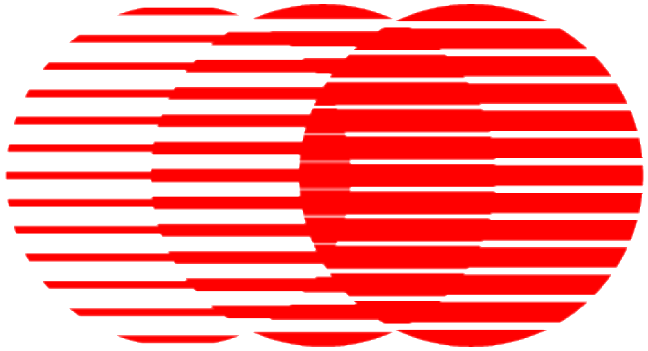

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BRINGING QUANTUM TO INDUSTRY: SOME ILLUSTRATIVE CASES

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What are we going to talk about today?

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Real examples of quantum computing for industry

How do we do this? Towards an actionable quantum strategy

Takeaways and final remarks

Real examples of quantum computing for industry (1/4)

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Optimization

Energy Sector

THE CHALLENGE

- In the current **energy crisis**, more and more **households, SMEs** and **enterprises** are turning to **self-generation** of **electric power**, typically by using **solar panels**.
- While this is a great way to **reduce carbon emissions** as well as to gain **energy sovereignty**, it also brings **difficulties** in **electric grids operation**.

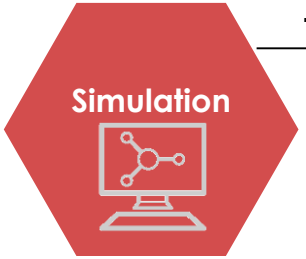
THE SOLUTION

- **Quantum and quantum-inspired** techniques to **optimize electric power flows** in **electric grids** and thus, optimizing **electric grids operation.**

OUR VIEW

- **Quantum technologies** are **transformative** across many sectors, and the **energy sector** is one of them.
- The **impact** of **electric grids operation optimization** goes well **beyond economic efficiencies**. It contributes to a **more sustainable** and **resilient energy sys**tem, as well as **emissions reduction objectives.**
- This is one clear example of how **quantum computing** generates **tangible benefits**.

Real examples of quantum computing for industry (2/4)



Financial Markets

THE CHALLENGE

- How can we **simulate the adoption of cryptocurrencies** as a **payment method by non-financial firms**?
- This complex behavior is very difficult to simulate using classical computers.
- To make things worse, **cryptocurrencies are very volatile** – and how this impacts the behavior of the players is far from trivial.

THE SOLUTION

- **Cryptomarket simulation** using **quantum annealers:**
  - These machines are able to tackle **financial networks of 8-10 players**, with a maximum **of 2^{90} configurations**.
  - **Classical computers cannot** address **financial networks of practical relevance.**

OUR EXPERIENCE

- In our proof of concept project with **Bank of Canada**, we found that:
  - For **some industries**, **cryptocurrencies** would **share the payments market** with **traditional bank transfers** and **cash-like instruments**.
  - The **market share** for each would depend on **how the financial institutions respond to the cryptocurrency adoptions**, and on the **economic costs** associated with such trades.
- **Bank of Canada is the first G7 bank** to carry out a work like this.
- **Further research** in this realm is recommended to gain additional insights.

APRIL 2022

Bank of Canada and Multiverse Computing Complete Preliminary Quantum Simulation of Cryptocurrency Market

BANK OF CANADA
BANQUE DU CANADA

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Real examples of quantum computing for industry (3/4)

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AI and ML

Quantum Digital Twins

THE CHALLENGE

- **Manufacturers** generate **insane amounts of data** for the **supervision and co**ntrol of their **production systems**.
- **Processing** those **data** is **challenging and very resource intensive.** Even in a best case scenario, **accuracy** reaches an **upper bound** that can not be surpassed.
- This translates into **manufacturing processes** that **can not be improved** with **classical computing technologies**.

