



## WaveReady CWDM and DWDM Optical Transport Products

Unlock the True Capacity of Your Network with  
Cost-Effective, Flexible Solutions

# WaveReady—Cost-Effective Capacity

JDSU is building on its depth of experience as the premier supplier of optical communications technology to deliver the WaveReady line of optical networking and wavelength division multiplexing (WDM) modules and complete WaveReady systems. With WaveReady, JDSU delivers the high-value products that service providers need in order to maximize the capacity of their networks, improve service delivery flexibility, and ensure long-term investment protection.

Since 2001, more than 2,500 WaveReady system nodes and more than 30,000 stand-alone solutions have been deployed in all layers of the network, from the Access layer through to the Metro Edge and Aggregation layers, the Metro Core, and the Regional Backbone.

## High-Value Components, Recognized Expertise

JDSU built its WaveReady systems, products, and services based on its long and successful history in the optical space. Adding JDSU WaveReady products to an existing system, or including them in the initial design of a system, builds in the flexible expansion needed to generate new revenue with the capacity, quality, scalability, and availability required by today's high-bandwidth services.

WaveReady delivers value with proven:

- Simple, cost-effective solutions with best-in-class performance
- True carrier-class reliability (NEBS-3 certified)
- ITU- and Telcordia-compliant optical interfaces
- Proven intelligent features that make optical transport simple to operate and easy to install
- Fast, efficient system turn-up with minimal operations training
- Superior service and support team



# WaveReady Key Benefits

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The development and growth of services brings unprecedented business potential to both service providers and their customers. This potential also brings the challenge of deploying services across all levels of the network in the face of new protocols, ever-increasing bandwidth and data rate demand, fiber exhaust, management complexity, upgrade cost and constant change in customer requirements.

The JDSU WaveReady products are ready to meet all of these challenges. The WaveReady high-value optical transport products offer the innovative and competitive solutions sought by carriers and other service providers.

The following subsections list the key benefits of WaveReady.

## True Optical Layer CWDM and DWDM

WaveReady is unique in the degree to which it operates in the optical layer. Its protocol and data rate independent WDM (xWDM) solutions are prime examples of the advantages that true optical layer functionality provides.

## Simplicity

Fast and simple to implement, the JDSU WaveReady xWDM solutions can be deployed in minutes. Data rate and protocol agile interfaces reduce sparing costs. Flexible, adaptable modules support the use of a single line card for multiple applications.

## Reliability

Backed by the unmatched quality and innovation of JDSU, WaveReady NEBS Level 3 certified products deliver best-in-class performance and reliability. The robust, electro-static discharge (ESD) resilient, full card enclosures of WaveReady offer significant advantages in real-world deployments.

## Cost-Effectiveness

Protocol-independent WaveReady xWDM solutions can multiplex any combination of services required and carry Gigabit Ethernet (GigE), synchronous optical networking/synchronous digital hierarchy (SONET/SDH), storage area network (SAN), and other protocols over a single fiber, all with the same reach.

## Scalability

WaveReady brings flexibility and scalability to the network. Up to 80 channels can be multiplexed onto a single link. Amplifier, multiplexer/demultiplexer and transponder protocol and data rate independence delivers a smooth service and capacity upgrade path.

## Flexible Management

WaveReady is easy and inexpensive to manage. With many WaveReady modules, establishing an optical signal automatically establishes the management channel between the nodes. Reduce operating costs by using only the management features appropriate for a particular application, and upgrade whenever necessary with hitless software upgrades.

# WaveReady Key Benefits

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## Low Power

With the low power requirements of WaveReady systems, service providers can expect lower operating costs, especially for power, backup, and heating, ventilation, and air conditioning (HVAC) in both the central office (CO) and on the customer premises.

## High Density

WaveReady high-density shelves minimize the footprint required for new services and service upgrades. Combined with the ability of WaveReady modules to pack more traffic (and revenue) onto each fiber, WaveReady high density delivers reduced infrastructure costs, especially at the central office (CO).

## Services

The quality products from JDSU are supported by quality services and 24/7 support. JDSU offers Fiber Characterization services for in-depth analysis of fiber networks for existing and future deployments. In addition, the installation, turn-up, and test services that JDSU offers ensure the optimal implementation of WaveReady systems, delivering the capability, reliability, and simplicity service providers need.

# WaveReady in the Optical Layer

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## True Optical Layer CWDM and DWDM

WaveReady modules are transparent to the details of the signal, so WaveReady xWDM solutions deploy quickly and can multiplex any combination of services required—GigE, SONET/SDH, SAN, and other protocols and data rates—over a single fiber and long distances. Other important features supporting this service flexibility include:

- **Autolock:** WaveReady regenerators and amplifiers only need a connection—the modules automatically detect the data rate with no provisioning or equipment configuration required.
- **Easy multiplexing:** The capacity of a single fiber can be increased from a single channel to 4, 8, 32, or even 80 channels by adding the appropriate WaveReady xWDM components and making the connections. The upgrade can be performed often with no configuration and usually without interrupting existing services, all within the optical layer of the network.
- **Comprehensive management:** An optical connection automatically opens a management channel to most modules in a shelf and subtended shelves. WaveReady Node Manager software provides management for WaveReady nodes with standard simple network management protocol (SNMP) or TL1 interfaces or integrates with third-party tools such as HP OpenView, Telenium, and Netcool.

The true optical layer operation of WaveReady is simple and reliable. True optical layer functionality makes network infrastructure more manageable, improves scalability, ensures protocol-independence, and gives the network the built-in capacity to generate new revenue with the capacity, speed, and availability required by today's high-bandwidth services.

# WaveReady Systems



## Full-Featured Optical Transport Applications

WaveReady systems consist of interchangeable modules managed by software (SNMP/TL1) via an Ethernet serial connection or embedded management channel interfaces, and/or dry contact alarms. All WaveReady components are data rate and protocol independent, which offer exclusive ease of installation features and provide management flexibility.



