



# Comparing Vector and Raster Mapping for Internet Applications

*An ESRI® White Paper • August 2006*

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# Comparing Vector and Raster Mapping for Internet Applications

## An ESRI White Paper

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# Comparing Vector and Raster Mapping for Internet Applications

Developing Web-based mapping applications involves more choices than it did just a few years ago. Traditionally, Internet maps have been based on raster graphics created on a Web server and delivered to a client browser. More recently, mapping APIs have been using pregenerated raster tiles to enhance the viewing experience. Today, developers are starting to build sophisticated mapping applications using vector graphics.

Traditional raster maps don't require any special plug-ins for end users to view them. However, raster maps aren't capable of incorporating much functionality. Once the map image is created, it is fixed. To modify the image, another request must be made to the map server. Pregenerated raster tile maps provide images very quickly and allow for a smooth panning experience. Once the tile images are created, they can be reused many times, but they cannot be customized. Vector maps can be customized on the fly. Vector maps allow developers to create dynamic Internet applications in which users interact with the mapping data in a similar way to a desktop environment.

Before developers add maps to a Web application, they need to decide on a format that best fits their needs. Table 1 provides a summary of features and benefits of raster, tiled raster, and vector maps. To make an informed choice, developers must understand how these map types work in an Internet environment and the advantages of each. The goal of this paper is to provide a high-level overview of these formats and to encourage readers to learn more about how to take advantage of the latest technology as it becomes available.

**Table 1**  
**A Functionality Comparison of Raster and Vector Maps**

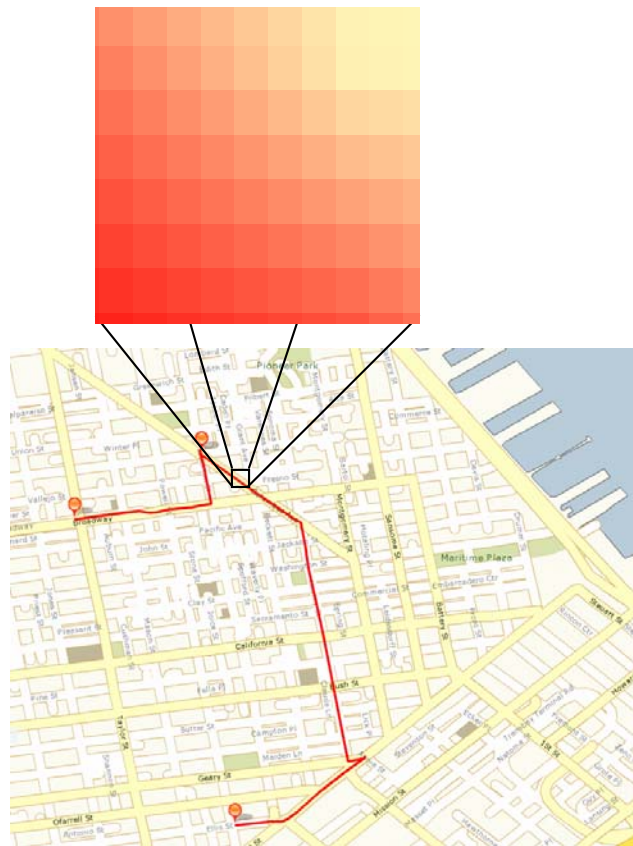
Map Image Format	Switch Layers, Styles, Projections	Suitable for Click, Drag, and Pan	Identify Features	Highlight, Animate Features	Special Plug-In Required
Raster (JPEG, GIF, PNG)	Yes	No	Requires server request	No	No
Tiled Raster (overlaid JPEG, GIF, PNG)	No	Yes	No	No	No
Vector (SWF, SVG)	Yes	Yes	Server request not required	Yes	Yes

## Traditional Internet Maps—Raster Maps

Traditional Internet maps use raster graphics, in formats such as JPEG or GIF, that are created on a Web server and delivered to a client browser. If an end user needs to manipulate the map (for example, turn on an additional data layer), the client application sends a new request to the server, which in turn creates and sends back a new map.

