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# DEVELOPMENT OF EDUCATIONAL AND RESEARCH SEGMENT OF INFORMATION SOCIETY IN UKRAINE

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The Grid-infrastructure for support of education and research in Ukraine is considered. Main components of this infrastructure are: Ukrainian Research and Academic Network, 128-processor cluster supercomputer, the system of distance learning, distributed information resources in education and science, electronic libraries and the administrative and educational system **"**Osvita**".** Grid-infrastructure provides the Ukrainian universities, research centers and virtual laboratories by the information and required computational resources. In conclusion an example of using the Ukrainian research and educational Grid-infrastructure for solving problems of ecological monitoring and telemedicine support for the Chernobyl nuclear power plant area was considered.

## 1. INTRODUCTION

For a long time, Ukraine and Russia had strong traditions in the field of cybernetics, mathematics and computer sciences. For example, in 1952 Ukraine was the third after USA and Great Britain to build up the computer. In spite of some social and economic problems, Ukraine has made some steps, especially after Geneva's WSIS-2003, in the direction of creating of the information society. This aim was recognized as on of priorities of the state. First of all, a number of the related laws were adopted. Among them — the Order of the President of Ukraine, more than 30 legislations and laws, the State program "Information and communication technologies (ICT) in education and science for 2006–2010". These legislative acts are regulating the relationships between state institutions, professional communities and business in the creating of all segments of the information society.

## 2. EDUCATIONAL AND RESEARCH SEGMENT OF INFORMATION SOCIETY OF UKRAINE

The educational and research segment is one of the most important elements of the information society. This segment includes two major directions: an extensive implementation of information and communication technologies at all stages of education and research process and the information management of this area. The main objectives of **the first direction** include:

- Creation of Grid-infrastructure for support of education and research.

- Infrastructural development of the Ukrainian research and academic network and integration it to the European networks GEANT and GEANT – 2.

**The second direction** is aimed at:

- Implementation of efficient information management of the education and research area.
- Development of facilities for storage, processing and open access to the research and educational information resources (data bases, archives, etc.).

The largest components of the Grid-infrastructure for support of education and research are (fig. 1): the Ukrainian Research and Academic Network [1], the system of distance learning, distributed information resources in education and science, electronic libraries and the administrative and educational system, named "**Osvita"**

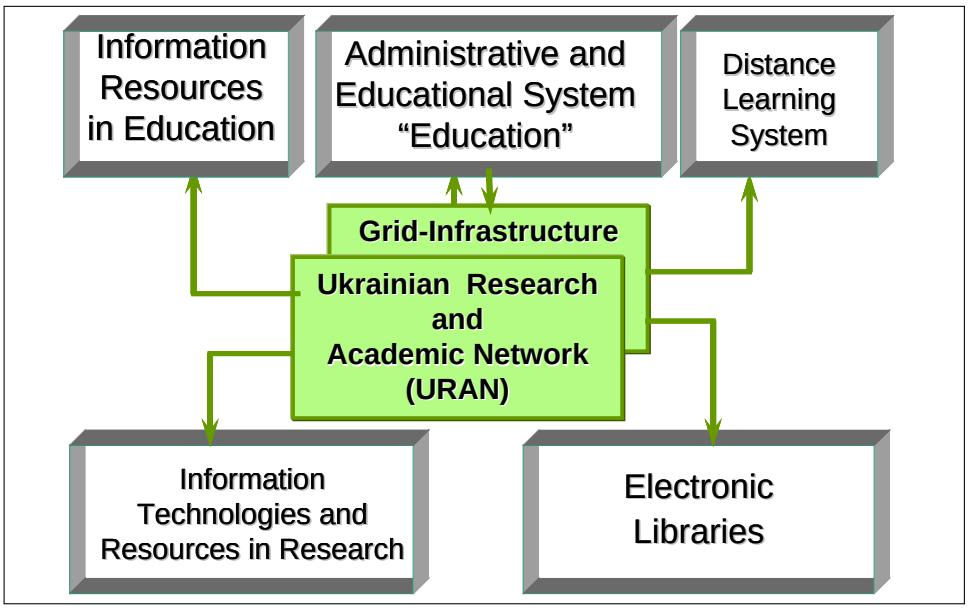


*Fig. 1*. Grid-Infrastructure for Support of Education and Research

The architecture of **Research and Academic Network (URAN)** is shown in fig. 2. The backbone of URAN is based on the main nodes in six largest cities of Ukraine — Kiev, Kharkiv, Dnepropetrovsk, Lviv, Odessa, and Donetsk. Totally, 20 out of 26 regions of Ukraine are connected to the network**.**

The total open access traffic of URAN has increased 50 times within the last 5 years, and today it constitutes 1.5 terabyte per month. In every region both the optic fiber and satellite communication segments are developed, which ensure the rate of data transfer up to 1 GB/s.

