Quantum Source

Scientific Concept Animation

by

Muza Productions

Part one: getting to a million qubits

Script:

It's very clear that a universal quantum computer will need millions of entangled qubits and employ error correction to be useful. But having that many qubits all at once is just not feasible.

So, what's the solution?

Using photons as qubits allows spreading these millions of qubits over multiple generations along the timeline of the computation, so that only several hundred of them are generated at any given moment.

[animation should show small clusters tiled to form 2D layers and later 3D structure]

To better understand how this can be achieved, let's take a look at the general layout of such a computer.

It all starts here with these resource state generators (R.S.Gs) that repeatedly produce small clusters of entangled photons. These clusters are then delivered to stiching devices that entangle them to each other, resulting in a huge cluster of entangled qubits.

But we don't stop there - we also want these clusters to be entangled with states that will be produced later in time. That's where the delay loops come in.

By using delay loops, which are essentially long fibers, we can send some of the photons on a little journey to arrive later at the stitching device. This way, they can be entangled with a cluster from the next clock cycle.

By repeating this method with many RSGs and lots of stitching devices, we can create a massive cluster of entangled qubits that are fed to an array of detectors slice-by-slice. A classical computer determines the exact sequence of measurements, to achieve the desired computation.

With this approach, we can perform a million-qubit, error corrected calculation with only hundreds of qubits generated at each time. Thus making the universal quantum computer - a reality!

Optional section: a metaphor

Metaphors are a great way to help viewers understand complex ideas and remember them more easily. Using a metaphor in the animation could make it more engaging and help the ideas stick in the viewer's memory.

Potential Metaphors and their script:

Tapestry Fabric - [or a 3D printer] - We like this metaphor

It's like weaving a tapestry one section at a time, but instead of just adding more threads to the section, we're connecting each section to the next one in a perfectly entangled masterpiece. By repeating this method across many clock cycles and with lots of fusion devices, we can create a cluster of qubits that's so huge, it'll make any computation possible.

a Symphony

Think of it like a symphony - each note is played by a different instrument, but they all come together to create a beautiful piece of music. In this case, the instruments are Resource State Generators (RSGs) and Fusion Devices, and the music is a million-qubit computation.

Jigsaw puzzle analogy

Think of it like building a really complicated jigsaw puzzle. You start with lots of small pieces (individual qubits), and then you use the fusion devices to start putting them together into bigger and bigger clusters. And just like in a jigsaw puzzle, you need the right pieces in the right place to make the big picture. The delay loops help ensure that those pieces are there when you need them.

Part two: Generating a Resource State

In this animation, we're going to show you how we generate resource states of qubits for use in our photonic quantum computer.

(Animation shows a cloud of heavy metals cooled with laser traps to temperatures close to 0 kelvin)

Narrator: In order to generate single photons and entangle them together deterministically, we use a system that is nonlinear at the single-photon level. One such system is a single atom.

(Animation shows one atom rising out of the gas cloud and approaching the RSG)

Narrator: We trap a single atom on a photonic chip using optical tweezers.

(Animation shows the atom being held by optical tweezers)

Narrator: A laser is then focused on the atom, causing it to emit a photon.

(Animation shows a photon being emitted from the atom)

Here we will include a description of the dual rail system, once I fully understand it.

Narrator: This photon then interacts with another photon pulse also emitted by the atom. As the two pulses interact, they become entangled.

(Animation shows the two photons interacting and becoming entangled)

Narrator: We repeat this process multiple times, causing more and more photons to interact with the atom and become entangled, forming a cluster.

(Animation shows more and more photons interacting with the atom, becoming entangled and forming a cluster)

Narrator: The clusters of entangled photons are then sent through a fiber, where they are stitched together to create millions of entangled photons at each calculation cycle of the photonic quantum computer.

(Animation shows the clusters of entangled photons leaving the chip and being sent through a fiber, then shows the clusters being stitched together)

Narrator: And that's how we generate clusters of qubits at Quantum Source. By using a single atom as our system, we can generate true single-photon pulses and entangle them together deterministically. And with this approach, we can create millions of entangled photons at each calculation cycle of the photonic quantum computer.

(Animation concludes by zooming out to show the larger setup, tying together the ideas we visualized on the atomic scale with the larger concept of RGSs and their place in the bigger picture of the computing architecture).