An Enterprise GIS Solution for Network Support System
- Network Expansion Plan

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Abstract:

GIS has played a significant role in the development of Network Support Systems through its ability to offer mapping solutions across different networks in Telecom industry. It helps in maintaining the various inventories involved in a telecommunication network like routers, Center Office terminals, cables, etc effectively. The users could see the locations of these inventories spatially in a map together with their attribute information. These attribute details are available either as separate reports or as a summary table just below the map. Furthermore they can also be viewed as notes on the map, when the user hovers around a particular area. These features will facilitate the users in analyzing, mapping and querying the network data relatively faster, thereby helping the network engineers to plan efficiently. This paper deals with one such application developed by Infosys for a particular Network Expansion scenario for one of its Telecom customers.

The paper starts describing about the general business benefits that can be achieved by implementing the GIS technologies in a Telecom industry. It then continues elucidating the application in detail and the business values provided by the application.

Conceptually this application, Network Path Indicator (NPI), can be used as a decision making tool for querying and tracing the spatial field data. It could also help the plant engineers to create, plan, save and publish their designs. It facilitates the display of network features in a map view along with associated cable capacity information, the network trouble locations and bonded pair data of the cables. This allows the Network Engineers to plan the provisioning for the subscribers effectively. The users will be able to view the effects of placing hypothetical terminals and equipments depending on the service availability at distribution terminals and service sites (subscriber locations).

Introduction:

GIS is a powerful technology that can be used to design any decision-making and planning tools to work on the geographical features. It also helps in managing the processes and actions that take place on these features in telecom affairs like customer relationships, workforce management, expanding the network services and other location based services.

Earlier the focus was on individual projects where individual departments/users created and maintained their data sets on their own desktop computers. Later as the Telecom industry evolved and expanded its networks, there has been extensive interaction and work-flow between departments. To manage such operations smoothly it was imperative to get the details about the customer locations and network assets deployed at various locations. To meet these challenges, the organizations had switched from stand alone desktop GIS applications to more integrated GIS applications.

One such Enterprise GIS application was needed for a particular network expansion scenario, for which Infosys had built the NPI. The NPI can use and display spatial data from different data sources, helping the Plant Engineers to view and analyze the network data. The planners can create hypothetical designs to install the necessary Telecom equipments at the right places and enhance their services to all subscriber locations. Some of the potential benefits that the NPI has provided as an Enterprise GIS solution to the Telecom industry are:

- ✓ Significantly reduced redundancy of data across the system.
- ✓ Improved accuracy and integrity of geographic information.
- ✓ More efficient use and sharing of data.
- ✓ Spatial Data can be integrated and used in decision making processes across the whole organization.
- ✓ Reduces the data acquisition costs and maintains the data quality across organizations and departments.

A Network Expansion Scenario:

A Telecom Company was trying to expand its service capabilities by providing high-speed broadband and IP Voice based services over an advanced IP based network. They were planning to do this by deploying fiber-to-the-network (FTTN*) and fiber-to-the-premises (FTTP*). In order to achieve this, they were looking for a system which would provide the following information on a user friendly map interface.

- ✓ Total number of the terminals available in its network.
- ✓ Subscribers served by each terminal.
- ✓ Possibilities of increasing the subscribers served by a particular terminal.
- ✓ The nearest terminal to a subscriber location from which a new connection can be provided.
- ✓ The number of incoming cables and pairs to a particular terminal and those that branch out from the same terminal.
- ✓ Identify the subscribers as per their reach from the Service Providing Terminals.
- ✓ Finding out whether any pair bonding solution is required in a particular distribution area.

As we could clearly see that all these information deal with the locations on the earth and hence had to be supported only with the spatial data. Thus it is very much essential for a Telecom service provider to locate its inventories, network elements and its subscriber locations spatially. NPI is an extremely useful tool to display all the above mentioned information geographically using a GIS interface. It also facilitates in displaying these information as a Report, to trace them and view on a map, to plan the

designs and to make decisions. Simulation of such real-time scenarios in the GIS environment can enable an easy and effective decision making with less manual effort.

