USING THE INTERNET TO MANAGE AND DISTRIBUTE GEOSPATIAL SUBMARINE CABLE DATA

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1.0 ABSTRACT

Improvements in computer hardware and software systems have led to significant opportunities to improve the manner in which submarine cable data is managed and distributed. This is particularly important given the increasing number of cable systems and the increasing importance that submarine cable protection will have on the maintenance of these systems. The "fast track" nature in which these systems are now engineered and installed also means that data must be exchanged and analyzed faster than ever before without any compromise to data quality or accuracy. These increased demands mean that, in many cases, traditional methods break down and new methods must be used to meet the requirements of very aggressive schedules.

This paper looks at how Racal Pelagos, Inc. (Racal Pelagos) has exploited recent advancements in data management, Geographic Information Systems (GIS), and the Internet to develop a system that significantly improves the manner in which RPL and geospatial submarine cable data in general is managed and distributed. The system focuses on the fundamental architecture of cable data rather than on standard file formats, thus enabling implementation of cable data in an internet-accessed relational database. The result is an Internet-based delivery system that provides users with immediate and instantaneous access to various cable data. In addition, this evolvement of "GIS through the Web" will promote the use of distributed databases and allow remote interaction with these databases.

This system can then be applied to other industries, which are impacted directly and indirectly by submarine cables. Such industries may include, but are not limited to fisheries, pipelines, and construction. The availability of submarine cable data in real-time and on-line could result in significant savings to both the cable owners and the other impacted industries.

The rapid delivery of "cable awareness charts" will be the next step in advancing this technology and will again aid in tremendous cost savings for all operating in the marine environment.

2.0 INTRODUCTION

The quantity and complexity of submarine cable installation data have increased dramatically over the past five years. This is partly due to the significant increase in the number of cable systems that are being installed, but is also the result of the digital survey technologies that are now available for route and as-laid data acquisition. The increased volume and complexity of these data have presented significant challenges to organizations, which are all required to interpret and distribute cable-related data. Such organizations might include marine survey companies, cable installers, cable owners, permitting agencies, government regulators, insurers, investors, and cable maintenance authorities. Even relatively simple cable data, such as RPL data, are handled with difficulty by many submarine cable organizations in various ad hoc or proprietary data formats. Racal Pelagos has been a leading provider of submarine cable services and software for more than ten years, and has recently made several advances in the management of submarine cable data, based on GIS and Internet technologies. By using commercial off-the-shelf software technologies, combined with custom-developed applications, Racal Pelagos has created an Internet-based, cable-specific data management and data distribution systems. The company has successfully used this system to support operations for in-house and external customers.

3.0 CURRENT PRACTICES

A number of recent developments in the submarine cable industry have conspired to render the handling and use of cable data increasingly difficult. Several of these developments include operational problems associated with the management of many new cable projects, however there are also several significant technical issues that need to be addressed.

As the number of submarine cable installations has increased, the allotted schedule for a typical installation has been compressed. The time between concept and the start of cable lay operations can now be as little as nine months, and data-oriented deliverables such as desktop studies, cable route surveys, route design, and cable engineering are now completed in weeks or months, instead of months and years. The difficulties presented by these compressed timelines are compounded by an increase in the number of multi-partner or consortium projects, which can now involve dozens of client partners, all with an interest in the installation. In addition to facilitating communications between installation partners, there is also an increasing requirement to distribute cable-related data to various third parties, such as permitting agencies, governments, resource management groups, insurance organizations, and investment groups. As a result, submarine cable data has a much wider audience than it had even five years ago and is becoming more important to a greater diversity of stakeholders every year. These changes in how submarine cable data are used and distributed have occurred in the context of the rapid development of the Internet, which has promoted instantaneous, 'on-demand' access to information from anywhere in the world. The business, social, and operational environment in which submarine cable information is used is therefore much more demanding than it was in the past.

Just as the demand for enhanced data use and data distribution has increased, improved sensor and instrumentation packages now deliver more data during acquisition. New technologies such as Differential Global Positioning System (DGPS), multibeam echo sounders, and digital side scan sonars, combined with highly instrumented cable engines, ploughs, and Remotely Operated Vehicles (ROVs) have increased the quantity of available submarine cable information by many orders of magnitude. This, in turn, has placed strains on the historical methods and systems used to process these data, including the data handling. Other related problems include the emergence of a wide range of proprietary and incompatible data formats, difficulties in tracking versioning and data editing operations through time (especially important in multi-versioned cable route designs), and challenges associated with ensuring the quality and security of data and data products.

