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Efficient Web based Geospatial Information System Application using Bing Maps

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Abstract: Producing and updating geospatial data is expensive and resource intensive. Hence, it becomes crucial to be able to integrate, repurpose and extract added value from geospatial data to support decision making and management of local, national and global resources. To develop an application for the web based is one of the newest challenges developers face today. The growing capability of the web has created a demand for applications that use geospatial information systems. When building GIS applications for the web, a developer can choose any of a number of architectures, technologies, and methods. This paper examines several of the techniques that can be used to develop web-based GIS applications using Bing Map Objects, Bing Maps complements these features by providing rich web mapping capabilities including UI controls, common map layers, aerial imagery, geo-coding, and routing capabilities. Together GIS and Bing Maps provide rich web mapping solutions for a wide spectrum of organizational scenarios.

Keywords: Geospatial Information System Application, Web Based GIS, Bing Map, UI Controls, Geo-coding,

I. INTRODUCTION

Most organizations have already integrated Geospatial Information Systems (GIS) into at least some critical line of business workflows. GIS departments along with software from ESRI, Pitney Bowes/MapInfo, GE Small world, or Autodesk provide customized spatial services across the enterprise. GIS systems are useful because of their powerful feature sets for geospatial data creation, queries, analysis, and data visualization. Many organizations have invested heavily in GIS infrastructure, hiring professional analysts and developers to create and maintain spatial data resources and services that are key to critical business decision systems. However, these traditional GIS tools have often evolved from client/server architectures and are not always well suited to newer web distribution models.

GIS departments are seeing rapidly growing demand for mapping and location solutions across the entire organization. This demand includes internal business decision systems, chain of supply relationships, and externally facing consumer applications. Map and location application users are no longer predominantly professional GIS analysts. Increasingly, users require access to location information and geospatial data visualization as easy to use web map applications.
By enhancing existing GIS systems with newer web mapping technologies, like Bing Maps, organizations can gain additional business value from GIS investments. Leveraging modern web based distribution models allows complex GIS analysis to be shared across the entire organizational spectrum of users. Location data visualization is then available at every stage of

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internal work flow processes, while easy to use consumer access can drive value out to the market attracting additional customers.

Web mapping is not new. Microsoft and other companies have been offering web mapping technologies for many years. This includes applications for almost every vertical market including real estate, travel, retail, government, and transportation. Web mapping applications can be developed quickly using common web technologies (such as JavaScript, Flash/Flex, or Silverlight).

Common web mapping platforms provide data visualization features that include…

• Mapping/Imagery – Road information, surface features, aerial imagery, in 2D and 3D views

• Find/Geocoding – Find specific addresses (geocoding) or Points of Interest like landmarks or business

• Routing/Directions/Traffic – Route query and display, driving directions, distance/time and traffic conditions.

Most web mapping services use industry standard web mapping techniques including Mercator projection, latitude and longitude (WGS-84) coordinate systems, and pre-rendered raster tile layers, commonly known as a tile pyramids. Pre-rendered tile pyramids, available from high capacity server clusters, provide enhanced user experience with near real time zoom and pan in client browsers.

Web Mapping Advantages

• Rich mapping and imagery – road and surface features, orthorectified imagery, oblique (Bird's Eye) imagery, 3D

• Services designed for the web – high performance raster tile pyramids (quad trees) for smooth user navigation in client browsers

• Scalability – web mapping platforms can easily scale from a few users to millions.

• Cloud computing – base map features flow from cloud servers outside an organization's infrastructure directly to a user's browser reducing required server capacity, bandwidth, and IT support.

• Data maintenance – creation and maintenance of base map features is handled by the web service, so additional personnel are not required by the organizations using these services.

• Users – Web mapping application require very little training, and can be tailored for non-GIS users who need to visualize data quickly to make better decisions.

GIS Advantages

• Spatial data creation/manipulation (e.g. creation of street features)

• Thematic mapping (e.g. choropleth maps, heat maps, etc)

• Geospatial analysis (e.g. plume modeling, drive time analysis, buffer queries, etc)

• Geo-processing (e.g. re-projection, spatial feature manipulation etc)

By merging web mapping services with existing GIS infrastructure, organizations can create best of breed web map applications, extend GIS investments, and deliver more value both internally and externally.

Fig:1 – Shows parcel polygon data from a city GIS database overlaid on Bing Maps with the

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ability to identify feature information by clicking on the map.

