



Fiber assurance solutions

Creating more value from your fiber plant



Fiber is the established choice for connecting core sites. Now, it's also becoming the dominant medium for access to enterprises, public buildings and cell sites. The communication and data services transported over those fiber networks are crucial for our working environments and our social lives. Network unavailability caused by damaged fiber can create major problems and even threaten the operation of critical infrastructures. Immediate action is indispensable.

Field forces need to be able to distinguish between issues caused by active devices and those caused by passive cables. In-service fiber monitoring solutions are the most efficient way to identify the root cause of link outages. This enables targeted action for highest service availability.

Time for change

The value of proactive, in-service fiber link monitoring is clear. It simplifies failure isolation, enabling fiber network providers to take immediate, targeted action, while also preventing false alarms and unnecessary truck rolls. This shortens the repair cycle, reduces the unavailability of a fiber link and also speeds up installation and commissioning of fiber services.

Why have service providers been reluctant to implement in-service fiber monitoring solutions until now? Previous fiber monitoring systems were optimized for reactive fiber measurement rather than in-service monitoring. Test equipment is typically designed for portability. It frequently fails to meet the cost and availability requirements of in-service monitoring solutions. Now, the latest innovation with optical components and digital signal processing has provided the basis for economically feasible, in-service fiber monitoring systems.

In case of network failures, time is of the essence. Fiber monitoring enables fast failure isolation and rapid restoration of services. Higher network availability is a major benefit for customers, enabling them to meet stringent business continuity requirements. As well as fiber degradation, insertion of bending couplers for eavesdropping can be identified by analyzing real-time attenuation data.

Who benefits from fiber monitoring?

1. Dark fiber providers
Fiber providers can offer a higher value service, providing real-time fiber integrity information.
2. Dark fiber customers
Fiber monitoring enables fast root-cause failure analysis, shortening repair cycles and detection of fiber tapping events.
3. Communication service providers
Fiber failures are located without additional truck rolls, allowing efficient and targeted action.
4. Mobile network operators
Transparent, non-intrusive monitoring of fiber links opens up the possibility of connecting mobile cell sites with any radio access technology.



Proactive, in-service fiber link monitoring for higher service availability and access to real-time fiber integrity information

Fiber link monitoring saves the day

A broken or accidentally disconnected fiber can disrupt mission-critical and revenue-generating services. Fiber network providers frequently operate under stringent service level agreements (SLAs). Their business depends on the ability to detect and isolate any problem in the network quickly and precisely. There's no room for doubt and inefficiency. Fiber link monitoring provides accurate real-time information, minimizing downtime and maximizing the value of fiber infrastructure.

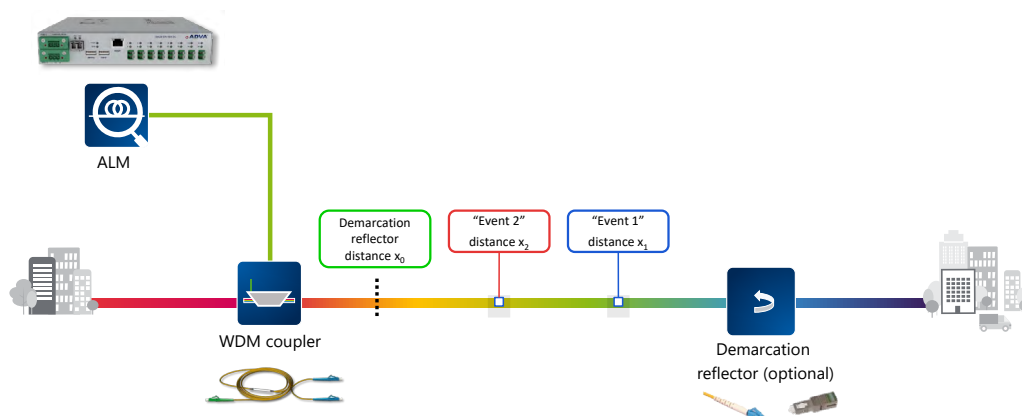
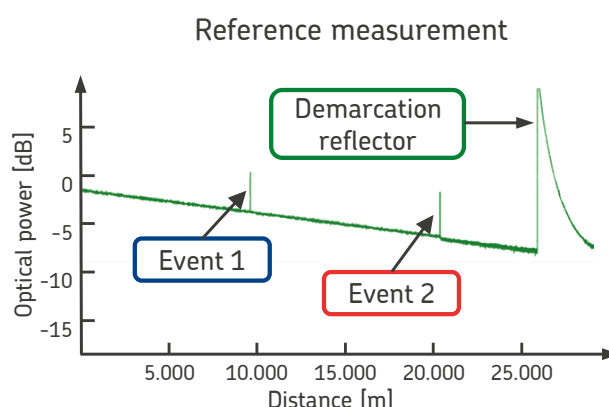
Simple and efficient

