

A high-speed train is captured in motion, blurred to convey speed, as it travels through a modern subway station. The station's ceiling is a striking feature, with curved panels in shades of green and yellow. The platform on the left has a tiled floor and a glass-enclosed structure. A large white diagonal graphic element separates the platform area from the train area.

# Application-optimized optical line systems

Maximize critical network scalability,  
flexibility and resilience

NOKIA



# Optical innovation needed

Keeping up with the growing demand for bandwidth is an ongoing innovation challenge for your optical network. Several trends are pushing it to its breaking point. Bandwidth demand is growing 35-40% per year driven largely by bandwidth-intensive video-based services. Dynamic and high-performance services like 5G, cloud and IoT are complicating network planning and challenging network agility. Emerging applications and services driven by AI and machine learning (ML), as well as augmented, virtual and extended reality (XR) applications will further stress existing fiber capacity.

## **Double your bandwidth**

If your transport network operates in the C-band then it is approaching the Shannon Limit of capacity and spectral efficiency. Fortunately, the L-band offers a whole unused spectrum band that can double the capacity of your current fiber.

## **Expand without stranding assets**

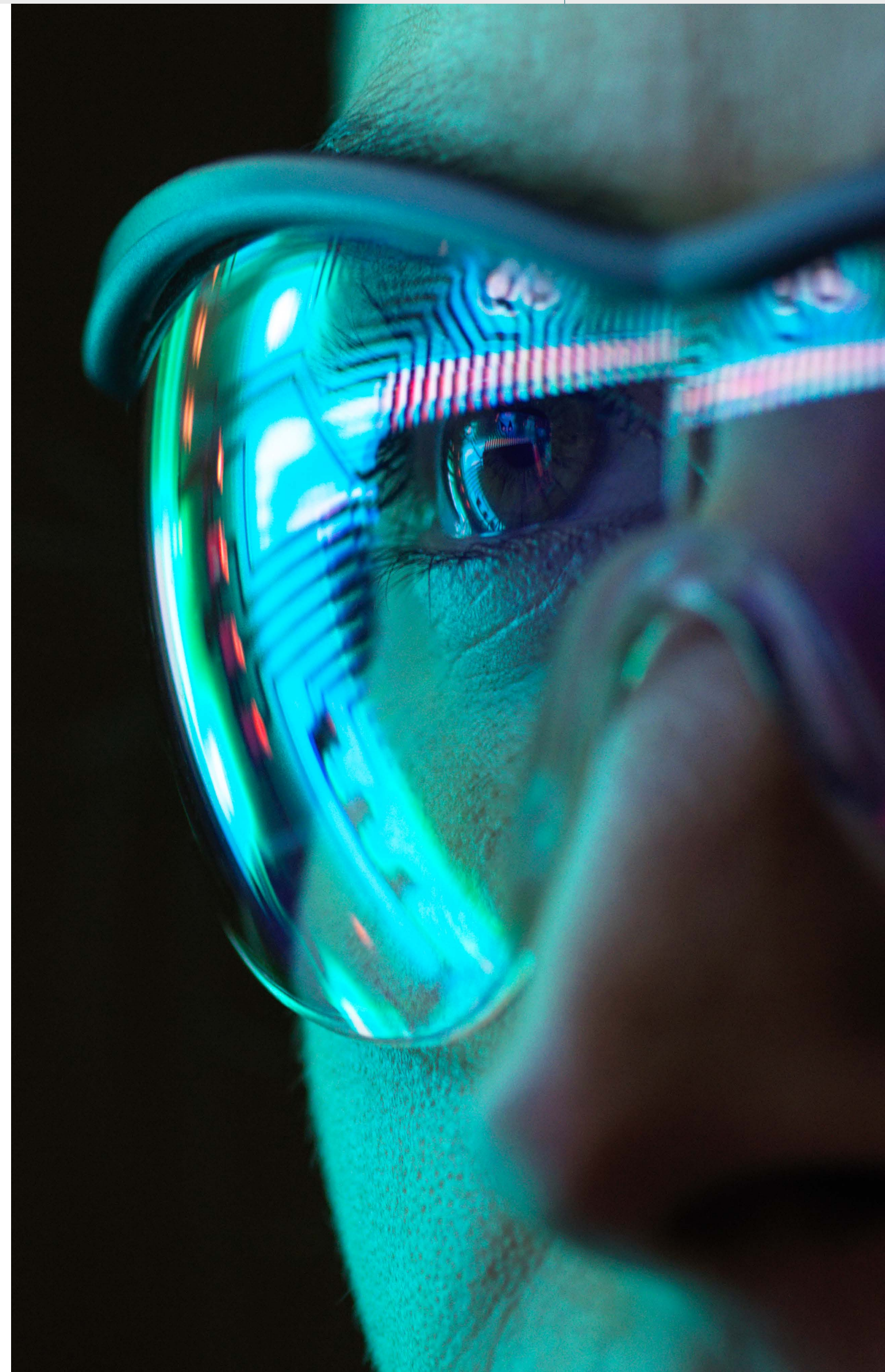
Nokia's Modular C+L optical line system solutions not only expand spectrum use, they allow you to scale your critical network selectively and seamlessly – link by link, node by node, and degree by degree. Double your existing fiber capacity by adding L-band DWDM capacity to select nodes, links or entire regions.

