The Quest for Quantum-Safe Cryptography: Navigating the Path to Securing Our Future

Inbar Badian

Don’t Worry!
This is not a Cryptography Lecture

But if there are risks to encryption…

Encryption is the process of converting plain, readable data into a secret code to keep it secure from unauthorized access

Digital Signatures

Crypto-Currency

Secure Chatting Service

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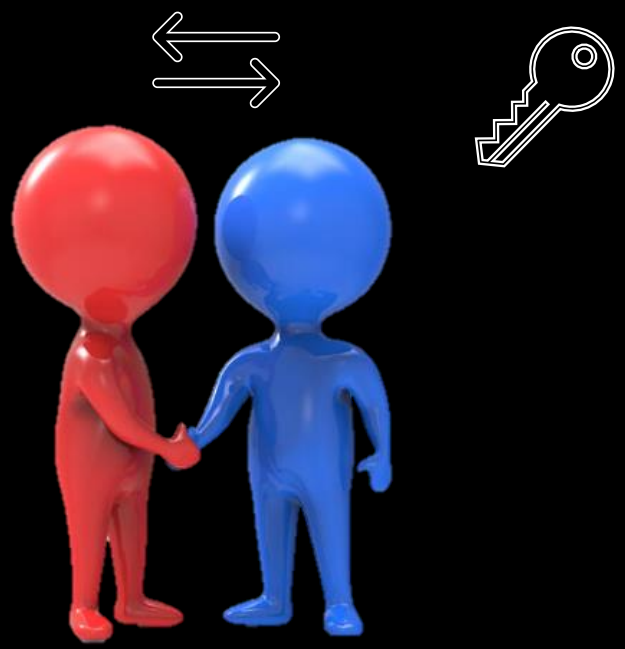
Encrypted Emails

