Spatial Informatics
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Lecture - 40
SDS / Spatial Cloud / GeoViz – V

Hello. So, we will continue our discussion rather today is the final lecture of this particular course and we will see some aspects of geo spatial cloud and also little bit discuss on the visualization aspects or Geo Visualization part of it, right.

So, as we are discussing in last lecture or in several lectures; so, what we have seen this cloud this spatial operation; spatial starting from spatial database, spatial data analysis to spatial data sciences. The one thing we have seen that this data are enormous in size right also both require both compute and IO intensive, right this one aspect of it.

On the other aspect what we have seen that some of the applications or most of the applications the requirement of the computing thing may not be constant or at the peak level throughout the means throughout the lifetime or through outs that day night type of applications right of things, right. Or in other sense this there is a requirement of going at a higher things higher compute and storage and type of things. In some cases again there is we have a slack period or not so high requirement.

As these are very much IO and compute intensive. So, there are this, so called hardware software running on the tools, a software or platforms these are pretty costly affair. So, it will be nice that if we have a scalable structure like when I require I go on hiring the infrastructure. If I do not require I go on releasing the infrastructure, right.

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So, that is why last class if you remember we discuss about huge volume of data and metadata, this properties or of spatial data and services need of services and service orchestration. Evolving standard and policies, and so whether there is a new need of geospatial cloud.

So, before going to the geospatial cloud per se what are will be properties and type of things let us have a quick discussion of what is a cloud thing and why it may be really went out over here, right. So, I believe that you most of you have a exposure to cloud in some form of other or at least have a have know that what how a cloud works, right.

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So, if we go for this NIST definition of cloud computing. So, it is a model that enable ubiquitous, convenient, on demand network access to a shared pool of configurable. Computing resources like it maybe network, server, storage, application, services that can be rapidly provision and released with minimal management effort or service provider interacts. So, this is the quote unquote definition of NIST right.

And, if you see our this spatial application data and services quite fits into the structure. So, it can be a provision and released when it is when there is a requirement or not and without minimal admissive. You do not have to have lot of management intercepts a or intervention to do that, right.

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So, typical characteristics of generic cloud which is valid for air also it is first of all on demand self service, when you require you can go on increasing it is as good as our electricity connection or a services like water service or even telecom service right. On demand self service or what we say pay as you go model I pay and I get the services, ubiquitous network access I can have any type of accessibility, resource pooling I can pool more resource when things are required.

Location independent it is ubiquitous in the sense that anywhere I can do that rapid elasticity. If I required I rapidly grow up in the things, if I do not require I release the material. So, this is another thing and measured service so it is like metered service right, whatever I use I pay for it and there is a concept of virtualization.

So, I have a virtual instances right. So, I have a virtual machine of so oh memory. So, it is gives me a feeling of actual machine, but it is a virtual machine likes those who have use cloud you see that you can provision; you have seen that you can provision VM's from the service providers with a particular configuration with a particular duration and you pay for it, right.

So, this is very convenient when you work suppose I want to do a some data analysis spatial data analysis of Kharagpur campus and then generate some map and then stop. So, every month once I want to do it, right. So, one is that I purchase those infrastructure and make a set up a lamp right, but if it is only requirement; if the requirement that

continues research is going on students are working on it that is pretty fine. But, if it is only requirement then you have a trouble right then you have a you may have to pay more on it.

So, in other sense I can provision a virtual machine. So, like I require 128 GB ram with say 1 terabyte or 10 terabyte data this space with the different type of thing. So, many processors or so many GPU etcetera you provision it right. Work it for that 1 day, 2 day and then release it generate the things and release it, right. So, that is a I create a virtual machine.

So, virtual machine can be a infrastructure wise or it can be a virtual instance of a software and type of like this, right. So, we are somewhere using different type of tools which are using this sort of a cloud services.

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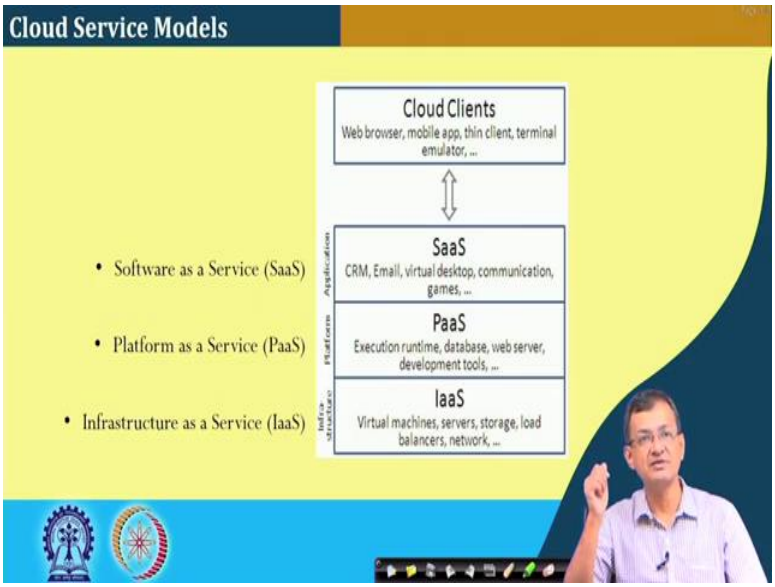

Typically if you look at a cloud there are three type of service model. One is what we are talking about IaaS infrastructure as a service where you have virtual machine, server, storage, load balancer, network etcetera. These are as if visualizing the physical infrastructure.

On the other hand at the top we have a SaaS type of service right, software as a service like CRM, email, virtual disk, gaming software. We can have say SDI as a service right or special data infrastructure as a service or GIS as a service, right. So, these are the

things which we can have those services as a which are at the thing as a software and service I do not care.

So, the software's are running somewhere in the underlying hardware and type of things, but I do not care about that I am more, I am paying for that software as a service right. So, and intermediate there is a concept called platform as a service like executing runtime, database, web server etcetera. You want to develop something over the things, you require a database service which runs on a hardware I do not care about it. I require the say this database with spatial extension these are the features I require this sort of web server I require. So, that is a platform as a service, right.

So, these three things based on our requirement I can provision it, right. So, these are follows all those properties of things what we have discussed characteristics of things. And client like that like when I am using I am a cloud client, I can connect it by a web browser, a mobile app, thin client, terminal emulator etcetera and connect to the things right. So, this can be a way of looking at it.

