broadband@work
ACROSS AMERICA™

Tools to Help You Put Broadband to the Test

JDSU can help you save time and money with your broadband deployment—end to end, across the network, and throughout the network life cycle






JDSU

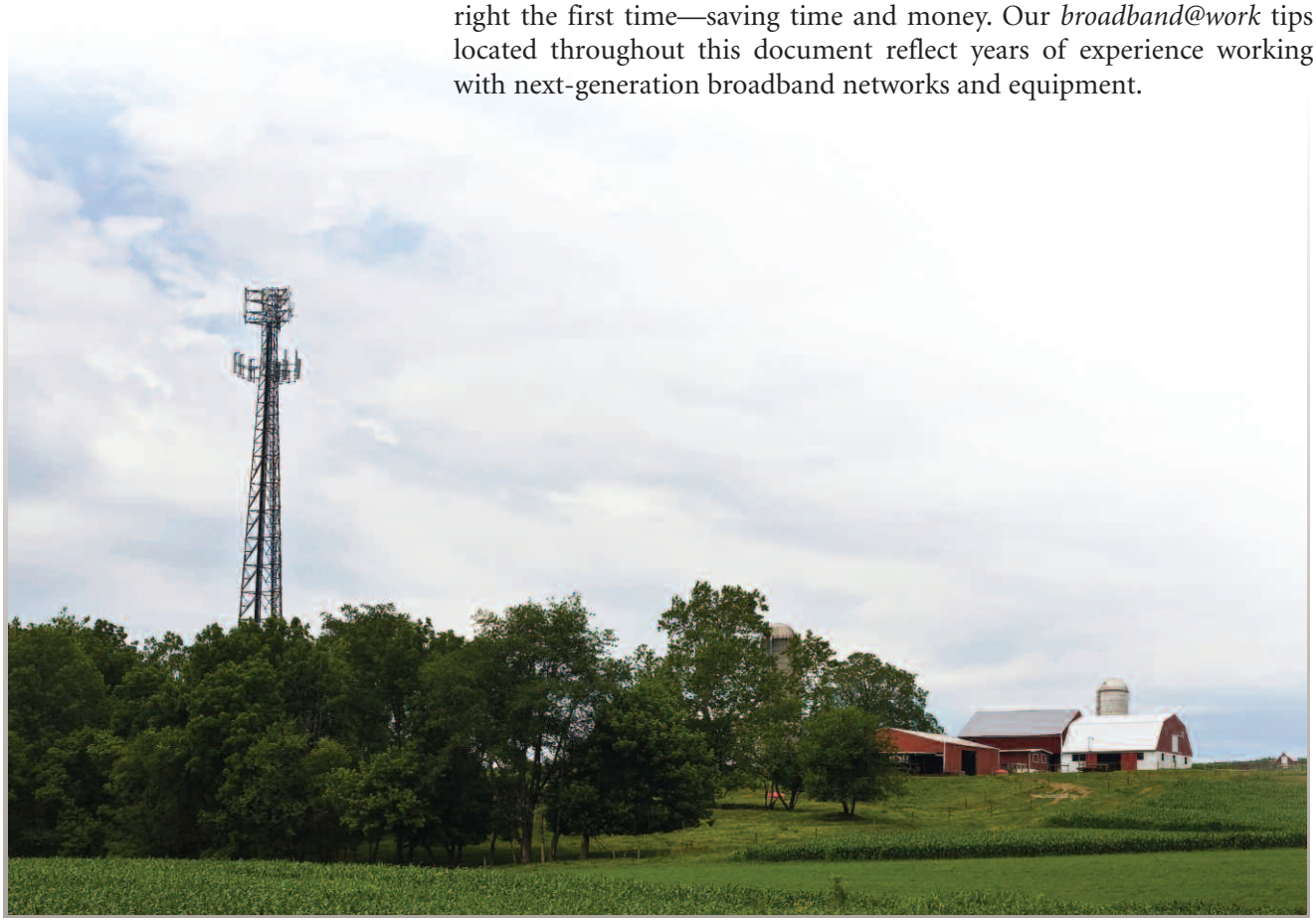
Broadband@Work Across America

The American Recovery and Reinvestment Act provides much needed funding to expand broadband access to rural and underserved communities across America.

For these communities, access to high-speed data, voice, and video services offers job creation and economic development benefits. Individuals can grow web-based businesses, take advantage of telemedicine and distance-learning applications, and enjoy more home entertainment options. As service providers, you will play the critical role in accelerating broadband deployment for more American communities.