As shown in figure 1, raster maps are composed of a two-dimensional array (rows and columns) of colored pixels that form a picture of a map. At high levels of magnification, raster images appear to have jagged edges, which represent the sides of individual pixel squares. This graininess is often referred to as "pixelation," and it occurs when the individually colored elements that make up an image become visible to the eye. These images appear properly when viewed at their requested scale, yet if the image is zoomed in on, individual pixels become apparent.

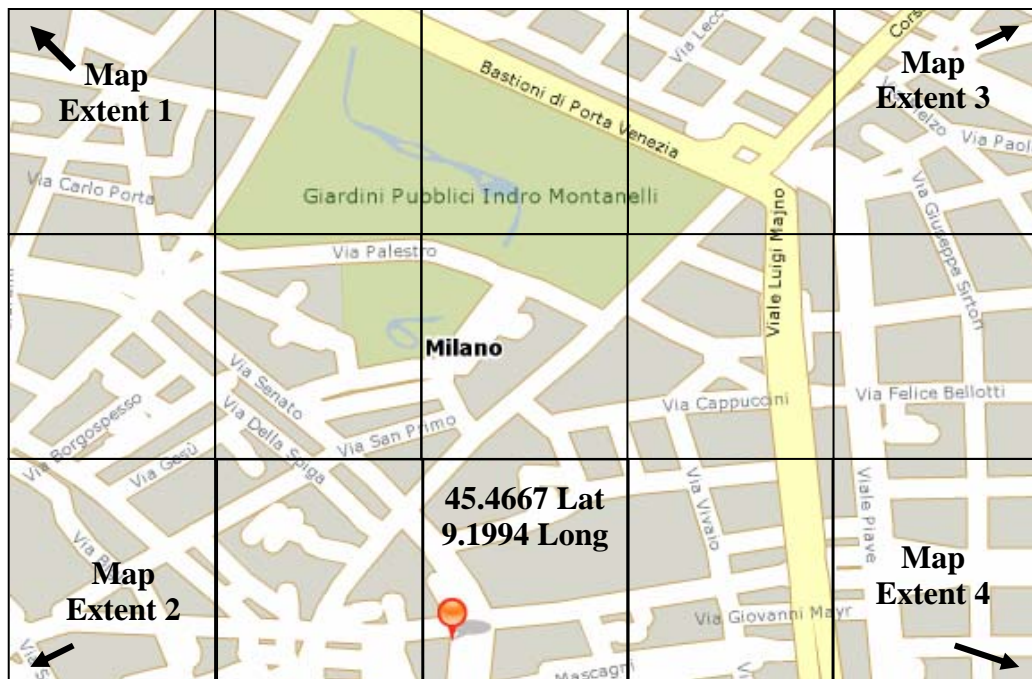
**Figure 1**  
**Raster Graphics Consist of Colored Pixels**



In 2005, several online mapping providers began providing maps in the form of tiled raster images. The full image is composed of many smaller image tiles that form a map when viewed together in a browser. All the map images have been created, or pregenerated, at some point prior to being displayed by the mapping service. Once the map images are pregenerated, they are simply stored as files on a server. Therefore, tiled raster maps offer high performance because the server doesn't need the overhead to create a map; it simply retrieves the appropriate raster files and sends them to the client. Another benefit of using tiled raster maps is they allow for a very smooth panning experience in the client browser. However, because the images are fixed, developers have limited control over the map viewing experience; for example, the map styles, which define the color schemes used within the map image, cannot be changed.

Typically, the only other metadata information available to developers using raster maps is the latitude-longitude extents, as shown in figure 2. Extents are the minimum bounding rectangle defined by four pairs of latitude-longitude coordinates, one pair of coordinates for each corner of the rectangle. If a developer knows the extents, he or she can then use the map image as a static background canvas for placing items, such as pushpins, on top of the image. The pushpins are aligned on the map through an application function that converts latitude-longitude coordinates to map image pixels.