SSL/TLS Encryption

Safe Online Banking

Symmetric vs. Asymmetric Encryption

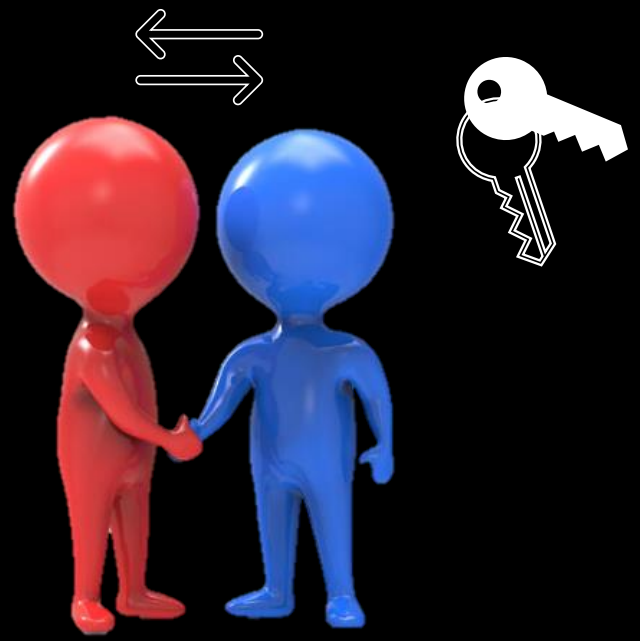
Exchange Symmetric



Symmetric Encryption

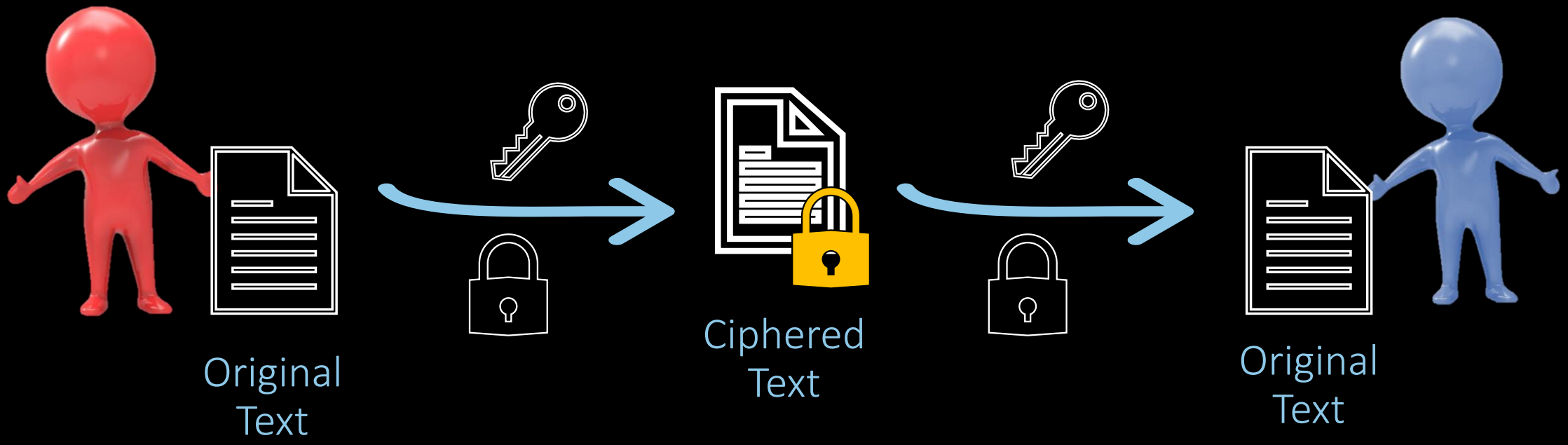
VS

Public Key Encrypts
