LABA

AI OSTIS

October 26, 2023

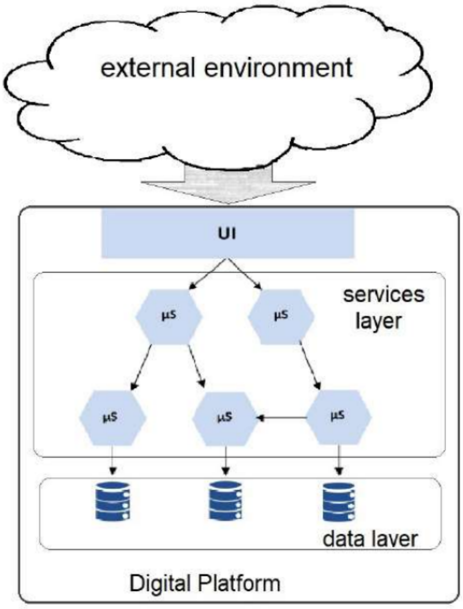

Figure 2: Generalized scheme of the Intelligent Services Platform

various sectors of the economy. Based on the Systems Theory by Ludwig von Bertalanffy, an ecosystem is commonly understood as «a complex open self-organizing, self-regulating and self-developing system» [1]. A Digital Ecosystem is often understood as a single common space in which many different services operate seamlessly, both from one company and several partner participants. Integration between them allows you to achieve maximum speed and transparency of processes, detect problems and improvement points in different business areas. An Intellectual Ecosystem implies a qualitative change in approaches to the creation of intelligent computer systems. The main goal is the formation of a common information space in the form of a general knowledge base and a general mechanism for the semantic compatibility of all intelligent agents of this system [2]. Figure 3 shows the general principle of building an Intelligent Ecosystem. The transition from data processing systems to knowledge management systems involves conceptually new approaches not only and not so much in mathematical and algorithmic support, but to a greater extent in the creation of hardware platforms. Various ideas have been put forward for a long time to achieve high real performance of a computing system by adapting its architecture to the structure of the problem being solved and creating a computing device that equally effectively implements both structural and procedural fragments of calculations [3] [4]. However, as a promising and comprehensive solution, the construction of new generation intelligent computers is considered. They will make it possible to remove a few issues that arise due to the technical limitations of existing computer architectures and bring the development of intelligent systems to a qualitatively new level.

III. TOWARDS A NEW GENERATION OF INTELLIGENT COMPUTERS

Let's define a new generation of intelligent systems through a description of their properties, distinguishing features and expected technical characteristics..

What can be expected from innovative mathematical models?

In terms of functional capabilities, intelligent systems should exhibit some (not necessarily all) qualitatively new properties, such as:

- semantic clustering;
- convergence (gradual blurring of the boundaries between data processing and knowledge processing);
- automatic knowledge acquisition;
- processing of fuzzy knowledge;
- generation (recreation) of images from patterns;
- modeling of cognitive functions and phenomena and so on.

In terms of applications, innovative mathematical models should be more versatile compared to neural and semantic networks.

In terms of technical characteristics, intelligent systems should provide:

- reduction of labor costs for the construction, operation, and development of new applied intelligent systems;
- increase in the level of intelligence (cognitivism) compared to known intelligent systems.

In terms of infrastructure, mathematical models and language tools for representing images and knowledge will be standardized and ensure cross-platform compatibility, meaning that high-level models, algorithms, and software will be portable across specialized, problemoriented, and universal computers [5].

What to expect from specialized hardware platforms?

In terms of architecture, intelligent computers should support the infrastructure of mathematical models, possibly incorporating features of both neural and semantic computations.

In terms of technical specifications, specialized computers may have performance that exceeds that of general-purpose computers by several orders of magnitude.

