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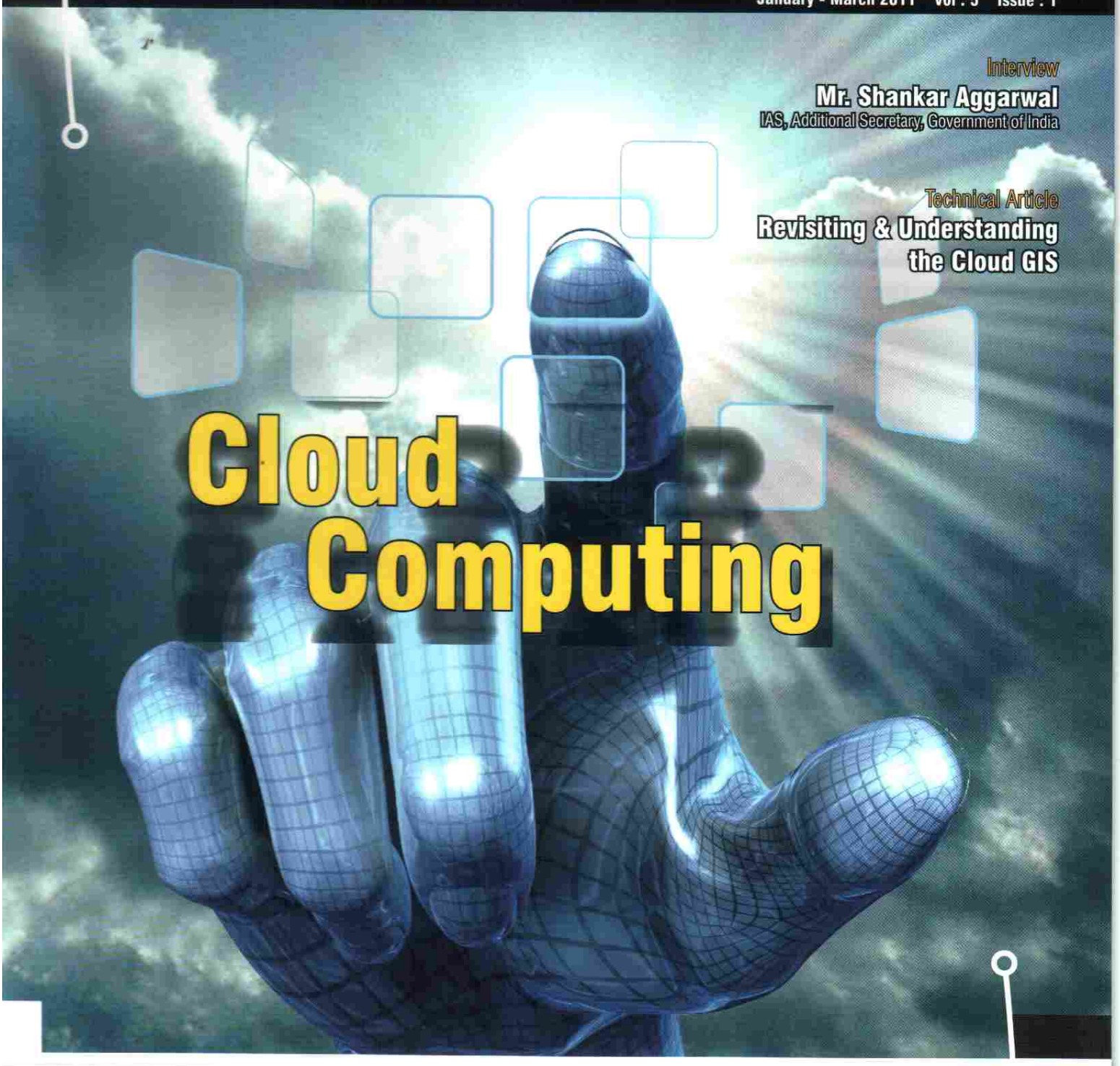

Interview

Mr. Shankar Aggarwal

IAS, Additional Secretary, Government of India

Technical Article

Revisiting & Understanding the Cloud GIS

Cloud Computing

The importance of understanding the situation before effective actions can be initiated, is well articulated in the statement, "Understanding precedes action"- this in fact is captured very nicely in Esri's new tag line- "Understanding Our World"

As the usage of geographic knowledge to understand the situations that we face gathers momentum, the need for the geo spatial information becomes very critical.

Access to the geo spatial information is now almost ubiquitous- the Esri technology enables the information to be seamlessly delivered across multiple platforms.

Different fast growing technologies like Mobile, Cloud and crowd sourcing which enable voluntary participation of the people in a society are adding tremendous value to the growth and adaption of geospatial technology and widespread usage and exploitation of geographic knowledge.

With the huge growth in the usage of mobile devices, the deployment of geo spatial tools leveraging the mobile technology is spreading rapidly. It is not only convenient as it can be used by field force- but also makes the information current as it enables live updation of data. For example, when used by the field force of a courier organization, it not only enables the pickup and delivery personnel to reach their destination using the most optimal route, but also alerts the service center if there are any challenges encountered in the route assigned and realign the route to an alternate person if needed. Another application which is gaining popular in the Indian context is the usage of the geo spatial tools on mobile devices by personnel in the forest department- they are able to capture and transmit any incidents like fire and also capture the movement of the wild animals and mark their locations at any specific instance and transmit it instantaneously to the control center. There are several such examples of the deployment on a mobile environment.

Another fast emerging technology, which is expected to substantially increase the usage of geo spatial tools for decision making is Cloud Technology. It is deal for both large corporations as well as for small and medium enterprises. Esri offers different ways to exploit Cloud- for example; one can use the Arc GIS server on Amazon Web Services, or use Arc GIS.com- a website offering tools and shared data for GIS applications. There are also specific tools that can be deployed and exploited using this technology- like Arc Logistics and Business Analyst on line. These environments help both the developer community as well as the users to exploit Cloud platform and services.

During the recently concluded Geo Vision series of seminars, many of our valued customers showed tremendous interest in these emerging technologies, and during the next few months, we will be planning many user meets and interactions across the country to showcase these technologies and exchange thoughts and ideas on leveraging these in an Indian context.

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President & COO

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Design, Preprint & Production
geospatial

Esri India makes its presence felt at the Geospatial World Forum 2011

Esri India participated in the Geospatial World Forum 2011, joining diverse stakeholders of the sector to discuss the "Dimension and Directions of the Geospatial industry."

Mr. Rajesh Mathur, Vice Chairman, NIIT GIS, spoke at the plenary session, highlighting the emerging trends on the geospatial technology horizon. Mathur demonstrated how GIS would remain at the center of the core practice of Geodesign—the intersection of geography and design.

According to him, design was all about geographic planning and decision-making. In addition, Mathur also talked about other market-driven geospatial practices like Web GIS and location intelligence.

Jack Dangermond of Esri Inc. shared his vision on the new modality of the geospatial industry through a video presentation, stating that it was built on enhanced sharing of knowledge and data as technologies evolved. He added that putting a map on the Web involving volunteered geographical information would result in the development of an integrated system where all devices were connected.

Another highlight of the Forum was the Exhibition, which saw 57 organizations showcase their solutions. Esri India was awarded the Best Exhibitor Award for its demonstration of GIS solutions.

ESRI participates at Aquatech India 2011

The economy of India is growing rapidly, with a combined annual growth rate of more than 10 percent. Due to the ever growing gap between the demand and supply of water, the Indian water sector is set to witness a phenomenal growth in the future. The water use is likely to increase substantially in the period up to 2025, particularly in the domestic, individual and power sub-sectors.

Esri participated at Aquatech India 2011 which was held in Mumbai from 4 – 6 March 2011. This top quality water event in India, is organised by Amsterdam RAI in partnership with Inter Ads-Brooks Exhibitions (India) Pvt. Ltd. and Support from the Ministry of Urban Development, Govt. of India. The latest technologies and developments in the field of water and wastewater management were highlighted and the show provided the manufacturers and suppliers a secure, recognized and reliable means/approach to enter the market. Offering a complete insight into the world of waste water and clean water. Featuring over 200 exhibitors from more than 20 different countries. Attracting thousands of professionals from the water industry. Though Aquatech was not wholly focused on to the IT segment of water managed but still Esri made its presence felt by showcasing few GIS applications in the Water domain.

Esri Assists Japan Earthquake and Tsunami Response

In response to the devastating Japan earthquake and tsunami, Esri has provided assistance to a myriad of organizations involved in the disaster response. The company is working closely with both domestic and international agencies to provide on-site personnel, geographic information system (GIS) software expertise, and project services. Esri also provided the organizations with software, data, imagery, and technical support.

"This is a devastating, large-scale disaster that is still unfolding," says Russ Johnson, director of public safety solutions for Esri. "Our full emergency operational procedures have been deployed to assist. We're working hard to provide response agencies with resources that can make a difference in saving lives and minimizing damage."

GIS solutions are helping officials use critical information for making rapid, effective decisions. The technology helps responders and emergency managers conduct rescue operations, prioritize medical needs, identify severely damaged areas, measure impacts to critical infrastructure, locate areas suitable for food and water distribution, and more.

In addition, an Esri-generated social media mapping application is available for both the media and public. People can follow events in near real time using the application to gain a greater understanding of the situation. It includes links to news reports as well as Tweets, YouTube videos, and Flickr photos. It also gives people the ability to view streets, satellite imagery, and topographic maps as part of the map overlay.

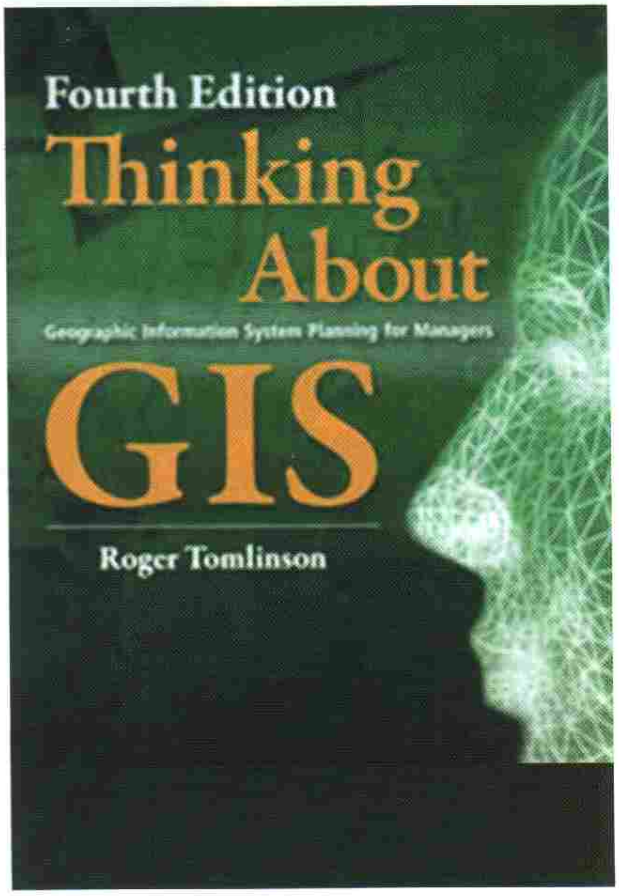
Roger Tomlinson's Updated Thinking About GIS Reflects New Technology Trends

Esri Press has released the fourth edition of Thinking About GIS: Geographic Information System Planning for Managers, the seminal book on planning and implementing a geographic information system (GIS). Roger Tomlinson, widely known as "the father of GIS," has updated this edition to include the latest trends in geospatial technology.

Drawing from decades of Tomlinson's consulting experience and worldwide GIS seminars, this book bridges the communication gap between senior managers who oversee information technology systems and technical specialists who design and implement the systems. It provides common ground for both groups so that each clearly understands the methodology needed to implement and maintain an effective GIS.

"Successful GIS implementation depends on a well-thought-out and executed plan," says Esri president Jack Dangermond. "If you follow the methodology presented in this book, you will be on the track to success. I hope that you find Roger Tomlinson's work as informative and beneficial as have my colleagues and I."

This fourth edition includes new case studies, an additional appendix discussing custom workflows, a DVD including exercises from Tomlinson's Planning a GIS training course, and links to more resources. A bonus is the video of Tomlinson's Planning and Managing a GIS presentation at the Esri International User Conference.



GIS AND CLOUD COMPUTING

Esri uses the cloud today in several different ways. The currently available options include the following:

- The ability to deploy ArcGIS Server on Amazon Web Services.
- ArcGIS.com, a Web site offering tools and shared data for GIS applications.
- ArcLogistics, a cloud application for optimizing routing, such as for delivery vehicles.
- Business Analyst Online, a cloud application for geographic analysis of demographic, consumer, business, and other data.

These examples illustrate how cloud computing can make life better for GIS developers and users. Each one is worth a closer look.

ARCGIS SERVER ON AMAZON EC2

ArcGIS Server is a platform for delivering GIS services to software on other systems. These capabilities are exposed as RESTful services, via SOAP, and in other ways, and they can be consumed by clients written using various technologies, including JavaScript, Adobe Flex, and Microsoft Silverlight.

Today, customers typically deploy ArcGIS Server on a computer running in their own data center. It's also possible, however, to deploy ArcGIS Server in the cloud using AWS. As Figure 3 shows, ArcGIS Server itself can run in an EC2 VM running Windows, while a relational database holding GIS data runs in a second VM.

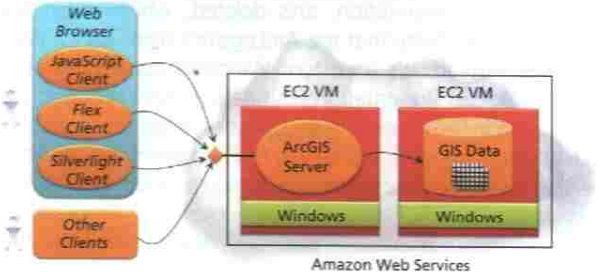


Figure 3: ArcGIS Server can be deployed in an EC2 VM on Amazon Web Services.

Deploying ArcGIS Server on AWS provides an alternative to deploying it solely in your own data center. But why would anybody do this? What are the advantages of choosing this option? There are several possible answers, including the following:

- Easier deployment: Esri provides a preconfigured AMI containing ArcGIS Server. Rather than install and configure the product on a machine in your data center, you can just create an EC2 VM from this AMI.
- Faster deployment: In many organizations, making a server machine available to run new software requires following a multi-step process, one that can take weeks or more. With AWS, by contrast, anybody with a valid credit card can get an EC2 VM deployed in a few minutes. If getting ArcGIS Server—and the application that uses it—up and running quickly is important, using the AWS option can make sense.
- Lower cost: As mentioned earlier, AWS charges customers for each hour a VM is running. Depending on usage and costs in your own data center, running ArcGIS Server on AWS might be a less expensive option. This is especially true for applications with elastic (i.e., widely varying) demand. If, say, an application typically uses a single instance of ArcGIS Server, but needs ten instances for occasional peak loads, the AWS pay-as-you-go model lets you pay for this higher usage only when you need it.
- Broad availability: Because software running on AWS can be accessed by anybody with an Internet connection, GIS services exposed by ArcGIS Server in an EC2 VM can be broadly available. While this raises the security bar, it can be an attractive approach for providing some kinds of information.
- Better performance: ArcGIS Server allows running various kinds of analysis on GIS data. If you're creating an application that performs complex data analysis, you might choose to deploy multiple instances of ArcGIS Server in multiple EC2 VMs, then use all of them in parallel to work on the same data. Applications running on AWS also have access to large amounts of bandwidth, which can significantly improve performance in some cases.
- Simpler development and testing: Because the AWS environment can be essentially identical to an on-premises Windows environment, a development team can build and test an ArcGIS Server application in the cloud, then deploy it either in the cloud or on premises. Given that creating (and paying for) EC2 VMs can be more flexible than creating the same environment in your own data center, this can make the development process easier.

