# Quantum Communication Lab


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POLITÉCNICA
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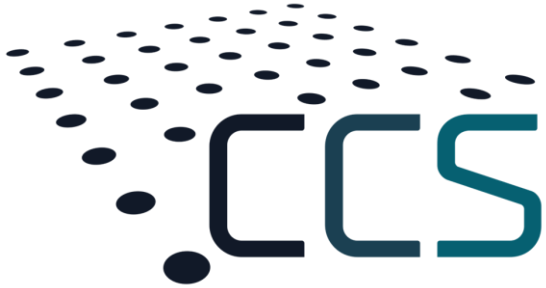


Center for
Computational
Simulation

# Quantum Communication Lab



I. Short introduction on Quantum Information

II. Simulation on Quantum Communication

III. The real world: Madrid Quantum Network

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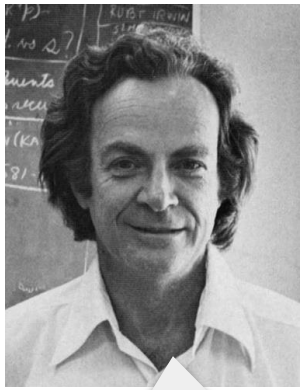
## Quantum mechanics and information

Richard Feynman



**Nature is quantum, goddamn it! So if we want to simulate it, we need a quantum computer**

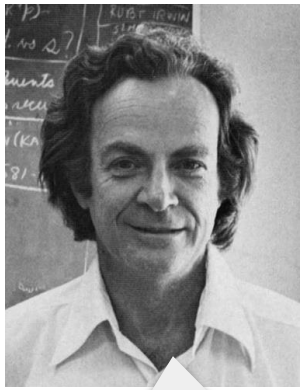


Feynman image: https://commons.wikimedia.org/wiki/File:Richard_Feynman_1988.png

## Quantum mechanics and information

**q- computer**

Richard Feynman



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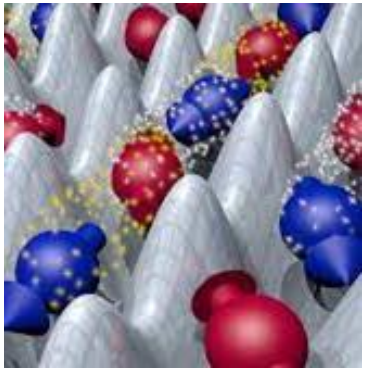

**q- simulator**

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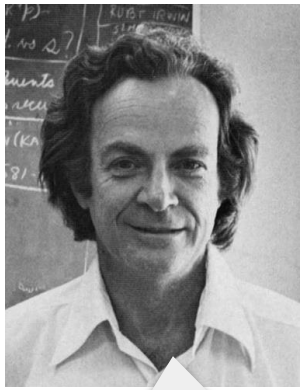

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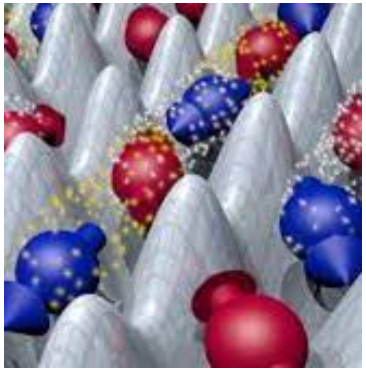

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**q- communication**

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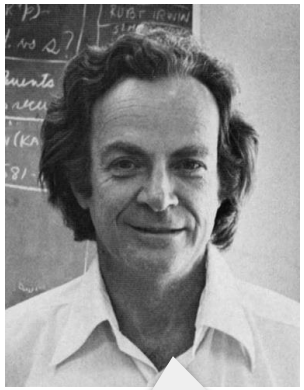

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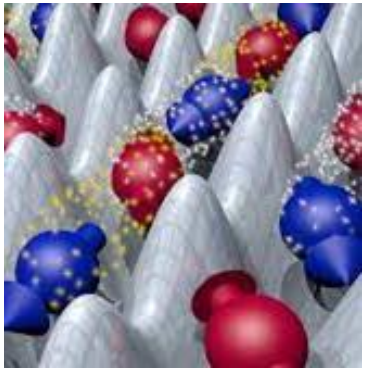

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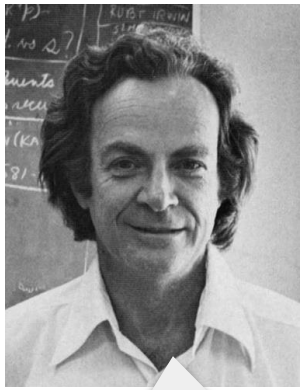

**Nature is quantum, goddamn it! So if we want to simulate it, we need a quantum computer**

Quantum paradigm

- provide **new resources** for a **quantum information theory** and
- enable **new advantageous techniques**.