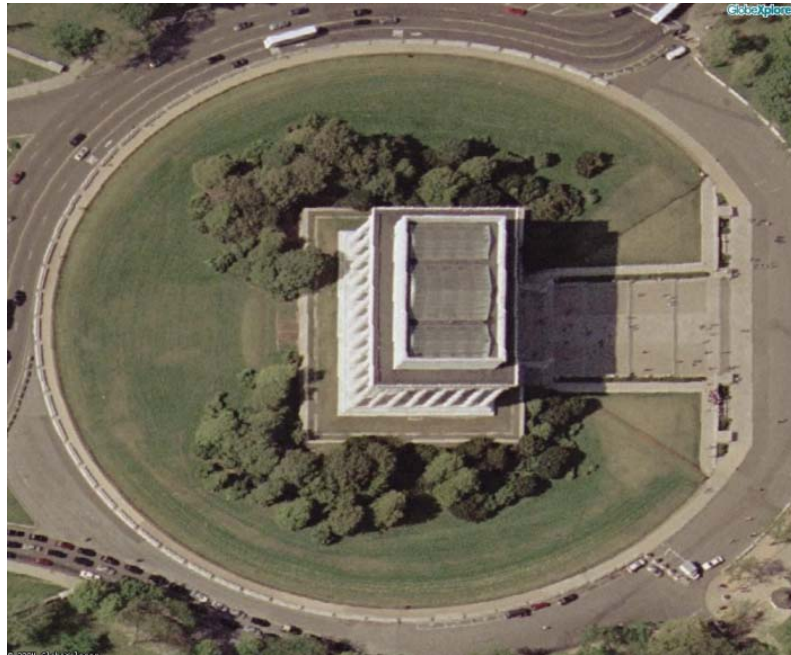
**Figure 2**  
Simulation of a Tiled Raster Map with the Tiles and Map Extents Outlined



Developers use raster mapping for several reasons. Anyone with access to the Internet can view raster graphics without special browser tools (known as plug-ins). End users can access applications containing raster map images without downloading or installing special software to view the maps. Some users avoid plug-ins due to security concerns, so applications that only use raster graphics can be viewed by all Internet users. The generation of raster map images is done completely at the mapping server (for example, ESRI® ArcWeb<sup>SM</sup> servers). Because of this, there is less risk of a client machine not properly rendering the image.

Each format of raster graphics (GIF, JPEG, and PNG) has a unique set of advantages. GIF is the most optimized format for displaying street or other line maps, and it also supports transparency. JPEG creates the smallest files when used on imagery maps and supports more than 16 million different hues. (Figure 3 provides an example of an imagery map.) PNG, developed as a nonproprietary equivalent to GIF when GIF was under patent protection, supports transparency and is lossless, which means data is not lost during compression.

**Figure 3**  
**A JPEG Map is a Good Choice for Displaying Satellite Imagery**



## **Introducing Vector Graphics**

Vector graphics move applications beyond simply viewing maps and into an interactive, rich client experience that uses features within map data. Adobe® Flash (SWF) and the nonproprietary Scalable Vector Graphics (SVG) are the two most common vector map formats. Because vector graphics consist of instructions that designate mathematical shapes, developers can build applications that manipulate mapping of entire objects. Vector graphics look good whether zoomed in or zoomed out, and they allow for dynamic resizing without having to request a new image from the map server. Oftentimes, the information contained in a map is more compelling when users can interact with its data.

For example, to define a radius around a particular latitude-longitude coordinate on a map, the application would insert a line of code, similar to the one below, into an SVG file. When the client browser renders the final image, the circle will be added to the map:

```
<circle cx='103' cy='103' r='50' style='fill:cyan;
opacity:0.3; stroke:black' />
```

This code adds a semitransparent cyan circle with a radius of 50, centered at the location (103,103) and outlined in black, as seen in figure 4.



