Bringing Neuroscience to HPC

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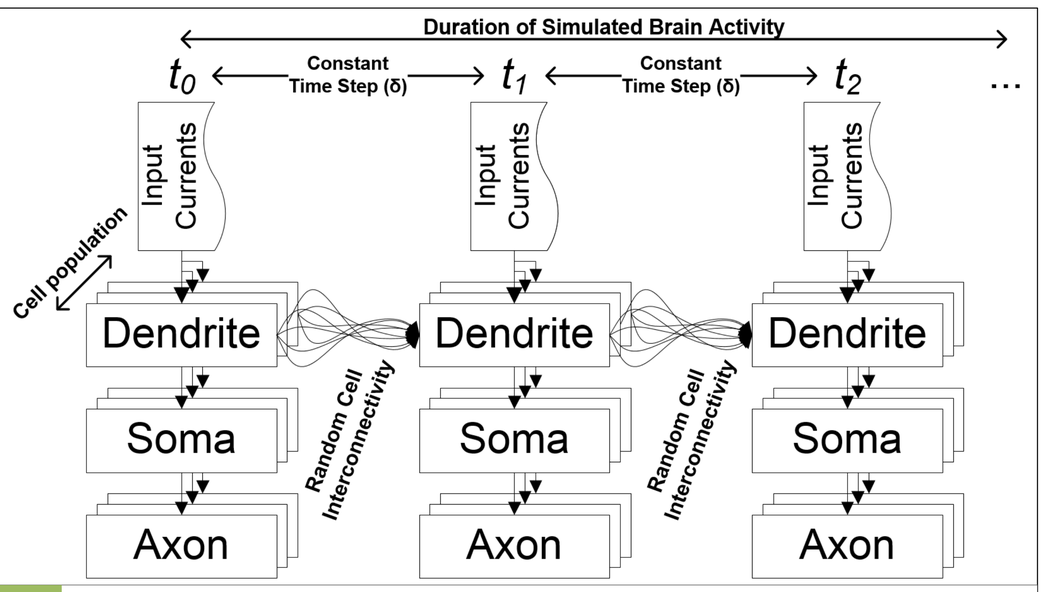
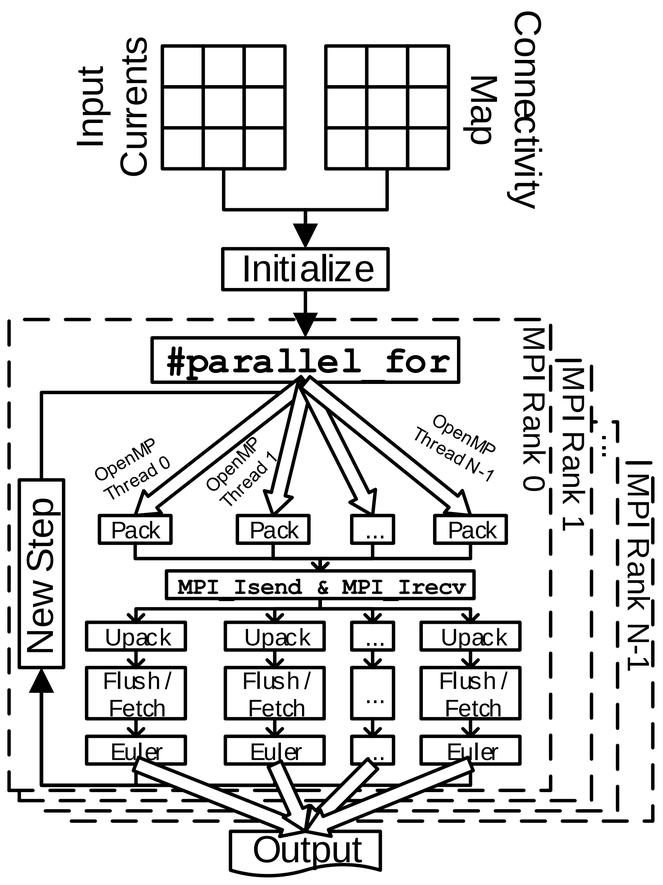
Abstract

- Brain Modelling is a very busy area for HPC research [1, 2, 3, 4, 5]
- Neuroscientific networks feature heavy computations and connectivity
- Neuron models range from black-box approaches to electrochemically accurate ODEs [6, 7]
- A new age of HPC-assisted tools are necessary for satisfactory simulation

- **GOAL1**: Develop high-performance neuronal simulators on HPC hardware
- **GOAL2**: Create a robust online service for neuroscientific workloads

