FiberWatch™

Remote Fiber Test System

System Description

Contents

NTEST

1 FiberWatch™ Remote Fiber Test System (RFTS)

FiberWatch™ is the first optical monitoring system designed to work with full-service, emerging and next generation network operators. By focusing on the network and introducing Domain-based network management, FiberWatch™ is able to provide real-time optical monitoring functionality extending the traditional RFTS (Remote Fiber Test System) model.

FiberWatch™ is the only tool that supports communication and co-ordination among network planning, engineering, operations and maintenance personnel. Through Domains, operators can manage their network status based upon operating region, maintenance teams, services and customers simultaneously. For example, with Customer Domains, operators can better manage service level agreements through real-time network status and QoS measures.

Through use of the automated reporting facility and Domains, network operators receive targeted and timely reports on the status of their fiber plant as it impacts customers and services throughout the network.

1.1 Network Management

Historically, optical fiber was restricted to backbone or trunk networks. However, in the last years, fiber has been deployed deeper and deeper into the network including local access, "to-the-curb", and “to-the-home” applications. The challenges of maintaining such a complex network continue to increase at such a rate that traditional maintenance and repair strategies are proving inefficient and thus costly for many carriers and service providers. Carriers and service providers need to get smarter about managing their networks. The primary challenges facing carriers today are:

- Our connected world expects telecommunication services, be it telephony, internet, television, or data networks, to operate 100% of the time.
- The convergence of telecommunications technologies and services increases the competitive landscape forcing a greater focus on QoS.
- How to efficiently manage an aging fiber infrastructure.
- Higher bandwidth communications delivering more revenue per fiber brings additional pressure to those responsible to maintain and operate the infrastructure.
- Increased reliance on leased physical plant resulting in a dependence on others to solve problems.
- The fiber is being pushed closer to the end user, resulting in denser networks that are hard to document with traditional methods.
- Increased reliance on contracted OSP construction and maintenance crews resulting in less control and assurance of network quality.
- The threat of vandalism or even terrorist attacks to fiber networks, a critical yet vulnerable asset.

To contend with these challenges, carriers require access to skilled and experienced field crews, a centralized trouble ticketing or management system, a complete network documentation system, and a fiber monitoring system to provide up to date information on network status.

1.2 Fiber Management Benefits

In a typical RFTS application, there are many operational features that may enhance both day-to-day and long-term network reliability, with two features being principle: fault detection-isolation and early detection of physical plant degradation. In this section, we discuss how these two features may lead to decreased network downtime and increased operational efficiency.

1.2.1 Fault Detection and Isolation

Fault detection and isolation represents one of the strongest features of the RFTS system. In the event of a cable break, the monitoring system is able to detect the physical problem (the fault), diagnose the problem, and then correlate this information with the Geographical Information System (GIS) to isolate the fault in *less than a minute*. This information is then broadcast to a number of systems with which the RFTS system integrates (alarm manager, trouble-ticketing system, direct dispatch through pager or SMS, etc…) in many cases, this time may be further reduced through integration with transmission management or other alarm management systems. The net result is immediate dispatch of restoration personnel to the fault location. Users of Fiber Monitoring Systems often realize a 4-6 hour decrease in repair time.

1.2.2 Early Detection

Proactive maintenance and care of network infrastructure are two of the best ways to provide peak network performance. With networks becoming larger and more complex, network operators are faced with the daunting task of maintaining the network with fewer resources. As designed, the RFTS system provides a time stamped characterization of the network segments. In particular, the OTDR trace provides a measure of attenuation, reflectance, and discontinuities along the entire length of the cable for the fibers under surveillance. This data, from day one of system deployment, provides a benchmark from which to continually assess network quality.

Through generation of appropriate measurements and system reports, operators can identify potential trouble spots. This allows for improved work crew prioritization. In situations where work crews are contracted, the reports may be transferred to the maintenance company as well. The RFTS system reports therefore compliment standard OSP inspection techniques. In the case of buried cable, the system may provide the only indication of cable quality. In general, the overall effect of early detection through RFTS will be reduced operating costs through proactive network maintenance.

An RFTS monitoring system can also have other uses:

- To **generate revenue** by offering advanced services monitoring the fibers provided
- As a **marketing tool** to convince customers that their network is the most reliable
- For **documenting** the outside plant network topology and geographic information
- For **archiving** the test data of all the optical cables in a centralized repository
- In **construction**, to monitor not-yet-commissioned cables from time of deployment until initiation of traffic
- To **integrate** the optical layer alarm information into the Operations Support System (OSS)

1.2.3 Security

Rogue parties can target fiber infrastructure to deliver attacks that can disrupt or bring down communications networks, which are carrying time sensitive and confidential information, negatively impacting national security. Possible security intrusions may be in the form of physical attacks like breaking or bending of the fiber, and transmission attacks like using clip-on sensors/devices which generate an additional loss into the circuit in order to tap or steal the information transmitted.

FiberWatch™ provides prevention, detection and reaction as security countermeasures.

Prevention: FiberWatch™ creates an optical signature of the network at a point in time and records it as a reference to detect any changes in the future.

Detection: Network changes are tracked and detected automatically and continuously by OTDR monitoring and optical power monitoring. OTDR monitoring detects the changes in fiber optic media whilst power monitoring detects the small changes in optical power levels.

Reaction: In cases of intrusions and detection of changes from the reference optical signature, the RFTS system automatically generates alarms, pinpoints the exact geographic location of intrusion, and identifies the affected circuits, all in a few seconds after the occurrence.

1.3 Benefits and Advantages Summary

The FiberWatch™ RFTS supports both standalone and integrated deployments. As designed, FiberWatch™ allows for seamless integration into alarm management, GIS, network documentation, and other automated systems. In general, FiberWatch™ offers the following advantages:

1.3.1 Software

- Completely WEB enabled client access and control
- Single server for more than 200 RTUs
- Software designed for easy integration with GIS and OSS systems
- Very easy to use for those with minimal OTDR expertise
- Automated data analysis and reporting
- Automated distribution of reports via email
- Domain centric network management
- Desktop layouts are fully configurable and persistent
- Right click menus provide quick access to common tasks
- Mouse over tooltips provide additional information

1.3.2 RTU Hardware

- Small form factor
- Integrated OTDR
- Remote software upgrades
- Low usage of network bandwidth

- Local access capability
- Platform for future monitoring applications

1.3.3 SLA Tracking and Management

- Documented network performance
- Documented network availability
- Performance and availability are computed and tracked by customer or service

1.3.4 Goggle Earth Integration

- Fiber alarms can be viewed in Google Earth
- Full route export capability
- Automatic email contains KML with route, landmark, and circuit break information
- Preferences allow enable/disable of email feature

1.3.5 Reduced Operational Costs

- Reduced network downtime
- Proactive and preventative maintenance
- Improved Sub-contractor management
- Most economical path to future monitoring needs

1.3.6 Reporting Features

- Short and long term analysis of fiber network performance
- Leverage data from long-term scheduled testing
- Tracking optical “hot spots”
- Automated report generation and distribution
- All reports are Domain-based for customers, services, operational regions, etc…
- Configure reports once
- Key report types: system status, monitoring status, fiber properties (span loss, splice loss, attenuation, etc…)

1.3.7 Leverage Prior Investments

- Integrate with GIS to allow greater access to network asset information
- Integrate with workflow management systems to operate in a coordinated fashion

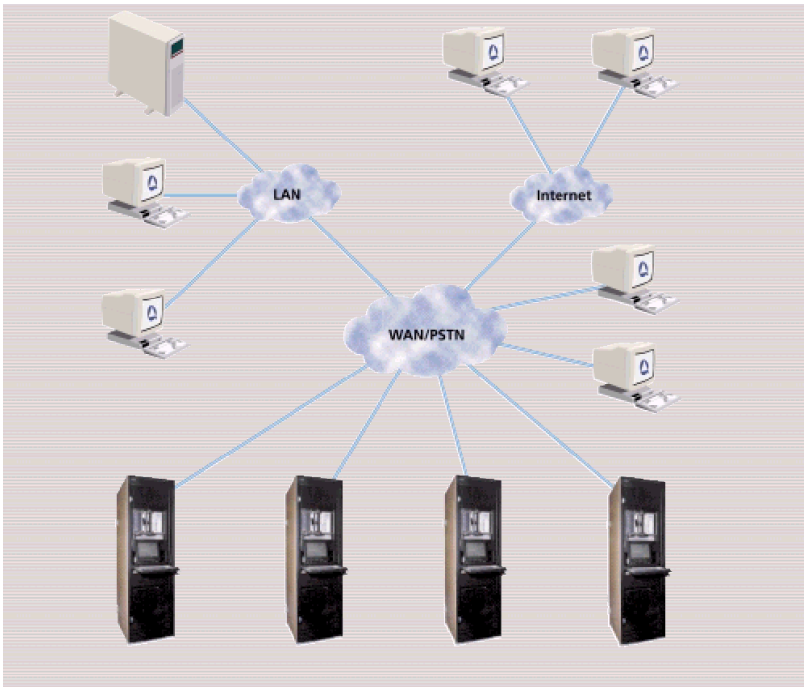
1.4 System Architecture

The architecture of the FiberWatch™ system is illustrated below, showing the computers as a server with a back-up server, clients to this server and a web client which is using the web portal for gaining access to the system. RTUs are connected with these computers through a LAN/WAN connection. This could also be using a number of other communications means.

