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INTERNATIONAL INNOVATION NETWORKS AS NEW STAGE OF INNOVATION DEVELOPMENT[1]

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Features of innovation structures evolution are considered in article. New level of innovation models that is based on the interaction between different innovation systems is offered. Features of innovation networks as perspective form of integration are considered, author's classification of the international innovation networks is offered. Examples of functioning of the EU international research networks are reviewed.

Keywords: *technology transfer, international collaboration, innovation networks, innovations.*

Introduction. Features of social and economic processes evolution and innovations globalization indicate that scientific approach to the strategic management has to evolve constantly. Under the internationalization in the sphere of high technology conditions there is a problem of searching optimum forms of the international interaction. These forms include the formation of innovation networks that are economical and technological form of the world innovation market development.

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That creates a chain of value. The combination of factors of production occurs the greatest efficiency for future innovation. As a result the certain economic subject does not need to be the best in everything: it is enough to be the best in its field and just to maintain the relations with the enterprises which are the best in the sphere.

Analysis of recent researches and publications. The problem of analysis of a network form for the organization of innovative process features is considered in the works of Gordenko G.V. [2], Dyatlov S.A. [3], Luksha O. [5], Ratner S.V. [5] and some other scientists. These researches emphasize the importance of cooperation and selection of it's the most effective forms.

It is noted in research that about two thirds of successful innovations in the USA are connected with any forms of cooperation between the companies, and also between the companies and public sector (government agencies, federal laboratories) and universities.

Innovations become result of more and more difficult interactions between firms, thus the role of federal financing increases. According to experts, efficiency of the network organization of any activity is that its result increases nonlinearly with a network scale growth, each unit of a network gains additional effect from simple increase in quantity of units [2].

Dyatlov S.A. [3] notes that these features characterize the transition of all countries in the world to the global information network economy, the sixth techno-economic paradigm, that is caused by development and adoption of new breakthrough and integrated network technologies till 2020-2030 (including those are based on the convergence of Cosmo-, Nano-, Bio- and Information technologies), which cover all areas and levels of socio-political, financial and economic spheres, as well as the formation of a qualitatively new global economic order.

Previously unsettled problem constituent. The analysis of the specified works showed that the international aspect of development and an assessment of networks potential in particular in the sphere of high technologies and their support and transfer must to be analyzed more carefully.

Main purpose of the article is the analysis of the international innovation networks as new form of innovation development.

Results and discussions. Globalization of economic relations, production internationalization, openness of national economies, liberalization of world trade, transfer of technologies move up the competition into the global character. Upto the present the sharpening contradictions and increased competition at almost all levels, sectors and types of world and national markets is observed. The competitiveness of goods and services in world markets has become the main condition for the success of the economic activity of countries, corporations and individual innovators.

In the context of the innovation technologies evolution the changing of models for innovation development and interaction is happening, and it is illustrated in the

following way (Fig. 1). At the present days the internationalization of innovation systems forms a new level of interaction, which we propose to call International Helix. In modern innovation theories it is noted that the basis of innovation system is that interaction and an exchange of knowledge need to be carried out near the sources of knowledge from the different innovation systems (the enterprises, universities, the research centers, consumers, suppliers from the different countries).

