

# 2 Architectures, Algorithms, and Protocols for the Quantum Internet

## Abstract

The application of quantum systems to computing and communication is pushing research into a new era of unlimited possibilities. Quantum will help solve previously impossible problems and create novel opportunities for science and society. The developments will be accelerated by the foundation of the Quantum Internet. Interconnecting remote quantum systems will escalate further the opportunities offered through distributed quantum applications, which will enable pooling the (initially scarce and dispersed) quantum compute resources to solve complex problems and achieve results unattainable with traditional computing or an isolated quantum computing. However, the nascent quantum networks have several research challenges ahead. Furthermore, a deeper understanding of the interconnection of quantum network devices with quantum computers and traditional equipment is required to enable short-term practical applications, like Quantum Key Distribution (QKD).

Two topics are open in this area.

## Topic 2.1 Routing and Provisioning in Quantum Networks

*Topic type: post-doc*

We are looking for post-docs for the study of architectures, algorithms, and protocols for quantum networks relying on the interconnection of nodes via quantum repeaters, terrestrial or satellite: they can create an ephemeral path through which entangled qubits can be used by quantum computers at a geographical distance. The protocols will have to take into account the specific properties of the quantum devices involved, as well as the requirements of future applications. Furthermore, new algorithms will be needed for the run-time optimisation of the (very limited) resources available. The contributions will be evaluated by means of mathematical and simulation tools. The research activities will contribute to the definition of key building blocks of the forthcoming Quantum Internet, as envisioned within the IRTF QIRG.

## Candidate profile

Ideal candidates should have or about to obtain a MSc degree (for the PhD level) or PhD degree (for the Post-doc level) in Computer Science, Computer Engineering, Mathematics, Physics, or closely related disciplines, and a proven track record of excellent University grades (PhD level) or of publications in relevant top-tier conferences and journals (Post-doc level). Preferably, the topic of the MSc/PhD thesis should be in one of the relevant research areas:

- routing and optimisation in traditional or quantum networks;
- quantum computing simulation or programming;
- measurement, network management, optimisation of SDN/traditional networks.

Knowledge of quantum computing, though preferable, is not a prerequisite for application. Good written and spoken communication skills in English are required.

## Industrial collaboration

The research activities in this area will be carried out in collaboration with [Leonardo](#) (worldwide leader company in Aerospace, Defence & Security, 50k employees, EUR 14bn revenues). The institute is a member of the [IBM Quantum Network](#), with access to digital quantum computers with up to 127 qubits for the execution of the research activities in this topic.

## Contacts

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