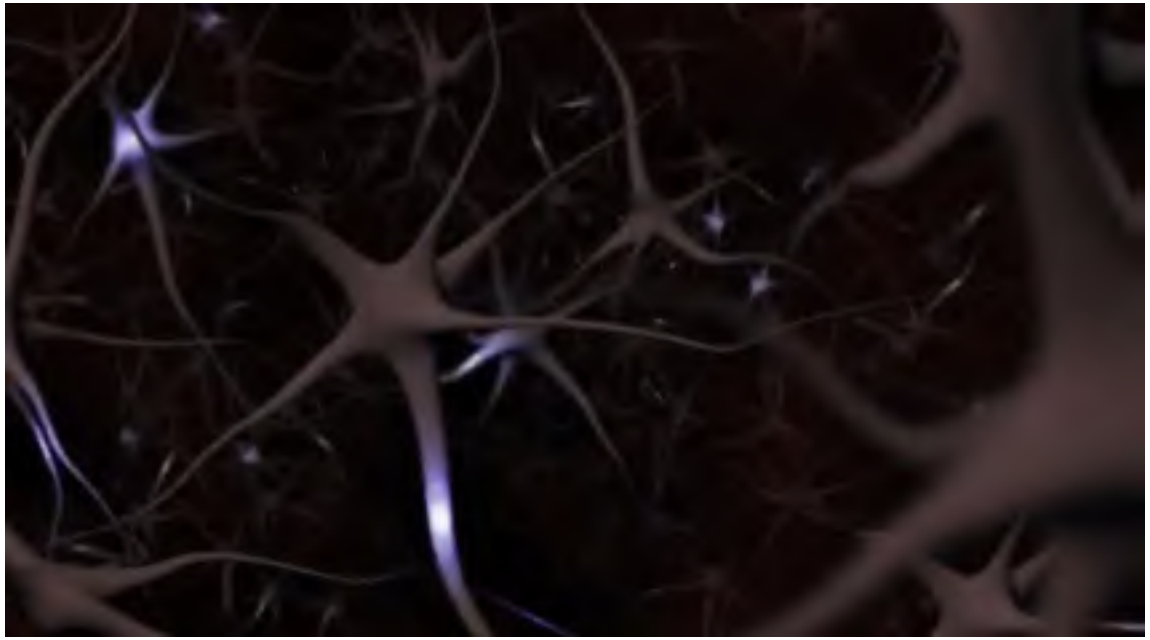


Cassiopeia Project

The *Neuromorphic* Advantage

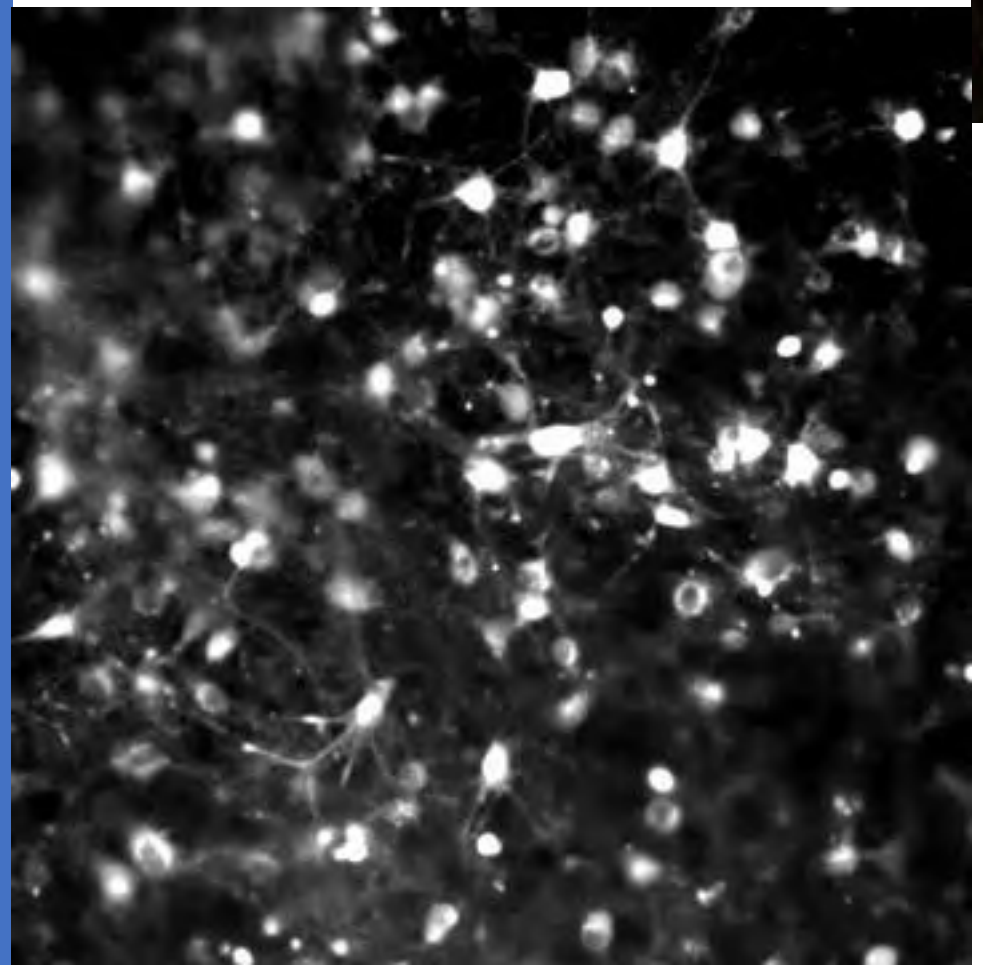
Efficient *Spiking Neural Networks* for Dynamic Edge AI