In addition to round the clock surveillance of the network as well as rapid fault isolation and identification, the FiberWatch™ solution provides the following features:

- Remote and distributed secure access to the system via the Web
- OSS integration via SNMP interface

- Integration with 3rd party documentation systems
- Ability to integrate clients with smart phones and other PDA devices



Architecture of the FiberWatch™ RFTS

1.5 Monitoring Approaches

The optical network can be monitored using either dark or active fiber monitoring. Dark fiber monitoring is when the OTDR light from the Remote Fiber Test System is on fibers without any traffic, but in the same cables as fibers with traffic. Active fiber monitoring is characterized by having the OTDR light on the same fibers as those with traffic, and in this case, the OTDR light will be at a different optical wavelength than the transmission light.

1.5.1 Dark Fiber Monitoring

Presently, the majority of the Remote Fiber Test Systems (RFTS) are connected to inactive or dark fibers. This solution offers an effective means of monitoring the integrity of the optical fibers without the added expense and concerns of tapping into the transmission fiber. All that needs to be considered is the suitable placement of RTU test heads to obtain complete coverage of the cables to be monitored. Although monitoring inactive fibers seems to be an ideal solution, circumstances may arise when it may not be possible or desirable. Considerations that may influence the type of RFTS to be deployed are the number of "spare" fibers available, capacity on presently active fibers, increased capacity demands of new services, planned upgrades of

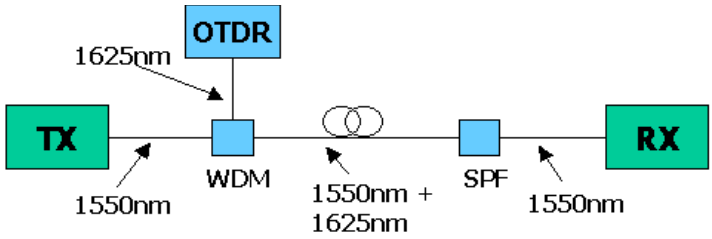
terminal equipment, and testing philosophy of the operating company. The answers to these questions will determine which RFTS type (active or inactive) and which wavelength would be most appropriate.

1.5.2 Active Fiber Monitoring

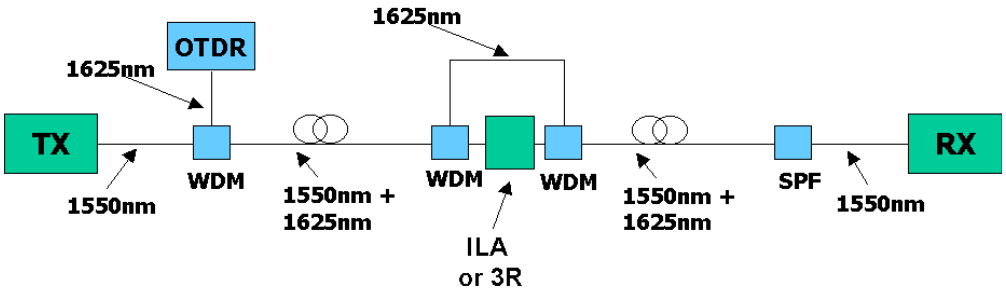
Active fiber monitoring requires a bit more analysis than dark fiber monitoring system. Considerations such as wavelength isolation requirements, impact to link loss budgets, and future upgrades need to be considered. Wavelength selection for an active RFTS is affected by existing and future pass band requirements, along with signal isolation criterion. If the transmission light is at 1550nm, the OTDR light will typically be at 1625nm.

To illustrate an active monitoring scenario, consider the case where monitoring is done on one active fiber. To couple the OTDR light onto the transmission fiber, a broadband Wavelength Division Multiplexer is needed. A short pass optical filter (SPF) is used at the far end to filter away the OTDR light before it reaches the terminal equipment. In the figure, the propagation direction of the transmission light and the OTDR light is the same. The light waves could also move in opposite directions, which is the preferred mode of operation. Inside the OTDR is a long pass optical filter (LPF). The purpose of this filter is to filter away any light different from OTDR light just before the OTDR receiver thus avoiding any disturbance of the OTDR test.

The coupling of the light is illustrated in the figure below.



If terminal equipment has to be by-passed, it will take place as illustrated in the figure below:



In this case, 2 WDMs are placed at the site of the regenerator that is being by-passed.

1.6 Domains

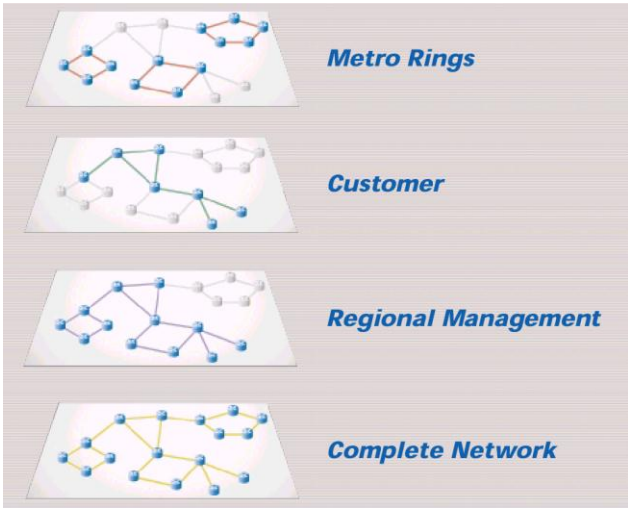
The FiberWatch™ system is based upon the Domain Concept. Invented by our team, the Domain Concept provides the system user with partitioned network views and operation in terms of all the system functionality. For instance, testing, reporting, monitoring, or alarming, can all be done on a domain basis. It also provides a root selection that allows the selection of all domains to achieve a global view of the network.

With domains the RFTS system administrator may define and configure groupings of RFTS components such as RTUs, OTAUs or fibers. Domains can be used to support regional, service, or customer-based management of the monitoring system. By utilizing Domains, system administrators can organize by whatever logical scheme desired. The following items can be organized by Domains:

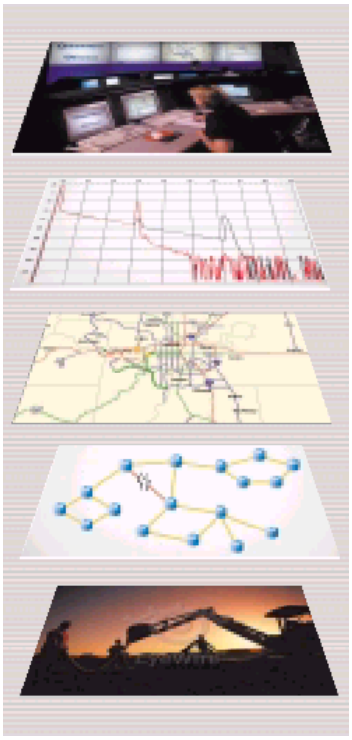
- configuration management
- scheduled tests
- alarms
- Quality of Service measures
- trend analysis
- system reports
- user access

By focusing on the network, FiberWatch™ provides a proactive, real-time monitoring solution extending the traditional RFTS model. Through Domains, FiberWatch™ supports communication and co-ordination among your network planning, engineering, operations, and maintenance personnel. Your operations personnel can easily manage and report on the network status based upon region, maintenance teams, network services and customers, simultaneously. For example, with Customer Domains, service level agreements are automatically tracked by the system with real-time updates provided at the click of the mouse, and with the Web interface, FiberWatch™ allows your customers access to the performance status of their part of the network.

The diagram below illustrates a few Domain examples.



Domain examples



This diagram illustrates the layered view FiberWatch™ provides a user in case of an alarm. Shown is a cable break caused by construction digging. The system will pinpoint the location of the fault within the network and on a map. In addition, it will automatically provide background test data (for instance an OTDR trace). This information is displayed within a NOC and can be broadcast to other locations as well.

Layered view in case of a cable break

1.6.1 Domain Configurations

The monitoring and maintenance of a network can be broken down into many different ways, each of which is unique to a specific organization. The Domain utility enables customized organization of network elements within the framework of the FiberWatch™ monitoring system. This organization could be defined in any one of a number of ways. In this section, we address Regional, Operational and Service approaches.

Regional Configuration

For many operators, the primary network maintenance structure is based upon geographical or regional constraints. For example, an operator with network services spanning several cities or districts may utilize maintenance crews that with regional responsibility. With FiberWatch™ Domains, the operator can create network views that are based upon the regional structure. In this fashion, work teams interfacing with the system for both routine maintenance and fault isolation are presented with map/network views that match their area of responsibility.

