

# DYNAMIC PORTRAYAL AND DIRECT LOCATION METHOD FOR NEW GEOGRAPHIC INFORMATION PROCESSING WEB SERVICE

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## Abstract

Japanese governmental organization, Geographical Survey Institute, began to provide the simple web GIS called "Denshikokudo Web System" at 15th July, 2003. This system is implemented as plug-in running on Internet Explorer and Mozilla. In this system, all information includes background map and geographical foundation information are provided with vector data model as a general rule.

In many cases, map providing services on Internet allocate main tasks to server side. The tasks are processed by CGI program or server side script in a general way. The server may have seamless map database or separated map files. They may be recorded as raster map files, and may be vector map data collections. However, the users of these map service can get map information with rasterized information, because it has advantage to correspond most kind of Internet browsers. This must be important advantage, but as a result, content of those map service becomes off-the-shelf function, and more popular map service provider must prepare high performance server system. It may take some capital investment. In addition, there are some disadvantages that output information can be used only image data. No additional geographical information is included on this output image, so that map information is used only background information.

As a solution of this disadvantage, a few map service providers began to use vector information using Java applet running on the client computers. In this architecture, very powerful and huge variety functions are provided with Java applet. This has the appearance of effective solution, but it has not be general provide model yet. Most of these provide model have poor cartographic function from vector information, and data amount of geographical foundation information become huge size and take long time to load map information, so it is not useful to use on broadband Internet.

Here "Denshikokudo Web System" plug-in is implemented with Active-X ( for Internet Explorer) or XP-COM ( for Mozilla ), most tasks are handled by client computers. This plug-in has some innovative technologies: (1) Fulfilling dynamic portrayal function completely processed by client side, (2) Very fast map loading technology using direct location calculate method, (3) Many contents that distributed from multi server location overlay system using ISO/TC211 international standard specifications.

It is realized that geographical information use and fulfill cartographic map image use are integrated. This means that geographic information and portrayal map information providing service comes under a new category by using these technologies. Contents and methods to implement and prospective development using these technologies are introduced and discussed in this paper.

This plug-in is able to download from <http://cyberjapan.jp/> at no charge. But note that it uses only in Japanese.

## Introduction

Geographical Survey Institute is the governmental organization to exercise jurisdiction over map revising all over Japan. Some scales of maps have been revised since over 100 years ago. The largest scale map covering all Japanese land published by Geographical Survey Institute is 1/25,000 scale topographical map series. This series have about 4,300 map sheets about 380,000km<sup>2</sup> wide. They are published as paper maps for a long time. But along with the popularization of GIS software, requests for a publication of digital map information have been increasing in recent years. Geographical Survey Institute met the needs of their request, published 1/2,500 scale vector dataset of digital map information as spatial foundation data for GIS in 1996, and each scale of map images, include 1/25,000 scale data, also published at same time. On the other hand, in Japan, a market size of World Wide Web (WWW) was begun to strongly increase at just about same time. Main portal web sites, for example Yahoo! Japan, Lycos Japan, Goo, Excite Japan, Infoseek, etc., though some sites were dumped into the dustbin now, began to start map information services each. No matter what their map database was designed, output of all cases of their map information services were raster map image, because raster map image can be browsed without any additional software like plug-in or Java applet. Basically request for most users were satisfied by these simple map information service. Geographical Survey Institute also opened simple map information service in 1999. Figure 1 shows