A selected way of the URAN infrastructure development is based on the dark optic fiber cables. The signal to these fiber cables is supplied by the customer (Customer Empowered Fiber — CEF). As seen from the experience of many countries, for example, the Netherlands, Poland, Hungary, the Czech Republic and others, this approach in the frameworks of one and the same budget can increase the system efficiency by 100 times. Other advantages of CEF-infrastructure have also been taken into consideration. It was also important for us, that the European research multi-gigabyte network GEANT–v2 is mostly based on dark fiber.

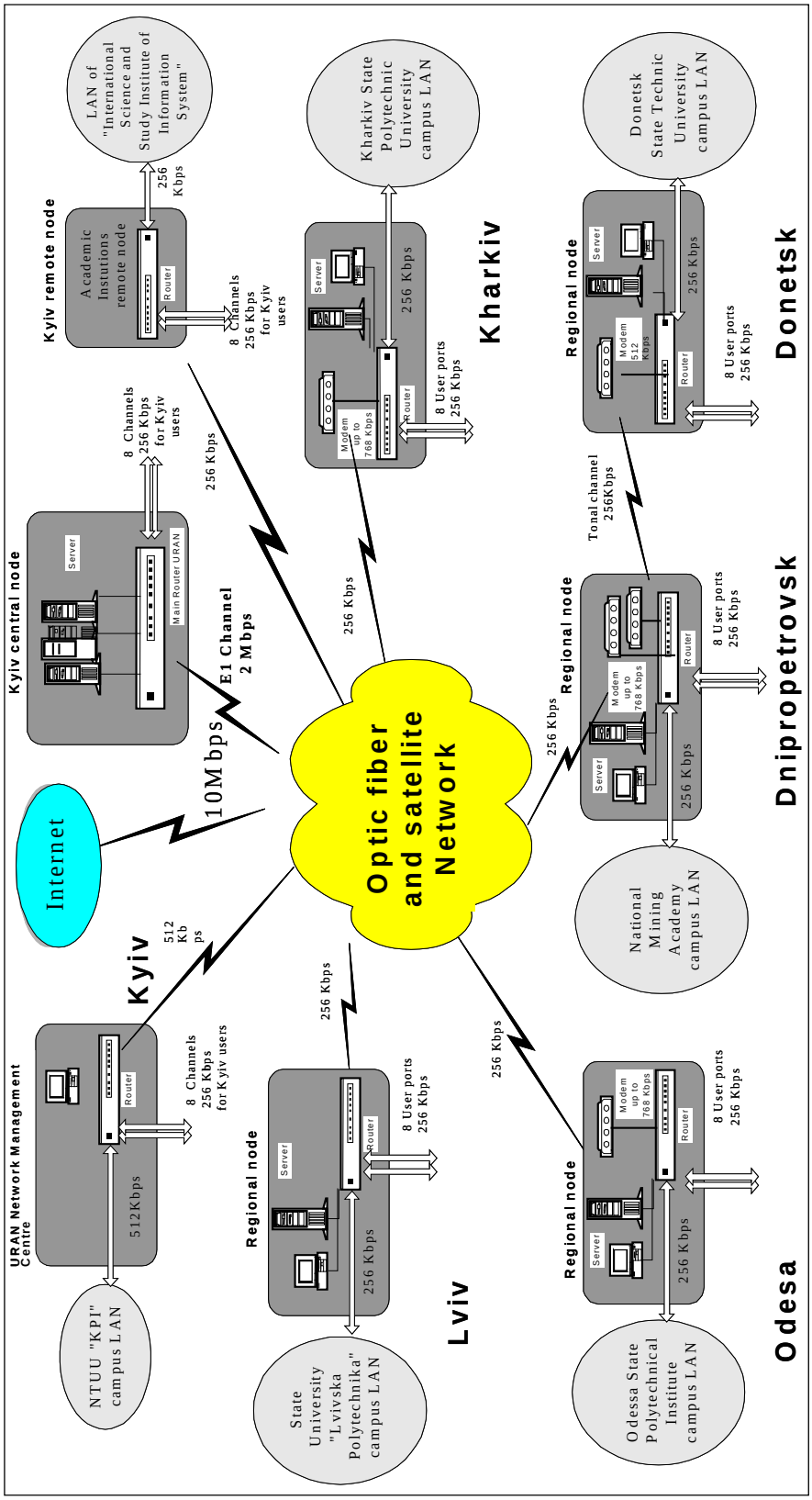


*Fig. 2.* The architecture of Ukrainian Research and Academic Network

One more important characteristic of URAN is its orientation to the project "Porto Optica" ("optic doors"), which is initiated by the Association of research and educational networks of the Central and Eastern Europe — CEENet and aimed at decreasing of a "great digital divide". The objectives of the project are:

- To study the possibility of development of regional and international CEF-segments of the research and educational networks in Eastern Europe with the aim of their connection to GEANT-2.
- To be the development and beginning of operation of the CEF-infrastructure of the national (including Ukrainian) research and educational networks.

Development of national research and educational networks remains in the focus of attention of the European Commission and Trans-European Research and Educational Networks Association (TERENA). But, first of all, it should be the decision of the national governments.