To increase operational efficiency, the work teams may utilize the Domain utility to generate automated reports that allow them to track potential network problems or assess ongoing Quality of Service measures for their area of responsibility.
As FiberWatch™ is Web enabled, all of the above features are available throughout the organization without the need to install software on dedicated computers.

Organizational Configuration
The FiberWatch™ system can be configured for mimic the operational structure of the operator. Given a multi-region operator, the specific organization of the monitoring system can be configured to handle special organizational requirements. In the case of a city where a different crew from the local access routes maintains a primary ring, FiberWatch™ supports independent notification and management of network problems by creating appropriate Domains with appropriate network links as members. In the case where an operator maintains a network for internal services, a Domain may be created that will allow for focused management of this outside plant resource.

Businesses and Services
Within a given network, a variety of different services may be offered, SDH/SONET, ATM, leased fiber or bandwidth, and IP services are examples. Each service has its own set of operational and performance requirements from the network infrastructure. Through the use of Domains, an operator can independently track and monitor the Quality of Service relative to user/customer defined requirements. For example, a business contracting services across several operating regions will require different levels of service for voice versus data services. The operator will therefore have to provide these different levels of service as well as document their delivery. FiberWatch™ supports automated tracking and reporting on such Service Level Agreements.

1.6.2 Domain Applications

User Accounts
Within FiberWatch™, user accounts are managed from a Domain basis. By default, the monitoring system has a single default Domain call System that contains all monitored elements including RTUs, OTAUs and fiber optic links. All other Domains are comprised of elements from the System Domain. When creating a user account, there are five permission levels:

- Administrator
- Operator
- Technician
- Customer
- Sales

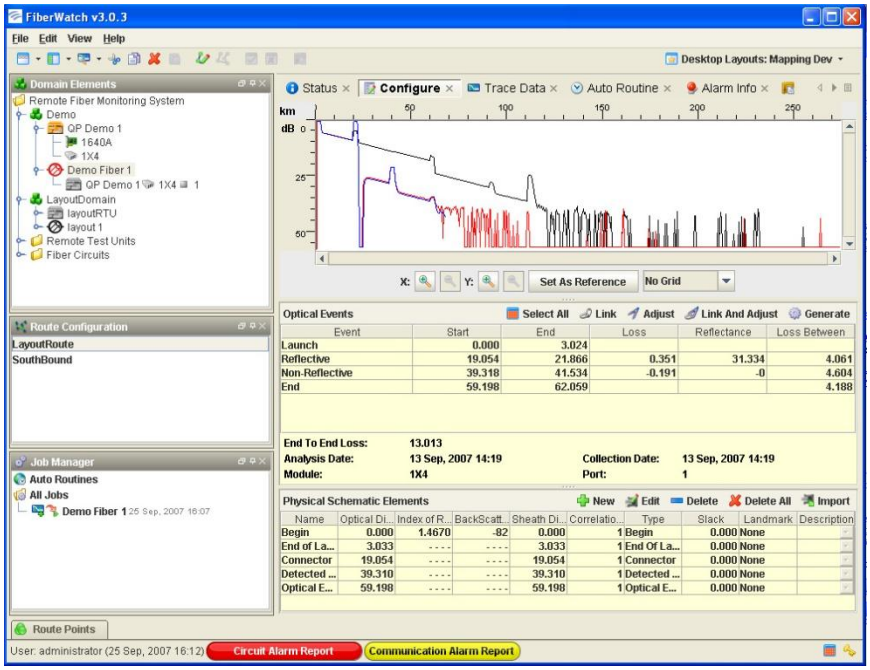
The Administrator has the ability to create monitoring equipment records, modify all system properties, create Domains and create user accounts. The Operator has the ability to modify monitoring system properties. The Technician has the ability to view testing parameters, investigate faults, generate reports and perform interactive tests with the fiber. The Customer has the ability to "view" the network and the testing results, but may not request test data or generate reports. The Sales account provides a read-only access to the system to generate generic network views and reports that are useful in a services selling role.

When creating an account, a given user has permissions assigned on a per Domain basis. In other words, an individual responsible for one region can be Operator in the appropriate Domain, but Technician in the other Domains. Thus, modifications to the system are limited to those with appropriate level and organizational responsibility.

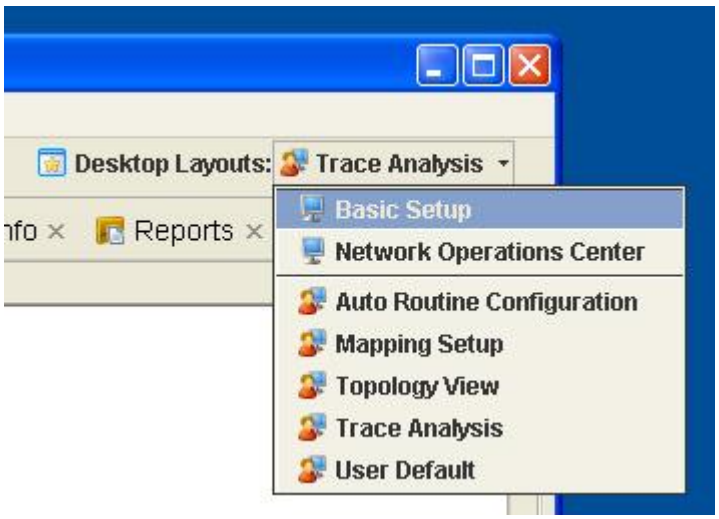
2 Software User Interface and Functions

The following section provides an overview of the user interface and functions. The graphical user interface in FiberWatch™ is fully based upon JAVA. This means that it is portable between platforms.

The FiberWatch application offers full user customization in an easy to use interface. The application comes configured with several default views to aid the user to easily access all data from within one interface. All views contain a Domain tree which gives the user easy access to all monitored circuits and allows the user to take on-demand tests, place fiber under surveillance, configure circuits and manage alarms with one click operation.

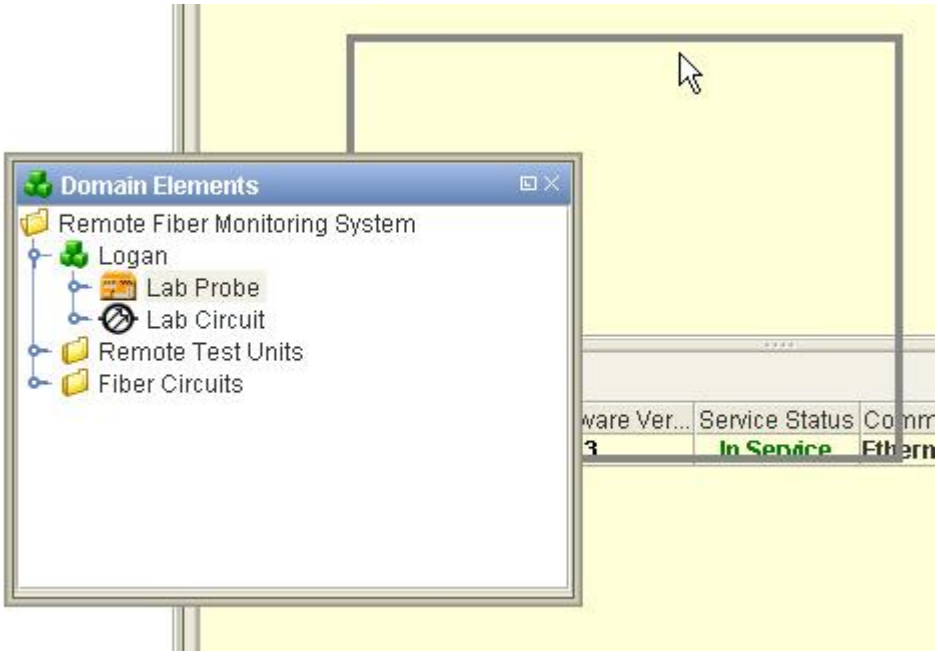


The default client installation provides 2 basic desktop views: "Basic Setup" and "Network Operations Center". These desktops provide a starting point for users to create their own personal desktop configuration. With these initial views the most commonly used panels are visible by default, while less commonly used functions are obscured.

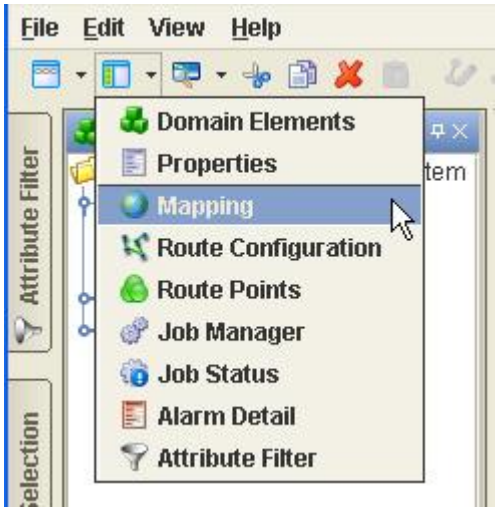


The screen icon signifies system default desktop configurations, while the user icon is displays next to user defined desktops. These menu items are automatically created anytime a user decides to save their current desktop layout.

