Introduction to Geographical Information System, GIS data models, spatial data, spatial database, A Location based Secure Access Control Method for Geospatial Data

Miss. Jalpa K. Goswami[1] Mr. Chetan Chauhan[2]
[1] P. G. Student [2]Professor
[1, 2]Department of Computer Engineering
[1, 2]Noble Group of Institution, Gujarat, India

Abstract—Geospatial data is data about the geographic location of earth surface features and boundaries on Earth. Nowadays spatial data is used in every field of society and due to the advancements in spatial data acquisition technologies, such as the advancements in the satellite sensor technologies, high precision digital cameras used in the capturing of photogram metric images and high precision land surveys are producing mass high precision spatial data. Due to these issues nowadays sensitivity of spatial data has increased too many folds. To store such high precision data onto the database is a big challenge today. Major security concerns of the geospatial data are based on authorization, authentication, access control, integrity, security and secure transmission of spatial data over the network and transmission media. In this paper the major security concerns of geospatial data, various data models, introduction to Geographical Information System, GIS data models, spatial data, and spatial database. The basic objective is to developed secure access control mechanism.

Key words: Geographical Information System - (GIS), GIS data models, spatial data, spatial database, Registration authority - (RA), Access Control List, Certificate authority service - (CAS), spatial database enterprise - (SDE), Spatial Database Management System - (SDBMS)

I. INTRODUCTION TO GEOGRAPHICAL INFORMATION SYSTEM (GIS)

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying the information related to the surface of the earth.

In recent years, GIS has emerged as a powerful technology as it has the potential to organize complex spatial environment with tabular relationships.

The emphasis given is on developing digital spatial database, using the data sets derived from precise navigation and imaging satellites, aircrafts, and digitization of maps.

In recent years, the use of GIS has been raised for effective data handling and also for analyzing and geographically transferring information around the world. Various software have developed many GIS solutions for retrieval, projection, transformation and analysis of both spatial and non-spatial data, so the user is able to manipulate and manage coordinate (location) and attribute (thematic) data and produce thematic maps as well as tabular reports.

The power of GIS is the ability to combine geospatial information in unique ways by layers or themes and extract something new.

An example, a GIS analysis might include the location of a highway intersection and the average number of vehicles that flow through the intersection throughout the day, and extract information useful for locating a business.

Overlaying the path of a severe thunderstorm with geospatial data on the types of structures encountered homes, stores, schools, post offices could inform an analysis of what types of building construction can survive high winds and hail.

II. GEOSPATIAL DATA

Geospatial is used as a synonym for geometric, graphical and geographic which means related to the earth, so in spatial data we store information related to the earth surface.

Geospatial data is the data or information which identifies the geographic location of features and boundaries on Earth, such as natural or constructed features, oceans, and more. Spatial data is often accessed, manipulated or analyzed through GIS.

Geospatial data can be acquired using a variety of technologies such as land surveyors, using satellites, aerial photographers, police, and even average citizens with a GPS-enabled cell phone can collect geospatial data using GPS and this collected data can be entered into GIS. The attributes of the collected data, such as land-use information, demographics, landscape features, or crime scene observations, can be entered manually.

In case of a land survey map, which is digitized from a map format to a digital format can be entered by electronic scanning. Remote sensing data from satellites is acquired digitally and communicated to central facilities for processing and analysis in GIS.

Spatial Data exists in many forms such as digital maps and printed maps, aerial photography, top sheets and digital satellite imagery. This data can be manipulated in desktop mapping or GIS programs such as Arc View, MapInfo, or Intergraph.

III. GIS DATA MODELS

GIS Data Models are sets of mathematical construct for representing and describing the geographical features of earth surface. Two commonly used GIS data models are Raster Data Model and Vector Data Model.

A. Raster Data Model

This data model represents continuous data over space. Raster data is divided into rows and columns. Example of raster data is a digital photograph.

Raster data stores large arrays of pixel values; it takes more digital storage space than vector data.

B. Vector Data Model

It is used to represent geographic features of earth surface. In a vector data model, each location is recorded as a single x, y coordinate. Points are recorded as a single coordinate. Lines are recorded as a series of ordered x, y coordinates.

IV. SPATIAL DATABASE

Spatial database is different from a relational database, it includes geographical and attribute data. Advances in relational database management technology giving users the option of storing their GIS data in a spatial database rather than using file based storage.

– Access Control Methods for Geospatial Data

Three important access control methods reviewed are as follows:

1) Role Based Access Control Method:

The relationship of roles and authorities is saved on a role control table which is maintained on the database server. For a client to access spatial database, firstly he has to register himself to spatial database server, and send his basic information including his name, ID, password, authorization code, role and ID.

Once he submits his basic information, database server returns authorization code and based on his authorization code, he can register his certificate from database server by right of their login password.

When users access the spatial database, they transmit their own certificates and roles to the database server, and then the server confirms the validity of their identities based on their certificates and lookups the role control table based on their roles in order to decide their authorities.

Certificates of the server agent, clients and Registration authority (RA), are generated and maintained by the Certificate authority service (CAS), its main task is to generate and manage certificates.

Registration of all clients and distribution of roles to them is maintained by the Registration Authority (RA). The server agent is an agency between spatial database enterprise (SDE) and spatial database, with which clients submit their access requests to Spatial Database Management System (SDBMS) and SDE To clients.

2) Fine Grained Security Access Control

One another method is Fine Grained Security Access Control method is based on Role Based Access Control Method. In this method the authorization mechanism used is a double authorization, and it is refined gradually.

The two authorization methods used restrict the user's access in two directions horizontal & vertical respectively.

Similarly to RBAC, by the first authorization, in this authorization all users are provided with their appropriate roles and users get the appropriate permissions of the role. It is the authorization to layers, with a horizontal layer as a unit.

The Secondary authorization judge whether the user has access to the data within a particular region based on the attribute information of the user stored. It is processed through layers in the vertical direction.

In the implementation process, a user gets the layers about location through the horizontal authorization firstly.

When the second authorization is further required, the vertical authorization will decide whether the user has access to the data within the specific regions.

On the authorization model above, there are two authorization methods, so we need different access control methods to achieve it. We use Access Control List method to apply access control and to authorize the end users with their roles. ACL is easy to implement, though it is time consuming when the resources are massive.

The second authorization is the fine-grained authorization. The fine-grained authorization requires the pre-processing of the polygon information, then according to the type of authorization, overlay the polygon and obtain the authorized region.

Now detection of conflict of role authorization is performed to detect if any conflict is there. If any conflict found then resolve it and return to the region that the user can access.

V. CONCLUSION

This paper gives fundamental idea about the geographic information system, Geospatial data, spatial database and GIS data models are Raster Data Model and Vector Data Model.

It will also give introduction about various access control methods for geographical data. One method is Role Based Access Control Method and another method is Fine Grained Security Access Control method. This paper contains some of them, so future work will developed a secure access control mechanism.

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