Feynman image: https://commons.wikimedia.org/wiki/File:Richard_Feynman_1988.png

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## Tools

There are current available quantum technology:

- **Physical platforms**

| | |
|---|---|
| **Photonics** | Nitrogen-vacancy center |
| Quantum dots | Superconductivity |

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- **Chimeras**

  Quantum repeaters **?** Quantum memories **?**

  Quantum switches **?** (⋯)

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| Quantum repeaters **?** | Quantum memories **?** |
| Quantum switches **?** | (⋯) |

- **Simulations**

| | | |
|---|---|---|
| **Netsquid** | NetSimQKD | ProjectQ |
| **Qiskit** | SimulaQron | Braket |

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- **Simulations**

**Netsquid**

**Qiskit**



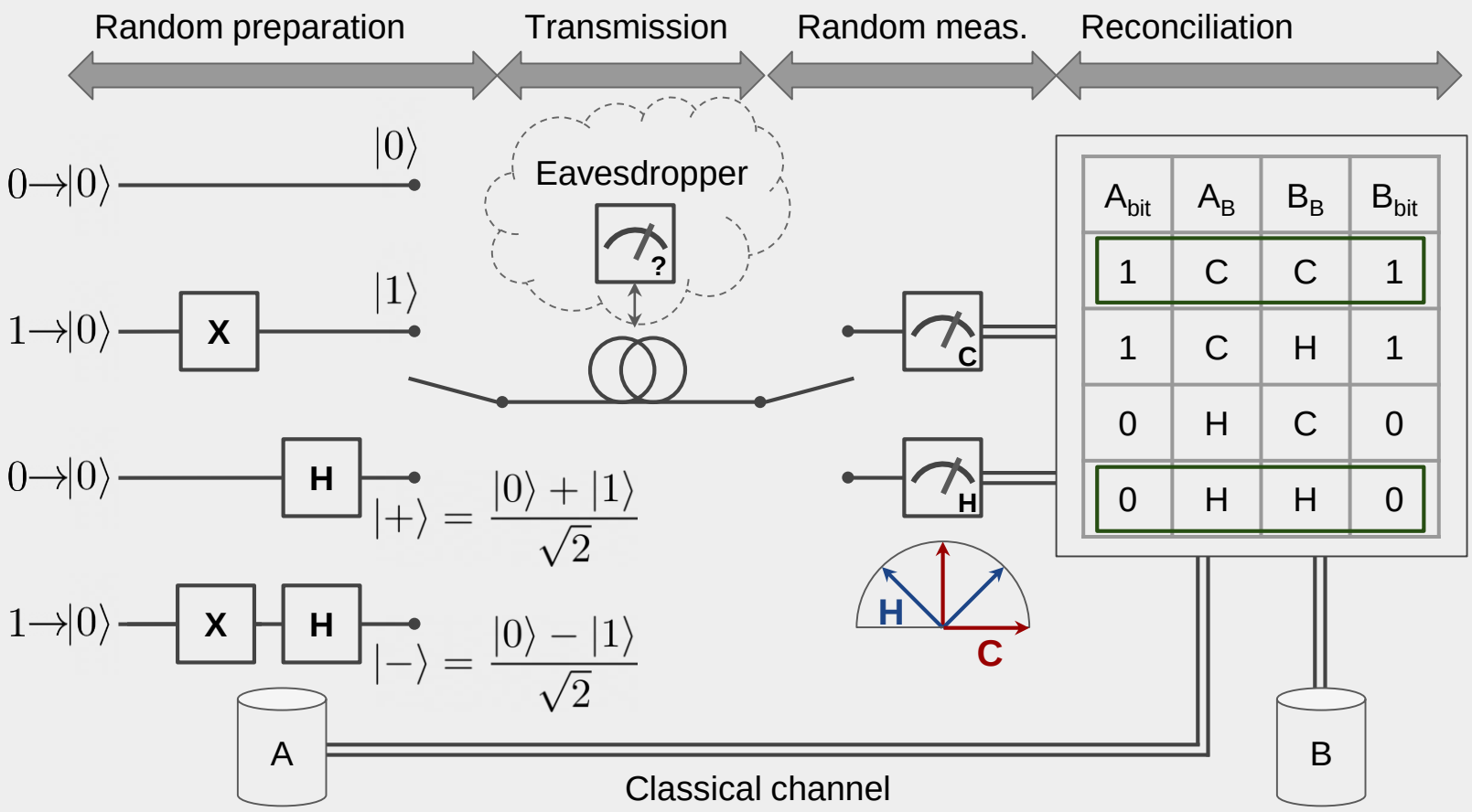
ProjectQ

Braket

## Basic techniques

**BB84**

Symmetric secret key generation.

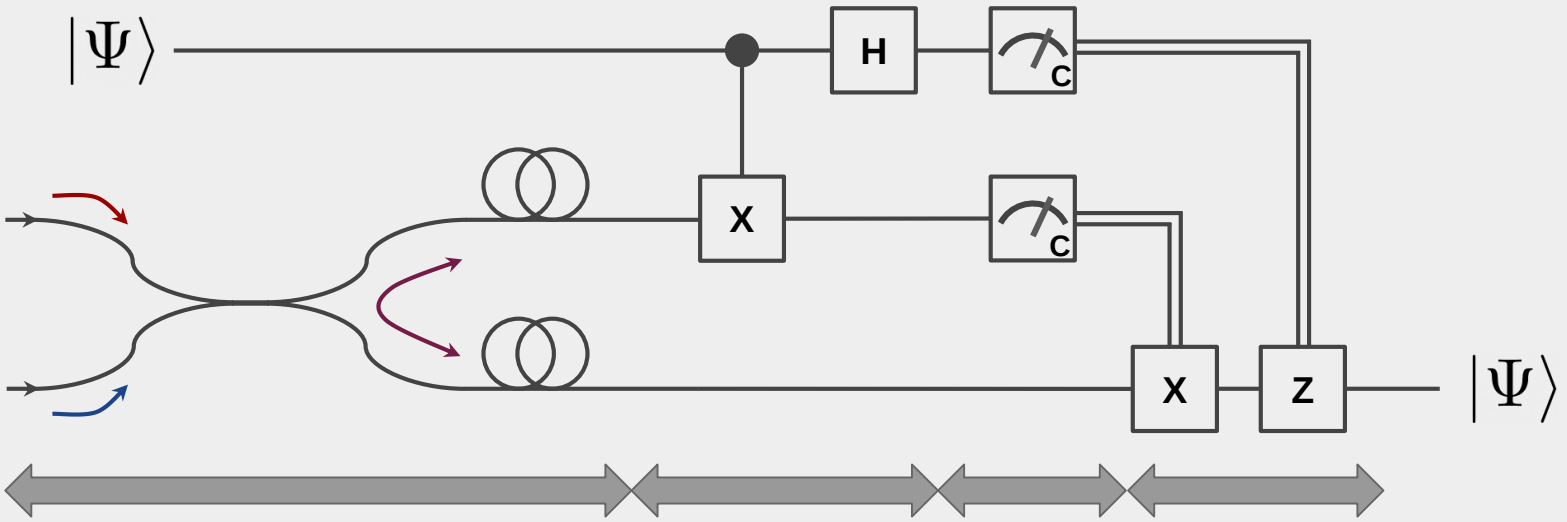



| $A_{bit}$ | $A_B$ | $B_B$ | $B_{bit}$ |
|---|---|---|---|
| 1 | C | C | 1 |
| 1 | C | H | 1 |
| 0 | H | C | 0 |
| 0 | H | H | 0 |