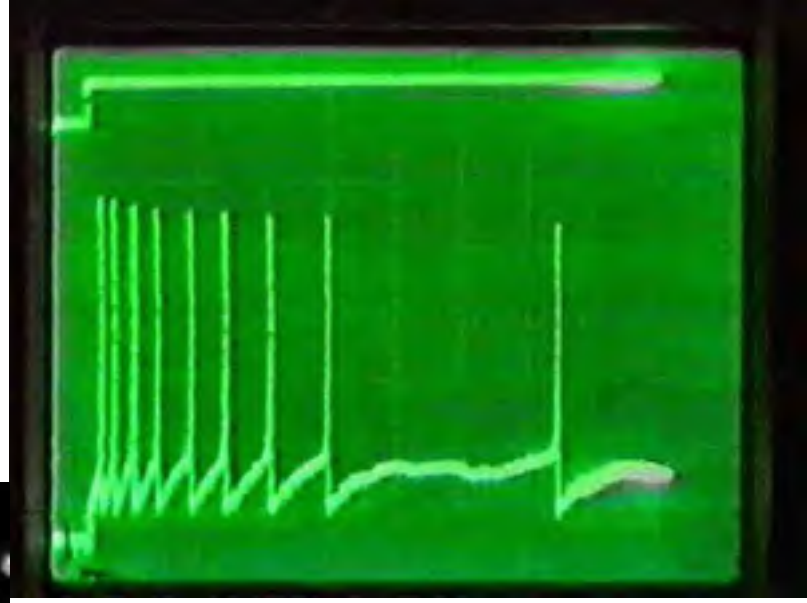
APPLIED BRAIN RESEARCH

Chris Eliasmith, co-CEO
Peter Suma, co-CEO

(Biological) Neural Computation

Neurons *Spike*

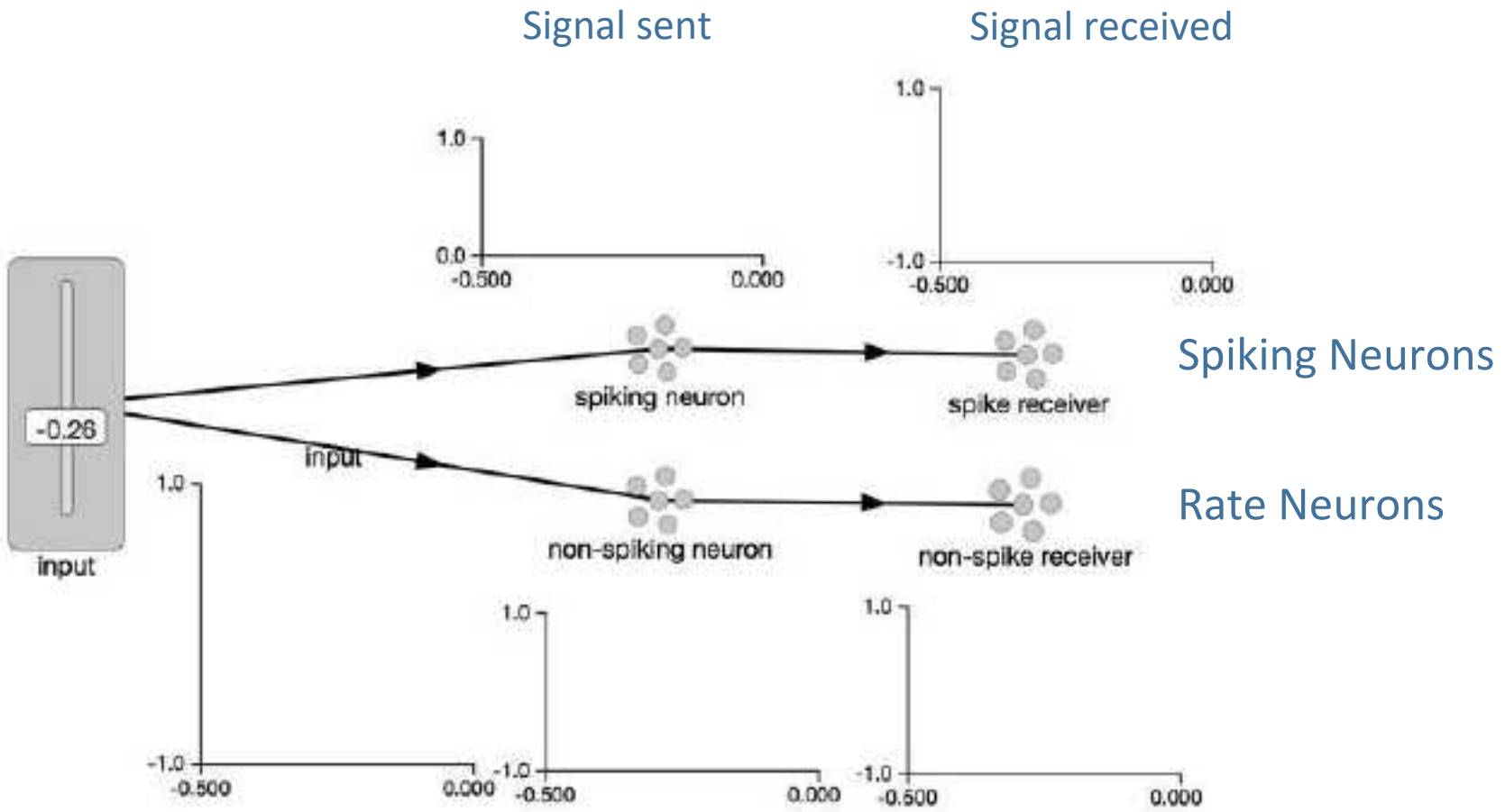




Spikes happen in *time*

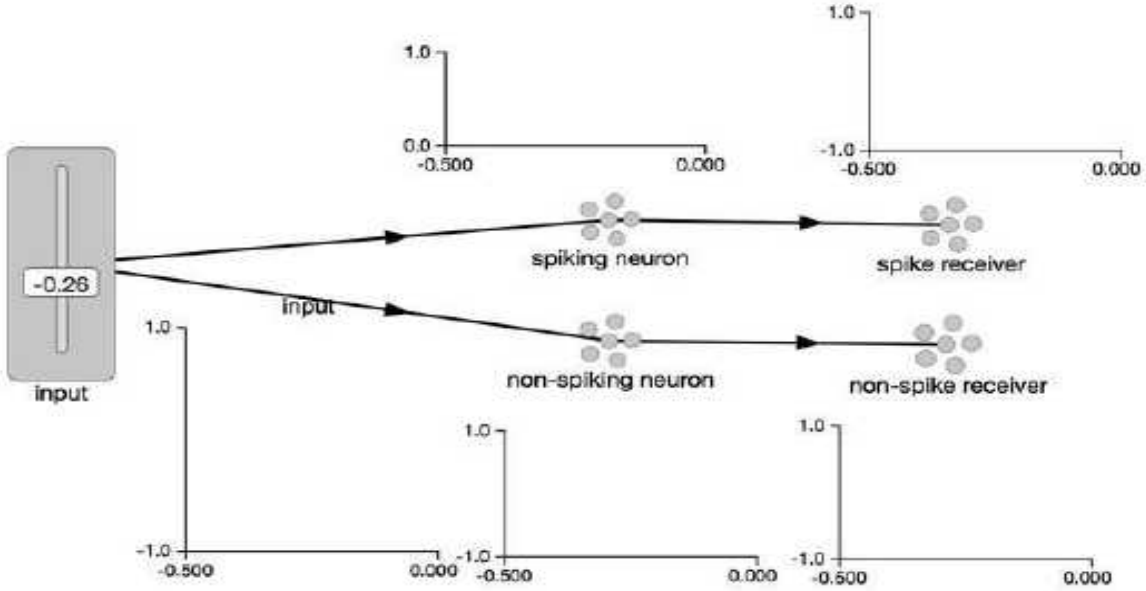
So What?

