

FIBER MEASUREMENT AND TESTING SOLUTION - OVERLAYING FIBER FAULT ON GIS LAYER

Ensuring Fiber Service Quality: Effective
Fiber Measurement and Testing Solution



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Abstract

High bandwidth and reliable networks are critical for delivering advanced digital services. As demand grows, accurate fiber measurement and testing become essential for ensuring uninterrupted service quality.

The shift to remote work post- COVID-19, has further intensified the need for stable, high performance fiber networks. This whitepaper explores the need for fiber measurement and testing, current challenges, and Cyient's vendor-agnostic solution.

Cyient's solution leverages Optical Time Domain Reflectometer (OTDR) data, integrating it with inventory and GIS systems to automate fault detection, service impact analysis, and repair workflows. This enables fiber network providers to significantly reduce Mean Time to Repair (MTTR), maintain service-level agreements (SLAs), and enhance customer experience.

Introduction

Optical fiber plays a crucial role in modern communication networks, spanning backhaul infrastructure for mobile operators, last mile broadband connections, and high-speed data centres. The increasing adoption of low-latency 5G and Fiber-to-the-X (FTTX) has further emphasized the importance of fiber networks.

Fiber optic links run across cities, remote landscapes, and even under the oceans. However, link breakages, incorrect splicing, or poor junctions can cause significant communication disruptions. Network operators require a centralized fiber analysis solution to quickly diagnose and resolve fiber faults, ensuring minimal downtime.

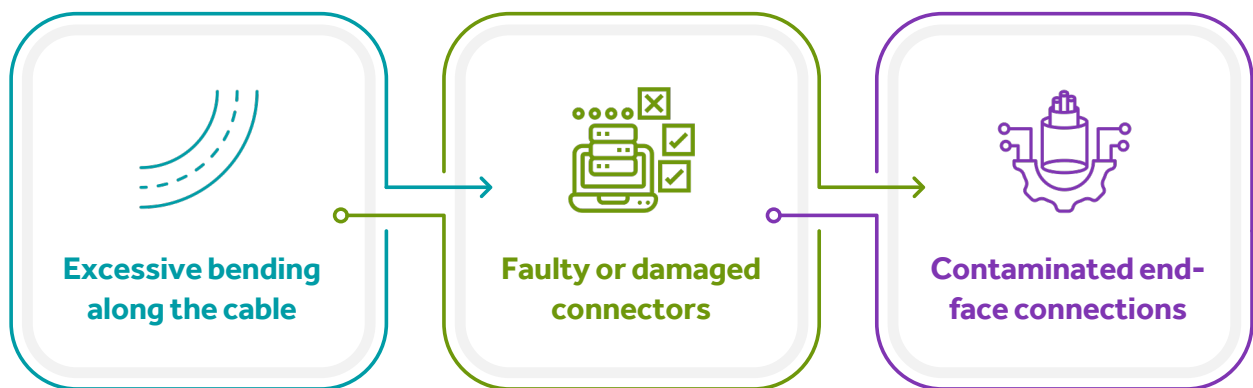
Fiber network providers also rely on fiber validation to verify subcontractor work during network expansion. However, current tools lack accuracy and automation in validating fiber installations. A robust fiber measurement and testing solution is essential to maintaining network integrity and ensuring compliance with high-quality standards.



Need for Fiber Measurement and Testing Solution

Fiber testing is the process of assessing optical fiber performance through key measurements such as insertion loss, optical return loss, and fault detection.

It is critical in detecting malfunctions caused by:



Fiber faults can occur unexpectedly, disrupting critical infrastructure. When a Network Operations Center (NOC) operator receives an unplanned fiber cut notification, rapid fault location and resolution become paramount. Identifying the cut location manually is inefficient, making automated solutions necessary.

Additionally, regular fiber testing ensures long-term network health, as measurements must be compared against baseline data over time. Engineers and technicians rely on Optical Time Domain Reflectometer (OTDR) instruments to analyze fiber performance, detect faults, and maintain connectivity.

