Fact Sheet

Defense Advanced Research Projects Agency

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SyNAPSE: Program Update

U.S. men and women in uniform confront unpredictable situations that demand complicated decision-making. They rely on their knowledge, intelligence and training to make the right decisions. Electronic devices that process information and provide sensor data can help, but are generally programmed to follow rigid rules and do not adapt well to changing circumstances. Addressing this shortcoming requires an entirely new class of electronics that can adapt to changing circumstances in a way comparable to that of a biological brain.

Breaking away from the traditional computer-based devices, the SyNAPSE (Systems of Neuromorphic Adaptive Plastic Scalable Electronics) program is working to create new electronics hardware and architecture for understanding information that enables compact systems with a performance that scales to biological levels.

The technical goals of the program are to build a new type of electronic system that can understand and respond to changing circumstances by solving difficult R&D problems in developing **hardware**, creating **architecture**, demonstrating effectiveness through **simulation**, and addressing varying levels of complexity (**environment**). Specifically, DARPA seeks to achieve several specific objectives:

- Create electronic hardware that can support critical information-related processes observed in biological systems.
- Design electronic architectures to support known organizational and functional features of biological neural systems such as connectivity, hierarchy, component circuitry, competitive self-organization, and modulatory regulation.
- Demonstrate functionality through large-scale digital simulations.
- Create virtual platforms (‘environments”) for training, evaluation and benchmarking of “intelligent” machines in understanding and response.

The SyNAPSE program vision consists of five phases, beginning with the development of electronic synaptic components and culminating in the creation of a ~10^8 neuron multi-chip system instantiated into a robotic platform. Detailed information about the specific milestones in each of the four core R&D areas may be found in DARPA Broad Agency Announcement 08-28

In the first phase, the DARPA SyNAPSE program demonstrated extremely small (nanometer scale) and energy efficient (1pJ per operation) electronic synaptic devices supporting biological adaptation rules.

These synaptic devices, when integrated with transistor-based neuronal devices, will enable large scale electronic neural systems built from the integration of novel and conventional electronics.

Also, demonstrated in this phase was the simulation of very large, biologically inspired neural systems on one of the world's largest supercomputers. These simulations, which model systems as large as 1 billion neurons and 10 trillion synapses, are the largest ever of their type. While not yet a demonstration of artificial intelligence, this large simulation capability is an important tool for understanding the function of biological neural systems and guiding the development of small and powerful electronic implementations that are the ultimate objective of the program.

DARPA's Defense Sciences Office uses the power of science to identify and pursue promising research ideas and transform them into new capabilities that will provide significant technological advantages to our Armed Services.

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