



X A N A D U

# Quantum Computing in Banking

AUGUST 2020

# Xanadu Overview



# Welcome to Xanadu

CEO



Christian Weedbrook, PhD

HARDWARE



Zachary Vernon, PhD

SOFTWARE



Nathan Killoran, PhD

ARCHITECTURE



Ish Dhand, PhD

CLOUD



Rafal Janik, MSc

**Team:** 60+ people | 40+ PhDs | 15+ nationalities



**Advisors:**



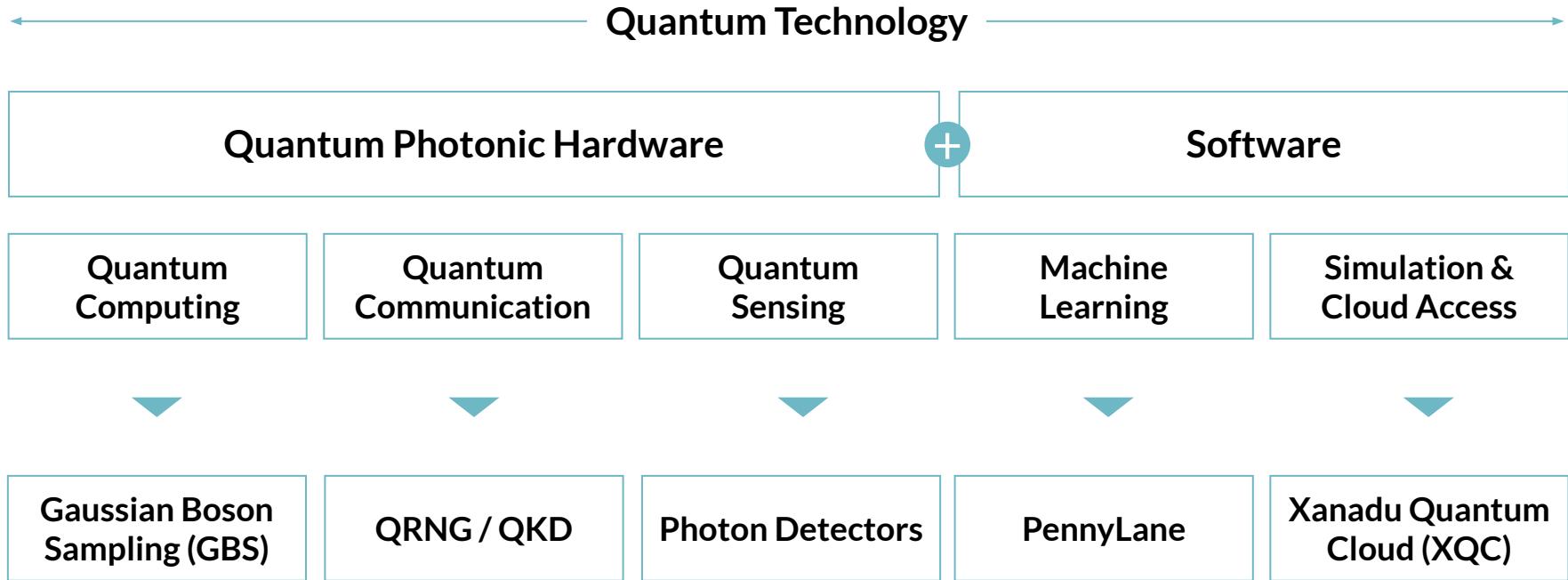
Founded in **2016**

Funding: **\$45M**

Office & Hardware Lab in **Toronto**

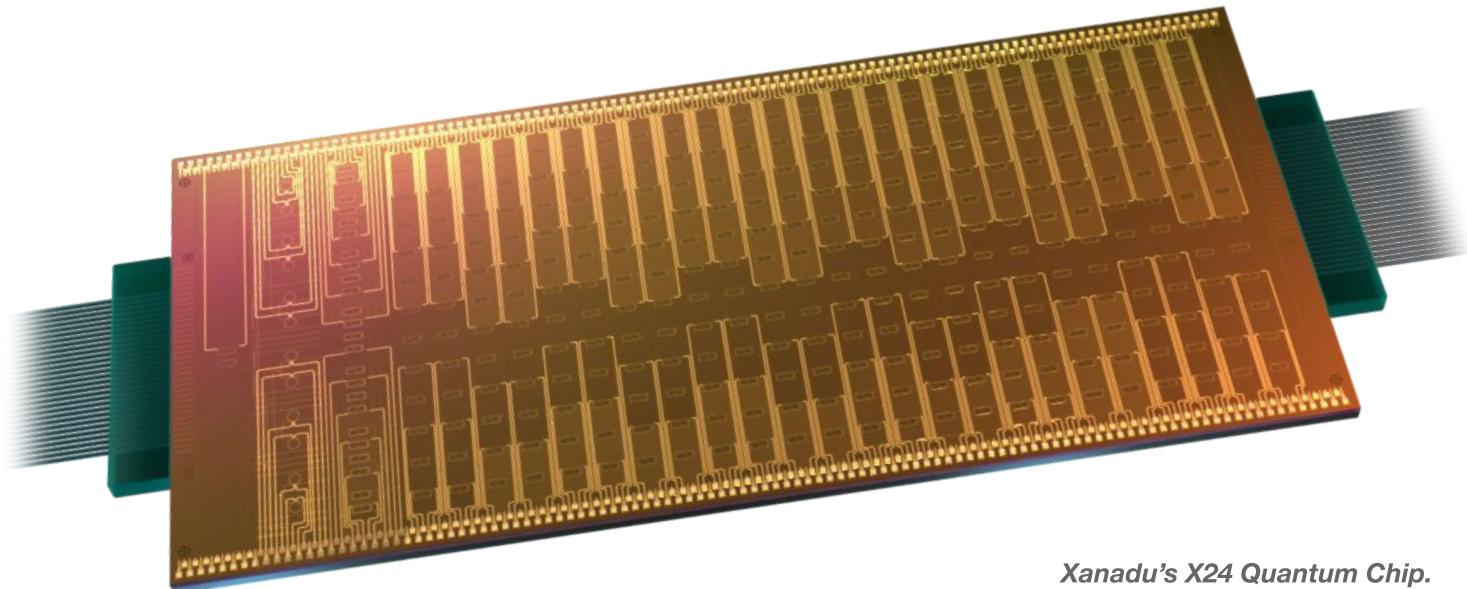


# Full-stack quantum technology company



# Photonic quantum computers

Xanadu designs and develops **integrated quantum photonic chips** that are useful for quantum computing, communication & sensing.



*Xanadu's X24 Quantum Chip.*

# Benefits of photonics

We are building quantum computers that are **practical & scalable**.

## PRACTICAL

### NO COOLING

QPU OPERATES AT  
ROOM TEMPERATURE

### SMALL FORM FACTOR

XANADU'S COMPUTERS  
ARE RACK MOUNTABLE

### LOWER COST

BUILDING ON TOP OF EXISTING  
TELECOM & OPTICS

## SCALABLE

### SCALABLE DESIGN

ROADMAP TO  
1,000,000+ QUBITS

### LOWER CONSUMPTION

1,000x  
LESS POWER

Room temperature quantum computers are simpler and do not require specialized components, enabling easier mass manufacturing and deployment

Photonics is the only approach with a clear roadmap to universal quantum computers

# Quantum in Banking



# Financial institutions working on quantum

## North America

Morgan Stanley



Scotiabank®



Bank of America



citibank

JPMorganChase

"As soon as quantum computing becomes real, it's going to be a must-have in financial services. Irrespective of whether it's three years, five years, 10 years. **If you haven't got the skills in-house to be able to exploit it, you're going to be left behind.**"

