Simulação de Redes de Comunicação Quântica

Tópicos Especiais em Redes: Novas Tecnologias para Internet do Futuro

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Roteiro

1. Introdução
2. Simulação de Redes Quânticas
3. Comparação entre simuladores (básico)
4. Aplicações Comuns:
    a. Send Qubits
    b. Send ERP
    c. QKD
5. Netsquid
6. QuISP
7. QuNetsim

TIMELINE

The idea of building a Quantum Computer was proposed by

R. FEYNMAN

1981

D-WAVE QUANTUM ANNEALER

1999

1992–1996

FIRST QUANTUM ALGORITHMS

Deutsch–Jozsa algorithm
Shor's algorithm
Grover's algorithm

2000

QUANTUM TECHNOLOGIES FOR QUBIT IMPLEMENTATION

SUPERCONDUCTING QUBITS

NV CENTERS

MAJORANAS

TRAPPED IONS

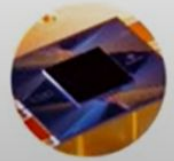
QUANTUM DOTS

IBM QUANTUM EXPERIENCE

2016

2019

QUANTUM SUPREMACY



QUANTUM INSPIRE

2020

NISQ era: quantum devices

TRAPPED IONS

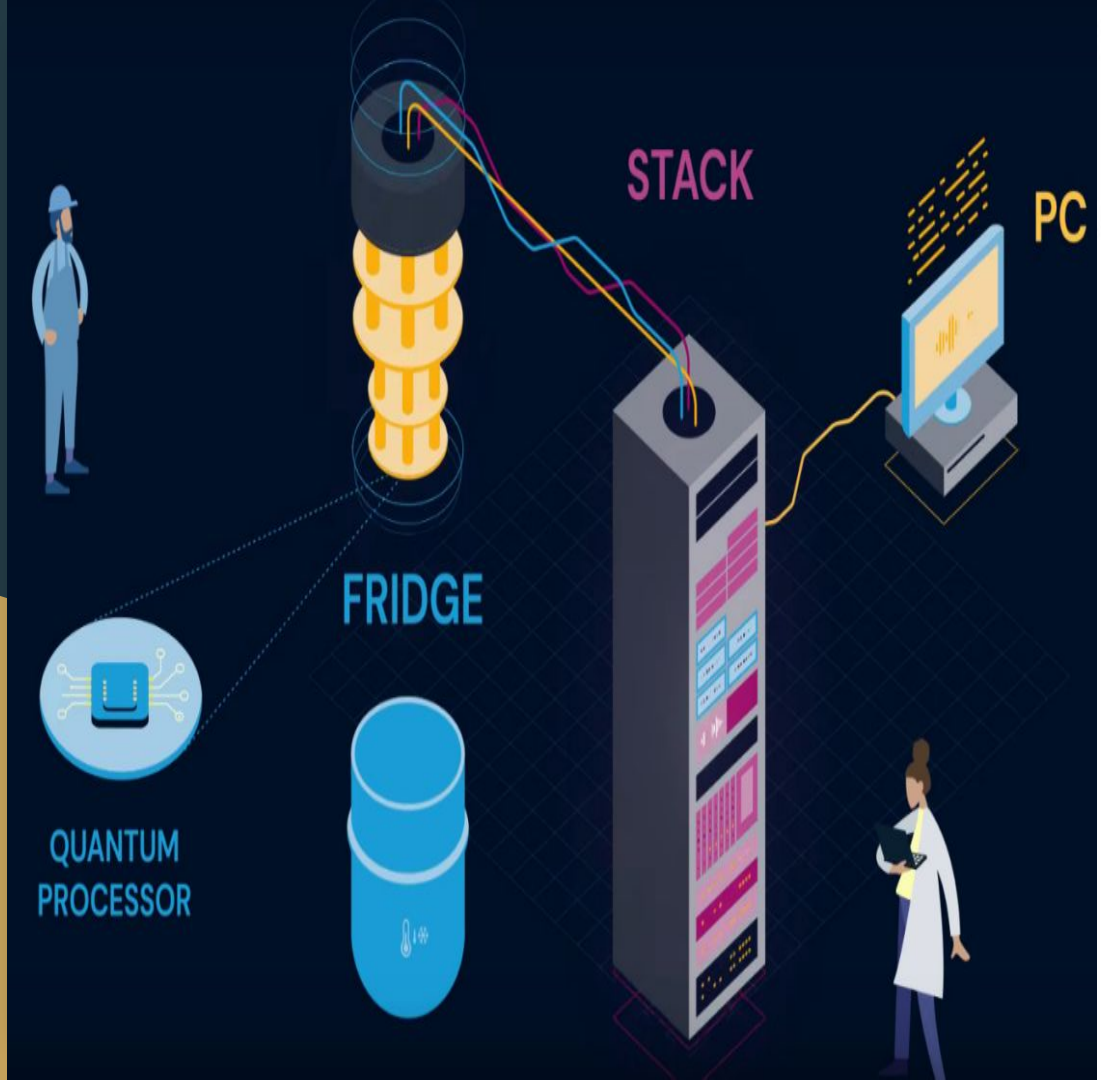
SILICON QUANTUM DOTS

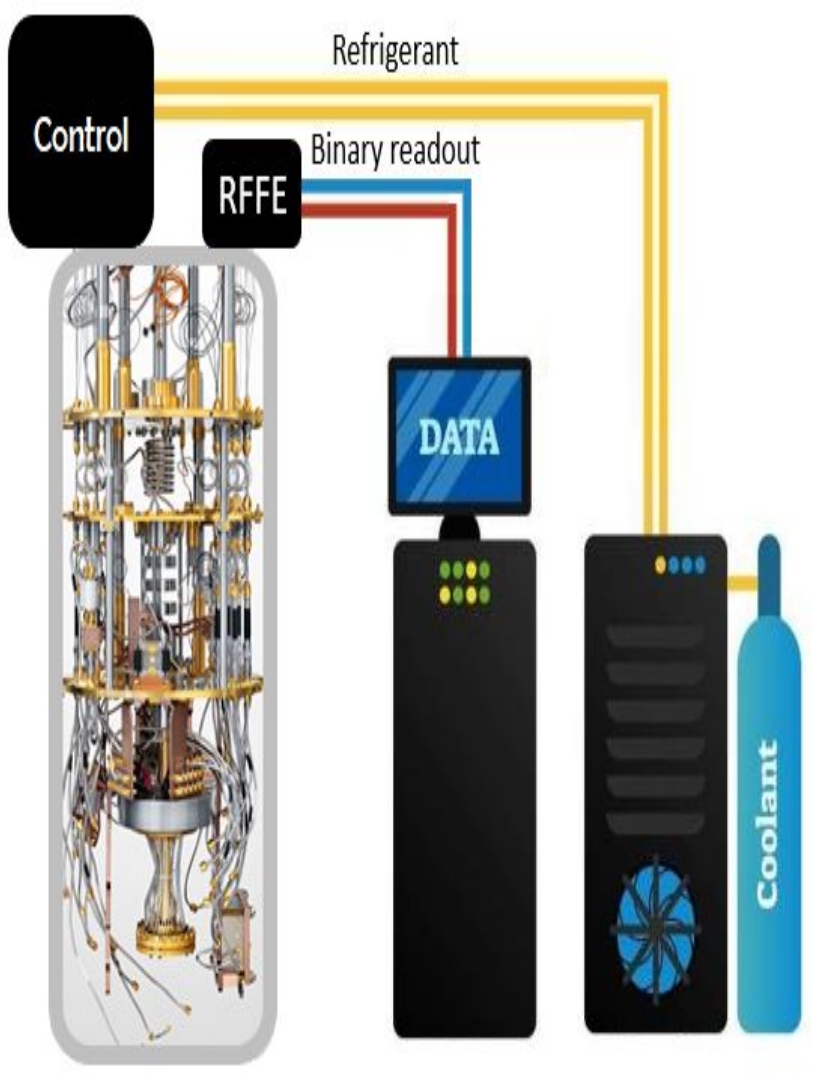
SUPERCONDUCTING QUBITS

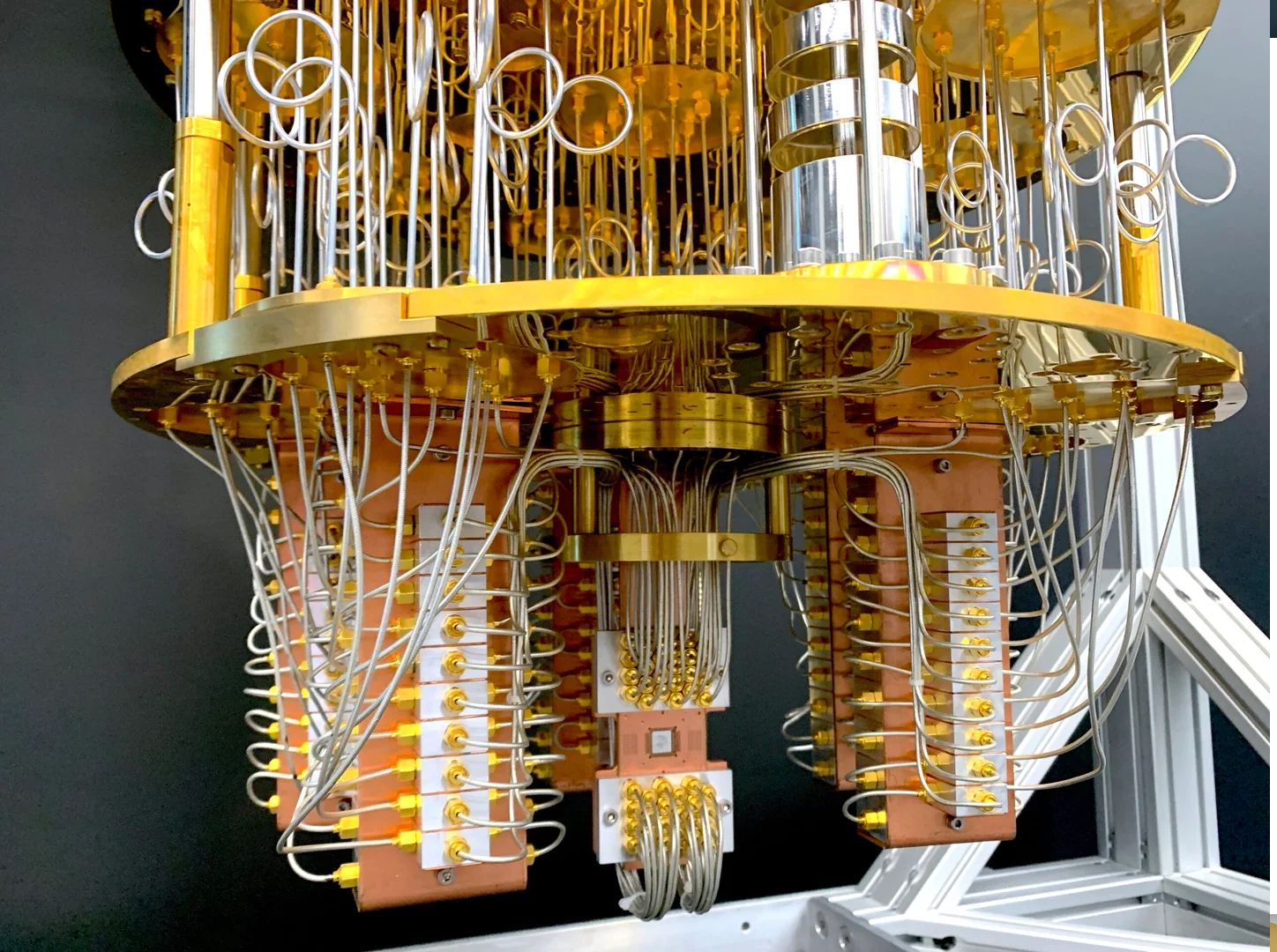
NV CENTERS

MAJORANA QUASIPARTICLE

- Coherence time
- Gate fidelity
- Gate operation time
- Qubit's connectivity
- Scalability
- Maturity

