Introduction to Quantum Internet

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Intro to QIH | 25/11/2022

SURF

- HPC-cooperation for research and education

- Future Computing
  - Quantum Communication and Internet
  - Quantum Computing

- Explore different Quantum Network configurations and help guide the development of Quantum Internet technology

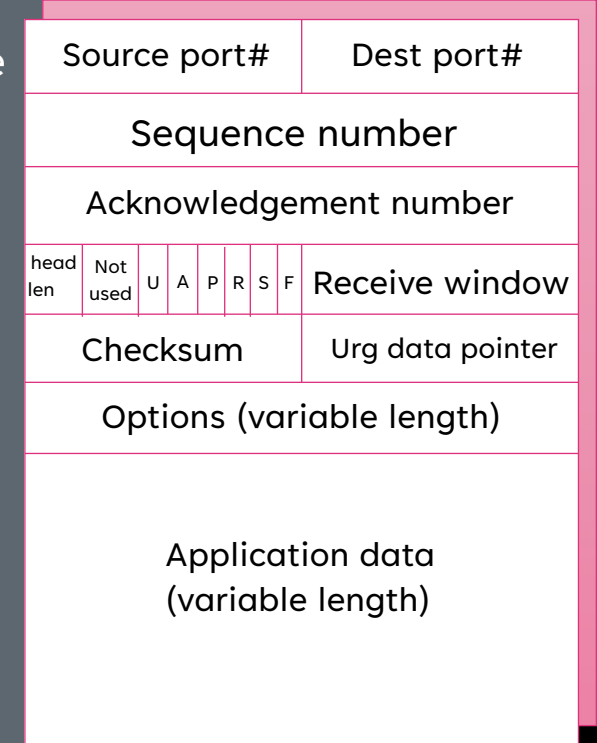- Quantum Internet Alliance (QIA)

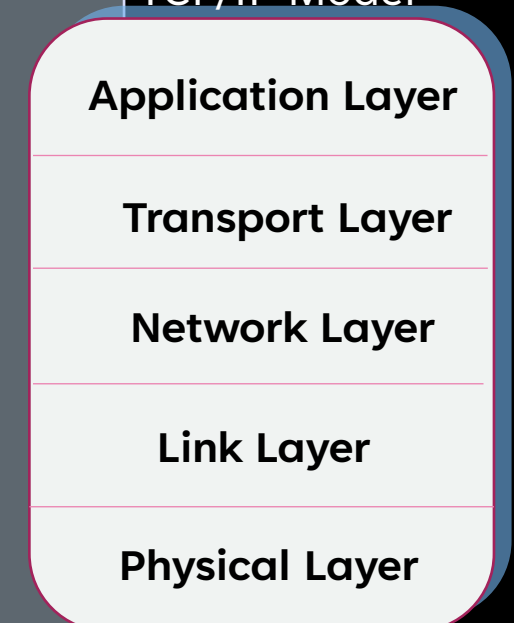# Quantum Internet

Why do we need it?

Classical Internet

— Network of computers that communicate information (bits)

— Messages transmitted as distributed packages across the network

— Packages have info on 32-bits type of data, origin, destination, checksum, variable length etc.

— Protocols on most layers

TCP Package

Source port#	Dest port#
Sequence number	
Acknowledgement number	

head len	Not used	U	A	P	R	S	F	Receive window

Checksum	Urg data pointer

Options (variable length)

Application data
(variable length)

TCP/IP Model

Application Layer
Transport Layer
Network Layer
Link Layer
Physical Layer

Encryption Methods

– RSA

– SSL

– Hash functions

– Etc.

