

Customising ArcIMS for Agricultural Geo-referenced Information System

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Abstract

The Department of Agriculture, South Africa, has developed a web based Agricultural Geo-referenced Information System – AGIS, on the ESRI ArcIMS/ArcSDE platform.

The developers of the system had to accommodate technical requests from the client that could not be performed with off the shelf IMS code. As a result a JAVA mapping interface was developed to include the basic IMS functionality and add the required requests.

The paper describes the architecture of the system (Unix O/S, Informix database) as well as the functionality developed and the applications within the AGIS web-services.

Introduction

The Agricultural Geo-referenced Information System (AGIS) www.agis.agric.za first went live in 1999. The official launch of the system was done at the World Summit for Sustainable Development (WSSD) in Johannesburg, 2002.

The strategic vision of AGIS is to facilitate access to structured, integrated, relevant, reliable and timely data and information for the agricultural sector of South Africa, using the Internet as the primary means for information dissemination¹.

The AGIS menu system was developed to provide access to information within a “three click environment”. The homepage has the following major components (see Figure 1) :

- A generic menu bar - displayed across the top of the homepage – this is displayed on each of the AGIS subtopic pages
- Shortcuts – displayed on the left hand side of the homepage
- Atlas shortcuts (Orientation Atlas, Natural Resource Atlas) – displayed in the centre section – top
- Latest News – shortcuts to the latest additions on the site.
- Dynamic Weather Station Information – weather information (updated every 15 minutes) for the ARC-ISCW-Pretoria weather station

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The majority of the information is suitable for use at national and provincial levels (1 : 250 000). Functionality is also provided for users to create their own maps – selecting an area of interest and the spatial layers for their map.

Following the initial deployment of the Atlases, the Department of Agriculture wished to improve the map layout and functionality of the generic Atlas viewer. This led to the terms of reference for a new viewer to be used as the platform for the AGIS dynamic map interface. Before discussing the development of the viewer the AGIS Architecture will be presented as background information.

Architecture

The AGIS architecture is built on Sun Enterprise servers with a Solaris operating environment and Informix database. The system uses two servers to create redundancy, the first is the live web server and the second is the development server, which is a mirror of the live machine. A schematic of the system is illustrated in Figure 3 . The Serving Centre is located at the Department of Agriculture.

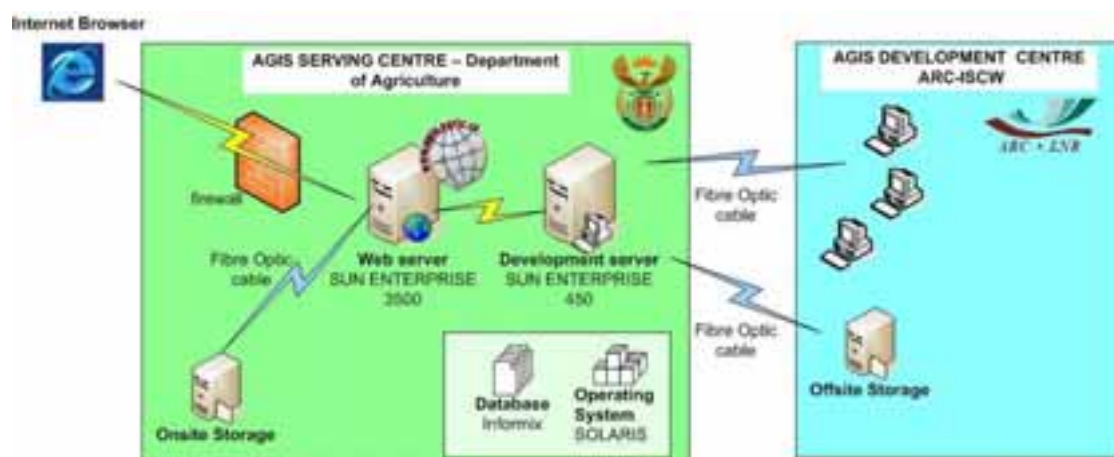


Figure 3 AGIS Architecture (Schematic)

The Development server is connected via a fibre optic link from the Serving centre to the Development Centre, which is located at the Agriculture Research Council – Institute for Soil Climate and Water (ARC-ISCW). The development team and other contractors have access to the development server via this link.