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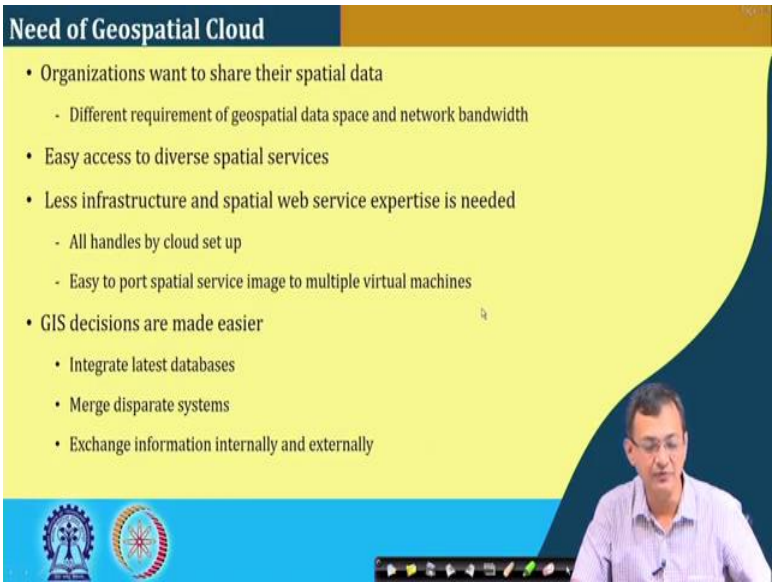

Need of geospatial cloud; so, this is a very brief overview or very very brief overview of the cloud things. So, we have different type of services, it can be provisioned as and when required and can be released whenever the, I do not require that service and there are I can have different application of spatial related.

Now, why we require this geospatial cloud which is becoming a very much requirement here. Organization wants to share their spatial data; now, most of the organization are having or mostly all organization now storing organization related to spatial domain or even non spatial domain. A storing that data in some form some or other form of digital services digital form right. And wants to share that spatial data may be at a cost or with some restrictions, right.

Different requirement for spatial data space network bandwidth comes into play. So, we require for processing etcetera. You require compute power by sharing you require different bandwidth, where storing required some storage space and that is purchasing, maintaining all those things are becoming a not only costly affair. It is also a lot of management issue from the organizational part.

Easy access to diverse spatial services, so another maybe that I how do I access different type of services. Nowadays we are using different maps for finding the roots of a particular things going to a particular location, searching a things, looking at the facilities and type of things, right. So, those are things which are easily accessible provided some mechanisms are there. Less infrastructure and spatial web service expertise's is needed.

So, for a some of the organization where mostly the domain expertise are there then I require that minimum infrastructure. Because infrastructure has lot of other things like those who have experience with having different type of server, creating server room, server infrastructure at times. The cost of the computing infrastructure and cost of the supporting infrastructure like ac power manpower supports and etcetera security and all supports are matching. If it is say x unit cost that is also extremely, sometimes that supporting infrastructure is more costly than the actual compute infrastructure, right. So, it is a very things all.

So, in this case all are handled by the cloud service provider easy to port spatial service image to multiple virtual machines right. So, I can instantiate different services image to virtual machine, and GIS the geospatial decision making becomes much easier right. Like I want to make this things more as a down to earth to the means down to planar level like a district magistrate using this geospatial services, or for some decision making at district.

Now, making a keeping a infrastructure for a DM office is a major headache, right. So, it has to have appropriate spaces and some of the districts may not have the type of facility of like far away from central or big cities and it is a major headache, right.

So, only concentrate on the things on the basically services, integrate latest databases, merge, disparate or diverge data sets, exchange information internally and externally make much easier when we have a cloud type of things. So, it is not only that whenever you require you have elastic thing also in ease of operation or ease of deployment of geospatial services much becomes much meaningful.

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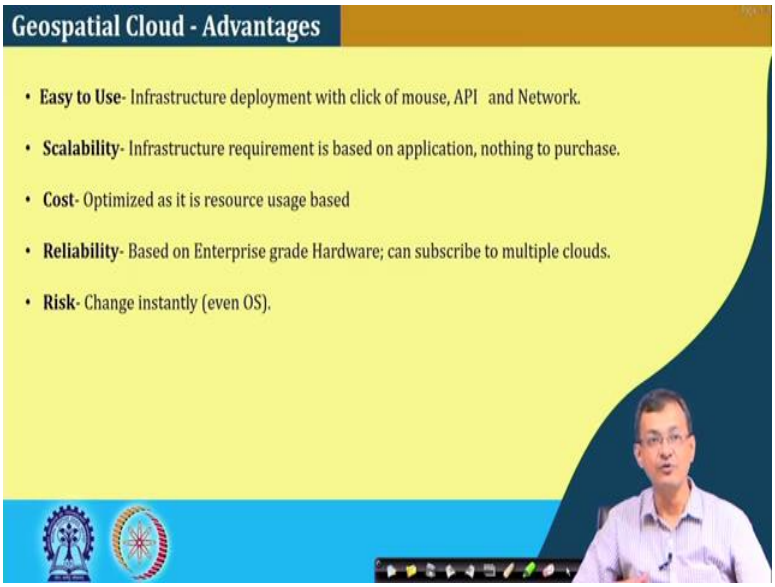

So, there are some of the advantages is to easy to use, infrastructure deployment with click of a mouse, API network etcetera. Scalability infrastructure requirement is based on application nothing to purchase. So, it is scalable you go on increasing or releasing there is nothings, cost optimized as it is resource uses it is things, it that cost optimization needs to be worked out that how good you and utilizing the infrastructure.

Reliability as based on enterprise grade hardware because the cloud service provider has we have a sally type of things where things are there can subscribe. A risk there is even there are challenges of the risk. So, there are different regularity things which are regulatory that policy things are coming up in our country government of India are making some of the register cloud provider. So, that it is ensure that the data rise in our within Indian Territory and type of things and there are lot of government level

protection government is trying to make. So, that ease of using this cloud services will be there.

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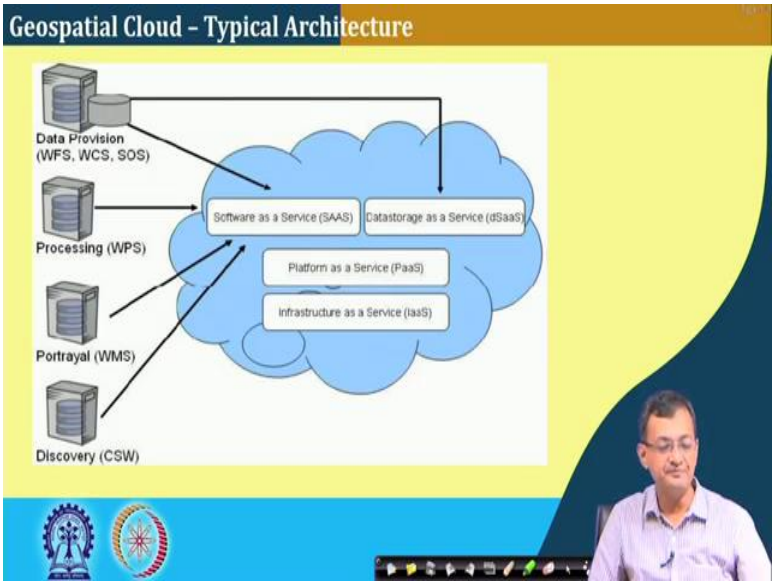

Now, if you look at a typical geospatial cloud what we need or how the architecture will look like. Like, so we require something as a software as a service, storage as a service, platform as a service, infrastructure as a service, these are the things which are in a typically a cloud infrastructure, now try to map. Now, if you see this WFS, WCS and there are different other type of services spatial services which are mostly we can categorized as a software as a service, right.

So, rather most of the things here we can keep as a software as a service right. Some of the things as a storage as a service are there. So, these are at the top level, but if you want to develop something for a organizational things or some research purpose as we have seen the case studies where we are working on say for a research problems.

