MPB TECHNOLOGIES INC. – MAJOR CONTRIBUTION TO THE LASER FIELD

BY MORREL P. BACHYNSKI

MPB Technologies Inc. participated in the development and supply of the first commercial trans-Atlantic undersea optical fiber network [TAT 9] built and deployed by the consortium of AT&T, Br. Telecom, France Telecom and Teleglobe Canada. MPB developed and supplied the undersea branching networks [UBM's] which permitted the interconnection of 5 countries [USA, Canada, United Kingdom, France and Spain]. The latter's interest was a communications outlet for the Barcelona Olympics.

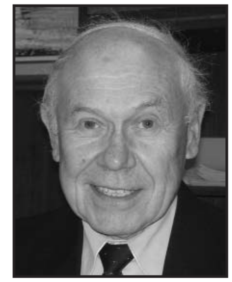
Following the installation of TAT 9, the challenge for MPB was how to stay in the "big leagues". Competing with the telecom giants — AT&T, Br. Telecom, France Telecom was certain business suicide. How then could MPB make these giants our customers? Clearly, MPB needed to find a niche, required by these technology intensive giants. In order to qualify, MPB would have to be the best in the world in their selected niche.

Many optical fibre communications networks have a few links whose span distance is longer than the spacing served by conventional optical repeaters. There seemed to be an opportunity for a supplier who could provide the equipment required for long unrepeatered links and MPB made the decision to concentrate on this niche.

Normally the highest transmitted power is at one end of the link at the transmitter end and attenuates as the signal propagates down the fiber. Were there any techniques whereby the maximum transmitted energy occurs at a point some distance down the span from the transmitter? Non-linear distributed Raman amplification [DRA] offered such a possibility and MPB concentrated on the development of this technology.

SUMMARY

MPB Technologies Inc. has developed world leading technology based on non-linear distributed Raman amplification which permits optical fiber communications over unrepeatered span lengths greater than 500 km. These innovations have been incorporated into "systems ready" telecom modules which have attracted the attention of international telecom giants who have become MPB's prime customers. More than 95% of MPB's business [all of which has been driven from this technology niche] is export.



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To produce Raman gain in the transmission fiber for signals in a particular wavelength band requires that the fiber be pumped at a relatively high power level [hundreds of milliwatts] at a wavelength, or wavelengths, shifted down from the signal wavelength[s] by an amount corresponding to the characteristic Raman shift of the fiber. For typical silica fiber, the Raman gain spectrum consists of a relatively broad band centered at a shift of about 440 cm^{-1}. Therefore, to provide gain for signals in the C-band [1530–1565 nm] for example, requires pump energy in the 1455 nm region.

MPB's approach was to develop pumping schemes for distributed Raman amplification [DRA] in optical fiber telecommunications systems in which pump energy at the wavelength[s] required for DRA of the transmitted optical signal[s] is developed within the transmission fiber through a series of Raman conversions. In one scheme, a 'primary' pump source of wavelength shorter than the ultimately desired pump wavelength[s] is launched into the fiber along with one or more significantly lower power secondary 'seed' sources. The wavelength and power of the secondary source[s] are chosen such that, when combined with the high power primary source, Raman conversions within the fiber ultimately lead to the development of high power at the desired pump wavelength[s], In another scheme, one or more seed sources are replaced by reflecting means to return into the fiber, backward traveling amplified spontaneous Raman scattered light resulting from high power in the fiber at a wavelength one Raman shift below the desired seed wavelength. In either case, the high power at the wavelength[s] required for DRA of the signal[s] is developed over a distributed length of the fiber rather than being launched at the transmitter, as in prior schemes. Consequently, the maximum power at the desired pump wavelength[s], and the peak signal gain, occur some distance into the fiber from the transmitter launch terminal. In one such scheme for a distributed Raman preamplifier, improved noise performance results, since the Raman gain occurs, on average, at a greater distance from the receiving terminal than with the standard pumping scheme.