## **Simplify architectures and operations**

You need an agile, and reliable transport network that cost-effectively meets traffic demands and customer expectations. Being able to flexibly scale your optical network can simplify your transport fabric for simpler traffic routing and reduced operational costs.

## **From network stress to nirvana**

As networks connect more things, people and processes, everything is mission-critical. Users demand quality of experience (QoE), which translates into low latency, high bandwidth, dynamic services. From health care and Industry 4.0 to work from home and sensors everywhere, downtime is not an option.







# Network stresses

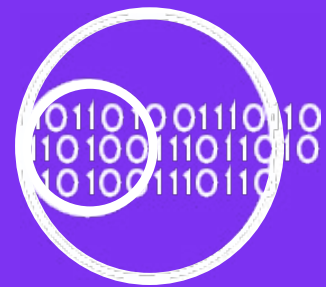
You need to maximize network capacity. But you also need to be agile enough to handle any kind of applications. And did we mention reliability? Many applications are looking for six and seven 9s as mission critical becomes mission normal. And, as if this wasn't a tall enough order, you need to address these challenges within your constrained Capex budget.

Focusing on these three key goals can help reduce the stress on you and your network:

- Scale capacity - stay ahead of traffic growth, maximize fiber plant capacity
- Improve network flexibility - adapt to dynamic traffic patterns, improve service velocity
- Improve network reliability - ensure the network can survive multiple failures

# Stress relief — application optimized line systems

When the ultimate objective seems unattainable, its time to expand your perspective. The right optical line systems solution can address these challenges by doubling your available bandwidth flexibly and reliably. A Nokia application-optimized optical line system solution brings benefits for every domain from the core to the edge of your network.



Cost-effectively and seamlessly expand network capacity

**Scalability** – cost-effectively and seamlessly expand network capacity into the L-band without stranding assets. Complete portfolios include modular and integrated C+L-band DWDM solution options.



Improve network bandwidth management flexibility and simplify network architectures and operations

**Flexibility** – improve network bandwidth agility and simplify network architectures, planning, and operations. Look for solutions with a range of integrated reconfigurable optical add/drop multiplexers (ROADMs), chassis, and add/drop options for access, metro/regional, and core applications.



Maximize service uptime and optimize network resource utilization

**Resilience** – maximize service uptime and optimize network resource utilization. Full-featured solutions leverage colorless, directionless, contentionless, and flexible grid (CDC-F) ROADMs as well as SDN or GMPLS-based control plane functions. This gives you additional options for fast network protection or restoration, not to mention hooks for automated network operations applications.





