BIOGRAPHICAL INFORMATION

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Specific Responsibilities

Mr. McDougald is responsible for Byers SpatialAge product management. He manages product definition, requirements analysis, as well as software development activities and processes.

Past Experience

Mr. McDougald's 25-year career spans over two major professions (or lines of business). His first 15 years was spent as an Engineer and Manager in the area of telecommunications outside plant engineering and planning, with 10 years in the design of OSP fiber optic networks. During the last 10 years, Mr. McDougald has served as a Business Analyst, Product Manager and V.P of Technical Sales, in the area of GIS system development within the telecommunications and utilities industries, specifically related to AVL (Automatic Vehicle Location) and Utility One Call systems. Mr. McDougald has been involved in GIS projects for BellSouth Telecommunications, US West (now Qwest) and Georgia Power Company.
In addition, he was a founding partner for a One Call Utility Locate Screening and Project Management Company that is an Internet based application service provider (ASP).

Educational Information

B.S-Industrial Arts Education – Middle Tennessee State University

Affiliations

ITS (Intelligent Transportation Society)-America and Georgia Chapter of ITS-America
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"From Desk-Drawer to Desktop"
Developing & Implementing a Collaborative
Fiber Facility Network Management & Design System

Abstract

In the Outside Plant (OSP) telecommunications networks of today, fiber optics has become the media of choice for transporting communication signals to end subscribers. As the fiber facilities are extended into every portion of the OSP network, the ability to design and manage these facilities has become increasingly important yet problematic with the current AM/FM/GIS tools and non-nodal telecom data models. This presentation will cover how current technologies and methods can be used to migrate incrementally from existing tile-based graphic systems into a geospatial seamless environment. It will cover the application benefits of being able to**:** view, traverse, and analyze fiber networks down to embedded optical wavelengths or individual strands with no spatial or data limitations. We will look at real-world cases of how this system benefits the engineering and planning, construction, maintenance and provisioning processes of a telecom provider. The process to interface, migrate, and interpolate data from existing sources into a geospatial world presents unique challenges**.** We hope to share how this application tool can become a reality that will increase your organization's efficiency and customer service by sharing near real-time data collaboratively via the web.

Proliferation of Fiber Networks

The continued demand for even higher bandwidth Broadband services by communication consumers has escalated the penetration of fiber into the last mile of the OSP network. Extending these facilities in combination with new and varied transport architectures and technologies has placed an ever increasing pressure on the ability to rapidly and accurately plan, design, implement and maintain the fiber facilities, not only at the physical layer but into the optical layer as well. The planning and design of the fiber network additions are typically segmented across multiple organizations due to current and past regulatory conditions. Today, many Local Exchange Carriers (LEC's) and Independent Local Exchange Carriers (ILEC's) plan and design local exchange fibers in one group, while inter-office and transport facilities are designed in another. However, in many cases, these organizations share the same structures or even fiber cables. The continuation of deregulation of the operating companies continues to blur the lines in the traditional segmentation of the OSP network. Thus, collaboration in the planning and design of the network is paramount to assure that maximum utilization of the overall fiber network occurs.

One of the more recent drivers for the expansion of the fiber networks is the push for FTTP (Fiber-To-The-Premise) deployment that is driving the optical circuits into the last 100 feet of the network. It is estimated that the RBOC's (Regional Bell Operating Companies) between 2004-2008 will spend over 40% of their capital expense budget on the deployment of FTTP facilities. The deployment of FTTP will place even greater pressure on the management of the existing fiber backbone network. The different network transport architectures and protocols include Passive Optical Network (PON), Synchronous Optical NETwork/ Synchronous Digital Hierarchy (SONET/SDH), Asynchronous Transfer Mode (ATM), and Dense Wave Division Multiplexing (DWDM) have different physical network design requirements. These requirements demand a system capable of modeling these networks, their related devices and circuit paths to a detailed level. In particular, the emerging network and transport architectures have more finite transmission characteristics that require a level of analysis that can only be accomplished currently in a manual environment where information from existing facility and equipment management systems are summarized onto manual schematics, diagrams and sketches. In addition to the design, the maintenance of the fiber network requires details that currently cannot be stored or presented within the existing facility and equipment management systems. From a maintenance perspective, with current facility systems there is on efficient way to locate and pinpoint network outages.