### WaveReady 3100 Shelf

The WaveReady 3100 is a 1 RU customer premises/remote terminal chassis, 2-slot, 1 RU high, 48 V DC or 110/220 V AC, NEBS Level 3 certified, ideally suited to remote terminal and stand-alone network applications. These shelves can also be daisy-chained together in future upgrades.

### WaveReady 3500F Shelf

The WaveReady 3500F is a 7 RU 14-slot fan cooled, redundant power entry, NEBS-3 certified, all-front access, full featured metro optical access platform, ideally suited to CO deployment.

### WaveReady Plug-In Modules

Use as many or as few of the interchangeable WaveReady modules, multiplexer, demultiplexer and optical add/drop multiplexer (OADM) cassettes, amplifiers, protection modules, transponders and regenerators, as needed in either platform. Build an optical transport system tailor-made for current requirements and future expansion.

## WaveReady Node Manager

Supported by both the WaveReady 3100 and 3500F, the JDSU innovative embedded management channel removes the need for additional management fiber, while WaveReady Node Manager software provides the management of WaveReady network elements.

Node Manager takes full advantage of this cost-saving state-of-the-art innovation in module and node management; node-level graphical user interface (GUI), access to all provisioning and troubleshooting features, and standard management interfaces.

## WaveReady Stand-Alone Optical Tools

Increasing demand and changing requirements drive a continual need for upgrade and enhancement. JDSU has a wide range of innovative, capable, stand-alone modules that solve common network problems easily and inexpensively.

- **Passive Mounting:** Rugged, stand-alone modules with optical toolbox functionality
- **Passive Optics:** ITU-compliant modules for coarse and dense wavelength division multiplexing (CWDM and DWDM) for a wide range of applications
- **Amplifiers:** Availability of a variety of fully configurable multichannel and single channel amplifiers
- **Regeneration:** Full 3R (reamplify, reshape, and retime) regeneration in a variety of modules
- **Protection Switching:** Stand-alone and chassis-based protection switching to fit the need
- **Service Demarcation and Link Monitoring:** Easy to install plug-and-play modules as needed



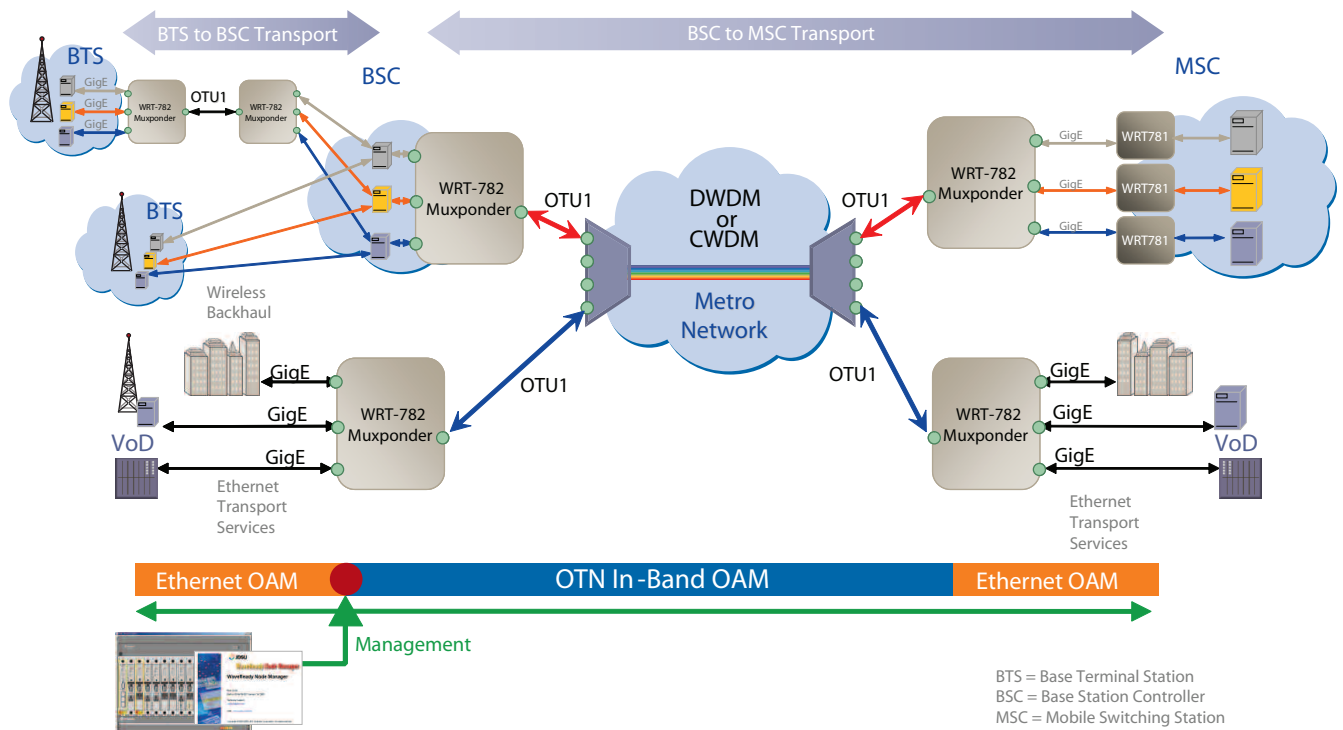
# WaveReady Applications

## Fourth Generation (4G) Wireless

Given the demand for more bandwidth in wireless networks, driven by consumer and business applications, service providers are turning to next-generation Ethernet equipment to provide enhanced connectivity while simplifying the management of a new network model.

WaveReady offers the ideal transport solution for 4G wireless networks. The WaveReady WDM transponders and muxponder provide the right transport and aggregation functionality while supporting the Ethernet operation, administration, and maintenance (O&M) capabilities needed to manage the latest generation of Ethernet transport networks.

