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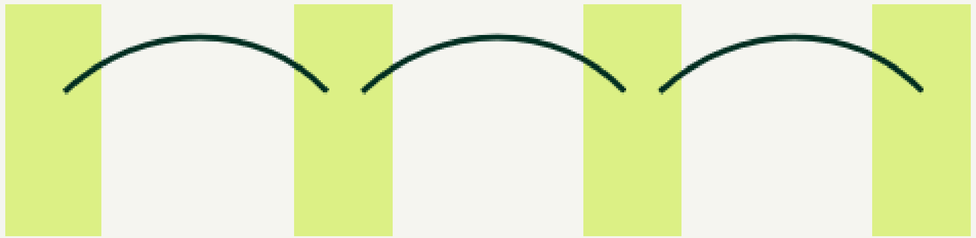
Gathering an ecosystem
around Distributed Quantum Computing

Quantum computers are limited in computational power.

To reach a quantum advantage in computing for all industries, a very large number of qubits (> 10 000) is required.

This cannot be achieved within a single processor.

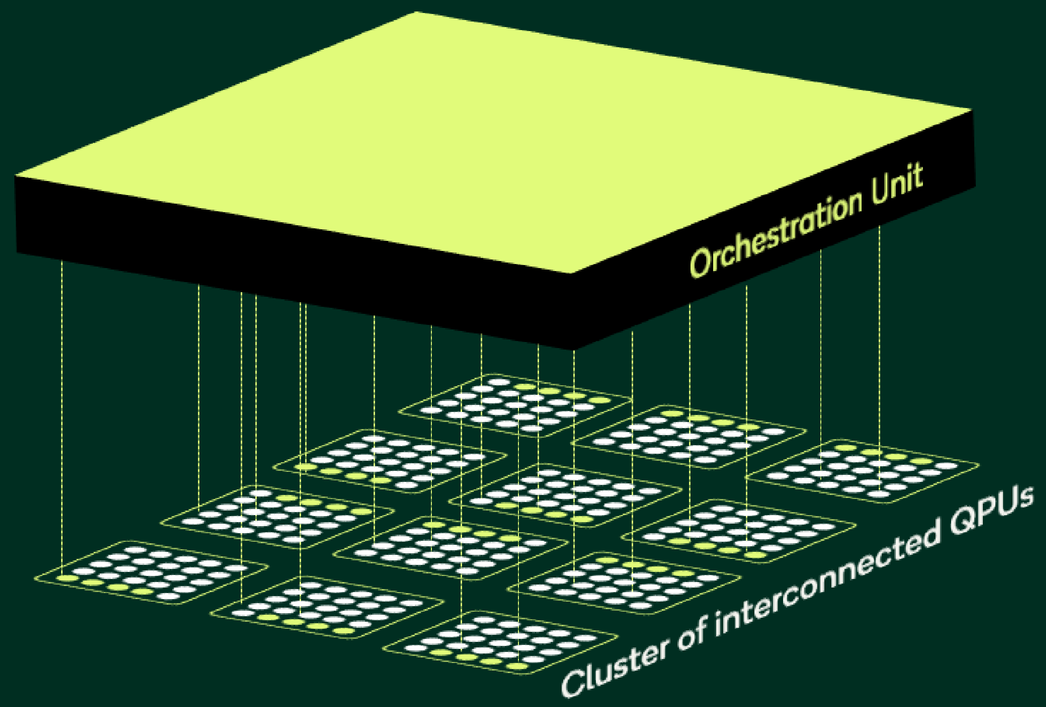
We must interconnect quantum processors to enable quantum computing to fully deliver its promises.



