E-SCIENCE PLATFORM

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Abstract

We introduced the concept and setting up of a new platform to support research, which was worked out in the Information Technology Institute, Academy of Management in Lodz. The platform is the subject of two projects developed in the ITI. The role of e-Science Platform (ESP) is to support distributed research teams activities, whose members work on the same subject but in separated research centers. The ESP provides the research teams tools for effective communication, storage and management of data and information generated during the research, within the so-called the Virtual Research Area (VRA). Many other useful tools for the researchers were also presented. An important element of the project is to initiate and stimulate research, and to give organizational and legal assistance from specialized units operating within the framework of ESP modules.

Key words: e-Science Platform, science management, tools for science

1 Introduction

The new solutions, based on the development of information technology management systems have dominated almost all aspects and areas of human activity. Relatively, in a minor way, these changes affect management of science. Conservatism of the scientific society and deeply rooted in a tradition methodology of scientific research do not introduce the revolutionary solutions. On the other hand, there is a great need to increase the effectiveness of research mainly due to the demands of the economy. This can be done by introducing new technologies, and implementing new solutions. In turn, the economy grows under the influence of the pressure of the society caused by consumer expectations.

Among many barriers which limit science and research, one should indicate those that are closely linked with the reality of today's socio-economic conditions. They are caused by the fact that the process of research has become a team work and it is dependent on the integrated exchange of information and experiences. While the development of the Internet has created excel-

lent opportunities for such exchange in the layer of technology, there are no appropriate solutions for organizational and structural changes. Currently, there are no specialized online tools that would help to integrate effective exchange of information between the scientists interested in the same subject field. Moreover, there is the technological feasibility of creating comprehensive solutions for the scientists conducting research on the same topic in different remote centers which consolidate their efforts. It is possible to create the web, virtual shared working spaces, which are a common place for meetings and joint activities.

Previous attempts to take similar actions in the area of creation of such supporting research platforms were limited to some fragmentary undertaking. For example, even in the cases of the large-scale projects: German eSciDoc [4] and the English VRE Sakai [20] focused almost only on providing an open space for storage and exchanging information and data. Accomplishments of so-called Virtual Research Environments (VRE) move far away from the started assumptions [7], [21]. Many of the developed platforms are dedicated to particular disciplines: neurobiology (Carmen System) [6], geography [16], biology [2], computing [17] and others. Also, grid computing platforms play an important role in e-science [8], [9], but they are designed for the specific power computations and they are only specialized tools.

The aim of this project was to develop new solutions for the management of science research. The particular attention was dedicated to distributed research. Distribution relates to teams, functions, resources and research infrastructure.

The project investigates following issues:

1. Design and implementation of an integrated system providing comprehensive support and maintenance for the research projects to the selected research teams.
2. To create an opportunity for a wide range of scientists to do research, especially for young people starting a career in science, by proposing the research topic, organizing the research team and enable the invention of a competing project. It gives the possibilities of realization of their own activities in the broader range. In consequence, the platform will help to organize support for the project to be realized by each researcher.

2 General Concept

In the area of the management of research, there are many specific solutions, including various applications based primarily on the use of information technology. In contrast to them, the proposed solution can provide comprehensive support for research teams. It is not only the IT system but also the

organizational and personnel infrastructure, whose main aim will be to inform, advise and assist in the formal issues. Such a comprehensive support platform will in particular:

