Suggestions for building quantum programs

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Séminaire TQCI

Overview of QuantumTech@INRIA

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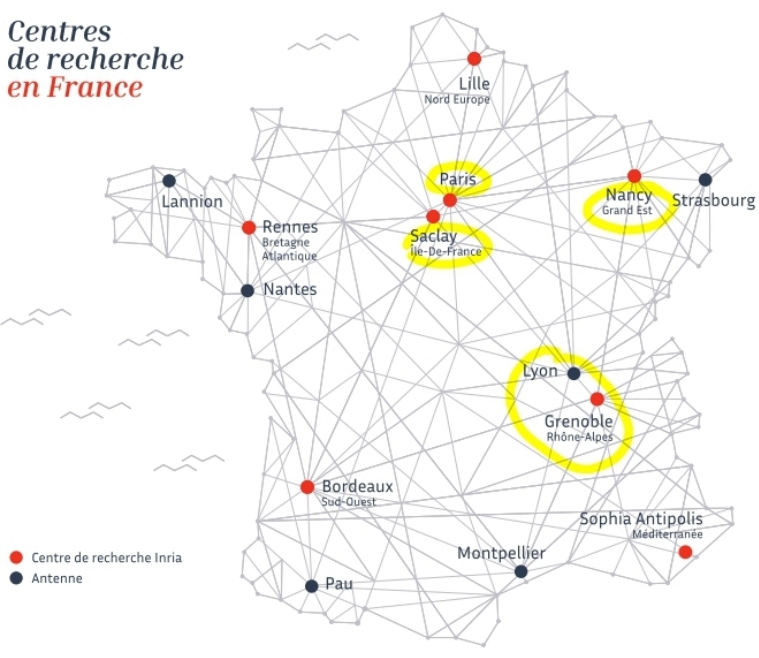
Timeline

- Started in 2001
- Since 2018, the number of permanent researchers has doubled
- 2020: 5 new PIs
- 2021: 4 new PIs
- 5 Active teams
- 2 are being created



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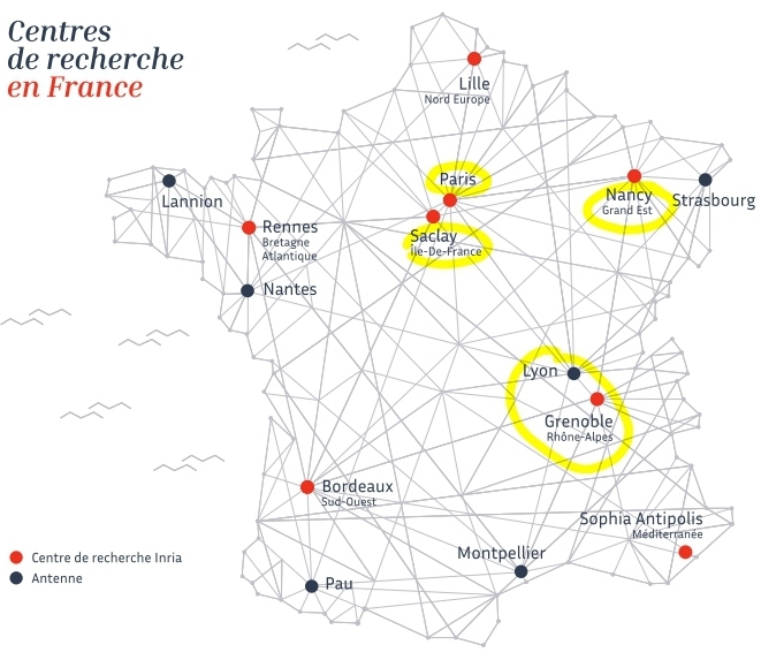