Where we may not require only not restricted only software as a service you also require a platform as a service. Where some I get access to some sort of a spatial data basis I get access to different development platform maybe Java or different other runtime platforms, I get access to some big data platform like say Hadoop cluster and type of things right.

In some cases I can still go to the infrastructure as a service where I want to install my own customized software to work on the things. But, for a user or a particular what we say department expertise using particular domain. They look at; they can look at it as a software as a service or what would I say is DI as a service spatial data infrastructure sort of a service right, which intern definitely use platform, which intern definitely use infrastructure, right.

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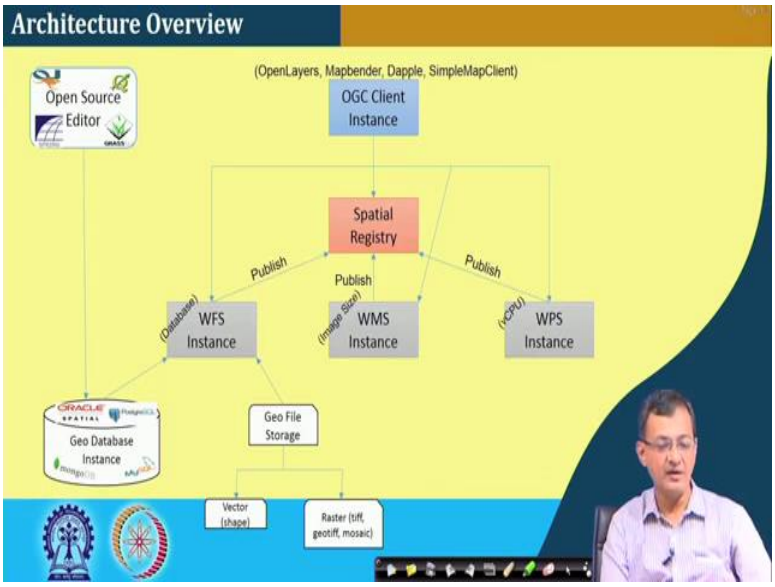

So, we can have another view of the things. So, there is a spatial resistive which is the core of the things having the resistive services. So, this OGC client instances from where people can connect or things can be connected.

So, there are WPS, WMS and WPS instances, feature service, map service and processing service. It connects to the databases instances and there are different type of geo files like raster, vector files and type of things. So, this is published there and it is consumed in different by the client services whether it is a WPS service, WFS service and type of things, right.

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So, in other sense that once we create a instant request for a SDI component. So, this instance is created image of SDI component services like feature service image, map service image, processing service image, catalogue service image. I created instance creator publish service publisher things will be there in the things. So, what is there I create a instance suppose I want to create a SDI for IIT, Kharagpur; so IIT, Kharagpur SDI.

So, one is that I buy hardware I download this tools for this SDI etcetera and type of things. Otherwise what I say I suppose there is a central out service like government of India of spatial services by DST or somebody. Then I take a instance of the service and create as a KGP SDI. So, the data is stored in somewhere services are pulled in, but what I put it is the domain expertise of the Kharagpur and requirement of the Kharagpur. This has multiple advantages right.

First of all I do not have to buy all those things etcetera, I do not have to there is a maintenance etcetera first of all the lead time deceases right. All this purchase procedure could have taken six months, but from the day one I could have started, right. Secondly, later on if it is sharable then it can be sharable at a national SDI level, right. This whatever data I collect as a Kharagpur level or at a district level or a state level can be sharable much easily with definitely with safeguard of policies and securities and type of things.

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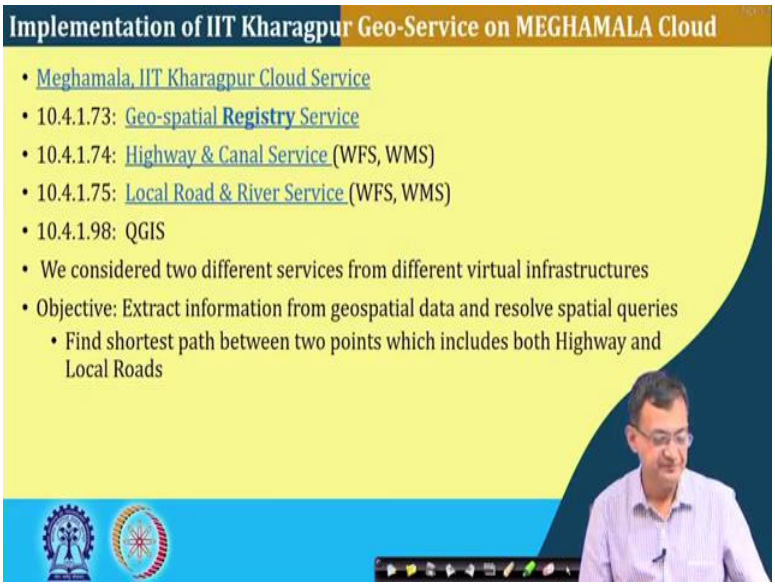

So, just want to show you that we have a private cloud developed by our internally or with open source systems are software called Meghamala rather, now we have a Meghamala 2 with a extension or a we have augmented this cloud to have a higher version.

So, we have we tried a geospatial cloud here with some of the instances registry service and WFS, WMS service of highway and canal, road network and also uses open source QGIS software for having QGIS things. So, objective is to extract information for geospatial data and resolve spatial query, path shortest path between two points which includes both highway and local roads, right.

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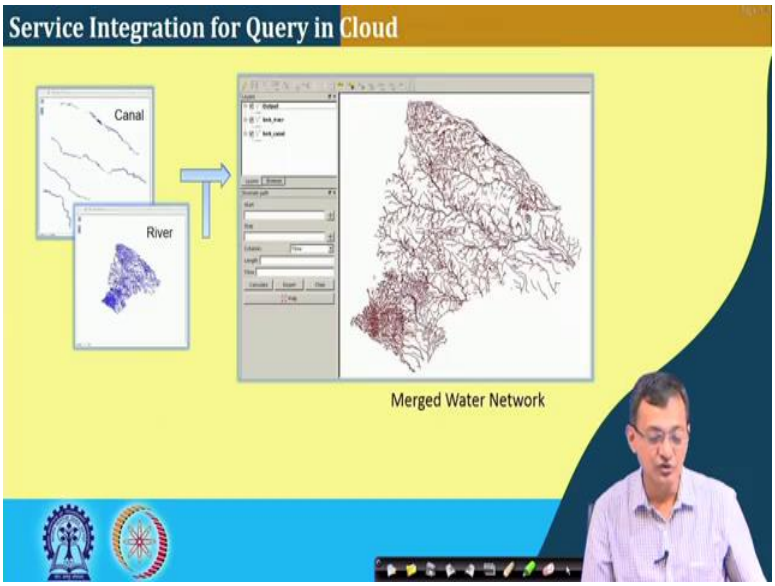

So, service integration for query in cloud case study I so, this is on the cloud we are doing right. So, see this highway and road networks are there which are road is coming from this one, these are all virtual machines. This 10 dot 14 dot 1 dot 75. The road services where as 1, 10 dot this highway services is from this services right, so two different services. Now we can basically merge this network. So, highway and road and create this merged network, right.