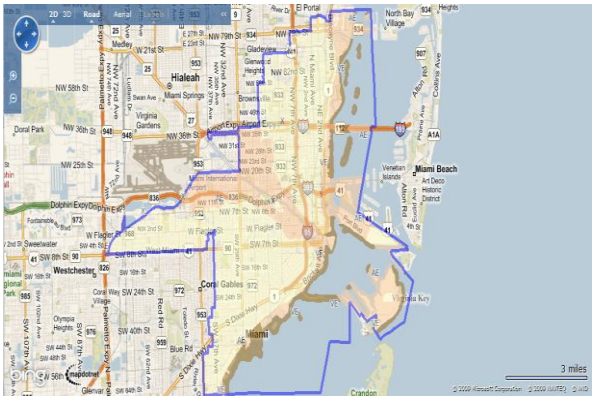

Fig:2 – Shows flood plan analysis data overlaid on Bing Maps

II Solution Overview and Architecture

Web mapping applications that leverage existing GIS capabilities are typically implemented using software (i.e. local premise systems) + services (i.e. SaaS or Cloud computing) architecture. GIS data and services remain in an organization's current systems. GIS analysts and users continue to create and manage this data in the same way they always have. However, additional web mapping services integrate with these existing GIS data layers and services to create high performance web mapping interfaces for web browsers. Since GIS systems produce data in both raster and vector formats, tools and techniques are required to integrate these data formats from existing GIS systems and merge them with web mapping capabilities.

Vector Data – consists of combinations of spatial primitives: points, lines, and polygons. These mathematically defined features are easily transformed using matrix algebra. As objects it is possible to attach event handlers directly to primitive features, producing highly interactive user interfaces. Additionally, attributes can be directly associated to individual spatial features. Common vector data formats for web mapping applications include JSON/GeoJSON and XML such as KML, GML, or GeoRSS. GIS vector datasets need to be transmitted as one of these formats for use in typical web mapping applications. Special consideration should be given to the quantity of vector primitives transmitted to a web application's interface, as too much vector data can affect an application's performance in the client browser.

Raster Data - Raster data can include native raster images, like aerial imagery e.g. GeoTIFF, or raster images rendered from large vector datasets at the server, e.g. land parcels. Raster data is supported in web mapping technologies as jpeg, png or PDF images. Raster data resources do not provide the level of geometry abstraction found in vectors and therefore lack some of the rich event handling capability found in vector data.

Raster + Vector data - Many web mapping applications take advantage of hybrid raster/vector approaches. Custom imagery or large vector data sets are displayed as images, either directly or in cached tile pyramids. Smaller vector sets can be displayed as additional vector overlays. User selection events can directly access any vector layers, but must make server requests for additional information associated with features in raster layers. In hybrid approaches only vector data of interest is loaded providing the balance between performance and data richness.

Many GIS tools have the ability to export, or expose layers as a service that can be called once or many times during a user session to retrieve data. Newer versions of GIS tools e.g. ESRI 9.3.x can do this natively, while some older GIS systems require an additional application to process and format data correctly. ArcGIS Server 9.3.x provides a number of ways to access existing GIS data and integrate with Web Maps...

1) ArcGIS JavaScript Extension for Microsoft Bing Maps – This JavaScript library can be added to any web mapping application. It allows developers to call ArcGIS server layers and

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services directly and show results in web maps. This includes functions to access tile layers, query layer attributes and execute geo-processing tasks (e.g. drive time analysis or plume modeling)

2) ArcGIS REST APIs – These APIs provide more direct access to ArcGIS server layers and services. For web mapping they can provide results directly in tile formats which can easily be overlaid on your web map.

This integration with GIS systems and data is often known as spatial extract, transform and load (ETL), where spatial data sets can be created in vector and raster formats required by web mapping applications.

In addition of GIS support for web mapping integration, there are a number of tools available that provide these features. OGC web service standards define middle tier service standards for exposing spatial data for access from browsers. Several implementations of these OGC web standards include ETL conversion as part of this web service. FME (Feature Manipulation Engine) from Safe Software is another example of ETL. These tools provide spatial ETL/conversion to take GIS data and convert to appropriate web mapping formats.