Running ArcGIS Server in the cloud isn't always the right solution, of course. In many organizations, for instance, storing sensitive information outside the firewall is frowned upon. Still, this alternative deployment approach can sometimes be the best option.

Figure 4: ArcGIS.com is a Web site providing access to GIS data and applications.

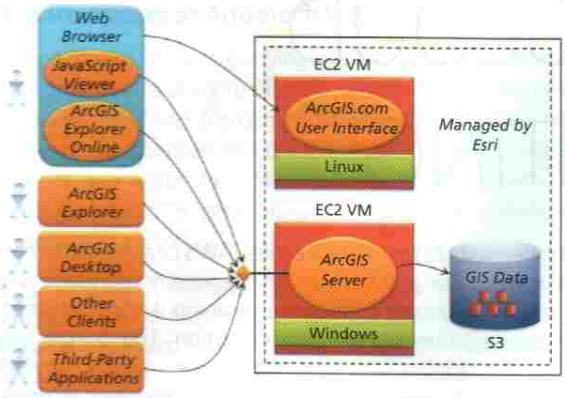


Figure 5: Run by Esri, ArcGIS.com provides Internet-accessible GIS data and applications that can be used by many clients.

ARCGIS.COM

Using the cloud to share GIS data and applications is an attractive idea. ArcGIS.com, run by Esri, provides a good example of this. Figure 4 shows the site's home screen.

As this screen shot suggests, ArcGIS.com provides a number of services, including the following:

- Storage of publicly available maps and other GIS information. (Esri provides some of this data, including things such as layers and basemaps, but users of the site also contribute.)
- Esri-created applications for examining and working with the site's information, such as tools for creating maps.
- A central site for finding and accessing GIS applications that use the data on ArcGIS.com, including applications that run on computers in non-Esri data centers.

Figure 5 shows the main components of ArcGIS.com.

ArcGIS.com provides tools designed to let non-expert users create and work with maps. As Figure 5 shows, those tools include a JavaScript viewer for browsing GIS data, along with the Silverlight-based ArcGIS Explorer Online, a more powerful tool for creating and working with maps. Both of these tools access data via services exposed by ArcGIS Server. These services can also be accessed through other Esri-provided clients, including ArcGIS Explorer (the more functional on-premises version of ArcGIS Explorer Online), ArcGIS Desktop, and mobile devices such as the iPhone. As mentioned earlier, it's also possible for non-Esri applications to access this data through the services exposed by ArcGIS Server.

As the figure shows, Esri has built ArcGIS.com today on Amazon Web Services. The site's logic, including its user interface and ArcGIS Server, runs in EC2 VMs, while the GIS data is stored as blobs in S3. This dependence isn't visible to the site's users, of course—they just see the user interface and other services that the site offers—but it's another example of how Esri is using cloud technology.

One final question worth addressing is this: Is ArcGIS.com a Web site or is it a cloud application? The real answer is that it's both. Some Web sites, such as those that provide only static pages to their users, clearly don't qualify as cloud applications. Others, though, especially sites offering useful tools such as ArcGIS.com, just as clearly do fit into the category of cloud applications. While not every Web site is a cloud application, it's probably fair to say that every cloud application can be seen as a Web site.

ARC LOGISTICS

Think about an organization that maintains a fleet of vehicles. Maybe it's a large delivery company that sends out hundreds of trucks a day, for example, or a home healthcare service that must coordinate pick-ups and drop-offs of a dozen people. While the details differ, these firms face a similar problem: They need to route their vehicles as efficiently as possible. Add in other important variables—vehicle capacity, the times that customers can accept delivery, and more—and the problem gets even harder.

The goal of ArcLogistics is to help them solve this problem. This cloud application lets a user enter the number of vehicles together with the stops they must make, then get back optimized routing for these vehicles. Figure 6 illustrates the application's components.

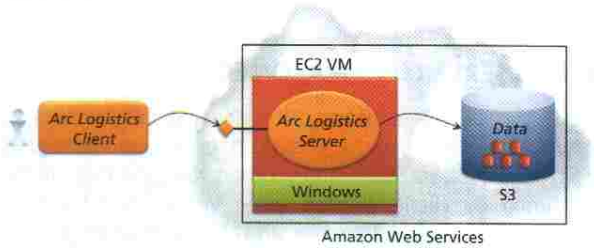


Figure 6: ArcLogistics is a cloud application for creating optimized routes.

Once again, this application is built on Amazon Web Services, with logic running in an EC2 VM and data stored in S3. (No sensitive client data is stored in the cloud, however—it's sent in, used for computation, and deleted, which minimizes security issues.) Note that the ArcLogistics client isn't a Web browser. Instead, it's a custom Windows application built using Windows Presentation Foundation. And although it's not shown in the figure, the ArcLogistics server component is actually built using ArcGIS Server. Esri also provides a desktop version of ArcLogistics. The application's cloud incarnation has some significant advantages over its on-premises predecessor, however. Those advantages include the following:

- Lower cost of entry: Rather than the fixed price of the desktop version, which is high enough to be feasible only for larger organizations, ArcLogistics in the cloud is priced based on the number of vehicles a customer has. This makes getting started cheaper, and it also opens the application to smaller organizations with only a few vehicles.
- Try before you buy: Rather than buy an on-premises application, install it, learn how to use it, and only then determine whether it actually has business value, ArcLogistics in the cloud lets a potential customer try the service on a small scale. The customer can then adopt (and pay for) the application only if it delivers significant value.

No on-premises data or software updates: To do its job, ArcLogistics needs an up-to-date picture of the geography over which it's finding optimized routes. Since the world changes, this database must be updated periodically. With the desktop version, each customer must regularly install updated data sent out by Esri. With ArcLogistics in the cloud, this is no longer required. Instead, all customers rely on a

single shared database that's updated centrally. Everybody always has current information with no need to install updates themselves. And because there's just one copy of the application, Esri can also update this code centrally, making new features immediately available to all users.

Better customer support: Since all customers of ArcLogistics in the cloud are using the same code with the same underlying data, the application's support people can do a better job. With the desktop version, different customers might have different releases, older data, or both, making support significantly more challenging.

Better performance: Computing optimized routes is CPU-intensive work. Doing this on a cloud platform such as AWS lets ArcLogistics create as many VMs as needed for whatever the current customer demand might be. It also lets customers avoid dedicating their own compute resources to this task.

ArcLogistics is a good example of an application that probably makes more sense in the cloud than it does in your data center. It's compute intensive, relies on a large and changing database, and doesn't need to store sensitive information outside your firewall. It's also a good example of how cloud computing can improve our lives.

BUSINESS ANALYST ONLINE

Suppose it's your job to choose a new location for a children's clothing store. To make a good decision, you'd like to know how many families with young children live within, say, a 20-minute drive of each potential location, along with their median income. Answering questions like these is the purpose of Business Analyst Online. By providing demographic information and other data, along with tools for working with that data, this cloud application can help business owners, planners, realtors, and others make better decisions. Figure 7 shows its main components.

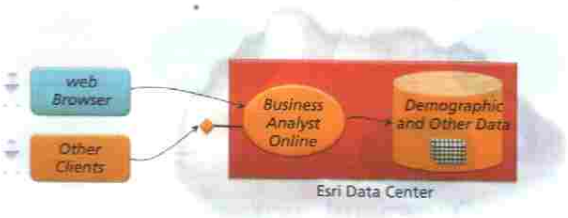


Figure 7: Business Analyst Online is a cloud application for working with demographic data, consumer data, and other information.

As the figure shows, Business Analyst Online can be accessed from an ordinary Web browser. The application also exposes a Web services interface that lets it be used by other clients. Esri provides an iPhone app, for example, and third parties can also access these services. Notice that this cloud application isn't built on Amazon Web Services or another cloud platform. Instead, it runs in Esri's own

Internet-accessible data centers. While cloud platforms can be quite useful, there's no requirement that a cloud application be built on one.

Like ArcLogistics, this application also comes in on-premises versions, including both a desktop and a server product. In some cases, such as when an organization wishes to merge its own data with the standard data this application provides, one of these on-premises versions is a better choice. In fact, the on-premises versions of the product allow more sophisticated analysis than their cloud siblings (today, at least). Yet there are a number of reasons why Business Analyst Online makes sense as a cloud application. They include the following:

- More approachable for infrequent or non-expert users: Many potential customers need the services of Business Analyst Online only occasionally. Rather than make them install on-premises software that they don't often use, putting this application in the cloud makes it simpler and quicker to access when needed. And because Business Analyst Online is designed to be easier to use than the on-premises version—its users aren't expected to be GIS professionals—using it only occasionally isn't especially difficult.

- Lower cost of entry: Like most cloud applications, Business Analyst Online charges its customers based on usage. While a frequent user of the service might buy an annual subscription, a customer is also free to buy just a single report and never use the service again. In either case, you pay only for what you use.

- No on-premises data or software updates: All Business Analyst Online customers use the same database, which is updated regularly by Esri. And because it's a cloud application, the code is also updated centrally. This makes software updates simpler—they're done by Esri—with new features available immediately to all of the application's users.

- Better customer support: Because all Business Analyst Online customers use the same code and the same data, Esri's support people don't need to worry about differences in configuration or installed data. This can potentially help them resolve customer support questions faster than with an on-premises product.

In some ways, GIS applications are an especially good fit for the cloud. Because they rely on large and changing data sets, putting both this data and tools to work with the data in the cloud can make sense. Business Analyst Online provides a good example of the value this provides.

CONCLUSION

There's no denying it: Cloud computing is here, and its effects will be widespread. In the GIS world, Esri provides clear examples of how these new technologies can be used. Those examples include:

- Using a cloud platform to provide new deployment options, such as running ArcGIS Server on Amazon Web Services.

- Using a cloud platform to support Web sites that provide broadly usable GIS data and tools, as illustrated by ArcGIS.com.

- Offering cloud applications that provide useful alternatives to their on-premises siblings, as shown by ArcLogistics and Business Analyst Online.

The move to the cloud is all but certain to have an impact on your organization, both in GIS and other areas. Why wait? The time to start understanding this shift is now.

Source: http://www.esri.com/library/whitepapers/pdfs/gis-in-the-cloud-chappell.pdf

ArcGIS Server Image Extension:

New mosaic dataset data model in ArcGIS 10

What is a mosaic dataset?

A mosaic dataset allows you to store, manage, view, and query small to vast collections of raster and image data. It is a data model within the geodatabase used to manage a collection of raster datasets (images) stored as a catalog and viewed as a mosaicked image. Mosaic datasets have advanced raster querying capabilities and processing functions and can also be used as a source for serving image services.

A mosaic dataset consists of

- A catalog that provides the source of the pixels and footprints of the rasters
- A feature class that defines the boundary
- A set of mosaicking rules that are used to dynamically mosaic the rasters
- A set of properties used to control the mosaicking and any image extraction
- A table for logging during data loading and other operations
- Optionally, a seamline feature class for seamline mosaicking
- Optionally, a color correction table that defines the color mapping for each raster in the raster catalog

Types of mosaic datasets

There are two types of mosaic datasets—one allows you to add all types of raster data and modify the properties and functions applied per raster and on the mosaic dataset. This is created using the Create Mosaic Dataset tool. There are no limitations to this mosaic dataset.

The other mosaic dataset only references either another mosaic dataset or raster catalog. It is created using the Create Referenced Mosaic Dataset tool. The referenced mosaic dataset behaves similarly to a regular mosaic dataset; however, it is read only, for example, you cannot add additional rasters to the mosaic dataset, you cannot build overviews, and you cannot calculate the pixel size ranges.

The workflow and tools to create mosaic datasets

There are two types of mosaic datasets—those used to manage, display, serve, and distribute raster data, and those created from existing raster catalogs or mosaic datasets. All the geoprocessing tools to create, edit, and manage a mosaic dataset are grouped together in the Mosaic Dataset toolset in the Data Management toolbox.

When you create a mosaic dataset that will be used to manage, display, serve, and distribute raster data, you will use the Create Mosaic Dataset tool.

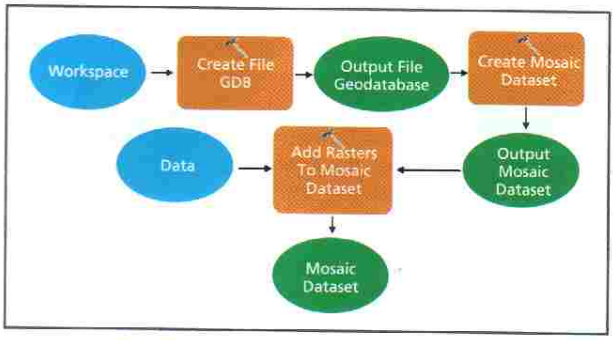
General workflow

1. The mosaic dataset is created in a geodatabase. If you don't have a geodatabase, you first need to create one.
2. Create the mosaic dataset using the Create Mosaic Dataset tool.

This creates an empty mosaic dataset and its schema in the geodatabase.

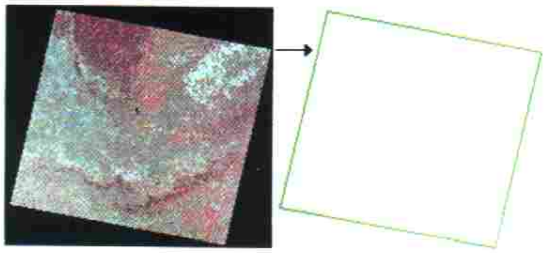
3. Add raster data using the Add Rasters to Mosaic Dataset tool.
   - Calculate cell size ranges—Use the Update Cell Size Ranges check box on the tool to do this at the time of ingest or later using the Calculate Cell Size Ranges tool.
   - Build the boundary of the image service—Use the Update Boundary check box on the tool to do this at the time of ingest or later using the Build Boundary tool.
   - The boundary is the extent of all the raster datasets, defined by their footprints, within the mosaic dataset and must exist.
   - Generate overviews—Use the Update Overviews check box on the tool to do this at the time of ingest or later using the Build Overviews tool.
4. View the mosaic dataset.
5. Serve as an image service using ArcGIS Server or make available locally.

You can create a model or write a script to create the mosaic dataset and add the data.



Recalculating footprints radiometrically

When you need to recalculate the footprint to remove those pixel values you don't want in your mosaic dataset, you can use the Build Footprints tool. For example, your footprint is originally the entire dimension of the image, but because it was rotated, you want it to reflect the actual valid pixel values of your images.



There are a number of options on the Build Footprints tool that can be modified that will affect the footprint output. For example, there may be a range of pixel values on the high and low ends of your data values that you don't want included. Normally, these pixel values can easily be defined, but if the data is stored with lossy compressions, the values will be a bit fuzzy. For example, instead of all values of 0, your values may be 0–3.