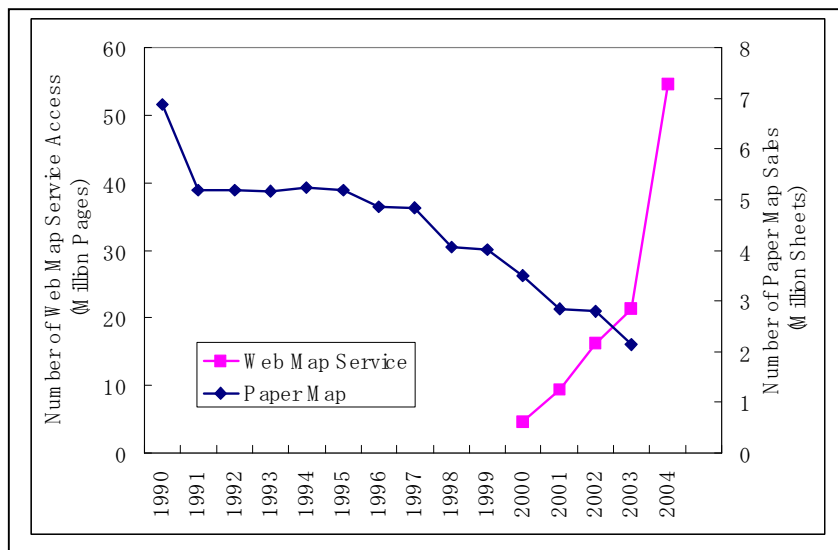


Figure 1 Transition of numbers of paper and web map use of GSI

transits of number of sheets of 1/25,000 topographical map sales result and access amount of map information service of Geographical Survey Institute web site. They brought decrement of paper map market size. Although, some of the main paper map companies became bankrupt or their business productivity were degraded, an amount of use of these map information services by WWW was increased smoothly.

In recent years, new kind of map information service by WWW began to be provided. This service have high performance functions, for example, smooth scrolling, smooth zooming, and some services have analysis functions like standalone GIS software, as you known, these are classified to Web-GIS site.

Some Web-GIS sites handle usual raster image as a method to output to browsers, and in other cases, directly handle vector dataset with additional software of browser. However, thus Web-GIS service has generally poor cartographic drawing capability as common problems, because traffic of network has to be kept size as small as possible. For example, the road feature is displayed as simple line information on the Web-GIS without various attributes of the road. We think that this is a result of an approach from GIS as method for a purpose of geographical analysis, so it is enough to provide

function as GIS with the poor cartographic capability. However, we think that the poor cartographic drawing confines Web-GIS application to special or limited fields. There are many users of map services and they need simple GIS functions like search of popular store information and path search. If Web-GIS has powerful cartographic capability as well as a paper map, Web-GIS will be useful and popular existence on the people's life. We have accountability to diffuse Web-GIS as a governmental policy. This paper focuses this common problem. We solved both problems by the method to realize dynamic portrayal generation with script of client side. And we have distributed the achievement named "Denshikokudo Web System" since July 2003 on web page <http://cyberjapan.jp/>. Three main components are implemented to solve these problems, a modeling system, direct location and adoption of dynamic portrayal function with client side scripts.

### An analysis of system design

At first, we analyzed a system design of implementation. Limited factors of implementation are follows:

- (1) An avoidance of server load.

If the implementation needs high power server that can go through huge load, cost of system construction will be strongly increased and it brings us barrier of diffusion. The system design must be considered an avoidance of server load, as possible as we can.