The WaveReady platform aggregates and transports Ethernet-based services while providing a full end-to-end management solution. The WaveReady solution also offers the key performance monitoring capabilities required to guarantee service level agreements (SLAs). All these features are essential to provide a clear demarcation capability for service providers transporting a mobile operators' traffic.



# Ethernet Services Delivery Meets the Future

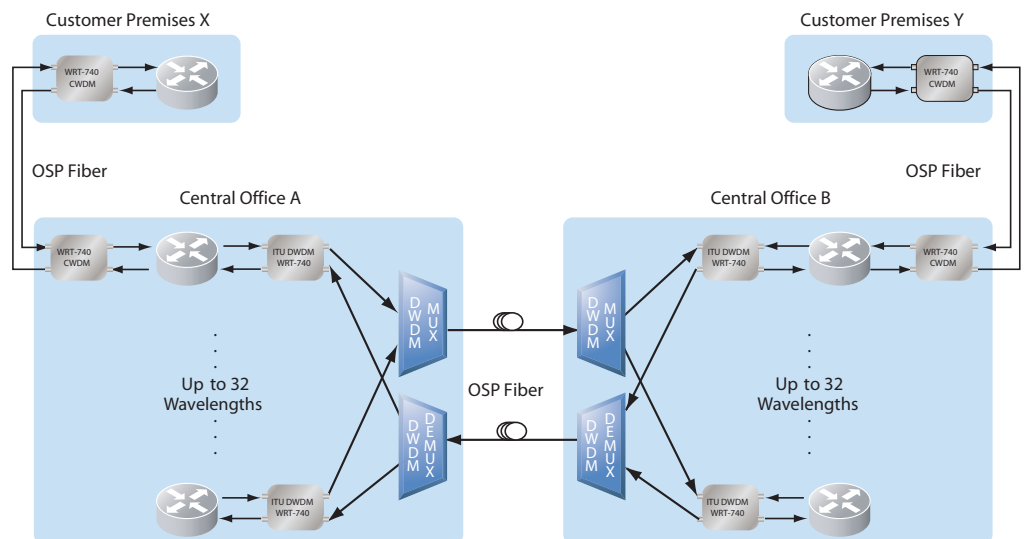
The widespread adoption of Ethernet, SANs, and other high-speed services at the Access and Metro Edge has transformed how customers do business. It has also transformed the business of optical transport. As the pace of business accelerates, service providers need the ability to react quickly and effectively to new demands, increased volume, and service disruptions. Compact, effective, flexible, high-density and cost-optimized CWDM and DWDM systems are needed to satisfy increased SAN and Ethernet transport requirements.

## It's Time for WaveReady

From the Access layer through to the Metro Edge, Aggregation and Metro Core layers, the JDSU WaveReady high-value optical transport products allow service providers to respond quickly to changes in the optical networking business.

WaveReady supports both 1 and 10 Gigabit Ethernet as well as 1, 2, 4, or 10 Gigabit Fiber Channel, and the independence of its protocol and data rate ensures that changes in requirements can be accommodated without changes to hardware, and often with no changes at all.

For example, with WaveReady a customer with an immediate need for a 1 Gigabit Fiber Channel but plans to move to 2, 4, or 10 Gigabit Fiber Channel next year can handle the upgrade transparently with no post-install site visit and few or no changes to installed equipment. If changes are required such as adjusting alarm thresholds they can be performed remotely through the WaveReady Node Manager.



# Wavelength Services Keeps Traffic Flowing

With the growth in optical transport—especially the growth in the wavelength hungry “triple play” of voice, video, and data—many service providers face recurring congestion in the network. Service providers need a highly effective, cost-optimized system that serves the needs of customers now and avoids congestion in the future. WaveReady facilitates deployment of new channels and services on fiber that exists to bring new channels online immediately.

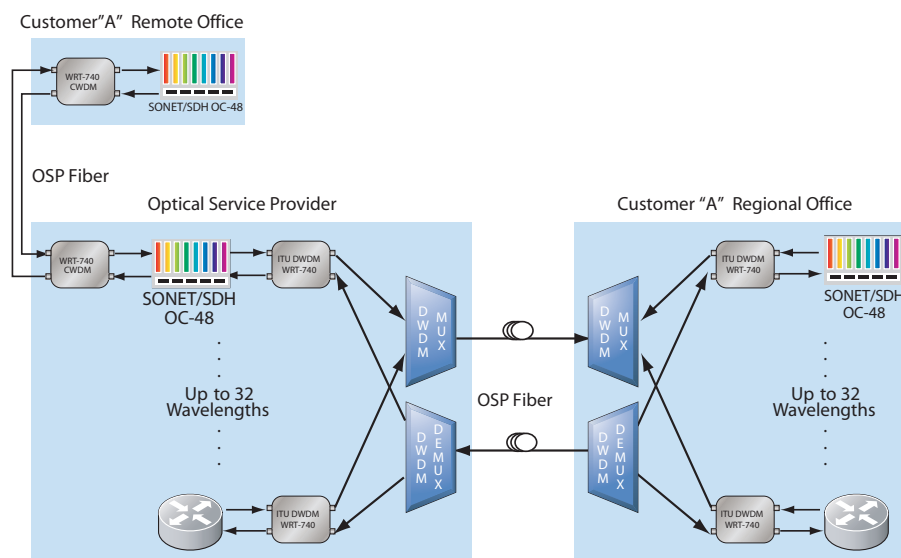
## Plan Ahead

Use WaveReady transponders to convert each service to a different wavelength and then multiplex all services together for transport across a single fiber link. Each wavelength behaves as a new fiber and the network gains a service-independent optical channel with each wavelength added, up to 80 wavelengths on a single fiber.