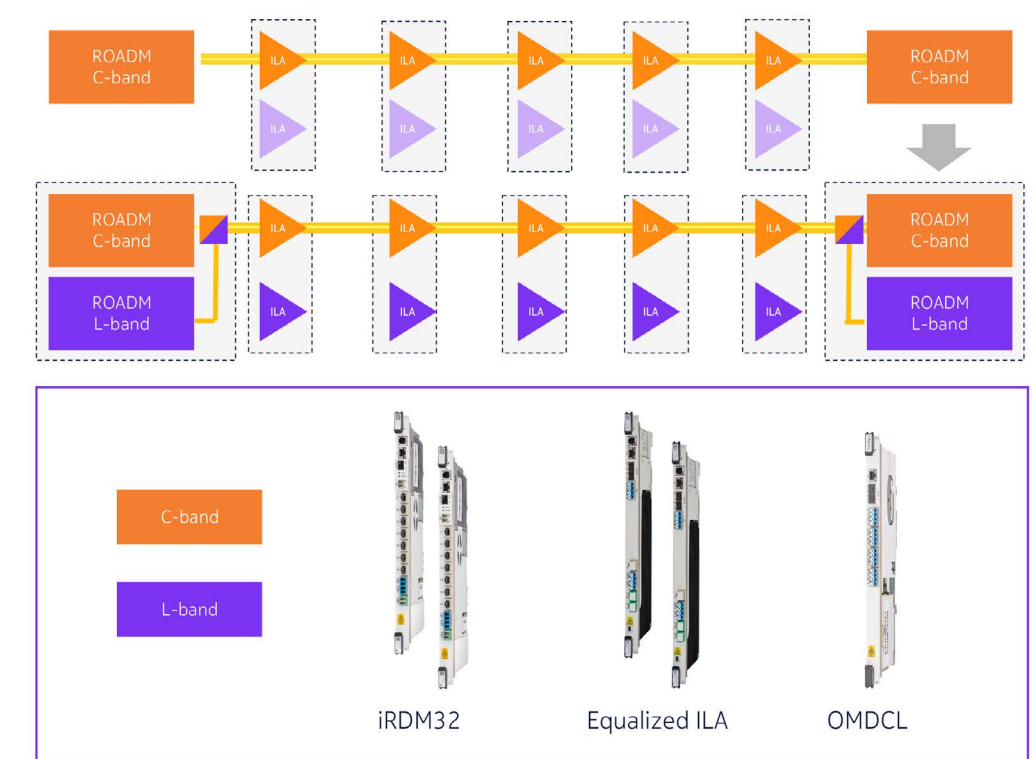
# Seamless scalability with C+L

Nokia leads the industry with modular optical line system solutions that allow you to scale your network capacity with selective C+L upgrades, or integrated C+L solutions that maximize capacity all at once. Our modular C+L optical line system solutions allow you to scale your critical network selectively and seamlessly – link by link, node by node, and degree by degree.

## Fully modular solution

The solution doubles fiber capacity on existing networks with up to 192 channels at 50GHz spacings, at up to 9.6THz of capacity. As additional capacity is required, you can simply upgrade ROADM and ILA sites with additional L-band modules as needed.

The modular C+L solution also offers an option to install combined C+L nodes at ILA sites during the initial deployment stage without needing to revisit them for future upgrades. When capacity is expanded, only ROADM sites are upgraded with additional L-band equipment – saving time, money, and truck rolls to multiple sites. Both options avoid the cost of leasing additional fiber pairs, reduce operational costs, and minimize future network disruptions.