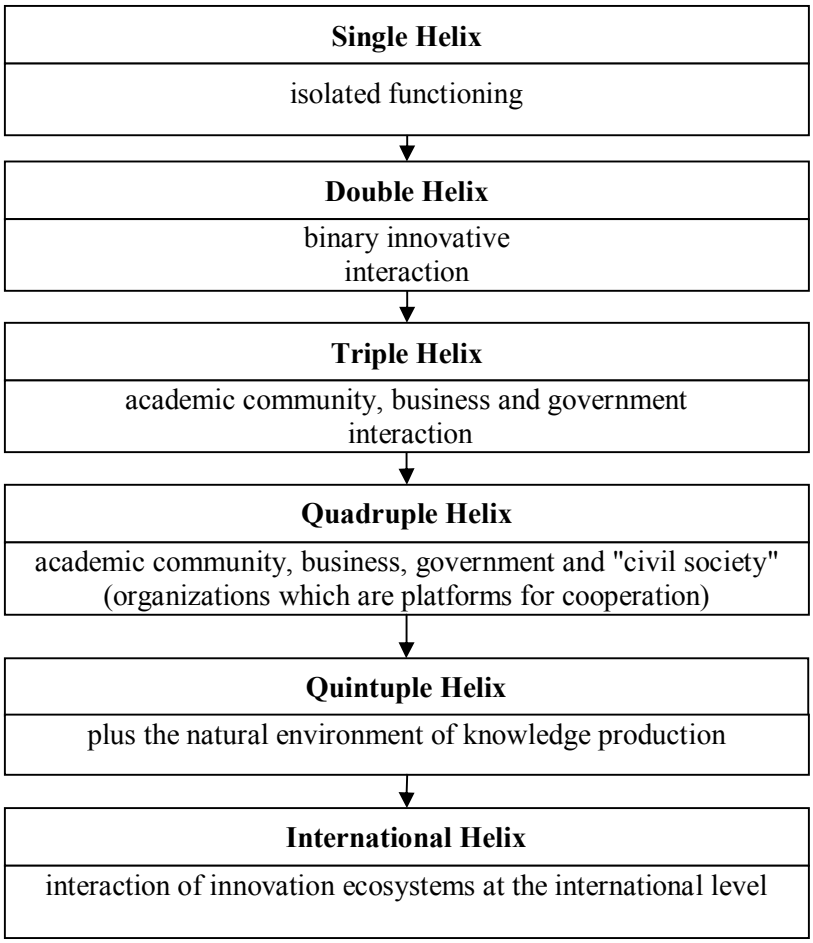

Fig. 1. **Evolution of innovation development models**
(designed by authors)

In the Quintuple Helix and International Helix models we suggest to consider an ecosystem of innovations as the self-organizing system where there is available all complex of the resources necessary for creation and growth of the innovative and technological companies, and the relationships between numerous participants of innovative process are streamlined and harmonized.

Based on this we can say that the emergence phenomenon of the unique innovative centers is not episodic in social and economic systems (the most known

example is the Silicon Valley in the USA) where all participants of innovative process naturally «concentrate» and where they can be in territorial close to each other for the best interaction (Fig. 2). Thus each innovation system at the different levels (the region, the country) is unique because it is based on specific type of economic culture.