1. Stimulate and initiate the researches by:
   - encouraging communities to undertake scientific research,
   - the assistance in finding and selecting research topics,
   - the support for the creation of research teams,
   - searching for personal and institutional partners interested in cooperation in specific research topics,
   - collecting and providing information on owners of research infrastructure – research equipment, laboratories, specialized software and their willingness to share their resources,
   - providing information on institutions research funding and running research projects in Poland and abroad,
   - the support in preparing grants and applying for them within various research projects and EU structural programs,
   - providing the templates of the documentation, the sample applications and a direct assistance,
   - the legal assistance in the preparation of the contracts and the protection of the intellectual property rights (patents, utility models, implementation).
2. Directly support the research teams by:
   - making available the research project management system,
   - a financial management for ongoing research project,
   - collecting and sharing internal resources of scientific information,
   - providing the tools: the professional scientific software applications,
   - providing the effective tools for finding the scientific information on the Internet,
   - providing the efficient and secure instant messaging systems for the internal research team communication (audio, video, email, electronic board),
   - providing the generator of the presentations of the research results which will be published on the Internet,
   - generating the on-line newsletters (journals),
   - allowing an organization of the virtual conferences and scientific seminars on the web,
   - allowing to create, to install and to configure their own programming and software tools, applications and electronic documents,
   - agency of sharing and leasing specialized software.

3. Promote and market a project by:
   - the promotion of research results and research teams in order to acquire funds for research,
   - organizing a scientific research market (the thematic auctions, a research web-stock exchange, etc.),
   - developing and providing the information about potential clients – commercial institutions and companies interested in buying and implementing new (which would require research and preparation) solutions, technologies, services. This ESP service would be directed to the groups of entrepreneurs interested in investing in the new areas of technology,
   - participating in the sale of research results or in the ordering of the research contracts between academic institutions and business,
   - making possible the cooperation between research institutions – subcontractors in the field of commission of the specialized research,
   - promotion and advertising of the e-platform.

Functions presented above are reflected in the architecture of the system. System – herein referred to as the e-Science Platform or ESP is composed of three functionally separate subsystems:

- Research Initialization Subsystem (RIS),
- Virtual Research Area Subsystems (VRAS),
- Logistic Support Subsystem (LSS).

The subsystems are shown to implement the above task groups, with the complex structure defined by the modular design of the data flows and the corresponding hierarchy of functionality. Some of these functions will be implemented by the personnel of the appropriate departments of the platform staff. This includes the following activities for the demonstration departments:

1. Department of Research Projects:
   - the design of the document templates necessary to apply for grants and research projects available within different programs. This includes the sample papers and examples,
   - the direct advice for the research groups,
   - acquiring and collecting information about ongoing research programs and the potential opportunities for cooperation within them,
   - searching for the personal and institutional partners interested in the specific topics
   - collecting information about owners of the research infrastructure – research equipment, laboratories, specialized software.

2. Administrative Department:
   - bookkeeping support for the projects,
   - the project management,
   - the legal assistance (advice) in the preparation of contracts and copyright protection.
3. Department of Promotion and Marketing:
   - advertising and promotion e-Science Platform (ESP),
   - promotion and dissemination of the research results of each scientific group,
   - the transfer developed technologies into the economy.

Designed methods and IT tools of the RIS will allow to initialize and stimulate research automatically. Some services offered by the system will be public and will only require a standard registration. Some functionalities and services, (services which require the direct involvement of the staff in the preparation of documentation or development of applications), will be made available to e-platform users after signing the contract. We suppose to make them available to public for free during the period of implementation of this project. Free access will make it possible to make research, development and tests of e–science platform. Meanwhile, intensive promotion activities will also be conducted.

3 Architecture of Platform

The VRAS subsystem is the core of the projected system It will be responsible for its key functions: the management and support of the registered research projects carried out by the research teams.

Taking into account today's realities, that is the great staff mobility and the fact that researchers are involved in multiple professional, social and personal activities, one should assume that the research groups are distributed – the personas attached to one projects are located in distant locations. The idea of stimulating the scientific research by using the ESP is based on the concept that such project teams gather around a common interests, rather than a common workplace. The VRAS must deliver appropriate integration tools, to ensure communication to be tailored to their needs. This communication should allow synchronous (on-line) or asynchronous information exchange. The VRAS communicator will be equipped with specialized tools to bring voice, video, text communication (chat, e-mail), tools for on-line sharing of graphics and electronic documents needed for the research. It will be possible to use all mentioned forms of communication simultaneously to provide high level of comfort. It should be noted that many forms of communication are available

in various computer applications, but they are not gathered as one, complex and comprehensive communication system.

