IBM now describing its first error-resistant quantum compute system

To address this, IBM has developed a message-passing decoder that can perform parallel evaluations of the syndrome data. The system explores more of the solution space by a combination of randomizing the weight given to the memory of past solutions and by handing any seemingly non-optimal solutions on to new instances for additional evaluation. The key thing is that IBM estimates that this can be run in real time using FPGAs, ensuring that the system works.

A quantum architecture

There are a lot more details beyond those, as well. Gambetta described the linkage between each computational unit—IBM is calling it a Universal Bridge—which requires one microwave cable for each code distance of the logical qubits being linked. (In other words, a distance 12 code would need 12 microwave-carrying cables to connect each chip.) He also said that IBM is developing control hardware that can operate inside the refrigeration hardware, based on what they're calling "cold CMOS," which is capable of functioning at 4 Kelvin.

The company is also releasing renderings of what it expects Starling to look like: a series of dilution refrigerators, all connected by a single pipe that contains the Universal Bridge. "It's an architecture now," Gambetta said. "I have never put details in the roadmap that I didn't feel we could hit, and now we're putting a lot more details."

The striking thing to me about this is that it marks a shift away from a focus on individual qubits, their connectivity, and their error rates. The error hardware rates are now good enough (4×10^{-4}) for this to work, although Gambetta felt that a few more improvements should be expected. And connectivity will now be directed exclusively toward creating a functional computational unit.

That said, there's still a lot of space beyond Starling on IBM's roadmap. The 200 logical qubits it promises will be enough to handle some problems, but not enough to perform the complex algorithms needed to do things like break encryption. That will need to wait for something closer to Blue Jay, a 2033 system that IBM expects will have 2,000 logical qubits. And, as of right now, it's the only thing listed beyond Starling.

https://arstechnica.com/science/2025/06/ibm-is-now-detailing-what-its-first-quantum-compute-system-will-look-like/