All applications are deployed on the development server and tested (off-line) before migrating to the live web webserver. In the event of system failure or maintenance to the web server, the development server is re-configured as the web server to ensure continuous service. Detailed system specifications are provided in Appendix A (Table 1).

AGIS Mapviewer functionality

Summaries of key features are described in this section. For a detailed list of features the reader is referred to Appendix A - Table 2 (cross referenced by numerals on illustrations).

Menubar is located across the top of the viewer window (see Figure 4) :

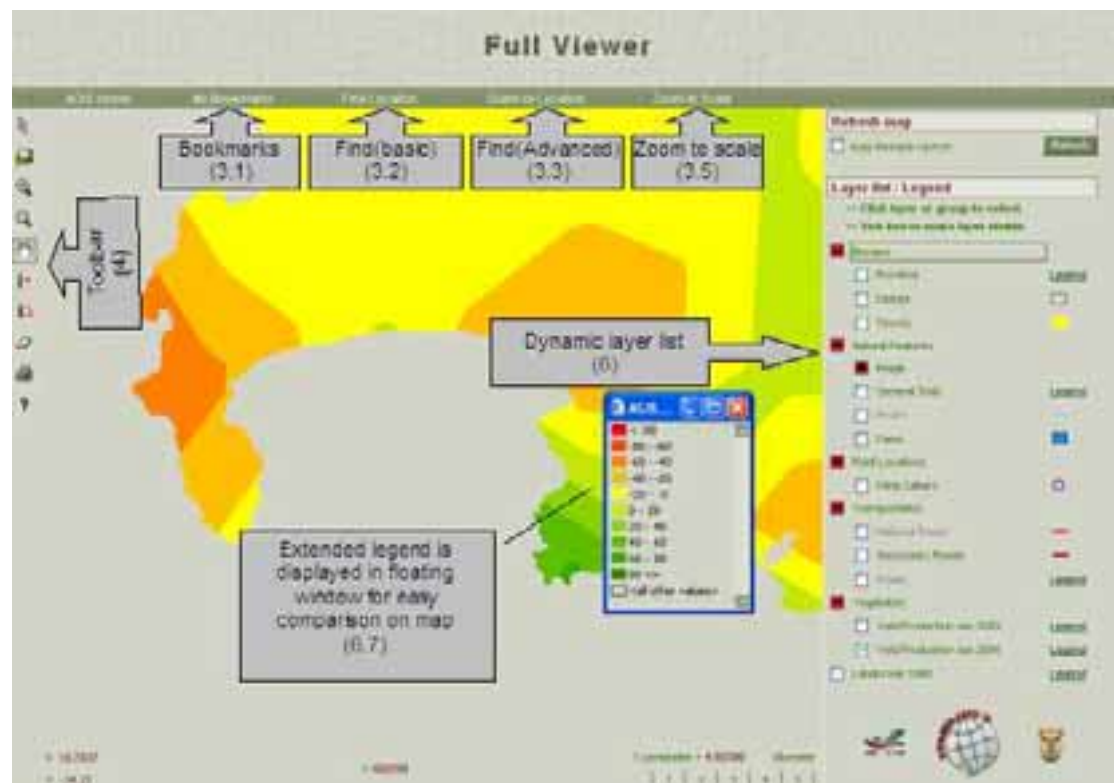


Figure 4 Mapviewer Features: Toolbar (4) Menubar (3) Dynamic Layers (6) and Extended Legend (6.7)

Features associated with the Menubar include :

- Bookmarks (to save and return to an extent)
- Find location (basic) – user selects from list then has option to zoom to results
- Find Location (Advanced) – the user is presented with a user friendly pre-defined structure to easily build an advanced SQL query (supporting queries on MSSQL and Informix databases)
- Query By Location - novice friendly buffer query interface
- Zoom to Scale – zooms the map to the specified scale (see Figure 5)