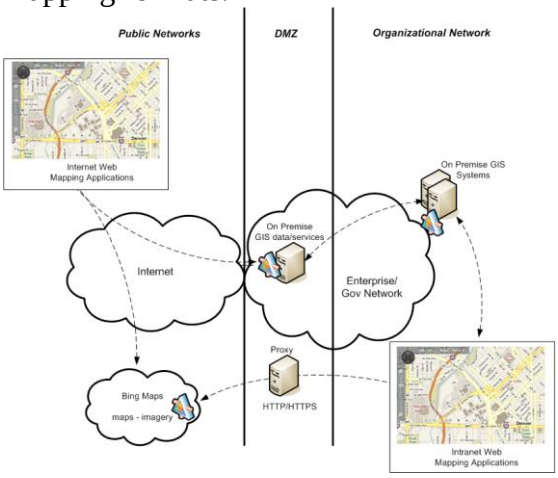

Fig: 3 – Sample GIS and Web Mapping Architecture Diagram – Shows web mapping and GIS application components

Tile Servers are often considered part of a web mapping solution when integrating with GIS. Tile servers process datasets into small raster tiles, stored in tile pyramids for use in web mapping interfaces. Tile pyramids enhance browser navigation performance but require pre-rendering at the server. Relatively static data can be pre-rendered as part of the data creation process. Tiles are stored as a pyramid directory structure of image files which can easily be hosted in a web server or in a Cloud repository. However, more dynamic data sources that get updated frequently or in near real time (e.g. weather), require tile and cache capability as part of the originating web service. The first time a user requests a tile the rendering process occurs, while subsequent requests come directly from a tile cache.

Web mapping platforms like Bing Maps provide high resolution worldwide base features without the significant cost of producing and serving this data internally. Some GIS vendors do offer web mapping capabilities, but world wide data resources must still be obtained and maintained by the user. Scalability of the resulting solution is then dependent on limited user administration resources. It is generally best to leverage web mapping platforms using the supplied APIs to build applications that merge with value added GIS datasets and analysis services.

III Bing Maps Platform

Bing Maps API's are a commercial platform from Microsoft that provides a set of geospatial services. Organizations can leverage some or all of these services when building web mapping and location enabled applications. The Bing Maps service platform provides data resources and comprehensive APIs to complement existing GIS systems and easily build web mapping interfaces. These could include store/facilities locators, asset/fleet tracking, and data visualization/decision making portals etc. Because Bing Maps includes modern web technologies it brings GIS services to the non-GIS user with easy to use web interfaces,

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intuitive navigation, and high performance search results.

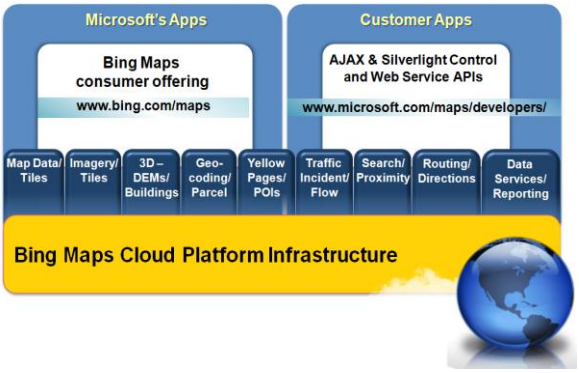

Fig: 4 - Bing Maps Platform and Features – Showing Bing Maps platform, datasets, APIs and applications

Bing Maps allows organizations to focus on value added layers and features, without devoting internal resources to common mapping layers and services. By allowing integration with existing GIS systems, data is easily viewed and manipulated on the web even by non GIS users. In addition, the Bing Maps Enterprise Content Network enhances this scenario by providing many distributed service nodes, to reduce internet latency, and provide improved scalability and redundancy. This gives organizations the best of both worlds.

IV Bing Maps APIs

AJAX/JavaScript APIs – These APIs are primarily for web browser development, so are well suited to web mapping applications with GIS. There is direct support for KML, GeoRSS, native vectors, and raster tile layers. Advantages of these APIs include working directly in a user's browser without specialized plug-ins beyond the ubiquitous JavaScript. Many UI features (such as panning/zooming etc) are part of the APIs. UI development with these API building blocks is relatively easy, and entry skill level is not high. JavaScript will also work with any web server technologies making the implementation very flexible. Disadvantages are seen with the richness of possible applications, and performance limitations due to JavaScript implementations. JavaScript also lacks advanced UI features such as animation, rich graphic design, transparency etc. For web mapping applications leveraging GIS, the JavaScript APIs provide vector and raster overlay import suitable to wide spread publication to every type of browser.