## Add Capacity with Ease

Interconnect customer sites and edge services to Metro Edge, Aggregation, and Metro Core layers with a wide variety of flexible, interchangeable components:

- WR 3500F CWDM/DWDM optical transport nodes
- WR 3100 SONET/SDH node replacement
- WR 3100 regeneration and/or amplification nodes
- WR 3100 CWDM optical transport nodes
- WR 3100 customer premises equipment (CPE) or collocate hand off
- WR 3500F DWDM/CWDM hybrid nodes
- CWDM passive optics



# WaveReady Applications

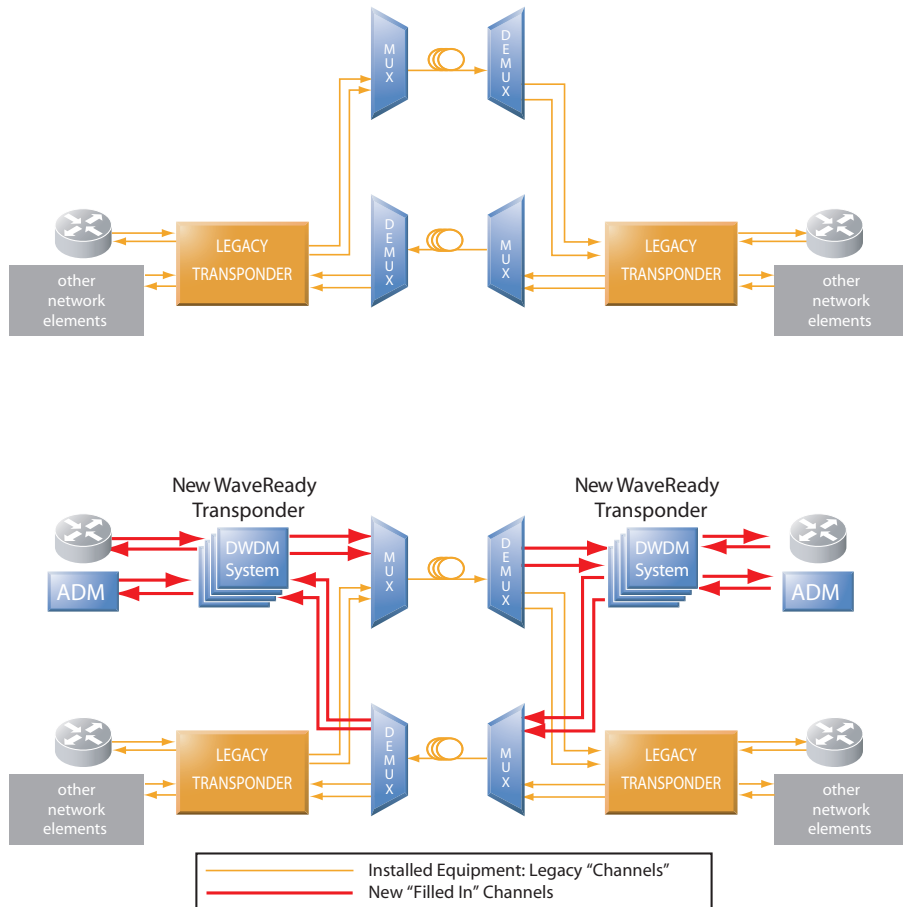
## Channel In-Fill

As demands for optical transport service increase, service providers must retire legacy equipment and bear the cost of upgrading to add channels and capacity. However, replacing legacy equipment is not always necessary. Often there is an opportunity to leverage existing investment well into the future.

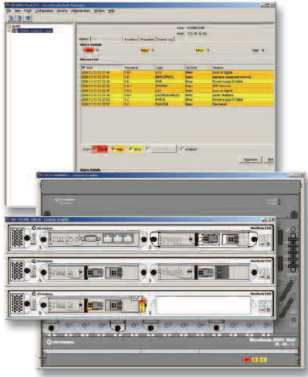
The innovative WaveReady channel in-fill system enhances the capacity of legacy networks by adding new wavelengths to existing fiber and avoiding the need for new fiber.

Channel in-fill offers significant savings over replacement or upgrades:

- Extends the life of existing hardware investments
- Saves cost for those systems that can still be upgraded



## WaveReady Applications Node Manager



WaveReady Node Manager software is a point-and-click GUI of WaveReady node elements and shelves. It provides simple access to all management features supported by WaveReady 3000 systems.

Node Manager allows on-site or remote management of all WaveReady systems, including troubleshooting, maintenance, and provisioning of modules and ports. Easily integrated into third-party management software, it provides a graphical, visual indication of alarms and traps with icon color changes. Launching of WaveReady Node Manager initiates auto-discovery of all WaveReady 3000 network elements.

### Embedded Management Channel

Node Manager takes full advantage of the patented WaveReady Embedded Management Channel technology. With WaveReady 3000 series shelves and most modules, any data connection also establishes a management connection.

### Full Access to All Management Features

- Auto-discovery and fault information on cards and shelves
- Inventory information
- Configuration (provisioning) functions
- Monitoring and status information
- Troubleshooting and maintenance features
- Event logs and software upgrades

### Physical View

- Representation of actual WaveReady 3100 and 3500F shelves and installed cards
- Alarms status on cards and ports
- In-context (cards, ports) application launching for alarms, inventory, status, maintenance and configuration

### Provisioning

- Simple access to all configurable settings
- Input and output power for all ports
- Card specifics (for example, wavelength and reach)
- Data rate monitoring

### Third-party Node Management

WaveReady network elements can also be managed through the standard SNMP or TL1 management protocols. This capability allows for the easy integration of WaveReady node elements in existing management systems such as HP OpenView, Netcool, and Telenium network management tools.