Main topics

- Controlling qubits
- Error correction and fault-tolerance
- Compilation / Languages
- Cryptography (q. & post q., cryptanalysis)
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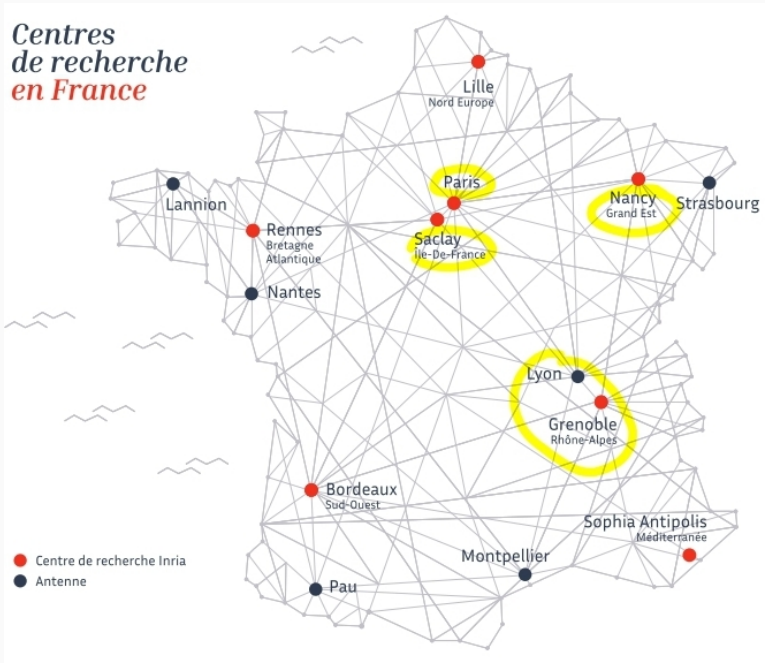

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Action plan

- Spread the word internally (Defi EQIP)
- Keep increasing the workforce
- Extend our coverage (architectures and applications)

Suggestions for building quantum programs

(Simplified) overview of QC development status

Dealing with (un)certainties

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What does it mean for end-users?

- We don't know when nor by how much QC will be useful

(Simplified) approach to quantum programs

A single (not so simple) objective

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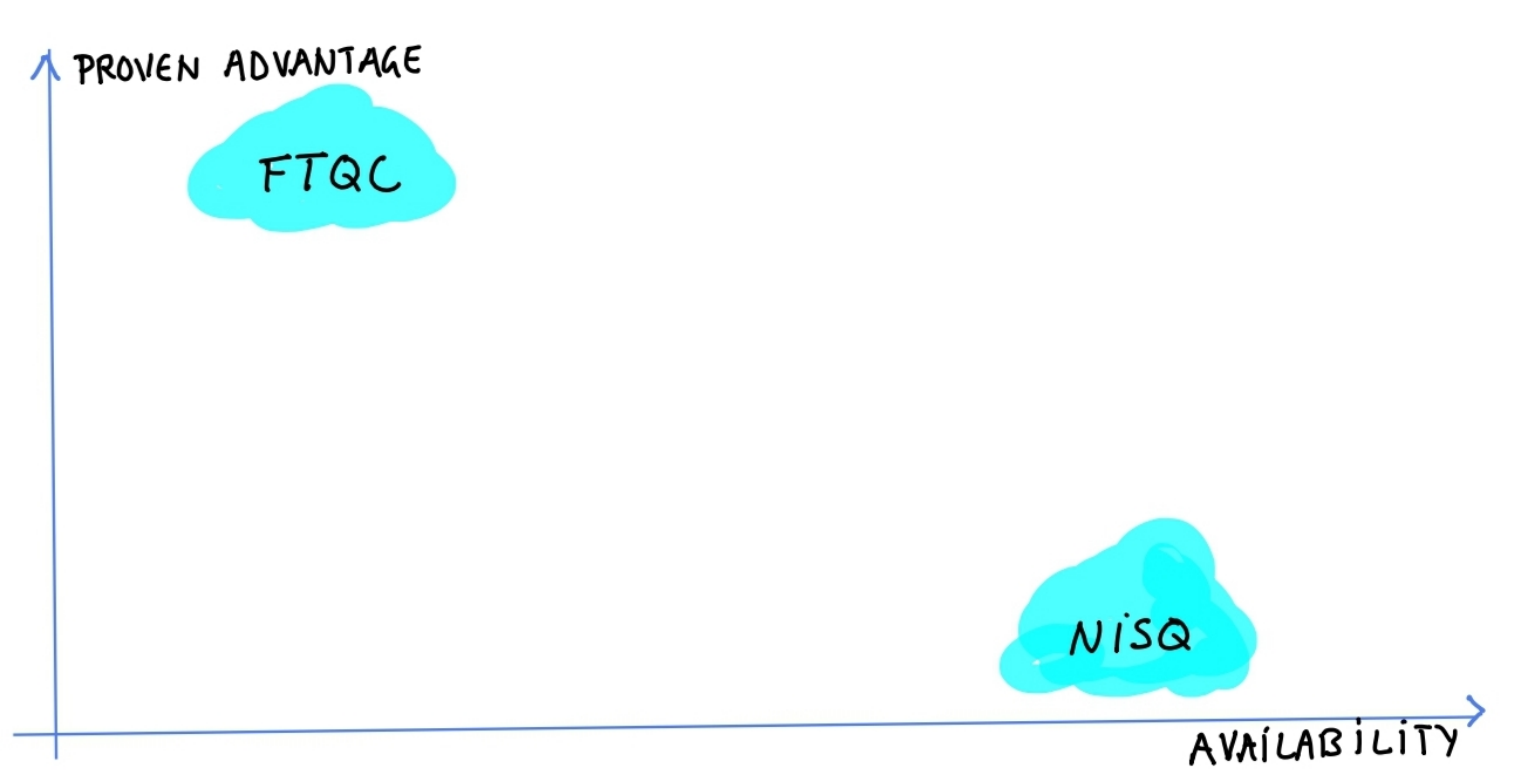

