Designing and Managing Fiber Optic Networks

G/Technology Fiber Optic Works: Intergraph®'s Complete Solution for Fiber Management
# Contents

1. Introduction .......................................................................................................................... 1

2. The Problem ........................................................................................................................ 2
   2.1. Limited Design Experience ......................................................................................... 2
   2.2. Insufficient Ad Hoc Records Systems ...................................................................... 3
   2.3. Insufficient Work Process Integration ...................................................................... 3

3. A Geospatially Enabled Fiber Management System ............................................................. 4

4. Benefits .................................................................................................................................. 5
   4.1. Transform Engineering Design .................................................................................. 5
   4.2. Transform Field Construction ................................................................................. 5
   4.3. Transform Customer Satisfaction ............................................................................ 5
   4.4. Transform Installation and Repair ............................................................................ 5
   4.5. Transform Planning, Marketing, and Sales ............................................................... 6
   4.6. Transform Enterprise Information Access ............................................................... 6

5. The Intergraph Solution ........................................................................................................ 7

6. How Does Intergraph’s Fiber Solution Work? ..................................................................... 9
   6.1. Outside Plant Design ............................................................................................... 9
   6.2. Inside Plant Design .................................................................................................. 10
   6.3. Automatically Generate Schematics ......................................................................... 11
   6.4. Supporting “Microduct” Technology ........................................................................ 12
   6.5. Fiber Splice Editor .................................................................................................... 13
   6.6. Cable and Circuit Reporting ..................................................................................... 14

7. Fiber Optic Works: Your Complete Fiber Solution .............................................................. 16
1. Introduction

The demand for fiber optic network infrastructure continues to grow as organizations position themselves and their communities for future growth. In addition to telecommunication companies, utilities and transportation agencies realize the benefits of installing a fiber network. Compared to alternatives such as coax cable, fiber provides more bandwidth and more flexibility at a similar price.

The growing demand for fiber optic networks not only creates the need for more designers, it also creates the need for an information system to manage the infrastructure. The integration of engineering design and visualization tools with network data asset management is an ideal application for a geospatially enabled infrastructure management system.

A geospatially enabled infrastructure management system can transform engineering, field construction, customer service, and more. Intergraph® G/Technology Fiber Optic Works provides you with a complete software product for fiber design and management, meeting the requirements for both outside and inside plant design. This white paper discusses the benefits of Intergraph’s Fiber Optic Works solution.
2. The Problem

The demand for increasing bandwidth (voice, video, and data traffic) continues to drive the demand for fiber optical networks. Based on the immense capacity of fiber – already the foundation of the world’s telecommunications system – Fiber to the Home (FTTH) is now being deployed around the world. Even with a challenging economy, almost all large developers use fiber in their new developments. Larger telcos deploy it in cities and suburbs, while smaller telcos install it in rural areas. Municipalities in the U.S. and elsewhere recognize how FTTH delivers a feasible solution today and positions their communities for tomorrow’s jobs and economic growth. Smart metering and smart grid applications are major reasons why utilities across the world invest in building private fiber infrastructures. Transportation agencies, requiring a communications backbone for their intelligent roadway management systems, are beginning to design and install their own fiber networks.

Fiber offers more bandwidth and more flexibility than alternatives at a similar price, such as coax cable (Figure 1). Fiber offers higher reliability and fewer connections inside the home. Phone companies, public utilities, state agencies, and now, numerous cable companies, have been installing future-proof fiber infrastructure.

Figure 1: Fiber offers more bandwidth and more flexibility than alternatives at a similar price, such as coax cable.

The surge of fiber networks requires new software tools for the design and management of fiber network infrastructure. While traditional copper networks have been around for decades, fiber networks are different, and the technology changes rapidly. The rapid adoption and deployment of fiber infrastructure creates several challenges for those building and operating these networks. These challenges include:

2.1. Limited Design Experience

The rapid growth of fiber highlights the need to train more designers to design fiber networks. Large and small organizations require better design tools. Companies need to share proven design methods across larger teams of designers, or make them available to the one or two designers in the organization now responsible for network design. To help ensure consistency in design, organizations need to share best
practices with design teams and individuals. The rapidly expanding use of fiber and the resultant rapid innovation in design and best practices has created challenges that require better ways to propagate standard approaches.