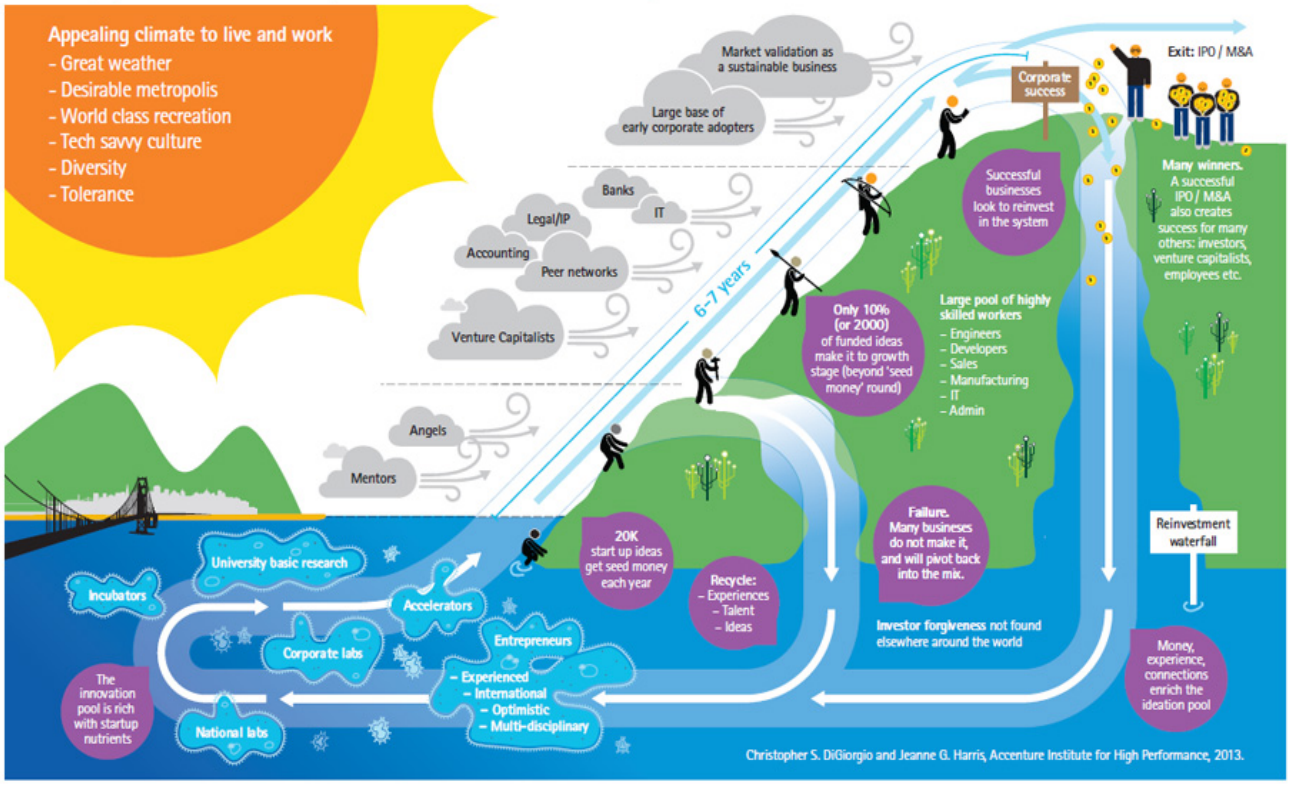

Fig. 2. **Silicon Valley Innovation Ecosystem** [15]

Competitiveness and advantage of knowledge development systems are also determined by adaptive possibilities of innovative process participants to unite different knowledge and innovation technologies through «co-development» (cooperation). In this case the new Quintuple Helix and International Helix models provide existence of platforms with open architecture where different types of knowledge can be combined.

Generally four strategic models of firms' collaboration which focused on achievement of essentially different strategic objectives are recognized [4, p. 9-10]:

1. Collaboration in the supply chain, which recognizes the fact that delivering products or services to the final consumer is more effective when interacting with strategic suppliers and customers are carried out in the framework of relations of cooperation.

2. Collaboration based on abilities. When necessary knowledge and experience for realization of the organizations strategy are provided with the third party.

3. Collaboration on the basis of the supply. It is based on the understanding that the supply of the product or service for consumers is only possible by combining the resources of two or more organizations.

4. Competitive collaboration which is based on the M. Porter`s concept of the market power as means of mutual benefit receiving.

The organizational tools of realization of these models are considerably evolved (Fig. 3) and today include strategy of creation of innovations ecosystems, the international alliances, industrial clusters and other forms of the organization and development of business which allow to get access to the qualified labor, new knowledge and technologies.