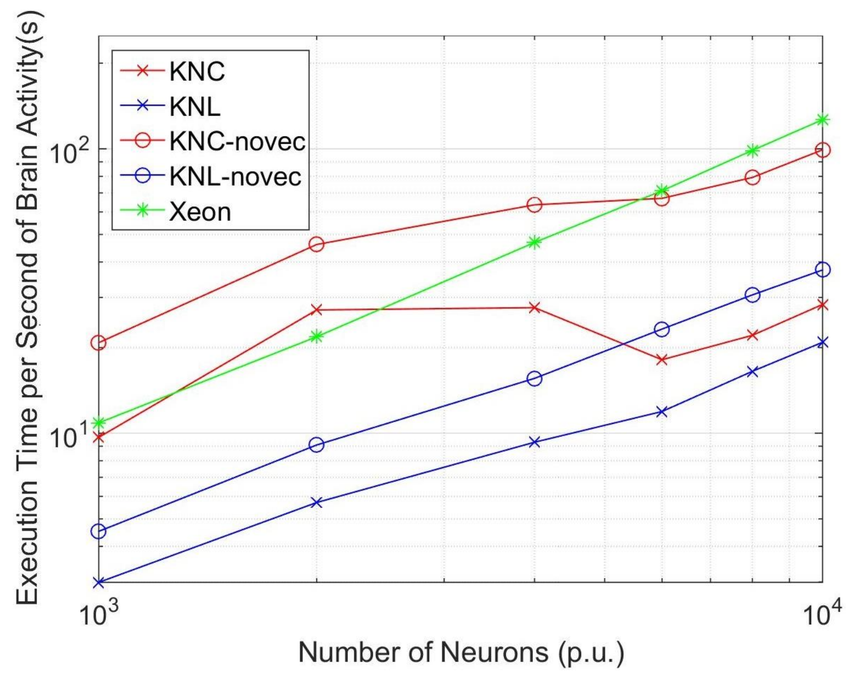


HPC Simulator



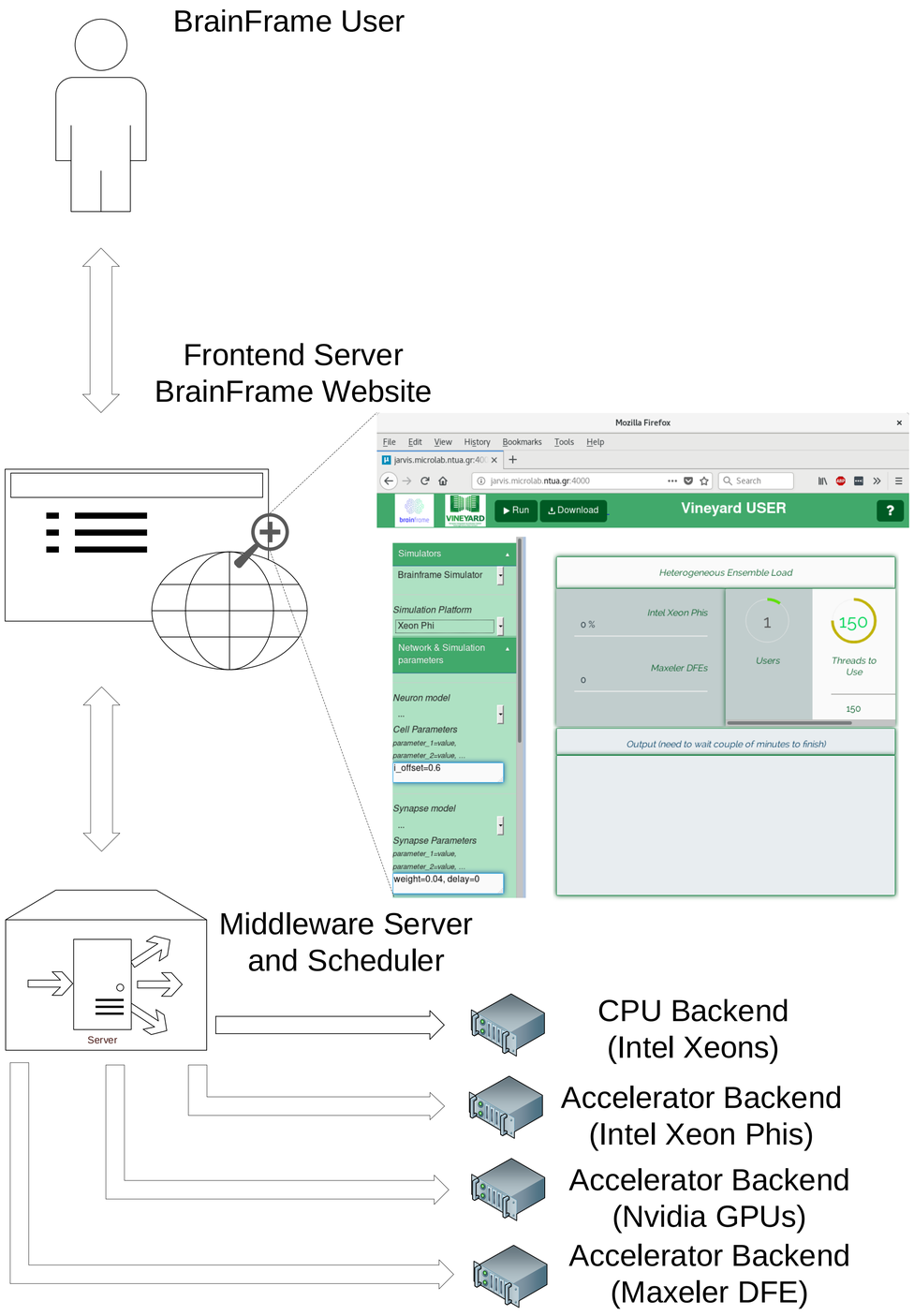
- Accelerated via OpenMP and MPI libraries
- Extensive usage of vectorized instructions

- Tested on Intel Xeon Phi 1st (KNC), 2nd (KNL) generation and Xeon CPUs [8, 9]
- Simulating realistic, complex networks



Featured Networks with 500 synapses per neuron

BrainFrame System



- **<u>BrainFrame:</u>** an online service for conducting accelerated neuroscientific experiments
  → modular, dockerized system for sustainability and adaptability

- <u>Front End:</u> utilizes simple GUI to offer the user two options:
  → quick neuronal network setup (select from drop-down menus) or
  → explicit experiment design (python scripting)
- <u>Middleware:</u> intermediate station:
  → translates user network configuration based on community-standard Python package for simulation of neural network models (PyNN) [10]
  → schedules simulation based on backend availability and workload parameters
- <u>Backend Cloud:</u> heterogeneous ensemble of HPC hardware:
  → backend performance profile depends on experimental setup

References

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