SpiNNaker: Low-Power Chips to Model a Billion Neurons

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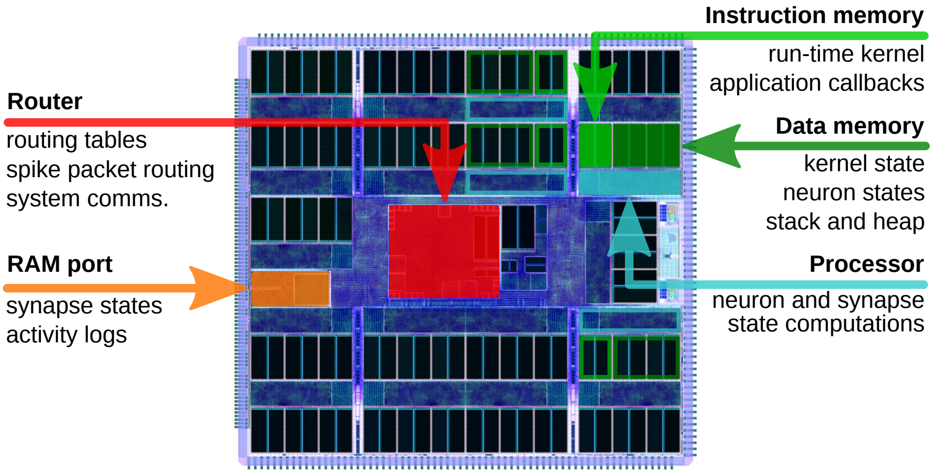
SpiNNaker is a computer architecture designed to model a billion neurons and a trillion synapses in real-time using minimal power [1]. A SpiNNaker chip contains eighteen processors, each of which may be programmed to simulate a thousand neurons, and novel reconfigurable hardware to emulate connective axons. A SpiNNaker machine comprises up to fifty-thousand such chips in order to simulate large volumes of neural tissue.



SpiNNaker chips have been successfully fabricated using ARM microprocessor designs and custom network-on-chip communications. On forty-eight-chip circuit boards, which will form the basic units of the supercomputer, the chips have demonstrated real-time simulation performance and sub-watt power requirements. Detailed models of the visual and somatosensory cortices have been simulated [2] using software that accepts anatomical data and configures the hardware accordingly, and the hardware has been extended to accept input from neuromorphic sensors that represent environmental-cues as biologically-plausible trains of spikes [3].

In three parts, this talk will present the SpiNNaker hardware, its application to modelling neural circuits, and its use in real-time sensory-motor loops. Architectural details and simulation methodology will be discussed, along with long-term project goals.

[1] S. Furber: Low-Power Chips to Model a Billion Neurons, IEEE Spectrum, 2012;49:45–49.

[2] T. Sharp et al.: Power-efficient simulation of detailed cortical microcircuits on SpiNNaker, Journal of Neuroscience Methods, 2012;210:110–118.

[3] J. A. Lenero-Bardallo et al.: A 3.6μs Latency Asynchronous Frame-Free Event-Driven Dynamic Vision Sensor, Journal of Solid State Circuits, 2011;46:1443–1455.