Bob's *public* key

$$K_B^+$$

Bob's *private* key

$$K_B^-$$

Plain text message, m → Encryption Algorithm → ciphertext $K_B^+(m)$ → Decryption Algorithm → Plain text message $m = K_B^-(K_B^+(m))$

Alice

Bob
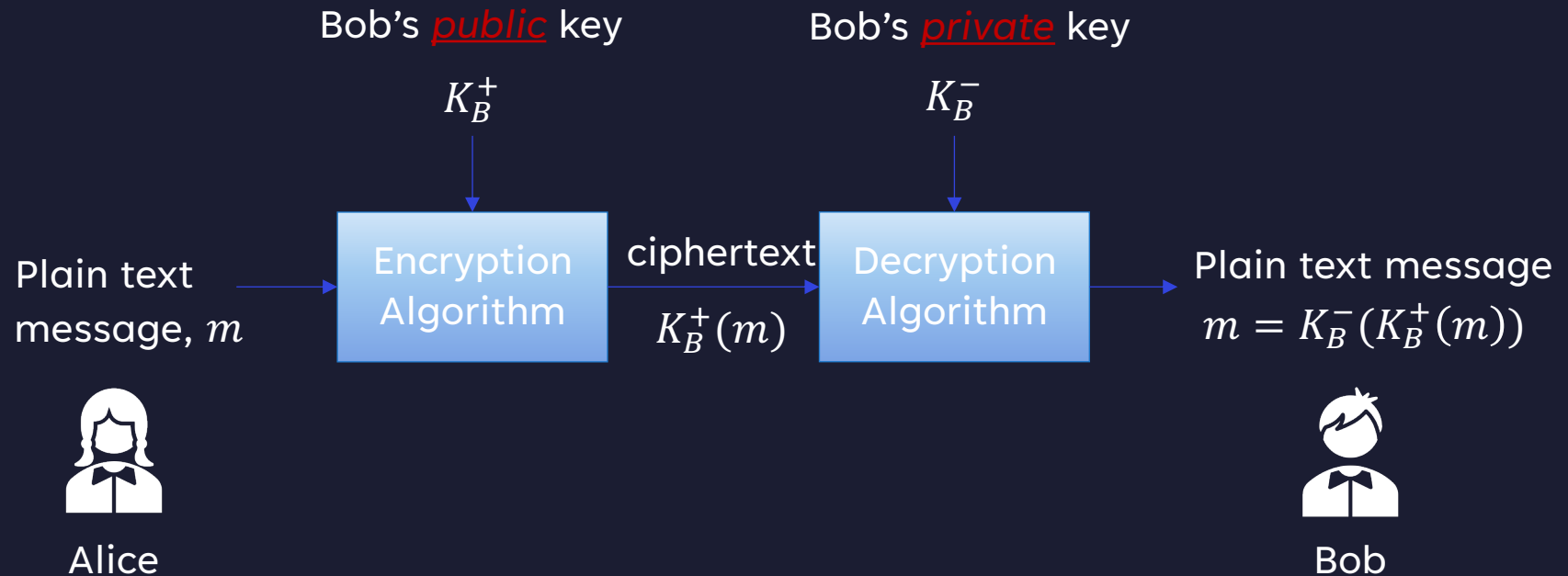
Quantum Computers

- 50-100 qubits NISQ devices

- IBM, Google, DWave, Rigetti, etc.

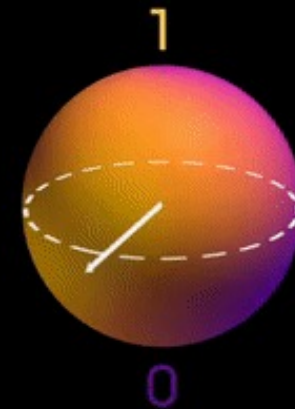- Current encryption methods are at risk

- [Shor's algorithm](#)
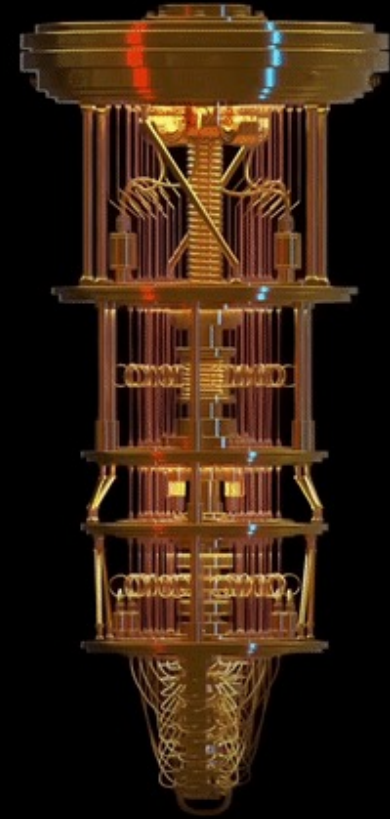
Quantum Bits (Qubits)