**The next segment of the Ukrainian Grid-infrastructure is the distance learning system** (fig. 3). This system comprises:

- Coordinating and providing centers.
- Distance learning and professional orientation centers.
- "Central and Eastern European Virtual University" (CEEVU).
- Educational and research institutions, who are developers and users of distance learning resources.

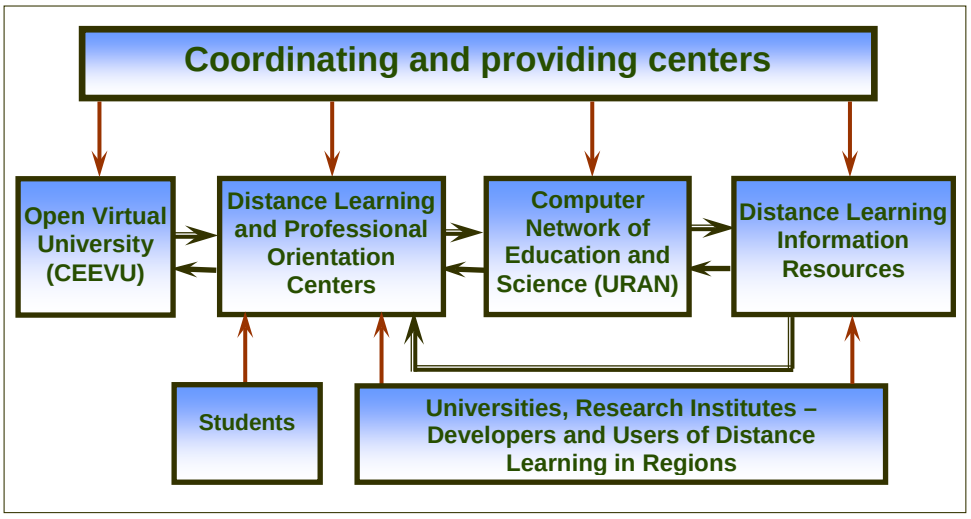


*Fig. 3.* Distance Learning System at the National Level

At present, in Ukraine there are more than 20 regional nodes of distance learning system, which are connected in the integrated medium by URAN network.

The CEEVU project unites, under the aegis of UNESCO, thirteen partners from eight countries of Europe. They are: Eastern European Networking Association (CEENet,), Technical University of Sofia (Bulgaria), Brno University of Technology (Czech Republic), University "Polytechnic of Bucharest" (Romania), Kaunas University of Technology (Lithuania), State Engineering University of

Armenia, Tallinn University of Technology (Estonia), National Technical University of Ukraine "Kyiv Polytechnic Institute" (Ukraine), Lviv Polytechnic National University (Ukraine), National Technical University "Kharkiv Polytechnic Institute" (Ukraine), Donetsk National Technical University (Ukraine), International University of Finances (Ukraine), Virtual University of Europe – NETTUNO (Rome, Italy). The directions of collaboration and main objectives of the virtual university are the joint educational and research activities of all partners, development and use of electronic educational facilities, distance learning in accordance with the coordinated educational programs.