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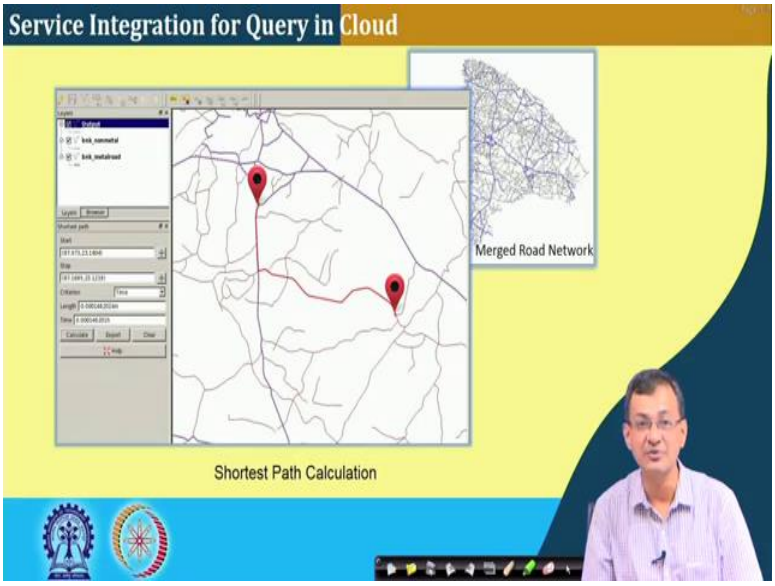

And now over that I can basically run a shortest path calculation which may be a spatial analysis or spatial computing type of platform. So, finding a source and destination and doing a short path calculation. So, see so as a user I have this somewhere the data, somewhere the computed and services and then can calculate the shortest path between two locations, right.

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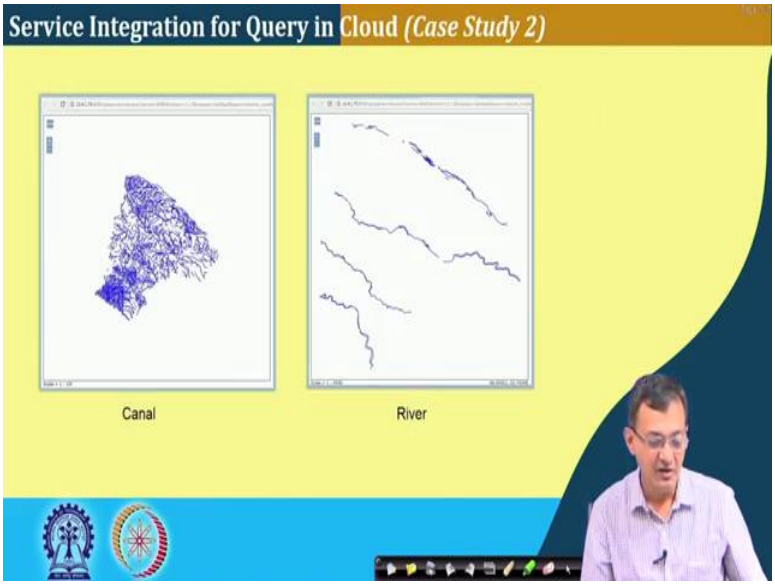

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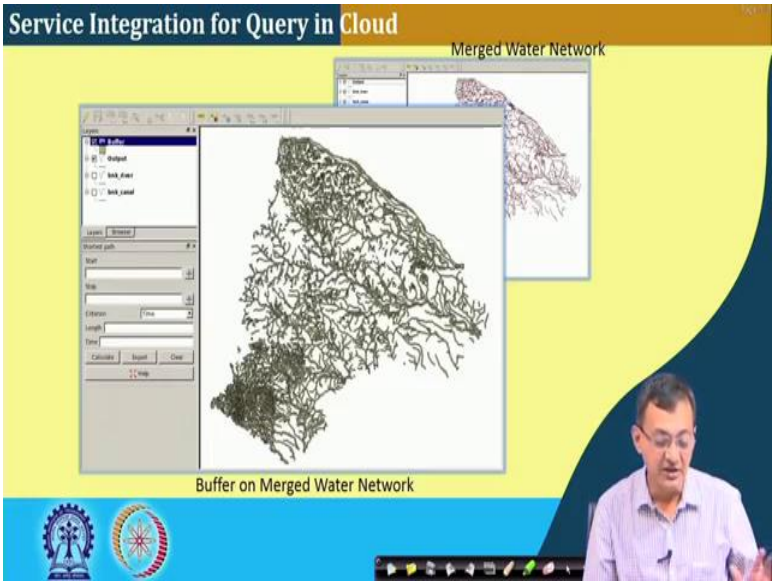

So, similarly canal and river so can be merged into a merged water network and then I can do something called buffering of the things. Like if there are heavy rainfall in some

of the things if it is buffer and what will be the inundation layer those type of things those layers are available, right. So, those are all are running on a cloud environment that is Meghamala under Meghamala crowded memory.

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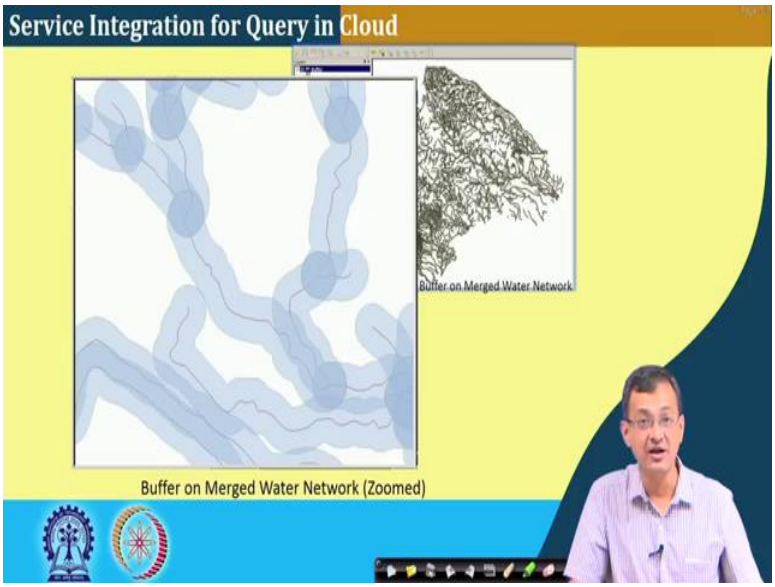

So, merged with a water network zoomed so, I have zooming effect. See lot of things we are having, we can visualize these things right and based on the things I can zoom the things even I can create a region of interest and zoom the things and see what are the things.

If I other layers are available I can put a say village network over that be z quarters and that even population mat which are the population likely to be affected if there is a flood which is so much area indentation and type of things. This is a regular buffer right I can I could have created a different type of a layer. If there is I could have known that elevation model and I can have functional things which can have a different type of re-regular polygon based on the elevation model etcetera and then overlay and type of things.

So, you see there are different computing analysis, several type of topological operations, zooming in zooming out display and interactive also, right. Whatever I require I can do it here I can able to select that which are the things I want to select and type of things. So, these are the things possible here, right.