### Avoids asset stranding

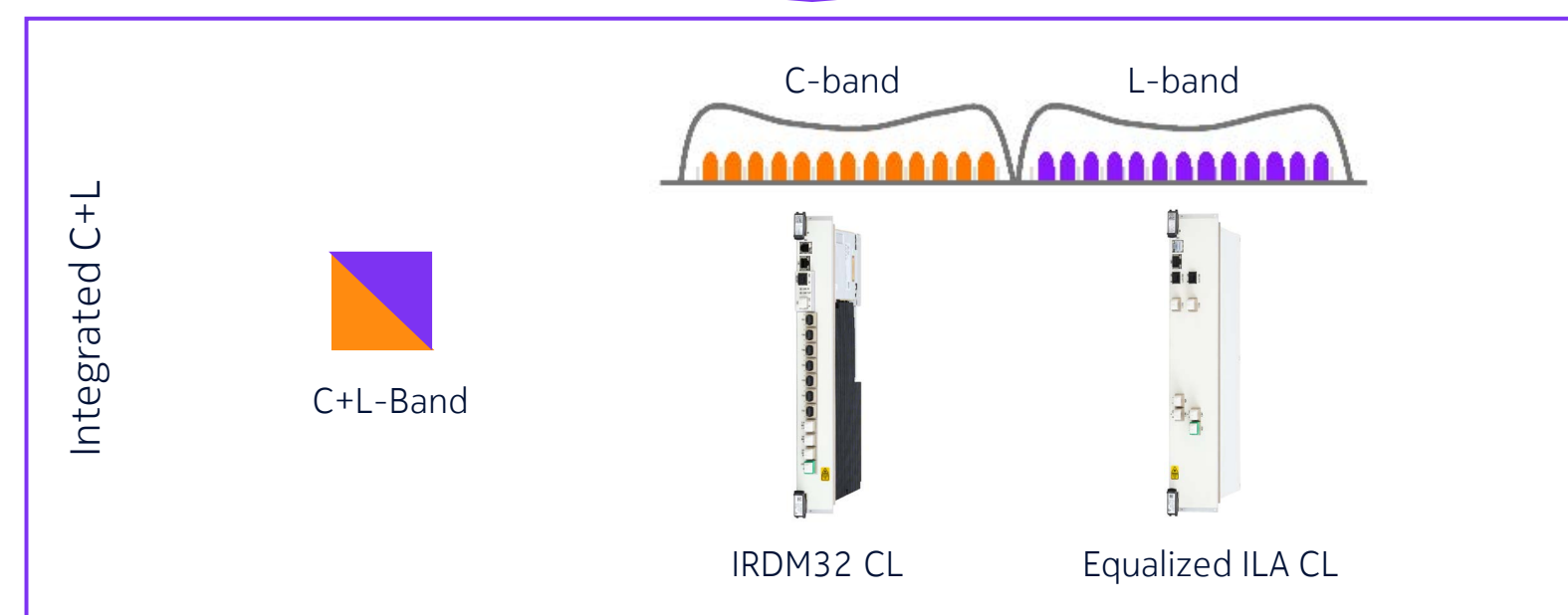
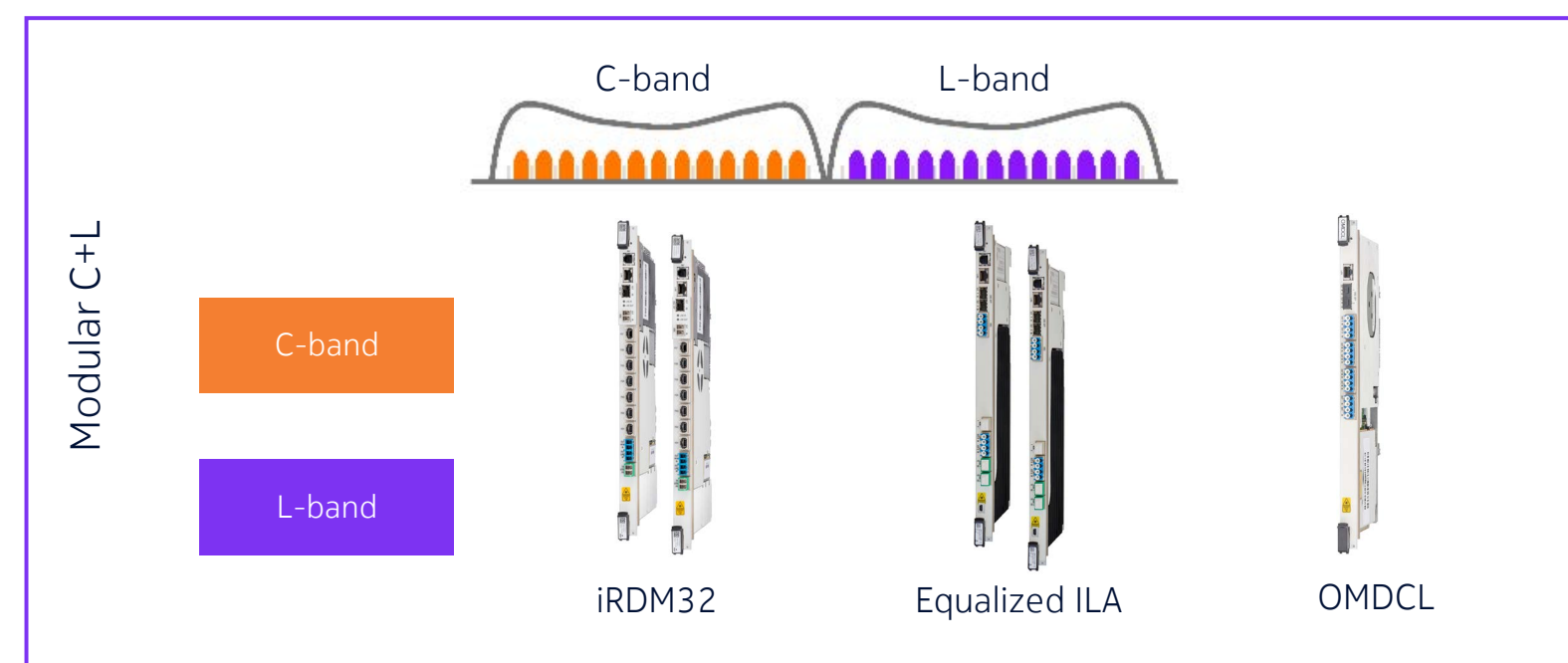
Unlike competing C+L solutions, with the Nokia solution, you can progressively and seamlessly upgrade nodes utilizing previous generations of C-band line system technology to new L-band systems. This optimizes Capex and improves equipment ROI by protecting and extending the life of embedded equipment.

