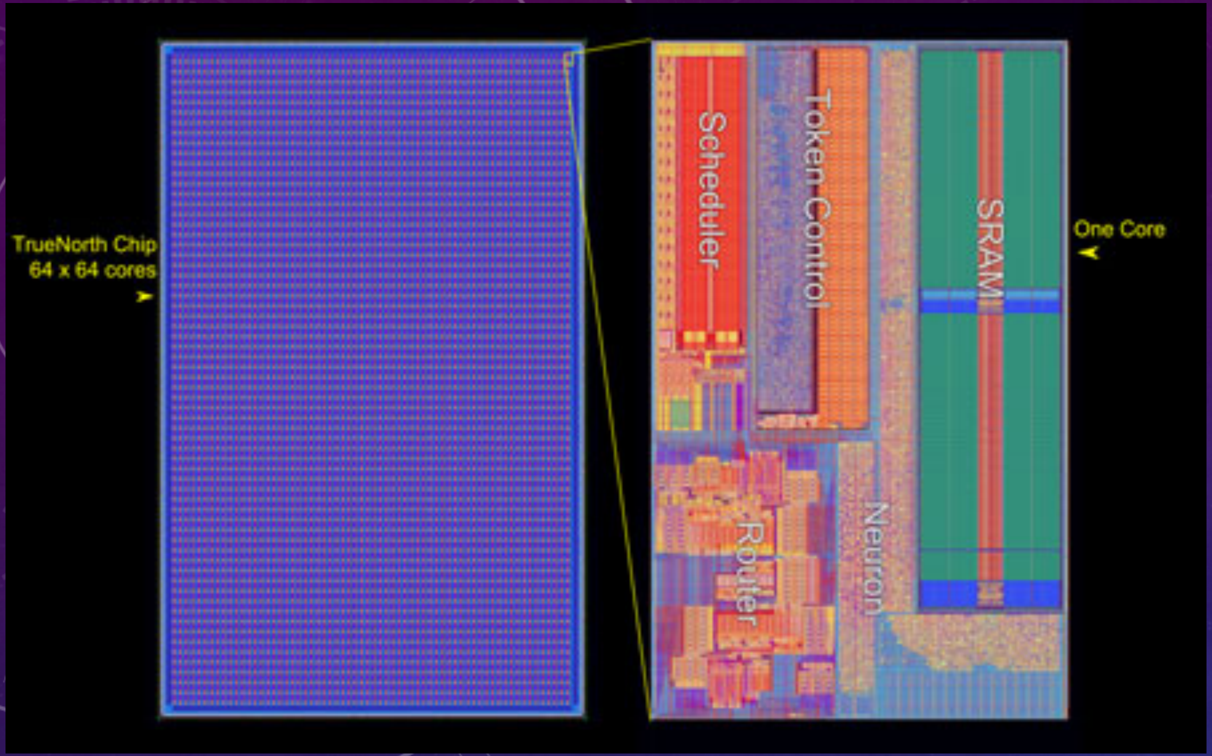


TRUENORTH

----A COMPUTER CHIP THAT EMULATES HUMAN COGNITION

SYNCHRONOUS CIRCUITS

- Imagine working in an office where, once you've finished one task, you had to wait until everyone in all the other cubicles completed the tasks they were working on before you could move on to your next assignment.
- That's how most digital devices that rely on synchronous circuits work. Built-in clocks allow the same amount of time for the completion of each computational function. Based on a binary system of ones and zeros, it's reliable, but it also means that the system can run only as fast as the slowest function in the chain.
- As a result, everything has to fit into a time budget, so unless you make everything faster, your chip doesn't run faster — and 'everything' includes things you don't always need

HISTORY

WHY SYNCHRONOUS CIRCUITS

- the blueprint of the modern computer (the “Von Neumann” machine) from the 1940s explains that asynchronous computation, which is the opposite of synchronous system, is advantageous.
- Many early machines were built this way(asynchronous), but computer architecture soon grew in complexity and included a lot more wires. Ensuring that a signal was sent and received correctly within the machine got trickier. An internal timekeeper was needed to make sure that things ran properly, and synchronous circuits became the law of the land

DRAWBACKS OF SYNCHRONOUS CIRCUITS

- What the machines gained in orderliness, though, they lost in speed. Take for instance, the computer in your phone. It's running at 1 GHz — a billion steps per second — so every step has to fit in one nanosecond. Whatever you're calculating has to be subdivided into equal blocks of time. If one step finishes early, you have to wait. That can add up to a lot of wasted time.
- Furthermore, If one step takes too long, an error occurs. In that case, the process has to be broken into smaller steps, or the step size has to be bigger — and that slows everything else down.
- This didn't pose much concern until the 1980s, when chips started getting bigger and more complicated and the clocks used to keep up with the computing power got more and more expensive to run — taking up as much as 20 percent of a chip's power consumption.