- Properties of a Qubit:
  - Superposition
  - Entanglement
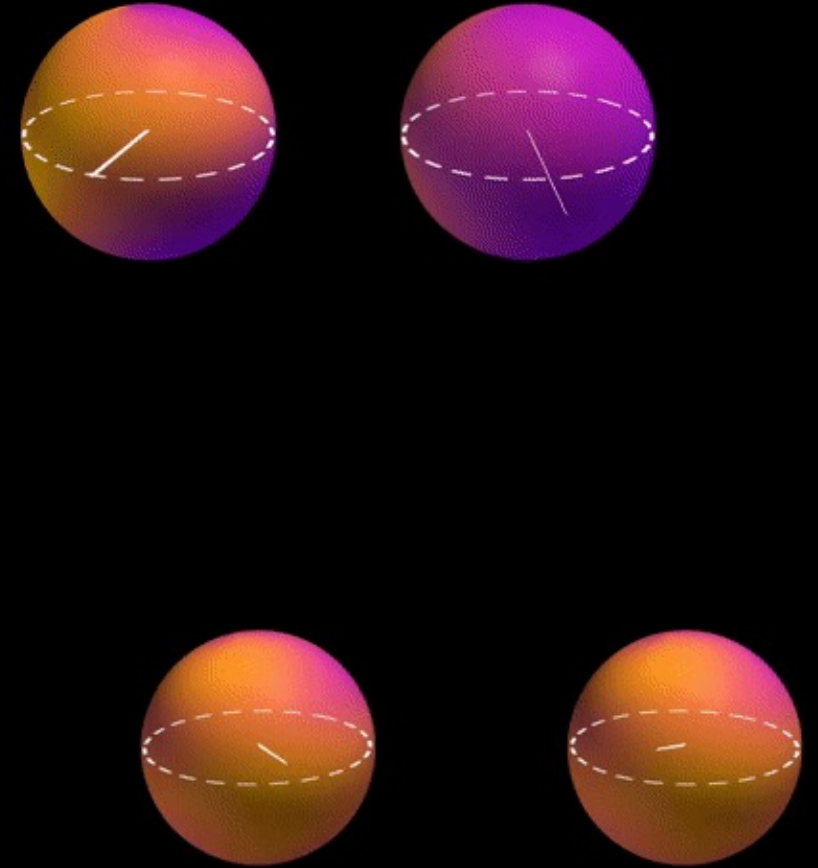 - Interferences

- Collapse after measurement

SUPERPOSITION

1

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Quantum Key Distribution (QKD)

– Entangled Qubits share the same information

– "Instantaneously" transfer information

– Entangled qubits can be used for cryptography:

   – BB84

   – B92

   – E91

– Eavesdropping is detected immediately

So why Quantum Internet?

– Inherently private: QKD, passwords enhancement

– Quantum Sensing (tasks that require coordination and synchronization)

– Connect other quantum computers with each other

    – Make an unlimited number of calculations in parallel

Issues

– Entanglements are weak

– Photons can get lost

– Detection efficiency

– No Cloning Theorem

– These might make the challenges slightly harder

References regarding Challenges

– [API for protocols](#)

– [TuDelft QNE QKD Challenge](#)

– [QNE-ADK](#)

– [Quantum Protocol Zoo](#)

– [IBM Qiskit QKD](#)

– Green computing:

  – [Towards climate justice in tech](#)

  – [Green Computing](#)

  – [Digital rights and environmental and climate justice](#)

Thanks!
Good luck with the Hackathon

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