The role of "JavaMach Cluster" in Industry 4.0

Sergey Dobrotvorskiy[1], Adam Hamrol[2], Eva Dostatni[3], Milan Edl[4], Serhii Gnuchykh[5], Ludmila Dobrovolska[6], Evgeniy Sokol[7]
{ sdobro50@gmail.com[1], adam.hamrol@put.poznan.pl[2], ewa.dostatni@put.poznan.pl[3], edl@fst.zcu.cz[4], qny4ix08@gmail.com[5], lyudmyla@ukr.net[6], omsroot@kpi.kharkov.ua[7]}

National Technical University "Kharkiv Polytechnic Institute" Kharkiv, Ukraine [1,5,6,7], Poznan University of Technology, Poznan, Poland [2, 3], University of West Bohemia[4]

Abstract. Today "Industry 4.0" its ideas resonate in different countries and on different continents. The article discusses what Industry 4.0 is. The stages of its emergence, formation, and causes are revealed. Its shortcomings and advantages are considered. The concept of using "JavaMach Cluster" is proposed. The purpose of creating JavaMach Cluster – the establishment of a unified educational, scientific, practical platform core of Industry 4.0 based on the use of common standards and Open Source technologies. The ERP system developed by us is considered. The concept of using microservices in the design of ERP systems is proposed.

Keywords: Industry 4.0, ERP, open source, engineering, JavaMach cluster.

1 Introduction

Industry 4.0 is characterized by the fusion of physical and digital technologies - Analytics, artificial intelligence, cognitive computing and the Internet of things (IoT). Today "Industry 4.0" its ideas resonate in different countries and on different continents [1]. For example, in China, this concept is called Acceleration as part of the "China 2025" strategy.

The prerequisites for the emergence and development of "Industry 4.0" are quite simple and obvious. First, if we look at people around, we see that most of them use smartphones, tablets, and other gadgets. Second, the Internet: people use it to work. Such a way of human interaction will soon gradually move to industry. In the future, human interaction with machines and between machines will change [2].

Today, the term "human-machine interface" is no longer fully true. Many of the cars themselves report their status and offer to take some kind of action. And in the future, they will communicate with other machines on their own and will only contact people occasionally. The German industry is investing 40 billion in industrial Internet infrastructure annually until 2020, according to the consulting firm Strategy. This is a significant chunk of European investment in the fourth industrial revolution, which is expected to amount to 140 billion euros per year. Of the 278 companies surveyed in Germany, 131 reported that they were already "involved in Industry 4.0.

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2 “JavaMach Cluster” within the framework of Industry 4.0

The term "Industry 4.0" appeared in Europe: in 2011, at one of the industrial exhibitions in Hanover, the German government started talking about the need for wider use of information technology in production [3]. A group of officials and professionals specially created for this purpose has developed a strategy for turning the country's production enterprises into "smart". This example was followed by other countries actively developing new technologies. Moreover, the term "Industry 4.0" began to be used as a synonym for the fourth industrial revolution.

The first industrial revolution began after the advent of steam engines, which allowed moving from manual labor to machine. The second occurred with the development of electricity and was characterized by the development of mass conveyor production. The third industrial revolution, also called digital, began with the creation of digital computers and the subsequent evolution of information technology. The digital revolution in this period is moving into the fourth, the features of which are the mass introduction of cyber-physical systems in production [4].

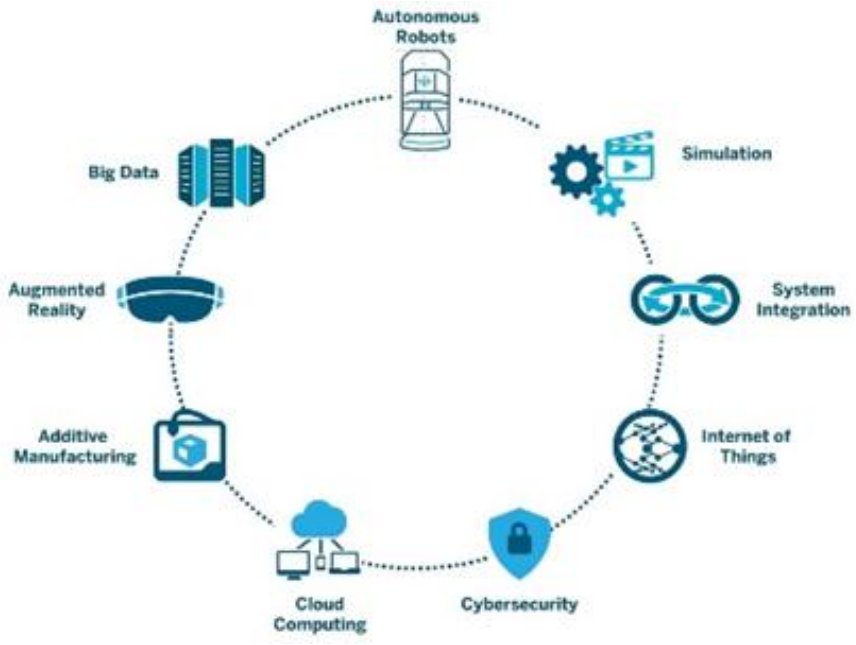

Fig. 1. Structure of the Industry 4.0

The main features of the new revolution were cloud technologies, the development of methods for collecting and analyzing Big Data, crowdsourcing, biotechnology, unmanned vehicles and medicine based on 3D printing. The structure is shown in figure 1.

