THE DEVELOPMENT AND APPLICATION OF A NEW TYPE WEB GIS ENGINE BASED ON FEATURE CONCEPT IN JAPAN

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ABSTRACT

As the Internet becomes more and more accepted in society as a means to disseminate and gather information, also the communication of geographic information over the Web using Web GIS will find its position is the evolving medium. Most major leading GIS companies hooked onto this trend and developed their own Web GIS software packages to put Web GIS applications on the Web, still providing access to the geospatial data behind it.

The large quantities of GIS had been developed for the many fields at those past years, the long time and much money have been used for developing the systems and the special database. In order to cast deduction of GIS development, the sharing of the legacy spatial data is become very important. The authors propose some methods to solve those problems of sharing the spatial information. And as verification, a new type Web GIS engine, called “FeatureBase”, which incorporates a powerful "Feature" concept in its core architecture is introduced in this paper.

KEYWORDS: GIS, Web GIS, Feature, Spatial Information Sharing, XML

1. INTRODUCTIONS

The Internet has changed our world. At present, Internet has already not merely been a kind of simple technological means, but also it had already developed and become a kind of the cyber economy. With GIS and combination of different new technologies, the promulgation of Web GIS become GIS a hot issue of field in recent years already. The traditional GIS are only used by the special occupation, and now many users wanted and were able to use the spatial data of GIS. There are many applications and researches of Web GIS for effective sharing of spatial data. However, there are two major problems in the Web GIS construct at present too, such as following shown:

1) The architecture of Web GIS.

(Such as low speed, difficult in operating, limitation of accessing clients, and so on.)

2) The sharing of spatial information (Applications and Data).

Within the large quantities of GIS had been developed for the many spatial fields at those past years, the recourse of applications and data became enormous, and it became very difficult in effective using and sharing among the different legacy system.

In this paper, the authors introduce a new type Web GIS engine “FeatureBase”, which could solve the problems of Web GIS architectures successfully in describing as following Chapter 2. Chapter 3 will discuss how solve the problems in sharing of the spatial data and applications.

2. THE ARCHITECTURE OF WEB GIS

The GIS vendors thought of converging Internet and GIS resulting in Web GIS. But the Web GIS engine had to be redesigned according to Internet specifications. This did not pose any difficulties in way of acceptance of Web GIS or Internet GIS as the already available software had to be only modified and extended to meet the Internet specifications. With time Internet GIS specific software were also designed. Today the client is offered a wide range of software and the client can choose from this range any software according to the need. The effective solutions could be supplied in the general Web GIS for the spatial data sharing and interoperability. However, there are some problems in the Web GIS construct of several respects at present too, such as following shown:

1) The limitation of Web GIS server transaction capacity for multiple clients.

2) The problem of response time in displaying and searching on the Map.

3) The difficult of data updating by Web clients real-time.

4) The impossibility of accessing to multi-Server (GIS data server) at the same time.

Here, as an example, the new Web GIS engine (called it “FeatureBase”, 2000, Japan) is described how to solve those problems in Web GIS.

2.1 Operating of spatial data and “Feature” concept

When the data of any GIS including ubiquitous GIS is storing into one Relational Database (RDB), the following requirements are needed.

1) Sharing of data (The legacy data can be using in the integration GIS.)

2) Safeties of data (geometries and attributes data can be update at the same time.)

3) *Easy operating*

Also using the RDB server, the Web GIS architecture enables effective system developments that enhance legacy investments. A geographical object "Feature" can be designed and retrieved from the feature storage by employing customized formats for specific applications, which encapsulates both geometries and attributes.

The spatial data in the legacy GIS can be classified two types - the internal Feature and extend Feature. The internal Feature is special and private depending on the job applications, which are stored in the local, and the extend Feature can be exchanged in among this GIS and the other GIS within the Net or Web. For sharing and using the spatial data of the legacy system, the real feature may be appeared as multi-implementations shown as figure 1 and figure 2.