Neuromorphic Computing



Nengo

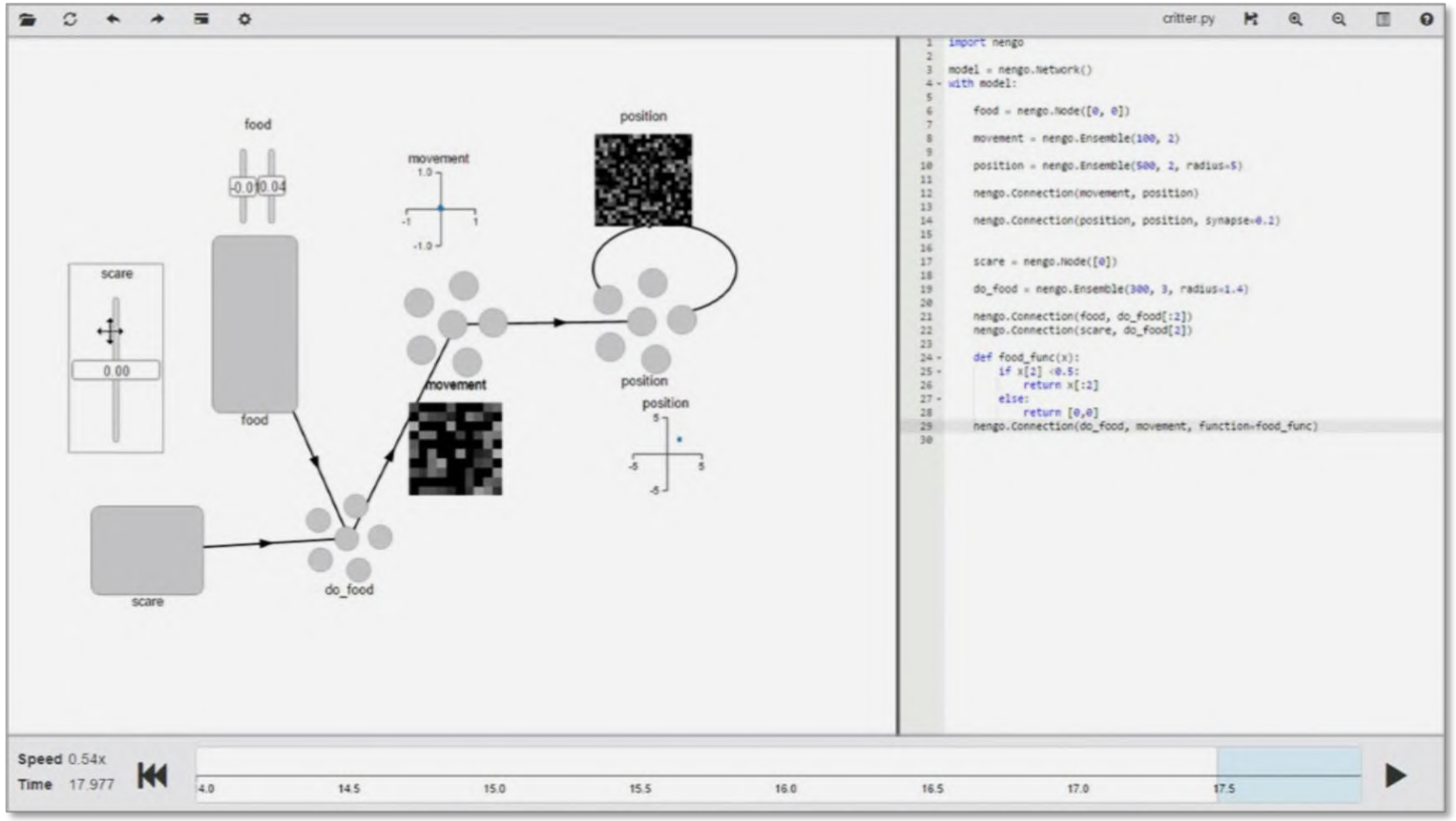
Neuromorphic Advantages



- Sparsification over time
  - Less communication
- Less computation
  - Fewer memory lookups
- Cheaper computation
  - Sum instead of multiply

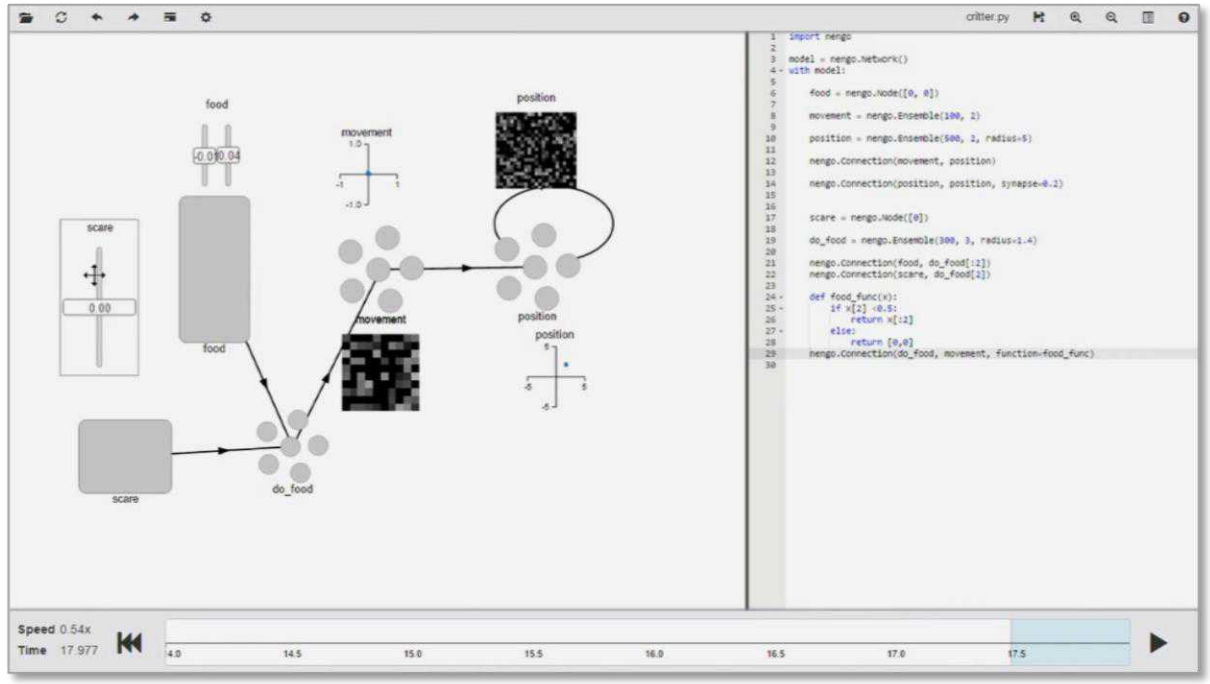
So What?

Neuromorphic Development Environment (NDE)



Design & Integrate Spiking Neural Networks

Neuromorphic Development Environment (NDE)



Current Backends

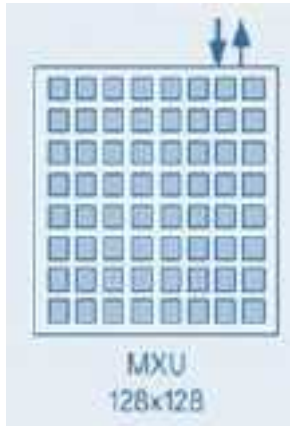
Nengo Python | Nengo OpenCL | Nengo DL | Nengo MPI | Nengo FPGA | Nengo Spinnaker | Nengo BrainDrop | Nengo Intel Loihi

(Conventional) (Neuromorphic)

Code Once, Run Anywhere

So What?

Neuromorphic Processing Unit

CPU	GPU	TPU	NPU
			
1971	1999	2016	2021

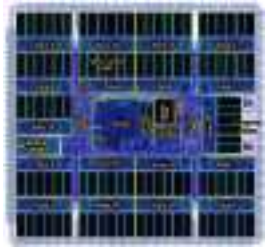
Low — Compute Parallelism, Temporal Sparsity & Scalability — High

High — Compute Energy per inference — Low

Neuromorphic Hardware

ABR FPGA
2019 – Small Shipping
2020 - Large

new



ABR Nengo
Brain Chip
Early 2021

Intel Loihi
Research Chip

So What?

