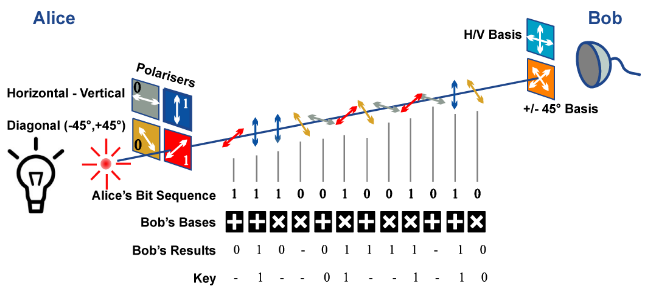
What is quantum communication?

Quantum communication is the art of transferring a quantum state from one place to another. Traditionally, the sender is named Alice and the receiver Bob. The basic motivation is that quantum states code quantum information - called qubits in the case of 2-dimensional Hilbert spaces and that quantum information allows one to perform tasks that could only be achieved far less efficiently, if at all, using classical information. The best known example is Quantum Key Distribution (QKD).

Quantum communication is built on a set of disruptive concepts and technologies. It is driven by fascinating physics and by promising applications. It requires a new mix of competencies, from telecom engineering to theoretical physics, from theoretical computer science to mechanical and electronic engineering. First applications have already found their way into niche markets, and many university labs are working on futuristic quantum networks, but most of the surprises are still ahead of us. Quantum communication, and more generally quantum information science and technologies, are here to stay and will have a profound impact on the 21st century.

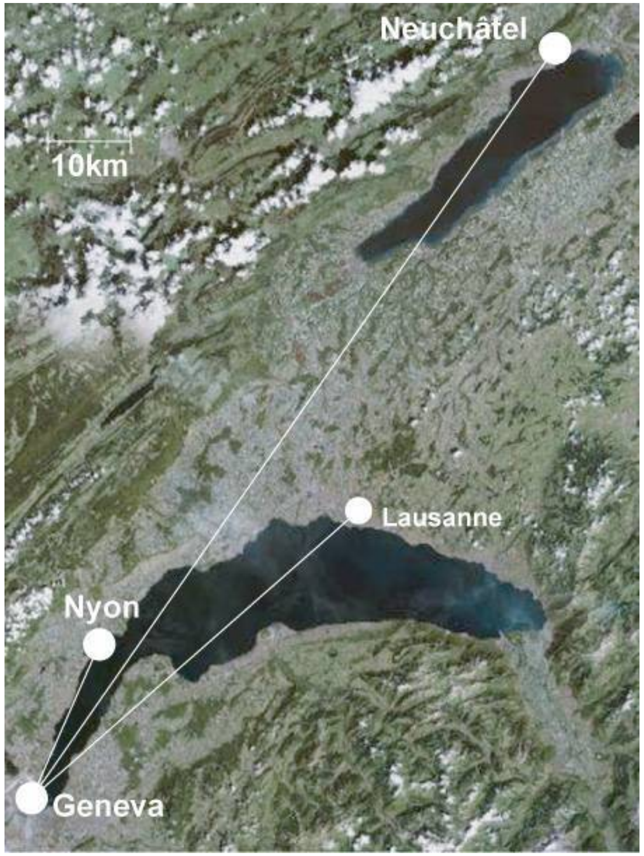
What is Quantum Key Distribution?

This technology allows one to distribute sequence of random bit whose randomness and secrecy are guaranteed by the laws of quantum physics. These sequences can then be used as secret keys with conventional cryptography techniques to guarantee the confidentiality of data transmissions.



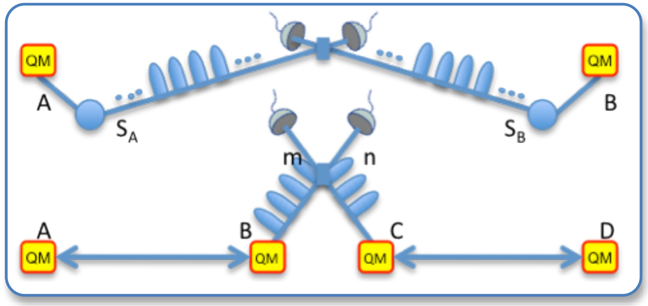
Why quantum repeaters are important?