### Optional integrated solution

The Nokia 1830 Integrated C+L line system can maximize your fiber capacity in a single deployment for maximum density and operational simplicity. It integrates the C- and L-band components into a single, managed continuous solution for both ROADM and ILA functions. The Integrated C+L-band solution delivers up to 9.6THz capacity in a single card with optimized support for high-capacity, large degree nodes, and high-capacity add/drop ports. The single C- plus L-band system is operated and managed by a common system. This, along with reduced cabling requirements, simplifies installations and operations. Plus, it supports high-performance CDC-F ROADM or economical Colorless FlexGrid (C-F) ROADM configurations for ultimate flexibility.

### Manages for SRS tilt

For all C+L-band upgrades, it's important to consider the impact of stimulated raman scattering (SRS) tilt on WDM network performance and wavelength management. SRS is a nonlinear effect of optical fibers that causes some power to be shifted from shorter C-band wavelengths to longer L-band wavelengths. Nokia 1830 WDM systems automatically monitor and dynamically adjust the system to ensure optimal performance, eliminating the impacts of SRS tilt across the entire C- and L-bands. This innovative, automated feature simplifies operations.



# No compromise flexibility and resilience

Nokia offers a range of optical line system solutions to support the capacity, reach and flexibility required for access, metro, regional, long-haul, and subsea applications. The Nokia 1830 family supports WDM optical line system functions in both telco-optimized chassis and compact modular data-center-optimized chassis. The former support coherent transponders, the latter, optical line system-only functions.

## Full ROADM support

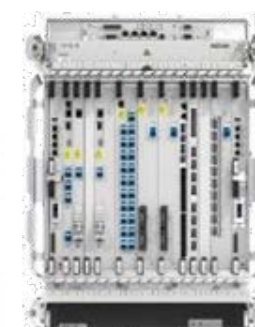
Nokia's application-optimized, no-compromise solutions provide a full suite of integrated ROADMs (iROADMs) to support small, low-degree, low add/drop nodes and large, high-degree, high add/drop nodes. Choose from multiple ROADM configurations — from the classic fixed port, static wavelength ROADMs to dynamic, CDC-F ROADMs.