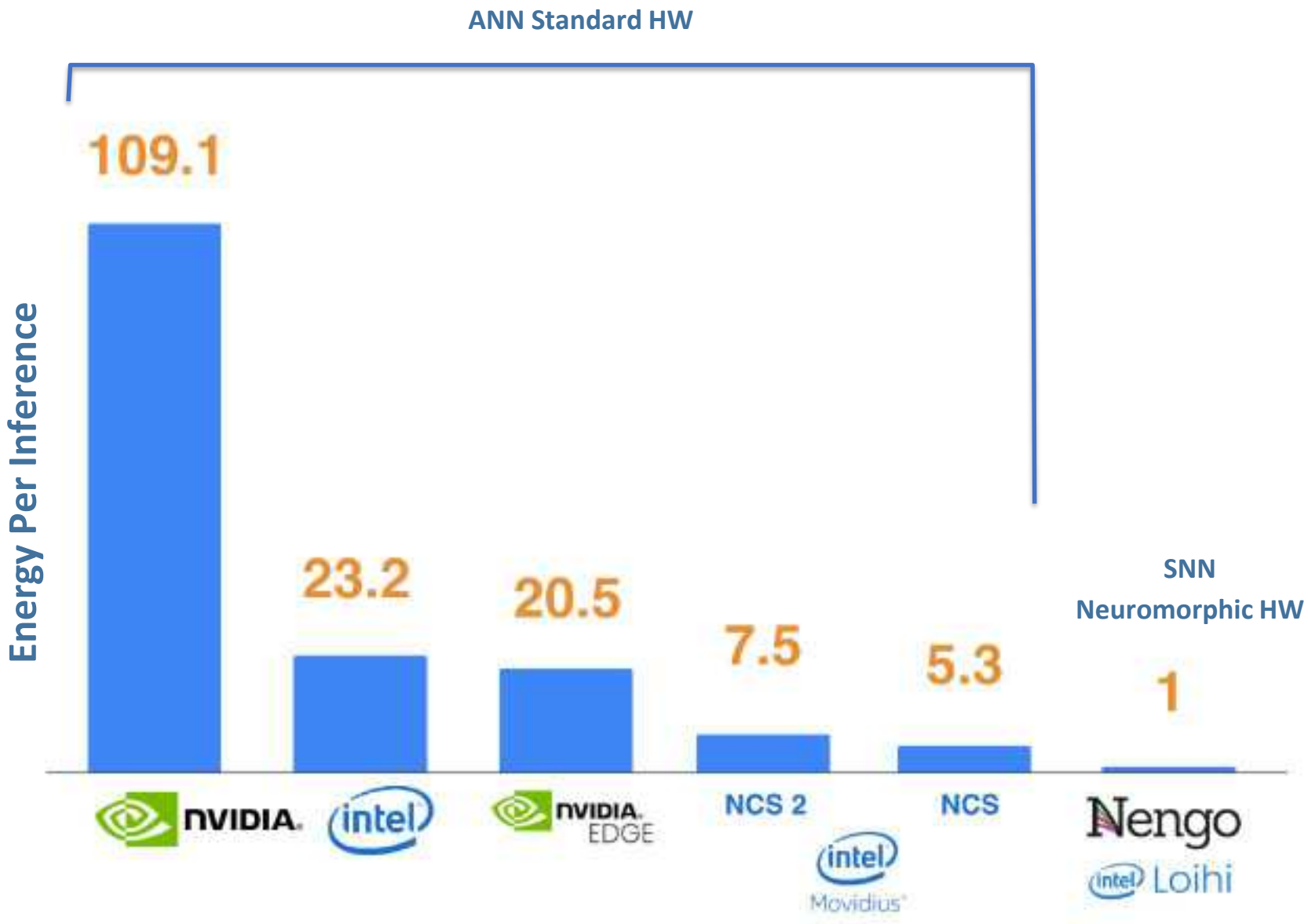
A Note on Measuring AI Hardware Performance

All of our results are:

implemented and measured on real neuromorphic hardware

- This is uncommon
- Critical because:
  - Captures *real-world* deployment
  - Results from *full system* optimization
  - Avoids notoriously poor TOPS/W comparisons