Scattered and reflected light from measurement signals is used to calculate the loss profile of a fiber link in real time. With such precise information, the operational team can immediately identify and locate any problem on the link. An optical measurement signal is generated and coupled into the fiber. Analyzing the reflected light provides detailed information about the loss profile and disturbances on the link. The loss profile, shown in the diagram, clearly indicates the location of the demarcation reflector as the end-point of the fiber, which frequently also represents the service demarcation. There's no interaction between the measurement signal and the user data. Fiber monitoring is fully transparent to user services.

ALM, our advanced fiber monitoring solution, dramatically alters how operators monitor their fiber networks. This new technology is the most cost-efficient professional fiber assurance product available on the market. Its core purpose is to proactively monitor fiber plants and help operators to resolve any issues before they impact services. With the ADVA ALM, operators are able to pinpoint faults and eliminate any wasted repair efforts.

Bringing light into the dark

Why can you see a beam of light shining through fog? It's because light scatters as it passes through diffusing media or hits a reflective surface. The same principle applies to fiber monitoring. A test signal is sourced into a single mode fiber and the scattered, reflected light is analyzed. This enables network operators to identify fiber disturbances caused by micro-bending or water diffusion, increased attenuation from splices or fiber connectors, and broken fibers or disconnected patch cables.



Non-intrusive monitoring using an independent test signal and real-time analysis of reflected light



ALM at work

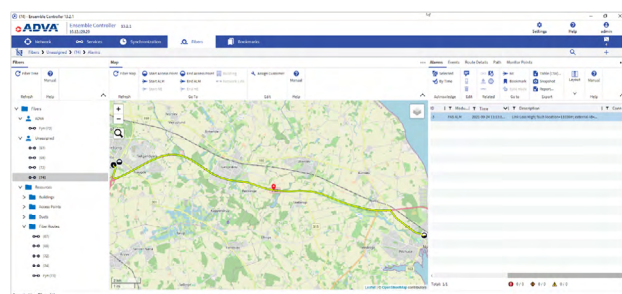
Our ALM is a unique plug-and-play fiber assurance device for proactive fiber monitoring. It enables operators to supervise their critical fiber infrastructure with minimal and simple additions to their existing network. The optical measurement signal generated by our advanced link monitoring solution is coupled into a single mode fiber and reflected back at the demarcation point. This test signal does not interfere with user traffic on the fiber, enabling fully non-intrusive monitoring of the fiber plant.

The seamless integration into our Ensemble Controller SW for management and control offers a range of sophisticated functions including advanced alarm management and reporting, trouble-ticket handling and a view of the entire network status.

Fits all your applications needs

Due to its innovative multifunctional design, our ALM is the ideal solution for any fiber monitoring application. Procedures for continuous in-service monitoring, fast fault localization and accurate detection of small changes in fiber infrastructure can be set up quickly, involving only a few mouse clicks. Its multifunctional test capabilities enable our ALM solution to accurately locate faults on access, core or backhaul links within distances of 300km and beyond. It can test up to 64 fiber services with a very short scanning cycle of only 2 to 5 seconds per active link. And it quickly detects intrusions that threaten network integrity, regardless of whether the services and applications provided on top of the dark fiber service utilize uncolored, CWDM or DWDM optics. What's more, our ALM device comes in a compact and versatile housing.