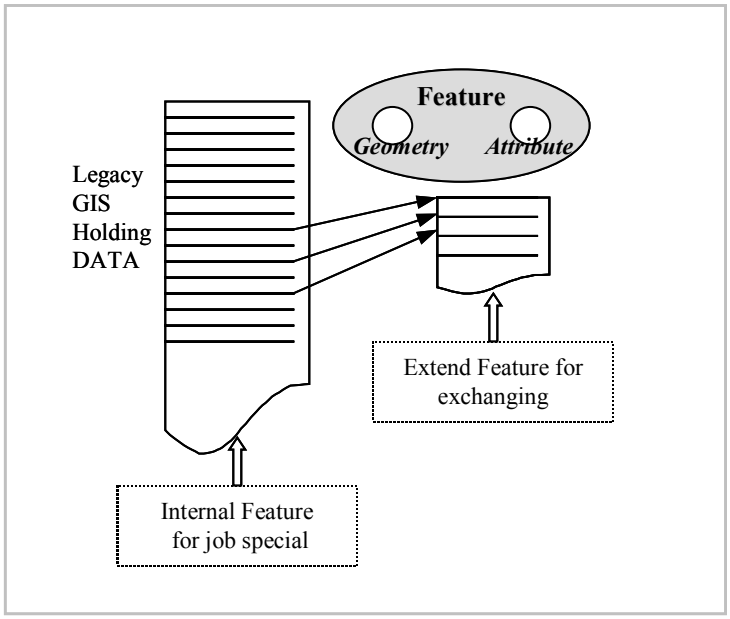


Figure 1. The feature of legacy GIS Data.

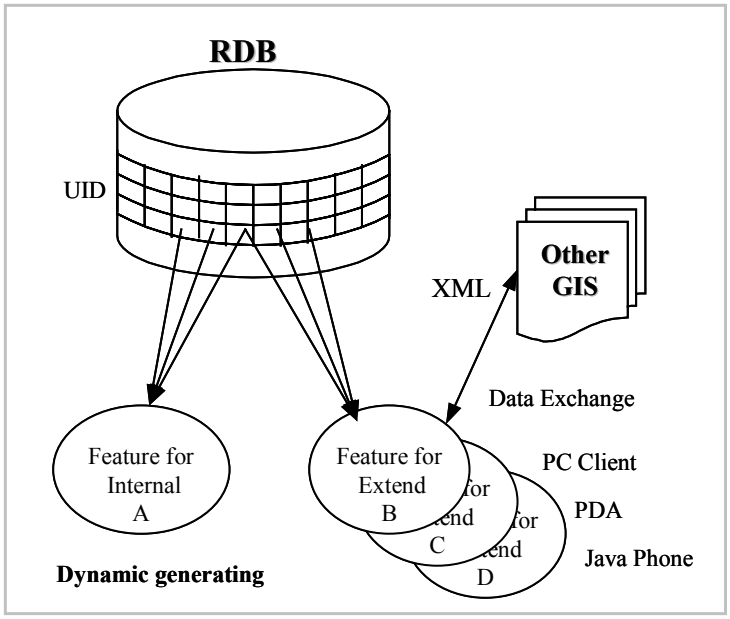


Figure 2. Construction of feature in RDB.

The spatial data can be shared and exchanged in the different GIS using this method. The extend feature can be acquired, edited, updated and exchanged in the system, on the other hand, the special data of Job projects defined as internal feature is established in RDB which are unable to get out and access. The safety of data can be guaranteed. And the small quantities of data are transferring in the system, the data updating and GIS analyzing online can be carried out at high speed. The effective using and sharing of spatial information, which is make possible in “FeatureBase” as described above. And “FeatureBase” not only could be used in personal computer and GIS Server, but also could

be collaborated with mobile terminals dynamically, such as mobile, PAD and Java phone.