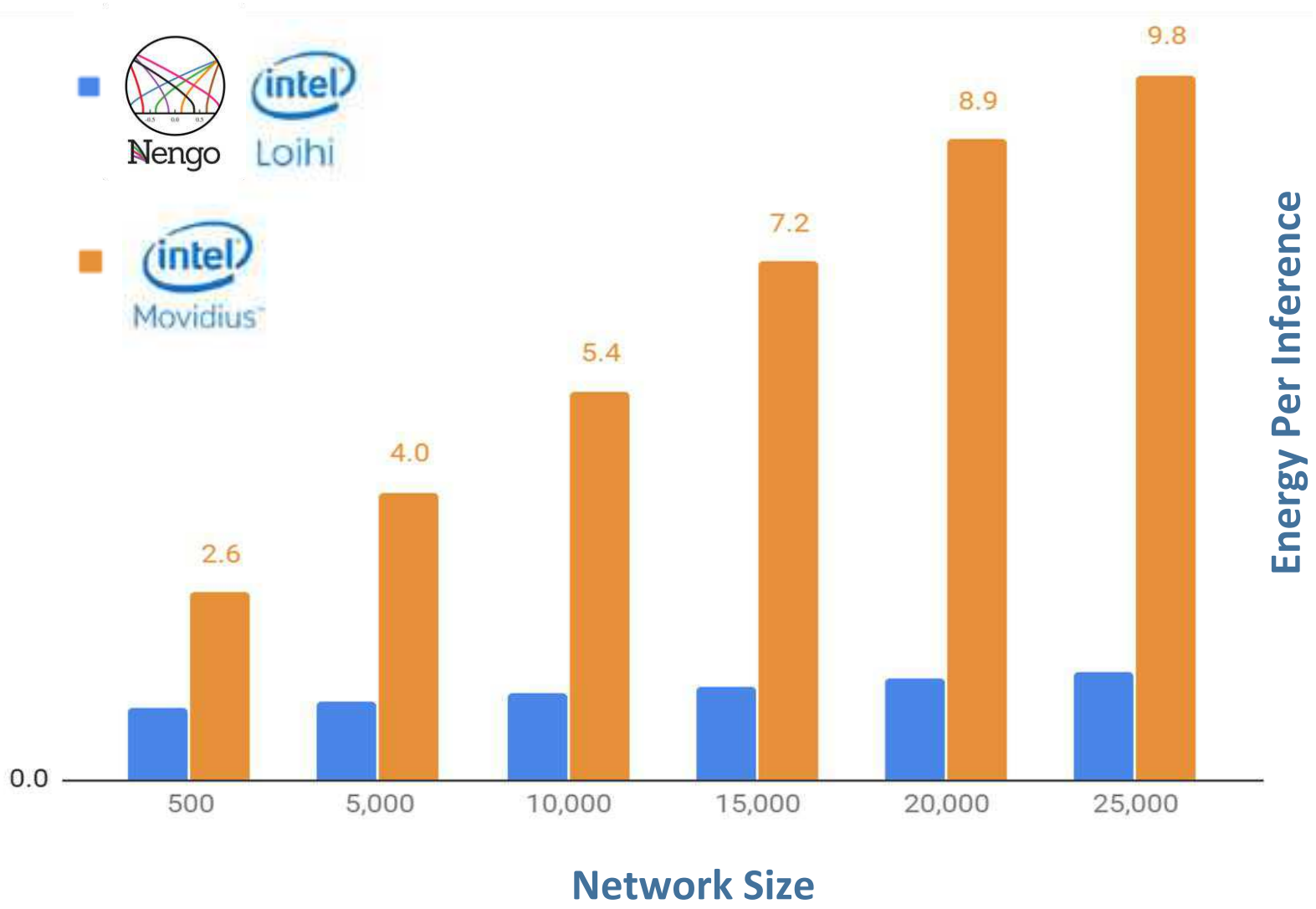
Neuromorphics: Deep Networks Lower Power