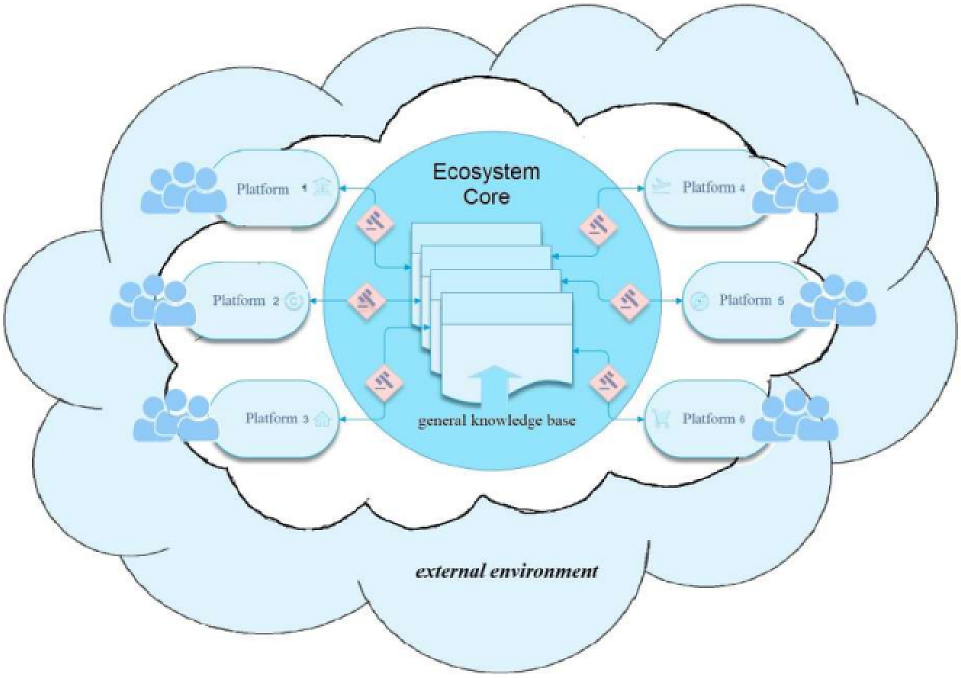

Figure 3: Generalized scheme of the Intellectual Ecosystem

In terms of the component base, modern electronic technologies, primarily FPGA and GPU, allow for the development and rapid prototyping of original technical solutions for innovative architectures of intelligent computers.

In terms of the structure and technical solutions topology, the architectures of modern neural networks, including convolutional ones, are tree-like schemes with reconvergent irregular connections, often with nonhomogeneous functions in processor elements. The architectures of modern semantic networks also represent graph schemes with irregular connections and non-homogeneous functions of processor elements. Attempts to structurally implement such architectures "bluntly" usually encounter technological limitations of the component base and do not have any significant effect. Therefore, in both cases, developers strive to find "workarounds." One of the most common solutions is to map the irregular connections of architectures onto a structure with a regular topology of connections. The simplest examples can be a bipartite graph, which is reduced to a technical solution in the form of a line of processor elements (Fig. 4), as well as lattice graphs, which are reduced to a technical solution in the form of a matrix of processor elements [6] [7] .

In more complex implementation variants, one should expect more complex variants of mapping the architecture onto the topology of processor elements connections. In terms of profitability, specialized computers may find their niche by unifying a wide range of intelligent computations and integrating into the overall infrastructure of artificial intelligence.

IV. OSTIS IN THE CONTEXT OF AMBITIOUS OBJECTIVES

Over the past 10-15 years, as OSTIS began "to take shape", it has primarily been viewed as a tool for building applied intelligent systems. Examples of this include an information service system for employees and a decisionmaking module for the quality control system of PJC "Savushkin Product", a set of prototypes for intelligent learning systems in various disciplines of secondary and higher education, and intelligent dialogue systems for medical and educational purposes implemented on universal software and hardware platforms. Currently, OSTIS can be considered as an independent infrastructure [9], within which all prerequisites exist for the creation of innovative specialized processors. These specialized