2.2 Distributed processing model

The following figure 3 illustrates the mainstream model of conventional Web GIS for geographical data reference. Generally, this model can be used the server/client structure on LAN environment and adopts HTTP protocol for communication system. However, the GIS manipulate vast amount of data and each PC client requires different area of data, As a result, GIS server are overload for retrieving and converting large geographical data.

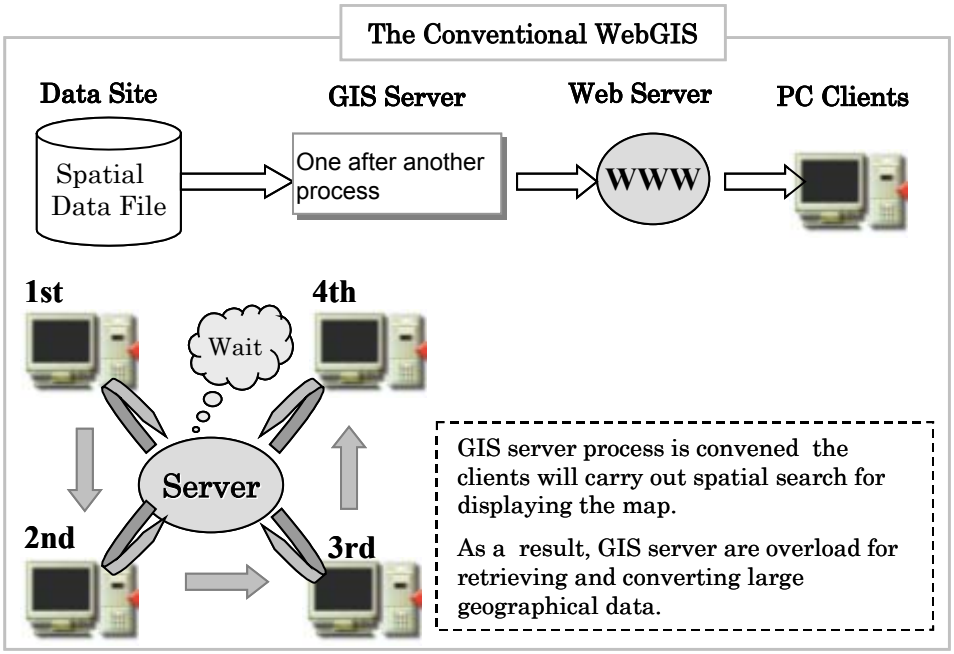


Figure 3. Conventional WebGIS for geographical data reference.