Fiber Network Data in Today's World

Currently most tier one and two LEC's (Local Exchange Carriers), ILEC's (Independent Local Exchange Carriers) and CLEC's (Competitive Local Exchange Carriers) operators have CAD/RDMS based Facility Management Systems (FMSs) for designing and maintaining OSP/ISP facilities. In most cases, other dispersed/isolated systems maintain data specific to equipment racking, optical patch panel connections and cards/ports for both optical and digital tributary circuits. In many cases, as mentioned previously, this data is segmented between local loop and transport circuits due to past regulatory requirements. This segmentation across multiple dispersed systems makes it tedious to analyze the physical end-to-end fiber capacity and optical layer from an enterprise perspective. The current CAD tile based graphical systems limit the ability to visually analyze the network from a birds eye and seamless view. In addition, the typical telecom Facility Management data model doesn't contain the entities such as strand and splice which are required to enable the capturing of detailed transmission loss data at splices or connections for the purpose of detailed circuit design and loss analysis.

Moving Towards the Future

Now that we have a clear picture of the current environment, *why* migrate facility data incrementally into a geospatial platform, without replacing the current FMS? For most telecoms, fiber facility data can be loaded from the existing AM/FM/GIS systems into many other geospatial platforms. This is not a problem, however this is far from replacing the existing Facility Management System (FMS). A total system level migration to a Geospatial platform is today considered cost prohibitive--we learned from the re-engineering trends of the 90's that the short term results from total system replacement is usually less than desirable. The concept of a Fiber Network Management System is not to simply replace functionality, but to extend it by interfacing with data from external systems to provide a powerful design and analysis tool. By bringing this data into a single graphical geospatial interface where the physical OSP network and logical optical layers merge.

This presentation describes implementations at a tier one LEC and a tier two ILEC. Both companies have implemented a Fiber Management Tool (FMT) to improve optical circuit provisioning and fiber facility planning and restoration. These FMT deployments are viewed as a first step in an incremental approach to migrating facility data into a geospatial environment.

This document does not focus on software development or its methodology and assumes that the typical processes are understood, but the focus is on the critical steps encountered during the implementation of FMT in both cases mentioned above.

These critical steps include:

> *Database Exploration & Design* – Analyze existing data sources and determine logical links between disparate systems. In addition, determine where and how data interfaces between FMT and external systems will exist. The methods for interfacing to this data can and will vary from system to system. In some cases, data may be exported on a periodic basis, or via transactional interfaces or programmatic interfaces via ODBC or JDBC connections retrieving data on an as-needed basis. In cases where data is replicated in both systems, determine and how often and whether to load target data incrementally, by bulk, or via transaction for FMT updates.
>
> *Conditioning Source Data* - Define changes to existing source facility data and assure data completeness and accuracy.
>
> *Facility Data Loading Process* – Define processes for loading/extracting facility data from source FMS to target FMT in both bulk and incremental modes.
>
> *Generate Fiber Nodal Model* – Define processes for creating FMT nodal-edge model entities. This process will be required for bulk, incremental and transactional loading.
>
> *FMT Functionality* – Review the system and business requirements to meet the needs of improving engineering, provisioning and maintenance processes.

Data, Data & Data

Today the data associated with fiber optic OSP & ISP facilities and optical circuits is segmented across many different data management systems and sub-systems. With this environment, the ability to interface/link this data up to a geospatial feature provides the ability for accurate, real-time capacity analysis and planning. With telecom companies driven to minimize capital expenditures in the backbone fiber facilities by maximizing the utilization of the physical fiber layer, these links and associations are critical in achieving this goal. Major components of the physical fiber network layers must be correlated to the optical and virtual layer entities in order to provide a full breadth view of available, unavailable and underutilized capacity. The most common link between circuit data and the physical fiber layer will be the logical fiber that is derived and created as an entity in FMT from fiber cable complements. A corresponding logical fiber attribute will reside in the assignment system. As other source databases were analyzed, other common links such as CLLI (Common Language Location Identifier) codes, an industry standard maintained by Telecordia, were identified as logical links. The CLLI code can be utilized to link equipment details such as cards/ports to devices that reside in the facility data. In many cases, circuits also have an association to cards/ports thus providing additional methods for linking to a physical layer. In addition to CLLI codes, other attributes such as addresses, system numbers, etc., can be found providing logical links between entities in these various systems. However, other pertinent information relative to analyzing the networks from these perspectives is often kept on dated spreadsheets, paper, or digital schematics all located in non-centralized data stores (local PC's). Often, the manual, digital, and paper data remain in the "desk drawer" or isolated on desktops of the documents' author. This makes sharing information with other interested parties difficult. The FMT system brings together a central repository for supportive documentation and data. FMT was designed to not only link the electronic data, but to link and share documents, as well. The various data sources are depicted in the typical FMT architecture below in figure 1.0.