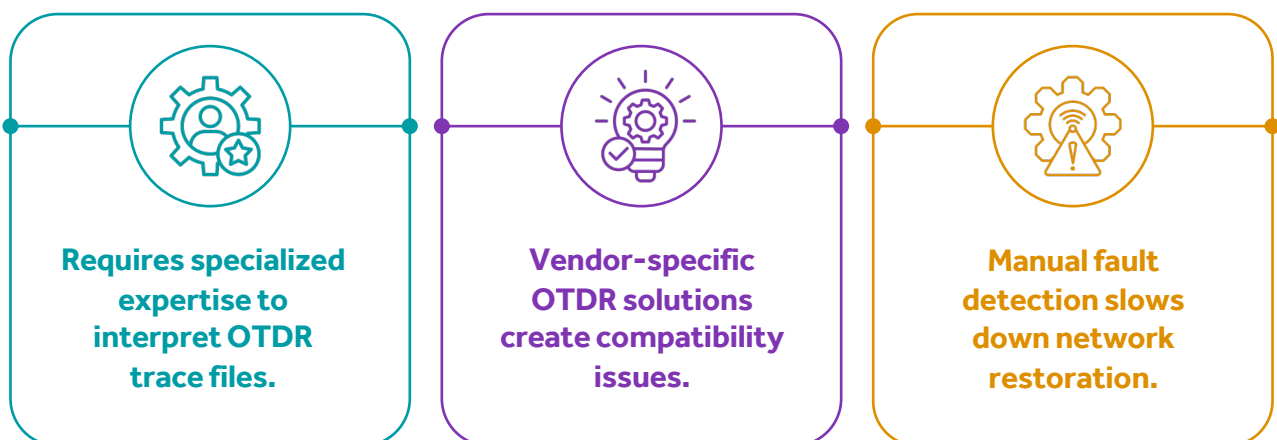


Optical Time Domain Reflectometer (OTDR) – A Key Tool for Fiber Testing

OTDR is a critical instrument for measuring and testing fiber optic networks, providing insights into fiber length, signal loss, and fault locations.. Below are key parameters measured by OTDR:

Parameter	Description
Fiber Length	Measures the total length of the optical fiber.
Event Location	Identifies splices, connectors, and faults.
Optical Loss	Determines signal loss in dB/km.
Reflectance	Measures reflections at connectors, splices, and fiber ends.
Attenuation Coefficient	Calculates the rate of signal loss per unit distance (dB/km).
Splice/Connector Loss	Quantifies loss at specific joints.
Fiber Break Detection	Pinpoints broken fiber sections.
Backscatter Level	Displays scattered light levels for analysis.
Ghosting Identification	Detects false reflections from highly reflective connectors.
Bend Loss	Identifies excessive bending causing high signal loss.

Challenges with Traditional OTDR Analysis:



To overcome these challenges, an automated solution is needed for real-time OTDR data processing.

Existing Solutions and Their Limitations

Several commercial fiber measurement and validation solutions exist, but they often come with limitations. Below are two leading solutions:

Solution	Features	Limitations
FastReporter by EXFO	- Batch processing of multiple OTDR traces. - Bidirectional fiber link analysis. - Customizable reporting.	- Designed primarily for EXFO's OTDR devices. - Limited automation for fault detection.
LinkWare PC by Fluke Networks	- Project-based test result organization. - Batch processing for efficiency. - Overlapping trace comparisons.	- Primarily supports Fluke Networks' testing devices. - Does not integrate with GIS or service impact analysis tools.