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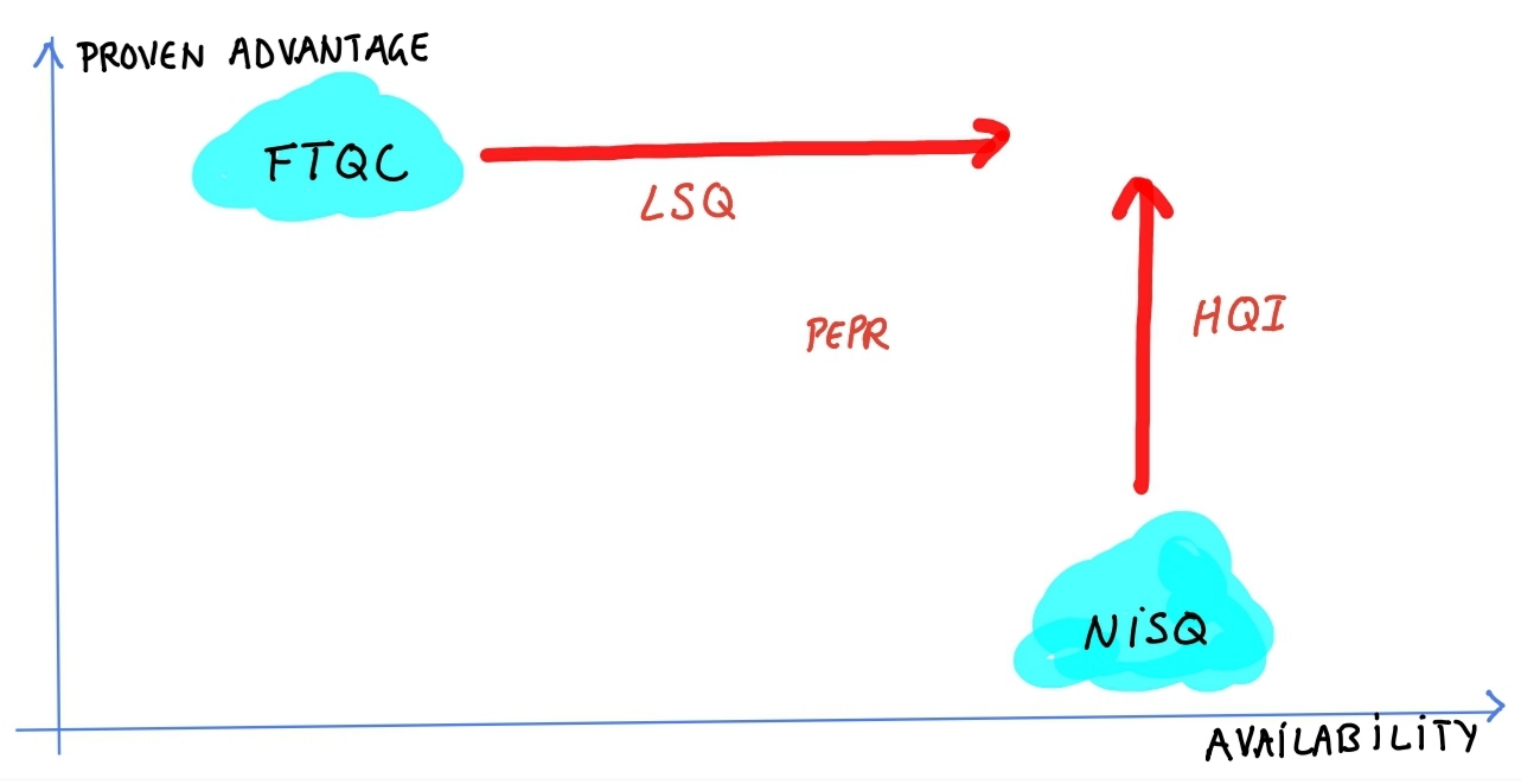