Changing your system layout is as easy as dragging and dropping panels. Panel sizes, location, and visibility attributes are all stored as part of a desktop layout. Also, with the addition of floatable panels (panels can be dragged off the main application and made into their own floating panels), moving panels is easy. Floating windows can easily be dismissed by simply clicking the "X" in the top right corner.



To retrieve a dockable frame, there is a master list in an easily accessible toolbar drop down button. And of course, you can always select one of your previously saved desktops to restore the desktop to the way you want.

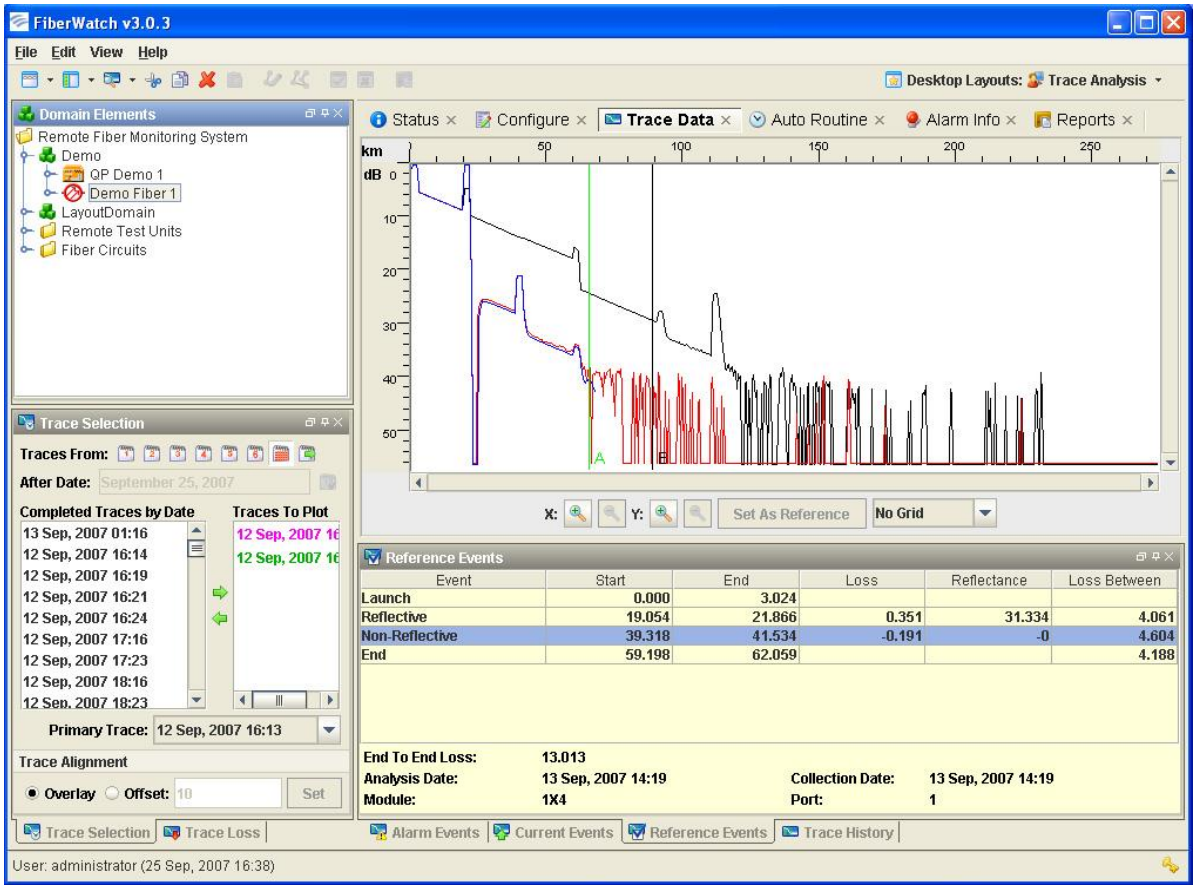


In addition to dockable frames, major system tabs are also configurable. You may choose the order you like, split them, or not display them at all. Any custom tab arrangements may be saved as well.

2.1.1 Operator User View

The Operator User View is intended for Maintenance personnel and NOC personnel. This user interface contains the following functions:

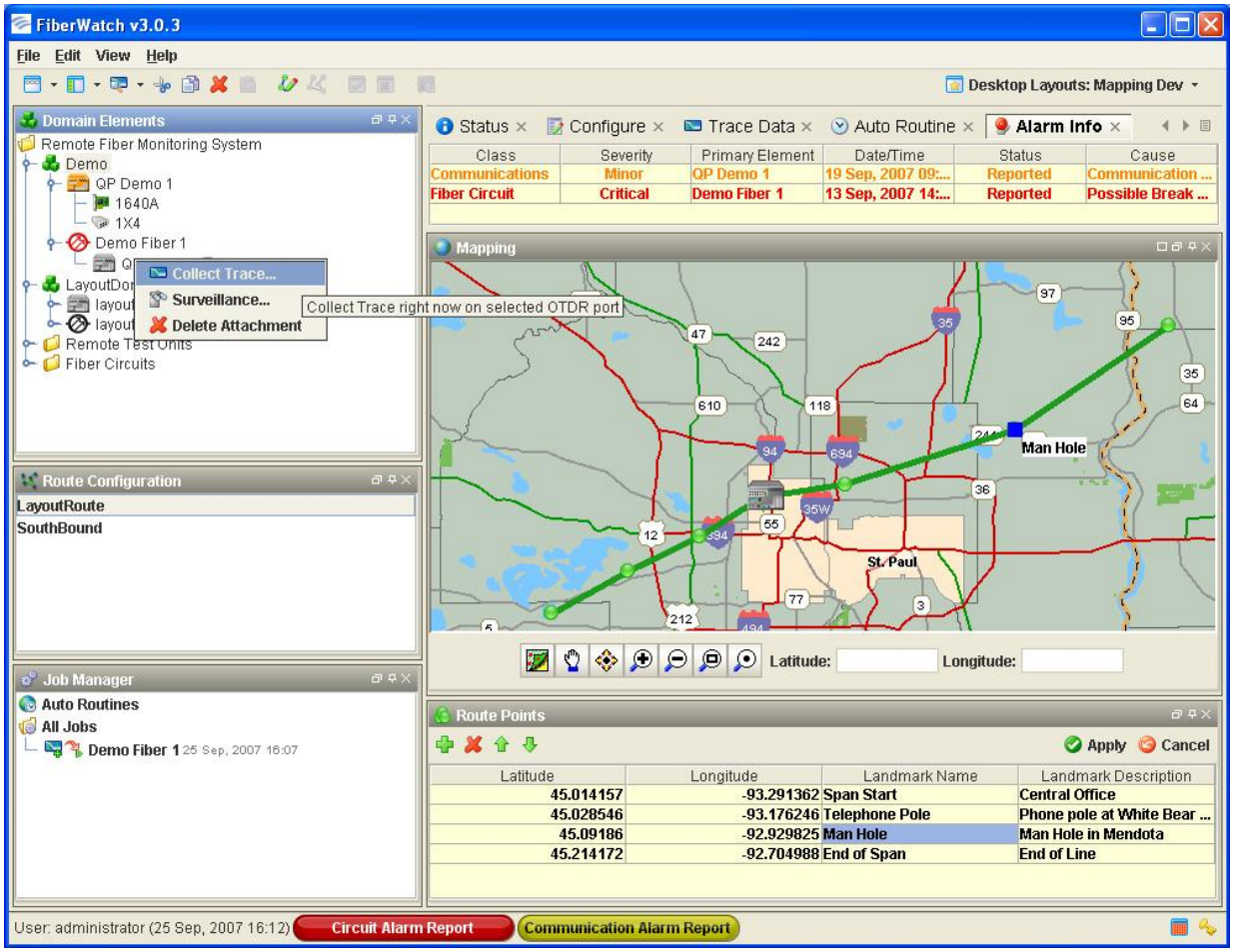
- System overview
- RFTS Equipment status
- Fiber Status
- Alarm Status
- Job Status
- Alarm handling
- Network View
- OTDR Test on Demand Set-up and initiation and termination
- OTDR Surveillance Testing Set-up and initiation and termination
- OTDR Scheduled Testing Set-up and initiation and termination



Operator User View

2.1.2 Map View

The Map View gives an overview by domain of all of the monitored circuits in a geographical format with their current status. Monitored fibers will be displayed in green and fibers in an alarm state will be displayed in red. Fiber tests can be initiated by clicking on the desired circuit route on the map. There is also an OTDR mapping view that allows the user to drag a marker across an OTDR trace and the marker position will be displayed on the fiber route in the map view.