2.2. Insufficient Ad Hoc Records Systems

Large and small teams need standard processes to operate efficiently and effectively. For many organizations, the design and installation of new fiber infrastructure resulted in the creation of numerous ad hoc record systems to capture the design and installation data describing the network. For smaller organizations, there is usually little time to create an optimum information system solution for only a few users. Designers usually create drawings with computer-aided design (CAD) files and locate them in various places. Meanwhile, network data is recorded in spreadsheets, and IP addresses may be recorded in another local database. The information is not directly related between the different filing systems. To manage a change to the system after installation – such as reassigning an IP address – you must spend hours researching and assembling all the data.

2.3. Insufficient Work Process Integration

Fiber represents a significant investment in your network assets. This asset information is central to several key business processes, including the provisioning and customer service of the network. When ad hoc record systems house the asset information, it becomes nearly impossible to significantly automate the other provisioning and customer service-related work processes. This results in significant operational inefficiencies. Provisioning systems require data to be re-entered redundantly, even though that information was captured during network design. Customer outages and calls require organizations to locate CAD drawings and visually inspect them to determine possible causes of the outage. This forces you to spend time and money inefficiently, while customers become impatient and satisfaction levels drop.
3. A Geospatially Enabled Fiber Management System

The solution to these problems is an information system that integrates both the design and asset management processes required for the fiber network. The integration of engineering design and visualization tools with network data asset management is an ideal application for a geospatially enabled infrastructure management system. Such a solution combines the geospatial mapping and spatial analysis capabilities of a geographic information system (GIS) with the design and engineering capabilities of computer-aided design CAD, together with the database and reporting capabilities of an enterprise asset management system (EAM). This solution gives you the ability to view the fiber network data geographically on a map, and to design new fiber networks and additions interactively in a CAD-like environment. As the fiber network is designed using CAD, all of the important network asset data is captured during the design process and stored in one integrated database. The fiber network engineering drawings and all data are integrated in one easy-to-use system. The single system can also integrate and incorporate tools for engineering calculations as part of the design process. This type of system provides design tools to help the novice fiber designer and to enforce consistent design across a larger group of designers. The integrated data management system consolidates all information into one easy-to-access database. Information about the network is readily available in one place for easy access, for designers and for use in other mission critical business systems.
4. Benefits

4.1. Transform Engineering Design

A geospatially enabled fiber management solution can transform engineering design. One integrated system can support the design, estimating, tracking, and closure of capital jobs for the full asset life cycle. This system can serve as an enterprise platform that can help enforce standardized designs and materials requests, while supporting the creation and maintenance of an enterprise asset record. It can reduce duplicative hardcopy maps and eliminate redundant work. It can provide seamless data across the enterprise representing the network assets for use in other business systems. The system can improve job coordination, workload balancing, and support outsourcing opportunities. You can optimize capital jobs in a number of ways, including standardizing materials. For the engineering design process, such systems have directly contributed to productivity and cost reductions of 10 to 15 percent.

4.2. Transform Field Construction

The benefits of a geospatially enabled solution can transcend the design process and transform field construction. Such a solution extends the engineering design and construction process from the office to the field with an automation of information flow to-and-from the field for jobs, work plans, and as-built capture. Adopting an enterprise architecture can streamline the entire workflow, reducing labor by eliminating duplicative data capture and providing immediate information updates. Using Intergraph's mobile solution, the system enables better two-way communications among office, field staff, and contractors, reducing the number of field trips, and reducing or eliminating windshield time. More accurate bill of materials reports to match contractor's jobs result in fewer delays by contractor and fewer adds and retires. With the elimination of backlog records, there is no more latent information. This results in better planning and coordination between the design office and contractors. Contractors can input directly to the system, eliminating extensive paperwork. Such systems have achieved productivity and cost reductions of 10 to 20 percent.