This is a historic opportunity to bring the benefits of broadband to the one-third of Americans who currently do not have broadband access. Whether you are deploying fiber-to-the-home (FTTH), digital subscriber line (DSL), wireless, hybrid fiber-coaxial systems, or broadband over power lines you need the tools and expertise to install, test, and verify infrastructure and services efficiently and cost-effectively.

This is where we can help you. As a leader in broadband network test and measurement solutions and optical components, JDSU has decades of experience working with large and small telecom service providers, cable operators, utilities, municipalities, and network equipment manufacturers. With JDSU, you have a partner who can help you get it right the first time—saving time and money. Our *broadband@work* tips located throughout this document reflect years of experience working with next-generation broadband networks and equipment.



Will Your Network Pass the Test?

As millions of Americans watch video over the web, download music and video, and send increasingly large files, today's broadband networks have to meet increasingly stringent tests. For service providers, you have to deliver high-quality service at an affordable price. You need the knowledge, tools, and solutions to:

- Build new broadband access networks
- Understand what can go wrong
- Detect common problems
- Fix network and installation problems
- Ensure reliable service

Here are solutions to some of the more common issues and problems service providers face when deploying FTTx networks and providing broadband services:

Application	Potential Problem	Test Solution
Installing Fiber	Dirt contaminates the line and can damage the equipment	An all-in-one test instrument that serves as a power meter for turning up fiber and also inspects the fiber for dirt contamination
Deploying Ethernet Equipment	Configuration errors in Ethernet switches and routers lead to frame loss and delay	Ethernet testers that enable technicians to verify the Ethernet link and configuration in the central office and video serving and hub offices
Identifying and Solving DSL Service Problems	Wideband and impulse noise impairments impede service quality	Application aware test solutions that can test multiple layers at the same location and time to identify and solve the service problem
Processing Video	Signal delays can cause synchronization issues for video and its audio timing	Video analyzers that measure timing accuracy, jitter, and drift to ensure nanosecond resolution
Installing CM service with margin	Leaving the home without conducting proper tests can cause data service problems later resulting in customer dissatisfaction and repeat truck rolls	DOCSIS®-capable triple-play instrument that measures all key digital parameters including two-way DOCSIS communication tests to ensure there is some margin before services can be affected

Inside the New Broadband Network

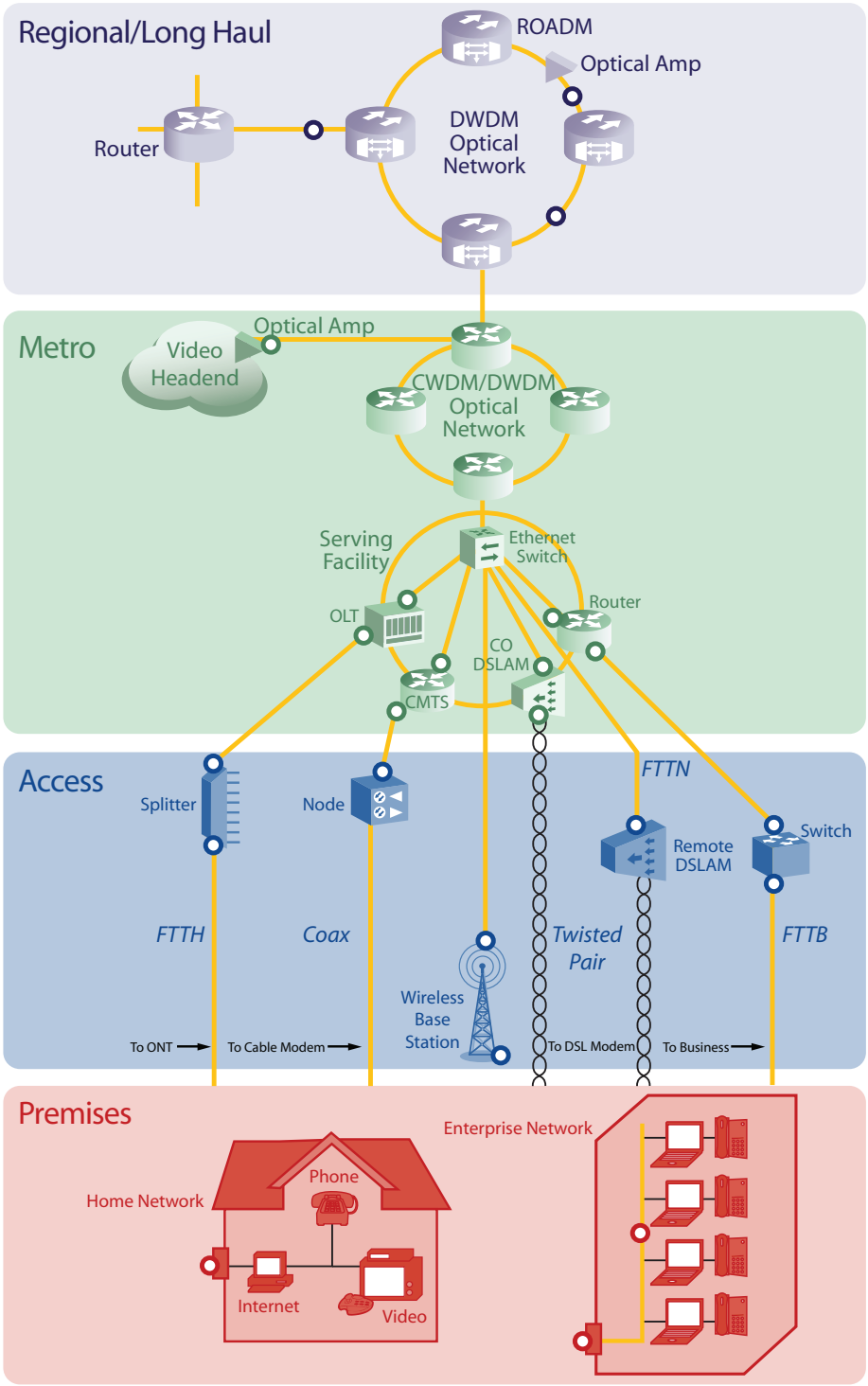
Today's broadband network represents four key components:

Regional/Long Haul and Metro Networks
the fiber optic and network switching core network as well as the network connecting two or more local area networks, using multiple access methods to carry voice, video, image, and multimedia data

Access Network
the broadband access technologies connecting a customer location to the network switch or points of presence

Premises
the broadband devices and services used by a customer in the home, office, and mobile settings

As a provider, whether you are directly responsible for all or just a portion of these network components, you need a strategy that guarantees quality of service (QoS) end to end and throughout the network life cycle—from design to operation—to give your customers the broadband service they require.



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Use a Power Meter to Test Passive Optical Network Installations and Inspect Before You Connect

Optical line terminal (OLT) installation at the headend or CO to customer premises are key in building the PON. Upon completion and turn-up, the technician may opt to perform power level checks at the OLT or FDH and the other unit to the fiber to the ONT. A power meter is used to measure and verify adequate power flows in both directions. If a problem is detected, the technician can then use an OTDR to troubleshoot the network segment. Various OTDR configurations may be utilized depending upon network topology and test point access.

Pushing optical fiber much deeper into the access network, in some cases all the way to the customer premises, is an important part of the strategy of nearly every service provider. Passive optical networks (PONs), point-to-point, and other types of fiber optic infrastructure offer the potential for practically unlimited bandwidth and also facilitate greater control over the operation, administration, and provisioning of the access network.

Testing PON Frame Installation and Connection

At the fiber distribution hub (FDH), all fibers coming from the central office (CO) are connected to splitters. An optical time domain reflectometry (OTDR) measurement from the CO is recommended to verify splice quality out to the hub, ensuring all fibers are connected to the network. A measurement at 1310/1550 nm is then performed from the hub downstream to check fiber and splice quality.

Testing at the Curb and/or Customer Premises

At the curb or junction box, prior to connecting the drop cable and at the side of the house, prior to connecting the drop to the optical termination unit (ONT), the technician should check optical power levels and inspect the connectors for dirt or contaminants prior to connecting. These quick and easy-to-perform steps are essential—if problems arise later during the installation, any issues with the fiber plant have already been ruled out and the root issue is either inside the home or upstream in the network.

Inspect Before You Connect

When time is money, it makes sense to inspect before you connect. An OTDR test tool is essential for verifying proper continuity after fusion splicing for feeder or distribution networks. A uni- or bidirectional OTDR measurement from the CO at 1310/1550 nm can be used to qualify the fiber and splices. Actual laying of the fiber may be outsourced in some deployments so that the technician performing the install may need only to test the power level and connectors. In other cases, one person might be responsible for the entire job and need only an OTDR, power meter, and connector inspection scope.