Map View

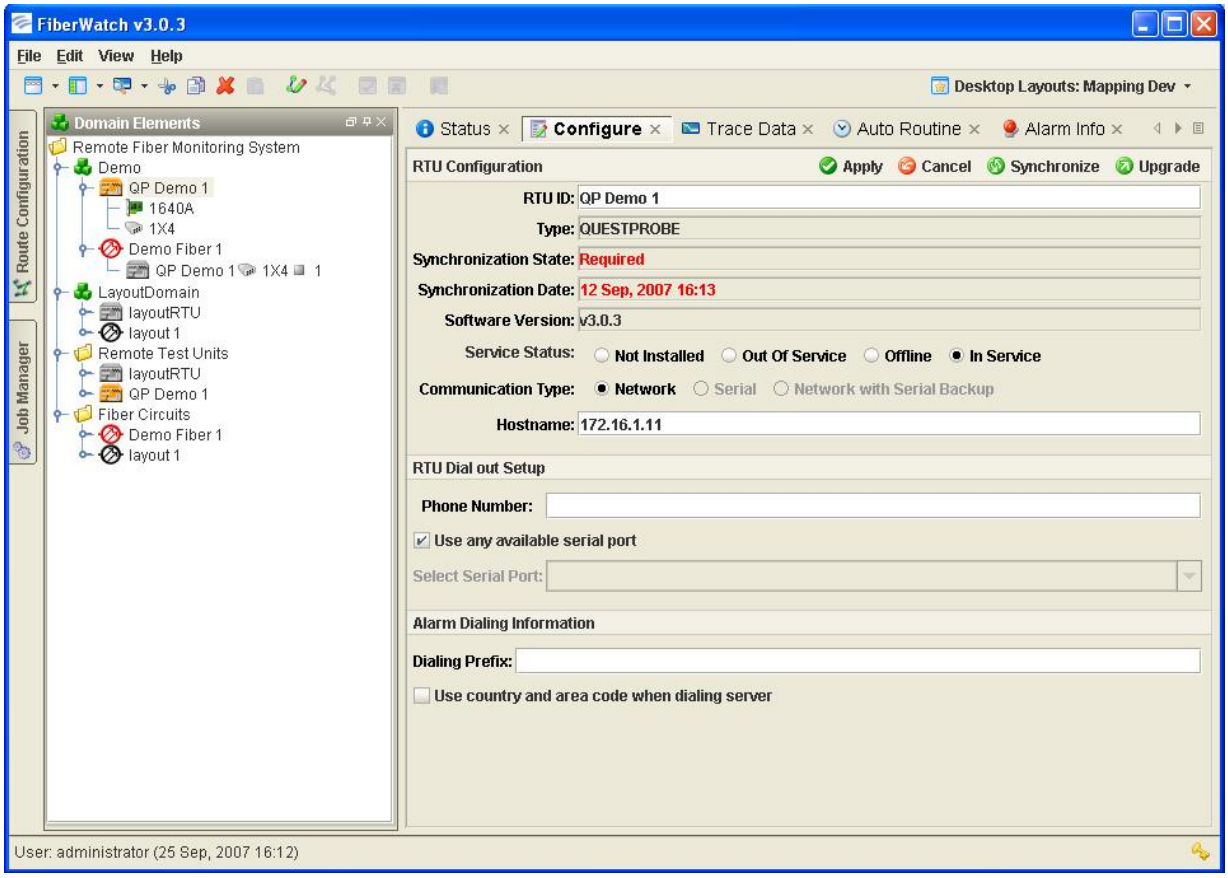
2.1.3 Topology View

The Topology View allows the user to view a monitored circuit in a schematic type view. This view shows the fiber with defined landmarks, and distances and losses between these landmarks. If the geographic map is displayed simultaneously selected schematic elements also will be displayed on the map.

2.1.4 Configuration View

The Configuration View is designed for the system administrator. This user interface provides the following functions:

- RFTS equipment definition and set-up
- Domain definition and set-up
- Route definition and set-up including landmarks
- User access and level control
- Alarm Status
- Job Status
- Network View
- OTDR Test on Demand Set-up and initiation and termination



Configuration View

2.2 Reporting

FiberWatch™ supports a reporting wizard utility that allows users to generate reports based upon:

- Alarm history
- Specific alarm events
- System usage
- System status
- Network status
- Network Quality of Service
- Temporal/statistical analysis of test data

In this fashion, the reports provide a mechanism to track the network performance. To simplify report generation, the user may select to generate a report based upon a Domain rather than just the entire system. If a user has access limited to a single domain, the report will be limited in a similar fashion. To further automate network tracking, each generated report has an option to be automatically generated (and emailed) on a periodic basis. Domain group members have the option of receiving such reports as well.

2.2.1 Reporting Functions

FiberWatch™ is the first to provide automated network tracking and analysis. With this functionality, FiberWatch™ provides network operators with a set of tools to track network performance and characteristics over time, including network availability and QoS measures. The reporting application combined with Domains allows users to manage their business customers in a targeted and automated fashion.

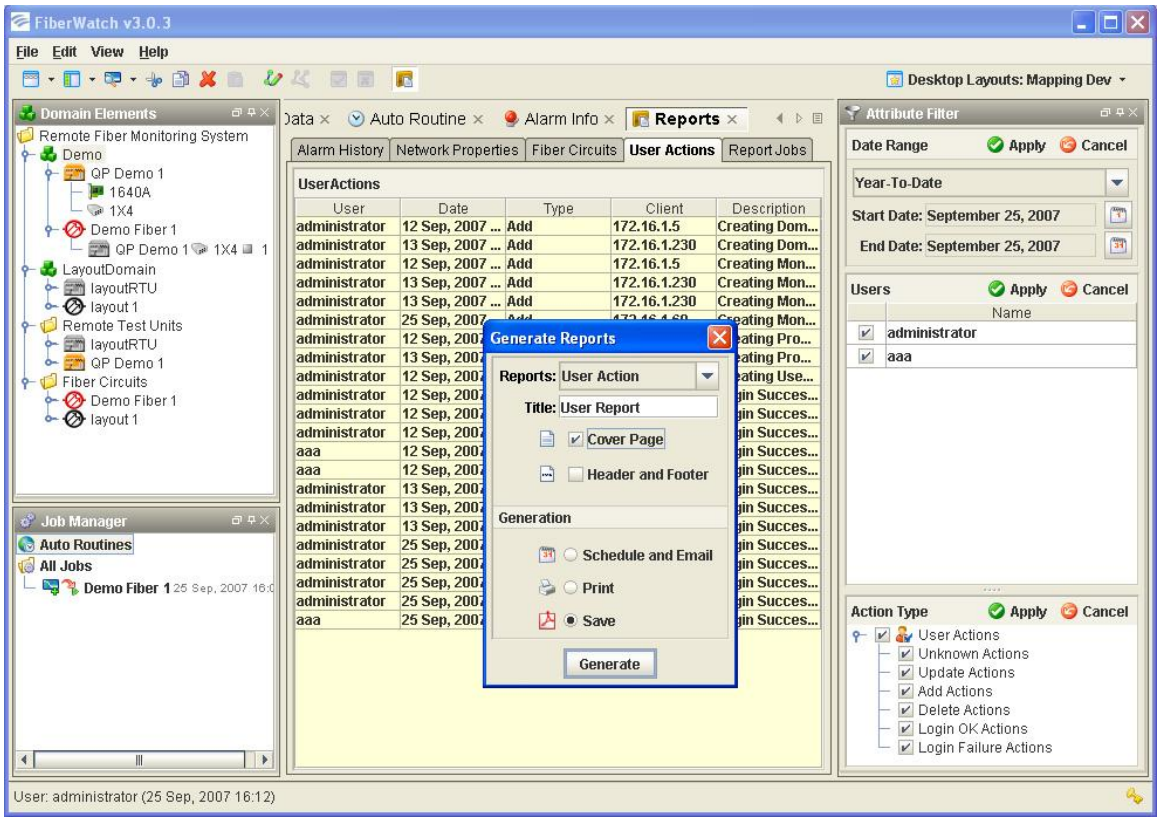
The reporting application supports three core functions: scheduled testing over time, historical reports on network faults and network characterization. With the scheduled testing feature, a body of knowledge can be built up over the lifetime of the network. In this manner, such routine tasks as periodic trace collection can be eliminated or reduced saving money. Once a database of information is under creation, FiberWatch™ automates the analysis process by providing time-based reports that show network performance over time, on a per span or per event basis.

