How can quantum technologies be integrated into a future proof security infrastructure

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Quantum Everywhere

Quantum Encryption

Quantum Mechanics

Quantum Supremacy

Quantum-Safe

Quantum Repeater

Quantum Resistant

Quantum Algorithm

Quantum Key Distribution

Post- Quantum

Quantum Computing

Quantum Crypto Algorithm

Qubits

Quantum Key Generation

Qubert

QKD

What is Quantum?

What does Quantum mean?

Its was originates from "quantum mechanics," a basic theory in physics. It's a fundamental theory in physics which describes nature at the smallest scales of atoms and subatomic particles

What is a Quantum Computing

A machine that performs calculations based on the laws of quantum mechanics, which is the behavior of particles at the sub-atomic level.

Quantum mechanics

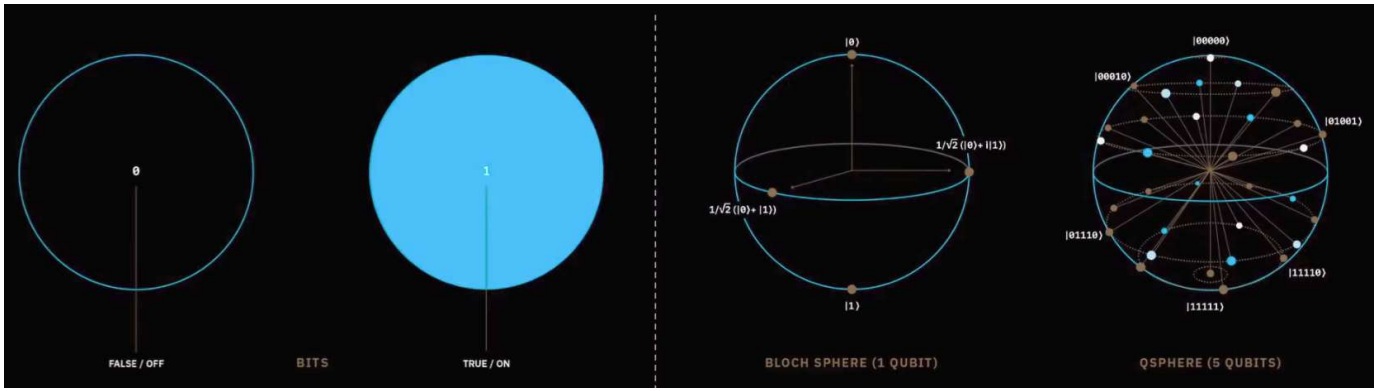
$$i\hbar\frac{\partial}{\partial t}|\psi(t)\rangle = \hat{H}|\psi(t)\rangle$$

Schrödinger equation

Principles of Quantum Computing

Classical Computing - Bits

Quantum Computing - Qubits



Traditional computers are based on a binary system (0 or 1) per **bit**. One bit can have only two states "on" or "off".

More information can be represented by a single **qubit**. a qubit can take on the properties of 0 and 1 simultaneously at any one moment.

The Benefits of Quantum Computing

Because of this property of qubit its calculation abilities are exponentially higher in magnitude.

- Time : Solves problems in much fewer steps and at a faster speed
- Complexity: Could process massive amount of complex data.
- Accuracy: Capability to convey more accurate answers.

- With around 49 qubits computers can outperform even the fastest supercomputer today. **Quantum Supremacy**

The Applications of Quantum Computing

- Molecular and Biomedical Simulations
  - Researchers at Harvard University used a D-Wave One quantum computer to solve the puzzle of how some proteins fold in 2012.
- Machine Learning and AI
  - Big data is out there to be analyzed, but we need more powerful computers to process the petabytes of unanalyzed data.
- Financial Services
  - Complex financial modeling and risk management within the financial industry as well.

- Unwanted access to the encrypted data
  - By breaking current public key cryptography (DH, RSA, ECC…)

Current Crypto Algorithms

- The challenge with currently popular algorithms is that their security relies on one of three hard mathematical problems:
  - the integer factorization problem – the decomposition of a composite number into a product of smaller integers.
  - the discrete logarithm problem
  - the elliptic-curve discrete logarithm issue.

- Theses problems can be easily solved on a sufficiently powerful quantum computer running Shor's algorithm.

Reference: ETSI – Standard Organization 2017

Current Crypto Algorithms

Name of method	Application	Resilience against Quantum Computer
RSA	Encryption, signature	✗
ECC	Encryption, signature	✗
AES 256	Encryption	✓
Hash-based	Authentication	✓
Lattice-based (NTRU)	Encryption; signature	✓
Code-based (Mc Eliece)	Encryption	✓
Multivariate polynomials	Encryption; signature	✓
Supersingular elliptic curve isogenies	Encryption; possibly signature	✓