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Sectionalize and Isolate DSL Problems

Application-aware test solutions that can test multiple layers at the same location at the same time can aid greatly in isolating problems in smaller networks where there is less rigid separation of work responsibility and no large network operations center to monitor every corner of the network. For example, if you have a customer who is experiencing video degradation on IPTV service delivered over DSL, you can test the service to make sure it is running clean to the house and upstream to the network.

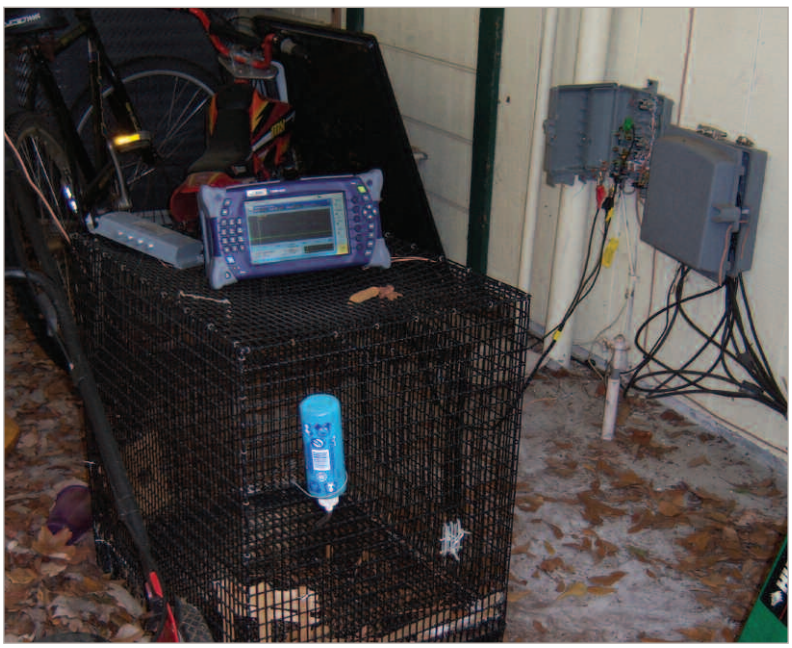
As DSL technology has evolved from asymmetric DSL (ADSL) to ADSL2+ to very high-speed DSL (VDSL2), it has demonstrated the ability to deliver ever increasing data rates—enough to deliver triple-play voice, video, and data services. The high data rates used to deliver broadband services such as Internet Protocol TV (IPTV) place far more demands on the existing copper plant than plain old telephone service (POTS) or even first-generation ADSL-based Internet. Pushing the rate and reach curve to offer video and high-speed data over the copper plant increases the sophistication of the testing required to ensure quality of experience (QoE) and QoS.

Addressing Bridged Tap, Wet Sections, and Metallic Faults

Because an earlier generation of Internet data service was less than 1.5 Mbps, common faults and impairments such as bridged taps, wet sections, and metallic faults often did not prevent achievement of the minimum required ADSL sync speed. But these previously marginal conditions usually have a much larger impact on high-speed and video performance. A comprehensive automated pair-check test takes the guesswork out of prequalification and troubleshooting by proactively identifying, locating, and removing these problems.

Detecting Wideband and Impulse Noise

Wideband and impulse noise conditions that were marginal when there were only a few working DSL pairs in the cable can become sources of trouble as the number of subscribers increases over time. Additionally, these problems can be intermittent in nature, making them harder to diagnose. The ability to measure wideband and impulse noise in snapshot mode and over time as well as the ability to analyze the noise spectrum over time are essential troubleshooting tools.



Ensuring Performance of HFC Access Networks

Engineers and technicians struggling with assignments as diverse as tracking down and fixing ingress, aligning optical nodes, and providing proof of performance need easy, cost-effective methods for efficient installation, qualification, maintenance, and troubleshooting of Hybrid Fiber Coaxial (HFC) networks.

Troubleshooting Return Path Ingress and Noise Problems

The number one challenge for cable operators in maintaining high-quality two-way communication services is detecting and resolving return path ingress and noise problems quickly before they negatively impact the customer. Because return path noise aggregates from each house when it returns to the headend, high ingress from one house can degrade the data reliability and quality of the entire node. In order to solve these problems, operators need a return path monitoring and maintenance system powerful enough to simultaneously monitor performance of the HFC return path while supporting field and network operations center (NOC) troubleshooting. It increases network availability for two-way services and helps to retain the most profitable customers by easily detecting impulse noise, ingress, and critical path delay (CPD) on all nodes before service quality is affected. The system also accelerates troubleshooting without impairing monitoring functions or headend personnel by broadcasting live spectrum to the field technicians.