Dedicated functionally and structurally space within the server system provided for the needs of the research team is the most important service offered by the VRAS. This service will also provide tools for archiving data. This space will be managed remotely by members of the research teams and will be fully manageable for them. An editable graphical interface will play a very important role and will allow configuring the Virtual Research Area Subsystem. It is assumed that this part of the VRAS will be available to the member of a research group on the individual basis. It is expected that the users of the VRAS will, later on, develop themselves different configuration models and standards, which could set the optimal environment for them. High level of security is an important aspect of the VRAS (data encryption, AAA services), so a suitable level of access will be granted the members of the research teams on a basis of an appropriate agreement.

The VRAS tools will permit:

- to organize the work of the environment of each research team; this includes inter-disciplinary research with the broad means of a communication,
- to realize the group work management,
- to realize the security of all documents and activities of the research team by making the subsystems of the e-platform available only for the members of the registered research groups,
- to realize the project management,
- to realize a trawl of scientific information in global and local networks (the content search),
- to use of the standardized document templates placed into the system library and to update the library with group's own standards and templates,
- to use the software applications library available to registered users of the EPS. The library will be updated by shared software (software produced by the research groups),
- to publish the research results in the electronic bulletin boards and to define the levels of access for others,
- to organize internal, local and global conferences on-line,
- to use of a links library and to update it,
- to use a dedicated search engine.

The shared functionalities above and research environments, procedures and software will ensure that e-work will be effective. They will be realized by administering a part of a platform space as own research team area dedicated to each registered group.

A shared environment of the research team consists of:
- a files server,
- an applications server,
- a library of the dynamic templates of graphical interfaces,
- the software applications allowing to manage information within the shared area,
- the individual subsystems available only to the particular members of particular groups (Individual VRAS – IVRAS).

As a part of ensuring synchronous and asynchronous group communication the following functionalities will be designed:
- the chat-rooms with the possibility of archiving of the discussions,
- the thematic oriented forums,
- a dedicated mail server available to group members, administrative stuff etc.,
- the internal blogs,
- the tools ensured access to a library of files, applications and publications,
- the audio and video conference tools with the possibility of archiving of the conversations,
- a shared board to operate with a common graphical and text editors giving also possibilities to share equations, mathematical formulas, etc.,
- the marked off waveband for video transmission.

The VRAS will safely store: documents, yet raw test results, analysis, parts of unfinished work, common concepts, fragments of source code, models, etc. Depending on the security right either everybody or members of the research groups will be granted simultaneous access to the stored data. Within the VRAS, selected or all elements will be archived. Therefore, the research team will not lose any ideas and documents that have been developed in the discussion network. On the other hand, this information is neither duplicated nor gathered by the group members individually. The information is available at any time for any authorized members. It is possible to create copies of data stored in the VRAS. The efficient management of such organized data is another difficult aspect of the subsystem.

There will be another important tool available in the VRAS – it will be a specific management system adapted for the researchers' needs. It will be dedicated mainly to the project manager, but also for those team members who are responsible for the elaboration of the necessary documentation, reports and description of the project. The tool will be equipped with a set of the standard electronic documents that will, in the maximum way, simplify scheduling tasks, documenting research, development and settlement of the vari-

ous stages of research. It will monitor the activity of individual team members and evaluate their performance. The mechanisms to motivate and stimulate activity and performance will also be implemented.

The tools for automatically generated electronic newsletters published the results of the research on the Internet will be also available in the VRAS. The newsletters will be edited by the users or the research teams. The users will also be equipped with applications to organize online the scientific conferences and seminars.