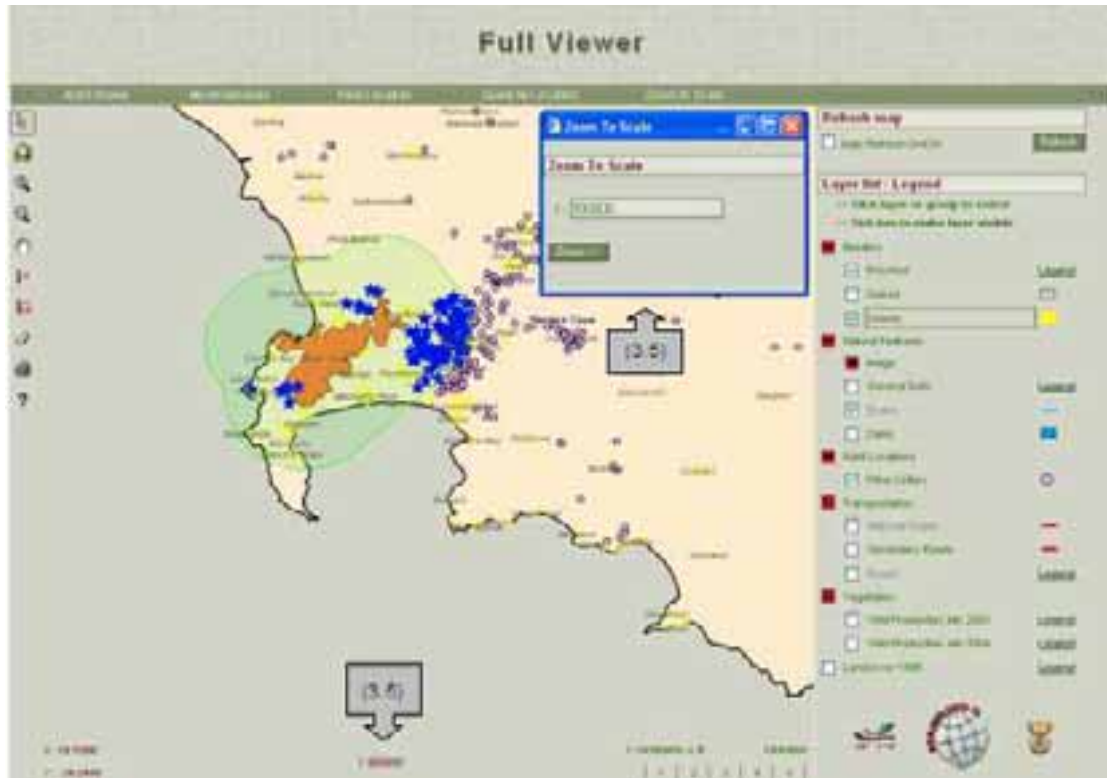


Figure 5 Zoom to Scale

- Project specific menu bar is displayed according to specifications defined in the management system (the standard menu is automatically moved upwards to create space for the additional menu bar –see Figure 6).



Figure 6 Project Specific Menubar

More discussion on the project specific toolbar will be made under the heading “Challenges and Constraints”.

Dynamic Layer List and floating Legend - Layers are grouped according to similar feature types (e.g. socio-economic, infrastructure, natural resources). Groups may be expanded or collapsed - to provide easy navigation through long layer lists (see Figure 4). Both layers AND groups may be set as active (for queries) by clicking on the layer or group name.

Single line legends are displayed next to the layer name at all times whereas Multiple-line legends are displayed by clicking a link next to the layer name. The extended legend is then displayed in a floating window (This is especially useful for graduated colour ramps (see Figure 4).

Toolbar uses Instinctive icons and tool tips, e.g. “Click to identify features at a point”, “Drag to identify features in an area”. The Print button displays a page with a printable version of the map. (User may add own heading and choose whether to include a north arrow, scale bar and/or legend). The tools with tips are illustrated in Figure 7 :