- Head of Innovation at Scotiabank

## Rest of World



Santander

DBS

BBVA

徽商银行  
HUI SHANG BANK

CaixaBank

MIZUHO

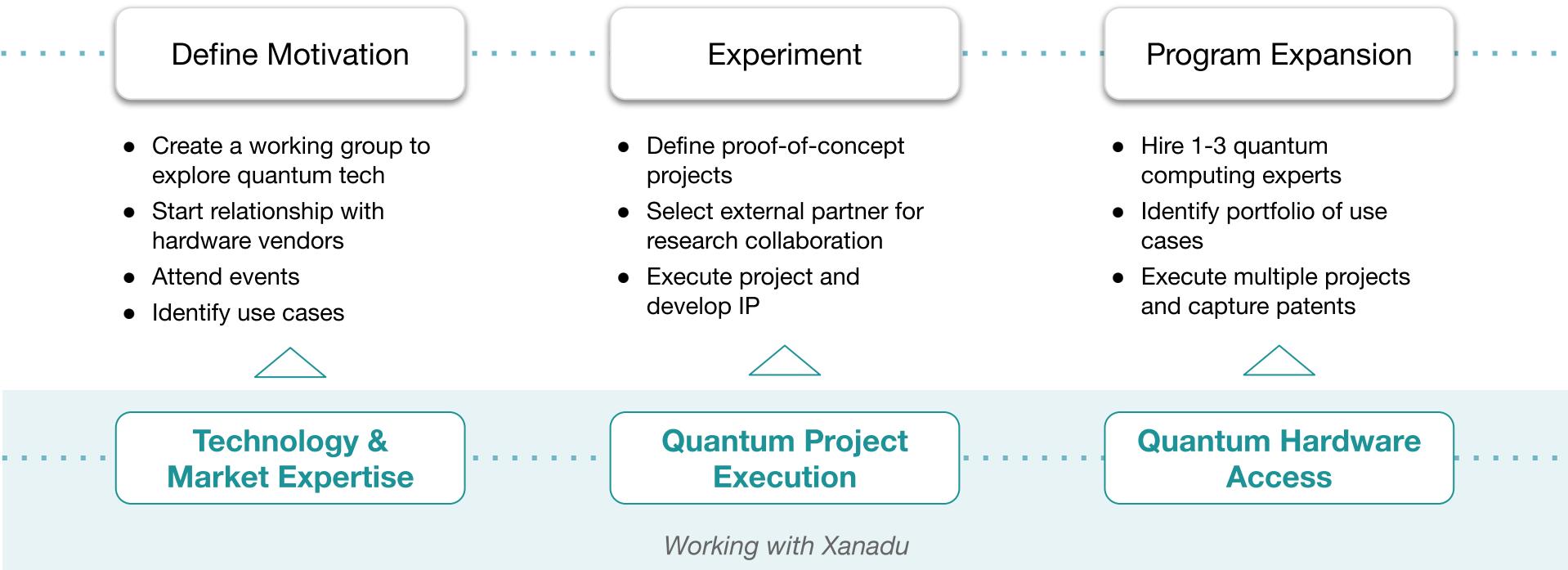
"The quantum technologies ecosystem is evolving very quickly and we believe that the **collaboration with various partners, public and private alike, is key in order to translate the benefits of the technology into tangible progress**"

- Head of Research at BBVA

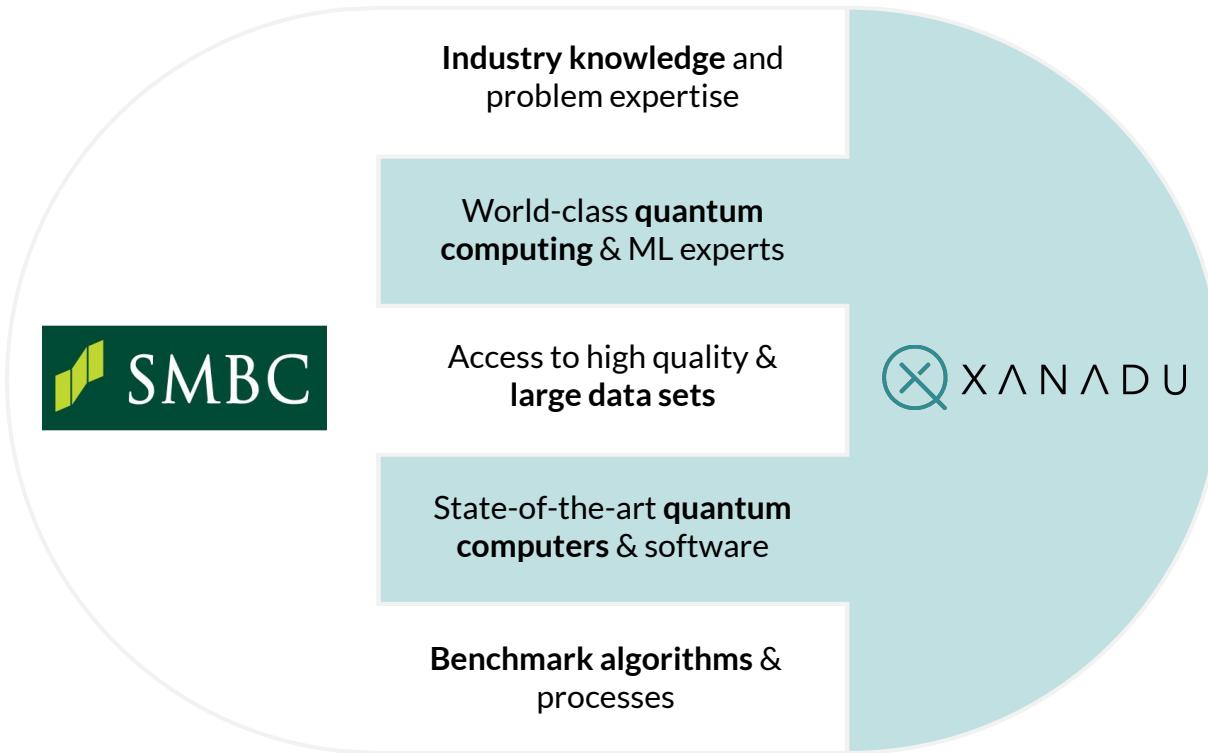
"Quantum computing is set to bring widespread benefits as well as disrupt many existing business processes.. This is why it's **important for companies to future-proof themselves by adopting this new technology** from an early stage."