INSPIRED BY HUMAN BRAIN

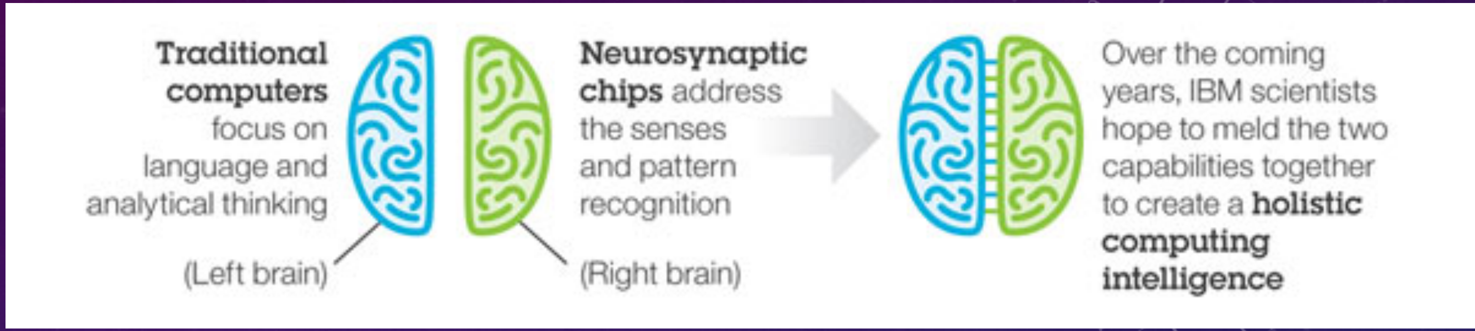
- There's clearly not a single, carefully synchronized signal that goes to every single neuron in your brain, so it seems that asynchrony is a natural way to think about how computation there occurs.
- "The brain is an asynchronous system that we don't really understand very well, and it can do certain things that we don't know how to get computers to do today — and that's interesting," Also, there's evidence that the brain has a "massively powerful asynchronous computational substrate" that can learn how to do a lot of different applications.
- Since neuroscience has given us a much better understanding of what's happening in the brain, and that information inspired the architecture of the TrueNorth chip.

TRUENORTH

- a 4-square-centimeter chip that possesses some 5.4 billion transistors, and 1 million “neurons” that communicate via 256 million “synapses.”
- asynchronous systems. In devices with these types of circuits, each function is allowed as little or as much time as needed to complete its task. No need to wait for other functions.
- To allow for greater complexity and use much less energy, all of these functions work asynchronously and in parallel — similar to how neuroscientists believe the brain operates.
- Neuromorphic chip. The neurons of TrueNorth work in parallel with each other, each doing what it needs to do to complete a task. They communicate via bursts of electric current, known as spikes. One of the most remarkable things about TrueNorth is how power-efficient it is. Drawing 70 milliwatts of power — equal to that of a hearing aid — its consumption is miniscule compared to conventional computers performing similar tasks.

APLICATION

COMPUTER VISION



- To see what kind of real-world applications TrueNorth might have, the research team developed a multi-object detection and classification application and tested it with two challenges: one was to detect people, bicyclists, cars, trucks, and buses that appear periodically on a video; the other was to correctly identify each object. TrueNorth proved adept at both tasks.
- it allows users to change the channel without touching the TV or a remote control. Samsung, which has evaluated the TrueNorth chip, announced that it is developing a system in which TV users can control their sets simply by gesturing.
- This kind of neuromorphic chips can be key to realizing self-driving cars, more human-like robots, and devices to help people with visual impairments..

LIMIT ON DEVELOPMENT

- Not only did the research team invent the chip, they needed to invent the tools used to build it, since existing current computer-assisted design (CAD) software wasn't adequate.
- One of the things that prevents people from working on asynchronous circuits are the lack of tools to design them, There's a huge industry that spends billions of dollars each year improving these CAD tools, but they aren't tailored to the work on asynchronous design so researchers have to write their own tools.
- Since the unveiling of TrueNorth, the number of researchers working on asynchronous circuits has increased significantly, but it's still a small community. Most research teams develop tools only for their research use. But if they can modify them to be more universal, the field will break out, and the technology will advance even more rapidly.

THANKS