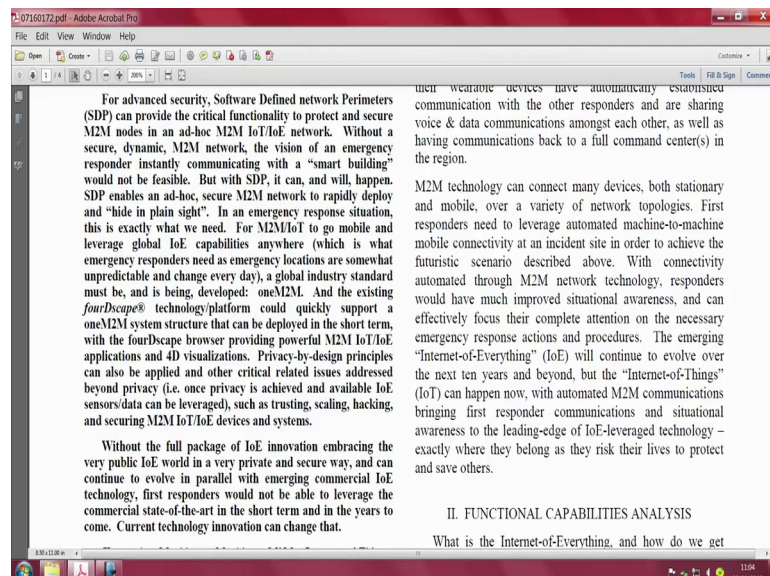
So, let us not get into that alright. So, here we have the situational awareness that responders, it should have the connectivity automated with the M 2 M network technology, responder must should have much improved situational awareness. And,
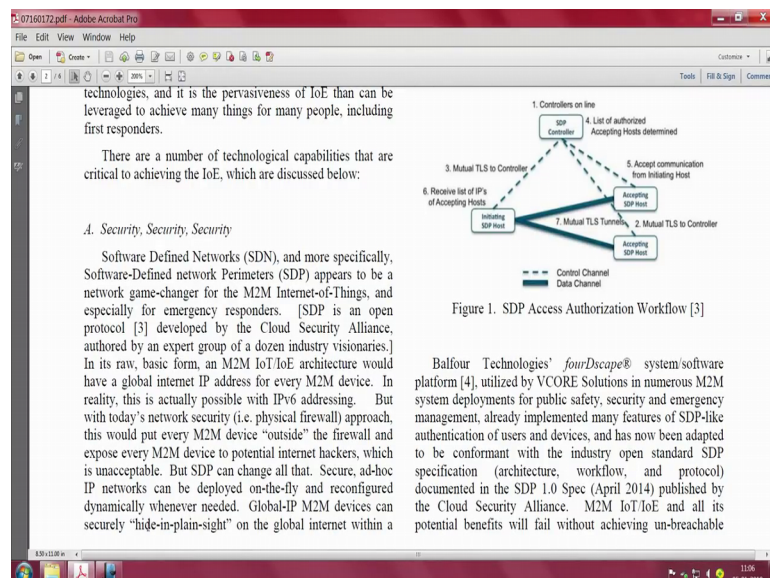
therefore, they can focus on rescuing humans and therefore, internet of everything is a key driving part here.

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Now, if you want to do all of that, we will skip this M 2 M part because that is something that people have all, I think you other courses would cover that.

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So, let us just look at the requirement for SDP, which is the software defined security. So, software defined parameters frame work. So, here it says that he is essentially it is going to be like a big game-changer for Machine to Machine Internet of Things. Because of the

following reason that if you look at a I o T devices that are there, they will all be in the in the 20 30 billion devices that are likely to come up. Each one of them will have an IPV 6 address; that means, they are easily addressable from anywhere on the internet.