The authors will design a specialized meta-search engine as a part of the VRAS. This engine will be equipped with its own database of indexes, which will be updated by the network robots that will automatically search for scientific information. The database will also be updated by the resources that will be available through studies and data collection within the system. The data will come from the data stored in the system by all teams using e-science platform, for example.

Taking into consideration the particular importance of the scientific and technical information for the research, usability analysis such as: the intelligent search, the validation of the accuracy and reliability of information or technology of semantic networks, will be taken to design of new information management methods. The new solutions in the area of the research project management will be validated. We will assess the effectiveness of the applied methods and tools, and the long-term effects of their use. On this basis, it will be possible to redesign the components of e-Science Platform.

Based on the gathered research results and taking into consideration the basis of implemented methods and tools, the structural model of e-Science Platform and the implementation design will be proposed. The model takes into account the necessary structural data models, the models of processes, data flows and state transitions [10], [11]. Functional and non-functional requirements will be defined. The results of the study on the worked out model will be used into an implementation design.

It is expected that the developed system will be constructed as a modular structure. This will include the components related to data management, users management and include users and system administrators interfaces. An optimization of the project in the area of correctness, consistency and compactness will be carried out.

Basing on the carried out research, the prototype of a core e-Science Platform will be accomplished. It will contain the main modules of the ESP with its functionality, i.e.: the VRAS and this part of the RIS which realizes an initiation of research and is used for completing the research teams. These elements of the ESP are its core. The prototype will be tested against integration of all subsystems and the communication layer. The test results will be basic for the modules of the ESP integration and for the communication tools (an information system infrastructure) modernization.

On the other hand, this early stage of studies will offer initial information for future platform users and help determine the circle of potential customers entering the service. Simultaneously, the physical infrastructure for the implementation of the Platform such as network client applications, supporting designed organizational services will be tested. At the same time, administration departments will be trained and the appropriate procedures will be designed.

4 Design and Analysis of Implementation Conditions

Implementing such a complex and pioneering system as the ESP requires the adoption of certain assumptions on the model of the project life cycle and the related software. The combination of prototyping and incremental models were adopted to the whole project. Prototyping minimizes risks arising from the adoption of wrong assumptions. This includes the initial difficulties of determining the needs of potential users of the system. Since ESP is a universal system, intended for research groups of different areas and disciplines of science, (engineering through the natural, medical, social science, to the humanities), it is difficult to determine in advance the full list of requirements to be met, and what factors will determine its attractiveness and usefulness. Hence the planned activities have been related to the implementation of appropriate initial studies on the implementation of the prototype, including the main and the most difficult elements of the system (the method of incomplete implementation). In contrast, incremental model can be easily combined with an incomplete implementation method in the prototyping model, while ensuring rapid progress [11].

We anticipate analyzing the system using structural methods. In the initial phase, new models will be created: a model describing the static part of the system and functional one covering the dynamic part of the system. Then, both models will be integrated into the dataflow model. Entities diagrams, transitions diagrams, and data flow diagrams will be used for this stage of design. It should be noted that above findings are related to specific, formal actions that will be made during the process of analysis and will not affect the initial concept. These initial concepts will be used to draw up the architecture of the system, the structure and general functionality of individual modules and the communication frame together with the communication interfaces. At the initial stage organizational, staff structure, services of the system and project procedures are also pre-determined.

In the design phase, detailed diagram of the implementation of the system will be proposed. The diagram will cover not only the created software but also the organization of work of the teams routinely operating within the system and using its applications for planned service activities.

The components which will be responsible for collaboration between users will be designed. The security policies (principles of administering the system, granting of privileges) will be implemented. Special attention must be paid to the safety of the stored and transmitted data. Due to the confidentiality of the results of the research conducted by the research teams the e-Science Platform will meet increased requirements for authentication and authorization of the users being given an access to the isolated areas (Virtual Research Areas). It is expected that in the isolated areas of the work VRAs, the access to the resources will be only granted to the members of the research teams and the main administrator of the system. The members are expected to set up the security policies autonomously. The system administrator defines the access rules to the shares located in the Platform.