The distribution of quantum states over long distances is essential for future applications such as quantum key distribution and quantum networks. The direct distribution of quantum states is limited by unavoidable transmission losses of the channel used to transmit these quantum states. The direct approaches are limited to much less than 500 km, even under the most optimistic assumptions for technology evolution. In practice this has seen real world QKD implementations up to 150km, performed by the Geneva group in Switzerland.



What are quantum repeaters?

In the same way that classical communication uses amplifiers, it is possible to extend the distance over which entanglement, & hence quantum information, is distributed by chaining several quantum repeaters, one after the other, over successive fibre optic communication links.



The QuReP Quantum Repeater technology is centred around quantum light-matter interactions at the quantum level in ensembles of rare earth ions frozen in a crystal that store quantum information by coherent control of the quantum degrees of freedom.

The storage of quantum states allows us to wait for successful transmission of a photon over an extended distance, thus overcoming the problems of loss.

The combination of entangled photons, quantum memories and high-performance singe-photon detectors is at the heart of the QuReP project and one of the key challenges for the commercial realisation of quantum repeaters.

QuRep aims to:

- Bring the device & system performance & specifications to a mature, engineering-ready level
- Integrate all of these elements into a coherent & functional system
- Ensure that the system is compatible with standard optical fibre transmission systems
- Demonstrate key generation over concatenated quantum repeaters

The QuReP Consortium

University of Geneva, Switzerland

- Nicolas Gisin

Lunds Universitet, Sweden

- Stefan Kröll

Universität Paderborn, Germany

- Wolfgang Sohler

CNRS, Centre National de la Recherche Scientifique, France

Laboratoire Aimé Cotton

- Jean-Louis Le Guoet

Laboratoire de Chimie de la Matière Condensée de Paris

- Philippe Goldner

ID Quantique SA, Switzerland

- Grégoire Ribordy

The consortium competencies extend from fundamental aspects of spectroscopy (CNRS (LCMCP)) to 3 groups that have already shown AFC memory functionality in different systems (Uni Geneva, CNRS (LAC), Uni Lund), Uni Paderborn is probably the leading applied physics groups in Europe working on integrated photonic sources based on nonlinear materials. Uni Geneva is one of the few groups in Europe, and indeed the world, whose expertise covers all aspects of quantum communication, from single photon detectors, photon sources, and quantum memories to the theory of quantum communication architectures and security. The industrial partner IDQ, are the world leaders in the commercialisation of quantum communication. They have a proven experience in industrialising advanced quantum technologies and are ready to exploit the next generation of entanglement-enabled technologies that should arise from this project.

Contact

Project Coordinator

Name: Prof. Nicolas Gisin

Tel: +41 22 379 6597

Fax: +41 22 379 3980

E-mail: nicolas.gisin@unige.ch

Project Manager

Name: Dr Rob Thew

Tel: +41 22 379 6929

Fax: +41 22 379 3980

E-mail: robert.thew@unige.ch

Affiliation and Address

Université de Genève

20 rue de l'école de médecine

1211 Genève Switzerland

Web

http://quantumrepeaters.eu

Project reference: 247743

Instrument: Photonics STREP

Timeline

Start Date: 01/01/2010

End Date: 31/12/2012

Budget

Overall Cost: 2 481 878,00 €

Funding: 1 900 000,00 €

SEVENTH FRAMEWORK PROGRAMME

QuReP

Quantum Repeaters for Long Distance Fibre-Based Quantum Communication

The aim of QuReP
is to
develop a Quantum Repeater:
The elementary building block required to overcome current distance limitations for long-distance quantum communication.