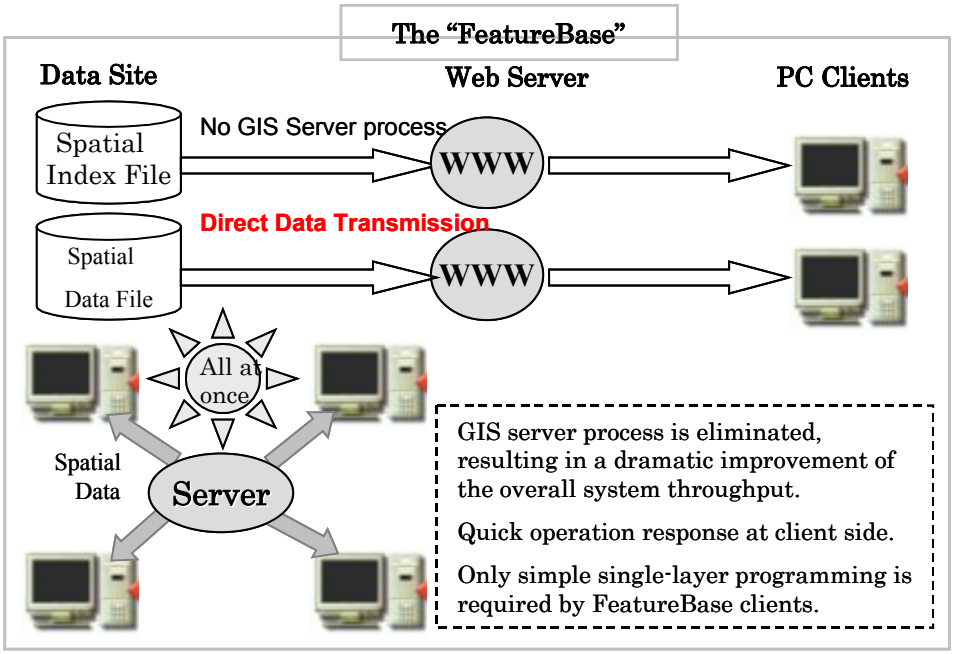


Figure 4. The distributed processing model for spatial data reference

In the distributed architecture shown as following figure 4, which is required map data are retrieved by clients independently and with no centralized processing. As a result, server overhead is reduced and concurrent data distribution service can be made to large numbers of clients.

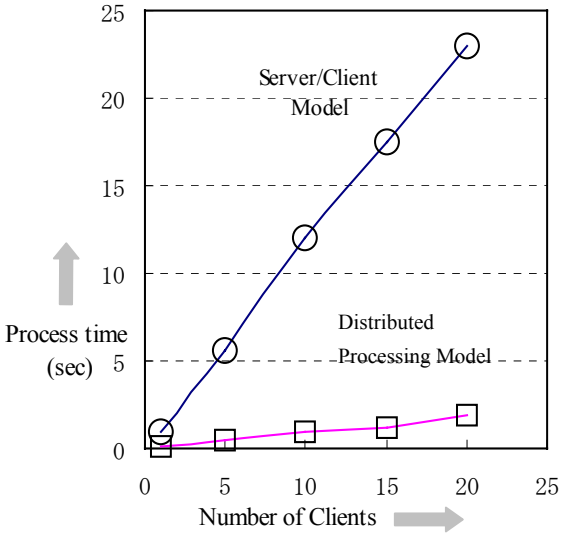


Figure 5. Comparison the results of the data distribution performance.

The figure 5 shows the verification test results between server/client model and distributed processing model. Naturally, the more clients' request data, the gap between the two models widens.

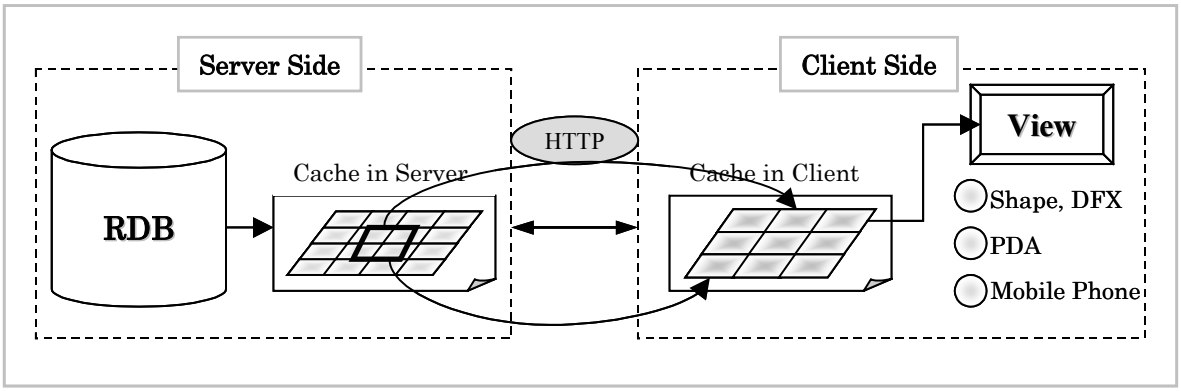
2.3 Two stage cache system

FeatureBase adopts a two-stage cache to achieve high performance spatial data distribution over a LAN or the Web. The two stages cache on the server and client cooperate to produce performance optimized for application, device, and bandwidth. The method are able to use in solving the slow speed of map operating and displaying.