## Basic techniques

**Teleportation**

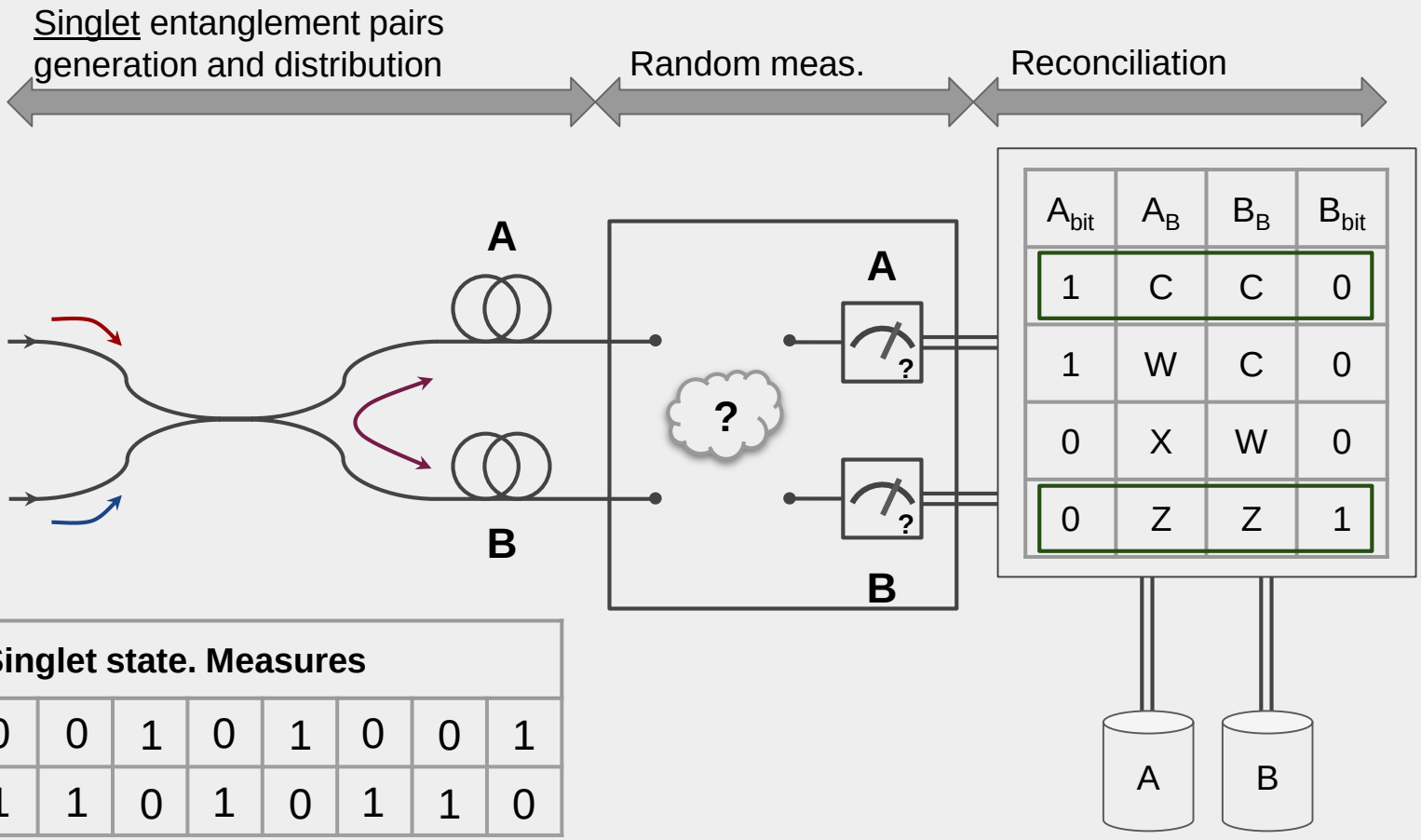
Fully quantum communication



# Basic techniques

**E91**

Symmetric secret key generation.




| Singlet state. Measures | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |