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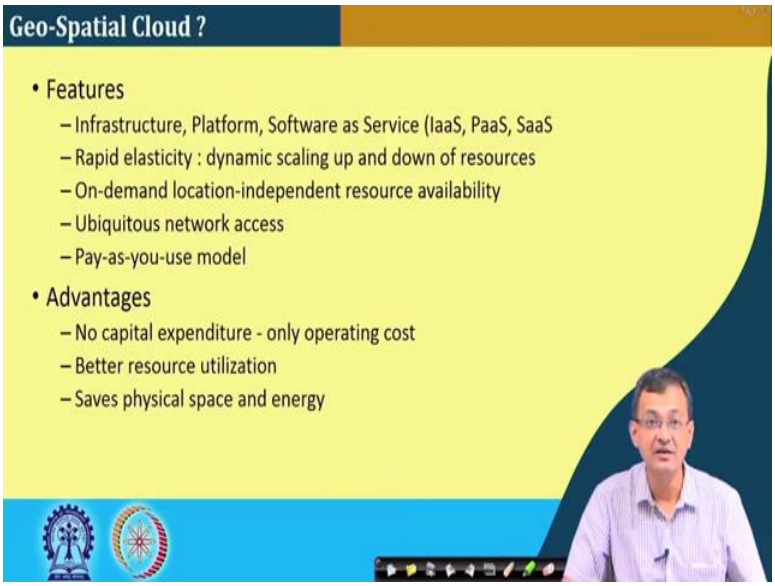

So, what are the feature what we expect that infrastructure platform software as a service; rapid elasticity, on demand location-independent resource availability, ubiquitous network, pay as you go model; that means, as you go or as you use model. So, as much as I use I can thinks right. So, these are the things what we have seen when we look at the cloud basic cloud characteristics. So, this is very much is valid for our geospatial cloud. Advantage no capital infrastructure only operating cost, better resource utilization, saves physical space and energy, right.

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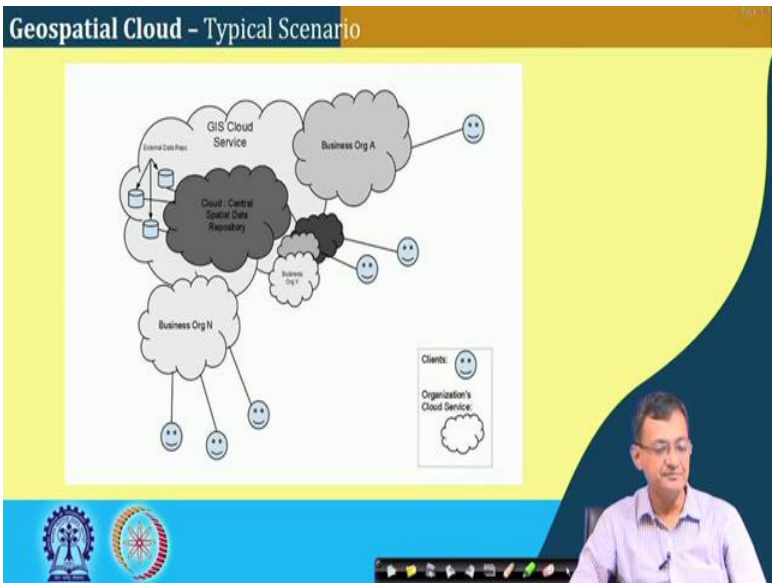

So, this is another typical scenario like we have seen in some other things. So, there are several business organization or so to say. Different organization like I we can consider a for in our countries is place one may be sub of India, water resource department, or organization like soil survey soil survey or GSI and type of things, right. There are different service provider and they are different client.

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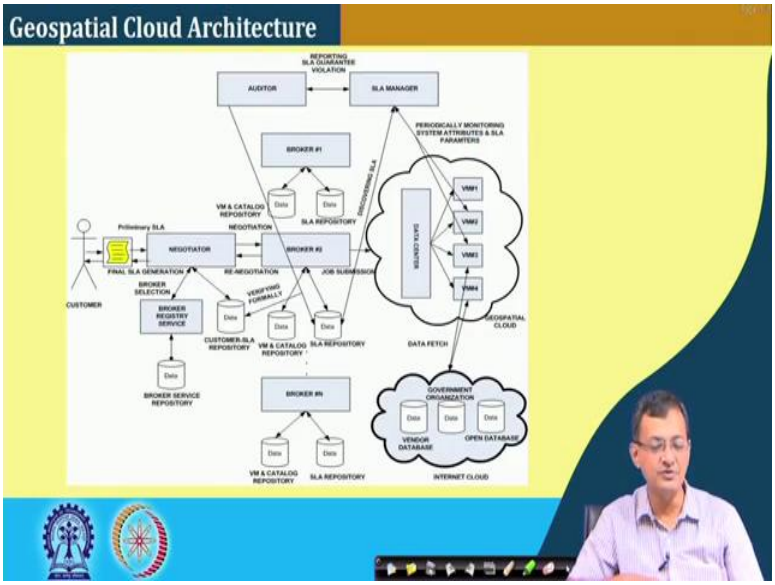

User and this is more a typical more nitty-gritty of the architecture where a consumer or a customer request for the things. There can be negotiator that finding that which are the data available. How much cost is there? What sort of scale you require based on that it sense to other bookering services which booker for the things. So, there can be number of brokers or cloud agents which takes care of the different type of repositories etcetera right. So, this is more of a detailed type of services.

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So, what we see cloud as a service provider as a resource services right, resource allocation manipulation or management of the VM etcetera; a data services maintain persistence user a system data, spatial data provide a configurable user environment; interface services user visible interface, handling, authenticity etcetera. So, there are different type of services which is valid for other cloud infrastructure also equally valid for our spatial cloud infrastructure, right.

So, this says that how a briefly that how a spatial cloud which is becoming a very much needed what we say infrastructure for hosting or mass scale uses or deployment or spatial services for at different level of government or citizen at large, right.

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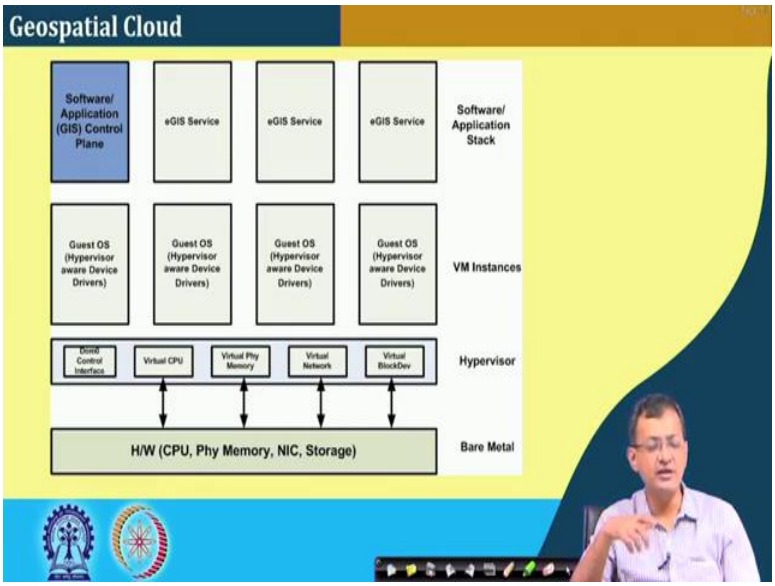

So, with this we can; even we can see that if we have these are the software stacks. So, these are bare metal this is the basic hardware over that we have a hypervisor, or which basically also called VMM; Virtual Machine Monitor which emulates this different virtual machines and different services.