There are two stages cache in the system, one cache is created for server for multi geometry data types and targets like as Shape, DFX, and for the PC, PDA, and mobile phone. The other cache is created in client side for displaying the map and operating the geographical data by users, which it is shown in local and commutating with Web server and GIS server.

The cache in server side can be utilized to generate distribution data optimized for specific platforms and applications. For example, to accommodate the difference in display capacity between PC and PDA, the same Feature data is distributed with cache in larger tile sizes for PC clients and smaller tile sizes for PDA clients. FeatureBase also filters Feature Type for each application. For example, cache for PC's may include sidewalk and detailed foot print data, while cache for PDA's may only include road centerline and landmark point information. Because users need different information density for each to

map scale and zoom, the system provides variable cache with appropriate information density for specific user requests. When a Web client requests map data display, if the client already has target area cache in its memory, the cache data is displayed. If not, the client accesses display cache service to retrieve target cache if it exists on the server. If no target cache exists on the server, Cache Service accesses Feature Storage and generates new cache. Server side cache is shared among all user clients, so the more users access and request map data display, the more cache will be generated to cover wider areas. This provides significant map display performance improvement for all users over the most frequently used areas.



2.4 Flexible system configuration

FeatureBase clients can retrieve spatial data from multiple Feature Storage servers concurrently and overlay these features in their local environment. For example, over the Web, a user can retrieve land use maps from the urban planning department, hazard maps from the disaster prevention department, aerial photos from the mapping department and overlay them locally to satisfy specific project requirements.

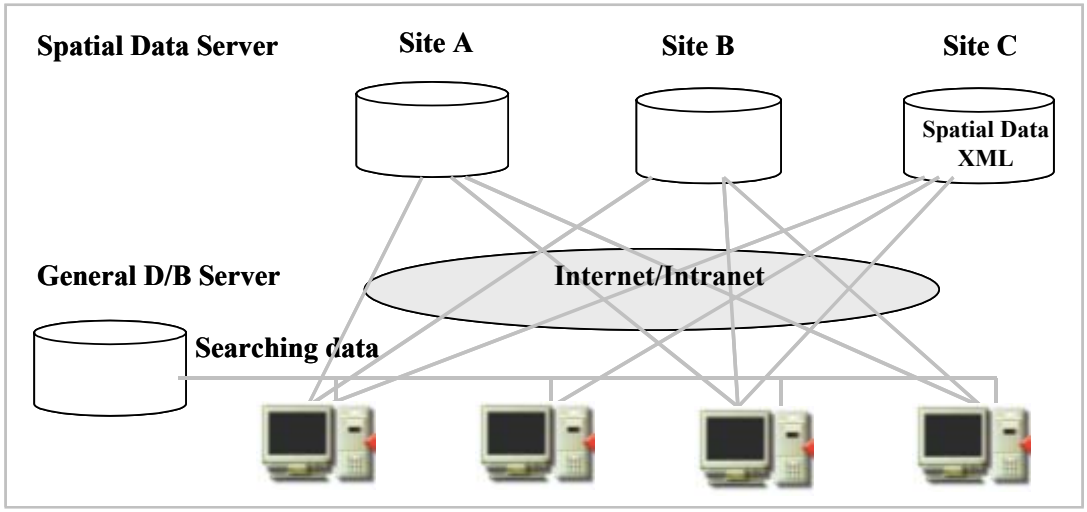


Figure 7. The configuration of flexible system.

3. THE SOLVING METHOD ABOUT SHARING OF SPATAIL DATA

3.1 The problem in sharing of legacy spatial data

Over the past year, the large quantities of GIS (Geometrics Data and applications) had been developed for the many fields, such as critical operations, resource management, traffic, educational, water resources, military affairs, etc. extensively. On the progressing and diffusing of the GIS, the spatial information data have been produced. Generally, these spatial data have some characteristic and potential including the massiveness data, the innumerable variety of data categories and the complementary each of each spatial data. The long time and much money have been used for developing the systems and the special database. In order to cast deduction of GIS development, the sharing of legacy data become very important.