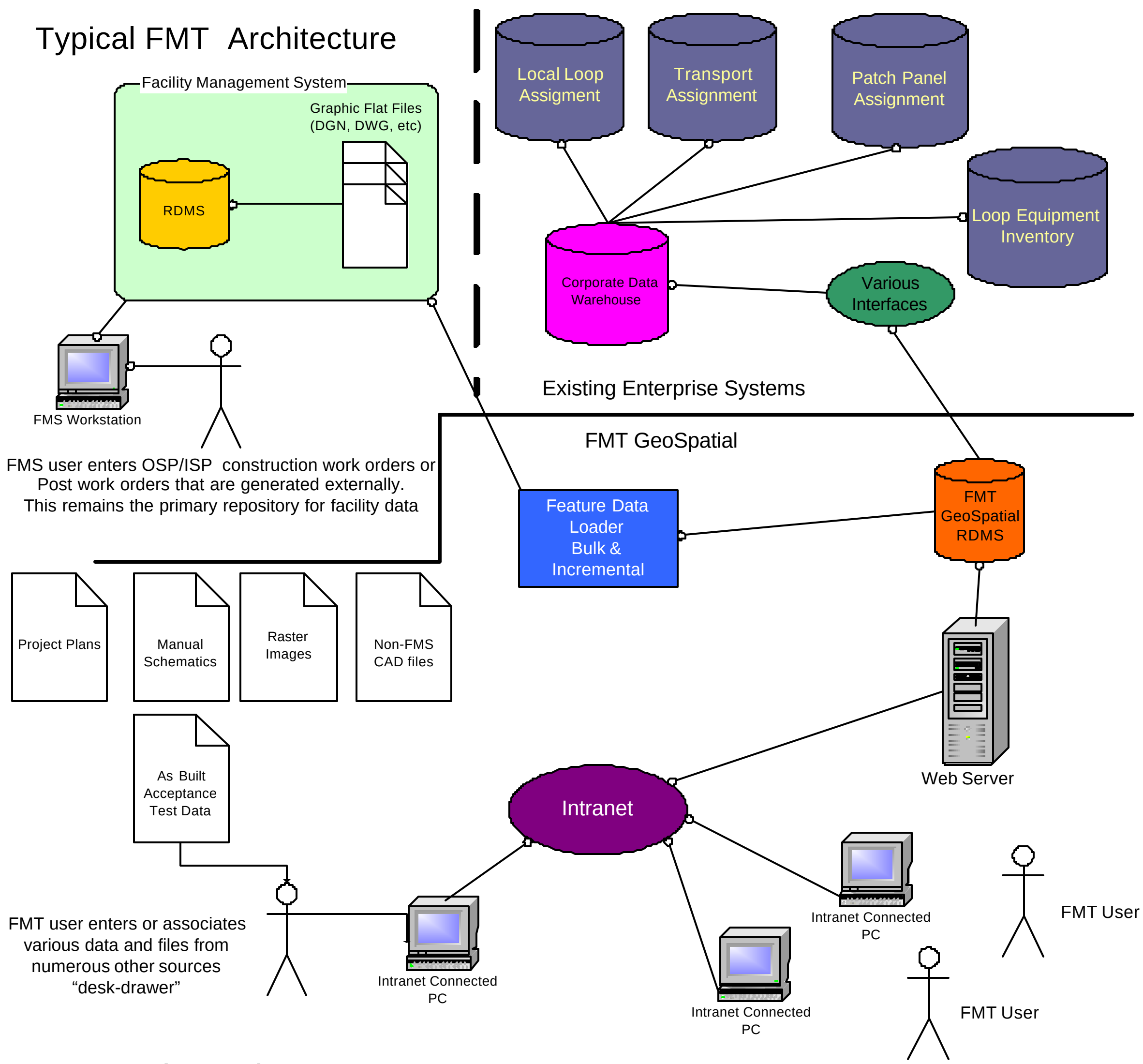

Figure 1.0 Typical FMT Architecture

Conditioning Source Data

Before the FMT database can be established, data must be extracted from the source FMS. Prior to this extraction, several required data conditions must exist for FMT to effectively generate the required physical entities in creating a true edge-nodal model. One of the primary data sources used to create network connectivity is the facility complement data. Complements are common data attributes associated with fiber facilities such as fiber cables and fiber devices (Multiplexers, Network Interfaces, Gateways). Most telecom FMS data models utilize complements to manage physical connectivity of fiber strands without having a strand entity. These records are typically structured with ID, low pair and high pair ranges, line numbers, sequences, throw status, owner feature ID and source feature ID. These features need correct sourcing, especially in fiber rings (i.e. SONET) where sourcing must represent direction or side of a ring. In addition to complements, splice case features are needed to provide physical connectivity between fiber cables. However, splice case features can be created during the FMT data loading process. In addition, the splice case must be utilized to designate where fiber cables connect between wire centers or LATA geographical boundaries. This will provide the ability for FMT logic to traverse programmatically across wire center boundaries, providing seamless analysis unbounded by current dataset or system limitations. These features can be created in a batch process within the existing system. In addition to splice case features, the manhole and conduit features containing fiber cables should be intelligent and with associations to each other and the fiber cables within. In most cases, the cost to build these features within the source FMS is minimal and this linking provides the ability for underground facilities to be visualized and represented in FMT.

Loading Facility Data Initially and Ongoing

The loading of the source facility data is a programmatic process that can be accomplished via custom software reading the graphics files and associated relational data in a step process. These processes are defined specifically to bulk load data in an “initial” load and then incrementally update data ongoing from the source to the FMT target tables. In addition to custom software, commercial “off-the-self” products are available that can translate/transform and import/export both graphical and relational data from various formats into enterprise spatial RDMS