Abstract:
Cochin Port is one of India’s gateways to the rest of the world and plays a significant role in the country’s economy to grow. Cochin Port has established IT systems way back in the mid-eighties and continuously updated the systems to business requirements. As part of its continuing journey towards excellence, Cochin Port has embarked on a comprehensive ERP (Enterprise Resource Planning) implementation program to be christened as ‘e-port’ which will help the Port
• To improve its business processes and work practices
• To closely monitor the performance in all areas of operations and management
• To provide improved levels of operations and efficient service delivery to its internal and external customers.

Along with the implementation of a fully Integrated Port Information System (iPINS) using SAP-based ERP, a GIS solution which is integrated with Estate Management System of SAP is also being developed.

Port operators today face increased demands for operational efficiency, effective facility management, comprehensive security, and sensitive environmental management. These diverse challenges require access to detailed, up-to-date information and careful analysis to produce optimal results. Geographic information system (GIS) technology provides management solutions that incorporate the location of port assets to give them a decisive competitive advantage. The integrated GIS solution developed also helps Cochin Port to enhance the efficiency of using the port’s land in terms of lease/rental management and planning new allocations. It is also capable of providing storage, retrieval and management of different layers of port’s infrastructure and utilities. Moving from printed maps to ArcIMS Web sites allowed Cochin Port employees to fully utilize the benefits of the GIS data.

This paper presents the approach of designing the spatial data model for Cochin Port and implementation of the GIS solution using the industry-leading platform that includes ArcGIS, ArcSDE, and ArcIMS and the use of SAP-XI to integrate GIS and Enterprise Resource Planning (ERP).

About the Authors:
1. Nogy Augustine
Mr. Nogy Augustine, an associate in Geospatial Tech Group of Tata Consultancy Services having 4.6 years of experience in the field of GIS and Remote Sensing. His major area of experience has been in GIS Application Development, GIS Modelling & Analysis and Image Processing. He has worked mainly in the domain of GIS-SAP integration, Tsunami modeling, Vehicle Tracking, Forestry, Environment, Electric Modelling, Transportation and Urban planning.

2. Bimal Biswal
Working as a Team Lead with Tata Consultancy Services Limited. He has over 7 years of experience within the Geospatial industry, His experience includes project implementation using AM/FM, GIS and remote sensing techniques. He has extensive experience in working with desktop to enterprise level GIS implementations, Integration, customization, data conversion, data migration using Intergraph, ESRI and leading GIS Software specifically in Utility Sector(Power, Water, Gas).
Introduction:

Port operators today face increased demands for operational efficiency, effective facility management, comprehensive security, and sensitive environmental management. These diverse challenges require access to detailed, up-to-date information and careful analysis to produce optimal results. Geographic information system (GIS) technology provides management solutions that incorporate the location of port assets to give them a decisive competitive advantage. Integrating SAP and ESRI GIS software provides a powerful synergism allowing CoPT to become more productive, thereby improving business insight.

Background:

Cochin Port Trust (CoPT) owns estate land of 862 Hectares. CoPT has leased out its lands, buildings and other structures to external parties. A system is required to automate the processes relating to lease management, occupation/vacation, renewal and demand & collection of rentals etc integrated with a graphical representation of the entire land and water area owned by the Port.

GIS is a powerful technology that can be used to design any decision-making and planning tools to work on the geographical features. A GIS solution has been implemented which has been integrated with the Real Estate Management module of SAP using ESRI-SAP connectors which brings a cohesive ICT system for effective port management. Integrating GIS and Enterprise Resource Planning (ERP) allows users to turn rows and columns of tabular data into maps for spatially visualizing and analyzing data.

The solution helps CoPT to enhance the efficiency of using the port’s land in terms of lease/rental management and planning new allocations. It is also capable of providing storage, retrieval and management of different layers of port’s infrastructure and utilities.