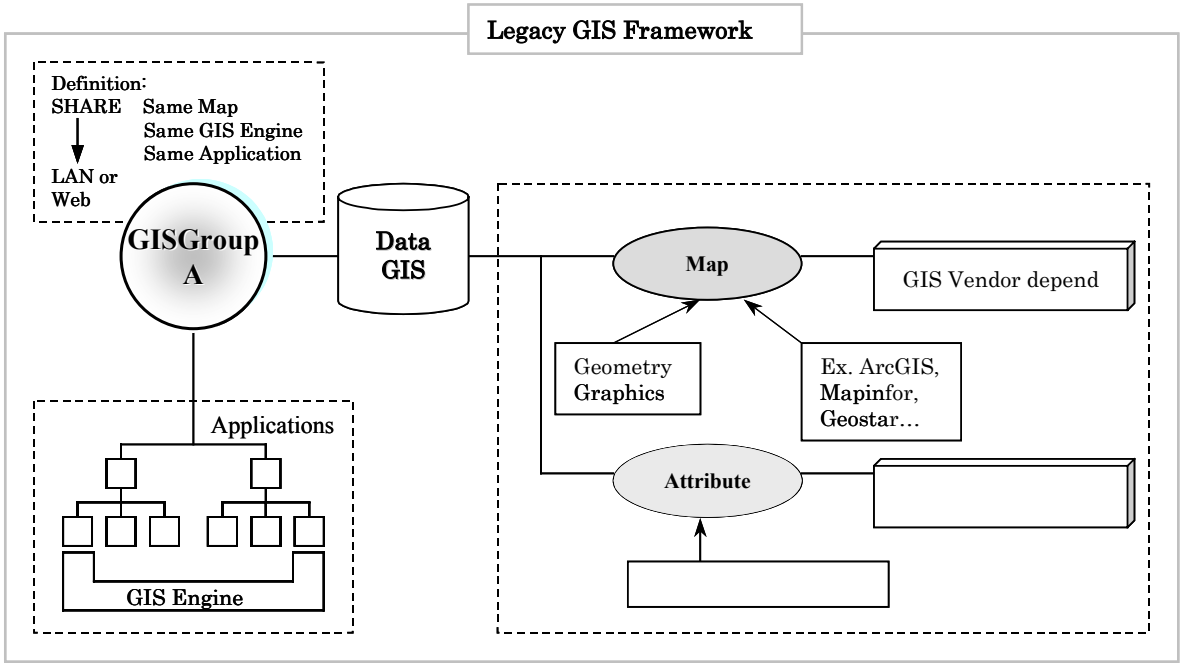


Figure 8. The Constructs of a GIS framework.

On the other hand, the project progresses steadily through each stage and concludes with a fully functional municipal Web GIS system with dynamic spatial and attribute data. The immense popularity and acceptability which Internet gained over the last few years attracted GIS vendors throughout the world. How to use those legacy data including GIS data and the other specification data in the other GIS and data issue respect in the LAN or Web, it is a problem. And now, there is no good method to solve that the data sharing in the deferent single GIS architecture.

The single GIS architecture can be defined as a GIS Work Group, which is shown as the figure 6. The one single GIS architecture provides many applications, and within the progressing of the technical in the special, the infrastructure of GIS database will be become very complicated. As the figure 7 shown, thought the plural GIS groups, the data

sharing and exchanging is difficult and unable in fact at now.

Here, the authors propose a solution to discuss how to solve the sharing of spatial information (applications and data) among the different legacy GIS.