FlexGrid ROADMs and multiple configuration options leverage evolving coherent DSP modulation schemes. This makes them key network automation building blocks to meet dynamic traffic needs. Advanced C-F and CDC-F FlexGrid ROADMs with flexible add/drop options enable dynamically reconfigurable networking that can autonomously deploy, optimize and restore wavelengths.

Common, interoperable hardware and management across DC- and telco-optimized platforms maximize deployment flexibility and simplify operations and sparing plans.



**1830 PSI-4L, -8L Compact Modular Platforms**



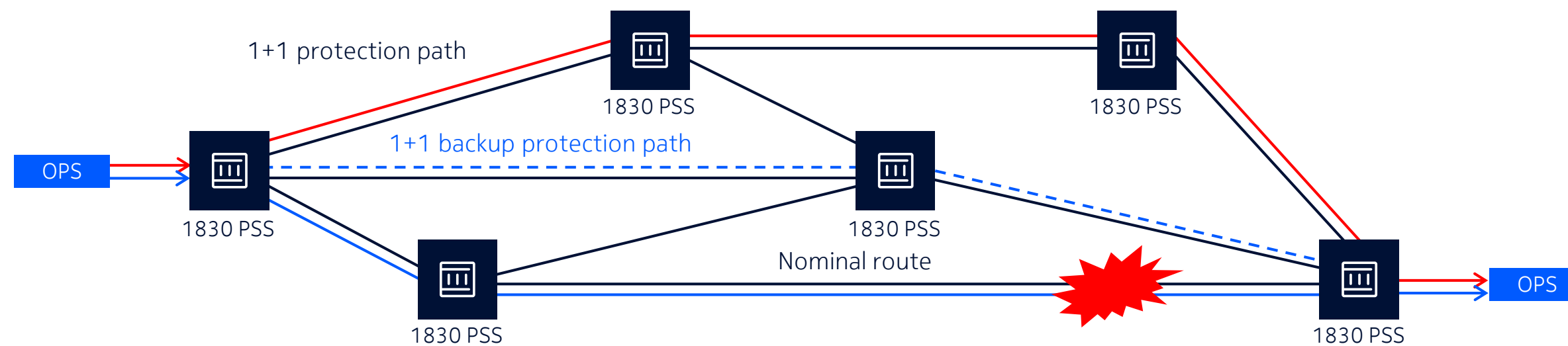
**1830 PSS-8, -16, -32**



## Resilience for maximum uptime

Nokia optical line systems seamlessly upgrade network capacity and improve bandwidth management flexibility. Bandwidth utilization and flexibility can, however, still be hampered by network availability and reliability issues. Nokia application-optimized line system solutions help to maximize network uptime for greater reliability.

Optical layer restoration and protection options help ensure high network reliability for mission-critical services. Complete solutions offer application-driven network resilience options. One option is to implement Layer 0 1+1 protection switching that provides ultrafast <50ms wavelength switching on reserved dual paths. A second option is optical layer restoration with the ability to automatically reroute and restore traffic around network faults using CDC-F and GMPLS — thus avoiding the 50% capacity penalty. A third option combines protection switching with optical layer restoration for the ultimate mission-critical services assurance capability.