What can be done?

Building expertise

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Why

- Linking external knowledge to internal know-how

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- Know where to look for quantum advantage
  - Smaller datasets
  - Quantum data...

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  - Do I reduce the uncertainty about when performance is at breakeven and/or how much will be gained?

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- Value is created with longer projects

Building commitment

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- It's a long journey: difficult to answer to the question "how much can be gained?"
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  - expensive but might bring gains before QC / identify building blocks that could be possibly be replaced by Q Algorithms
- Go for PoC, simulations, analytic x simulations to get an sense of required parameter sets

Short focus on making the best out of PoCs

Step-by-step approach

Methodology

1. Survey existing approaches
2. Which ones are the most profitables for the program
3. Adapt to real hardware
4. Study requirements for obtaining the required functionality / advantage

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Practice

1. Applications for quantum networks

Protocol Library

Functionality	Protocols
Anonymous Transmission	GHZ-based Quantum Anonymous Transmission
	Verifiable Quantum Anonymous Transmission
Authentication of Classical Messages	Uncloneable Encryption
Authentication of Quantum Messages	Purity Testing based Quantum Authentication
	Polynomial Code based Quantum Authentication
	Clifford Code for Quantum Authentication
	Trap Code for Quantum Authentication
	Auth-QFT-Auth Scheme for Quantum Authentication
	Unitary Design Scheme for Quantum Authentication
	Naive approach using Quantum Teleportation
Byzantine Agreement	Fast Quantum Byzantine Agreement

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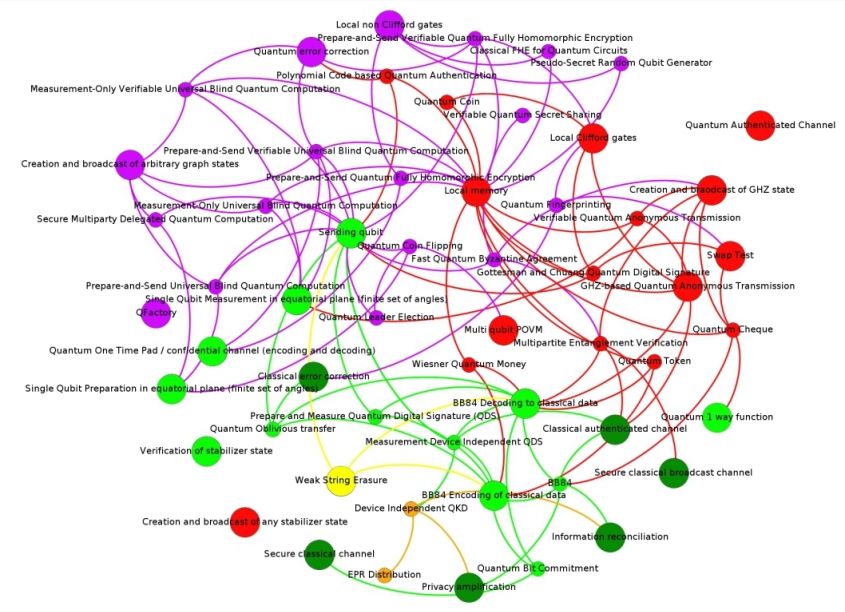