**Figure 4**  
**Vector Graphics Consist of Geometric Instructions**

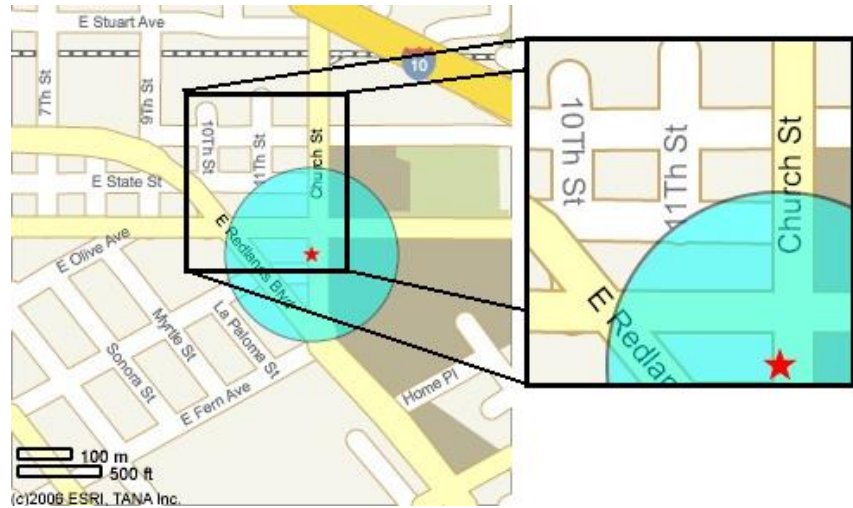
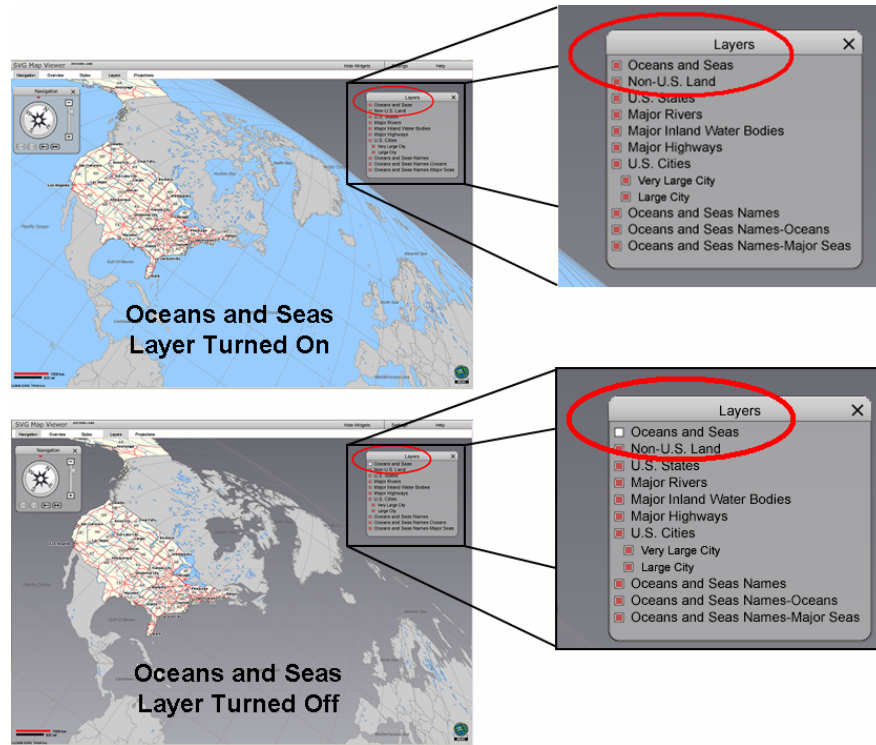


Figure 5 shows the ArcWeb Services SVG Map Viewer to demonstrate an application that uses SVG functionality to enhance the user experience. Among many features in this customizable application, end users can toggle data layers on and off, tilt the earth at various angles, and change map projections.