Big Data is a set of technologies that are designed to perform such operations:

- process large amounts of data compared to "standard" scenarios,
- be able to work with fast data in very large volumes,
- be able to work with structured and poorly structured data in parallel in different aspects.

3d modeling - is a unique method of creating a large range of physical objects on the basis of a single platform. It provides an opportunity to abandon heterogeneous approaches to solving various problems in favor of a single approach implemented in digital form.

IoT - the concept of space in which all of the analog and digital worlds can be combined. It is not just a set of different devices and sensors, combined with wired and wireless communication channels and connected to the Internet, and it is a closer integration of the real and virtual worlds in which communication is between people and devices.

Cloud computing is the provision of computing services (servers, storage, databases, network equipment, software, Analytics, etc.) over the Internet. This is the so-called cloud. The companies that provide these computing services are called cloud providers. They usually charge for cloud-based computing services based on usage, just like you charge for water or electricity at home.

One of the most tangible aspects of the fourth industrial revolution is the idea of "service-oriented design" [5]. It can range from users who use factory settings to produce their own products to companies that supply customized products to individual consumers.

The potential for this type of production is huge. For example, the connection between the smart products of the IoT and the smart machines that produce them, that is, the industrial Internet will mean that they will be able to produce themselves independently and determine the target production depending on the needs defined by them.

In addition, the growing integration of smart plants into industrial infrastructures will mean significant reductions in energy costs [6]. Many factories spend a lot of energy during production breaks like weekends and holidays. The smart factory could avoid it.

Proponents of this type of integrated production believe that Industry 4.0 has the potential to change the very definition of human labor [7]. Because machines can perform repetitive, routine tasks in production with far more efficient than humans, these tasks will be largely automated. However, for this automation, we need engineers able to create such systems. This raises a number of problems that are not supporters of this technology are often missed. The first of which is the lack of qualified scientific and industrial personnel. With a full range of essential knowledge in the field of Cybernetics, design, programming and so on. It will require a completely new engineering approach-a digital model, as well as a lot of engineers and programmers who will work with it.

Smart devices that can communicate with each other and the digital model will be needed. In this case, the simulation of the control system becomes the most important part of this process.

Therefore, we propose to develop an international “JavaMach Cluster”. “JavaMach Cluster” is a cluster that unites on a voluntary basis by organizations and people on a single principle: use of the Java programming language for solving engineering. “JavaMach Cluster” is a voluntary Association of departments and enterprises of mechanical engineering based on Java platform. The purpose of “JavaMach Cluster’ create Cluster – the establishment of a unified educational, scientific, practical platform and the core of mechanical engineering based on the use of the Java programming language and Web technologies. The initiative to create “JavaMach Cluster” belongs to the Department of Engineering Technology and machine tools NTU "KPI". There are several reasons for the urgency of creating a cluster. The first is due to the need for interactive representation of the Department in the Internet space, i.e. the creation of a virtual Internet Department. The second is an attempt to combine the efforts of machine-building departments of Ukraine to improve the training of specialists at the junction of information and engineering technologies on a single Java platform. In addition, the third most

important thing is to move from the way of consumers of programs to the way of their creation. The development of this cluster not only solves the problem of training of qualified scientific and industrial personnel.

Maximizing the benefits of the fourth industrial revolution requires massive cooperations that do not limit corporate boundaries, especially when it comes to making sure that all machines speak the same language. If the unfinished product arrives at a machine that cannot read its RFID chip because it is programmed at a different frequency, the production process will turn into chaos. Thus, the definition of common platforms and languages in which machines of different corporations will communicate freely remains one of the main tasks in the spread of cyber-physical systems. “JavaMach Cluster” will also allow us to solve this problem. Because all software products will be developed on one platform. “JavaMach Cluster” offers the development of a single standard for a set of solutions [7].

On the other hand, excessive homogeneity can also be dangerous. Following Google's example, a handful of influential companies may take over the unnatural advantage in Industry 4.0.

Another major security challenge: building secure networks is a difficult task, and integrating physical systems with the Internet makes them more vulnerable to cyber-attacks [8]. With the growth of Industry 4.0, production processes can be terrorized remotely by manipulating the production Protocol or simply paralyzing the process. For as smart factories are becoming more common, their security will become more and more topical issue.