Measurements for DOCSIS Data Carrier Health

High packet loss as well as low throughput speeds many times are caused by low downstream carrier quality and poor transmit level at the customer premises. Digital quality measurements can typically reveal downstream carrier quality problems which causes download speed and VoIP call issues. The modulation error ratio (MER) is a measure of the signal-to-noise ratio (SNR) in a digitally modulated signal and is good for showing consistent issues such as a constant ingress spike. Bit error rate (BER) measurement is good for detecting intermittent ingress issues. The cable modem range test can measure the return transmit level, which will communicate with the headend cable modem termination system (CMTS) to show how much margin remains before communications become disabled. When the transmit level is at its maximum, data link loss can result when the loss from the customer premises to the headend becomes slightly larger. If the transmit level is too low, ingress from the customer premises will have an increased effect on data link reliability due to low MER.

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Use Sweep to Maintain Peak Performance of Your HFC Network

One core requirement of any HFC network with two-way services is ensuring sound HFC frequency response in both the forward and return paths. Service quality depends upon signals with the best SNR and the lowest intermodulation distortion. The majority of all transmission errors, including digital carriers, can be detected by measuring the frequency response of the transmitted signals. Because sweep results are independent of transmission methods and formats, they provide the most effective and efficient method for technicians to set up amplifiers with the right gain versus frequency.

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Proactively Test Coaxial Cable to Prevent Video over Data (VOD) Degradation

Coaxial cable faults and splitters that create excessive loss or noise ingress conditions can reduce the SNR, leading to video packet loss and degradation of the video service. One common scenario exists where broadcast video is delivered using traditional QAM RF technology and video on demand (VoD) service is delivered as a separate IPTV stream. The broadcast QAM RF video generally has more robust forward error correction than typical IP-based VoD, so fault conditions on the cable can then lead to the difficult to diagnosis situation where the broadcast video works fine but the VoD service is degraded—on the same TV. Proactive testing of coaxial cable runs within the home can prevent this scenario from turning into a trouble call later. When troubleshooting, the ability to quickly isolate the problem to the physical coaxial cable media and reliably locate the affected leg or fault saves time.

A wide range of technologies—Multimedia over Coax Alliance (MoCA), HomePNA, Data-Over-Cable Service Interface Specification (DOCSIS), HomePlug, WiFi, Ethernet, and traditional quadrature amplitude modulation (QAM) RF video signals—can be employed in the home. Depending upon the technology, a range of different physical media—coax; category 3, 5, and 6 cable; wireless; home power lines—are used to get content to the physical user.

Spotting WiFi Problems

WiFi is the dominant method of in-home broadband Internet data distribution. Typically, non-hardware-failure-related WiFi problems such as weak signal, same channel interference, or encryption problems account for as much as 20 percent of in-home "can't connect" or "slow connectivity" problems. The ability to systematically and efficiently identify and resolve these problems is critical to controlling service costs.

Mapping In-home Infrastructure

Some in-house coaxial and twisted pair networks have undergone several generations of change and expansion as residents switch between cable and satellite providers and add their own runs. Trying to make sense of the infrastructure under these circumstances can be a time-consuming, trial-and-error process. Tools that allow the installer to quickly map the in-home infrastructure and locate splitters, faults, un-terminated runs and other issues such as satellite boxes still connected to runs, and saves time and reduces the potential for problems later.

Homework for the Home

As much as 80 percent or more of post-installation problems with triple-play service results from issues in the in-home environment. A systematic method of diagnosing these problems is essential to avoid wasted time, effort, and money.

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Use an Ethernet Tester for Verification

Configuration errors in Ethernet switches and routers can lead to frame loss, delay, and variation with significant impact on video quality. Ethernet testers enable technicians to verify the Ethernet link and transport layer configuration in the CO, video serving offices, and video hub offices.

Whether you are building out your own metro regional networks or using a partner network to carry broadband services from providers to your edge networks, ensuring transport quality will be key for successful broadband service deployment. Metro core networks increasingly use IP/Ethernet as a preferred transport technology.

Testing Ethernet to the Edge

Metro IP networks are prone to packet loss so verification of packet and transport networks is critical to detect any quality degradation that will affect the customers' QoE and QoS. Ethernet is the preferred solution for metro/edge/hub transport networks. Operators require the capability of testing Ethernet networks for appropriate delivery of agreed QoS features.