**Figure 5**  
**Before and After Screen Shots: Users**  
**Can Toggle Layers and Shapes On and Off**



Applications that incorporate vector graphics are fast for a number of reasons. For the most basic functions, such as turning on and off geographic data layers and zooming in and out, metadata can be accessed and manipulated locally without the need to make a round-trip to the server to bring back the information. As shown in figure 6, once the data is retrieved by the application, such as ArcWeb Services Explorer, the end user can change the map styles or other attributes on the fly to assist in analyzing and viewing geographic data. For advanced functionality such as spatial searches, this information can be easily added to the mapping application as a searchable layer provided through the Web service API.

**Figure 6**  
**Vector Map Example: Changing Transparency of Layers On the Fly**

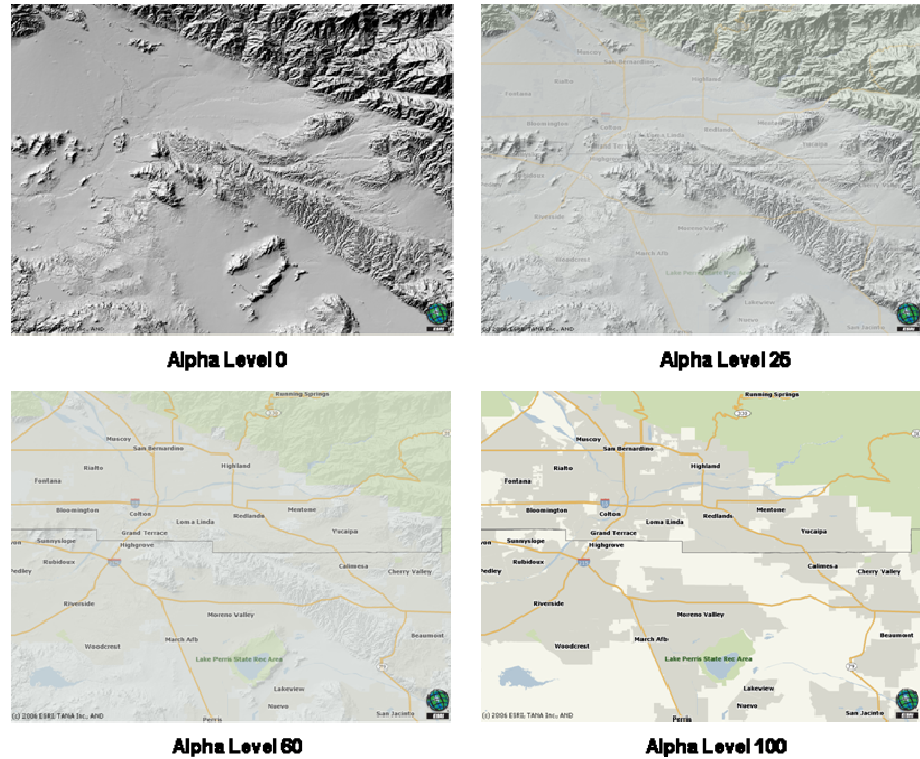


Table 2 provides an overview comparing SWF and SVG. SWF, sometimes pronounced "swiff" and often referred to as Flash, is a proprietary vector graphics file format produced by Adobe/Macromedia Flash. SWF files are intended to be played by the Adobe Flash Player functioning as a browser plug-in or a stand-alone player, or files can be encapsulated with the player. Adobe's Flash Player, a browser plug-in, is currently the most common vector image viewer used on the Internet for viewing .swf files. According to a December 2005 study by the NPD Group, 97.7 percent of Internet users have some version of the Adobe Flash Player installed, with about 50 percent having the latest version.<sup>1</sup> Although SWF maps do require a plug-in, most users will already have one installed.