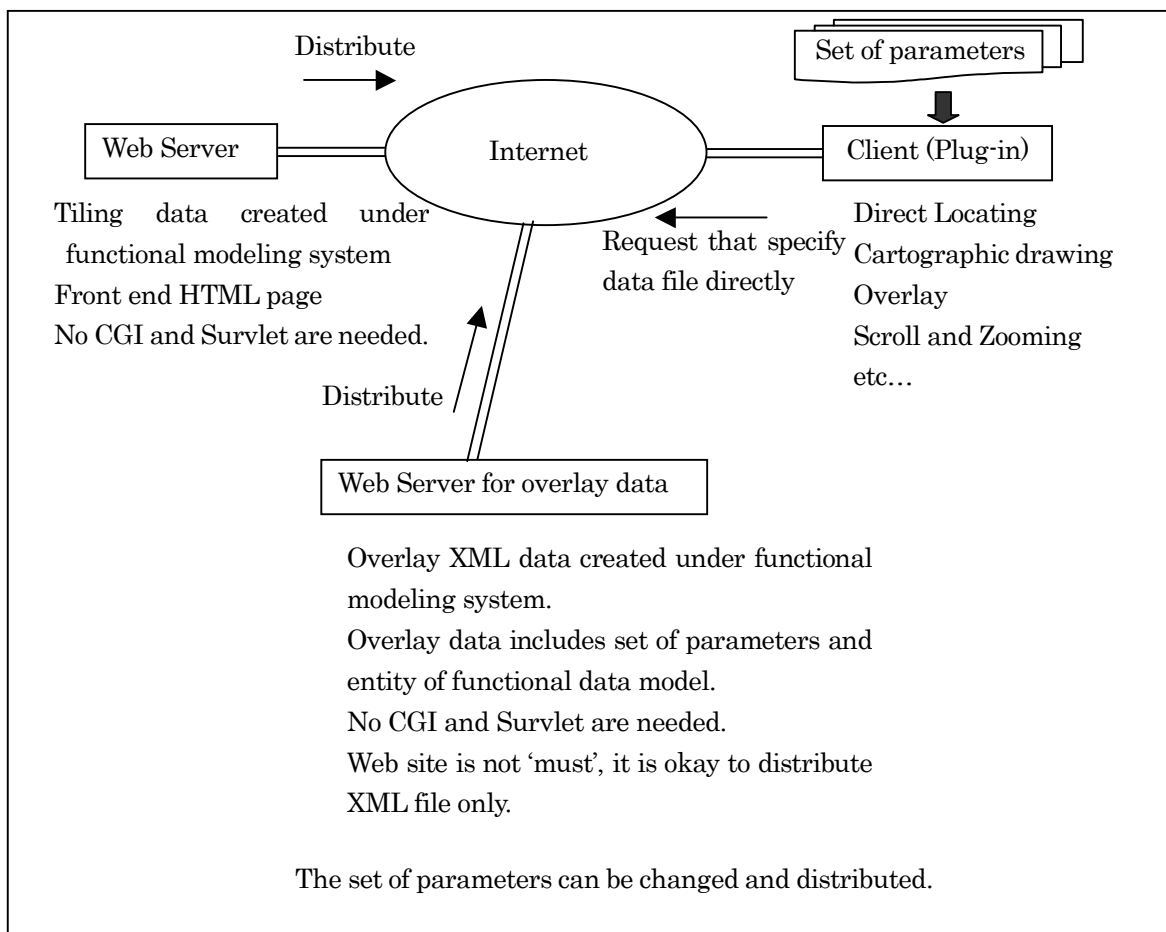


Figure 2 System Design (the simplest construction)

(2) A reduction of map management cost.

The cost of map management should not be ignored. The map management consists of many handling of creation, revision, update of data files and so on. If the provider wants to host various kinds of services, various map dataset must be prepared to support each service. This brings increment of management cost and also will be barrier of diffusion. The system design must be considered from a point of view of a reducing map management cost.

(3) A flexibility of web service design.

Web-GIS will be used for various purposes and application, and an entity of Web-GIS is written by HTML object, so flexibility of HTML page design must be kept in good order.

Under above factors, we decided system design shown as figure 2. A main part of processing is located at client side as plug-in software of browsers, and minimal part of system is located at server side. The map-providing server is only web server. It is not necessary that the server have basic capability of positioning, cartographic drawing and overlaying. Client side handles their capabilities. Especially, locating function is solved by dynamic locating of client side with rules of nomenclature of map filename and tiling.

These components are packed to dynamic link libraries of Denshikokudo Web System and behave just as HTML object. The designer of webpage can call the libraries object under Document Object Model of browser by <object> element, and the designer can use commands of over 100 functions implemented as a set of Application Programmers Interface (API) function of Denshikokudo Web System that are written by JavaScript function. The APIs consist of some packages of functions, basic map control package, and graph object package, map editor package, and so on. The web service designer can select and combine these API packages according to need. By this, the flexibility of web page design is kept and an expandability of system capability and design is considered.

## **Main components**

### Modeling system under a functional dimension of features

First component is a dataset created with a modeling system that defined under the functional dimension of the feature on the real world. The functional dimension is usually similar to a geometrical dimension of the feature.

A great many discussions and opinions about a modeling method of features existed far in advance. They focus attention on an each feature, and they look like to want to make feature model as many as they possible. This probably corresponds to a feature catalogue under discussion of ISO/TC211.