System Overview

This section outlines the basic components of GIS technology and how they interact to create an enterprise system. It is important to understand that GIS is not an end unto itself, but a means to convey data to professionals that allow them to perform their work more effectively and efficiently. Furthermore, it provides a means to communicate the information they produce, to policy makers and the general public. In this regard, GIS is truly an enterprise rescue, not limited to the few who specialize in its development and maintenance, but for all who seek and require the information it can deliver. With this approach, GIS becomes a tool for everyone to use, across the enterprise. The GIS solution
has been developed and implemented after analyzing the requirements of Port, below scope has been formulated to achieve the solution.

- **Design and Development of a comprehensive spatial database for the CoPT Area using high resolution satellite image and GPS survey.**
- **Development of a complete and scalable system for geographic data creation, management, integration, analysis and dissemination of spatial information to the users at different departments in Port through intranet.**
- **Integration of GIS module with Estate Management System of SAP through the middleware SAP-XI which allows turning rows and columns of tabular data into maps for spatially visualizing and analyzing data.**

**A comprehensive Spatial Database for Cochin Port**

The spatial database has been designed and developed for the entire port area to accommodate the information needs of Port with the associated non spatial attribute data. The required features have been extracted from Satellite Imagery (Quickbird) and conducting GPS survey which finally shaped the Geodatabase for Cochin Port Trust.

For creating the spatial data layers we have used Quickbird multispectral and panchromatic datasets at 2.4 m and 0.6 m spatial resolutions respectively, covering the administrative area of Cochin Port Trust. The datasets were acquired on 11 January 2008 and ArcGIS Desktop software was used for creating a pan-sharpened multi-spectral dataset of the region. Visual interpretation procedure was applied using on-screen digitization of the Quickbird pan-sharpened colour composite image, for generating the spatial layers. Around 30 spatial layers were generated which include Port Boundary, Water body, Land Plots, Buildings, Roads, Berths, Utility networks, Storage Tanks etc.
Spatial database created for Cochin Port using Quickbird Imagery

Extensive GPS based field works have been carried out over the port area in support of the satellite-derived information for their correction and validation. The infrastructure information is also been updated by such survey.

Architecture of GIS Solution

GIS for Port Information system has been developed using ESRI and Oracle technologies. The architecture of the GIS system is based on the following conceptual layers. Major layers of the solution are

Spatial Database Server – It is based on Geodatabase and Server GIS components which have been developed using ArcGIS Server Basic 9.2 (ArcSDE Technology) over Oracle10g database. ArcGIS Server Basic provides core Geodatabase management tools and technology for data storage, management, and distribution. ArcSDE technology serves as the gateway between GIS clients (both desktop and web) and the RDBMS. It enables GIS cell editor to easily store, access, and manage spatial data on the database using ArcGIS desktop editor tool.
**Web Application** – Developed using ArcIMS 9.2 software which provides Web publishing of GIS maps, data, and metadata for access by CoPT users. The ArcIMS software has been used for serving mapping requirements to its browser based clients in different departments in Cochin Port. The development of web application has been done using ArcIMS 9.2 Application Developer Framework (ADF) which includes a full set of Web controls, tasks, and an API that wraps ArcXML functionality. The Web GIS Solution will provide the interface to all CoPT web users to view the spatial data stored in the GIS database with a linkage to the corresponding attribute data. Different services

**Client applications** – Developed on ArcGIS Desktop Editor Software which allows authorized users of GIS cell to edit and update the spatial and non spatial data stored in the Geodatabase. ArcEditor is a powerful GIS desktop system for editing and managing geographic data. ArcEditor includes all the functionality of ArcView and adds a comprehensive set of tools to create, edit, and ensure the quality of CoPT data. An extensive set of tools is included for simple data cleanup, defining and preserving data integrity, performing query and spatial analysis, data use and integration, map viewing, navigation and printing.