THE SOLUTION

- **Integration** of **quantum and quantum-inspired algorithms** into **digital twin simulation workflows.**
- A **digital twin** is a **virtual representation** of an **object or system** that **spans its lifecycle**, is **updated from real-time data**, and uses **simulation, machine learning** and **reasoning** to **help decision-making.**
- A **digital twin** is actually a **virtual environment**, which makes it considerably **richer for study**. A digital twin can itself **run any number of useful simulations** in order to **study multiple processes**.
- Thus, **quantum and quantum – inspired artificial intelligence** is particularly **well suited for digital twins**, and will be a fundamental part in their development.

OUR EXPERIENCE

- Through our **strategic alliance** with **leading manufacturer Bosch**, we are helping Bosch to integrate **quantum algorithms** into their **digital twin simulation workflows.**
- **Bosch** is exploring **quantum computing and simulation** as part of its broader **Industry 4.0 efforts** focused on **increasing data collection**, **analytics and simulation across its 240 pl**ants. These efforts have connected **120,000 machines** used in manufacturing and **over 250,000 devices** into **new digital twin workflows.**
- **Our work** with **Bosch** will explore ways **quantum and quantum-inspired algorithms** could **help scale Bosch simulations** more efficiently.

VentureBeat

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BOSCH

Real examples of quantum computing for industry (4/4)

Ultra-secure communications

THE CHALLENGE

- **Ultra-secure communications** are **critical** to a series of sectors, and, for obvious reasons, the **financial sector** is one of them.
- It is suspected that nefarious actors are carrying out what it is called ***"Harvest Now, Decrypt Later"***, with the **financial sector** being one of their **priority targets**.

THE SOLUTION

- **Post-quantum cryptography** and **quantum cryptography** are the schemes to address the **threat** posed by **quantum hackers**.
- On July the 5th, the National Institute of Standards and Technology (**NIST**) announced the first four **quantum-resistant cryptographic algorithms**. These algorithms are a first step in building **quantum-resistant communication infrastructures**.
- However, some experts see post-quantum cryptography as a **temporary solution**, as these algorithms are based on our current understanding of quantum computers.
- **Quantum cryptography** algorithms are based on **Quantum Key Distribution (QKD) protocols**. QKD is **resistant** to **any kind of attack.**

EXPERIENCES IN INDUSTRY

- American bank **JP Morgan** is pioneering quantum technologies, and quantum cryptography is no exemption.
- In February 2022, **JP Morgan** partnering with **Toshiba and Ciena** demonstrated the **viability of a QKD network for metropolitan areas**, **resistant** to **quantum computing attacks** and capable of supporting **800 Gbps** data rates for **mission-critical applications** under real-world environmental conditions.
- JP Morgan will use this solution to **secure** its **mission-critical blockchain application**, demonstrating for the first time the use of QKD for this.

JPMorgan Chase, Toshiba and Ciena Build the First Quantum Key Distribution Network Used to Secure Mission-Critical Blockchain Application

Proof of Concept Showed Ability to Detect and Defend Against Potential Threats and Eavesdroppers

How do we do this? Towards an actionable quantum strategy

"If you don't get strategy right, everything else you do is at risk."

Cynthia A. Montgomery - strategist.
Timken Professor of Business Administration at Harvard Business School

How can we formulate and implement an actionable quantum strategy?

Understand the environment. In a broad sense

Identify trends and mega-trends. Think like a futurist

Embrace uncertainty. Uncertainty can be a guiding light

It's all about planning

- Hope for the best and plan for the worst
- Do strategic planning like a futurist
- Extreme ownership

Flexible implementation. Continuous adaptation to change

Takeaways and final remarks

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- The **second quantum revolution** is **here**. And it is **accelerating**
- **Businesses** can **harness** the **power of quantum computing** for problems related to **optimization**, **simulation** and **quantum artificial intelligence and machine learning**
- **Specific examples** of current application of quantum technologies in the industry are **energy grids optimization**, **simulation of cryptomarkets** and **quantum digital twins**
- **Securization of data and communications** is key for organizations. **Post-quantum cryptography** and **quantum cryptography** are the solutions against the quantum threat
- **If you don't do strategy right, everything else you do is at risk**. Companies **across all sectors**, and particularly those in strategic sectors, need a **strategy for quantum technologies**

ARE YOU READY TO TAKE THE QUANTUM LEAP?

THANK YOU

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