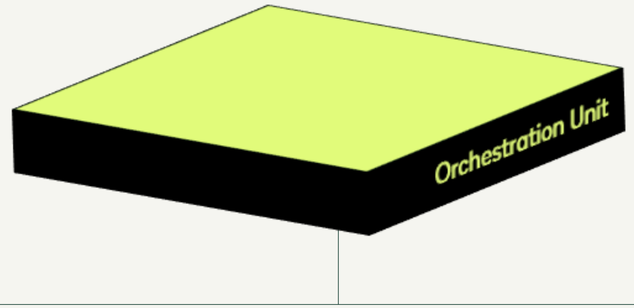
Quantum processors in clusters

Interconnecting quantum processors in clusters

Quantum computers in clusters in data centers



We need **full-stack** quantum interconnection



Algorithms

Distribution of quantum algorithms

Architecture

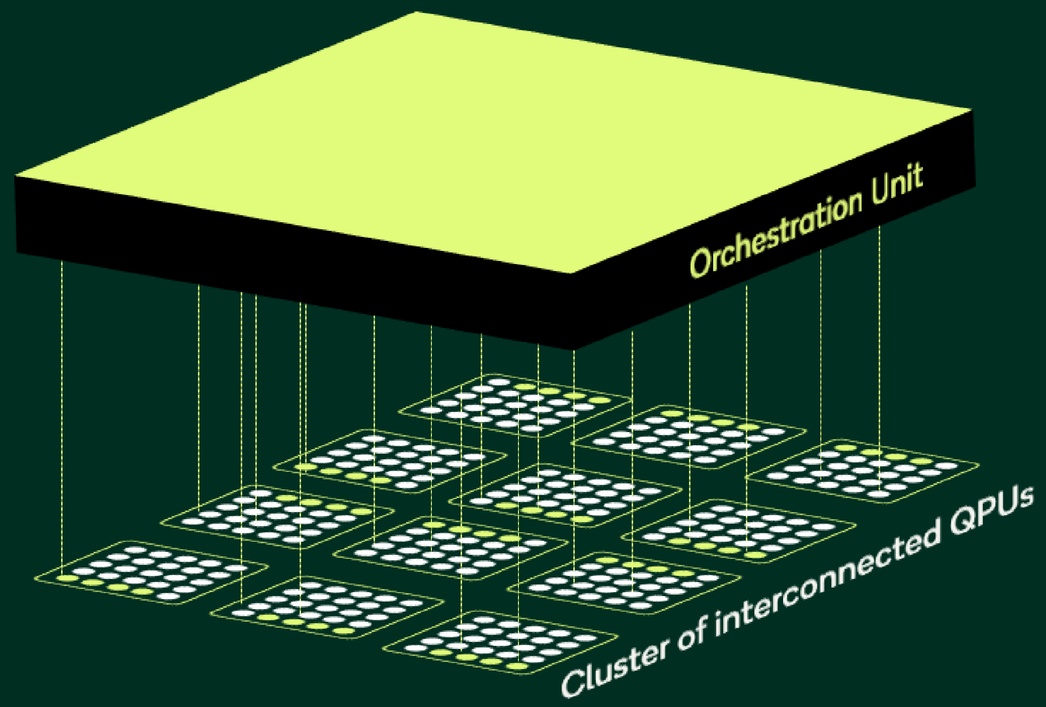
Protocols to share entanglement

Hardware

Photonic quantum networks with storage capabilities

Interconnecting quantum processors in clusters

Quantum computers in clusters in data centers



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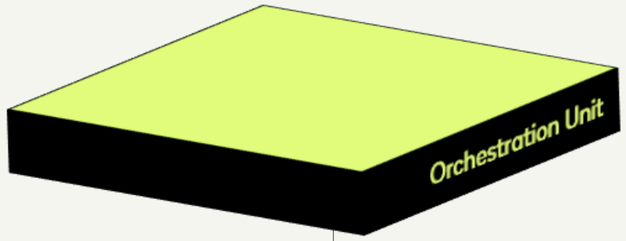

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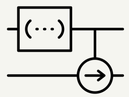


Hardware

Photonic quantum networks with storage capabilities

Welinq: providing links to the future.

Incorporated in 2022, from 15+ years of cutting edge research at Sorbonne University and CNRS

A tiger team of founders, expert in business, science and technology


Tom Darras


Julien Laurat


Eleni Diamanti


Jean Lautier-Gaud

350 m^2 of labs and offices in Paris historical center

Grand Prix i-Lab 2022,
Hello Tomorrow Challenge Winner 2023,
EIC Transition Laureate 2024
EIC Accelerator Laureate 2024

We have developed a world-record quantum memory to enable quantum interconnection.

