A Lightweight, Integrated SVG – based Oilfield Web GIS Platform[1]

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Abstract

Development of vital national oil and gas reserves involves data from many disciplines including reservoir engineering, drilling engineering, geology and more. Integrating such disparate data types into a web based geographic information system (GIS) has proved problematical for oil field users. Traditional web GIS does no allow for seamless integration of oilfield applications into the web GIS paradigm. This paper described a novel lightweight, integrated oil and gas field WebGIS platform based on scalable vector graphics (SVG), a widely used W3C specification that solves many web-based rendering issues. The platform introduces a 'fine-grain' integration framework which supports user-object-application integration. A meta-model is proposed that gives the platform excellent scalability and flexibility. This WebGIS platform has been used on the Daqing oil field. Users can query their information of interest and this can be displayed using a variety graphics technology.

***Keywords*：** WebGIS，SVG，metadata driven, oil gas development, information Integration, Visualization

1 Introduction

At present, with the development of Intranet and IT application, information technology plays an important role in oil field development. After the oil field is developed, it has accumulated all kinds of valuable data. The users are not satisfied with traditional query mode, any longer. With the development of GIS , these users wish to query all kinds of data based on GIS, namely, by object of GIS navigation. Meanwhile, these users wish the results queried be displayed in a graphic mode. It is well known that these users’ requirements must be resolved by means of GIS technique.

Presently, there exist many popular WebGIS[1,2,3], such as arcGIS, MapInfo and so on. These commercial WebGIS platform’s common characteristics are expensive, and meanwhile these WebGIS software running efficiency is not ideal. Oil field needs a their special own GIS, which can integrate GIS information and oil field application, namely, it can implement to integrate applications and users with GIS spatial objects. According to oil fields’ requirements, some key technologies are researched such as GIS technique, XML technique[4], AJAX technique[5], SVG (Scalable Vector Graphics) technique[6,7], metadata technique , information integration[8] and some

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related technologies. A kind of light GIS framework is proposed, it can not only implement GIS basic functions such as map moving, map zooming, map locating and so on, but also integrates all kinds of applications of oil fields. This platform has been applied in Daqing oil field, all kinds of applications are integrated into this platform.

2 Related to Technique and Its Application

2.1 Technique of SVG

SVG (Scalable Vector Graphics) is a language for describing two-dimensional graphics in XML . This specification is released by W3C, which allows for three types of graphic objects: vector graphic shapes (e.g., paths consisting of straight lines and curves), images and text. Graphical objects can be grouped, styled, transformed and composited into previously rendered objects. The feature set includes nested transformations, clipping paths, alpha masks, filter effects and template objects.SVG drawings can be interactive and dynamic. Animations can be defined and triggered either declaratively (i.e., by embedding SVG animation elements in SVG content) or via scripting. Sophisticated applications of SVG are possible by use of a supplemental scripting language which accesses SVG Document Object Model (DOM), which provides complete access to all elements, attributes and properties. A rich set of event handlers such as onmouseover and onclick can be assigned to any SVG graphical object. Because of its compatibility and leveraging of other Web standards, features like scripting can be done on XHTML and SVG elements simultaneously within the same Web page.

SVG is a language for rich graphical content. For accessibility reasons, if there is an original source document containing higher-level structure and semantics, it is recommended that the higher-level information be made available somehow, either by making the original source document available, or making an alternative version available in an alternative format which conveys the higher-level information, or by using SVG's. In light WebGIS platform, the technology of SVG is employed to describe all kinds of space objects' position information, by means of group which is provided by SVG, the light WebGIS implements layers management. The other functions of WebGIS is implemented by SVG.

2.2 Technique of Metadata and Its Application in the Platform

Metadata[9] is structured data which describes the characteristics of a resource. It shares many similar characteristics to the cataloguing that takes place in libraries, museums and archives. The term "meta" derives from the Greek word denoting a nature of a higher order or more fundamental kind. A metadata record consists of a number of pre-defined elements representing specific attributes of a resource, and each element can have one or more values. Table 2-1 shows an example of a simple metadata record。

Table 2-1 An example of a simple metadata record	
Element name	**Value**
Title	Web catalogue
Creator	Dagnija McAuliffe
Publisher	University of Queensland Library
Identifier	http://www.library.uq.edu.au/iad/mainmenu.html
Format	Text/html
Relation	Library Web site