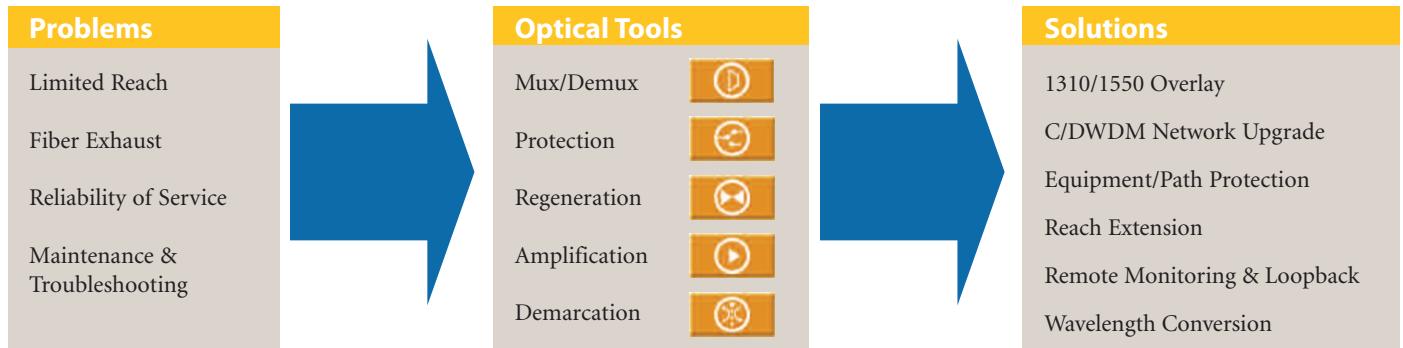
# WaveReady Optical Toolbox

## A Toolbox with All the Right Tools

No network is perfect; there is a constant requirement for upgrade and repair. WaveReady has the right tools and expertise needed to make solving network problems easy.

The WaveReady toolbox of optical stand-alone modules, mixed-and-matched to fit the requirement, can be used in a broad range of very common applications:

- **Regeneration:** Of any service over either CWDM or DWDM
- **Passive Optics:** ITU-compliant modules for CWDM and DWDM for a wide range of applications
- **Amplifiers:** Availability of multichannel and single-channel versions
- **Protection Switching:** Stand-alone and chassis-based protection switching to fit the need
- **Service Demarcation and Link Monitoring:** Easy to install plug-and-play modules as needed



# Regeneration/Amplification

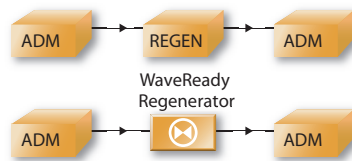
Whether a link needs regeneration at an intermediate site or amplification at the originating site unique suite of WaveReady economical regeneration and amplification tools guarantee the reach required.

## Extended Reach and Budget

Unlike traditional regeneration and amplification solutions, WaveReady deploys quickly and integrates seamlessly throughout a network.

Regenerators and amplifiers supply compact (1 RU) solutions, providing 3R, protocol and data rate independent regeneration and amplification for all wavelengths. WaveReady solutions regenerate at a fraction of the cost of full feature SONET/SDH regeneration nodes and amplify without forklift or truck roll.

## WaveReady Regeneration

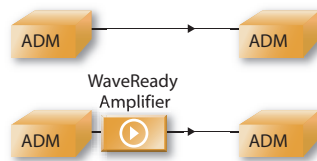


**Problem:**  
Costly SONET/SDH regeneration at an intermediate site

**Solution:**  
Substitute a WaveReady regenerator for a fraction of the cost

- Compact solution (1 RU)
- 3R regeneration
- Data rate and protocol independent
- Both single channel and DWDM multichannel optics

## WaveReady Amplification



**Problem:**  
Insufficient ADM reach and no mid-span site available

**Solution:**  
Use a WaveReady Amplifier to boost the optical signal at the originating ADM site.

**Typical values for WaveReady WRA-1xx amplifiers:**  
Use a WaveReady Amplifier to boost the optical signal at the originating ADM site.

- Configurable as a booster or pre/inline amplifier
- Constant signal gain mode configurable up to 13 dB (WRA-110) and up to 26 dB (WRA-119)
- Constant total output power mode configurable up to 10 dBm (WRA-110) and up to 19 dBm (WRA-119)

# WaveReady Optical Toolbox

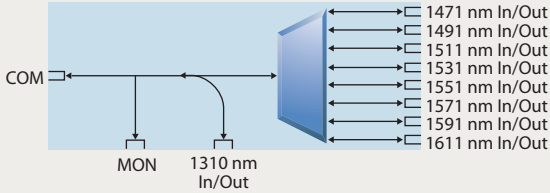

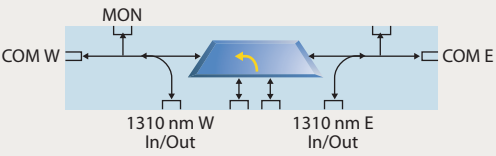

## Passive Optics

### Meet and Exceed Customer Demands

Inexpensive and easy to install and operate, ready for immediate deployment, off-the-shelf WaveReady solutions include CWDM and DWDM multiplexers and demultiplexers, OADM, and optical drop module (ODM) components, and the passive optic LGX platforms service providers require.