- Global Head of Analytics at Standard Chartered

# Starting a quantum computing research program

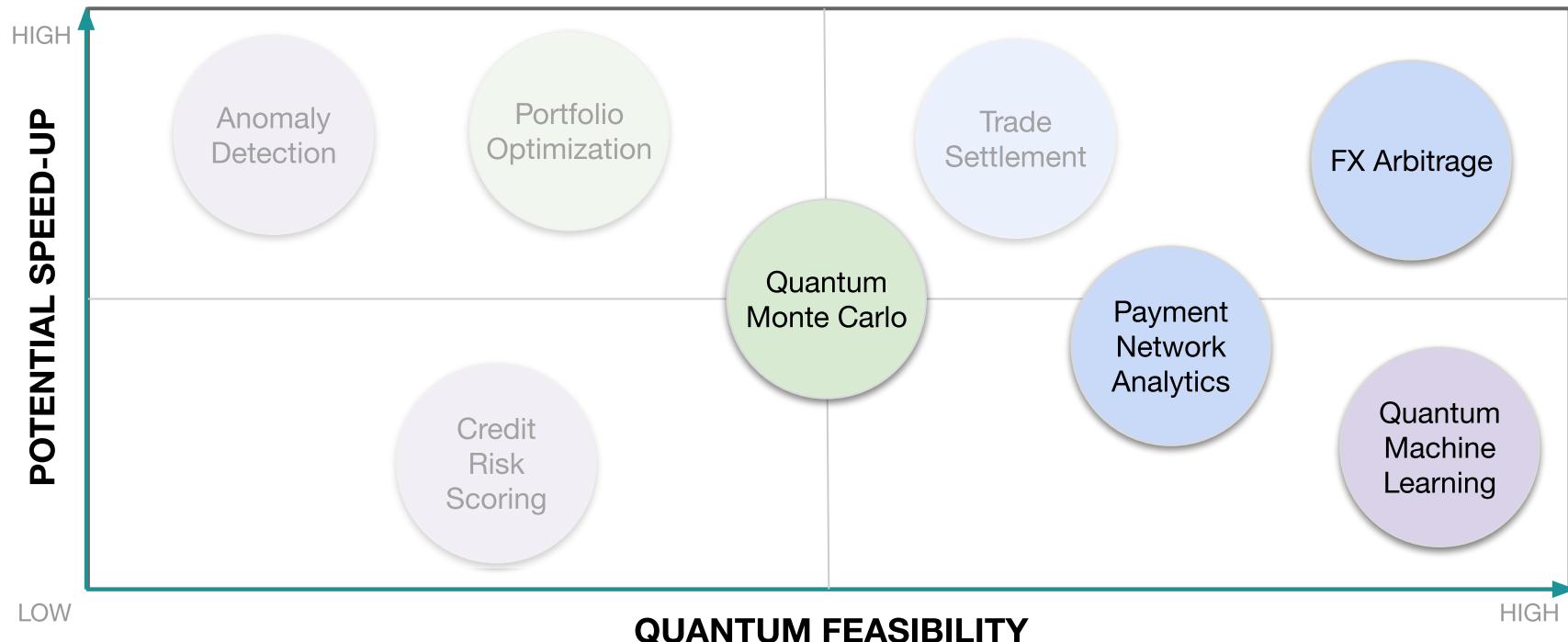


# Mutually beneficial partnership



# Emerging applications

- Optimization
- Machine Learning
- Graph Analytics



# Foreign exchange arbitrage

## Problem Description

Because the Forex markets are decentralized, even in this era of automated algorithmic trading, there can exist moments where a currency traded in one place is somehow being quoted differently from the same currency in another trading location.