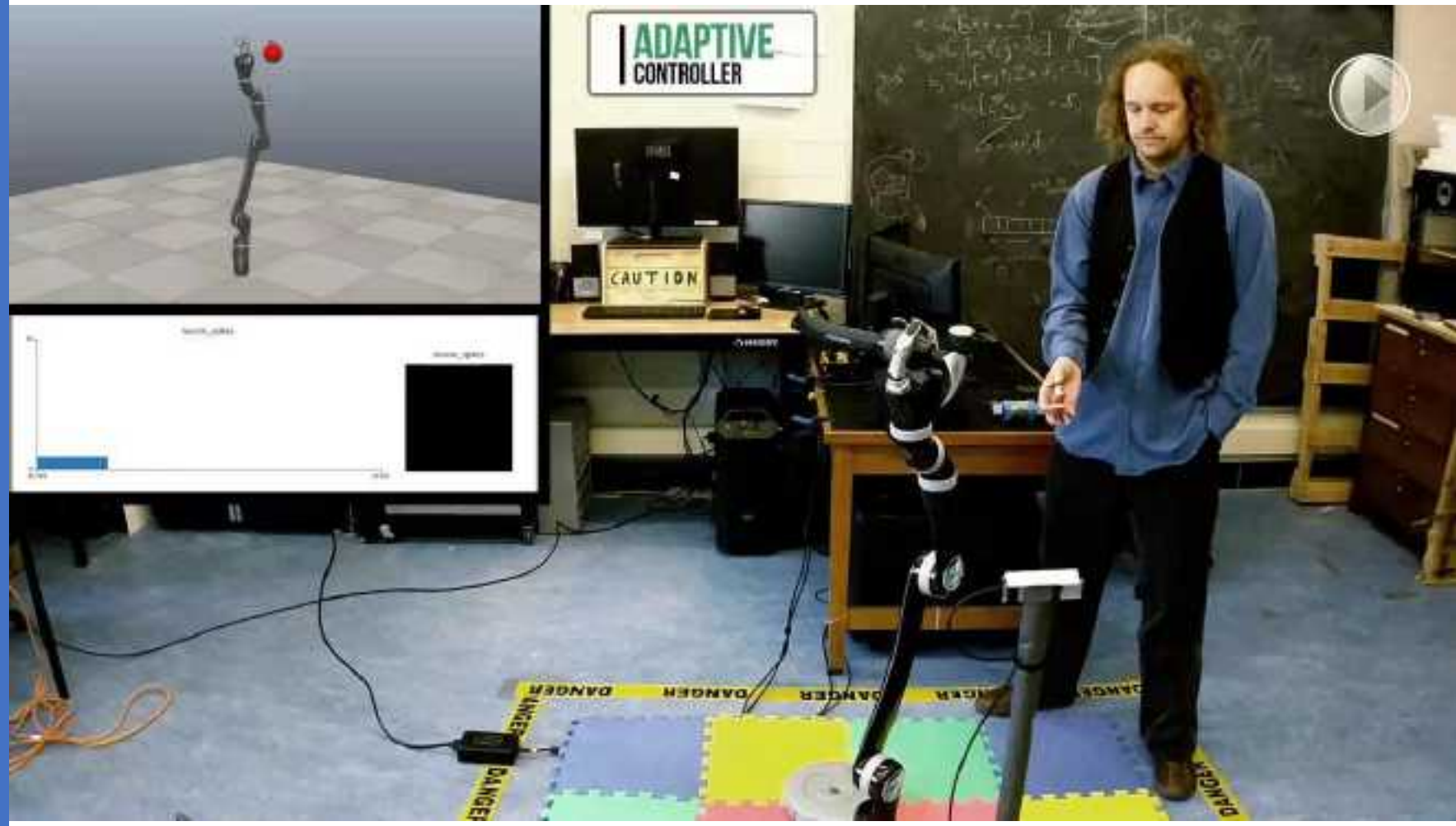
ANN Accuracy – 92.7%

SNN Accuracy – 93.8%

Neuromorphics: Superior Scaling



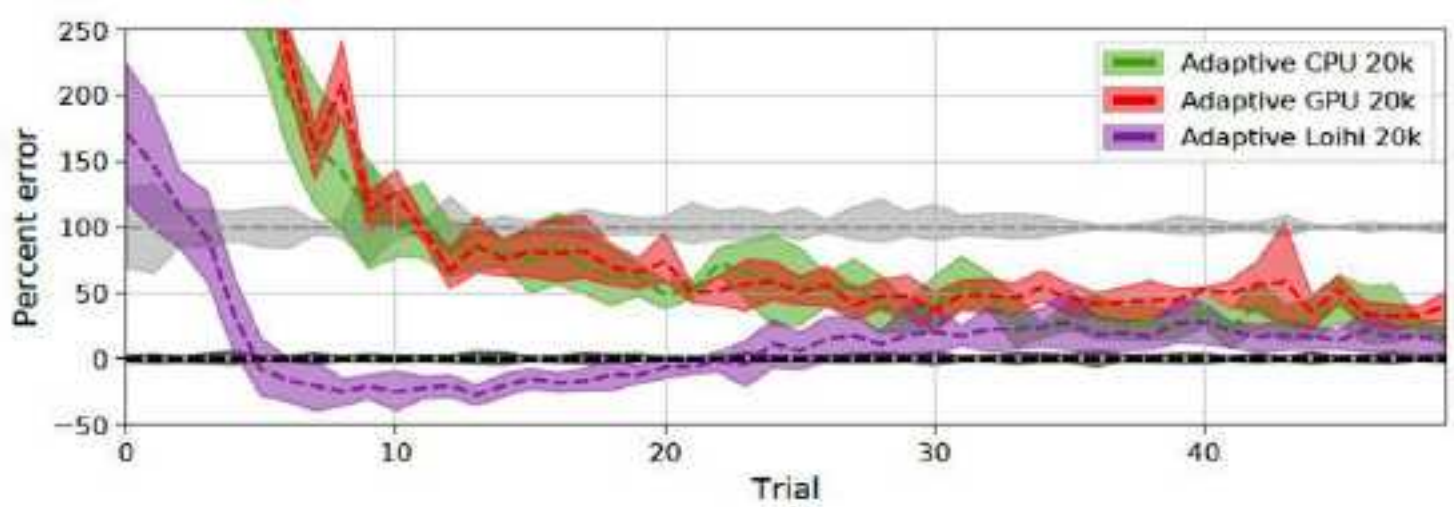
Application: Adaptive Control



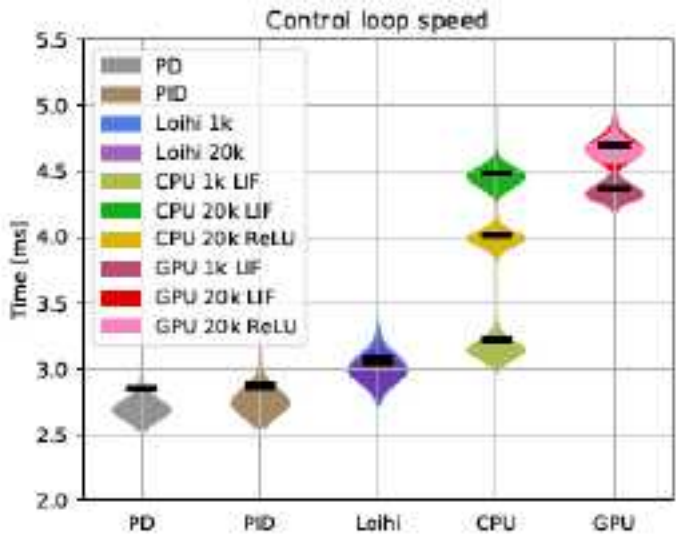
