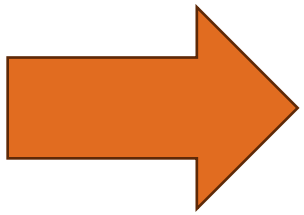
The Quantum Impact: Reflections from a New College Graduate

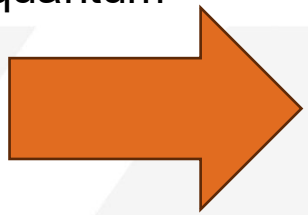
Conferred by Tino Lara

Reflect

During this presentation, reflect on your own experiences within your field and how you think quantum computing will impact the industry you work in.



This is an introductory presentation with the goal of providing you the perspectives of a recent graduate new to the mainframe field. By sharing my limited experiences and personal research, I hope to inspire your own personalized outlook on the potential impacts of quantum computing.



As we conclude, I will encourage audience members to share how this information may have changed their outlook on IBM Quantum Computing and how it may impact future industries.

Problem Statement - What is Quantum Computing and its Computational Impact?

To answer this question, we must first establish a base level of understanding of current mainframe enterprise solutions like the z17 to be able to understand what quantum computing is and its impacts.

Agenda

- We will go over the IBM z17 and the computational impact it has on the industry.
- What quantum computing is, its anatomy, and its performance.
- How quantum computing is impacting industries today and what technological advancements are following it.

Z17 - What is it and its Anatomy?

An enterprise server solution provided by IBM which has the following hardware capabilities (IBM z17 Model ME1 Server):

- Max of four CPC drawers
- Max of 32 Telum II chips
- Max of 32 AI Accelerators
- Max of 256 (208 for customer use) cores at 5.5 GHz (Base Clock Frequency)
- Up to 64 TB of DDR5 addressable memory per system (16 Tb per CPC drawer).

CPC Drawer – A literal drawer that contains Power Supply Units, Symmetric Multiprocessing Ports, Fans, Flexible Service Processors, Oscillator Cards, and Power Control Cards.

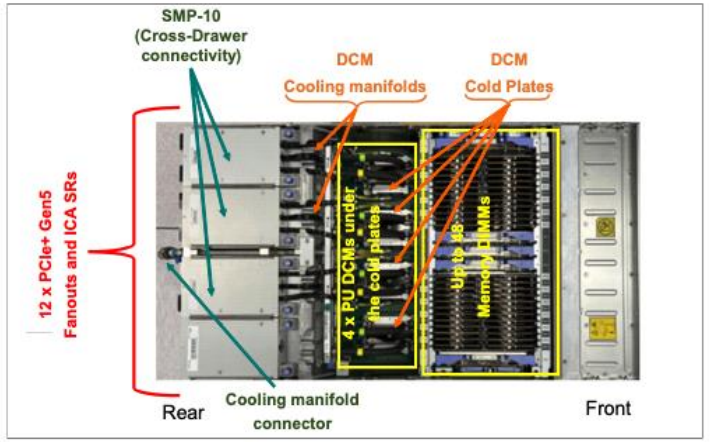


Figure 2-5 CPC drawer components (top view)

"IBM Z17 (9175) Technical Guide." *Ibm.com*, 30 Sept. 2016, www.redbooks.ibm.com/abstracts/sg248579.html. Accessed 30 Sept. 2025.

"IBM Z17 (9175) Technical Guide." *Ibm.com*, 30 Sept. 2016, www.redbooks.ibm.com/abstracts/sg248579.html. Accessed 30 Sept. 2025.

Z17 - Performance Regarding AI Inferencing

Regarding Artificial Intelligence, the IBM z17 can process up to 450 billion inferencing operations by users daily with 1 (ms) millisecond response time, that's:

- 18.75 Billion query transfers per hour
- 312.5 Million query transfers per minute
- 5.2 Million query transfers per second

All while maintaining 99.999999% of guaranteed uptime and reliability!

Inference Operation – When a user queries information and data is compared, contrasted, and answered based on the information the AI model was trained on.

"IBM Z17." *Ibm.com*, 2025, www.ibm.com/products/z17.

Z17 - Cryptographic Functionalities

Each processor unit (PU) or core in a central processor complex (CPC) includes a cryptographic coprocessor (CPACF) that supports algorithms by using clear or protected keys.

- **CPACF –** A cryptographic coprocessor (not an HSM) operates synchronously with the PU supporting pervasive encryption for databases. This also offers a set of symmetric cryptographic functions that improve the performance of clear key encryption and decryption.

The Crypto Express8S (CEX8S) includes a general-purpose processor, nonvolatile storage, and specialized cryptographic electronics. Supports tamper-sensing and tamper-responding capabilities and delivers high-performance cryptographic operations.

- **CEX8S Adapter** (CCA Mode) – A hardware security module (HSM) that is installed in the PCIe+ I/O drawer of the IBM z17. It provides cryptographic algorithms, secure key management, and many special functions required for industries such as banking. The CCA interface includes more than 157 APIs with over 1,000 cryptographic algorithm options including quantum safe algorithms such as Dilithium and Kyber.