Validating Link and Transport Quality

Configuration errors in Ethernet switches and routers link and transport layer parameters can lead to frame loss, frame delay, and frame delay variation with significant impact on video quality. Ethernet testers enable technicians to verify the Ethernet link and transport layer configuration in the CO, video serving offices, and video hub offices.

Verifying Video Transport Stream Quality

Intermittent frame loss and delay variation can also impact the video transport stream quality. IP video testing at Ethernet switches verifies quality of Motion Piture Experts Group (MPEG) transport streams.

Resolving Headend and Core Issues for High-Quality Video

Each stage of broadband service delivery introduces a different set of criteria to validate and different potential issues to address. The service provider must validate both the physical plant's ability to carry the bandwidth and the content leaving the producer and entering the operator's headend to detect fault conditions. This is true especially for fast-growing video applications.

Validating Source Video Quality

Video streams need to be analyzed as they enter the headend prior to encoding to detect problems such as macro blocking, blur, and jerkiness. A digital broadcast test platform can provide real-time analysis to ensure the source video is error-free before it is encoded, multiplexed, or modulated for distribution.

Ensuring Proper Network Element Configuration

When multiplexing and mapping programs, it is vital to ensure that programs are where they are supposed to be and properly reflected in the program association table and program map table. An analyzer compares the input of the multiplexer with its output to continuously ensure that the configuration is correct and content is properly mapped.

Monitoring Digital Program Insertion

Because network operators increasingly are utilizing Digital Program Insertion (DPI) to maximize advertising revenue, problems can quickly affect the bottom line. Test equipment should enable you to efficiently test DPI broadcast equipment and monitor and troubleshoot associated MPEG streams with DPI data. This approach rapidly tests message formats and identifies errors in splice points or DPI tables, protecting an important revenue source.

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Validate Video Timing and Lip-sync

Any time video is processed, there are delays in the signal. Ensuring the health of the reference timing involves more than simple jitter measurements. The MPEG analyzer measures timing accuracy, jitter, and drift with nanosecond resolution. The ability to compare video and audio timing is critical to diagnose lip-sync issues. Intermittent frame loss and delay variation can also impact the video transport stream quality. IP video tests at Ethernet switches verify quality of MPEG transport streams.

An Elementary Stream Analyzer can be used to test the compressed video frame by frame to identify violations of encoding specifications and provide detailed information about the frames, macro blocks, motion vectors, and other compression parameters.

Assessing Your Network and Enhancing Service Performance

Broadband deployment poses many challenges to service providers.

JDSU has extensive experience working with service providers to create and optimize operational procedures that enable reliable delivery of advanced services. JDSU emphasizes deployment methodologies that help you easily deploy and get services to market quickly and ensure high service quality all with cost-effective support.

Phase 1—Network and Infrastructure Audit
The JDSU Professional Services team conducts an audit of your network and operational infrastructure to identify potential issues and their root causes to ensure achievement of your business objectives. These issues range from network and system architectural flaws to lack of proper surveillance systems and operational procedures.

Phase 2—Field Testing and Verification
JDSU performs a set of targeted field tests to isolate root causes of faults and to determine specific actions for isolating issues identified during the audit phase. The actions include preparing test plans, conducting tests, and performing post-test analysis.

Phase 3—Analysis, Modeling, and Recommendation
In the final phase, JDSU provides recommendations with specific action items to ensure your network, service architecture, and operational process and practices are maximized for efficient operation.

In addition, we offer various consulting services to address the specific challenges of deploying and maintaining broadband technologies with a phased program to enable operators to cost-effectively deliver high-quality services.

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Qualify and Validate Your Fiber Plant

The new generation of broadband networks makes it essential to go beyond basic testing to qualify and validate the fiber plant operation at higher speeds to support dense wavelength division multiplexing (DWDM) and reconfigurable optical add-drop multiplexer (ROADM) upgrades. Characterizing your fiber links allows you to determine which links can support which speeds to easily evaluate older fiber plants, make evaluations when acquiring plants, and make upgrade plans. In many rural area build-outs, coarse wavelength division multiplexing (CWDM) provides more moderate bandwidth upgrades at a lower cost with relative ease of deployment.

A Trusted and Tested Broadband Partner

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As you build and operate your broadband network, you can count on JDSU as a valued partner. With more than 175 patents, an installed base of more than 400,000 test instruments, and an extensive test and measurement portfolio, JDSU offers you the expertise and experience to meet all of your broadband needs.

From testing 100G optical network technology in our labs to providing service providers with an array of test instruments for a range of broadband technologies, our goal is to help you save time and money while delivering the highest quality services.

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