such as (Oracle, Db2 and SDE). In the examples utilized in this document, both custom and off-the-self translators were used. However, custom facility data loader software was used that interpreted the graphical properties of features from graphics files to determine the type of feature. These features are loaded into staging tables in the target database where graphics are linked with the corresponding attributes. The custom data loading process (see figure 2.0) is comprised of 4 major processes defined as follows:

- *Graphics Translator:* the component to read data from source graphics files, convert them into the target RDMS spatial data format, and store the converted objects into staging tables in the target database, which are used later to link graphics to the tabular data. This component also writes graphics files information to the Drawing table, including files that are loaded and the timestamp of each file.

- *Non-Feature Table Translator:* A non-feature table is a DB table without any associated graphics data, such as complements in a typical facility management telecom model. This translator copies data of non-feature tables from the source database to the FMT database and is not dependent on any other component of the facility data loader.
- *Linker:* is the component to copy each record in a source feature table with its corresponding FMT feature table as well as to put all graphics data associated with it into the FMT table. After the Linker process, each feature instance is a record, which includes both attribute data and graphics data, in the FMT database table.
- *Primitive Graphics Linker*: is the component to filter primitive graphics (graphics without corresponding attribute data) into several specific primitive tables based on predefined descriptors that are specified in the metadata. The process can be configured to start after the Graphics translator finishes successfully.

After the initial data load, the facility data loader will operate in an incremental mode, loading only the differential data between the source and target. When running incrementally, the Graphic Translator checks the timestamps on the graphical files to see which file has change since the last update. Once these files are established, then the translator performs an equality check between the temporary geometries and the target geometries of features from the same source file to determine which features need to be updated. Features with different checksum values are loaded into the staging tables to either replace an existing feature or insert as a new feature that was identified.