So, there are different VM instance over that we have different services like EGIS services and type of things like that enterprise services, SDI services, spatial services. So, that is the stack which is hosted by the service provider and we as a user it can be organization. It can be individual user can leverage on this services right.

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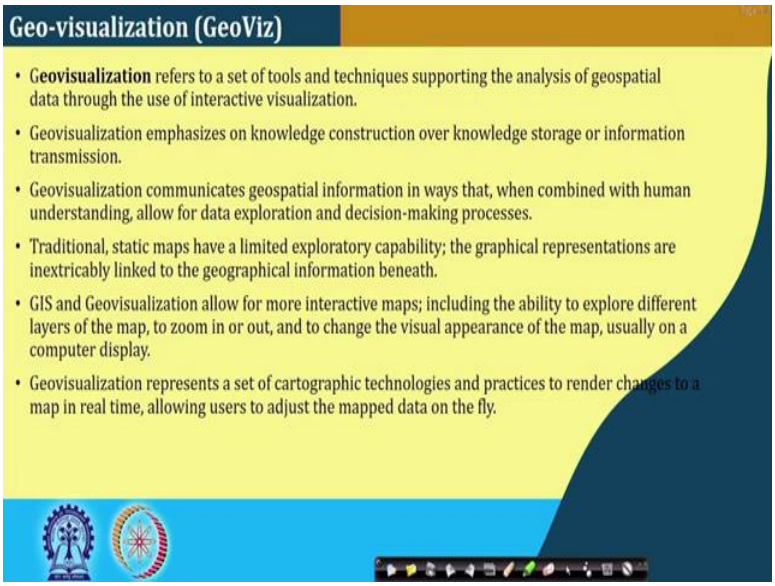

So, another aspects already we are into it is the visualization, right. So, just thought that may be one couple of slide on the things. So, it is what is it is refers to is say if you look at refers to a set of tools techniques supporting analysis of geospatial data through the use of interactive visualization, more emphasis on the visualization. So, analysis etcetera is there so it is a set of tools.

So, it emphasizes on the knowledge, construction over knowledge, storage or information transmission. So, it is more of the how I can develop a knowledge construction over the knowledge storage etcetera. In other sense how I can make it visualize to the say decision maker, citizen at large or a general public to take extract knowledge for it is own consumption and taking decision based on the things, right. So, construct their knowledge from the underlying data set.

So, geo visualization communicate with geospatial information in a ways that when combined with human understanding allow the data exploration and decision making processes, right. Traditionally what we have seen static maps have a limited exploratory.

So, one we have a static map so it is admitted; so, whatever it is showing you are showing. So, if I have a interactive maps then there is a possibility that I can have a interactive things on the things. So, the graphical representation or link to the geographic information will help in taking things. So, like if you have seen that I layer I put a layer zoom the things as we are seeing sometime back. So, it is possible that interactively

looking at it. And there are possible that if you have 3D you can change the direction of the axis and see that other part and type of things.

So, geo visualization represents set of cartography technologies and characteristics to render changes to a map in real time allows user to adjust map data on the fly. So, these are pretty effective for user specially the decision makers to take appropriate decision taking from the things. So, there is a domain expertise with the user and along with this what we try to do have a better visualization of the data set. So, I will just; so, that we have some of the case studies we have seen earlier also just to that how that visualization helps.

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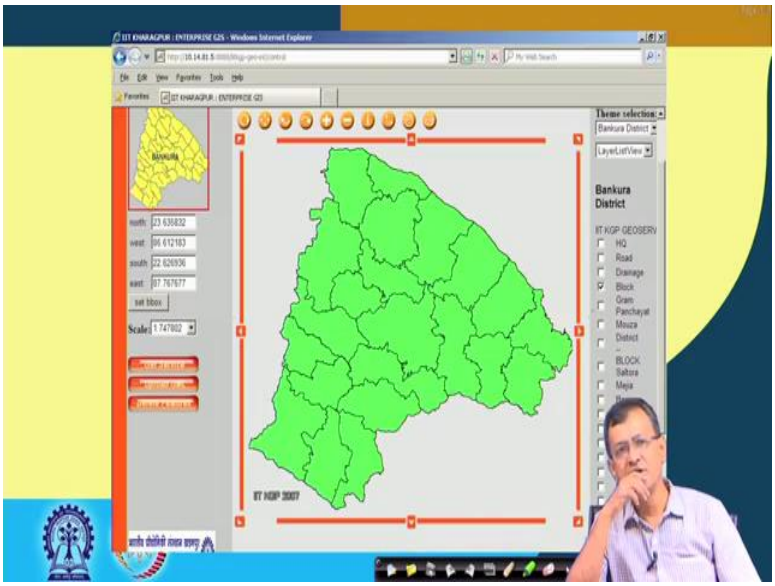

So, see there here we have different option though much better visualization is required. So, to say visualization itself is a separate field of study, right. There are institute courses which looks into visualization based of human perspective etcetera. Here we just want to expose that it matters when we look at the thing. Like here what is there it is a particular Bankura district there are different blocks and we have different options which are able to look at it, not only that we have options of scale and type of things.

So, if I want to generate a map I can have a scaled map or I can have different scale or displaying the maps. Like I want to display the block headquarters I select those things. I want to display along with the drainage network sorry, this is the road network or transportation network road network then I can click and see the things.

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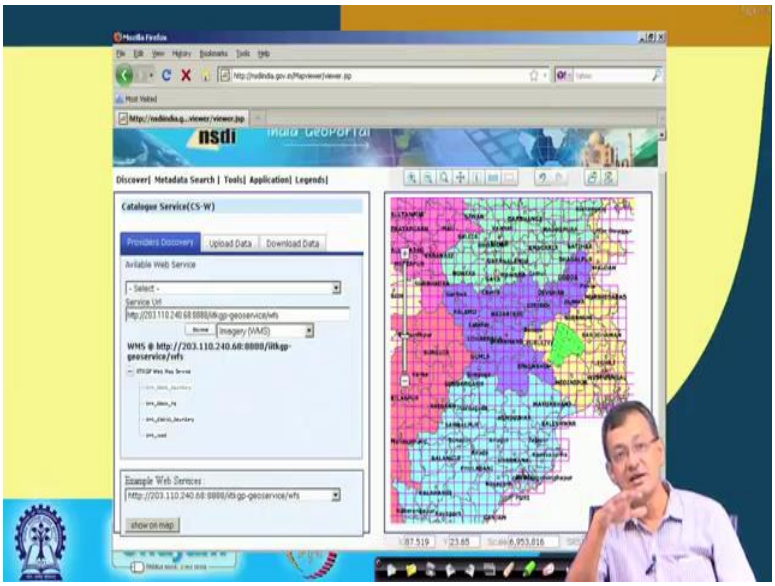

I can even this is a important things I can even put this on a national perspective. So, this is an NSDI portal right, National Spatial Data Infrastructure of Government of India Portal. Now, there are service mode I can put say, I put here that our IITKGP service of giving service of this Bankura and it is sits on the Bankura districts out here, right.