These discrepancies in pricing offer spot trading opportunities and are often early risk indicators, however they tend to be extremely short lived.

## Quantum Solution

### Why Quantum?

- Even with the small number of currencies traded there are trillions of path to explore which is classically intractable
- Using quantum computing, there is the possibility to perform this search in timescales shorter than the average lifetime of arbitrage opportunities

### Estimated Speedup



Polynomial

Exponential

### Hardware Timeline

**1-2 Years**

# Payment network analytics

## Problem Description

Network analysis offers a new approach to understanding the complex relationships among participants in Large Value Transfer Systems (LVTS), the main system used for clearing and settling transactions between financial institutions.

However as these networks are often large making it computationally impossible to explore all possible paths in the network.

## Quantum Solution

### Why Quantum?

- Network analytics capabilities of Xanadu's GBS devices offer novel algorithms for exploring and de-risking payment networks
- Current heuristic based approaches can be improved by classical/quantum hybrid methods

### Estimated Speedup



Polynomial

Exponential

### Hardware Timeline

**1-2 Years**

# Quantum machine learning (QML)

## Problem Description

Quantum-enhanced machine learning refers to quantum algorithms that solve tasks in machine learning, thereby improving and often expediting classical machine learning techniques.

QML can be applied in any area of the business where classical machine learning is being used today (i.e., customer analytics, fraud detection, cybersecurity, etc.)

## Quantum Solution

### Why Quantum?

- Potential for increased performance due to enhanced representational capacity of quantum
- Can move existing models to quantum hybrid models and run on hardware today
- Very active area of research with daily advancements

### Estimated Speedup



Polynomial

Exponential

### Hardware Timeline

**0-5 Years**

# Quantum monte carlo

## Problem Description

Current Monte Carlo (MC) methods are useful for optimization and probabilistic sampling, but require a trade-off between runtime and accuracy due to limitations in computational capacity and data quality.

Typically, Banks leverage MC methods to price large portfolios across various risk scenarios, which leads to a massive computational demand requiring overnight processing.

## Quantum Solution

### Why Quantum?

- Quantum computation is an emerging platform for achieving faster, more accurate MC simulations
- Ability to explore all scenarios to identify true risks
- Reduce increasing computational costs of new regulatory requirements