The partner-universities develop joint distance courses and arrange the teaching process. The coordination center of CEEVU provides technical support of the distance learning system. The information resources of the virtual university have the distributed structure with the open access to users by connecting to the servers of the university centers. Education is based either on the curricula of the chosen university, or on jointly developed programs of CEEVU. Students are free to choose either of these curricula.

**The third segment** of the Ukrainian Grid-infrastructure (fig. 4) provides the Ukrainian universities, research centers and virtual laboratories by **the information and required computational resources**. On the first stage it gives the opportunity of the remote access to the data bases in different fields, for example, economics, natural sciences, ecology, medicine, telemedicine and others.

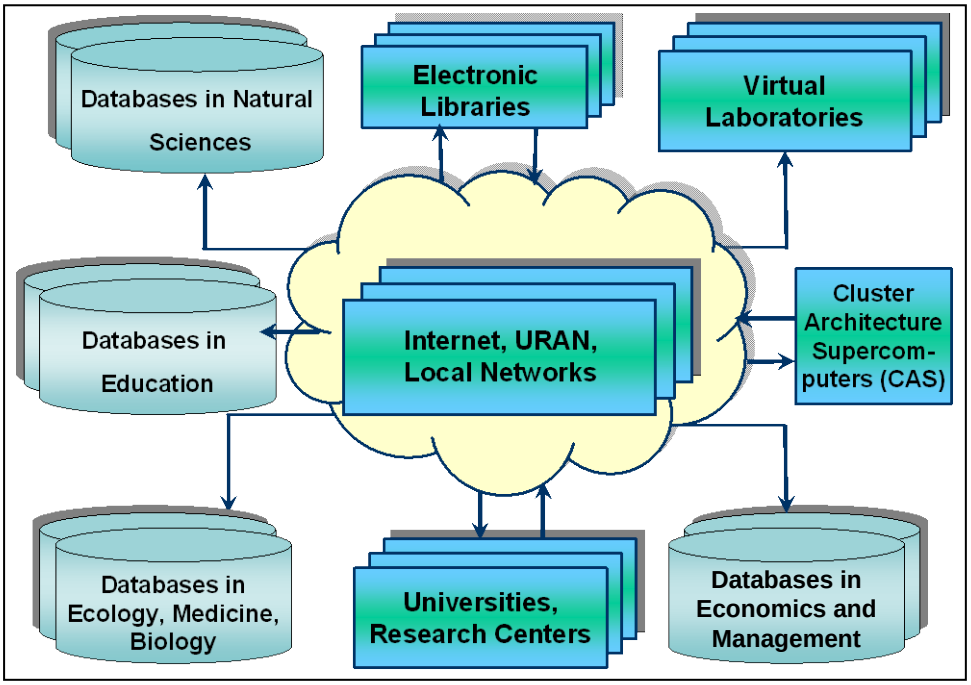


*Fig. 4.* Information and Computational Resources of Science and Education

At the Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine two cluster architecture supercomputers (CAS 1 and CAS 2) have been developed and put into operation [2]. On the second stage they planed to be connected to the Ukrainian Grid-infrastructure by the research and academic

networks. It will allow research centers and universities from different regions of Ukraine to be connected to these supercomputers for solving problems with great volume of computations. In the construction of this supercomputers there were used the distributed data bases and 15 new intellectual technologies developed by Ukrainian mathematicians and engineers. The computational characteristics of these supercomputers are represented in Table.