Online Learning for Visually Guided Reaching

Neuromorphics:

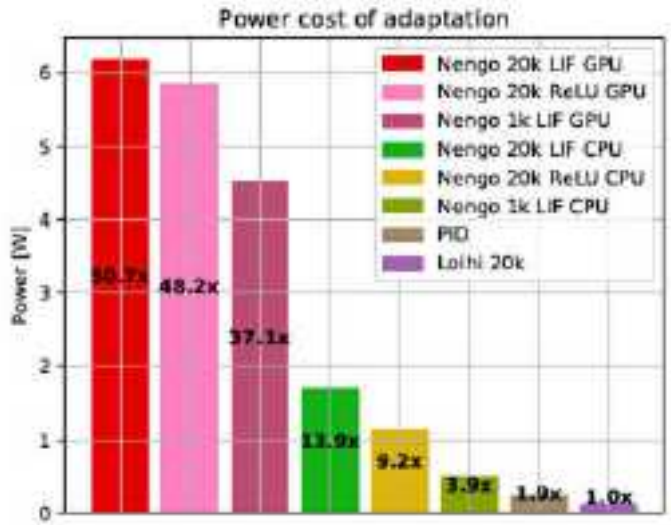
- More accurate
- Faster
- Lower power



Accuracy (~same)



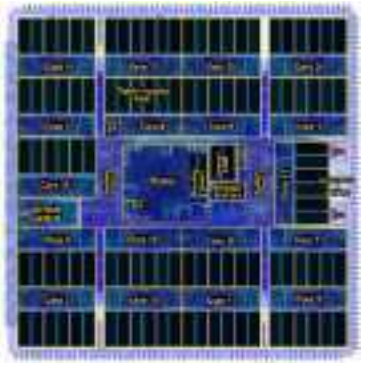
Speed (25-35%)



Power (10-50x)

What’s Next?