### Estimated Speedup



Polynomial

Exponential

### Hardware Timeline

**2-3 Years**

# Quantum Project Execution



# Example project

## CONTEXT



Duration: 6 months

**Objective:** Evaluate the impact of quantum computing on financial derivatives pricing

### Stakeholders:

- SVP & CIO
- Chief Architect

## PROCESS

Research cutting-edge techniques



Develop proof-of-concept solution



Simulate solution using Xanadu's software



Benchmark quantum speedup and accuracy improvement

## RESULTS

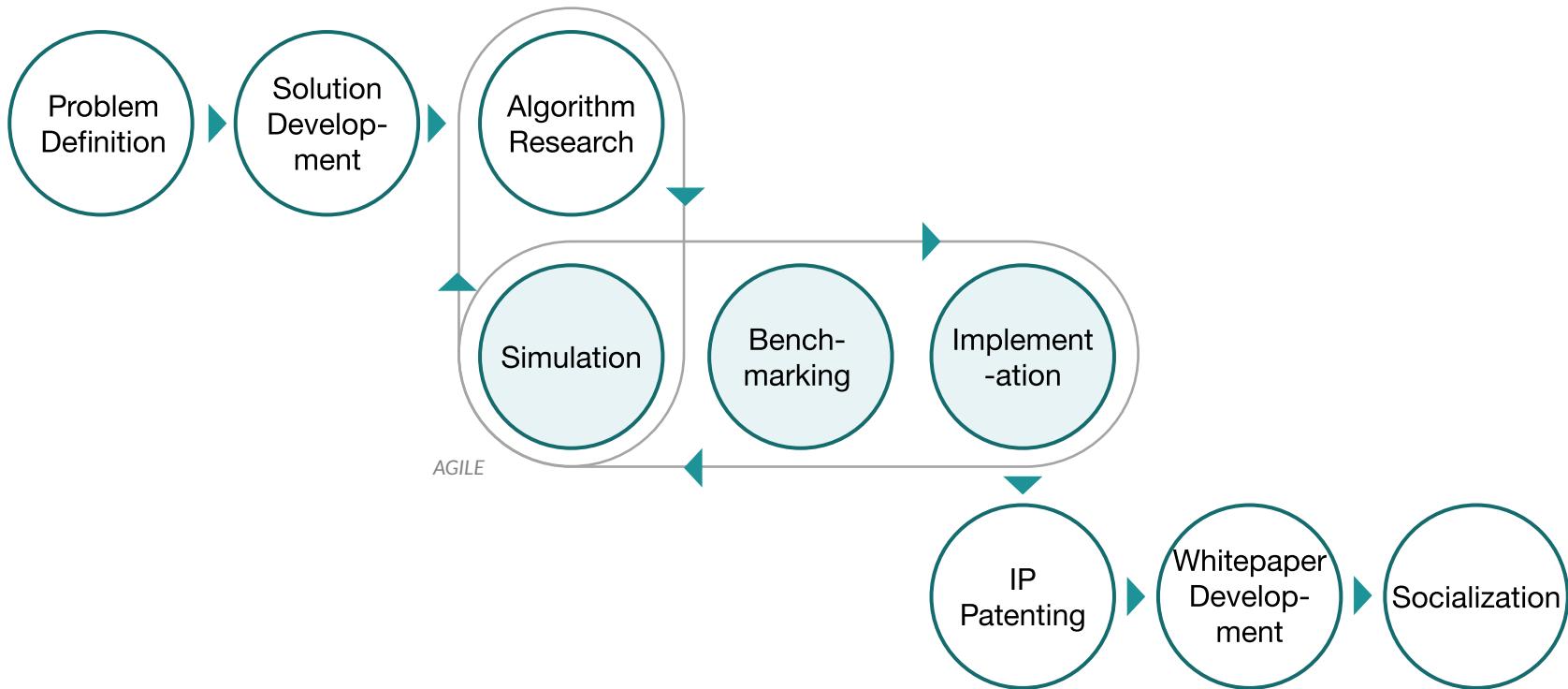
- Development of a proprietary quantum Monte Carlo algorithm
- Illustrating speedup from hours to minutes

"This collaboration gave us the **opportunity to explore using next-gen quantum computing** to optimize what we are able to offer our global customer base."

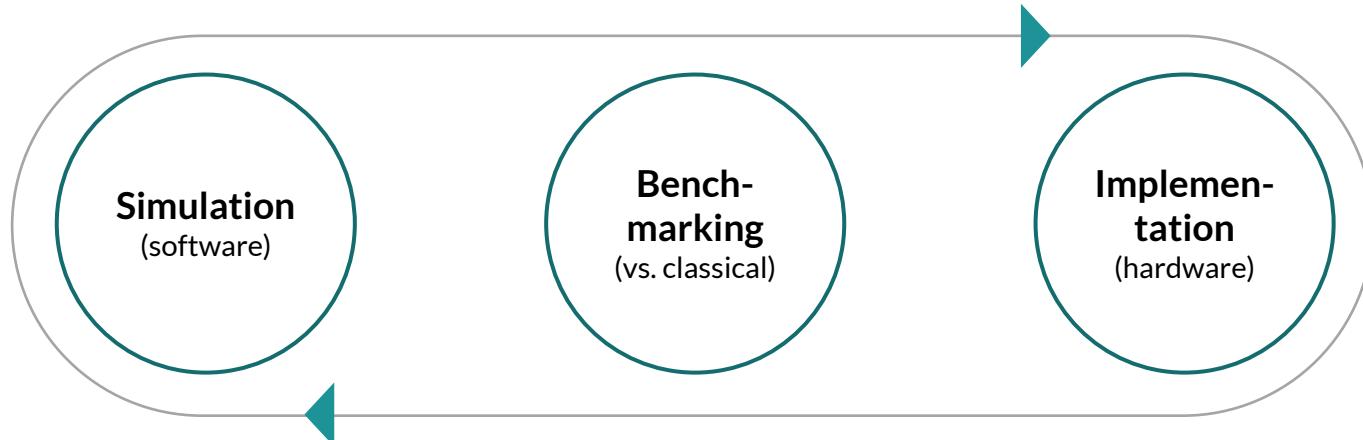
- SVP & CIO of Scotiabank Global Banking & Markets



# Quantum project execution methodology



# Quantum project execution methodology



- Create software package for simulating desired quantum algorithm/model
- Search for algorithms/models that can be achieved classically for comparison
- Benchmark the computational speedup and result accuracy to existing solutions
- Define requirements for running on quantum hardware
- Depict breakdown of required quantum gates



XANADU

Thank you.