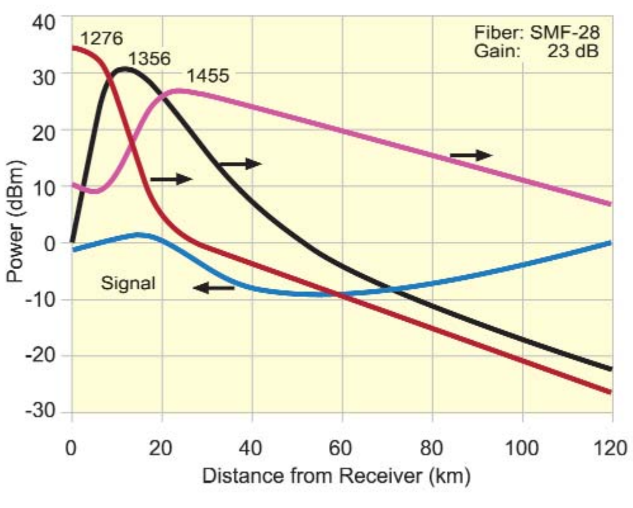

Fig. 1 Third Order Cascaded Raman: pump and signal power evolution along the fiber span.

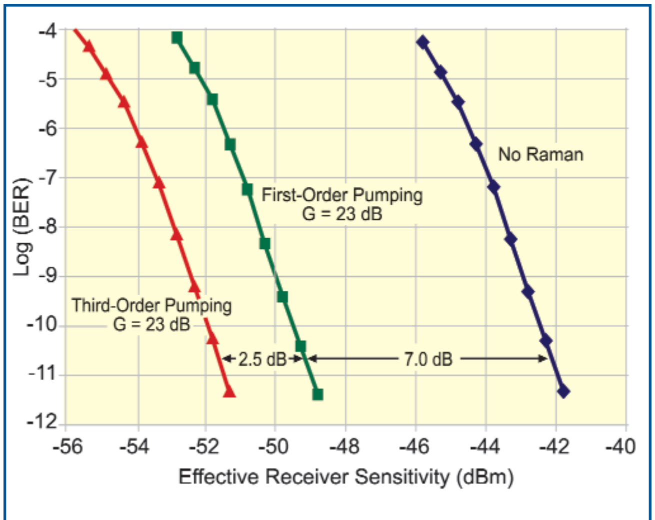

Fig. 2 2.5 GBit/s BER test in 100 km of SMF-28: EDFA only, first and third-order Raman pumping.

In Figure 1, cascaded Raman pumping at 1270nm [1st order], 1356 nm [2nd order] and 1455 nm [3rd order] shows the signal power evolution along the fiber span highlighting the movement of the maximum power away from the transmitter end. Figure 2 illustrates the Bit Error Rate [BER] for 1st order Raman and 3rd order Raman pumping showing the significant improvement that is possible with Raman pumping. Further MPB developments have included various DRA schemes including extension to 6th order pumping. Worldwide patents have been granted to MPB for these Raman fiber laser developments.

Based on the above innovations, MPB has developed telecom "system ready" high power Raman pump modules for extended unrepeatered span lengths. The modules are unique in their emphasis on performance, high systems availability, low spare costs and network readiness. Single and dual wavelength models are available for conventional Raman and MPB's proprietary 3rd order "Super Raman" pumping for both the C-band and L- band frequencies. A further development to further extend unrepeatered span lengths has been a remote optically pumped amplifier [ROPA] where an amplifier is located some distance from the terminal and is optically pumped by a source at the terminal. With these developments, unrepeatered span lengths in excess of 500 km are possible.

The evolution of the MPB concepts into practical telecom equipment, which can provide unrepeatered span lengths previously impossible, has caught the attention of the international telecom giants who have now become MPB's prime customers. Currently, over 95% of MPB's business is export and their equipment can be found on all continents of the world [except Antarctica!]. With the move to greater and greater telecom capacity and bit rates [40 G bits - 100 G bits] MPB's products perform equally well and the Company looks forward to the future.