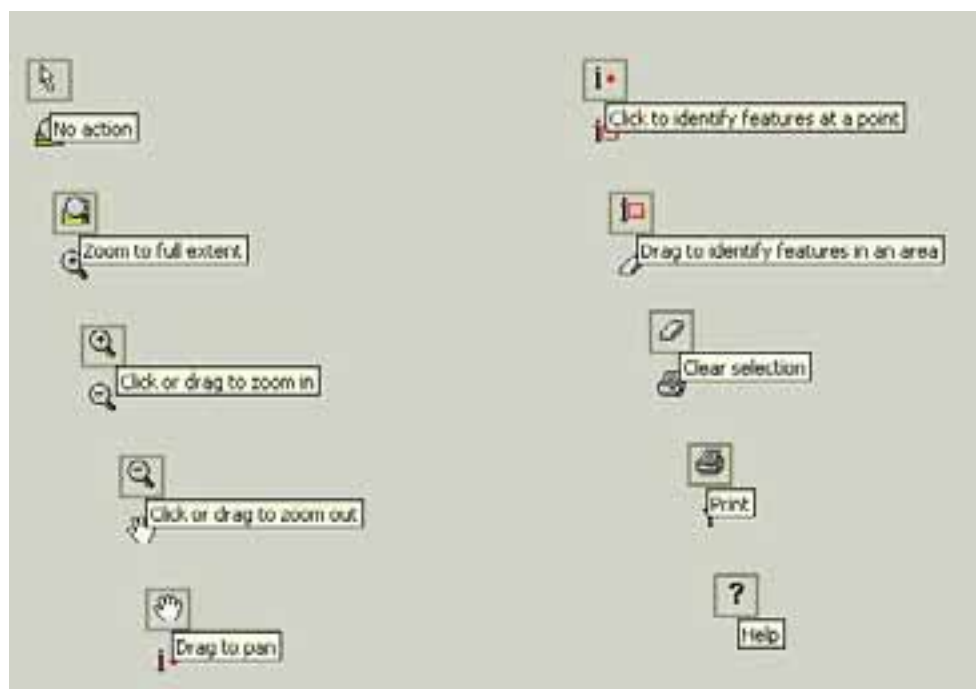


Figure 7 Toolbar icons

Results (search/query/identify) are displayed in a new window, which may be re-sized by the user. Only the columns specified in the management system ("Friendly" attribute names) are displayed in query results.

Results are limited to a total of 500 with 20 results displayed per page (direct links are available to all other result pages). The result table on each page may be sorted by clicking on any column heading (see Figure 8).

Results for Buffer Query

The query set of results are ordered by Name Ascending. Please note that this does not sort the entire set of results, but only the results displayed on this page.

There are 49 Rows Columns with 7 Columns.

Displaying records 1 to 20 of 49

Name	Address	Town	Code	Telephone	Region	Area	Location
Abundant Fruit Trees	PO Box 212	Cambridge	1100	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 1940	Cambridge	1101	021 481 120	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1102	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 1000	Cambridge	1103	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1104	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1105	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1106	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1107	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1108	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1109	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1110	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1111	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1112	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1113	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1114	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1115	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1116	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1117	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1118	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1119	021 481 100	0000	0000	
Abundant Fruit Trees	PO Box 100	Cambridge	1120	021 481 100	0000	0000	

Display records 1 to 20 of 49

Figure 8 Results Table

Digitizing on line has functionality for point, line and polygon features. There is unique password protection for every shape (shapes in the same layer may belong to different owners in a project). All points/vertices are listed in editing window and numbered on the map (see Figure 9).