The reports are generated as PDF documents by the system and automatically distributed to appropriate personnel via email. Each report contains a header that specifies:

- Report title
- Date and time
- Network segment
- Domains
- Distribution list
- Report description (user-defined)
- Report type (scheduled or manual)
- Alarm Reports

For alarm events, each report contains a summary of the event including OTDR data as well as geographic location, plus the following information:

- Alarm ID
- Network Segment/Fiber ID
- Alarm status – current
- Probable cause
- Date and time
- Optical and geographic distance to fault
- Geographic location
- Distance from closet landmarks (i.e. splices, manholes, etc.)
- Total downtime
- Affected Domains (i.e. region, central office, customers)



Report View

3 FiberWatch™ RTU Features

As part of the Remote Fiber Test System (RFTS), the FiberWatch™ RTU is installed within a fiber optic network to provide the physical interface for monitoring. FiberWatch™ RTUs monitor fiber loss and reflectance using an OTDR (Optical Time Domain Reflectometry). The RTU uses an optical switch called OTAU (Optical Test Access Unit) to test multiple fibers from a single OTDR. The RTU is capable of testing both dark (not in-service) and active (in-service) from the same unit with the use of WDMs (Wave Division Multiplexers) and filters. The RTU has a FiberWatch™ software client that allows access to the entire FiberWatch™ system.

Summary of RTU features:

- Standalone operation
- Local database for minimal data network impact
- Low communications overhead
- Software client available
- Remote software upgrades
- Primary and backup communication ports
- Internal optical switch with up to 24 ports
- Status display screen
- Dry contact relay major and minor alarm outputs
- Front panel error LED indicator
- Front panel 4 voltage level LED indicators
- Remote reset via telephone line
- Watchdog timer
- 4U Height
- AC and -48vdc versions available

The following sections provide information regarding the individual FiberWatch™ Probe RTU hardware components.

3.1 FiberWatch™ RTU Characteristics

Processor	Intel Processor
Memory	2 GB DDR2 SDRAM
Hard Drive	80 GB
Solid State Hard Drive*	32 GB
External Ports	4 USB, 2 PS/2, 2 Serial, 1 audio jack, 1 mic jack, 1 VGA
Operating System	Windows XP Embedded
OTDR Wavelength	1310, 1550, 1625, 1310/1550, 1550/1625, 1310/1550/1625
Optical Switch Module	OTAU:1xN (N=2, 4,8,12,16,24,32,36,48,60,72,96,120)
LAN Ports	Dual Gigabit Ethernet (10/100/1000Base-T)
Local or Remote Access	Client can reside on PC or laptop connected locally or remotely to RTU
Local Access Module *	1U rack mount module with display, mouse, and keyboard for local access

* Optional Features

3.2 Communications

Means of Control	The FiberWatch™ RTU supports both local and remote control.
Server to RTU Communications	The FiberWatch™ Probe RTU supports full communication via IP protocols. Minimum required bandwidth is 28kbit/s. As the FiberWatch™ Probe RTU operates in a standalone fashion, communications are needed only for the following functionality: • User initiated configuration • Response to On Demand Test requests • Results from Auto-Routine tests • Alarm information from RTU to server • Periodic health check of RTU to verify proper status and operation.
Optional Backup Communication Method	The FiberWatch™ RTU supports use of locally certified modems in conjunction with Ethernet based routers. Modems will be installed with the router.
RTU Normal Operation	The FiberWatch™ RTU does not require continuous use of network bandwidth to perform normal surveillance and analysis operations.

3.3 Environmental

Normal Operating Temperature	0 to 45°C (32° to 113°F)
Short Term Operating Temperature (up to 96 hours, 15 days total per year)	-5 to 50°C (23° to 122°F)
Normal Operating Humidity	Up to 90% non -condensing
Short Term Operating Humidity (up to 96 hours, 15 days total per year)	Up to 95% non-condensing
Storage Temperature	-25° to 60°C (-13° to 140°F)
EMI/ESD Compliance	The FiberWatch™ Probe RTU is fully compliant with CE regulations on both EMI and ESD

3.4 Power

The power supply converts power from its input power to the voltages needed by the various hardware components. There is an INPUT POWER switch on the front of the chassis, which switches the input power to the motherboard.

3.4.1 Power Supplies

Two types of FiberWatch™ Probe RTU Power Supplies are available:

- DC Power Supply: The DC power supply requires a nominal -48V DC input power. It accepts a voltage input range of -36 VDC to -72 VDC

- AC Power Supply: The AC power supply is intended for 110/220V AC operation. It will accept 100 to 240V AC at 50-60 HZ, 6-amp max.

Power Inputs	The FiberWatch™ standard RTU has a dual power DC input. Redundant, hot swappable power supplies for both the AC and DC RTU versions are also available. These hot swappable modules are capable of keeping the unit completely functioning in the event that one fails during normal operation.
Maximum Power Consumption	FiberWatch™ Probe RTU with OTDR Module – 50W

3.4.2 Voltage Indicators

Four LEDs located in the front lower left corner of the chassis are labeled for each of the voltages which the power supply provides. These voltages are +5V, +3.3V, +12V, and –12V. Their operation is:

- Off if there is no power present for that voltage
- Red if there is power present, but it is out of specification
- Green if there is power present according to specification

3.5 Mounting

Mounting Type	The FiberWatch™ RTU may be mounted in industry standard racks.
Rack Type	The FiberWatch™ RTU may be mounted in ETSI 525mm width racks.
Subrack mounting position	The FiberWatch™ RTU may be mounted using the front mount brackets.
Subrack Height	The FiberWatch™ RTU occupies a total of 4U in rack height.
Subrack Depth	The FiberWatch™ RTU occupies 250mm of rack depth.
Subrack Depth (for RTUs with redundant power supplies).	The FiberWatch™ RTU occupies 295mm of rack depth.

4 FiberWatch™ OTDR Module Specifications

The OTDR (Optical Time Domain Reflectometer) module sends a test pulse of light through a fiber and measures the light that returns. It has an optical connector, which is normally connected to the input port of the OTAU module with the supplied patch cord. The fiber optic port of the OTDR must be treated as laser radiation source.

Optical Specifications

MODEL NUMBER	Wavelength	Dynamic Range [1]	Event Dead Zone [2]	Attenuation Dead zone [3]
FW-RTUV-OTDR-1335	1310±20nm	37dB	4m	9m
FW-RTUV-OTDR-1535	1550±20nm	36dB	3.5m	9m
FW-RTUV-OTDR-3535	1310/1550±20nm	37/36dB	4/3.5m	9/9m
FW-RTUV-OTDR-1340	1310±20nm	40dB	4m	8m
FW-RTUV-OTDR-1540	1550±20nm	40dB	3m	6m
FW-RTUV-OTDR-1640	1625±15nm	40dB	3m	6m
FW-RTUV-OTDR-3540	1310/1550±20nm	40dB	4/3m	8/6m
FW-RTUV-OTDR-5640	1550/1625±20/ 15nm	40dB	3/3m	6/6m
FW-RTUV-OTDR-3564	1310/1550/1625±20nm	40dB	4/3/3m	8/6/6m
FW-RTUV-OTDR-1542	1550±20nm	42dB	5m	10m
FW-RTUV-OTDR-1343	1310±20nm	43dB	5m	10m
FW-RTUV-OTDR-1545	1550±20nm	45dB	5m	10m
FW-RTUV-OTDR-1643	1625±15nm	43dB	5m	10m
FW-RTUV-OTDR-3545	1310/1550±20nm	43/45dB	5/5m	10/10m
FW-RTUV-OTDR-5643	1550/1625±20/ 15nm	45/43dB	5/5m	10/10m
FW-RTUV-OTDR-1645	1625±15nm	45dB	5m	10m
FW-RTUV-OTDR-5645	1550/1625±20/ 15nm	45dB	5/5m	10/10m
FW-RTUV-OTDR-3565	1310/1550/1625±20nm	45dB	5/5/5m	10/10/10m
FW-RTUV-OTDR-1550	1550±20nm	50dB	5m	10m
FW-RTUV-OTDR-1650	1625±15nm	50dB	5m	10m
FW-RTUV-OTDR-6540A	1650±5nm	40dB	3m	6m
FW-RTUV-OTDR-6540P	1650±5nm	40dB	2.5m	7.5m

Notes:
Specifications and Part Numbers are subject to change without notice
1 SNR=1 with up to 128k averages (typical, subtract approximately 2 dB of range to 98% peak noise. Bellcore TR-TSY-000196 Issue 2)
2 Using Bellcore TR-TSY-000196 Issue 2 (typical)
3 Deadzones measured on -45 dB reflections (typical)

OTDR Common Specifications	
Distance Resolution	0.0001 km, 0.1 m, 1 ft, 0.0001 mi
Distance Range Setting	4, 8, 16, 32, 64, 128, 256 km
Loss Resolution	0.001 dB
Distance Sampling (Range Dependent)	0.125, 0.25, 0.5, 1, 2, 4, 8, 16 m
Data Points	Standard Up to 250,000; Optional up to 512,000
Linearity	0.04 dB/dB
Spectral Width (RMS)	<15 nm
Pulse Widths (Module/Range/ Wavelength Dependent)	5 ns to 30 µs
Distance Accuracy	0.0025% of distance measurement ± distance resolution ± index uncertainty
Laser Safety	Meets IEC60825-1 Class I and CDRH Class 1 Requirements (Eye Safe) 21 CFR 1040
Optical Connector	FC/UPC
Operating Temperature	0° to 45°C (32° to 113°F)
Short Term Operating Temperature (up to 96 hours, 15 days total per year)	-5° to 50°C (23° to 122°F)
Storage Temperature	-25° to 60°C (-13° to 140°F)
Humidity	95% max, non-condensing
Power Consumption	The power consumption of the OTDR is already included in the RTU specifications

5 FiberWatch™ OTAU (Optical Switch) Module Specifications

The OTAU module is the optical switch, which directs the OTDR output to the desired test fiber. It has an input optical connector, which should be connected to an OTDR module with the supplied patch cord. All optical connectors are removable from the front to ease removal for cleaning, and they are angled to provide proper bend radius for accurate test measurement. Additionally, OTAU's have a numerical status indicator which indicates which output port (if any) is currently connected to the input port. All fiber optic ports of the fiber optic switch must be treated as laser radiation sources.
The FiberWatch™ RTU allows for three types of OTAU modules, Internal, External, and Remote.