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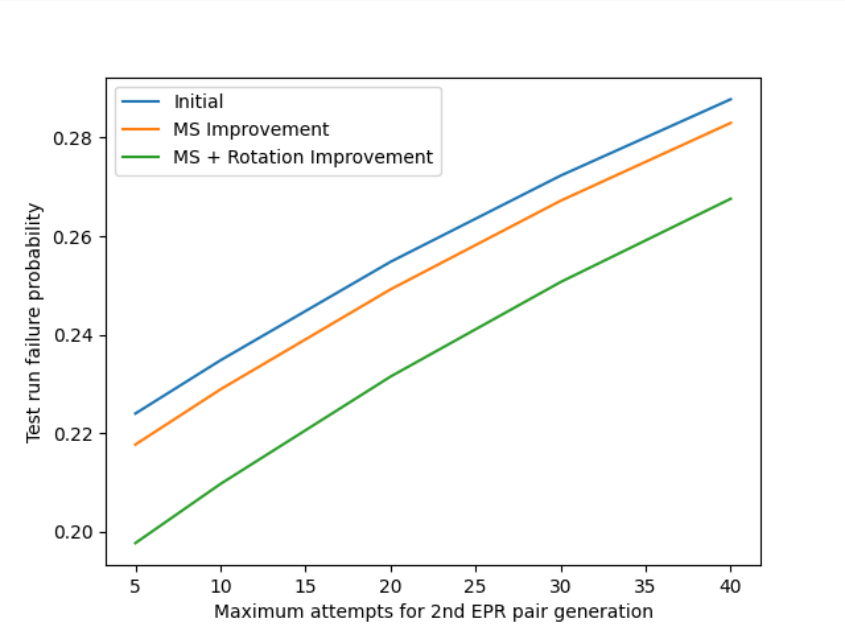

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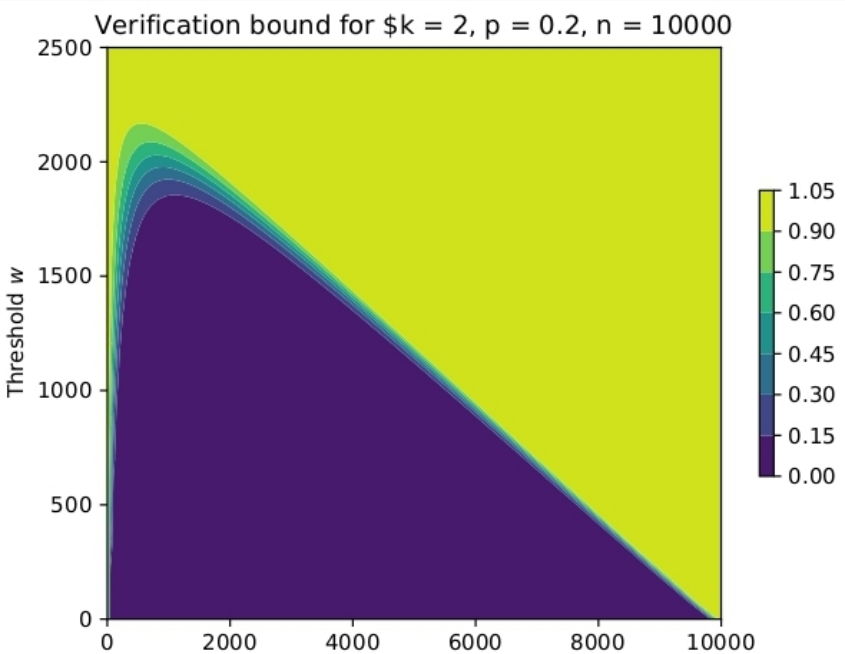
4. Overhead analysis and requirements to get functionning PoC



When to start?