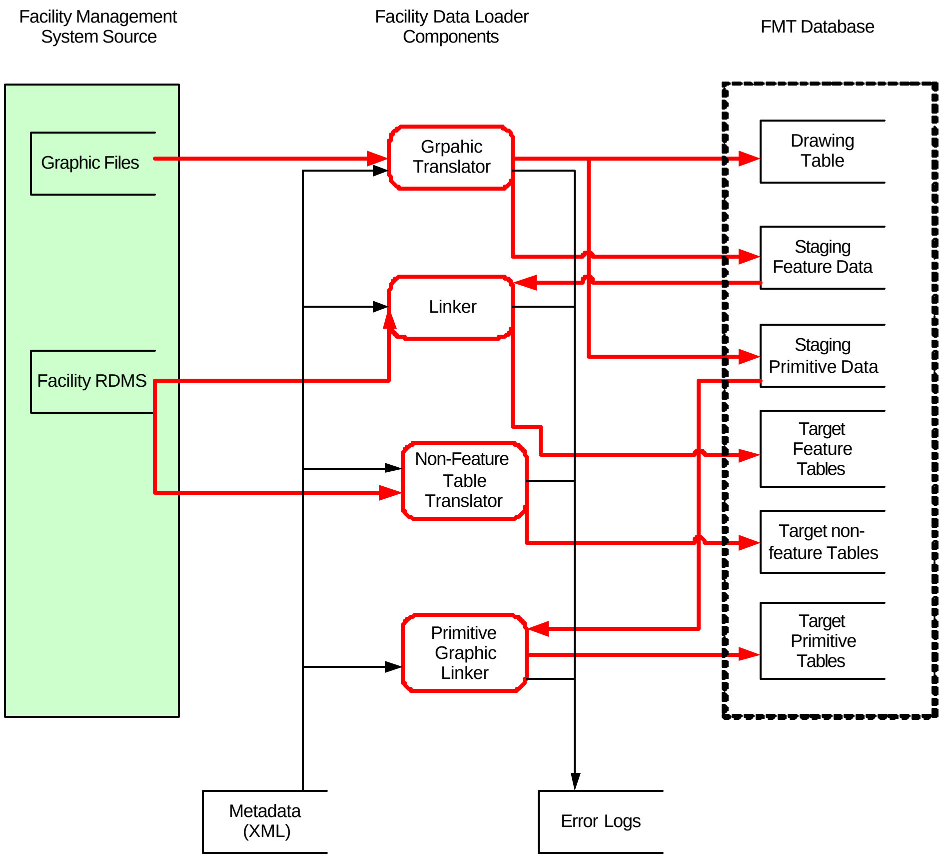

Figure 2.0 – FMT Data-loader Process Dataflow and Process Diagram.

Exploding The Fiber Facility Data Into A Nodal Model

Once the FMS source data is loaded into the FMT target database, a process called the "Fiber Assembler" is run. This creates physical and logical fiber entities that don't exist in the source data or other external systems. These physical entities include: STRANDS, PORTS, SPLICES and EQUIPMENT LOCATIONS. The logical entities created are FIBER ASSEMBLIES and ASSEMBLY SPLICES. The Fiber Assembly is a logical entity that joins the physical entities that make up a contiguous physical path in the fiber network. A contiguous path contains fiber strands and ports connected together. The Fiber Assembly is created to provide rapid access to the fiber network data and to expedite logic such as a fiber trace. The logic creating the assemblies traverses through the source connectivity data (complements) in reference to fiber and device features creating these entities and relationships--one logical fiber at a time. The creation of this data which is necessary for the node edge telecom model places a high precedence on the accuracy of complement sourcing data and fiber cable splice case association or know as A and Z node ID's as discussed in the *Conditioning Source Data* section. For FMT functionality benefits to be realized, source data must be both complete and accurate.

FMT Functionality

Once the FMT database is populated users are ready to access the application. The FMT application layer implemented in both case studies were JAVA applets connecting to an intranet web server. When the FMT application is launched, the user has access to standard GIS functions and capabilities such as feature layering zoom extents, thematic mapping, dynamic labeling, custom views, spatial queries and theme creations for custom maps. In addition to these general GIS features, a very important collaborative function is the ability to enter text notes or attach any file with any FMT feature, which provides and meets the document management requirements as addressed earlier. Therefore, a manual site sketch can be scanned to create a digital image and attached to the equipment location feature that is uploaded in the FMT database. This makes the file accessible to all FMT users who have proper permissions. These generic features greatly enhance the analytical capabilities with the facility data. However, the real power of FMT is in the custom functions and routines that deliver the end results for specific users.

The domain specific functions implemented in the FMT solutions were:

> *Fiber Trace* – Allows a user to run a trace by keying or selecting a: Logical Fiber, Assembly_ID or Optical_Circuit_ID (generic name for Circuit_ID or SONET_ID). The trace presents a graphical view distinctly highlighting features along the fiber path. In addition, tabular data is presented with the features ordered based on sourcing from the C.O. or remote with both calculated and estimated loss values. User can navigate from the tabular to graphical views via point & click. A trace can be launched from a fiber feature by selecting the logical fiber. With the data in FMT, fiber traces can transcend geographical or logical dataset boundaries that existed in the FMS source data--now traces can result in a truer picture of the paths as they connect from Central Office to Central Office. See figure 3.0 for a GUI example of a fiber trace.