<sup>1</sup> [http://www.adobe.com/software/player\\_census/flashplayer/version\\_penetration.html](http://www.adobe.com/software/player_census/flashplayer/version_penetration.html)

**Table 2**  
**Comparison of SWF and SVG**

	<b>Flash (SWF) Maps</b>	<b>SVG Maps</b>
<b>Vector-Based</b>	Yes	Yes
<b>Browser Plug-In</b>	Most users already have plug-in installed.	Fewer users already have plug-in installed.
<b>Licensing</b>	Adobe, proprietary, free	Open, nonproprietary, free
<b>Client-Side Programming Control</b>	Adobe Flash Player or encapsulated in an API	Most XML parsers
<b>Ability to Edit Map File</b>	No (binary file format)	Yes (XML-based text)

Several mapping API vendors, such as ESRI, offer APIs that provide functionality to embed a Flash container into a Web page. ESRI offers a JavaScript™ API that provides access to server-side functionality for improved control over the map appearance and to provide desktoplike functionality for Internet applications. Examples of functionality for ESRI's JavaScript API include the ability to create and work with thematic maps and manipulation of group layer properties, shapes, and lines. An example of manipulating group layer properties was shown in figure 6, above.

SVG is a newer format of vector graphics that is an open-source, nonproprietary standard created by the World Wide Web Consortium, creator of HTML, cascading style sheets (CSS), and XML. Because SVG is nonproprietary and built on top of XML, most of the commonly available XML parsers can read the source (unlike binary Flash files). As a result, the contents of an SVG file are searchable, and they can be manipulated using any programming language that can interact with XML. SVG can also be embedded into Adobe PDF documents. This is very useful when maps need to be included in print-quality reports.

SVG is also human readable, so it can be edited with any standard text editor, for example, Notepad. For mapping purposes, SVG offers a pixel-precise layout that fits well with pixel-to-coordinate conversion API methods and other utilities. For the control of layout, styling, coloring, and fonts, SVG has the ability to use CSS.<sup>2</sup> This allows users to format elements centrally rather than explicitly and also define new styles with their own names. It is important to note that not all SVG renderers are CSS compatible.

## Conclusion

Today's mapping APIs offer many choices for developers. Whether building simple or complex mapping applications, users should become familiar with the differences between the graphic formats and decide which best meets their needs. If an application just needs a static map for simple viewing, GIF, JPEG, and PNG formats offer an easy way to deliver good-looking maps that can be viewed by everyone. When building Internet mapping applications that require a rich look and feel or functionality similar to a desktop environment, then vector maps should be considered. Vector maps can interact with the mapping information in a dynamic manner, including turning layers on and off, or changing the transparency of a particular layer without a request to the server.

<sup>2</sup> <http://www.w3.org/TR/SVG/styling.html>



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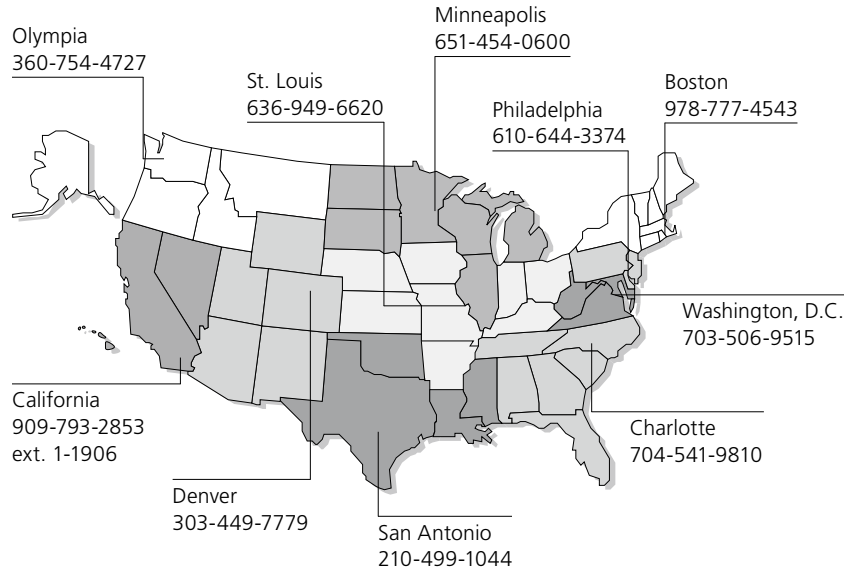
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