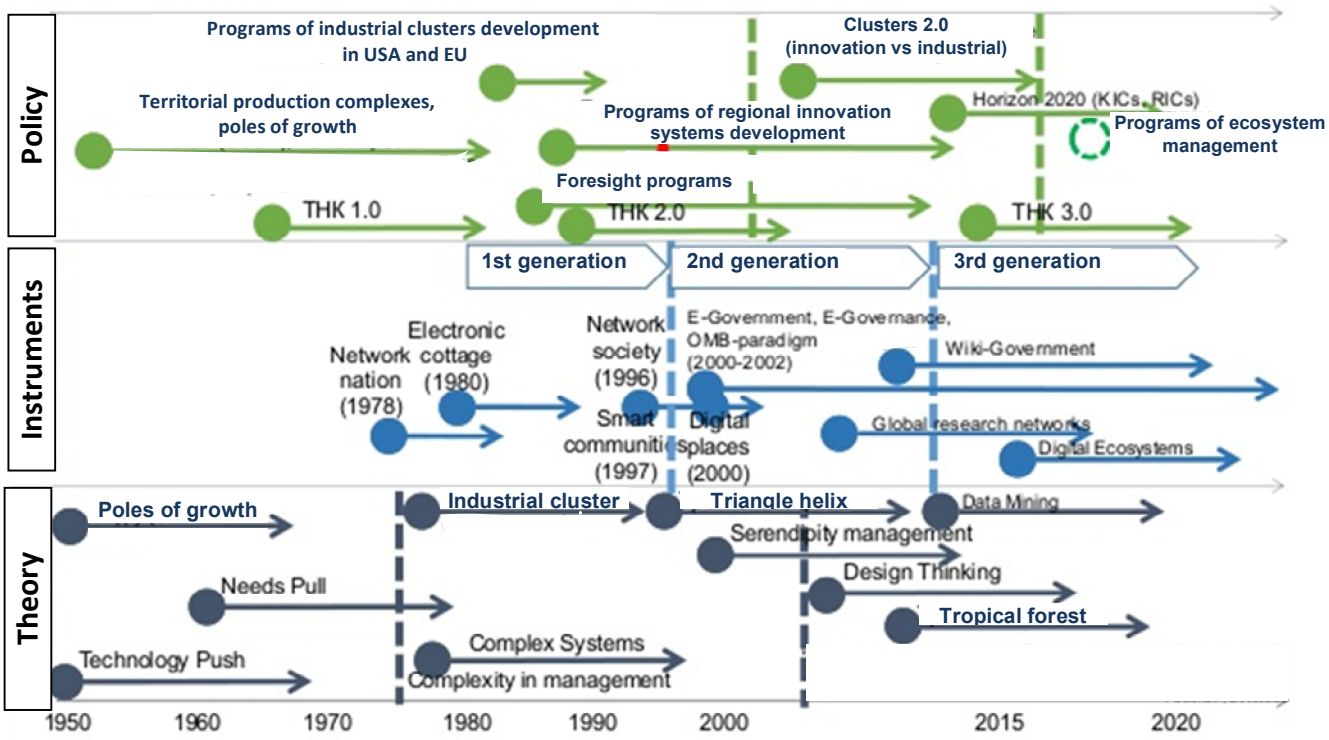

Fig. 3. **The evolution of innovation development mechanisms** [7]

We believe that today among the tools that can ensure the implementation of the provisions of the models Quintuple Helix and Helix International, we must highlight the innovation network that represent optimal hybrid form and occupies an intermediate position between market and hierarchy, and that is a new stage of innovation development models.

In General, a network is a form of business organization based on the formation of legally independent enterprises in a single space with the purpose of sharing technological resources for the implementation of all stages of the execution

of works and rendering of services from primary sources of raw material before the transferring production to the final consumer [8].

In the early nineties the attention of economists moved from integration to creation of networks as a result of understanding the need for expansion of cooperation. Because in order for the company to be innovative, it should not simply combine different units around the innovation process (project), but also create and strengthen lasting networking with customers, suppliers and other institutions.

Among the reasons for the emergence of innovation networks we distinguish:

1) the expansion of international scientific and technical collaboration for the implementation of large-scale projects (basic research, the space industry);

2) development of the markets for hi-tech production;

2) globalization in world economy;

3) development of the Internet and increase of availability for technological platforms of a number of fast-growing sectors.

In modern innovation theories (H. Etzkowitz, L. Leydesdorff, P. A. Gloor, M. G. Russell) it is also noted that the basis of innovation system is that interaction and an exchange of knowledge in the context of model of open innovations and high technologies is carried out taking into account a number of sources of knowledge from different innovation systems (the enterprises, universities, the research centers, consumers, suppliers) from the different countries. That way, networks can gain the international character more effectively.

Based on the conclusion that the international innovation networks are one of the new tools, we propose the following sequence of their development on the basis of the innovation cycle:

1) research networks that are focused on fundamental research;

2) research networks that combine both fundamental and applied research;

3) the technology transfer networks as a set of partnerships between academic and industrial organizations, providing rapid commercialization of research results;

4) scientific-production networks as a set of scientific, educational and industrial partners, that are united by a common goal, which aims to support all phases of the innovation cycle;

5) strategic network is a kind of scientific production networks, where additional development is a long-term strategy for all participant on the basis of their relationship.