Industry Expectations for an Ideal Solution

Fiber Network providers require an advanced fiber measurement and testing solution that addresses current challenges while ensuring efficiency, accuracy, and ease of use. An ideal solution should include the following capabilities:

1. Vendor Agnostic OTDR Support



- **File Format Compatibility:** The software must support industry-standard OTDR trace file formats, such as .sor, ensuring compatibility across different devices.
- **Comprehensive Analysis Tools:** Key features should include batch processing, bidirectional analysis, and customizable reporting to meet diverse fiber testing needs.
- **User-Friendly Interface:** An intuitive interface can enhance operational efficiency and reduce the learning curve for new users.

2. Automated Network Validation



Ensuring fiber installations meet quality standards.

3. Birth Certificate Generation



After the network validation, the fiber operator stores the final fiber measurement as a "Birth Certificate" for future reference. This certificate serves as proof that the fiber met performance standards at the time of deployment, helping network providers demonstrate compliance and maintain trust in their infrastructure quality. Additionally, it acts as a baseline for future comparisons, facilitating efficient troubleshooting, proactive maintenance, and a comprehensive understanding of the network performance over time.

4. Role-Based Access Control



Restricting access based on user roles.

5. AI-Enabled Fault Prediction



Comparing OTDR traces overtime for proactive maintenance.

6. GIS and Inventory System Integration



Providing location-based fault insights.

7. Historical Data Management and Smart Dashboard



Enabling trend analysis and network performance tracking.



Cyient's Fiber Measurement and Testing Solution

Cyient proposes **CyFAS** as a comprehensive OTDR analysis platform, integrating with various systems to streamline fiber testing and fault resolution as mentioned in Figure 1.