However, for the WWW map service, the feature catalogue is not suitable because of its huge size and difficulty to correspond new features that are not defined on catalogue. For the WWW service, minimize of amount of data transfer is one of the most important factors. In addition, it has to be update feature catalogue every time when new types of features are appeared.

We focus a function of features. For example, a road is generally used for a transfer of objects on itself. The object may be human beings, a bicycle, a bike or a car. People use roads as a method of moving, and understand the road is a linear feature. Therefore, the road exists as one-dimensional object in the real world for almost all people. On the other hand, the road may exist as two-dimensional objects for a road administrator, because an area of the road, for example, pavement area and center divider area is important for them. They probably think the road is an area feature. This means that a road have two functional dimensions, one dimension and two dimensions.

Here, zero functional dimensions can be replaced as a point type feature that has zero geometrical dimensions, and in a similar way, one functional dimension can be replaced as a curve, two functional dimensions also surface.

A small minority of data model can define almost all features in the world under functional modeling system. In fact, only five data models are defined in our Denshikokudo profile. This data are used to generate cartographic vector by client computer of users when they try to display this data as a map. But all data functional model are mapped to geometrical package of special schema of ISO/TC211 and they are encoded to XML files under encoding rule of ISO/TC211, so all

data can be overlaid by client side

Direct location by client side

Location functions to decide processing area from user requests are generally carried out on the server side. In this traditional model, the map data may be stored in database or prepared each tiling file. The software on the server creates a new HTML page that includes the requested map data, and returns the HTML page to client computers. There must be existed server side software in all cases in addition to web server. This general server-client model (Figure 3) needs a server very huge power and access processing capability.

Solving this problem, we implement a method of location function to client side completely under simple idea. The method is combination of rules of nomenclature of map filename and tiling. The tiling means all map files are separated to regular square area, and the tiling is classical method as the way to make dataset. The rule of nomenclature of map file