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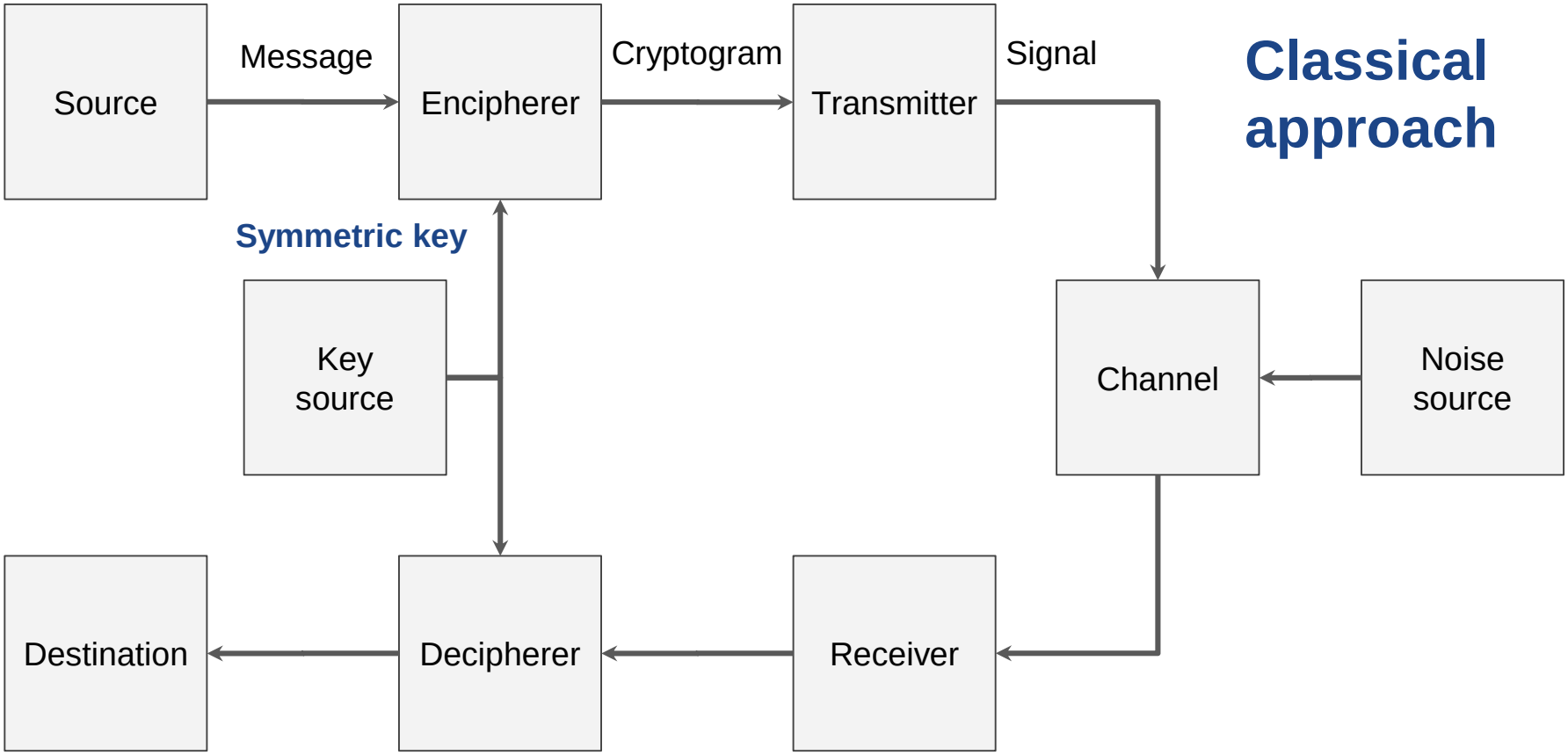
## Communication & cryptography