Private Key Decrypts



Asymmetric Encryption

Symmetric Encryption



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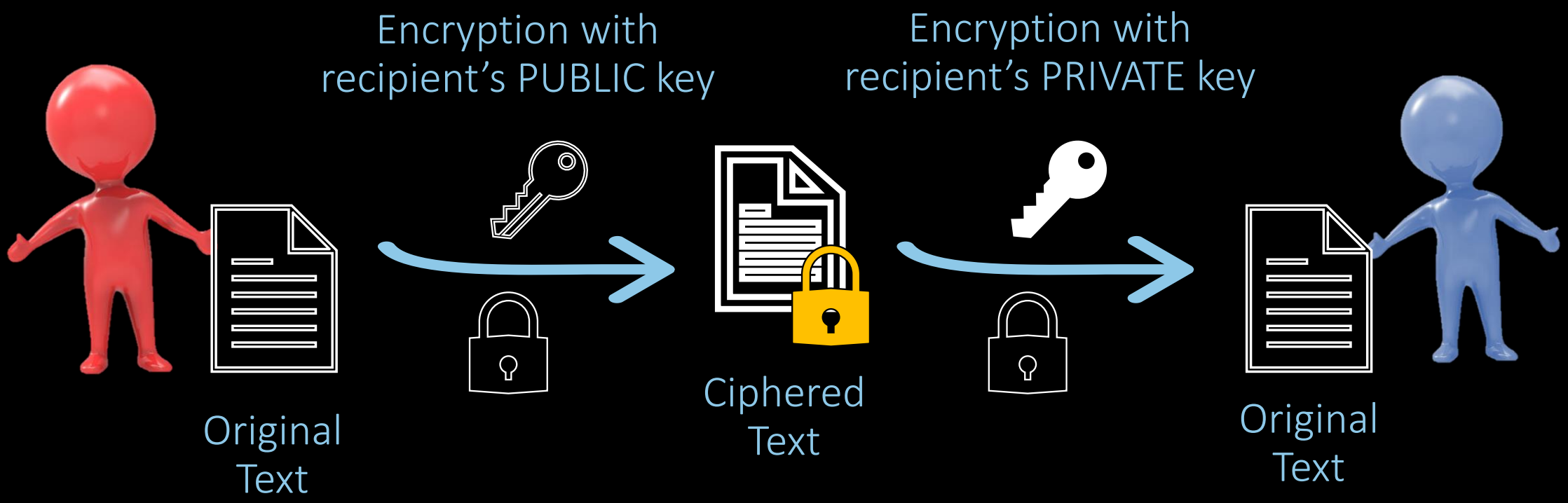
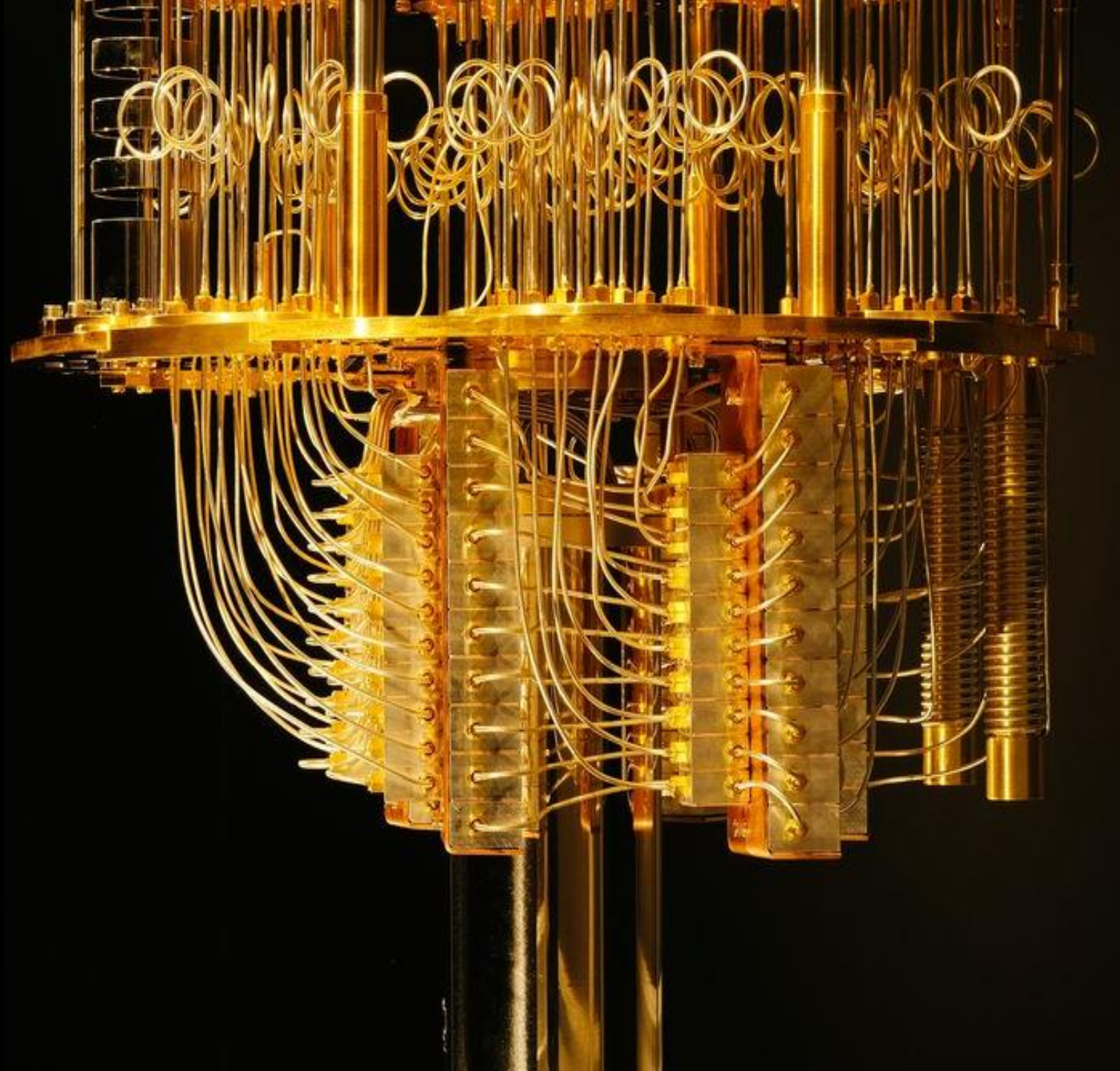


? ? ?