4.0 OBJECTIVES

The goals of a generally applied technological solution to address the new data management and distribution challenges facing the submarine cable industry are several. A key objective is to maximize the utility of information that can be extracted from the large volumes of available raw data. This objective is applicable to all stages of the submarine cable lifestyle, such as extracting the most cost-effective route from desktop study or route survey data to extracting valuable maintenance information from raw as-laid data. It is ultimately the value of this extracted information that determines the value of the entire data acquisition and processing effort. As a result, the intelligent use of data is a critical objective.

A secondary goal is the distribution of data and information to widely distributed stakeholders. This must be accomplished in the context of the accelerated schedules and reduced timeframes, without compromising the quality and integrity of the data. The users of submarine cable information are now demanding almost instantaneous access to data worldwide. There is also a growing need to provide these users with a means to interact with the data through feedback, interpretation, and modification. As a result, the solution must provide efficient management and re-distribution of such interactive contributions.

An additional goal is the efficient and secure management of data in such a manner that enables and promotes quality and confidence in the data products. As the value of submarine cable infrastructure increases, the consequences of an error or damage to information describing that infrastructure becomes more severe. Consequently, mechanisms for ensuring the quality and security of data are required in any proposed solution.

Reducing the costs associated with submarine cable data acquisition and processing is an additional important goal of any solution. This goal can be achieved in several ways, including the intelligent and licensed reuse of proprietary and/or public domain data. Costs could also be reduced through improved efficiencies in data processing and data distribution mechanisms, as well as the use of relatively inexpensive public domain data to replace or enhance expensive survey-acquired data.

5.0 THE RACAL PELAGOS SOLUTION

5.1 General

Racal Pelagos has been at the forefront of applying technology to submarine cable data management since the late 1980's. The company pioneered the development of cable-specific integrated navigation systems for cable installation operations and the on-board documentation of as-laid cable data. More recently, Racal Pelagos has developed and delivered submarine cable data management systems to several major cable companies. The company has also created and is operating a comprehensive, cable data distribution site on the World Wide Web. These successful initiatives, combined with the development of a sophisticated submarine cable data model have placed Racal Pelagos in an excellent position to address the data management and distribution issues now facing the submarine cable industry.

Racal Pelagos' approach to cable data management has been centered on the use of four key software technologies. The company has used its considerable field and data processing experience in the submarine cable industry to apply these four technologies to the management of cable data. At the core of the Racal Pelagos system is a data architecture, or 'schema', that accurately models cable data in a consistent and logically correct format. This data architecture determines what queries and operations are possible for the overall system and is therefore a critical component of the overall system. The four software technologies that combine in this solution are summarized in the following sections.

5.2 Geographic Information Systems (GIS) Technologies

Commercial GIS systems provide a range of data management functions, including the graphical presentation of data and metadata, spatial analysis functions, and charting. Cable data and cable route data are inherently spatial and are most effectively managed and used as geographic data. The new distributed GIS technologies recently released from Environmental Systems Research Institute Inc. (ESRI) also provide mechanisms for sharing cable data within a local workgroup or with widely distributed colleagues over the Internet. A key aspect of Racal Pelagos' development strategy is the company's close working relationship ESRI, the worlds largest vendor of Geographic Information Systems and spatial data management systems. Racal Pelagos is a consultant partner with ESRI and is a licensed reseller of ESRI products.

5.3 The Internet and Internet-Based Mapping Technologies

Web servers and service-based, Internet map servers now permit the publishing of cable-related data in high-quality maps on the Internet. These technologies thus enable the distribution of “up-to-the minute” RPL or route data to restricted groups, semi-restricted groups, or the general public. This capability can be used for a wide variety of purposes, including permitting programs, collaborative route-selection between project partners, route review by technical experts, or for cable-awareness purposes.

5.4 Relational Database Management Systems

Commercial Relational Database Management System (RDBMS) software is at the heart of any modern data management strategy. It is a mature means of handling large volumes of complex data in many different industries, such as inventory control, insurance, banking, and transaction processing. Commercial scale databases bring a level of formality, control, and security to data management that is not possible with a file-based system, regardless of how organized that system may be.