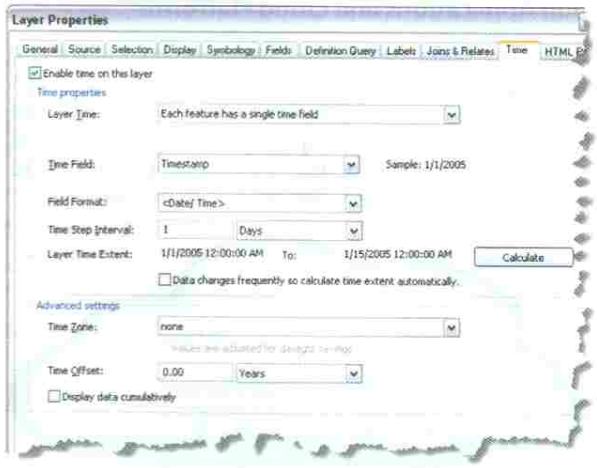
Color balancing a mosaic dataset

Color balancing method	Description
Dodging	This technique changes each of the pixel values towards the target color. If you choose this method then you must also choose the type of target color surface to use, which will affect what the target color is. Dodging tends gives the best result in most cases.
Histogram	This technique changes each of the pixel values according to the target histogram. The target histogram can be automatically calculated from the mosaic dataset, or a target raster can be specified. Histogram balancing works well when all the rasters within the mosaic dataset have a similar histogram shape.
Standard deviation	This technique will change each of the pixel values according to the standard deviation calculation. The standard deviation value can be automatically calculated from the mosaic dataset, or from a target raster. Standard deviation balancing works best when all the rasters in a mosaic dataset have the same histogram distribution of the normalized values.

To make your mosaic datasets look seamless, you need to choose a color balancing option. There are three color balancing options available: dodging, histogram, and standard deviation.

Using time in a mosaic dataset

There are many organizations that have large collections of imagery acquired at various dates covering the same area. This data will often be stored in different file formats, in different projections, and with different pixel sizes. For example, forestry companies may have imagery over their forest stands taken at different times of the year or taken over different years to help them manage their harvests. Also many cities or states have large collections of orthophotography acquired on an annual or semiannual schedule. These collections can be compiled into a single mosaic dataset, which can be used in-house or served as an image service to their clients.



For further details, please refer www.esri.com

Revisiting & Understanding the Cloud GIS

Introduction

The rise of cloud computing just might be the most important thing happening in information technology today. While not everything will move into the cloud, it's fair to say that nearly every organisation will use this new approach in some way. Given this reality, cloud computing has the potential to change many aspects of the world.

For users of geographic information system (GIS) technology, the cloud opens a number of new possibilities. But what are those possibilities and why might they be better than what you're doing now? In fact, why should you care about cloud computing at all?

Cloud Applications and Cloud Platforms

The phrase "cloud computing" means different things to different people. This discussion focuses entirely on public clouds, in which code and data live in Internet- accessible data centres owned by Amazon, Microsoft, Google and others. In this context, its useful to distinguish between two broad categories: cloud applications and cloud platforms (see Figure 1)

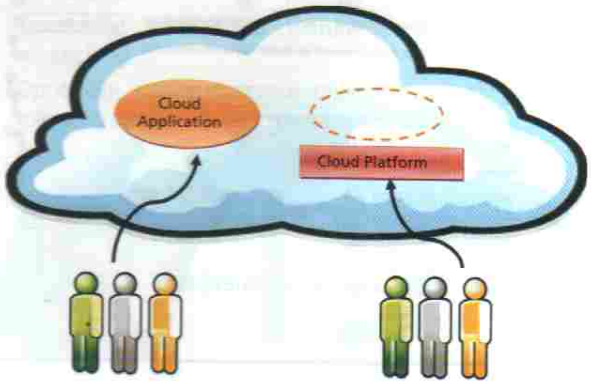


Figure1: Cloud applications are accessed by users, while cloud platforms are used by developers

Like the applications that run in your data center (sometimes referred to as on-premises applications), cloud applications have users. The big difference is that unlike on premises applications, cloud applications run in a shared data center that's accessed via the Internet. This application style is sometimes called Software as a Service (SaaS), and it gets more common every day. Some visible examples of SaaS applications include the customer relationship management provided by Salesforce.com; CRM, the document creation services provided by Google Apps, and the business- oriented email service offered by Microsoft Exchange Online. Going forward, more and more organisations are likely to rely on cloud applications for a range of business functions.

As Figure 1 shows, however, applications aren't the only cloud computing option. Its also possible to create platforms that run in Internet-accessible data centers rather than inside your own firewall. These cloud platforms can run applications, store data, and provide other useful services. And while one important role of cloud platforms is to support cloud applications, cloud platforms themselves are of interest to developers rather than end users, as the figure shows. Several providers offer public cloud platforms today, but the technology was pioneered by Amazon. Their offering, called Amazon Web Services (AWS), remains a leader in this space, and its's worth closer look.

Esri & Cloud Computing

Esri technology has come up with a noteworthy business model which promises to open the benefits of GIS to anyone anywhere. This innovative cloud computing technology gives subscribers full access to GIS tools such as data creation, analysis, editing and visualization. Simple collaborative utilities further enhance the spread of GIS across an office or across the globe. In continuation to our previous article on New Era of Cloud Computing in Arc India News (Vol4 Issue 3) where we introduced the cloud computing in GIS, this current article will revisit the basics and try to understand How Esri Technology fits in the Cloud GIS and how it is being implemented.

The technology and architecture that cloud service and deployment models offer are a key area of research and development for ESRI in current and future iterations of the ArcGIS system platform solutions. Cloud computing furnishes technological capabilities—commonly maintained off premises—that are delivered on demand as a service via the Internet. Since a third party owns and manages public cloud services, consumers of these services do not own assets in the cloud model but pay for them on a per-use basis. In essence, they are renting the physical infrastructure and applications within a shared architecture. Cloud offerings can range from data storage to end-user Web applications to other focused computing services.

One critical difference between traditional and cloud computing is the scalable and elastic nature cloud computing provides. Instead of a static system architecture, cloud computing supports the ability to dynamically scale up and quickly scale down, offering cloud consumers high reliability, quick response times, and the flexibility to handle traffic fluctuations and demand. Cloud computing also supports multitenancy, providing systems configured in such a way that they can be pooled to be shared by many organizations or individuals. Virtualization technology allows cloud vendors to convert one server into many virtual machines, thereby eliminating client-server computing with single-purpose systems. This maximizes hardware capacity and allows customers to leverage economies of scale.

The service model comprises three core options within the cloud computing environment. Creates a new sets of layer which replaces the classical multi-tier architecture model of web services

Figure 2: Architecture Model of Cloud

- SaaS & dSaaS are top layers and provide customised tools and storage facilities through web services. Software as a Service (SaaS) comprises end-user applications delivered as a service rather than as traditional, on-premises software.
- PaaS is the middle layer, provides COTS S/W & runtime environments. Platform as a Service (PaaS) provides an application platform, or middleware, as a service on which developers can build and deploy custom applications. Common solutions provided in this tier range from APIs and tools to database and business process management systems to security integration, allowing developers to build applications and run them on the infrastructure that the cloud vendor owns and maintains. Microsoft's Windows Azure platform services are often referenced as PaaS solutions at this middleware tier.
- IaaS is the bottom layer which provides infrastructures as standardized service. Infrastructure as a Service (IaaS) primarily encompasses the hardware and technology for computing power, storage, operating systems, or other infrastructure, delivered as off-premises, on-demand services, such as the Amazon Elastic Compute Cloud (Amazon EC2) or Amazon Simple Storage Service (Amazon S3), rather than as dedicated, on-site resources.

Cloud Computing Deployment Models

There are several types of cloud computing deployment scenarios. The National Institute of Standards and Technology (NIST) is emerging as the preferred provider of the de facto definition of cloud computing and the distribution models, seen here with some Esri examples.

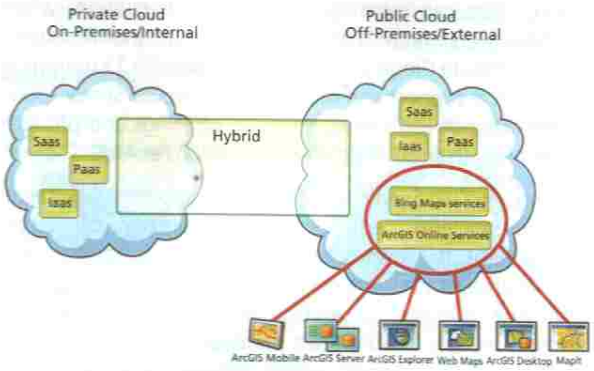


Figure 3: Some organizations, concerned about security, may opt for a private cloud or a hybrid deployment model.

The public cloud is the most commonly referenced regarding the topic of cloud computing, where the infrastructure and applications are owned by the organization selling cloud services. However, since many traditional vendors and users are not quite ready to jump into public cloud computing or are restricted from doing so, the cloud service tiers are replicated within a private cloud environment, behind the firewall, and maintained within the parameters of the host organization. Many believe that the sweet spot for cost optimization in an organization will rely on a delicate balance of public, or community, and private clouds. However, since this hybrid cloud solution is commonly bound together by proprietary technology, it will only be embraced by enterprise computing in the future as standards are developed.

Characteristics & Benefits

The important characteristics are –

- ability to scale
- provide computational power & storage dynamically in cost effective way
- Can use resources without managing underlying complexity of technology.

A Few Cloud Benefits

Lower Total Cost of Ownership	Reduced ongoing and life cycle costs
Increased Availability	Always on, always available
Faster Application Delivery	Expedites time to market; competitive advantage
Flexible Model	Scales by demand; no wasted capacity
Enables Collaboration and Community Computing	Platform for easier and faster information sharing, mobile workforce
Improved Business continuity	Inexpensive disaster recovery options
Rental Pricing Model	Pay-as-you-go; pay-in-advance; try before you buy

These leads to following benefits:

- Easy to Use - Infrastructure deployment with click of mouse/ API
- Scalability – Infrastructure requirement is based on application; nothing to purchase
- Cost - Optimized as it is resource usage based
- Reliability – Based on enterprise grade H/W; can subscribe to multiple clouds
- Risk - change instantly (even OS)

ArcGIS in the Cloud

Cloud computing is viewed as the next evolution that will impact businesses and how they manage their IT infrastructures. Cloud computing has a direct impact on GIS and GIS users. Esri has already been leveraging cloud computing resources for a number of years and, in the coming months, will offer additional products for direct use in the cloud. Esri's emerging cloud-ready strategy is to provide customers with a range of opportunities for choosing the most efficient, cost-effective, and secure mix of on- and off-premises GIS applications and services to meet their business needs.

ArcGIS in the cloud makes it possible to take advantage of the benefits of cloud computing, including deployment of Web 2.0 applications that require flexible scalability. ArcGIS Server and ArcGIS Online provide new, cost-effective, and flexible opportunities for organizations to deliver and consume GIS content and services in the cloud. Using ArcGIS in the cloud shifts the duty of maintaining on-premises resources to the cloud vendor, alleviating the customer's responsibility for maintenance and support.

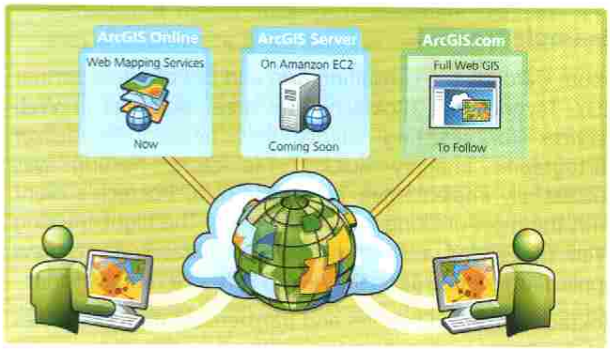


Figure4: ArcGIS will deliver a growing selection of online services and software.

A Complete Online GIS

The road map for Esri's cloud-based GIS offerings includes access to full GIS capabilities in a cloud environment. This will include authoring, analysis, geodata management, hosting Web services, and applications. Esri sees cloud-based GIS as a key aspect of any GIS system moving forward. Some aspects of this are available now, and more will be available over time. Over the next year, Esri will systematically release capabilities and components in a fully integrated system.

Tiles on a Cloud (Cloud computing and ArcGIS Server deliver a thrifty solution)

Significance of the Map Cache

The introduction of the map cache in the latest version of ArcGIS Server greatly enhances the delivery of cartographic imagery. Maps are initially processed and cut into smaller tiles. Map caching increases the speed of GIS applications because it eliminates the need to request data from the database, process it, then send it to the browser on demand. In response to a request, preprocessed tiles fall seamlessly into place and users enjoy a pleasant Internet mapping experience. The strategy of using cached map layers that aren't frequently updated as base layers and dynamic map services for operational layers provides users with a much more responsive Web map.

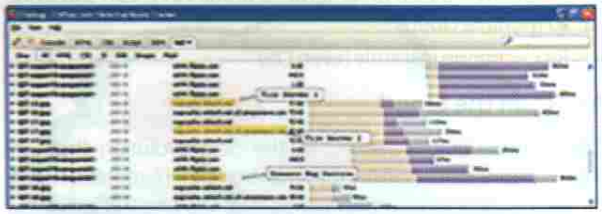


Figure 5: As the user base grows, Roktech simply increases the amount of data delivery services it requests from Amazon S3 and charges FltPlan.com accordingly.

Since the emergence of map-cached ArcGIS Server sites, user demand has noticeably increased. As a result, many smaller organizations that serve high-quality cartographic imagery are hitting a bandwidth limit fairly quickly as traffic to these sites grows. Since the cost of adding more T1 lines isn't realistic given limited budgets of many businesses and small governments, the result can be imagery that takes eons to render.

Configuring the Tiles

Both ArcGIS Server JavaScript and Flex APIs allow developers to tell applications to point to different tile servers. Essentially, tile servers are just places where map caches are stored. These tile servers (called "buckets" in Amazon S3 parlance) do not necessarily need to be on the same physical network as ArcGIS Server.

Example

South Carolina GIS consulting firm and Esri business partner ROK Technologies (Roktech) saw great potential in Web services for assisting clients that needed to deliver cartographic imagery quickly. Tile cache hosting was successfully implemented for FltPlan.com, Roktech's client with the most pressing bandwidth issue. The flight-tracking Web site served a nationwide raster dataset via its new application created using the ArcGIS Server API for JavaScript.

Roktech processed the tiles and transfers the map cache tiles for storage on both its own fiber network and the Amazon S3 cloud service. Roktech decided to use Adobe ColdFusion to process the tiles and prepare them for the upload to the Amazon S3 service. In addition to its main flight planning site, FltPlan.com ran sites that served ArcIMS maps and other ArcGIS-based dynamic layers. Even with its multiple T1 capacity, bandwidth for all FltPlan.com's sites became saturated within days of the new sites going live. Roktech moved FltPlan.com's map cache to its own facilities, offloaded the bandwidth draw to its own connection, and solved the problem. The transfer of the map cache immediately made a huge difference in site performance. As FltPlan.com's site continues to become more popular with the general aviation industry, it scales nicely.

ArcGIS Server on the Amazon Cloud

Increasingly, users have been asking to leverage ArcGIS in the cloud to supplement their local in-house resource and/or reduce their capital expenses for hardware. Esri is now supported and provide preconfigured Amazon Machine Images for ArcGIS Server for use in the Amazon cloud infrastructure. Running ArcGIS Server on Amazon allows organizations to take advantage of multiple cloud services and features. These include the ability to deploy ArcGIS Server across more than one data center and access Amazon's elastic computing infrastructure, which makes it possible for organizations to quickly adjust the capacity of ArcGIS Server services and applications to user demand.

