



IP Wave: Optimized, Automated, Open
IP Optical Networking



Apollo Modular C+L Band

Economical Expansion with Full C + L band Capacity


For a small investment today, Apollo's modular C+L band solution enables optical network operators to expand fibers seamlessly to L-band only when that step is needed. Notably, Ribbon's patented Fast SRS Suppression technology allows full use of the C and L-band spectrums, equal to more expensive integrated C+L solutions. Apollo modular C+L uniquely combines best economy with full capacity.

Approaches to Expand Fiber Capacity

As the popular C-band spectrum faces exhaust on a fiber pair, optical network operators must decide how to expand their fiber capacity. If additional unused and already paid for fibers are available then the decision is easy, simply add new C-band optical transmission gear on one of these fibers. However, if it is necessary to deploy or lease new fibers then this approach is much less attractive, since new fiber costs are easily more than 50% of an optical network investment.

Instead, operators are looking to expand capacity by using the L-band whose attenuation characteristics nearly match those of its C-band neighbor. Here too they must make a decision, whether to use a modular approach with pay-as-you-need economics, or an integrated solution that requires a large up-front investment. While every optical network operator's situation is unique, the table below summarizes the broad pros and cons of the alternative approaches when no additional existing fibers are available.



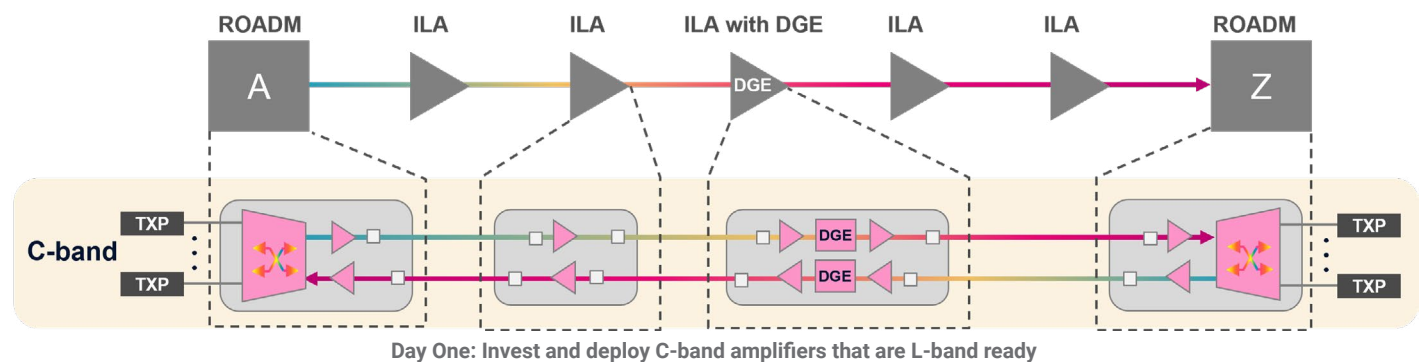
Approach	Description	Capacity	Cost
 Modular C+L band with Fast SRS Suppression	C-band amplifiers that are L-band ready, that allow adding L-band amplifiers and ROADMs only when they are needed and without impacting traffic.	Doubles the existing capacity. Patented technology corrects for SRS loss and tilt in milliseconds, delivering full and hitless C-band plus L-band capacity.	Lowest cost of all options. While there is a small incremental cost for the C-band amplifiers, the cost of adding the L-band amplifiers and ROADMs is delayed until they are needed.
Integrated C+L band	Integrated C+L band amplifiers and ROADMs that operate across the combined spectrum.	Doubles the existing capacity. Delivers full C-band plus L-band capacity.	Highest cost of using L-band. Requires an up-front investment in complex C+L amplifiers and ROADMs, even before the L-band spectrum is needed.
New fibers with C-band	New fiber pairs with traditional C-band optical gear.	Doubles the existing capacity. Delivers use of an additional C-band.	Highest cost overall. The cost of new fiber is over 50% of an optical network investment.

Apollo Modular C+L: The Best Approach to Expand Fiber Capacity

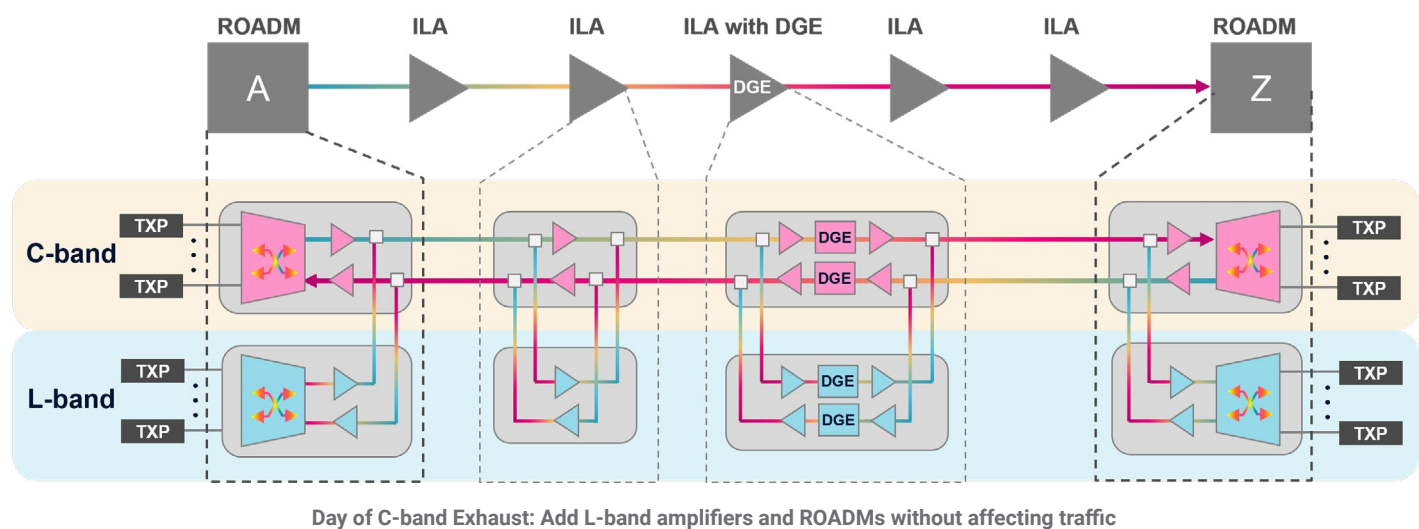
The diagrams below show the Apollo Modular C+L solution for fiber capacity expansion. It is a particularly attractive approach for routes where it is anticipated that C-band exhaust will occur at some point in the future, but it is not clear when this will occur, and may even be several years away.