A growing team

- First 25 key employees already onboard.
- Visionary scientific committee.
- €10M+ funding already secured.
- And all this within only two years.

Where we are going

- We will deliver our quantum memory product by end 2024.
- We will double our workforce by 2025.
- On our way to deliver full-stack, multi-platform quantum interconnects.

Interconnection is the missing element to scale quantum computing

All quantum computers providers need interconnection at short term as indicated in their roadmap

IBM — *"scaling to 100 k qubits with quantum links"* — Superconducting

Pasqal — *"interconnect towards scalable and practical quantum computing"* — Neutral atoms

PsiQuantum — *"You need to network chips together."* — Photonics

IONQ — *"photonically networked multi-core architecture"* — Ion traps

photonic — *"scalable, distributed, fault-tolerant and unified quantum computing and networking platforms"* — Silicon

And interconnects are set to become at least as important as in conventional computing

Multi-core GPU/CPU

Data centers

20%

NVIDIA.

Share of Nvidia revenues with data centers in 2023 made from interconnect hardware

Quantum Computing impacts on the energy sector

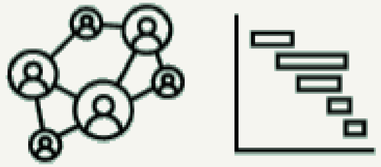
Production

Combinatorial Search
Material Science
Physical Modelling (PDEs)
Logistics

Networks

Networks

Energy Management

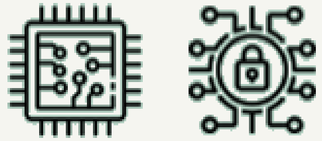


Optimization

Customers

Machine Learning

IT Infra structure



New computational power
Cyber-threat

îledeFrance

Ce projet est financé par la Région Ile-de-France

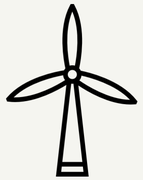
Introducing

AQADOC

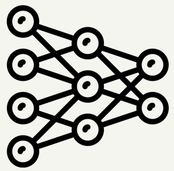
Gathering an ecosystem around Distributed Quantum Computing

Vision and goals of AQADOC

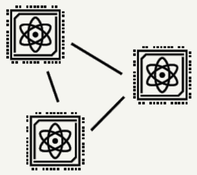
AQADOC++: the stepping-stone to make the French Ecosystem the landmark in networking quantum machines



Develop distributed quantum algorithms for industrial applications linked to the energy transition

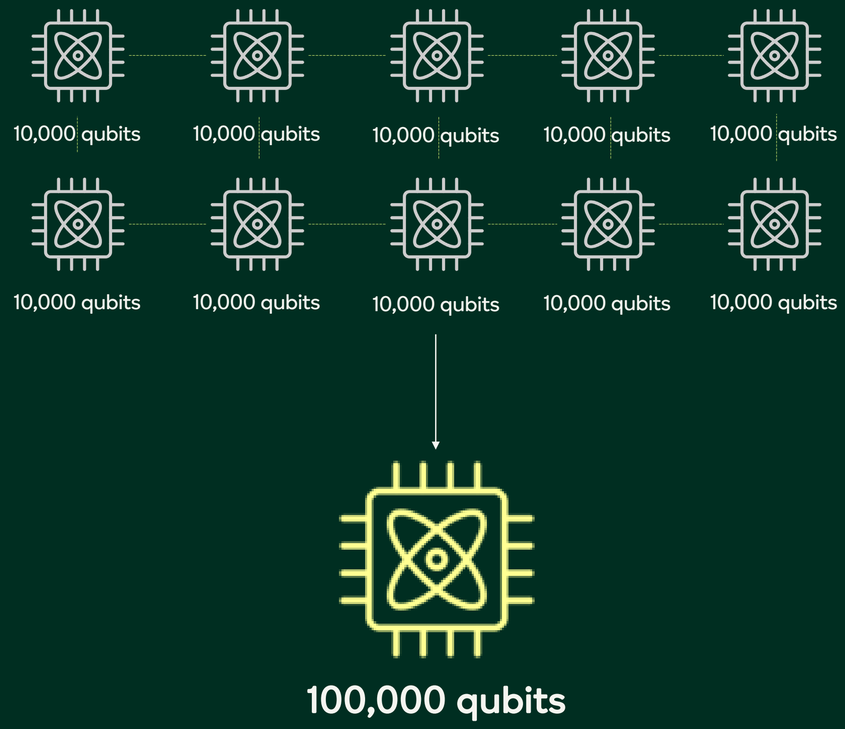


Accelerate the development of interconnection links to meet these algorithmic needs