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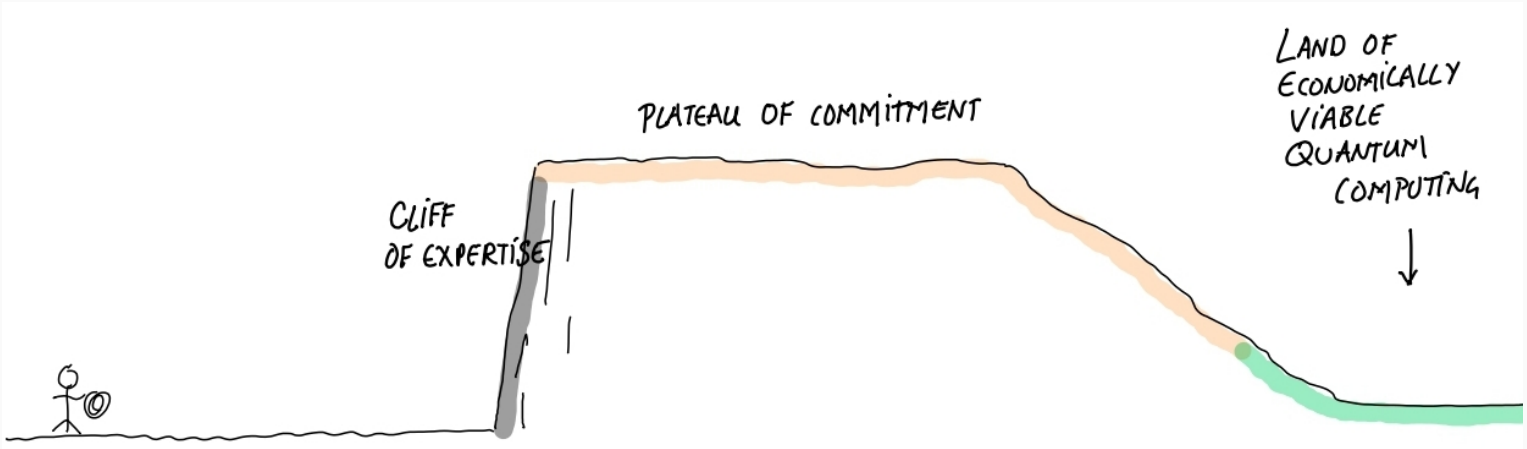

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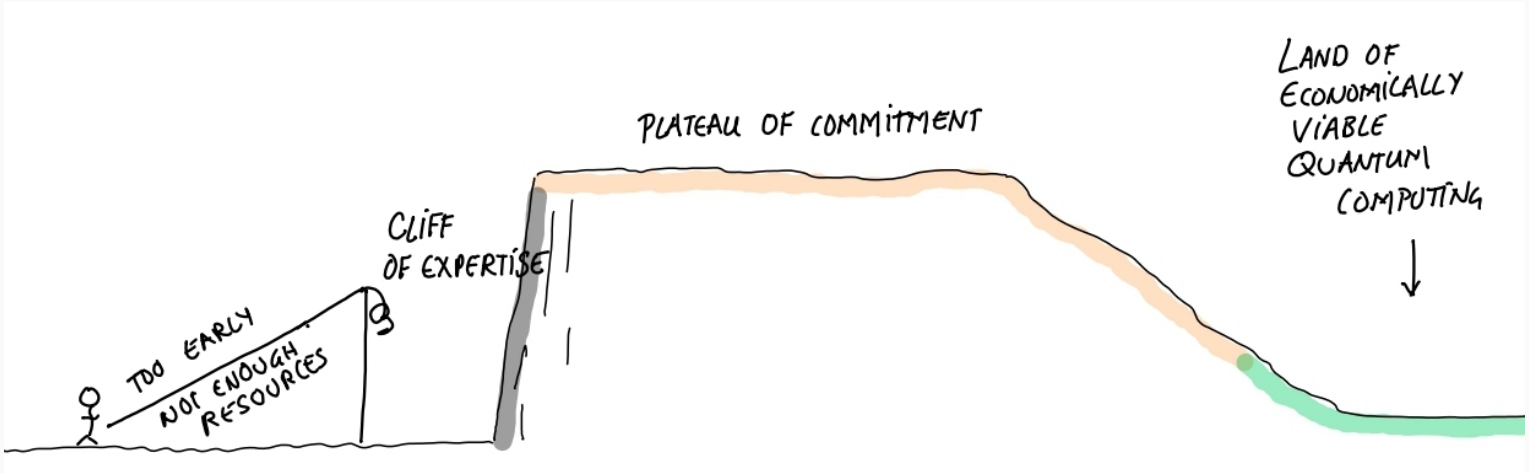