What do quantum computers have to do with encryption?



Quantum Computing is a game changer for humanity

Quantum computers have the potential to revolutionize many fields by solving problems that are currently beyond the capabilities of classical computers

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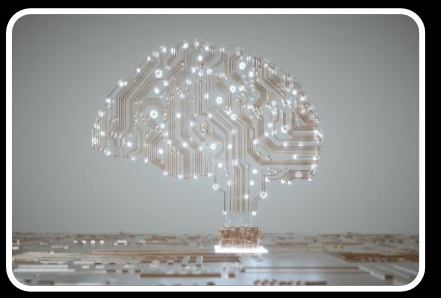

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Grover algorithm improves attacks on symmetric cryptography (e.g., AES, SHA), but we have the solution: double the key/hash size

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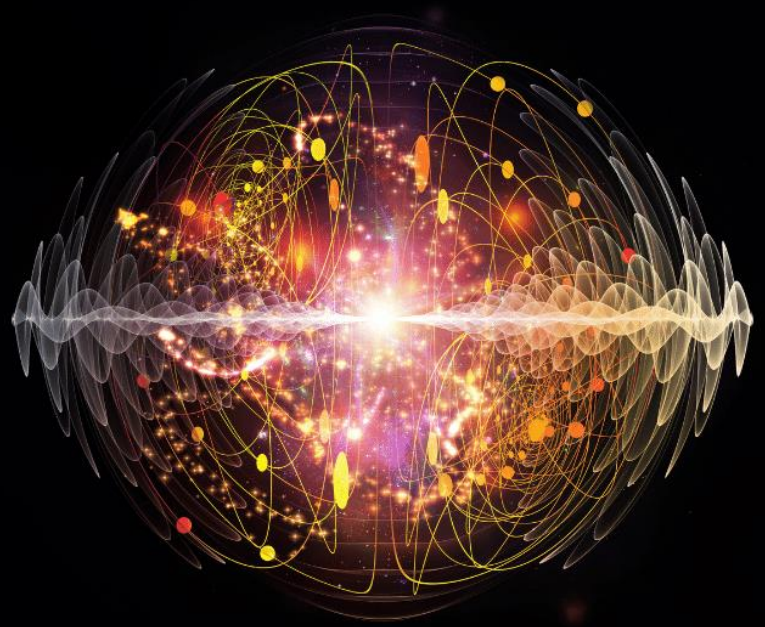
“When will quantum computers be usable to break encryption?” is a question being debated by many experts, speculating 5-10 years

But quantum-based attack already could be occurring now



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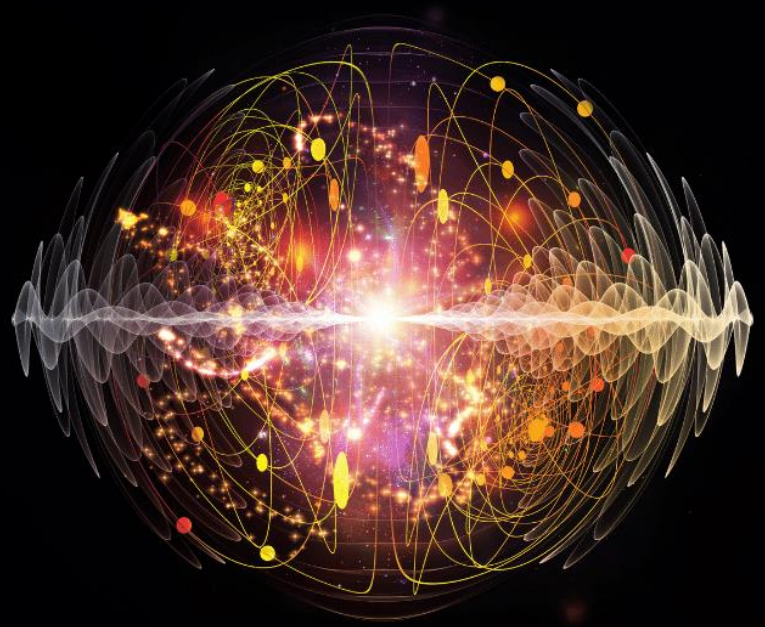
Encrypted data can be