4.3. Transform Customer Satisfaction

This solution can also transform customer satisfaction. Customer service representatives (CSR) and engineers can quickly resolve routine requests from customers, eliminating the need for offline research through records and reducing the need of field verification. The system can support rapid qualification of service availability to consumers, new and existing, through loop makeup queries based on customer location. The system eliminates time consuming map/record and assignment system research by integrating information from multiple systems in one GIS-type query. The response time to your customer is fast and information provided through the system is accurate, increasing customer satisfaction. Workflow transformation, including integration with corporate information systems (i.e., SAP, Oracle, others) and future assignment, work management, and other systems have achieved three to five percent productivity improvements across the enterprise.

4.4. Transform Installation and Repair

You can dramatically improve installation and repair processes through automated facility information and work order information on mobile terminals for installation and repair crews. The system can optimize routes and provide better information for accurate locations of terminals and devices, along with providing a more accurate inventory of materials. It can help provide more immediate recognition of priority services for restoration, such as which cable is in which manhole/duct. It can eliminate paper file management and replace paper with digital work orders. You can realize substantial benefits from a completely integrated
office/mobile “data-centric” architecture. The solution can streamline processes associated with access to external systems (assignment, job management, etc. from field). With the large numbers of technicians in the field that are impacted by these processes, typical productivity improvements of one to two percent represent significant productivity and material savings.

4.5. Transform Planning, Marketing, and Sales

The system can transform planning, marketing, and sales processes by providing a geospatial context for analysis of the network and customer data. It can enable enterprisewide analysis of the network, including consumer patterns and network availability. You can use it to integrate third-party demographic data with network data for strategic planning, marketing, and sales. It can also support more focused marketing and analysis of strong and weak purchasing patterns. You can identify over- and under-utilized portions of the network. The system can integrate data from external enterprise systems with the geospatial network data to target products, bolster sales, and consider expansion potential. It can help enforce standardization and enable collaboration of planning, sales, and marketing teams. Many of the benefits are strategic and more difficult to quantify, yet are important to growing and expanding the business. You can achieve a “market edge” with powerful performance and trend analysis and the ability to integrate network location data with customer and commercial data. By not being constrained to a particular geography, it can be a powerful tool for planning, marketing, and sales, within the current franchise area, or beyond.

4.6. Transform Enterprise Information Access

Most importantly, the system can enable enterprisewide access to current facility plant information and information maintained in integrated external systems. This can provide enterprise user access for locators, field technicians, customer service technicians (CSTs), network and cable techs, customer service representatives (CSRs), and others. You can eliminate reconciliation through records research. Individuals can make their own information searches instead of relying on engineers and records clerks. This can increase exposure and the use of accurate asset information across the enterprise, improving workflows and efficiency. Open access to enterprise information can empower hundreds or thousands of employees, breaking down information barriers.
5. The Intergraph Solution

Intergraph’s solution for the design and management of fiber networks is our G/Technology Fiber Optic Works product set, a proven enterprise-scalable geospatial infrastructure management solution that improves productivity and information access. Fiber Optic Works is an add-on, fully supported application to Intergraph’s G/Technology geospatial platform. G/Technology is the leading geospatial platform for hundreds of leading utilities and communications companies worldwide, managing their geospatial network infrastructure. Fiber Optic Works, built on G/Technology, is designed to take full advantage of Oracle database management technology and Oracle Locator geometry storage to deliver a world class fiber management solution. Fiber Optic Works provides a complete integrated outside and inside plant solution design and asset management solution for owners and operators of fiber network infrastructure.

Fiber Management Solution

- **Document**
  - Complete, connected OSP and ISP network inventory
  - Native discovery of SNMP devices for ISP
  - Sophisticated data collection utilities
  - Integration with logical managers

- **Design**
  - Sketching tools
  - Collaborative design capabilities
  - Job management
  - Version control
  - Physical design

- **Deploy**
  - Bill of materials
  - Service orders
  - OSP & ISP Work orders

- **Operate**
  - DNOC, End-to-end Network View OSP and ISP
  - Ability to locate failed devices
  - Integration with alarm management, help desk and other point applications
  - Disaster recovery

- **Provision**
  - Up-to-date views of OSP, ISP and circuit assignments
  - Integration with configuration management and service activation applications

Figure 2: Intergraph’s Fiber Optic Works Solution can break down organizational information silos.