Computational Characteristics of the Supercomputers CAS-1, CAS-2 (64-digit computation)

| **Description** | **Characteristics** | |
|---|---|---|
| | **CAS-1** | **CAS-2** |
| Peak performance per 1 processor (Gig hertz = 1×109 hertz) | 2,67 | 1,4 |
| Integral operations per sec. (IPS) | $1{,}34 \cdot 10^9$ | $5{,}6 \cdot 10^9$ |
| Operations with floating point (FLOPS) | $5{,}34 \cdot 10^9$ | $5{,}6 \cdot 10^9$ |
| **Total peak performance** | | |
| Integral operations per sec. (IPS) | $4{,}3 \cdot 10^{10}$ | $3{,}58 \cdot 10^{11}$ |
| Operations with floating point (FLOPS) | $1{,}7 \cdot 10^{11}$ | $3{,}58 \cdot 10^{11}$ |
| Speed of the system bus | 4,2 | 6,4 |
| The cluster real performance at Linpack test (FLOPS) | $1{,}125 \cdot 10^{11}$ | $2{,}8 \cdot 10^{11}$ |

The important task of this segment is also to transform the diverse digital information, which is produced by science, into knowledge. Generally, this process is performed by the hierarchical procedure, shown in fig. 5. The main stages of this p rocedure are:

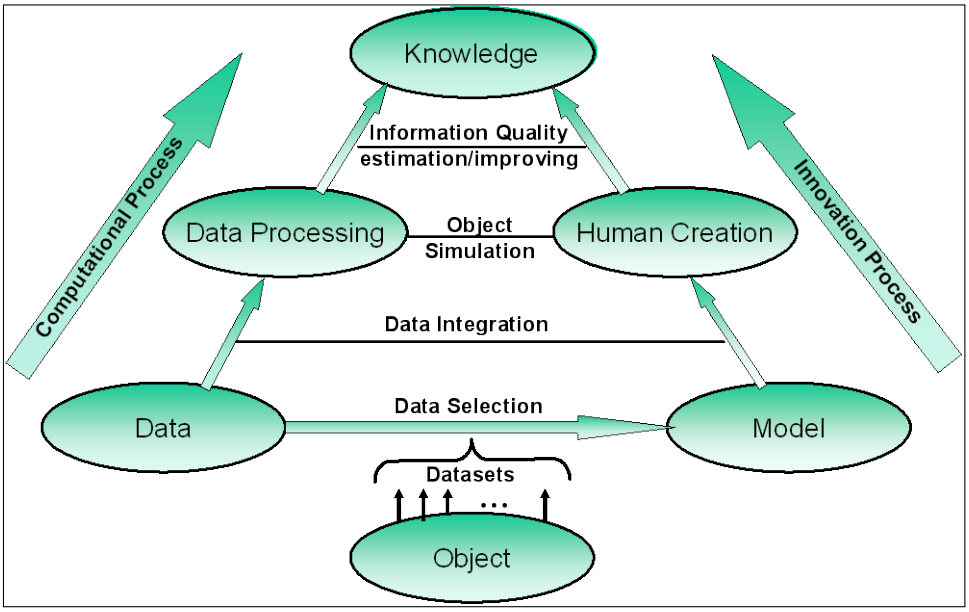


*Fig. 5.* Transformation of Information into the Knowledge

- **Data selection** (two important issues are to be considered at this stage: 1) how to select the necessary data among the distributed data holders, in order to identify the necessity of object modeling for specific goals? 2) how to determine the "weight" (significance) of each of selected datasets?).
- **Data integration** (the datasets compatibility problem at this stage has to be solved in terms of data standardization, termination, formalization, unification, resolution, digitization,...).
- **Object simulation** (at this stage two issues are to be solved: 1) how to establish a relationship between the datasets and selected models? 2) how to determine the parameters of the models?).
- **Information quality estimation and improving** (Issues to be considered at this stage: 1) what should be the quality of new datasets? 2) what conditions are to be provided to ensure a high quality of new datasets or knowledge? 3) are there any ways of improving the dataset quality?

In connection with the above, information and knowledge are interdependente. There is a cycle: Data → Information → Knowledge → feedback loops and mutual beneficiating at each cycle. As a result, improving data and knowledge availability brings many benefits to all participants by integrating everybody into the Global Information Society.

**The fourth segment** of the Grid-infrastructure unites more than 200 electronic libraries in the field of education and science. They include:

- Libraries of the universities (more than 100).
- Libraries of institutions of National Academy of Sciences (more than 50).
- Public libraries (more than 30).
- Libraries of distance learning centers (more than 20).

The system is built upon the unified operational, software and hardware platforms based on the library system ALEPH and contains the information centers, which are connected by optic fiber channels of data transfer of URAN.

