Radio Frequency Fingerprinting with Polarization Mode Dispersion
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Polarization mode dispersion is a concept better known in optics than in radio frequency communities. In the field of optics, such dispersion is caused by group delay differences in the propagation of polarization modes in an optical fiber. It results in a deformation of the received optical signal and attempts are typically made to reduce or remove its impact.

In wireless communications, the same phenomenon can be measured as the radio frequency signal reflects off of walls, ceilings and floors in a multipath channel between transmitter and receiver, leading to delay differences between polarization modes. In this application, it is found to be useful as a means to fingerprint a signal. If the transmitting device is stationary, its resulting fingerprint is quite stable.

Polarization is displayed on a Poincaré Sphere, a spherical coordinate system on which a dot or constellation represents a certain signal orientation from an antenna. Polarization Mode Dispersion, on the other hand, is frequency dependent. Thus, a pulse with any bandwidth appears as a line segment on the surface of a sphere (Figure 1). The location and shape of the line segment depends on many factors, such as the orientation and type of transmitting antenna, as well as the multipath channel factors between transmitter and receiver.

The use of polarization mode dispersion for fingerprinting an electromagnetic signal is not well known and often raises a number of questions. This tutorial is designed to address a number of questions that come up often when this novel concept is introduced to industrial control engineers charged with cybersecurity for operational technology networks.

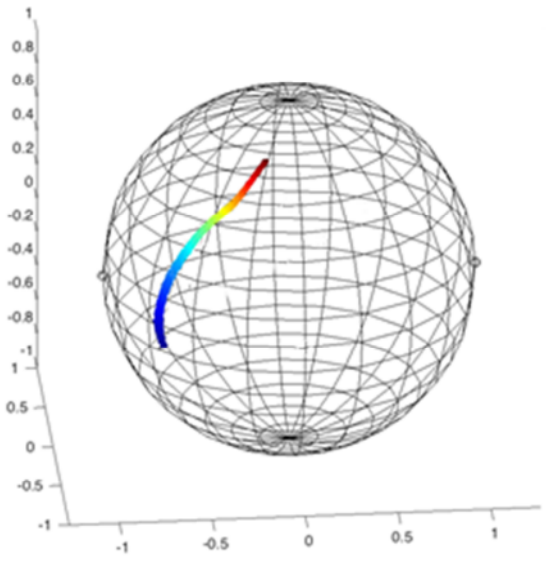

Fig. 1. A Poincare' Sphere showing an RF signal fingerprint varying from red to blue frequency.