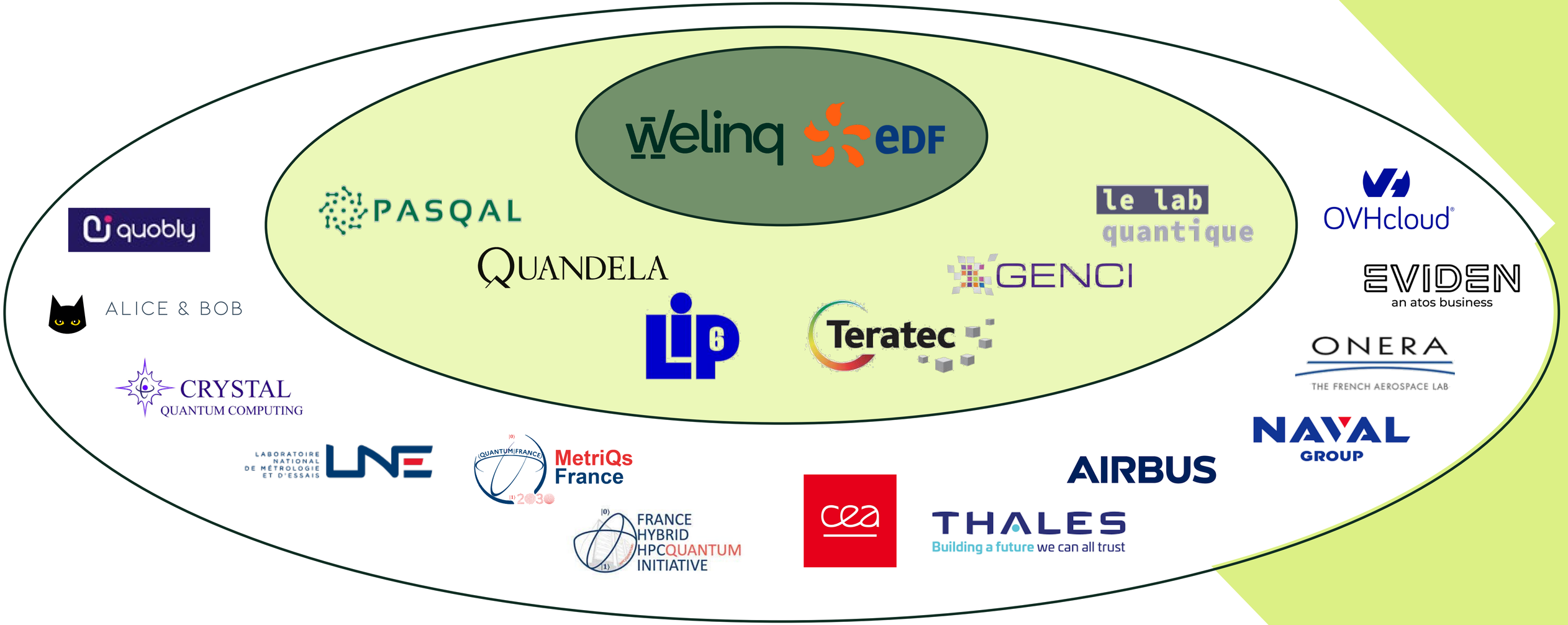


Pave the way for multi-core quantum computing capacity

We will create the software backbone of distributed quantum computing to make quantum usefulness a reality for industry.

