NEURON-TO-NEURAL NETWORK/BRAIN AND NEURON-TO-NANODEVICE SIGNAL EXCHANGE PROTOCOLS: CONCEPT DEVELOPMENT

A. PROJECT OUTLINE

This project is devoted to development of a concept and models of direct nanochip/nanodevice – brain communications that would ultimately lead to future integration of the human brain into digital networks. Identification and investigation of physico-chemical mechanisms that could be used for high frequency (HF) transmission of electromagnetic (e-m) signals between neurons, and between a neuron and a nanodevice are in the focus of this project. The development of theoretical description, computational models and experimental validation of the theoretical results is directed toward a discovery of the existence of specific "signal exchange protocols" (SEPs) that can be used to monitor and coordinate activities of natural neural assemblies (local and global neural networks – the brain), similar in functions to, but much more complex than transmission control protocols used in computer network communications (TCP/IP).

B. MOTIVATION

A crucial role of the TCP/IPs has been demonstrated by exploitation of digital communication networks, such as the internet. Similar procedures are studied and used in conjunction with the human brain (see, for example, Future Force Warrior program, www.natic.army.mil/soldier/wsit). These studies have concentrated on macroscopic, or global, features of the "correlated" behavior of neural systems. However, current state of modern statistical mechanics and quantum field theory, and the availability of nanoelectronic instrumentation and methods provides an opportunity to investigate the existence, possible "microscopic" origins and characteristics of physico-chemical processes that may exemplify a "cognitive" signal exchange between neurons/the brain and a nanodevice. One may envision procedures that use digitally-directed, high-frequency electromagnetic (e/m) pulses that are delivered (by means of an implanted nanodevice, or wireless) to required locations in a neuron with a spatial resolution of several nanometers, thus directly linking the human brain to existing machine-based information and device systems. Realization of such human-digital integrated information technologies (HDIT) will open a new technological era for the modern society.