In this design phase, obtained experiences will be used. Physical structure of the system and the properties of VRAs will be redefined in detail. The process will concentrate on assuring the consistency and relationship between the elements of the system.

Due to the nature of research projects, key features the designers will focus on:

- high reliability of the whole system, ensuring minimal loss of the data in the event of failure,
- high system performance in the server layer, core network and data storage components to guarantee the ability of accomplishment of the projects that require high performance computing,
- high availability which allows supporting many research projects at the same time,
- high scalability of the server farm and the core network, giving the opportunity to allocate the resources according to the needs of individual projects,
- the ability to manage the project team access to servers (the logical separation of networks),
- providing a quality of services, particularly important in the case of overloading the network or other system components.

To ensure the network core work properly specialized technical equipment is needed. This equipment will cover such features as: the possibility of network virtualization, scalability and reliability. Due to the extremely large number of expected data to be processed and stored, it was decided to propose dedicated equipment and software to store and process the data in safe and efficient environment.

Complex server structure has been designed for network services, applications and designing purposes. Blade server seems to be the preferred solution because of its compact architecture, management software and offered features. Blade servers, storage and backup systems designed in DAS and/or

NAS architecture will ensure adaptability and scalability. Novell management and monitoring system has been designed as an important element of the network structure. In terms of network reliability, it is necessary to continuously analyze the state of individual devices and the connections between them. Managing the network and network operating systems also requires reporting on the configuration, status, performance parameters, etc. It is also important to acquire such data quickly and easily.

The designed network system allows controlling storage, security and distribution of researchers, documents and data. Since the data is stored centrally, the software installed on the servers should contain consistent mechanisms to enable navigation and search for specific information. In addition, these resources must be indexed on the basis of the content and keywords. The servers should enable the research group to share the selected data. The projected features of the Platform must be integrated with the directory service and email service.

The planned streaming server and installed applications will allow transmission of streams of multimedia, and archiving the transmitted data in real time. The server will allow transmitting sound and video in high resolution and quality. This server also allows setting up the video and audio debates on research, presentation of research and experiments results. The system will support H.264 and HE-AAC standards and would be able to transmit the streams of audio and video date to the mobile devices (the mobile phones and PDA). This ability assures continuous access to the audio and video date stored into the Platform databases.

The Platform will be equipped with Database servers that will use the standard query language SQL, with built-in language to create procedures for internal components. The system must be designed to separate physical and logical structure, and hence high scalability and stability that are required to build various applications for the project. The server should provide the opportunity to object-oriented programming. It must also support the language of PL-SQL and include tools for data mining and Business Intelligence [1].

Within the blade servers, we intend to place ESP applications. There will also be projected the management systems, systems for organizing and managing information. The systems will use internal ontology and new methods of internal search. One can find here:

- an electronic board,
- an internal system of file sharing and file exchange,
- a management library system for teams' documents,
- the e-conference tools,
- the e-newsletter tools,
- manageable, templates of documents database,
- the VRAS security management tools,

- a scientific meta-search engine,
- a system of the Internet search.

The VRA will be located in virtualized environments whose resources will be given to designers and users of the ESP. In the case when greater computing power must be given, the system will provide tools assigning physical resources to a particular service, applications and users. Virtualization will save and economize the available equipment resources. It will provide a high level of security. The physical layer is designed in such a manner to be able to restore any component of the system as soon as possible in case of failure.

During the first stage of implementation, we will design and create the most important components of ESP, i.e. the basic modules of the RIS and VRAS. We will also launch internal research focused to the Virtual Research Areas VRAs. At this stage of implementation, the prototype will be ready for use and tests. The reliability of the software will be tested during the pilot studies. The method of implementation is the direct result of the adoption of combining the two models mentioned above. Such strategy of the project has been recognized as the safest in terms of implementation of the functionalities of the project. It also allows an effective optimization of implemented procedures.