Today networks of the first two types are most developed. The others pass a stage of the formation.

For performance evaluation of networks, we propose to consider the completed project EGEE (Enabling Grids for E-sciencE), which is a network of the second type. The Enabling Grids for E-sciencE project is no longer active. The distributed computing infrastructure built and nurtured by the projects DataGrid (2002-2004),

EGEE-I, -II and -III (2004-2010) is now supported by the European Grid Infrastructure.

Grid computing is the collection of computer resources from multiple locations to reach a common goal. The grid can be thought of as a distributed system with non-interactive workloads that involve a large number of files. Grid computing is distinguished from conventional high performance computing systems such as cluster computing in that grid computers have each node set to perform a different task/application.

Grid computing offers a way to solve Grand Challenge problems such as protein folding, financial modeling, earthquake simulation, and climate/weather modeling. Grids offer a way of using the information technology resources optimally inside an organization. They also provide a means for offering information technology as a utility for commercial and noncommercial clients, with those clients paying only for what they use, as with electricity or water.

Grid computing is being applied by the National Science Foundation's National Technology Grid, NASA's Information Power Grid, Pratt & Whitney, Bristol-Myers Squibb Co., and American Express.

Virtual grid organizations in the field of scientific research are, in fact, an international networks of research institutes and laboratories. They have no legal status, but can and already very effectively solve scientific problems.

260 centers from 55 countries took part at the stage 3 of the project . Among partner centres can be distinguished the follows BalticGrid, SEE-GRID, EUMedGrid, EUChinaGrid, EUIndiaGrid, EELA, Naregi, OSG, TeraGrid (Fig. 4).

Fig. 4. **Leading international and national GRID-projects in EU, USA and Asia**

The project as an international innovation network has provided such benefits to its members:

- simplified access. EGEE reduces the costs, which connected with a variety of the systems of the accounting of users which aren't connected among themselves. Users can join in the virtual organizations with access to grid-infrastructure which contains working resources necessary to each user.

- performance of calculations on demand. Grid-technologies considerably reduce a waiting time of access to them distributing resources more effective.

- geographically distributed access. The infrastructure is available from everywhere where good access to the network is provided. Resources become widely available.

- extremely large amount of resources. Due to the consistency of resources and user groups, in the framework of EGEE for applied work will be available resources such amounts, which neither computer center in the world may provide.

- sharing of the software and data. Thanks to uniform structure of computing means, in EGEE it is easy for users to share the software and databases and to develop the software.

- high level application support. The competence of all members of EGEE provides a thorough, comprehensive support for all major applications.

Now Core Values of European Grid Infrastructure (EGI) are:

1. Leadership: EGI is a leading pan-European infrastructure, integrating worldwide computing, storage and data resources to support an ecosystem built on innovation and knowledge transfer.

2. Openness: EGI operates collaboratively with a transparent governance structure that integrates the views and the requirements of all stakeholders, from research communities to resource providers.

3. Reliability: EGI provides a reliable infrastructure that research communities can depend on in order to collaborate with their peers and deliver innovation.

4. Innovation: EGI will continue to meet the needs of research communities operating at unparalleled geographic and technical scale by partnering to bring new technologies into production.

The Enabling Grids for E-science project based in the European Union and included sites in Asia and the United States, was a follow-up project to the European DataGrid (EDG) and evolved into the European Grid Infrastructure. This, along with the LHC Computing Grid (LCG), was developed to support experiments using the CERN Large Hadron Collider. A list of active sites participating within LCG can be found online as can real time monitoring of the EGEE infrastructure. The relevant software and documentation is also publicly accessible. There is speculation that dedicated fiber optic links, such as those installed by CERN to address the LCG's data-intensive needs, may one day be available to home users thereby providing internet services at speeds up to 10,000 times faster than a traditional broadband

connection. The European Grid Infrastructure has been also used for other research activities and experiments such as the simulation of oncological clinical trials.