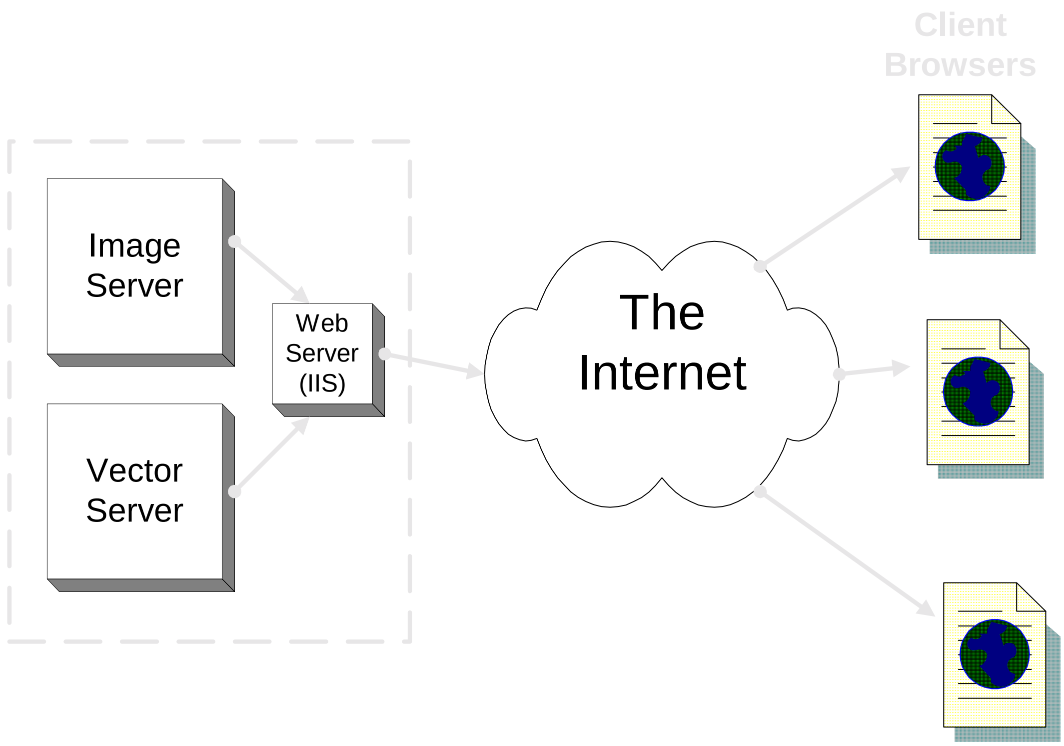
An additional consideration is the fact that RPL data and submarine cable data, in general is inherently spatial and that the spatial portion of the database is indexed to two values – latitude and longitude. This problem of storing spatial data in relational databases is particularly relevant to databases required to allow data access at interactive speeds, and has been addressed by Racal Pelagos using multidimensional indexing technology.

5.5 Customized Software Development

In order to efficiently synchronize the use of various off-the-shelf GIS, RDBMS, and web server systems, it is necessary to maintain control over the inter-system communication and the user interface of the overall system. This is accomplished through the use of the C++ and Visual Basic programming languages, as well as several web-scripting languages. Customized software can therefore be thought of as the ‘glue’ that holds the overall system in place as a single, coherent technology.

6.0 DATA MANAGEMENT AND DISTRIBUTION VIA THE INTERNET

The four technologies outlined above have been combined by Racal Pelagos to create an Internet-based submarine cable data management and distribution System. At the heart of the system is a dedicated cable database built on a commercial, off-the-shelf relational database management system. This database would constitute a central repository for all cable data and would be available for use in a variety of different ways, including the serving of cable data over the World Wide Web in either cartographic, tabular, or electronic formats. The database would also serve as an internal management tool for an organization or consortium and would be fully capable of supporting the dispersed nature of international offices or consortium partners using secure Internet access.



The associated Internet distribution channels are based on a combination of commercial web server tools and custom application software, enabling specific functionality required by the customer. The system would combine both vector and image data sources in an integrated and seamless environment. Racal Pelagos has incorporated the latest image compression technology to permit client side manipulation of very large image data. This means that customers can pan and zoom around large image files, such as side scan sonar mosaics at interactive speeds. This image technology is combined with sophisticated streaming of vector data that facilitates interactive client tools. A customer can identify, query, and even edit this vector data from remote sites that access the Racal Pelagos server via the Internet.

7.0 SECURITY

The principal security concern with a system such as that proposed here is restricting access of distributed data to authorized users while at the same time potentially allowing public access of some data to the public. This security must be substantial due to the value of the data and of the infrastructure described by the data. The first line of defense is standard password/username security managed from within the custom-built site. This requires every user to enter a user name and password in order to be logged onto the system. The usage of the system by each username will be tracked and any attempts to gain unauthorized entry will be recognized.

Additional levels of security can also be provided depending upon the nature of the data and security requirements of the customer. One such system is provided through the use of Secure Sockets Layer 3.0 (SSL3), which encrypts the packets transferring between client and server. This is handled using a secure version of HTTP, known as secure HTTP (or HTTPS) as the transport.

Another level of security could be established through the use of encryption certificates. These certificates work by installing an encryption code on a client computer and then checking for this code (or certificate) before allowing access to the system.

8.0 POTENTIAL APPLICATIONS

The system developed by Racal Pelagos and described in this paper can service a wide range of potential users in a variety of applications. Despite its infancy, the system has already been successfully used to provide submarine cable customers with improved data distribution and delivery channels.