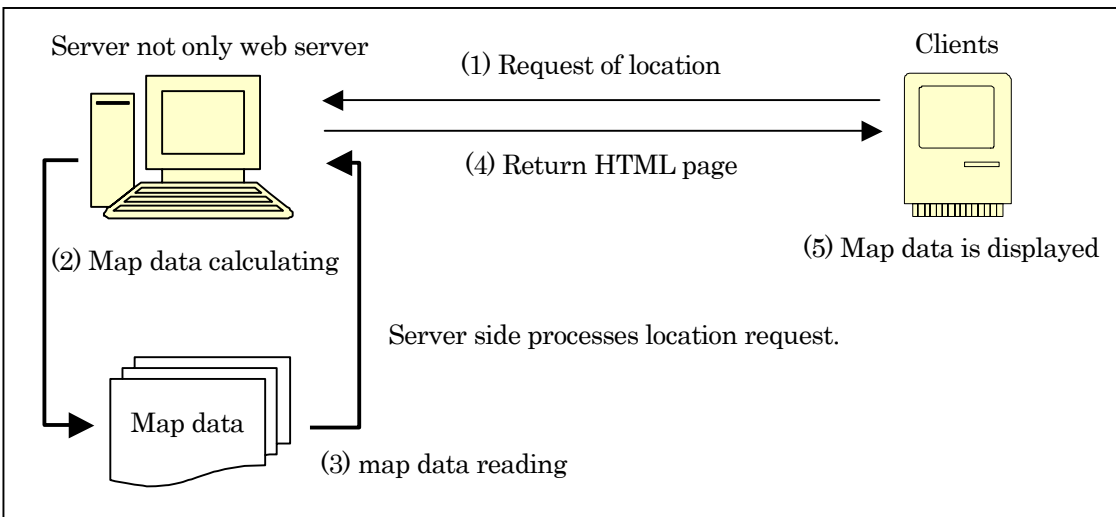


Figure 3 Traditional web map service model

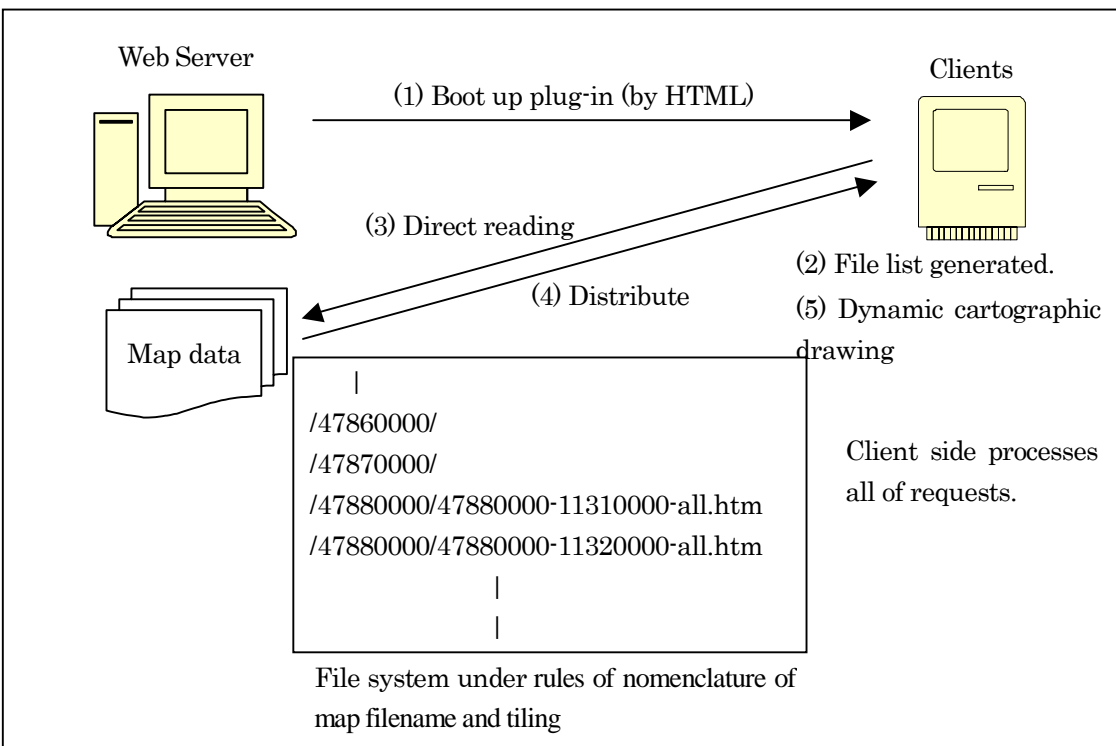


Figure 4 Direct location methods by client side

name of our system is shown as follows:

- (1) Each file name consists of three parts, longitude value, and latitude value, character that shows data kind. The longitude and latitude values are taken from values of southwest angle of a tile.
- (2) The longitude and latitude values are represented by 8 digits integer and unit of value is 1/100 second, for example, longitude 133 degrees east is represented to 47880000.
- (3) The kind code is represented by character, generally 3 or 4 characters.
- (4) Three parts of file name are connected by '-' character and the extension of each file name is ".htm".
- (5) All files under this rule of nomenclature are located under named latitude value folders.

Therefore, the location of map tiling files is shown as inside of figure 4 on the server.