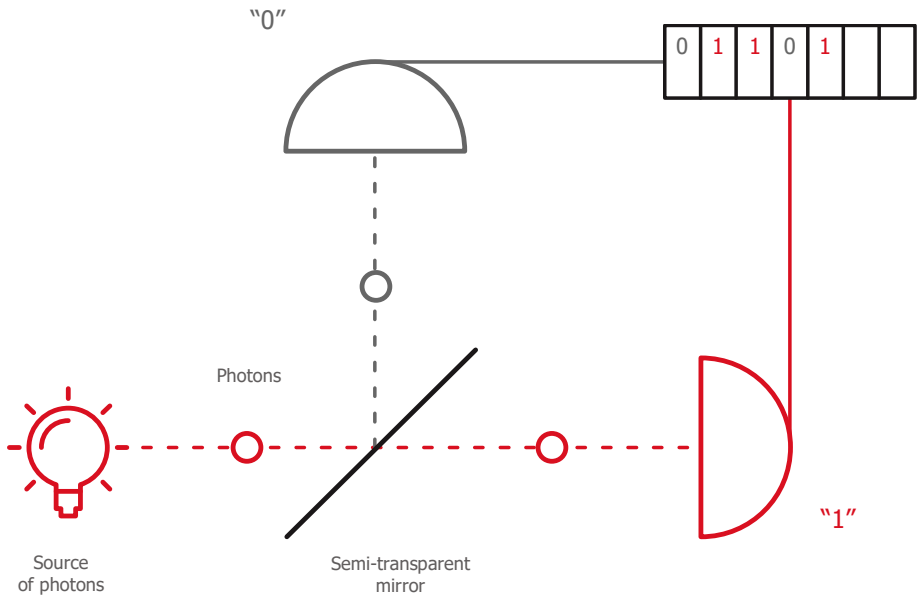
Reference: ETSI – Standard Organization 2017

Quantum-Safe Solutions

Post-Quantum Algorithms

- Post-Quantum or Quantum Resistant Algorithm
  - refers to cryptographic algorithms that are believed to be secure against an attack by a quantum computer.
- Currently post-quantum cryptography research is mostly focused on six different approaches (ETSI):
  - Lattice-based cryptography
  - Multivariate cryptography
  - Hash-based cryptography
  - Code-based cryptography
  - Supersingular elliptic curve isogeny cryptography
  - Symmetric key quantum resistance (AES and SNOW)

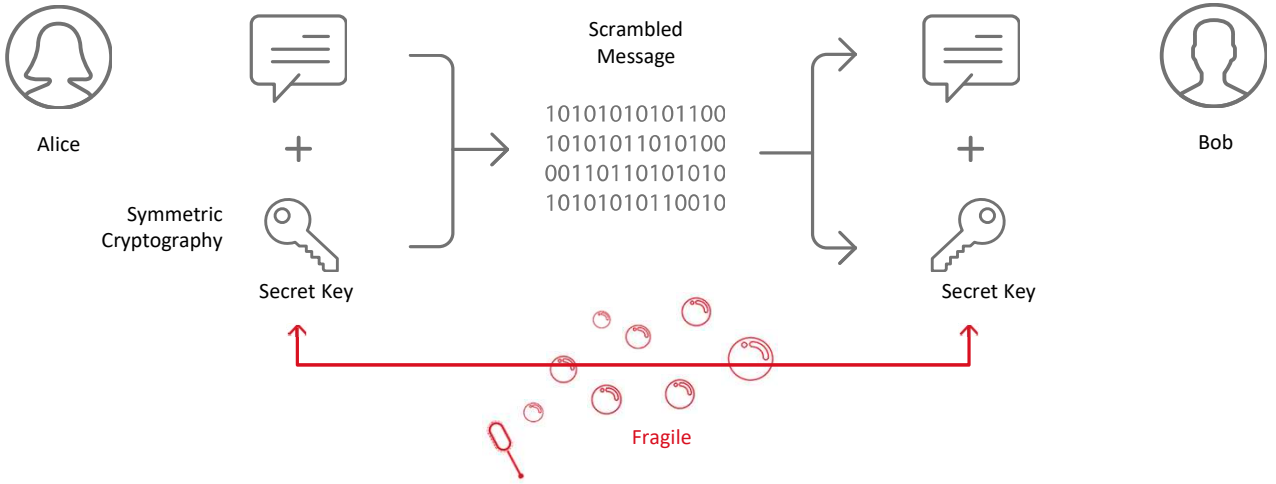
Quantum Random Number Generator



- Photons travelling through a semi-transparent mirror. The mutually exclusive events (reflection/transmission) are detected and associated to '0' or '1' bit values respectively.
  - Speed of output and full availability
  - Reliability & trust (Metas, CTL and AIS31)
  - Unpredictable output
  - High Quality entropy and keys

Quantum Key Distribution

- A secure communication method which implements a cryptographic protocol involving components of quantum mechanics.
- A shared random secret key known only by two parties, which can then be used to encrypt and decrypt messages.
- The key can be used with any chosen encryption algorithm to encrypt and decrypt - standard communication channel.
- Detect Unwanted third party, a results from a fundamental aspect of quantum mechanics: the process of measuring a quantum system in general disturbs the system.



ID Quantique – Path to Quantum Safety

Quantum Random Number Generation (QRNG)

- ✓ **Instantly strengthen your crypto key material**
- ✓ Feed higher quality entropy into key generation servers, HSMs, Linux & crypto applications and connected devices

Crypto agility and Post Quantum Crypto

- ✓ Be **crypto-agile** to move to next generation **Post Quantum** Crypto
- ✓ Be **QKD ready** (ready to upgrade to quantum cryptography)
- ✓ Protect your investments for today and for tomorrow

Quantum Key Distribution (QKD)

- ✓ **Quantum Cryptography** for secure transmission
- ✓ Provide forward secrecy & anti-eavesdropping of private key exchange/back up
- ✓ Use QKD today for backend **IP protection**

Recommendations

- Start to Encrypt now
  - AES 256 or Hash-based cryptography
- Know your Crypto Assets
  - Situation assessment (Algorithm, length of the keys etc..)
- Think Agility
  - Solution that will evolve in time – crypto agility
- One size do not fit them all
  - Adapt the solution to the case
  - The value of your data in time
  - Hybrid systems can improve security for sensitive data (Post quantum crypto with QKD)

Thank you

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Post Quantum Safe: auch in Zukunft sichere Daten

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