***Teleportation***

**The Next Scientific Realm**

**Pentagon Now Developing Teleportation**
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WASHINGTON -- In what may be the largest quantum computer research program in the world, the Pentagon is developing the ability to teleport messages across the battlefield and around the globe.

Teleportation, simply stated, is the process of making information disappear from one place so it can reappear in another. The concept was made popular with the Star Trek TV series and the oft-imitated quote, "Beam me up, Scottie."

The concept is based on quantum physics, using photons rather than electrical energy used by current computers and telephone networks. A photon is a unit of electromagnetic energy that has the properties of both a particle and a wave. Photons have no electrical charge or mass, but do carry momentum and energy.

Teleporting means information will be transferred faster than the speed of light, much more securely, and without giving away the location of either the sender or receiver.

"There's no way an eavesdropper can intercept a message. No way. It's impossible. If you look at the message, you destroy it. There's no way to view the message except by the intended recipient, so two things happen," said Henry Everitt, a physicist at the Army Research Office, Durham, N.C. "First, the eavesdropper didn't see the message; and second, the intended recipient didn't get the message, so the parties involved know there was an eavesdropper."

Although teleporting objects or people remains within the realm of science fiction, the ability to teleport information is a scientific reality.

"This has gone from nothing -- I mean no money at all in the world -- to being one of the hottest areas in physics, one of the hottest areas in science, and one of the largest programs we have here at the Army Research Office," Everitt said.

"When you spread this across the four organizations involved, we are funding the largest coordinated quantum information science program in the world. At least that was true last year. People aren't going to let us be in the lead for long," Everitt said.

The Quantum Information Science Program, coordinated by the U.S. Army's Research Office, is funded and supported by the Army, the National Security Agency, the Defense Advanced Research Projects Agency, and the office of the deputy director of defense for research and engineering at the Pentagon. It was funded for $19 million in 1999 and is expected to receive more funding in 2000, although this year's budget has not been fully ironed out.

The program involves 34 projects by researchers at 21 universities, three government laboratories and two corporate laboratories.

"The Holy Grail in all of this is to build a quantum computer that will do things a classical computer could never do," Everitt said.

Although a full-fledged quantum computer may be decades away, the teleportation device, one of the elements needed for the quantum computer to work, should be available within the next decade, Everitt said.

The exterior of a quantum communications system could look similar to modern communications devices. It could resemble a desktop computer, a hand-held computing device, or a cellular telephone. But the internal workings would be dramatically different, because it would use photons rather than conventional electronics. Bandwidth would be determined by the number of photons inside.

The two people sharing information first would have to share nearly identical twin photons -- photons created at the same time and forever entangled with one another.

Once the information was introduced onto the first photon, it would disappear and reappear on the other.

In the process, the sender will obtain a numerical key, which he must then share with the receiver so that the receiver can open the document.

"The sender actually has to tell that to the receiver, actually has to send some classical data. And he can put it in an envelope, or send a telegram, make a phone call or write it in the sky with an airplane; it doesn't matter," said Sam Braunstein, a physicist at the University of Wales, Bangor, Wales.

"Without the teleported information, the key is useless to anybody; and without the key, you can't look at or copy the photon without destroying it," Everitt said.

The sender and receiver would have to share as many photons as necessary, depending on the size of the message being sent.

"If the message was a simple one -- say 'shoot' or 'don't shoot' -- only one photon pair would be needed. If the message was a complicated one -- say a classified video -- zillions of photons would be needed," Everitt said.

Although he would not supply details, Everitt said a major contract award is expected soon, and that other business opportunities will arise as the technology moves from the laboratory to integration and demonstration.

"We're at the point now where all the basic elements have been demonstrated in some form," Everitt said.

"I don't think we have any other question marks about whether this technology can work," he added. "The big question now is more a matter of integration, pulling the pieces together. The next milestone I anticipate in the next few years is demonstrating these same phenomena in solid state systems that previously have only been demonstrated in atoms. After that, I think we have our rudimentary teleportation communication systems going."

The program already has seen several successes, including the teleportation of information in the laboratory.

"It has been demonstrated that information can be teleported over 40 kilometers using existing technology," Everitt said. "There is no limit to the distance over which information can be teleported."

The technology does have its limitations, however. Because any attempt to tamper with it, or any misstep in trying to open it, can lead to its destruction, the person sending the information will have to contact the receiver through conventional communications to inform him that the message been sent and to provide the proper code for opening it.

In addition, photons can be created only in pairs, meaning a message can be teleported to only one person at a time.

"All quantum teleportation occurs between a single sender and a single receiver. Of course, the receiver of the message could re-teleport it to another party, but each time a new pair of entangled photons must be shared and used. Therefore, any quantum network would have to be established link by link," Everitt said.