Intergraph’s solution for fiber data management meets the IT requirement for an enterprise data environment, and can break down the business silos, while seamlessly supporting the activities of these groups that span their organizational units (Figure 2). It is no longer acceptable to build isolated islands of data or workflows that end at an organizational boundary. As an example, the provision of a service must be seamless from a data and process point of view from the service representative, to the engineer, to the construction team, to the installer, to the final service activation. Intergraph systems are designed as enterprise implementations to support workflows across the organization.

Intergraph is the market leader in providing an open, centralized data repository for communications and utility company network inventory. In the communications industry, our solutions provide complete infrastructure management for both inside and outside your plant. To meet the needs of our customers, Intergraph technology is built on an open database environment that stores all data and geometry in a
standard regional database management system (RDBMS) with no proprietary components between the user application and the network information database.

To ensure that our solutions meet the present and future requirements of our customers, we support the key standards that define both technology process requirements. Two key components of these standards are the New Generation Operational Support Systems (NGOSS) and Enhanced Telecom Operations Map® (eTOM). NGOSS requires a complete, centralized inventory of network information to support the deployment of operational and business support systems and software. To achieve this, Intergraph’s fiber data management development strategy was to:

- Start with a “clean sheet” to ensure the solution was not compromised
- Develop a “data driven” environment and add the functionality on top of the technology
- Focus on NGOSS standards to meet the business processes
- Focus on performance
- Provide a single point of access for all user requirements:
  - Designers
  - Web viewers
  - Mobile users
- Include “job” access to all to ensure the most current view

The result is a “data-centric” solution that supports the end-to-end business workflow and information requirements of a communications company.

Further, eTOM is the most widely used and accepted standard for business processes in the telecom industry. The eTOM describes the full scope of business processes required by a service provider and defines the key elements and how they interact, creating a guidebook that is fast becoming the common business language of the telecom industry. The areas supported by Intergraph’s products include the service and network management layers related to infrastructure life cycle management; product life cycle management; operations support and readiness; service fulfillment; fault management; and performance management.
6. How Does Intergraph’s Fiber Solution Work?

6.1. Outside Plant Design

The designer of the fiber network designs and digitizes fiber features using the standard G/Technology feature placement workflow and a fiber splicing editor. The end-to-end workflow is as follows. At a given location (central office, switching center), the user creates an ISP Connect feature. From this feature, the user places fiber cables, splices, remote terminals, service wires, and optical network units (ONUs) via the G/Technology new feature command. Each of these features is automatically connected via Node-Ordered Connectivity. During the design process, the designer has full access to all design information and uses a software tool that enforces standard design best practices. Both novice and experienced designers benefit from information access and the enforcement of recommended design best practices.

For example, designers can manually splice features, or automatically create them via functional interface software when the ends of two cables are in proximity. When created, the functional interface software attempts to perform a straight-through splice. If this is possible, the software completes the records for the splice and then sets the splice-type attribute to resolved. If a straight-through splice is not possible because of the presence of multiple cables, the software sets the splice-type attribute to unresolved. These attributes allow the symbology of the splice to change to reflect its state and provide useful cross-checks during design.

The placement of fiber includes the cable network, splice closures, optical service wires, network termination devices at the home, splitters (in splices, cabinets, racks) and the central office terminating devices. The application also includes placement of the civil structures, such as conduit, manholes, poles, and housing structures (huts, buildings, and ECMs) to address all necessary infrastructure in one design.
6.2. Inside Plant Design

For inside plant design, when fibers enter a building, hut, cabinet, or any location where there is equipment that terminates the fiber, the system can create, manage, and view the connected fibers and equipment. Fiber Optic Works provides the user with seamless tracing and visualization of the fiber network from the outside plant and into the building to the equipment connected to the fiber strands (Figure 3). Presentation of all this information in multiple windows allows the end user to easily understand the network configuration, path, connectivity, and equipment configuration. Figure 4 depicts a typical fiber cable and building termination with inside plant details.