Advantages of a Map Interface and Platform Independent Architecture:

The advanced data acquisition techniques and the concepts of spatial data representation as Interactive Maps have become a revolution these days. Also Java and Struts, being a platform independent language and a flexible J2EE distributed framework respectively, they help to build robust applications. Such applications could be used for network planning and decision making and also in many other telecom affairs. Thus combining both GIS and J2EE framework, NPI has been built as a powerful application for serving spatial data over a Map Interface, across the different telecom systems in an enterprise.

The Network Path Indicator (NPI) –:

The NPI is a map interface which simulates all the network inventories as a real time environment and helps the planners to:

- ✓ Make a decision as to how to design the FTTN distribution areas in order to provide enhanced services to all customers within the distribution area.
- ✓ Identify areas and customers eligible for pair bonding* solutions.
- ✓ Interpret where there may be 'false red*' (fault) scenarios that can be corrected.
- ✓ Identify cable trouble locations that affect pair bonding to be used in network analysis.
- ✓ Enhance the business values and to allow for efficiencies within the network along with operational savings.

Following are the business benefits achieved by using NPI in Telecom firms:

- ✓ Decision Support tool for network management.
- ✓ Provide efficiency within network along with Operational Savings.
- ✓ Increase organization's overall efficiency.
- ✓ Save time and manual effort.
- ✓ Provide a competitive edge.
- ✓ Ensure a higher level of customer satisfaction.

To cater the Network Expansion Scenario's objectives explicitly, the NPI was built with the following tools:

- ✓ Hypothetical Element/Image placement Tool.
- ✓ Extended Identify Tool.
- ✓ Drill Down and Network Path Tracing tool.
- ✓ Map Notes.

The NPI Architecture:

ArcIMS, one of the ESRI's Server GIS Product, is designed with flexible open architecture, providing almost unlimited customization possibilities. Several APIs including the Servlet connectors, Java Connectors, HTML Viewer are provided by the ArcIMS, to facilitate the customization. AJAX is also implemented in NPI for a faster searching of input data. Hence NPI Application has incorporated the ArcIMS Architecture to build its Map Interface and its Request/Response Communication with the server. The Map Interface has few more additional map tools along with the basic map tool functionalities like zooming, panning, etc.

The ArcIMS clients had to communicate with ArcIMS Server through a Web server and Connectors using ArcXML requests. NPI has used Servlet Connectors, which has its own API. The developers can use these APIs to build the ArcXML requests and parse ArcXML Responses to communicate with the ArcIMS Server. The ArcIMS Servlet connector is available in both Windows and UNIX.

NPI's Functional Process Flow:

- ✓ NPI uses the HTML viewer as its front end for the Map User Interface.
- ✓ The application builds its ArcXML requests and embeds in the servlet and sends the same to the Web Server.
- ✓ The Web Server compiles the servlets in the Servlet Engine.
- ✓ This connector uses the servlet engine to provide a communication link between the Web server and the ArcIMS Application Server. It accepts ArcXML and sends ArcXML only.
- ✓ The ArcIMS Spatial Server gets the work done with the services running inside it and sends the response back to the ArcIMS Application Server.
- ✓ The ArcIMS Application Server sends back the response in the ArcXML format to the Servlet Connector and it's passed to the client end.
- ✓ Finally the response is displayed as a Map on the Client end.