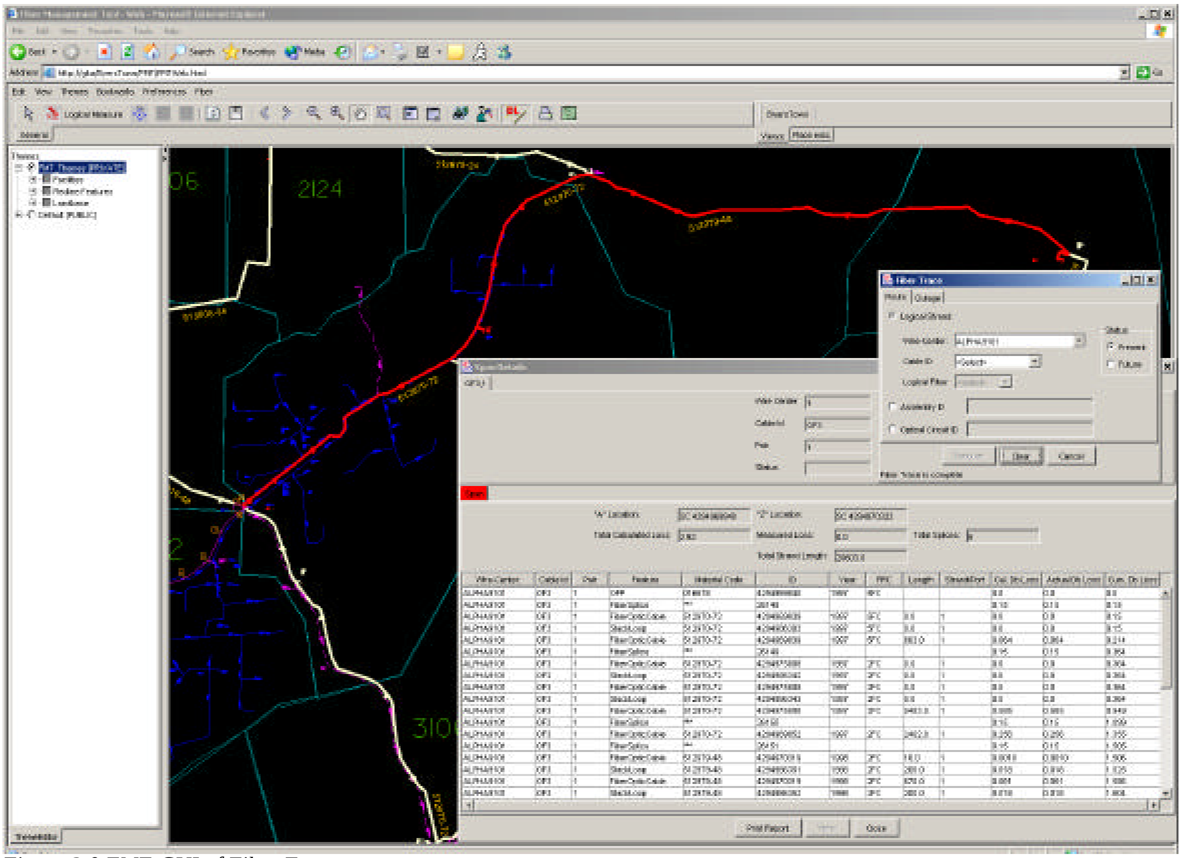

Figure 3.0 FMT-GUI of Fiber Trace

Fiber Outage Locate – Determines the geographical and logical location of a fiber outage. In order to calculate this location, the user first enters a Db_loss or optical sheath distance value for a logical fiber. The system first determines logically the cable section where the outage has occurred then interpolates along the outage cable section geometry to pinpoint the corresponding geographical location. This interpolation takes into considerations fiber loops (coils of fiber at a single geographical location) and the ratio of sheath distance to feature linear distance. This allows the outage location to be accurately pin pointed. The fiber outage logic recognizes when a locate has been launched from a fiber device and calculates (on user selected side) the distance from said device. In addition to pinpointing the location, this function can present restoration orders based on circuit data associated with the physical strand layer.