The Fiber Optic Works solution supports all the necessary functions to inventory the portion of the fiber network that exists in any ISP structure (building, cabinet, hut, etc.) and allows the user to easily add, delete or edit the ISP cables, connections, and equipment. The user can identify the location of network cables and equipment on a scaled floor plan, select them, and view all their information, connectivity, and attributes. Users can easily place, edit, and delete cables and equipment for all engineering projects. For equipment, the user simply selects the device from a list of standard materials and then drags the equipment graphic and positions it in the rack elevation view.
6.3. Automatically Generate Schematics

For users who need to visualize the network in a view that provides a simple, easy-to-use presentation, Fiber Optic Works provides an automatic schematic generator that traces either the fiber cable network or a circuit and presents it in a window in the application. This schematic view is an easy, effective way to see the extent of long and complex fiber networks. This schematic is interactive with the geographic map and users can select any cable in the schematic view and the geographic view will zoom to that location and display the cable attribution. Figure 5 depicts a combination of windows presenting geographic views and a number of user-selected schematic views automatically available to clarify the information. Powerful automatic schematic generation saves time, improves productivity, and makes information easier to understand to reduce the chance of error.
6.4. Supporting “Microduct” Technology

The telecommunications market is an environment of rapidly changing technologies to support the demand of new services and increased bandwidth. The new technologies are more cost efficient and simpler to maintain, but they do require changes in the way the networks are documented and planned and requires software to continue to keep pace with the new types of network design. One of the latest innovations in network design is the “tube-guided fiber” used in FTTH networks. These tubes are plastic ducts optionally preconfigured with inner ducts, and they can have fiber cables or unprotected fiber strands blown through them (Figure 6). The industry uses the terms tube, inner duct, and “microduct” interchangeably. Today, the “microduct” cabling technology is used more and more across the world. The fiber counts have grown up to 96 per cable and can be installed in ducts of only 8 millimeters in diameter. Bundles of inner ducts can be jetted over 1500 meters or more through its contained fiber duct.

Intergraph’s G/Technology Fiber Optic Works solution is designed to easily handle “microduct” technology. The Fiber Splice Editor has an option to display the number of the fiber in the cable, the number of the fiber within the bundle, or both, providing a complete solution for the last approach to design and management of the fiber network (Figure 7).
6.5. Fiber Splice Editor

The fiber splice schematic presents two views of a splice to the user. A user can select any splice location and can use the splice editor utility to see the physical connections inside the splice in a schematic view (Figure 8) or presented in a tabular form (Figure 9). The schematic view provides a clear view of the connections in the proper colors of fiber tubes and fiber strands. The user can also select only the specific fiber strands that they want to view and the other strands will not be displayed.
Designing and Managing Fiber Optical Networks

Figure 7: The fiber splice schematic view gives users a clear view of the connections.

Figure 8: The Fiber Splice Editor also supports tabular views of splicing data.

6.6. Cable and Circuit Reporting

Reporting and easy access to information is key benefit of Intergraph’s Fiber Optic Works solution. The Fiber Circuit Report (Figure 9) command provides a number of analytic functions. Users can generate four different report types with this command, which include:

- Path Report (with or without OTDR length or loss as input)
- Usage Report
- Closest Available Service Report
- OTDR Report

A schematic view can also be generated from this report for any traced circuit or individual fiber strand.

The command software can easily write and add other custom reports to this same reporting framework. New reports are added at the top of the report form.

Figure 9: The most commonly requested reports are available “out of the box” as standard reports with the system.
7. Fiber Optic Works: Your Complete Fiber Solution

Communications companies, municipalities, utility companies and transportation agencies that are building or maintaining a fiber infrastructure need the proper tools to design and maintain the new fiber network asset record. Fiber network design is new and the technology continues to change at a rapid pace. The right system and solution needs to be robust and supportable by a vendor committed to innovation and providing software reflecting the best practices of the industry. Intergraph provides a complete product designed specifically for fiber design and management. Intergraph’s G/Technology Fiber Optic Works product meets the need for both outside plant, and optionally, inside plant design. Our solution works with G/Technology, Intergraph’s open, enterprise scalable geospatial platform. Intergraph solutions improve design productivity and can integrate with enterprise information systems to dramatically improve information access across the enterprise.

For an interactive demonstration and to learn more about Fiber Optic Works, visit Integraph.com or contact your local Intergraph sales representative for more information.
For more information about Intergraph, visit our website at www.intergraph.com.

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