“Harvested Now and Decrypted Later”
(HNDL)



Post Quantum Cryptography Algorithms

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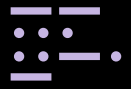
PQC Algorithms Types

Key Encapsulation Mechanisms



Digital Signature Algorithms

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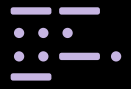

Digital Signature Algorithms

Families of Hard Problems

Lattice

Code

Isogeny

Hash

Multivariate

The Post Quantum Cryptography Standardization Process

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CRYSTALS-Kyber
For encryption

CRYSTALS-Dilithium
For signatures

Falcon
For signatures

Sphincs+
For signatures

Supersingular Isogeny Key Encapsulation (SIKE) Algorithm

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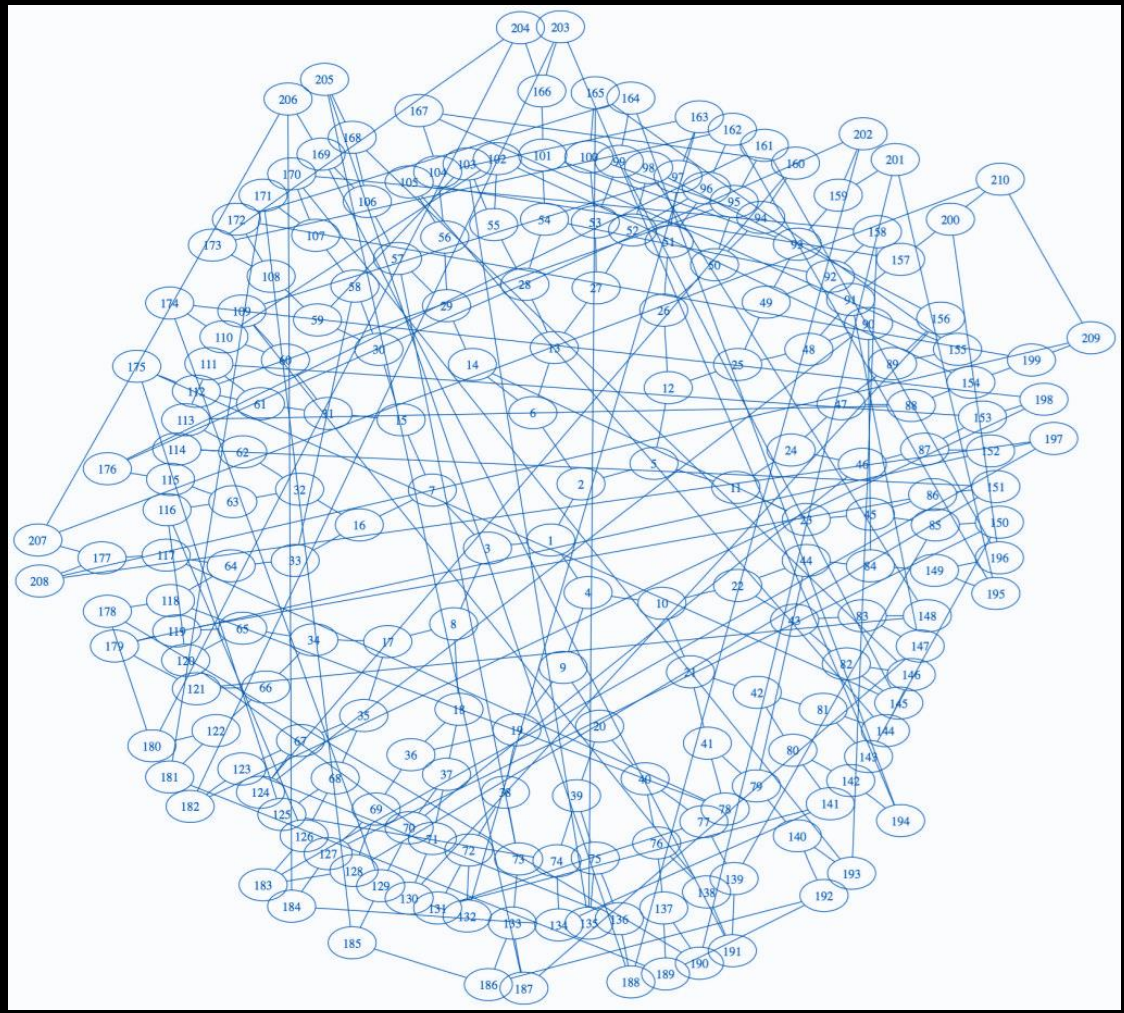