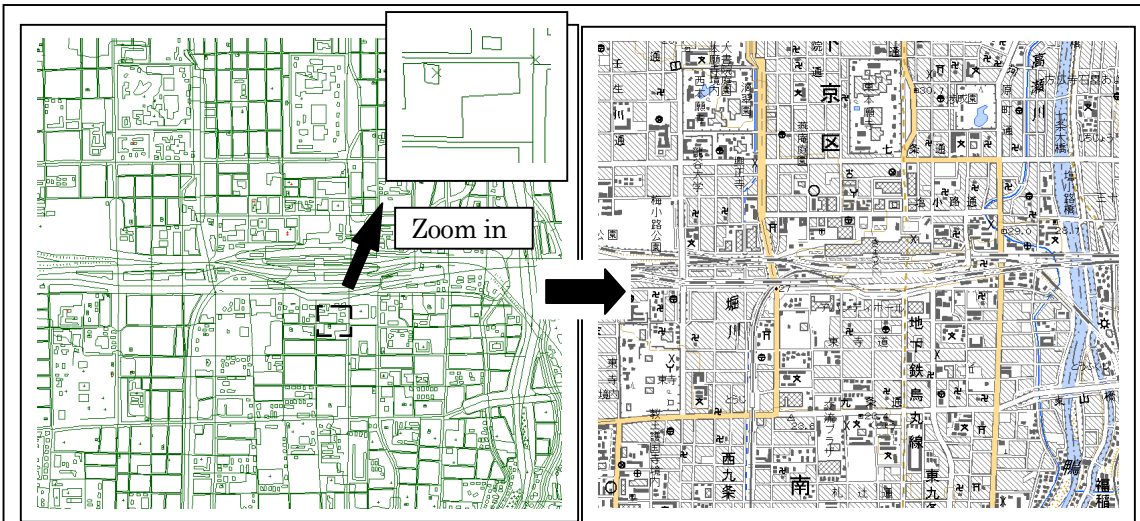
By this, no software to process location on the server becomes to be necessary, because it is able to make a list of file names with this rules of nomenclature on the client side (Figure 4). The file system under this rule of nomenclature makes an advantage for decrease of construction cost of server side.

#### Dynamic portrayal function with client side scripts

Dynamic portrayal function is the way to utilize appropriate for essence of vector geographic information. The script of client side always calculates all of length about such as line width, circle round length, and symbol size, to fit real length in the real world to pixel size on screen. If the parameter value of line width gives 25 and unit is "meter", drawn width of the line on the screen is calculated to depend on current displayed scale. All of cartographic drawings are fitted to displayed scale dynamically, so a result of cartographic drawing is created as close as raster image.

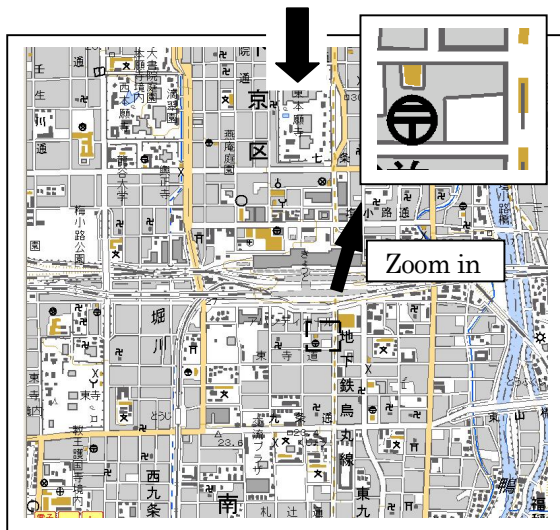
Portrayal Type	parameter name	meaning
common	name	name of style name
	type	string of basic portrayal type
	display	flag of whether displayed when data is read
	transparent	flag of transparency
	selection	flag of allow selection or not
	level	display level of map scale range
	size	size of a symbol file by pixel or meter unit in the real world
symbol	uri	URI of a symbol file
	size	size of a symbol file by pixel or meter unit in the real world
text	color	drawing color consists of RGB value
	mode	drawing position of text
	font	used font name, and included size and style as nested parameters
string	rgb	drawing color consists of RGB value
	style	specified drawing pattern of the line
	width	width of a line by pixel or meter unit in the real world
symbolline	paint	flag of application of symbol pattern to a line
	rgb	drawing color consists of RGB value
	appstyle	definition of symbol pattern applied to a line
	type	type of a line
	width	width of a line by pixel or meter unit in the real world
	pattern color	drawing color of symbol pattern
	join	drawing method of an apex
	start	flag whether pattern drawing is started by continuous or empty
	span	span of continuous line of symbol pattern
	limit	minimum distance what is drawn by symbol line

Table 1 List of parameters of basic portrayal type (except circle, road and polygon)