ArcGIS Server Now Available as Cloud-Based Subscription

Today all the Esri customers have the option to purchase a cloud-based subscription to ArcGIS Server, Esri's server-based geographic information system (GIS) software. With this option, users can purchase an annual subscription, which bundles a preconfigured ArcGIS Server instance on Amazon's Elastic Compute Cloud (EC2) infrastructure with 12 months of Esri technical support and maintenance. ArcGIS Server Cloud Bundle expands Esri's growing cloud offerings and provides customers with another deployment option for ArcGIS Server.

Running ArcGIS Server in the cloud simplifies GIS server deployment and reduces the complexity of server management. It allows organizations to more rapidly meet larger-than-average workloads and demand by scaling up or down the number of ArcGIS Server instances without investing in new on-premises hardware. Users gain direct access to ArcGIS Server within minutes and can begin publishing services and supporting Web mapping applications immediately. ArcGIS Server Cloud Bundle is also a green computing option that allows organizations to reduce their overall energy consumption.

Estimating the Cost of a GIS in the Amazon Cloud

To understand how costs are calculated for cloud services—using Amazon™ Elastic Compute Cloud (EC2) as an example—and how to estimate the costs of using Amazon cloud services with an ArcGIS Server cloud implementation: first one has to understand ArcGIS® Server on Amazon EC2.

What Is ArcGIS Server on Amazon EC2?

ArcGIS Server is the core server GIS software made by Esri, used for creating, managing, and distributing GIS Web services, applications, and data. ArcGIS Server is typically deployed on-premises within the organization's service-oriented architecture (SOA) or off-premises in cloud computing environments or data centers.

Esri offers ArcGIS Server on Amazon EC2 as a preconfigured solution for organizations wishing to deploy their GIS servers

on established cloud infrastructures rather than use their own local infrastructures. ArcGIS Server on Amazon EC2 provides two Amazon

Machine Images (AMIs): ArcGIS Server and an enterprise geodatabase configured on PostgreSQL.

An AMI represents a machine image or the state of a machine once it's completely configured for a certain need. In the case of ArcGIS Server on Amazon EC2, the ArcGIS

Server AMI is used to launch instances of ArcGIS Server. Each instance is configured to run on Windows®2008 and includes a 100 GB drive for GIS data

Choosing Services Offered on Amazon

Amazon offers optional services that can be associated with an instance or group of instances. The pricing for these services is based on a pay-as-you-go pricing model.

- Elastic Block Store (EBS) is the storage that can be attached directly to an instance to become a local drive to the machine. The EBS can be detached and managed separately as needed.
- Elastic IP addresses provide an IP address that never changes inside the cloud.
- Elastic Load Balancing automatically distributes incoming application traffic across multiple Amazon EC2 instances.
- Auto Scaling ensures that the number of Amazon EC2 instances being used scales up (increases) during demand spikes to maintain performance, then automatically scales down during traffic lulls to minimize costs.
- Amazon CloudWatch provides visibility into AWS cloud resource utilization, operational performance, and overall demand patterns including metrics such as CPU utilization, disk reads and writes, and network traffic.

Calculating the Costs

The costs of running an instance on hosted infrastructure depend primarily on two factors—the hourly rate of the instance type and data transfer to and from the instance. On Amazon EC2, users can realize cost savings by making sure to use only the resources that are needed, when they are needed. When estimating cloud computing costs, time savings is often overlooked as a factor of potential costs. Typical time-saving variables include time to set up and maintain cloud resources.

Beyond the general concepts of data transfer, underutilized resources, and time, Amazon cloud consumers must consider the types of instances they are using as well as the other (optional) Amazon Web Services that they may add to their solution. Both instances and services are priced based on hourly use.

Choosing an Instance

Determining an instance type that provides the right capacity for applications that run in the cloud is similar to choosing the capacity of virtualized machines on premises.

On Amazon EC2, each instance type has an hourly cost that is dependent on the operating system and the software license associated with that instance. The ArcGIS Server AMI is preconfigured to run only with 64-bit instance types, and it is based on Windows 2008.

It is expected that Amazon cloud consumers will provide their own ArcGIS Server licenses to enable use of the Esri® preconfigured AMIs. As such, the hourly cost for running an instance on Amazon's infrastructure is based solely on the instance type and the license fee for using Windows.

For a complete list of the hourly cost per each instance type, visit www.aws.amazon.com/ec2/#pricing

Implementing an Example

In this example, ArcGIS Server on Amazon EC2 is used to support a Web mapping application used by government officials, the public, and the media. Ideally, the application needs to be accessible 24 hours a day, seven days a week, and handle heavy traffic loads intermittently without degradation in performance. The IT and GIS staff want to be able to monitor cloud resource use and update the application and geodatabase on a quarterly basis. It is assumed that the organization has licensed ArcGIS Server.

The ArcGIS Server AMI is used to launch an instance that will publish and maintain three separate map services. The data used by the services is stored in a file geodatabase of about 80 GB in size, and the Web application is built on ArcGIS API for Flex™. Both the data and the application are also stored in the cloud as part of the instance.

Example Deployment Components include

- ArcGIS Server AMI
- ArcGIS Server instance running
  - File geodatabase
  - Three published services
  - Web application
- Custom ArcGIS Server AMI
- Amazon Elastic Load Balancer
- Amazon CloudWatch plus Auto Scaling

Figure 6 : ArcGIS Server Instance with Added Components

Summarising the Cost Estimation

Planning for the types of loads, usage, and features, along with the costs of each of the cloud services, provides a way to estimate the potential costs of cloud services. For ArcGIS Server on Amazon EC2

- Begin with a Standard Large Instance type as a baseline for estimating instancecosts.
- For solutions requiring high availability, plan for multiple instances and costs associated with Elastic Load Balancing and Amazon CloudWatch.
- While an elastic IP address will not necessarily add to the cost of the solution (as long as it is attached to an instance), it makes instance replacement seamless and easy if an instance goes down or needs to be replaced. Without the elastic IP address, troubleshooting and setup costs could impact the project.
- Creating a custom AMI that reflects the solution setup can save time and money when it becomes necessary to re-create or update the setup. It is good practice to compare estimates to the actual bill to see how accurate those estimates are. Continuous monitoring of the system and the bills is one of the best tools to keep costs under control.

For details on how to set up and use the ArcGIS Server AMIs, please refer to the ArcGIS Server on Amazon EC2 documentation at www.help.arcgis.com/en/arcgisserver/10.0/help/arcgis_server_on_amazon_ec2/

Mr. Shankar Aggarwal is a 1980 batch IAS officer who has worked in various Central and State Govt. Ministries before taking charge in the Ministry of IT as the Head of NeGP (National e-Governance Plan). He is shouldering a very important responsibility of carrying the nation to the next level by evangelizing the use of ICT in making Government services accessible to the common man in his locality, through common service delivery outlets and ensure efficiency, transparency & reliability of such services at affordable costs to realize the basic needs of the common man.

For the implementation of NeGP, DIT is creating the Common and Support Infrastructure (National/State Wide Area Networks, National/State Data Centres, and Common Services Centres & Electronic Service Delivery Gateways) and making suitable arrangements for monitoring and coordinating the implementation of NeGP under the directions of the competent authorities in this regard. The DIT also has taken initiatives to evolve/ lay down Standards and Policy Guidelines, provide Technical and Handholding Support, undertake Capacity Building, R&D, etc., as required, for successful implementation of various e-Governance Projects. DIT has been mandated to adequately strengthen itself and its various arms like NIC(National Informatics Center), STQC(Standardization, testing & Quality Certification), CDAC(Center for Development of Advanced Computing), NISG(National Institute of Smart Governance), etc., to play these roles effectively.

Prior to the current role he has held key leadership positions in Deptt. of Housing and Urban Planning, Deptt of technical education, Trade Tax, State Transport, Bundelkhand University, Indian Oil Corporation, Small Scale Industries, Personnel & Training in the Central Government and Conventional and Non Conventional Energy Department in State Government of UP.

Q. What is the vision & Strategy for NeGP

The vision of NeGP is to "Make all Government services accessible to the common man in his locality, through common service delivery outlets and ensure efficiency, transparency & reliability of such services at affordable costs to realize the basic needs of the common man"

- Focus on Services & Service levels
  - Business Process Reengineering & Change Management
  - Creation of Service Delivery Platform
- Centralized Initiative
- Decentralized Implementation
- Ownership and Central Role of Line Ministries
- Emphasis on Public Private Partnerships
- Capacity Building
- Standards for Interoperability
- Awareness and Communication
- Third party Impact Assessment

In addition to above, the following new elements have been included in the strategy:

- Use of Mobile Technology
- Creation of Common Platforms – Cloud Computing
- Electronic Service Delivery Law
- Citizen Engagement Framework

Q. In what ways does GIS contribute to this vision of NeGP

1. Geographic Information (GI) Technologies and Spatial Decision Support System (SDSS)

Spatial Decision Support System (SDSS) essentially integrates map and tabular data in GIS environment. However, Alpha-Numeric Decision Support System has slowly shifted to Spatial Decision Support System (SDSS) only after the availability of Remote Sensing data, which has the capability of providing up-to-date data on the area of study. Spatial Decision Support has matured to another dimension to capture spatial data through GPS Survey.

90 per cent of the decisions taken by the government are geographic in nature. Equally, most of the data available with government is also in geographic. Survey of India is a long tradition survey organization to provide benchmark for spatial data of the country. At the same time state level survey organizations are also available to make large-scale maps for their field level operations. Such a large country has wide map resources on both small and large scales need its maximum exploitation on various uses. In this framework, any data can be built further so that an up-to-date and additional data layers be available for taking decisions and in turn better governance.

2. Geomatics in e-Governance

Geomantic in e-governance (g-governance) means embedding geospatial and information technologies such as high resolution imagery, GPS, broadband internet, distributed GIS, 2G and 3G communications, location-aware Wi-Fi (wireless fidelity) and WiMax, voice activated customer response system, radio frequency identification (RFID) , developments in computer networks , open source GIS, web GIS, mobile computing and communication, mobile GIS etc. are set to leverage the g-governance in a powerful way. Given the nature and pace of technological change, ICT strategies, tools, and innovations will continue to shape the information environment of governance

E-governance has an a-spatial, administrative wing to it, but it is powered by GIS and related "spatially aware software. At the municipal level, e-governance entails access to survey lines, property definitions and tax assessment information. Public notices are web posted, and forms for everything from dog licensing to tendering of construction contracts are managed on-line. At the state or provincial level, e-governance is poised to become the vehicle for automobile registration and other services including campground reservation, passport renewal, postal services and plebiscites. The appeal of e-governance is the promise of more efficient and transparent delivery of services. Its success is dependant, however, on high levels of web access. E-governance is being actively pursued by almost every level of government. The technology to do so is dependent on spatial data and GIS functionality.

Geomantics encompasses all aspects of geo-referenced data viz. acquisition, integration, decision support and dissemination. Its applications are fundamental to population growth, economic development and consumption of natural resources. Geomatics addresses the vital elements of any information system viz. geographic measurement, geo-accounting, spatial analysis and integrated decision-making.

3. Application areas of Geospatial Data in E-governance

There are vast scopes for better governance using geospatial data. To name a few:

- Land Records Management
- Disaster Management
- Hazard Management
- Watershed Development
- Environmental Management
- Integrated Development
- Transport Network Management
- Electricity Distribution and Transmission Management
- Law and Order
- Fleet Management and navigation

Q. Do you think Cloud can play an important role in the making of National e-Governance Plan for India?

Yes, Cloud Computing can play an important role in achieving the objectives of the National e-Governance Plan. The NeGP provides for creation of common infrastructure components like Data Centres and Networks to be shared by large number of Departments in a State. Cloud Computing technologies can help the State Data Centres deliver necessary computing resources to implementing Line Departments based on their requirements. This can save the time and cost involved in each Department setting up its own separate infrastructure in the form of Servers, storage, etc for project implementation. It will also enable successful e-Governance projects to be replicated across diverse States/Geographies by making them available over a cloud.

Q. State Data Centre (SDCs) being initiated under the Mission Mode Plan of NeGP, what is the role of Department of Information Technology at the Central Government level?

The scheme on State Data Centre was conceptualized by the DIT which was approved in Jan, 2008 with a total outlay of Rs.1623.20 Crores towards the Capital and Operational expenses over a period of 5 years. The States/UTs have been categorized in three categories viz : Large, Medium and Small. To facilitate smooth and time bound implementation, the Department of Information Technology, formulated and issued the policy guidelines including roles and responsibility of various Stakeholders involved. Further, DIT has assigned the consultancy agencies to the States who are assisting the States in RFP preparation, bid process management, supervision and overall implementation of the State Data Centre. Program Management Unit was also setup at DIT to keep track of each and every State SDC project starting from DPR approval to implementation of State Data Centre.

DIT has approved the proposals received from 31 States/UTs. Further a template RFP has been provided to the States/UTs to ensure that all important components and considerations that go with the state-of-the-art and best practices requirements for Data Centres are addressed. Department of Information Technology has been involved in monitoring of the SDC project in all the State from the approval of the proposal from the State till implementation of State Data Centre and its Operation and maintenance over a period of 5 years. DIT has been a member of Project Implementation committee setup by each State to provide them with technical support and guidance, as and when required.

As on date 11 SDCs have been made operational and it is expected that the remaining SDCs shall be made operational by March, 2012.

Q. Setting up these SDCs at State level, will be delivering different kinds of services what are they and how they will benefit the citizen at large?

State Data Centre (SDC) is one of the three components of the core infrastructure of National e-Governance Plan (NeGP). Under the SDC Scheme, it is proposed to establish Data Centres in all the States/UTs so that common secure IT infrastructure is created to host state level e-Governance applications/Data to enable seamless delivery of Government to Government (G2G), Government to Citizen (G2C) and Government to Business (G2B) services. These SDCs will ensure better Operations, Standardization of Systems & management control leading to faster deployment and reduced costs, offering dynamic scalability as their demand grows including security related requirements and uptime of the highest order.

The e-governance initiatives in India face the twin challenges of automating the government departments and taking the on-line services to the common man. Government to Citizen Services (G2C) has evolved over a period of time. There are various application that are being delivered by the State such as Land Records, Registration, Grievance, Birth/ Death certificate, etc... The other components i.e. NeGP plan State Wide Area Network (SWAN), Common Service Centres (CSC), State Service Delivery Gateways (SSDG) and e-District shall work seamlessly with State Data Centre in reaching the common man providing the services. SDCs provides sharable, reliable and secured infrastructure for hosting e-Governance applications to provide efficient electronic delivery to the citizens.

Q. What roler do you think NeGP has to play in building the National Spatial Database Infrastructure of the country

National Spatial Data Infrastructure (NSDI), India will be the single point nodal agency to coordinate for providing information about all glossarial infrastructure, data and metadata in the country. All non-spatial data/information and information about delivery of services to citizen under NeGP also can be linked to NSDI. With linkages of NeGP, NSDI will be a powerful tool in the spatial information domain.

FEEDBACK

The last issue of Arc India News was good and informative. The article on the understanding and implementing ArcGIS Image server was an interesting read, it throws light on the growing need for better access to Imagery. The other articles on magazines were also quite interesting and informative. The complimentary copy of Arc India news should also be send to various institutions across India.

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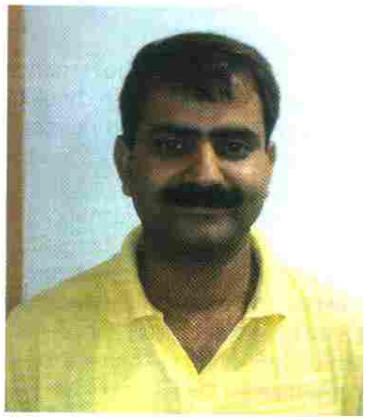

Arc India magazines from Esri India has always been very useful and informative for all GIS users and researchers. Research articles published in Arc India are very high quality. The Article "Introducing ENVI 4.8" in last issue was very informative and must read. The other articles were also useful and worth reading.