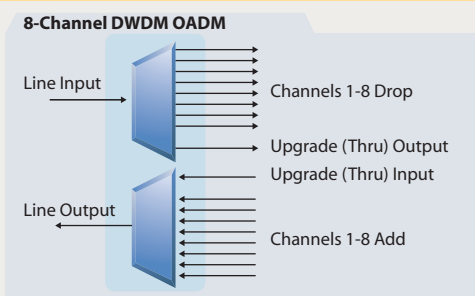

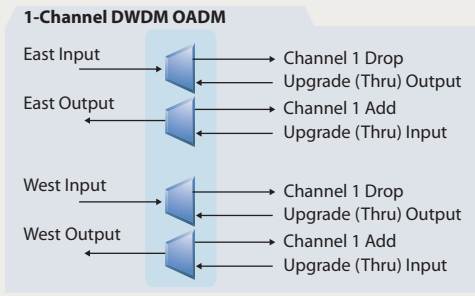

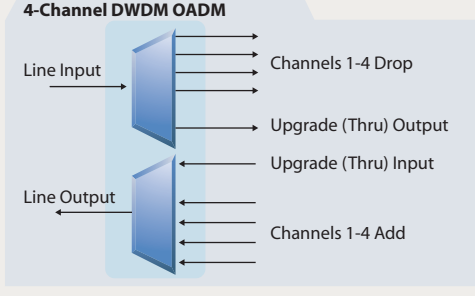

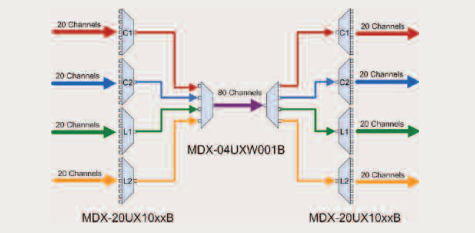

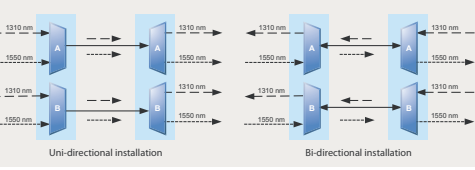

### WaveReady Passive Solutions

WaveReady offers a variety of passive optic configurations to suit any requirement. All JDSU WaveReady passive optics are LGX compatible. JDSU also offers LGX adaptor brackets to fit these modules into the WaveReady 3500F chassis as well as 1 RU rack-mount or splice tray passive mounting solutions.

CWDM	Passive Optics	
	<p>4 -wavelength CWDM universal multiplexer: 1310 port, 1471-1531 nm</p> <p>8-wavelength CWDM universal multiplexer: 1310 port, 1471-1611 nm</p>	
	<p>2-wavelength CWDM ODM with 1310 port, 1471-1491 nm</p> <p>2-wavelength CWDM ODM with 1310 port, 1511-1531 nm</p> <p>2-wavelength CWDM ODM with 1310 port, 1551-1571 nm</p> <p>2-wavelength CWDM ODM with 1310 port, 1591-1611 nm</p> <p>4-wavelength CWDM ODM with 1310 port, 1471-1531 nm</p> <p>4-wavelength CWDM ODM with 1310 port, 1551-1611 nm</p>	

# WaveReady Optical Toolbox

## Passive Optics

Passive Optics		
<p><b>DWDM</b></p> <p><b>8-Channel DWDM OADM</b></p> 	<p>8-channel integrated DWDM multiplexer/demultiplexer with upgrade port</p>	
<p><b>1-Channel DWDM OADM</b></p> 	<p>1-channel DWDM OADM, east and west bidirectional</p>	
<p><b>4-Channel DWDM OADM</b></p> 	<p>4-channel integrated DWDM multiplexer/demultiplexer with upgrade port, base unit, channels 1-4</p> <p>4-channel integrated DWDM multiplexer/demultiplexer with upgrade port, upgrade unit, channels 5-8</p>	
	<p>Modular-UMUX system: Modular C- and L-band multiplexer/demultiplexer system upgradable in 20 channel increments up to a maximum of 80 channels.</p>	
<p><b>1310/1550 Combiners</b></p> 	<p>Dual 1310/1550 multiplexer/demultiplexer with SC connector, 1-slot LGX-compatible universal multiplexer/demultiplexer</p>	

## Equipment and Path Optical Protection Switching

Any interruption of service in a network is disastrous. To protect the network from interruption—and the potential loss of business and revenue that could result—service providers need a strong and dependable toolset to detect problems and instantly re-route traffic around a point of failure.

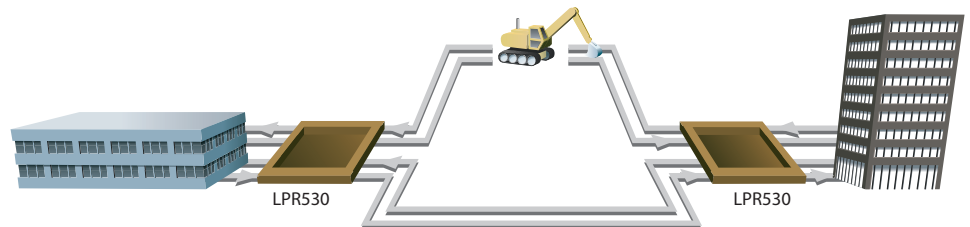
### WaveReady Security

High quality, flexible, and easy to install, WaveReady optical path protection solutions deliver proven stability and reliability with minimal investment and training.

Per channel and per fiber protection switching options protect aggregated links with built-in protection for each service and can include optical demarcation and monitoring.

WaveReady multi-service, protected ring transport includes additional important features:

- Supports up to 40 wavelengths added or dropped on the same ring
- Uses WRT transponders at add/drop points to perform wavelength conversion
- Uses pairs of transponders like the WRT-780, WRT-840, and WRT-852 with the LightProtector 530 to offer full path protection and remote management
- WRT-760 offers a built-in protected interface to the ring.



# WaveReady Optical Toolbox

## Wavelength Overlay

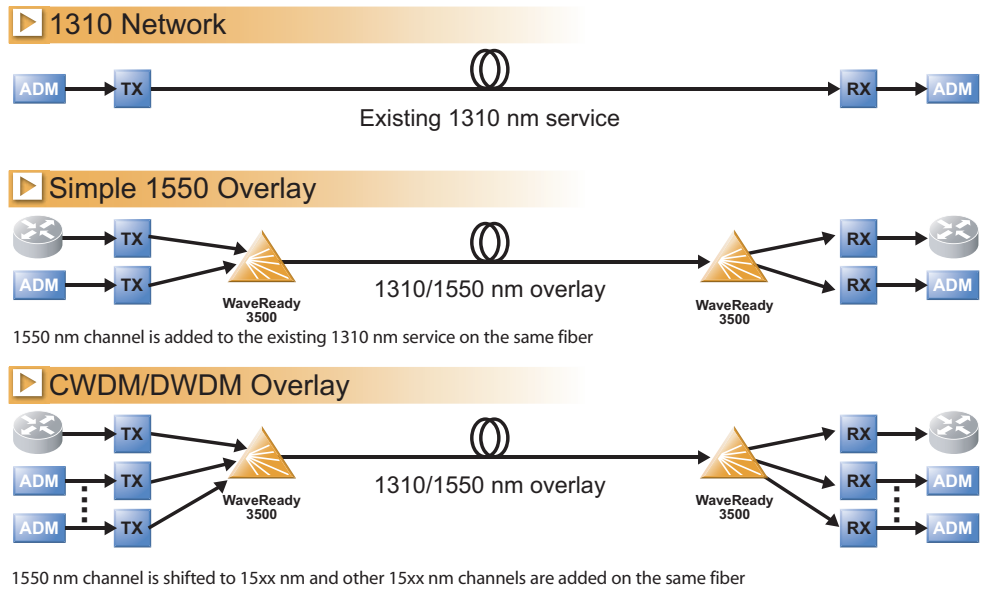
As customers expand optical transport usage to include voice, video, and data, service providers need an alternative to laying more fiber and disrupting capital expenditure budgets.