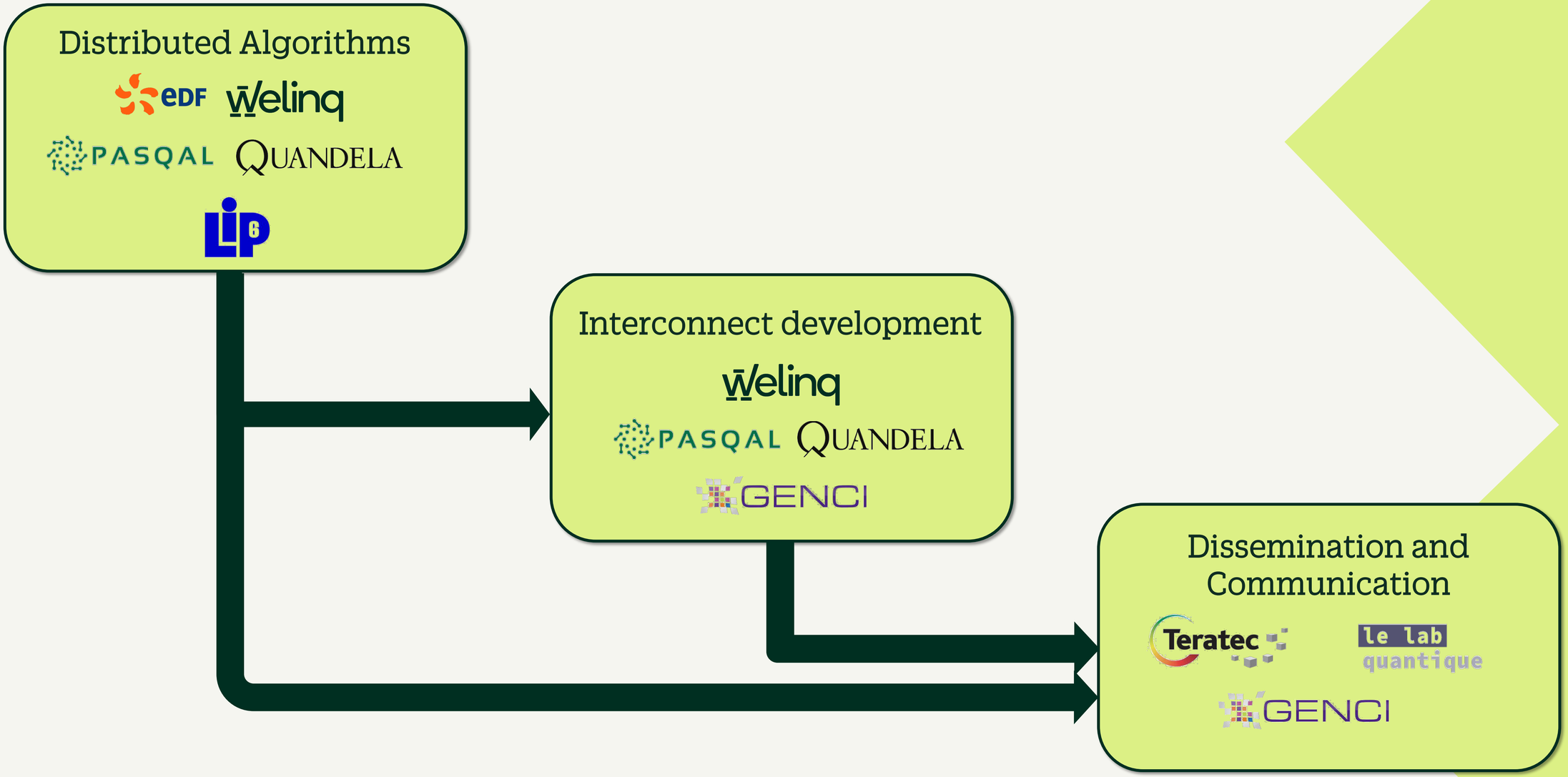


AQADOC++: a landmark project federating the ecosystem



A consortium of complementary actors involved in networking quantum computers.