A quantum approach to communications



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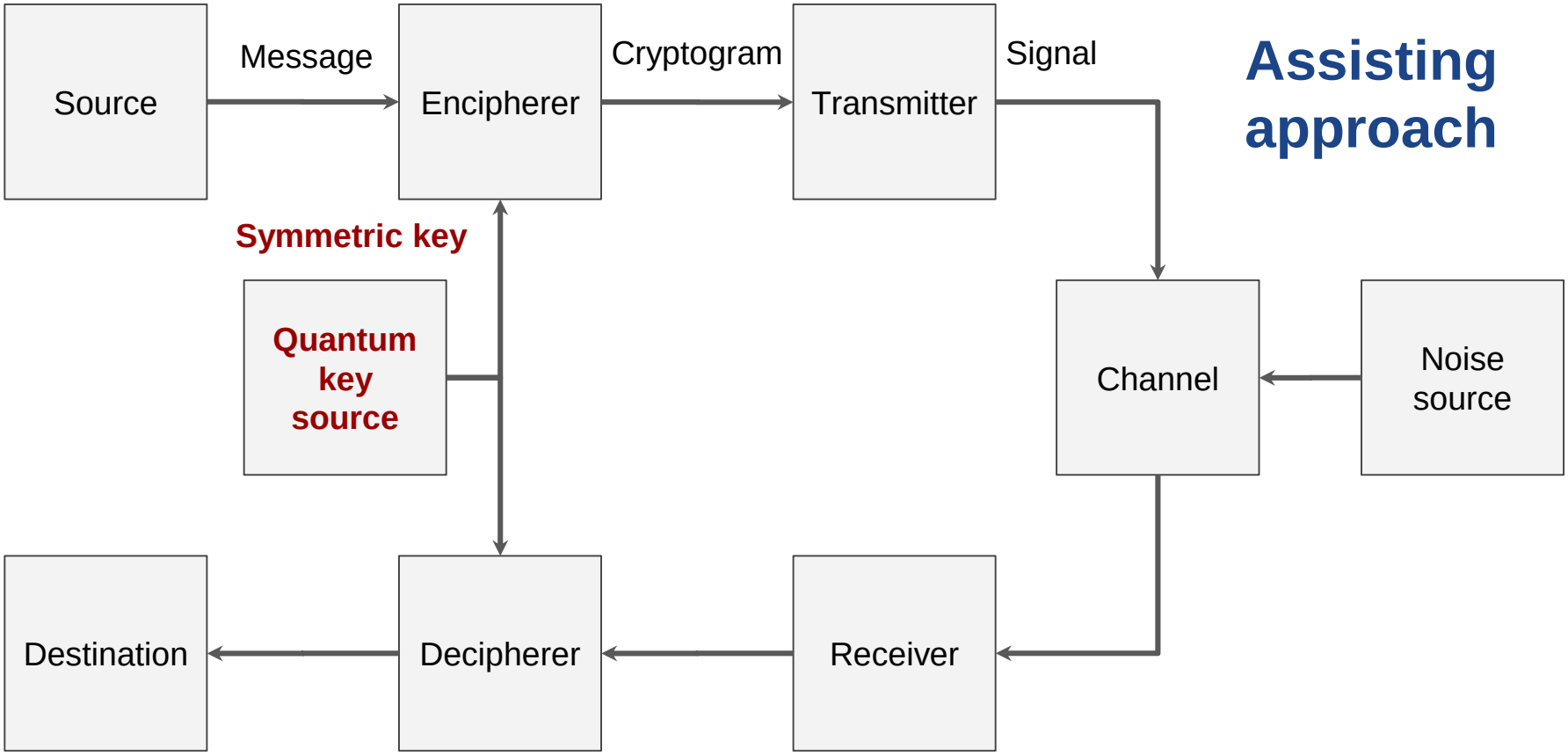
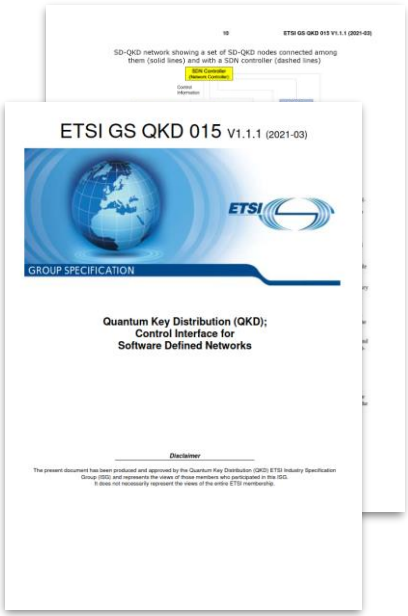
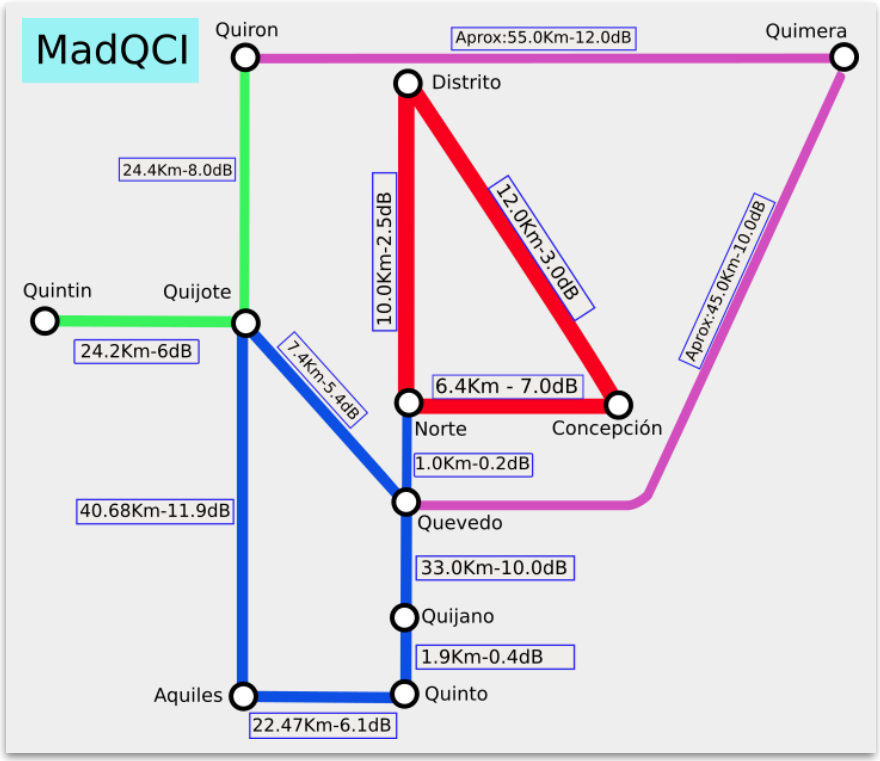