### Build on What You Have

The WaveReady innovative wavelength overlay enhances the capacity of legacy networks by adding bandwidth and services without adding fiber. New wavelengths are overlaid transparently on the existing service within the existing fiber. The integrity of all existing services is maintained. WaveReady wavelength overlay increases the capacity of legacy SONET/SDH (and other) networks by providing a clean migration path to WDM, CWDM, and DWDM.

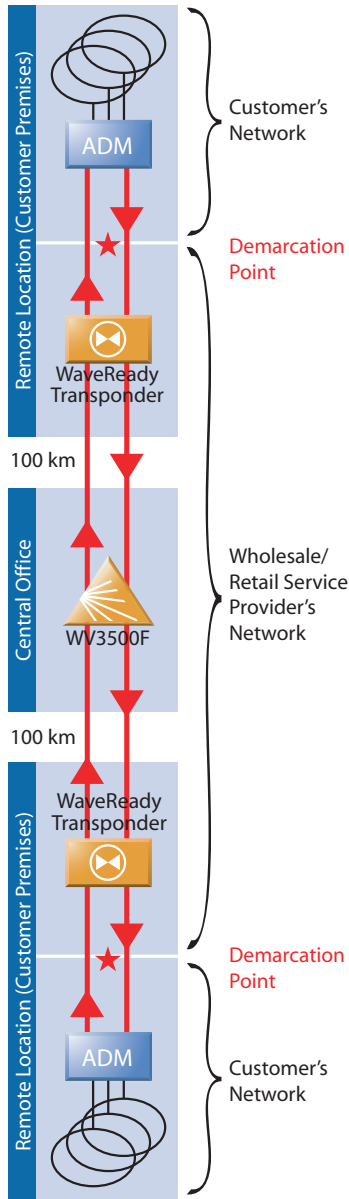
### Typical Application

The figure shows a typical installation for an existing service of 1310 nm with 1550 nm overlaid on the fiber.



# WaveReady Optical Toolbox

## Service Demarcation



The reliable operation of interconnected, interdependent optical networks is critical. In particular, reported optical problems must be located and diagnosed quickly. The JDSU WaveReady service demarcation gives service providers the ability to respond quickly and accurately to problems and breakdowns and the flexibility to cope with the rapidly evolving needs of optical transport.

### Find it. Fix it.

WaveReady transponder managed demarcation points let providers quickly and accurately determine whether a reported optical problem originates on the service provider side of the optical network or in a connected network, then they can troubleshoot for fault isolation to properly dispatch repair crews.

WaveReady transponders offer a full suite of optical layer demarcation features. Loopback of all optical interfaces, both network (facility) and client (customer) port input/output power monitoring with loss of signal (LOS) and loss of lock (LOL) alarms, and data rate monitoring, including alarms when customer bandwidth consumption exceeds expected values, ensure secure and reliable monitoring of the network.

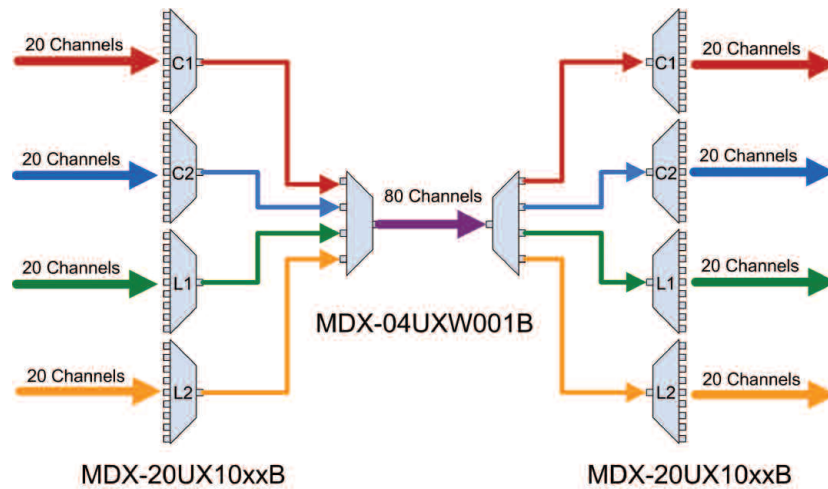
In addition, all demarcation features are remotely accessible through the WaveReady embedded management channel. No optical supervisory channel or out-of-band management connection is required.

Increasing traffic is stretching legacy networks to the limit of their capacity. Rather than adding new fiber, service providers need new approaches and new tools to keep networks running smoothly and efficiently. With WaveReady fiber exhaust solutions that smooth and efficient increase in capacity can be achieved by adding up to 80 channels on a single fiber.

WaveReady transponders convert each service to a different wavelength and then multiplex all services together for transport across the same fiber link. In effect, each wavelength behaves as a new fiber. The network gains a service-independent optical channel with each wavelength added.