Each metadata schema will usually have the following characteristics:

- a limited number of elements
- the name of each element
- the meaning of each element

Typically, the semantics is descriptive of the contents, location, physical attributes, type (e.g. text or image, map or model) and form (e.g. print copy, electronic file). Key metadata elements supporting access to published documents include the originator of a work, its title, when and where it was published and the subject areas it covers. Where the information is issued in analog form, such as print material, additional metadata is provided to assist in the location of the information, e.g. call numbers used in libraries. The resource community may also define some logical grouping of the elements or leave it to the encoding scheme. For example, Dublin Core may provide the core to which extensions may be added. Some of the most popular metadata schemas include:

- Dublin Core[10]
- AACR2 (Anglo-American Cataloging Rules) [11]
- GILS (Government Information Locator Service)[12]
- EAD (Encoded Archives Description) [13]
- IMS (IMS Global Learning Consortium)[14]
- AGLS (Australian Government Locator Service)[15]

Since the platform employs metadata technique, the platform becomes more scalable and flexible. The partial meta-model of the platform is showed in the figure 1.

3 Logical Integration Framework

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There exist many general integration technologies, such as microsoft's COM/DCOM(Common Object Model/Distributed Common Object Model)[16], OMG's CORBA(Common Object Request Broker Architecture)[17,18]. These common technologies are applied to integrate applications in a simple mode. These integration models are not implemented integration in a fine-grain mode. Therefore, these integration models are not able to satisfy with oil field requirements. A kind of integration framework is proposed, it can implement applications integration with object and user. Figure 2 shows the framework.

From the figure 2, it shows that the integration framework including fives central parts, the first part is 'Specialities', the second part is 'users', the third part is 'view/applications', the fourth part is 'objects', and the last part is its engine part, namely, 'metadata driven model'.

For oil fields, it will involve in all kinds of specialities, such as oil reservoir engineering, oil production engineering, oil ground engineering and so on. These different specialties includes all kinds of applications, here, these applications are divided into two type applications, the one is self_defined_app , and the other is external_app. Among the 'self_defined_app', it includes two type applications, the