5.1 Internal OTAU Module

The Internal OTAU module connects to the FiberWatch™ RTU chassis via a USB interface, and It takes its power internally from the RTU. The RTU supports the use of one internal optical switch. Additional optical switches may be used, but the External OTAU Module variant is required. All optical connectors are removable from the front to ease removal for cleaning, and they are angled to provide proper bend radius for accurate test measurement.

Specifications

Internal OTAU Specifications	
Output ports	2, 4, 8, 12, 16, and 24
Connector Type	FC, FCA, SC, SCA, LC, E2000, F3000, LX-5
Insertion Loss *	≤ 1.0 dB, typical ≤ 0.6 dB
Channel Crosstalk	< -80 dB
Return Loss	> 55 dB, typical –60 dB
Switching Time	< 65 ms + 10 ms per channel
Isolation	< -80 dB
Back Reflection	1310 nm, 1550 nm, and 1625 nm
Wavelength	≤ 1.0 dB, typical ≤ 0.6 dB
Repeatability	+/-0.02 dB max; +/-0.01 dB typical
Lifetime	Greater than 10^8 Switching Cycles
Power	2.5 W
Operating Temperature	0° to 50°C (32° to 122°F)
Short Term Operating Temperature (up to 96 hours, 15 days total per year)	-5° to 60°C (23° to 140°F)
Storage Temperature	-40° to 70°C (-40° to 158°F)

* Add 0.2 dB per UPC connector and 0.3 dB per APC connector

5.2 External OTAU Module

The External OTAU module is typically used when more than 24 monitoring ports are needed. It mounts in the equipment rack adjacent to the FiberWatch™ Probe RTU. It can be powered with -48V DC or 100-240 VAC. It is controlled via a supplied serial cable connected from a serial port on the FiberWatch™ RTU to the serial port on OTAU. It can also be controlled via USB or Ethernet. All optical connectors are removable from the front to ease removal for cleaning, and they are angled to provide proper bend radius for accurate test measurement.

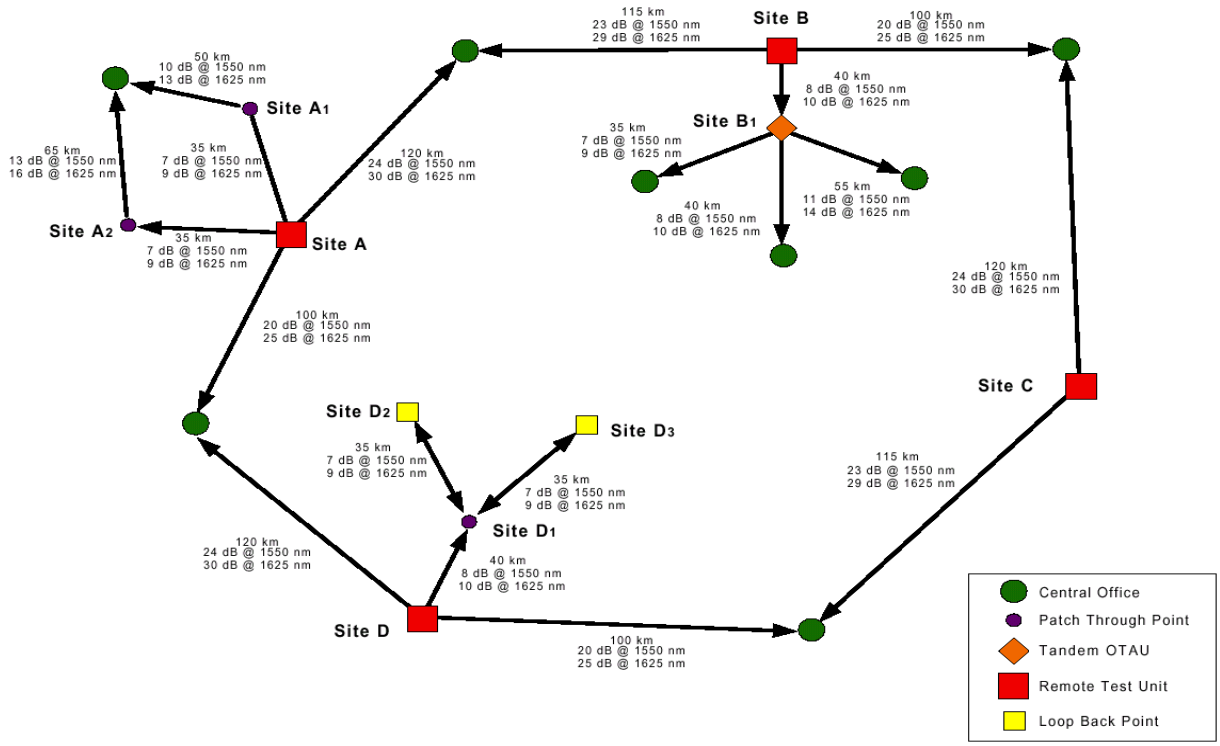
Specifications

External OTAU Specifications	
Input Ports	1 port (2 or 4 ports are also available)
Output ports	2, 4, 8, 12, 16, 24, 32, 36, 48, 60, 64, 72, 96, 120, and 128.
Connector Type	FC, FCA, SC, SCA, LC, E2000, F3000, LX-5
Insertion Loss *	≤ 1.0 dB, typical ≤ 0.6 dB
Channel Crosstalk	< -80 dB
Return Loss	> 55 dB, typical –60 dB
Switching Time	< 65 ms + 10 ms per channel
Isolation	< -80 dB
Back Reflection	1310 nm, 1550 nm, and 1625 nm
Wavelength	≤ 1.0 dB, typical ≤ 0.6 dB
Repeatability	+/-0.02 dB max; +/-0.01 dB typical
Lifetime	Greater than 10^8 Switching Cycles
Power	4.0 W
Mechanical Dimensions	1U (1x2–12): 1.75 x 17 x 12 in (44 x 432 x 305 mm) 2U (1x16–36): 3.5 x 17 x 12 in (89 x 432 x 305 mm) 3U (1x48–120): 5.25 x 17 x 12 in (133 x 432 x 305 mm)
Operating Temperature	0° to 50°C (32° to 122°F)
Short Term Operating Temperature (up to 96 hours, 15 days total per year)	-5° to 60°C (23° to 140°F)
Storage Temperature	-40° to 70°C (-40° to 158°F)

* Add 0.2 dB per UPC connector and 0.3 dB per APC connector

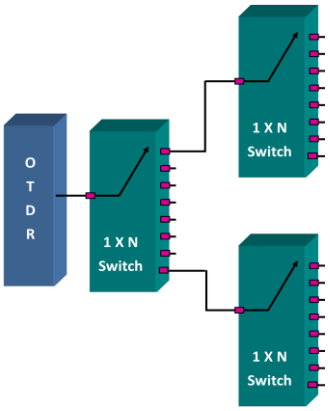
5.3 Remote OTAU Module

The Remote OTAU module is an external OTAU that is mounted in a remote site to allow more efficient use of the RFTS equipment. The diagram below illustrates the use of Remote OTAU modules in a network. The Remote OTAU module shares the same specifications as the External OTAU module.



5.4 Cascaded OTAU Modules

All OTAUs (Internal, External, and Remote) can be cascaded to increase the number of fibers available to monitor beyond 120 ports. The FiberWatch™ software seamlessly manages cascaded OTAU modules.