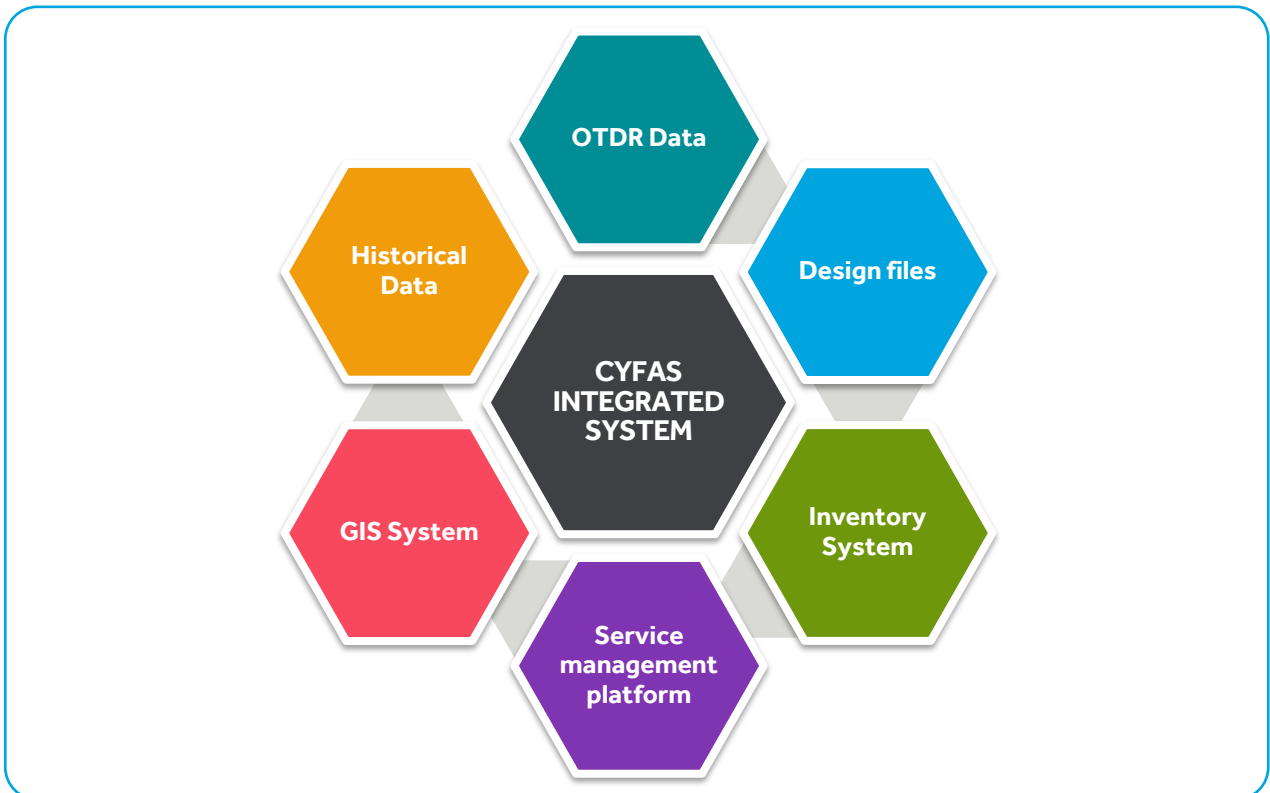
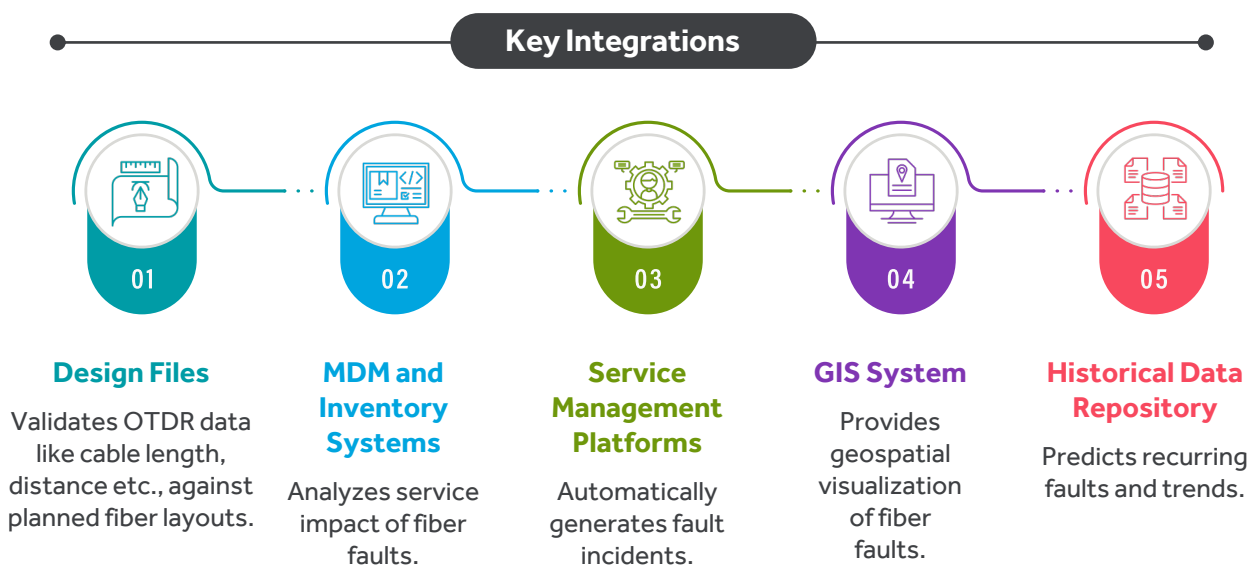


Figure 1: CyFAS Integration with External Systems



1. CYFAS Solution Architecture

The following picture (Figure 2) depicts a high-level architectural view of our proposed solution.