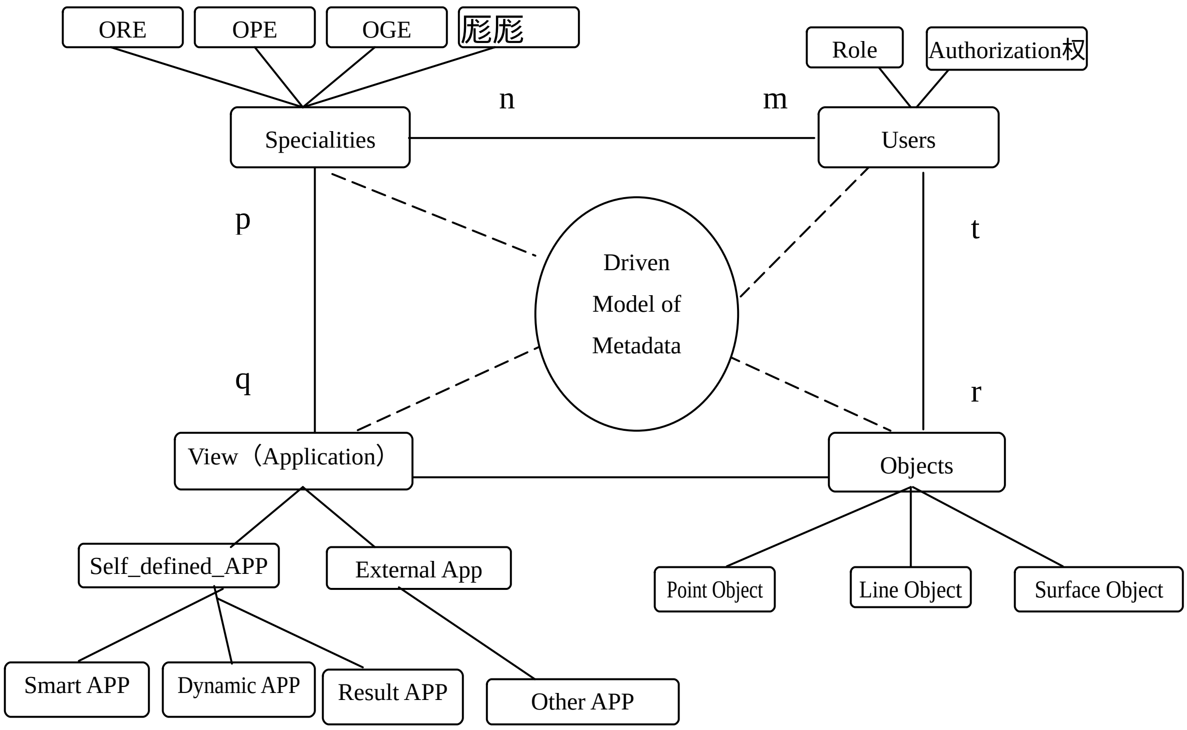

Figure 2 Logical Architecture of Integration Framework based on User-

Notes: ORE Oil Reservoir Engineering; OPE Oil Production Engineering; OGE: Oil Ground Engineering,

one is 'smart applications', the second is 'dynamic applications', and the last is 'result app'. Here, it is necessary to explain the 'self_defined_app ', this kinds of applications are defined by this platform.

For oil fields, there exist many kinds of GIS objects, such as oil well, oil field, pipeline, road, and so on, as a whole, these different GIS objects are divided into three kinds of objects, the first is point type, such as oil wells, injection wells and so on. The second is line type, such as gathering pipelines, roads, communication circuits, and so on. The last type is surface objects, such as oil fields, basins, seismic sites and so on. These different type objects associate different information, such as the object of oil well, which associates the information of oil well position, production information, and workover information and so on. The gathering pipeline associates fluid pressure and temperature, length, and start-end position information, and so on. Therefore, whenever those applications for gathering pipeline is involved, these applications must be related to gathering pipeline, namely, in GIS map, the users can get gathering pipeline information by navigation of the gathering pipeline object.

The users are interested in different type objects and different applications related to this objects, therefore, these applications interested for users can be authorized to the users. By means of this way, the users can get personalized applications.

The last part is the kernel part of the platform, 'metadata driven model', this meta-model defines all kinds of metadata, it includes object metadata, users metadata, application metadata, menu metadata, authorization metadata, graphic metadata and so on.

By means of this integration framework, all kinds of applications and all kinds of objects in the oil fields and all kinds of users can be integrated into this platform.

3 The Organization Model of Objects and Speciality

In the oil fields, during exploration and development, all kinds of business processes are involved in all kinds of objects, among these objects, some of them are related to space, such as oil well, oil pipeline, field, injection well and so on. In the oil fields, there exist many specialties, such as oil gathering system, injection system, gas gathering system and so on. The relationship between objects and specialties is showed in figure 3.,

From the figure 3, it shows oil gathering system, injection system, gas gathering