**The fifth segment** of the Grid-infrastructure is the National educational and administration system, named "Osvita" (fig. 6). It is a complex of administrative, legal, software and hardware facilities, which ensure automation of a lot of administrative functions and information processes at the national level and follow-up of preparation of state documents on education. Here, their validity and integrity is preserved, and reliable mechanisms are developed for protection of certain segments of information and provision of open access to others.

## 3. EXAMPLE OF APPLICATION OF GRID-INFRASTRUCTURE

In conclusion let us consider an example of using the Ukrainian research and educational Grid-infrastructure for solving problems of **ecological monitoring and telemedicine support** for the Chernobyl Nuclear Power Plant area.

One of the problems arising after the Chernobyl catastrophe is the necessity of continuous control over the state of the sarcophagus above the fourth bloc of the Chernobyl Nuclear Power Plant and the continuous monitoring of the ecologi-

cal conditions of adjacent territories. It carried out by the regional centers of ecological monitoring (fig. 7).

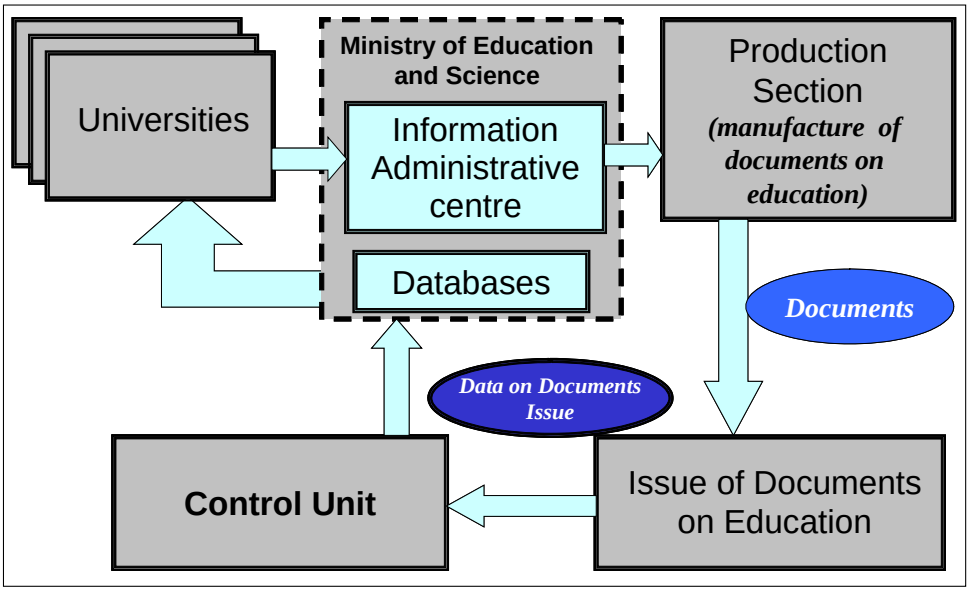


*Fig. 6.* Educational and Administrative System "Education"

The people working at the Chernobyl NPP live in the town of Slavutych, located at the distance of 30 km. from Chernobyl and 130 km. from the capital of Ukraine – Kiev city. More than 84 % of the inhabitants of this town belong to the higher risk group regarding diseases and loss of the working ability. These people need special, high quality medical service and consulting assistance. The obstacle is the insufficient involvement of highly qualified medical personnel, due to the remoteness from the regional center. The total number of those working at the reactor is more then 4300 persons, out of them women - more then 1300. Practically, all the inhabitants of the town are in contact with ionizing radiation.

The purpose of the monitoring system is the analysis of health of various professional groups, taking into account the risk factors. It will make possible to work out individual programs of improving the health recovery. For efficient medical monitoring the express diagnostics system and the system of remote transfer of the analysis and research data are developing. It will make possible to carry out consultations via telecommunication means. The interaction of institutions of the Chernobyl Telemedicine System is shown in fig. 8. This system consists of two main centers. One is the diagnostics and rehabilitation center, which is situated in the town of Slavutych. It carries out monitoring of the main medical factors of those working at the Chernobyl Power Plant and members of their families in accordance with individual programs. These data are transferred via URAN network to the International Center of Telemedicine, which is located in Kiev at the National Technical University of Ukraine "Kiev Polytechnic Institute". Highly qualified medical personnel in the field of medicine are working in this center. They will analyze the data obtained on each patient and work out recommendation on prevention and treatment.