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Enterprise GIS Cloud for Municipal Corporations

Introduction

In times of digital technology taking its upgear, governments are becoming information-intensive service enterprises. E-government or online government is an effort to address the issues in operations, information and IT. It aims at creating open and efficient interactions among the various stakeholders, eg. Governments, citizens, business enterprises etc. The goal of municipal government is met through the daily operations of many departments under the management of the government's administrative officer and the policy direction of the elected officials. In India Municipal Corporation is a state government formed department that works for the development of a city, which has a population of more than twenty thousand. The growing population and urbanization in various cities of India were in need of a local governing body that can work for providing necessary community services like health centers, educational institutes and matters related to housing and property tax etc.

Today Municipal Corporations have been facing various IT obstacles in adopting the new upcoming technology innovations. Looking at the various needs of the Corporations, many of them adopted variety of means to ease out their daily operations. The use of geographic information system (GIS) technology within municipal government during the past 30 years has clearly demonstrated that effective use of geospatial information is a critical element. This is because addressing the varied combinations of factors that affect the health, safety, and other quality-o f- life concerns of residents throughout the municipality is inherently based on geography or "location." Another important new technology being consider in this regard is the Cloud Computing, which is defined as the Internet based computing in which shared resources, software and information are provided to computers and other devices on demand. The innovative cloud computing technology gives subscribers full access to all the GIS tools. Integration of GIS Services with Cloud Computing is emerging with the range of opportunities for choosing the most efficient, cost effective and secure mix of various GIS applications and services to meet the business needs of the stakeholders.

Municipal Corporations can effectively reduce the costs and give a smooth and speedy service to its citizens in three ways - Through improved technology efficiency ; Service sharing and Reduced labor.

Municipal Corporations in India

In India a Municipal Corporation is a local government body that administers a city of population 200,000 or more. The growing population and urbanization in various cities of India were in need of a local governing body that can work for providing necessary community services like health centers, educational institutes and matters related to housing and property tax.

Municipal Corporation in India formed under the Corporations Act of 1835 of Panchayati Raj system mainly deals in providing essential services in every small town as well as village of a district/city. Their elections are held once in five year and the people choose the candidates. The aim behind its creation was to provide the convenient services to the people as it caters to their daily problems and holds a central importance in the entire state departments. The largest corporations are in the four metropolitan cities of India. These cities not only have a large population, but are also the administrative as well as commercial centers of the country. The largest Municipal Corporations in India currently are Mumbai, followed by Delhi, Kolkata, Chennai, Hyderabad, Bangalore and Ahmedabad.

The Municipal Corporation is responsible for roads, public transportation, water supply, records of births and deaths (delegated from Central Govt Birth and Death Registration Act), sanitation that includes waste management, sewage, drainage and flood control, public safety services like fire and ambulance services, gardens and maintenance of buildings. The sources of income of the Corporation are property tax, entertainment tax, octroi (now abolished from many cities) and usage fees for utilities.

Components of an Enterprise GIS Cloud Implementation

GIS Cloud implementation whether at the project, department, or enterprise level, must consider each of the components that comprise an operational information system.

- **Infrastructure As a Service (IAAS)** -The system infrastructure includes the hardware, communications network, GIS, database management system (DBMS), and commercial off-the-shelf (COTS) software required for implementing the complete information system. The system infrastructure represents the technology components of the information infrastructure.

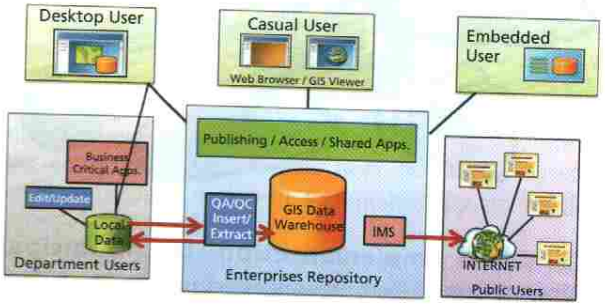

Figure 1: GIS Warehouse Architecture (IAAS)

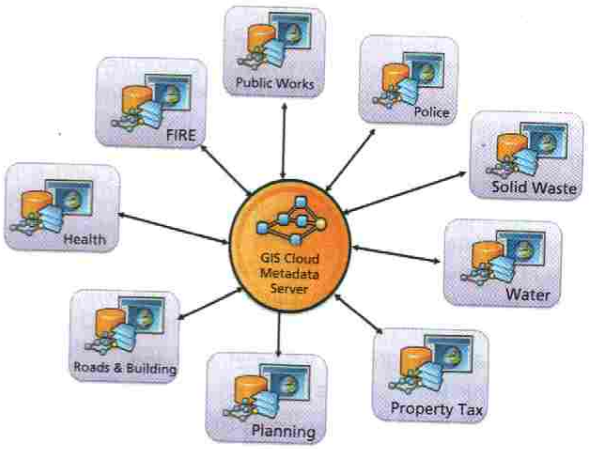

Figure 2: Web based Enterprise GIS cloud Architecture

- **Platform as a Service (PAAS)** - The enterprise geodatabase model identifies the design and metadata for the enterprise and departmental geographic data resources. The procedures for management of the

Geodatabase resources are often addressed as part of the metadata. The geodatabase model and GIS data resource management procedures comprise the information components of the information infrastructure

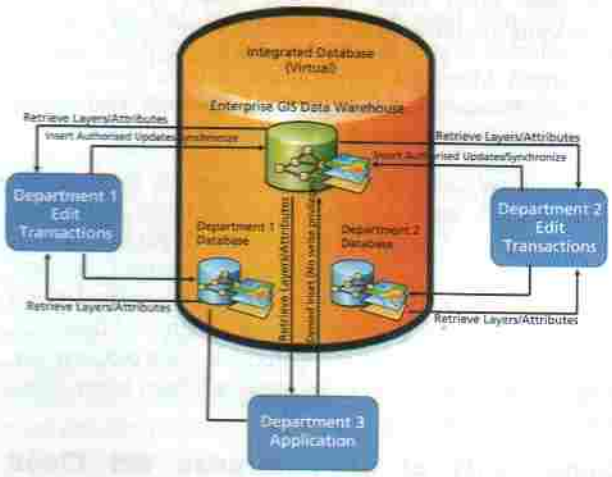

Figure 3: Shared GIS Database

- **Software as Service (SAAS)** —The GIS applications include all of the client side and server side applications associated with municipal business processes. GIS applications include business critical applications and other end user GIS applications to perform data management, editing/maintenance, spatial analysis, mapping, and visualization.

Figure 4: GIS Applications (SAAS)

GIS Cloud Implementation for Municipal Corporations

GIS provides a framework for collaboration and communication by providing a common frame of reference—location—and allowing people to share information about locations. In many municipal governments, the current GIS implementation model is file-based and stove-piped. Individual users or projects create and maintain their own data sets on their own desktop computers. This often leads to a proliferation of redundant data and applications. The goal of an enterprise GIS Cloud is to implement interoperable technologies, standards, and methods so that GIS data and services can be used more efficiently and more effectively. When an organization coordinates its GIS efforts, users of spatial data can spend more time on the analytical capabilities of a GIS and less time searching for, compiling, and integrating the data they require for their analysis activities.

Most municipalities have been using GIS or GIS map products for many years. Typically this began as a single project, for example, as the preparation of the general plan map of land use. Because of the benefits realized in that one project, GIS usage expanded to include a system to support multiple users within the department. In turn, municipalities began to recognize the benefits of using GIS in many different departments, and multiple department GIS implementations evolved. However, often these multidepartment implementations were not well coordinated, resulting in redundant maintenance of data sets, duplication of applications, and inefficiencies for the sharing of data due to a lack of applied standards. Today, the evolution of multiuser information systems is yielding enterprise GIS Cloud solutions enable data and application sharing through systematic engineering of business processes and enforcement of data standards.

Shared Municipal GIS Services in the Cloud

As we are broadly aware the Services that behests the Municipal Corporations is vast service domains such as Engineering, Health, Land, Public Works, Revenue Departments etc. The service portfolio varies from State to State in India. The delivery of all these services often requires the involvement of and collaborations between the various departments. Today efficient and effective information sharing between the involved departments is critical and methods that improve information sharing within and between government agencies, such as e-government and open government initiatives can help improve service delivery to citizen. Most of the IT applications used to support service delivery for the municipalities are directly aligned to the departmental structure, with the applications covering only the tasks associated with the single department, however at times the service delivery to the citizen involves the work of many departments.

Lets take an example for building a house and submitting the tax.

"The landowner applies to the Building department for the building permit. The building department internally interacts with the Land department for the maps of the land to see if there is any deviation in the land whether its commercial or residential, that will allow the building department to give the permit to the landowner for building the commercial or residential as per the maps. After the work has been completed and the Certificate of Occupancy has been issued, the Assessor's office must update the land records details to reflect the renovations and initiate a parcel reassessment. The newly assessed value has to be updated in the tax system for calculation of the property tax liability. Finally the property tax payments are collected by the tax department are directly entered into the tax system and must later be updated in and reconciled with the amounts of the finance department's account ledger. This example here describes the involvement of various departments of the Land Department."

The idea of showcasing this example here is that a service delivery from a Municipality involves various departments at large and the technologies such as GIS and cloud sharing can bring down the complexities of this interdepartmental information sharing and keeping the records updated.

The use of cloud computing in a GIS Implementation means to drive cost effective, green, innovative and sustainable solutions throughout the different department levels in a Municipal corporation. GIS Cloud Computing is internet based services and solutions in which resources, software and information are provided to computers and other devices on demand. As such, cloud computing represents a complete paradigm shift in which details of GIS implementation and IT operation are subtracted from the users. The user no longer needs to understand all the details of the architecture in which the services is laid and they can use sophisticated services with nothing more than a Web Browser and Internet connection.

The Municipal GIS Shared Services Cloud enables a diverse coupling between the various GIS /IT applications so that each application can be used independently between them and can be easily configured. Multiple applications can be worked together supported by metadata sharing. Diverse coupling of integrated applications will not only improve the productivity but also the quality of the services of local government to the citizens.

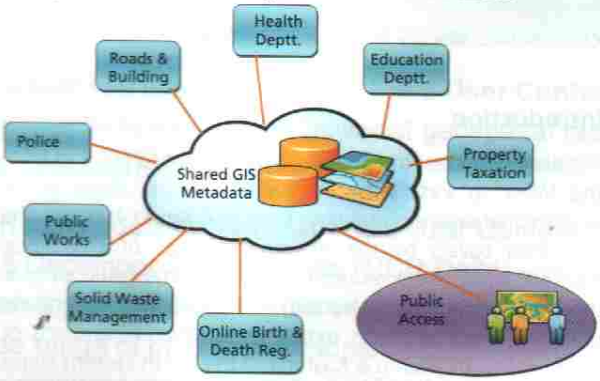

Figure 5: Municipal GIS Shared Services

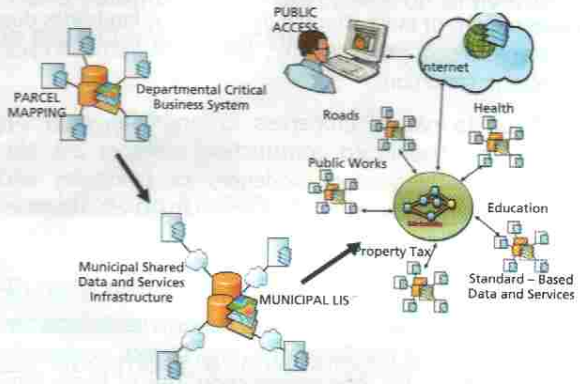

Figure 6: Enterprise GIS Cloud

Service Composition in the GIS Cloud Ecosystem

To fully leverage all the capabilities of the GIS based platform, the applications must run within the cloud. It is necessary to accommodate the diversity of such applications while allowing unified operations. Service composition in the GIS Cloud Ecosystem enables the Municipal GIS Shared Service system to scale and secure many-to-many application integration in a simple manner. The Cloud service features an information hub that will coordinate with the data and sharing among all the applications which include GIS, IT and Non GIS as well. To ensure the scalability of many-to-many application integration the service composition components of the Shared Municipal GIS Cloud provides a mechanism to allow sharing of the data among the participating applications. Applications will store shared data in the shared database and the metadata system will provide an API for the application to manage and contribute their shared data to the Cloud platform. At the same time each independent application can also have its own private database as well. This allows the each application to run as an independent service,

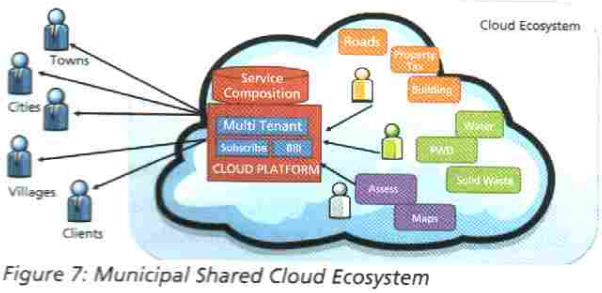

Figure 7: Municipal Shared Cloud Ecosystem

while enjoying the integration benefit when clients subscribe to them together.

The ROI experienced by each municipality is unique to its conditions. Some of the common themes of these experiences include reducing staff time required to perform repetitive tasks or support public information inquiries at the counter; substituting automated GIS procedures for costly outsourcing of mapping functions; identifying lost revenues in the form of taxes and fees that were not being collected; and successfully using detailed GIS analysis and mapping to support grant and other funding applications. Many benefits of enterprise GIS are not readily expressed in terms of ROI. These benefits often take the form of improved decision making through access to more complete data resources. Examples of these qualitative benefits of enterprise GIS include

- A consolidated perspective on the use of GIS applications and data throughout the municipal government
- The elimination of redundant data collection and management
- The development and distribution of the core GIS data layers for the municipality, each from its definitive source
- Opportunities for process reengineering with a spatial focus that will improve overall efficiency
- A simplified approach to GIS implementation and integration through the development of architecture templates and enterprise GIS best practices
- A simplified user experience for locating, understanding, and using municipal data layers

Conclusions

With the advent of the new cloud technology, the means is finally to handle the change in the IT landscape of the Municipal corporations to successfully handle various services to the citizens. Finally the rapid and wide acceptance of the Internet and the development of the GIS tools to use the Internet to provide data, map and portal services have introduced opportunities for integrating GIS data resources on the fly that may be stored in a decentralized manner by multiple agencies. Along with the advances in GIS, hardware and communications networks have increasingly become faster and capable of delivering large quantities of data and information to share.

Map making and geographic analysis are not new, but a GIS performs these tasks faster and with more sophistication than traditional manual methods do. Without owning the individual software, the Internet GIS technology has opened new paths for disseminating, sharing, displaying, and processing spatial information on the Internet. Web-based solutions provide a low-cost, efficient way to deliver map products to users.

The urban planning and information system is a step towards web-GIS based solution, which is certainly helping public in a big way. The utility departments are encouraged to view maps and data using a PC sitting comfortably in their ward offices thereby not visiting head offices as often they did earlier. Fire and Health department departments find it useful during emergency services since all information is brought around the hot spots with the click of a button. The most beneficial amongst all departments are the roads and building and town planning. The search for maps and documents seems to be over. Where hours are counted to locate maps, now that uncertainty is over. The future of this system lies on sharing the information to the public and to other municipal corporations of India and world via www.