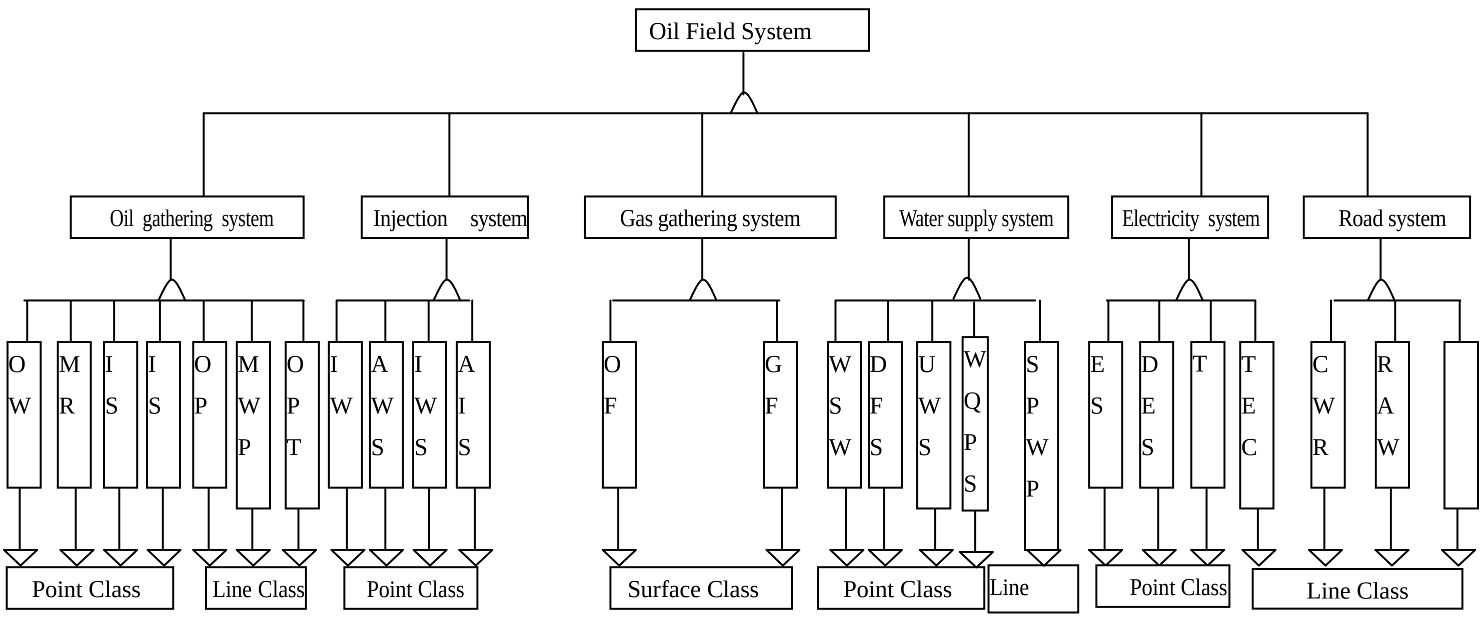

Figure 3 The Organization of Spciality, Business Object and Object of GIS

Notes: ORE Oil Reservoir Engineering; OPE Oil Production Engineering; OGE: Oil Ground Engineering, OW: Oil Well, MR: Measure Room, IS: Intermediate Station, HS: Heating Station, OP: Oil Pipeline, MWP: Mixed Water Pipeline, IW: Injection Well, OPT: Oil Pipeline Trunk, AWS: Allocation Water Station, IWS Injection Water Station, AIS: Allocation Injection Station, OF: Oil Field, GF: Gas Field, WSW: Water Source Well, DFS：Drain Flooded Station, UWS：Underground Water Resource, WQPS: Water quality Process Station, SPWP: Supply and system, water supply system, Electricity system, road system and communication system. On the GIS map, these different systems are showed and managed by different layers. These layers are divided by several groups, and these different groups includes three category layers, the firs is point layer, the second is line layer, and the last is surface layer. And every category includes all kinds of concrete objects. The

