A European Flagship Project on Quantum Technologies

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The EU needs strong leadership now in order to stay at the forefront of the second quantum revolution, build on its scientific excellence and create a booming and competitive industry for future independence and prosperity.

- Reinforce scientific leadership
- Establish leading engineering capability attractive to industry and investments
- Create a favourable innovation ecosystem
- Train a new generation of QT professionals and engage in dialogue with citizens
Quantum Manifesto was handed over to European Commission in May 2016
QT Flagship Community Consultations

More than 3600 supporters from academia and industry
Quantum Technologies Flagship structure

Budget / 10 years: 1 Billion €

First call for 3-year ramp-up phase: end of September 2017
130 millions €
Europe Quantum Technologies Flagship
http://qurope.eu/content/qipc-roadmap

Quantum Computers: Hardware & Software
Quantum Simulators
Quantum Communication: Devices & Systems
Quantum Sensing & Metrology

Enabling Science

Theory, Algorithms & Protocols

$|\Psi\rangle \propto |N, 0\rangle - |0, N\rangle$

$QFI = 4 \text{var}_\Psi(H)$
Q. Communication in the HLSC Report

*Quantum communication milestones*

- **In 3 years**, development and certification of QRNG and QKD devices and systems, addressing high-speed, high-TRL, low deployment costs, novel protocols and applications for network operation, as well as the development of systems and protocols for quantum repeaters, quantum memories and long distance communication;

- **In 6 years**, cost-effective and scalable devices and systems for inter-city and intra-city networks demonstrating end-user-inspired applications, as well as demonstration of scalable solutions for quantum networks connecting devices and systems, e.g. quantum sensors or processors;

- **In 10 years**, development of autonomous metro-area, long distance (> 1000km) and entanglement-based networks, a "quantum Internet", as well as protocols exploiting the novel properties that quantum communication offers.

Academic and industrial work promoting standardisation and certification should be addressed at every stage.
Summary

• Long, **complex process** from idea to implementation. Now in „hot phase“ of preparation

• **Community feedback** important part of preparation phase

• Most important **values**: transparency, openness, fairness

• Strategic research agenda along **four application domains** (Simulation, Computing, Communication, Sensing and Metrology) **plus Basic Science**

• Implementation mainly through **peer-reviewed calls for proposals**; steering and focussing through calls, milestones and KPIs

• **Additional measures** for training/education, outreach, start-up support, patent protection, standardization and norms, community building
Let’s turn our smartphone into a QRNG and a Quantum Simulator

The smartphone you have in your pocket is already an elementary quantum processor 😊

Sanguinetti et al., PRX 4, 031056 (2014)
Qcomp in the HLSC Report

Quantum computing milestones

✓ In 3 years, fault tolerant routes for making quantum processors with more than 50 qubits will be demonstrated;

✓ In 6 years, quantum processor fitted with quantum error correction or robust qubits will be realized, outperforming physical qubits;

✓ In 10 years, quantum algorithms demonstrating quantum speed-up and outperforming classical computers will be operated.
Qsim in the HLSC Report

Quantum simulation milestones

- In 3 years, experimental devices with certified quantum advantage on the scale of more than 50 (processor) or 500 (lattices) individual coupled quantum systems;

- In 6 years, quantum advantage in solving important problems in science (e.g. quantum magnetism) and demonstration of quantum optimisation (e.g. via quantum annealing);

- In 10 years, prototype quantum simulators solving problems beyond supercomputer capability, including in quantum chemistry, the design of new materials, and optimisation problems such as in the context of artificial intelligence.
Qsens in the HLSC Report

Quantum sensing and metrology milestones

- In 3 years, quantum sensors, imaging systems and quantum standards that employ single qubit coherence and outperform classical counterparts (resolution, stability) demonstrated in laboratory environment;

- In 6 years, integrated quantum sensors, imaging systems and metrology standards at the prototype level, with first commercial products brought to the market, as well as laboratory demonstrations of entanglement enhanced technologies in sensing;

- In 10 years, transition from prototypes to commercially available devices.