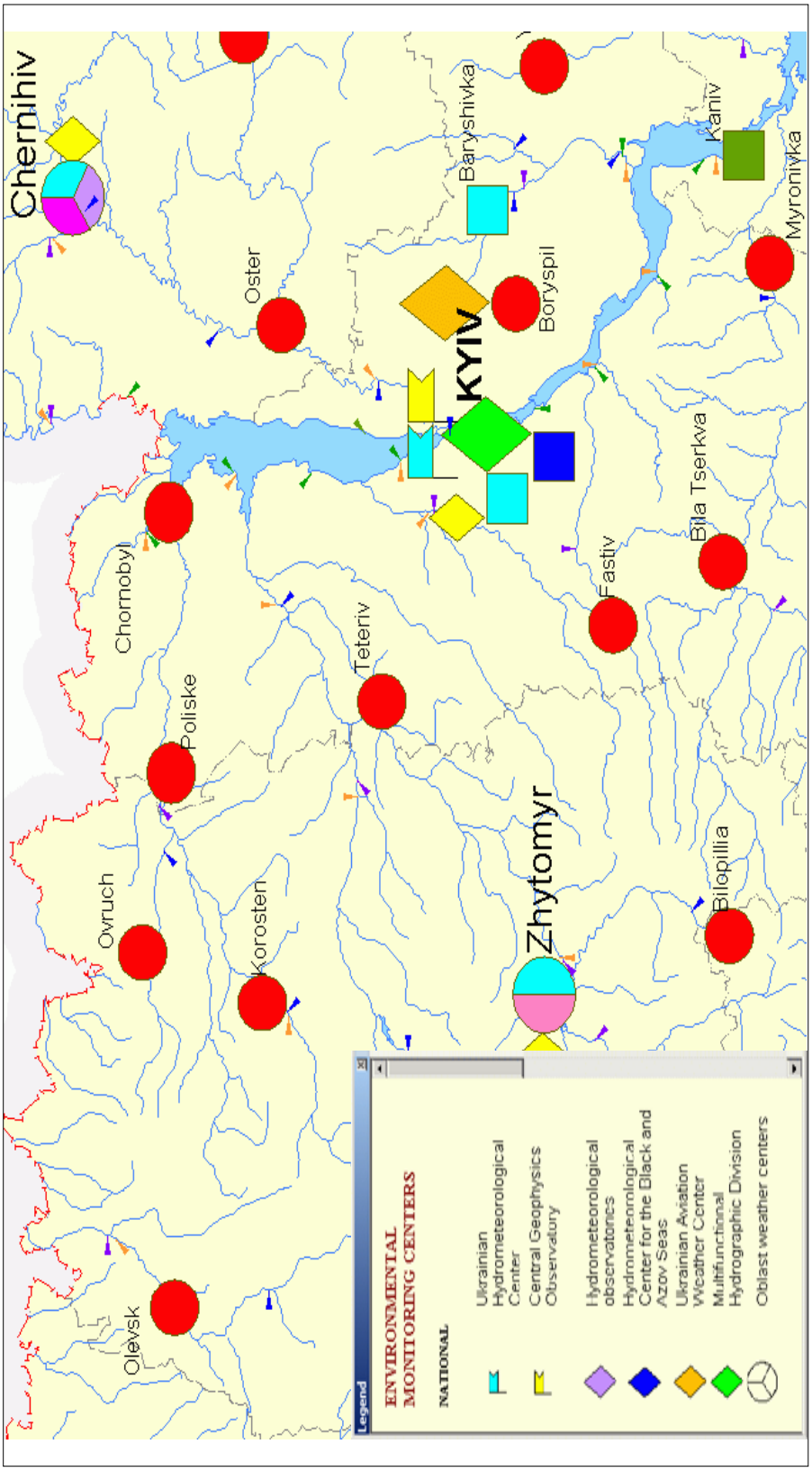


*Fig. 7.* Environmental Monitoring Centers

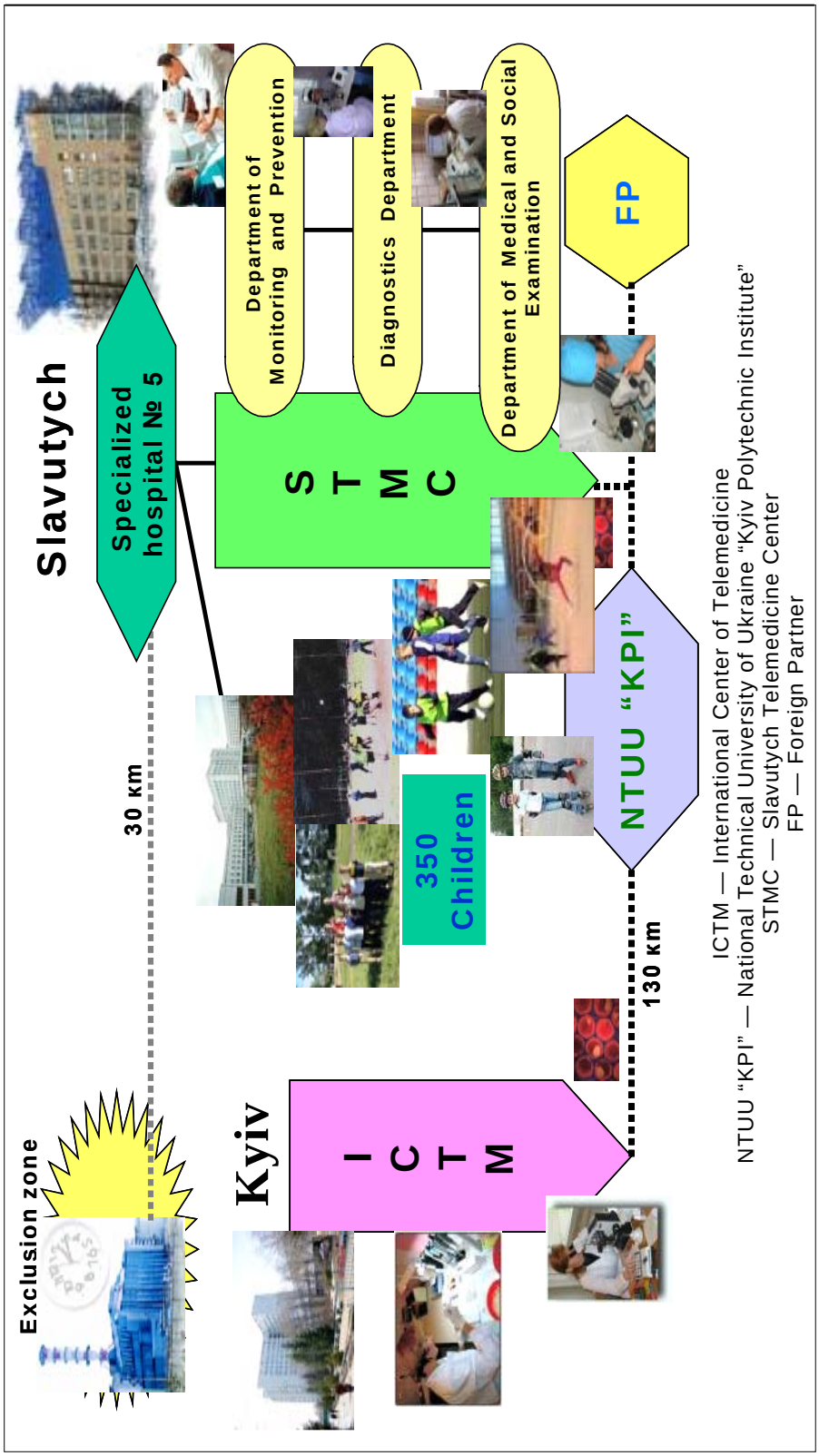


*Fig. 8.* Chernobyl Telemedicine System

## 4. SOME CONCLUSIONS

Achievement of the above indicated goals will allow:

1. Ensure the people's right of open access to important scientific and educational information.
2. Sort out the social problems connected with providing equal conditions for an access to education and science.
3. Create conditions for continuous life-long education.
4. Raise the efficiency of public administration of education and science.
5. Promote Ukraine's integration into the global research and educational area.

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