RSoft Application: All-Optical Wavelength Conversion in Optical Networks
Photonic Crystal Fiber (PCF) As a Highly Nonlinear Element

Overview
A leading North American optical network equipment manufacturer was looking for novel ways to test all-optical wavelength conversion.

The Challenge
Wavelength converters are essential in dynamically reconfigurable optical networks. Traditional wavelength conversion methods use optical-electrical-optical (O-E-O) conversions, which require higher component counts and pose scalability, deployment and reliability challenges. Photonic crystal fibers (PCFs) attract a lot of attention and are used in optical communication systems for specialized applications because of their unique characteristics compared to the conventional fibers. For air-guided PCFs, light is guided in a hollow air hole with almost zero dispersion. In index-guided PCFs, light is guided in a small area surrounded by air holes with enhanced nonlinear effects. RSoft™ FemSIM™ is a generalized mode solver based on the Finite Element Method (FEM) that can calculate any number of transverse or cavity modes of an arbitrary structure on a non-uniform mesh. FemSIM can model a PCF and provide fiber characteristics that can be used in OptSim™.

Figure 1. PCF modeled in FemSIM
The Solution

PCF is a highly nonlinear optical component. Strong nonlinearities can induce polarization switching by way of nonlinear polarization rotation, resulting in all-optical wavelength conversion. PCF data is obtained from FemSIM (Figure 1) for modeling an all-optical wavelength converter design in OptSim (Figure 2).

![Figure 2. PCF simulation setup schematics in OptSim](image)

The Result

FemSIM and OptSim yielded the following results:

- Data at vertically polarized, control signal wavelength is switched to a 45° linearly polarized probe signal wavelength, thereby achieving all-optical wavelength conversion without the need for O-E-O conversion (Figure 3)
- The wavelength converter is data rate transparent, which means that if the data rate changes in the future, the same device will work, providing future-proof design and cost savings

![Figure 3. Bit error rate (BER) versus received power for two different converted outputs](image)

For more information, please contact Synopsys' Optical Solutions Group at (626) 795-9101, visit [http://optics.synopsys.com/rsoft/](http://optics.synopsys.com/rsoft/), or send an e-mail to rsoft_sales@synopsys.com.