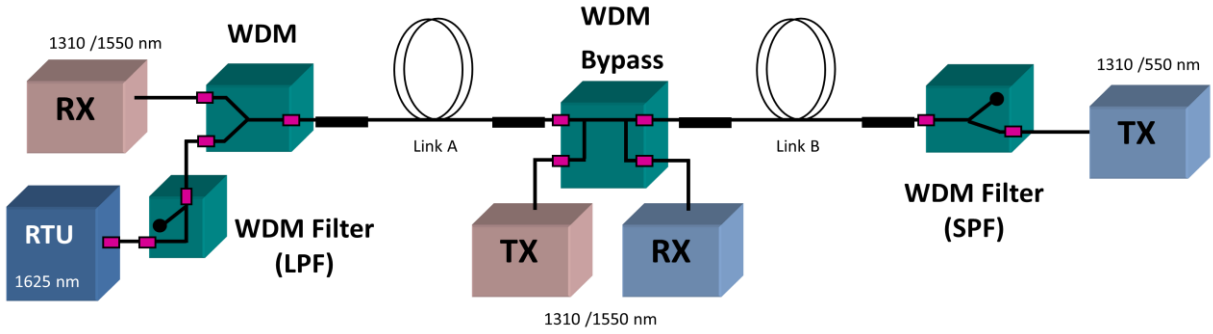
6 FiberWatch™ WDM and Filter Module Specifications

When used with the appropriate filters and WDMs (Wavelength Division Multiplexers) components, the FiberWatch™ RTU can be installed in applications carrying live-traffic, where out-of-band testing occurs using a wavelength that differs substantially from those used in a telecom or datacom network. This allows for interference-free testing. WDMs (Wave Division Multiplexers) and filters are used to monitor active fibers in a Remote Fiber Test System (RFTS). A WDM multiplexes the 1625 OTDR test signal with the traffic carrying signal at 1310 or 1550 nm or multiple wavelengths on the 1260-1570 nm pass band. A low pass filter filters out the 1625 nm test signal and a high pass filter filters out the any traffic signals at 1310/1550 nm.

The WDM uses proven optical filter technology to multiplex two signals or filter out undesirable signals. The WDM and filters are symmetric, and their construction offers unparalleled reliability, low insertion loss, and high isolation. All optical connectors are removable from the front to ease removal for cleaning, and they are angled to provide proper bend radius for accurate test measurement.

Key Characteristics:

- Filter Technology
- High Isolation
- Low Insertion Loss
- High Reliability
- Modular Design or rack mounting options
- Removable adapters for easy cleaning



The following sections provide information regarding the individual FiberWatch™ WDM and Filter hardware components.

6.1 WDM and Filter Environmental and Mechanical Specifications

WDM and Filters Common Specifications	
Storage Temperature:	-40°C to +85°C
Operating Temperature:	-20°C to +70°C
FSXpert™ Module Type:	Fits into FSXpert™ chassis (19"/23" EIA or WECO)
LGX Module Type:	Fits into LGX chassis (19"/23" EIA or WECO)
Rack Mount Module Type:	19"/23" EIA or WECO
Fiber Optic Connectors:	SC, FC, ST®, LC, ASC, AFC, LX.5®, E2000™, F3000™
Reference Standards:	EIA/TIA 455, GR1209, GR1221, CECC 81000 and IEC 68

6.2 WDM Optical Specifications

WDM Specification	
Wavelength Short (S):	1270-1570 nm
Wavelength Long (L):	1610-1640 nm
Insertion Loss* C-L:	1.0 dB maximum
Insertion Loss* C-H:	1.0 dB maximum
Isolation C-S 1625 nm:	65 dB minimum
Isolation C-L 1310/1550 nm:	55 dB minimum
Directivity S-L 1310/1550 nm:	50 dB minimum
Directivity L-S 1625 nm:	50 dB minimum
Return Loss:	50 dB minimum
PDL:	0.15 dB maximum

* Add 0.2 dB per UPC connector and 0.3 dB per APC connector

6.3 WDM Bypass Optical Specifications

WDM Bypass Specification	
Wavelength Short (S):	1270-1570 nm
Wavelength Long (L):	1610-1640 nm
Insertion Loss* IN 1310/1550 nm:	1.0 dB maximum
Insertion Loss* OUT 1310/1550 nm:	1.0 dB maximum
Insertion Loss* BYPASS 1625 nm:	1.0 dB maximum
Isolation C-L 1625 nm:	65 dB minimum
Return Loss:	50 dB minimum
PDL:	0.15 dB maximum

* Add 0.2 dB per UPC connector and 0.3 dB per APC connector

6.4 Filter Optical Specifications

Short Pass Filter (Far-End Filter) and Long Pass Filter (OTDR Filter) Specification	
Wavelength Pass (Short Pass Filter):	1270-1570 nm
Wavelength Stop (Short Pass Filter):	1610-1640 nm
Wavelength Pass (Long Pass Filter):	1610-1640 nm
Wavelength Stop (Long Pass Filter):	1270-1570 nm
Insertion Loss*:	0.8 dB maximum
Isolation 1625 nm (Short Pass):	45 dB minimum
Isolation 1310/1550 nm (Long Pass):	45 dB minimum
Return Loss:	50 dB minimum
PDL:	0.15 dB maximum

* Add 0.2 dB per UPC connector and 0.3 dB per APC connector

7 FiberWatch™ Server and Client Specifications

The FiberWatch™ Server controls operations between the RTUs and the clients. There are two types of servers. The FiberWatch™ Enterprise Server is suited for medium to large systems or small systems with growth potential. It comes configured with an Oracle Standard One database able to manage over 200 RTUs. The FiberWatch™ WorkGroup Server is suited for small systems of up to 5 RTUs. The FiberWatch™ WorkGroup Server can be upgraded to an Enterprise Server.

FiberWatch™ Windows Enterprise Server Specifications	
Chassis Configuration	Tower or Rack Mount
Operating System	Windows Server® 2008, Standard Edition, Includes 5 CALs
Processor	Intel® Xeon® Processor
Hard Drive Primary + Backup	250GB 7.2K RPM SATA 3Gbps 3.5-in, 2 HotPlug Hard Drives
Memory	4 GB
Network Adapter	Dual Embedded Gigabit Ethernet NIC
Optical Drive	DVD-RW Drive
Power Supply	Redundant Power Supply with Dual Cords
Keyboard & Mouse	USB, English, Included
Monitor	22 in. 1680 x 1050
Removable Disk and Tape Drives Optional	Internal SATA Drive Bay *

FiberWatch™ Unix Enterprise Server Specifications (requires optional Unix module)	
Chassis Configuration	Rack Mount
Operating System	Solaris 10
Processor	One six- or eight-core 1.0 GHz UltraSPARC T1 processor
Hard Drive Primary + Backup	One 250 GB 3.5 in. 7,000 rpm SATA or two 146 GB 2.5 in. 10,000 rpm SAS drives; RAID 0, 1
Memory	2 GB
Network Adapter	Four 10/100/1000 Mb/sec Ethernet, one PCIe slot
Optical Drive	DVD-RW Drive
Power Supply	One 300 W power supply; 100-240 V AC
Keyboard & Mouse	USB, SUN English, Included
Monitor	22 in. 1680 x 1050
Removable Disk and Tape Drives Optional	Sun StorageTek 3000, 6000, and 9000 family of arrays, Sun StorageTek C2 autoloader, Sun StorageTek C4, L25, L180 and L500 tape libraries*

FiberWatch™ WorkGroup Server Specifications	
Chassis Configuration	Tower
Operating System	Windows 7
Processor	Intel® Core™ 2 Duo Processor (2.80GHz, 3M, 1066MHz FSB)
Hard Drive	250GB 7.2K RPM SATA 3Gbps 3.5-in
Memory	4 GB
Network Adapter	Embedded Gigabit Ethernet NIC
Optical Drive	DVD-RW Drive
Keyboard & Mouse	USB, English, Included
Monitor	22 in. 1680 x 1050

FiberWatch™ Windows Client Specifications	
Chassis Configuration	Tower
Operating System	Windows XP, Vista, Windows 7
Processor	Intel® Celeron® Processor 450 (2.2GHz, 512K, 800MHz FSB)
Hard Drive	100GB 7.2K RPM SATA 3Gbps 3.5-in
Memory	2 GB
Network Adapter	Gigabit Ethernet NIC
Optical Drive	DVD-RW Drive
Keyboard & Mouse	USB, English, Included
Monitor	22 in. 1680 x 1050

Notes:
Specifications and Part Numbers are subject to change without notice
Client software is also compatible with Sun Solaris computers with optional Unix module
Client software is also compatible with Apple's Mac computers with optional Mac module
* Not included in standard configuration

8 Optional Local Access Module (LAM)

The Local Access Module (LAM) is a Display/Keyboard/Touchpad assembly, housed in a 1U high, rack-mount drawer assembly. This can be purchased as an optional component and integrated with the main unit. The LAM is easily adapted to 19”, 23”, or 21” racks. The LAM is the PC equivalent of a display, keyboard and mouse used in connection with the FiberWatch™ Probe RTU as an option.

Local Access Module

Includes,

LCD Display
Keyboard/Mouse

The LAM uses an integrated keyboard with a built-in glide-pad as a pointing device. Two supplied cables plug into the Keyboard and Mouse ports of the FiberWatch™ Probe RTU. The LAM is available with AC or DC power.

Part Number	Description
FW-LAM-DC	FiberWatch™ Local Access Module DC power, Display and Keyboard
FW-LAM-AC	FiberWatch™ Local Access Module AC power, Display and Keyboard