Geographic information system (GIS)



Service providers and their customers require full visibility of network integrity. They need to be able to direct field forces precisely to the location of a fiber failure. Geographic information systems combine fiber monitoring data with geographic information of cable routes. A graphical user interface shows a fiber map and clearly indicates locations of any faults or anomalies. There is no easier and faster way for repair teams to identify the position of a fiber break. Our Ensemble Fiber Director builds on real-time data from our advanced fiber monitoring solution ALM. It further enhances the spatial resolution by correlating the

Why proactive fiber monitoring?

1. Degradations are identified before services are affected.
2. Precise root-cause analysis avoids unsuccessful repair attempts.
3. Localizing failures shortens repair cycles.
4. Real-time information assures service quality.
5. Maintenance-free demarcation does not consume power.

measurement data with the location of connectors and splices in the network. This calibration assures highest precision in real world applications. The Ensemble Fiber Director is part of the Ensemble Controller solution, which provides easy operation as well as simple integration into customer's business support system. With extensive customization options as well as immediate notification capabilities, fiber operators can further optimize their operational processes and thus offer more stringent SLAs to increase customer satisfaction.

Solution components

1. Monitoring unit

Our ALM monitoring unit calculates a loss profile of the monitored fiber link by analyzing the reflected measurement signal.



2. WDM coupler

The test signal operates at a wavelength distinct from the user traffic. A WDM coupler combines both signals on the supervised fiber.



3. Demarcation reflector

A passive demarcation reflector defines the service hand-off point. It does not consume power and can be applied even under harsh environmental conditions.



Applying fiber link monitoring

There are good reasons for communication service and dark fiber providers to monitor their fiber asset with advanced link monitoring. The system is simple to install and operate. It assures service quality with real-time information on fiber integrity. Field forces can locate fiber incidents and initiate immediate counter-action. There's no need for additional truck rolls for fault analysis. What's more, dark fiber customers have a means to differentiate between problems on their premises and fiber failures.

Improving service quality

Service providers want to maximize the value of their fiber asset. By providing real-time information on fiber integrity, latency and attenuation, they can offer high-value advanced services.

Customers benefit from this information in various ways. Network failures are remotely detected and isolated based on a comprehensive set of real-time information, without additional onsite visits. This avoids time-consuming fault isolation and shortens repair cycles as counter measures can be initiated immediately.

Proactive fiber monitoring also detects malicious attacks on a network as coupling devices for eavesdropping cause additional attenuation that can be detected on the loss profile of the fiber link.