A small example of a Supersingular Isogeny Graph, for the prime p=2521, graph image by Denis Charles, principal applied scientist, Microsoft Research

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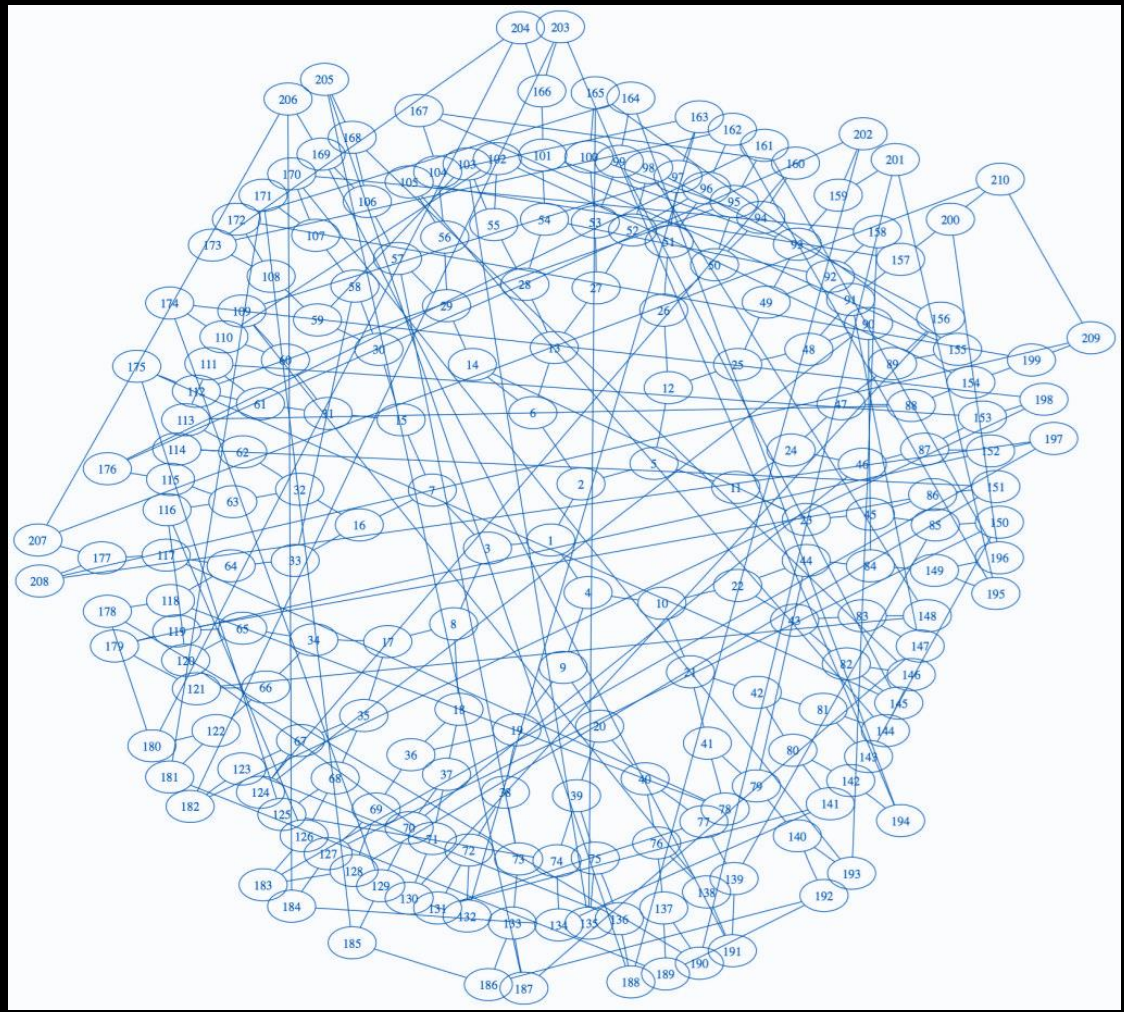
- Refers to a family of encryption mechanisms based on the Supersingular Isogeny Diffie-Hellman (SIDH) key exchange protocol.
- It was designed to be a PQC superhero, but it was broken in 2022