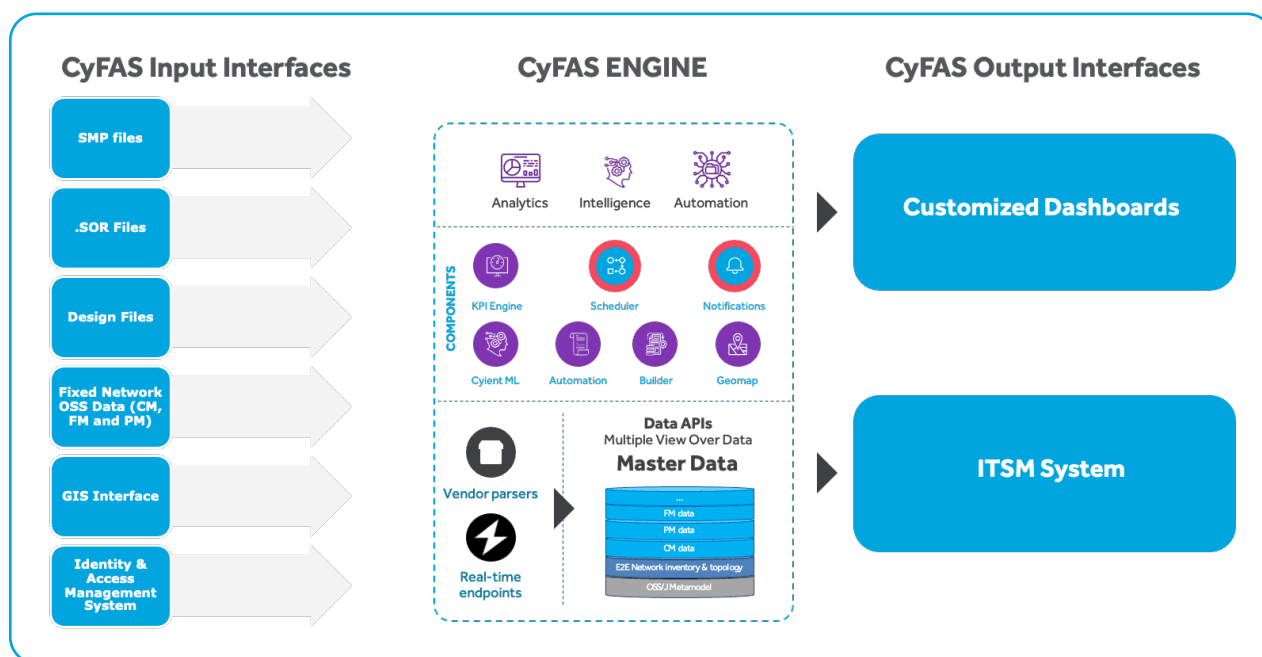


Figure 2: CyFAS Solution Architecture

The solution proposed in the above diagram is based on the current market requirements as understood from various Fiber providers.

The architecture comprises of

- A single-pane dashboard displaying network faults and KPIs.
- GIS-based visualization for real-time fault location mapping..
- Microservices module consisting of CMDB, ITSM & FSM workflows and Low Code/ No Code for necessary workflow creation and modification.
- Reports generating issues related to incorrect splicing, fiber bend and others.

Salient features of CyFAS

- **Design Data Processing:** Extracts and processes key design parameters such as section identifier, splice lengths, etc.
- **Automated OTDR Data Analysis:** Supports batch processing of multiple OTDR trace files (.SOR) at regular intervals.
- **Centralized Data Management:** Stores and manages test results in a secure, centralized database.
- **Comprehensive Reporting:** Generates reports on splice loss, birth certificate details, incorrect fiber lengths and alarm-based threshold breaches, all is accessible via the CyFAS dashboard.