For the implementation stage, we chose some parts of its architecture of which two are the most compact and, at the same time, the most complex. Although functionally the VRAS consists of two main subsystems: instant messaging and the shared project areas (the others are independent and are separate modules), it seems impossible to make good use of modular structure techniques mainly due to complex internal interactions and highly complicated flow of data. This is because such a modular structure would not be optimal, both in terms of an implementation, as well as from the point of view of a system performance. Also the subsystem RIS, although modular, has a complex architecture. For these reasons, it is necessary to create the appropriate prototypes that will be comprehensively tested before the final implementation of other modules.

It should be noted that ESP cannot be set up as a routine implementation and cannot be delivered as boxed, ready to use software system. This is due to the wide range of customized and novel features which are made available in the ESP.

The universal nature of the ESP resulting from the adaptations to the needs of many academic disciplines and for a vast range of research tasks makes this project specially difficult. It is impossible to predict in advance what will be the future needs of the research teams**,** and therefore, must be implemented into the ESP. Hence, ESP must be a tool so flexible that it can be adapted to lots of requirements. This also means: open in the terms of an architecture,

editable, a hardware independent platforms, independent on user's operating system.

In order to ensure conditions stated above, it was decided that the main applications will be implemented in Java and Oracle (version at least 10g) environments. They guarantee the independence of application from hardware [3], [12], [19]. The proposed solution is based on the Java Enterprise and should function correctly in any hardware platform, operating system or application server [5], [18]. The Oracle Database is used in those areas, where the aspects of the data security, the system stability and speed are key points [13]. NetBeans, Subersions will be used as a version control and library servers.

The next phase of the project will concentrate on the implementation of the remaining elements of the system. Additional VRAS tools such as Internal Information Management Systems (IIMS) – based on XML technologies and specific methods of indexing will be created. In the future, Resource Description Framework (RDF) with its own internal ontology technology will be added. At this stage, we will also create tools for e-conferences, e-newsletter, etc. Simultaneously, external modules collaborating with the VRAS will be provided. This includes the Internet and an intranet database and a metasearch engine, primarily for scientific purposes, combined with its own indexing system.

After this stage, the final integration of all elements of the VRAS will be done. The proper security schemes, management, administration of the system will be fine tuned. In the very final stage of the project tests of the whole system will be conducted, the initial documentation will be written and the application will be made available for the pilot, external studies and necessary tests. Test will also concentrate on the ESP users and their overall level of satisfaction.

The results of these tests will allow to prepare a detailed assessment report. The results will help to determine the suitability of the ESP to support research. Tests will provide the answer to the question which of the functions of the ESP are particularly relevant to the individual areas of research teams. This information will be useful in the development of the ESP tools, methods, procedures, which will make the system more accurate for different groups of scientists.

In parallel with the tests, we will carry out intensive promotional campaign introducing this novel ESP platform. We will focus on its capabilities in supporting of research and in helping to find the funds for research. The methods of collaboration with other research centers and research teams will be shown. One of the most necessary conditions for the success of the Platform is to reach a great number of people involved in science, managers of science and research institutions. They should be familiarize with the ideas of the ESP. The public tests made available to scientists will be an important feature of this part of the implementation. For large applications, which the ESP is, the