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CASE STUDY

Landslide Hazard Zonation Mapping Using Remote sensing and GIS in Mountainous Terrain, A Case study: Around Rishikesh and National hghway-58

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Landslide hazard zonation refers to the division of a land surface into homogeneous areas or domains and their ranking according to degrees of actual potential hazard caused by mass movement. Landslide is a destructive geological process which causes damage to life, property, roads, bridges, and houses. Landslides are the most widespread and damaging hazard, especially in the Himalayas region. It is difficult to eliminate them, but attempt can be made to reduce the damage and loss of lives that they cause. In this study, a part of Garhwal Himalaya region has been chosen to identify landslide susceptible areas. Geographical Information System (GIS) has been used for preparation of database, analysis, modeling and output. IRS 1D LISSIII have been used for landuse/landcover map and LANDSAT data for lineaments identification. High resolution data of Google Images from internet have been taken for identification of site specification Risk Identification. Analytical Hierarchy Process (AHP) method has been used to calculate the weights of landslide influence parameters. The input parameters used in this study area are IRS IC LISS III imagery, topographic maps, Landuse map, GPS observation data and field visits. Arc GIS 9.2 software have been used for integration of input layers after assigning them suitable weights. The resultant landslide susceptible map has been classified into five categories very low, low, moderate, high and very high. The validation was done by GPS field data and Google Image.

Aim of the Project

The main aim of the study is to quantify the landslide Hazards around the Rishikesh surrounding area and National Highway -58, by preparing Landslide Hazard Zonation Map (LHZ) using Geographical Information Analysis, Remote sensing, and validates the result by Landslide Inventory mapping using GPS field survey along part of National Highway passing through the study area.

Objectives

1. To understand basic Mechanism of Landslide and the relation between causing factors.
2. To understand the triggering mechanism of various mass movement process in region due to different causative factors.
3. To create detail GIS database of the different thematic parameters depending upon the degrees of influence on landslide process.
4. Use of GIS Analysis Techniques to evaluate the importance of the factors.
5. To Prepare Landslide Hazard Zonation Map for the Rishikesh Area.
6. To Prepare Landslide Hazard Zonation Map for part of National Hihway -58 falling in the study area with buffer zone of 2km.
7. Preparation of Landslide Inventory map along NH-58 Using GPS field survey.

Introduction

Himalayan ranges stretches over a distance of 2500 Km from the West to East with an average width along entire longitudinal extension ranging from 110 Km to 400 km. The vast area covers by the mountain ranges of Geological younger ages. These ranges contain some fantastic altitude gradients. The entire Himalayan ranges are technically unstable. Every year this region faces several hundreds of landslides from Jammu & Kashmir to the North Eastern states including Himachal Pradesh, Uttaranchal and Sikkim Himalayas, leading to enormous loss of life and properties. Various regions of India affected differently by landslides due and characteristic, physiographic, geological, climatological and tectonic conditions.

In addition to natural proneness to landslides, improper planning and haphazard construction practices are also responsible for increased incidences of landslides and consequent damages of properties and human lives. However recurrent landslides occurs due to different causative factors like Topographic, Lithological, Structural features, Natural calamities like earthquake, heavy rainfall, cloud bursts, Human activities and improper development activities without considering the depth of natural factors, unscientific formation cutting for road construction, use of heavy high explosives in blasting produces instability. The increases the failure of slope stability triggers mass movement and resulting in landslides. The brunt of landslides is mainly felt on national highways which get blocked during rainy season when more and more landslide area triggered. The landslide leads to destruction of roadways and ongoing areas where escape for people and vehicles is almost impossible, for supply of aid material in routine and emergency are of civil sector and troops in border areas. Besides a huge sum is required for removal of debris, prevention of further landslide and planning activities increases work pressure over the Border Road Organizations (BRO), which is involved in construction, development and maintaining the roads in hilly terrain of Himalayan region.

The research basically has focused on the landslide hazard zonation mapping around Rishikesh and surrounding area which covered with in the Topomap- 53J/8 of 1:50,000 Scale of Survey of India. Validation of result carried out by landslide inventory mapping using GPS, Maps& other instrument along part of NH- 58 from Rishikesh to Kaudiyala village falling on the road 31 km from Rishikesh.

Methodology

The methodology adopted is as follows.

- Selection of area for study where landslide problems are existence.
- Data availability /data procurement and collection.
- Select satellite images suitable for regional and local level landslide study for land use identification and image processing.

- Collect topographic map relevant to satellite images and scale of study.
- Collect relevant secondary data from all sources and access previous studies conducted on the area.
- Collect primary data from the site on landuse. Groundwater and other data (Rainfall, Temperature etc.).
- Data organization data preprocessing, import satellite data and Raster scan Topomap in GIS environment and provide projection system.
- Generation of relevant thematic data like Contour Map, DEM, Drainage Map, Slope map, Aspect Map, Drainage frequency map, Lineament occurrence Map, Lineament Intersection Map, Road Map, Landslide Inventory Map and Location Map.
- Convert vector thematic to raster format using raster conversion tool.
- Define landslide hazard classification and rating/weight for each thematic classes as per their role in landslide triggering intensity in attributed information.
- GIS analysis: - Select GIS analysis tools for overlay operation by providing weight calculated for each thematic and prepared landslide zonatation map.
- Estimate geometrically, geographically and statically landslide prone area with their hazard intensity class.
- Verify the landuse land error map, geography different hazard zones obtained in the GIS analysis methodology in the around.
- Prepare final thematic maps and landslide hazard zonation map by reanalysis in GIS environment with symbolization.
- Prepare final print out maps at 1:50,000 or as need scale.

Thematic data creation in ARC/INFO Platform

Thematic Maps and Data Type: Following different thematic maps have prepared in the ARC /GIS Environment. The metadata standards are defined before data base creation. The following section describes the metadata information and data standards assign for each thematic. The rank and weight assigned to the every feature category depending upon the importance of the factor involved in the land sliding triggerincauses.

List of Thematic maps, data and feature Types

Sl.No.	Thematic Maps	Data Type	Feature Type
1	Contour Map	Vector	Line Data
2	Digital Elevation Model TIN (DEM)	Vector TIN	Pdlygon
3	Digital Elevation Model RASTER (DEM)	Raster	Polygon
4	Slope Map	Raster	Polygon
5	Aspect Map	Raster	Polygon
6	Drainage Map	Vector	Polyline
7	Drainage Frequency Map	Raster	Polygon
8	Lineament Map	Vector	Polyline
9	Lineament Occurrence Map	Raster	Polygon
10	Lineament Intersection Map	Raster	Polygon
11	Land use Map	Raster	Polygon
12	Road Network Map	Vector	Polyline
13	Landslide Inventory Map	Vector	Point
14	Location Map	Vector	Point

Table Shown Parameters and Rank Values

Sl. No.	Thematic/Parameters	Categories	Rank
1	Slope Map	0-15	2
		16-25	7
		26-45	9
		> 45	3
2	Aspect	Flat	1
		North, NE Facing	2
		East. SE.NW Facing	3
		West Facing	4
		SW Facing	5
		South Facme	6
3	Landuse	Dense Vegetation (More than 40% Canopy)	0
		Medium Vegetation (10 to 20% Canopy)	3
		Degraded Vegetation (More than 40% Canopy)	6
		Barr'en Land (non Rocky, west land)	5
		Agriculture land	6
		Build up area	5
		River Sand	2
		Water Body	0
4	Lineament Occurrences	0 (Number of Lineament Occurrence with in 1 sq Km)	0
		1-2	2
		3-4	4
		5&>	8
5	Lineament Intel section Map	0 (Number of Lineament intersection)	0
		1-2	3
		3-4	6
		<5	9
6	Drainage Frequency Map	0 (No Drainage /Streams with in lsq km)	1
		1-2	3
		3-4	5
		5-6	7
		<7	9

GIS Analysis for landslide hazard Zonation Mapping

Landslide Hazard Zonation Map is prepared in present work by using weighted overlay method of raster analysis available in ARC/GIS software .The Analytic Hierarchy Process (AHP) has been used for calculation of weight and rank assignment to different thematic parameters of landslide importance.

a) Description: Analytic Hierarchy Process (AHP) :

The types of decision problems that interest geographers and spatial planners typically involve a large set of feasible alternatives and multiple conflicting and incommensurate evaluation criteria. The alternatives are usually evaluated by a number of people (managers, decision makers, domain experts, interest groups), who are often characterized by unique preferences with respect to the relative importance of criteria on the basis of which the alternatives are evaluated. Accordingly, many real-world spatial planning and management problems give rise to geographic information system (GIS)- based multi criteria decision-making (MCDM) or Spatial Multicriteria Decision Analysis (SMCDA). These two distinctive areas of research, GIS and MCDM, can benefit from each other. On the one hand, GIS techniques and procedures have an important role to play in analyzing a

variety of spatial data for decision making. On the other hand MCDM and a wide range of related methodologies, such as multi attribute utility theory (MAUT), public choice theory and collaborative decision making offer collection of techniques and procedures to reveal decision makers' preferences and to incorporate them in to GIS based decision making.

To this end, GIS-based (or spatial) multi criteria decision analysis can be defined as a collection for analyzing geographic events where the results of the analysis (decisions) depend on the spatial arrangement of the events. Spatial multi criteria analysis is a part of broadly defined spatial analysis. Despite the fact that most spatial decision problems are multi- criteria in nature involving economic, social, environmental, and political dimensions and conflicting values, the process of multi criteria decision-making is not well established or effectively integrated into the field of spatial analysis and GIS. The Spatial Multicriteria Decision Analysis (SMCDA) is a kind of multi attribute decision, making (MADM) process. The main elements of SMCDA are evaluation criteria, alternatives and decision maker's preferences. SMCDA problems typically involve criteria of varying importance to decision makers. Consequently, information about the relative importance of the criteria is required. This is usually achieved by assigning a weight to criterion. The derivation of weights is a central step in eliciting the decision maker's preferences. A weight can be defined as a value assigned to an evaluation criterion that indicates its importance relative to other criterion in the overall utility. A number of criterion weighting procedures based on the judgments of decision makers have been proposed in the multicriteria decision literature. Some of the most popular procedures are ranking, rating, pair wise comparison and trade-off analysis. The pair wise comparison method was developed by Saaty (1980) in the context of the Analytic Hierarchy Process (AHP). This method involves pair wise comparisons to create a ratio matrix. It takes as an input the pair wise comparisons and produces the relative weights as output. Specifically, the weights are determined by normalizing the eigenvector associated with the maximum Eigen value of the (reciprocal) ratio matrix. The present work involved six parameters: slope, aspect, drainage frequency, lineament occurrences, Lineament intersections and landuse. It required assessing the relative importance of these. This has been done by pair wise comparison of each pair of parameters.

The procedure consists of three major steps (Malczewski, J., 1999).

1. Development of the pair wise comparison matrix
2. Computation of the criterion weights
3. Estimation of the consistency ratio

Scale for pair wise comparison (Satty 1980)

Intensity of Importance	Definition
1	Equal importance
2	Equal to moderate importance
3	Moderate importance
4	Moderate to strong importance
5	Strong importance
6	Strong to very strong importance
7	Very strong importance
8	Very to extremely strong importance
9	Extreme importance

1. Development of the pairwise comparison matrix:

The method employs an underlying scale with values from 1 to 9 to rate the relative preferences for two criteria, the scale has been shown in Table.1. Thus, if criterion A receives a score of 2 relative to criterion B, criterion B should receive a score of 1/2 as compared to criterion A. Same logic can be used to complete the lower left side of matrix of pairwise comparisons. When comparing anything to it, the evaluation scale must be 1, representing equally preferred criteria. This pair wise comparison matrix of the criteria parameters was input to the multicriteria weighted software (Venkateswarlu, 2007). Now criteria weights were computed using these score values, as given below.

Computation of criterion weights

	Slope	Drainage Frequency	Landuse	Lineament Intersection	Lineament Occurrences	Aspect
Slope	1	2	2	2	8	9
Drainage Frequency	1/9	1	2	3	6	6
Landuse	1/3	1/3	1	2	9	6
Lineament Intersection	1/2	1/3	1/2	1	8	7
Lineament Occurrences	1/2	1/6	1/6	3	1	4
Aspect	1/9	1/9	1/7	1/6	1/5	1

Factor and weights

S.No	Factor	Weighted by pairwise comparision method (AHP)
1	Slope	26.45
2	Aspect	3.46
3	Lulc	6.55
4	Drainage Frequency	21.72
5	Lineament Occurance	16.33
6	Lineament Occurance	25.52

2. Computation of criterion weights:

The criteria weights were computed using multicriteria weighted software. The normalized weights are estimated by computing the eight values and eight vectors of opinion matrices created by the domain experts while deciding the order of preference of parameters categories for a particular decision problem on a nine point scale.

3. Estimation of consistency ratio

The consistency ratio was estimated to find out the consistency of the comparison criteria. It is based on consistency vector, lambda and consistency index. The consistency ratio of 0.10 or less indicates a reasonable level of consistency in pair wise comparisons; if consistency ratio is greater than 0.10, the values of the ratio are indicative of inconsistency judgment. Consistency ratio for the weights was calculated using the multicriteria weighted software, Criteria Ranking Module- which gave its value as 0.0985 this showed good consistency in pairwise comparisons.

Methodology used

In this study, weighted rating scheme was used. For integration of all layers arithmetic weighted overlay approach was used, that is built in ARC GIS software, an arithmetic weighted overlay process accepts both continuous and discrete grid layers, and the resulted data are continuous grid data layer. The complete methodology is shown in methodology diagram. All the factors are reclassified based on the importance of each factor influencing landslide hazard, using ARC GIS spatial analyst module. Each subclass is given rating between 0-9 in an increasing order of hazard; zero indicates low hazard and 9 indicates high hazard. All the rating classes are multiplied by corresponding weight to

obtain the landslide potential index map. Weights and its rating of landslide influence factors shown in Table .The weights are calculated by Analytical Hierarchy process (AHP). Lowest weight indicates low landslides and higher weight indicate high landslides. The resulting values are obtained the range from 32 to 331. It should be classified into five classes very low, low, moderate, high and very high, moving average with window size of 3, 7 and 9 were considered for. The resultant LHZ map is shown in fig.

Result

Landslide Hazard Zonation Map along road site:

The result obtained for the output (LHZ) map of the buffer area of 2 km along National Highway -58 is that the most of the landslides are falling in the high hazard zone. This verification is carried out by overlying the GPS data of landslide inventory mapping carried out along the road site during field survey.

Landslide Hazard Zonation map was created using eight thematic layers extracted from satellite and secondary data. Themes taken here have direct or indirect effects on landslide. With the help of Remote Sensing & GIS all these themes were identified, extracted and weights were assigned to each theme to overlay them in GIS environment. Some themes account less for landslide and some accounted more:

- Structural theme (fault, fold, thrust, and lineament) and topographical slope have very high influence on landslide
- 54% area is landslide prone area i.e. high risk of landslide in that area
- While 25% area is at moderate risk and rest of the area is at low risk.
- Lansuse/Landcover, transport themes are relatively less significant.
- Use of Remote Sensing & GIS greatly helps to identify real dangerous areas (in respect to landslide) and give fairly good accuracy.

Since,the area is mountainous and has high dissected hills (in most places) probability of landslide is high and with the help of remote sensing and GIS, it is estimated. Since population is increasing unceasingly, construction will keep increasing in high danger zones also. Moreover natural factor also contribute to it but we should try to mitigate man made causes.