What we will deliver in 3 years within AQADOC



Case study: risk assessment

Key objectives

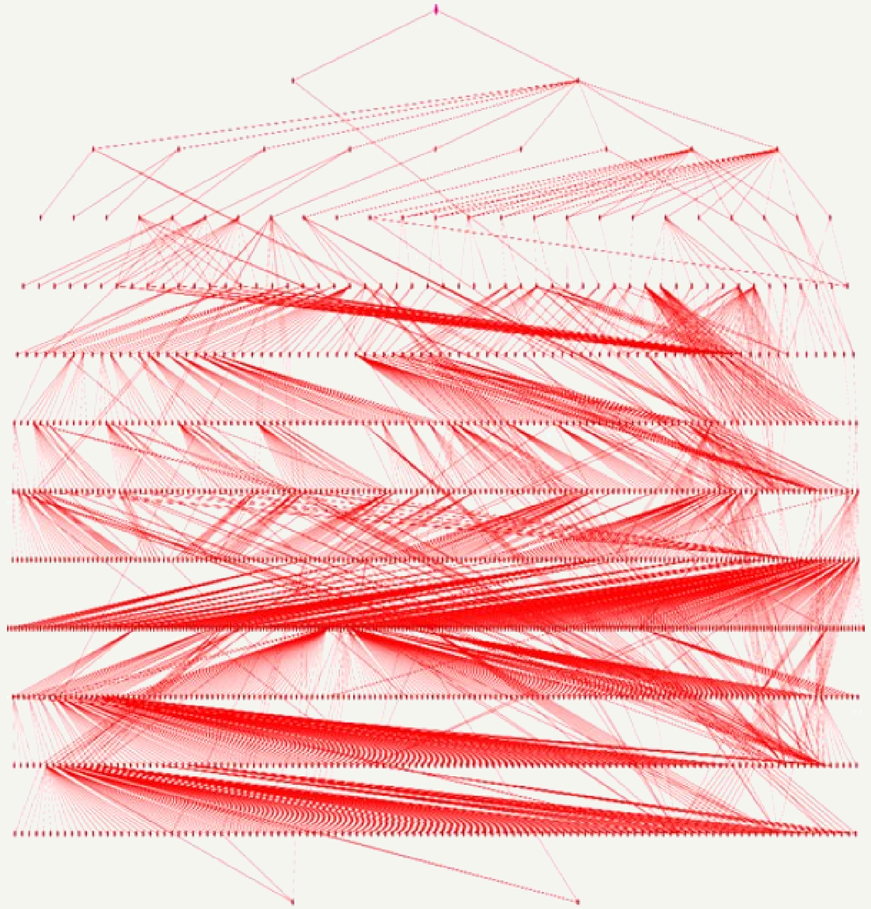
Goal

Assess the risks by systematically exploring all the scenarios that could lead to an incident.

How?

The possible combinations of failures are grouped together in a fault tree that is run through by an algorithm.

Exponential complexity will require new computational paradigms and distributed architecture



Fault tree with 10 events

Program of the Day.

13:30 → 13:45	**WELCOME COFFEE**
13:45 → 14:05	**Introduction of the Day** Tom DARRAS, WELINQ
14:05 → 14:25	**A story on parallelization in HPC** Cyril BAUDRY, EDF
14:25 → 14:45	**Quantum Algorithms for Modular Architectures** Ioannis LAVDAS, WELINQ
14:45 → 15:15	**Distributed Quantum Computing in HPC environment** Andres GOMEZ, *Applications and Projects Department Manager and head of Quantum research team* at Galicia Supercomputing Center
15:15 → 15:45	**A compiler for distributed quantum computing** Michele AMORETTI, *Associate Professor of Computer Engineering* at the University of Parma (Italy)
15:45 → 16:00	**A end user identified use case** Joseph MIKAEL, EDF
16:00 → 16:30	**COFFEE BREAK**

Welinq

Program of the Day.

16:00 → 16:30	**COFFEE BREAK**
16:30 → 16:45	**Status of studies and future work** Constantin DALYAC, PASQAL
16:45 → 17:00	**Status of studies and future work** Pierre-Emmanuel EMERIAU, QUANDELA
17:00 → 17:20	**A litterature Review of Quantum Paralelization on the algorithm side** Christophe DURR, *CNRS Researcher at Sorbonne University*, LIP6 Laboratory
17:20 → 17:35	**Ecosystem** Siméon VALDMAN, LLQ
17:35 → 17:45	**AQADOC Onboarding process** Andréa RALAMBOSON, TERATEC
17:45 → 17:55	**Closing** WELINQ

Welinq

Thank you!
And enjoy the Day!

Région îledeFrance

Ce projet est financé par la Région Ile-de-France