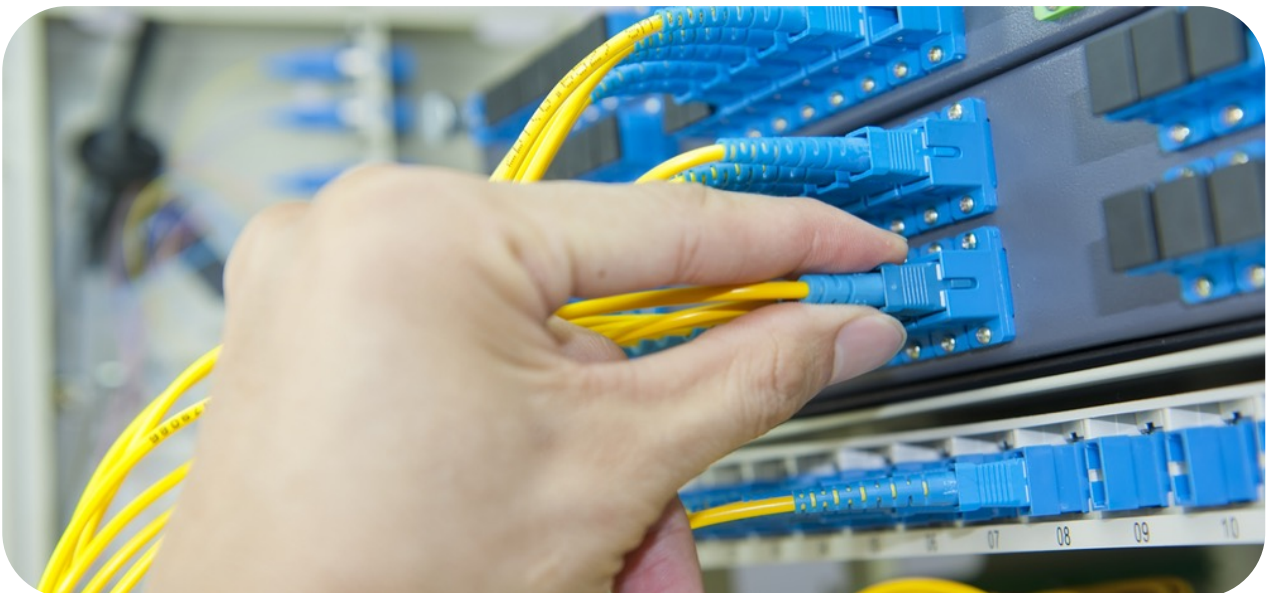
2. OTDR Comparison Reports

By analyzing OTDR data over different time intervals, CyFAS can:

- Identify **start and end points**, splice loss, connector count, and return loss.
- Perform **comparative analysis** to track fiber performance over time.
- Generate **real-time alerts and events**, including geolocation-based fault detection using GIS data.

Comparison Report					
OTDR Trace Details For: 3DAD20.S001.2003.1310			OTDR Trace Details For: 3DAD20.S001.2003.1310		
Fiber ID:	G.652 (standard SMF)	Fiber Type:	228	Fiber ID:	G.652 (standard SMF)
Updated Date	Wed, 16 May 2018 01:28:45 +0000 (1526434125 sec)	Distance(In Kilometers)	0.151	Updated Date	Wed, 16 May 2018 01:28:13 +0000 (1526434093 sec)
Splice Loss	-0.147 dB	Refl Loss	-39.752	Splice Loss	-0.034 dB
attenuation	-31.118 dB	ORL	0.12 dB	attenuation	-29.057 dB
Total Loss	-0.103 dB			Total Loss	0.073 dB
OTDR Trace Details For: 3DAD20.S001.2003.1310			OTDR Trace Details For: 3DAD20.S001.2003.1310		
Fiber ID:	G.652 (standard SMF)	Fiber Type:	228	Fiber ID:	G.652 (standard SMF)
Updated Date	Wed, 16 May 2018 01:28:13 +0000 (1526434093 sec)	Distance(In Kilometers)	0.151	Updated Date	Wed, 16 May 2018 01:28:13 +0000 (1526434093 sec)
Splice Loss	-0.034 dB	Refl Loss	-46.018	Splice Loss	-0.034 dB
				Refl Loss	-46.018