Query tools developed in WebGIS
Architecture of GIS system

Integration of GIS module with Estate Management System of SAP

One of the significant outputs of the solution developed in Cochin Port is the integration of the GIS module with Estate Management System of SAP using ESRI-SAP connector (SAP-XI) which brings a cohesive ICT system for effective port management. Integrating SAP ERP and ESRI GIS software provides a powerful synergism allowing Cochin Port to become more productive, improve business insight and provide the adaptability necessary to accelerate
business strategies. Here SAP Exchange Infrastructure (XI) which is SAP’s enterprise
application integration (EAI) software been used to facilitate the exchange of information
between SAP ERP and ESRI's GIS database. SAP XI is considered as an integration broker
since it mediates between entities with varying requirements in terms of protocols,
connectivity and format. The Port uses the GIS-based real estate management application
to map all the port’s property leases, to enhance the efficiency of usage of port’s land in
terms of lease/rental management, planning of new allocations etc.

Key factors that we considered for GIS-SAP integration are the Business Process modeling,
Data modeling and Integration methods. Introducing GIS into business process offers
capabilities to have the provisions of geographic context to business decisions by integrating
business data with geodatabases and feature tables. During the data modeling stage,
mapping of the non spatial data of the business objects which is stored in SAP and spatial
data which is stored in GIS system has been done. Later a seamless integrated data base
for the asset system will be developed which can utilize the key features of geo spatial
information and also transactional history of an asset with the help of this integrated data
base.

Depending on the business scenario for each feature in the GIS tables a corresponding SAP
Business Object will be assigned which depends on the Business domains and it can be
Rental Objects, Functional Locations, Equipment, Material, Work Areas, Connection Points,
Devices, and Buildings.
Integration of SAP and GIS can be unidirectional or bidirectional according to the business requirement. Main target of the integration will be to synchronize the GIS and SAP data in residing in two different databases. It can be either real-time synchronization or batch data synchronization which helps to expand the integration scenarios to include land leasing, work orders processing, mobile integration etc. In Cochin port the integration that has been done is of unidirectional (i.e. data flows from SAP to GIS) and the synchronization has been done using a batch program.

The primary key used for communicating between the systems is a unique ID number, specific to the type of feature being manipulated. This ID is stored in a Classification Characteristic in the SAP system and as a GIS attribute. Eventually, it can be planned that GIS will store the minimal SAP details for faster retrieval.

SAP data available in GIS screen

With both systems integrated, a port user can visualize SAP-REM application data within the GIS application which enhance the efficiency of usage of port’s land in terms of lease/rental management, planning of new allocations using GIS tools. GIS enhances ERP with tools for making better decisions and maximizing the return on information technology investments.
Conclusion

The main advantage of using GIS is port information system is, it integrates information from various aspects of port operations. It provides insight through visualization (mapping) of information and relationships and supports information sharing throughout the organization. It gives Cochin Port the ability to integrate disparate information sources into a common operational picture of all port facilities, with greater power to control their operations and positively impact their bottom line. Since queries on data can be done through GIS, it reduces effort and saves time and improves efficiency. Users from different functional areas will be served using the tools capable of visualizing and performing spatial analysis with the spatial data linked to SAP. The solution promotes data sharing, provides a single common view of spatial and related data throughout the organization. GIS enhances SAP with tools for making better decisions and maximizing the return on information technology investments.

Results and Benefits

- A comprehensive spatial database of the CoPT area.
- A user friendly web GIS solution to view the Port infrastructure and assets using flexible and robust map navigation tools and customized tools to support the printing of maps and reports.
- A graphical interface integrated with REM module of SAP showing the physical status of the land plots, leased buildings, and quarters.
- Decision support using customized query and analysis module for land transactions (allotment & re-allotment etc), planning areas for future development.

Business Values:

- Provide integrated information from all aspects of port assets and ability to track and analyze assets over space and time.
- Provide insight through visualization (mapping) and spatial analysis of information and relationships.
- Provide support information sharing throughout the organization.
- Enable mapping and display of vessel locations for traffic control and safety management.
- Enhancing the efficiency of usage of port’s land in terms of lease/rental management, planning of new allocations using GIS.
- To plan the areas for future development by identifying areas with the required characteristics using spatial analysis module in GIS.
• Act as a decision making tool to map all critical facilities for incident response.

References