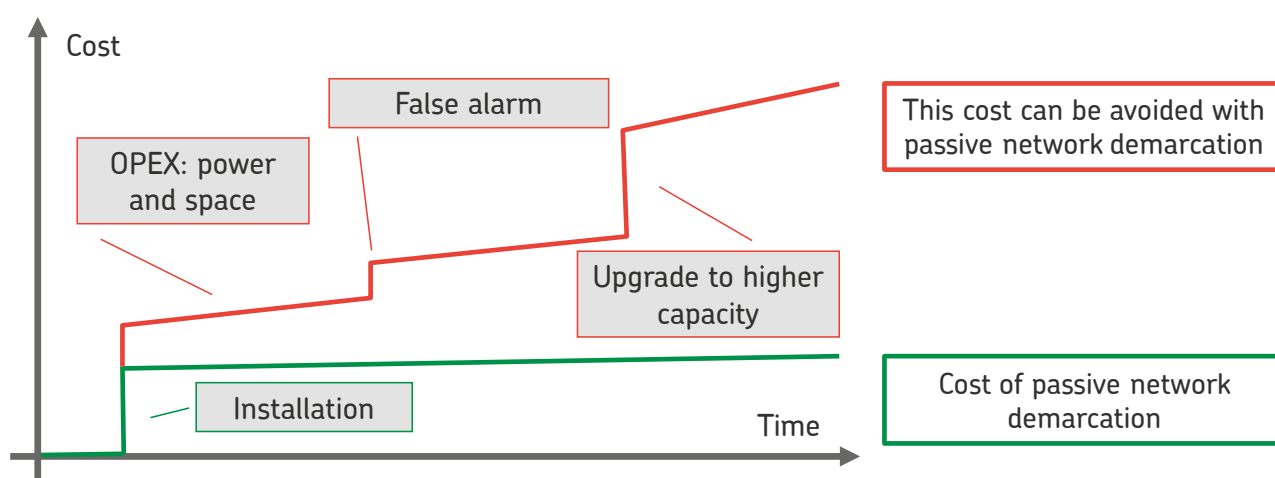
Essential use cases

1. Supervised dark fiber services: higher value with better SLAs
2. Service-agnostic demarcation: change services without site visits
3. Monitoring layers in isolation: immediate fault isolation for shorter repair cycles
4. Securing a fiber link: protect against eavesdropping
5. Sensor networks: monitor sites without power supply

The merits of passive demarcation

Today, active demarcation devices are installed at a service hand-off point on the customer premises. The very same information can also be gained by monitoring services at the central office, if fiber integrity can be assured.

Hence, central service monitoring in combination with fiber link monitoring is an interesting alternative to active demarcation devices. Passive demarcation has obvious cost advantages, as shown in the cost curve. It compares the cost of our demarcation solution including installation with an active demarcation device that has higher first-in cost, adds operational cost for power and space as well as upgrade cost from the introduction of new services.



The diagram highlights the significant OPEX advantage of passive versus active demarcation. Passive demarcation assures availability of the fiber link at lowest cost. On the other hand, active demarcation can provide additional OAM information and resiliency by local switching.

Monitoring network layers independently

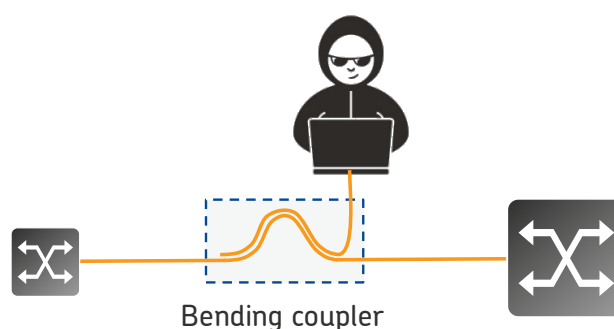
There are various problems that can disturb a network connection. There might be a failed interface card, a dirty fiber connector, a misconfigured router or a broken fiber. If the problem is analyzed by a network management system optimized to control an active network element, all problems look very similar and the operator cannot

differentiate between them and identify the root cause, let alone the location of the problem. This is where monitoring of the physical transmission media comes in. Results from fiber link monitoring enable a service provider to immediately understand the root cause of a problem.

Securing a connection with link monitoring

Fiber optical transmission systems are potentially at risk of being intercepted. An attacker might introduce a bending coupler or a splitter into a fiber link in order to gain access to the optical signal and to the user data being transmitted. The insertion of those coupling devices adds attenuation at a discrete point on the link. Such suspect signatures can be used to detect malicious attacks.

When an attacker introduces a coupler into a fiber link, the additional loss can be detected by a link monitoring system. This improves the integrity of fiber links and secures communication against eavesdropping.