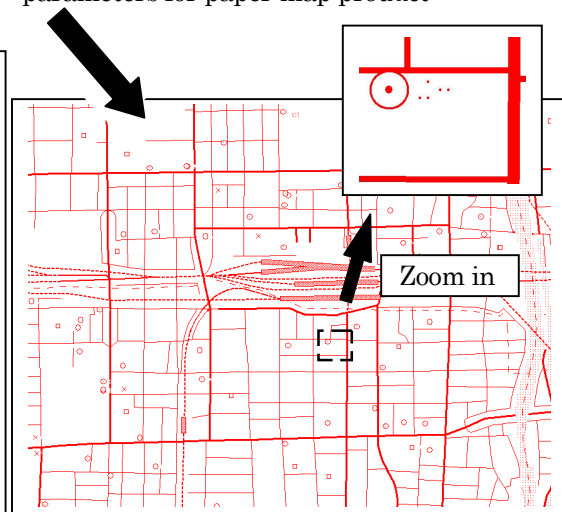


Essential vector data distributed from server that created under functional data model.

Result of dynamic drawing used a set of parameters for paper map product



Result of dynamic drawing used a set of parameters for web map service.



Result of dynamic drawing used a set of parameters for map for visually impaired humans.

Various cartographic drawings are generated only and same original essential vector data, so if essential data is revised once, all map products are updated at same time dynamically.

Figure 5 Examples of dynamic portrayal (Area of around Kyoto station in Japan).

There are eight basic portrayal types that have been defined as cartographic symbol similar to written symbol on the paper map, 'symbol', 'text', 'circle', 'string', 'road', 'symboline', 'polygon', and 'symbolpolygon'. 'Symbol', 'text', and 'circle' types are classified to zero dimension functional data model, 'string', 'road', and 'symboline' are one dimension, and the others are two dimensions one.

Each basic portrayal type has some common parameters and some specific parameters each, for example, symbol basic type has following parameters: portrayal name, display status when it is read, transparency status, authorization of selection status, and displayed level value as common parameters, and URI of symbol data and symbol size as each parameters. Table 1 shows parameter list of each portrayal types.

The client computer can have the set of parameters of basic portrayal type as text file, and the set of parameters can be changed another set of parameters, so the set of parameters separated from data and software can be distributed. Dynamic portrayal can realize truth of separation between feature data and cartographic drawing of it. We think that this might give birth to new business model.

A minimal unit of portrayal is classified by layer name, so all data included in same layer are made cartographic drawing with same portrayal function. The final cartographic drawing data is completely generated by the portrayal function of clients.

Denshikokudo Web System carries out the dynamic portrayal function on following steps:

- (1) Displayed map location by longitude and latitude value or URL of data file with API function.

If the URL of data file is specified, the plug-in read specified data file and calculates location range value with combination of east and west longitude value, and north and south latitude value of the data file.

- (2) A list of URLs of map tile file is generated by plug-in.

A list of filename of tile map that calculated from specified location under the rule of nomenclature shown inside of figure 4 is generated.

- (3) Map tile file are read and given to dynamic portrayal function.

The functional dimension data created under above modeling system are included on each map tiling files. The dynamic portrayal function check off the attribute of basic portrayal type of all functional data and definition of cartographic drawing written on parameter files and applies cartographic drawing to all functional data.

- (4) Cartographic drawing as well as same one of paper map is displayed as background information of Web-GIS

Figure 5 shows results of dynamic portrayal. All results are generated from same data.

## **Conclusion**

We think this method that all of cartographic drawing is carried out completely on client side by dynamic portrayal may bring us a drastic change for form of map distribution in future.

This dynamic portrayal can realize separation between cartographic drawing and essence of data itself for GIS. For a service provider, one dataset of essence of data created under functional modeling system is only needed, and no cartographic drawing data is needed to prepare to host map or Web-GIS service. For users of map service and Web-GIS, they can choose a set of parameters and can use a map generated by chosen portrayal function.

This means that each map users may see deference cartography map generated from same data, and a right of choice of cartography begins to move from map provider to users. This may be new category of map services, because map provider does not need to consider cartography and prepare essential vector data only; all of cartography and processing are carried out by users.

And we think a system that adopted dynamic portrayal and direct location method can be constructed without special server preparation and with very low cost, therefore distribution of geographical information on Internet will be made easier, and it will become a strong support to diffuse GIS.

## Reference

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