

Electronic circuits are all around us having strong impact on social development and future lifestyle demands. Any of currently used cell phones has thousands of times more computing power than all of the first computers used in Apollo missions to send a man to the space. One can find a microprocessor in almost all household appliances i.e. fridge, washing machine or electric ovens. Supercomputers are used to solve many problems of quantum chemistry or high energy physics giving important answers about the matter constituents, molecules or periodic clusters along with their response to various disturbances coming from light or any other field. Computers are also working for human health trying to solve most demanding problems of medicine. Microsoft's 'cancer project' is trying to use supercomputers and machine learning algorithms to help oncologists figure out the most effective individualized cancer treatment for their patients and understand how cancers develop and what treatment to use. One may state for certain that without computers the technological advance would not be possible. We are also taking part in an never ending run for still faster and more powerful computers that could be engaged to solve more and more complicated problems on the mankind. Along with faster computers we require lower power consumption and ecological friendly technological processes during their construction. These requirements are typically contradictory putting a clear limit to the currently used technological processes. In particularly one is not able to keep reduce consumed power as the electric current consumption increase with frequency of the synchronization signal (clock signal) used in all microprocessors of this times. One of possible solutions for the problem is a complete change of the point of thinking about the digital machines and the computation process. What if one is able to change the serial synchronous behavior of the microprocessor into parallel signal processing? For such parallel architecture the result is not formally provided by a sequence of logical operations that use transistors and registers but is realized by direct transformation (mapping) of the input signals on the output. For such approach the output signal is given almost instantaneously in a similar way as it is done in our brain. Our brain do the mapping of input signals basing on unique configuration of connections between the neural cells that constitute the brain tissue. Process of learning is than a sequence of repetitions that is responsible for realization of appropriate connections between the neural cells. Therefore our memory and our experiences are written and saved in the form of unique topology of neural cells.

In this project we aim to make a first step in fabrication of hardware units performing parallel paradigm of computation. We are going to mimic the behavior of human brain and realize so called artificial neural networks (ANN). In the assumption the ANNs is going to be built of semiconducting quantum dots (QD) representing the biological neurons. From the functional side biological neural cell is responsible of receiving of incoming signals and emission of output signal ('ON') each time when the sum of incoming signals cross some arbitrary threshold point. Such behavior may be well realized by the QD. For each QD there exists at least two states that represent the 'ON' and 'OFF' states being linked with emission of the signal and lack of the output signal. Certain configurations of the adjacent QDs will be than capable of performing assumed mapping between the input and output. The QDs base model of ANN is able to work after fulfillment of one major condition related to ability of effective signal transport between the adjacent QDs what in fact is the main objective of the project. In this project we aim to investigate the possibility of signal transport over various QDs. In this project it is assumed that such signal transport may be realized by a near-field i.e. an spatial region outside the atomic structure of a single QD for which there is an nonzero and quite large probability of finding of an electron. Existence of another QD in very close proximity (almost touching each other) allow one to catch the electron by another QDs what in fact may realize transport layer for signal processing by the QD ANN. Positive response to the question about the possibility of signal transport in the QD ANNs is therefore a fundamental problem standing in front of fabrication of completely new and ultra-fast computer processors. From this point the project is found as cutting edge subject for development of next generation computers.