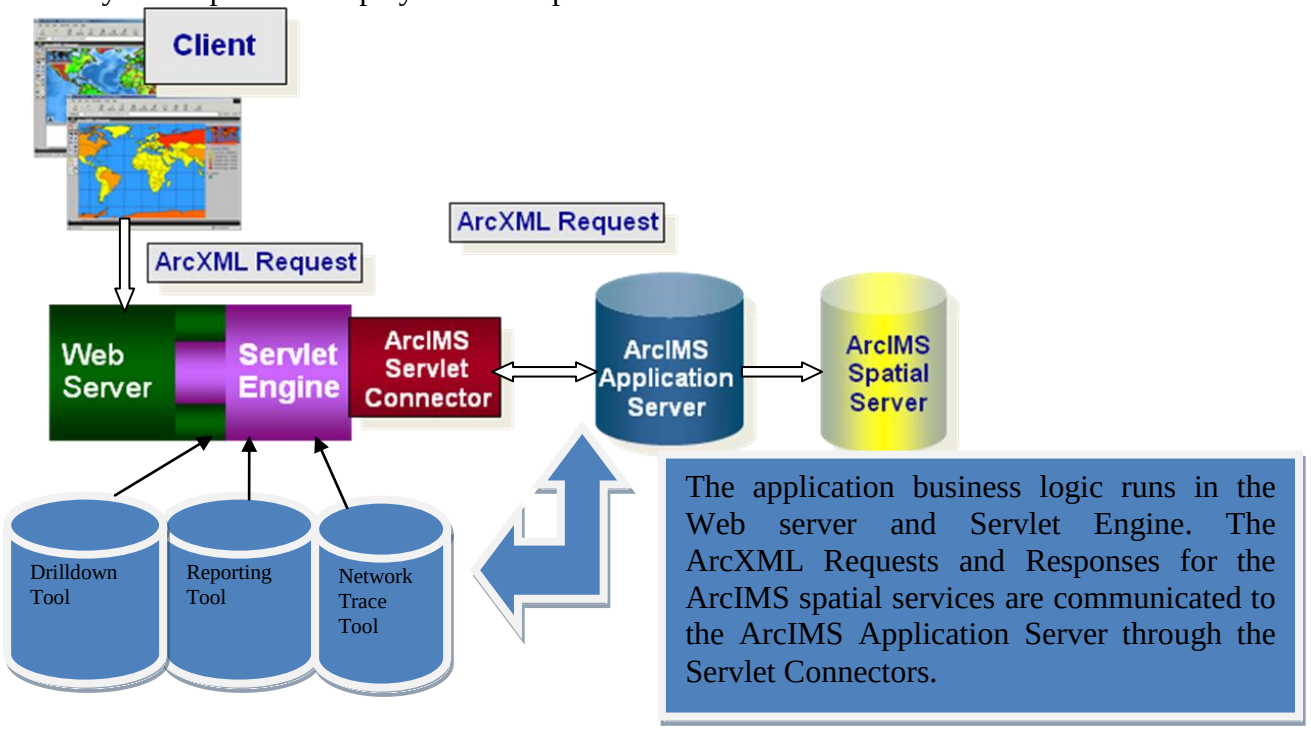

Fig.1: NPI Architecture

Hypothetical element/image placement

This tool is used to place hypothetical elements or images on the map and store the details of those elements as x and y co-ordinates. This looks similar to placing notes on the map. It can help the planners and engineers in the following ways:

- ✓ To perform design operations such as locating the places for new cellular towers, business outlets, service terminals etc., with suitable back end data.
- ✓ To store the values of these hypothetical elements in the database as a specific design under respective user login ids.

- ✓ To classify the network elements and or regions seen on the map based on different criteria such as distance ranges, strength of the signal from terminals, subscriber locations etc.
- ✓ To load the designs and view them based on their user ids or the zoomed regions on the map.
- ✓ To provide the planners an Interactive Classify Frame where the planners can have options for choosing the classification type, such as color, distance ranges, etc., thus helping the planners to analyze the data seen on the map.

Fig.2: Hypothetical Network Elements Placed on the Map

Extended Identify Tool:

This facility would operate in a similar way like the basic identify map tool. However an additional DHTML layer has been used to display the initial data with links to show the detailed information on a separate page. This helps the users to obtain the first level information of the data initially. This improves the performance substantially as it takes a lot of time to get the detailed information from the database every time when the identity tool is clicked. Thus it helps the planners for an effective analysis of the work force management/ network elements/other location based spatial data such as:

- ✓ Cable.
- ✓ Terminal.
- ✓ Living Unit.
- ✓ Central Offices.

Fig.3: Extended Identify Tool with links.