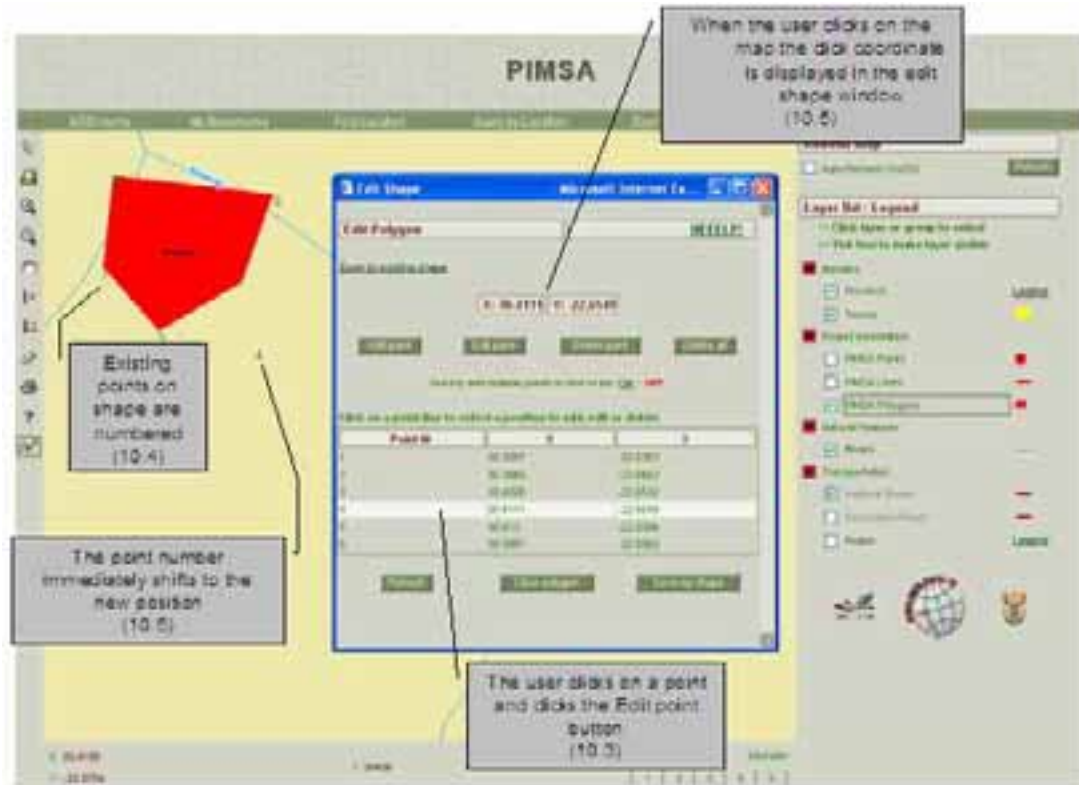


Figure 9 Digitizing features (polygon)

Management System

Part of the development included a Management System to load, display and maintain the Atlas systems. Key components of the Management system are :

- Manage information about layers – “friendly” layer names, censorship of attributes, “friendly” attribute names and define the attributes to be used for ordering searches
- Manage Project owners - Add, edit and delete project owners.
- Projects – a project (Atlas) – define/change project name, add, edit and delete projects. Specify project-specific functionality and associated menu options. Add and delete layers.
- Project Layers – user specification for groups, sub-groups and the exact position where layers should be placed (up to 5 levels deep). The layer list in the viewer is dynamically generated from the project database at runtime to display the layers for the project in the groups and order specified by the user. The user may specify whether the layer should be visible or not by default and the default level of display for the menu/legend display.

An illustration of the AGIS Atlas Management system is provided in Figure 10 below.

Figure 10 AGIS Atlas Management system

Challenges and Constraints

There were several challenges and constraints that the developers encountered during the coding of this application (some are still unresolved). One of the major challenges was ensuring core ArcGIS functionality was included in the new viewer. Further constraints are summarised below :

- “Project specific toolbar” - introduced in order to make provision for “Extension” type functionality, specific to a project. Advance planning to ensure that this functionality would be available consumed a large portion of the development team’s time.
- Removal of highlight layers – Each time the user zooms or pans the “highlight” layer cannot be refreshed without re-calling the map.initMap() routine (.axl). The concept of the Java connector is to load information from the .axl into the Java objects ONCE, and then re-use the Java objects for subsequent map requests.
- Ordering of results - data results are very fast with the ArcIMS 9.0 Java connector, but it does not support the ordering of results. For this reason, all queries requiring ordering have to be performed with the ArcSDE Java connector. IMS is only used to render the result. This is an inefficient workaround resulting delayed response times. *It is anticipated that the release of ArcIMS 9.2 will address this constraint.*
- & ‘ “ < and > - The filter.setCheckesc() function works for results on a normal highlight layer, but NOT for results on a buffer layer. The Java connector bombs if it encounters any of these characters (& ‘ “ < and >) in the results.

- Dynamic Layer inclusion – provision to allow the inclusion of external mapservice layers on AGIS has been implemented (this is absent on the current system).

The authors would gladly appreciate any advice/recommendations from the developer community relating to these challenges and constraints.

Conclusion and Future plans

A customised mapviewer was developed with additional features not supported by the ArcIMS Java connector. The map layout and functionality of the generic Atlas viewer for the Agricultural Geo-referenced Information System (www.agis.agric.za) was improved as a result of this development. A management system to allow administrators to create, maintain and update the Atlases was also developed as part of the project. There are technical issues unresolved which will require further research.