"IBM Z17 (9175) Technical Guide." *Ibm.com*, 30 Sept. 2016, www.redbooks.ibm.com/abstracts/sg248579.html. Accessed 30 Sept. 2025.

Z17 - Reflecting on Security

Regarding security, the following is provided by IBM's 2025 Cost of Data Breach Report which will provide an outlook to IBM's z17 security performance. Here's some general information regarding causes and costs related to breaches.

- The global cost of a data breach is $4.44 Million in 2024 which is a 9% decrease in comparison to 2023. Regarding the United States, it was $10.22 Million as of 2025, increasing the average by 9%.
- The industry that remained most expensive for breaches was healthcare at 7.42 Million in 2025 and 9.77 Million in 2024. Breaches took the longest to identify and contain at 279 days which is five weeks longer than other industries. On a positive note, the time to identify and contain a breach decreased falling to 241 days reaching a nine-year low (2025).
- The leading cause of breaches were phishing attacks making up 16% of breaches (2025). Therefore, breaches only related to means of social engineering attacks like phishing emails.
- The uttermost cause of breaches was system error at 9.1% (2025).

We can conclude as IBM technological advancements continue to be developed, the higher social engineering attacks continue to succeed hardware and software related attacks.

IBM. "Cost of a Data Breach Report 2025." *IBM*, 2025, www.ibm.com/reports/data-breach.

Quantum Computer - What is it?

Quantum Computer – A computer which instead uses quantum bits (qubits) instead of bits (1's and 0's) to process data.

qubit – Can behave like a bit and store a zero or one but can also be a weighted combination of zero and one at the same time which is known as a *superposition*. There are four different kinds of qubit's which are superconducting qubits, trapped ion qubits, quantum dots, and photons.

Weighted Combination (Weighted Linear Combination) - is a total value which represents the probabilities of two or more outcomes to occur.

A simple example would be selecting a single batch of apples out of many based on the weighted linear combination (superposition) from ratings of flavor and appearance.

Chou, Jyh-Rong. “A Weighted Linear Combination Ranking Technique for Multi-Criteria Decision Analysis.” South African Journal of Economic and Management Sciences, vol. 16, no. 5, 2013, Pretoria. Retrieved 27 Aug. 2025.

Qubit Example

Now we have an idea of what a qubit is, let's explain how it works!

I want to select a batch of apples, based on flavor and appearance.

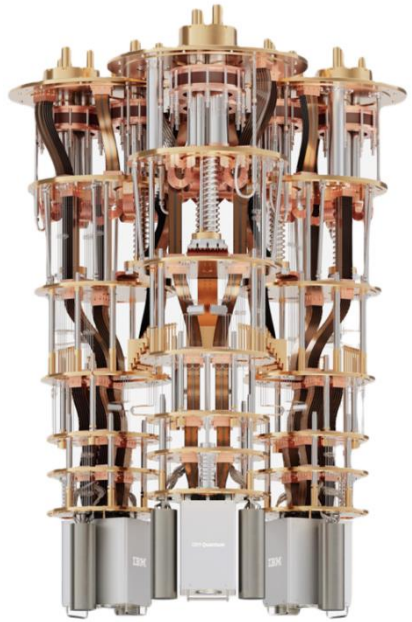
To select a batch of apples, I associate percentages to flavor (70%) and appearance (30%). These percentages determine the probability of me selecting a batch of apples. I give a higher percentage to flavor because I can always slice off what I don't want.

As a I try one apple from each batch; I assign a rating and multiply my rating by the percentages I assigned to flavor and appearance. After doing so, I would add both results to obtain my weighted linear combinations.

For this batch of apples, I would perform the arithmetic ((10 * 0.3) + (6 * 0.7)) which has a weighted linear combination of **7.2**!

Chou, Jyh-Rong. "A Weighted Linear Combination Ranking Technique for Multi-Criteria Decision Analysis." South African Journal of Economic and Management Sciences, vol. 16, no. 5, 2013, Pretoria. Retrieved 27 Aug. 2025.

Quantum Computing - Anatomy & Performance



The picture on the top right the IBM Quantum System Two which contains three QPU Heron r3 Processors pictured bottom right.

The following lists the physical and statistical anatomy of the Heron processor:

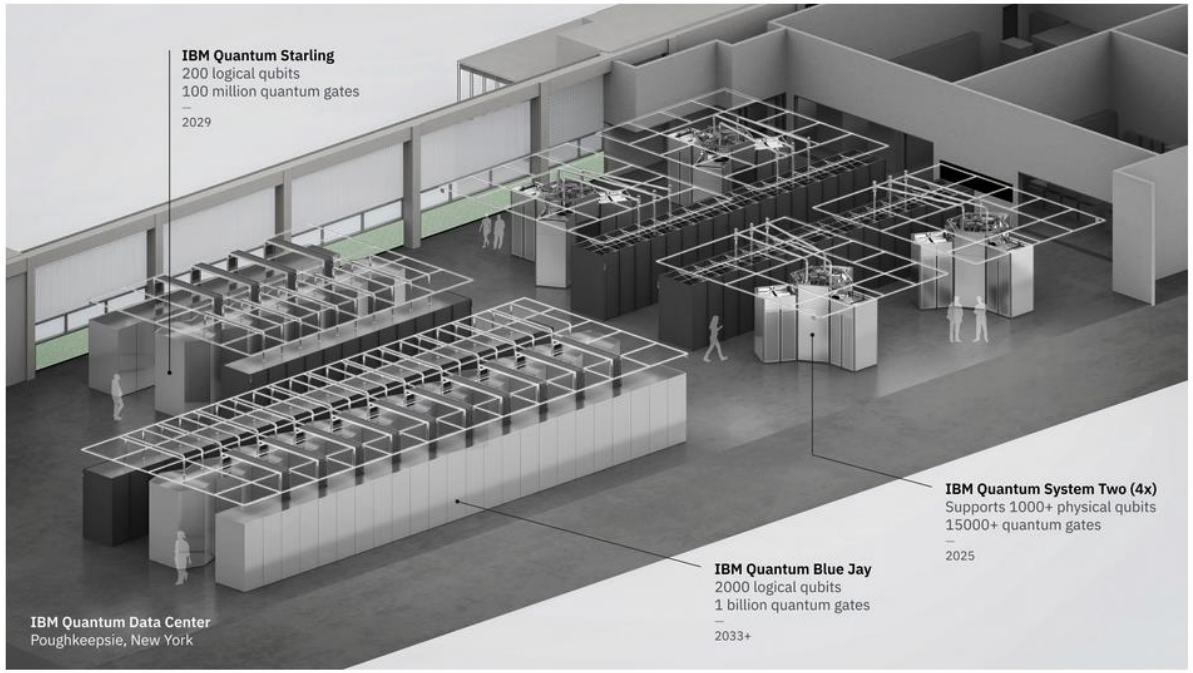
- 156 fixed-frequency qubit
- 250,000 couplers (CLOPS) which is the amount of measured hardware-aware circuit operations per second
- A 2Q error of 8.07E-4 (best) which represents the lowest two-qubit error rate from all edges measured by isolated randomized benchmarking
- A 2Q error layered of 3.50E-3 which represents the average two-qubit error rate per layered gate (EPLG) for a 100-qubit range
- Capabilities of achieving more than 5,000 gate operations

AbuGhanem, M. IBM Quantum Computers: Evolution, Performance, and Future Directions. arXiv, 17 Sept. 2024, arXiv:2410.00916 [quant-ph]. https://arxiv.org/abs/2410.00916.

"Compute Resources | IBM Quantum Platform." *Ibm.com*, 2025, quantum.cloud.ibm.com/computers?system=ibm_pittsburgh. Accessed 30 Sept. 2025.

Quantum Computing - Modularity

IBM Quantum emphasizes modular quantum computing, where smaller quantum processors are interconnected to form a larger, cohesive system, enabling scalability without the limitations of a single processor.



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Quantum Computing - Quantum Hybrids

"...hybrid quantum supercomputing architecture, has quantum computers working in tandem with traditional high-performance computing and AI infrastructure. In the hybrid system, different components of a problem are processed by the engine best suited to solve them. The companies provide an example where quantum computers simulate the behavior of atoms and molecules, while traditional AI supercomputers simultaneously provide massive data analysis on the output. With the quantum and traditional systems linked and working together, the companies believe real-world problems can be solved at unprecedented speed and scale."

Chiappetta, Marco. “IBM And AMD Collaborate On New Hybrid Quantum-Supercomputing Architectures.” Forbes, Contributor, 2025. Retrieved 23 Sept. 2025.

Quantum Computing - Current Impacts

Recently, the company HSBC uncovered a huge breakthrough in the financial quantum sector, "...the bank said that experimental trials with IBM had delivered a 34% improvement in predicting bond trading outcomes. The trial is being touted as the first piece of empirical evidence that quantum hardware can deliver real-world value on the trading floor." Furthermore, in reflection, "..the highly complex nature of these factors is where the trial results showed an improvement using quantum computing techniques when compared to classical computers working alone using standard approaches."

Nolan, Beatrice. “HSBC claims a quantum computing breakthrough in bond trading: ‘we are on the cusp of a new frontier.’” AOL, 25 Sept. 2025, www.aol.com/finance/hsbc-claims-quantum-computing-breakthrough-161958917.html.

Looking Into The Future

Regarding Hybrid Quantum Computers, IBM has recently partnered with AMD to further hybrid quantum computing.

This partnership aims to allow IBM quantum computers to work in unison with AMD enterprise architectures to potentially advance software support, algorithm discovery and enhancement, and LLM architectures.

As we learned, IBM already supports hybrid quantum computers with their own z17 enterprise solution, but this powerful partnership could significantly broaden capabilities especially in software support, LLM's, & data processing.

What do you think?

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