New technologies enhance quantum cryptography

A team of Los Alamos National Laboratory scientists, in collaboration with researchers from the National Institute of Standards and Technology in Boulder, Colo., and Albion College, in Albion, Mich., have achieved quantum key distribution (QKD) at telecommunications industry wavelengths in a 50-kilometer (31 mile) optical fiber. The work could accelerate the development of QKD for secure communications in optical fibers at distances beyond current technological limits.

In research published recently in *Applied Physics Letters*, the team describes the use of new superconducting transition-edge sensors (TES) to distribute cryptographic key material at wavelengths of 1,550 nanometers through 50 kilometers of optical fiber. TES could provide increases in range and performance over current QKD photon detection schemes. Unlike the single-photon sensitive avalanche photodiodes (APD) that are typically used in optical fiber QKD systems, TESs detect photons by measuring minute temperature increases in a superconducting material caused by the absorption of individual photons.

"The enhancements we've made," said Los Alamos quantum physicist Danna Rosenberg, "center around a new method of detecting single photons, which can be one of the most challenging aspects of QKD. The TESs provide significantly higher detection efficiencies and lower dark count rates than those of typical APDs. The high efficiency and low probability of dark counts, coupled with the relatively short recovery time of TESs, should permit higher secret key transmission rates at longer distances than APD-based systems."

In addition to employing TESs, the team experimented with bright optical pulse and electrical signal synchronization schemes. One method of synchronization involved sending a bright 1,310 nanometer pulse just before sending a 1,550 nanometer pulse. Using a bright pulse reduced transmission errors that might occur due to changes in the length or optical properties of the fiber link. An electrical synchronization scheme used a rubidium atomic clock to synchronize information senders and receivers.

When used with electrical synchronization schemes, the TESs have the potential to increase distances that optical fibers could be used for QKD. Using the current system, the maximum transmission distances for data with bright pulse and electrical synchronization are 83 kilometers (51.57 miles) and 138 kilometers (85.75 miles), respectively. More sophisticated methods of filtering photons than the experimenters employed, might someday allow users to send quantum keys securely over distances in excess of 270 kilometers (167.77 miles), compared to the current record of 122 kilometers (75.8 miles).

Source: Los Alamos National Laboratory