The distributed.net project was started in 1997. The NASA Advanced Supercomputing facility (NAS) ran genetic algorithms using the Condor cycle scavenger running on about 350 Sun Microsystems and SGI workstations.

In 2001 United Devices operated the United Devices Cancer Research Project based on its Grid MP product, which cycle-scavenges on volunteer PCs connected to the Internet. The project ran on about 3.1 million machines before its close in 2007.

As of 2011, over 6.2 million machines running the open-source Berkeley Open Infrastructure for Network Computing (BOINC) platform are members of the World Community Grid, which tops the processing power of the current fastest supercomputer system (China's Tianhe-I).

The next level of networks` development is technology transfer networks which are directed in touch sciences and productions.

In the context of the analysis of the international technology transfer that represents «a complex of the long, average and short-term mutually beneficial economic relations of its subjects concerning transfer of a technological package taking into account their economic interests and intensity of rivalry in the market» [1, p. 8], to consider innovation networks during the developing, transferring and supporting of use of technologies is offered.

The main function of the international networks of a technology transfer this effective distribution of information on technologies and knowledge and searching of new opportunities for implementation of the general innovative projects on its basis [5]. Proceeding from it, the general requirements to instruments of network interaction that are used in networks of a transfer of technologies are follows: to render assistance to the most effective exchange of information between participants of innovative activity.

The international character of a network provides realization of functions of a network at the global level that provides stimulation of transition from local to global competitiveness. The specified transition significantly complicates functioning of networks at the expense of increase in number of participants that causes differentiation of their tasks and approaches to financing, creation of network communities, selection, to granting and structuring services.

Thus, all management models of partners interaction of potential international network structures are quite perspective both for the innovation sphere, and for improvement of quality of life in different spheres (production of goods and services, health care, education, culture, ecology, town planning, municipal management).

Conclusions and further researches directions. The international innovation network answers new reality such as to an information field of competences and technologies that self-organized. Networks can be guided by increase of enterprise

potential, the solution of problems of contacts and communications within the country, and also at the international level, market validation of ideas, i.e. those questions that remain barriers to business.

Overcoming of barriers of innovative activity on the basis of new organizational approaches will help to stimulate growth of enterprise culture of network communities on a global scale. Therefore in the context of a state policy it is expedient to stimulate development of the network organizations in the sphere of a technology transfer and communication of academy with industry and to create conditions for creation of network interaction between the organizations which take part in production of an innovative product or service. Realization of the specified actions will allow reaching a scale effect of the international activity of innovative firms (creation of innovative agglomerations and landscapes).

In further researches it is necessary to put into practice methods of tools interaction of virtualization innovation systems with real for the purpose of the saved-up experience transfer, the intellectual capital, new models of management and communication of big groups of people, positive experience of effective institutes of virtual community and its norms.

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МІЖНАРОДНІ ІННОВАЦІЙНІ МЕРЕЖІ ЯК НОВИЙ ЕТАП ІННОВАЦІЙНОГО РОЗВИТКУ

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У статті розглянуті особливості еволюції інноваційних структур. Запропоновано новий рівень інноваційних моделей, що базується на необхідності взаємодії різних інноваційних систем. Розглянуто особливості інноваційних мереж як перспективної форми інтеграції, запропонована авторська класифікація міжнародних інноваційних мереж. Розглянуто приклади функціонування міжнародних науково-дослідних мереж ЄС.

Ключові слова: *трансфер технологій, міжнародне співробітництво, інноваційна мережа, інновації.*

МЕЖДУНАРОДНЫЕ ИННОВАЦИОННЫЕ СЕТИ КАК НОВЫЙ ЭТАП ИННОВАЦИОННОГО РАЗВИТИЯ

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В статье рассмотрены особенности эволюции инновационных структур. Предложен новый уровень инновационных моделей, что базируется на необходимости взаимодействия разных инновационных систем. Рассмотрены особенности инновационных сетей как перспективной формы интеграции, предложена авторская классификация международных инновационных сетей. Рассмотрены примеры функционирования международных научно-исследовательских сетей ЕС.

Ключевые слова: *трансфер технологий, международное сотрудничество, инновационная сети, инновации.*