Fig.4 Detailed information appearing in a separate page

DrillDown and Network Path Tracing Tool:

This tool helps the planner to drilldown on any features on the Map. For instance, to get a detailed information about a cable running on the field, the planner has to click on the particular cable on the map. The details of the entire cable path would be displayed at the bottom with a hyperlink. The single cable path can have many cable segments. To view the detailed information of each cable segment present in a particular cable path, the planner has to select that cable path link. Meanwhile the selected cable path will be highlighted and seen on the Map. Some of the cable information that can be obtained and viewed are :-

- ✓ The cable pair numbers.
- ✓ The cable material.
- ✓ The Gauge value of the particular cable.
- ✓ The status of the cable, if it's already assigned or if its fault or if it is to be assigned in future.
- ✓ Any logical name assigned for that particular cable.
- ✓ The spatial data source name that provides these cable information.

Fig 5: Drilldown Information with a Link.

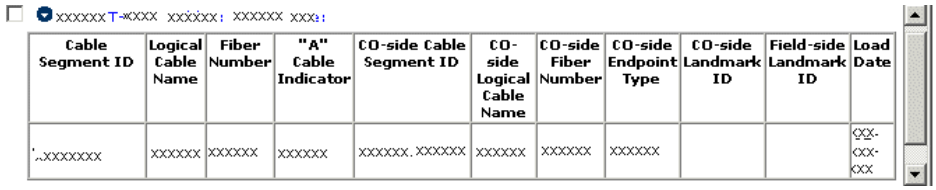

Fig 6: Cable segment details of the particular cable path link selected


Fig 7: The Traced Network (Green Colored) on the Map

Map Notes:

Whenever a planner creates a design and has to attach some notes to it on the map, the Map Notes can be used. These notes can be added anywhere on the map as per the planner's choice, by simply clicking on that location and entering the required information. Such map notes are generally useful for making notations of any adjustments made on any feature on the field. The planner can also save the whole design along with the attached notes in the database for future analysis.

Fig 9: The Map Notes tool

Reports:

The Plant Engineers can build their query to retrieve specific data for analyzing purposes using the Reports Tool.
Such Reports can assist in:

- ✓ Collecting details about various network components deployed on the field.
- ✓ Retrieving the spatial data from various spatial data sources.
- ✓ Displaying the specific data in a user defined format.
- ✓ Tracing and viewing the selected data on the map.

These report generating modules were developed using Struts, one of the loosely coupled J2EE architecture. They are platform independent and can be plugged into any other map application, to retrieve the data and display on the map.

Fig.10: Data Trace on the Map

Conclusion:

We have seen that a GIS based telecom application supports various telecom inventory and operational service system related requirements along with standard GIS functionalities. NPI is one such real time application which uses a map interface to display the spatial data and helps the enterprise in:

- ✓ Managing the Inventories and network equipment placement at the subscriber locations.
- ✓ Planning and designing the network and provide network data.
- ✓ Identifying the unreachable and fault locations and to offer service maintenance accordingly.

Thus apart from viewing the spatial data, NPI also serves as a decision making tool, a report generating tool, a classification tool and as an Interactive Planner. The implementation of this enterprise GIS Solution has reduced the overall maintenance costs and manual work. NPI has made an effective use of GIS resources in providing efficiency in service fulfillment, customer relationship, workforce management, network expansion and extended network services.

References:

www.esri.com
www.gis.com

Appendix:

FTTN: (Fiber To The Network)	FTTN is a broadband architecture that provides high speed internet and other services by running fiber to the node.
FTTP: (Fiber To The Premises)	FTTP is also a broadband architecture delivering triple play services (telephone, internet and television) all the way to the home.
Pair Bonding:	Pair-bonding is a technique that bonds, or connects, two pair of unshielded twisted pair copper wire (UTP) so that they behave as one cable with twice the bandwidth. Thereby it increases the bandwidth supplied to a subscriber.
False Red Scenario:	The subscriber locations that are out of reach and cannot be covered using the Pair Bonding Solution, but can be corrected using some other solution.