SOAP/XML APIs – SOAP/XML web service APIs support server side calls. Requests can be made with rich result objects in XML. Advantages include ease of use with .NET and other development technologies that support SOAP/XML, running as multithreaded background services, (e.g. bulk geo-coding), and support of any type of UI, including older browser versions, mobile, and smart clients. Disadvantages are that maps returned are static, lacking any navigation controls, so these features need to be developed as part of the application.

Silverlight APIs – These APIs use Microsoft Silverlight technology, which are primarily .NET based APIs with code that runs inside the user's browser. Advantages include ease of development with .NET, powerful UI features such as animation, rich graphic design, and transparency. In addition managed client side code means high performance display of large vector data sets and in some cases GPU accelerated graphics (10x performance increases are not uncommon).

Applications can use combinations of Bing Maps APIs, i.e. Silverlight for visualizing data and SOAP/XML for geo-coding. Bing Maps web mapping APIs provide high performance, feature rich enhancements to traditional GIS systems.

Fig: 5 – Which APIs are best for web mapping integration with GIS? Below are some of the features of the different Bing Maps APIs to help with the decision process.

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Important Features	Bing Maps AJAX Control	Bing Maps Web Service	Bing Maps Silverlight Control
Native web browser functionality?	Yes	No	Yes
Vector data overlay	Yes	No	Yes
Raster data overlay	Yes, via tile layers	No	Yes, via tile layers
Out of the box UI features	Standard controls, map navigation tools, push-pins, and pop-ups	Basic raster images	All Silverlight 3 controls, navigation tools.
Server side requests to Bing Maps	Partial, in ASP.NET (or other server page technology)	Yes, rich server side calls via SOAP/XML directly to Bing Maps	Partial, in ASP.NET (or other server page technology)
High volume vector data integration	Not native, via raster and custom tile layers	No	Yes, native support for high volume vector datasets
Animation	Limited	No	Yes
Data Binding	Yes	No	Yes

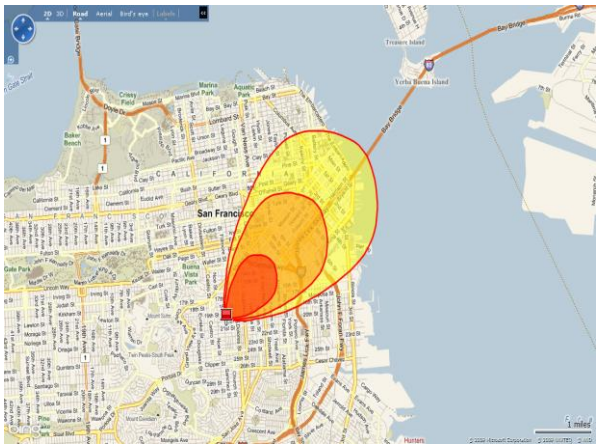

Fig: 6 – Bing Maps APIs integrated with ArcGIS geo-processing features for plume modelling.

Fig: 7 – Plume model viewed up close on aerial images

V CONCLUSION

Many organizations have powerful Geospatial Information System platforms for creating, managing, and analysing spatial data. When building GIS applications for the web, a developer can choose any of a number of architectures, technologies, and methods. This paper examines several of the techniques that can be used to develop web-based GIS applications using Bing Map Objects. Bing Maps complements these features by providing rich web mapping capabilities including UI controls, common map layers, aerial imagery, geo-coding, and routing capabilities. Together GIS and Bing Maps provide rich web mapping solutions for a wide spectrum of organizational scenarios.

REFERENCES

[1] D. Nebert. Developing spatial data infrastructures: The sdi cookbook. technical
report, global spatial data infrastructure, 2004.
[2] Baclawski K and Schneider T, 2009, The open ontology repository initiative: Requirements and research
challenges. In: Collaborative Construction, Management and Linking of Structured Knowledge at the
International Semantic Web Conference.
[3] Grosjean J, Plaisant C and Bederson B, 2002, SpaceTree: Supporting exploration in large node link tree, design
evolution and empirical evaluation. In Proceedings of IEEE Symposium on Information Visualization,
Boston, USA, 57-64.
[4] Smith MK, Welty C and McGuinness DL, 2009, OWL Web Ontology Language Guide. World Wide Web
Consortium
[5] Bing Maps Overview - http://www.microsoft.com/maps/
[6] Bing Maps APIs - http://www.microsoft.com/maps/developers/
[7] Bing Maps Customer Data Network - http://msdn.microsoft.com/en-us/library/dd807493.aspx