## Madrid SDN - QKD Network

A **software defined** testbench network for quantum communications such as QKD.



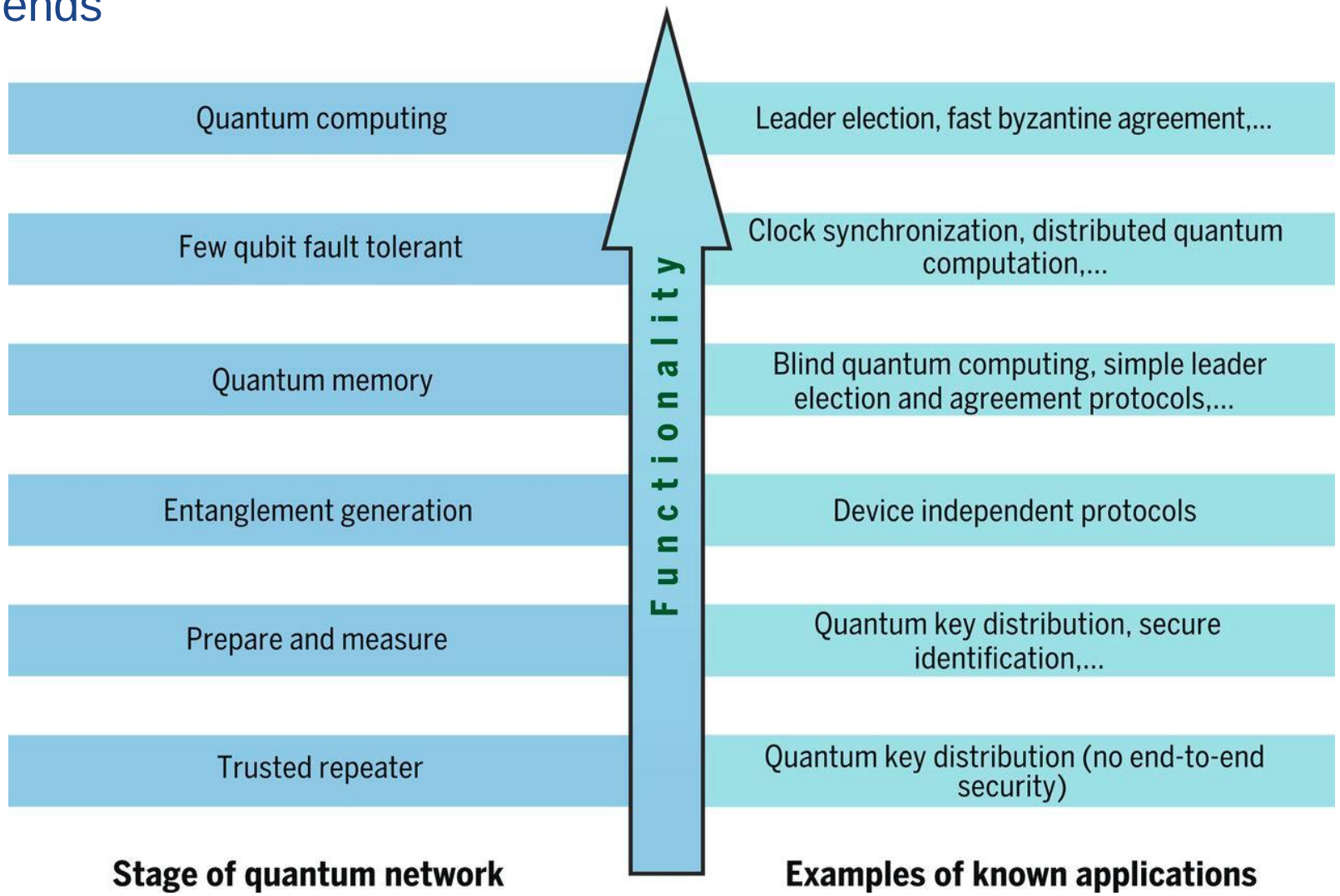




redi madrid