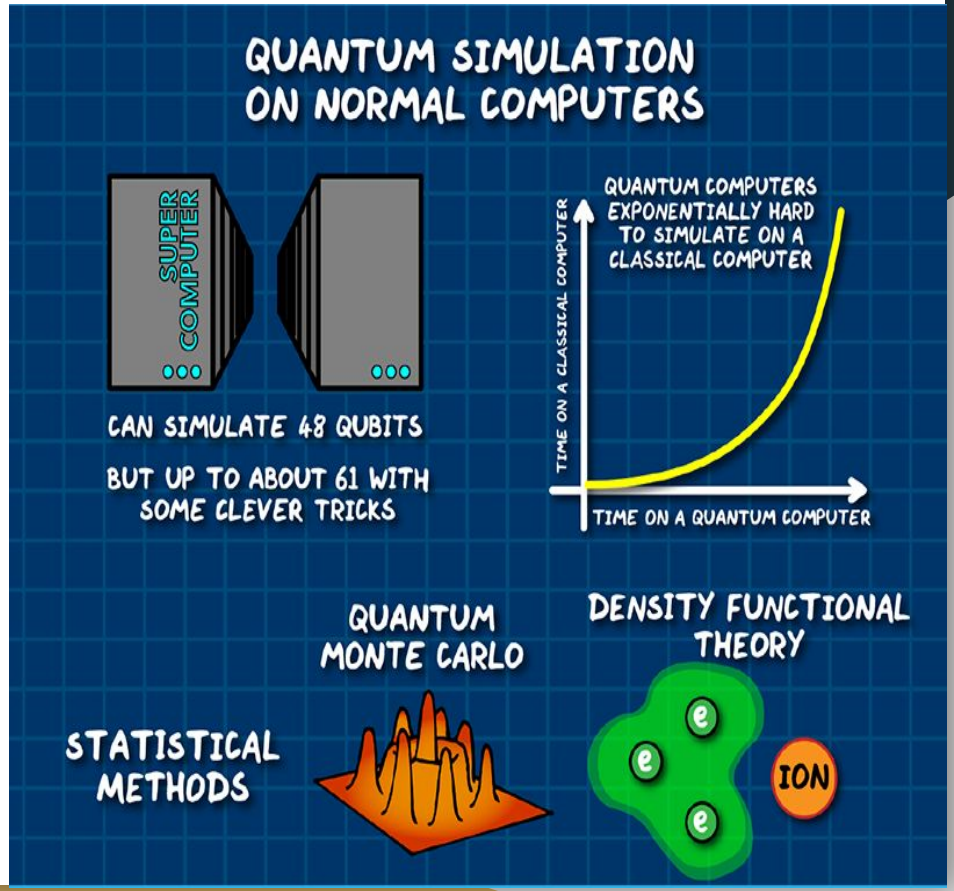

STACK
PC
FRIDGE
QUANTUM
PROCESSOR


Refrigerant
Control
Binary readout
RFFE
DATA
Coolant



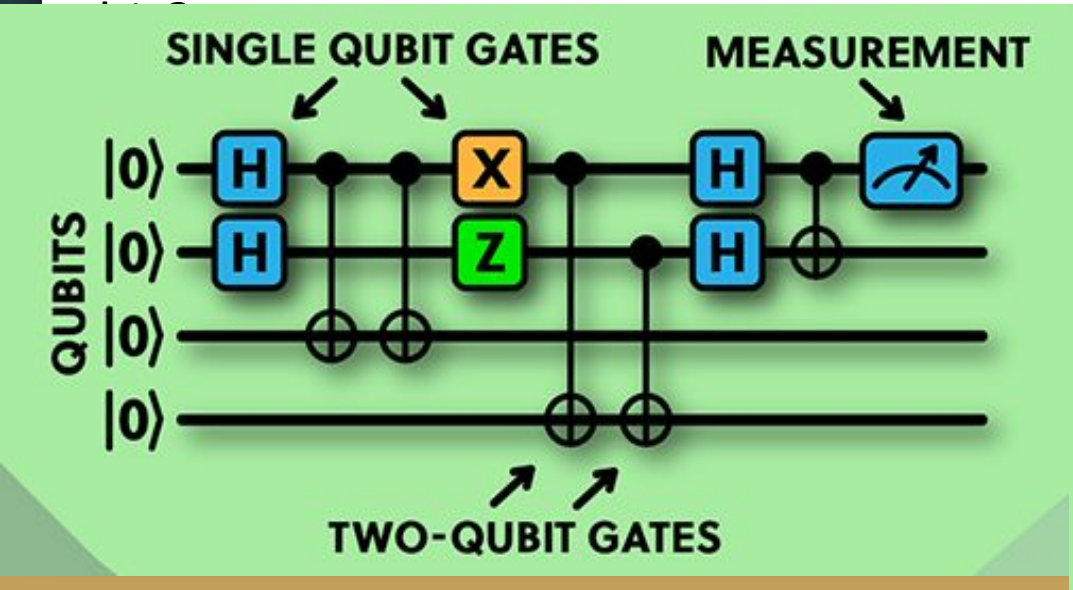
Quantum Simulation

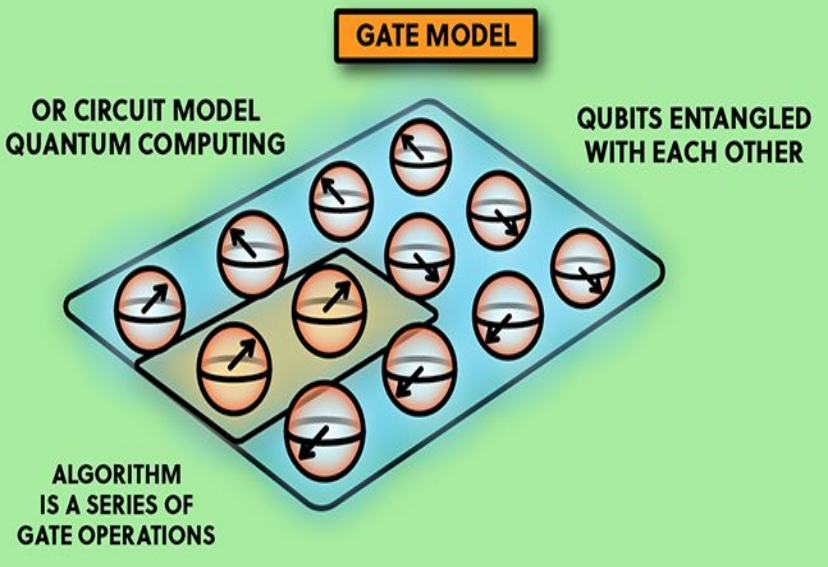
- How to experiment if I don't have a quantum computer or a quantum lab?
- The challenge of simulating quantum
  - Classical Computers can simulate a limited number of Qubits
  - How to accurately simulate quantum properties: superposition, entanglement, coherence.



Quantum Simulation

- There are many quantum simulation tools available
- Can we simulate quantum networks using



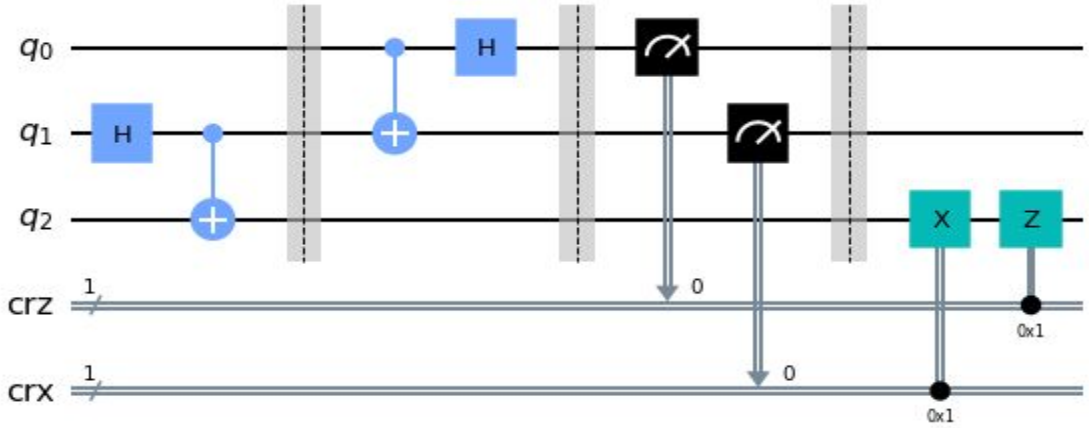


Example

- Coding a network from scratch
- low level programming (network)
- **Teleportation Circuit using Qiskt**

```
## SETUP
# Protocol uses 3 qubits and 2 classical bits in 2 different registers
qr = QuantumRegister(3, name="q")
crz, crx = ClassicalRegister(1, name="crz"), ClassicalRegister(1, name="crx")
teleportation_circuit = QuantumCircuit(qr, crz, crx)

## STEP 1
create_bell_pair(teleportation_circuit, 1, 2)

## STEP 2
teleportation_circuit.barrier() # Use barrier to separate steps
alice_gates(teleportation_circuit, 0, 1)

## STEP 3
measure_and_send(teleportation_circuit, 0, 1)

## STEP 4
teleportation_circuit.barrier() # Use barrier to separate steps
bob_gates(teleportation_circuit, 2, crz, crx)
teleportation_circuit.draw(output='mpl')
```

The Circuit



The Qiskit Code

Qiskit

Quantum **Network** Simulators

- Time-saving for testing Network functions and protocols
- Some Simulators are focus in only one application such as QKD
- Some Researchers choose to create it own simulator to test a particular problem or experiment.
- For multi-purpose quantum network simulators, a few are available:

Netsquid

QuISP

QuNetSim

Conclusion

- Networks Quantum Simulators can help new researchers
- The choice of the simulator depends on:
  - The problem you are interested.
  - The need for flexibility: do I need to re-write many things?
  - Your familiarity with the programming language
- We still don’t have a Simulator that implements Mobile or Satellite quantum networks.