So, security is really an issue and if you look at network security, if you look at fire wall and all that, every device which is an IoT device has to lay "outside" the firewall and essentially getting exposed to you know internet hacking and all that. So, there is no way by which you can have you can do both. Expose an IoT device as well as keep it inside the firewall, it is not going to happen, that is not going to be easy.

So, you will have to find out a way and to expose the device and yet keep it secure, that essentially means you must do "hide-in-plain-sight" somehow. And, SDP is really an answer for this kind of hide in you know you know basically "hide-in-plain-sight". So, what is the framework under which SDP works? It is just not so, let us look at that part very carefully, look at what the sentence is with SDP, you can deploy an M 2 M device network, that is not dependent on physical network infrastructure layout just use SDP to gather desired the gather the desired I P-addressable M 2 M devices, into a secure logical network.

So, as long as M 2 M devices can achieve internet connectivity by any wired whatever be the method, they can be configured into the secure SDP network. And, once the first responder's devices set of devices which form a network, and the building infrastructure devices are part of the secure network, then several things open up for people you know for first responders to actually save people inside the building.

So, this SDP framework will allow you to do all of that. He gives you an example if a M mobile M 2 M device geo-locates within range of an m SDP M 2 M network node, it can provide appropriate SDP authentication credentials, and it can dynamically join the network. What this means is that the proposed vision of the emergence responder walking toward a "smart" building that have building's occupant sensor starting communication with him her can be achieved with SDP networks.

SDP has already been demonstrated as an operational concept and with a M 2 M SDP approach, it becomes irrelevant which type of network communications you are actually talking of so, it is agnostic to any link layer technologies out there. All of them can be leveraged to create M 2 M IoT network with as many individual secure SDP subnets as

needed. So, how does it all work and how does this critical functionality come about? You can see that network access authorisation workflow is shown here there are two types of channels here, dotted line indicates the control channel and the thick line indicates the data channel and there are numbers here.

You see the SDP controllers so, let us pass through this 1 2 3 4 5, which will essentially give you an idea of what is what exactly plays out here. And, then 6 7 essentially being the last 2 steps 7 actually being, the last step towards sharing the data. First is the SDP controllers are all several of them are online and there are accepting SDP hosts ok. So, you can see accepting SDP host is here one of them is here and the other one is here right both of them are accepting SDP host.

And, they are essentially you know registering with this SDP controller, and then what actually happens is there is an initiating SDP host. This could be like a first responder's device which wants to connect to the building network. So, there is a an initiating SDP host that is also on a dotted line. Once the so, this happens 1 2 and 3 happens 3 is actually mutual TLS to controller. So, everything is based on transport layer security or TLS to the controller. Four, essentially means that list of authorised accepting hosts are determined at the SDP controller, there are many who may not want to become accepting SDP hosts, but there is never the less a list of authorised accepting host which are determined.

And, then 5 is accept communication from initiating host, that is this is the initiating host who wants to connect to these 2 accepting SDP hosts and now that SDP controller has given the list. Now, it knows that the IP addresses are not available right at the initiating SDP host. So, receive list of IP IPS of accepting hosts. And, then the initiating IP SDP host directly can contacts the accepting hosts with these thick lines which is essentially for gathering data. So, till such time the SDP controller initiates everything and makes available the IP addresses.

The initiating SDP host cannot get data from any one of them. And, that is essentially establishing all these mutual TLS chart you know tunnels between SDP host and accepting host and all that and only then data can flow. You can see now we moved away from first responder networks to a framework, which is meant for secure transfer of data between initiating SDP hosts and you know accepting SDP host, which is a quiet strange

that why did we move away from an application into something which is a very specific to a protocol framework and so on.

But, this is not correct if you think that way because if you want your first responder network to succeed, whatever solution you are trying to put you have to Co design with security. And, this is a framework and I thought it more relevant for us to describe SDP here, rather than in a security module right.

So, please co design your first responders solutions with security built into that system is a classic example of how you need to do co design of any solution? So, that is the reason why this part comes up here.