3 The main common cluster tasks

A single platform of communication between the cluster members. Adaptation of mechanical engineering to European standards. Participation in European projects. Creation of a single technological core For Ukrainian enterprises integration of JavaMach-core with CAD/CAM/CAE/ CAPP/ PDM / ERP systems. The main goal is to create an Industry 4.0 level system in the future. On the example of solving the problem "Optimization of selection of billets from rolled products for machining centers" the Department implements in detail the approaches of solving the server part of the project, the formation of databases and features of WEB solutions in the works of bachelors and masters.

We develop a multi-module EPR system for the organization of the strategy of integration of production and operations, human resource management, financial management and asset management, focused on continuous balancing and optimization of enterprise resources through a specialized integrated package of application software that provides a common model of data and processes for all areas of activity [9]. The structure of which is shown in the figure.

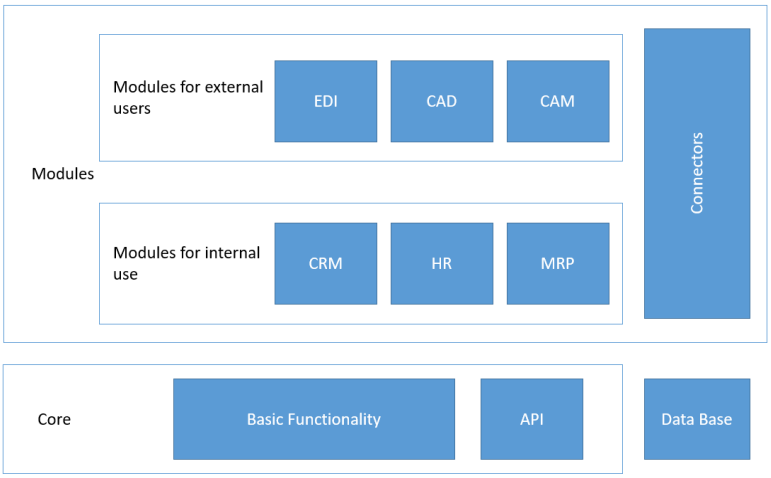

Fig. 2. Structure of the ERP system

The scheme of interests of ERP systems is shown in figure 2.

Platform. The software environment in which the work will be performed (fig. 2 Core). It sets the rules of behavior and interaction of modules, components of the system. Basic functionality, the list of functions without which the system cannot work. Only the developer can make changes to the platform code.

Data. This includes data store on the server, the software for work with databases (SQL or any alternative), instruments for the interpretation and processing of data and sending them to the software modules (fig. 2 Database).

Modules. Components that connect to the platform as needed (fig. 2 Modules). All of them work with the database and use the basic functionality. In General, modules should work independently of each other, and should "seamlessly" connect and disconnect if the need for them disappeared. This paradigm fits perfectly into the concept of micro-services. In addition, is - an important feature of the ERP-system. Modules can be divided into several types:

- Internal use modules (fig. 2). They are intended for internal use in enterprises. These are personnel management, warehouse management, technical module (CAD/CAM/CAE), information module, logistics, and supply and procurement management. Modules can be connected, disabled, configured.

- External use modules (fig. 2). They are intended for interaction with external users, potential and real customers of the company, partners, and users of products, suppliers and buyers. It can be an online store, personal accounts for suppliers and customers on a corporate website and similar solutions.

- Connectors (fig. 2). Ready-made solutions for communication with third-party applications. They allow you to integrate data exchange, telephony, mail, and accounting. That is, with those systems that are not usually included in the ERP but are already used in the company.

Advantages of our ERP system. This system is designed to help the staff of the enterprise, taking over the solution of certain tasks, including:

- Improving the efficiency of enterprise management,

- Data availability. Once entered, the data is available throughout the system and no reconciliation, no additional approvals and checks are required [10],

- Ensuring reliable accounting, control of income and transparency of cash and material resources,

- Organization of effective planning and forecasting,

- Control over the work of employees,

- Improving the efficiency of data exchange between all divisions of the company.

We build these systems based on micro-services architecture. This is a modern representation of service-oriented architecture used to create distributed software systems [11]. The modules in the micro-services architecture interact with each other to accomplish the goal. Micro-services are an architectural style in which large complex software applications consist of one or more smaller services. Each of these micro-services focuses on one task, which is a small business functionality.

4 Conclusions

Industry 4.0 is moving by leaps and bounds. Combining different technologies. Therefore, we propose the concept of using "JavaMach Cluster" as the center of a single educational, scientific, practical platform of the core Industry 4.0 based on the use of a single standard and Open Source technologies. Also, the structure of the ERP system developed by us was presented. The creation of such a cluster for solving the problems of the industry requires the unification of efforts of many countries in Europe.

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