



Use cases of quantum entanglement

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1. All the possible use cases

- 1.1 Entanglement applications
- 1.2 Types of entanglement
- 1.3 What options are on the table for us

2. Use cases CESNET can provide

- 2.1 Quantum communication
- 2.2 More possibilities

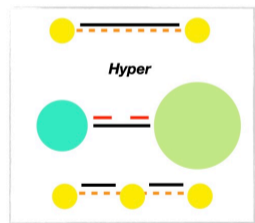
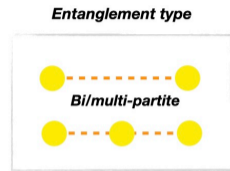
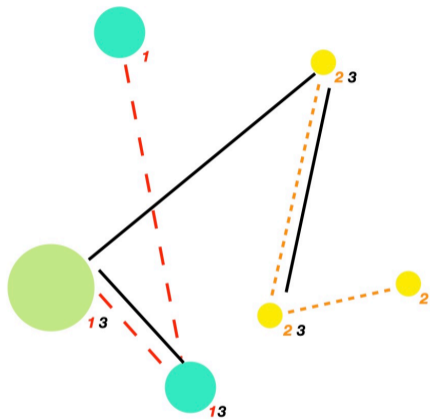
- 1. exploration of fundamental quantum physics**
 - testing of local-realism
 - delayed choice of quantum eraser
- 2. quantum communication**
 - noise resistant QKD
 - QKD over longer distances
- 3. quantum teleportation**
- 4. quantum metrology**
 - precise measurement surpassing the shot noise limit
- 5. quantum computing and quantum simulation**

DoF

1 - spin
 2 - polarization
 3 - path

Particle type

Photon
 Ion
 Molecule



We want to offer:

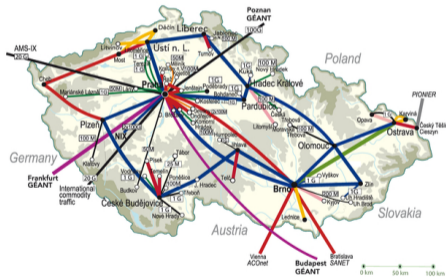
1. a reliable generation and distribution of entanglement
2. a quantum communication channel with high information capacity and high speed
3. all-fiber alternatives to free-space setups

Our offer could be interesting for:

1. research institutions and universities
2. cyber-security agencies
3. government agencies

Entanglement-based QKD on CESNET telecom fibers:

- in metropolitan areas (so far deployed QKD in lab, QBER 4.8 %, preliminary key rate 86 bits/s)
- between two cities in CZ (upgrade to twin-field QKD or to multi-entangled source), ongoing in three projects (private, national, QCI)
- non-dependent on commercial RNG



- **Superdense coding:** sending *a-priori* entangled qubits to send 2 bits of information on one qubit
- **Entanglement distribution:** providing source of entangled particles for fundamental research
- **Photonic quantum computing**

Thank you for your attention!



Shi, Yicheng and Moe Thar, Soe and Poh, Hou Shun and Grieve, James A and Kurtsiefer, Christian and Ling, Alexander (2020)

Stable polarization entanglement based quantum key distribution over a deployed metropolitan fiber

Applied Physics Letters 117(12), 124002



Ikuta, Takuya, and Hiroki Takesue (2018)

Four-dimensional entanglement distribution over 100 km

Scientific reports 8(1), 817



Horodecki, Ryszard, Paweł Horodecki, Michał Horodecki, and Karol Horodecki (2009)

Quantum entanglement

Reviews of modern physics 81(2), 865