On Day One, the link is equipped with Apollo C-band amplifiers that are L-band ready. This readiness includes:

1. Integrated CT filters for attaching the L-band amplifiers when needed.
2. Specialized Fast SRS Suppression firmware that is used when L-band is added, to ensure that the full capacity of the C and L bands are usable without traffic impacts.
3. Equipping selected amplifiers in the chain with a DGE to optimize C and L band equalization.



When C-band exhaust ultimately occurs, only then are L-band amplifiers and ROADMs added, and this is done without impacting the C-band traffic. This approach delays investing in L-band until it is needed and can be justified economically. Moreover, when the time comes to make that investment, it will allow using the most recent L-band technologies at very likely reduced price points.



Apollo's product line for its Modular C+L solution includes:

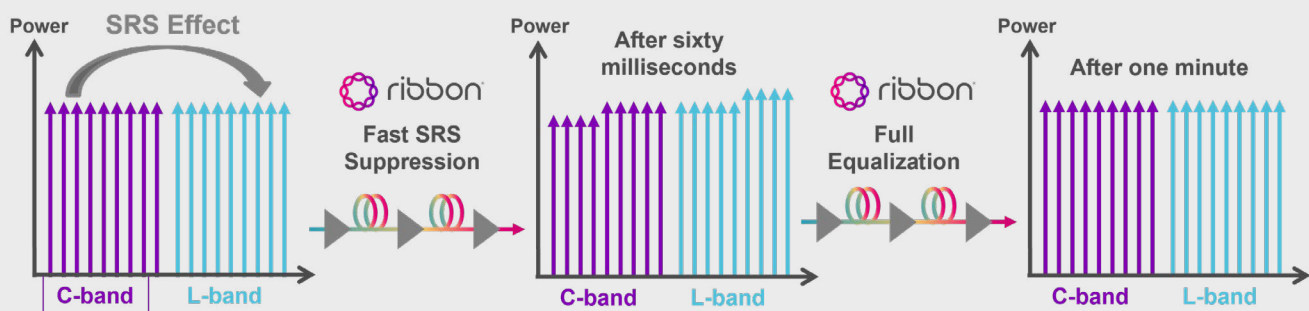
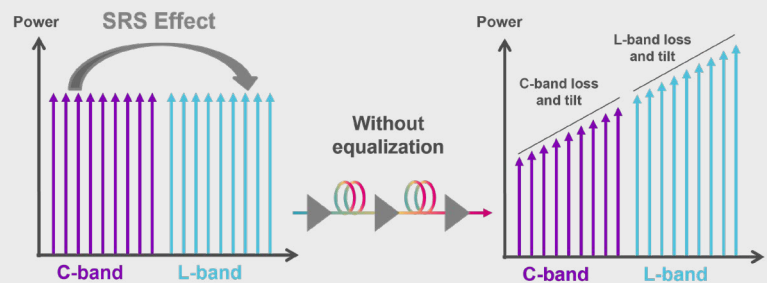
- A full range of transponders from 100G to 1.2T
- Multiple configurations for L-band ROADMs up to 20 degrees
- C-band amplifiers that are L-band ready, with optional DGEs
- L-band amplifiers, with optional DGEs
- A high power C+L Raman amplifier for use in longer spans or to improve OSNR for maximum spectral efficiency

Apollo Fast SRS Suppression Firmware

A known issue with the modular C+L approach is the SRS (Stimulated Raman Scattering) effect whereby the C-band channels transfer optical power to the L-band channels. This causes a loss of power in the C-band and tilt to the overall spectrum. Without equalization this impacts the efficiency of the combined C+L band solution.

More precisely the issue is with the speed of the equalization response. All modern amplifiers have the ability to equalize for SRS power loss and tilt. However, it typically takes over a minute to scan the C and L band spectrums, and apply the correcting algorithms. This is problematic when individual channels are added and dropped and can lead to unacceptable traffic affecting conditions.

Ribbon solves this problem with a patented Fast SRS Suppression solution, whereby power is equalized to within about 1dB of the target equalization in less than 60 milliseconds, ensuring that traffic is not affected. This is followed by complete smooth equalization for optimum C plus L band transmission performance.



In summary, for a small incremental investment on day one, Apollo's modular C+L band solution enables optical network operators to expand fibers seamlessly to L-band only when that step is needed. Moreover, Ribbon's patented Fast SRS Suppression technology allows *full use* of both spectrums, matching the capabilities of more expensive integrated C+L solutions. Apollo modular C+L uniquely combines full capacity with the best economics.

Contact Us

Contact Ribbon to learn how Modular C+L Band can Expand your Fiber Capacity