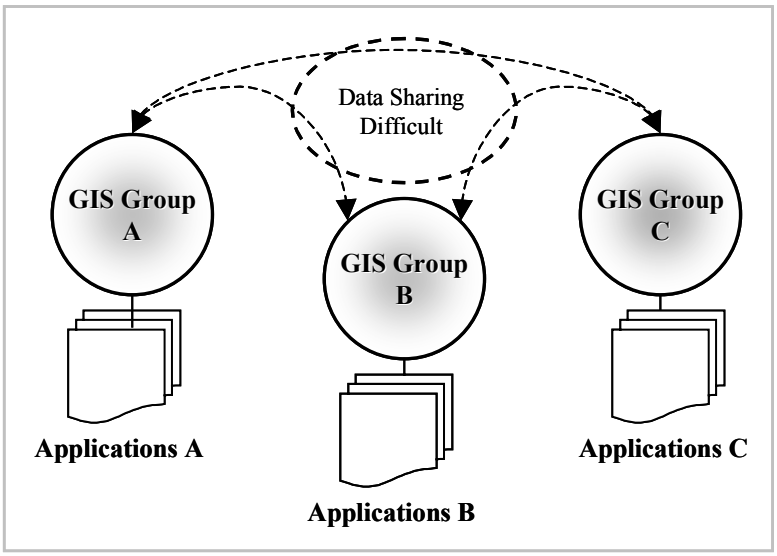


Figure 9. Sharing of spatial data in multi-GIS architectures.

3.2 The solving method

The authors propose a model to share and use the legacy spatial data among the different system. The construction of the model is shown as figure 8. In the model, the spatial data of legacy GIS (including other special systems) are storied in the center server, the extend feature can be transferred among the different system, the data updating, entering and deleting also be realized. The database adjustment, server composition, XML definition document (SO/TC211 and GML) are easy to materialize via the former methods, but the spatial data Converter creating is need to devise within new solution, which might transcend the concept of general GIS or WebGIS engines.

The authors propose that the following two types are able to use with the model here.

1) Star Type (Integrated Server)

All of spatial data defined as "Features" by XML are collected from each of the legacy systems, and stored in an Integrated Server, those spatial data can be shared in the system.

Advantage to Star Type: *A*synchronous transmission of the data, easy operating and easy developing, using for large system.

Disadvantage to Star Type: *D*ifficult of server managing and data updating.

2) Network Type (Peer-to-Peer Architecture)

The sharing spatial data are operated directly among the different system by the

requesting in client. The data can be transferred freely in the system. Naturally, the security is needed.

Advantage to Network Type: *S*olution of the problems in Star type.

Disadvantage to Network Type: *D*ifficult of system developing and using, difficult of transferring the GIS service.