Diversity Check – Provides the ability for an engineer to validate an existing or planned view of the network to assure that the two sides of a ring path are diverse. This function allows the user to select two logical fibers or two different sides of an existing ring and then the system compares the physical paths of these fibers to determine if they are diverse. The function has two different modes, one is a route level check that analyzes to see if the corresponding fiber cables don't share the same structure or physical route corridor and the second mode is a sheath level check that determines if the paths don't share a common sheath.

Logical distance Measure – Determines the sheath distance between any two random points on the network. The user clicks two points on any network feature and the system presents a list of connected logical fibers between these points. User selects a logical fiber to measure then the measurement is presented and the path between points is highlighted.

Strand Viewer – Provides a user with a tabular view of all strands for a selected fiber cable. Provides details about the strands A and Z connectivity and termination ends, as well as section and segment measured and estimated loss details

Splice Details Viewer – Provides a detailed view of the A and Z connectivity for a selected splice case. This gives the user a tabular view of all strand-strand, strand-port or port-port connections. The user can enter splice measured loss values within this interface, as well.

Equipment Racking – Provides the ability to enter Bay and Rack logical entities at an equipment location then associate fiber devices with the appropriate rack and enter position details. Users can see a tabular representation of each rack and its associated equipment and relative physical position.

Optical Circuit Viewer – Provides a view of both transport and derived Optical Circuits such as DWDM (Dense Wave Division Multiplexer) circuits. The user can see each optical circuit summarized at the particular optical layer and the relationships between optical transport and tributary/derived circuits.

Sheath Utilization Viewer – Provides both tabular and thematic graphical presentation of fiber sheaths and the summarized percent utilization at the physical fiber layer. Provides a quick reference to see routes that are exhausting or routes where available capacity can be utilized. This data can be rolled up and summarized into route structure features such as route conduits that can contain multiple sheaths.

Plan Management – Provides for plan creation and state management of plans. Plans can reside as Private--meaning only the author will see its additions and modifications or as Public--meaning the plan is viewable by other users. In addition to these states, a Plan can be Published, which means that the content that differs from the live model (the data from the source FMS) is merged into the live model with the latest published plan changes to be displayed distinctly, both graphically and in the data base (?). When a plan is created, it can name a prerequisite plan to inherit changes from the prerequisite plans into the new plan as existing or in place. A user can place planned features and enter or update connectivity via logical complements or physical connectivity. These connectivity changes will cause the Fiber Assembler process to run the first time logic, e.g., Fiber Trace is invoked while active in the plan. When fiber assemblies are created they are assigned a state attribute of either Existing, Future or Planned, regardless of whether created during data loading or plan creation. When running a fiber domain logic like Fiber Trace, the user can specify Existing or Future state.

There are many domain functions that can be provided. These were just a few of the features implemented in the FMT cases utilized in this document.

The Net Effect – What's The Benefit ?

So, why deploy a separate web enabled system for your fiber facility design and analysis? To simply state it, deploy a system to extend the functionality of existing systems and data. The FMT implementations provides a tool to help extend and improve functionality beyond what was currently available and required by the telecom engineers and maintenance personnel to build the existing fiber networks.

The benefits of FMT are seen as:

- *Web enabled access to facility data* – FMT described in this document is a web application providing interactive/dynamic mapping and presentations via the intranet. There are many ways to implement web-enabled applications from developing JAVA applets to utilizing other off-the-shelf, thin client technologies.
- *Optimize Fiber Facility Utilization* – The ability to access and visualize utilization at physical and virtual layers improves the management of the existing facilities.
- *"Just-In-Time" Facilities* –Capacity and utilization data residing in a single route monitoring system can be more accurate and complete resulting in more timely network reinforcements.
- *Improved Planning Across Network Segments* –Users across the operating company enterprise can share plans within an electronic forum that increases communications and minimizes overlap and redundancy.
- *Reduce the Planning/Estimating Timeline for Customer Estimates* – The ability to estimate based on up-to-date, accurate facility data reduces the current guesswork in estimating circuit design for customers.
- *Reduce Circuit Provisioning Timeline*-- Links to assignment, equipment and cross connect data can provide the ability to reserve end-to-end facilities assuring capacity will be available when orders are activated/installed.
- *Reduce Network Outage Downtime* – The ability to rapidly pin-point and visualize affected circuits and customers geographically with in a single system reduces the outage or downtime.
- *Utilize External Spatial Data* – With the fiber facility data in a open geospatial database other external data can be easily integrated such as demographic and Ortho-satellite imagery for planning and FTTP design