massive participation of users in the testing is extremely important. Firstly, it offers the opportunity to increase the number of tests carried out, and secondly makes the tests independent of authors and developers' certain subjective ways of assessing the software. Testing software in β-version – pilot tests are especially important in the situation where the dual mode of design (prototyping and incremental) has been used during the creation of applications [14], [15]. A survey questionnaire will be used. In the first stage of the implementation, the questionnaires will allow to obtain information necessary for further development and configuration of the ESP. In order to carry out these surveys, a part of the system will be made available (the ESP web site) for free, for general use. A user will have to register in the system and answer research survey questions to be granted the access. Two questionnaires are planned – one, at the moment of registering a new user and the other after a certain period of time. The purpose of the first survey is to obtain the initial information about the preferences of the scientific community, which the respondent belongs to, as well as his own needs. This part of the survey will help understanding the needs of representatives of science disciplines. It will also allow overcoming barriers in cooperation between the research centers and, finally, will determine the research-related financing needs. Also, the survey will be important to determine the research disciplines which are preferred areas in the research programs (e.g. EU), in which research topics are considered to be a priority. It is vitally important to determine the degree of distribution of the researchers within the discipline, and the tendency of methods and tools usages within the different disciplines.

The second survey is provided to find the answers to the questions about the usage of the Platform. An assessment of its functionality, the shortcomings, faults, errors and expectations from users will be tested. This will help introducing, in the next stage of implementation, expected new features, adaptations and changes according to the needs of users. In particular, it is expected to find the answer to the following questions: what additional functionalities should be implemented into the VRAS, what tools should it be equipped with. The questions should be asked to examine the point of view of representatives of various research disciplines. While using the system, designers will also achieve additional goals, important for the implementation of the Platform.

Because some features of the ESP system will be managed by branches of organizational personnel, the interfaces and modules will be prepared and presented to them. This applies to: the Research Projects Department, the Department of Administration and the Department of Promotion and Marketing. These departments are necessary to support and assist the research teams in legal, formal, funds issues, etc. This will generally be provided as the remote, on-line aid using the designed, specific to individual departments, tools.

For those purposes, web portals, integrated with the ESP applications will be offered.

In the final phase of the project, again, one will redefine and test implementation of security issues for each of the modules. This will allow redefining permissions and access levels for different users of the ESP. Then, the user interface that ensures the integration of applications across the VRAS with the RIS and the administrative modules will be finished. An internal consistency and the further security issues will be tested.

During the closing stage of the project, we will create the final system documentation, including user manual in electronic and printed form, and a manual for the system administrators. The detailed procedures will be developed for the personnel of the ESP to support the work of scientific research teams.

After finishing the implementation of the ESP there will be a period of 5 years since the date when the system is made available to the users, when any software errors will be removed and new functions will be implemented.

5 Conclusions

E-Science Platform project is a complex organizational and technical task, requiring the creation of a specific administrative structure necessary to support the research teams, to build an advanced computing infrastructure with several integrated applications. The implemented functionalities of the system will correlate its elements and threads, which will lead to achievement of synergy, and therefore will improve a management of research carried out by the scientific teams.

In the process of designing of the described system, one should carefully consider the environment in which the system will operate. This environment consists of many different elements. The environmental conditions are the most important. They are related and specific to the diverse academic and scientific research institutions and the researchers community. Another important factor that must be taken into consideration is the fact that methodology and approach used for the scientific research are different to the ones used in ordinary projects. This includes such elements as a group work, distribution of members of the research groups. These elements cause the particular difficulties not only within the field of the management of the research teams, but affect the whole scientific projects. All these factors must be taken into account when designing such a complicated system.

Since the ESP must use all the resources effectively and efficaciously, the detailed analysis of the functioning of the system must be carried out. One should not only examine the role and the potential functions of individual elements of the system but also examine the structural aspect and the links between diverse elements. This leads to the conclusion that such complex

tasks must be accomplished by the team which, on one hand has been experienced in modeling and designing the management systems and on the other hand, the one having had an experience of the research projects. That is why, within the cycle of the project, the ESP user will also be an analyst.

The following phases of the ESP project: modeling and design are the most important elements of the entire life cycle of the system. These stages will determine the shape of the system, its functionality and efficiency. Errors committed in this phase may completely disqualify the use of the system after, and what even worse, discourage the potential ESP users.

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