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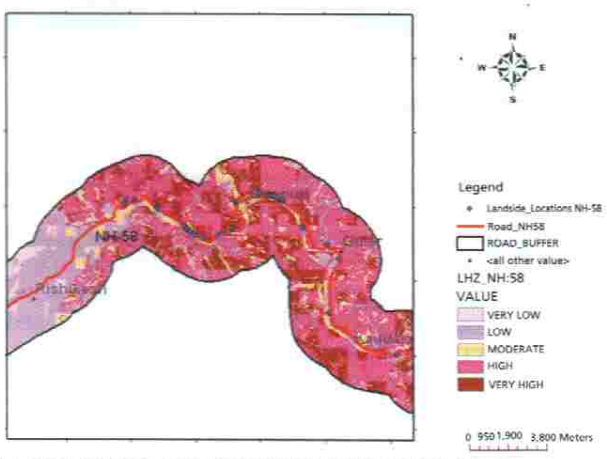
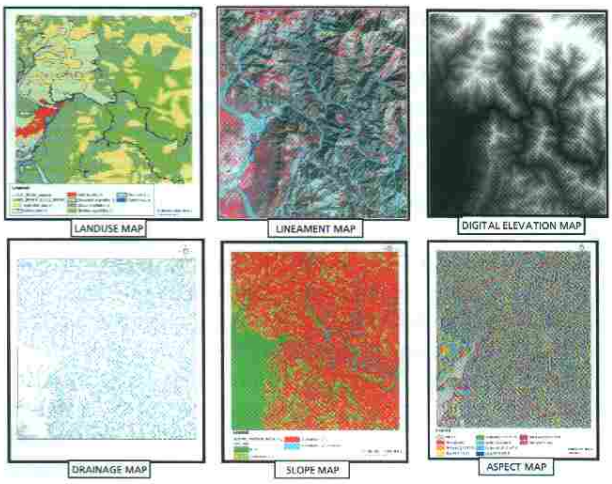
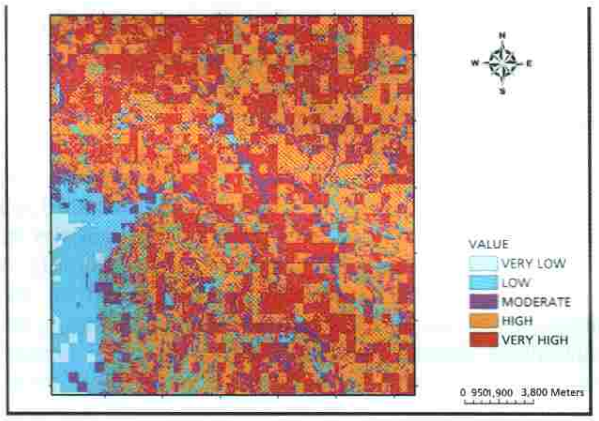


LANDSLIDE HAZARDS ZONATION MAP ALONG NH-58





LANDSLIDE HAZARD ZONATION MAP

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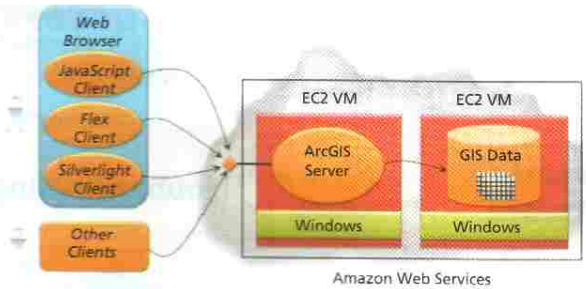
ArcGIS Server on Amazon EC2: Step by Step

What is ArcGIS Server on Amazon EC2?

ArcGIS Server on Amazon EC2 allows you to deploy ESRI ArcGIS Server on the Amazon Elastic Compute Cloud (EC2). In this type of deployment, ArcGIS Server runs on Amazon's hardware, which you administer through Web services.

Advantages of deploying ArcGIS Server on Amazon EC2 include the following:

- No installation required—You don't have to install ArcGIS Server yourself. Instead, you use an Amazon Machine Image (AMI) that already has ArcGIS Server installed and preconfigured. Once you deploy the AMI, you are ready to start creating and using services.
- Scalable on demand—If you need more computing power, you can launch additional EC2 instances, which you can think of as virtual servers on Amazon's cloud that are all created from the same parent AMI. Creating new instances can even be done programmatically in response to usage statistics. New instances can be created in a matter of minutes, allowing your ArcGIS Server to gracefully respond to abrupt spikes in traffic.
- Amazon provides a load balancer that you can use to route traffic to the different instances. When you no longer need the instances, you can destroy them and incur no further charges for them
- No hardware infrastructure to maintain—Deploying ArcGIS Server on Amazon EC2 requires no special hardware; you just have to be able to connect to the Internet. You create and manage your EC2 instances through the AWS Management Console, a Web application provided by Amazon. You connect to your machines through Windows Remote Desktop to set up your data, services, and applications.



Introduction to Amazon terminology

Before you begin working with the Amazon platform, there are some new terms and concepts that are helpful to learn.

AWS Management Console

The AWS Management Console is Amazon's Web-based interface for managing your Amazon Elastic Compute Cloud (EC2) instances. This is where you configure your architecture in the cloud, adding instances, configuring load balancers, adding storage volumes, adjusting security, and so on.

The AWS Management Console requires you to log in with an account that you've set up with Amazon for the purpose of using its cloud. After a successful login, you can browse or search for the ArcGIS Server Amazon Machine Image (AMI) and use it to create EC2 instances

EC2 instance

An EC2 instance is a virtual machine that you create in EC2. You create the instance using an AMI that is preconfigured with Windows Server 2008 and ArcGIS software. The following AMIs are available:

- ArcGIS Server AMI—Includes ArcGIS Server and ArcGIS Desktop
- ArcGIS Enterprise Geodatabase AMI—Includes an enterprise geodatabase running on PostgreSQL deployment.

EBS volume

Amazon Elastic Block Store (EBS) volumes are virtual disk drives that you can attach to your EC2 instance to add more storage. The ArcGIS Server AMI creates a 100 GB EBS volume "GIS Data" and attaches it to the instance as the D: drive. A connection to this drive is preconfigured in ArcCatalog. Similarly, the Enterprise Geodatabase AMI comes with an attached 100 GB EBS volume to store the PostgreSQL cluster.

Elastic Load Balancer

Amazon Elastic Load Balancers (ELBs) are a way to distribute work across multiple EC2 instances. All requests to your server go through the load balancer, which then evenly distributes the requests to the available EC2 instances. You can add or remove participating EC2 instances from the load balancer at any time.

Regions and Availability Zones

Amazon EC2 consists of multiple data centers around the world that are designed to address enterprise architecture challenges.

- Amazon Regions represent data center facilities in dispersed geographic locations such as California, USA; Virginia, USA; Ireland; and Singapore. You can use Regions to get your deployment physically closer to your users (thereby improving performance) or to meet legal requirements for international deployment.
- Amazon Availability Zones are distinct locations within a region that are engineered to be isolated from failures in other Availability Zones. Configuring your application in multiple zones provides an extra layer of availability in case one of the zones should fail.

S3

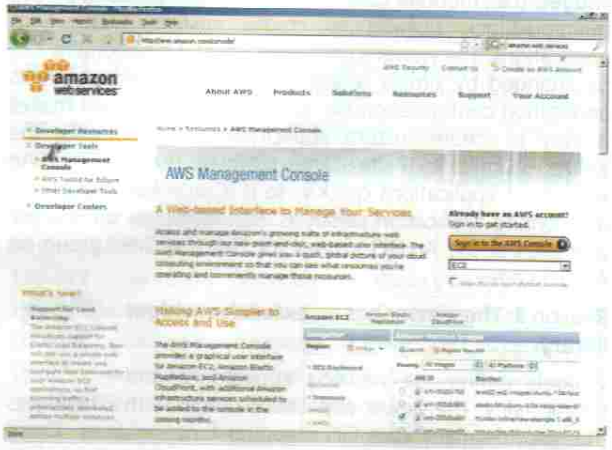
Amazon Simple Storage Service (S3) is an Amazon service designed specifically for data storage in the cloud. This storage option has the lowest potential for data failure or loss. You can use S3 as a place for data backup or as a middle ground for data transfer between your on-premise deployment and your EBS volumes. Also, any snapshots you create of your EBS volumes are stored on S3.

The ArcGIS Server on Amazon EC2 workflow

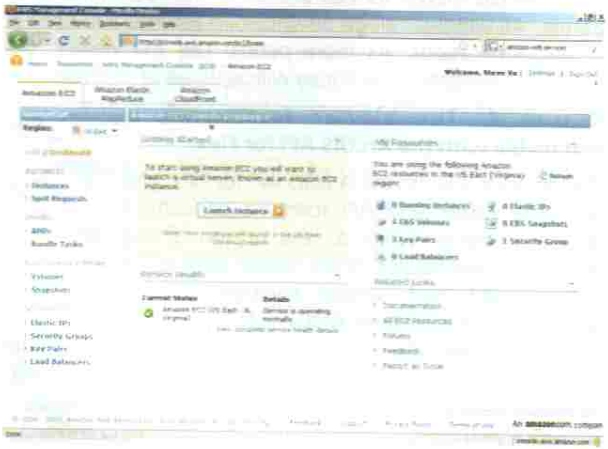
Creating an enterprise deployment of ArcGIS Server on Amazon EC2 is a multistep process that requires some architectural planning and understanding of Amazon Web Services. One example of a basic workflow is listed below. The

approach you take with ArcGIS Server on Amazon EC2 may vary based on your deployment needs.

1. Get ready to deploy ArcGIS Server on the Amazon cloud.
   - In a Web browser, go to Amazon Web Services home page: http://aws.amazon.com
   - Create an Amazon account and make sure it includes Elastic Compute Cloud (EC2) access.
   - Get access to the ESRI-created Amazon Machine Images (AMIs).
   - Create the typical Amazon security groups for ArcGIS Server, configuring at least one security group that allows remote desktop access.



2. Activate ArcGIS Server.
   - Use the ArcGIS Server AMI to launch an EC2 instance.
   - Connect to your new instance using Windows Remote Desktop.



3. Set up a place to store your data.
   - Choose where to store your data on the cloud.
   - Optionally, configure additional EBS volumes for local data storage.
   - Optionally, configure ArcSDE using the enterprise geodatabase AMI.
4. Move your data to Amazon.
   - Choose a data transfer method and move your data.
   - Give the SOC account permissions to access your data.
5. Create GIS services and applications.
   - Use ArcGIS Server to create services for mapping, geocoding, and so on.
   - Migrate your applications to the EC2 instance and repoint them at the services now running on your EC2 instance.
6. Customize security on your EC2 instance.
   - Change the administrator password for your EC2 instance.
   - Optionally, configure ArcGIS Server security.
   - Optionally, make other security adjustments to the EC2 instance such as firewall adjustments, SSL configuration, and so on.
7. Create a custom AMI.
   - Remove any sensitive or user-specific information that you don't want duplicated in a custom AMI.
   - Save your configuration as a custom AMI. This provides a backup of your configuration and can be used to scale out your deployment by launching additional instances.
8. Launch a new "production" instance of your AMI.
   - Use your custom AMI to launch an EC2 instance representing your "production" deployment.
   - Alter your Amazon security group rules to disable or restrict Remote Desktop access to the production EC2 instance. This increases security on the production instance.
   - Configure an Amazon Elastic IP address for the production EC2 instance so it can be recovered or updated with minimal downtime.
   - Optionally, create or destroy instances in response to demand, either manually or programmatically, using the Amazon Auto Scaling API. Multiple machines can be connected by an Amazon Elastic Load Balancer (ELB).

ArcGIS Server on Amazon EC2 includes

The following Amazon Machine Images (AMIs):

- ArcGIS Server AMI
  - ArcGIS Server* on Windows 2008
  - ArcGIS Desktop* (included for your convenience to administer ArcGIS Server services)
  - ArcSDE on Microsoft SQL Server Express
  - A 100 GB drive for GIS Data

You must authorize ArcGIS software with appropriate licensing.

You can use your existing licenses for Server and Desktop to authorize ArcGIS software on Amazon EC2 or purchase additional licenses.

- Enterprise Geodatabase AMI
  - PostgreSQL database configured for use as an Enterprise Geodatabase on Windows 2008
  - A 100 GB drive for storage of data.

ArcGIS Server Licensing on Amazon EC2

Use ArcGIS Server perpetual license or choose from 1, 3, or 12 month, renewable term licensing options

As the AWS account owner the customer is responsible for all costs incurred by the use of the Amazon Web Services infrastructure (Network, Computing, and Storage). Those costs will be billed separately by Amazon

For details or Cost for Amazon EC2 Services, Please refer http://aws.amazon.com/ec2/

5ive Reasons to Use the ArcGIS Viewer for Flex

With the ArcGIS Viewer for Flex, you can easily create fully functional GIS applications on the web. Your GIS maps and analytic tools can be accessed by users inside and outside your organization with a simple web browser.

This configurable application can be downloaded and set up in a matter of minutes and includes many core GIS mapping functionalities: data display, map navigation, query and search, simple markup, printing, and data editing. The viewer's look and feel, analytic capabilities, and data content can be customized to specific business needs without writing a single line of code. If you have ArcGIS Server and want to quickly and easily create powerful web mapping applications, this is the product for you.

ArcGIS Viewer for Flex is a configurable web client application built on the ArcGIS API for Flex that enables you to quickly and easily create powerful GIS mapping applications for the web. It is a browser-based viewer designed to work with ArcGIS Server and ArcGIS Online services. The viewer application is hosted on premises and includes many core GIS mapping functionalities. It supports the latest capabilities offered by ArcGIS Server and has minimal system requirements: a web browser with the Adobe Flash Player plug-in installed and web server software to make the viewer available as a web resource. It is built with the latest Adobe Flash Builder 4 technology and practices. Distinct from the other viewer options offered by Esri, ArcGIS Viewer for Flex is configurable and hosted on premises. The ArcGIS.com viewer and ArcGIS Explorer Online, two other client viewers, are not configurable and are hosted by Esri.

The ArcGIS Viewer for Flex Resource Center is the main source for getting more information about the application. It contains all the resources needed to start working with the viewer including

- Links to the viewer application download packages
- Help and developer documentation
- Sample application configurations and live widget samples
- A link to the support forum

Reason 1: The viewer can be used immediately out of the box.

Getting started with the ArcGIS Viewer for Flex is a simple 1-2-3 process:

- Download the compiled viewer application.
- Unzip the download package.
- Place the contents of the download package (a single installation folder) in a web server resources directory.

The entire process takes six to eight minutes. Once these three steps are complete, the ArcGIS Viewer for Flex application is ready for use. By default, it is preconfigured to access services from ArcGIS Online, so you can start to explore the viewer's capabilities immediately.

It is easy to get started with the viewer. It fully supports ArcGIS Server functionality and web services. Viewer functionality includes support for basemaps, operational layers, dynamic legends, data query, search, GeoRSS feeds, drawing, time-aware data, and data editing. It also works with maps created and shared with the ArcGIS.com viewer, so you can use the ArcGIS Viewer for Flex with shared maps published online.

Reason 2: The viewer can be configured; no programming is needed.

The viewer's look and feel, functionality, and data content can be easily customized without any programming. The viewer configuration is designed with the nondeveloper in mind. You simply edit XML files to configure the viewer to meet your specific business requirements. A few simple edits to the application configuration file enable the viewer to work with your web services. This means an organization can brand and customize (e.g., use a company logo, custom data, and appearance) its web client applications with minimal effort—no programming or developer resources are needed.