OPEN QKD

CiViQ

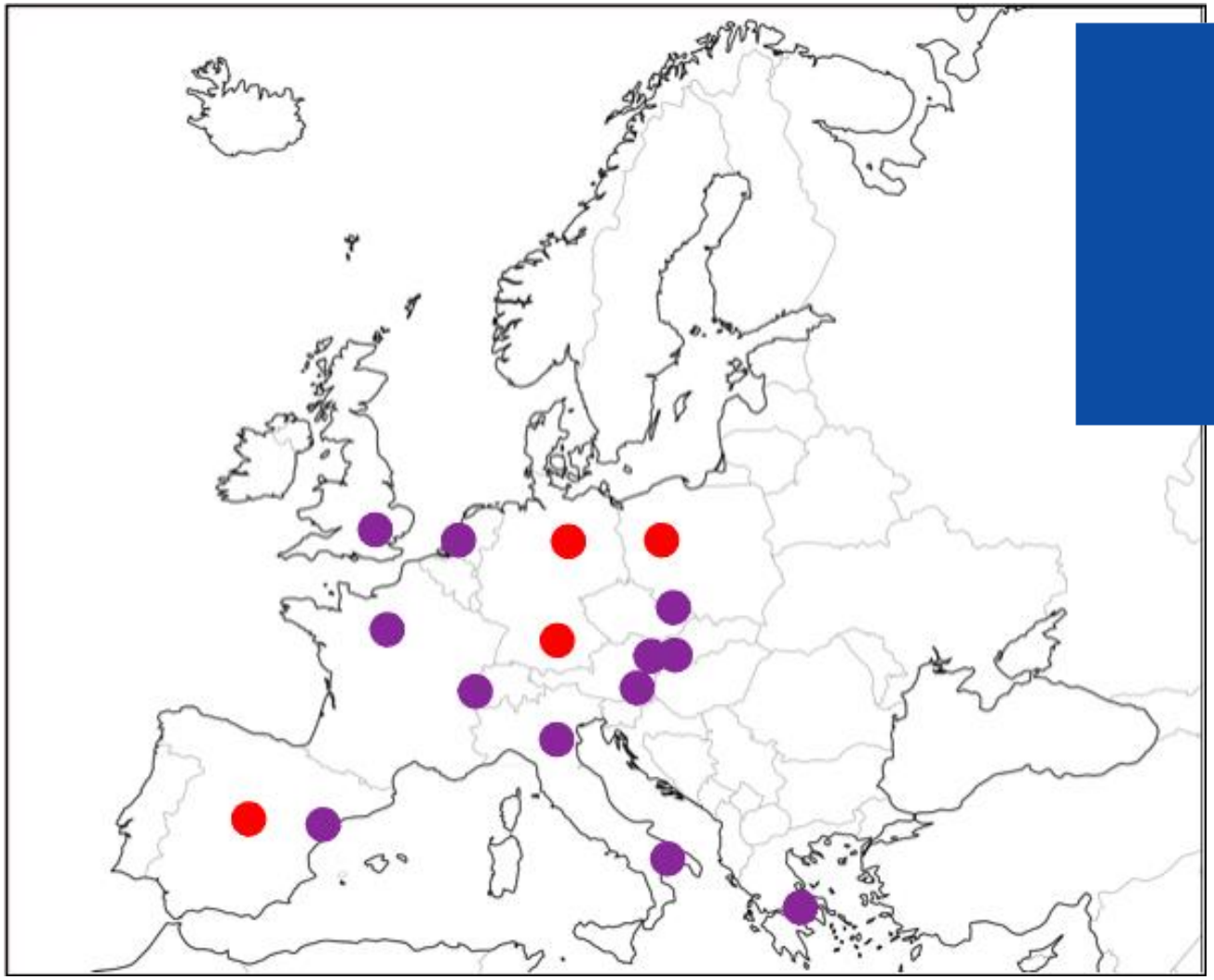
## Trends






https://science.sciencemag.org/content/sci/362/6412/eaam9288/F1.large.jpg

## Trends



**EuroQCI**