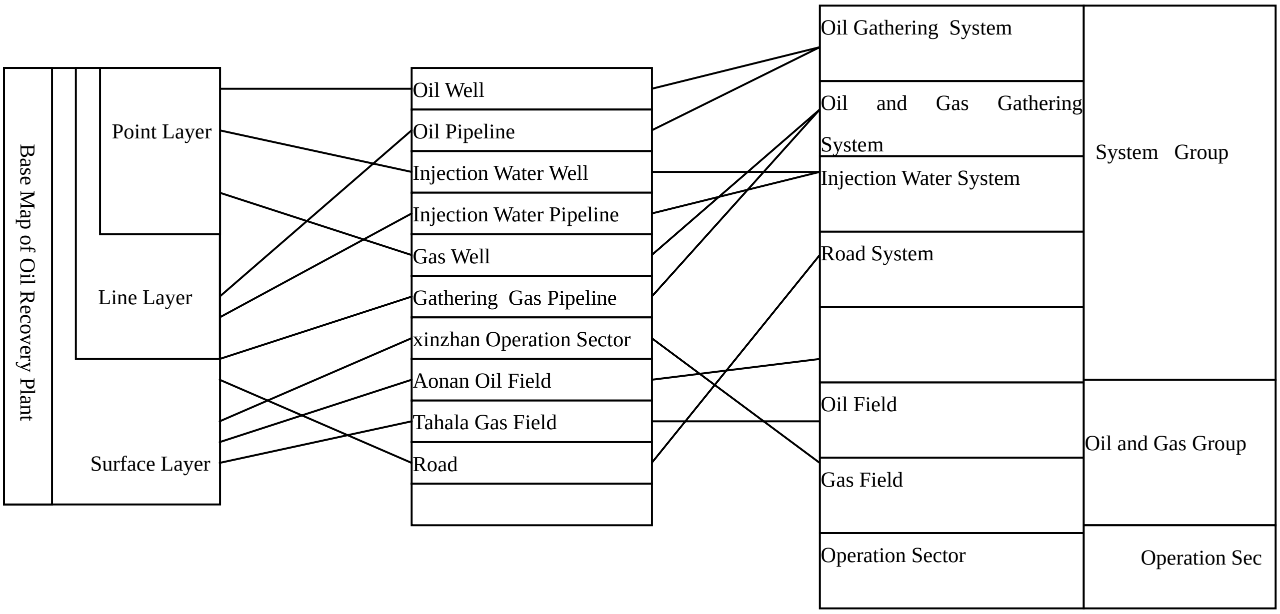

Figure 4 Relationship among the groups, layers and objects

relationship among the group, layers and objects is showed in figure4.

4 The Running Architecture of Platform

This light WebGIS platform is distributed architecture, and its architecture is showed in figure 5. From the bottom to top, it is composed of four layers, the first layer is data base servers layer, which is used to store objects' space information and all kinds of specialities' data. The second layer is applications' server layer, which includes service of dynamic SVG generating, service of application data query, service of data maintaining, service of graphics data and other services, this layer play an import role in the platform. The third layer is web browse, which includes HTML pages, XML files, SVG documents and JavaScript files and so on, this layer provide all kinds of documents with internet explorer. And the last layer is client layer, which includes brows and SVG plug. In the figure 4, the database server layer includes many all kinds of databases, these databases maybe drilling business database, or oil recovery database, or logging well database, or geologic database, or all kinds of metadata and so on. These data include not only speciality data, but also all kinds of metadata needed by platform. These metadata include metadata of user, metadata of application, metadata of authorization, metadata of role, metadata of space object and so on. These metadata play an important role in navigating all kinds of data, this is called metadata driven. By means of these metadata, the platform likes a car, these metadata likes a motor. The platform running is driven by this 'motor'.

In the second layer, it includes all kernel functions. Among them, the service of dynamic SVG creating and loading. This service is responsible for gathering object space data from space database, and generating SVG document, at last, it will transfer these SVG document to client sides. The service of application data is responsible for gathering all kinds of application data from all kinds of speciality database and submits the client side.

The service of data maintaining is responsible for maintaining all kinds of data, including all kinds of metadata. The service of graphics data is responsible for gathering all kinds of data for drawing common graphics and speciality graphics. The oil field needs many different kinds of graphics, such as histogram, pie graph, contour map and other graphics. This service is able to provide all kinds of data for these graphics, it is responsible for not only gathering data, but also analyzing these data. The rest layers' functions is obvious, here, these layers are not discussed in detail.