ABR Nengo Brain Chip



Proven Technology

- Building off SpiNNaker 2

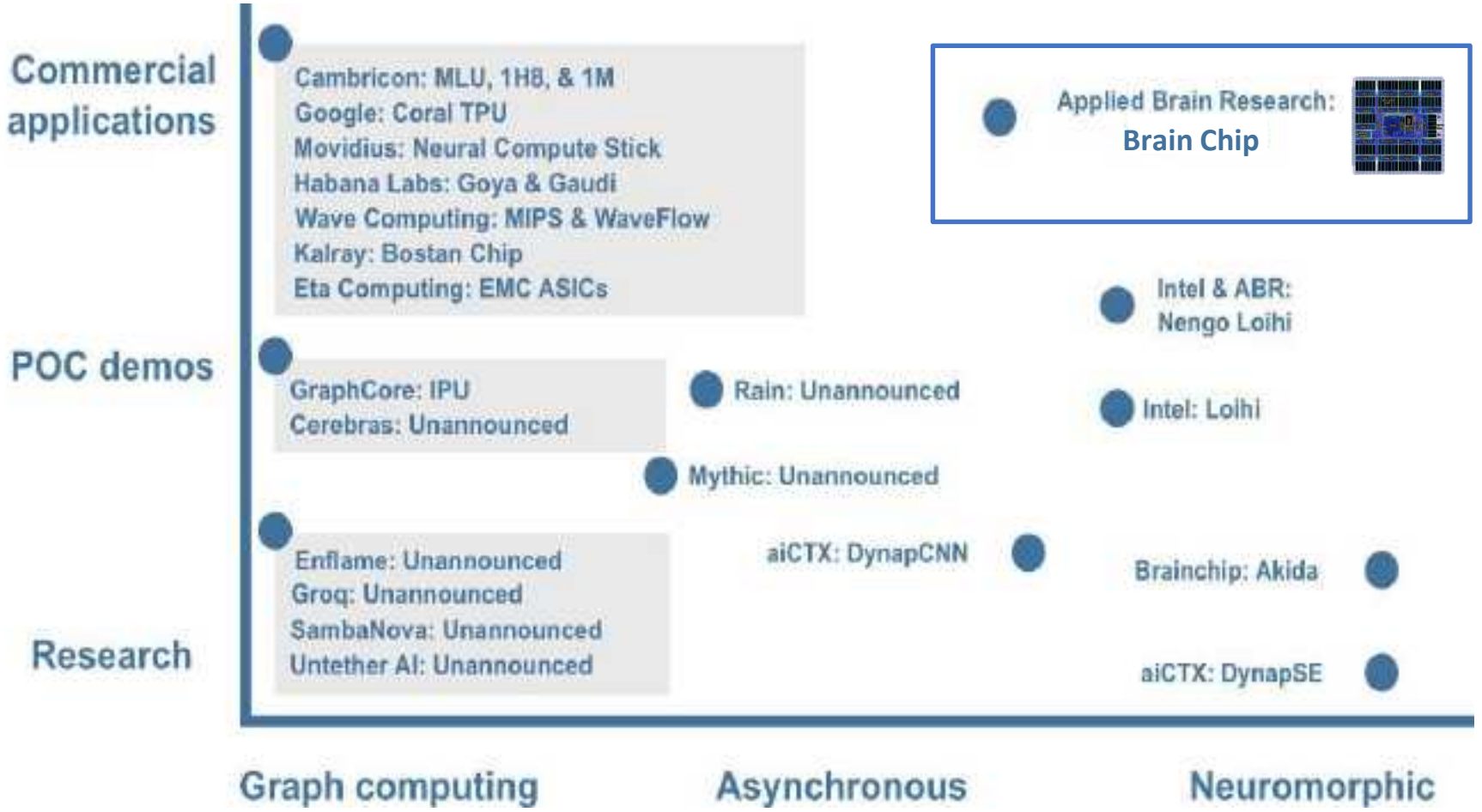
Low Power

- FD-SOI CMOS with adaptive body biasing to operate at low energy
- Dynamic source voltage and clock speed management driven by computational load

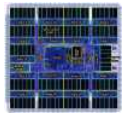
Flexible

- *Hybrid* spiking and non-spiking design
- Enables task specific optimization

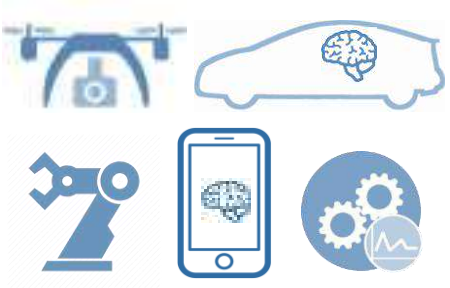
Neural Network Hardware Landscape



AI TOOLS



NDE, Libraries
& AI Chips



AI BRAINS

Voice, Video, Control, Security
for Cars, Smartphones, Drones,
Robots, IoT

GLOBAL AUTO MAKER

LEADING PHONE MAKER

TOP 5 ENERGY COMPANY

AI R&D

Dynamic, Full-loop,
Cognitive AI

Building Neuromorphic Brains for Low power, Dynamic, Edge AI

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