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The dedicated massively-parallel FPGA-based simulator for complex systems modeling

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ARUZ (Analyzer of Real Complex Systems) [1,2] is a scalable, fully parallel data processing system equipped with low-latency communication channels, dedicated for simulations involving interactions among huge amount of relatively simple elements working in parallel. These elements can represent atoms, molecules or groups of atoms in molecular simulation of complex system. ARUZ was constructed in BioNanoPark in Lodz (Poland) using reconfigurable components – FPGAs (Field Programmable Gate Arrays) instead of common processors. Device is composed of almost 26 000 FPGAs interconnected in 3D network by 75 000 cables. The simulator architecture was inspired by the Dynamic Lattice Liquid (DLL) model [3] designed to simulate dynamics in complex liquid systems, like polymer melts, multi-phase systems, etc. [4,5]. The algorithm based on this model is executed in cycles representing discrete time steps. In each cycle, every element can be moved to the neighboring lattice node or/and have its properties updated. The algorithm requires global synchronization and is dominated by local data exchange and simple logical operations. ARUZ can simulate the system composed of several million of elements in milliseconds time scale with more than 10^9 algorithm steps performed per day.

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