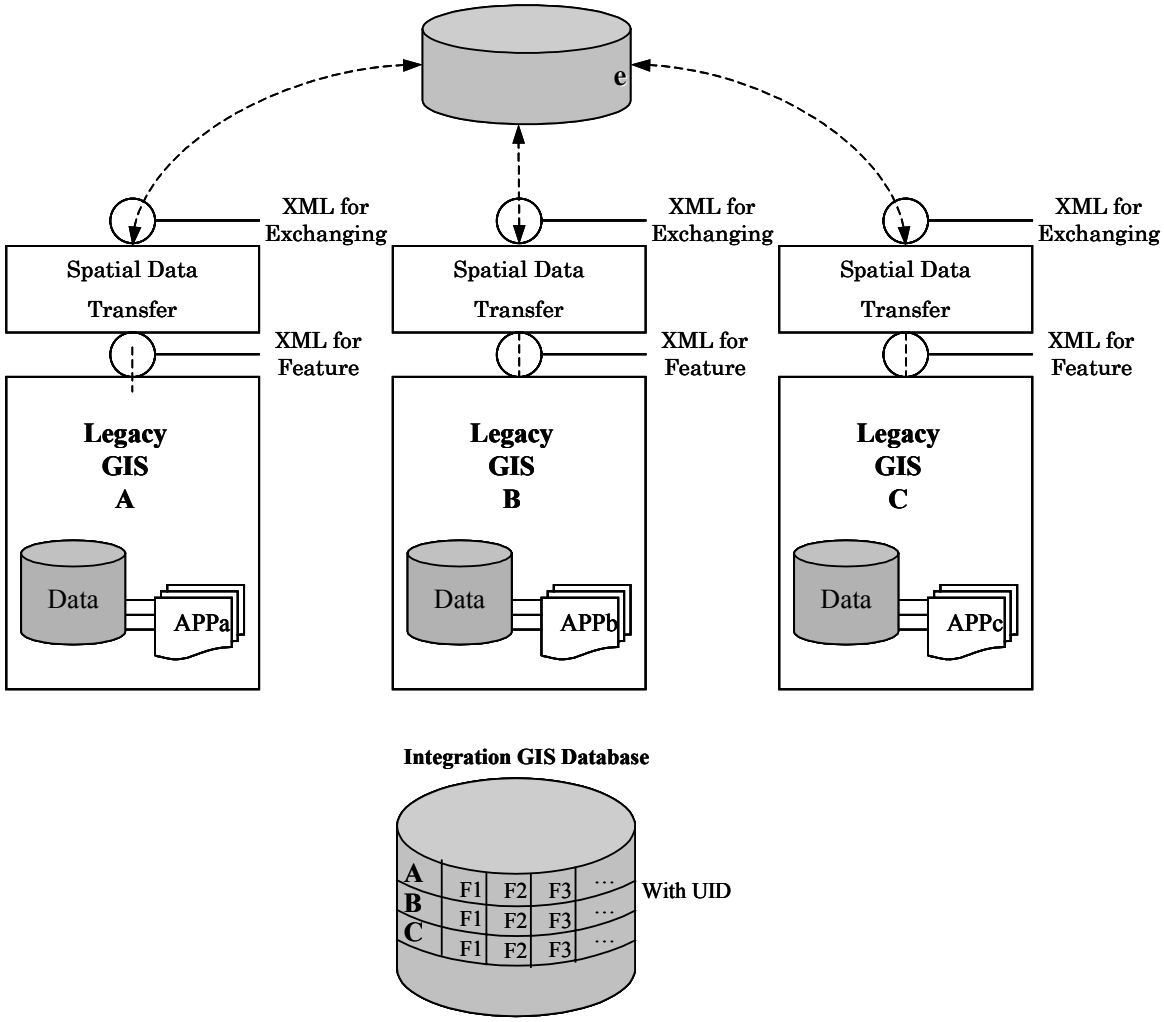


Figure 10. Transferring of spatial data in the legacy GIS.

4. CONCLUSIONS

In this paper, a detail description is given about the solutions of sharing and using the spatial data in different legacy system. For developing those GIS applications, much money and long time had been used. When the new GIS project will be developed and the legacy GIS will be update for Web version, if the effective using of the legacy spatial data is readily achievable, the development expense including cost and time can be economized.

Some solutions is proposed to share the data in venous legacy special applications, for example, the Base Map and Raster data, and the same data in GIS, those data can be shared

and exchanged in Web GIS at the former method.

As the verification, a new type Web GIS engine “FeatureBase”, which has been developed by Dawn Corporation in Japan, is introduced here. Using in “FeatureBase”, some good architectures can be got to agree the requests in sharing of spatial information as described above. In FeatureBase, a spatial object "Feature" is designed and retrieved from the Feature storage by employing customized formats for specific applications. The distributed processing model and "two stage display cache" achieves are adopted in FeatureBase, which are able to use for map operating and geographic analysis effectively on the Net or Web. And the using of “Feature” (geometry and attitude), the sharing of the data in single GIS is cleared. However, the problem of sharing and transferring the specialty GIS applications is remained. As a future discussion, the new solution which is used to share and use the legacy spatial data among the different system. Those methods and proposals will lead us to the next stage of developing the new version of the FeatureBase capability.

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