Figure 3: Sample OTDR Trace Details



3. CYFAS Integration with GIS

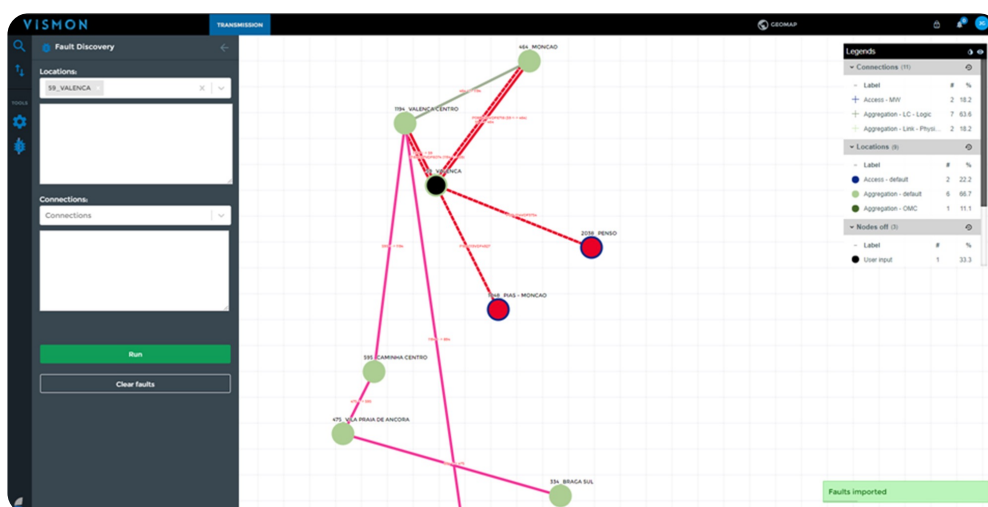
CyFAS integrates with GIS and inventory management systems to provide a georeferenced visualization of fiber network.



Figure 4: sample Georeferenced View

4. CYFAS – Service Impact Analysis

CyFAS enhances network management by integrating with GIS and inventory systems to visualize network topology and analyze fault impact on the detected network issues.



THE CYIENT THOUGHT BOARD

Fiber measurement and validation is a critical step for fiber network providers to ensure quality, meet promised performance parameters, and maintain trust. Cyinet Fiber measurement solution, CyFAS offers the following functionalities to support fiber network providers.



Fiber Analysis
Reporting



On-Demand
Testing



Birth Certificate
Recording



Unified Dashboard
Visualization



File Format
Parameter Extraction



GIS Integration



Master Data
Generation



Network Architecture
Visualization



Data Archiving and
Comparison



Reports
Extraction



Repository
Management



Birth Certificate
availability

Conclusion

Ensuring reliable fiber networks requires a sophisticated measurement and testing approach. Cyient's **CyFAS** solution automates OTDR analysis, integrates with GIS and inventory systems, and proactively predicts faults, enhancing network resilience.

By adopting CyFAS, fiber network providers can:

- Reduce Mean Time to Repair (MTTR)
- Improve SLA compliance
- Enhance customer experience
- Minimize service disruptions

Cyient delivers comprehensive end-to-end fiber lifecycle services, encompassing planning, design, quality assessment, OSS/BSS transformation, M&A support, and network operations. Additionally, Cyient has developed innovative solutions like **CyPlanet** to accelerate fiber planning and design, enhancing efficiency and scalability.

With Cyient's expertise in fiber network automation, providers can future-proof their infrastructure for the demands of next-generation connectivity.

About the Author



Mukesh Bansal is Data and Technology leader for the communication industry at Cyient (EMEA). He advises customers on digital transformation, tools rationalization, OSS transformation, automation to reduce complexity, enhancing efficiency and realizing the business benefits using the GenAI and other latest technology and best practices.



About Cyient

Cyient (Estd: 1991, NSE: CYIENT) delivers intelligent engineering solutions across products, plants, and networks for over 300 global customers, including 30% of the top 100 global innovators. As a company, Cyient is committed to designing a culturally inclusive, socially responsible, and environmentally sustainable tomorrow together with our stakeholders.

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