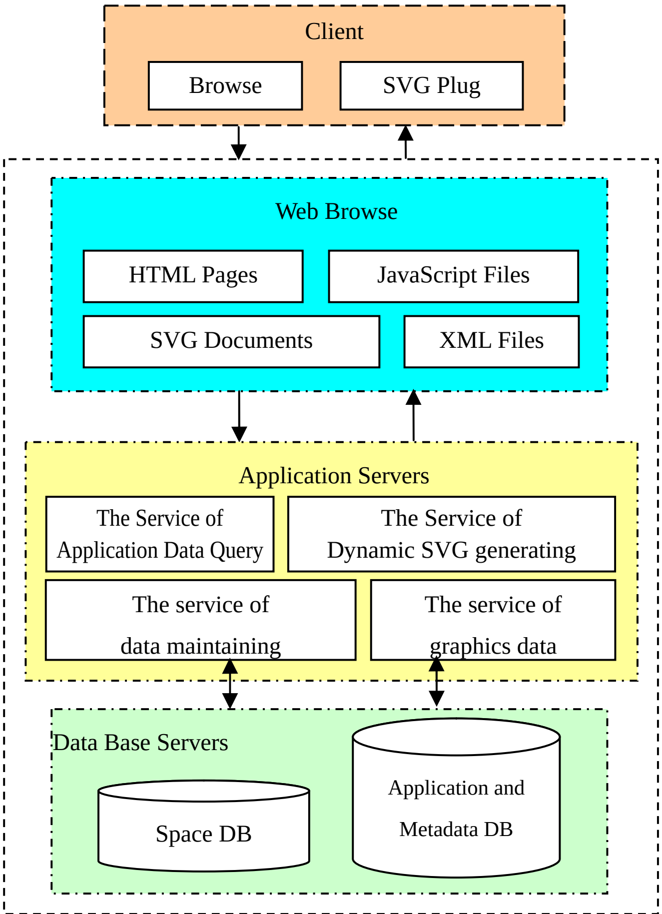

Figure 5 The Architecture of Platform

5 Finite State Machine Design for Event of Client Side

In the client, all kinds of complex events need to process, on the whole, by abstracting these complex events, it includes five classes, see the figure 6. Namely, the mouse events are divided into 5 classes, the first class event is 'OnClick', which is responsible for creating SVG document and implements layers management. The second class event is 'OnMousemove', which is responsible for displaying the coordinates of mouse location in GIS map. The third class event is 'OnMouseover', which is responsible for two part functions, the first function is getting the object information, and the second function is dynamic creating SVG element. The fourth class event is 'OnMouseout', which is responsible for dynamic deleting the element in the SVG document. The last class event is 'OnMousedown', which is responsible for two part functions, the first function is displaying the results, the second is querying object information. From the figure 6, all the events communicate with server sides by means of Ajax engine.