See it is without any formal or tedious interaction if that is permitted I can put the data on the things which can be viewed by others. If again the WFS services are there, then I can it can be analyzed with other layers like I have collected say the best known, or best collected data set could have been they are collected by the district itself right; so, some of the data which is on the local ground level data.

So, if a district level things DM office can able to upload this at the national level. It becomes a things which is accessible by others right definitely always it is there that who can access, how can access and type of what extent it can access is restricted by the policy and the different security rules, but it can be accessible, right.

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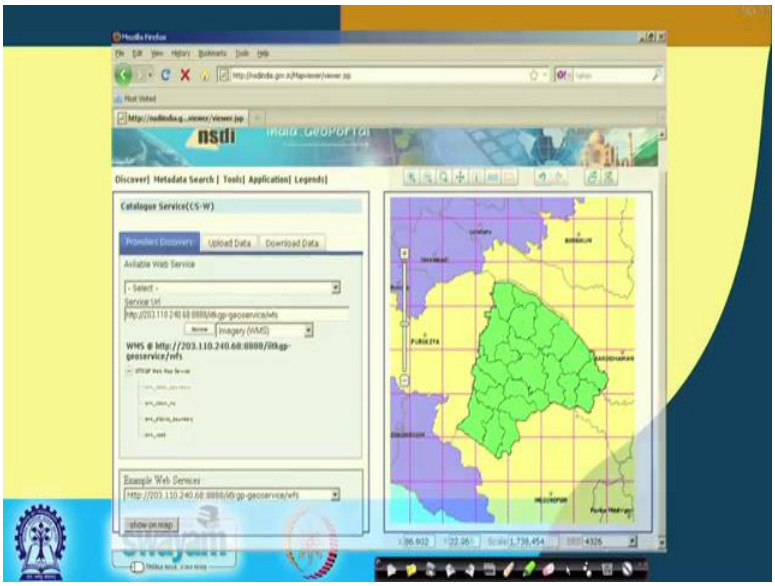

So, I can have this layers on the NSDI portal the same blocks, same road network and type of things, I can zoom it and do different operations, right.

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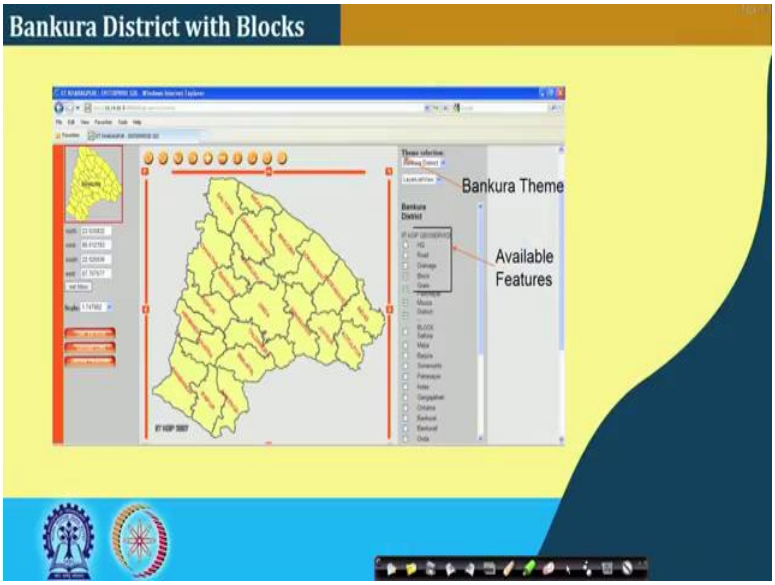

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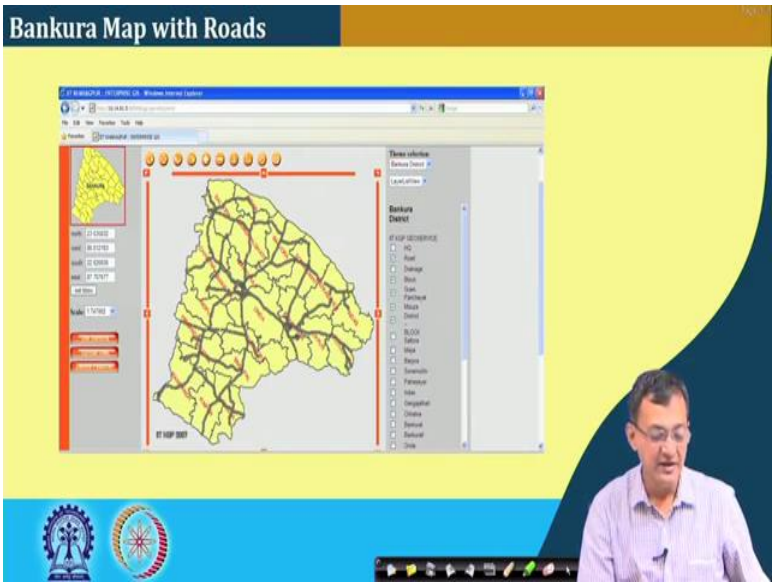

Again coming back to this Bankura district I can have a specific over that over the block with Gram Panchayat, Muja and with along with that road network, right major road network.

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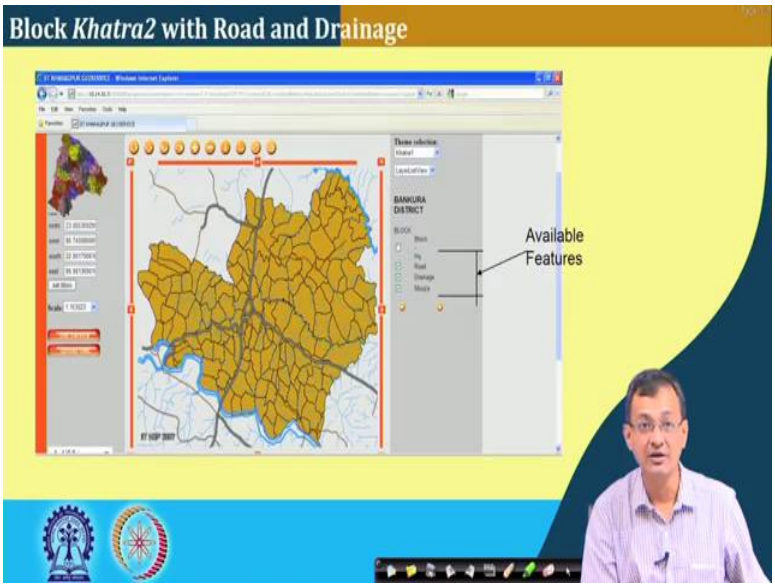

I can even extract or I can zoom a particular block, right. This is a particular block which is zoomed which is that Khatra there is a block there.