Behind the scenes, viewer architecture has a plug-and-play design; its user interface and functionality are based on widgets (i.e., modular code chunks) that can be assembled in building-block fashion to create custom web client applications. The viewer's user interface and functionality can be changed by simply referencing different widgets in its application configuration file. Configuring the viewer makes it easy to create custom applications. Conceptually, the viewer is similar to a site starter template used for creating web client applications quickly, so it is an ideal solution for prototyping application solutions. For examples, see the live user sites at the ArcGIS Viewer for Flex Live Sites group on ArcGIS.com.

Reason 3: The viewer has an extensive widget library.

Widgets define the viewer's appearance and functionality. The viewer application comes with 20 widgets that provide many core GIS mapping functionalities. These widgets can be used in various combinations to create different, focused web mapping solutions. In addition, an online gallery of developer sample widgets contributed by the viewer user community and developer sample widgets provided by Esri staff and users is available in the code gallery of the ArcGIS Viewer for Flex section of the ArcGIS Resource Center. All widgets can be downloaded for free and used in viewer applications. As more people use the viewer, the number of widgets in this library will continue to increase.

Reason 4: The viewer framework is extensible with the ArcGIS API for Flex.

The viewer is built on the ArcGIS API for Flex, and both the viewer and API follow a concurrent release schedule. When a new version of the Flex API is released, a new version of the viewer built on the new API is also released. Each version released supports the latest functionality available in ArcGIS Server. The viewer source code is also available online, enabling developers who are familiar with the Flex API to further customize the viewer. Developers can extend the existing viewer in several ways by

- Modifying or enhancing the behavior of existing widgets
- Creating new widgets (i.e., new functionality) from scratch
- Extending the core viewer framework for a more customized client application

Some widgets in the widget gallery also include source code that can be leveraged by developers to meet specific business/application needs. This makes the viewer an extensible ArcGIS Server web client application for users who want advanced customization options.

Reason 5: The viewer is free and fully supported by Esri.

The ArcGIS Viewer for Flex application and its source code are available as free downloads for existing ArcGIS Server users. This configurable client application is provided at no cost. It is frequently updated to support the latest ArcGIS Server capabilities and is fully supported by Esri. Users can call Esri Support and get technical assistance with the viewer when needed.

Source: www.esri.com / http:// http://help.arcgis.com/en/webapps/flexviewer/

Query Builder

Environment : WindowsXp
Version : ArcGIS Server 10 with Flex
Description : The following code is used to create query builder widget and query the server and display result in Datagrid and on a map.
Code Snippet :

```
<?xml version="1.0" encoding="utf-8"?>
import com.esri.ags.FeatureSet;
import com.esri.ags.Graphic;
import com.esri.ags.events.QueryEvent;
import com.esri.ags.layers.
ArcGISDynamicMapServiceLayer;
import com.esri.ags.layers.FeatureLayer;
import com.esri.ags.layers.Layer;
import
com.esri.ags.layers.supportClasses.Field;
import com.esri.ags.layers.supportClasses.
LayerDetails;
import com.esri.ags.layers.supportClasses.
LayerInfo;
import com.esri.ags.tasks.QueryTask;
import com.esri.ags.utils.GraphicUtil;
import com.esri.viewer.ViewerContainer;
import mx.collections.ArrayCollection;
import mx.controls.Alert;
import mx.controls.listClasses.ListBase;
import
mx.controls.listClasses.ListBaseSelectionD
ata;
import mx.events.ListEvent;
import mx.rpc.AsyncResponder;
private function init():void
{
queryTask3.execute(query3);
queryTask3.addEventListener(QueryEvent.EXE
CUTE_COMPLETE, onQueryComplete);
// Function to fetch layer Ids to provide
data in combobox
function
onQueryComplete(event:QueryEvent):void
                    {
var tmp:Array = map.layerIds;
var results1:ArrayCollection = new
ArrayCollection(tmp);
results1.removeItemAt(0);
cbo_layer.dataProvider = results1;
                    }
              }
// Function to fetch field names of
selected feature layer private function
onChange(event:ListEvent):void
              {
queryTask3.execute(query3);
queryTask3.addEventListener(QueryEvent.EXE
CUTE_COMPLETE, onQueryComplete6);
function
onQueryComplete6(event:QueryEvent):void
                    {
var featureSet:FeatureSet =
FeatureSet(event.featureSet);
var results2:ArrayCollection = new
ArrayCollection();
for each (var field:Field in
featureSet.fields)
{
var name:String= field.name.toString();
results2.addItem({label:name , data:
field});
                              }
cbo_field.labelField = "label";
cbo_field.dataProvider = results2;
                    }
              }
// Function to execute query to display
result on map
private function queryData():void
              {
queryTask2.execute(query);
queryTask2.addEventListener(QueryEvent.EXE
CUTE_COMPLETE,
onQueryComplete);
              }
private function
onQueryComplete(event:QueryEvent):void
              {
var featureSet:FeatureSet =
FeatureSet(event.featureSet);
var results:ArrayCollection = new
ArrayCollection();
for each (var graphic:Graphic in
featureSet.features)
              {
var fieldValue:String =
graphic.attributes[cbo_field.selectedLabel
].toString();
results.addItem({label: fieldValue,
data:graphic});
                    }
cbo_fieldname.labelField = "label";
cbo_fieldname.dataProvider = results;
queryString.text +=
cbo_field.selectedLabel;
              }
// Function to fetch field values of
selected field
protected function
cbo_layer_changeHandler(event:ListEvent):v
oid
{
if (cbo_layer.selectedIndex == 2)
                    {
Alert.show("Please select layer");
                    }
else if(cbo_layer.selectedIndex == 0)
                    {
cbo_layer.addEventListener(Event.SELECT,on
Change);
cbo_layer.labelField =
cbo_layer.selectedLabel ;
// write feature service for particular
map layer
queryTask2.url="(Map Service url)";
queryTask.url="(Map Service url)";
queryTask3.url="(Map Service url)";
                    }
```

```
                else
                {
cbo_layer.addEventListener(ListEvent.CHANG
E,onChange);
cbo_layer.labelField =
cbo_layer.selectedLabel ;
// write feature service for particular
map layer
queryTask2.url="="(Map Service url) ";
queryTask.url="="(Map Service url) ";
queryTask3.url=" ="(Map Service url)";
            }
            }
// Function to add graphic layer and zoom
to query result
protected function
btnViewOnMap_clickHandler(event:MouseEvent
):void
{
    {
      query1.returnGeometry= true;
queryTask.execute(query1, new
AsyncResponder(onResult, onFault));
function onResult(featureSet:FeatureSet,
token:Object = null):void
if (featureSet.features.length == 0)
      {
Alert.show("No Feature found. Please try
again.");
      }
      else
      {
var graphicsExtent:Extent =
GraphicUtil.getGraphicsExtent(featureSet.f
eatures);
if (graphicsExtent)
            {
map.extent = graphicsExtent;

map.addLayer(myGraphicsLayer);
            }
      }
}
```


SMT. PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE

Margao, Goa

Re-accredited By NAAC at Grade "A"

A Cumulative Grade Point Average of 3.29out of 4.00

POSTGRADUATE DEPARTMENT OF GEOGRAPHY

THE TIGERS

College at A Glance

Smt. Parvatibai Chowgule Cultural Foundation's College of Arts and Science is one of the oldest academic institutions in the State of Goa, founded in June, 1962. The college has various departments offering a number of undergraduate and postgraduate courses. It has also many short term skill-based courses and student support services for the benefit of students. The faculty is involved in teaching and research. More than 40 per cent of the faculty members have Ph.D. degree. The entire campus is Wi-Fi enabled and technology is extensively used in teaching – learning process. The college has state–of–the–art of infrastructure. As a recognition of this, the NAAC (Bangalore) has re-accredited the college with Grade 'A' (with CGPA of 3.29 on a four point scale). It has an independent science block, library, sports complex, college cafeteria, studio, auditorium, independent cubicles for the faculty and student's co-operative stores. The college boasts of an artificial field turf football ground, one of its kind in whole of South Asia and a unique fitness & sports medicine center. The college is on the path to redefine education by bringing world class facilities not only in terms of infrastructure but also in form of academic curriculum like Honor's Programmes.

About the Department

The Department of Geography is leading and pioneer department in the State of Goa that offers entire Geography with 6 papers at Third Year Bachelor's Degree, MA in Geography and Post Graduate Diploma in Geoinformatics. The department has well equipped laboratory. The faculty is highly qualified with strong academic background and diversified research ability with 3 research projects completed and more than 40 research publication in last five years. The department also publishes in-house bi-monthly newsletter "Geographia". To make students globally competent, they are adequately exposed to various discussion forums, workshops, field-trips, guest lectures and internal projects. The department has also started Honors' Programme in Tourism as well as in Geomatics. Our vision is to give a winning edge to our students and make this department as the nodal centre of learning, teaching, training and research.

Postgraduate Diploma in Geoinformatics - Course Structure (Affiliated to Goa University)

Commenced from 2009-2010,The Diploma in Geoinformatics is a 1 year full time course with GIS and RS modules and a dissertation project, with evaluation at the end of each module. The course curriculum demands full time attendance and commitment from the students. Each daily session comprises 3 hours of classroom lecture followed by at least 3 hours of lab work. Projects of 2 months duration are assigned to the students during the course. Application of Geoinformatics in various development contexts will be analyzed through appropriate case studies. Tutorials and demonstrations are aimed to familiarize the students with emerging technologies in present scenario.

THE ENTRANCE

M.A. Geography – Course Structure (Affiliated to Goa University)

Geography is one of the most established domains of research. Post graduation course provides an in-depth knowledge of the basic four branches of geography, i.e. Geomorphology, Climatology, Population and Economic Geography. In addition to this, recent technology of Remote Sensing and GIS are also taught in the course. Further, these tools can be used in application areas in Geography during their dissertations. This helps the students to stay updated with the technological development related to this field.

Facilities

- Air Conditioned High Tech GIS Lab
- Classrooms with LCD Projector
- Wide collection of satellite images and aerial photographs
- GPS instruments
- Individual computer for each student in the lab
- Unlimited database Space for each student
- Centralized Printing and additional computer labs
- Internet facility round the clock
- Add on courses- (AutoCAD professional, AutoDesk Map, Surveying, Writing Skills, Visual Basic, ArcObejcts, Personality Development and many more)

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GIS BATCH 2009-2010 with Dr. SUDHA RAVINDRANATH

HI-TECH LAB (Geoinformatics Lab)

GIS BATCH 2010 - 2011

Web Application Combines Mapping and Analysis for Australia Floods

Allows Anyone to Visualize Public Reports, Response Information

Esri developed a newly launched web application that provides mapping and analysis to enhance Australia flood information supplied through the Ushahidi social network. The network allows people to report incidents via SMS, e-mail, or the web. The information is categorized and analyzed using geographic information systems (GIS) technology to provide hot spot visualization. By combining web GIS capabilities with Ushahidi data, anyone can view reports of flood incidents, damages, requests for help, and response requirements in a map context.

The application allows people to easily view the density or clusters of multiple events, such as property damage, roads affected, and hazards. These density color-coded hot spots illustrate geographic areas where similar requests, statements, and issues are clustered. This allows both government officials and the public to identify problems or issues reported by a number of people in a common area. They can better understand the distribution of reports by category and by time.

"Ushahidi information, combined with ArcGIS, provides a timely and relevant map-based picture," says Russ Johnson, director of public safety, Esri. "What's unique about this site is the analytics involved. It's more than just dots on a map. Esri developed this application to organize a lot of data and provide a better understanding of the data quickly."

The application demonstrates how GIS can analyze and transform large volumes of data into actionable intelligence. Background map data or basemap layer options include street maps, satellite imagery, topographic maps, and more. In addition, the data can be visualized over time to understand both spatial and temporal trends together. A temporal tool is available to present data for a particular day or range of days. It allows you to select multiple days on the map chronologically with the "time-slide tool." As dates move sequentially, the updated data is automatically displayed for the indicated time period. This provides a visual understanding of how an incident evolves over time.

Since December 2010, the Esri disaster response team, as well as ESRI Australia Pty. Ltd., has been working to support response to this incident. There are several applications available through the Esri disaster response portal. For instance, there is a common operational picture (COP) for the Brisbane City Council that was developed with the assistance of ESRI Australia. People or organizations affected by the flood can request GIS support directly through the portal located at esri.com/australia.

Esri Education Licenses Bring GIS to More German Universities

While select German universities have taught geographic information systems (GIS) for more than 20 years, three new statewide Esri education site licenses will make the technology available to all 700,000 students attending the 165 universities in Baden-Wurttemberg, Bavaria, and Lower Saxony.

"Through the implementation of these multistate GIS site licenses, all our teachers and students have the opportunity to apply modern geographic information technologies to innovative research and future problem solving," said Peter Castellaz, director of information and communication technologies in teaching and research at the Ministry of Science, Research, and Arts in Baden-Wurttemberg.

Participating universities receive

- Unlimited use of Esri's full range of ArcGIS software
- Free access to Esri Virtual Campus courses
- Free software licenses for the students' personal computers

In addition to the geography and geodesy departments that traditionally use GIS, the technology is also regularly used in the biology, archaeology, forestry, and landscape design departments at German universities. The universities' economics, engineering, and computer science departments have also recently discovered the power of GIS tools.

"Engaging university students with modern geotechnologies provides the basis for a sound education in the many fields where geospatial issues are involved," said Daniel Schober, education manager at Esri Deutschland GmbH. "In addition to its use in teaching and research, university administrators can use ArcGIS for facilities management, campus mapping, and safety planning."

For more information about Esri's higher education program, visit esri.com/highered.

Careers at esri India

Role: Role: Application Developer/ Sr. Developer

Experience
Should have 2+ years experience in GIS Application Development.

Skill Set

Knowledge of .Net/Java/ J2EE/Flex/ Desktop customization using .Net technology database as backend.

Proficient in designing/developing multi-tiered secured business applications for high availability, scalability and of high performance

Should have experience EJB, Servlet, JPA, JNDI, JMS, JMX, web services, XML.

Should have knowledge in GIS domain with specifically ESRI Technologies i.e. Arc GIS Object/Arc Engine/Arc GIS Server.

Soft Skill

Very good oral and written communication skills

Strong team player, flexible yet results-driven

Ability to Multitask and be able to balance multiple priorities and alert clients & team to project scope changes

Role: Asst Business Manager / Business Manager Sales

Soft Skill

Understanding of the entire sales cycle

Understanding the processes in the government sales

Exposure to enterprise sales

Driving sales targets

Skill Set

Excellent inter-personal

Go getter attitude

Excellent communication skills

Rich Experience in Client relationship management

Experience
4 to 9 years

Location
Mumbai/ Kolkata

Role: Role: Executive - PMO

Soft Skill

Expert in handling project financial, revenue, PCM, forecasting etc.

Hands on experience in the entire gamut of PMO activities.

Skill Set

Good team player and Multitasking capabilities.

Good project management and delivery experience.

Proven initiative and ability to work with minimal supervision.

Experience
2 to 5 years

Location
Bangalore

e-mail your resume to gistalent@esriindia.com or send it through post to:

Head, Human Resource, ESRI India
B-1/H-9 Colosseum, MCIA, Mathura Road, New Delhi - 110044, INDIA.

Kindly mention the position applied for and your current location in the subject line.

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