The AGIS system currently has the facility for users to create their own maps using the existing mapviewer. Future plans include :

- The development of the capability for users to create their own atlas using map new mapviewer format.
- Lack of support for Informix Metadataserver will require a workaround. (Proposed solution is to store xml documents generated from ArcCatalog in a database structure, which can exported to XML ArcCatalog formats upon request).
- Creation of high quality printable maps that can be downloaded as a picture or a PDF format. This challenge involves substantial web customization with ArcIMS, or the migration to an ArcObjects based environment (e.g. ArcGIS Server)

Geoprocessing functionality for various decision support systems is crucial to the growth of the AGIS system. Migration to an architecture that supports geoprocessing and modelling (ArcGIS Server) is currently under consideration. The JAVA development environment has already been established on AGIS and therefore the migration to the JAVA Application Development Framework for ArcGIS Server should have minimal complications. However, a shift in the development paradigm will be required to take advantage of the powerful and complex ArcObjects over the existing simple mapping components and features in ArcIMS.

Migration to ArcGIS Server would bring other exciting prospects to the AGIS system :

- The ability to create webservices that can be used in other governmental organizations by means of geoprocessing and modelling services (e.g. Crop Suitability Decision Support System).
- The ability to serve 3D globes with ArcGIS Server and ArcGlobe, which can also incorporate geoprocessing and modelling services.

Acknowledgements

The authors wish to acknowledge the following organisations and staff for their contributions, participation and collaboration in the compilation of this paper:

- The National Department of Agriculture, South Africa
- The Agriculture Research Council, Institute for Soil Climate and Water, South Africa
- CEIT Development
- GIMS

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Appendix – A-

Table 1 AGIS – Specification

Component	Sub-Component	Description
Software	GIS	<ul style="list-style-type: none"> • ESRI ArcIMS • ESRI ArcSDE
	Operating System	<ul style="list-style-type: none"> • SUN Solaris
	Database	<ul style="list-style-type: none"> • IBM Informix • Excalibur • Data Director for Web • Spatial Blade • Client SDK • Web Blade • IX DBMS
	Development Software	<ul style="list-style-type: none"> • Markup Languages HTML, XML • Development Software Data Director for Web (Windows) / Netbeans • Communication Software Informix Client SDK • Development Platform - Informix Web Datablade / JAVA / JSP • Scripting Language -JavaScript • Style Sheets (Look & Feel) CSS, XSL
	Webserver	<ul style="list-style-type: none"> • Perl • Tomcat • iPlanet • Apache (ISA) • Java 2.x JDK • Samba
Hardware	Processor	<ul style="list-style-type: none"> • 4 x 400 Mhz CPU
	RAM	<ul style="list-style-type: none"> • 4 GB
	Network	<ul style="list-style-type: none"> • 3 x 10/100 mbs
	WAN	<ul style="list-style-type: none"> • Local (SA) = 256kB • International = 128kB
Data	Internal Disk Space	<ul style="list-style-type: none"> • 2 x 18 GB • 2 x 36 GB
	Onsite Storage	<ul style="list-style-type: none"> • approximately 6 TB • RAID 3 x arrays
	Offsite Storage	<ul style="list-style-type: none"> • 3.7 TB

