The Need for Single Photon Sources in Quantum Communication

It is easy to see that society depends more and more upon technology to not only get work done but to communicate and even live in some cases. As more amazing technology rolls out every year, people become more and more enthused with using such fantastic machinery. One of the biggest drawbacks of anything new is the onslaught of nefarious uses for such new devices. With the way technology has been dependent lately on the internet and open communication and information sharing, it is getting more and more dangerous to not worry about security. Exploits have existed for all kinds of computers and technology for as long as they have been around and the fight to suppress such exploits has only ever been slightly ahead. Thus, the need for new ways to protect technology has become a prime concern.

There are of course the advantages to improving technology, one of which of course has been the research and development of quantum mechanics. The advances in technology have been able to propel the research and uses of what used to be unattainable theory not even 50 years ago. There are still areas that are lacking however, and it is for these reasons that truly secure technology has yet to fully erupt.

Quantum physics has brought with it a whole new world of understanding, one of which being the ability to study on such a small level such as the quantum particles of photons in optics. Single photons are of high importance in quantum communication, as photons have the ability to become entangled. By using entanglement, it will be possible to one day build quantum computers.
The real boon of secure communications comes from a fundamental aspect of quantum mechanics: by taking a measurement on a system, the information is “used up” and thus the sender / receiver are able to immediately detect any tampering. This is very different to the way information works now, where most forms of communications are basically broadcast and can be picked up by anyone looking for them.

While all of the theory and possible application might be incredibly promising, there are still incredible gaps towards achieving such goals. Mainly, the ability to produce photons on a reliable and efficient basis. Such photon production can be done various ways, and in a classical sense, the laser is an amazing photon producer. The problem with classical photon sources though is that they produce large bunches and near random occurrences of photons. What is needed for true quantum communication is a Single Photon Source that produces antibunched photons that are controlled and efficient.

Antibunching is when a single photon is separated in time and distance from another. By attenuating a laser, you can make it so very few photons are produced, but you will at best get a few photons at a time without periodicity. This is not reliable for quantum communication, as it is obvious that information would not be efficiently coded. There are few single photon sources that reliably produce antibunched photons, and ones that are could not be implemented in everyday use. These sources are large, complex and expensive.

A familiar single photon source is the Colloidal Quantum Dot. When excited with laser light, the quantum dot (QD) will release a photon in order to bring its energy level back to ground. While this of course happens in many specimen, the QD have a fluorescent lifetime that prohibits them from emitting more than one photon at a time. This enables the user to know how
often a photon will be released from the QD and control the output of communication. The quantum dots however have a few disadvantages. One is that they shall eventually become “bleached,” where they basically become overused and will not steadily produce photons.

Once it is found how to produce single photons on a level that quantum communication can be had reliably and often, then it is feasible to believe that the future has arrived and the world of communication and information sharing (or keeping) has been revolutionized. Of course, we cannot say now that there will never be new theory and practice developed that completely nullifies the groundbreaking effect quantum communication will have. For it is impossible to know what will come next, since everything being worked on now wasn’t even believed to exist by some of the greatest minds history has ever seen. But until then, science must take single photon sources out of the research labs, shrink them down from their bulky setups, make them efficient and create a marketable product. Otherwise, we’ll still have to rely on the computer geeks in basements working on algorithms to break the next unbreakable code.