### Discover Your Network's True Capacity

There are as many fiber exhaust configurations as there are networks. JDSU can help identify the most effective, and cost-effective, fiber exhaust configuration to meet the requirements of any network.



# WaveReady Installation Services

## Simplifying Deployment of JDSU Systems

JDSU offers full fiber characterization, installation, integration, configuration, and program management services to ensure effective implementation of WaveReady systems, from the simplest deployment through to complex custom solutions tailor-made to satisfy extraordinary, exacting requirements.

JDSU can also install and configure test management software in the network operations center. Trusting JDSU with system deployment saves time, reduces repeat visits, and shortens the time to profitability.

### Highlights

- Frees staff and resources to perform other jobs
- Reduces repeat visits and installation time with documented and proven installation and final testing procedures
- Minimizes negative impacts of system installation on the network because of JDSU system and network expertise
- Keeps installation projects timely and organized with experienced JDSU program managers

## Test and Turn-Up Assistance: Final System Verification

Test and Turn-up Assistance is a service for customers who prefer to perform the physical installation themselves and ask JDSU to perform final configuration and certification. JDSU offers planning services and site visits to perform a visual inspection of the system, final card insertion, programming of the system, and execution of a complete test and certification procedure.

### Highlights

- Certify the performance of a JDSU system before turn-over to the end user
- Resolve potential problems caused by non-JDSU components
- Use on-site personnel and the expertise of JDSU to perform an installation

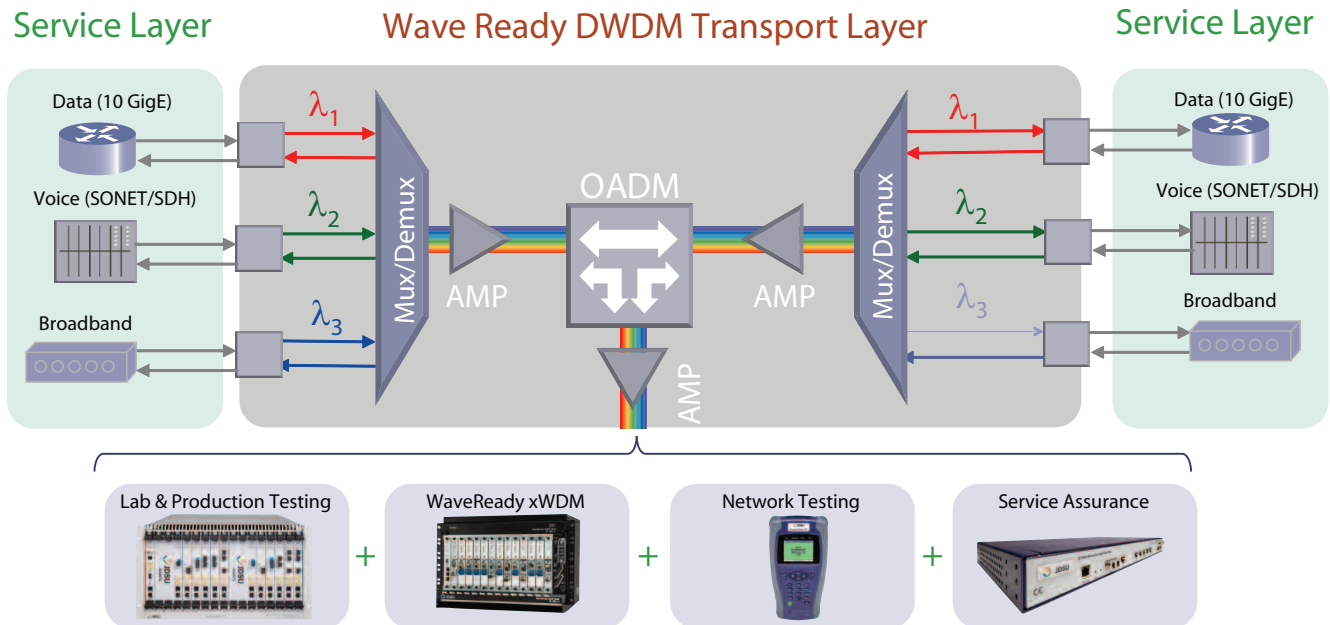
## Typical 2.5 Gb/s and 10 Gb/s Fiber Test

Fiber installation	IL	OTDR	ORL	PMD	CD	SA	OSA	Level	BERT
≤2.5 Gb/s per Channel	X	X	X						
≥10 Gb/s per Channel	X	X	X	X	X				
C+L-Band DWDM	X	X	X			X			
Equipment Installation				X	X		X	X	
System Turn-Up							X	X	X
System Maintenance		X		X			X	X	X
<b>System Upgrade</b>									
≤2.5 Gb/s per Channel			X					X	X
≥10 Gb/s per Channel			X	X	X	X		X	X
DWDM ext.			X		X	X	X		X
Dark Fiber Lease for 10 Gb/s per Channel			X	X		X	X		

# Optical Solutions for the Entire Network Lifecycle

## Design It, Build It, Test It, Assure It

WaveReady is one component of the industry-leading JDSU portfolio of WDM products that include solutions for installing, testing, maintaining and assuring WDM components and networks. Please contact your JDSU sales representative to learn more about our broad range of fiber characterization, transport and network test equipment.



## The Optical Layer—More than a Marketing Phrase

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JDSU has been involved in the development of the optical network since the beginning. Because of that experience, JDSU understands that the key to delivering business value, flexibility, agility, and long-term investment protection lies in developing products, like WaveReady, that deliver full optical layer functionality to every layer of the network.

Optical layer functionality and independence are important because they give service providers freedom.

- The freedom to transport, transparently, any protocol or service on a single WDM platform
- The freedom to create a more capable network that is service-agile and that can seamlessly deliver new services simply by adding wavelengths to the existing WDM transport system
- The freedom to manage networks easily, completely, and proactively instead of reacting to problems in the services layer
- The freedom to exploit the true capacity and increase the profitability of current and future networks



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