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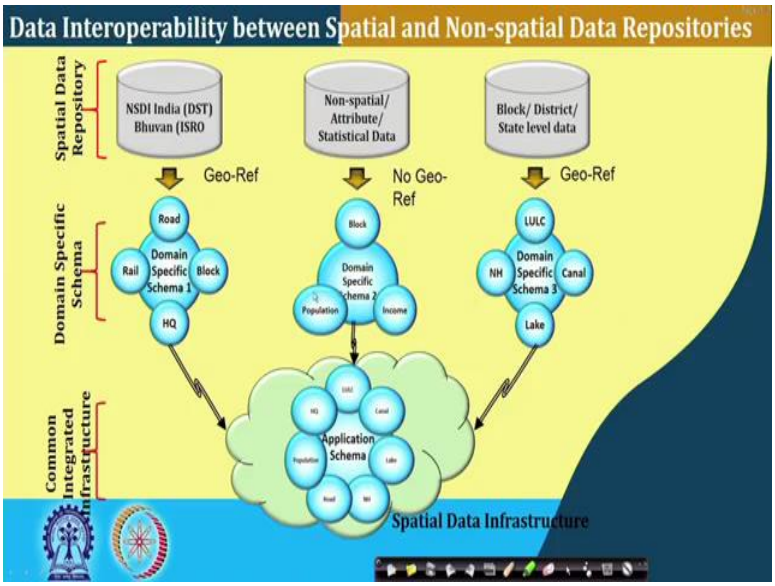

And for all these what we require we appropriate modeling of the things, right. So, there are see when I have different type of data set something coming from DST or ISRO, something at the district level, something at the national level, but not directly geo reference like sensor data etcetera. I require the different schemas to be model and type of things which we have done it here, right.

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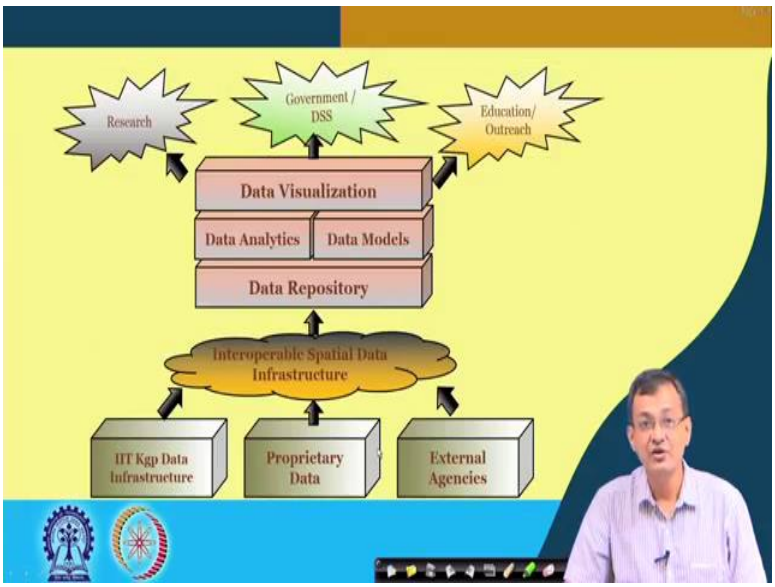

So, and if we try to put together; so, what if we see that these are the different visualization effect. So, if we look at this particular course per se what we try to look see

that how spatial data can be captured. How spatial data can be modeled? How spatial data can be interoperate or integrated.

For that this modeling of the schema etcetera is a much important things. So, that so and that schema can be generated by the domain expertise domain expert only, right. A soil schema generated by me will be a problem right, even a something related to hydrology generated by somebody who is expertise in transportation will be problem otherwise.

So, the domain expert needs to be directly involved in generating the schema etcetera, and then I can have a application schema which is for the SDI which can cater to a different things. See there is no data is involved only the schemas or the structures are involved. So, sharing this is not a problem, but if you require the data you pull the data by WFS service from the organizations right.

So, if you if we try to put the whole thing it is there are different type of thing like IIT Kharagpur, proprietary or some private data set, proprietary data set. Some external data set etcetera, interoperable spatial infrastructure and data visualization analytics data model repository and type of things. And we can do definitely government level decision support, education outreach and research on the things.

So, particularly in this course what we try to emphasize on is that what are the importance of spatial informatics, how this spatial data set is different from other type of data set, what are the problems in storing these challenges in storing these data sets and type of things and how to make technology like spatial analytics or spatial data science and spatial cloud visualization things which plays a important role in things.

I believe this will help you in or this we could able to have a overview of the spatial informatics as a whole. And we those who are in can use want to use as for decision making or decision support system can able to now realize that where which are the key points to be need to be address.

And those who are interested in research and further academic activities, they will be able to find out lot of challenges in it right every, if you look at that every topic itself as a lot of things to be worked on right. Though we can we have we have use different techniques and type of and modified according to things which are there existing.

So, it has a truly multidisciplinary and over one or more than one decade or around two decades. There is a lot of in lot of requirement of computer science methods, technologies, algorithms we put into plates place to make this spatial informatics as a success, right.

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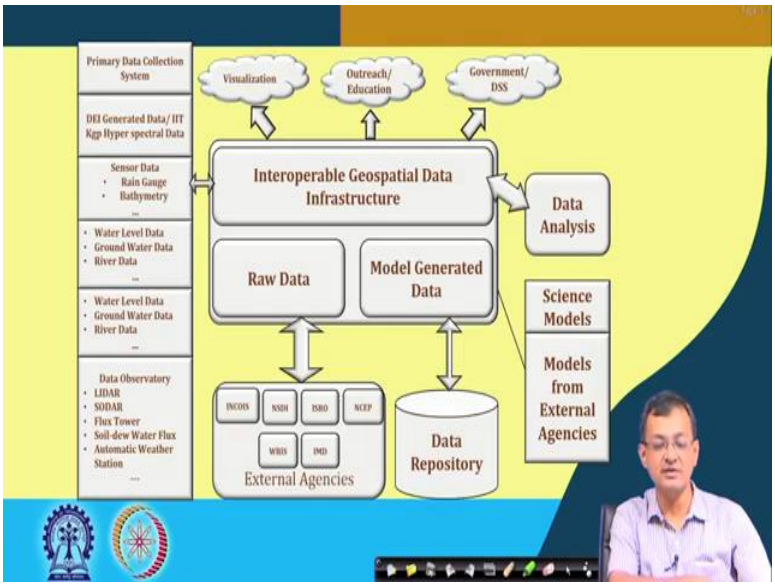

So, to have final slides so to say; so, there is a requirement of different science model, model from external agencies, data analytics etcetera. There are different contributing agencies, there are data repositories; there is a bunch sort of application area, data collection mechanisms. And what we require that different starting from decision support to research to outreach and type of things is required. So, I require we require interoperable geospatial infrastructure so to say to handle this.

So, to conclude in this particular course what we tried to look at that different aspects of spatial informatics, which starting from spatial data basis, spatial data modeling and that spatial query engines, how to optimize things spatial networks, and different type of spatial computing and analytics stuff like data mining looking as different aspects of spatial data science.

We also seen and discussed on some different type of case studies involving spatial data and how they evolve over, how they help us in taking different decision support systems decision support mechanisms, right. Also we have seen that geospatial cloud which is becoming a de facto standard or requirement for having this spatial services really

putting it to the decision makers and users and other aspects of geo visualizations and everything ok.

Hope you have enjoyed this course and it will be helpful both in those who are looking at a decision making type of things or academics or search. Thank you for your attention and taking of this course.

Thank you.