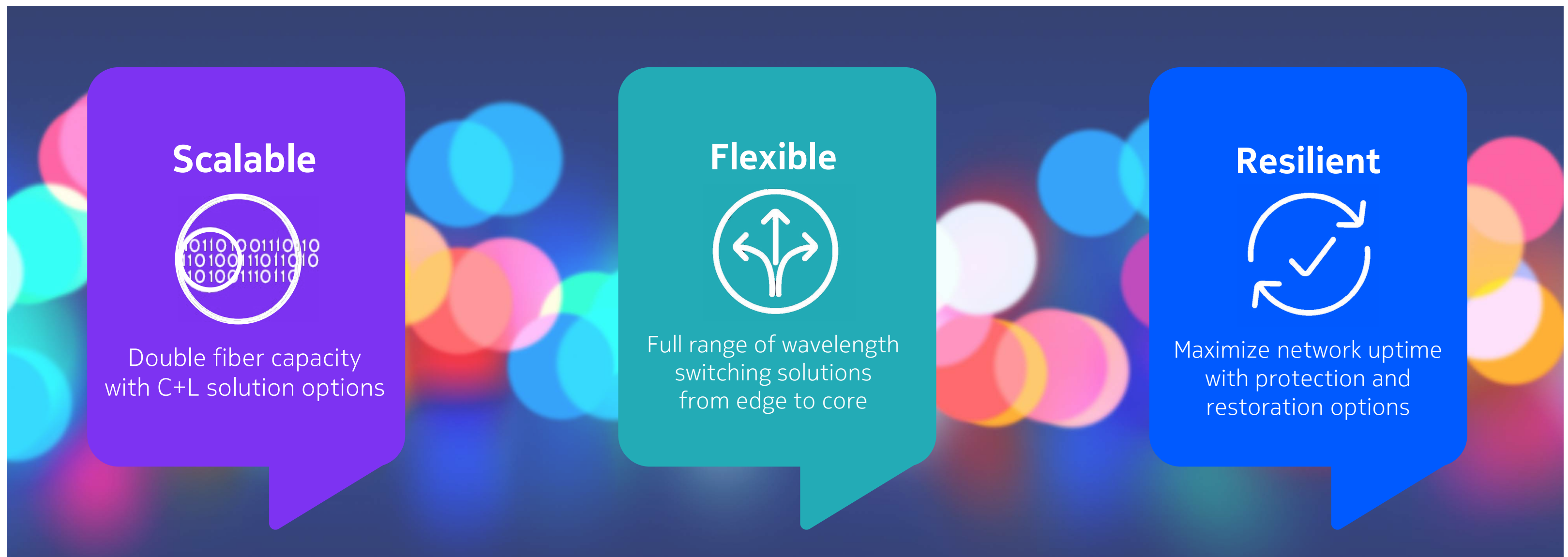


# Stressless optical line system solutions

As stresses mount on your network with growing bandwidth, flexibility and reliability demands, the Nokia Application-Optimized Line System solution relieves those stresses with:

- Cost-effective and seamlessly expandable network capacity
- Improved network bandwidth agility and simplified architectures and operation
- Maximized service uptime and optimized network utilization

Worldwide, network operators have deployed Nokia optical line systems to address the stresses associated with supporting bandwidth-hungry applications and rapidly shifting traffic patterns. We'd love to help you reduce your stress with the right optical line system for your network.





## Nokia application-optimized line system success stories

Scalability, flexibility, and resilience in action

### Service providers

#### Cable SP - Mexico

- Expanded LH network with 14 new routes
- CDC-F iROADMS combined with GMPLS and OTDR for flexibility and network resilience

#### Incumbent CSP - Germany

- End-to-end OTN/WDM network
- Maximum flexibility with CDC-F and C-F iROADMs combined with GMPLS L0/L1 for network protection



#### Top 3 CSPs, CNP - India

- National long-distance networks
- Massive scalability with C+L
- CDC-F iROADMs and GMPLS for network protection



### Webscalers

#### Carrier Neutral IX - Korea

- Automated network operations, restoration, and optimization for improved QoE and reduced OPEX
- CDC-F iROADMs, L0 GMPLS



#### Tier 1 Hyperscaler – US

- Region-wide open line system
- C+L for massive scalability
- CDC-F iRDM32 solution

#### India and Middle East

- Tier 1 hyperscalers
- Partner with CSPs for data center and capacity buildouts
- C+L for scalability
- CDC-F and GMPLS for flexibility and network protection



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# NOKIA

At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering the future where networks meet cloud to realize the full potential of digital in every industry.

Through networks that sense, think and act, we work with our customers and partners to create the digital services and applications of the future.

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