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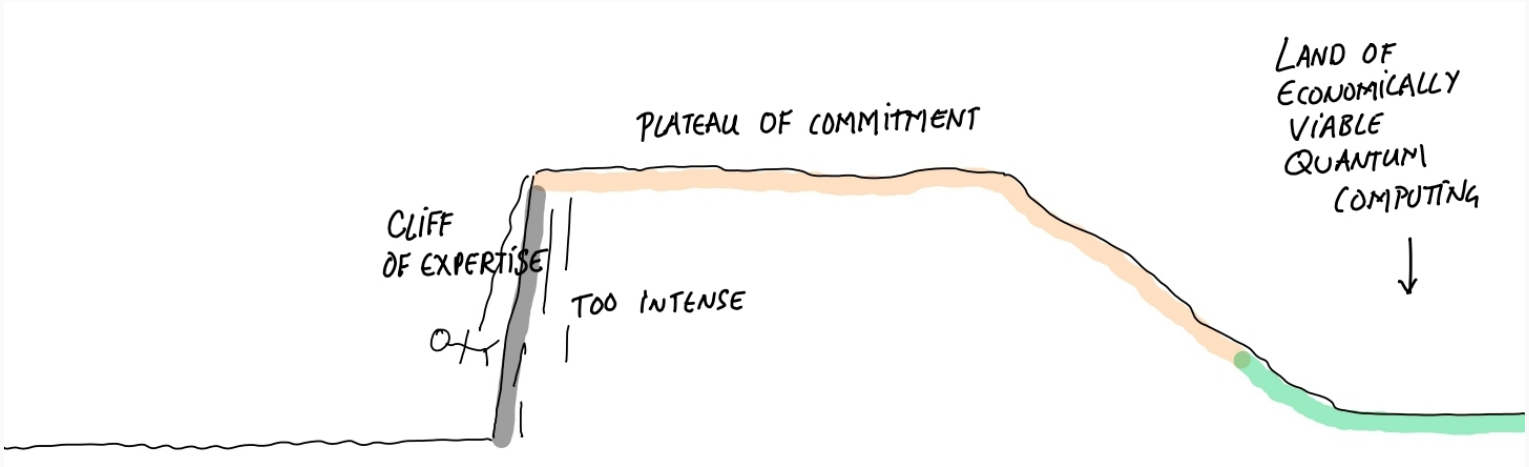

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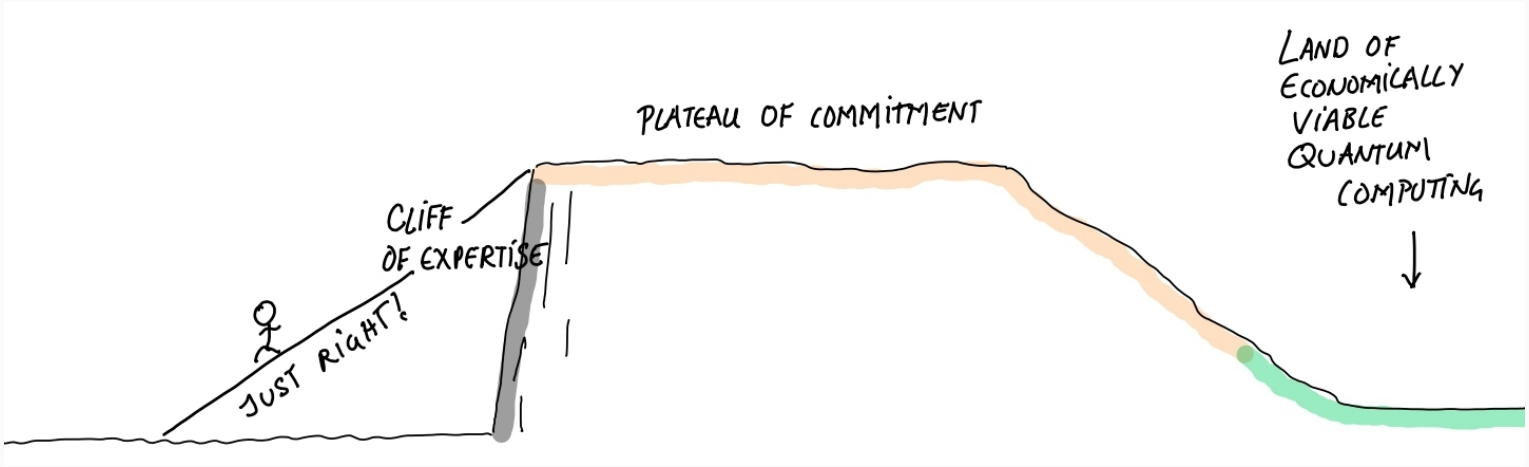

Thank you