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Diffie-Hellman Key Exchange Algorithm

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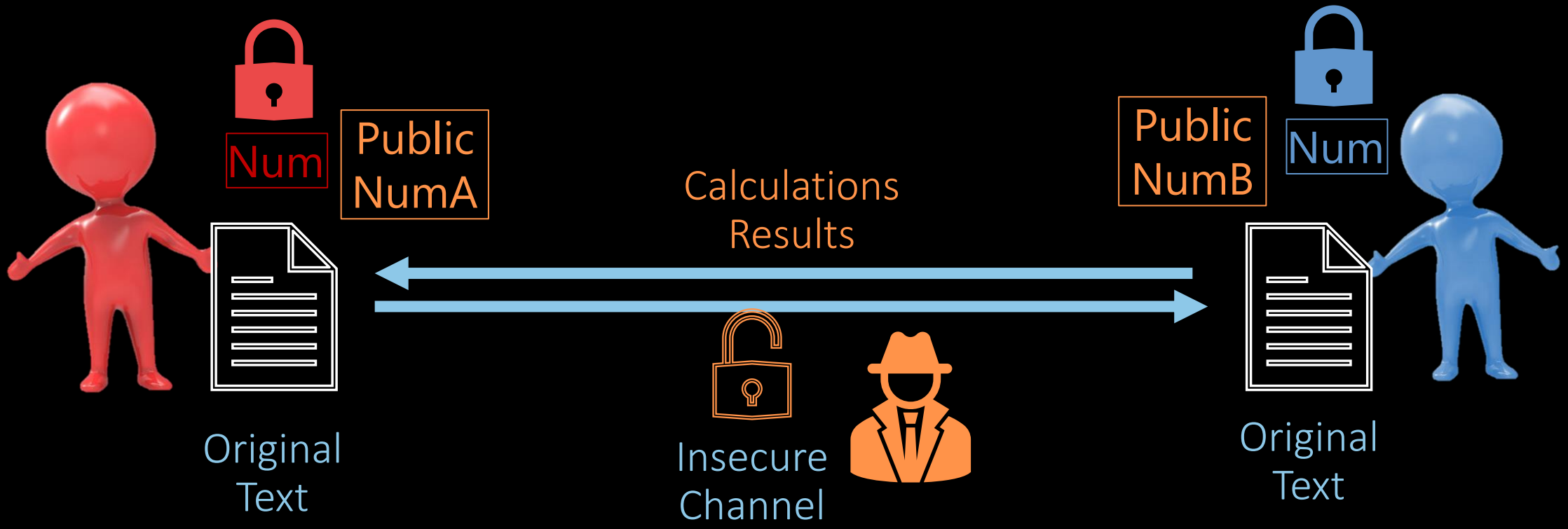