Table 2 Map viewer requirements and features

1	User friendly management system:
1.1	Manage info about layers:
1.1.1	Specify friendly name for layer to be displayed in layer list.
1.1.2	Specify which columns must be included in results – sensitive information in certain columns can be protected.
1.1.3	Specify friendly names for the columns (to be displayed as headings).
1.1.4	Specify columns by which results for the layer must be ordered.
1.2	Manage project owners:
1.2.1	Add, edit and delete project owners.
1.3	Projects:
1.3.1	Add, edit and delete projects.
1.3.2	Specify a name for the project, which is automatically displayed as the map heading.
1.3.3	Specify a specific directory for the project, which contains a menu bar for the project and project-specific functionality. If a directory is specified the general menu bar is automatically shifted upwards and the project menu bar is displayed below it to provide access to project-specific functionality.
1.3.4	Layers may be added to and removed from the project.
1.4	Project layers:
1.4.1	The user may specify groups, sub-groups and the exact position where layers should be placed (up to 5 levels deep). The layer list in the viewer is dynamically generated from the project database at runtime to display the layers for the project in the groups and order specified by the user.
1.4.2	The user may specify whether the layer should be visible or not by default.
1.4.3	For each layer, the user may specify up to which level the menu should be expanded when the map loads.
2	Map heading:
2.1	The project name as specified in the management system is used as the map heading.
3	Novice friendly menu bar:
3.1	My Bookmarks - to save and return to an extent.
3.2	Find Location (Basic) - list with friendly names of layers and text box to easily search for any string in any column of the layer as specified in the management system. User can zoom to features from results.
3.3	Find Location (Advanced) – the user is presented with a user-friendly pre-defined structure to easily build an advanced SQL query. Columns allowed in the management system are listed by friendly name. Operators are selectable (as supported by different databases – MSSQL and Informix). Test values are entered in text boxes. Advanced SQL queries are made simple and fast.
3.4	Query By Location - novice friendly buffer query interface. Last identified features are stored in memory and buffer query may be executed at any time.
3.5	Zoom to Scale – zooms the map to the specified scale.
3.6	Project specific menu bar is displayed if a project directory is specified in the management system. The standard menu is automatically moved upwards to create space for the additional menu bar.
4	Novice friendly toolbar:
4.1	Instinctive icons and tool tips, e.g. “Click to identify features at a point”, “Drag to identify features in an area”.
4.2	Print button displays a page with a printable version of the map. User may add own heading and choose whether to include a north arrow, scale bar and/or legend.
5	Status display:
5.1	Eye-friendly decimal degree display and scale at bottom of map instead of in status bar.

6	Dynamic layer list:
6.1	Layers are grouped as specified by user in management system.
6.2	Groups are expanded to level selected by user in management system when map loads.
6.3	Groups may be expanded or collapsed to provide easy navigation through long layer lists.
6.4	Layers set to be visible in management system are visible by default.
6.5	Auto refresh button automatically refreshes map when a layer is toggled between visible or not.
6.6	Both layers AND groups (any group) may be set as active by clicking on the layer or group name. Features may be identified (by click or drag) on the selected layer OR group. When a group is selected the layer menu from the selected group down is displayed with the identify results. The user may simply click on the layer to apply the search area to that layer. It is not necessary to re-select the extent to run the query on different layers in the group.
6.7	Single line legends are displayed next to the layer name at all times. This is visually pleasing and eliminates the need to toggle between layer list and legend. Multiple-line legends are displayed by clicking a link right next to the layer name. The extended legend is then displayed in a floating window, which can be dragged over the map to easily compare features to the legend. This is especially useful where legend colours are difficult to distinguish.
7	Map services:
7.1	Multiple projects can run from the same map service. Different projects use different layers in the same map service as specified in the management system. This makes it possible to rapidly deploy project-specific maps without the need to create new map services. When the map service is updated or enhanced, it is immediately reflected in all projects utilizing the map service.
7.2	The same project can run on two different map services, thereby changing the look of layers. A project may be called with any map service as long as the project layers specified in the management system are contained in the map service.
8	Results:
8.1	Results are displayed in a new window, allowing the user to adjust the size.
8.2	Only the columns specified in the management system are displayed in query results.
8.3	The friendly column names specified in the management system are displayed as column headings.
8.4	Any column named "website" is automatically displayed as a hyperlink to enable easy linking to more info.
8.5	All results must be ordered as specified in the management system.
8.6	Results are limited to a total of 500. 20 results are displayed per page with direct links to all other result pages.
8.7	The result table on each page may be sorted by clicking on any column heading.
9	Map size:
9.1	Map fills screen regardless of size. Map may be resized.
10	Digitizing:
10.1	Digitizing functionality for point, line and polygon.
10.2	Unique password protection for every shape (shapes in the same layer may belong to different owners in a project).
10.3	All points are listed in editing window.
10.4	All points are numbered on the map.
10.5	A user clicks on a point on the map – the click coordinates are displayed in the editing window – the user may decide to add the point to the end of the list, or to replace any existing point in the list with the new point – the new/existing point number is immediately displayed in the new location on the map – the user may save the new shape or refresh the original shape.
10.6	Quick add functionality to add points to the end of the list by continuously clicking.

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