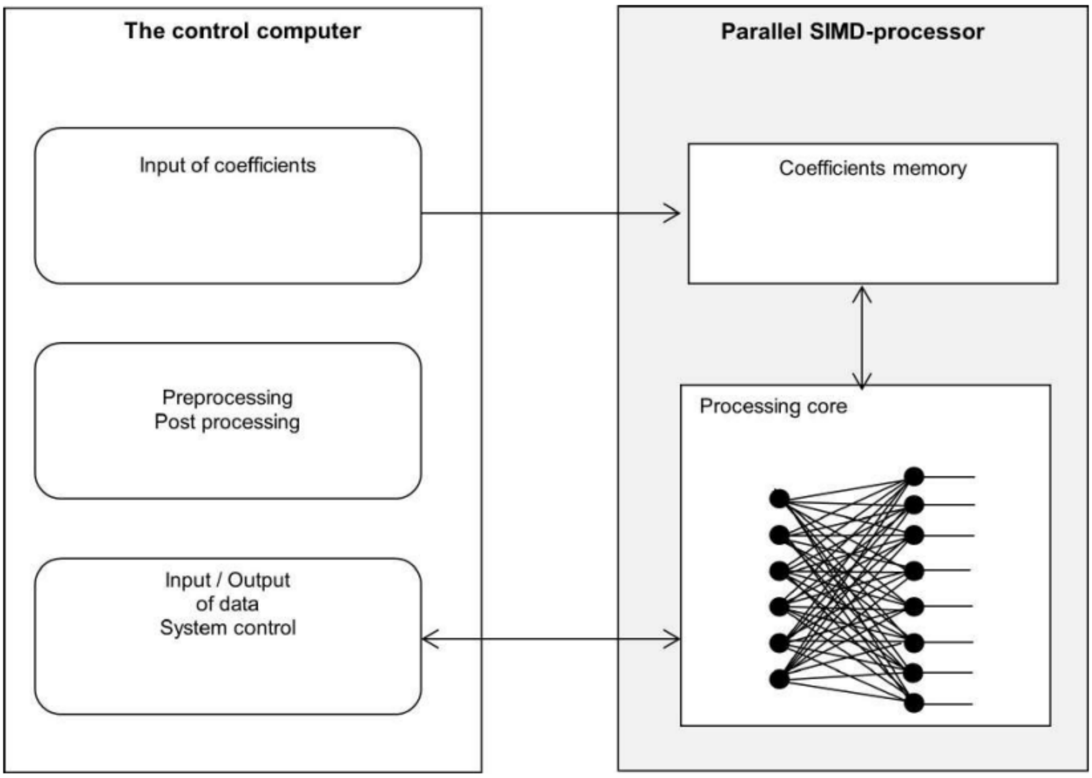

Figure 4: Enter Caption

processors within OSTIS are viewed as an option for interpreting computer system models developed based on OSTIS platforms [10]. One of the principles of OSTIS is to ensure platform independence of computer systems (OSTIS systems) developed on its basis. In other words, the development of such a system is reduced to the development of its model (including functional modules for solving tasks), described by means of a knowledge representation language and the subsequent loading of this model onto an OSTIS platform that meets certain requirements. Figure 5 illustrates a fragment of the OSTIS ecosystem, which is a comprehensive infrastructure for the interaction of OSTIS systems, users, and other computer information systems. As shown in the figure, specialized (associative semantic computers) developed under the infrastructure conditions will directly support distributed knowledge processing, significantly increasing their efficiency compared to universal computers.

Thus, in general, an OSTIS platform can be implemented either in hardware (e.g., as a specialized processor) or in software (e.g., as a virtual machine based on modern von Neumann computers). At the same time, there can be many implementation options for both hardware and software OSTIS platforms, and each such option may have its own advantages and disadvantages, considering the classes of tasks solved by specific OSTIS systems.

References

[1] A. I. Galushkin. *Supercomputers and Neurocomputers. Neurocomputers: design and applications*. Begel House Publ, 2000. Chap. No. 6.

[2] N. Verenik Y. Seitkulov A. Girel and M. Tatur. *Some regularities and objective limitations of implementing semantic processing algorithms on computing systems with massive parallelism.* 2014. Chap. Vol. 2, Issue 2, pp. 92–101.

[3] M. Tatur. *Problem-Oriented Processors for the Solving of Classification Tasks*. Slovakia. 2013. Chap. Vol. 11, No. 2, pp. 155–164.

[4] A. Yu. Popov. *rintsipial'no novyi protsessor dlya obrabotki mnozhestv, struktur dannykh i grafov [Fundamentally new processor for processing sets, data structures and graphs]* . 1905. URL: `https://elearning.bmstu.ru/iu6/mod/page/view.php?id=1690%20(accessed%202021)`.

[5] *Towards knowledge societies: UNESCO world report.* Paris: 2005, p. 226.

[6] A. V. Tuzikov. *Tsifrovaya transformatsiya. Osnovnye ponyatiya i terminologiya [Digital transformation. Basic concepts and terminology]*. Minsk. 2020, p. 267.

[7] L. Chernyak. *Arkhitektura fon Neimana, rekonfiguriruemye komp'yuternye sistemy i antimashina [Von Neumann architecture, reconfigurable computer systems and anti-machine]*. Moscow. 2008. Chap. Vol. 6.