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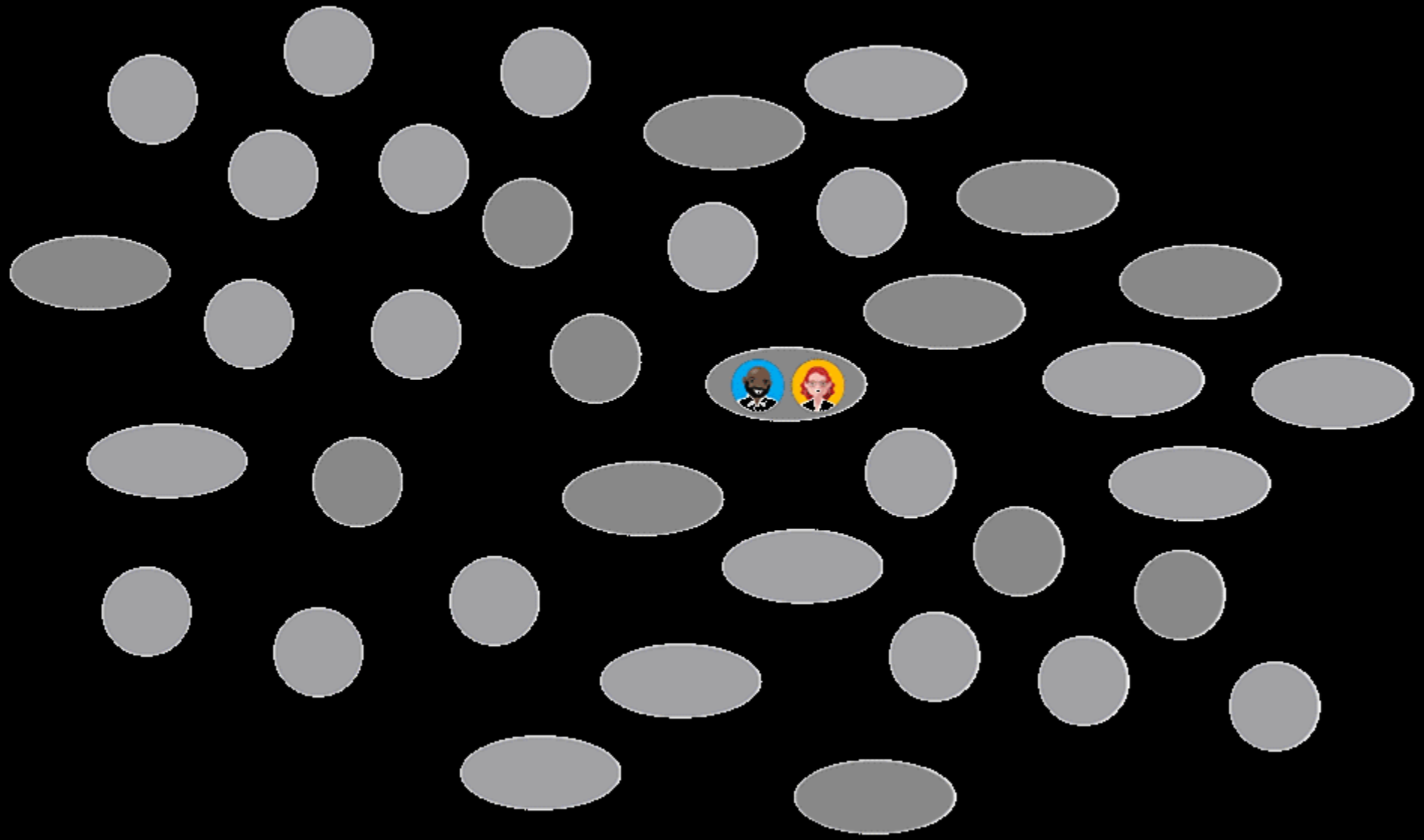

So… what can we do from here?

Keep in Mind and Take Action

- The field of PQC algorithms is still emerging – Explore the topic and keep up with new research and developments

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- Crypto protocols have security proofs that reduce the problem of complex systems to understanding simpler mathematical problems
- But we need people and time analyzing these problems to develop confidence about their difficulty.
- Prioritize hybrid cryptography and crypto agility as the preferred solution to ensure security in the present.

For more resources

- Microsoft Research Post Quantum Cryptography
- Microsoft Azure Quantum
- Microsoft Azure Quantum Resource Estimator
- Quantum Magazine
- NIST Post-Quantum Cryptography Standardization Process
- NIST Migration to Post-Quantum Cryptography Project

Thank you!