In general, these technologies and this type of system can be used to provide the following services to the marine cable industry:

- data distribution and publication
- collaborative review and interactive editing
- quality control

Looking at specific applications within the submarine cable industry, such a system could be deployed and find immediate acceptance in the following environments:

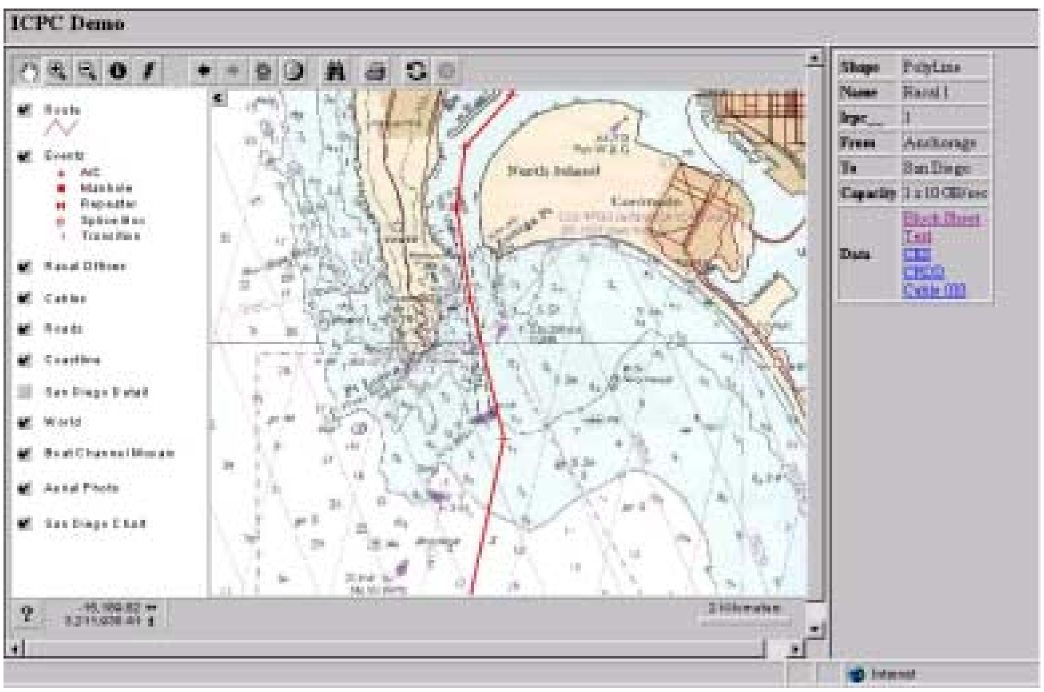
- desktop study
- cable route survey
- planning
- permitting
- cable installation
- cable maintenance

- cable protection
- cable repair

9.0 CASE STUDY: CABLE PROTECTION

The system described in this paper is perfectly suited for managing and distributing RPL data via the World Wide Web for the purposes of cable protection. This could be accomplished in a manner that involves at least two separate distribution channels that access the same underlying cable database.

The first of these web-based distribution channels would provide cable route data and graphical cable-awareness charts to the public. This channel, which would essentially be an "on-line cable-awareness chart", would be entirely browser-driven and would be controlled by the user via a graphical, or cartographic, user interface. The second distribution channel would provide technical level RPL data, possibly including processed engineering data, to authorized users and/or customers using a secure Internet connection.



The principal service, provided by public-level web access to the database, would be the delivery of a graphical cable-awareness chart for a user-selected area with cable route data super-imposed over bathymetric and other chart data. The user interface for the public distribution channel would present the user with a world-scale chart from which the user could quickly navigate to an area of interest using simple 'zoom' and 'pan' controls. The user would initiate a query by graphically selecting an area of interest from the world-scale chart using successively more detailed graphical selections. Once the user had 'zoomed in' past a specific zoom scale all of the available cable and background data would be displayed on the view. The user could browse through this information interactively, by panning and zooming, to refine their area of interest. The user could then chose to print the current view to their system printer, effectively creating their own cable awareness chart for their own selected area. These self-printed cable awareness charts (and the display from which they are printed) would be similar in appearance to publicly available cable awareness charts produced by fisheries and maritime authorities in the United Kingdom and elsewhere. The charts would have a professional appearance and would include borders, coastlines, bathymetric contours, and other ancillary data in addition to cable routes. These ancillary data would be arranged in thematic 'layers', which could be enabled or disabled by the user. The user could make the cable awareness chart as complex or as simple as required based on their individual needs.

A demonstration of this concept can be viewed at the web site http://gis.racal-pelagos.com. This web site has been set up to demonstrate some of the general concepts outlined in this paper.

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