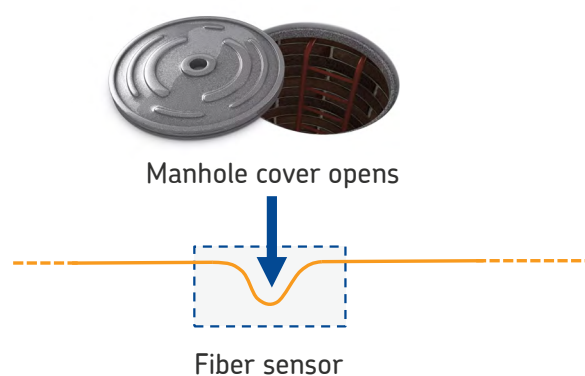


Unmasking an attacker with real-time monitoring of fiber loss

Securing a site with link monitoring

Some sites along a fiber link need to be monitored but have no available power. In cases like this, such as manholes that need to be managed and controlled, active devices can't gather local information and transmit it to a central control site. Vandalism is often reported, ranging from removing a cover to cutting through cables. To minimize negative impact, immediate action needs to be taken.

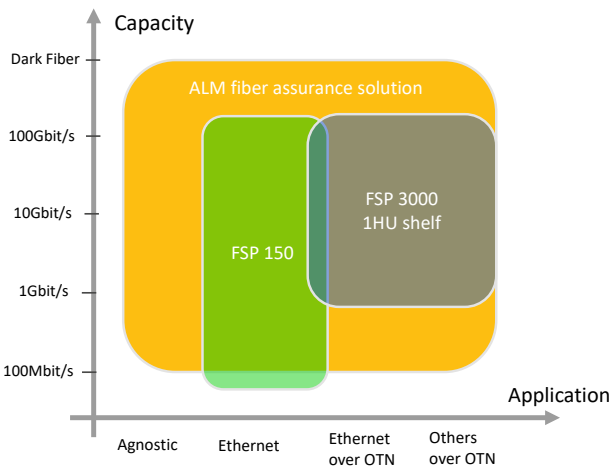
If a service provider wants to monitor such sites, there's a simple solution: applying fiber sensors in combination with link monitoring solutions. Fiber sensors transform mechanical stress into attenuation, which can be measured remotely. There's a wide range of sensors for monitoring torsion, temperature and humidity for deployment at remote sites. In most cases, a spare fiber will be used to access these passive sensors.






Passive, remotely monitored fiber sensors for measuring pressure, humidity and temperature

A range of different devices or a single assurance solution for all services? – Your choice

Today’s communication networks are built on a connectivity infrastructure applying a range of interfaces, such as OTN for high-capacity, fixed bandwidth connectivity, Ethernet for packet connections, CPRI in the mobile fronthaul network or 5G-SDI for 4K native video signals. Each interface comes with different service assurance capabilities and different management tools. In consequence, service providers will apply a range of demarcation devices aligned with the needs and capabilities of different services. Fiber link monitoring minimizes the range of network demarcation devices needed. And, as fiber monitoring is agnostic to the communication service, a single assurance technology can be applied with any technology.



	Product	Application
	FSP 150 ProNID family	Ethernet and IP service demarcation over Ethernet, MPLS and IP networks with a rich set of OAM functions
	FSP 3000 (1HU chassis)	SDH, OTN, Ethernet, 3G-SDI, transparent bitrate over OTN networks featuring OTN OAM
	ALM, Ensemble Fiber Director	Service-agnostic, non-intrusive link monitoring using a passive demarcation reflector; Ensemble Fiber Director eases operation with map-based GUI

ADVA offers a rich set of network demarcation devices, which can be applied in a wide range of applications. Our ALM device complements the solution portfolio with a service agnostic monitoring technology that does not require an active component at the remote end. The table provides an overview of the different demarcation technologies complementing our proactive fiber assurance solution.





Sets a new benchmark for fiber assurance

For more information

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About ADVA Optical Networking

ADVA Optical Networking is a company founded on innovation and driven to help our customers succeed. For over two decades our technology has empowered networks across the globe. We're continually developing breakthrough hardware and software that leads the networking industry and creates new business opportunities. It's these open connectivity solutions that enable our customers to deliver the cloud and mobile services that are vital to today's society and for imagining new tomorrows. Together, we're building a truly connected and sustainable future. For more information on how we can help you, please visit us at: www.adva.com.