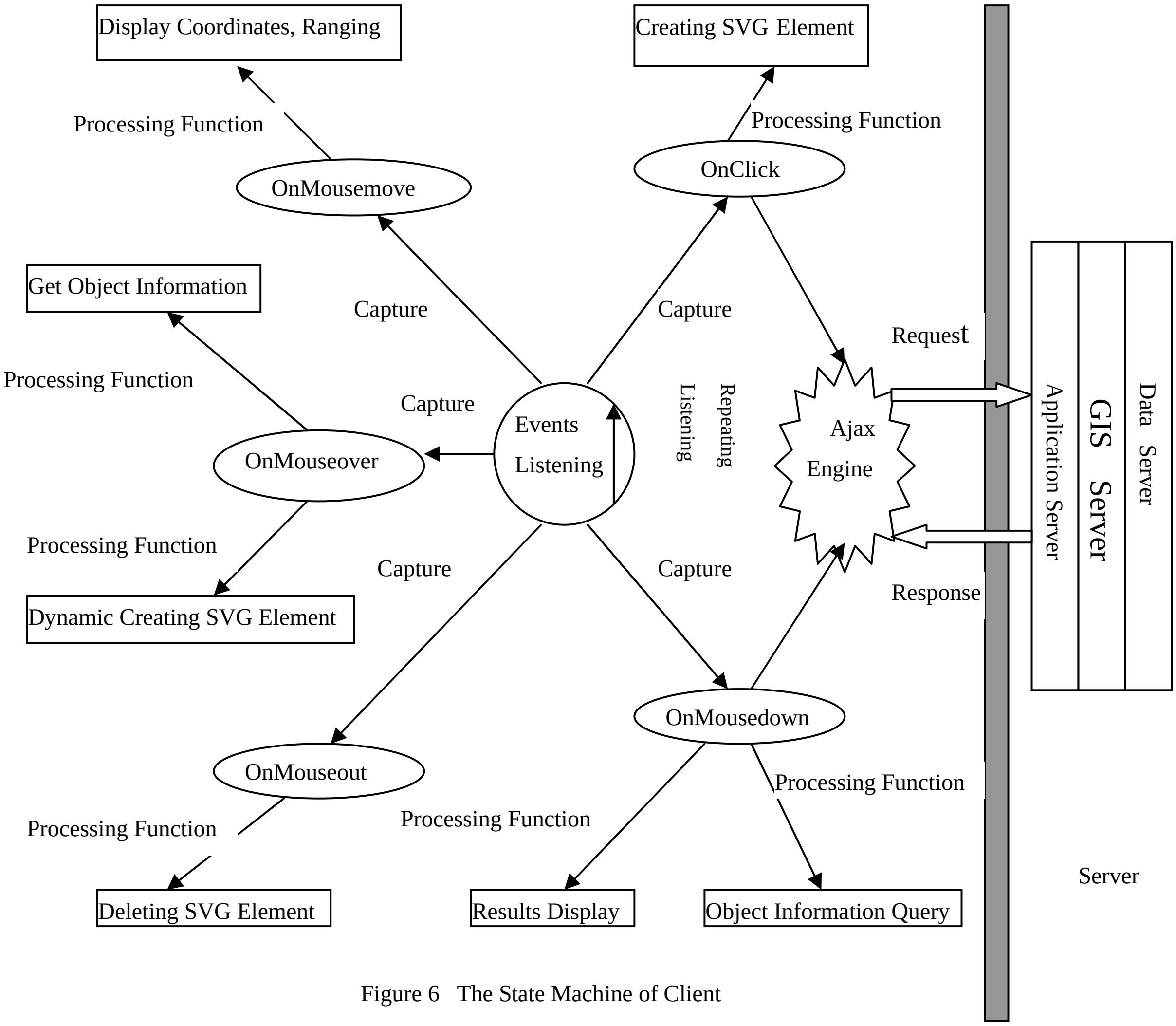

Figure 6 The State Machine of Client

By means of reasonable event management mechanism, the client architecture becomes clear and events management becomes very easy.

6 The Application Example of Platform

Whether the light WebGIS platform design or implementation, some advanced technique is employed, such as metadata technique, meta-model driven technique, SVG technique, XML technique, Ajax technique and so on. By means of these key technologies, the platform logical frame is proposed, which implements seamless integration among the GIS objects, the users and all kinds of applications. In the light WebGIS platform, all kinds of GIS objects are organized by point type, line type and surface type. Besides these organization, these GIS objects can be organized by oil field specialities, such as oil gathering system, gas gathering system and so on. Considering the platform scalability and flexibility, the entire platform is driven by metadata. Considering common data exchange, the platform employs XML. Meanwhile, in order to implement the platform maintain, all kinds of software tools are designed and developed such as integration tool, common graphics tool, early-warning tools and so on. By means of these tools, some simple functions can be customized, such as daily report, monthly report, and some histogram, piegraph and so on. In Daqing oil field, all kinds of specialities'data has been stored in data centre, such as oil well and water well production data, log data, seismic data and so on. Based on the data centre, by means of the light WebGIS platform, all kinds of applications and users are integrated, different speciality users can obtain interested information. The one example is showed in figure 7.

Next, some more advanced technique will be used, such as SOA technique, the light WebGIS platform will be become service-driven.

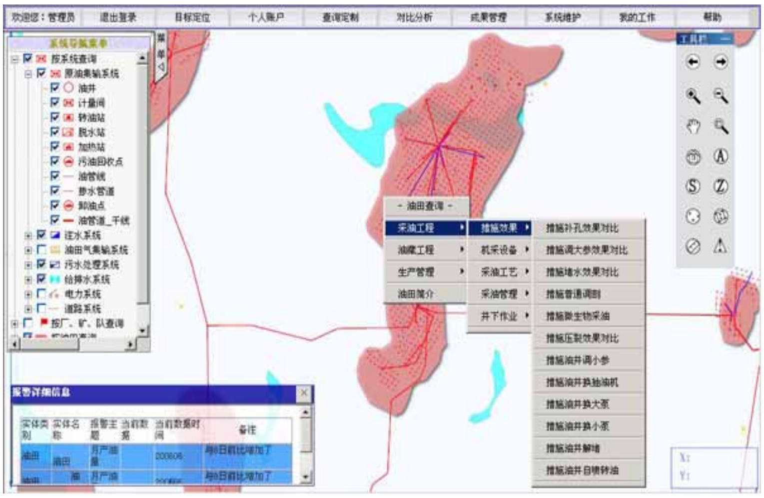

Figure 7 An example of the light WebGIS Application

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Biography

Man Yuan, Post PHD, I finished postdoctoral research report in 2007, in Beihang university .
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3) Internet service management and Network QoS
4) Mobile Computing
5) Geography Information System.

Projects: I direct and take part in all kinds of projects more than 20.

Current research project:

1) National advanced Science —A Large Scale Data Exchange Centre for Oil field exploration and development
2) Mobile Computing is supported by Nokia China R&D.
3) Heilongjiang Science Fund: Resource Monitoring in GRID

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